

SEPTEMBER 11, 2020  
PROJECT NO. - 2019-083

441 HURONIA ROAD  
FUNCTIONAL SERVICING & STORMWATER  
MANAGEMENT REPORT

CITY OF BARRIE



355310 BLUE MOUNTAINS-EUPHRASIA TOWNLINE  
CLARKSBURG, ON N0H 1J0

## Table of Contents

|                                                       |    |
|-------------------------------------------------------|----|
| Introduction .....                                    | 1  |
| Existing Site Conditions .....                        | 1  |
| Existing Sanitary Sewer .....                         | 1  |
| Existing Watermain .....                              | 2  |
| Geotechnical Information .....                        | 2  |
| Existing Stormwater Infrastructure & Background ..... | 2  |
| Existing Condition Stormwater Modelling .....         | 3  |
| Proposed Site Design .....                            | 9  |
| Sanitary Servicing .....                              | 9  |
| Water Servicing .....                                 | 9  |
| Utilities .....                                       | 10 |
| Stormwater Approval Criteria .....                    | 11 |
| Stormwater Modelling - Proposed Development .....     | 11 |
| Stormwater Quality Controls .....                     | 15 |
| Water Balance and On-Site Infiltration Targets .....  | 15 |
| Erosion and Sediment Controls .....                   | 17 |
| Conclusions .....                                     | 18 |

### Drawings

- Drawing Set Cover Sheet
- C1 – Existing Conditions Plan
- C2 – Grading Plan
- C3 – Servicing Plan
- C4 – Post Development Catchment Plan
- C5 – Erosion & Sediment Control Plan
- C6-C10 – Standard Details



## **Appendices**

Appendix A – Legal & Site Plan

Appendix B – Background Information

Appendix C – Geotechnical Reports

Appendix D – Pre-Development Stormwater Information

Appendix E – Post-Development Stormwater Information

Appendix F – OGS Information

Appendix G – LSRCA TTT Results - Phosphorous Budget

Appendix H – Water Balance Details

Appendix I – Water Demand

## Introduction

CAPES Engineering Ltd. has been retained by Dr. Behrooz Azizi to prepare a functional servicing and stormwater management report in support of a Site Plan Agreement for the 0.51 ha site located at 441 Huronia Road in the City of Barrie.

It is proposed to construct a 900.48 sq. m commercial medical building containing with a total of 68 parking spaces (including 4 barrier free and 1 compact car space). The site will have a single (two) way access point to Huronia Road (See Site Plan in **Appendix A**) and will be Municipally serviced with water and sewer connections.

We believe that the proposed site plan will not require Ministry of the Environment Climate and Parks (MECP) approval as it is to be developed as private site plan with a Commercial use. Approvals are required from the City of Barrie as well as the Lake Simcoe Region Conservation Authority (LSRCA). A permit from the LSRCA will not be required as the site is outside of their regulated area.

The following report is intended to discuss the servicing requirements for the site and to demonstrate the viability of the project in support of the Site Plan Application.

## Existing Site Conditions

The existing 0.51 ha site is located at 441 Huronia Road in the City of Barrie and is legally described as Part 3 of the West Half of Lot 11 Concession 12 (Geographic Township of Innisfil now in the City of Barrie), Plan 51R-17293 Please refer to **Appendix A** for the legal plan prepared by Rodney C. Raikes Surveying Ltd. in June 1988.

The site is bound by 431 Huronia Road to the north, Huronia Rd. to the west, and the BCRY Rail Line to the east and south. There are some small trees along the eastern property line adjacent to the BCRY rail corridor, otherwise the site is vacant and covered by grasses.

The majority of the site generally slopes west and south at an average of 1.7% from the high point near the north-west corner of the site (elevation 262.69) to the low point near the southern property line (elevation 260.77). There is an exiting entrance driveway to the site from Huronia Road across from the Ellis Drive intersection.

Huronia Road has an asphalt surface with open ditches and is slated to be expanded in the future, however there is currently no timeline for the widening to occur. The flow from the eastern ditch of Huronia Road flows south along the site frontage. Flow going south in the eastern ditch reaches the BCRY rail corridor and flows along the north-west side of the train tracks to Big Bay Point Drive. The existing conditions stormwater flows and system capacity are discussed further below.

According to the County of Simcoe mapping the site also sites within a Wellhead Protection Zone (Q1 and Q2) and is completely within a Highly Vulnerable Aquifer.

## Existing Sanitary Sewer

There is an existing 825 mm dia. concrete sanitary sewer on Huronia Road (See **Appendix B**) but we do not believe there is a sanitary service lateral from the sewer into the development site. We believe from the as-constructed details provided by the City that this sanitary line was installed in 1985.

### Existing Watermain

A 300 mm dia. watermain was installed on the west side of Huronia Road in 1985, however we believe that no water service connection was provided to the development site.

There are fire hydrants on the west side of Huronia Road, including one directly west of the property line at the NW corner of the intersection of Ellis and Huronia. Please refer to **Appendix B** for the relevant as-constructed drawings for the site.

### Geotechnical Information

A preliminary geotechnical investigation was completed on the site by Central Earth Engineering (CEE) in Jan. 2020. CEE completed 4 boreholes on the site and determined that fill was present in depths between 1.5 m to 2.3 m thick. Underlying the fill was a fairly consistent layer of clayey silt (glacial till) to a depth of approximately 9.6 m. In one of the boreholes (2) there was a clayey silt glacial till between the fill and the silty sand layer.

The estimated saturated hydraulic conductivity (Ksat) of the dominant silty sand layer, as determined through rising head data using Hvorslev's solution, was 0.32 mm/hr which translates into an infiltration rate of approximately 30 mm/hr. The clayey silt till layer has a lower infiltration rate of 12 mm/hr.

The recommended Ksat for the site for design purposes from this report was 3.6 mm/hr or an infiltration rate of 50 mm/hr.

The geotechnical information for the site has been included in **Appendix C** of this report.

A follow up study was completed in August 2020 including in-situ testing which demonstrated a subsurface Ksat of between 5.7 mm/hr and 12.3 mm/hr. The updated Geotech report has also been included in **Appendix C**.

Groundwater was originally measured in 3 out of the 4 boreholes at depths between 8.2 and 5.3 m below grade and was expected to be at or below an elevation 250.6.

No readings were recorded on the site through the Spring of 2020. In consultation with the LSRCA and with permission from the Owner of 131 Ellis Drive which is across the street from the site, the measured maximum groundwater fluctuation through the Spring of 2020 is to be used on 441 Huronia. We have appended the information from Terraprobe Ltd. In Appendix C of the report which indicates as maximum groundwater fluctuation of 2.5 m. Applying this to the groundwater levels on 441 Huronia results in a maximum groundwater level of 259.24.

### Existing Stormwater Infrastructure & Background

There are no formal stormwater management controls on the existing site however flow from the site is captured by the Municipal ditch system on Huronia Road and within the BCRY rail corridor.

We understand that the site was erroneously included in the overall drainage catchment for the Lover's Creek Estates Phase 2 development to the south of the site in 1997. The as-built drawings show the drainage flowing south past the BCRY tracks, however there is no culvert under the BCRY tracks to convey the flow.

The topographic survey shows that flow travels south in the Huronia Road ditch to the BCRY tracks and then flows back north-east to Big Bay Point Road on the west of the rail line. The Huronia Road ditch slopes at an average of 1.4% while the rail line ditch slopes at an average of 0.76% between the south and north-east corners of the site. We currently do not have topographic information in the rail corridor for the approximately 300 m between the north edge of the development site and Big Bay Point Road, but the average slope between the two points is 1.0%

According to the as-constructed drawings for the Big Bay Point Road Reconstruction project (1998) the flow is directed to a ditch inlet catchbasin connected to an 856 mm x 1344 mm elliptical concrete pipe at 0.39% slope. The elliptical pipe slopes east under the BCRY tracks and then heads north through a 1200 mm dia. concrete pipe at 0.8%. The storm sewer then discharges to a pipe in an easement on the west side of the Willow Landing Elementary School at 330 Big Bay Point Road. We currently do not have any additional information for the storm system beyond this point, but we assume that the flow is discharged to a small watercourse of the Barrie Creeks system. Please refer to **Appendix B** of this report for background information of the storm conveyance system.

As part of this design submission the City has requested that we analyse the capacity of the existing stormwater conveyance system between the site and the discharge point at the easement beside the elementary school.

We have been provided with a storm drainage plan from the 1998 Big Bay Point Road Reconstruction project and we believe the storm flows were generated using the Rational Method. As per discussions with the City of Barrie we have opted to remodel this system with PCSWMM rather than the Rational Method to be consistent with the calculated peak flows generated by the development and site and to allow for ease of calculation in the absence of all the supporting information for the pipe network and previous design.

As both Huronia Road and Big Bay Point Road are classified as Arterial roads we believe the design criteria for the flow route between the site and the outlet to the Easement beside the elementary school is as follows:

- Flow in the Huronia Ditch to be equal to the 100-year storm event with the depth of flow not to exceed the centerline of the road elevation on Huronia Road
- Flow in the BCRY ditch to be equal to the 100-year storm event with the depth of flow not to exceed the elevation of the trail tracks
- Flow in the storm sewer system on Big Bay Point Road equal to the 5 year storm event without surcharge
- Flow in the combined overland and pipe network on Big Bay Point Road equal to the 100-year storm event.

The results of the PCSWMM analysis for the existing system is discussed below.

### Existing Condition Stormwater Modelling

We have utilized PCSWMM 2019 modelling software (Version 7.2.2785, SWMM version 5.0.013-5.1.013) to undertake the analysis of the existing site conditions. We have tested the site for the 2-100 storm event for the 4-hour Chicago Storm and the 12 hr SCS Type II Storm as required by the LSRCA.

We have also analysed the 4 hr 25 mm Chicago storm (quality control storm) and the Regional (Timmins & Hazel) storms. Please refer to **Appendix D** for the pre-development catchment plan and modelling summary results for the existing condition 100-year design storm event (to reduce the volume of paper in the hard copy report we have only included the 100 year event but other events can be provided upon request in digital form).

We selected PCSWMM as it integrates more easily with the required LSRCA Treatment Train Tool (which is based on EPA SWMM), allows for integration of LID and infiltration within the model and SWMM based software is the most widely used stormwater modelling software in the industry.

The contributing drainage area for the site was determined using a combination of aerial imagery from Simcoe County Mapping (<https://maps.simcoe.ca/public/>), topographic survey of the site completed in 2019, a site visit completed in 2019, and as constructed information provided by the City of Barrie

The total on-site drainage area has been determined to be 0.51 ha in size and flows primarily by overland sheet flow to the south and west into the Huronia Road and BCRY ditch system. There is no external drainage area onto the site as flow from the north, east and south is interrupted by grading along the north edge of the site and the BCRY Rail tracks are lower than the site. The west edge of the site is bound by the Huronia Rd ROW and Municipal ditches which prevent flow from entering the site from that direction.

We have opted to model the existing site as a single catchment while external drainage areas required for the analysis of the existing flow route to Big Bay Point Road have been split into 6 catchments as follows:

Catchment S1 – 0.51 ha – 441 Huronia Development Site

Catchment S2 – 12.59 ha – Catchment area west of Huronia Road equivalent to Catchments 1, 1a, 2, 3, 4, and 6 from the City supplied Drawing 1998-015-002 for the Big Bay Point Road Reconstruction project. This catchment (along with all the other catchments from drawing 1998-015-002) was modelled previously with a 'C' value of 0.65. We have assigned a % imperviousness of 70% based on measuring the approximate area of pervious area from County Aerial mapping.

Catchment S3 – 0.19 ha – Represents the Huronia Rd. ROW which drains via ditch to the BCRY ditch at the south edge of the study area. This catchment was not previously included in the Big Bay Point Road analysis. The impervious level of this catchment has been set at 35%.

Catchment S4 – 0.17 ha – Represents the BCRY corridor adjacent to 441 Huronia Rd. which was previously not included in the Big Bay Point Road Reconstruction analysis. The runoff discharges to the BCRY ditch and flows north.

Catchment S5 – 1.95 ha – This catchment is the equivalent of Catchment 5 in the Big Bay Point Rd. Reconstruction drawing 1998-015-002 and at 85% impervious represents the rear yards of several commercial businesses and the BCRY Rail Corridor. Runoff discharges to the BCRY ditch and flows north to Big Bay Point Rd.

Catchment S6 – 5.80 ha – Represents the equivalent to Catchments 7, 8 and 11 from the Big Bay Point Road Reconstruction Drawing 1998-015-002. The impervious level has been set to 25% as the majority

of the catchment includes the park area east of the BCRY rail tracks. The runoff drains to the storm sewer system on Big Bay Point Road.

Catchment S7 – 0.40 ha – Represents the north half of the Big Bay Point Road drainage area equivalent to Catchment 9 on Drawing 1998-015-002. This catchment has been set at 85% impervious and drains to the storm sewer system on Big Bay Point Road.

Based on the 2020 Geotechnical Investigation completed by CEE the native soils for the site are a “silty sand” and using the USDA Natural Resources Conservation Service Soil Texture Calculator the dominant soil on site is classified as a “sandy clay loam”

[https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2\\_054167](https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167)

The silty sand or “sandy clay loam” has a recommended infiltration rate of 50 mm/hr a Saturated Hydraulic Conductivity of 3.2 mm/hr. The updated geotechnical information from Aug. 2020 indicates a subsurface Ksat for the site of between 5.7 and 12.3 mm/hr. We have maintained the original 3.2 mm/hr for surface infiltration on pervious areas as to be conservative.

We have selected the Green Ampt Method of infiltration for the site for a Sandy Clay Loam as per the geotechnical information provided. Green Ampt infiltration parameters for suction head and initial moisture deficit have been determined as per Rawls (1983).

$K_s = 3.2 \text{ mm/hr}$  (Sandy Clay Loam) – As per 2020 Geotechnical Report

Suction Head = 219.964 mm (Sandy Clay Loam as per Rawls 1983)

Initial Deficit (fraction) = 0.154 (Sandy Clay Loam as per Rawls 1983)

We have used the mapping available from the Ontario Geological Society (available as an add on to Google Earth) for the external drainage areas and determined that there are three dominant soils types: sandy silt to silty sand till, ice contact stratified deposits (sand, gravel, minor silt, clay & till) and fine textured glaciolacustrine deposits (silt and clay, minor sand and gravel). To be conservative we have assumed the same soil type with a Ksat of 3.2 mm/hr for the entire study area.

Rainfall data was obtained from the Barrie WPCC and adjusted for Climate Change as per the City standards. The 2-100 year 4-hour Chicago, 12 hr SCS Type II, 25 mm Chicago, Hurricane Hazel and Timmins Storm events were modelled for the site as per the LSRCA standards.

Barrie WPCC 2003 Rainfall Intensity (mm/hr) + 15 % to Account for Climate Change

| Return Period | Duration (min) |       |       |      |      |      |      |     |      |
|---------------|----------------|-------|-------|------|------|------|------|-----|------|
|               | 5              | 10    | 15    | 30   | 60   | 120  | 360  | 720 | 1440 |
| 2 years       | 115.5          | 81.5  | 67.4  | 43.1 | 25.3 | 15.5 | 7    | 3.9 | 2.3  |
| 5 years       | 150            | 107.9 | 89.9  | 56.2 | 32.8 | 21.9 | 9.9  | 5.4 | 3.2  |
| 10 years      | 173            | 125.5 | 104.9 | 65.1 | 37.6 | 26.1 | 11.8 | 6.3 | 3.8  |
| 25 years      | 201.8          | 147.4 | 123.7 | 76   | 43.8 | 31.4 | 14.3 | 7.6 | 4.5  |
| 50 years      | 223.3          | 163.9 | 137.7 | 84.3 | 48.4 | 35.4 | 16   | 8.5 | 5.1  |
| 100 years     | 244.7          | 180.1 | 151.6 | 92.3 | 53   | 39.3 | 17.7 | 9.4 | 5.5  |

Barrie WPCC 2003 Rainfall Depth (mm) + 15 % to Account for Climate Change

| Return Period | Duration (min) |      |      |      |      |      |       |       |       |
|---------------|----------------|------|------|------|------|------|-------|-------|-------|
|               | 5              | 10   | 15   | 30   | 60   | 120  | 360   | 720   | 1440  |
| 2 years       | 9.7            | 13.6 | 16.8 | 21.5 | 25.3 | 31.1 | 42.3  | 46.7  | 55    |
| 5 years       | 12.5           | 17.9 | 22.4 | 28.2 | 32.8 | 43.8 | 59.5  | 64.3  | 76    |
| 10 years      | 14.4           | 20.9 | 26.2 | 32.5 | 37.6 | 52.2 | 70.8  | 76    | 89.9  |
| 25 years      | 16.8           | 24.6 | 30.9 | 38.1 | 43.8 | 62.9 | 85.2  | 90.7  | 107.5 |
| 50 years      | 18.6           | 27.3 | 34.4 | 42.1 | 48.4 | 70.7 | 95.9  | 101.7 | 120.6 |
| 100 years     | 20.4           | 30   | 37.8 | 46.2 | 53   | 78.5 | 106.5 | 112.5 | 133.6 |

Additional PCSWMM model input parameters for the Manning's roughness coefficient ( $n$ ) and depression storage were determined from the US EPA TR-55 Report (1986) (Table 3.8 in the City SWM Standards) and from UNESCO Manual on Urban Drainage (1987).

Table 3.8: Manning's Roughness Coefficients - for Overland Flow

| Cover                      | Manning's "n" |
|----------------------------|---------------|
| Impervious Areas           | 0.013         |
| Woods                      |               |
| ---- with light underbrush | 0.400         |
| ---- with dense underbrush | 0.800         |
| Lawn                       |               |
| ---- short grass           | 0.150         |
| ---- dense grass           | 0.240         |
| Agriculture                | 0.050-0.170   |

Adapted from Soil Conservation Service, Urban Hydrology for Small Watersheds,  
U.S. Dept. of Agriculture, Soil Conservation Service, Engineering Division, Technical Release 55, June 1986

## 10.2 Initial Abstraction/Depression Storage

**Table 10.2:** Initial abstraction/depression storage

| Cover            | Depth (mm) |
|------------------|------------|
| Woods            | 10         |
| Pasture/Meadow   | 8          |
| Cultivated       | 7          |
| Lawns            | 5          |
| Wetland          | 12/16      |
| Impervious areas | 2          |

**Ref:** UNESCO, Manual on Drainage in Urbanized Areas, 1987.

The pre-development site is largely fallow meadow with some thin tree cover on the east side of the site and as such we have calculated an overall Manning's value of 0.15 and depression storage value of 5 mm for the site. We have used these values for the pervious external drainage areas, again to be conservative. Impervious areas have been assigned a an 'n' value of 0.013 and a depression storage value of 2 mm.

Inverts for the overland and storm sewer system were obtained either through As-Constructed Drawings (1998-015-004) or from topographic survey from 2019.

Please refer to **Table 1** below for a summary of the pre-development peak runoff.



**Table 1 – Pre-Development Modelling Results**

| Storm Event       | Total Peak Flow Offsite SW (m <sup>3</sup> /s) | Total Volume Offsite SW (m <sup>3</sup> ) |
|-------------------|------------------------------------------------|-------------------------------------------|
| 12 Hr SCS Type II |                                                |                                           |
| 2-year            | 0.02                                           | 80                                        |
| 5-year            | 0.05                                           | 150                                       |
| 10-year           | 0.06                                           | 190                                       |
| 25-year           | 0.09                                           | 260                                       |
| 50-year           | 0.11                                           | 310                                       |
| 100-year          | 0.13                                           | 350                                       |
|                   |                                                |                                           |
| 4 Hr Chicago      |                                                |                                           |
| 2-year            | 0.00                                           | 0                                         |
| 5-year            | 0.00                                           | 0                                         |
| 10-year           | 0.01                                           | 10                                        |
| 25-year           | 0.01                                           | 20                                        |
| 50-year           | 0.01                                           | 30                                        |
| 100-year          | 0.02                                           | 40                                        |
|                   |                                                |                                           |
| 25 mm             | 0.00                                           | 0                                         |
| Hazel             | 0.06                                           | 660                                       |
| Timmins           | 0.05                                           | 530                                       |
|                   |                                                |                                           |

The 100-year 12 hr SCS Type II Storm produces the highest peak flow from the site while the Hurricane Hazel event produces the highest volume. Please refer to **Appendix D** for a summary of the results for the 100-year SCS storm. Additional storm results or the full digital model can be provided upon request.

We have also included the 5 year and 100 year Hydraulic Gradeline (HGL) Analysis from PCSWMM for both the storm sewer and the overland route (respectively) to demonstrate the capacity of the system. The 100 year storm event produces more flow than the Regional storm and has been used to demonstrate safe conveyance. We have set the boundary condition for the storm sewer discharge to the drainage easement to “Normal” to simulate a backwater condition rather than a free discharge as it is currently unknown what the downstream condition is for the system.

Under the 5 year (SCS) storm there is no surcharge in the storm sewer system on Big Bay Point Drive as per the City standards.

In the 100 year (SCS) storm event there is capacity in the Huronia Road and BCRY ditch system to convey the flow. When the flow reaches Big Bay Point Road the pipe system cannot convey all of the flow and as such water will flow over the road surface to the north and enter the drainage easement. The elevation

of the flow reaches approximately 256.31 or 0.14 m over the centerline of the road which is within the allowable parameters set out by the City of Barrie Engineering Standards.

## Proposed Site Design

It is proposed to construct a new two-way, 9.0 m wide, asphalt entrance from Huronia Road at the west side of the site across from Ellis Drive. A new 902.9 m<sup>2</sup> light industrial commercial medical building will be constructed at the north end of the site.

A total of 68 parking spaces will be provided including 1 EV Charging spot and 4 Barrier Free spaces. Landscaped areas will be provided primarily on the east side of the site adjacent to the BCRY rail corridor as well as in the north-east and southern corners of the site.

An outdoor garbage enclosure will not be provided for the site as garbage will be stored inside the buildings and collection will be provided by private contractor.

Please refer to **Drawing C2 & C3** for the proposed site layout.

The site will be serviced by new Municipal water and sewer connections from Huronia Road.

A traffic study completed with site turning movements has been completed by JD Engineering and has been submitted under separate cover.

## Sanitary Servicing

The proposed building will have a 200 mm dia. sanitary sewer connection with a new sanitary manhole located between the building and the property line. The sanitary sewer will require a new connection point to the 825 mm dia. concrete sanitary sewer on Huronia Road and it is proposed to route the connection through the area where the road access point will be.

As per the City of Barrie Sanitary Design guidelines Commercial sewage flows may be related to the water usage which in this case has been determined to be 0.24 L/s which includes a peaking factor of 4 (see following section on Water Servicing).

The proposed sanitary sewer connection is a 200 mm dia. pipe at a minimum slope of 3.7%, which based on mannings equation provides a full flow capacity of 0.06 m<sup>3</sup>/s (60 L/s) and a maximum velocity of 2 m/s. There is more than sufficient capacity in the proposed pipe system and the proposed configuration meets the City of Barrie guidelines for velocity, pipe size and slope.

## Water Servicing

It is proposed to connect the building to the existing 300 mm dia. watermain on Huronia Road with both a 150 mm dia. pipe for fire protection and a 50 mm dia. line for domestic water use. As no water service connection was provided in 1985, this will require excavating Huronia Road to connect to the main. (See **Drawing C3**)

There is an existing fire hydrant at the NW corner of Ellis Drive and Huronia Road and the distance from this Fire Hydrant to the main entrance of the new building is 58 m.

As per City Guidelines a Siamese connection will be provided at the SW corner of the building as well as new hydrant located within an island in the parking area as the distance from the closest hydrant on Huronia Road is greater than 45 m from the Siamese connection.

The City of Barrie requires a minimum commercial fire flow of 136 L/s @ 138 kpa (20 psi) residual and a preferred flow rate of 152 L/s @ 138 kpa (20 psi)

A flow test was completed by Vipond in July 2020 for a Hydrant at the NW corner of the intersection of Ellis Drive and Huronia Road and has been included in **Appendix I**. The next hydrant north on the west side of Huronia Road was used as the static hydrant. The test hydrant (#1566) was found to have a static pressure of 68 psi and a minimum residual of 66 psi at a discharge rate of 1508 USGPM.

Using the following relationship from the City of Barrie Water Transmission Design Guidelines:

$$QA = QT \sqrt{\frac{ha}{ht}}$$

Where: QA = Flow at 20 P.S.I.

QT = Flow at Test

ha = Pressure Drop Available

ht = Pressure Drop at Test

$$QA = 1508 * ((68-20)/(68-66))^{(1/2)}$$

$$QA = 7388 \text{ GPM} =$$

The calculated flow at 20 psi residual is equal to 5116 USGPM or 466 L/s which is well in excess of the City of Barrie recommended for a Commercial site.

The domestic flow requirement for the site has been based on a total number of water fixture units for the building of less than 260 and the conversion of the fixture units to a water demand in L from OBC Table 7.4.10.5. The Total peak domestic demand is calculated at 0.24 L/s. We have also calculated the required Fire Flow for the building based on the Office of the Fire Marshal, OFM Guideline, Fire Protection Water Supply Guideline for Part 3 in the Ontario Building Code (Oct 1999). The total Fire Flow is calculated as 60 L/s which far less than the calculated supply flow rate.

Please refer to the calculations provided in **Appendix I** for the water demand.

## Utilities

Hydro is provided on Huronia Road from an overhead pole line on the east side of the road. A new electrical connection will be coordinated (by others) with Alectra Utilities (formerly Powerstream) and extended to the proposed building.

Telecommunications and natural gas connection (if required) is to be coordinated by others.

Street lighting will be provided by both on-building lighting and streetlighting on the site and will be dark sky compliant. Please refer to the Photometric plans and report prepared by GAC Engineering Services Engineering. The light pole locations have been added to the engineering drawing set.

### Stormwater Approval Criteria

The stormwater management for the development lot must conform to the current City of Barrie Engineering Standards (2020), Interim Low Impact Development (2019), the recommendations of the 2019 Drainage Master Plan, the Lake Simcoe Protection Plan (2009), the LSRCA Technical Guidelines for Stormwater Management Submissions (2016) as well as subsequent LSRCA policy with respect to Phosphorous Budget and Water Balance.

This site is considered to be a “Major Development” as defined by the Town, LSRCA and LSPP as the site creates more than 500 sq. m of new impervious building area and as such is subject to the approval requirements for that designation.

The following are the criteria the site must achieve:

- Post Development peak runoff must match pre-development peak runoff for the 2-100 year storm events.
- Safe Conveyance of the Regulatory (Timmins/Hazel/100 Year) storm
- Best efforts to Detain & Treat 25 mm of rainfall on site as per LSRCA requirements.
- Enhanced level of quality control as defined by the MOECC (80% TSS Removal).
- Incorporate Low Impact Development (LID) where possible
- Infiltration practices should be designed to fully drain the 25 mm, 4 hr storm event within 48 hours
- Infiltration infrastructure should be located 1.0 m above the seasonal high groundwater level
- Best efforts towards an overall site water balance as per the LSRCA Water Balance Offsetting Policy (Jan. 2019)
- Elimination of Phosphorous discharge (or pay to compensate) as per the Sept. 2017 LSRCA Offsetting Policy

In addition, the site will be for a proposed commercial use, sits within a Highly Vulnerable Aquifer and Wellhead Protection Area Q1 and Q2 and as such infiltration activities are only allowed for rooftop or pervious areas.

### Stormwater Modelling - Proposed Development

Stormwater quantity control for the site will be achieved by directing roof runoff to an infiltration storage tank located east of the building below the parking area. Flow from the remaining pervious areas of the site will be directed to a second subsurface tank near the south end of the site. Overflow from the infiltration tank will be directed to the southern storage tank via a 300 mm dia. pipe. The parking area flow will be directed through a Stormfilter Oil Grit Separator prior to discharge into the subsurface tank. Flow out of the subsurface tank to the ditch on Huronia Road will be controlled by using an orifice/weir combination set within a control manhole.

The subsurface infiltration system (both infiltration and storage) will consist of Atlantis Flo Tanks along the east side and south end of the site under the parking lot. The infiltration subsurface tank system will only collect and infiltrate runoff from the roof of the building as per the LSRCA policy on infiltration for commercial sites within an area mapped as a Highly Vulnerable Aquifer. Due to the low infiltration rates on the site the infiltration system will require a drain in order to ensure it will empty within 48 hours for a 25 mm storm. The 75 mm dia. drain will be connected to the internal storm sewer system. The infiltration system will be located a minimum of 1.0 m above the seasonal high groundwater as determined in the Central Earth Engineering geotechnical report and Terraprobe maximum GW fluctuation of 2.5 m. The maximum GW on the site has therefore been calculated at 259.24.

As per LSRCA policy we have assumed that no infiltration occurs in the subsurface tank during the design storms but have allowed infiltration during the 25 mm quality control storm and for the water balance calculations. The southern subsurface storage tank will have an impermeable liner to prevent infiltration of the incoming stormwater. Please refer to **Drawings C3 and C6** for details of this SWM tanks.

The proposed infiltration tank system will have a bottom elevation of 260.46, a bottom area of 195 sq. m and a depth of 0.44 m. The 75 mm dia. drain for tank system will be set at an elevation of 260.60. The facility has a total volume of 81.5 m<sup>3</sup> (95% void space) with 25.94 m<sup>3</sup> of storage below the orifice invert.

The proposed storage tank at the south end of the site will have a bottom elevation of 259.79, a bottom area of 368.85 sq. m and a depth of 0.44 m. The 75 mm dia. control orifice for this tank system will be set at an elevation of 259.75 with a 0.2 m wide trapezoidal weir set 0.2 m above that. The facility has a total volume of 154m<sup>3</sup> (95% void space).

Using the proposed site plan (**Appendix A**) we have measured the overall imperviousness of the site and found it increases from 0.0% (pre-development) to 78% (proposed condition). Approximately 22% of the site will be grassed and landscaped.

We have separated the post development model into five sub-catchments (as well as the additional 6 external areas used for the external storm system capacity analysis) to better model the proposed on-site controls. The total site area reduces in size from the pre-development due to the 4.0 m wide road widening along the Huronia Road frontage.

Area S1 represents the 0.09 ha roof area of the building (100% impervious). Runoff from the roof will be collected in a series of roof drains and piped east of the building to a subsurface infiltration trench located under the parking area. The infiltration system is to consist of a series of Atlantis Flo Tanks and will be 0.44 m deep and a total footprint area of 195 m<sup>2</sup>. It will be left open (95% void space) and provide a total storage volume of 81.5 m<sup>3</sup>.

Area S8 (0.277 ha) is the majority of the site and consists almost entirely of paved parking areas (98% impervious). Runoff from this area will flow overland to a Stormfilter oil, grit separator (OGS) in the SW part of the site. The OGS will in turn discharge treated water to the subsurface Atlantis Tank storage system. Pervious areas of this catchment have been modelled with a Mannings n of 0.15 and depression storage of 5 mm to reflect urban lawn.

Area S9 is a small (0.028 ha) landscaped area along the northern part of the site. This area can't be graded to send flow to the onsite SWM system and space is very limited to provide any kind of swale or conveyance system. This area is pervious and will be landscaped but does include a proposed walkway. We propose to utilize Ecoraster Bloxx for this walkway to minimize any potential runoff leaving the site. Details of the limited permeable paver system have been included in **Appendix E** and on **Drawing C10**. Pervious areas of this catchment have been modelled with a Mannings n of 0.40 and depression storage of 10 mm to reflect the additional landscaping (trees and shrubs) proposed.

Areas S10 (0.034 ha) and S11 (0.036 ha) represent the pervious areas along the west side of the site and the east side of the site respectively. These areas are 100% pervious and will be landscaped. It is not possible to route flow from either of these small areas to the SWM facility on-site and any flow will sheet flow to either the Huronia Rd. ditch or the BCRY ditch. The pervious areas of these catchments have been modelled with a Mannings n of 0.40 and depression storage of 10 mm to reflect the additional landscaping (trees and shrubs) proposed. Please refer to **Drawing C4** for the post development drainage plan.

The proposed OGS is to be a Contech SFPD Model 0816 which will provide 80% TSS removal for 90% of the annual flow (See **Appendix F**). The proposed unit is a cartridge filter unit which will provide phosphorous removal as well as TSS removal in excess of the LSRCA assumed 50% TSS removal as defined in the Treatment Train Tool. Please refer to **Appendix F** for the NJCAT certification which demonstrates the 80% TSS Removal efficiency.

The proposed storm sewer has been designed to convey the 100-year storm event with the overland flow route for excess flow on the surface of the asphalt. Please refer to **Appendix E** for the hydraulic grade line analysis for the 100-year event. Structures will have deepened sumps to help increase the quality control aspect of the manholes.

Please refer to **Table 2** for a summary of the Post Development Peak Flows, **Drawing C4** for the Post Development catchment plan, **Appendix F** for the 100-year 12 hr SCS Type II storm PCSWMM output and to **Appendix H** for the 25 mm 4 hr Chicago (quality control) storm PCSWMM output results which includes infiltration.

A separate model has been created which allows for infiltration from the roof of the building, however the results presented below in Table 2 do not account for any infiltration in the system

**Table 2 – Post Development Modelling Results**

| Storm Event        | Existing Peak Flow Offsite<br>(m <sup>3</sup> /s) | Peak Flow To Infiltration Tank<br>(m <sup>3</sup> /s) | Peak Flow To Storage Tank<br>(m <sup>3</sup> ) | Combined Peak Flow Bypassing Storage<br>(m <sup>3</sup> /s) | Total Peak Flow Offsite <sup>1</sup><br>(m <sup>3</sup> /s) |
|--------------------|---------------------------------------------------|-------------------------------------------------------|------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|
| 12 Hr SCS Type II  |                                                   |                                                       |                                                |                                                             |                                                             |
| 2-year             | 0.02                                              | 0.02                                                  | 0.06                                           | 0.00                                                        | 0.01                                                        |
| 5-year             | 0.05                                              | 0.03                                                  | 0.09                                           | 0.02                                                        | 0.04                                                        |
| 10-year            | 0.06                                              | 0.03                                                  | 0.09                                           | 0.03                                                        | 0.06                                                        |
| 25-year            | 0.09                                              | 0.04                                                  | 0.11                                           | 0.03                                                        | 0.07                                                        |
| 50-year            | 0.11                                              | 0.04                                                  | 0.13                                           | 0.04                                                        | 0.09                                                        |
| 100-year           | 0.13                                              | 0.05                                                  | 0.14                                           | 0.05                                                        | 0.10                                                        |
|                    |                                                   |                                                       |                                                |                                                             |                                                             |
| 4 Hr Chicago       |                                                   |                                                       |                                                |                                                             |                                                             |
| 2-year             | 0.00                                              | 0.02                                                  | 0.04                                           | 0.00                                                        | 0.00                                                        |
| 5-year             | 0.00                                              | 0.03                                                  | 0.06                                           | 0.00                                                        | 0.005                                                       |
| 10-year            | 0.01                                              | 0.03                                                  | 0.07                                           | 0.00                                                        | 0.01                                                        |
| 25-year            | 0.01                                              | 0.04                                                  | 0.09                                           | 0.00                                                        | 0.01                                                        |
| 50-year            | 0.01                                              | 0.04                                                  | 0.10                                           | 0.00                                                        | 0.01                                                        |
| 100-year           | 0.02                                              | 0.04                                                  | 0.12                                           | 0.00                                                        | 0.02                                                        |
|                    |                                                   |                                                       |                                                |                                                             |                                                             |
| 25 mm <sup>1</sup> | 0.00                                              | 0.02                                                  | 0.05                                           | 0.00                                                        | 0.003                                                       |
| Hazel              | 0.06                                              | 0.01                                                  | 0.04                                           | 0.00                                                        | 0.04                                                        |
| Timmins            | 0.05                                              | 0.01                                                  | 0.04                                           | 0.00                                                        | 0.04                                                        |
|                    |                                                   |                                                       |                                                |                                                             |                                                             |

1 – Assumes no infiltration from Roof

Please refer to **Appendix E** for the post development 100-year SCS storm results from PCSWMM. Additional results can be provided upon request if needed.

The proposed design reduces the peak flows from the site to below pre-development levels for all storm events including the Regional storms. There is a small amount of runoff from the pervious areas that bypass the SWM facility, but the maximum flow is 0.01 m<sup>3</sup>/s for Catchment S9, 0.02 m<sup>3</sup>/s for S11 and S10 (each) in the 100 year event which is very low.

Discharge from the site subsurface tank system to the Huronia Road ditch system is at a maximum of 0.05 m<sup>3</sup>/s and a maximum velocity of 1.05 m/s. We have specified rip-rap in the ditch to prevent scour and have provided rip-rap sizing calculations in **Appendix E**. The minimum d50 size is only 22 mm and we have specified 100 to 150 mm dia.

## Stormwater Quality Controls

The LSRCA quality control criteria requires the long-term removal of 80% total suspended solids (TSS). In addition, phosphorous discharge from the site must match pre-development level. In practice (as per the MOE SWM Drainage Guidelines) the TSS and P removal are calculated based on a 4 hr Chicago Distribution 25 mm storm event.

We have utilized the LSRCA LID Treatment Train Tool to model the TSS and Phosphorous removal for the site as required by the LSRCA.

Please refer to **Appendix G** for the LSRCA TTT report which indicates the pre-development discharge of TSS and TP from the site are both 0 kg (as there is no runoff from the site in the 4 hr 25 mm storm).

The LSRCA TTT indicates a TSS and TP removal of 75% and 60% (respectively) for subsurface infiltration facilities which this site uses only for the roof runoff. The proposed Stormfilter OGS which utilizes cartridge filters to remove additional TSS and Phosphorous has been assigned a TSS removal efficiency of 80% and a TP removal of 82%. The NJCAT and ETV testing which supports this result along with the Removal Efficiency analysis has been included in **Appendix G**.

Based on the design, we have provided an enhanced level of TSS removal at 80% and a 79.4% TP removal efficiency for the system.

The TTT calculates runoff from the site to three decimal places and indicates that after treatment including the Infiltration system and Stormfilter OGS that 0.003 kg of Phosphorous will still be generated.

The LSRCA P Offsetting Policy requires that any Phosphorous discharged from the site is subject to an offset cost to be calculated as follows:

$$\text{TP (0.003 kg/yr)} \times 2.5 \text{ (offset ratio)} \times \$35,000 = \$262.50$$

The total offset cost under the policy for the site is therefore equal to \$262.50, which is to be paid to the LSRCA by the Developer.

For comparison purposes and at the request of the LSRCA we have also provided the results of the TTT based on a continuous basis, however neither TP nor TSS removal rates are calculated based on this continuous rainfall information and it is included for information only.

## Water Balance and On-Site Infiltration Targets

The LSRCA requires that each development site provide a minimum of 25 mm of runoff from new impervious areas be retention/treated on-site. This is to be achieved through the detention of the first 25 mm of runoff from impervious surfaces, treatment for quality control and infiltration.

The site has a total of 0.364 ha of new impervious area and the 25 mm retention/treatment/infiltration target for the site is therefore as follows:

$$- \text{LSRCA} - 25 \text{ mm} \times 3,640 \text{ m}^2 = 91 \text{ m}^3$$

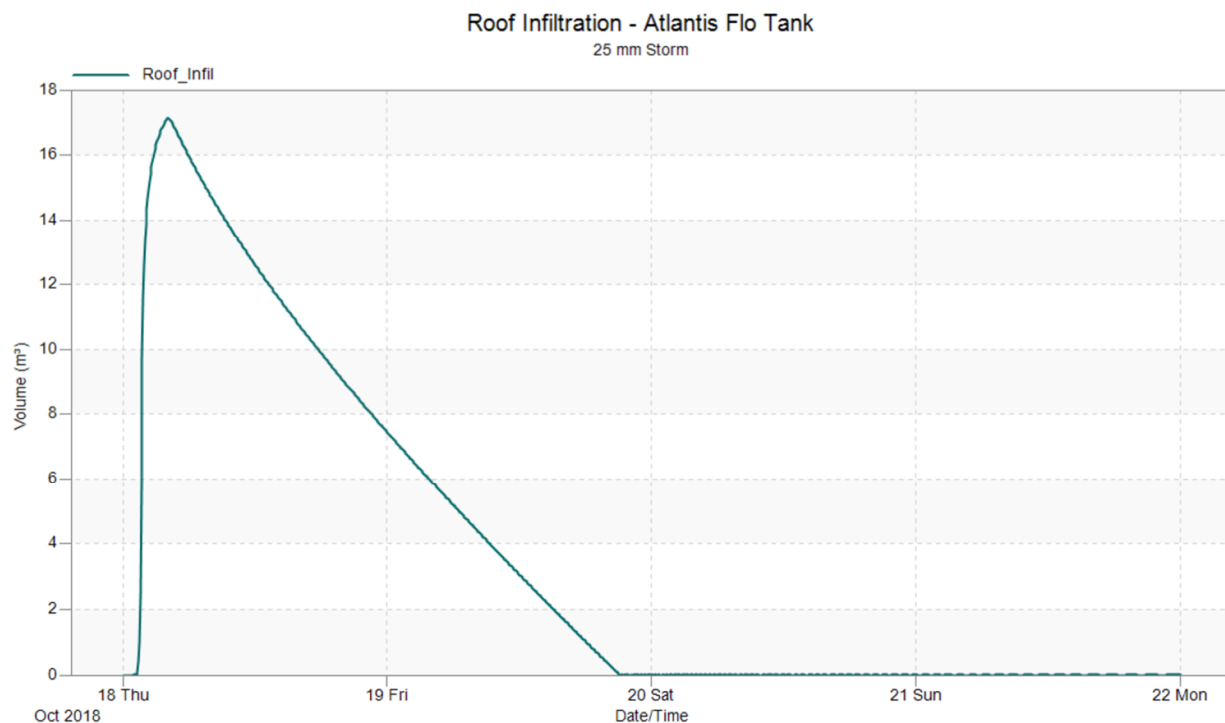
In addition, the LSRCA requires best efforts towards a water balance with any infiltration shortfall subject to the Jan. 1, 2019 LSRCA Water Balance Offsetting Policy.



The infiltration tank system provides 81.5 m<sup>3</sup> of storage volume/treatment while the Stormfilter and Storage tank system provides an additional 154 m<sup>3</sup> of volume/treatment. This equates to a total of 235.5 m<sup>3</sup> of storage volume provided for the treatment of the 25 mm storm.

The low infiltration rate on the site makes it difficult to design a system that can infiltrate the full 25 mm and fully drain within 48 hrs.

Please refer to the hydrograph below for the infiltration storage system which shows that it fully drains within a 48 hr period during the 25 mm storm event. The 25 mm storm event output (including infiltration) has also been included in **Appendix E**.



Central Earth Engineering (CEE) has prepared a preliminary water balance using the Thornthwaite Method which does not address the requirement for the 25 mm retention/infiltration target but deals with the overall site water balance.

The analysis indicates that the predevelopment infiltration volume of approximately 1,551.2 m<sup>3</sup>/year.

The post development condition analysis by CEE which was based on an 80% impervious level which is slightly higher than the current 78% impervious level. In this scenario the infiltration was determined to be 310 m<sup>3</sup>/year.

The water balance deficit (assuming no LID on the site) that must be designed for is therefore equal to 1,241 m<sup>3</sup>/year. Please refer to **Appendix C** for the preliminary water balance information from CEE.

It is proposed that this deficit would be reduced by the implementation of the subsurface infiltration tank connected to the rooftop. As the site is a commercial use within a highly vulnerable aquifer LSRCA

policy does not allow for infiltration from the other impervious areas from the site and the pervious areas on the site only represent 22% of the site and are narrow and distributed around the edges.

The LSRCA utilizes a spreadsheet-based method to determine the required size (bottom area) of the infiltration-based LID for a site to meet the water balance requirements. We have been provided a copy of the LSRCA calculation spreadsheet and have run it for the building roof area being directed to the infiltration trench.

Please refer to **Appendix H** for a copy of the LSRCA spreadsheet calculation results.

The 900 m<sup>2</sup> building alone would need to infiltrate 185% of the annual rainfall to meet the overall site water balance target, which is obviously not possible. We have used a 25 mm event depth to represent 95% of the rainfall events over the year to maximize the infiltration from the building roof. This equates to a rainfall volume of 22.5 m<sup>3</sup>, and a bottom surface area in the LID facility of 366 m<sup>2</sup>.

The proposed infiltration system connected to the building roof leader system by a dedicated pipe system is to be 0.44 m deep with a bottom area of 195.16 m<sup>2</sup> and a volume (assuming 95% void space as per the manufacturers recommendation) of 81.5 m<sup>3</sup>. The proposed volume of the facility therefore exceeds the LSRCA criteria, but the bottom area is only approximately 51% of the required.

The PCSWMM analysis for the 25 mm storm events demonstrates that 100% of the roof runoff directed to the infiltration tank is infiltrated (a small portion of the flow is held as depression storage on the room). A total of 21 m<sup>3</sup> of runoff is infiltrated from the roof and the facility fully drains within 48 hours.

As per the LSRCA 1<sup>st</sup> Submission comments we have revised the total water balance offsetting calculations as requested:

Water Balance Deficit (1241 m<sup>3</sup>/yr) – volume available for infiltration (713 m<sup>3</sup>/yr) = 528 m<sup>3</sup>/yr

The LSRCA Water Balance Offsetting Policy requires that the water balance deficit from the site is subject to an offset cost. The storage volume based on Table 4 (LSRCA Recharge Compensation Fee Schedule) for this site is equal to 54 m<sup>3</sup>. We have used the lowest storage volume level required from Table 4 for the calculation.

**Water Balance Deficit (528 m<sup>3</sup>/yr) = Storage Volume Required 23.23 m<sup>3</sup>**

**23.23 m<sup>3</sup> x \$1,200 = \$27,878.40**

The total water balance offset cost under the policy for the site is therefore equal to \$27,878.40, which is to be paid to the LSRCA by the Developer.

## Erosion and Sediment Controls

We recommend that heavy duty silt fence as per OPSD 219.130 be installed along the perimeter of the site and temporarily into the ROW for the connection to the ditch for to prevent sediment transport during construction. These controls should remain in place and be maintained until the vegetation is re-established on the site.

In addition, a construction mud-mat to minimize sediment transport from truck movements during construction should be installed which has been shown on the ESC **Drawing C5**

## Conclusions

It is proposed to develop the 0.51 ha site at 441 Huronia Road in the City of Barrie to provide a 900 sq. m (footprint) commercial medical building complete with asphalt access laneway and parking.

The site will be serviced with a Municipal watermain connection for potable water and fire protection which will require a new connection to the main on Huronia Road. Fire fighting capabilities are also available via existing fire hydrants on the north side of Ellis Drive and a new hydrant and Siamese connection on the site. Sewage will be discharged to the existing sanitary sewer on Huronia Road via a new 150 mm dia. connection.

Stormwater management will be implemented in the form of two subsurface storage tanks, and a Stormfilter quality control device.

Quantity control will be provided by an outlet structure on the downstream side of the subsurface infiltration tanks and will reduce the post development peak flow to below pre-development levels for all storm events.

Runoff from the rooftop is considered clean and will be infiltrated into one of the subsurface infiltration tank systems on the east side of the site. Any overflow from this system will be directed to the second storm tank.

The on-site controls do not provide a full water balance or fully meet the required TP removal targets and it is proposed that compensation as per the LSRCA Offsetting Policies will be provided. The remaining TSS removal target and 25 mm retention and treatment target from the LSRCA have been met.

Approvals will be required from the City of Barrie, LSRCA and this report is intended to provide support for the proposed Site Plan Agreement and demonstrate that the site is feasible from an engineering point of view. We believe that this report demonstrates the site can be constructed to meet all of the City and LSRCA guidelines and criteria.

Report Prepared By:

Clayton Capes, MSc. P.Eng.

CAPES Engineering Ltd.



## Drawings

Drawing Set Cover Sheet

C1 – Existing Conditions Plan

C2 – Grading Plan

C3 – Servicing Plan

C4 – Post Development Catchment Plan

C5 – Erosion & Sediment Control Plan

C6-C10 – Standard Details



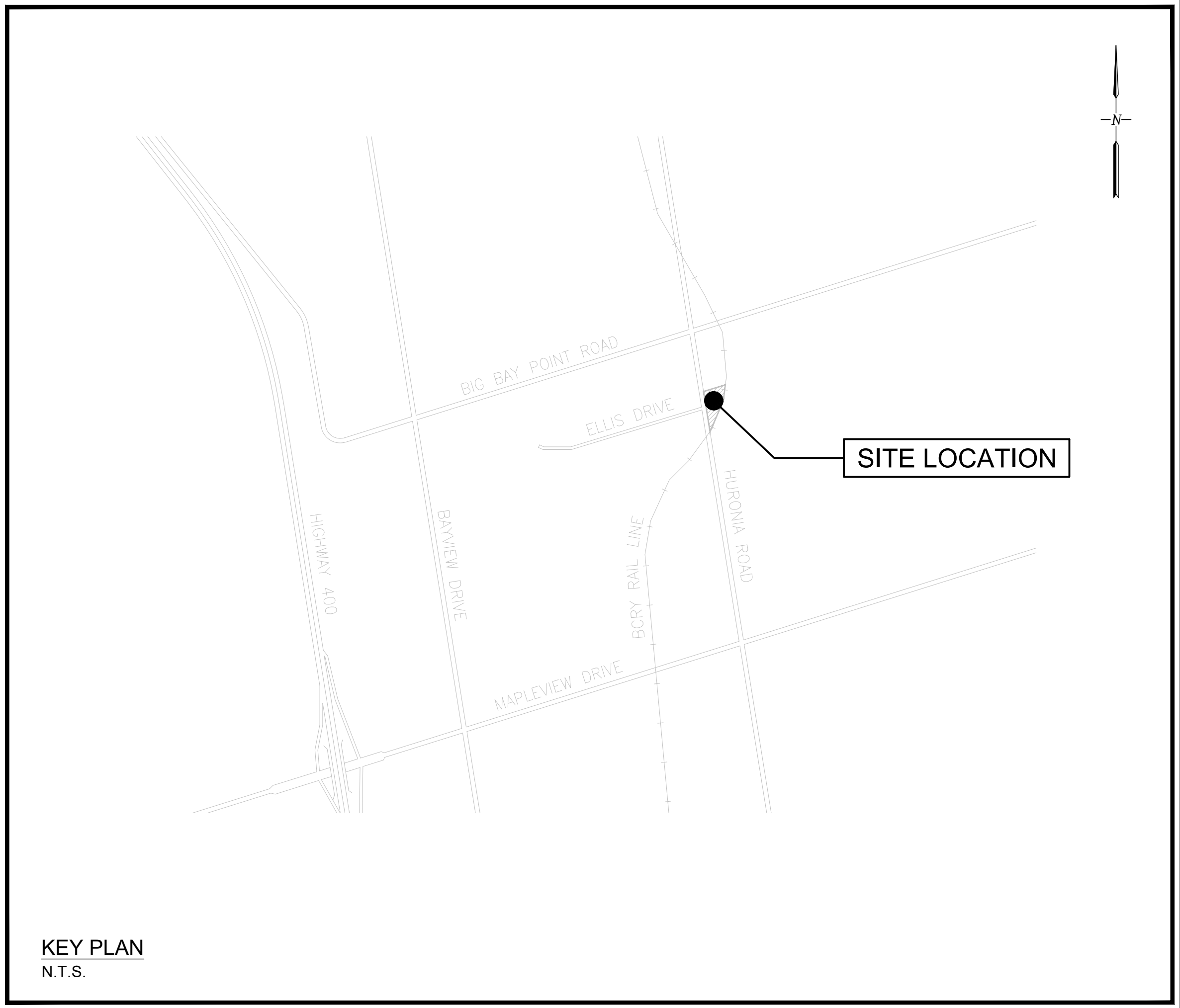
MR. BEHROOZ AZIZI

# 441 HURONIA ROAD SITE PLAN

## CITY OF BARRIE

DRAWING INDEX

|     |                                 |
|-----|---------------------------------|
| C1  | EXISTING CONDITIONS PLAN        |
| C2  | GRADING PLAN                    |
| C3  | SERVICING PLAN                  |
| C4  | POST-DEVELOPMENT DRAINAGE PLAN  |
| C5  | EROSION & SEDIMENT CONTROL PLAN |
| C6  | STANDARD DETAILS                |
| C7  | STANDARD DETAILS                |
| C8  | STANDARD DETAILS                |
| C9  | STANDARD DETAILS                |
| C10 | STANDARD DETAILS                |



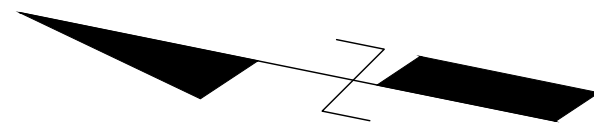
MR. BEHROOZ AZIZI

Project No. 2019-083

REVISED FUNCTIONAL SERVICING REPORT - 2020/09/11





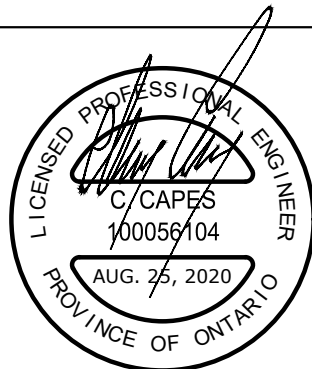


## KEY PLAN

1. This drawing is the exclusive property of CAPES Engineering Ltd. The reproduction of any part without express written consent of this Corporation is strictly prohibited.
2. The contractor shall verify all dimensions, levels, and datums on site and report any discrepancies or omissions to CAPES Engineering Ltd. prior to construction.
3. This drawing is to be read and understood in conjunction with all other plans and documents applicable to this project.

ELLIS DRIVE

SITE BENCHMARK  
MNR MON. # 00119713848  
ELEV=261.68



Client  
MR. BEHROOZ AZIZI



355310 BLUE MOUNTAINS - EUPHRASIA TOWNLIN  
CLARKSBURG, ON N0H 1J0

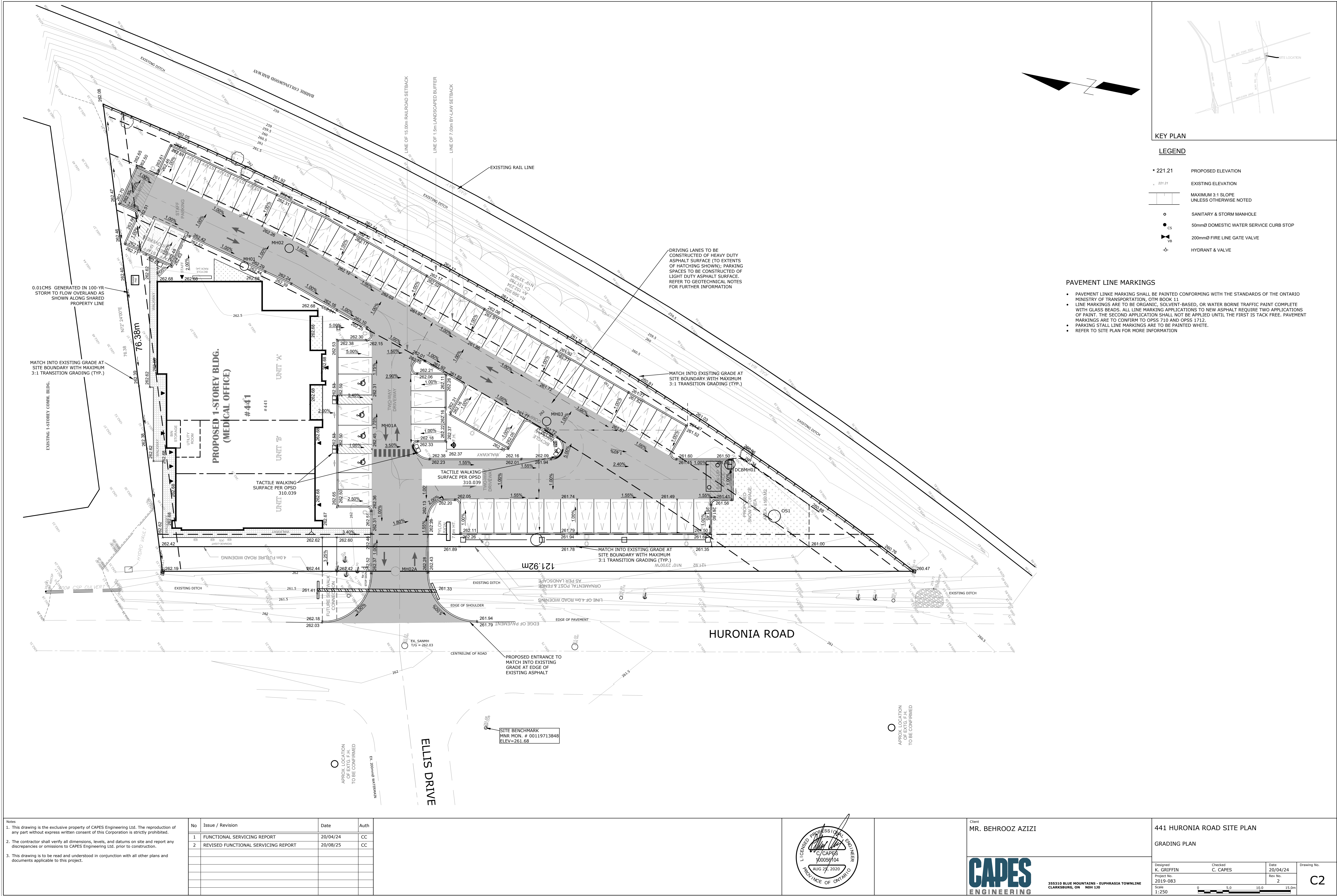
441 HURONIA ROAD SITE PLAN

## EXISTING CONDITIONS PLAN

|                                                                                                      |                     |                  |
|------------------------------------------------------------------------------------------------------|---------------------|------------------|
| Designed<br>K. GRIFFIN                                                                               | Checked<br>C. CAPES | Date<br>20/04/24 |
| Project No.<br>2019-083                                                                              |                     | Rev No.<br>2     |
| Scale<br>1:250  |                     |                  |

C1





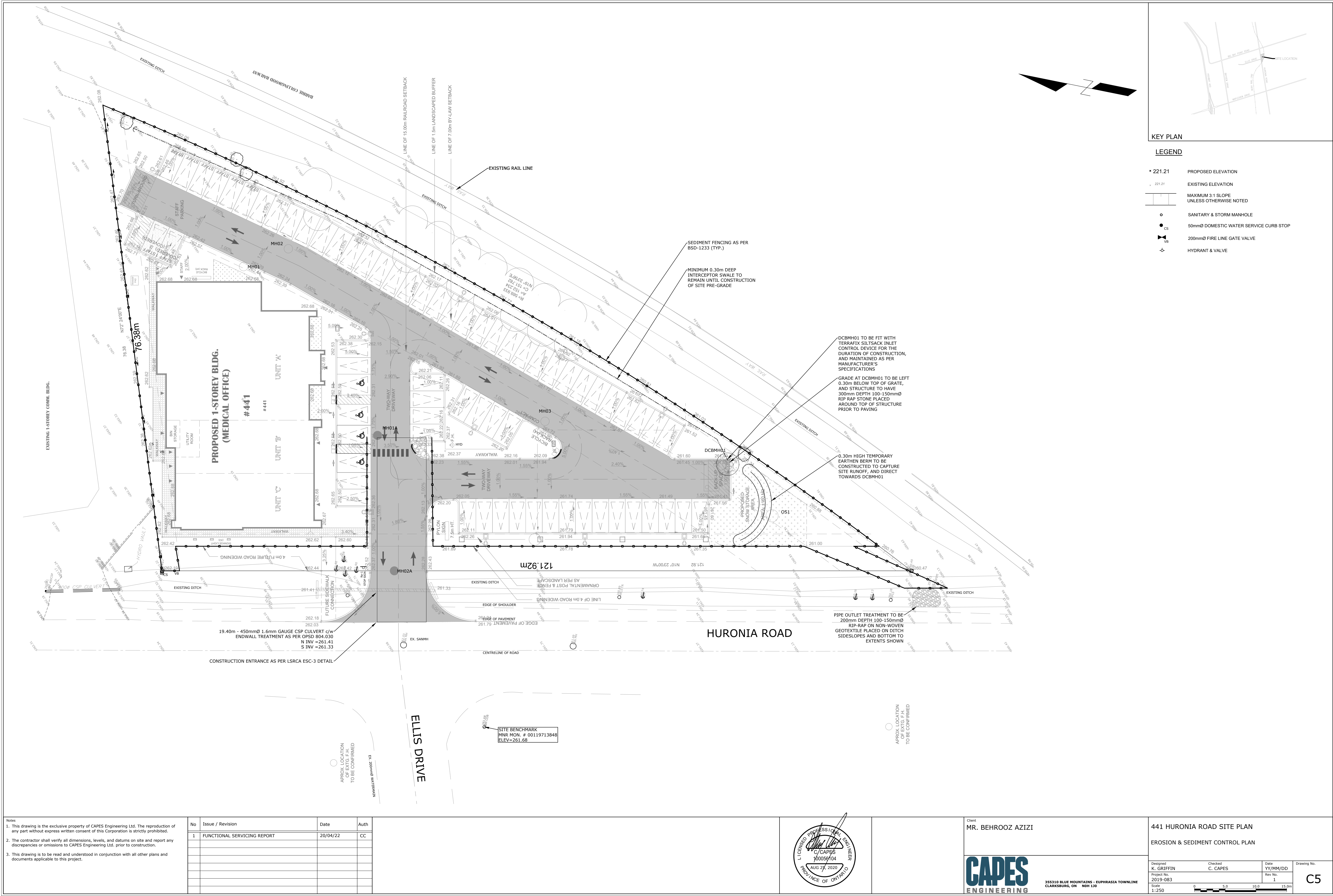


















## BACKFILL

THE TYPE OF MATERIAL AND DEPTH OF GRANULAR BEDDING BELOW THE PIPE WILL, TO SOME EXTENT, DEPEND ON THE METHOD OF CONSTRUCTION USED BY THE CONTRACTOR. PIPE BEDDING FOR FLEXIBLE PIPES SHOULD FOLLOW THE REQUIREMENTS IN THE S.O. 202-202-0302 OR 202-202-0303 OR APPLICABLE MUNICIPAL STANDARDS. PIPE BEDDING FOR RIGID PIPES SHOULD FOLLOW THE REQUIREMENTS IN ONTARIO PROVINCIAL STANDARD DRAWINGS 802.030 TO 802.033 OR APPLICABLE MUNICIPAL STANDARDS.

THE CONTRACTOR SHALL PROVIDE ADEQUATE SUPPORT FOR PIPES WITH THE BEDDING REQUIREMENTS AS LAID OUT IN THE ABOVE REFERENCED OPS DRAWINGS. WHERE DISTURBANCE OF THE TRENCH BASE HAS OCCURRED FROM GROUNDWATER SEEPAGE, CONSTRUCTION TRAFFIC, ETC., THE CONTRACTOR SHALL SOFTEN AND RECOMPACT THE SUBGRADE TO MEET THE SPECIFIED COMPACTED GRANULAR FILL. IF WEAK ZONES ARE ENCOUNTERED, ADDITIONAL BEDDING MATERIALS AND DIFFERING CONSTRUCTION PRACTICES MAY BE REQUIRED AND SHOULD BE DETERMINED DURING CONSTRUCTION.

THE GRANULAR BEDDING TO BE IMPLEMENTED, GRANULAR BEDDING AND COVER MATERIAL SHOULD CONSIST OF A WELL GRADED, FREE DRAINING MATERIAL, SUCH AS GRANULAR A (OPSS, MUNI 1010). ALL GRANULAR BEDDING MATERIAL MUST BE COMPACTED TO A MINIMUM OF 95% SPD. CLEAR STONE OR GRANULAR BEDDING SHALL BE PROVIDED AT THIS SITE PROVIDED IT IS FULLY WRAPPED IN A NON-WOVEN FILTER FABRIC.

## BACKFILL

- EXCAVATED NATIVE SOILS AND EARTH FILL MAY BE USED AS BACKFILL IN TRENCHES PROVIDED THE MOISTURE CONTENT IS WITHIN 2% OF OPTIMUM. THE BACKFILL SHOULD BE COMPACTED TO A MINIMUM OF 95% SPM2. BELOW PAVEMENT AREAS, THE BACKFILL SHOULD BE COMPACTED TO A MINIMUM OF 98% SPM2. THE LAYER THICKNESS WILL HAVE TO BE REDUCED TO UTILIZE SMALLER COMPACTION EQUIPMENT EFFICIENTLY OR BY USING GRANULAR MATERIAL INSTEAD OF LOCALLY SOURCED FILL. ANY BACKFILL THAT IS FROZEN, CONTAINS A HIGH PERCENTAGE OF FINE SAND, OR CONTAINS A HIGH PERCENTAGE OF FINE GRAY CLAY IS AN UNSUITABLE DELETERIOUS INCLUSION SHOULD NOT BE USED AS BACKFILL. THE MAXIMUM COBBLE OR BOLDER SIZE SHOULD NOT EXCEED HALF OF THE LOOSE LIFT THICKNESS (I.E. ALL PARTICLES WITH A DIAMETER GREATER THAN 100 MM SHOULD BE REMOVED).
- WHERE TRENCHES ARE WITHIN THE TRAVELED PORTIONS OF A ROADWAY, BACKFILLING TO THE PROST PENETRATION DEPTH OF 1.2 METERS SHOULD CONSIST OF NATURAL, NON-ORGANIC, CLEAN, CONSISTENT SOIL OR GRANULAR MATERIAL SURROUNDING THE TRENCH. IF THIS TECHNIQUE CANNOT BE UNDERTAKEN, THEN FREQUENTLY PROBLEMS ARISE WITH YEARLY DIFFERENTIAL FROST HEAVE MOVEMENTS BETWEEN THE TRENCH BACKFILL AND THE ADJACENT NATIVE SOIL. THIS CAN BE AVOIDED FOR THE TRENCHES TO BE FROZEN TO THE SAME DEPTH AS THE TRENCHES INSTEAD OF GLACIAL TILL WHICH IS MORE SUSCEPTIBLE TO FROST EFFECTS. ALTERNATIVELY, IF DIFFERENT SOIL IS USED AS THE BACKFILL DUE TO ISSUES WITH ACHIEVING COMPACTION, A FROST TAPER OF 5H:1V CAN BE USED TO PROVIDE FOR HELP MITIGATE THE POTENTIAL FOR DIFFERENTIAL SETTLEMENT AND FROST HEAVE.

PAVEMENT DESIGN

## SUBGRADE PREPARATION

NEW PARKING AND DRIVING AREAS WILL BE CONSTRUCTED AS PART OF THE PROPOSED COMMERCIAL DEVELOPMENT. IT IS EXPECTED THAT SUBGRADE SOILS BELOW A PAVEMENT STRUCTURE AT THE SITE WILL CONSIST OF EARTH FILL. THE SUBGRADE WILL BE REINFORCED WITH A GEOTEXTILE TO PROVIDE THE REQUIRED STRUCTURE, PROVIDED THE SUBGRADE IS PROOF-ROLLED AND APPROVED BY A GEOTECHNICAL ENGINEER AT THE TIME OF CONSTRUCTION AND DOES NOT CONTAIN EXCESSIVE MOISTURE OR ORGANIC MATERIALS OR OTHER HAZARDOUS MATERIALS. THE EARTH FILL COUNTERED IN BOTH DIRECTIONS (CONTAINING TOPSOIL THROUGHOUT) MAY NOT BE A SUITABLE SUBGRADE FOR THE PAVEMENT STRUCTURE AND WILL HAVE TO BE ASSESSED ON SITE TO DETERMINE IF IT MUST BE REPLACED. UNWEATHERED NATURAL SUBGRADE SOILS ARE NOT A SUITABLE SUBGRADE SHOULD BE COMPACTED TO A MINIMUM OF 98% SPND. IT IS ANTICIPATED THAT THE SUBGRADE BEARING MODULUS WILL BE 25,000 KPA/M. THE LONG-TERM PERFORMANCE OF THE PAVEMENT STRUCTURE IS HIGHLY DEPENDENT UPON THE SUBGRADE BEARING CAPACITY. THEREFORE, DURING CONSTRUCTION CONTROL PROCEDURES MUST BE MAINTAINED TO ENSURE THAT UNIFORM SUBGRADE MOISTURE AND DENSITY CONDITIONS ARE ACHIEVED AS MUCH AS POSSIBLE WHEN THE SUBGRADE IS REPLACED. IF THE NATURAL SUBGRADE IS NOT DISTURBED OR WEAKENED AFTER IT IS EXPOSED.

### PAVEMENT STRUCTURE

HEAVY DUTY SURFACE

- 40mm HL3 (OPSS 1150) WITH PG 58-28 AC (OPSS.MUNI 1101), COMPACTED PER OPSS 310
- 80mm HL8 (OPSS 1150) WITH PG 58-28 AC (OPSS.MUNI 1101), COMPACTED PER OPSS 310
- 150mm GRANULAR 'A' (OPSS.MUNI 1010), 100% SPMDD
- 450mm GRANULAR 'B' I OR II (OPSS.MUNI 1010, 100% SPMDD

LIGHT DUTY SURFACE

- 40mm HL3 (OPSS 1150) WITH PG 58-28 AC (OPSS.MUNI 1101), COMPACTED PER OPSS 310
- 50mm HL8 (OPSS 1150) WITH PG 58-28 AC (OPSS.MUNI 1101), COMPACTED PER OPSS 310
- 150mm GRANULAR 'A' (OPSS.MUNI 1010), 100% SPMDD
- 300mm GRANULAR 'B' I OR II (OPSS.MUNI 1010, 100% SPMDD

- THE GRANULAR MATERIALS SHOULD BE PLACED IN LIFTS 200 MM THICK OR LESS AND MUST BE COMPACTED TO A MINIMUM OF 100% SPMD FOR BOTH GRANULAR BASE AND GRANULAR SUBBASE. ASPHALT MATERIALS SHOULD BE ROLLED AND COMPACTED AS PER OPSS 310. THE GRANULAR AND ASPHALT PAVEMENT MATERIALS AND THEIR PLACEMENT SHOULD CONFORM TO OPSS 310, 501, 1010 AND 1150.
- IF THE PAVEMENT CONSTRUCTION OCCURS IN WET, WINTER OR INCLEMENT WEATHER, IT MAY BE NECESSARY TO PROVIDE ADDITIONAL SUBGRADE SUPPORT FOR THE GRANULAR SUBGRADE. THE THICKNESS OF THIS ADDITIONAL SUBGRADE OR GRANULAR SUBBASE, BASE OR BOTH, FURTHER, TRAFFIC AREAS FOR CONSTRUCTION EQUIPMENT MAY EXPERIENCE UNSTABLE SUBGRADE CONDITIONS. THESE AREAS MAY BE STABILIZED UTILIZING ADDITIONAL THICKNESS OF GRANULAR MATERIALS

## EXCAVATIONS AND TEMPORARY GROUNDWATER CONTROL

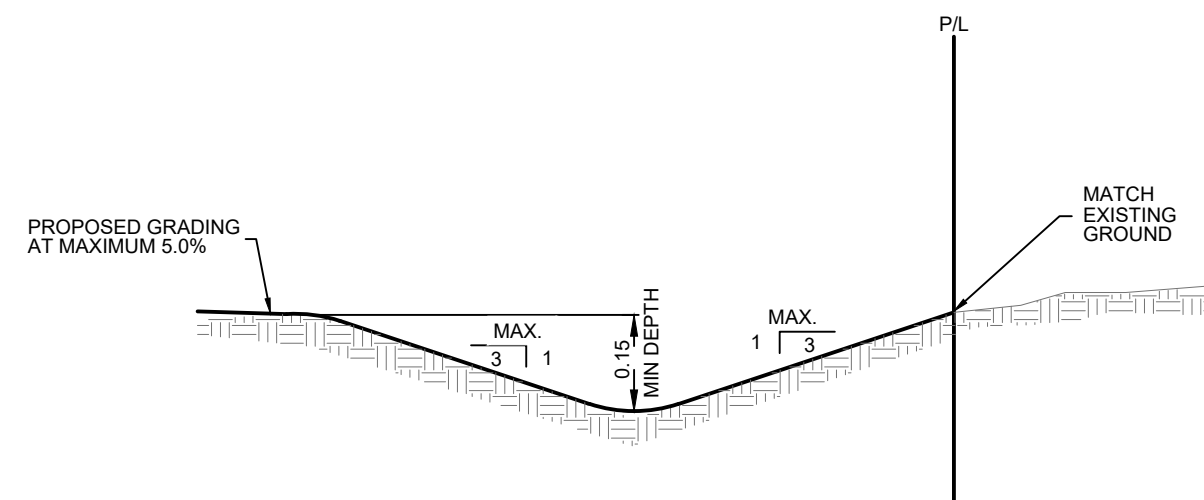
- EXCAVATIONS MUST BE CARRIED OUT IN ACCORDANCE WITH THE OCCUPATIONAL HEALTH AND SAFETY ACT, ONTARIO REGULATION 213/91 (AS AMENDED), CONSTRUCTION PROJECTS, PART III - EXCAVATIONS, SECTION 222 THROUGH 242. IN ADDITION TO THE REQUIREMENTS OF THE REGULATION, THE SOILS BASED ON THE SOILS ENCOUNTERED AT THIS SITE: TYPE 3 SOILS - ALL SOILS ON THE TRENCH SIDEWALLS TO BE CONSTRUCTED NO STEEPER THAN 1 HORIZONTAL TO 1 VERTICAL FROM THE BASE OF THE EXCAVATION.
- ALL SUPPORTS TO BE INSTALLED FOR STEEPER EXCAVATIONS ARE STIPULATED IN SECTIONS 235 THROUGH 238 AND 241 OF THE OHS AND INCLUDE PROVISIONS FOR TIMBERING, SHORING AND MOVABLE TRENCH BOXES. IN ORDER TO REDUCE THE POTENTIAL FOR INSTABILITY OF THE TRENCH EXCAVATION, ALL MATERIALS OR HEAVY EQUIPMENT SHOULD NOT BE PLACED NEAR THE CREST OF THE TRENCH EXCAVATIONS.
- ALL EXCAVATIONS ARE EXPECTED TO BE ABOVE THE PREVAILING GROUND WATER TABLE, THERE SHOULD BE LIMITED GROUNDWATER CONTROL ISSUES PRESENT. DURING TIMES OF HIGH PRECIPITATION, SOME WATER MAY COLLECT AT THE BASE OF THE EXCAVATION. LOCAL Sumps PLACED AT THE BASE OF THE EXCAVATION CAN BE USED TO CONTROL ANY SUCH WATER.
- IT IS IMPORTANT TO NOTE THAT SOILS ENCOUNTERED IN THE CONSTRUCTION EXCAVATIONS MAY VARY SIGNIFICANTLY ACROSS THE SITE. OUR PRELIMINARY SOIL CLASSIFICATIONS ARE BASED SOLELY ON THE MATERIALS ENCOUNTERED IN WIDELY SPACED SINGLE POINT TESTS. IT IS RECOMMENDED THAT YOU VERIFY THAT UNDER SIMILAR CONDITIONS EXIST THROUGHTOUT THE PROPOSED AREA OF EXCAVATION. IF DIFFERENT SUBSURFACE CONDITIONS ARE ENCOUNTERED AT THE TIME OF CONSTRUCTION, WE RECOMMEND THAT CEE BE CONTACTED IMMEDIATELY TO DISCUSS THE CONSTRUCTION PROPOSAL.

### COMPACTION SPECIFICATIONS

- STANDARD PROCTOR MAXIMUM DRY DENSITY (SPMDD) IS THE LEVEL TO WHICH A SOIL OR AGGREGATE IS COMPACTED. TO ACHIEVE THE SPECIFIED SPMDD AS INDICATED IN THIS REPORT, ALL SOILS OR AGGREGATES MUST BE PLACED IN LIFT

THICKNESSES NO GREATER THAN 200 MM. IF THIS IS NOT THE CASE, ONLY THE UPPER PORTION OF THE LIFT WILL BE ADEQUATELY COMPACTED, AND THE LOWER PORTION OF THE LIFT HAS A HIGH PROBABILITY OF NOT MEETING COMPACTION SPECIFICATIONS. IN ADDITION, INDUSTRY STANDARD EQUIPMENT USED TO DETERMINE THE DEGREE OF COMPACTION CONSISTS OF NUCLEAR DENSOMETERS. THESE DEVICES HAVE AN INHERENT LIMITATION IN THAT THEY CANNOT TEST BEYOND 300 MM IN DEPTH, AND SO THE DEGREE OF COMPACTION BEYOND THIS DEPTH CANNOT BE QUANTITATIVELY DETERMINED.

- ALONG WITH LIFT THICKNESS, ENSURING THAT THE SOIL OR AGGREGATE IS WITHIN 2% OF ITS OPTIMUM MOISTURE CONTENT ENSURES THAT THE SPECIFIED COMPACTION CAN BE REACHED. IF THE SOIL OR AGGREGATE IS TOO DRY, IT IS EITHER VERY DIFFICULT OR IMPOSSIBLE TO REACH THE SPECIFIED COMPACTION. THIS IS ESPECIALLY TRUE FOR WHEN HIGHER COMPACTION SPECIFICATIONS SUCH AS 98% AND 100% SPMD ARE REQUIRED.
- IF THE SOIL OR AGGREGATE IS TOO WET, IT IS ENCOUNTERED IN THE BOREHOLES WITH ASSOCIATED MOISTURE CONTENTS, THE SOILS AT THIS SITE ARE CONSIDERED AS FOLLOWS: HALF OF IN-SITU SOIL AT OR NEAR OPTIMUM MOISTURE CONTENT, ONE QUARTER OF IN-SITU SOIL ABOVE OPTIMUM MOISTURE CONTENT, ONE QUARTER OF IN-SITU SOIL BELOW OPTIMUM MOISTURE CONTENT.
- THE ZONES WITH HIGHER MOISTURE CONTENT WILL REQUIRE MOISTURE CORRECTION PRIOR TO THE ADDITION OF THE AGGREGATE. THE OPTIMUM MOISTURE CONTENT CAN BE REDUCED BY TILLING THE SOIL, SPREADING THE SOIL OR CLAY, OR BLENDING IT WITH DRIER MATERIAL. SOIL THAT IS DRY OF OPTIMUM COULD BE BLENDED WITH WETTER SOIL OR HAVE WATER ADDED PRIOR TO RE-USE. IT MUST BE ALSO NOTED THAT THE ABOVE MENTIONED PERCENTAGES ARE BASED ON THE ASSUMPTION THAT NO CONSTRUCTION OCCURS, AS THE PREVAILING WEATHER CAN HAVE A SIGNIFICANT EFFECT ON THE MOISTURE CONTENT OF STOCKPILED AND IN-SITU SOIL.
- CONSTRUCTION TO THE ABOVE OPTIMUM MOISTURE CONTENT IN AREAS WHERE COMPACTION FILL WILL BE PLACED OVER THE EXPOSED SUBSISTE SOIL SUBGRADE, ANY LOOSE, SOFT, WET OR UNSTABLE AREAS SHOULD BE SUB-EXCAVATED, AND BACKFILLED WITH CLEAN FRESH FILL OF GRANULAR B<sub>3</sub> (POSS. MMD 1010) COMPACTED TO A MINIMUM OF 95% OF THE SPECIFIED COMPACTION APPLIES TO SITE SERVING, SLAB ON GRADE AND PAVEMENT SUBGRADE.



### TYPICAL SIDE YARD SWALE

GENERAL NOTES – SANITARY SEWERS

SANITARY SEWERS

- SANITARY SEWER TO BE LOCATED AT THE CENTRELINE OF THE ROAD.
- SEWERS SHALL BE CONSTRUCTED WITH BEDDINGS AS PER OPSD-802.031 (GRAN. "A" EMBEDMENT MATERIAL) FOR FLEXIBLE PIPES AND OPSD-802.030 OR 802.031 CLASS B (GRAN. "B" BEDDING MATERIAL) FOR RIGID PIPE UNLESS OTHERWISE APPROVED BY THE DIRECTOR OF ENGINEERING.
- MAXIMUM DEFLECTION FROM COMBINED LIVE AND DEAD LOADING SHALL NOT EXCEED ANY C.S.A., O.P.S. OR MANUFACTURERS RECOMMENDED SPECIFICATIONS.
- PVC, CONCRETE AND PROFILE WALL PVC SEWERS SHALL HAVE RUBBER GASKET TYPE JOINTS AND SHALL BE CERTIFIED TO CONFORM TO ALL APPLICABLE CURRENT C.S.A. SPECIFICATIONS.
- CONCRETE SANITARY SEWERS SHALL HAVE A MINIMUM STRENGTH OF 50 N/mm<sup>2</sup> CONFORMING TO CSA STANDARD A257.2-1982, CLASS 50-D (PREVIOUSLY C.S.A. STANDARD A257.2-1974, CLASS II).
- MAINTENANCE HOLE TOPS (FRAMES) ARE TO BE SET TO BASE COURSE ASPHALT GRADE AND THEN ADJUSTED TO FINAL GRADE WHEN THE TOP LIFT OF ASPHALT IS LAYED. ALL ADJUSTMENT WILL BE ACCORDANCE WITH BSD-N2.
- ALL CONNECTIONS TO NEW SANITARY MAINS SHALL BE PRE-MANUFACTURED, FABRICATED TEES, CONNECTIONS TO EXISTING SANITARY SEWER SHALL BE MADE WITH APPROVED FACTORY MADE TEES OR INSERTA-TEES IN STRICT ACCORDANCE TO MANUFACTURES GUIDELINES.

GENERAL NOTES - SANITARY SEWER

### SANITARY SERVICE LATERALS

- A. LATERAL LATERAL CONNECTION TO BE LOCATED AT THE CENTRELINE OF THE LOT AND CAPPED.
- B. SLOPE OF LATERAL TO BE MARKED 2.0m Post PROPERTY LINE WITH A 50 x 100mm WOOD MARKER, PAINTED GREEN, EXTENDING FROM SERVICE INVERT TO 300mm ABOVE GROUND LEVEL.
- C. PIPE TO BE MINIMUM 100 mm DIA. PIPE SDR28, RUBBER GASKET TYPE JOINTS AND SHALL CONFORM TO AUSTRIAN STANDARD EN 12201-1 RESIDENTIAL HOUSE AND 155mm MINIMUM DIA. PIPE SDR28 FOR INDUSTRIAL/COMMERCIAL DEVELOPMENT.
- D. MINIMUM DEPTH OF LATERAL AT PROPERTY LINE SHALL BE 2.4m measured FROM THE SEWER OVERTO FINISHED GROUND SURFACE ELEVATION UNLESS NOTED OTHERWISE.
- E. ALL CONNECTIONS TO NEW SANITARY MAINS SHALL BE PRE-MANUFACTURED, FABRICATED TIES, CONNECTIONS TO EXISTING SANITARY MAINS SHALL BE APPROVED FACTORY MADE TIES OR INSERTA-TIES IN STRICT ACCORDANCE TO MANUFACTURERS GUIDELINES.
- F. MINIMUM PIPE SLOPE TO BE 2.0%, MAXIMUM 8.0% (EXCEPT 1000-1010, 1006-1020).

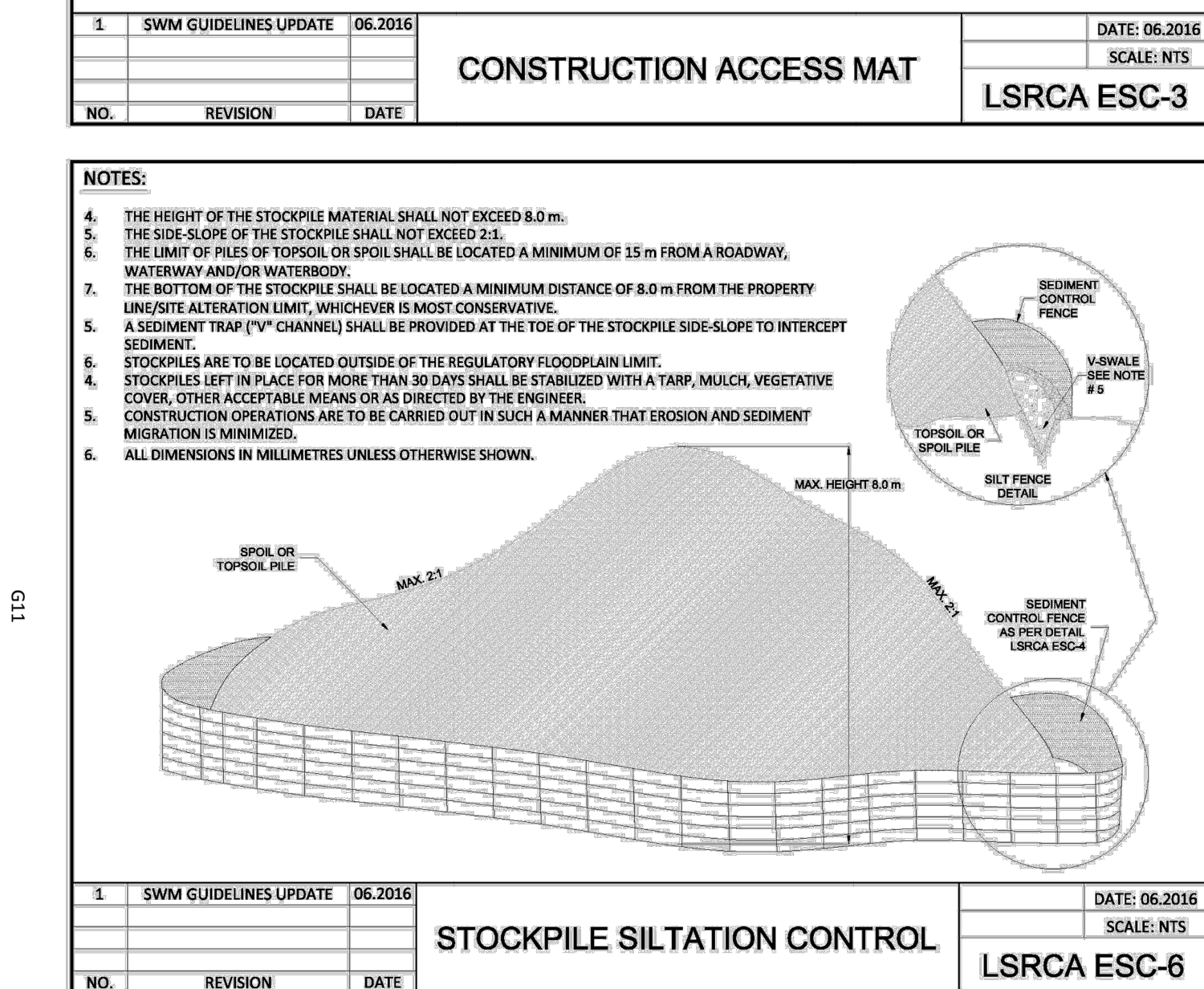
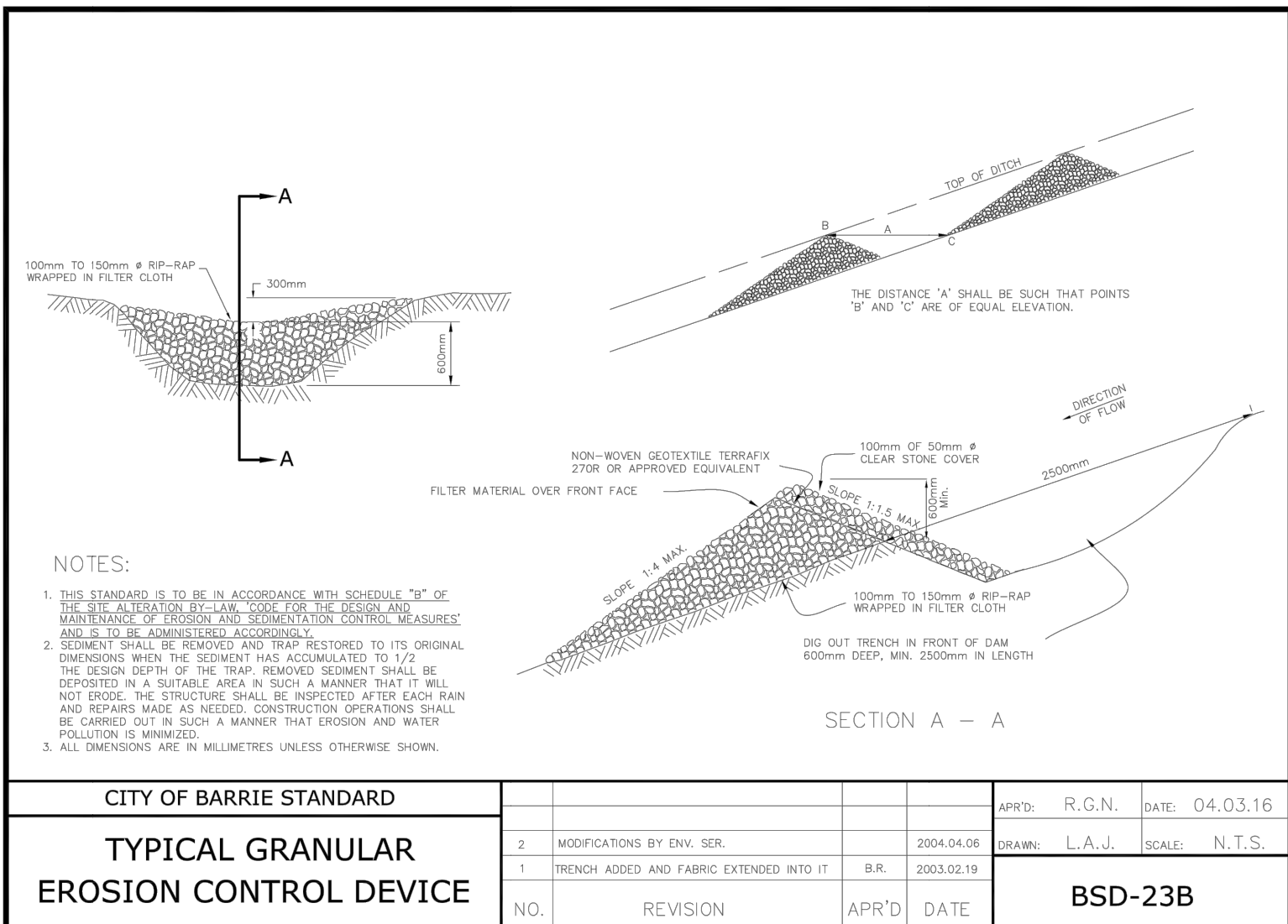
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|----------------------------------|-----|----------------------|---------|------------|-----------------|----------------|
| CITY OF BARRIE STANDARD          |     |                      |         |            | APPRO'D: R.G.N. | DATE: 92.05.15 |
| GENERAL NOTES<br>SANITARY SEWERS | 2.  | OPSD NUMBERS REVISED | K.C.    | 2000.08.17 | DRAWING: L.A.J. | SCALE: N.T.S.  |
|                                  | 1.  | CHANGES TO B. TO C.  | K.C.    | 95.04.24   |                 |                |
|                                  | NO. | REVISION             | APPRO'D | DATE       | BSD-N4          |                |

GENERAL NOTES - STORM SEWER

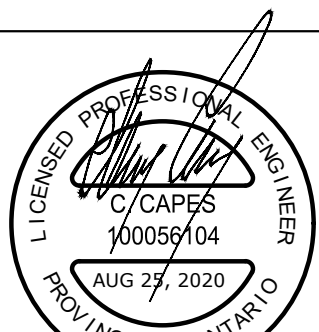
TORM SEWER

- STORM SEWER TO BE PROVIDED ON ALL ROADS WITH CURB AND GUTTER.
- ALL CATCH BASIN LATERALS AT 2% GRADE UNLESS OTHERWISE NOTED.  
PIPE SIZE MAXIMUM 250mm dia. SINGLE, 3 JOINT DIA. DOUBLE.
- STORM SEWERS SHALL BE CONSTRUCTED WITH BEDDING AS PER OPSD-802.010 (GRAN "A" EMBEEMENT MATERIAL) OR FLEXIBLE PIPES AND OPSD-802.030 (OR 802.031 CLASS B (GRAN "A" BEDDING MATERIAL) FOR RIGID PIPE UNLESS OTHERWISE APPROVED BY THE DIRECTOR OF ENGINEERING.
- MAINTENANCE HOLE TOPS (RAMPS) AND CATCH BASIN (FRAMES) ARE TO BE SET TO BASE COURSE ASPHALT GRADE. ALL OTHERS TO FINAL GRADE. WHEN THE TOP LIFT OF ASPHALT IS PLACED, ALL ADJUSTMENT WILL BE ACCORDANCE WITH 85D-112.
- STORM SEWER TO BE LOCATED OFFSET 3.0m SOUTH OR EAST OF CENTRELINE UNLESS OTHERWISE SPECIFIED.
- ALL CONNECTIONS TO THE STORM MAIN SHALL BE MADE WITH A STORM MANHOLE OR APPROVED FACTORY TIE CONNECTION AS PER OPSD-708.01 OR 708.03.
- PIPE MATERIAL TO BE REINFORCED CONCRETE WITH A MINIMUM STRENGTH OF 50 N/m<sup>2</sup>/mm<sup>2</sup> CERTIFIED TO C.S.A. STANDARD A247-1982, CLASS 50 (PREVIOUSLY C.S.A. STANDARD A272-1974, CLASS II) OR AS CERTIFIED TO C.S.A. STANDARDS 1422 AND 1424.
- STORM SEWER TO BE MINIMUM 300mm DIAMETER WITH JOINTS CONFORMING TO C.S.A. STANDARD A257.3.
- ALL PIPE BEDDING MUST CONFORM TO OPSD, MAXIMUM COVER TABLE, NO FLEXIBLE PIPE SEWERS WILL BE INSTALLED WITH A DEPTH OF COVER GREATER THAN 6 METRES UNLESS SPECIFICALLY APPROVED BY THE DIRECTOR OF ENGINEERING.
- ALL PIPE HANDLING INSTALLATIONS MUST BE IN STRICT COMPLIANCE WITH MANUFACTURERS INSTALLATION GUIDELINES AND THE O.C.P.A. OR UNBELI GUIDELINES.
- SUMP PUMP DISCHARGE PIPING IN BOULEVARD:
- IN THE EVENT OF OVERACTIVE SUMP PUMP ACTIVITY, A 150mm DIAMETER PUMP-OUT DISCHARGE SEWER MAY BE INSTALLED, WITH A MINIMUM 10% SLOPE TO THE STREET. THE DISCHARGE FRONTAGES OF DISCONNECTED LOTS, WITH AN OFFSET OF 0.6m FROM BACK OF CURB, THIS SEWER IS TO BE CAPED AT THE UPSTREAM END AND IS TO OULET INTO THE NEAREST CATCH BASIN DOWNSTREAM. DEPTH OF SEWER IS TO BE EQUAL TO SUBGRADEIN DEPTH. NOT TO BE DIRECTLY

|                                                                                     |                                             |                 |               |                |
|-------------------------------------------------------------------------------------|---------------------------------------------|-----------------|---------------|----------------|
| <div>CITY OF BARRIE STANDARD</div> <div>GENERAL NOTES</div> <div>STORM SEWERS</div> | 4. NOTE "C" = SUMP PUMP DISCHARGE PIPING    | B.R. 2003.01.07 | APPRO: R.G.N. | DATE: 92.05.15 |
|                                                                                     | 3. NOTE "I" & "C" = DIRECTOR OF ENGINEERING | B.R. 2002.10.29 | FRAME: L.A.J. | SCALE: N.T.S.  |
|                                                                                     | 2. NOTE "C" OPSS NUMBER REVISION            | K.C. 2000.03.16 |               |                |
|                                                                                     | 1. NOTE "D" CHANGED                         | K.C. 98.03.30   |               |                |
|                                                                                     | NO.                                         | REVISION        | APR'D         | DATE           |

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Client  
MR. BEHROOZ AZIZI

## 441 HURONIA ROAD SITE PLAN

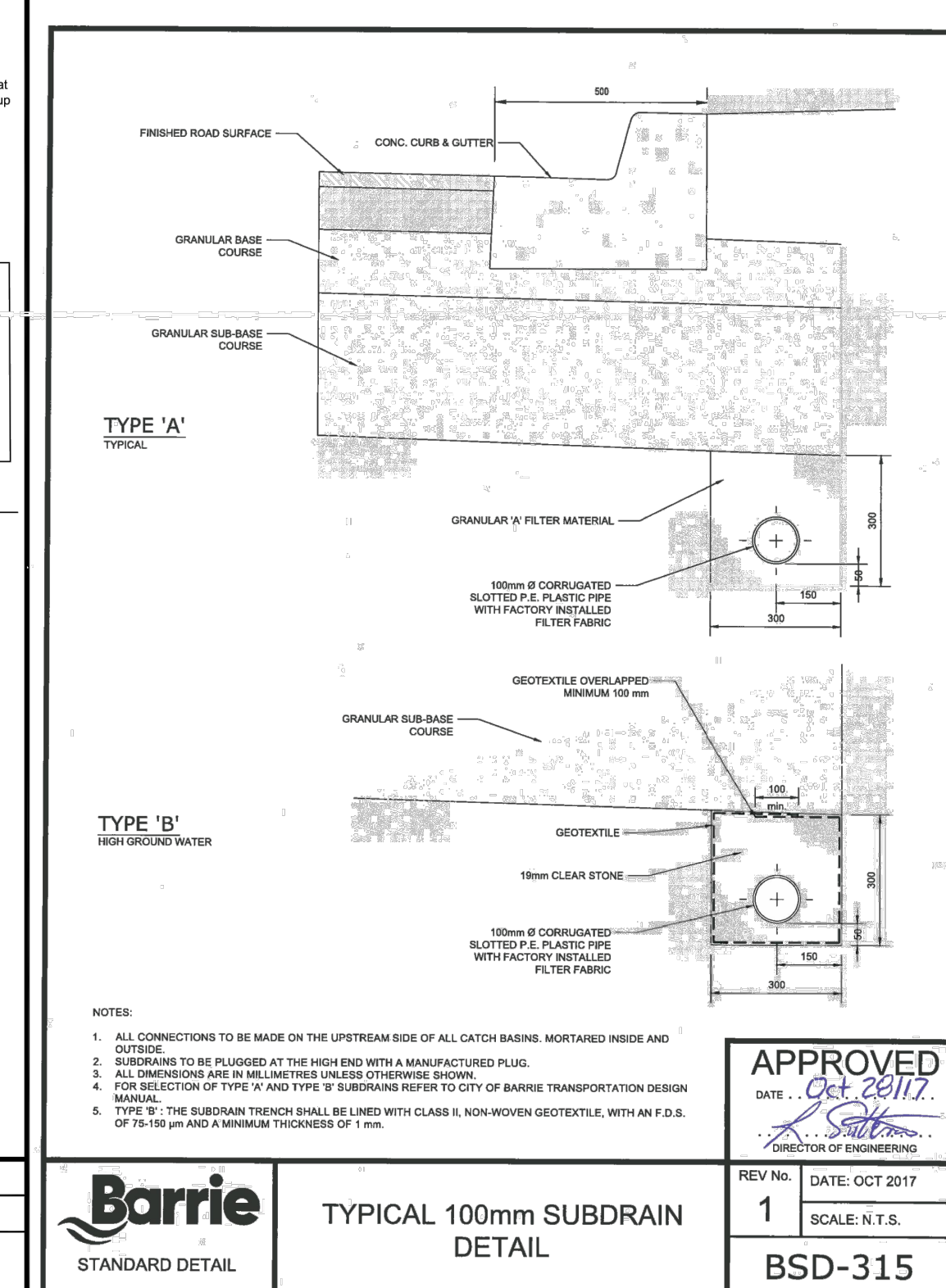
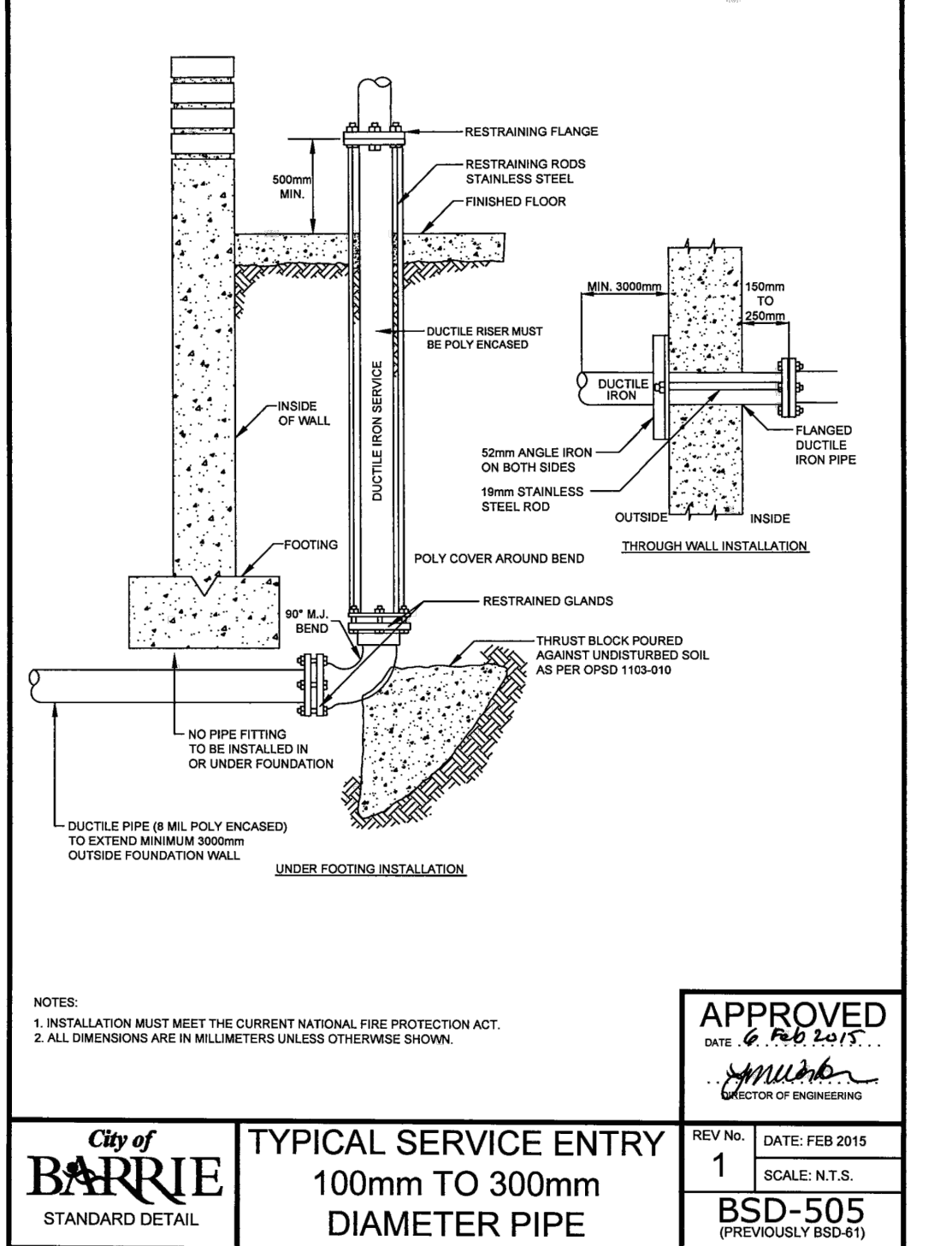
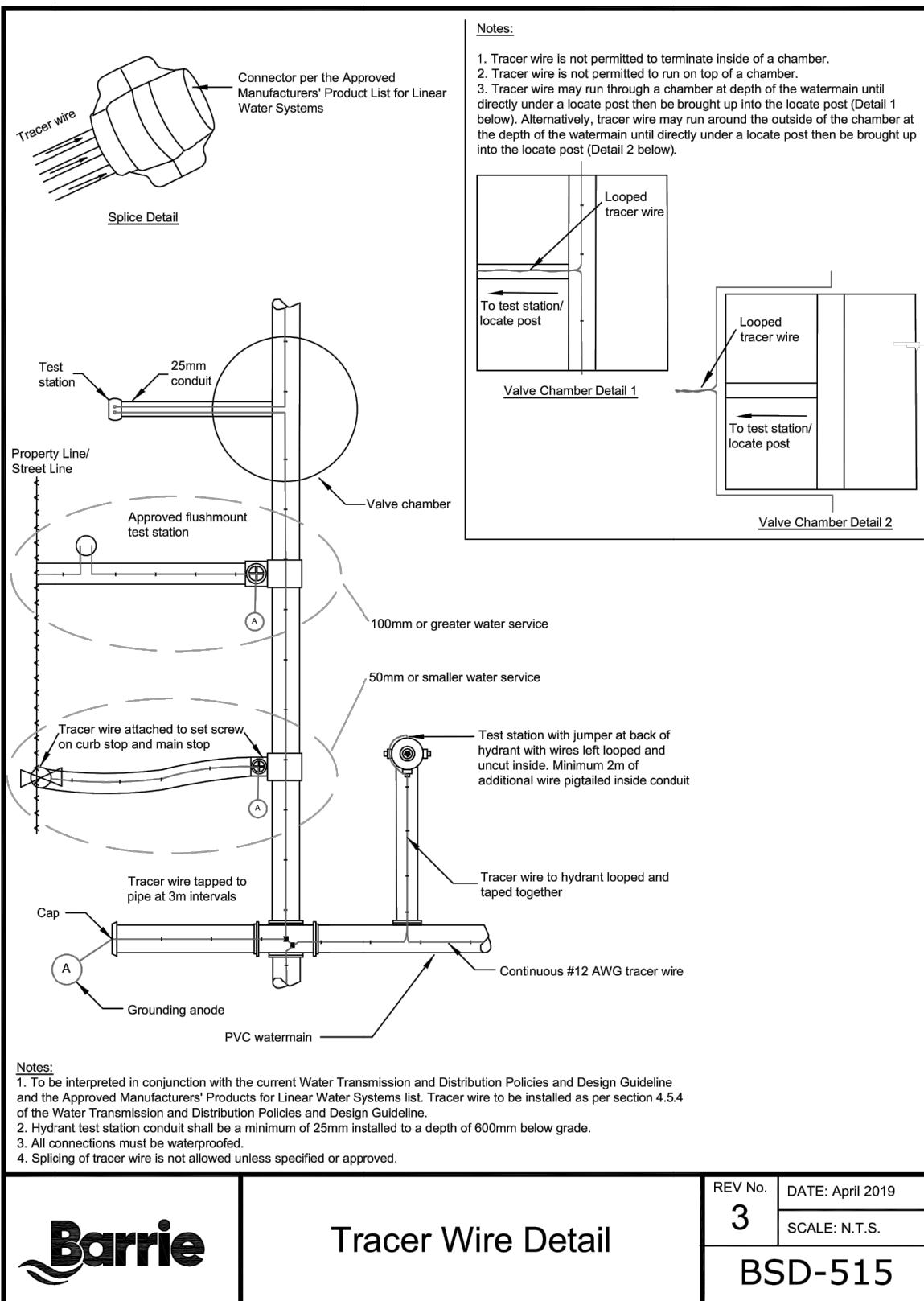
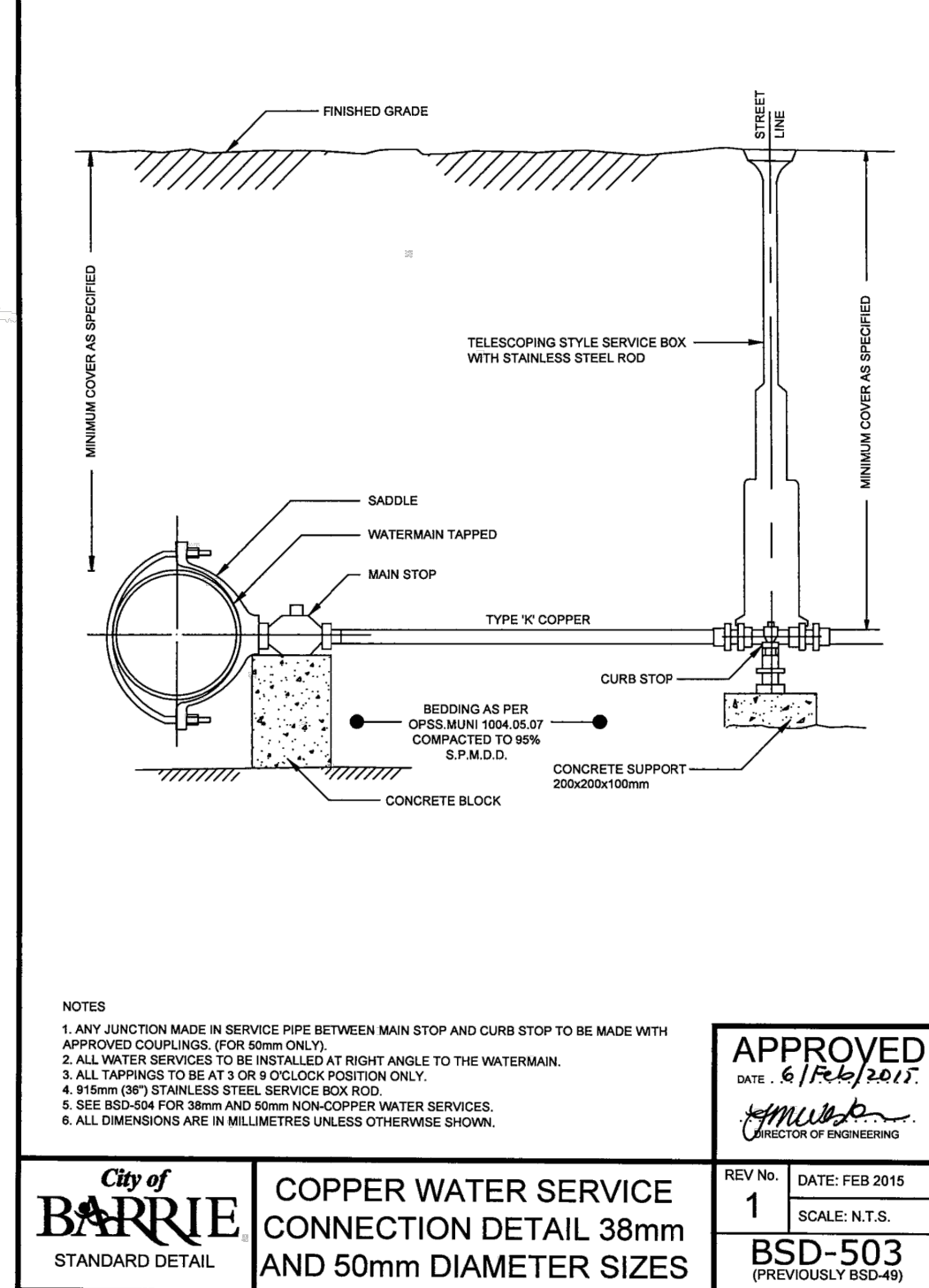
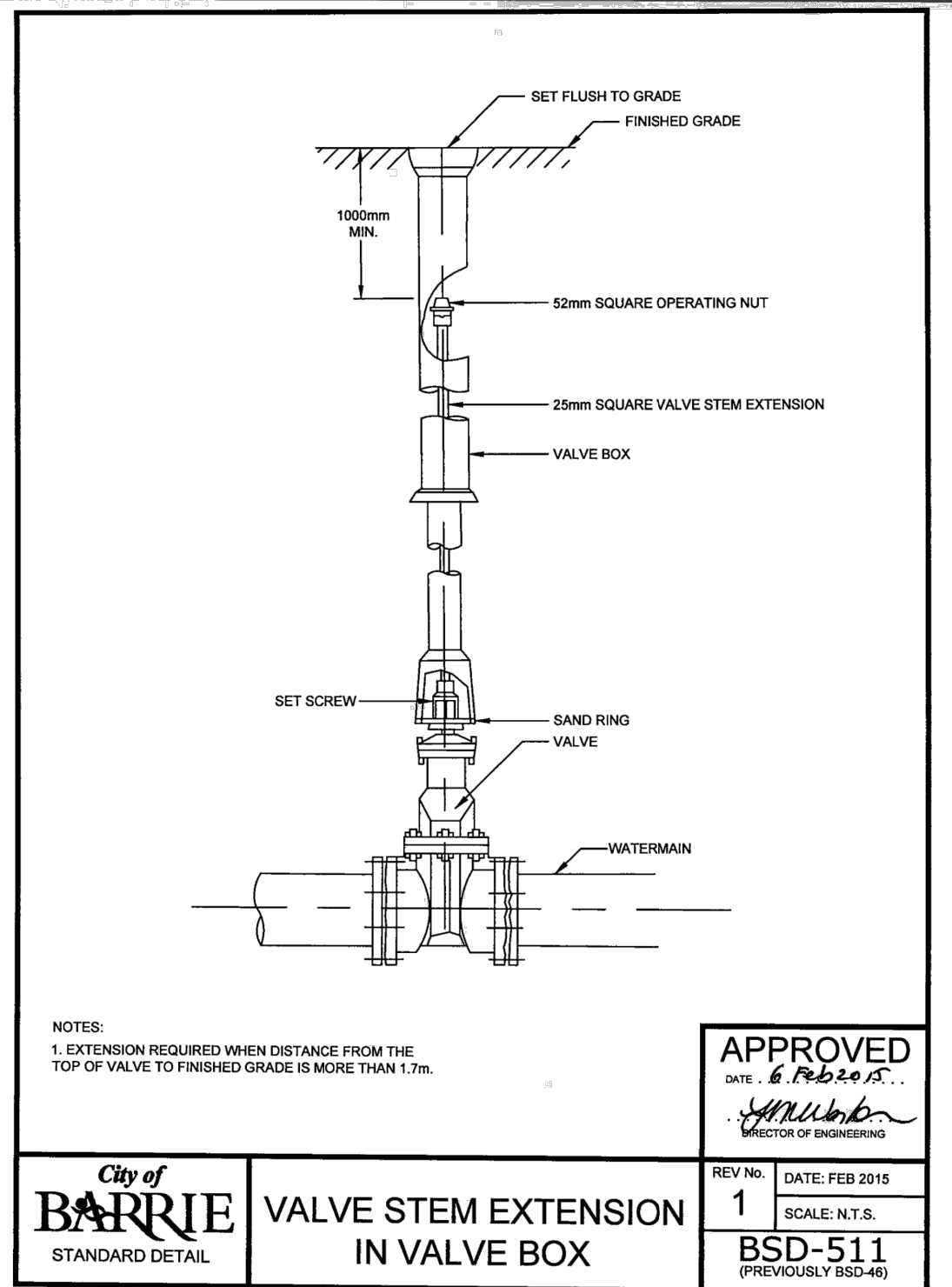
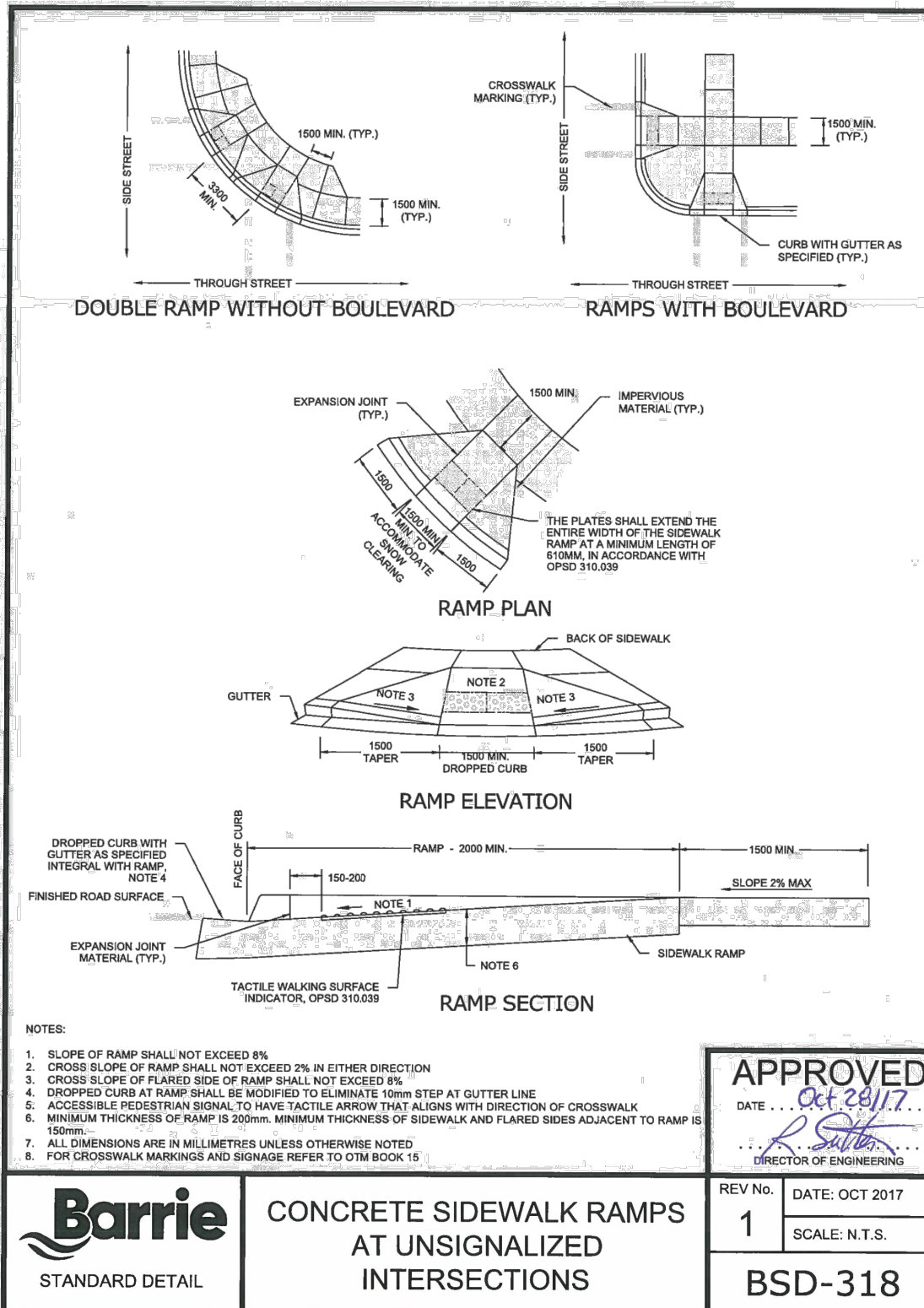
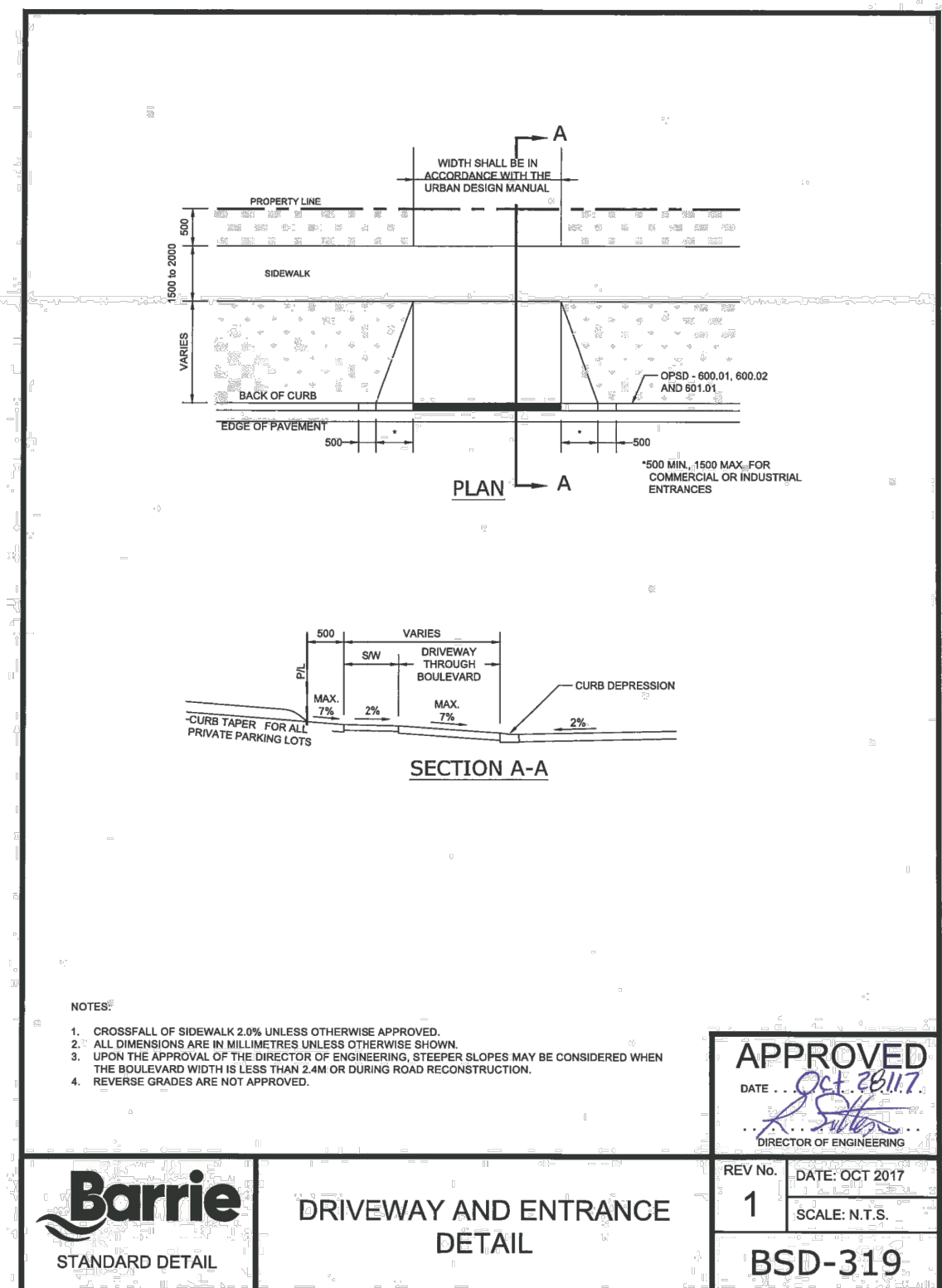
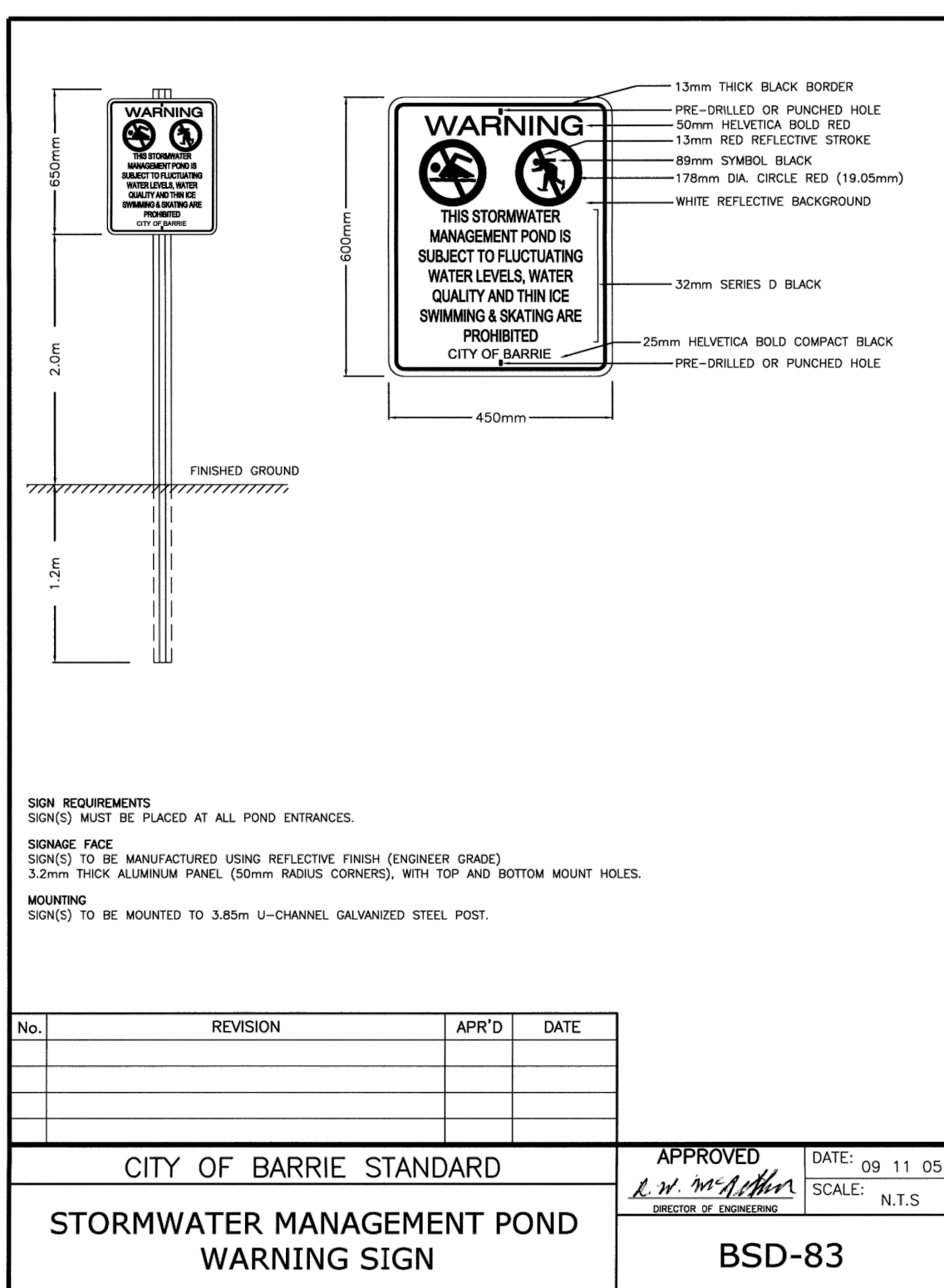
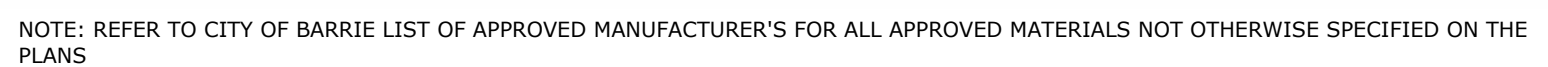
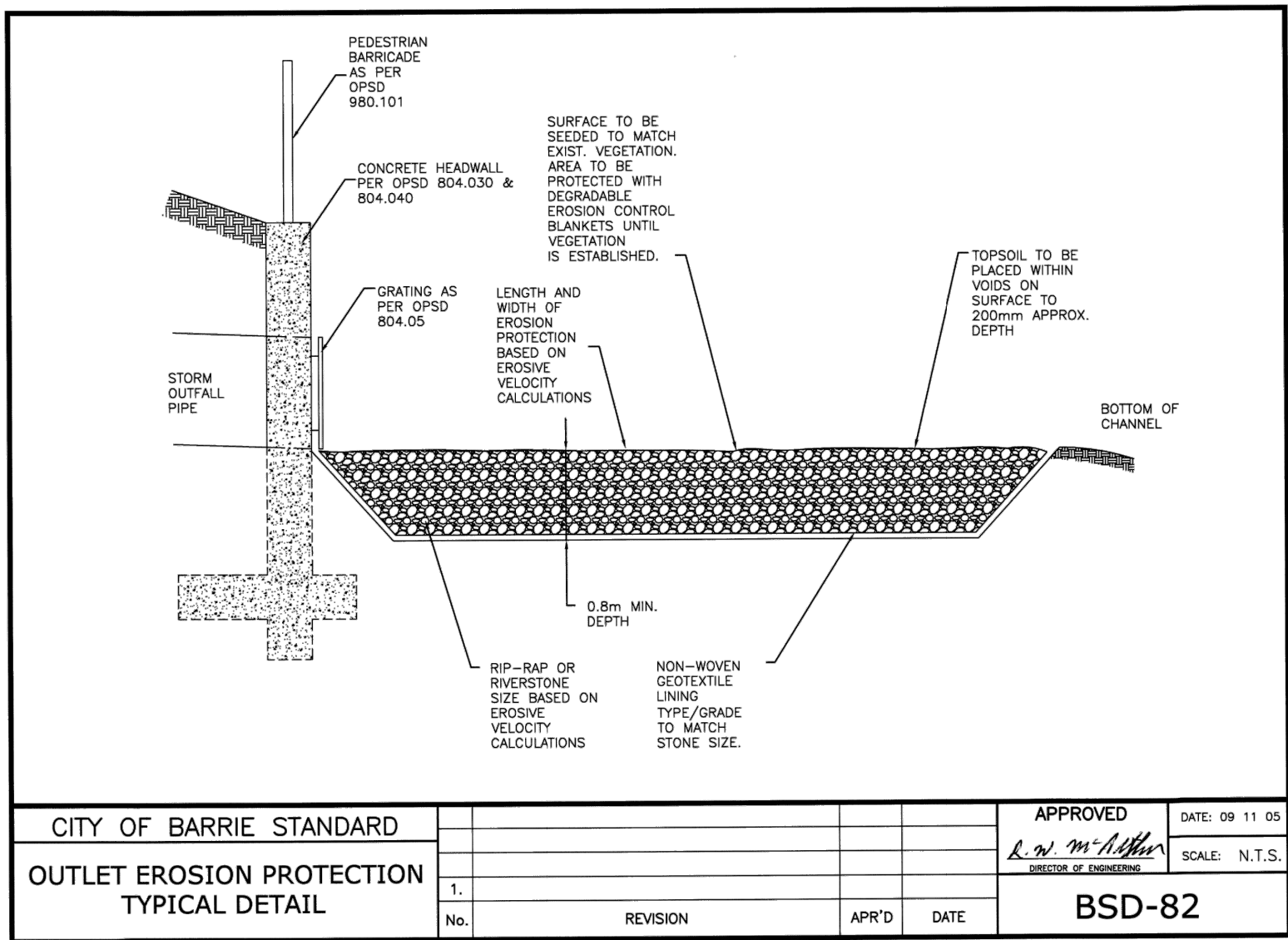
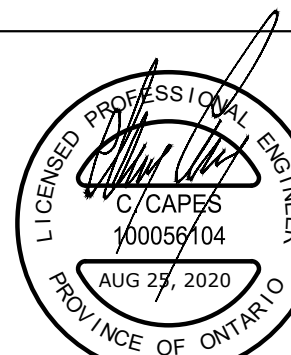
## STANDARD DETAILS

**CAPE**  
**ENGINEERING**

355310 BLUE MOUNTAINS - EUPHRASIA TOWNLINE  
CLARKSBURG, ON N0H 1J0

|              |    |
|--------------|----|
| Rev No.<br>2 | C7 |
|--------------|----|



[illegible]

Client  
**MR. BEHROOZ AZIZI**

**CAPE**  
ENGINEERING

355310 BLUE MOUNTAINS - EUPHRASIA TOWNLINE  
CLARKSBURG, ON NOH 1J0

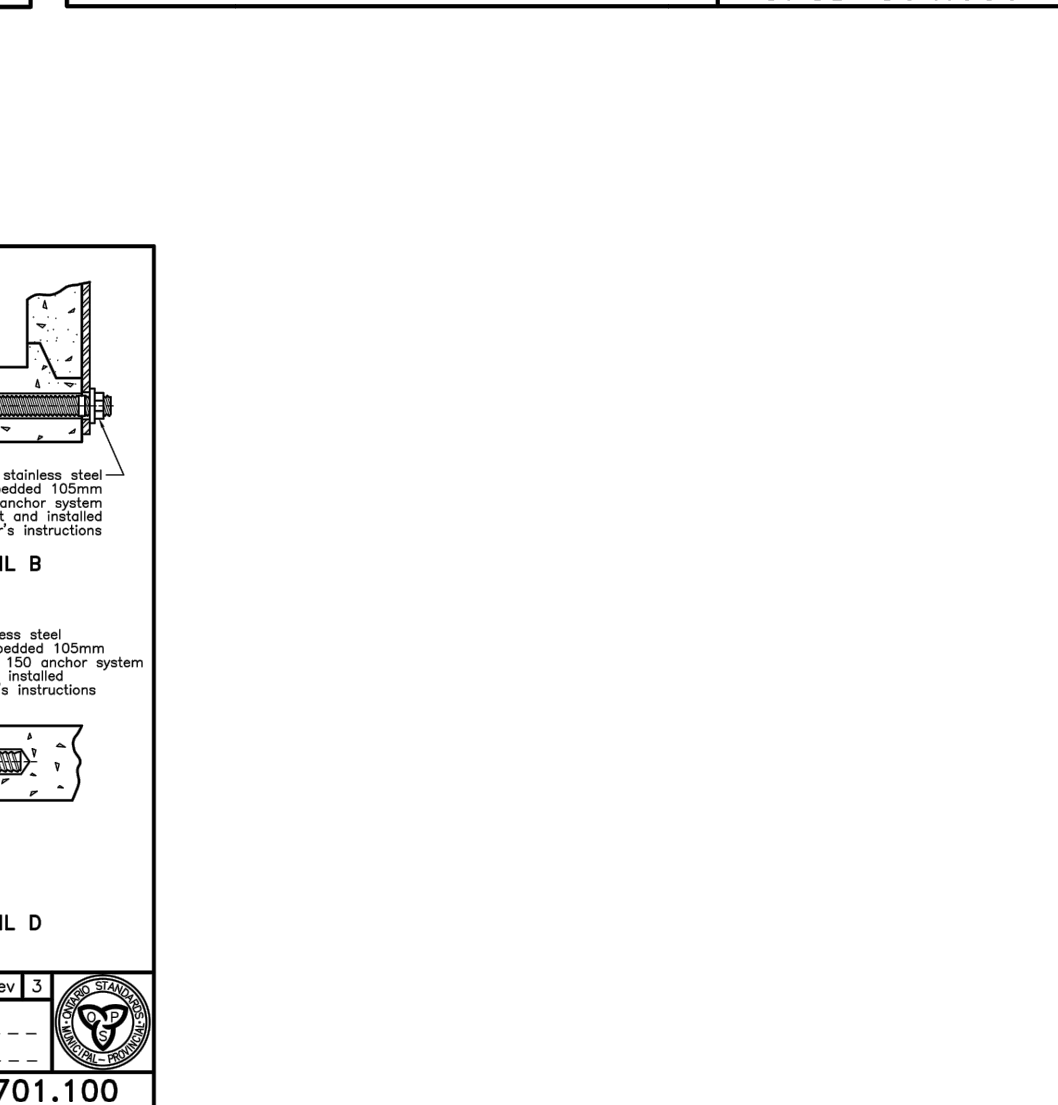
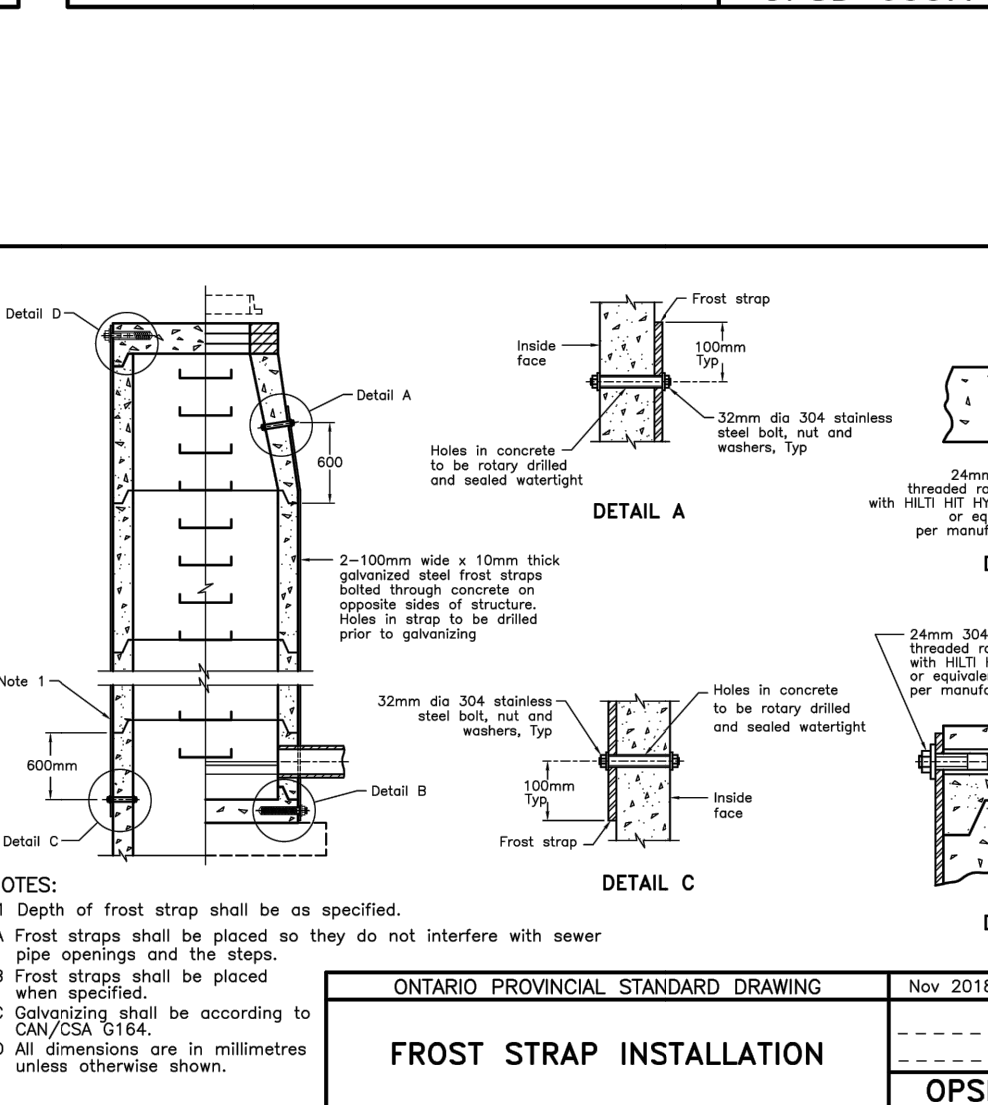
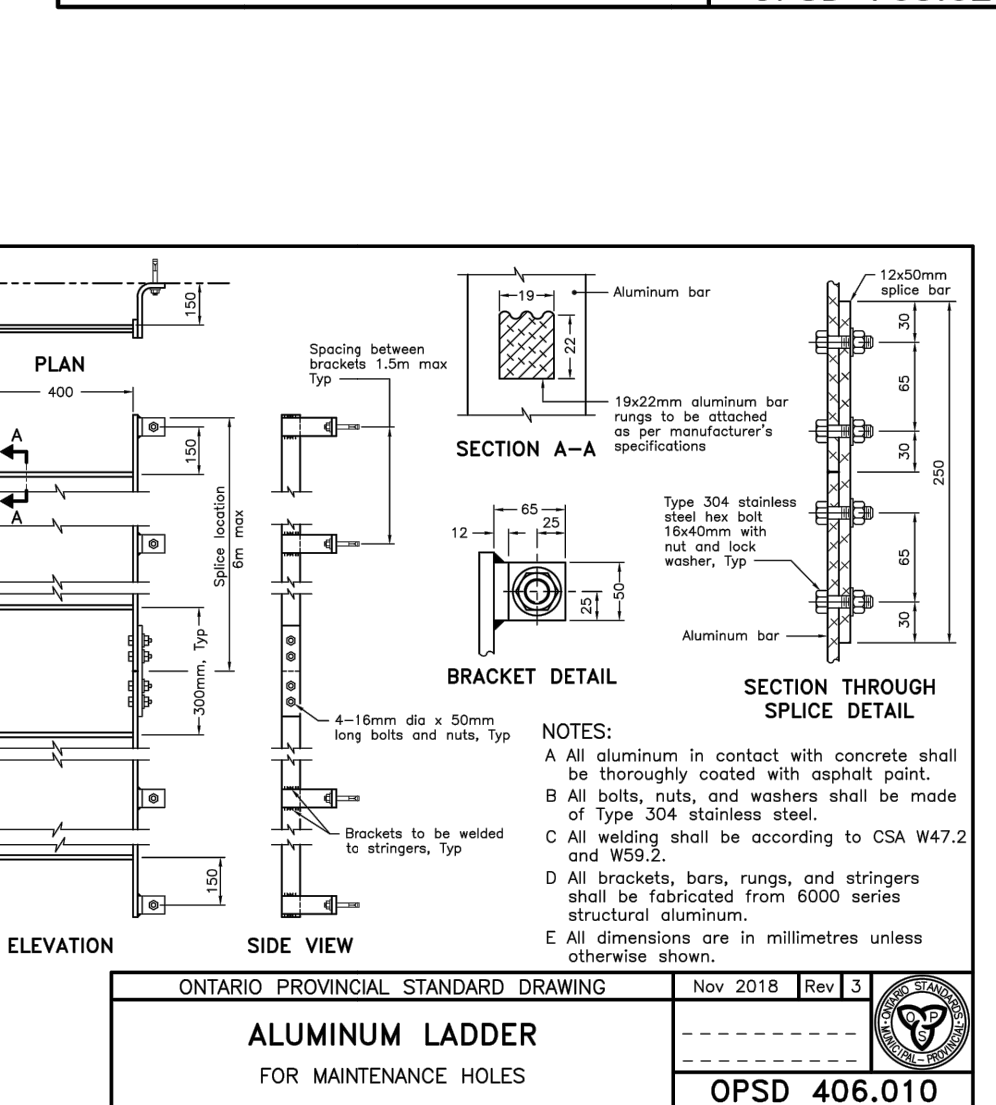
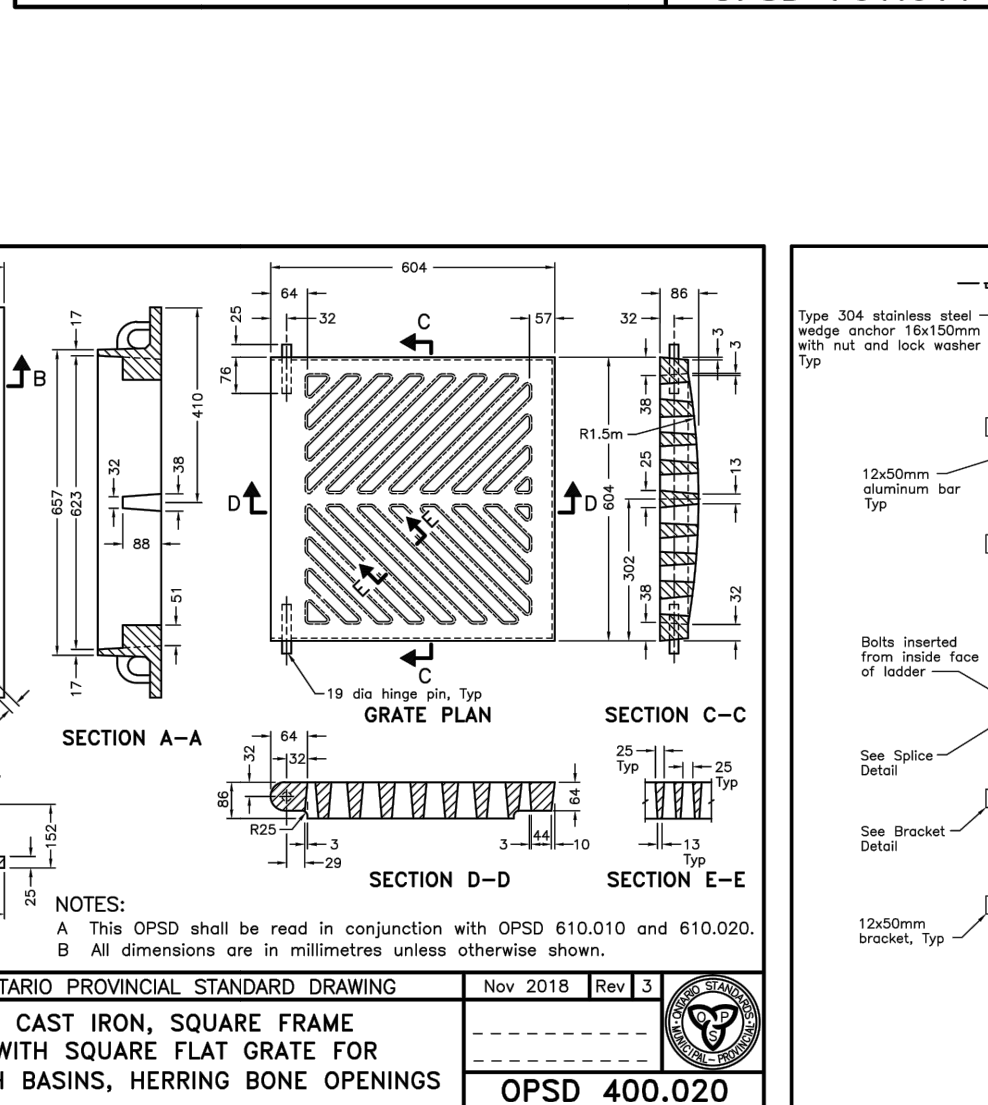
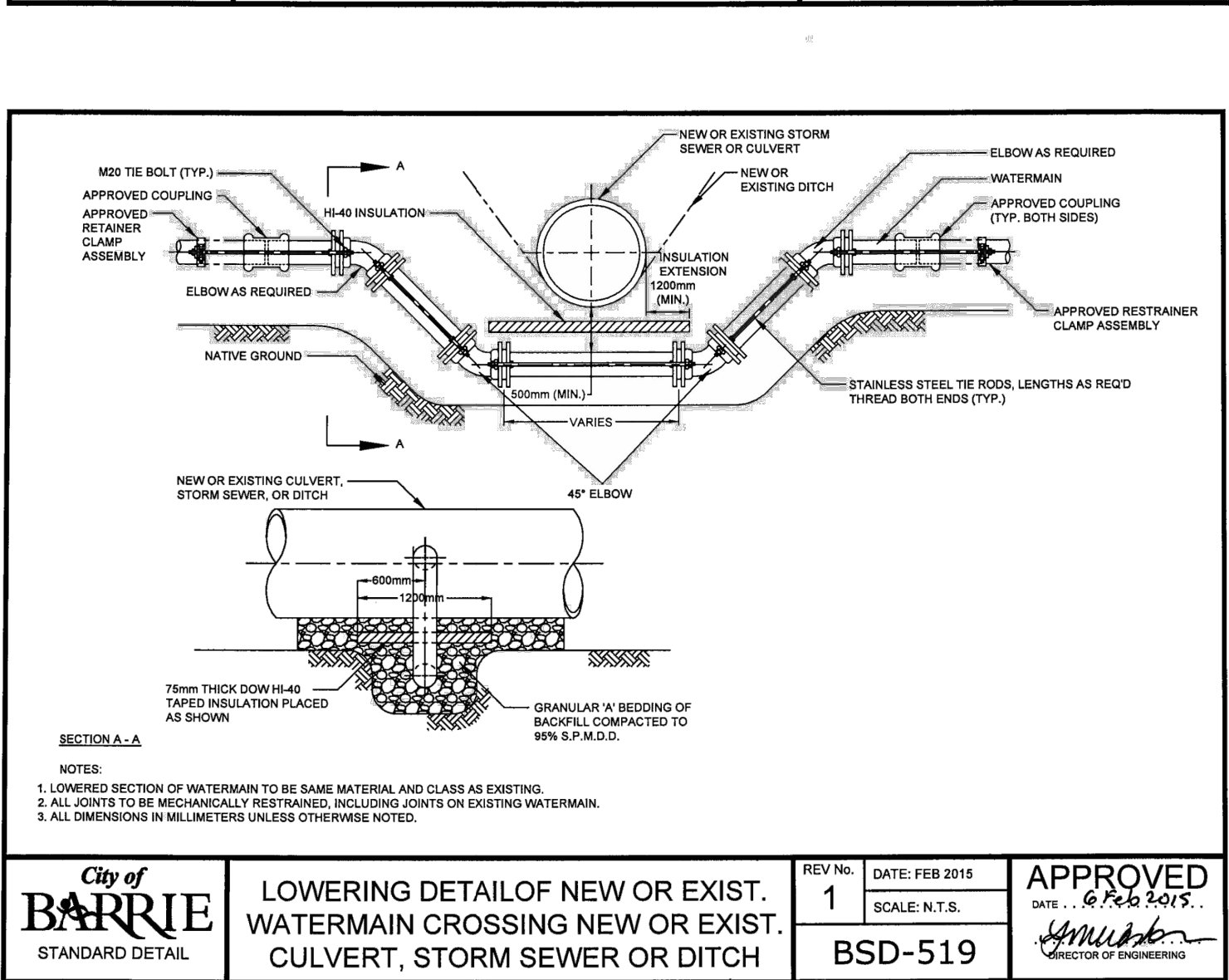
441 HURONIA ROAD SITE PLAN

## STANDARD DETAILS

|                                |
|--------------------------------|
| Designed<br><b>K. GRIFFIN</b>  |
| Project No.<br><b>2019-083</b> |
| Scale<br><b>AS NOTED</b>       |

|                     |                  |                      |
|---------------------|------------------|----------------------|
| Checked<br>C. CAPES | Date<br>20/04/24 | Drawing No.<br><br>C |
|                     | Rev No.<br>2     |                      |





|                                                                                                                                                                   |                         |                                                    |                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|----------------------------------------------------|---------------------------------------------------------------------------------------|
| Client<br>MR. BEHROOZ AZIZI                                                                                                                                       |                         | 441 HURONIA ROAD SITE PLAN<br><br>STANDARD DETAILS |                                                                                       |
| <br><br>355310 BLUE MOUNTAINS - EUPHRASIA TOWNLINE<br>CLARKSBURG, ON NOH 130 | Designed<br>K. GRIFFIN  | Checked<br>C. CAPES                                | Date<br>20/04/24<br><br>Drawing No.                                                   |
|                                                                                                                                                                   | Project No.<br>2019-083 |                                                    | Rev No.<br>2                                                                          |
|                                                                                                                                                                   | Scale<br>AS NOTED       |                                                    |  |
|                                                                                                                                                                   |                         |                                                    |                                                                                       |





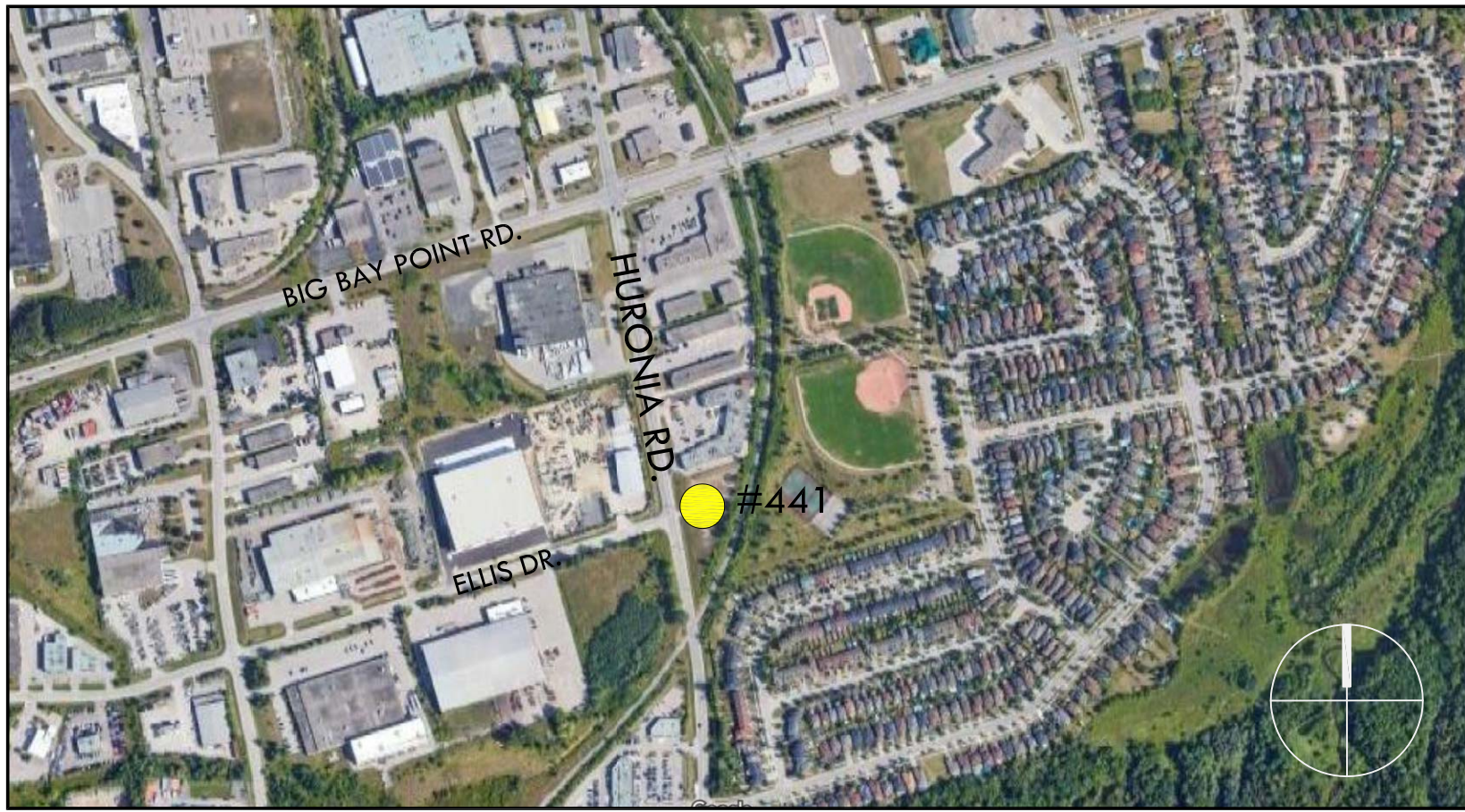


# Appendices

## Appendix A – Legal & Site Plan







|                                                                                          |                                                                                                                                                                                    |                                       |                                                                             |
|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-----------------------------------------------------------------------------|
| SITE STATISTICS:                                                                         |                                                                                                                                                                                    | REQUIRED                              | PROPOSED                                                                    |
|                                                                                          | LOT AREA: (POST ROAD WIDENING)                                                                                                                                                     | MIN. 700 M2                           | 4,655 M2 (1.15 ACRES)                                                       |
|                                                                                          | LOT FRONTAGE:                                                                                                                                                                      | MIN. 15.00 M                          | 121.92 M                                                                    |
|                                                                                          | TOTAL BLDG. GFA:                                                                                                                                                                   | N/A                                   | 902.90 M2 (±9,720 SF)<br><small>EXCL. BN STORAGE &amp; UTILITY ROOM</small> |
|                                                                                          | BUILDING COVERAGE:<br>- BUILDING (INCL. ROOF OVERHANGS);<br>- CAR PORT (x2);<br>TOTAL:                                                                                             |                                       | 985 M2<br>50 M2<br>1,035 M2                                                 |
|                                                                                          | LOT COVERAGE:                                                                                                                                                                      | MAX. 60%                              | 23% (ROUNDED UP)                                                            |
|                                                                                          | BUILDING HEIGHT:                                                                                                                                                                   | 14.00 M                               | AS SHOWN                                                                    |
|                                                                                          | SETBACKS:<br><br>FRONT YARD SETBACK:<br>SIDE YARD SETBACK:<br>REAR YARD SETBACK:<br>RAILROAD SETBACK:                                                                              | 6.00 M<br>3.00 M<br>7.00 M<br>15.00 M | 3.00 M<br>3.00 M (2.4M @ WL. PROJ.)<br>18.00 M<br>15.00 M                   |
|                                                                                          | PARKING & LOADING:<br><br>REGULAR PARKING: 1 SPACE PER 15M2<br>EV CHARGING STATIONS AS PER OBC 3.1.21.<br>BARRIER FREE PARKING: 2 PER 51-100 SPACES<br>LOADING SPACE: 0-999 M2 GFA | 61<br>NOT REQ'D<br>2<br>0             | 68<br>1 ROUGH-IN<br>4<br>0                                                  |
|                                                                                          | AREA CALCULATIONS:<br>TOTAL LANDSCAPED AREA:<br>TOTAL PAVED AREA:<br>TOTAL BUILDING AREA:<br>(POST ROAD WIDENING)                                                                  |                                       | 979 M2<br>2,742 M2<br>934 M2                                                |
| AVERAGE GRADE CALC. DIAGRAM:<br><br>PROPOSED GRADE 5.0M BEYOND FDN. AT<br>BLDG. CORNERS. |                                                                                                                                                                                    | AVG.GRADE: 262.50                     |                                                                             |

|                          |                                                                               |                                                      |                                                      |                                                      |
|--------------------------|-------------------------------------------------------------------------------|------------------------------------------------------|------------------------------------------------------|------------------------------------------------------|
| SIMPLIFIED O.B.C. MATRIX |                                                                               | UNIT 'A'                                             | UNIT 'B'                                             | UNIT 'C'                                             |
|                          | MAJOR OCCUPANCY CLASSIFICATION:                                               | 'D' - OFFICES                                        | 'D' - OFFICES                                        | 'D' - OFFICES                                        |
|                          | UNIT AREA (LEASABLE):                                                         | 523.05 M2                                            | 203.60 M2                                            | 176.25 M2                                            |
|                          | OCCUPANT LOAD:<br>TABLE 3.1.17.1.                                             | 60 PERSONS<br>(PER DESIGN)                           | 45 PERSONS<br>(203.60M2 /4.60)                       | 39 PERSONS<br>(176.25M2 /4.60)                       |
|                          | 3.2.2.56 GROUP D, UP TO 2 STOREYS, SPRINKLERED COMBUSTIBLE OR NON-COMBUSTIBLE |                                                      |                                                      |                                                      |
|                          | PLUMBING FIXTURE REQ'S:<br>3.7.4.2 (1) & TABLE 3.7.4.7                        | 38 OCCUPANTS<br>(AREA/14M2)<br><br>2 MALE + 2 FEMALE | 15 OCCUPANTS<br>(AREA/14M2)<br><br>1 MALE + 1 FEMALE | 13 OCCUPANTS<br>(AREA/14M2)<br><br>1 MALE + 1 FEMALE |
|                          |                                                                               |                                                      |                                                      |                                                      |

The Architect does not retain the consultants and therefore is not responsible for the accuracy of survey, structural, mechanical, electrical, etc. engineering information shown on the drawing. Refer to the appropriate engineering drawings before proceeding with work.

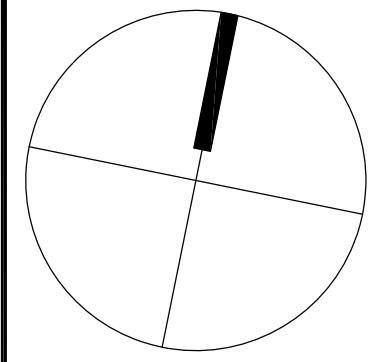
Contractor shall verify and check all dimensions and conditions on site prior to starting any of the work and report any discrepancy to the Architect and consultants before proceeding. Confirmation must conform to all applicable Codes and Requirements of Authorities having Jurisdiction pertaining to this application.

No investigation has been undertaken or reported on by this office in regards to the environmental condition or pollution of this site.

This drawing is not to be scaled.

All dimensions and areas to be confirmed on site by Ontario Land Surveyor.

|     |              |                                 |    |
|-----|--------------|---------------------------------|----|
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|     |              |                                 |    |
|     |              |                                 |    |
|     |              |                                 |    |
|     |              |                                 |    |
|     |              |                                 |    |
| 08  | MAY 13, 2020 | FOR SITE PLAN APPROVAL          | SZ |
| 07  | MAY 12, 2020 | FOR CLIENT APPROVAL             | SZ |
| 06  | MAY 06, 2020 | FOR REVIEW                      | SZ |
| 05  | APR 15, 2020 | REVISED BLDG. OUTLINE           | SZ |
| 04  | MAR 23, 2020 | REVISED FOR DISCUSSION          | SZ |
| 03  | JAN 16, 2020 | PRE-CONSULT MTG.                | SZ |
| 02  | DEC 10, 2019 | FOR PRE-CONSULT MTG. SUBMISSION | SZ |
| 01  | DEC 08, 2019 | FOR DISCUSSION                  | SZ |
| no. | date         | issued                          | by |



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| Date       | Time  | Location | Weather       | Temperature | Humidity | Wind Speed | Wind Direction | Notes                      |
|------------|-------|----------|---------------|-------------|----------|------------|----------------|----------------------------|
| 2023-10-27 | 08:00 | Forest A | Clear         | 15°C        | 65%      | 10 km/h    | SE             | Initial survey             |
| 2023-10-27 | 10:30 | Forest A | Clear         | 18°C        | 60%      | 12 km/h    | SE             | Observing bird activity    |
| 2023-10-27 | 13:00 | Forest B | Partly Cloudy | 22°C        | 55%      | 15 km/h    | SW             | Monitoring insect behavior |
| 2023-10-27 | 15:30 | Forest B | Partly Cloudy | 20°C        | 50%      | 18 km/h    | SW             | Collecting soil samples    |
| 2023-10-27 | 18:00 | Forest A | Clear         | 16°C        | 68%      | 10 km/h    | SE             | End of day summary         |
| 2023-10-28 | 07:00 | Forest A | Clear         | 14°C        | 70%      | 8 km/h     | SE             | Morning observations       |
| 2023-10-28 | 09:30 | Forest A | Clear         | 17°C        | 65%      | 11 km/h    | SE             | Bird sightings             |
| 2023-10-28 | 12:00 | Forest B | Partly Cloudy | 21°C        | 58%      | 14 km/h    | SW             | Insect collection          |
| 2023-10-28 | 14:30 | Forest B | Partly Cloudy | 19°C        | 52%      | 16 km/h    | SW             | Soil analysis              |
| 2023-10-28 | 17:00 | Forest A | Clear         | 15°C        | 72%      | 9 km/h     | SE             | Final report               |
| 2023-10-29 | 06:00 | Forest A | Clear         | 13°C        | 75%      | 7 km/h     | SE             | Early morning data         |
| 2023-10-29 | 08:30 | Forest A | Clear         | 16°C        | 68%      | 10 km/h    | SE             | Bird activity              |
| 2023-10-29 | 11:00 | Forest B | Partly Cloudy | 20°C        | 55%      | 13 km/h    | SW             | Insect study               |
| 2023-10-29 | 13:30 | Forest B | Partly Cloudy | 18°C        | 50%      | 15 km/h    | SW             | Soil sampling              |
| 2023-10-29 | 16:00 | Forest A | Clear         | 14°C        | 70%      | 9 km/h     | SE             | Summary                    |
|            |       |          |               |             |          |            |                |                            |

PROJECT TITLE

441 HURONIA RD., BARRIE, ON

SHEET TITLE

## SITE PLAN



DATE  
Dec. 2019

DATE PLOTTED  
11-10-2000

PROJECT NO.

19118

DRAWN BY  
SZ

CHECKED BY  
SZ

DRAWING NO.

# A1

SCALE 1:250

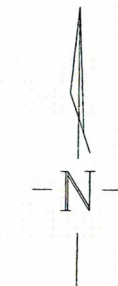
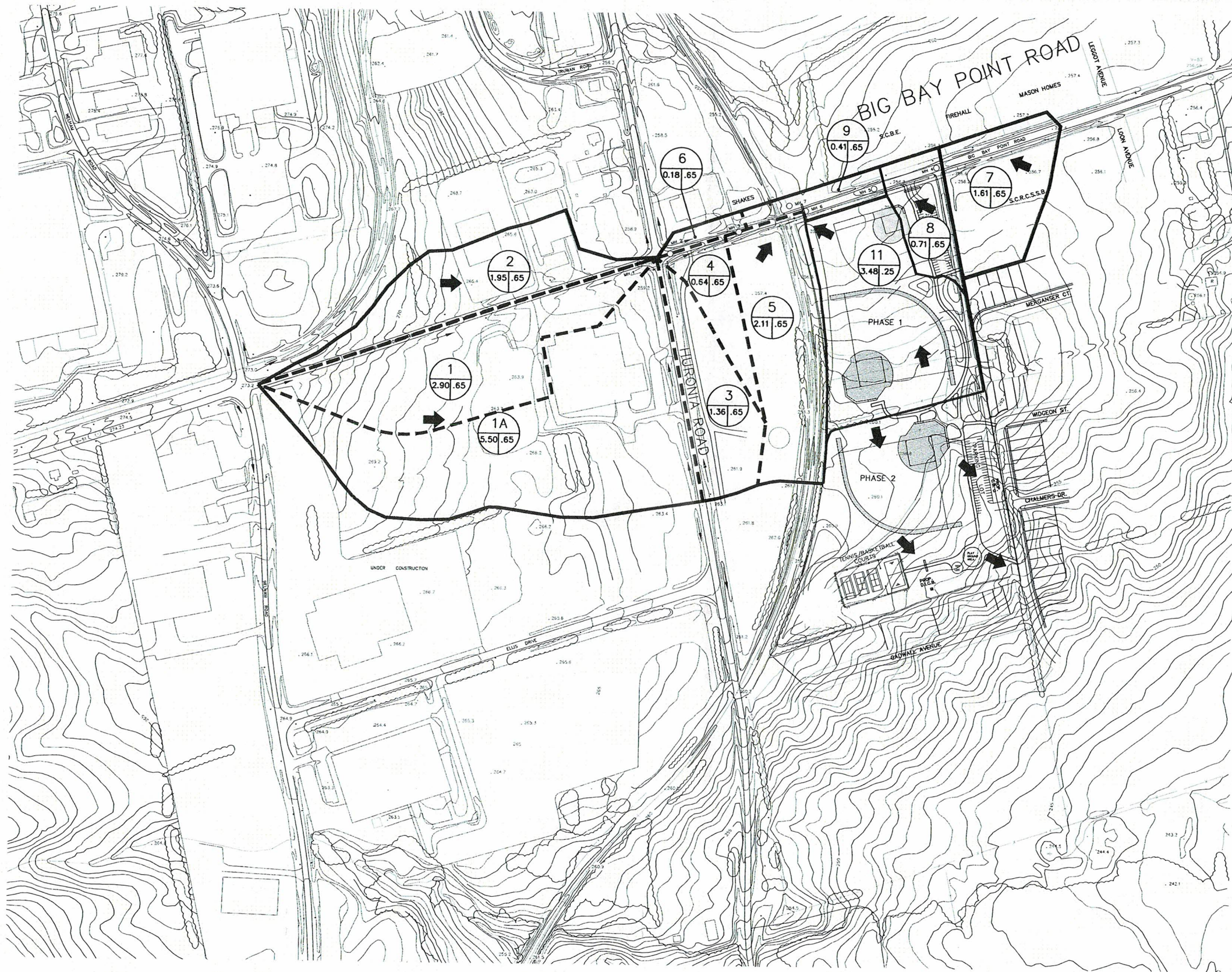
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## Appendix B – Background Information



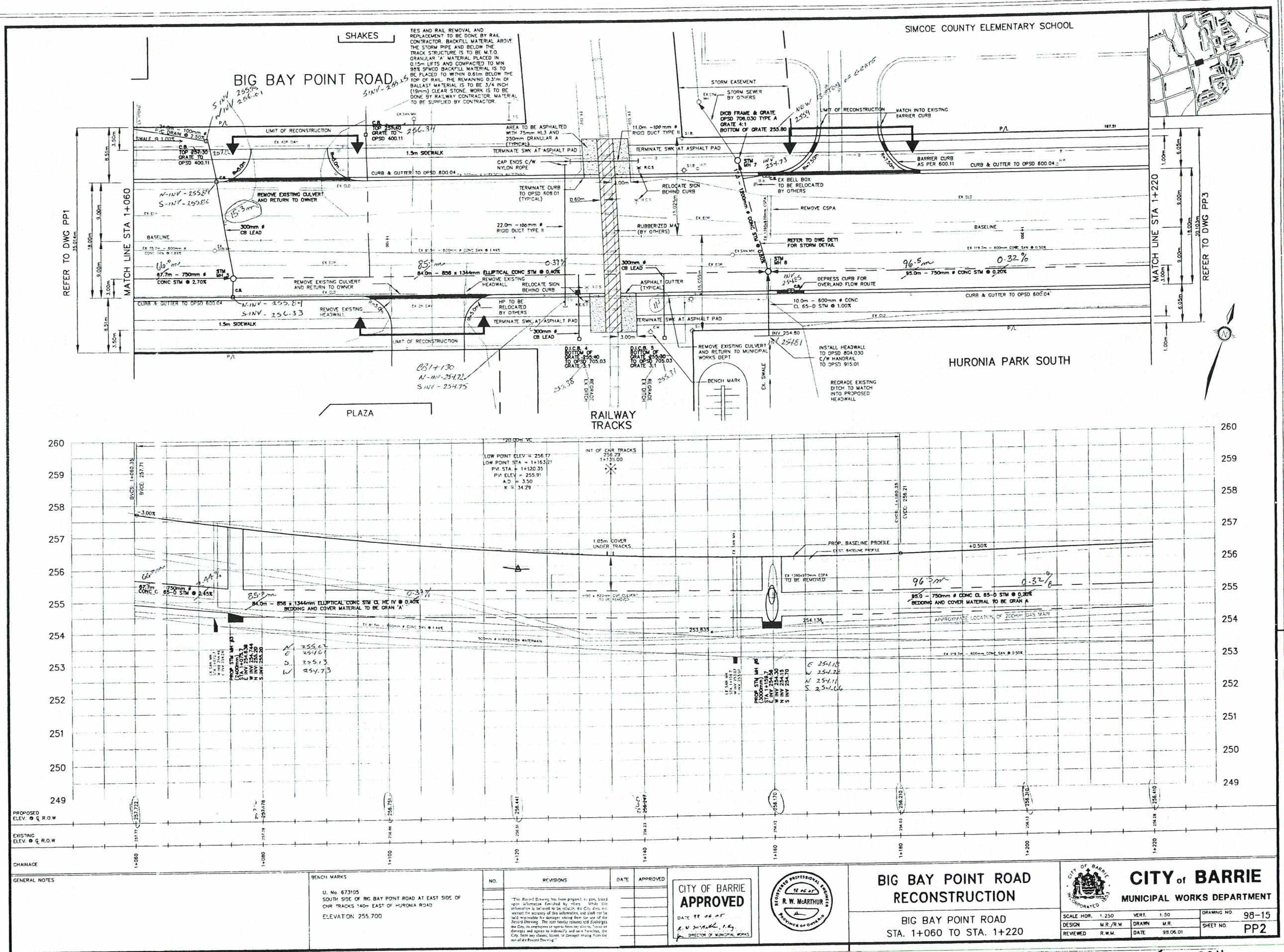


### LEGEND

- DRAINAGE BOUNDARY
- - - SUB-DRAINAGE BOUNDARY
- ➔ DIRECTION OF FLOW
- 1 — AREA #
- 1 — RUN-OFF COEFFICIENT
- 1 — AREA IN (ha)

| <p>GENERAL NOTES</p> | <p>BENCH MARKS</p> | <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NO.</th> <th>REVISIONS</th> <th>DATE</th> <th>APPROVED</th> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table> | NO.      | REVISIONS | DATE | APPROVED |  |  |  |  |  |  |  |  |  |  |  |  | <p><b>CITY OF BARRIE</b><br/>APPROVED<br/>DATE 98.06.05<br/>R. W. McARTHUR<br/>DIRECTOR OF MUNICIPAL WORKS</p> | <p><b>BIG BAY POINT ROAD RECONSTRUCTION</b><br/><br/>STORM DRAINAGE PLAN</p> | <p><b>CITY of BARRIE</b><br/>MUNICIPAL WORKS DEPARTMENT</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>SCALE HOR. 1:2000</td> <td>VERT. —</td> <td>DRAWING NO. 98-15</td> </tr> <tr> <td>DESIGN M.R./R.M.</td> <td>DRAWN M.R.</td> <td>SHEET NO. STM1</td> </tr> <tr> <td>REVIEWED R.W.M.</td> <td>DATE 98.06.01</td> <td> </td> </tr> </table> | SCALE HOR. 1:2000 | VERT. — | DRAWING NO. 98-15 | DESIGN M.R./R.M. | DRAWN M.R. | SHEET NO. STM1 | REVIEWED R.W.M. | DATE 98.06.01 |  |
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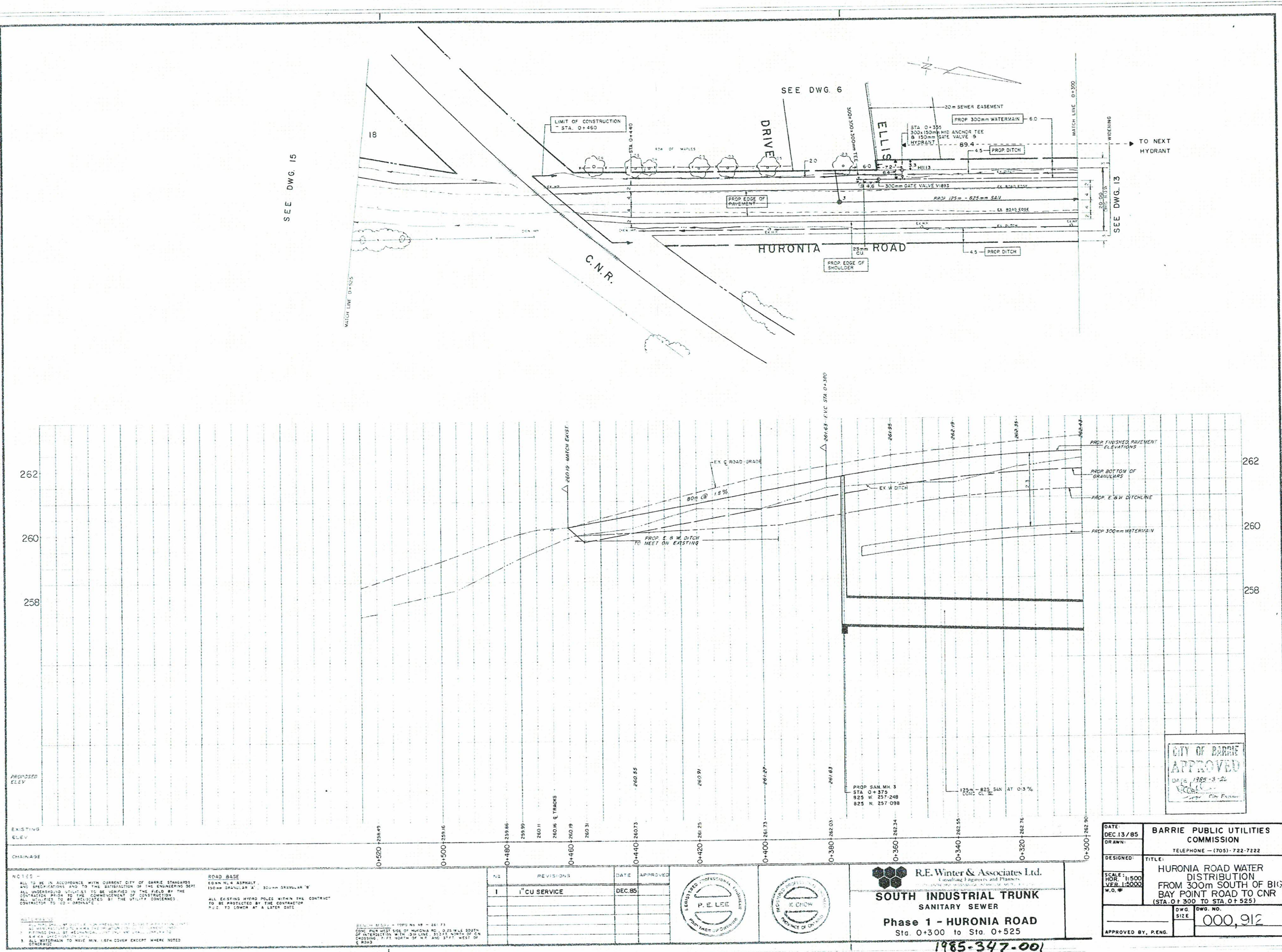




S1E,000.0M.DWG

DWG. NO. 000,912

DWG. NO.  
000,912









## Appendix C – Geotechnical Information



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## **GEOTECHNICAL REPORT**

Proposed Commercial Development  
441 Huronia Road  
Barrie, Ontario

Prepared For: Dr. Behrooz Azizi  
Type of Document: Final Report  
Reference Number: 19-1243A  
Prepared By: Russell Wiginton, P.Eng.  
Reviewed By: Alexander Winkelmann, P.Eng.  
Date Issued: January 9, 2020



## Table of Contents

|          |                                                          |           |
|----------|----------------------------------------------------------|-----------|
| <b>1</b> | <b>Introduction .....</b>                                | <b>1</b>  |
| <b>2</b> | <b>Procedures and Methodology .....</b>                  | <b>1</b>  |
| <b>3</b> | <b>Subsurface Conditions .....</b>                       | <b>2</b>  |
| 3.1      | General Overview .....                                   | 2         |
| 3.2      | Stratigraphy.....                                        | 2         |
| 3.3      | Ground Water .....                                       | 3         |
| <b>4</b> | <b>Engineering Design Parameters &amp; Analysis.....</b> | <b>3</b>  |
| 4.1      | Foundation Design.....                                   | 4         |
| 4.2      | Seismic Site Classification .....                        | 4         |
| 4.3      | Earth Pressures .....                                    | 5         |
| 4.4      | Slab on Grade Design .....                               | 6         |
| 4.5      | Site Servicing .....                                     | 6         |
| 4.6      | Pavement Design .....                                    | 7         |
| <b>5</b> | <b>Constructability Considerations .....</b>             | <b>9</b>  |
| 5.1      | Excavations and Temporary Groundwater Control .....      | 9         |
| 5.2      | Compaction Specifications .....                          | 9         |
| 5.3      | Quality Verification Services .....                      | 10        |
| 5.4      | Site Work .....                                          | 11        |
| <b>6</b> | <b>Limitations and Conclusion.....</b>                   | <b>11</b> |
| 6.1      | Limitations.....                                         | 11        |
| 6.2      | Conclusion .....                                         | 12        |

### Figures

Figure 1 – Site Location Plan

Figure 2 – Borehole Location Plan

### Appendices

Appendix A – Borehole Logs

Appendix B – Geotechnical Laboratory Data

Appendix C – Typical Details

# 1 Introduction

Central Earth Engineering Inc. (CEE) was retained by Dr. Behrooz Azizi to complete a geotechnical investigation and report for the proposed commercial development located at 441 Huronia Road, in Barrie, Ontario. A site location plan is provided as Figure 1. The existing property is approximately 0.5 hectares in size and triangular. The property is currently a vacant field and is bounded by Huronia Road to the west, an existing commercial plaza to the north and a railway to the southeast. The site is relatively flat with grades ranging from about Elev. 261 to 262 metres. CEE is completing a hydrogeological study for the site under a separate cover.

CEE was provided with the following drawing set in preparation of this report:

- *“Huronia Road Development, 441 Huronia Road, Barrie, Ontario”, by Gerrits Engineering Limited.*

This drawing set indicates a 2-storey office building with no underground levels will be constructed in the northwest corner of the site, and the remaining parts of the property will be parking and driving areas. It is understood that the drawing set is preliminary and is subject to change (e.g. the building location may change, the number of storeys may be reduced, etc.). No grading plans were provided to CEE but significant grade changes are not expected. It is expected that the site will be municipally serviced.

The purpose of the geotechnical investigation was to assess the subsurface soil conditions at the site by advancing four (4) exploratory boreholes and to provide geotechnical engineering recommendations in support of the proposed commercial development. The borehole locations are shown on Figure 2. This report summarizes the borehole findings, provides design recommendations for foundations, slabs on grade, earth pressures, seismic site classification and pavements, and provides considerations for constructability such as soil excavation, compaction, and temporary groundwater control.

# 2 Procedures and Methodology

Prior to the commencement of drilling activities, the locations of underground utilities including natural gas, electrical, telephone, water, etc. were marked out by public and private utility locating companies. The fieldwork for the drilling program was carried out on December 12<sup>th</sup>, 2019. A total of four boreholes (Boreholes 1 to 4) were advanced on site by Drilltech Drilling using a track-mounted drill rig, continuous flight solid stem augers and standard soil sampling equipment.

All samples were collected as per ASTM D1586 to assess the strength characteristics of the substrate. The boreholes were advanced to depths of 6.5 to 9.6 metres below existing grade. The horizontal locations were laid out in the field by CEE prior to the drilling operations. Ground surface elevations of the boreholes were measured using laser level survey equipment in reference to a geodetic benchmark (Cosine Station #00119713848) with a known geodetic elevation of 261.316 metres in reference to datum CGVD2013. GPS measurements measured with a handheld GPS unit and referenced to the NAD 83. Monitoring wells were installed in Boreholes 1, 2, and 4 to facilitate long-term measurements of groundwater levels.

The CEE field staff examined and classified characteristics of the soils encountered in the boreholes, including the presence of fill materials, made groundwater observations during and upon completion of the drilling, recorded observations of borehole construction, and processed the recovered samples. Soil sampling was conducted at



regular intervals for the full depth of the borehole. The boreholes were backfilled upon completion. All recovered soil samples were logged in the field, carefully packaged and transported to the laboratory for more detailed examination and classification. In the laboratory, the samples were classified as to their visual and textural characteristics and geotechnical laboratory testing was carried out with the results included in Appendix B. Stabilized groundwater levels were measured in the three installed monitoring wells on December 20<sup>th</sup>, 2019.

## 3 Subsurface Conditions

### 3.1 General Overview

The detailed soil profiles encountered in the boreholes are indicated on the attached borehole logs in Appendix A. The borehole locations are shown on Figure 2 and geotechnical laboratory test results are included as Appendix B. It should be noted that the conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the borehole locations. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change.

In addition, the descriptions provided in the borehole logs are inferred from a variety of factors, including: visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (speed of drilling, shaking/grinding of the augers, etc.). The passage of time also may result in changes in conditions interpreted to exist at locations where sampling was conducted.

### 3.2 Stratigraphy

#### 3.2.1 Topsoil and Earth Fill

Borehole 1 encountered 100 mm of topsoil at the ground surface, and Borehole 4 encountered a surficial zone of earth fill that was mixed with topsoil.

Underlying the topsoil in Borehole 1 and at the ground surface in Boreholes 2 to 4, a surficial zone of earth fill was encountered that consisted of silt and sand to silty sand with trace clay and trace gravel. The earth fill extended to depths of 1.5 to 2.3 metres below grade (Elev. 259.6 to 260.6 metres) and was brown and moist. The full depth of earth fill in Borehole 4 was mixed with topsoil and was dark brown. The Standard Penetration Test (SPT) results ("N" Values) measured in the earth fill ranged from 5 to 18 blows per 300 mm of penetration, indicating a loose to compact relative density.

#### 3.2.2 Glacial Till

Underlying the earth fill, Borehole 2 encountered a glacial till deposit with a cohesive matrix consisting of clayey and sandy silt with trace gravel and trace organics. The clayey silt glacial till was encountered at a depth of 1.5 metres below grade (Elev. 260.6 metres) and extended to a depth of 3.1 metres (Elev. 259.1 metres). The clayey silt glacial till was dark brown and moist, and the measured Standard Penetration Test (SPT) results ("N" Values) were 3 and 9, indicating a soft to stiff consistency. The disturbed soil samples collected from the split spoon sampler were also tested using a pocket penetrometer to obtain a general sense of the undrained shear strength

of the deposit. The pocket penetrometer testing indicated that the undrained shear strength ranged from approximately 150 to 225 kPa.

Underlying the earth fill in Boreholes 1, 3, and 4, and underlying the clayey silt glacial till in Borehole 2, a glacial till deposit was encountered with a cohesionless matrix consisting of silty sand with trace to some clay and trace gravel. The silty sand glacial till was encountered at depths of 1.5 to 3.1 metres below grade (Elev. 260.5 to 259.1 metres) and extended beyond the vertical depth of investigation at 6.5 to 9.6 metres below grade (Elev. 255.3 to 251.8 metres). The silty sand glacial till was brown and moist, and the measured SPT "N" Values ranged from 11 to greater than 100 blows per 300 mm of penetration, indicating a compact to very dense (but generally very dense) relative density.

### 3.3 Ground Water

Unstabilized ground water level measurements and cave measurements were taken upon completion of drilling of each borehole. These measurements provide a rough estimate of the possible excavation and temporary ground water control constructability considerations that may arise. The boreholes remained open and dry. 50 mm diameter PVC monitoring wells were installed in Boreholes 1, 2, and 4 to facilitate the measurement of stabilized groundwater levels. The results are shown on the borehole logs in Appendix A and are summarized in the table below.

| Monitoring Well | Well Screen Location |                | Strata Screened         | Depth / Elevation (m) of Groundwater Table |                              |
|-----------------|----------------------|----------------|-------------------------|--------------------------------------------|------------------------------|
|                 | Depth (m)            | Elevation (m)  |                         | Dec. 12 <sup>th</sup> , 2019               | Dec. 20 <sup>th</sup> , 2019 |
| 1               | 7.6 to 9.1           | 254.4 to 252.9 | Silty Sand Glacial Till | 8.2* / 253.5                               | 5.3 / 250.6                  |
| 2               | 7.6 to 9.1           | 254.6 to 253.1 |                         | Dry                                        |                              |
| 4               | 7.6 to 9.1           | 253.6 to 252.1 |                         |                                            |                              |

\*Water level measured same day as drilling and may not represent a stabilized level.

Based on the above groundwater level measurements and moisture contents of the recovered soil samples, it is expected that the groundwater table is at or below a depth of 5.3 metres below grade. The wells installed in Boreholes 2 and 4 were dry. It is possible that the well installed in Borehole 1 captured a zone of perched water within the glacial till deposit rather than the prevailing groundwater table.

The silty sand glacial till deposit is cohesionless but contains more than 30% fines and will have a relatively lower permeability that typically precludes the free flow of water when wet. Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions.

Additional groundwater considerations and data is provided in the hydrogeological study being prepared by CEE under a separate cover.

## 4 Engineering Design Parameters & Analysis

It is currently proposed to construct a 2-storey office building with no underground levels in the northwest corner of the site, and the remaining parts of the property will be parking and driving areas. It is understood that the proposed development plan is preliminary and is subject to change (e.g. the building location may change, the



number of storeys may be reduced, etc.). No grading plans were provided to CEE but significant grade changes are not expected. It is expected that the site will be municipally serviced.

## 4.1 Foundation Design

The topsoil and earth fill encountered beneath the site are not suitable for the support of new foundations. The undisturbed glacial till deposits encountered at depths of 1.5 to 2.3 metres below existing grades (Elev. 260.6 to 259.6 metres) are suitable to support new foundations.

Foundations at this site may be constructed as conventional spread and strip footing foundations that extend down to bear on the undisturbed clayey silt to silty sand glacial till at Elev. 260.6 to 259.6 metres. The foundations can be designed using a geotechnical reaction at SLS of 150 kPa, for 25 mm or less of total settlement. The factored geotechnical resistance at ULS is 225 kPa.

It is important to note that these bearing capacities are applicable for foundations set onto undisturbed glacial till that was encountered at 1.5 to 2.3 metres below existing grades. If the grade is raised prior to foundation construction, the foundations must be extended through any new grade raise in addition to the required depth to reach the competent bearing elevation.

The minimum strip and spread footing widths to be used shall be dictated as per the Ontario Building Code, regardless of loading considerations. Footings stepped from one level to another must be at a slope not exceeding 7 vertical to 10 horizontal. This concept should also be applied to excavations for new foundations in relation to existing footings or underground services unless rigid shoring is provided. All footings exposed to ambient air temperature throughout the year must be provided with a minimum of 1.2 metres of earth cover or equivalent insulation for frost protection.

The foundation design parameters provided below are predicated on the assumption that the foundation subgrade surface is undisturbed, and that all deleterious, softened, disturbed, organic, and caved material is removed. The foundation excavation must be done in such a way that groundwater is controlled to prevent any disturbance to the foundation base. Temporary groundwater control is discussed in Section 5.2.

The foundation subgrade must be reviewed by a geotechnical engineer prior to concrete placement to ensure the below foundation design parameters are applicable, and to provide remedial recommendations if necessary. If the foundation excavation will be open for a prolonged period of time, the foundation subgrade should be protected with a skim coat of lean mix concrete (after inspection by the geotechnical engineer), to ensure that no deterioration will occur due to weather effects.

## 4.2 Seismic Site Classification

Section 4.1.8.4 of the Ontario Building Code provides values of the acceleration and velocity-based site coefficients ( $F_a$  and  $F_v$ ) for various time periods, associated with specific Site Classes. These Site Classes are based on the energy-corrected Average Standard Penetration Resistance values and undrained shear strength within the upper 30 metres of soil underlying the grade beams or foundations of the proposed structure. As the boreholes were advanced less than this depth at the site, the site classification recommendation provided below assumes that the soil conditions are similar below the drilled depth.

Underneath the proposed foundations, the soil will consist of cohesive glacial till with an undrained shear strength of greater than 150 kPa, or a generally very dense cohesionless glacial till. Based on this, the Site Classification for this site is "C".

### 4.3 Earth Pressures

Underground levels, basements, retaining walls, cantilevered shoring walls and shoring walls with a single level of earth anchors all must be designed to resist unbalanced lateral earth pressures imparted from the weight of adjacent soils. Lateral earth pressures are calculated using the following equation:

$$P = K[\gamma h + q]$$

where,

- P** = the horizontal pressure at depth, **h** (m)
- K** = the earth pressure coefficient (dimensionless)
- h** = depth below surface in metres
- γ** = the bulk unit weight of soil, (kN/m<sup>3</sup>)
- q** = surcharge loading (kPa)

The above equation assumes that a drainage system is present which prevents the build up of any hydrostatic pressure behind the structure subjected to the unbalanced lateral earth pressures. If this is not the case, the equation must be revised to also incorporate the submerged unit weight of the soil multiplied by the earth pressure coefficient, in addition to the water pressure itself.

The values for use in the design of structures subjected to unbalanced lateral earth pressures at this site are as follows:

| Soil Type                | γ - Bulk Unit Weight (kN/m <sup>3</sup> ) | φ - Friction Angle (degrees) | Earth Pressure Coefficient (dimensionless) |                          |                          |
|--------------------------|-------------------------------------------|------------------------------|--------------------------------------------|--------------------------|--------------------------|
|                          |                                           |                              | K <sub>a</sub> - Active                    | K <sub>o</sub> - At-Rest | K <sub>p</sub> - Passive |
| Granular 'B' (OPSS 1010) | 21.0                                      | 32                           | 0.31                                       | 0.47                     | 3.25                     |
| Earth Fill               | 19.0                                      | 30                           | 0.33                                       | 0.50                     | 3.00                     |
| Clayey Silt Glacial Till | 21.0                                      | 32                           | 0.31                                       | 0.47                     | 3.25                     |
| Silty Sand Glacial Till  | 21.0                                      | 36                           | 0.26                                       | 0.41                     | 3.85                     |

The calculation of the earth pressure coefficients is based on Rankine theory, which provides a conservative estimate as no friction between the soil and the structure is accounted for. The earth pressure coefficients provided above are only applicable for flat ground surfaces beyond the structure and must be increased for sloping ground surfaces.

The earth pressure coefficients referenced within the above table are a function of the friction angle of the adjacent soil, and both the degree and direction of movement of the structure subjected to unbalanced lateral earth pressures. For structures that are restrained at the top (such as basement walls), the at-rest earth pressure coefficient will apply. For structures that allow for 0.1 to 1% of movement away from the soil, the full active earth



pressure coefficient will apply. For structures that allow for 1 to 10% of movement into the soil, the full passive earth pressure coefficient will apply. The percentage movement is based on the height of the structure.

Other types of structures such as shoring walls with multiple rows of tiebacks and soil nail walls are subject to different loading conditions and must be analyzed separately.

## 4.4 Slab on Grade Design

The topsoil and earth fill encountered in Borehole 4 (containing topsoil throughout) are not suitable for the support of a slab on grade. Proof-rolled and approved earth fill free of excessive organics and neatly cut and inspected glacial till deposits are suitable for the support of a lightly loaded unreinforced concrete slab on grade.

The subgrade for the slab on grade must be assessed by the geotechnical engineer, prior to the placement of an aggregate base. If any soft or weak subgrade areas are identified, or if there are areas containing excessive amounts of moisture or deleterious/organic material, they must be locally sub-excavated and backfilled with approved clean earth fill or imported granular material and compacted to a minimum of 98% SPMDD. The modulus of subgrade reaction appropriate for design of a slab on grade on approved earth fill is 25,000 kPa/m, and the modulus of subgrade reaction appropriate for design of a slab on undisturbed glacial till is 50,000 kPa/m.

All building floor slabs must be provided with a capillary moisture barrier and drainage layer. This is made by placing the concrete slab on a minimum 200 mm layer of 19 mm clear stone (OPSS.MUNI 1004) compacted by vibration to a dense state. The upper 50 mm of clear stone can be replaced with 19 mm crusher run limestone for a working surface.

The proposed commercial building has no basement levels or other below-grade space. Perimeter and under-slab drainage at the foundation level is not required, provided that the underside of concrete slab is at least 200 mm above the prevailing grade of the site and the surrounding surfaces slope away from the building at a gradient of at least 2% to promote surface water run-off and to reduce groundwater infiltration adjacent to foundations. To minimize infiltration of surface water, the upper 150 mm of backfill could comprise relatively impervious compacted soil material.

## 4.5 Site Servicing

### 4.5.1 Bedding

The type of material and depth of granular bedding below the pipe will, to some extent, depend on the method of construction used by the contractor. Pipe bedding for flexible pipes should follow the requirements in Ontario Provincial Standard Drawing 802.010 or 802.013 or applicable municipal standards. Pipe bedding for rigid pipes should follow the requirements in Ontario Provincial Standard Drawings 802.030 to 802.033 or applicable municipal standards.

A subgrade consisting of earth fill or glacial till will provide adequate support for pipes with the bedding requirements as laid out in the above referenced OPS drawings. Where disturbance of the trench base has occurred from groundwater seepage, construction traffic, etc., the disturbed soils should be sub-excavated and replaced with suitably compacted granular fill. If weak zones are encountered, additional bedding materials and differing construction practices may be required and should be determined during construction.

Regardless of whether flexible or rigid pipes are implemented, granular bedding and cover material should consist of a well graded, free draining material, such as Granular 'A' (OPSS.MUNI 1010). All granular bedding must be compacted to a minimum of 95% SPMDD. Clear stone or high-performance bedding is permitted at this site provided it is fully wrapped in a non-woven filter fabric.

#### 4.5.2 Backfill

Excavated native soils and earth fill may be used as backfill in trenches provided the moisture content is within 2% of optimum. The backfill should be compacted to a minimum of 95% SPMDD. Below pavement areas, the backfill should be compacted to 98% SPMDD. In confined areas the layer thickness will have to be reduced to utilize smaller compaction equipment efficiently or by using granular material instead of locally sourced fill. Any backfill that is frozen, contains a high percentage of organic material (topsoil, peat, etc.) or moisture, or has otherwise unsuitable deleterious inclusion should not be used as backfill. The maximum cobble or boulder size should not exceed half of the loose lift thickness (i.e. all particles with a diameter greater than 100 mm should be removed).

Where trenches are within the traveled portions of a roadway, backfill within the frost penetration depth of 1.2 metres should consist of native, non-organic, excavated material consistent with the soils surrounding the trench. If this technique is not undertaken, then frequently problems arise with yearly differential frost heave movements between the trench backfill and the adjacent native soil. This would occur, for example, if imported granular fill was used to backfill the trenches instead of glacial till which is more susceptible to frost effects. Alternatively, if different soil is used as the backfill due to issues with achieving compaction, a frost taper of 5H:1V can be implemented to help mitigate the potential for differential settlement and frost heave.

### 4.6 Pavement Design

#### 4.6.1 Subgrade Preparation

New parking and driving areas will be constructed as part of the proposed commercial development. It is expected that subgrade soils below a pavement structure at the site will consist of earth fill. The earth fill will be an adequate subgrade for the support of a pavement structure, provided the subgrade is proof-rolled and approved by a geotechnical engineer at the time of construction and does not contain excessive amounts of organics, moisture or deleterious materials. The earth fill encountered in Borehole 4 (containing topsoil throughout) may not be a suitable subgrade for the pavement structure and will have to be assessed on site to determine if it must be sub-excavated and replaced with approved earth fill. The pavement subgrade should be compacted to a minimum of 98% SPMDD. It is anticipated that the subgrade bearing modulus will be 25,000 kPa/m.

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

#### 4.6.2 Drainage

Control of surface water is an important factor in achieving a good pavement life. The need for adequate subgrade drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (at a minimum grade



of 3 percent) to provide effective drainage toward subgrade drains. Grading adjacent to pavement areas should be designed to ensure that water is not allowed to pond adjacent to the outside edges of the pavement.

Continuous pavement subdrains should be provided along the edges of the parking area and drained into respective catchbasins to facilitate drainage of the subgrade and the granular materials. The subdrain invert should be maintained at least 0.3 metres below subgrade level. To minimize the problems of differential movement between the pavement and catchbasins/manholes due to frost action, the backfill around the structures should consist of free-draining granulars. Typical pavement drainage details are included in Appendix C.

#### 4.6.3 Pavement Structure

The industry pavement design methods are based on a design life of 15 to 20 years for typical weather conditions depending on actual traffic volumes. The following pavement thickness designs are provided on the above noted considerations and subgrade basis.

| Pavement Layer                                                                                             | Compaction Requirements                               | Minimum Component Thickness |            |
|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-----------------------------|------------|
|                                                                                                            |                                                       | Light Duty                  | Heavy Duty |
| <u>Surface Course Asphaltic Concrete:</u><br>HL3 (OPSS 1150) with PG 58-28 Asphalt Cement (OPSS.MUNI 1101) | OPSS 310                                              | 40 mm                       | 40 mm      |
| <u>Binder Course Asphaltic Concrete:</u><br>HL8 (OPSS 1150) with PG 58-28 Asphalt Cement (OPSS.MUNI 1101)  |                                                       | 50 mm                       | 80 mm      |
| <u>Base Course:</u><br>Granular A (OPSS.MUNI 1010)                                                         | 100% Standard Proctor Maximum Dry Density (ASTM-D698) | 150 mm                      | 150 mm     |
| <u>Subbase Course:</u><br>Granular B Type I or II (OPSS.MUNI 1010)                                         |                                                       | 300 mm                      | 450 mm     |

The granular materials should be placed in lifts 200 mm thick or less and must be compacted to a minimum of 100% SPMD for both granular base and granular subbase. Asphalt materials should be rolled and compacted as per OPSS 310. The granular and asphalt pavement materials and their placement should conform to OPSS 310, 501, 1010 and 1150.

If the pavement construction occurs in wet, winter or inclement weather, it may be necessary to provide additional subgrade support for heavy construction traffic by increasing the thickness of the granular subbase, base or both. Further, traffic areas for construction equipment may experience unstable subgrade conditions. These areas may be stabilized utilizing additional thickness of granular materials.

It should be noted that in addition to adherence of the above pavement design recommendations, a close control on the pavement construction process will also be required in order to obtain the desired pavement life. Therefore,

it is recommended that regular inspection and testing should be conducted during the pavement construction to confirm material quality, thickness, and to ensure adequate compaction.

## 5 Constructability Considerations

### 5.1 Excavations and Temporary Groundwater Control

Excavations must be carried out in accordance with the Occupational Health and Safety Act, Ontario Regulation 213/91 (as amended), Construction Projects, Part III - Excavations, Section 222 through 242.

Where workers must enter a trench or excavation the soil must be suitably sloped and/or braced in accordance with the OHSA. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. The regulation stipulates safe slopes of excavation as follows based on the soils encountered at this site:

- Type 3 Soils – All soils on site: Trench sidewalls to be constructed no steeper than 1 horizontal to 1 vertical from the base of the excavation.

Minimum support system requirements for steeper excavations are stipulated in Sections 235 through 238 and 241 of the OHSA and include provisions for timbering, shoring and moveable trench boxes. In order to reduce the potential for instability of the trench excavations, materials excavated from the service trenches and/or other fill materials or heavy equipment should not be placed near the crest of the trench excavations.

As excavations are expected to be above the prevailing ground water table, there should be limited groundwater control issues present. During times of high precipitation, some water may collect at the base of the excavation. Local sumps placed at the base of the excavation can typically control groundwater seepage in this scenario.

It is important to note that soils encountered in the construction excavations may vary significantly across the site. Our preliminary soil classifications are based solely on the materials encountered in widely spaced boreholes advanced on site. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that CEE be contacted immediately to evaluate the conditions encountered.

### 5.2 Compaction Specifications

Standard Proctor Maximum Dry Density (SPMDD) is the level to which a soil or aggregate is compacted. To achieve the specified SPMDD as indicated in this report, all soils or aggregates must be placed in lift thicknesses no greater than 200 mm. If this is not the case, only the upper portion of the lift will be adequately compacted, and the lower portion of the lift has a high probability of not meeting compaction specifications. In addition, industry standard equipment used to determine the degree of compaction consists of nuclear densometers. These devices have an inherent limitation in that they cannot test beyond 300 mm in depth, and so the degree of compaction beyond this depth cannot be quantitatively determined.

Along with lift thickness, ensuring that the soil or aggregate is within 2% of its optimum moisture content ensures that the specified compaction can be reached. If the soil or aggregate is too dry/wet, it is either very difficult or



impossible to reach the specified compaction. This is especially true for when higher compaction specifications such as 98% and 100% SPMDD are required.

Based on our review of the soil types encountered in the boreholes with associated moisture contents, the soils at this site are considered as follows:

- Half of in-situ soil: At or near optimum moisture content.
- One quarter of in-situ soil: Above optimum moisture content.
- One quarter of in-situ soil: Below optimum moisture content.

The zones with higher moisture content will require moisture conditioning prior to re-use in areas that require compaction. Moisture could be reduced by tilling the soil, spreading the soil out, or blending it with drier material. Soil that is dry of optimum could be blended with wetter soil or have water added prior to re-use. It must be also noted that the above percentages can change based on the time of year in which construction occurs, as the prevailing weather can have a significant effect on the moisture content of stockpiled and in-situ soil.

In addition to the above compaction specifications, in any areas where compacted fill will be placed over the exposed native soil subgrade, any loose, soft, wet or unstable areas should be sub-excavated, and backfilled with clean earth fill of Granular 'B' (OPSS.MUNI 1010) compacted to a minimum of 98% SPMDD. This recommendation applies to site servicing, slab on grade and pavement subgrades.

### 5.3 Quality Verification Services

On-site quality verification services are an integral part of the geotechnical design function, and for foundations and retaining walls, are required under the Ontario Building Code. Quality verification services are used to confirm that construction is being conducted in general conformance with the requirements as outlined in the drawings, reports and specifications prepared for the proposed development.

Central Earth Engineering can provide all the on-site quality verification services outlined below:

- The subgrade for shallow commercial building foundations must be field reviewed by the geotechnical engineer as required in the OBC.
- Installation of retaining structures over 1.0 metres high and related backfilling operations must be field reviewed on a continuous basis by the geotechnical engineer as required in the OBC.
- Part-time monitoring of the subgrade support capabilities (i.e. proof-roll), material quality, lift thickness, moisture content, degree of compaction, etc. is recommended for the following areas to ensure the recommendations within this report are followed and they perform adequately in the long-term:
  - o Slabs on grade;
  - o Pavement structure (granulars and asphalt); and
  - o Bedding/backfilling of site servicing.
- Testing of the concrete (compressive strength, slump, air content, etc.) and testing of the asphalt (asphalt content and gradation) are recommended to ensure that the quality of the materials being brought to site meet the requirements of the project.

## 5.4 Site Work

The soils found at this site may become weakened when subjected to traffic, particularly when wet. If there is site work carried out during periods of wet weather, then it can be expected that the subgrade will be disturbed unless an adequate granular working surface is provided to protect the integrity of the subgrade soils from construction traffic. Subgrade preparation works cannot be adequately accomplished during wet weather and the project must be scheduled accordingly. The disturbance caused by the traffic can result in the removal of disturbed soil and use of granular fill material for site restoration or underfloor fill that is not intrinsic to the project requirements.

The most severe loading conditions on the subgrade may occur during construction. Consequently, special provisions such as end dumping and forward spreading of earth and aggregate fills, restricted construction lanes, and half-loads during paving and other work may be required, especially if construction is carried out during unfavourable weather.

If construction proceeds during freezing weather conditions, adequate temporary frost protection for the founding subgrade and concrete must be provided. The soil at this site is susceptible to frost damage. Consideration must be given to frost effects, such as heave or softening, on exposed soil surfaces in the context of this particular project development.

## 6 Limitations and Conclusion

### 6.1 Limitations

The recommendations and comments provided are necessarily on-going as new information of underground conditions becomes available. More specific information with respect to the conditions between samples, or the lateral and vertical extent of materials may become apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during excavation operations. Consequently, conditions not observed during this investigation may become apparent. Should this occur, CEE should be contacted to assess the situation and additional testing and reporting may be required.

CEE should be retained for a general review of the final design drawings and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, CEE will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of the design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report was prepared by CEE for the account of Dr. Behrooz Azizi. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Central Earth Engineering Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.



## 6.2 Conclusion

It is recognized that municipal/regional governing bodies, in their capacity as the planning and building authority under Provincial statutes, will make use of and rely upon this report, cognizant of the limitations thereof, both as are expressed and implied.

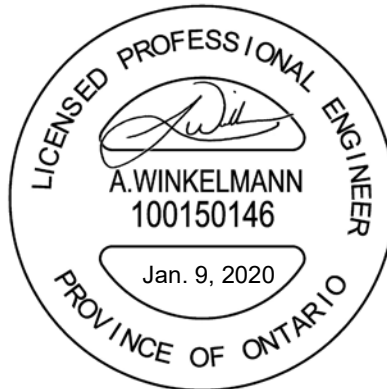
We trust this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to contact our office.

Yours Truly,

Central Earth Engineering Inc.



Alexander Winkelmann, P.Eng.  
President, Geotechnical Engineer



Russell Wiginton, P.Eng.  
Geotechnical Engineer

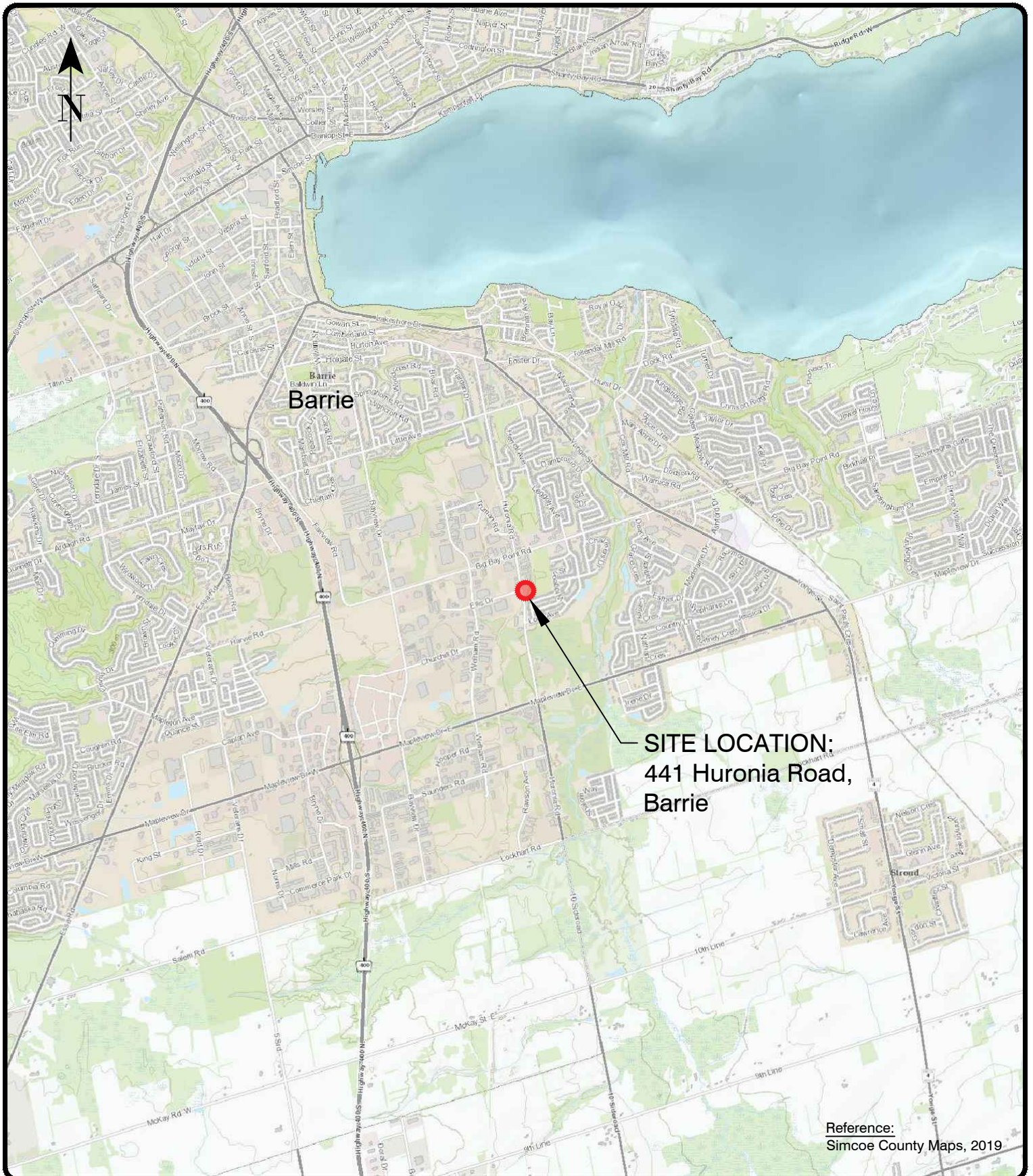


Figures –

**SITE LOCATION PLAN**

**BOREHOLE LOCATION PLAN**





Geotechnical Engineering and Construction  
Materials Testing & Inspection

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Project:

441 Huronia Road, Barrie, Ontario

Title:

SITE LOCATION PLAN

Approved by:

A.W.

Date:

January 2020

Project No.:

19-1243A

Drawn by:

R.W.

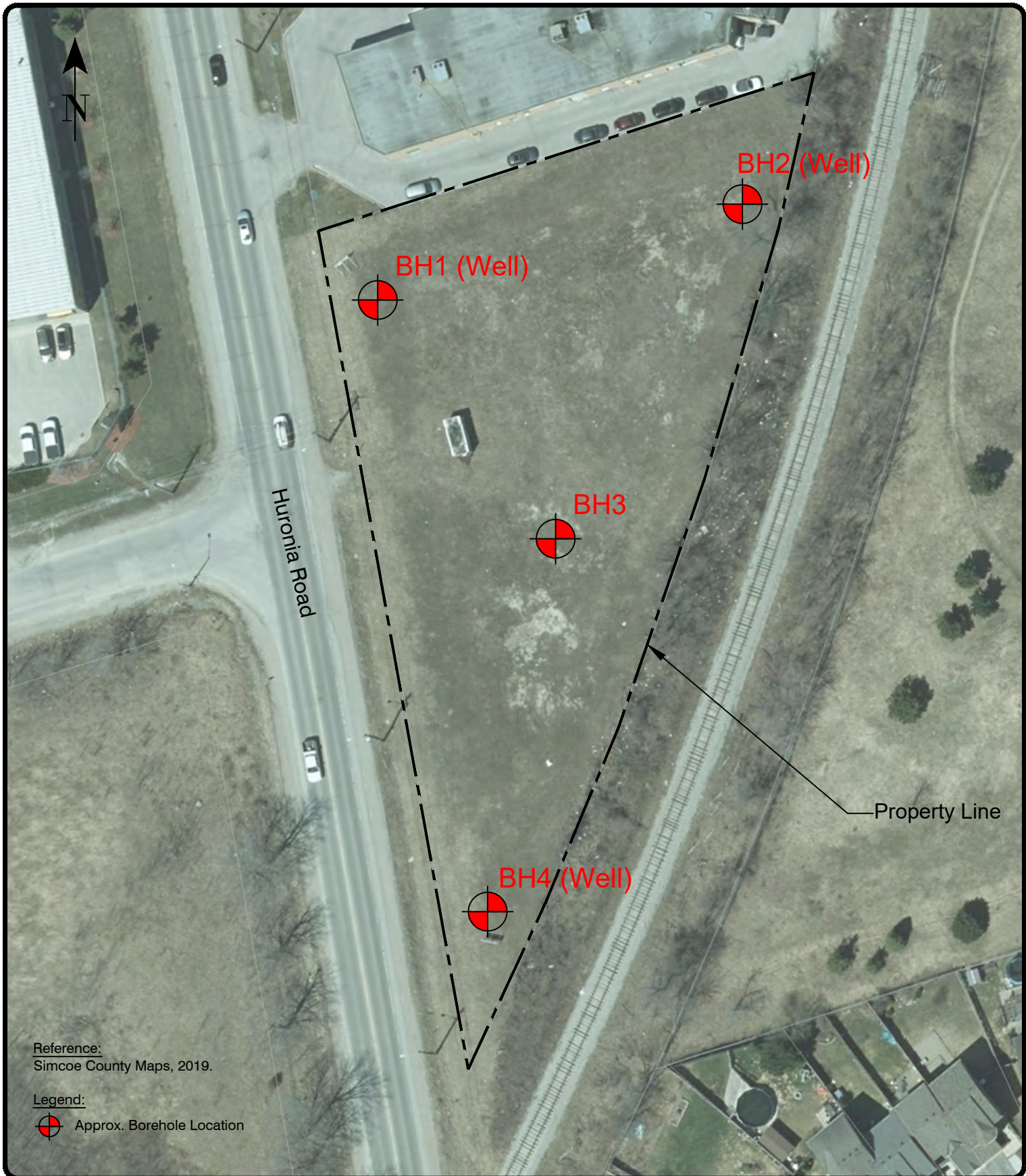
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N.T.S.

Figure No.:

1





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|                                            |      |          |              |
|--------------------------------------------|------|----------|--------------|
| Project: 441 Huronia Road, Barrie, Ontario |      |          |              |
| Title: BOREHOLE LOCATION PLAN              |      |          |              |
| Approved by:                               | A.W. | Date:    | January 2020 |
| Drawn by:                                  | R.W. | Scale:   | 1:750        |
| Project No.:                               |      | 19-1243A |              |
| Figure No.:                                |      | 2        |              |



## Appendix A – **BOREHOLE LOGS**

# RECORD OF BOREHOLE No. 1



Project Number: **19-1243A**  
 Project Client: **Mr. Behrooz Azizi**  
 Project Name: **441 Huronia Road**  
 Project Location: **Barrie, Ontario**  
 Drilling Location: **NW Corner of Lot**

Drilling Method: **Solid Stem Augers** Drilling Machine: **Track Mount**  
 Logged By: **RD** Northing: **4911659** Date Started: **2019-12-12**  
 Reviewed By: **AW** Easting: **606473** Date Completed: **2019-12-12**

| LITHOLOGY PROFILE                                                                                    |          | SOIL SAMPLING |               |              |               | DEPTH (m) | ELEVATION (m) | FIELD TESTING                                                                                                                                                                                    | LAB TESTING                                                                                                                                                                                | Instrumentation Installation | COMMENTS & GRAIN SIZE DISTRIBUTION (%) |
|------------------------------------------------------------------------------------------------------|----------|---------------|---------------|--------------|---------------|-----------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------------|
| DESCRIPTION                                                                                          | Geodetic | Sample Type   | Sample Number | Recovery (%) | SPT "N" Value |           |               | Shear Strength Testing (kPa)<br>X Other Test<br>+ Pocket Penetrometer<br>▲ Field Vane (Intact)<br>△ Field Vane (Remolded)<br>40 80 120 160<br>Penetration Testing<br>○ SPT ● DCPT<br>10 20 30 40 | △ Combustible Organic Vapour (ppm)<br>▲ Combustible Organic Vapour (%LEL)<br>* Total Organic Vapour (ppm)<br>100 200 300 400<br>Atterberg Limits<br>PL Water Content (%) LL<br>10 20 30 40 |                              |                                        |
| FILL: Silty Sand, Trace Gravel, Loose to Compact, Brown, Moist                                       | 262.04m  | SS            | 1             | 58           | 5             | 0         | 262           | 5                                                                                                                                                                                                | 9                                                                                                                                                                                          |                              | Topsoil = 100mm                        |
|                                                                                                      |          | SS            | 2             | 89           | 13            |           |               | 13                                                                                                                                                                                               | 8                                                                                                                                                                                          |                              |                                        |
| SILTY SAND GLACIAL TILL, Trace to Some Clay, Trace Gravel, Dense, Brown, Moist<br>--- Very Dense --- | 260.5    | SS            | 3             | 100          | 32            | 2         | 260           | 32                                                                                                                                                                                               | 7                                                                                                                                                                                          |                              | 8 57 26 9                              |
|                                                                                                      |          | SS            | 4             | 100          | 76            |           |               | 76                                                                                                                                                                                               | 8                                                                                                                                                                                          |                              |                                        |
|                                                                                                      |          | SS            | 5             | 100          | 79            |           |               | 79                                                                                                                                                                                               | 7                                                                                                                                                                                          |                              |                                        |
|                                                                                                      |          |               |               |              |               |           |               |                                                                                                                                                                                                  |                                                                                                                                                                                            |                              |                                        |
|                                                                                                      |          | SS            | 6             | 100          | 71            |           |               | 71                                                                                                                                                                                               | 9                                                                                                                                                                                          |                              |                                        |
|                                                                                                      |          |               |               |              |               |           |               |                                                                                                                                                                                                  |                                                                                                                                                                                            |                              |                                        |
|                                                                                                      |          | SS            | 7             | 100          | 56            |           |               | 56                                                                                                                                                                                               | 9                                                                                                                                                                                          |                              |                                        |
|                                                                                                      |          |               |               |              |               |           |               |                                                                                                                                                                                                  |                                                                                                                                                                                            |                              |                                        |
|                                                                                                      |          | SS            | 8             | 100          | 100+          |           |               | 100+                                                                                                                                                                                             | 7                                                                                                                                                                                          |                              |                                        |
|                                                                                                      |          |               |               |              |               |           |               |                                                                                                                                                                                                  |                                                                                                                                                                                            |                              |                                        |
| End of Borehole @ 9.6m                                                                               | 252.5    | SS            | 9             | 53           | 100+          |           |               | 100+                                                                                                                                                                                             | 9                                                                                                                                                                                          |                              |                                        |

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Groundwater depth encountered on completion of drilling: **Dry**

Groundwater depth observed on **2019-12-12** at a depth of: **8.2m**

Cave depth after auger removal: **Open**

Observed on **2019-12-20** at a depth of: **5.3m**

Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :100**

Page: **1 of 1**



# RECORD OF BOREHOLE No. 2



Project Number: **19-1243A**  
 Project Client: **Mr. Behrooz Azizi**  
 Project Name: **441 Huronia Road**  
 Project Location: **Barrie, Ontario**  
 Drilling Location: **NE Corner of Lot**

Drilling Method: **Solid Stem Augers** Drilling Machine: **Track Mount**  
 Logged By: **RD** Northing: **4911674** Date Started: **2019-12-12**  
 Reviewed By: **AW** Easting: **606525** Date Completed: **2019-12-12**

| LITHOLOGY PROFILE                                                                                       |          | SOIL SAMPLING |               |              |               | DEPTH (m) | ELEVATION (m) | FIELD TESTING                                                                                                                                                                                    | LAB TESTING                                                                                                                                                                                | Instrumentation Installation | COMMENTS & GRAIN SIZE DISTRIBUTION (%) |
|---------------------------------------------------------------------------------------------------------|----------|---------------|---------------|--------------|---------------|-----------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------------|
| DESCRIPTION                                                                                             | Geodetic | Sample Type   | Sample Number | Recovery (%) | SPT "N" Value |           |               | Shear Strength Testing (kPa)<br>X Other Test<br>+ Pocket Penetrometer<br>▲ Field Vane (Intact)<br>△ Field Vane (Remolded)<br>40 80 120 160<br>Penetration Testing<br>○ SPT ● DCPT<br>10 20 30 40 | △ Combustible Organic Vapour (ppm)<br>▲ Combustible Organic Vapour (%LEL)<br>* Total Organic Vapour (ppm)<br>100 200 300 400<br>Atterberg Limits<br>PL Water Content (%) LL<br>10 20 30 40 |                              |                                        |
| FILL: Silty Sand, Trace Gravel, Loose, Brown, Moist                                                     | 262.16m  | SS            | 1             | 67           | 6             | 0         | 262           | 6                                                                                                                                                                                                | 6                                                                                                                                                                                          |                              | No topsoil present                     |
|                                                                                                         |          | SS            | 2             | 83           | 6             |           |               |                                                                                                                                                                                                  | 7                                                                                                                                                                                          |                              |                                        |
| CLAYEY SILT GLACIAL TILL, Sandy, Trace Gravel, Trace Organics, Soft, Dark Brown, Moist<br>--- Stiff --- | 260.6    | SS            | 3             | 50           | 3             | 1.5       | 260.6         | 3                                                                                                                                                                                                |                                                                                                                                                                                            |                              |                                        |
|                                                                                                         |          | SS            | 4             | 100          | 9             |           |               | 9                                                                                                                                                                                                | 20                                                                                                                                                                                         |                              |                                        |
| SILTY SAND GLACIAL TILL, Trace to Some Clay, Trace Gravel, Compact, Brown, Moist<br>--- Dense ---       | 259.1    | SS            | 5             | 67           | 11            | 3.1       | 259.1         | 11                                                                                                                                                                                               | 11                                                                                                                                                                                         |                              | 1 66 21 12                             |
|                                                                                                         |          | SS            | 6             | 100          | 37            |           |               | 37                                                                                                                                                                                               | 6                                                                                                                                                                                          |                              |                                        |
|                                                                                                         |          | SS            | 7             | 100          | 59            |           |               | 59                                                                                                                                                                                               | 7                                                                                                                                                                                          |                              |                                        |
|                                                                                                         |          | SS            | 8             | 100          | 56            |           |               | 56                                                                                                                                                                                               | 8                                                                                                                                                                                          |                              |                                        |
|                                                                                                         |          | SS            | 9             | 100          | 100+          |           |               | 100+                                                                                                                                                                                             | 6                                                                                                                                                                                          |                              |                                        |
| End of Borehole @ 9.6m                                                                                  | 252.6    |               |               |              |               | 9.6       | 252.6         |                                                                                                                                                                                                  |                                                                                                                                                                                            |                              |                                        |

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Groundwater depth encountered on completion of drilling: **Dry**

Groundwater depth observed on **2019-12-12** at a depth of: **Dry**

Cave depth after auger removal: **Open**

Observed on **2019-12-20** at a depth of: **Dry**

Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :100**

Page: **1 of 1**

# RECORD OF BOREHOLE No. 3



Project Number: 19-1243A  
 Project Client: Mr. Behrooz Azizi  
 Project Name: 441 Huronia Road  
 Project Location: Barrie, Ontario  
 Drilling Location: Centre of Lot

Drilling Method: Solid Stem Augers Drilling Machine: Track Mount  
 Logged By: RD Northing: 4911625 Date Started: 2019-12-12  
 Reviewed By: AW Easting: 606499 Date Completed: 2019-12-12

| LITHOLOGY PROFILE      |                                                                                | SOIL SAMPLING |               |              |               | DEPTH (m) | ELEVATION (m) | FIELD TESTING                                                                                                                                                                                 | LAB TESTING                                                                                                                                                                             | Instrumentation Installation | COMMENTS & GRAIN SIZE DISTRIBUTION (%) |
|------------------------|--------------------------------------------------------------------------------|---------------|---------------|--------------|---------------|-----------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------------|
| DESCRIPTION            |                                                                                | Sample Type   | Sample Number | Recovery (%) | SPT "N" Value |           |               | Shear Strength Testing (kPa)<br>× Other Test<br>+ Pocket Penetrometer<br>▲ Field Vane (Intact)<br>△ Field Vane (Remolded)<br>40 80 120 160<br>Penetration Testing<br>○ SPT ● DCPT 10 20 30 40 | △ Combustible Organic Vapour (ppm)<br>▲ Combustible Organic Vapour (%LEL)<br>* Total Organic Vapour (ppm)<br>100 200 300 400<br>Atterberg Limits<br>PL Water Content (%) LL 10 20 30 40 |                              |                                        |
|                        | FILL: Silty Sand, Trace Clay, Trace Gravel, Compact, Brown, Moist              | SS            | 1             | 100          | 16            | 0         | 260           | ○ 16                                                                                                                                                                                          | ○ 8                                                                                                                                                                                     |                              | No topsoil present<br><br>11 65 20 4   |
|                        |                                                                                | SS            | 2             | 78           | 18            |           |               | ○ 18                                                                                                                                                                                          | ○ 6                                                                                                                                                                                     |                              |                                        |
|                        | --- Loose, Moist to Wet ---                                                    | SS            | 3             | 78           | 5             |           |               | ○ 5                                                                                                                                                                                           | ○ 12                                                                                                                                                                                    |                              |                                        |
|                        | SILTY SAND GLACIAL TILL, Trace to Some Clay, Trace Gravel, Dense, Brown, Moist | SS            | 4             | 100          | 45            |           |               | ○ 45                                                                                                                                                                                          | ○ 8                                                                                                                                                                                     |                              |                                        |
|                        | --- Very Dense ---                                                             | SS            | 5             | 100          | 53            |           |               | ○ 53                                                                                                                                                                                          | ○ 7                                                                                                                                                                                     |                              |                                        |
|                        |                                                                                | SS            | 6             | 100          | 100+          |           |               | ○ 100+                                                                                                                                                                                        | ○ 7                                                                                                                                                                                     |                              |                                        |
|                        |                                                                                | SS            | 7             | 100          | 100+          |           |               | ○ 100+                                                                                                                                                                                        | ○ 6                                                                                                                                                                                     |                              |                                        |
| End of Borehole @ 6.6m |                                                                                |               |               |              |               |           |               |                                                                                                                                                                                               |                                                                                                                                                                                         |                              |                                        |

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Groundwater depth encountered on completion of drilling: **Dry**

Cave depth after auger removal: **Open**

Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :100**  
 Page: **1 of 1**





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|                  |                          |                   |                    |                 |                   |
|------------------|--------------------------|-------------------|--------------------|-----------------|-------------------|
| Drilling Method: | <u>Solid Stem Augers</u> | Drilling Machine: | <u>Track Mount</u> |                 |                   |
| Logged By:       | <u>RD</u>                | Northing:         | <u>4911572</u>     | Date Started:   | <u>2019-12-12</u> |
| Reviewed By:     | <u>AW</u>                | Easting:          | <u>606491</u>      | Date Completed: | <u>2019-12-12</u> |

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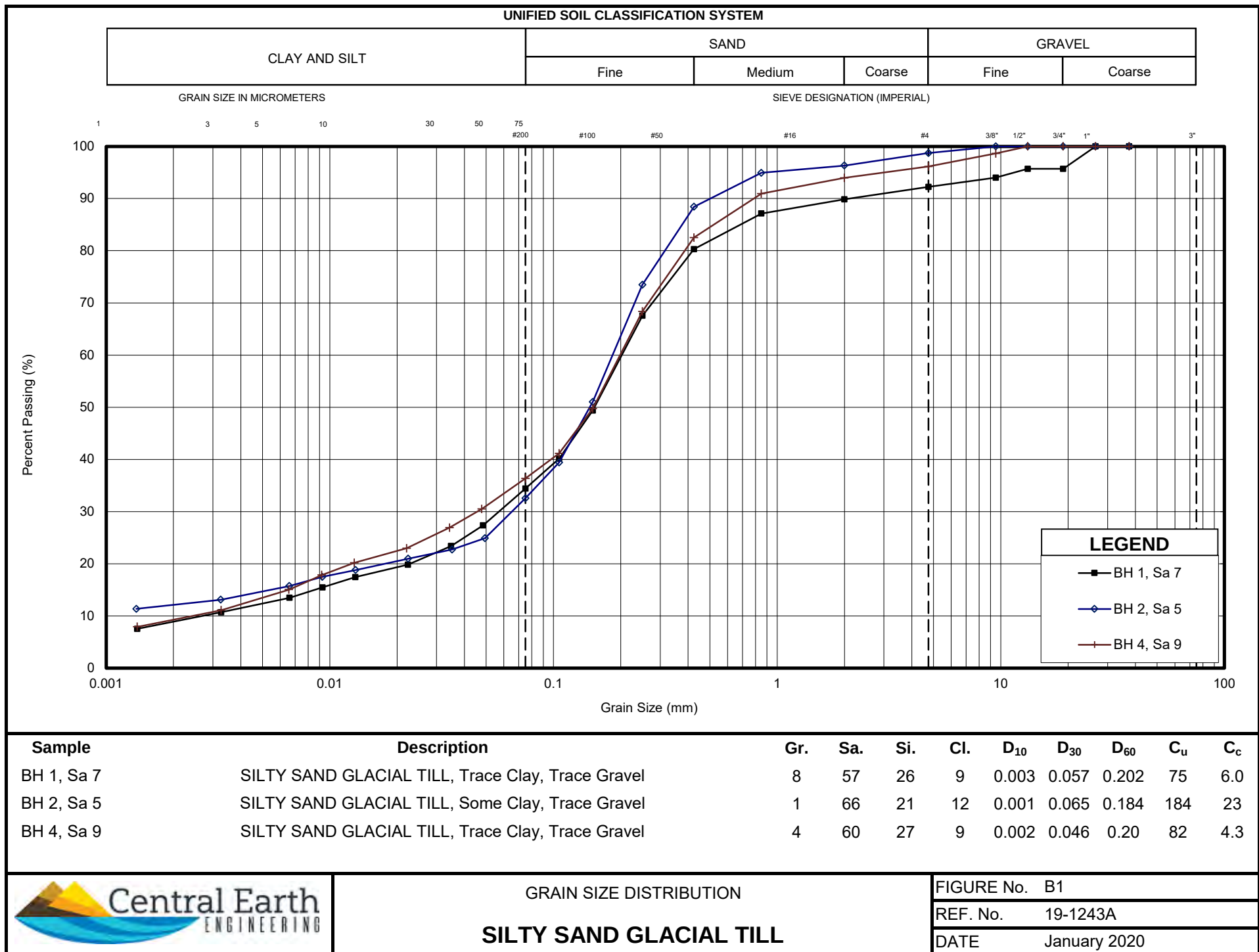
Cave depth after auger removal: **Open**

 Observed on **2019-12-20** at a depth of: **Dry**

Page: 1 of 1

Appendix B –  
**GEOTECHNICAL LABORATORY DATA**



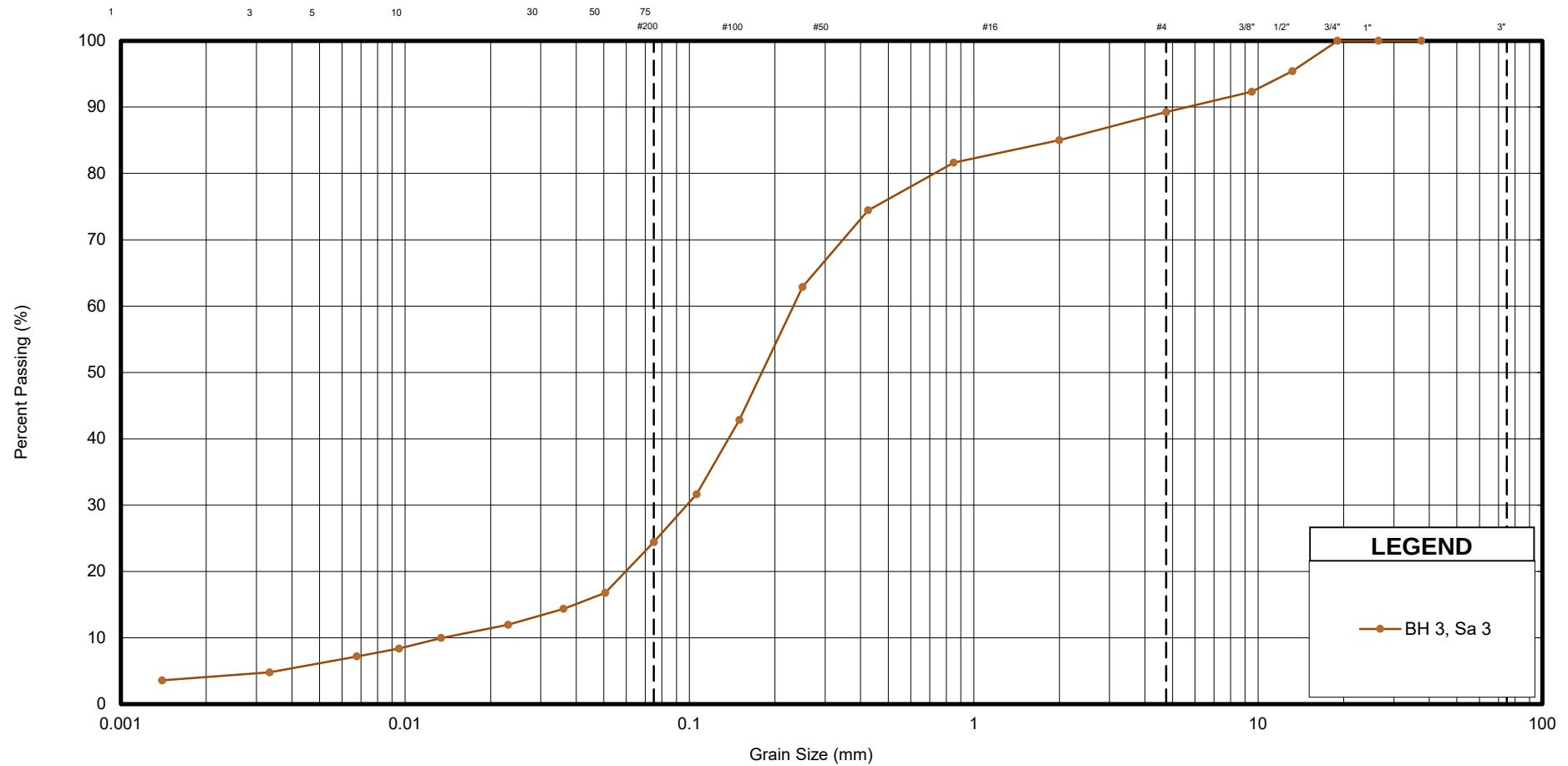


# UNIFIED SOIL CLASSIFICATION SYSTEM

| CLAY AND SILT | SAND |        |        | GRAVEL |        |
|---------------|------|--------|--------|--------|--------|
|               | Fine | Medium | Coarse | Fine   | Coarse |

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (IMPERIAL)



| Sample     | Description                                     | Gr. | Sa. | Si. | Cl. | D <sub>10</sub> | D <sub>30</sub> | D <sub>60</sub> | C <sub>u</sub> | C <sub>c</sub> |
|------------|-------------------------------------------------|-----|-----|-----|-----|-----------------|-----------------|-----------------|----------------|----------------|
| BH 3, Sa 3 | EARTH FILL: Silty Sand, Some Gravel, Trace Clay | 11  | 65  | 20  | 4   | 0.013           | 0.098           | 0.23            | 17.2           | 3.1            |



GRAIN SIZE DISTRIBUTION

**EARTH FILL**

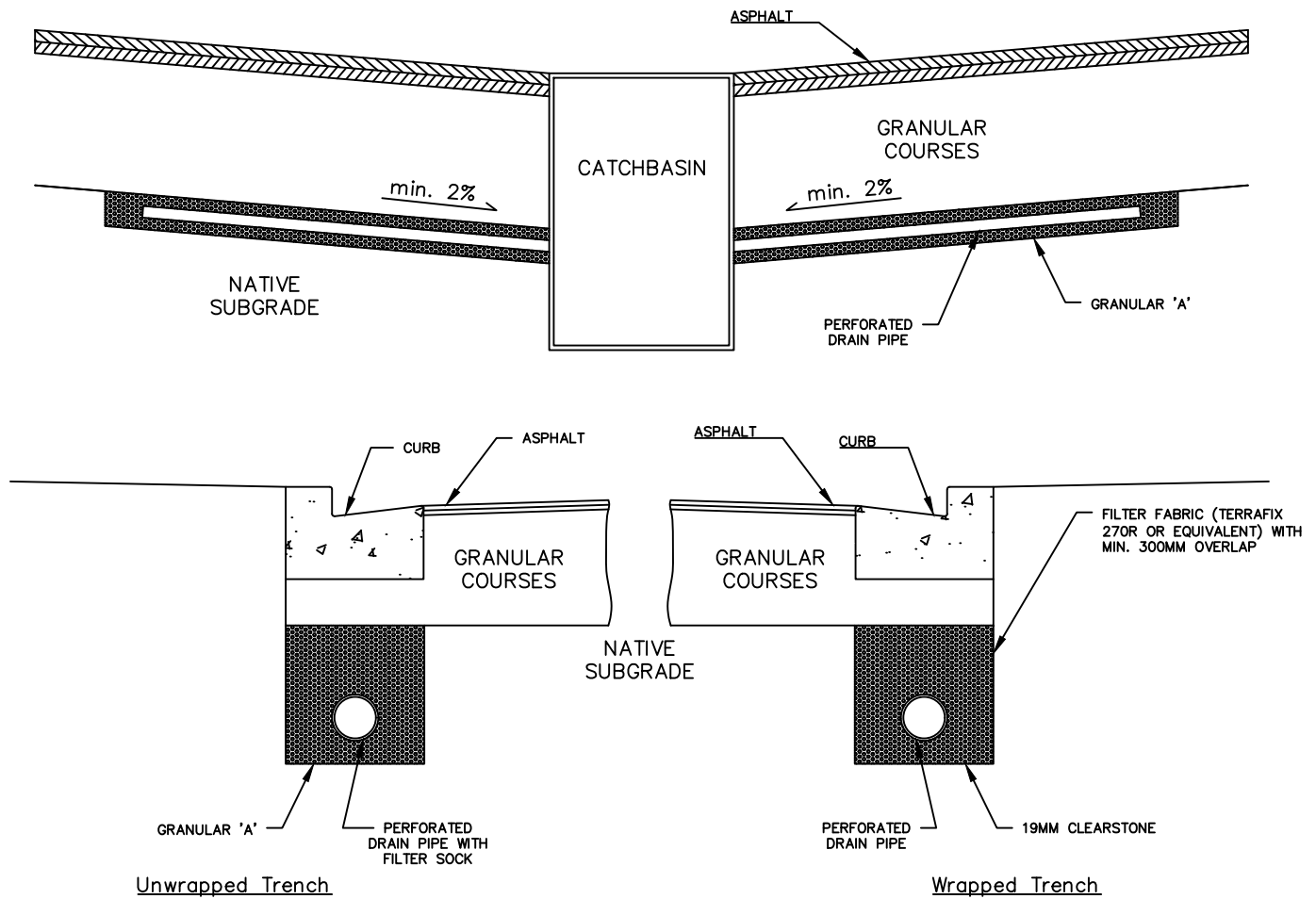
FIGURE No. B2

REF. No. 19-1243A

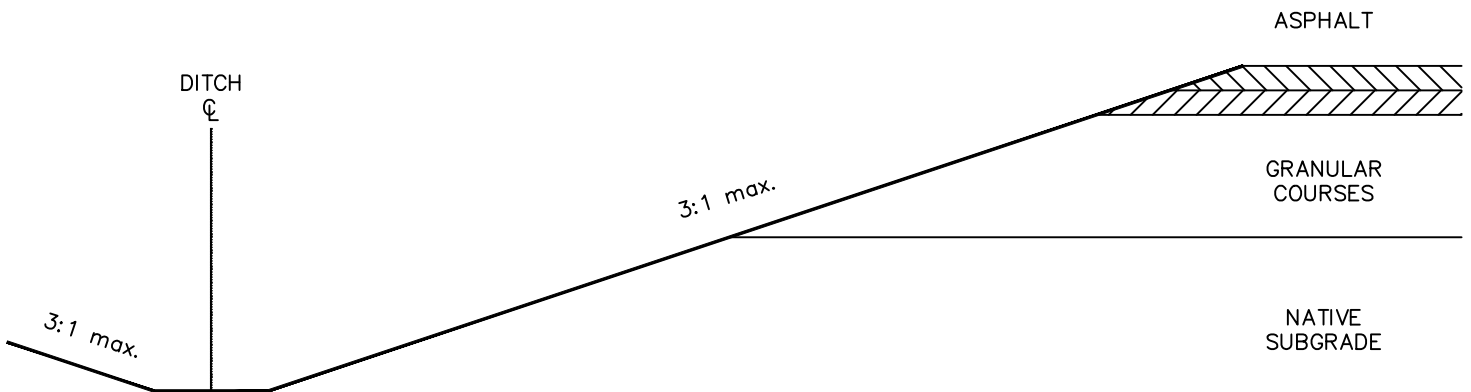
DATE January 2020



## Appendix C – **TYPICAL DETAILS**



Urban Cross Sections



Rural Cross Section





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## **HYDROGEOLOGICAL REPORT**

Proposed Commercial Development  
441 Huronia Road  
Barrie, Ontario

Prepared For: Dr. Behrooz Azizi  
Type of Document: Final Report  
Reference Number: 19-1243A  
Prepared By: Russell Wiginton, P.Eng.  
Reviewed By: Alexander Winkelmann, P.Eng.  
Date Issued: January 13, 2020

## Table of Contents

|          |                                                   |           |
|----------|---------------------------------------------------|-----------|
| <b>1</b> | <b>Introduction .....</b>                         | <b>1</b>  |
| <b>2</b> | <b>Site Setting .....</b>                         | <b>1</b>  |
| 2.1      | Physiography, Surficial and Bedrock Geology ..... | 1         |
| 2.2      | Topography and Drainage.....                      | 1         |
| 2.3      | MECP Well Records.....                            | 2         |
| 2.4      | Visual Inspection of Site .....                   | 2         |
| 2.5      | Regulatory Requirements.....                      | 2         |
| <b>3</b> | <b>Procedures and Methodology .....</b>           | <b>4</b>  |
| <b>4</b> | <b>Subsurface Conditions .....</b>                | <b>5</b>  |
| 4.1      | General Overview.....                             | 5         |
| 4.2      | Stratigraphy .....                                | 5         |
| 4.3      | Groundwater .....                                 | 6         |
| <b>5</b> | <b>Discussion and Analysis .....</b>              | <b>8</b>  |
| 5.1      | Proposed Development Plan.....                    | 8         |
| 5.2      | Ground Water Control Methodology.....             | 8         |
| 5.3      | Water Balance .....                               | 9         |
| 5.4      | Recommended Mitigation Measures .....             | 11        |
| <b>6</b> | <b>Limitations and Conclusion.....</b>            | <b>14</b> |
| 6.1      | Limitations .....                                 | 14        |
| 6.2      | Conclusion.....                                   | 15        |



## Table of Contents (Cont.)

### **Figures**

- Figure 1 – Site Location Plan
- Figure 2 – Borehole Location Plan
- Figure 3 – Subsurface Profile
- Figure 4 – MECP & CEE Well Locations
- Figure 5A – Wellhead Protection Area Map
- Figure 5B – Significant Groundwater Recharge Area Map
- Figure 5C – Highly Vulnerable Aquifer Map

### **Appendices**

- Appendix A – Borehole Logs
- Appendix B – Geotechnical Laboratory Data
- Appendix C – Rising Head Test Data
- Appendix D – MECP Well Records
- Appendix E – Water Balance Analysis
- Appendix F – Groundwater Chemistry Certificates of Analysis

# 1 Introduction

Central Earth Engineering Inc. (CEE) was retained by Dr. Behrooz Azizi to complete a hydrogeological study for the proposed commercial development located at 441 Huronia Road, in Barrie, Ontario. A site location plan is provided as Figure 1. The existing property is approximately 0.51 hectares in size and triangular. The property is currently a vacant field and is bounded by Huronia Road to the west, an existing commercial plaza to the north and a railway to the southeast. The site is relatively flat with grades ranging from about Elev. 261 to 262 metres.

CEE was provided with the following drawing set in preparation of this report:

- *“Huronia Road Development, 441 Huronia Road, Barrie, Ontario”*, by Gerrits Engineering Limited.

This drawing set indicates a 2-storey office building with no underground levels will be constructed in the northwest corner of the site, and the remaining parts of the property will be parking and driving areas. It is understood that the drawing set is preliminary and is subject to change (e.g. the building location may change, the number of storeys may be reduced, etc.). No grading plans were provided to CEE but significant grade changes are not expected. It is expected that the site will be municipally serviced.

This report has been prepared following Conservation Authority guidelines and City of Barrie Terms of Reference for hydrogeological report submissions. CEE has also been retained to complete a geotechnical report for the site under a separate cover.

## 2 Site Setting

### 2.1 Physiography, Surficial and Bedrock Geology

The site is located within the physiographic area denoted as the Lake Simcoe Basin within the Simcoe Lowlands (Chapman & Putnam, 1984). The Simcoe Lowlands were flood by Lake Algonquin and are bordered by shorecliffs, beaches, and bouldery terraces. Thus, the Simcoe Lowlands are floored by sand, silt and clay. Based on surficial and bedrock geology mapping of the site by the Ontario Geological Survey, the surficial geology at the site consists of stone-poor, sandy silt to silty sand textured glacial till on Paleozoic terrain. At depth, limestone bedrock of the Lindsay Formation is present.

### 2.2 Topography and Drainage

Topographic mapping by the MNRF and County of Simcoe show that the site slopes gently to the south. The borehole ground surface elevations indicate that the site slopes from about Elev. 262.2 metres in the north to about Elev. 261.1 metres in the south. No surface water features were observed on the site.

This site is in the Lovers Creek subwatershed, which is part of the Lake Simcoe watershed. Based on the topography, it is expected that surficial runoff drains to the south. The Ontario Flow Assessment Tool (OFAT) by MNRF shows the site drains to the south into a tributary of Lovers Creek, about 500 metres southeast of the site. The tributary flows into Lovers Creek, which generally flows north and outlets into Kempenfelt Bay of Lake Simcoe.



## 2.3 MECP Well Records

Ministry of Environment, Conservation and Parks (MECP) water well records were obtained within 500 metres of the site area to assess the general nature of the groundwater resource in near vicinity of the site, and historical/current uses of wells in the area. Five (5) well records were found, and a summary of the data obtained from this review is presented below. The approximate MECP well locations are shown on Figure 4 and the well records are included in Appendix D along with a summary table of the well data.

The wells were installed for the following uses:

- One (1) for farming water supply;
- One (1) for municipal observation;
- One (1) for monitoring; and
- Two (2) abandoned or unknown use.

The stratigraphic descriptions within the MECP monitoring well records are typically inaccurate due to the methodology in which they are determined (observations of drill cuttings and no consistency of soil descriptions between different drillers). Though this is the case, an overall sense of the deep stratigraphy can be determined by looking at commonalities between most stratigraphic descriptions and where the wells were terminated in an aquifer. In the area surrounding the site, the well records generally indicate that there is an upper deposit of “sand,” followed by “clays,” sometimes followed by deeper “sand” deposits. The well records indicate that there is an unconfined aquifer in the upper “sand” and a confined aquifer in the deeper “sand” below the confining “clays.”

## 2.4 Visual Inspection of Site

The property is vacant, triangular in shape and has a total area of approximately 0.51 ha. The site is vegetated with low-lying grass. The site slopes gently from the north near Elev. 262.2 metres to the south near Elev. 261.2 metres. An aerial image of the site showing the existing conditions is provided on Figure 2. In general, surface drainage is expected to occur as sheet drainage across the site and will generally flow to the south based on the site topography. A roadside ditch runs adjacent to Huronia Road along the west side of the site which likely collects sheet drainage from the site and conveys the runoff to the south.

Based on our preliminary visual estimates, it appears the following hard cover and soft cover surfaces exist:

- Hard Cover – none (0%).
- Soft Cover – flat grass area (100%).

## 2.5 Regulatory Requirements

### 2.5.1 Source Water Protection

The following documents should be used in determination of the regulatory requirements when it comes to maintaining hydrogeological function at this site:

- “*Lake Simcoe Protection Plan*”, dated July 2009, by MOECC, MNR & LSRCA.
- “*Approved South Georgian Bay Lake Simcoe Source Protection Plan*”, dated January 26, 2015, by LSRCA.

- “Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP,” dated November 2018, by LSRCA.

The Lake Simcoe Protection Plan (LSPP) Designated Policy (DP) 6.36 builds on the Provincial Policy Statement (PPS) and *Clean Water Act, 2006*, to define a Significant Groundwater Recharge Area (SGRA). The definition from the LSPP is below.

- “6.36-DP: A significant groundwater recharge area is an area identified,
  - o as a significant groundwater recharge area by any public body for the purposes of implementing the PPS;
  - o as a significant groundwater recharge area in the assessment report required under the *Clean Water Act, 2006*, for the Lake Simcoe and Couchiching/Black River Source Protection Area; or
  - o by the LSRCA in partnership with MOE and MNR as an ecologically significant groundwater recharge area in accordance with the guidelines developed under policy 6.37.”

Based on Simcoe County online mapping, the following is noted:

- Wellhead Protection Area (WHPA): The site is within WHPA Q2 (Figure 5A);
- Significant Groundwater Recharge Area (SGRA): The site is not within an SGRA (Figure 5B); and
- Highly Vulnerable Aquifer (HVA): The site is within an HVA (Figure 5C).

“Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP,” (by LSRCA, dated November 2018) Section 6.0 describes the policy hierarchy for water balance required for Lake Simcoe Watershed. The policies from most to least stringent are described below:

1. Source Protection Plan Land Use Policy (SPP LUP) 12: “Planning Approval Authorities shall only permit new major development (excluding single detached residential, barns and non-commercial structures that are accessory to an agricultural operation) in a WHPA-Q2 where the activity would be a significant drinking water threat, where it can be demonstrated through the submission of a hydrogeological study that the existing water balance can be maintained through the use of best management practices such as low impact development. Where necessary, implementation and maximization of off-site recharge enhancement within the same WHPA-Q2 to compensate for any predicted loss of recharge from the development.”
2. Designated Policy (DP) 6.40: “Outside of the Oak Ridges Moraine area, an application for major development within a significant groundwater recharge area (SGRA) shall be accompanied by an environmental impact study that demonstrates that the quality and quantity of groundwater in these areas and the function of the recharge areas will be protected, improved or restored.”
3. Designated Policy (DP) 4.8 d): “An application for major development shall be accompanied by a stormwater management plan that demonstrates: through an evaluation of anticipated changes in the water balance between pre-development and post-development, how such changes shall be minimized.”

The proposed development is within a WHPA-Q2, therefore SPP LUP-12 applies and comments and discussion is provided in Section 5. The development is not within an SGRA, therefore DP-6.40 does not apply. The proposed development at the site is considered a major development by the Lake Simcoe Protection Plan (LSPP) since more than 500 m<sup>2</sup> of impervious surface (dwellings, roadway) will be created, therefore DP-4.8 applies and will be addressed in this report using a water balance as discussed in Section 5.3.

The site is within an HVA and the proposed land use will be commercial. Based on Table 2 in “*Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP*,” infiltration-based practices are not permitted for this site for runoff from impervious areas. Infiltration of runoff from vegetated areas and rooftops is always permitted.

The following policy will also apply at the site:

- “*Phosphorous Offsetting Policy*”, dated September 2017, by LSRCA.

Section 4.4 Phosphorous Offsetting Policies in the above document discusses the applicable policies, including that the application for a major development “... *shall be accompanied by a Preliminary Phosphorous Budget as part of an overall Functional Servicing Report or Preliminary Stormwater Management Report.*” Phosphorous offsetting must be carried out as part of the stormwater management report to be completed for the site by others. Some additional details are provided in Section 5.4.3 of this report.

The following documents are also referenced for content in the hydrogeological report:

- “*Hydrogeological Study, Terms of Reference*,” City of Barrie, dated January 2019;
- “*Hydrogeological Assessment Submissions, Conservation Authority Guidelines for Development Applications*,” dated June 2013, by Conservation Authorities Geoscience Group.

### 2.5.2 Temporary Groundwater Dewatering

The volume of water entering the excavation will be based on both ground water infiltration and precipitation events. Based on the requirements under O. Reg. 63/16: *Registrations Under Part II.1 of the Act – Water Taking*, the following dewatering limits and requirements are as follows as they pertain to temporary groundwater dewatering for construction purposes:

- Construction Dewatering less than 50,000 L/day: The takings of both groundwater and stormwater do not require a hydrogeological report and does not require registration on the Environmental Sector Activity Registry (EASR) nor a Permit to Take Water (PTTW) from the Ministry of Environment, Conservation and Parks (MECP).
- Construction Dewatering greater than 50,000 L/day and less than 400,000 L/day: The taking of groundwater and/or stormwater requires a hydrogeological report and registration on the Environmental Sector Activity Registry (EASR) but does not require a Permit to Take Water (PTTW) from the MECP.
- Construction Dewatering greater than 400,000 L/day: The taking of groundwater and/or stormwater requires a hydrogeological report and requires a Permit to Take Water (PTTW) from the MECP.

## 3 Procedures and Methodology

Prior to the commencement of drilling activities, the locations of underground utilities including natural gas, electrical, telephone, water, etc. were marked out by public and private utility locating companies. The fieldwork for the drilling program was carried out on December 12<sup>th</sup>, 2019. A total of four boreholes (Boreholes 1 to 4) were advanced on site by Drilltech Drilling using a track-mounted drill rig, continuous flight solid stem augers and standard soil sampling equipment.



All samples were collected as per ASTM D1586 to assess the strength characteristics of the substrate. The boreholes were advanced to depths of 6.5 to 9.6 metres below existing grade. The horizontal locations were laid out in the field by CEE prior to the drilling operations. Ground surface elevations of the boreholes were measured using laser level survey equipment in reference to a geodetic benchmark (Cosine Station #00119713848) with a known geodetic elevation of 261.316 metres in reference to datum CGVD2013. GPS measurements measured with a handheld GPS unit and referenced to the NAD 83. Monitoring wells were installed in Boreholes 1, 2, and 4 to facilitate long-term measurements of groundwater levels.

The CEE field staff examined and classified characteristics of the soils encountered in the boreholes, including the presence of fill materials, made groundwater observations during and upon completion of the drilling, recorded observations of borehole construction, and processed the recovered samples. Soil sampling was conducted at regular intervals for the full depth of the borehole. The boreholes were backfilled upon completion. All recovered soil samples were logged in the field, carefully packaged and transported to the laboratory for more detailed examination and classification. In the laboratory, the samples were classified as to their visual and textural characteristics and geotechnical laboratory testing was carried out with the results included in Appendix B. Stabilized groundwater levels were measured in the three installed monitoring wells on December 20<sup>th</sup>, 2019.

## 4 Subsurface Conditions

### 4.1 General Overview

The detailed soil profiles encountered in the boreholes are indicated on the attached borehole logs in Appendix A and a subsurface profile is included as Figure 3. The borehole locations are shown on Figure 2 and laboratory test results are included as Appendix B. It should be noted that the conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the borehole locations. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change.

In addition, the descriptions provided in the borehole logs are inferred from a variety of factors, including: visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (speed of drilling, shaking/grinding of the augers, etc.). The passage of time also may result in changes in conditions interpreted to exist at locations where sampling was conducted.

### 4.2 Stratigraphy

#### 4.2.1 Topsoil and Earth Fill

Borehole 1 encountered 100 mm of topsoil at the ground surface, and Borehole 4 encountered a surficial zone of earth fill that was mixed with topsoil.

Underlying the topsoil in Borehole 1 and at the ground surface in Boreholes 2 to 4, a surficial zone of earth fill was encountered that consisted of silt and sand to silty sand with trace clay and trace gravel. The earth fill extended to depths of 1.5 to 2.3 metres below grade (Elev. 259.6 to 260.6 metres) and was brown and moist. The full depth of earth fill in Borehole 4 was mixed with topsoil and was dark brown. The Standard Penetration Test (SPT) results

("N" Values) measured in the earth fill ranged from 5 to 18 blows per 300 mm of penetration, indicating a loose to compact relative density.

#### 4.2.2 Glacial Till

Underlying the earth fill, Borehole 2 encountered a glacial till deposit with a cohesive matrix consisting of clayey and sandy silt with trace gravel and trace organics. The clayey silt glacial till was encountered at a depth of 1.5 metres below grade (Elev. 260.6 metres) and extended to a depth of 3.1 metres (Elev. 259.1 metres). The clayey silt glacial till was dark brown and moist, and the measured Standard Penetration Test (SPT) results ("N" Values) were 3 and 9, indicating a soft to stiff consistency. The disturbed soil samples collected from the split spoon sampler were also tested using a pocket penetrometer to obtain a general sense of the undrained shear strength of the deposit. The pocket penetrometer testing indicated that the undrained shear strength ranged from approximately 150 to 225 kPa.

Underlying the earth fill in Boreholes 1, 3, and 4, and underlying the clayey silt glacial till in Borehole 2, a glacial till deposit was encountered with a cohesionless matrix consisting of silty sand with trace to some clay and trace gravel. The silty sand glacial till was encountered at depths of 1.5 to 3.1 metres below grade (Elev. 260.5 to 259.1 metres) and extended beyond the vertical depth of investigation at 6.5 to 9.6 metres below grade (Elev. 255.3 to 251.8 metres). The silty sand glacial till was brown and moist, and the measured SPT "N" Values ranged from 11 to greater than 100 blows per 300 mm of penetration, indicating a compact to very dense (but generally very dense) relative density.

### 4.3 Groundwater

#### 4.3.1 Groundwater Levels

Unstabilized ground water level measurements and cave measurements were taken upon completion of drilling of each borehole. These measurements provide a rough estimate of the possible excavation and temporary ground water control constructability considerations that may arise. The boreholes remained open and dry. 50 mm diameter PVC monitoring wells were installed in Boreholes 1, 2, and 4 to facilitate the measurement of stabilized groundwater levels. The results are shown on the borehole logs in Appendix A and are summarized in the table below.

| Monitoring Well | Well Screen Location |                | Strata Screened         | Depth / Elevation (m) of Groundwater Table |                              |
|-----------------|----------------------|----------------|-------------------------|--------------------------------------------|------------------------------|
|                 | Depth (m)            | Elevation (m)  |                         | Dec. 12 <sup>th</sup> , 2019               | Dec. 20 <sup>th</sup> , 2019 |
| 1               | 7.6 to 9.1           | 254.4 to 252.9 | Silty Sand Glacial Till | 8.2* / 253.5                               | 5.3 / 250.6                  |
| 2               | 7.6 to 9.1           | 254.6 to 253.1 |                         | Dry                                        |                              |
| 4               | 7.6 to 9.1           | 253.6 to 252.1 |                         |                                            |                              |

\*Water level measured same day as drilling and may not represent a stabilized level.

Based on the above groundwater level measurements and moisture contents of the recovered soil samples, it is expected that the groundwater table is at or below a depth of 5.3 metres below grade. The wells installed in Boreholes 2 and 4 were dry. It is possible that the well installed in Borehole 1 captured a zone of perched water within the glacial till deposit rather than the prevailing groundwater table.

The silty sand glacial till deposit is cohesionless but contains more than 30% fines and will have a relatively lower permeability that typically precludes the free flow of water when wet. Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions.

#### 4.3.2 In-Situ Permeability and Infiltration

A rising head test was completed in the monitoring well installed in Borehole 1 on December 20<sup>th</sup>, 2019. Water was manually purged from the monitoring well using LDPE piping and a foot valve. The static water level within the monitoring well was measured prior to the start of testing, and the change in water level was monitored at select time intervals once the water had been purged from the monitoring well. The test was completed to estimate the horizontal hydraulic conductivity (K) of the soil at the well screen depth.

A hydraulic conductivity value was calculated from the rising head data using Hvorslev's solution (1951). Due to lower permeability of the silty sand glacial till, the rising head test conducted in the monitoring well installed in Borehole 1 did not recover sufficiently to reach  $T_0$ , which is the time required for the water level to rise to 37% of the initial change (i.e. drop) in water level. As such, the result was approximated by extrapolating a line of best fit to estimate  $T_0$ . The semi-log plot for drawdown versus time for the rising head test from Borehole 1 is provided in Appendix C and is summarized in the table below.

| Monitoring Well | Well Screen Location |                | Strata Screened         | Hydraulic Conductivity |
|-----------------|----------------------|----------------|-------------------------|------------------------|
|                 | Depth (m)            | Elevation (m)  |                         |                        |
| 1               | 7.6 to 9.1           | 254.4 to 252.9 | Silty Sand Glacial Till | $9 \times 10^{-8}$ m/s |

In addition to the above-noted permeability data, the hydraulic conductivity of the soils encountered on site was estimated from grain size distribution curves (as provided in Appendix B). According to Freeze and Cherry (1979), the typical hydraulic conductivity of the glacial till on site is on the order of  $10^{-6}$  m/s to  $10^{-12}$  m/s. The actual measured hydraulic conductivity of the silty sand glacial till is within the expected range. For the purposes of design, it is recommended to use a hydraulic conductivity of  $1 \times 10^{-7}$  m/s for the silty sand glacial till across the site.

Determination of percolation rates are based on the "Ministry of Municipal Affairs and Housing (MMAH) Supplementary Guidelines SB-6, Percolation Time and Soil Descriptions, September 14, 2012". Under the Unified Soil Classification System, the silty sand glacial till would be characterized as S.M. and the clayey silt glacial till in Borehole 2 would be characterized as M.L. Based on this document, the soil type, and the results of the hydraulic conductivity testing, the estimated percolation rate (T-Time) for the near surface soils would be as follows:

- Silty Sand Glacial Till (S.M.): 20 mins/cm (30 mm/hr)
- Clayey Silt Glacial Till (M.L.): Over 50 mins/cm (less than 12 mm/hr)

#### 4.3.3 Baseline Groundwater Chemical Testing

To assess the suitability for discharge of pumped groundwater to the land surface during potential dewatering activities, one (1) unfiltered and one (1) filtered groundwater sample were collected from the monitoring well installed in Borehole 1 on December 19<sup>th</sup>, 2019. The samples were collected and placed into pre-cleaned laboratory-supplied vials and/or bottles provided with analytical test group specific preservatives, as required.



Dedicated nitrile gloves were used during sample handling. The groundwater samples were submitted to CALA-accredited Caduceon Environmental Laboratories for analysis.

The groundwater samples were compared to Provincial Water Quality Objectives (PWQO). The results are provided in Appendix F and the exceedances are summarized in the table below.

| Sample ID         | Ground Water Sample Parameter Exceedances to PQWO |
|-------------------|---------------------------------------------------|
| BH 1 (Unfiltered) | Zinc, Lead, Iron, Copper, Cobalt, Cadmium         |
| BH 1 (Filtered)   | Lead, Iron, Copper, Cobalt                        |

It is expected that the measured levels of metals in the groundwater are naturally occurring and primarily from suspended solids within the groundwater sample, though a component may be from dissolved metals. The unfiltered sample typically had more total metal concentrations than the sample that was run through a 75 µm filter, since metals typically bind to sediment particles that are removed by filtration. Groundwater quality mitigation measures are discussed in Section 5.4.3.

## 5 Discussion and Analysis

### 5.1 Proposed Development Plan

CEE was provided with the following drawing set in preparation of this report:

- “Huronia Road Development, 441 Huronia Road, Barrie, Ontario”, by Gerrits Engineering Limited.

This drawing set indicates a 2-storey office building with no underground levels will be constructed in the northwest corner of the site, and the remaining parts of the property will be parking and driving areas. It is understood that the drawing set is preliminary and is subject to change (e.g. the building location may change, the number of storeys may be reduced, etc.). No grading plans were provided to CEE but significant grade changes are not expected. It is expected that the site will be municipally serviced.

### 5.2 Ground Water Control Methodology

#### 5.2.1 Temporary Construction Ground Water Control

The volume of water entering the excavation will be based on both ground water infiltration and precipitation events. Grading plans were not provided to CEE, but it is not expected that excavations or utility trenches will extend below the groundwater table that was encountered at or below a depth of 5.3 metres below grade. As excavations are expected to be above the prevailing ground water table, there should be limited ground water control issues present. During times of high precipitation, some water may collect at the base of the excavation. Local sumps placed at the base of the excavation can typically control groundwater seepage in this scenario.

Construction dewatering is expected to be less than 50,000 L/day, and per O.Reg. 63/16, registration on the Environmental Sector Activity Registry (EASR) nor a Permit to Take Water (PTTW) will be required from the Ministry of Environment, Conservation and Parks (MECP).

## 5.2.2 Permanent Building Drainage

The proposed commercial building has no basement levels or other below-grade space. Perimeter and under-slab drainage at the foundation level is not required, provided that the underside of concrete slab is at least 200 mm above the prevailing grade of the site and the surrounding surfaces slope away from the building at a gradient of at least 2% to promote surface water run-off and to reduce groundwater infiltration adjacent to foundations. To minimize infiltration of surface water, the upper 150 mm of backfill could comprise relatively impervious compacted soil material.

## 5.3 Water Balance

### 5.3.1 Water Balance Components

A water balance is an accounting of the water resources within a given area. The water balance equates the precipitation (P) over a given area to the summation of the change in ground water storage (S), evapotranspiration/evaporation (ET), surface water runoff (R) and infiltration (I) using the following equation:

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

The components of the water balance vary in space and time and depend on climatic conditions as well as the soil and land cover conditions (i.e., rainfall intensity, land slope, soil hydraulic conductivity and vegetation). For example, runoff occurs at a higher percentage during periods of snowmelt when the ground is frozen or during intense rainfall events.

Precise measurement of the water balance components is difficult, and as such, approximations and simplifications are made to characterize the water balance of a property. Field observations of the drainage conditions, land cover and soil types, groundwater levels and local climatic records are important inputs to the water balance calculations.

- Precipitation (P): For the purposes of approximating the annual precipitation at this site, the monthly rainfall between 1981 and 2010 was used based on Government of Canada (Environment Canada) historical weather data for the Barrie WPCC weather station (Climate ID 6110557, Latitude 44.38 N, Longitude 79.69 W, Elevation 229 metres), which is located relatively close to the site.
- Storage (S): Although there are groundwater storage gains and losses on a short-term basis, the net change in groundwater storage on a long-term basis is assumed to be zero.
- Evapotranspiration/Evaporation (PET): The evapotranspiration and evaporation components vary based on the characteristics of the land surface cover (i.e., type of vegetation, soil moisture conditions, perviousness of surfaces, etc.). Potential evapotranspiration refers to the water loss from a vegetated surface to the atmosphere under conditions of an unlimited water supply. Evaporation occurs from a hard surface (such as flat rooftops, asphalt, etc.).
- Water Surplus (R + I): The difference between the mean precipitation and evapotranspiration is referred to as the water surplus. The water surplus is divided into two parts: as surface or overland runoff (R) and the infiltration into the surficial soil (I). The infiltration is comprised of two end member components: one component that moves vertically downward to underlying aquifers (referred to as percolation, deep infiltration or net recharge) and a second component that moves laterally through the near surface soil

profile or shallow soils as interflow that re-emerges locally to surface (i.e., as runoff) at some short distance and time following precipitation.

### 5.3.2 Approach and Methodology

The analytical approach to calculate the water balance involves monthly soil-moisture balance calculations to determine the pre-development infiltration volumes. The detailed water balance calculation is provided in Appendix E, which are summarized in this and subsequent sections of the report. The following assumptions were used as part of the soil-moisture balance calculations:

- A soil moisture balance approach assumes that soils do not release water as potential recharge while a soil moisture deficit exists.
- During wetter periods, any excess of precipitation over evapotranspiration first goes to restore soil moisture. Considering the nature of the cohesionless near surface soils (sand to silty sand) and a mostly grassed site, a soil moisture storage capacity of 75 mm was used.
- Once the soil moisture deficit is overcome, any further excess water can then pass through the soil as infiltration and either become interflow (indirect runoff) or recharge (deep infiltration).

Monthly potential evapotranspiration calculations accounting for latitude, climate and the actual evapotranspiration and water surplus components of the water balance based on the monthly precipitation and soil moisture conditions was calculated. The MOECC SWM Planning and Design Manual (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used, and a corresponding infiltration factor was calculated. The water surplus was multiplied by the infiltration factor to determine both the pre-existing and post-condition annual volumes for run-off and infiltration for the property.

A post-development water balance scenario was also calculated based on the proposed land development plan, as discussed in Section 5.3.3. The drawing, *"Huronion Road Development, 441 Huronia Road, Barrie, Ontario"*, by Gerrits Engineering Limited shows the proposed development including a commercial building, parking and driving areas, and some areas that are assumed to be landscaped.

It is noted that the infiltration and runoff values presented in Appendix E are estimates only. Single values are used for the water balance calculations, but it is important to understand that infiltration rates are dependent upon the hydraulic conductivity of the surficial soils which may vary over several orders of magnitude. As such, the margins of error for the calculated infiltration and runoff component values are potentially quite large. These margins of error are recognized, but for the purposes of this assessment, the numbers used in the water balance calculations are considered reasonable estimates based on the site-specific conditions and useful for comparison of pre- to post-development conditions.

### 5.3.3 Pre and Post Water Balance

The detailed water balance calculations are included in Appendix E. The pre-development calculations are summarized in the table below:



| Pre-Development Land Use |            | Pre-Development Average Annual Runoff Volume (m <sup>3</sup> /year) | Pre-Development Average Annual Infiltration Volume (m <sup>3</sup> /year) |
|--------------------------|------------|---------------------------------------------------------------------|---------------------------------------------------------------------------|
| Soft Cover               | Hard Cover |                                                                     |                                                                           |
| 100% (flat grass areas)  | 0%         | 388                                                                 | 1,551                                                                     |

The post-development calculations are summarized in the table below:

| Post-Development Land Use          |                                    | Post-Development Average Annual Runoff Volume (m <sup>3</sup> /year) | Post-Development Average Annual Infiltration Volume (m <sup>3</sup> /year) |
|------------------------------------|------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------------|
| Soft Cover                         | Hard Cover                         |                                                                      |                                                                            |
| 20% (grassed and landscaped areas) | 80% (buildings and pavement areas) | 3,332                                                                | 310                                                                        |

These calculations suggest that, without mitigation such as low impact development measures, the proposed development will decrease average infiltration by about 1,241 m<sup>3</sup>/year. The proposed development will increase runoff by about 2,944 m<sup>3</sup>/year (859% increase). The potential impacts of these changes and recommended mitigation measures are discussed below.

## 5.4 Recommended Mitigation Measures

### 5.4.1 Runoff Quantity

Urban development of an area affects the natural water balance. The most significant difference is the addition of impervious surfaces as a type of surface cover (i.e., roads, parking lots, driveways, and rooftops). Impervious surfaces prevent infiltration of water into the soils and the removal of the vegetation reduces the evapotranspiration component of the natural water balance. The evaporation component from impervious surfaces is relatively minor (estimated to be 15% of precipitation) compared to the evapotranspiration component that occurs with vegetation in this area (up to two thirds of precipitation). So, the net effect of the urbanization of the site is that most of the precipitation that falls onto impervious surfaces increases the surplus water resulting in more direct runoff from developed areas and reduced natural infiltration.

In conjunction with increased runoff, there is a reduction in infiltration to the shallow groundwater system. A reduction in infiltration can potentially lead to a lowering of the local water table and reduce the potential for this seasonal water table intersection and discharge.

Methods which do not necessarily increase infiltration rate, but decrease the volume and concentration of surface water runoff can be considered at this site:

- Increasing the topsoil thickness by about two times the normal thickness (up to 30 cm) to retain more water in storage; and
- Implementation of rainwater harvesting which intercepts, diverts and stores roof runoff (i.e. cisterns) for future use.

## 5.4.2 Mitigation Measures for Maintaining Infiltration

The increases in surface water runoff that will occur with urban development and mitigation of the potential impacts to the local water table due to reduction of infiltration may be minimized by using appropriate stormwater management and using low impact development (LID) measures to promote infiltration. These measures can be implemented on-site.

The basic premise for low impact development is to try to minimize changes to runoff and infiltration. As outlined in the MOECC SWMP Design Manual (2003) and Low Impact Development Stormwater Management Planning and Design Guide published by the CVC and TRCA (2010), there are a suite of techniques that may be considered to promote infiltration and reduce runoff. In order to maintain ground water function at the site the following typical LID measures can be considered as part of typical site developments:

- Collection of runoff from the building rooftops and redirection to grass areas and overland flow. If feasible, it is recommended that there be a minimum 5 metre flow path over pervious areas to allow this mitigation method to be fully effective;
- Provision of gentle slopes in open areas or along drainage ditches in order to allow time for water infiltration;
- Construction of engineered infiltration measures such as soakaway pits, infiltration galleries or bioswales (subsurface infiltration methods can only be considered in areas where there is sufficient soil permeability and depth to water table to accommodate the systems within the unsaturated zone); and
- Construction of grass channels or filter strips which allow infiltration, discharge at a lower rate and direct roof runoff to overland flow.

Implementation of LID measures will not only allow for infiltration of the surface water into the near-surface groundwater regime but allow for increase in natural filtration of surficial runoff, prevent sedimentation transport and potential erosion, and help reduce flooding by increasing the transit time for water on the site. These types of LID techniques promote natural infiltration by providing additional water volumes in the pervious areas. This is particularly effective in the summer months, when natural infiltration would not generally occur because the additional water overcomes the natural soil moisture deficit.

The details will be provided by others in a stormwater management report for the site. This includes demonstrating through plans and sections (including all dimensions, materials used and including the seasonal high groundwater level) how this infiltration deficit will be mitigated. In addition, the stormwater management report will need to include calculations to demonstrate that the LID facilities will be adequately sized both volumetrically and for area to allow completed drawdown within a 24 to 48 hours time period.

As it is a requirement of maintaining the same levels of infiltration post construction, no appreciable change in the groundwater table elevation should occur over the long-term condition. There are no domestic water supply wells within a 500-metre radius of the site.

## 5.4.3 Groundwater Quality

Depending on land use, runoff from urban developments may contain a variety of dilute contaminants such as suspended solids, chloride from road salt, oil and grease, metals, pesticide residues, bacteria and viruses. The site is within an HVA and the proposed land use will be commercial. Based on Table 2 in *"Lake Simcoe Protection*

*Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP,*” infiltration-based practices are not permitted for this site for runoff from impervious areas. Runoff from pavement areas can become contaminated with chloride and sodium from de-icing salt applications, hydrocarbons and metals from vehicles, etc. Low Impact Development Stormwater Management Planning and Design Guide published by the CVC and TRCA (2010), indicates that runoff can be infiltrated from low to medium traffic parking lots if it is pretreated using sedimentation and / or filtration, such as oil / grit separators or biofilters, prior to infiltration. Pretreatment options should be explored by the stormwater management facility designer and may allow for infiltration from paved areas if approved by the reviewing agencies. LSRCA also has compensation programs if pre to post infiltration cannot be maintained.

Infiltration of runoff from vegetated areas and rooftops is always permitted. A general principal is that runoff from rooftops and vegetated sources should not be mixed with runoff from paved areas (even if pretreated) prior to infiltration. For groundwater, generally except for the dissolved constituents such as nitrogen and salt, most contaminants are attenuated by filtration during groundwater flow through the soils. The prevailing groundwater table beneath the site is relatively deep at 5.3 metres below grade or deeper, allowing for attenuation as infiltrated water percolates through the soil matrix before reaching the water table.

LID measures or end treatments such as oil/grit separators or wet ponds help to remove suspended solids and other contaminants in runoff prior to infiltration or conveying the flows off the site, especially when a treatment train approach is taken for stormwater management. The stormwater management facilities (to be designed by others) must be designed such that the water quality is maintained or improved prior to discharging water from the site or infiltrating water into the ground.

Phosphorous will also be removed from the site through implementation of measures such as LID or end treatments. This will be addressed in the stormwater management report prepared for the site by others. “*LSRCA Technical Guidelines for Stormwater Management Submissions*” (dated September 1, 2016, by LSRCA) states that 80% removal of annual Total Phosphorous is required for major developments and provides a list of typical phosphorous removal rates for various stormwater management best management practices. LID measures are recommended for this site to maintain the pre to post development water balance. LID’s used in a treatment train approach remove phosphorous, and some typical removal rates are 60% for infiltration trenches, 65% for vegetated filter strips, and 87% for a perforated pipe infiltration / exfiltration system based on the LSRCA guidelines.

The results of the groundwater chemical testing compared to Provincial Water Quality Objectives (PWQOs) as provided in Appendix E and summarized in Section 4.3.3 show that there are several exceedances for metals in the unfiltered groundwater samples. Field filtering using a 75-micron filter was also carried out prior to collecting the second sample to provide a general reference to how filtering during actual dewatering activities can improve groundwater quality. The results show that filtering helps to remove or reduce the metal exceedances since metals usually bind to sediment that is readily removed using filters. This chemistry testing was carried out to establish baseline conditions but dewatering or significant discharge of groundwater during construction is not anticipated since excavations are not expected to extend below the prevailing groundwater table. As such, little to no water is expected to be discharged to the ground surface and will therefore have no impact on surface water features.



## 6 Limitations and Conclusion

### 6.1 Limitations

The investigation and comments are necessarily on-going as new information of underground conditions becomes available. More specific information with respect to the conditions between samples, or the lateral and vertical extent of materials may become apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during excavation operations. Consequently, during the future development of the property, conditions not observed during this investigation may become apparent. Should this occur, Central Earth Engineering should be contacted to assess the situation and additional testing and reporting may be required.

Central Earth Engineering should be retained for a general review of the final design drawings and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, Central Earth Engineering will assume no responsibility for interpretation of the recommendations in the report. For example, it should be appreciated that modifications to bearing levels may be required if unforeseen subsoil conditions are revealed after the excavation is exposed to full view or if final design decisions differ from those assumed in this report.

The comments given in this report are intended only for the guidance of the design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report was prepared by Central Earth Engineering for the account of Dr. Behrooz Azizi. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Central Earth Engineering accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

## 6.2 Conclusion

It is recognized that municipal/regional governing bodies, in their capacity as the planning and building authority under Provincial statutes, will make use of and rely upon this report, cognizant of the limitations thereof, both as are expressed and implied.

We trust this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to contact our office.

Yours Truly,

Central Earth Engineering Inc.



Alexander Winkelmann, P.Eng.  
President



Russell Wiginton, P.Eng.  
Project Engineer



Figures –

**FIGURE 1 – SITE LOCATION PLAN**

**FIGURE 2 – BOREHOLE LOCATION PLAN**

**FIGURE 3 – SUBSURFACE PROFILE**

**FIGURE 4 – MECP & CEE WELL LOCATION MAP**

**FIGURE 5A – WELLHEAD PROTECTION AREA MAP**

**FIGURE 5B – SIGNIFICANT GROUNDWATER RECHARGE MAP**

**FIGURE 5C – HIGHLY VULNERABLE AQUIFER MAP**





Reference:  
Simcoe County Maps, 2019

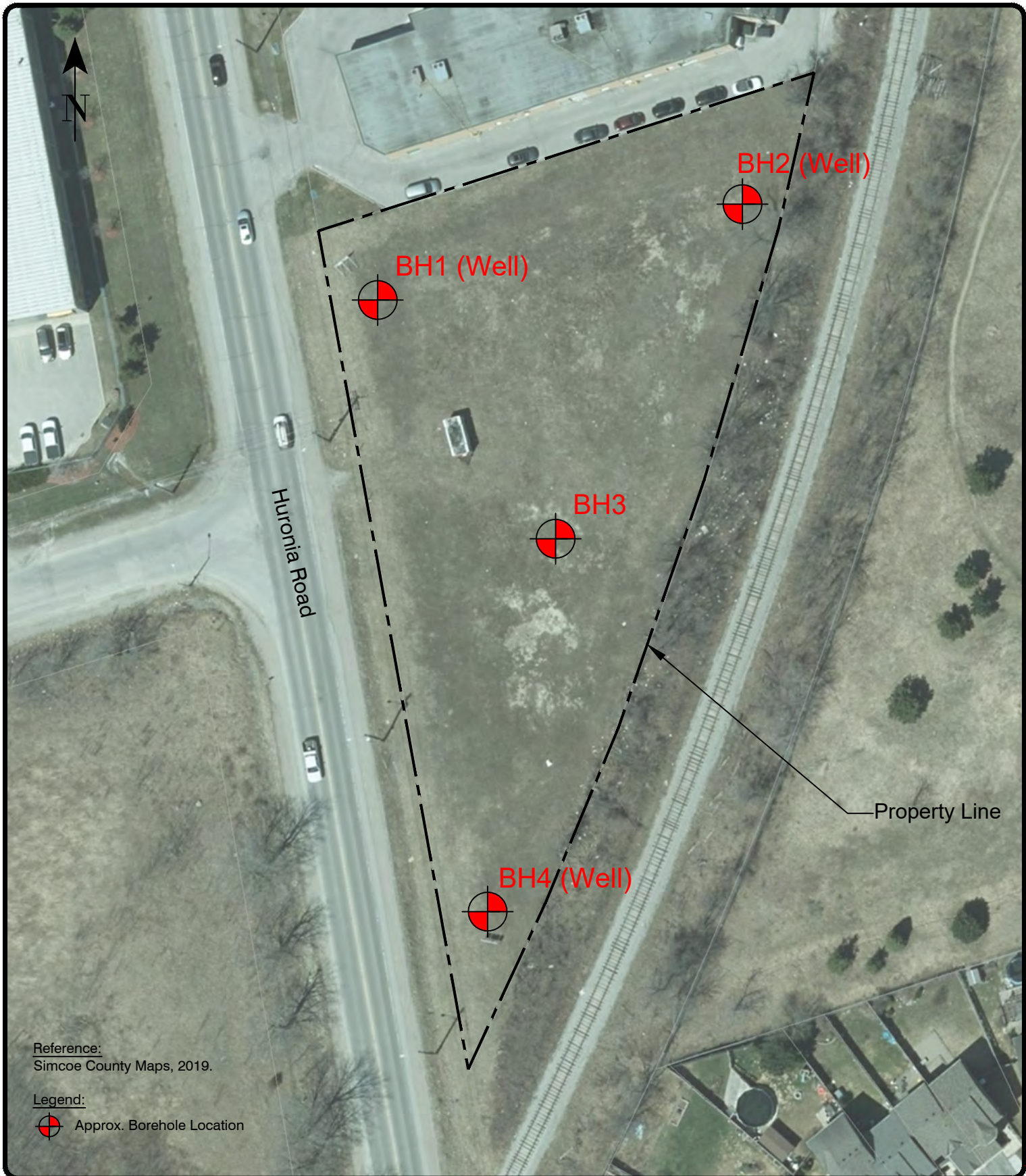


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|                                            |          |        |              |
|--------------------------------------------|----------|--------|--------------|
| Project: 441 Huronia Road, Barrie, Ontario |          |        |              |
| Title: SITE LOCATION PLAN                  |          |        |              |
| Approved by:                               | A.W.     | Date:  | January 2020 |
| Project No.:                               | 19-1243A |        |              |
| Drawn by:                                  | R.W.     | Scale: | N.T.S.       |
| Figure No.:                                | 1        |        |              |

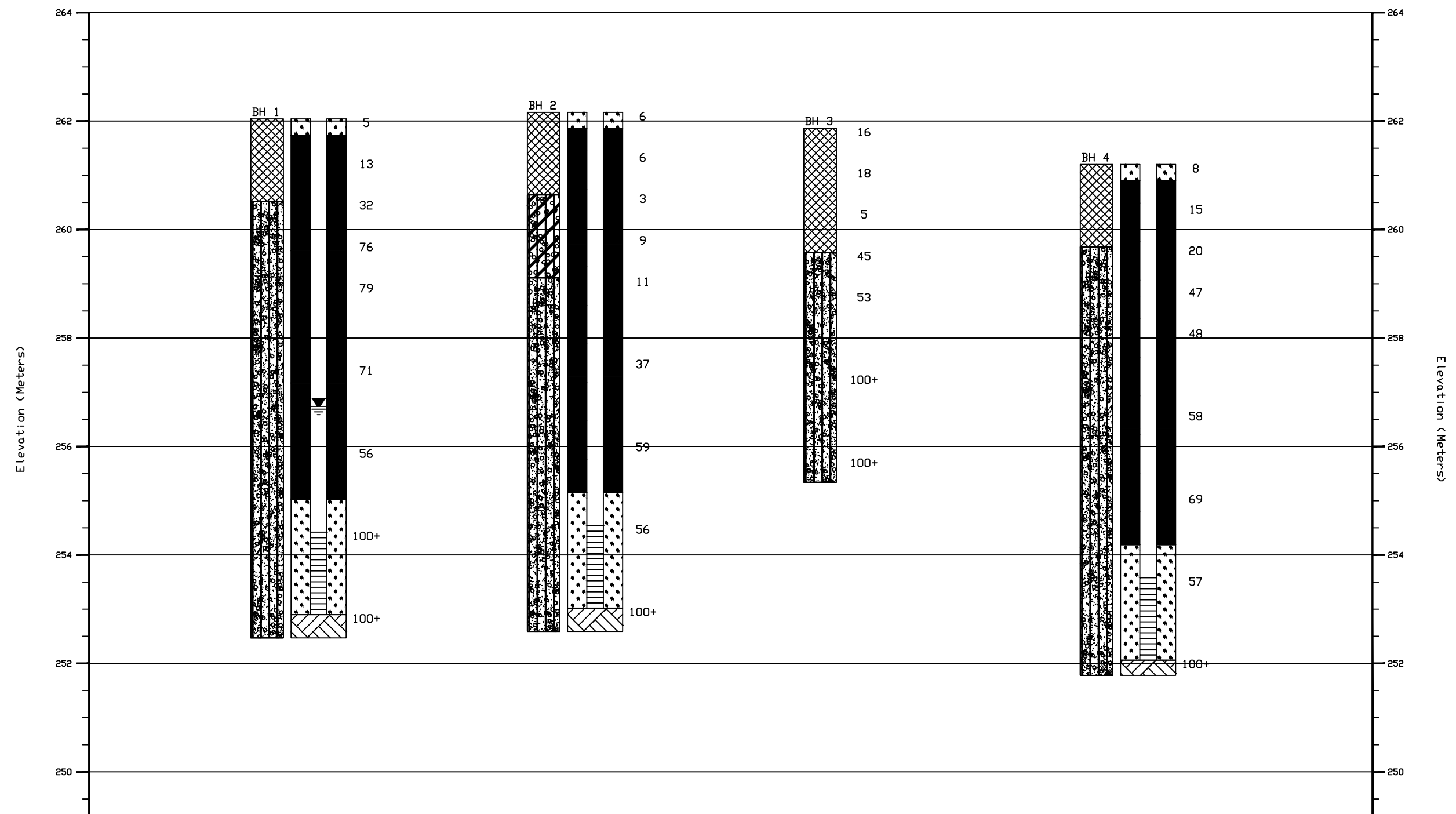




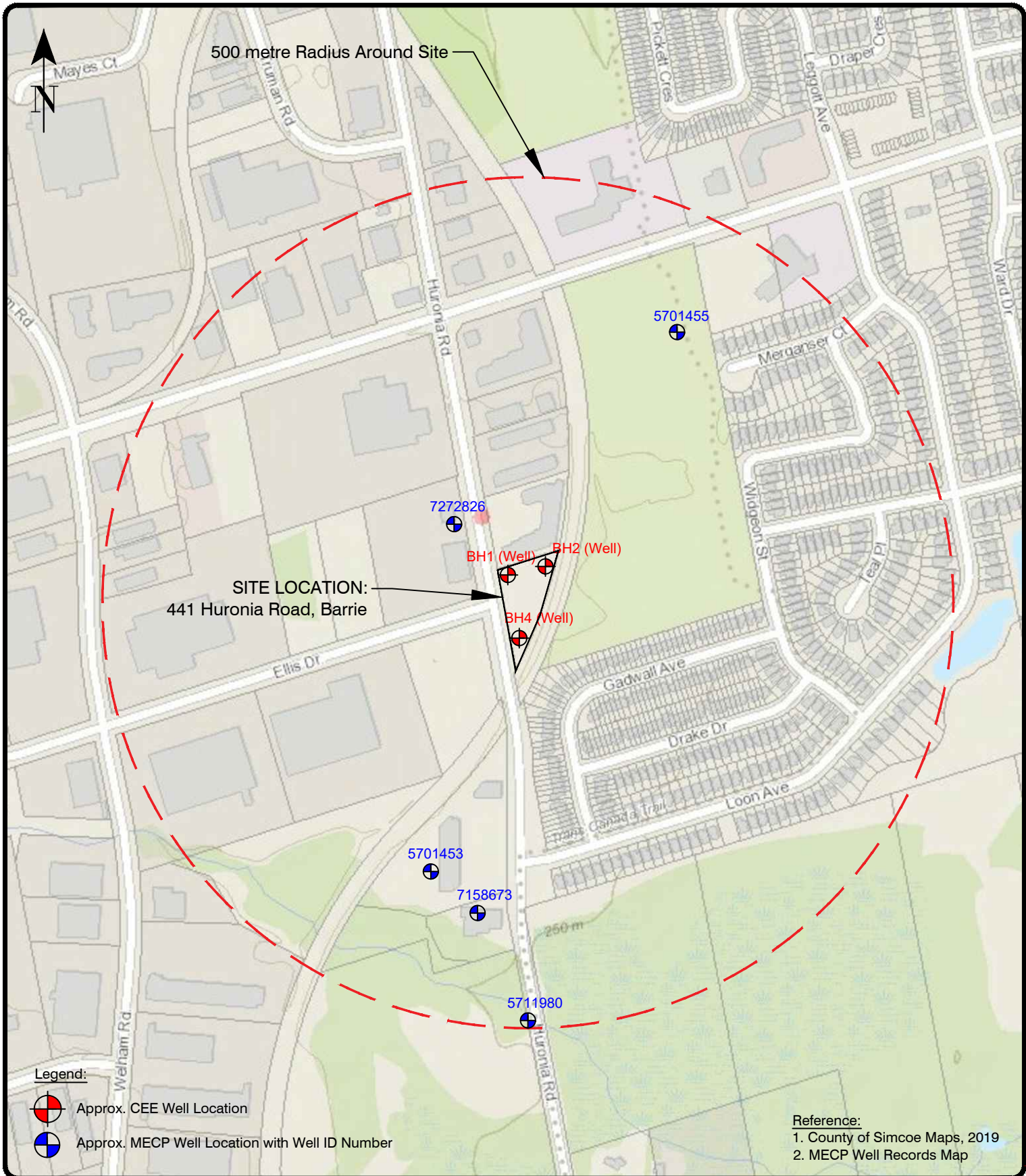
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|--------------------------------------------|------|----------|--------------|
| Project: 441 Huronia Road, Barrie, Ontario |      |          |              |
| Title: BOREHOLE LOCATION PLAN              |      |          |              |
| Approved by:                               | A.W. | Date:    | January 2020 |
| Drawn by:                                  | R.W. | Scale:   | 1:750        |
| Project No.:                               |      | 19-1243A |              |
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441 Huronia Road, Barrie

Title:

MECP & CEE WELL LOCATION PLAN

Approved by:

R.W.

Date:

January 2020

Project No.:

19-1243A

Drawn by:

R.W.

Scale:

N.T.S.

Figure No.:

4



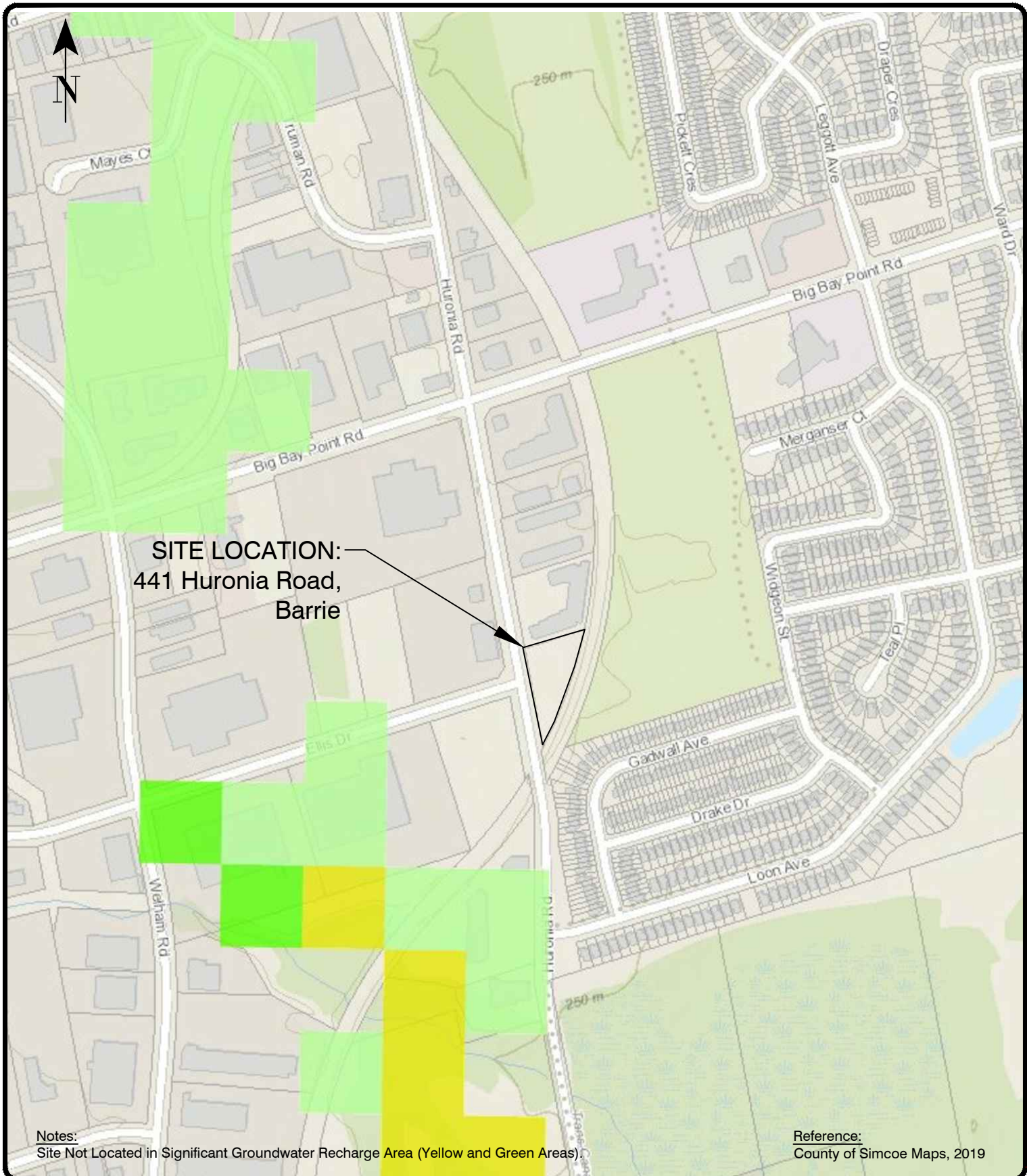


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|              |      |                              |              |
|--------------|------|------------------------------|--------------|
| Project:     |      | 441 Huronia Road, Barrie     |              |
| Title:       |      | WELLHEAD PROTECTION AREA MAP |              |
| Approved by: | R.W. | Date:                        | January 2020 |
| Drawn by:    | M.T. | Scale:                       | N.T.S.       |
| Project No.: |      | 19-1243A                     |              |
| Figure No.:  |      | 5A                           |              |





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Project:

441 Huronia Road, Barrie

Title:

**SIGNIFICANT GROUNDWATER RECHARGE AREA MAP**

Approved by:

R.W..

Date:

January 2020

Project No.:

19-1243A

Drawn by:

M.T.

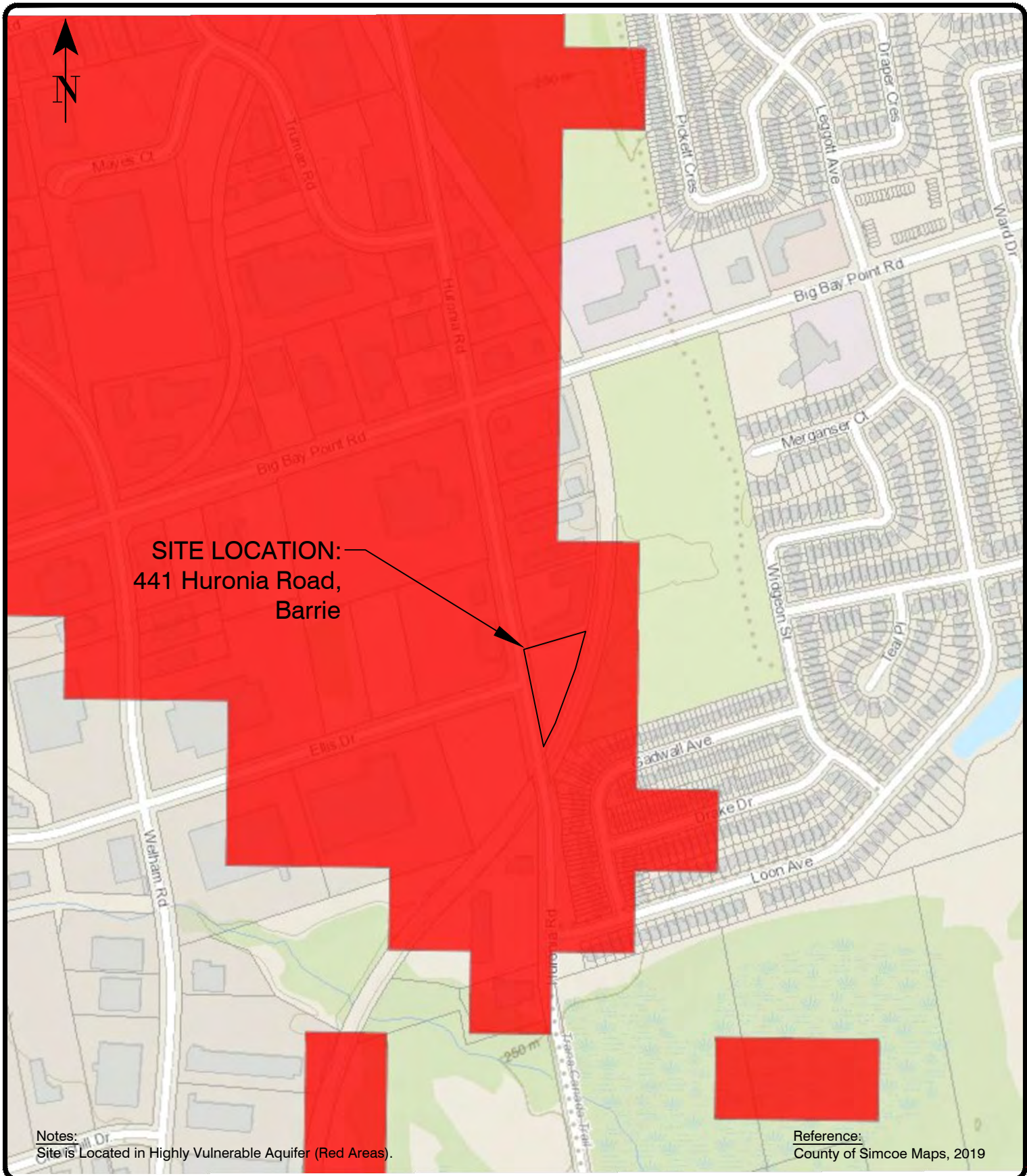
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N.T.S.

Figure No.:

**5B**





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Project:

441 Huronia Road, Barrie

Title:

HIGHLY VULNERABLE AQUIFER MAP

Approved by:

R.W.

Date:

January 2020

Project No.:

19-1243A

Drawn by:

M.T.

Scale:

N.T.S.

Figure No.:

5C

## Appendix A – **BOREHOLE LOGS**

# RECORD OF BOREHOLE No. 1



Project Number: **19-1243A**  
 Project Client: **Mr. Behrooz Azizi**  
 Project Name: **441 Huronia Road**  
 Project Location: **Barrie, Ontario**  
 Drilling Location: **NW Corner of Lot**

Drilling Method: **Solid Stem Augers** Drilling Machine: **Track Mount**  
 Logged By: **RD** Northing: **4911659** Date Started: **2019-12-12**  
 Reviewed By: **AW** Easting: **606473** Date Completed: **2019-12-12**

| LITHOLOGY PROFILE                                                                      |                                                                                                      | SOIL SAMPLING |               |              |               | DEPTH (m) | ELEVATION (m) | FIELD TESTING                                                                                                                                                                                    | LAB TESTING                                                                                                                                                                                | Instrumentation Installation | COMMENTS & GRAIN SIZE DISTRIBUTION (%) |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------|---------------|--------------|---------------|-----------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------------|
| DESCRIPTION                                                                            |                                                                                                      | Sample Type   | Sample Number | Recovery (%) | SPT "N" Value |           |               | Shear Strength Testing (kPa)<br>X Other Test<br>+ Pocket Penetrometer<br>▲ Field Vane (Intact)<br>△ Field Vane (Remolded)<br>40 80 120 160<br>Penetration Testing<br>○ SPT ● DCPT<br>10 20 30 40 | △ Combustible Organic Vapour (ppm)<br>▲ Combustible Organic Vapour (%LEL)<br>* Total Organic Vapour (ppm)<br>100 200 300 400<br>Atterberg Limits<br>PL Water Content (%) LL<br>10 20 30 40 |                              |                                        |
| Lithology Plot<br>Geodetic 262.04m<br>1.5 260.5<br>9.6 252.5<br>End of Borehole @ 9.6m | FILL: Silty Sand, Trace Gravel, Loose to Compact, Brown, Moist                                       | SS            | 1             | 58           | 5             | 0         | 262           | 5                                                                                                                                                                                                | 9                                                                                                                                                                                          |                              | Topsoil = 100mm                        |
|                                                                                        |                                                                                                      | SS            | 2             | 89           | 13            |           |               | 13                                                                                                                                                                                               | 8                                                                                                                                                                                          |                              |                                        |
|                                                                                        | SILTY SAND GLACIAL TILL, Trace to Some Clay, Trace Gravel, Dense, Brown, Moist<br>--- Very Dense --- | SS            | 3             | 100          | 32            | 2         | 260           | 32                                                                                                                                                                                               | 7                                                                                                                                                                                          |                              |                                        |
|                                                                                        |                                                                                                      | SS            | 4             | 100          | 76            |           |               | 76                                                                                                                                                                                               | 8                                                                                                                                                                                          |                              |                                        |
|                                                                                        |                                                                                                      | SS            | 5             | 100          | 79            |           |               | 79                                                                                                                                                                                               | 7                                                                                                                                                                                          |                              |                                        |
|                                                                                        |                                                                                                      | SS            | 6             | 100          | 71            | 4         | 258           | 71                                                                                                                                                                                               | 9                                                                                                                                                                                          |                              |                                        |
|                                                                                        |                                                                                                      | SS            | 7             | 100          | 56            | 6         | 256           | 56                                                                                                                                                                                               | 9                                                                                                                                                                                          |                              | 8 57 26 9                              |
|                                                                                        |                                                                                                      | SS            | 8             | 100          | 100+          | 8         | 254           | 100+                                                                                                                                                                                             | 7                                                                                                                                                                                          |                              |                                        |
|                                                                                        |                                                                                                      | SS            | 9             | 53           | 100+          |           |               | 100+                                                                                                                                                                                             | 9                                                                                                                                                                                          |                              |                                        |

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Groundwater depth encountered on completion of drilling: **Dry**

Groundwater depth observed on **2019-12-12** at a depth of: **8.2m**

Cave depth after auger removal: **Open**

Observed on **2019-12-20** at a depth of: **5.3m**

Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :100**

Page: **1 of 1**



# RECORD OF BOREHOLE No. 2



Project Number: **19-1243A**  
 Project Client: **Mr. Behrooz Azizi**  
 Project Name: **441 Huronia Road**  
 Project Location: **Barrie, Ontario**  
 Drilling Location: **NE Corner of Lot**

Drilling Method: **Solid Stem Augers** Drilling Machine: **Track Mount**  
 Logged By: **RD** Northing: **4911674** Date Started: **2019-12-12**  
 Reviewed By: **AW** Easting: **606525** Date Completed: **2019-12-12**

| LITHOLOGY PROFILE |                                                                                                         | SOIL SAMPLING |               |              |               | DEPTH (m) | ELEVATION (m) | FIELD TESTING                                                                                                                                                                                    | LAB TESTING                                                                                                                                                                                | Instrumentation Installation | COMMENTS & GRAIN SIZE DISTRIBUTION (%) |
|-------------------|---------------------------------------------------------------------------------------------------------|---------------|---------------|--------------|---------------|-----------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------------|
| DESCRIPTION       |                                                                                                         | Sample Type   | Sample Number | Recovery (%) | SPT "N" Value |           |               | Shear Strength Testing (kPa)<br>X Other Test<br>+ Pocket Penetrometer<br>▲ Field Vane (Intact)<br>△ Field Vane (Remolded)<br>40 80 120 160<br>Penetration Testing<br>○ SPT ● DCPT<br>10 20 30 40 | △ Combustible Organic Vapour (ppm)<br>▲ Combustible Organic Vapour (%LEL)<br>* Total Organic Vapour (ppm)<br>100 200 300 400<br>Atterberg Limits<br>PL Water Content (%) LL<br>10 20 30 40 |                              |                                        |
|                   | FILL: Silty Sand, Trace Gravel, Loose, Brown, Moist                                                     | SS            | 1             | 67           | 6             | 0         | 262           | 6                                                                                                                                                                                                | 6                                                                                                                                                                                          |                              | No topsoil present                     |
|                   |                                                                                                         | SS            | 2             | 83           | 6             |           |               |                                                                                                                                                                                                  | 7                                                                                                                                                                                          |                              |                                        |
|                   | CLAYEY SILT GLACIAL TILL, Sandy, Trace Gravel, Trace Organics, Soft, Dark Brown, Moist<br>--- Stiff --- | SS            | 3             | 50           | 3             | 1.5       | 260.6         | 3                                                                                                                                                                                                |                                                                                                                                                                                            |                              |                                        |
|                   |                                                                                                         | SS            | 4             | 100          | 9             | 2         | 260           | 9                                                                                                                                                                                                | 20                                                                                                                                                                                         |                              |                                        |
|                   | SILTY SAND GLACIAL TILL, Trace to Some Clay, Trace Gravel, Compact, Brown, Moist<br>--- Dense ---       | SS            | 5             | 67           | 11            | 3.1       | 259.1         | 11                                                                                                                                                                                               | 11                                                                                                                                                                                         |                              | 1 66 21 12                             |
|                   |                                                                                                         | SS            | 6             | 100          | 37            | 4         | 258           | 37                                                                                                                                                                                               | 6                                                                                                                                                                                          |                              |                                        |
|                   | --- Very Dense ---                                                                                      | SS            | 7             | 100          | 59            | 6         | 256           | 59                                                                                                                                                                                               | 7                                                                                                                                                                                          |                              |                                        |
|                   |                                                                                                         | SS            | 8             | 100          | 56            | 8         | 254           | 56                                                                                                                                                                                               | 8                                                                                                                                                                                          |                              |                                        |
|                   | End of Borehole @ 9.6m                                                                                  | SS            | 9             | 100          | 100+          | 9.6       | 252.6         | 100+                                                                                                                                                                                             | 6                                                                                                                                                                                          |                              |                                        |

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Groundwater depth encountered on completion of drilling: **Dry**

Groundwater depth observed on **2019-12-12** at a depth of: **Dry**

Cave depth after auger removal: **Open**

Observed on **2019-12-20** at a depth of: **Dry**

Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :100**

Page: **1 of 1**

# RECORD OF BOREHOLE No. 3



Project Number: 19-1243A  
 Project Client: Mr. Behrooz Azizi  
 Project Name: 441 Huronia Road  
 Project Location: Barrie, Ontario  
 Drilling Location: Centre of Lot

Drilling Method: Solid Stem Augers Drilling Machine: Track Mount  
 Logged By: RD Northing: 4911625 Date Started: 2019-12-12  
 Reviewed By: AW Easting: 606499 Date Completed: 2019-12-12

| LITHOLOGY PROFILE                                                                      |                                                                                | SOIL SAMPLING |               |              |               | DEPTH (m) | ELEVATION (m) | FIELD TESTING                                                                                                | LAB TESTING                                                                                                                                                                 | Instrumentation Installation | COMMENTS & GRAIN SIZE DISTRIBUTION (%)                   |
|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|---------------|---------------|--------------|---------------|-----------|---------------|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------------------------------|
| DESCRIPTION                                                                            |                                                                                | Sample Type   | Sample Number | Recovery (%) | SPT "N" Value |           |               | Shear Strength Testing (kPa)                                                                                 |                                                                                                                                                                             |                              |                                                          |
| Lithology Plot<br>Geodetic 261.87m<br>2.3 259.6<br>6.5 255.3<br>End of Borehole @ 6.6m | FILL: Silty Sand, Trace Clay, Trace Gravel, Compact, Brown, Moist              | SS            | 1             | 100          | 16            | 0         | 260           | X Other Test<br>+ Pocket Penetrometer<br>▲ Field Vane (Intact)<br>△ Field Vane (Remolded)<br>○ SPT<br>● DCPT | △ Combustible Organic Vapour (ppm)<br>▲ Combustible Organic Vapour (%LEL)<br>* Total Organic Vapour (ppm)<br>100 200 300 400<br>Atterberg Limits<br>PL Water Content (%) LL |                              | No topsoil present<br><br><br><br><br><br><br>11 65 20 4 |
|                                                                                        | ---                                                                            | SS            | 2             | 78           | 18            |           |               |                                                                                                              |                                                                                                                                                                             |                              |                                                          |
|                                                                                        | ---                                                                            | SS            | 3             | 78           | 5             |           |               |                                                                                                              |                                                                                                                                                                             |                              |                                                          |
|                                                                                        | SILTY SAND GLACIAL TILL, Trace to Some Clay, Trace Gravel, Dense, Brown, Moist | SS            | 4             | 100          | 45            |           |               |                                                                                                              |                                                                                                                                                                             |                              |                                                          |
|                                                                                        | ---                                                                            | SS            | 5             | 100          | 53            |           |               |                                                                                                              |                                                                                                                                                                             |                              |                                                          |
|                                                                                        | ---                                                                            | SS            | 6             | 100          | 100+          |           |               |                                                                                                              |                                                                                                                                                                             |                              |                                                          |
|                                                                                        | ---                                                                            | SS            | 7             | 100          | 100+          |           |               |                                                                                                              |                                                                                                                                                                             |                              |                                                          |

CENTRAL EARTH ENGINEERING

647 Welham Road, Unit 14  
 Barrie, Ontario L4N 0B8  
 T : (705) 719-7994  
 E: info.com  
 W: centralearth.com

Groundwater depth encountered on completion of drilling: **Dry**

Cave depth after auger removal: **Open**

Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :100**

Page: **1 of 1**

# RECORD OF BOREHOLE No. 4



Project Number: **19-1243A**  
 Project Client: **Mr. Behrooz Azizi**  
 Project Name: **441 Huronia Road**  
 Project Location: **Barrie, Ontario**  
 Drilling Location: **Southern Corner of Lot**

Drilling Method: **Solid Stem Augers** Drilling Machine: **Track Mount**  
 Logged By: **RD** Northing: **4911572** Date Started: **2019-12-12**  
 Reviewed By: **AW** Easting: **606491** Date Completed: **2019-12-12**

| LITHOLOGY PROFILE |                        | SOIL SAMPLING |               |              |               | DEPTH (m) | ELEVATION (m) | FIELD TESTING                                                                                                                                                                     | LAB TESTING                                                                                                                                                                 | Instrumentation Installation | COMMENTS & GRAIN SIZE DISTRIBUTION (%) |    |    |    |
|-------------------|------------------------|---------------|---------------|--------------|---------------|-----------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------------|----|----|----|
| Lithology Plot    | DESCRIPTION            | Sample Type   | Sample Number | Recovery (%) | SPT "N" Value |           |               | Shear Strength Testing (kPa)<br>X Other Test<br>+ Pocket Penetrometer<br>▲ Field Vane (Intact)<br>△ Field Vane (Remolded)<br>40 80 120 160<br>Penetration Testing<br>○ SPT ● DCPT | △ Combustible Organic Vapour (ppm)<br>▲ Combustible Organic Vapour (%LEL)<br>* Total Organic Vapour (ppm)<br>100 200 300 400<br>Atterberg Limits<br>PL Water Content (%) LL |                              | GR                                     | SA | SI | CL |
| Geodetic          | 261.20m                | SS            | 1             | 83           | 8             | 0         | 261.20        | 8                                                                                                                                                                                 | 13                                                                                                                                                                          |                              |                                        |    |    |    |
|                   | 259.7                  | SS            | 2             | 100          | 15            | 0.5       | 259.7         | 15                                                                                                                                                                                | 11                                                                                                                                                                          |                              |                                        |    |    |    |
|                   | 257.7                  | SS            | 3             | 72           | 20            | 1         | 257.7         | 20                                                                                                                                                                                | 9                                                                                                                                                                           |                              |                                        |    |    |    |
|                   | 255.8                  | SS            | 4             | 100          | 47            | 1.5       | 255.8         | 47                                                                                                                                                                                | 8                                                                                                                                                                           |                              |                                        |    |    |    |
|                   | 254.8                  | SS            | 5             | 100          | 48            | 2         | 254.8         | 48                                                                                                                                                                                | 6                                                                                                                                                                           |                              |                                        |    |    |    |
|                   | 252.8                  | SS            | 6             | 100          | 58            | 3         | 252.8         | 58                                                                                                                                                                                | 6                                                                                                                                                                           |                              |                                        |    |    |    |
|                   | 251.8                  | SS            | 7             | 100          | 69            | 4         | 251.8         | 69                                                                                                                                                                                | 7                                                                                                                                                                           |                              |                                        |    |    |    |
|                   | 250.8                  | SS            | 8             | 100          | 57            | 5         | 250.8         | 57                                                                                                                                                                                | 8                                                                                                                                                                           |                              |                                        |    |    |    |
|                   | 249.8                  | SS            | 9             | 100          | 100+          | 6         | 249.8         | 100+                                                                                                                                                                              | 8                                                                                                                                                                           |                              |                                        |    |    |    |
|                   | End of Borehole @ 9.4m |               |               |              |               | 9.4       | 248.8         |                                                                                                                                                                                   |                                                                                                                                                                             |                              |                                        |    |    |    |

CENTRAL EARTH  
ENGINEERING

647 Welham Road, Unit 14  
 Barrie, Ontario L4N 0B8  
 T : (705) 719-7994  
 E : info.com  
 W : centralearth.com

Groundwater depth encountered on completion of drilling: **Dry**

Groundwater depth observed on **2019-12-12** at a depth of: **Dry**

Cave depth after auger removal: **Open**

Observed on **2019-12-20** at a depth of: **Dry**

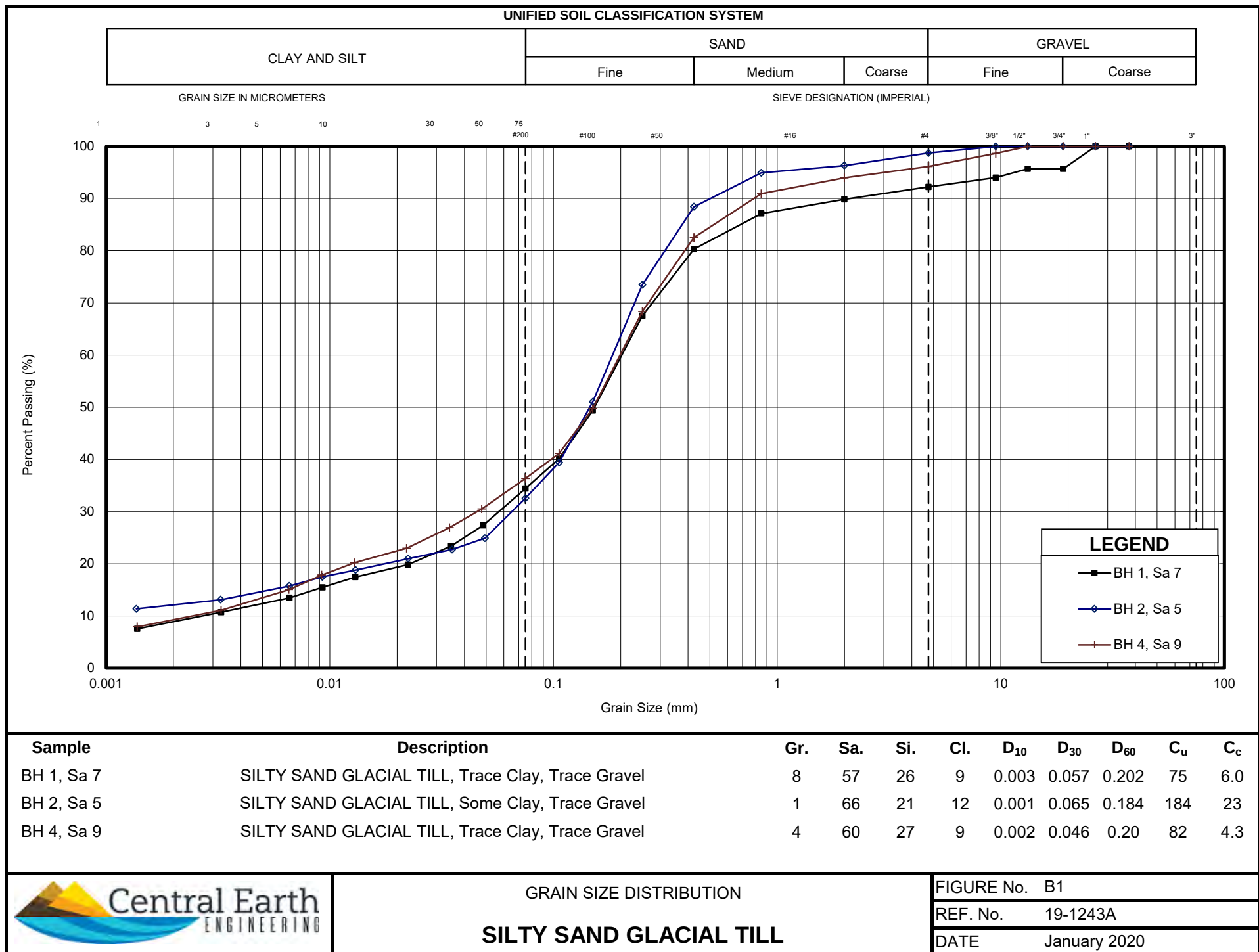
Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :100**

Page: **1 of 1**



## Appendix B – **GEOTECHNICAL LABORATORY DATA**

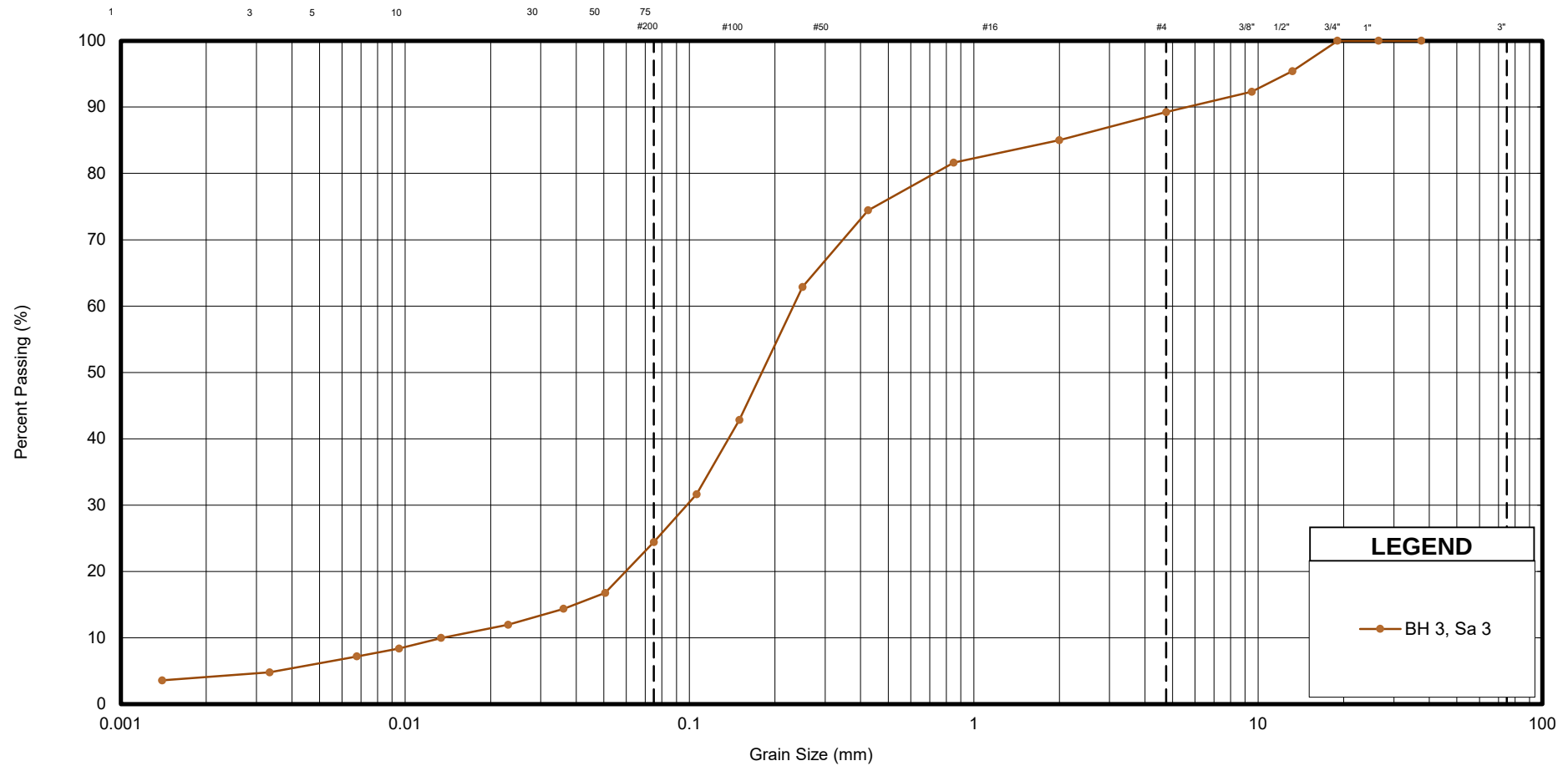


# UNIFIED SOIL CLASSIFICATION SYSTEM

| CLAY AND SILT | SAND |        |        | GRAVEL |        |
|---------------|------|--------|--------|--------|--------|
|               | Fine | Medium | Coarse | Fine   | Coarse |

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (IMPERIAL)



| Sample     | Description                                     | Gr. | Sa. | Si. | Cl. | D <sub>10</sub> | D <sub>30</sub> | D <sub>60</sub> | C <sub>u</sub> | C <sub>c</sub> |
|------------|-------------------------------------------------|-----|-----|-----|-----|-----------------|-----------------|-----------------|----------------|----------------|
| BH 3, Sa 3 | EARTH FILL: Silty Sand, Some Gravel, Trace Clay | 11  | 65  | 20  | 4   | 0.013           | 0.098           | 0.23            | 17.2           | 3.1            |



GRAIN SIZE DISTRIBUTION

**EARTH FILL**

FIGURE No. B2

REF. No. 19-1243A

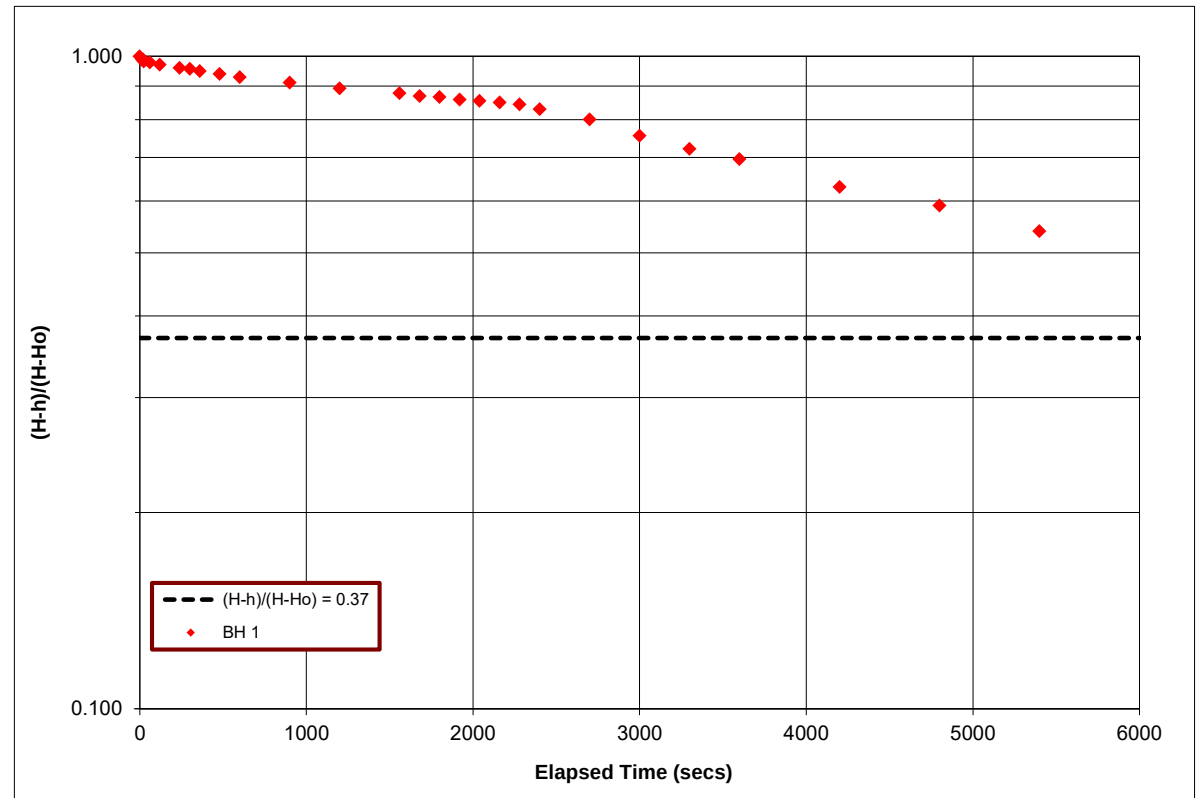
DATE January 2020



## Appendix C – **RISING HEAD TEST DATA**

## Recovery Testing - Hvorslev Method (1951)

| BH 1 |                     |                    |                 |       |              |
|------|---------------------|--------------------|-----------------|-------|--------------|
| Time | Elapsed Time (mins) | Elapsed Time (sec) | Water Level (m) | H-h   | (H-h)/(H-Ho) |
|      |                     |                    | 5.300           |       |              |
|      | 0.00                | 0                  | 8.06            | 2.760 | 1.000        |
|      | 0.25                | 15                 | 8.03            | 2.730 | 0.989        |
|      | 0.33                | 20                 | 8.03            | 2.730 | 0.989        |
|      | 0.42                | 25                 | 8.01            | 2.710 | 0.982        |
|      | 1.00                | 60                 | 8.00            | 2.700 | 0.978        |
|      | 2.00                | 120                | 7.980           | 2.680 | 0.971        |
|      | 4.00                | 240                | 7.950           | 2.650 | 0.960        |
|      | 5.00                | 300                | 7.940           | 2.640 | 0.957        |
|      | 6.00                | 360                | 7.920           | 2.620 | 0.949        |
|      | 8.00                | 480                | 7.895           | 2.595 | 0.940        |
|      | 10.00               | 600                | 7.865           | 2.565 | 0.929        |
|      | 15.00               | 900                | 7.815           | 2.515 | 0.911        |
|      | 20.00               | 1200               | 7.765           | 2.465 | 0.893        |
|      | 26.00               | 1560               | 7.725           | 2.425 | 0.879        |
|      | 28.00               | 1680               | 7.700           | 2.400 | 0.870        |
|      | 30.00               | 1800               | 7.690           | 2.390 | 0.866        |
|      | 32.00               | 1920               | 7.670           | 2.370 | 0.859        |
|      | 34.00               | 2040               | 7.660           | 2.360 | 0.855        |
|      | 36.00               | 2160               | 7.645           | 2.345 | 0.850        |
|      | 38.00               | 2280               | 7.630           | 2.330 | 0.844        |
|      | 40.00               | 2400               | 7.590           | 2.290 | 0.830        |
|      | 45.00               | 2700               | 7.510           | 2.210 | 0.801        |
|      | 50.00               | 3000               | 7.385           | 2.085 | 0.755        |
|      | 55.00               | 3300               | 7.290           | 1.990 | 0.721        |
|      | 60.00               | 3600               | 7.220           | 1.920 | 0.696        |
|      | 70.00               | 4200               | 7.040           | 1.740 | 0.630        |
|      | 80.00               | 4800               | 6.93            | 1.630 | 0.591        |
|      | 90.00               | 5400               | 6.79            | 1.490 | 0.540        |



K = Hydraulic Conductivity

r = radius of well casing

R = Radius of well screen or filter pack

L = Length of the well screen (in Slug Test) or the length of submerged portion of the well screen (in Rising Head)

T<sub>0</sub> = time for water level to rise or fall to 37% of the initial change

r (m) = 0.025

L (m) = 1.5

R (m) = 0.05

T<sub>0</sub> (sec) = 8,000 (Extrapolated)

K (m/s) = 9E-08

### Notes:

1 - All water levels are in metres from ground surface

1 - R is radius of sand pack

2 - T<sub>0</sub> is determined from plots where (H-h)/(H-Ho) = 0.37

3 - Analysis based off of Hvorslev (1951)



### RIISING HEAD TEST - BOREHOLE 1

|           |              |
|-----------|--------------|
| APPENDIX: | C            |
| REF. No.: | 19-1243A     |
| DATE:     | January 2020 |

## Appendix D – **MECP WELL RECORDS**



| Well ID | Date Installed | Well Use                   | Depth to Top of Screen | Water Level | Stratigraphy Summary                                                                                                                                                       |
|---------|----------------|----------------------------|------------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5701453 | 03-Aug-67      | Unknown                    | Unknown                | 4.0 m       | 0 to 2.4 m - Sand<br>2.4 to 6.7 m - Clay<br>6.7 to 7.6 m - Gravel                                                                                                          |
| 5701455 | 05-Jun-67      | Farming                    | 39.6 m                 | 19.8 m      | 0 to 20.4 m - Sand<br>20.4 to 28.0 m - Clay<br>28.0 to 31.3 m - Gravel and Sand<br>31.3 to 39.0 m - Fine Sand<br>39.0 to 40.5 m - Coarse Sand                              |
| 5711980 | 02-Aug-74      | Municipal Observation Well | Unknown                | 86.9 m      | 0 to 28.7 m - Clay<br>28.7 to 39.9 m - Sand<br>39.9 to 86.9 m - Clay<br>86.9 to 94.5 m - Sands<br>94.5 to 97.9 m - Clay<br>97.9 to 98.8 m - Sand<br>98.8 to 100.6 m - Clay |
| 7158673 | 06-Jan-11      | Well Abandonment Record    | n/a                    | n/a         | n/a                                                                                                                                                                        |
| 7272826 | 12-Sep-16      | Monitoring Well            | 3.1 m                  | Unknown     | 0 to 4.6 m - Sand                                                                                                                                                          |

56 UTM 172 606384 E

SR 4911097 N

Elev. SR 0835

# WATER WELL RECORD

Basin 22 County or District Simco

Township, Village, Town or City

Con. 12 Lot 10

Date completed

3 (day)

Aug (month)

1967 (year)

Owner

Address

RR#5 Barrie

## Casing and Screen Record

## Pumping Test

Inside diameter of casing 30

Static level 13

Total length of casing 25

Test-pumping rate 2 G.P.M.

Type of screen tiled Well

Pumping level

Length of screen

Duration of test pumping

Depth to top of screen

Water clear or cloudy at end of test clear

Diameter of finished hole 30

Recommended pumping rate 2 G.P.M.

with pump setting of 23 feet below ground surface

## Well Log

## Water Record

### Overburden and Bedrock Record

From ft.

To ft.

Depth(s) at which water(s) found

Kind of water (fresh, salty, sulphur)

Sand  
Brown clay  
Grey clay  
Gravel

0 8  
8 15  
15 22  
22 25

13 Fresh

For what purpose(s) is the water to be used?

Is well on upland, in valley, or on hillside? upland

Drilling or Boring Firm Roth Well Digging

Address RR#5 Barrie

Licence Number 116

Name of Driller or Borer B. Roth

Address Same

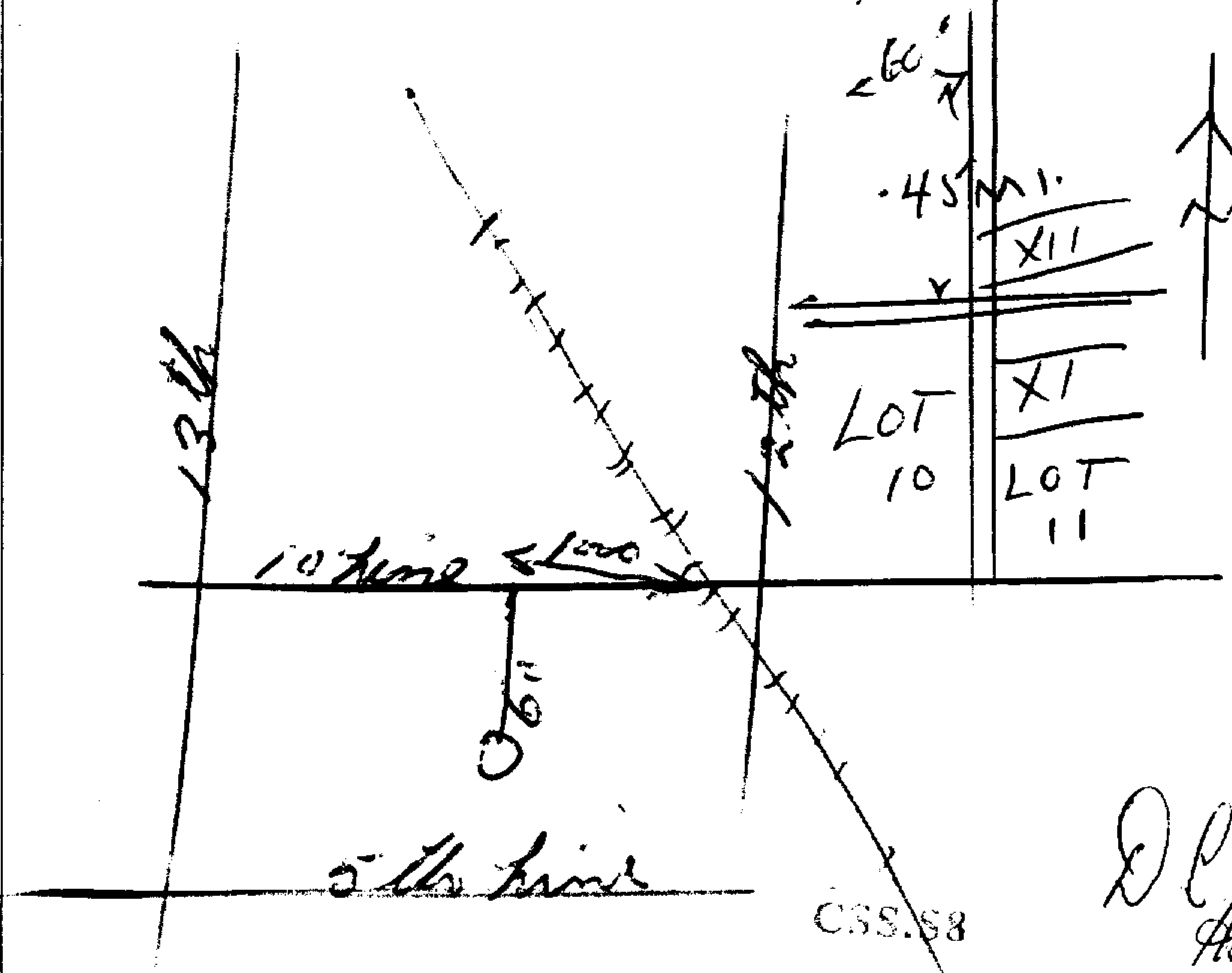
Date

B. Roth

(Signature of Licensed Drilling or Boring Contractor)

## Location of Well

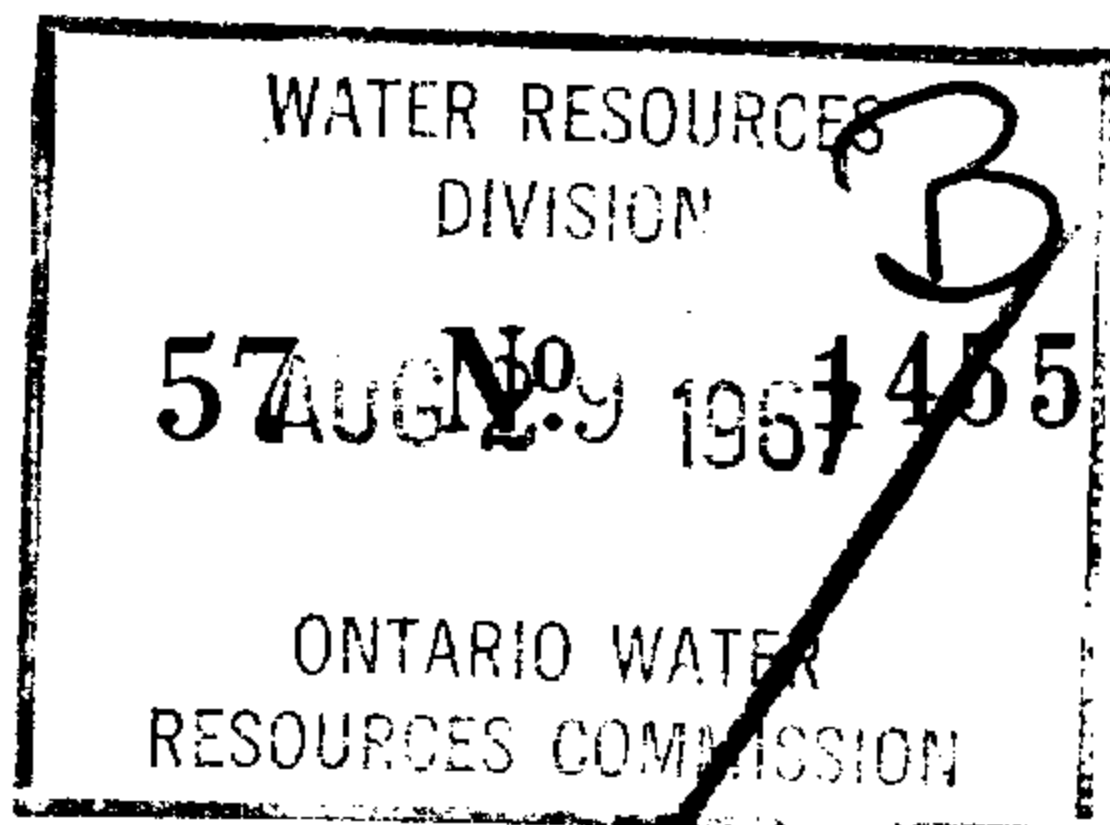
In diagram below show distances of well from road and lot line. Indicate north by arrow.





SR

UTM 17Z 606663E



SR 4911719N

The Ontario Water Resources Commission Act

Elev. SR 0850

# WATER WELL RECORD

Basin 22 SIMCOE

Township, Village, Town or City INNISFIL

Con. 12 Lot 11

Date completed 5-6-67  
(day month year)

Owner

Address

RR #4 BARRIE ONT

## Casing and Screen Record

Inside diameter of casing 6 1/4  
 Total length of casing 133 ft.  
 Type of screen Johnson S.S. Slot 25.  
 Length of screen 3 ft.  
 Depth to top of screen 130 ft.  
 Diameter of finished hole 6 1/4

## Pumping Test

Static level 65 ft.  
 Test-pumping rate 10 G.P.M.  
 Pumping level 125  
 Duration of test pumping 3 hrs.  
 Water clear or cloudy at end of test clear.  
 Recommended pumping rate 8 G.P.M.  
 with pump setting of 110 feet below ground surface

## Well Log

## Water Record

### Overburden and Bedrock Record

From  
ft.To  
ft.Depth(s) at  
which water(s)  
foundKind of water  
(fresh, salty,  
sulphur)

dig well  
 sandy clay. Brown.  
 gravel and sand.  
 fine sand.  
 coarse sand.

| From ft. | To ft. | Depth(s) at which water(s) found | Kind of water (fresh, salty, sulphur) |
|----------|--------|----------------------------------|---------------------------------------|
| 0        | 67     |                                  |                                       |
| 67       | 92     |                                  |                                       |
| 92       | 102    |                                  |                                       |
| 102      | 128    |                                  |                                       |
| 128      | 133    | 128 - 133                        | fresh.                                |

For what purpose(s) is the water to be used? farm.

Is well on upland, in valley, or on hillside? upland.

Drilling or Boring Firm Henry. Hammers.

Well Drilling Contractor

Address RR. 13.

Barrie, Ont.

Licence Number 2570.

Name of Driller or Borer John Vander Meulen.

Address RR #1, Barrie, Ont.

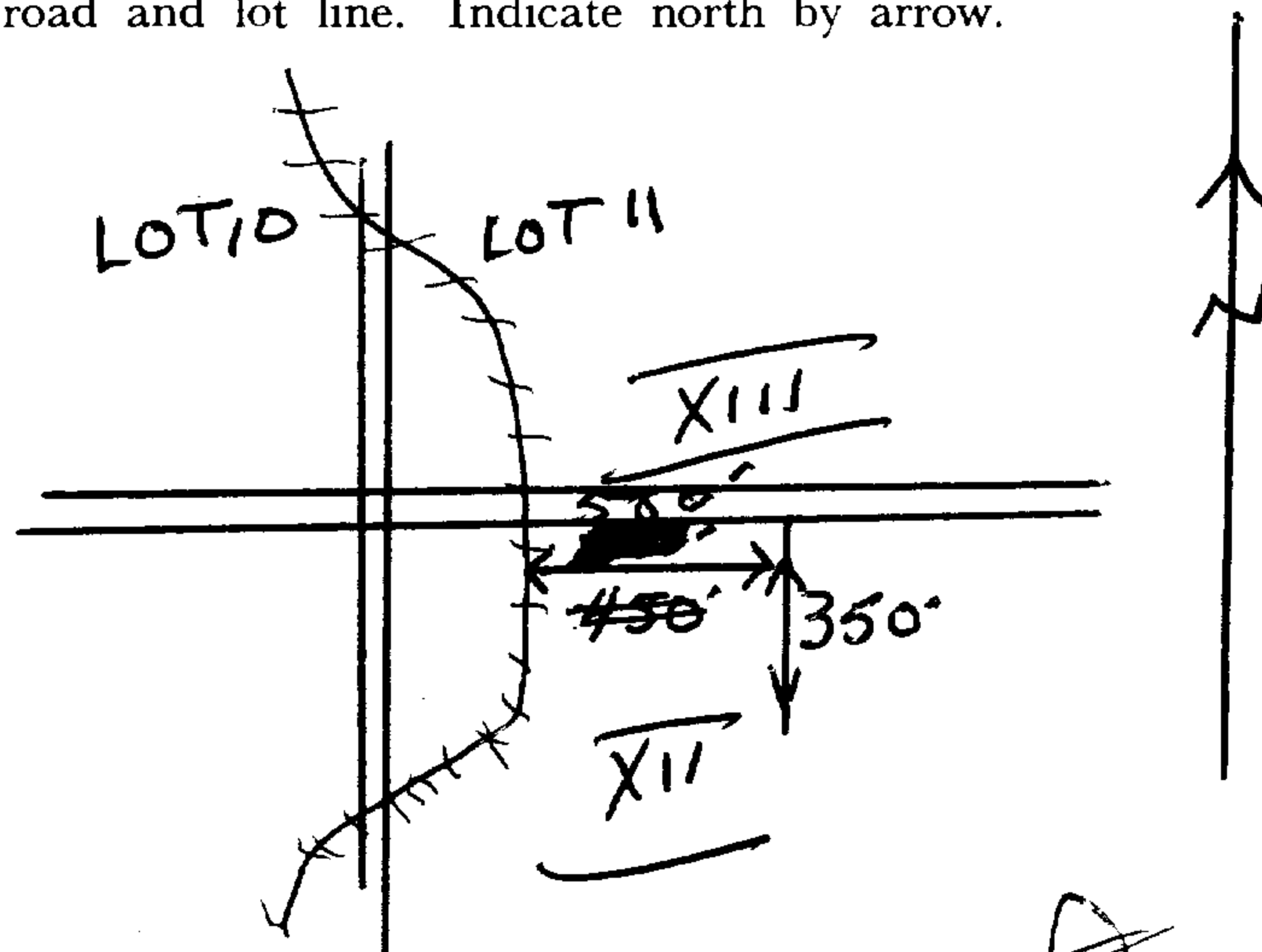
Date June 8/67

Henry Hammers

(Signature of Licensed Drilling or Boring Contractor)

## Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.









Measurements recorded in: ☐ Metric ☐ Imperial

A082330

## Well Owner's Information

|                                                                |                                                       |                               |                                |                                                         |
|----------------------------------------------------------------|-------------------------------------------------------|-------------------------------|--------------------------------|---------------------------------------------------------|
| First Name<br><b>LES</b>                                       | Last Name / Organization<br><b>BERTRAM &amp; SONS</b> | E-mail Address                |                                | <input type="checkbox"/> Well Constructed by Well Owner |
| Mailing Address (Street Number/Name)<br><b>500 Huronia Rd.</b> |                                                       | Municipality<br><b>Barrie</b> | Province<br><b>Ont</b>         | Postal Code<br><b>L4N9H4</b>                            |
|                                                                |                                                       |                               | Telephone No. (inc. area code) |                                                         |

## Well Location

|                                                                  |            |                             |                     |                                           |
|------------------------------------------------------------------|------------|-----------------------------|---------------------|-------------------------------------------|
| Address of Well Location (Street Number/Name)<br>500 Huronia Rd. |            | Township<br>Barrie          | Lot                 | Concession                                |
| County/District/Municipality<br>Simcoe                           |            | City/Town/Village<br>Barrie | Province<br>Ontario | Postal Code<br>                           |
| UTM Coordinates<br>NAD 83                                        | Zone<br>18 | Easting<br>606445           | Northing<br>4911259 | Municipal Plan and Sublot Number<br>Other |

**Overburden and Bedrock Materials/Abandonment Sealing Record** (see instructions on the back of this form)

[illegible]

abandonment of bored well - 24'

### Annular Space

| Depth Set at (m/ft) |     | Type of Sealant Used<br>(Material and Type) | Volume Placed<br>(m <sup>3</sup> /ft <sup>3</sup> ) |
|---------------------|-----|---------------------------------------------|-----------------------------------------------------|
| From                | To  |                                             |                                                     |
| 24'                 | 22' | clean sand                                  |                                                     |
| 22'                 | 16' | Bentonite                                   | 14 bags                                             |
| 16'                 | to  | surface-clean sand                          |                                                     |

### Results of Well Yield Testing

| After test of well yield, water was:<br><input type="checkbox"/> Clear and sand free<br><input type="checkbox"/> Other, specify _____ | Draw Down    |                    | Recovery   |                    |
|---------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------|------------|--------------------|
|                                                                                                                                       | Time (min)   | Water Level (m/ft) | Time (min) | Water Level (m/ft) |
| If pumping discontinued, give reason:                                                                                                 | Static Level |                    |            |                    |
|                                                                                                                                       | 1            |                    | 1          |                    |
| Pump intake set at (m/ft)                                                                                                             | 2            |                    | 2          |                    |
| Pumping rate (l/min / GPM)                                                                                                            | 3            |                    | 3          |                    |
|                                                                                                                                       | 4            |                    | 4          |                    |
| Duration of pumping<br>_____ hrs + _____ min                                                                                          | 5            |                    | 5          |                    |
| Final water level end of pumping (m/ft)                                                                                               | 10           |                    | 10         |                    |
| If flowing give rate (l/min-/ GPM)                                                                                                    | 15           |                    | 15         |                    |
|                                                                                                                                       | 20           |                    | 20         |                    |
| Recommended pump depth (m/ft)                                                                                                         | 25           |                    | 25         |                    |
| Recommended pump rate (l/min / GPM)                                                                                                   | 30           |                    | 30         |                    |
|                                                                                                                                       | 40           |                    | 40         |                    |
| Well production (l/min / GPM)                                                                                                         | 50           |                    | 50         |                    |
| Disinfected?<br><input type="checkbox"/> Yes <input type="checkbox"/> No                                                              | 60           |                    | 60         |                    |

## Construction Record - Casing

| Inside Diameter (cm/in) | Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel) | Wall Thickness (cm/in) | Depth (m/ft) |    |                                                             |
|-------------------------|--------------------------------------------------------------------------|------------------------|--------------|----|-------------------------------------------------------------|
|                         |                                                                          |                        | From         | To |                                                             |
|                         |                                                                          |                        |              |    | <input type="checkbox"/> Water Supply                       |
|                         |                                                                          |                        |              |    | <input type="checkbox"/> Replacement Well                   |
|                         |                                                                          |                        |              |    | <input type="checkbox"/> Test Hole                          |
|                         |                                                                          |                        |              |    | <input type="checkbox"/> Recharge Well                      |
|                         |                                                                          |                        |              |    | <input type="checkbox"/> Dewatering Well                    |
|                         |                                                                          |                        |              |    | <input type="checkbox"/> Observation and/or Monitoring Hole |
|                         |                                                                          |                        |              |    | <input type="checkbox"/> Alteration (Construction)          |
|                         |                                                                          |                        |              |    | <input type="checkbox"/> Abandoned, (Filling)               |

## Status of Well

☐ Water Supply  
☐ Replacement Well  
☐ Test Hole  
☐ Recharge Well  
☐ Dewatering Well  
☐ Observation and/or Monitoring Hole  
☐ Alteration (Construction)  
☐ Abandoned, Insufficient Supply  
☐ Abandoned, Poor Water Quality  
☒ Abandoned, other, specify  
☐ Other, specify

### Construction Record - Screen

| Outside Diameter<br>(cm/in) | Material<br>(Plastic, Galvanized, Steel) | Slot No. | Depth (m/ft) |    | <input type="checkbox"/> Abandoned, Poor Water Quality<br><input checked="" type="checkbox"/> Abandoned, other, specify _____<br><input type="checkbox"/> Other, specify _____ |
|-----------------------------|------------------------------------------|----------|--------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                             |                                          |          | From         | To |                                                                                                                                                                                |
|                             |                                          |          |              |    |                                                                                                                                                                                |
|                             |                                          |          |              |    |                                                                                                                                                                                |
|                             |                                          |          |              |    |                                                                                                                                                                                |

### Water Details

| Water found at Depth                |                                                                                 | Kind of Water: <input type="checkbox"/> Fresh <input type="checkbox"/> Untested |    | Depth (m/ft) |  | Diameter (cm/in) |
|-------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|----|--------------|--|------------------|
| (m/ft) <input type="checkbox"/> Gas | <input type="checkbox"/> Other, specify                                         | From                                                                            | To |              |  |                  |
| Water found at Depth                | Kind of Water: <input type="checkbox"/> Fresh <input type="checkbox"/> Untested |                                                                                 |    |              |  |                  |
| (m/ft) <input type="checkbox"/> Gas | <input type="checkbox"/> Other, specify                                         |                                                                                 |    |              |  |                  |
| Water found at Depth                | Kind of Water: <input type="checkbox"/> Fresh <input type="checkbox"/> Untested |                                                                                 |    |              |  |                  |
| (m/ft) <input type="checkbox"/> Gas | <input type="checkbox"/> Other, specify                                         |                                                                                 |    |              |  |                  |
| Water found at Depth                | Kind of Water: <input type="checkbox"/> Fresh <input type="checkbox"/> Untested |                                                                                 |    |              |  |                  |
| (m/ft) <input type="checkbox"/> Gas | <input type="checkbox"/> Other, specify                                         |                                                                                 |    |              |  |                  |

## Hole Diameter

| Depth (m/ft) |    | Diameter (cm/in) |
|--------------|----|------------------|
| From         | To |                  |
|              |    |                  |
|              |    |                  |
|              |    |                  |

### Well Contractor and Well Technician Information

|                                       |                                                          |                                                 |  |
|---------------------------------------|----------------------------------------------------------|-------------------------------------------------|--|
| Business Name of Well Contractor      |                                                          | Well Contractor's Licence No.                   |  |
| Buker Drilling Ltd                    |                                                          | 1467                                            |  |
| Business Address (Street Number/Name) |                                                          | Municipality                                    |  |
| 3396 Penetanguishene Rd               |                                                          | Barrie                                          |  |
| Province                              | Postal Code                                              | Business E-mail Address                         |  |
| Ont                                   | L4H 4Y8                                                  | buker@look.ca                                   |  |
| Bus. Telephone No. (inc. area code)   |                                                          | Name of Well Technician (Last Name, First Name) |  |
| 705 728 3819                          |                                                          | Brian Buker                                     |  |
| Well Technician's Licence No.         | Signature of Technician and/or Contractor Date Submitted |                                                 |  |
| T226                                  | Brian Buker 2011 01 06                                   |                                                 |  |

### Map of Well Location

Please provide a map below following instructions on the back.

N

Elys

Huronia Rd

500 Huronia Rd.

MOON

Comments:

Well owner's information package delivered

☐ Yes

☐ No

|                        |   |   |   |   |   |   |   |  |  |  |  |
|------------------------|---|---|---|---|---|---|---|--|--|--|--|
| Date Package Delivered |   |   |   |   |   |   |   |  |  |  |  |
| Y                      | Y | Y | Y | M | M | D | D |  |  |  |  |
| Date Work Completed    |   |   |   |   |   |   |   |  |  |  |  |
| 2                      | 0 | 2 | 0 | 1 | 1 | 1 | 1 |  |  |  |  |

Ministry Use Only  
Audit No. **Z 94549**  
**FEB 02 2011**  
Received



## Well ID

Well ID Number: 7272826

Well Audit Number: Z238664

Well Tag Number: A156794

*This table contains information from the original well record and any subsequent updates.*

## Well Location

### Address of Well Location

**Township** BARRIE CITY (INNISFIL)

**Lot**

**Concession**

**County/District/Municipality** SIMCOE

**City/Town/Village**

**Province** ON

**Postal Code** n/a

**UTM Coordinates**  
NAD83 — Zone 17  
Easting: 606420.00  
Northing: 4911700.00

**Municipal Plan and Sublot Number**

**Other**

## Overburden and Bedrock Materials Interval

| General Colour | Most Common Material | Other Materials | General Description | Depth From | Depth To |
|----------------|----------------------|-----------------|---------------------|------------|----------|
| BRWN           | SAND                 | SILT            |                     | 0 ft       | 15 ft    |

## Annular Space/Abandonment Sealing Record

| Depth From | Depth To | Type of Sealant Used (Material and Type) | Volume Placed |
|------------|----------|------------------------------------------|---------------|
| 0 ft       | 5 ft     | BENTONITE                                |               |
| 5 ft       | 15 ft    | SAND                                     |               |

## Method of Construction & Well Use

| Method of Construction | Well Use   |
|------------------------|------------|
| Rotary (Convent.)      | Monitoring |

## Status of Well



## Observation Wells

## Construction Record - Casing

| Inside Diameter | Open Hole or material | Depth From | Depth To |
|-----------------|-----------------------|------------|----------|
| .75 inch        | PLASTIC               | 0 ft       | 5 ft     |

## Construction Record - Screen

| Outside Diameter | Material | Depth From | Depth To |
|------------------|----------|------------|----------|
| .75 inch         | PLASTIC  | 10 ft      | 15 ft    |

## Well Contractor and Well Technician Information

Well Contractor's Licence Number: 7190

## Results of Well Yield Testing

After test of well yield, water was

If pumping discontinued, give reason

Pump intake set at

Pumping Rate

Duration of Pumping

Final water level

If flowing give rate

Recommended pump depth

Recommended pump rate

Well Production

Disinfected? N

## Draw Down & Recovery

| Draw Down Time(min) | Draw Down Water level | Recovery Time(min) | Recovery Water level |
|---------------------|-----------------------|--------------------|----------------------|
| SWL                 |                       |                    |                      |
| 1                   |                       | 1                  |                      |
| 2                   |                       | 2                  |                      |
| 3                   |                       | 3                  |                      |
| 4                   |                       | 4                  |                      |
| 5                   |                       | 5                  |                      |
| 10                  |                       | 10                 |                      |

|    |    |
|----|----|
| 15 | 15 |
| 20 | 20 |
| 25 | 25 |
| 30 | 30 |
| 40 | 40 |
| 45 | 45 |
| 50 | 50 |
| 60 | 60 |

## Water Details

| Water Found at Depth | Kind     |
|----------------------|----------|
|                      | Untested |

## Hole Diameter

| Depth From | Depth To | Diameter |
|------------|----------|----------|
| 0 ft       | 15 ft    | 6 inch   |

**Audit Number:** Z238664

**Date Well Completed:** September 12, 2016

**Date Well Record Received by MOE:** October 11, 2016

## Appendix E – **WATER BALANCE ANALYSIS**



19-1243A - 441 Huronia Road Water Balance Analysis

| MONTHLY AND YEARLY WATER BALANCE COMPONENTS |                                                                |      |      |      |      |      |       |       |       |      |      |      |      |       |
|---------------------------------------------|----------------------------------------------------------------|------|------|------|------|------|-------|-------|-------|------|------|------|------|-------|
|                                             |                                                                | JAN  | FEB  | MAR  | APR  | MAY  | JUN   | JUL   | AUG   | SEP  | OCT  | NOV  | DEC  | YEAR  |
| Potential Evapotranspiration Calculation    | Average Temperature: T (°C)                                    | -7.7 | -6.6 | -2.1 | 5.6  | 12.3 | 17.9  | 20.8  | 19.7  | 15.3 | 8.7  | 2.7  | -3.5 | 6.9   |
|                                             | Heat Index: i=(T/5) <sup>1.514</sup>                           | 0.00 | 0.00 | 0.00 | 1.19 | 3.91 | 6.90  | 8.66  | 7.97  | 5.44 | 2.31 | 0.39 | 0.00 | 36.8  |
|                                             | Unadjusted Daily Potential Evapotranspiration: U (mm)          | 0.0  | 0.0  | 0.0  | 25.2 | 59.0 | 88.5  | 104.1 | 98.1  | 74.7 | 40.6 | 11.5 | 0.0  | 501.7 |
|                                             | Adjusting Factor for U (Latitude 44°)                          | 0.81 | 0.82 | 1.02 | 1.12 | 1.26 | 1.28  | 1.29  | 1.20  | 1.04 | 0.95 | 0.81 | 0.77 | -     |
|                                             | Adjusted Potential Evapotranspiration - PET (mm)               | 0.0  | 0.0  | 0.0  | 28.2 | 74.3 | 113.3 | 134.3 | 117.8 | 77.7 | 38.6 | 9.3  | 0.0  | 593.4 |
| Pervious Components                         | Precipitation: P (mm)                                          | 82.5 | 61.8 | 58.1 | 62.2 | 82.4 | 84.8  | 77.2  | 89.9  | 94.0 | 77.5 | 88.9 | 73.6 | 932.9 |
|                                             | Adjusted Potential Evapotranspiration: PET (mm)                | 0.0  | 0.0  | 0.0  | 28.2 | 74.3 | 113.3 | 134.3 | 117.8 | 77.7 | 38.6 | 9.3  | 0.0  | 593.4 |
|                                             | P - PET                                                        | 82.5 | 61.8 | 58.1 | 34.0 | 8.1  | -28.5 | -57.1 | -27.9 | 16.3 | 38.9 | 79.6 | 73.6 | 339.5 |
|                                             | Change in Soil Moisture Storage (mm)                           | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | -28.5 | -57.1 | -27.9 | 16.3 | 38.9 | 0.0  | 0.0  | -     |
|                                             | Water Holding Capacity (max. 75 mm)                            | 75.0 | 75.0 | 75.0 | 75.0 | 75.0 | 46.5  | 0.0   | 0.0   | 16.3 | 55.3 | 75.0 | 75.0 | -     |
|                                             | Water Surplus Available for Infiltration or Runoff             | 82.5 | 61.8 | 58.1 | 34.0 | 8.1  | 0.0   | 0.0   | 0.0   | 0.0  | 0.0  | 59.9 | 73.6 | 377.9 |
|                                             | Potential Infiltration based on MOECC Infiltration Factor (mm) | 66.0 | 49.4 | 46.5 | 27.2 | 6.4  | 0.0   | 0.0   | 0.0   | 0.0  | 0.0  | 47.9 | 58.9 | 302.3 |
|                                             | Potential Surface Water Runoff (mm)                            | 16.5 | 12.4 | 11.6 | 6.8  | 1.6  | 0.0   | 0.0   | 0.0   | 0.0  | 0.0  | 12.0 | 14.7 | 75.6  |
| Impervious Components                       | Precipitation: P (mm)                                          | -    |      |      |      |      |       |       |       |      |      |      |      | 932.9 |
|                                             | Potential Evaporation: PE (mm), Assume 15%                     | -    |      |      |      |      |       |       |       |      |      |      |      | 139.9 |
|                                             | Potential Surface Water Runoff: P - PE (mm)                    | -    |      |      |      |      |       |       |       |      |      |      |      | 793.0 |

| PRE- AND POST-DEVELOPMENT WATER BALANCE (NO LOW IMPACT DEVELOPMENT MEASURES IN PLACE) |                                                             |                                   |                       |                                  |                                |                                      |                                                                            |
|---------------------------------------------------------------------------------------|-------------------------------------------------------------|-----------------------------------|-----------------------|----------------------------------|--------------------------------|--------------------------------------|----------------------------------------------------------------------------|
|                                                                                       |                                                             | Total Land Area (m <sup>2</sup> ) | Est. Fraction of Land | Est. Land Area (m <sup>2</sup> ) | Runoff (m <sup>3</sup> /annum) | Infiltration (m <sup>3</sup> /annum) | % Runoff Change Pre to Post                                                |
| Existing Land Use (Pre-Development)                                                   | Pervious Area                                               | 5131.0                            | 100%                  | 5131.0                           | 387.8                          | 1551.2                               | 859%                                                                       |
|                                                                                       | Impervious Area                                             |                                   | 0%                    | 0.0                              | 0.0                            | 0.0                                  | % Infiltration Change Pre to Post                                          |
|                                                                                       | TOTAL                                                       | -                                 | 100%                  | 5131.0                           | 387.8                          | 1551.2                               | 20%                                                                        |
| Proposed Land Use (Post-Development)                                                  | Pervious Area                                               | 5131.0                            | 20%                   | 1026.2                           | 77.6                           | 310.2                                | Infiltration Required to Meet Pre-Development Conditions (m <sup>3</sup> ) |
|                                                                                       | Impervious Area (Estimated from "Huronia Road Development") |                                   | 80%                   | 4104.8                           | 3255.0                         | 0.0                                  |                                                                            |
|                                                                                       | TOTAL                                                       | -                                 | 100%                  | 5131.0                           | 3332.5                         | 310.2                                | 1241                                                                       |

- Notes
- 1. Both potential infiltration and surface water runoff are independent of temperature
  - 2. Assumption is in January maximum soil moisture storage value is present (75mm)
  - 3. Water Holding Capacity & Infiltration Factors taken from Table 3.1 of MOE SWMPDM, 2003
  - 4. Average Temperature and Precipitation taken from Barrie WPCC between 1981 and 2010
  - 5. Adjusting Factor for U based on Lorente, 1961

| Infiltration Criteria       | Site Description                             | Infiltration Factor |
|-----------------------------|----------------------------------------------|---------------------|
| Topography                  | Flat Land - Average Slope Less Than 0.6 m/km | 0.3                 |
| Soils                       | Open Sandy Loam                              | 0.4                 |
| Cover                       | Cultivated Land                              | 0.1                 |
| Sum of Infiltration Factors |                                              | <u>0.8</u>          |

Appendix F –  
**GROUNDWATER CHEMISTRY CERTIFICATES OF ANALYSIS**

**C.O.C.: G85593**

**REPORT No. B19-41122 (i)**

**Rev. 1**

**Report To:**

**Central Earth Engineering Inc**  
647 Welham Rd, Unit 14,  
Barrie ON L4N 0B7 Canada

**Attention:** Alex Winkelmann

**Caduceon Environmental Laboratories**

112 Commerce Park Drive  
Barrie ON L4N 8W8  
Tel: 705-252-5743  
Fax: 705-252-5746

DATE RECEIVED: 23-Dec-19

JOB/PROJECT NO.: 441 Huronia Road

DATE REPORTED: 08-Jan-20

P.O. NUMBER: 19-1243A

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

| Parameter                          | Qty | Site Analyzed | Analyst Initials | Date Analyzed | Lab Method     | Reference Method |
|------------------------------------|-----|---------------|------------------|---------------|----------------|------------------|
| Alkalinity (as CaCO <sub>3</sub> ) | 2   | Holly Lane    | VK               | 27-Dec-19     | A-ALK-03 (o)   | SM 2320B         |
| Cyanide                            | 2   | Kingston      | US               | 27-Dec-19     | A-CN-001 (k)   | SM 4500CN        |
| Colour                             | 2   | Holly Lane    | ST               | 30-Dec-19     | A-COL-01 (o)   | SM 2120C         |
| Conductivity                       | 2   | Holly Lane    | VK               | 27-Dec-19     | A-COND-02 (o)  | SM 2510B         |
| Anions                             | 2   | Holly Lane    | LMG              | 31-Dec-19     | A-IC-01 (o)    | SM4110C          |
| Nitrogen - Ammonia (N)             | 2   | Kingston      | SHU              | 27-Dec-19     | A-NH3-001 (k)  | SM4500-NH3-H     |
| o-Phosphorus (P)                   | 2   | Kingston      | SHU              | 27-Dec-19     | A-o-PO4 K      | PE4500-S         |
| pH                                 | 2   | Holly Lane    | VK               | 27-Dec-19     | A-PH-01 (o)    | SM 4500H         |
| Turbidity                          | 2   | Holly Lane    | ST               | 30-Dec-19     | A-TURB-01 (o)  | SM 2130          |
| Chromium (VI)                      | 2   | Holly Lane    | LMG              | 03-Jan-20     | D-CRVI-01 (o)  | MOE E3056        |
| Mercury                            | 2   | Holly Lane    | PBK              | 03-Jan-20     | D-HG-02 (o)    | SM 3112 B        |
| Metals - ICP-OES                   | 2   | Holly Lane    | AHM              | 02-Jan-20     | D-ICP-01 (o)   | SM 3120          |
| Metals - ICP-MS                    | 2   | Holly Lane    | TPR              | 30-Dec-19     | D-ICPMS-01 (o) | EPA 200.8        |
| Calculation                        | 2   | Holly Lane    | JGC              | 03-Jan-20     | D-Ion Balance  | Calc.            |

PWQO - Provincial Water Quality Objectives  
PWQO - Provincial Water Quality Objectives



Christine Burke  
Lab Manager

R.L. = Reporting Limit

Test methods may be modified from specified reference method unless indicated by an \*

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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**C.O.C.: G85593**

**REPORT No. B19-41122 (i)**

**Rev. 1**

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647 Welham Rd, Unit 14,  
Barrie ON L4N 0B7 Canada

**Attention:** Alex Winkelmann

**Caduceon Environmental Laboratories**

112 Commerce Park Drive  
Barrie ON L4N 8W8  
Tel: 705-252-5743  
Fax: 705-252-5746

DATE RECEIVED: 23-Dec-19

JOB/PROJECT NO.: 441 Huronia Road

DATE REPORTED: 08-Jan-20

P.O. NUMBER: 19-1243A

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

| Parameter                               | Client I.D. |                | MW BH 1<br>(filtered)    | MW BH 1<br>(unfiltered)  | PWQO |  |
|-----------------------------------------|-------------|----------------|--------------------------|--------------------------|------|--|
|                                         | Sample I.D. | Date Collected | B19-41122-1<br>19-Dec-19 | B19-41122-2<br>19-Dec-19 | PWQO |  |
| Units                                   | R.L.        |                |                          |                          |      |  |
| pH @25°C                                | pH Units    |                | 7.73                     | 7.71                     | 8.5  |  |
| Conductivity @25°C                      | µmho/cm     | 1              | 1100                     | 1110                     |      |  |
| Alkalinity(CaCO <sub>3</sub> ) to pH4.5 | mg/L        | 5              | 365                      | 358                      |      |  |
| Hardness (as CaCO <sub>3</sub> )        | mg/L        | 1              | 585                      | 1440                     |      |  |
| Cyanide (Free)                          | µg/L        | 5              | < 5                      | < 5                      | 5    |  |
| Chloride                                | mg/L        | 0.5            | 127                      | 131                      |      |  |
| Fluoride                                | mg/L        | 0.1            | < 0.1                    | < 0.1                    |      |  |
| Nitrite (N)                             | mg/L        | 0.1            | < 0.1                    | < 0.1                    |      |  |
| Nitrate (N)                             | mg/L        | 0.1            | 4.7                      | 4.7                      |      |  |
| Sulphate                                | mg/L        | 1              | 18                       | 18                       |      |  |
| Colour                                  | TCU         | 2              | < 2                      | < 2                      |      |  |
| Turbidity                               | NTU         | 0.1            | 4.4                      | 1470                     |      |  |
| Ammonia (N)-Total                       | mg/L        | 0.01           | 0.01                     | 0.05                     |      |  |
| o-Phosphate (P)                         | mg/L        | 0.002          | 0.010                    | 0.014                    |      |  |
| Calcium                                 | µg/L        | 20             | 187000                   | 501000                   |      |  |
| Magnesium                               | µg/L        | 20             | 28600                    | 46100                    |      |  |
| Potassium                               | µg/L        | 100            | 3100                     | 3300                     |      |  |
| Sodium                                  | µg/L        | 200            | 56000                    | 57400                    |      |  |
| Antimony                                | µg/L        | 0.1            | 0.1                      | 0.1                      | 20   |  |
| Arsenic                                 | µg/L        | 0.1            | 0.5                      | 1.5                      | 5    |  |
| Barium                                  | µg/L        | 1              | 109                      | 241                      |      |  |
| Beryllium                               | µg/L        | 0.1            | < 0.1                    | 0.3                      | 11   |  |
| Boron                                   | µg/L        | 5              | 37                       | 37                       | 200  |  |

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Christine Burke  
Lab Manager

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JOB/PROJECT NO.: 441 Huronia Road

DATE REPORTED: 08-Jan-20

P.O. NUMBER: 19-1243A

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

| Parameter               | Client I.D. |                | MW BH 1<br>(filtered)    | MW BH 1<br>(unfiltered)  | PWQO |  |
|-------------------------|-------------|----------------|--------------------------|--------------------------|------|--|
|                         | Sample I.D. | Date Collected | B19-41122-1<br>19-Dec-19 | B19-41122-2<br>19-Dec-19 | PWQO |  |
| Units                   | R.L.        |                |                          |                          |      |  |
| Cadmium                 | µg/L        | 0.015          | 0.027                    | 0.137                    | 0.1  |  |
| Chromium                | µg/L        | 2              | < 2                      | 2                        |      |  |
| Chromium (VI)           | µg/L        | 1              | < 1                      | < 1                      | 1    |  |
| Cobalt                  | µg/L        | 0.1            | 1.8                      | 6.0                      | 0.9  |  |
| Copper                  | µg/L        | 2              | 11                       | 7                        | 5    |  |
| Iron                    | µg/L        | 5              | 1200 <sup>3</sup>        | 1840 <sup>3</sup>        | 300  |  |
| Lead                    | µg/L        | 0.02           | 1.24                     | 4.38                     | 1    |  |
| Mercury                 | µg/L        | 0.02           | < 0.02                   | < 0.02                   | 0.2  |  |
| Manganese               | µg/L        | 1              | 198                      | 930                      |      |  |
| Molybdenum              | µg/L        | 0.1            | 0.5                      | 0.3                      | 40   |  |
| Nickel                  | µg/L        | 0.2            | 3.2                      | 5.9                      | 25   |  |
| Selenium                | µg/L        | 1              | < 1                      | < 1                      | 100  |  |
| Silver                  | µg/L        | 0.1            | < 0.1                    | < 0.1                    | 0.1  |  |
| Thallium                | µg/L        | 0.05           | < 0.05                   | < 0.05                   | 0.3  |  |
| Uranium                 | µg/L        | 0.05           | 0.48                     | 0.66                     | 5    |  |
| Vanadium                | µg/L        | 0.1            | 1.9                      | 4.7                      | 6    |  |
| Zinc                    | µg/L        | 5              | 5                        | 24                       | 20   |  |
| Anion Sum               | meq/L       |                | 11.6                     | 11.6                     |      |  |
| Cation Sum              | meq/L       |                | 14.3                     | 31.5                     |      |  |
| % Difference            | %           |                | 10.4 <sup>1</sup>        | 46.4 <sup>2</sup>        |      |  |
| Ion Ratio               | AS/CS       |                | 0.812                    | 0.367                    |      |  |
| Sodium Adsorption Ratio | -           |                | 1.01                     | 0.658                    |      |  |
| TDS(ion sum calc.)      | mg/L        | 1              | 661                      | 995                      |      |  |
| Conductivity (calc.)    | µmho/cm     |                | 1215                     | 1927                     |      |  |

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Christine Burke  
Lab Manager

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DATE RECEIVED: 23-Dec-19

JOB/PROJECT NO.: 441 Huronia Road

DATE REPORTED: 08-Jan-20

P.O. NUMBER: 19-1243A

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

|                       |       |      | Client I.D.    | MW BH 1<br>(filtered) | MW BH 1<br>(unfiltered) | PWQO |  |
|-----------------------|-------|------|----------------|-----------------------|-------------------------|------|--|
|                       |       |      | Sample I.D.    | B19-41122-1           | B19-41122-2             | PWQO |  |
|                       |       |      | Date Collected | 19-Dec-19             | 19-Dec-19               |      |  |
| Parameter             | Units | R.L. |                |                       |                         |      |  |
| TDS(calc.)/EC(actual) | -     |      |                | 0.599                 | 0.897                   |      |  |
| EC(calc.)/EC(actual)  | -     |      |                | 1.10                  | 1.74                    |      |  |
| Langelier Index(25°C) | S.I.  |      |                | 1.09                  | 1.46                    |      |  |

1. Outside of 10% Acceptance Criteria
2. Outside of 10% Acceptance Criteria, solids present
3. Sediment present
4. Revised report to correct project name and number as per client request

PWQO - Provincial Water Quality Objectives  
PWQO - Provincial Water Quality Objectives



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Christine Burke  
Lab Manager

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Tel: 705-252-5743  
Fax: 705-252-5746

DATE RECEIVED: 23-Dec-19  
DATE REPORTED: 08-Jan-20  
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: 441 Huronia Road  
P.O. NUMBER: 19-1243A  
WATERWORKS NO.

**Summary of Exceedances**

| Provincial Water Quality Objectives |             |       |
|-------------------------------------|-------------|-------|
| MW BH 1 (filtered)                  | Found Value | Limit |
| Lead (µg/L)                         | 1.24        | 1     |
| Iron (µg/L)                         | 1200        | 300   |
| Copper (µg/L)                       | 11          | 5     |
| Cobalt (µg/L)                       | 1.8         | 0.9   |
| MW BH 1 (unfiltered)                | Found Value | Limit |
| Zinc (µg/L)                         | 24          | 20    |
| Lead (µg/L)                         | 4.38        | 1     |
| Iron (µg/L)                         | 1840        | 300   |
| Copper (µg/L)                       | 7           | 5     |
| Cobalt (µg/L)                       | 6.0         | 0.9   |
| Cadmium (µg/L)                      | 0.137       | 0.1   |

PWQO - Provincial Water Quality Objectives  
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R.L. = Reporting Limit

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie



Christine Burke  
Lab Manager

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**C.O.C.: G85593**

**REPORT No. B19-41122 (ii)**

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Barrie ON L4N 0B7 Canada

**Attention:** Alex Winkelmann

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Tel: 705-252-5743  
Fax: 705-252-5746

DATE RECEIVED: 23-Dec-19

JOB/PROJECT NO.: 441 Huronia Road

DATE REPORTED: 08-Jan-20

P.O. NUMBER: 19-1243A

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

| Parameter  | Qty | Site Analyzed | Analyst Initials | Date Analyzed | Lab Method      | Reference Method |
|------------|-----|---------------|------------------|---------------|-----------------|------------------|
| PHC(F2-F4) | 2   | Kingston      | KPR              | 30-Dec-19     | C-PHC-W-001 (k) | MOE E3421        |
| VOC's      | 2   | Richmond Hill | JE               | 27-Dec-19     | C-VOC-02 (rh)   | EPA 8260         |
| PHC(F1)    | 2   | Richmond Hill | JE               | 27-Dec-19     | C-VPHW-01 (rh)  | MOE E3421        |

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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Lab Manager

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Fax: 705-252-5746

DATE RECEIVED: 23-Dec-19

JOB/PROJECT NO.: 441 Huronia Road

DATE REPORTED: 08-Jan-20

P.O. NUMBER: 19-1243A

SAMPLE MATRIX: Groundwater

WATERWORKS NO.

| Parameter         | Client I.D. |                | MW BH 1<br>(filtered)    | MW BH 1<br>(unfiltered)  | PWQO |  |
|-------------------|-------------|----------------|--------------------------|--------------------------|------|--|
|                   | Sample I.D. | Date Collected | B19-41122-1<br>19-Dec-19 | B19-41122-2<br>19-Dec-19 | PWQO |  |
| Units             | R.L.        |                |                          |                          |      |  |
| Benzene           | µg/L        | 0.5            | < 0.5                    | < 0.5                    | 100  |  |
| Toluene           | µg/L        | 0.5            | < 0.5                    | < 0.5                    | 0.8  |  |
| Ethylbenzene      | µg/L        | 0.5            | < 0.5                    | < 0.5                    | 8    |  |
| Xylene, m,p-      | µg/L        | 1.0            | < 1.0                    | < 1.0                    |      |  |
| Xylene, o-        | µg/L        | 0.5            | < 0.5                    | < 0.5                    | 40   |  |
| Xylene, m,p,o-    | µg/L        | 1.1            | < 1.1                    | < 1.1                    |      |  |
| PHC F1 (C6-C10)   | µg/L        | 50             | < 50                     | < 50                     |      |  |
| PHC F2 (>C10-C16) | µg/L        | 50             | < 50                     | < 50                     |      |  |
| PHC F3 (>C16-C34) | µg/L        | 400            | < 400                    | < 400                    |      |  |
| PHC F4 (>C34-C50) | µg/L        | 400            | < 400                    | < 400                    |      |  |

1 Revised report to correct project name and number as per client request

PWQO - Provincial Water Quality Objectives  
PWQO - Provincial Water Quality Objectives



Christine Burke  
Lab Manager

R.L. = Reporting Limit

Test methods may be modified from specified reference method unless indicated by an \*

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.



C.O.C.: G85593

REPORT No. B19-41122 (ii)

Rev. 1

**Report To:**

**Central Earth Engineering Inc**  
647 Welham Rd, Unit 14,  
Barrie ON L4N 0B7 Canada

**Attention:** Alex Winkelmann

**Caduceon Environmental Laboratories**

112 Commerce Park Drive  
Barrie ON L4N 8W8  
Tel: 705-252-5743  
Fax: 705-252-5746

DATE RECEIVED: 23-Dec-19  
DATE REPORTED: 08-Jan-20  
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: 441 Huronia Road  
P.O. NUMBER: 19-1243A  
WATERWORKS NO.

**Summary of Exceedances**

PWQO - Provincial Water Quality Objectives  
PWQO - Provincial Water Quality Objectives

R.L. = Reporting Limit

Test methods may be modified from specified reference method unless indicated by an \*

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie



Christine Burke  
Lab Manager

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August 20, 2020 (Rev. 1)

Reference No. 19-1243B

**2745230 Ontario Inc.**

Attn: Dr. Behrooz Azizi

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**RE: In-Situ Infiltration Testing  
Proposed Commercial Development  
441 Huronia Road, Barrie, Ontario**

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Dear Dr. Azizi,

This letter provides the results of the infiltration testing conducted at 441 Huronia Road in Barrie, Ontario, in support of the design of proposed Low Impact Development (LID) measures. This revision (Revision 1, dated August 20, 2020) is being provided to include a factored saturated hydraulic conductivity value for design purposes.

## Introduction & Background Information

CEE previously prepared the following reports in support of the proposed commercial development:

- “*Geotechnical Report, Proposed Commercial Development, 441 Huronia Road, Barrie, Ontario*”, Ref. No. 19-1243A, dated Jan. 9, 2020; and
- “*Hydrogeological Report, Proposed Commercial Development, 441 Huronia Road, Barrie, Ontario*”, Ref. No. 19-1243A, dated Jan. 13, 2020.

As part of the subsurface investigation conducted for these reports, four boreholes were advanced with three of the boreholes having a monitoring wells installed. In general, the entire site had a 1.5 to 2.3 metre thick layer of earth fill at surface, under which a cohesionless and competent glacial till deposit was encountered to the full depth of investigation (up to 9.6 metres below existing grade). Groundwater was encountered at 5.3 metres below existing grade (Elev. 256.74 metres) in one of the monitoring wells, with the other two monitoring wells remaining dry.

CEE was also sent the following drawings/documents for review in preparation of this report:

- “*441 Huronia Road, Functional Servicing & Stormwater Management Report*”, Project No. 2019-083, dated April 24, 2020, by CAPES Engineering; and
- Civil Engineering Drawing Set: “*441 Huronia Road Site Plan, City of Barrie*”, Project No. 2019-083, Drawings C1 to C10, dated 20/04/24, by CAPES Engineering.

Based on our review of the aforementioned drawings/documents, it is proposed to infiltrate a total water volume of 21 m<sup>3</sup> per annum. It is noted that this amount is relatively small, but is due to the fact that only

run-off from the roof is allowed to infiltrate due to the site being commercial in nature and being within a Highly Vulnerable Aquifer and Wellhead Protection Area. A Low Impact Development (LID) measure consisting of an Atlantis Flo-Tank system is proposed at the northeast corner of the site that will infiltrate the rooftop run-off. Another Atlantis Flo-Tank system is located on the south corner of the site but will be lined with an impermeable liner such that no infiltration can occur. Proposed grades in the northeastern corner of the site will be near Elev. 262.5 metres (close to existing grades), and the base of the LID measure at the northeast corner of the site will be set at Elev. 260.42 metres (approximately 2 metres below existing grade). The Atlantis tanks will be underlain by a minimum 100 mm of clean washed river sand.

It is understood that the LSRCA has provided comments regarding the most recent submission that need to be addressed for this development. The comment that pertains to what CEE will address in this infiltration letter report is as follows:

*LSRCA First Submission Hydrogeology Review, 441 Huronia Rd - Barrie (APID104811), June 16, 2020 - Comment H3:*

*The initial hydraulic conductivity testing estimated that infiltration will occur at a rate of about 12 mm/hr. In-situ percolation testing is to be carried out in the vicinity of and at the base of any proposed LID infiltration facilities, this will better establish the local infiltration rate and will aid in sizing the facility appropriately.*

The geotechnical and hydrogeological reports prepared for this site provided an estimate of infiltration rate based on grain size distribution curves. To address the comments from the LSRCA, additional field work has been completed to determine the in-situ infiltration rate of the soils within the footprint of the LID measure.

## Field Methodology and Subsurface Conditions

The infiltration testing conducted conformed to the requirements laid out in the *CVC Low Impact Development Stormwater Management Planning and Design Guide*, Appendix C, Section C2.3. The requirements are summarized as follows:

- Conduct infiltration testing using a Guelph Permeameter (or other approved method) to determine the field-saturated hydraulic conductivity;
- Conduct up to two infiltration tests per test pit, one test at the bottom elevation of the LID measure and one test up to 1.5 metres below the bottom elevation of the LID measure should it be warranted due to changes in soil characteristics;
- Convert the saturated hydraulic conductivity to infiltration rate using the approximate relationships provided within Table C1 of the guideline and applying the appropriate factor of safety based on Figure C1.

Measurement of the field-saturated hydraulic conductivity ( $K_{fs}$ ) was carried out using a Guelph Permeameter apparatus (Model 2800K1) on July 24, 2020, in two (2) test pits shown on the enclosed location plan. CEE directed a backhoe to dig to a depth of 2 metres below existing grade in the LID measure footprint, and this depth is near the proposed infiltration level of Elev. 260.42 metres for the LID measure. Once the base elevation was reached, infiltration tests were performed using the Guelph



Permeameter. A sample and description of the soil at this elevation was then obtained. An additional 1.5 metres was excavated below the proposed base of the LID measure. Additional samples were collected and another test was completed in the soil deposit encountered below the proposed infiltration depth.

The logs for Test Pits 1 and 2 are enclosed. The test pits encountered 150 to 200 mm of topsoil at the ground surface, underlain by earth fill that extended to depths of 2.3 to 2.4 metres below grade. The earth fill consisted of sand with trace to some silt and trace to some gravel. Both test pits encountered a 0.10 to 0.15-metre-thick layer of clayey and sandy silt glacial till at a depth of 2.3 to 2.4 metres below grade (about 0.3 to 0.4 metres below the infiltration depth). The clayey silt till was underlain by silty sand glacial till with some clay that extended from a depth of about 2.4 to 2.55 metres below grade to beyond a depth of 3.5 metres.

Infiltration tests were completed in both test pits in the earth fill at 2 metres below grade. Infiltration of the thin clayey silt glacial till layer could not be accurately measured with the Guelph Permeameter testing apparatus due to the limited thickness of the deposit. An additional infiltration test was completed in the test pits at 2.8 to 2.9 metres below grade in the silty sand glacial till deposit.

## Analysis Methods

The field-saturated hydraulic conductivity of the soil was calculated using the one-head method which is calculated as follows:

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

Where:

- C<sub>1</sub> = shape factor
- Q = flow rate (cm<sup>3</sup>/s)
- H<sub>1</sub> = water column height (cm)
- a = well radius (cm)
- α\* = alpha factor (0.12 cm<sup>-1</sup>)

Hydraulic conductivity and infiltration rate are two different concepts and conversion from one parameter to another must account for the hydraulic gradient and consequently cannot be done through unit conversion. In accordance with the CVC guidelines, the infiltration rate was determined as per the relationship with the field-saturated hydraulic conductivity provided within the: "Ontario Ministry of Municipal Affairs and Housing (OMMAH). 1997. *Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario*", which is summarized below.

| Hydraulic Conductivity, K <sub>fs</sub> (cm/s) | Percolation Time, T (min/cm) | Infiltration Rate, I (mm/hr) |
|------------------------------------------------|------------------------------|------------------------------|
| 0.1                                            | 2                            | 300                          |
| 0.01                                           | 4                            | 150                          |
| 0.001                                          | 8                            | 75                           |
| 0.0001                                         | 12                           | 50                           |
| 0.00001                                        | 20                           | 30                           |
| 0.000001                                       | 50                           | 12                           |

Infiltration rate is the inverse of percolation time. The approximate relationship (as provided in Figure C1 of the CVC guideline) in which the infiltration rate can be directly calculated is as follows:

$$K_{fs} = 6 * 10^{-11} (I)^{3.7363}$$

A factor of safety is then applied to the calculated infiltration rate to account for soil variability, gradual accumulation of fine soil sediments during the lifespan of the facility, and compaction during construction. A higher factor of safety is applied if a soil with a lower infiltration rate is encountered within 1.5 metres of the base of the infiltration measure.

## Results of Infiltration Testing

The results of the infiltration tests are provided on the enclosed Guelph Permeameter analysis spreadsheets and are summarized below. The test depth of 1.9 to 2.0 metres is at the proposed LID infiltration elevation.

| Test Pit | Test Depth (m) | Soil Type                      | Field-Saturated Hydraulic Conductivity |       | Infiltration Rate (mm/hr) |
|----------|----------------|--------------------------------|----------------------------------------|-------|---------------------------|
|          |                |                                | cm/sec                                 | mm/hr |                           |
| 1        | 2.0            | Fill: Sand, Trace to Some Silt | $2.11 \times 10^{-4}$                  | 7.6   | 56.5                      |
|          | 2.9            | Silty Sand Glacial Till        | $3.42 \times 10^{-4}$                  | 12.3  | 64.3                      |
| 2        | 1.9            | Fill: Sand, Trace to Some Silt | $1.57 \times 10^{-3}$                  | 5.7   | 96.6                      |
|          | 2.8            | Silty Sand Glacial Till        | $1.28 \times 10^{-3}$                  | 46.1  | 91.6                      |

As previously mentioned, a factor of safety is applied depending on the soil strata encountered within 1.5 metres below the infiltration elevation. The infiltration rate of the thin clayey silt glacial till layer encountered at 2.3 to 2.4 metres below grade could not be accurately measured with the Guelph Permeameter (the deposit was too thin to measure). Despite being a thin layer, the clayey silt till is expected to have a substantially lower infiltration rate compared to the cohesionless earth fill and underlying silty sand till and will increase the safety factor per the CVC Guideline Table C2. It is assumed the clayey silt till will have an infiltration about 15 to 25% of the infiltration measured for the earth fill, indicating an estimated ratio of infiltration rates between 4.1 to 8.0 and a recommended safety correction factor of 4.5. If the subgrade below the LID measure is over-excavated by about 0.5 metres and backfilled with the clean washed river sand, the infiltration would be made into the silty sand glacial till and the safety correction factor can be reduced to 2.5.

It is recommended to use the lower infiltration or field-saturated hydraulic conductivity values measured in the test pits for design to account for variability within the soil strata. The recommended infiltration and field-saturated hydraulic conductivity rates with applied factors of safety are summarized below for design purposes.

- LID measure as proposed set at 2.0 metres below grade - Infiltration will be made into the earth fill consisting of sand with trace to some silt:
  - Factored Field-Saturated Hydraulic Conductivity is 2 mm/hr.
  - Factored Infiltration rate is 12 mm/hr.
- LID measure if subgrade is over-excavated to silty sand glacial till near 2.5 metres below grade and backfilled with clean washed river sand:

- Factored Field-Saturated Hydraulic Conductivity is 3 mm/hr.
- Factored Infiltration rate is 26 mm/hr.

## Closure

We trust this information is sufficient for your present purposes. Should you have any questions concerning the above, or can be of any further assistance, please do not hesitate to contact the undersigned.

Regards,

Central Earth Engineering Inc.



Alexander Winkelmann, P.Eng.  
President, Geotechnical Engineer



Russell Wiginton, P.Eng.  
Geotechnical Engineer





## **TEST PIT LOCATION PLAN**



# 19-1243A, 441 Huronia Rd., Barrie

Testpit Location Plan

Legend

TPs



Google Earth

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## TEST PIT LOGS



# TEST PIT LOG 1

|               |                            |             |                    |
|---------------|----------------------------|-------------|--------------------|
| Project Name: | 441 Huronia Road           | Test Pit #: | 1                  |
| Project #:    | 19-1243B                   | Date/Time:  | July 24, 2020      |
| Project Loc.: | Barrie, Ontario            | Inspector:  | R. Dodds           |
| Client:       | Mr. Behrooz Azizi          | Weather:    |                    |
| Contractor:   | Eisses Brothers Excavating | Equipment:  | John Deere Backhoe |
| Northing:     | 4911679 m                  | Easting:    | 606525 m           |

| Depth (m) |        | Symbol | Stratigraphy                                                             | Samples | Notes |
|-----------|--------|--------|--------------------------------------------------------------------------|---------|-------|
| Top       | Bottom |        |                                                                          |         |       |
| 0         | 0.2    |        | Topsoil                                                                  |         |       |
| 0.2       | 2.4    |        | FILL: Sand, Trace to Some Silt,<br>Trace to Some Gravel, Brown,<br>Moist | GS1     |       |
| 2.4       | 2.55   |        | CLAYEY SILT GLACIAL TILL, Sandy,<br>Brown, Moist                         | GS2     |       |
| 2.55      | 3.5    |        | SILTY SAND GLACIAL TILL, Some<br>Clay, Brown, Moist                      | GS3     |       |
|           |        |        |                                                                          |         |       |
|           |        |        |                                                                          |         |       |
|           |        |        |                                                                          |         |       |

## Additional Notes

Seepage:

Caving:

Other:

# TEST PIT LOG 2

|               |                            |             |                    |
|---------------|----------------------------|-------------|--------------------|
| Project Name: | 441 Huronia Road           | Test Pit #: | 2                  |
| Project #:    | 19-1243B                   | Date/Time:  | July 24, 2020      |
| Project Loc.: | Barrie, Ontario            | Inspector:  | R. Dodds           |
| Client:       | Mr. Behrooz Azizi          | Weather:    |                    |
| Contractor:   | Eisses Brothers Excavating | Equipment:  | John Deere Backhoe |
| Northing:     | 4911662 m                  | Easting:    | 606521 m           |

| Depth (m) |        | Symbol | Stratigraphy                                                             | Samples | Notes |
|-----------|--------|--------|--------------------------------------------------------------------------|---------|-------|
| Top       | Bottom |        |                                                                          |         |       |
| 0         | 0.15   |        | Topsoil                                                                  |         |       |
| 0.15      | 2.3    |        | FILL: Sand, Trace to Some Silt,<br>Trace to Some Gravel, Brown,<br>Moist | GS1     |       |
| 2.3       | 2.4    |        | CLAYEY SILT GLACIAL TILL, Sandy,<br>Brown, Moist                         | GS2     |       |
| 2.4       | 3.5    |        | SILTY SAND GLACIAL TILL, Some<br>Clay, Brown, Moist                      | GS3     |       |
|           |        |        |                                                                          |         |       |
|           |        |        |                                                                          |         |       |
|           |        |        |                                                                          |         |       |

## Additional Notes

Seepage:

Caving:

Other:

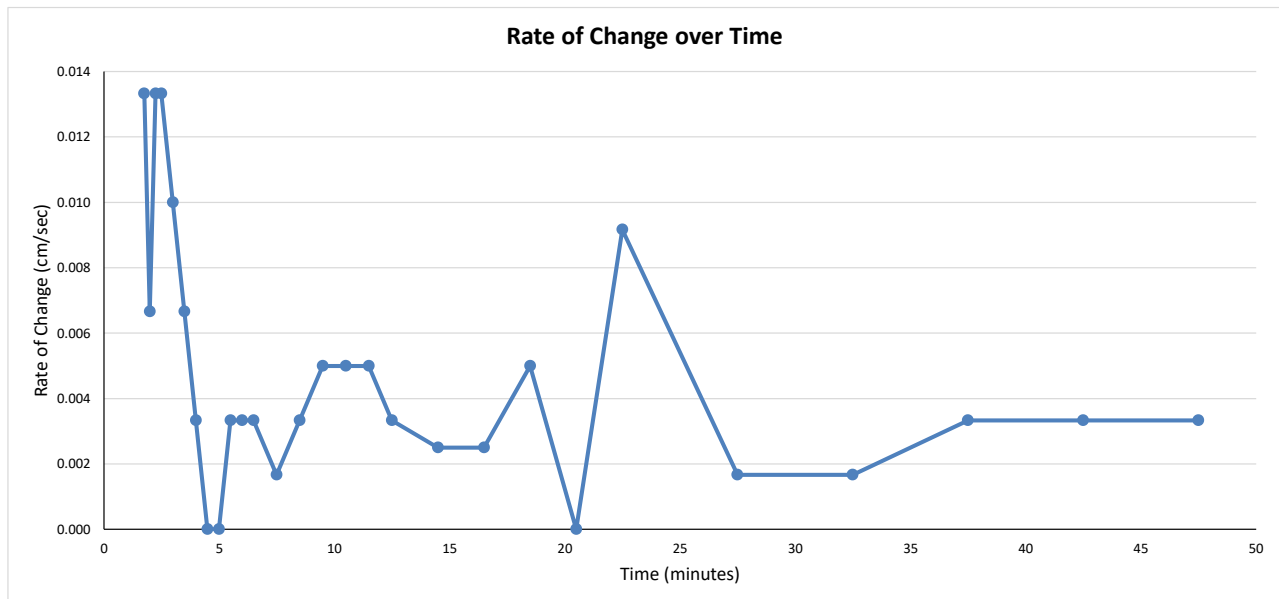
## **GUELPH PERMEATER ANALYSIS RESULTS**



# Guelph Permeameter Infiltration Rate Determination



## Test Location: Test Pit 1 at 2.0 metres



### INPUT PARAMETERS

|            |   |        |                  |
|------------|---|--------|------------------|
| $\alpha^*$ | = | 0.12   | cm <sup>-1</sup> |
| H          | = | 5      | cm               |
| a          | = | 3      | cm               |
| X          | = | 35.22  | cm <sup>2</sup>  |
| R          | = | 0.0033 | cm/sec           |

### SHAPE FACTOR

|                                          |       |
|------------------------------------------|-------|
| Shape Factor (1, 2 or 3) =               | 1     |
| Shape Factor Value (cm <sup>-1</sup> ) = | 0.803 |

### CALCULATED PARAMETERS

|                |   |          |                      |
|----------------|---|----------|----------------------|
| H <sub>a</sub> | = | 1.67     | unitless             |
| Q <sub>1</sub> | = | 0.116226 | cm <sup>3</sup> /sec |

### CALCULATED DESIGN VALUES

|                 |   |          |                    |
|-----------------|---|----------|--------------------|
| k <sub>fs</sub> | = | 2.11E-04 | cm/sec             |
| Φ <sub>m</sub>  | = | 1.76E-03 | cm <sup>2</sup> /s |
| Infiltration:   | = | 56.5     | mm/hr              |

### Variable Glossary

|            |                                                                                                                                                                                                           |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\alpha^*$ | 1) is the ratio of gravity to capillarity forces during infiltration or drainage<br>2) determined from table 1 on page 47 of the manual (or the adjacent table)                                           |
| H          | 1) is the water head in the BH<br>2) determined by the height that the inner tube is pulled up during field operation                                                                                     |
| a          | 1) is the radius of the borehole<br>2) determine by the size of the auger                                                                                                                                 |
| X          | 1) is the resevoir constant<br>2) determined by the resevoir knob at the top of the unit<br>• if the knob is up X = 35.22 (outer and inner reservoir)<br>• if the knob is down X = 2.16 (inner reservoir) |
| R          | 1) is the steady state rate of flow per minute<br>2) is determined by timing the drop of water in the Guelph Permeameter                                                                                  |

### Equation Glossary

|                          |                                                                                                                                                                                                                                                                                  |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H <sub>a</sub>           | is the ratio of head to borehole radius                                                                                                                                                                                                                                          |
| Q <sub>1</sub>           | is the flow rate                                                                                                                                                                                                                                                                 |
| C <sub>(1, 2 or 3)</sub> | is the shape factor which accounts for the saturated area of the soil<br>• Select C <sub>1</sub> if $\alpha^*$ is $\geq 0.12$ cm <sup>-1</sup><br>• Select C <sub>2</sub> if $\alpha^*$ = 0.04 cm <sup>-1</sup><br>• Select C <sub>3</sub> if $\alpha^*$ = 0.01 cm <sup>-1</sup> |
| k <sub>fs</sub>          | is the field saturated hydraulic conductivity of the soil                                                                                                                                                                                                                        |
| Φ <sub>m</sub>           | is an indicator of the capillary pull exerted by the unsaturated soil on the water                                                                                                                                                                                               |

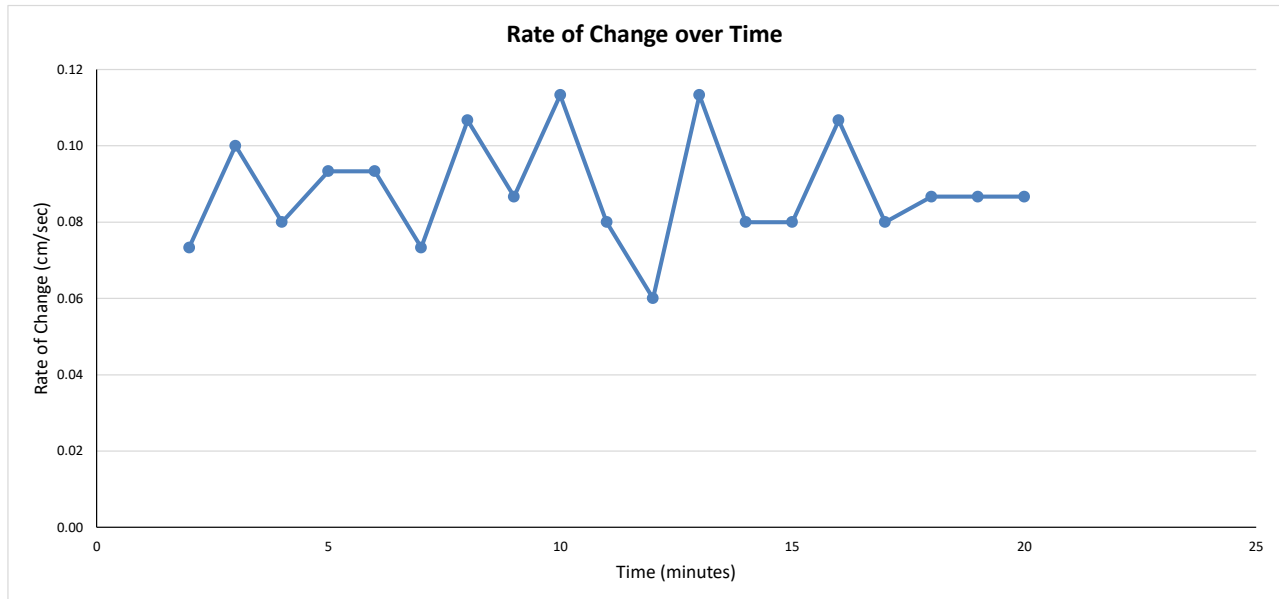
Table 1. Soil texture-structure categories for site-estimation of  $\alpha^*$  (adapted from Elrick et al., 1989)

| Soil Texture - Structure Category                                                                                                                                 | $\alpha^*$ (cm <sup>-1</sup> ) |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Compacted, structureless, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.                                        | 0.01                           |
| Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.                                                          | 0.04                           |
| Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils. | 0.12                           |
| Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.                                      | 0.36                           |

# Guelph Permeameter Infiltration Rate Determination



## Test Location: Test Pit 1 at 2.9 metres



### INPUT PARAMETERS

|              |       |                  |
|--------------|-------|------------------|
| $\alpha^*$ = | 0.12  | cm <sup>-1</sup> |
| H =          | 5     | cm               |
| a =          | 3     | cm               |
| X =          | 2.16  | cm <sup>2</sup>  |
| R =          | 0.087 | cm/sec           |

### SHAPE FACTOR

|                                          |       |
|------------------------------------------|-------|
| Shape Factor (1, 2 or 3) =               | 1     |
| Shape Factor Value (cm <sup>-1</sup> ) = | 0.803 |

### CALCULATED PARAMETERS

|                  |         |                      |
|------------------|---------|----------------------|
| H <sub>a</sub> = | 1.67    | unitless             |
| Q <sub>1</sub> = | 0.18792 | cm <sup>3</sup> /sec |

### CALCULATED DESIGN VALUES

|                   |          |                    |
|-------------------|----------|--------------------|
| k <sub>fs</sub> = | 3.42E-04 | cm/sec             |
| Φ <sub>m</sub> =  | 2.85E-03 | cm <sup>2</sup> /s |
| Infiltration:     | 64.3     | mm/hr              |

### Variable Glossary

|            |                                                                                                                                                                                                            |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\alpha^*$ | 1) is the ratio of gravity to capillarity forces during infiltration or drainage<br>2) determined from table 1 on page 47 of the manual (or the adjacent table)                                            |
| H          | 1) is the water head in the BH<br>2) determined by the height that the inner tube is pulled up during field operation                                                                                      |
| a          | 1) is the radius of the borehole<br>2) determine by the size of the auger                                                                                                                                  |
| X          | 1) is the resevoir constant<br>2) determined by the reservoir knob at the top of the unit<br>• if the knob is up X = 35.22 (outer and inner reservoir)<br>• if the knob is down X = 2.16 (inner reservoir) |
| R          | 1) is the steady state rate of flow per minute<br>2) is determined by timing the drop of water in the Guelph Permeameter                                                                                   |

### Equation Glossary

|                          |                                                                                                                                                                                                                                                                                  |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H <sub>a</sub>           | is the ratio of head to borehole radius                                                                                                                                                                                                                                          |
| Q <sub>1</sub>           | is the flow rate                                                                                                                                                                                                                                                                 |
| C <sub>(1, 2 or 3)</sub> | is the shape factor which accounts for the saturated area of the soil<br>• Select C <sub>1</sub> if $\alpha^*$ is $\geq 0.12$ cm <sup>-1</sup><br>• Select C <sub>2</sub> if $\alpha^*$ = 0.04 cm <sup>-1</sup><br>• Select C <sub>3</sub> if $\alpha^*$ = 0.01 cm <sup>-1</sup> |
| k <sub>fs</sub>          | is the field saturated hydraulic conductivity of the soil                                                                                                                                                                                                                        |
| Φ <sub>m</sub>           | is an indicator of the capillary pull exerted by the unsaturated soil on the water                                                                                                                                                                                               |

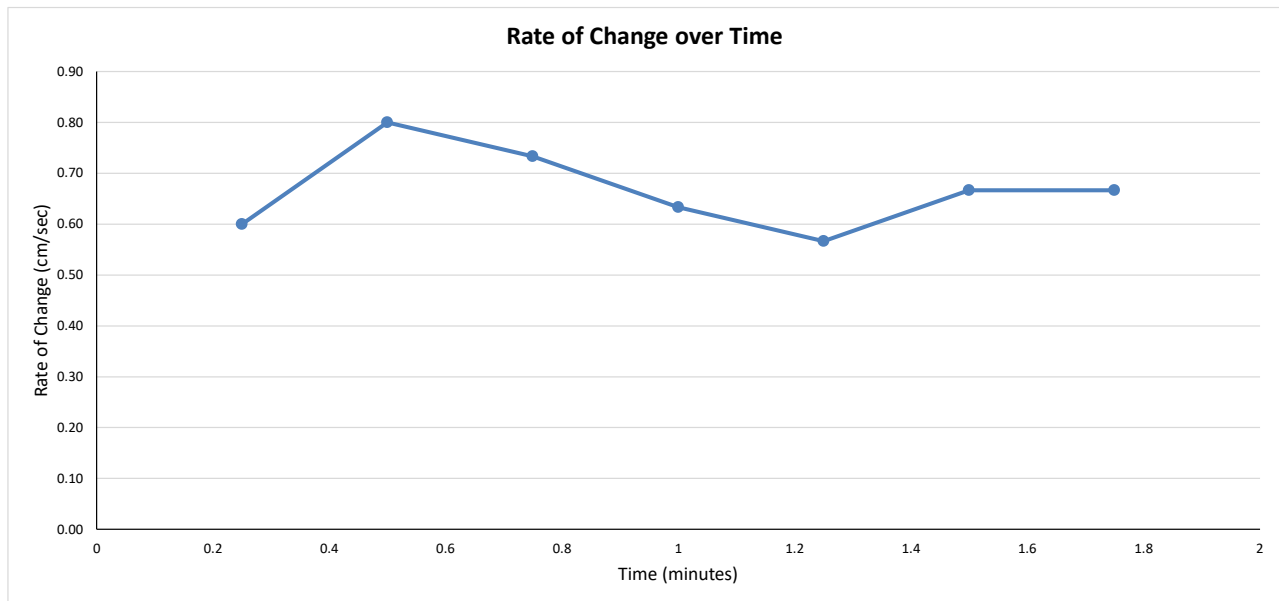
Table 1. Soil texture-structure categories for site-estimation of  $\alpha^*$  (adapted from Elrick et al., 1989)

| Soil Texture - Structure Category                                                                                                                                 | $\alpha^*$ (cm <sup>-1</sup> ) |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Compacted, structureless, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.                                        | 0.01                           |
| Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.                                                          | 0.04                           |
| Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils. | 0.12                           |
| Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.                                      | 0.36                           |

# Guelph Permeameter Infiltration Rate Determination



## Test Location: Test Pit 2 at 1.9 metres



### INPUT PARAMETERS

|            |      |                  |
|------------|------|------------------|
| $\alpha^*$ | 0.12 | cm <sup>-1</sup> |
| H          | 10   | cm               |
| a          | 3    | cm               |
| X          | 2.16 | cm <sup>2</sup>  |
| R          | 0.67 | cm/sec           |

### SHAPE FACTOR

|                                          |       |
|------------------------------------------|-------|
| Shape Factor (1, 2 or 3) =               | 1     |
| Shape Factor Value (cm <sup>-1</sup> ) = | 1.288 |

### CALCULATED PARAMETERS

|                |        |                      |
|----------------|--------|----------------------|
| H <sub>a</sub> | 3.33   | unitless             |
| Q <sub>1</sub> | 1.4472 | cm <sup>3</sup> /sec |

### CALCULATED DESIGN VALUES

|                 |          |                    |
|-----------------|----------|--------------------|
| k <sub>fs</sub> | 1.57E-03 | cm/sec             |
| Φ <sub>m</sub>  | 1.31E-02 | cm <sup>2</sup> /s |
| Infiltration:   | 96.6     | mm/hr              |

### Variable Glossary

|            |                                                                                                                                                                                                                                                                                                                |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\alpha^*$ | <ol style="list-style-type: none"> <li>is the ratio of gravity to capillarity forces during infiltration or drainage</li> <li>determined from table 1 on page 47 of the manual (or the adjacent table)</li> </ol>                                                                                              |
| H          | <ol style="list-style-type: none"> <li>is the water head in the BH</li> <li>determined by the height that the inner tube is pulled up during field operation</li> </ol>                                                                                                                                        |
| a          | <ol style="list-style-type: none"> <li>is the radius of the borehole</li> <li>determine by the size of the auger</li> </ol>                                                                                                                                                                                    |
| X          | <ol style="list-style-type: none"> <li>is the resevoir constant</li> <li>determined by the reservoir knob at the top of the unit <ul style="list-style-type: none"> <li>if the knob is up X = 35.22 (outer and inner reservoir)</li> <li>if the knob is down X = 2.16 (inner reservoir)</li> </ul> </li> </ol> |
| R          | <ol style="list-style-type: none"> <li>is the steady state rate of flow per minute</li> <li>is determined by timing the drop of water in the Guelph Permeameter</li> </ol>                                                                                                                                     |

### Equation Glossary

|                          |                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H <sub>a</sub>           | is the ratio of head to borehole radius                                                                                                                                                                                                                                                                                                                                     |
| Q <sub>1</sub>           | is the flow rate                                                                                                                                                                                                                                                                                                                                                            |
| C <sub>(1, 2 or 3)</sub> | is the shape factor which accounts for the saturated area of the soil <ul style="list-style-type: none"> <li>Select C<sub>1</sub> if <math>\alpha^*</math> is <math>\geq 0.12</math> cm<sup>-1</sup></li> <li>Select C<sub>2</sub> if <math>\alpha^*</math> = 0.04 cm<sup>-1</sup></li> <li>Select C<sub>3</sub> if <math>\alpha^*</math> = 0.01 cm<sup>-1</sup></li> </ul> |
| k <sub>fs</sub>          | is the field saturated hydraulic conductivity of the soil                                                                                                                                                                                                                                                                                                                   |
| Φ <sub>m</sub>           | is an indicator of the capillary pull exerted by the unsaturated soil on the water                                                                                                                                                                                                                                                                                          |

Table 1. Soil texture-structure categories for site-estimation of  $\alpha^*$  (adapted from Elrick et al., 1989)

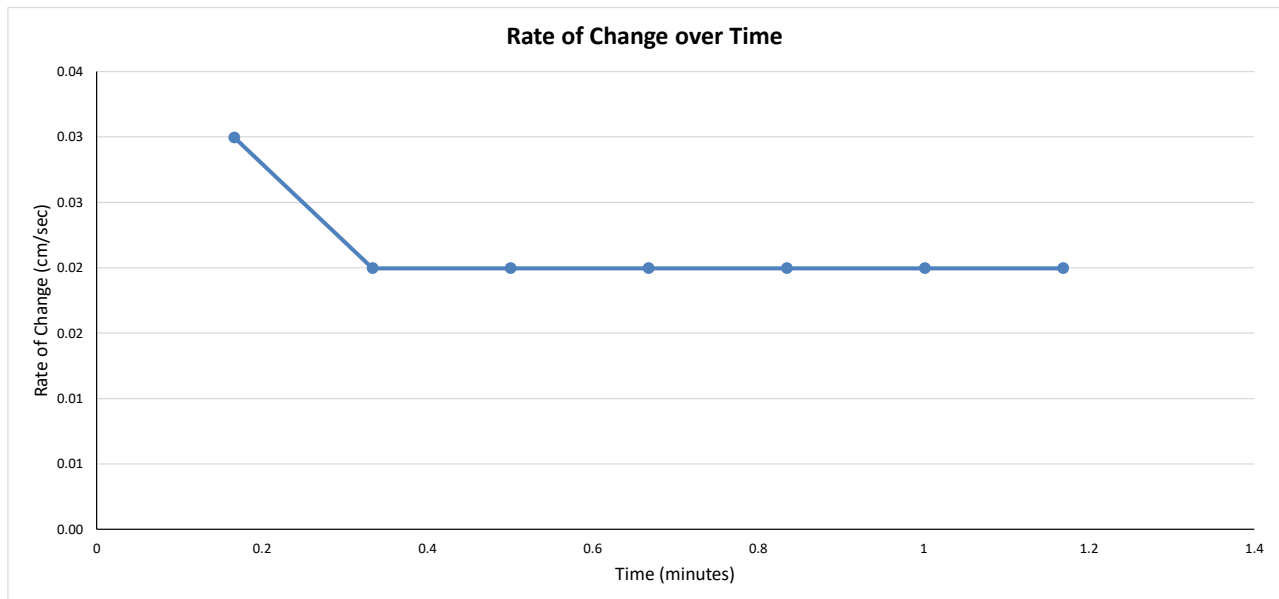
| Soil Texture - Structure Category                                                                                                                                 | $\alpha^*$ (cm <sup>-1</sup> ) |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Compacted, structureless, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.                                        | 0.01                           |
| Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.                                                          | 0.04                           |
| Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils. | 0.12                           |
| Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.                                      | 0.36                           |



# Guelph Permeameter Infiltration Rate Determination



## Test Location: Test Pit 2 at 2.8 metres



### INPUT PARAMETERS

|            |       |                  |
|------------|-------|------------------|
| $\alpha^*$ | 0.12  | cm <sup>-1</sup> |
| H          | 5     | cm               |
| a          | 3     | cm               |
| X          | 35.22 | cm <sup>2</sup>  |
| R          | 0.02  | cm/sec           |

### SHAPE FACTOR

|                                          |       |
|------------------------------------------|-------|
| Shape Factor (1, 2 or 3) =               | 1     |
| Shape Factor Value (cm <sup>-1</sup> ) = | 0.803 |

### CALCULATED PARAMETERS

|                |        |                      |
|----------------|--------|----------------------|
| H <sub>a</sub> | 1.67   | unitless             |
| Q <sub>1</sub> | 0.7044 | cm <sup>3</sup> /sec |

### CALCULATED DESIGN VALUES

|                 |          |                    |
|-----------------|----------|--------------------|
| k <sub>fs</sub> | 1.28E-03 | cm/sec             |
| Φ <sub>m</sub>  | 1.07E-02 | cm <sup>2</sup> /s |
| Infiltration:   | 91.6     | mm/hr              |

### Variable Glossary

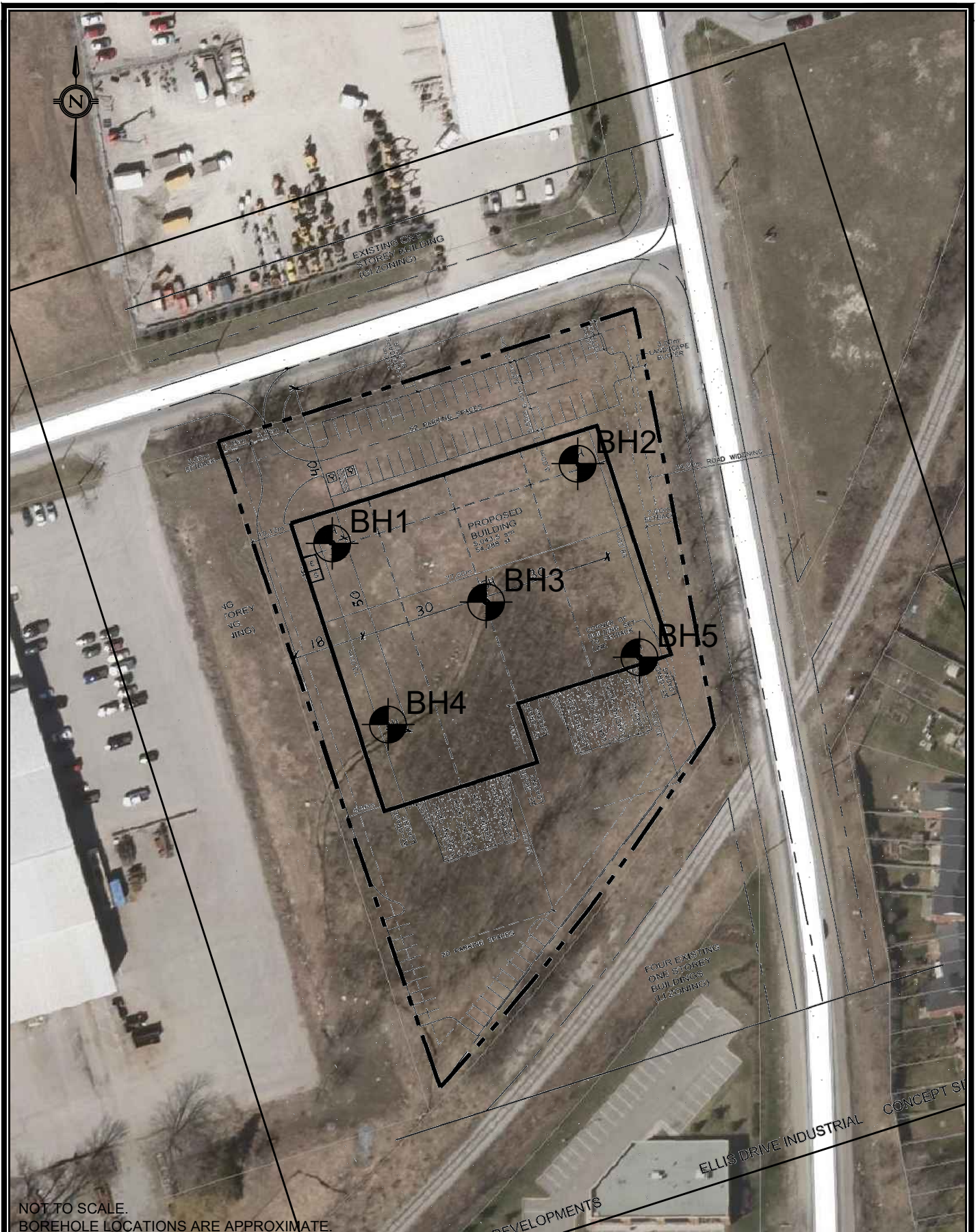
|            |                                                                                                                                                                                                             |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\alpha^*$ | 1) is the ratio of gravity to capillarity forces during infiltration or drainage<br>2) determined from table 1 on page 47 of the manual (or the adjacent table)                                             |
| H          | 1) is the water head in the BH<br>2) determined by the height that the inner tube is pulled up during field operation                                                                                       |
| a          | 1) is the radius of the borehole<br>2) determined by the size of the auger                                                                                                                                  |
| X          | 1) is the reservoir constant<br>2) determined by the reservoir knob at the top of the unit<br>• if the knob is up X = 35.22 (outer and inner reservoir)<br>• if the knob is down X = 2.16 (inner reservoir) |
| R          | 1) is the steady state rate of flow per minute<br>2) is determined by timing the drop of water in the Guelph Permeameter                                                                                    |

### Equation Glossary

|                          |                                                                                                                                                                                                                                                                                  |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H <sub>a</sub>           | is the ratio of head to borehole radius                                                                                                                                                                                                                                          |
| Q <sub>1</sub>           | is the flow rate                                                                                                                                                                                                                                                                 |
| C <sub>(1, 2 or 3)</sub> | is the shape factor which accounts for the saturated area of the soil<br>• Select C <sub>1</sub> if $\alpha^*$ is $\geq 0.12$ cm <sup>-1</sup><br>• Select C <sub>2</sub> if $\alpha^*$ = 0.04 cm <sup>-1</sup><br>• Select C <sub>3</sub> if $\alpha^*$ = 0.01 cm <sup>-1</sup> |
| k <sub>fs</sub>          | is the field saturated hydraulic conductivity of the soil                                                                                                                                                                                                                        |
| Φ <sub>m</sub>           | is an indicator of the capillary pull exerted by the unsaturated soil on the water                                                                                                                                                                                               |

Table 1. Soil texture-structure categories for site-estimation of  $\alpha^*$  (adapted from Elrick et al., 1989)

| Soil Texture - Structure Category                                                                                                                                 | $\alpha^*$ (cm <sup>-1</sup> ) |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Compacted, structureless, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.                                        | 0.01                           |
| Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.                                                          | 0.04                           |
| Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils. | 0.12                           |
| Coarse and gravelly sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.                                      | 0.36                           |



**Terraprobe**

220 Bayview Drive, Barrie, Ontario, L4N 4Y8  
Tel: (705) 739-8355 Fax: (705) 739-8369

Title:

BOREHOLE LOCATION PLAN

File No.

3-19-00017-01

FIGURE :

2

Terraprobe -- 3-19-0017-02  
 131 Ellis Drive, Barrie

| Monitoring/<br>Borehole Location | Ground Surface<br>Elevation (m) | Static Water Level Depth Below Existing Ground Surface (m) |           |           |           |          |  |  |  |
|----------------------------------|---------------------------------|------------------------------------------------------------|-----------|-----------|-----------|----------|--|--|--|
|                                  |                                 | 15-Apr-19                                                  | 24-Apr-19 | 27-Aug-19 | 26-Mar-20 | 6-May-20 |  |  |  |
| BH1                              | 264.7                           | -6.5                                                       | -5.0      | -6.2      | -4.5      | -5.0     |  |  |  |
| BH2                              | 262.1                           | -5.6                                                       | -2.5      | -4.9      | -2.5      | -3.1     |  |  |  |
| BH4                              | 262.7                           | -6.6                                                       | -2.6      | -5.1      | -2.6      | -3.3     |  |  |  |
|                                  |                                 |                                                            |           |           |           |          |  |  |  |

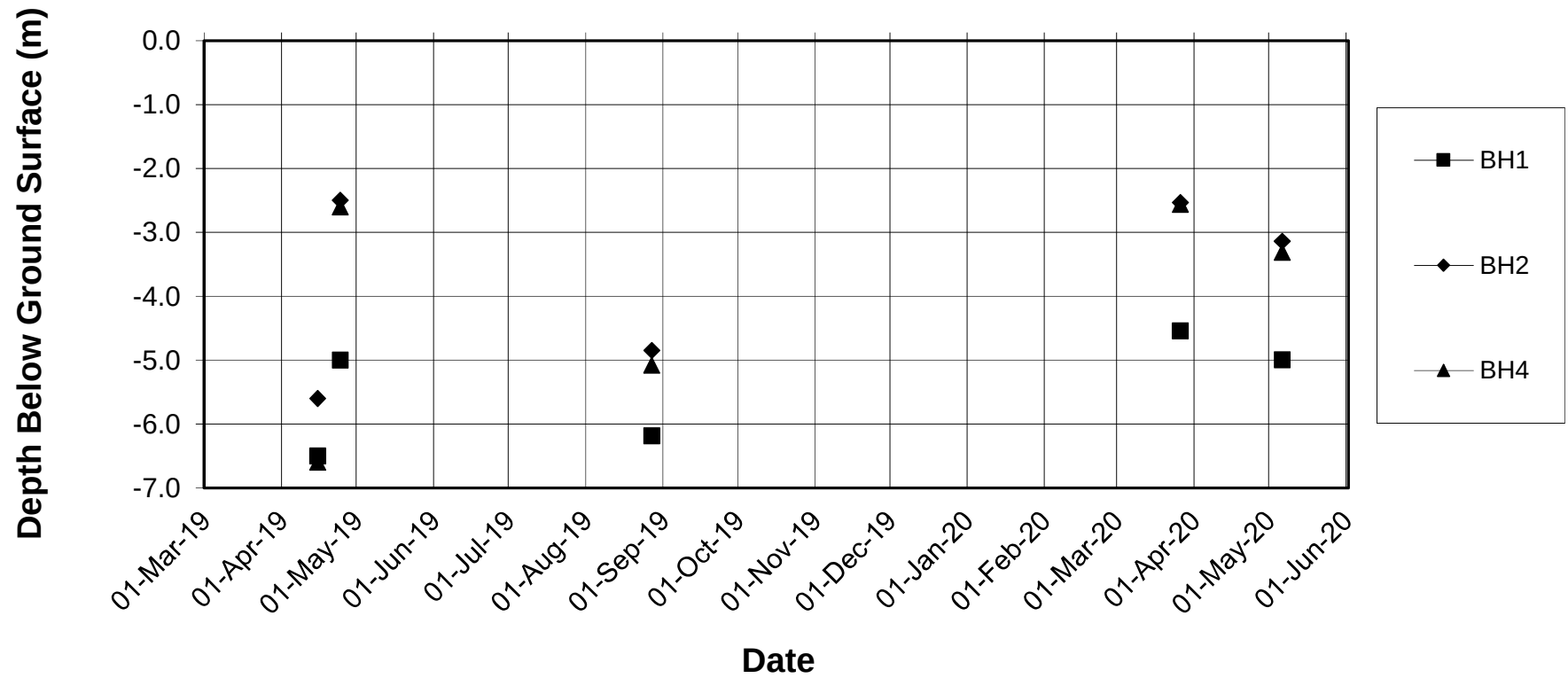
noted

| Monitoring/<br>Borehole Location | Ground Surface<br>Elevation (m) | Static Water Level Elevation (m) |           |           |           |          |  |  |  |
|----------------------------------|---------------------------------|----------------------------------|-----------|-----------|-----------|----------|--|--|--|
|                                  |                                 | 15-Apr-19                        | 24-Apr-19 | 27-Aug-19 | 26-Mar-20 | 6-May-20 |  |  |  |
| BH1                              | 264.7                           | 258.2                            | 259.7     | 258.5     | 260.2     | 259.7    |  |  |  |
| BH2                              | 262.1                           | 256.5                            | 259.6     | 257.3     | 259.6     | 259.0    |  |  |  |
| BH4                              | 262.7                           | 256.1                            | 260.1     | 257.6     | 260.1     | 259.4    |  |  |  |
|                                  |                                 |                                  |           |           |           |          |  |  |  |

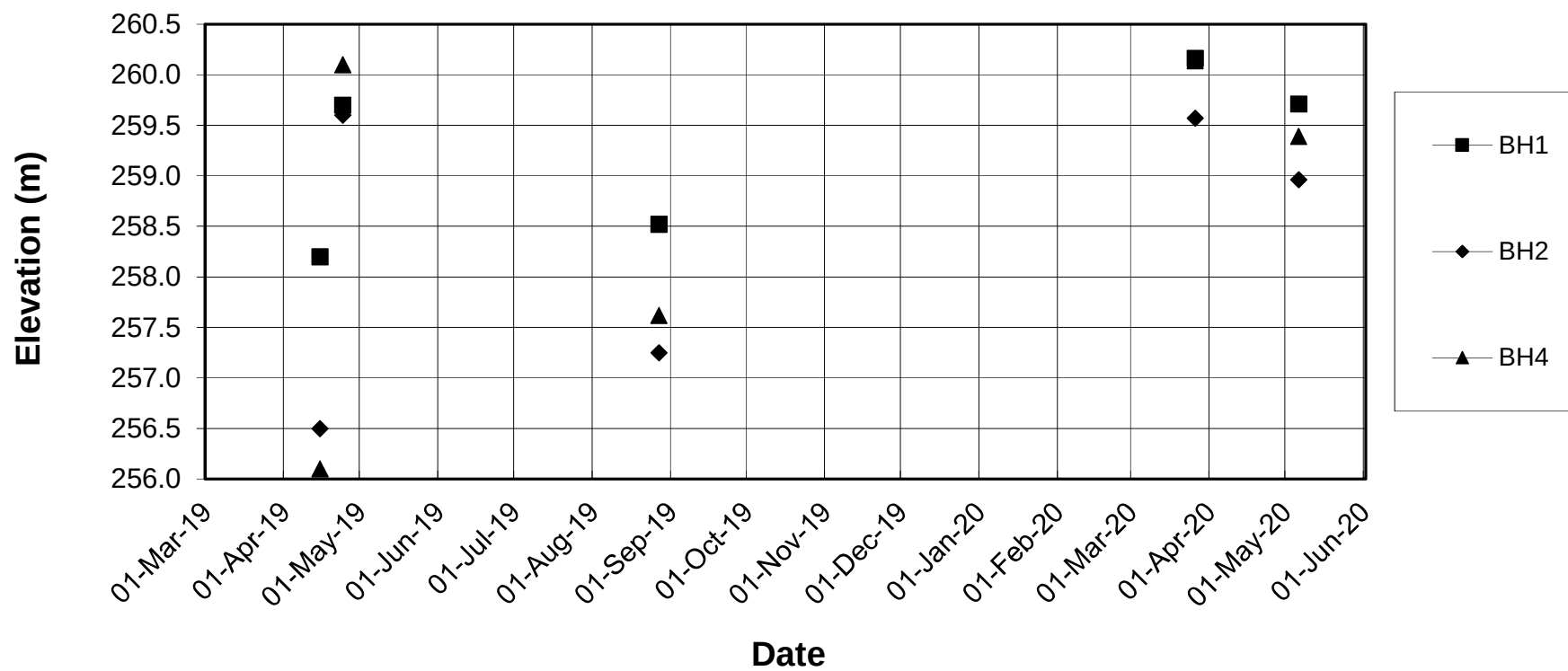
noted



**Groundwater Level Monitoring**  
**131 Ellis Drive -- Barrie**  
**Terraprobe -- 3-19-0017**

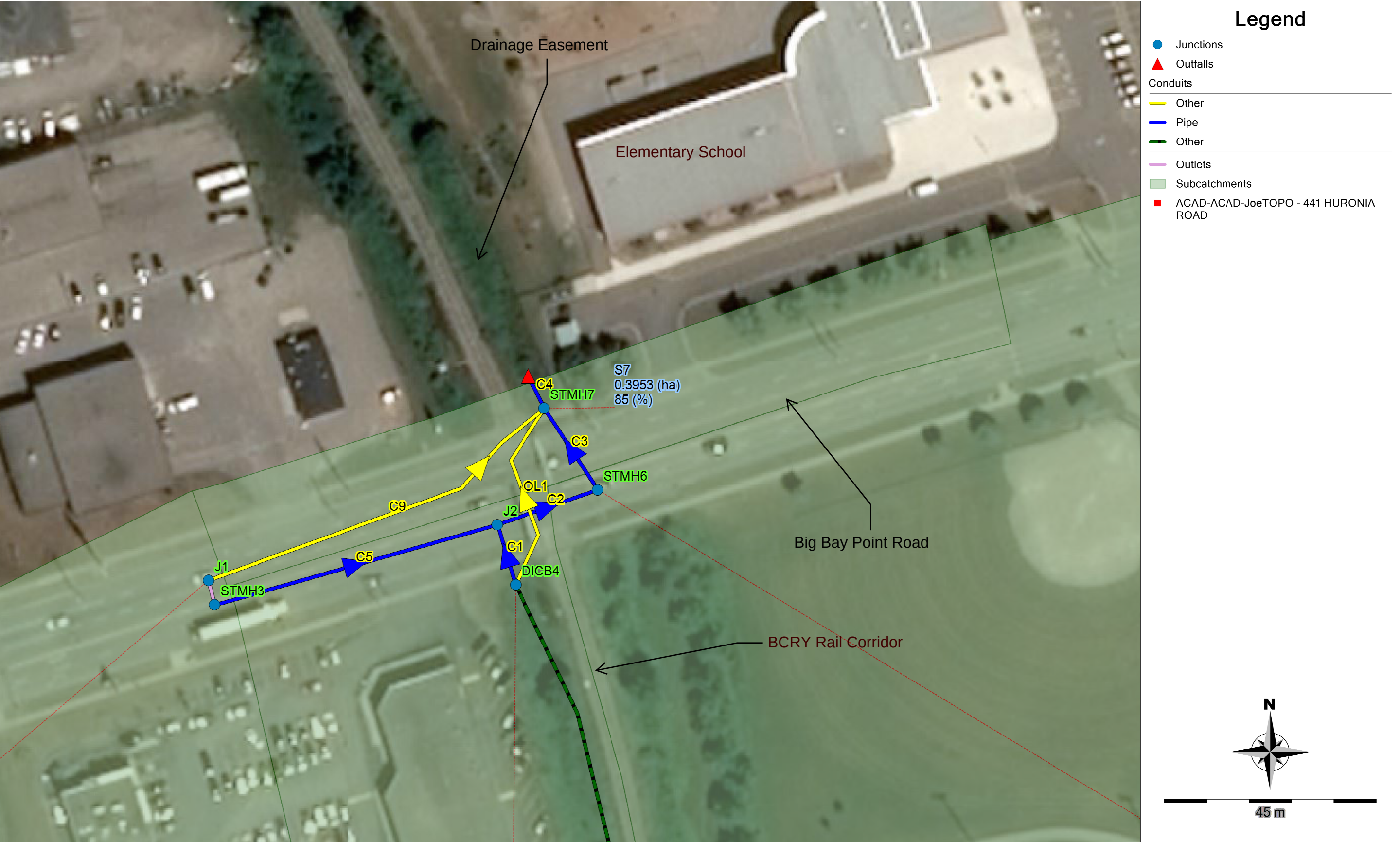


**Groundwater Level Monitoring**  
**131 Ellis Drive -- Barrie**  
**Terraprobe -- 3-19-0017**



## Appendix D – Pre Development SWM Information











Existing Condition - PCSWMM Model View





## Existing Condition - 100 Year SCS Type II 12 Hr Storm - PCSWMM Output

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

\*\*\*\*\*

Element Count

\*\*\*\*\*

Number of rain gages ..... 15

Number of subcatchments ... 7

Number of nodes ..... 10

Number of links ..... 11

Number of pollutants ..... 0

Number of land uses ..... 0

\*\*\*\*\*

Raingage Summary

\*\*\*\*\*

| Name                      | Data Source               | Data Type | Recording Interval |
|---------------------------|---------------------------|-----------|--------------------|
| 100Yr4HrChic              | CHIC4Hr100Yr              | INTENSITY | 5 min.             |
| 10Yr4HrChic               | CHIC4Hr10Yr               | INTENSITY | 5 min.             |
| 25mm                      | 25mm                      | INTENSITY | 5 min.             |
| 25Yr4HrChic               | CHIC4Hr25Yr               | INTENSITY | 5 min.             |
| 2Yr4HrChic                | CHIC4Hr2Yr                | INTENSITY | 5 min.             |
| 50Yr4HrChic               | CHIC4Hr50Yr               | INTENSITY | 5 min.             |
| 5Yr4HrChic                | CHIC4Hr5Yr                | INTENSITY | 5 min.             |
| Hurricane_Hazel_(0-25)    | Hurricane_Hazel_(0-25)    | INTENSITY | 60 min.            |
| SCS_Type_II_101.7mm_50Yr  | SCS_Type_II_101.7mm_50Yr  | INTENSITY | 6 min.             |
| SCS_Type_II_112.5mm_100Yr | SCS_Type_II_112.5mm_100Yr | INTENSITY | 6 min.             |
| SCS_Type_II_46.7mm_2Yr    | SCS_Type_II_46.7mm_2Yr    | INTENSITY | 6 min.             |
| SCS_Type_II_64.3mm_5Yr    | SCS_Type_II_64.3mm_5Yr    | INTENSITY | 6 min.             |
| SCS_Type_II_76mm_10Yr     | SCS_Type_II_76mm_10Yr     | INTENSITY | 6 min.             |
| SCS_Type_II_90.7mm_25Yr   | SCS_Type_II_90.7mm_25Yr   | INTENSITY | 6 min.             |
| Timmins_Storm_(0-25)      | Timmins_Storm_(0-25)      | INTENSITY | 60 min.            |

\*\*\*\*\*

Subcatchment Summary

\*\*\*\*\*

| Name | Area  | Width  | %Imperv | %Slope | Rain Gage                 | Outlet |
|------|-------|--------|---------|--------|---------------------------|--------|
| S1   | 0.51  | 39.31  | 0.00    | 1.3000 | SCS_Type_II_112.5mm_100Yr | J6     |
| S2   | 12.59 | 298.30 | 70.00   | 2.0000 | SCS_Type_II_112.5mm_100Yr | J1     |

|    |      |        |       |        |                           |       |
|----|------|--------|-------|--------|---------------------------|-------|
| S3 | 0.19 | 309.83 | 35.00 | 2.0000 | SCS_Type_II_112.5mm_100Yr | J7    |
| S4 | 0.17 | 17.23  | 5.00  | 2.0000 | SCS_Type_II_112.5mm_100Yr | J5    |
| S5 | 1.95 | 355.14 | 85.00 | 2.0000 | SCS_Type_II_112.5mm_100Yr | DICB4 |
| S6 | 5.80 | 579.92 | 25.00 | 2.0000 | SCS_Type_II_112.5mm_100Yr | STMH6 |
| S7 | 0.40 | 395.30 | 85.00 | 2.0000 | SCS_Type_II_112.5mm_100Yr | STMH7 |

\*\*\*\*\*

#### Node Summary

\*\*\*\*\*

| Name  | Type     | Invert<br>Elev. | Max.<br>Depth | Ponded<br>Area | External<br>Inflow |
|-------|----------|-----------------|---------------|----------------|--------------------|
| DICB4 | JUNCTION | 254.83          | 1.60          | 0.0            |                    |
| J1    | JUNCTION | 257.40          | 0.25          | 0.0            |                    |
| J2    | JUNCTION | 254.37          | 0.86          | 0.0            |                    |
| J5    | JUNCTION | 258.41          | 0.59          | 0.0            |                    |
| J6    | JUNCTION | 259.80          | 0.53          | 0.0            |                    |
| J7    | JUNCTION | 261.66          | 0.51          | 0.0            |                    |
| STMH3 | JUNCTION | 254.64          | 3.01          | 0.0            |                    |
| STMH6 | JUNCTION | 254.11          | 2.06          | 0.0            |                    |
| STMH7 | JUNCTION | 253.97          | 2.45          | 0.0            |                    |
| OF1   | OUTFALL  | 253.91          | 1.20          | 0.0            |                    |

\*\*\*\*\*

#### Link Summary

\*\*\*\*\*

| Name | From Node | To Node | Type    | Length | %Slope | Roughness |
|------|-----------|---------|---------|--------|--------|-----------|
| C1   | DICB4     | J2      | CONDUIT | 13.3   | 0.9776 | 0.0130    |
| C2   | J2        | STMH6   | CONDUIT | 22.6   | 0.3982 | 0.0130    |
| C3   | STMH6     | STMH7   | CONDUIT | 20.6   | 0.6782 | 0.0130    |
| C4   | STMH7     | OF1     | CONDUIT | 7.6    | 0.7885 | 0.0130    |
| C5   | STMH3     | J2      | CONDUIT | 62.5   | 0.4322 | 0.0130    |
| C6   | J7        | J6      | CONDUIT | 136.1  | 1.3671 | 0.0300    |
| C7   | J6        | J5      | CONDUIT | 172.6  | 0.8054 | 0.0300    |
| C8   | J5        | DICB4   | CONDUIT | 303.7  | 1.1790 | 0.0300    |
| C9   | J1        | STMH7   | CONDUIT | 81.7   | 1.5053 | 0.0130    |
| OL1  | DICB4     | STMH7   | CONDUIT | 41.6   | 0.0024 | 0.0130    |
| OL2  | J1        | STMH3   | OUTLET  |        |        |           |

\*\*\*\*\*

#### Cross Section Summary

\*\*\*\*\*

| Conduit | Shape         | Full<br>Depth | Full<br>Area | Hyd.<br>Rad. | Max.<br>Width | No. of<br>Barrels | Full<br>Flow |
|---------|---------------|---------------|--------------|--------------|---------------|-------------------|--------------|
| C1      | CIRCULAR      | 0.30          | 0.07         | 0.07         | 0.30          | 1                 | 0.10         |
| C2      | HORIZ_ELLIPSE | 0.86          | 0.93         | 0.26         | 1.34          | 1                 | 1.85         |
| C3      | CIRCULAR      | 1.20          | 1.13         | 0.30         | 1.20          | 1                 | 3.21         |
| C4      | CIRCULAR      | 1.20          | 1.13         | 0.30         | 1.20          | 1                 | 3.46         |
| C5      | HORIZ_ELLIPSE | 0.86          | 0.93         | 0.26         | 1.34          | 1                 | 1.93         |
| C6      | TRAPEZOIDAL   | 0.50          | 1.25         | 0.30         | 4.00          | 1                 | 2.19         |
| C7      | TRAPEZOIDAL   | 0.40          | 0.84         | 0.22         | 3.70          | 1                 | 0.91         |
| C8      | TRAPEZOIDAL   | 0.40          | 0.84         | 0.22         | 3.70          | 1                 | 1.11         |
| C9      | Street1       | 0.23          | 2.12         | 0.15         | 18.00         | 1                 | 5.53         |
| OL1     | TRIANGULAR    | 0.25          | 7.12         | 0.12         | 57.00         | 1                 | 0.67         |

\*\*\*\*\*  
Transect Summary  
\*\*\*\*\*

Transect Street1

Area:

|        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 0.0005 | 0.0020 | 0.0045 | 0.0080 | 0.0125 |
| 0.0180 | 0.0245 | 0.0319 | 0.0404 | 0.0499 |
| 0.0604 | 0.0719 | 0.0843 | 0.0978 | 0.1123 |
| 0.1278 | 0.1442 | 0.1617 | 0.1802 | 0.1996 |
| 0.2201 | 0.2415 | 0.2632 | 0.2849 | 0.3066 |
| 0.3283 | 0.3500 | 0.3717 | 0.3934 | 0.4151 |
| 0.4368 | 0.4585 | 0.4803 | 0.5029 | 0.5264 |
| 0.5510 | 0.5766 | 0.6032 | 0.6308 | 0.6593 |
| 0.6889 | 0.7195 | 0.7511 | 0.7836 | 0.8172 |
| 0.8518 | 0.8873 | 0.9239 | 0.9614 | 1.0000 |

Hrad:

|        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 0.0155 | 0.0310 | 0.0464 | 0.0619 | 0.0774 |
| 0.0929 | 0.1083 | 0.1238 | 0.1393 | 0.1548 |
| 0.1703 | 0.1857 | 0.2012 | 0.2167 | 0.2322 |
| 0.2476 | 0.2631 | 0.2786 | 0.2941 | 0.3096 |
| 0.3250 | 0.3445 | 0.3751 | 0.4056 | 0.4361 |
| 0.4666 | 0.4970 | 0.5273 | 0.5576 | 0.5878 |
| 0.6180 | 0.6481 | 0.6783 | 0.7072 | 0.7343 |
| 0.7597 | 0.7836 | 0.8061 | 0.8273 | 0.8473 |
| 0.8662 | 0.8841 | 0.9011 | 0.9172 | 0.9326 |
| 0.9472 | 0.9612 | 0.9747 | 0.9876 | 1.0000 |

Width:

|        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 0.0256 | 0.0511 | 0.0767 | 0.1022 | 0.1278 |
| 0.1533 | 0.1789 | 0.2044 | 0.2300 | 0.2556 |



|        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 0.2811 | 0.3067 | 0.3322 | 0.3578 | 0.3833 |
| 0.4089 | 0.4344 | 0.4600 | 0.4856 | 0.5111 |
| 0.5367 | 0.5556 | 0.5556 | 0.5556 | 0.5556 |
| 0.5556 | 0.5556 | 0.5556 | 0.5556 | 0.5556 |
| 0.5556 | 0.5556 | 0.5656 | 0.5911 | 0.6167 |
| 0.6422 | 0.6678 | 0.6933 | 0.7189 | 0.7444 |
| 0.7700 | 0.7956 | 0.8211 | 0.8467 | 0.8722 |
| 0.8978 | 0.9233 | 0.9489 | 0.9744 | 1.0000 |

\*\*\*\*\*  
 NOTE: The summary statistics displayed in this report are  
 based on results found at every computational time step,  
 not just on results from each reporting time step.  
 \*\*\*\*\*

\*\*\*\*\*

#### Analysis Options

\*\*\*\*\*

Flow Units ..... CMS

#### Process Models:

Rainfall/Runoff ..... YES  
 RDII ..... NO  
 Snowmelt ..... NO  
 Groundwater ..... NO  
 Flow Routing ..... YES  
 Ponding Allowed ..... YES  
 Water Quality ..... NO  
 Infiltration Method ..... GREEN\_AMPT  
 Flow Routing Method ..... DYNWAVE  
 Surcharge Method ..... EXTRAN  
 Starting Date ..... 10/18/2018 00:00:00  
 Ending Date ..... 10/22/2018 00:00:00  
 Antecedent Dry Days ..... 0.0  
 Report Time Step ..... 00:05:00  
 Wet Time Step ..... 00:05:00  
 Dry Time Step ..... 00:05:00  
 Routing Time Step ..... 5.00 sec  
 Variable Time Step ..... YES  
 Maximum Trials ..... 8  
 Number of Threads ..... 1  
 Head Tolerance ..... 0.001500 m

| *****                      | Volume    | Depth |
|----------------------------|-----------|-------|
| Runoff Quantity Continuity | hectare-m | mm    |

```

*****
Total Precipitation .....      2.431      112.500
Evaporation Loss .....          0.000          0.000
Infiltration Loss .....          0.394          18.234
Surface Runoff .....           2.017          93.356
Final Storage .....            0.025           1.142
Continuity Error (%) .....     -0.206

```

```

*****
Flow Routing Continuity
*****
                        Volume      Volume
                        hectare-m    10^6 ltr
                        -----
Dry Weather Inflow .....          0.000          0.000
Wet Weather Inflow .....          2.019         20.190
Groundwater Inflow .....          0.000          0.000
RDII Inflow .....              0.000          0.000
External Inflow .....           0.000          0.000
External Outflow .....          2.024         20.236
Flooding Loss .....             0.000          0.000
Evaporation Loss .....           0.000          0.000
Exfiltration Loss .....           0.000          0.000
Initial Stored Volume ....          0.000          0.000
Final Stored Volume .....          0.000          0.000
Continuity Error (%) .....     -0.228

```

```

*****
Time-Step Critical Elements
*****
Link C4 (26.05%)

```

```

*****
Highest Flow Instability Indexes
*****
Link OL2 (41)
Link C5 (6)

```

```

*****
Routing Time Step Summary
*****
Minimum Time Step      :      0.50 sec
Average Time Step      :      4.22 sec
Maximum Time Step      :      5.00 sec
Percent in Steady State :     -0.00

```

Average Iterations per Step : 2.01  
 Percent Not Converging : 0.01

\*\*\*\*\*  
 Subcatchment Runoff Summary  
 \*\*\*\*\*

| Subcatchment | Total<br>Precip<br>mm | Total<br>Runon<br>mm | Total<br>Evap<br>mm | Total<br>Infil<br>mm | Imperv<br>Runoff<br>mm | Perv<br>Runoff<br>mm | Total<br>Runoff<br>mm | Total<br>Runoff<br>10^6 ltr | Peak<br>Runoff<br>CMS | Runoff<br>Coeff |
|--------------|-----------------------|----------------------|---------------------|----------------------|------------------------|----------------------|-----------------------|-----------------------------|-----------------------|-----------------|
| S1           | 112.50                | 0.00                 | 0.00                | 43.14                | 0.00                   | 69.46                | 69.46                 | 0.35                        | 0.13                  | 0.617           |
| S2           | 112.50                | 0.00                 | 0.00                | 12.83                | 77.56                  | 20.95                | 98.51                 | 12.40                       | 4.73                  | 0.876           |
| S3           | 112.50                | 0.00                 | 0.00                | 26.96                | 38.68                  | 46.40                | 85.08                 | 0.16                        | 0.09                  | 0.756           |
| S4           | 112.50                | 0.00                 | 0.00                | 40.33                | 5.53                   | 66.69                | 72.22                 | 0.12                        | 0.05                  | 0.642           |
| S5           | 112.50                | 0.00                 | 0.00                | 6.23                 | 94.20                  | 10.71                | 104.91                | 2.05                        | 0.98                  | 0.933           |
| S6           | 112.50                | 0.00                 | 0.00                | 31.69                | 27.68                  | 52.82                | 80.50                 | 4.67                        | 2.06                  | 0.716           |
| S7           | 112.50                | 0.00                 | 0.00                | 6.22                 | 93.96                  | 10.68                | 104.65                | 0.41                        | 0.20                  | 0.930           |

\*\*\*\*\*  
 Node Depth Summary  
 \*\*\*\*\*

| Node  | Type     | Average<br>Depth<br>Meters | Maximum<br>Depth<br>Meters | Maximum<br>HGL<br>Meters | Time of Max<br>Occurrence<br>days hr:min | Reported<br>Max Depth<br>Meters |
|-------|----------|----------------------------|----------------------------|--------------------------|------------------------------------------|---------------------------------|
| DICB4 | JUNCTION | 0.08                       | 1.48                       | 256.31                   | 0 06:01                                  | 1.47                            |
| J1    | JUNCTION | 0.01                       | 0.21                       | 257.61                   | 0 05:54                                  | 0.21                            |
| J2    | JUNCTION | 0.06                       | 1.08                       | 255.45                   | 0 05:53                                  | 1.08                            |
| J5    | JUNCTION | 0.01                       | 0.20                       | 258.61                   | 0 06:03                                  | 0.20                            |
| J6    | JUNCTION | 0.01                       | 0.21                       | 260.01                   | 0 05:58                                  | 0.21                            |
| J7    | JUNCTION | 0.00                       | 0.10                       | 261.76                   | 0 05:54                                  | 0.10                            |
| STMH3 | JUNCTION | 0.04                       | 1.08                       | 255.72                   | 0 05:49                                  | 0.82                            |
| STMH6 | JUNCTION | 0.07                       | 1.34                       | 255.45                   | 0 05:54                                  | 1.33                            |
| STMH7 | JUNCTION | 0.08                       | 1.40                       | 255.37                   | 0 05:54                                  | 1.39                            |
| OF1   | OUTFALL  | 0.08                       | 1.20                       | 255.11                   | 0 05:47                                  | 1.20                            |

\*\*\*\*\*  
 Node Inflow Summary  
 \*\*\*\*\*



| Node  | Type     | Maximum<br>Lateral<br>Inflow<br>CMS | Maximum<br>Total<br>Inflow<br>CMS | Time of Max<br>Occurrence<br>days hr:min | Lateral<br>Inflow<br>Volume<br>10^6 ltr | Total<br>Inflow<br>Volume<br>10^6 ltr | Flow<br>Balance<br>Error<br>Percent |
|-------|----------|-------------------------------------|-----------------------------------|------------------------------------------|-----------------------------------------|---------------------------------------|-------------------------------------|
| DICB4 | JUNCTION | 0.985                               | 1.091                             | 0 05:54                                  | 2.05                                    | 2.69                                  | 0.116                               |
| J1    | JUNCTION | 4.730                               | 4.730                             | 0 05:54                                  | 12.4                                    | 12.4                                  | -0.447                              |
| J2    | JUNCTION | 0.000                               | 0.570                             | 0 06:08                                  | 0                                       | 6.09                                  | -0.026                              |
| J5    | JUNCTION | 0.053                               | 0.251                             | 0 06:00                                  | 0.125                                   | 0.64                                  | 0.548                               |
| J6    | JUNCTION | 0.125                               | 0.196                             | 0 05:56                                  | 0.355                                   | 0.514                                 | -0.180                              |
| J7    | JUNCTION | 0.093                               | 0.093                             | 0 05:54                                  | 0.158                                   | 0.158                                 | -0.392                              |
| STMH3 | JUNCTION | 0.000                               | 0.399                             | 0 05:49                                  | 0                                       | 3.69                                  | 0.122                               |
| STMH6 | JUNCTION | 2.057                               | 2.380                             | 0 05:54                                  | 4.67                                    | 10.8                                  | 0.009                               |
| STMH7 | JUNCTION | 0.201                               | 7.129                             | 0 05:54                                  | 0.414                                   | 20.2                                  | 0.004                               |
| OF1   | OUTFALL  | 0.000                               | 7.130                             | 0 05:54                                  | 0                                       | 20.2                                  | 0.000                               |

\*\*\*\*\*  
Node Surcharge Summary  
\*\*\*\*\*

Surcharging occurs when water rises above the top of the highest conduit.

| Node  | Type     | Hours<br>Surcharged | Max. Height<br>Above Crown<br>Meters | Min. Depth<br>Below Rim<br>Meters |
|-------|----------|---------------------|--------------------------------------|-----------------------------------|
| J2    | JUNCTION | 0.26                | 0.225                                | 0.000                             |
| STMH3 | JUNCTION | 0.01                | 0.222                                | 1.932                             |
| STMH6 | JUNCTION | 0.19                | 0.135                                | 0.725                             |

\*\*\*\*\*  
Node Flooding Summary  
\*\*\*\*\*

No nodes were flooded.

\*\*\*\*\*  
Outfall Loading Summary  
\*\*\*\*\*

| Outfall Node | Flow<br>Freq<br>Pcnt | Avg<br>Flow<br>CMS | Max<br>Flow<br>CMS | Total<br>Volume<br>10^6 ltr |
|--------------|----------------------|--------------------|--------------------|-----------------------------|
| OF1          | 70.87                | 0.206              | 7.130              | 20.236                      |
| System       | 70.87                | 0.206              | 7.130              | 20.236                      |

\*\*\*\*\*  
Link Flow Summary  
\*\*\*\*\*

| Link | Type    | Maximum<br> Flow <br>CMS | Time of Max<br>Occurrence<br>days hr:min | Maximum<br> Veloc <br>m/sec | Max/<br>Full<br>Flow | Max/<br>Full<br>Depth |
|------|---------|--------------------------|------------------------------------------|-----------------------------|----------------------|-----------------------|
| C1   | CONDUIT | 0.298                    | 0 06:09                                  | 4.22                        | 3.12                 | 1.00                  |
| C2   | CONDUIT | 0.686                    | 0 06:09                                  | 1.57                        | 0.37                 | 1.00                  |
| C3   | CONDUIT | 2.377                    | 0 05:54                                  | 2.10                        | 0.74                 | 1.00                  |
| C4   | CONDUIT | 7.130                    | 0 05:54                                  | 6.30                        | 2.06                 | 1.00                  |
| C5   | CONDUIT | 0.336                    | 0 05:50                                  | 0.96                        | 0.17                 | 1.00                  |
| C6   | CONDUIT | 0.090                    | 0 05:54                                  | 0.43                        | 0.04                 | 0.30                  |
| C7   | CONDUIT | 0.200                    | 0 06:00                                  | 0.76                        | 0.22                 | 0.51                  |
| C8   | CONDUIT | 0.227                    | 0 06:03                                  | 0.45                        | 0.20                 | 0.75                  |
| C9   | CHANNEL | 4.608                    | 0 05:54                                  | 2.52                        | 0.83                 | 0.93                  |
| OL1  | CONDUIT | 0.491                    | 0 06:01                                  | 0.36                        | 0.73                 | 0.44                  |
| OL2  | DUMMY   | 0.100                    | 0 03:19                                  |                             |                      |                       |

\*\*\*\*\*  
Flow Classification Summary  
\*\*\*\*\*

| Conduit | Adjusted<br>/Actual<br>Length | Fraction of Time in Flow Class |           |             |             |             |            |              |             |               |
|---------|-------------------------------|--------------------------------|-----------|-------------|-------------|-------------|------------|--------------|-------------|---------------|
|         |                               | Dry                            | Up<br>Dry | Down<br>Dry | Sub<br>Crit | Sup<br>Crit | Up<br>Crit | Down<br>Crit | Norm<br>Ltd | Inlet<br>Ctrl |
| C1      | 1.00                          | 0.01                           | 0.00      | 0.00        | 0.01        | 0.00        | 0.00       | 0.99         | 0.00        | 0.00          |
| C2      | 1.00                          | 0.01                           | 0.00      | 0.00        | 0.02        | 0.00        | 0.00       | 0.97         | 0.00        | 0.00          |
| C3      | 1.00                          | 0.01                           | 0.00      | 0.00        | 0.75        | 0.24        | 0.00       | 0.00         | 0.05        | 0.00          |
| C4      | 1.00                          | 0.01                           | 0.00      | 0.00        | 0.70        | 0.30        | 0.00       | 0.00         | 0.88        | 0.00          |
| C5      | 1.00                          | 0.01                           | 0.00      | 0.00        | 0.99        | 0.00        | 0.00       | 0.00         | 0.98        | 0.00          |
| C6      | 1.00                          | 0.46                           | 0.22      | 0.00        | 0.32        | 0.00        | 0.00       | 0.00         | 0.44        | 0.00          |

|     |      |      |      |      |      |      |      |      |      |      |
|-----|------|------|------|------|------|------|------|------|------|------|
| C7  | 1.00 | 0.39 | 0.07 | 0.00 | 0.54 | 0.00 | 0.00 | 0.00 | 0.94 | 0.00 |
| C8  | 1.00 | 0.01 | 0.38 | 0.00 | 0.61 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 |
| C9  | 1.00 | 0.51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.49 | 0.00 | 0.00 |
| OL1 | 1.00 | 0.98 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 |

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# Conduit Surcharge Summary

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| Conduit | -----<br>Both Ends | Hours Full<br>Upstream | -----<br>Dnstream | Hours<br>Above Full<br>Normal Flow | Hours<br>Capacity<br>Limited |
|---------|--------------------|------------------------|-------------------|------------------------------------|------------------------------|
| C1      | 1.45               | 1.98                   | 1.45              | 2.13                               | 1.45                         |
| C2      | 0.26               | 0.26                   | 0.32              | 0.01                               | 0.01                         |
| C3      | 0.19               | 0.19                   | 0.31              | 0.01                               | 0.01                         |
| C4      | 0.31               | 0.31                   | 0.35              | 0.34                               | 0.31                         |
| C5      | 0.01               | 0.01                   | 0.26              | 0.01                               | 0.01                         |
| C8      | 0.01               | 0.01                   | 1.75              | 0.01                               | 0.01                         |

Analysis begun on: Tue Apr 7 07:45:42 2020

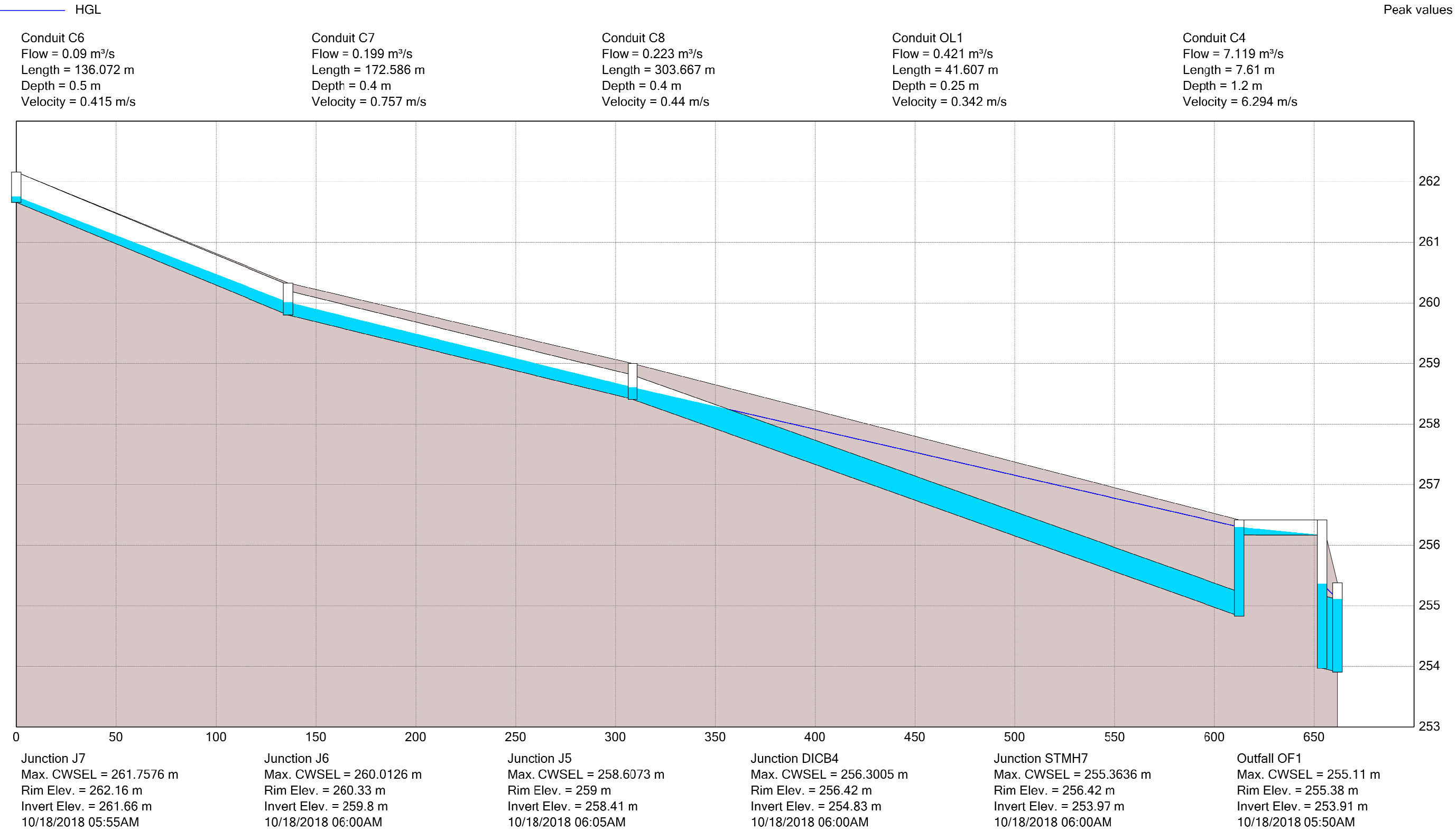
Analysis ended on: Tue Apr 7 07:45:43 2020

Total elapsed time: 00:00:01



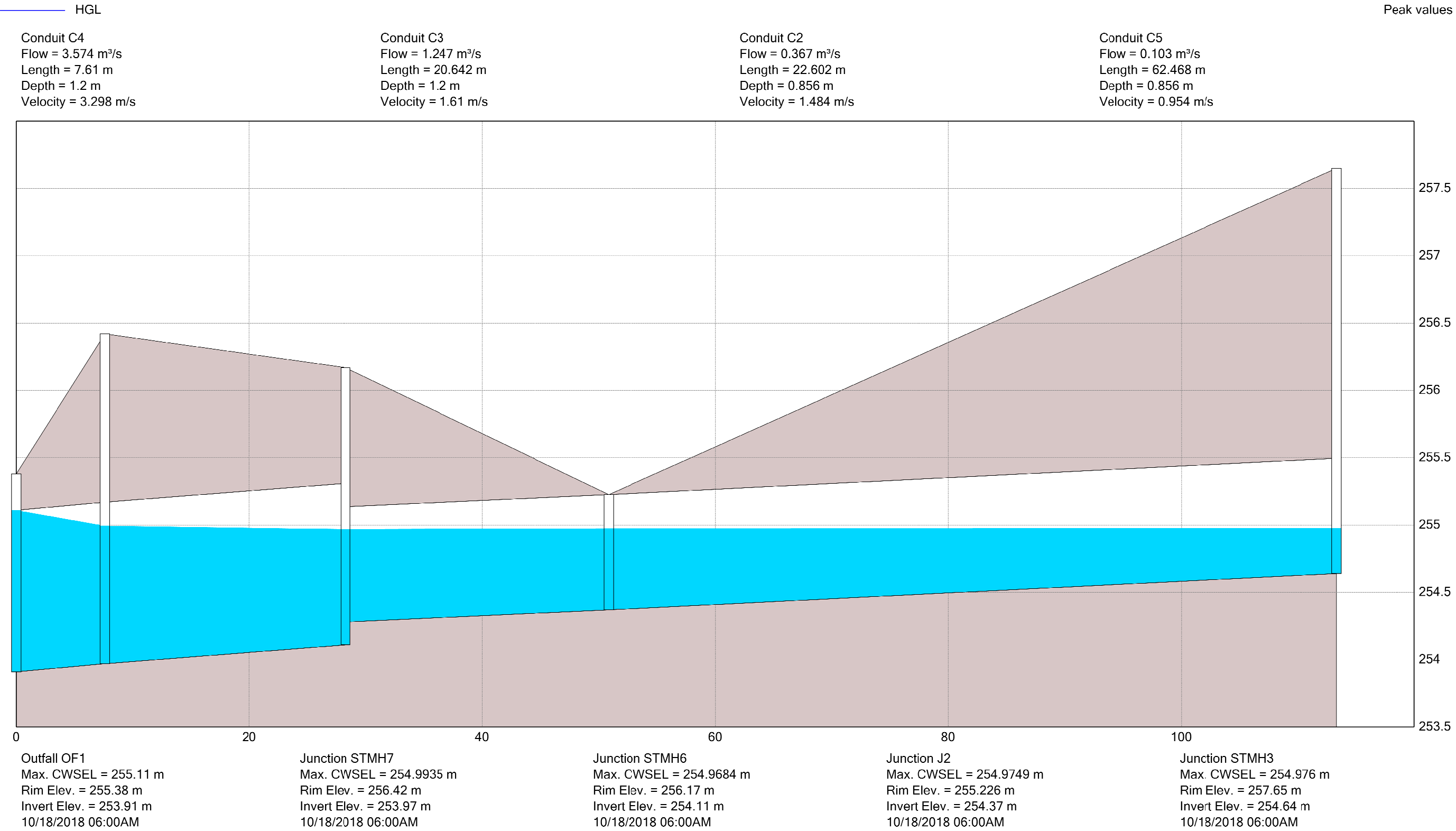
Profile 1 - Overland Flow - 441 Huronia Road to Big Bay Point Road

100 Year 12 Hr SCS Type II Storm



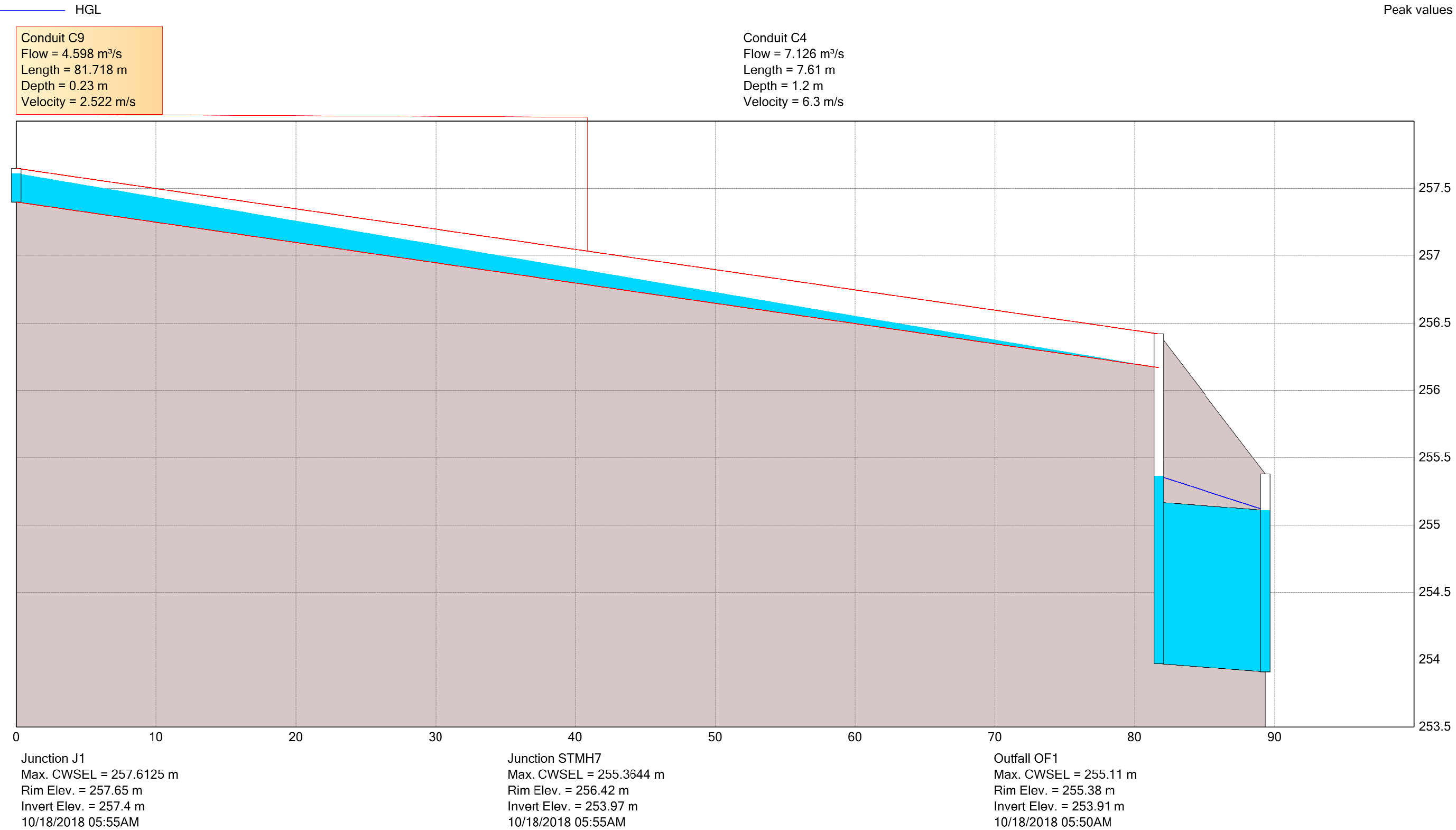
Profile 2 - Storm Sewer - Big Bay Point Road

5 Year 12 Hr SCS Type II Storm



Profile 3 - Overland Flow - Big Bay Point Road

100 Year 12 Hr SCS Type II Storm



## Appendix E – Post Development SWM Information



**Project Name:** 441 Huronia Road  
**Project No.:** 2019-083  
**Location:** City of Barrie  
**Created By:** CC  
**Checked By:** CC  
**Date Created:** 15-Apr-20  
**Date Modified:** 24-Apr-20



## Outlet From Storage Chamber

| Outlet Type       | Elevation (m) | Head (m) | $\delta h$ (m) | h (m) | P (m) | H (m) | Outlet from Structure     |                              |  | Total m <sup>3</sup> /s |
|-------------------|---------------|----------|----------------|-------|-------|-------|---------------------------|------------------------------|--|-------------------------|
|                   |               |          |                |       |       |       | Orifice m <sup>3</sup> /s | Trap. Weir m <sup>3</sup> /s |  |                         |
| Orifice           | 259.75        | 0.00     | 0.00           |       |       |       | 0.000                     |                              |  | 0.000                   |
| Orifice           | 259.80        | 0.05     | 0.01           |       |       |       | 0.001                     |                              |  | 0.001                   |
| Orifice           | 259.85        | 0.10     | 0.06           |       |       |       | 0.003                     |                              |  | 0.003                   |
| Orifice           | 259.90        | 0.15     | 0.11           |       |       |       | 0.004                     |                              |  | 0.004                   |
| Orifice + Trap. W | 259.95        | 0.20     | 0.16           | 0.00  | 0.16  |       | 0.005                     | 0.000                        |  | 0.005                   |
| Orifice + Trap. W | 260.00        | 0.25     | 0.21           | 0.05  | 0.21  |       | 0.006                     | 0.004                        |  | 0.010                   |
| Orifice + Trap. W | 260.05        | 0.30     | 0.26           | 0.10  | 0.26  |       | 0.006                     | 0.012                        |  | 0.018                   |
| Orifice + Trap. W | 260.10        | 0.35     | 0.31           | 0.15  | 0.31  |       | 0.007                     | 0.022                        |  | 0.029                   |
| Orifice + Trap. W | 260.15        | 0.40     | 0.36           | 0.20  | 0.36  |       | 0.007                     | 0.033                        |  | 0.041                   |
| Orifice + Trap. W | 260.20        | 0.45     | 0.41           | 0.25  | 0.41  |       | 0.008                     | 0.047                        |  | 0.054                   |
| Orifice + Trap. W | 260.25        | 0.50     | 0.46           | 0.30  | 0.46  |       | 0.008                     | 0.061                        |  | 0.070                   |
| Orifice + Trap. W | 260.30        | 0.55     | 0.51           | 0.35  | 0.51  |       | 0.009                     | 0.077                        |  | 0.086                   |
| Orifice + Trap. W | 260.35        | 0.60     | 0.56           | 0.40  | 0.56  |       | 0.009                     | 0.094                        |  | 0.103                   |
| Orifice + Trap. W | 260.40        | 0.65     | 0.61           | 0.45  | 0.61  |       | 0.010                     | 0.112                        |  | 0.122                   |
| Orifice + Trap. W | 260.45        | 0.70     | 0.66           | 0.50  | 0.66  |       | 0.010                     | 0.132                        |  | 0.142                   |
| Orifice + Trap. W | 260.50        | 0.75     | 0.71           | 0.55  | 0.71  |       | 0.010                     | 0.152                        |  | 0.162                   |
| Orifice + Trap. W | 260.55        | 0.80     | 0.76           | 0.60  | 0.76  |       | 0.011                     | 0.173                        |  | 0.184                   |
| Orifice + Trap. W | 260.60        | 0.85     | 0.81           | 0.65  | 0.81  |       | 0.011                     | 0.195                        |  | 0.206                   |
| Orifice + Trap. W | 260.63        | 0.88     | 0.84           | 0.68  | 0.84  |       | 0.011                     | 0.209                        |  | 0.220                   |
| Orifice + Trap. W | 260.68        | 0.93     | 0.89           | 0.73  | 0.89  |       | 0.012                     | 0.232                        |  | 0.244                   |
| Orifice + Trap. W | 260.73        | 0.98     | 0.94           | 0.78  | 0.94  |       | 0.012                     | 0.256                        |  | 0.268                   |
| Orifice + Trap. W | 260.78        | 1.03     | 0.99           | 0.83  | 0.99  |       | 0.012                     | 0.281                        |  | 0.294                   |
| Orifice + Trap. W | 260.83        | 1.08     | 1.04           | 0.88  | 1.04  |       | 0.013                     | 0.307                        |  | 0.320                   |
| Orifice + Trap. W | 260.88        | 1.13     | 1.09           | 0.93  | 1.09  |       | 0.013                     | 0.334                        |  | 0.347                   |
| Orifice + Trap. W | 260.93        | 1.18     | 1.14           | 0.98  | 1.14  |       | 0.013                     | 0.361                        |  | 0.374                   |
| Orifice + Trap. W | 260.98        | 1.23     | 1.19           | 1.03  | 1.19  |       | 0.013                     | 0.389                        |  | 0.402                   |
| Orifice + Trap. W | 261.03        | 1.28     | 1.24           | 1.08  | 1.24  |       | 0.014                     | 0.418                        |  | 0.431                   |
| Orifice + Trap. W | 261.08        | 1.33     | 1.29           | 1.13  | 1.29  |       | 0.014                     | 0.447                        |  | 0.461                   |
| Orifice + Trap. W | 261.13        | 1.38     | 1.34           | 1.18  | 1.34  |       | 0.014                     | 0.477                        |  | 0.491                   |
| Orifice + Trap. W | 261.18        | 1.43     | 1.39           | 1.23  | 1.39  |       | 0.015                     | 0.507                        |  | 0.522                   |
| Orifice + Trap. W | 261.23        | 1.48     | 1.44           | 1.28  | 1.44  |       | 0.015                     | 0.539                        |  | 0.554                   |
| Orifice + Trap. W | 261.28        | 1.53     | 1.49           | 1.33  | 1.49  |       | 0.015                     | 0.571                        |  | 0.586                   |
| Orifice + Trap. W | 261.33        | 1.58     | 1.54           | 1.38  | 1.54  |       | 0.015                     | 0.603                        |  | 0.618                   |
| Orifice + Trap. W | 261.38        | 1.63     | 1.59           | 1.43  | 1.59  |       | 0.016                     | 0.636                        |  | 0.652                   |
| Orifice + Trap. W | 261.43        | 1.68     | 1.64           | 1.48  | 1.64  |       | 0.016                     | 0.670                        |  | 0.686                   |
| Orifice + Trap. W | 261.48        | 1.73     | 1.69           | 1.53  | 1.69  |       | 0.016                     | 0.704                        |  | 0.720                   |
| Orifice + Trap. W | 261.53        | 1.78     | 1.74           | 1.58  | 1.74  |       | 0.016                     | 0.739                        |  | 0.755                   |
|                   |               |          |                |       |       |       |                           |                              |  |                         |
|                   |               |          |                |       |       |       |                           |                              |  |                         |
|                   |               |          |                |       |       |       |                           |                              |  |                         |

Orifice

$$Q = C_d A_o \sqrt{2g \delta h}$$

$$Q = \text{Peak Runoff (m}^3/\text{s)}$$

$C_d$  = Constant ( 0.63 orifice, 0.8 for orifice tube)

$A_o$  = Cross sectional Area of Orifice (m<sup>2</sup>)

$g$  = gravity, 9.8 m/s<sup>2</sup>

$\delta h$  = change in elevation between middle of the discharge pipe and the water surface (m)

|                  |       |
|------------------|-------|
| $C_d$            | 0.63  |
| Orifice Dia. (m) | 0.075 |

Trapezoidal Weir

$$Q = 1.86bh^{3/2}$$

$$Q = \text{Peak Runoff (m}^3/\text{s)}$$

$b$  = width of weir bottom (m)

$h$  = distance from weir opening to top of water surface (m)

|     |      |
|-----|------|
| $b$ | 0.20 |
|-----|------|

**Project Name:** 441 Huronia Road  
**Project No:** 2019-083  
**Location:** Barrie

**Date:** 8/26/2020

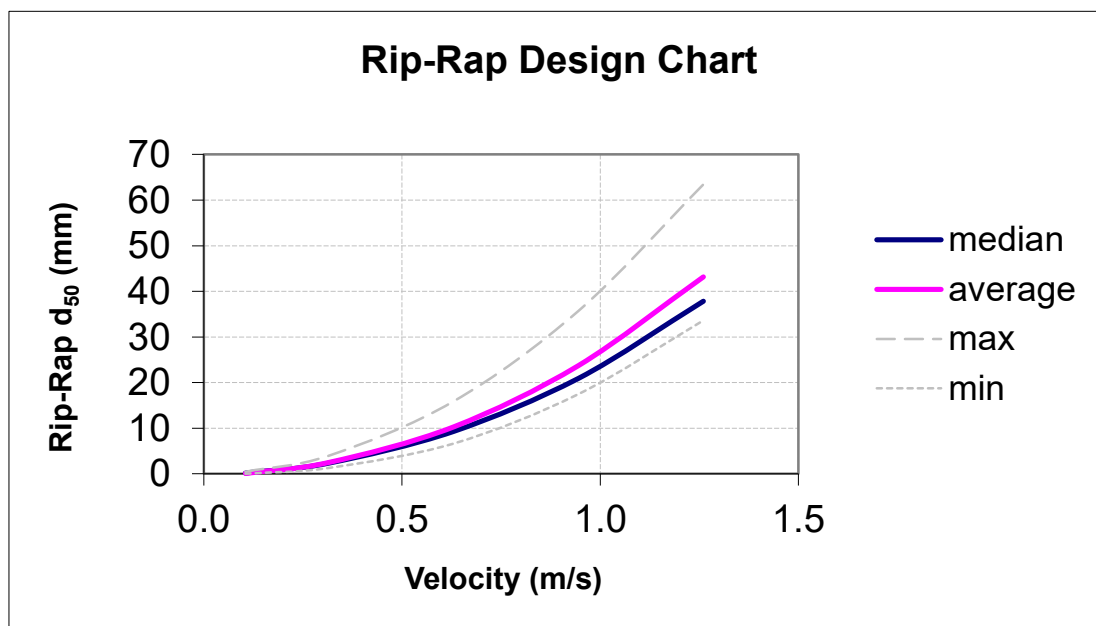
## Outlet Spillway



slope (Z:1) **3**       $\&-atan(slope)$   $\sin(70)$   
                                          0.321750554    1.22173

- note slope is channel side slope not longitudinal slope

| Design                     | Velocities    |               |               |               |               |               |
|----------------------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Velocity (m/s) <b>1.05</b> | 0.11          | 0.32          | 0.63          | 0.95          | 1.26          |               |
|                            | $d_{50}$ (mm) | $d_{50}$ (mm) | $d_{50}$ (mm) | $d_{50}$ (mm) | $d_{50}$ (mm) | $d_{50}$ (mm) |
| Smith                      | 28            | 0             | 3             | 10            | 23            | 41            |
| USBR                       | 44            | 0             | 4             | 16            | 36            | 63            |
| Cox                        | 37            | 0             | 2             | 8             | 19            | 34            |
| MTO                        | 22            | 0             | 1             | 7             | 17            | 35            |
| median                     | 33            | 0             | 2             | 9             | 21            | 38            |
| average                    | 33            | 0             | 2             | 10            | 24            | 43            |
| max                        | 44            | 0             | 4             | 16            | 36            | 63            |
| min                        | 22            | 0             | 1             | 7             | 17            | 34            |



## Post Development 100 Year 12 Hr SCS Type II Storm - PCSWMM Output

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

\*\*\*\*\*

Element Count

\*\*\*\*\*

Number of rain gages ..... 15  
 Number of subcatchments ... 11  
 Number of nodes ..... 19  
 Number of links ..... 20  
 Number of pollutants ..... 0  
 Number of land uses ..... 0

\*\*\*\*\*

Raingage Summary

\*\*\*\*\*

| Name                      | Data Source               | Data Type | Recording Interval |
|---------------------------|---------------------------|-----------|--------------------|
| 100Yr4HrChic              | CHIC4Hr100Yr              | INTENSITY | 5 min.             |
| 10Yr4HrChic               | CHIC4Hr10Yr               | INTENSITY | 5 min.             |
| 25mm                      | 25mm                      | INTENSITY | 5 min.             |
| 25Yr4HrChic               | CHIC4Hr25Yr               | INTENSITY | 5 min.             |
| 2Yr4HrChic                | CHIC4Hr2Yr                | INTENSITY | 5 min.             |
| 50Yr4HrChic               | CHIC4Hr50Yr               | INTENSITY | 5 min.             |
| 5Yr4HrChic                | CHIC4Hr5Yr                | INTENSITY | 5 min.             |
| Hurricane_Hazel_(0-25)    | Hurricane_Hazel_(0-25)    | INTENSITY | 60 min.            |
| SCS_Type_II_101.7mm_50Yr  | SCS_Type_II_101.7mm_50Yr  | INTENSITY | 6 min.             |
| SCS_Type_II_112.5mm_100Yr | SCS_Type_II_112.5mm_100Yr | INTENSITY | 6 min.             |
| SCS_Type_II_46.7mm_2Yr    | SCS_Type_II_46.7mm_2Yr    | INTENSITY | 6 min.             |
| SCS_Type_II_64.3mm_5Yr    | SCS_Type_II_64.3mm_5Yr    | INTENSITY | 6 min.             |
| SCS_Type_II_76mm_10Yr     | SCS_Type_II_76mm_10Yr     | INTENSITY | 6 min.             |
| SCS_Type_II_90.7mm_25Yr   | SCS_Type_II_90.7mm_25Yr   | INTENSITY | 6 min.             |
| Timmins_Storm_(0-25)      | Timmins_Storm_(0-25)      | INTENSITY | 60 min.            |

\*\*\*\*\*

Subcatchment Summary

\*\*\*\*\*

| Name | Area | Width | %Imperv | %Slope | Rain Gage                 | Outlet     |
|------|------|-------|---------|--------|---------------------------|------------|
| S1   | 0.09 | 26.40 | 100.00  | 1.0000 | SCS_Type_II_112.5mm_100Yr | Roof_Infil |
| S10  | 0.03 | 84.75 | 0.00    | 2.0000 | SCS_Type_II_112.5mm_100Yr | S3         |

|     |       |        |       |        |                           |         |
|-----|-------|--------|-------|--------|---------------------------|---------|
| S11 | 0.04  | 120.33 | 0.00  | 2.0000 | SCS_Type_II_112.5mm_100Yr | S4      |
| S2  | 12.59 | 298.30 | 70.00 | 2.0000 | SCS_Type_II_112.5mm_100Yr | J1      |
| S3  | 0.23  | 382.17 | 35.00 | 2.0000 | SCS_Type_II_112.5mm_100Yr | J7      |
| S4  | 0.17  | 17.23  | 5.00  | 2.0000 | SCS_Type_II_112.5mm_100Yr | J5      |
| S5  | 1.95  | 355.14 | 85.00 | 2.0000 | SCS_Type_II_112.5mm_100Yr | DICB4   |
| S6  | 5.80  | 579.92 | 25.00 | 2.0000 | SCS_Type_II_112.5mm_100Yr | STMH6   |
| S7  | 0.40  | 395.30 | 85.00 | 2.0000 | SCS_Type_II_112.5mm_100Yr | STMH7   |
| S8  | 0.28  | 27.70  | 98.00 | 1.0000 | SCS_Type_II_112.5mm_100Yr | DCBMH01 |
| S9  | 0.03  | 94.33  | 0.00  | 2.0000 | SCS_Type_II_112.5mm_100Yr | S3      |

\*\*\*\*\*  
LID Control Summary  
\*\*\*\*\*

| Subcatchment | LID Control | No. of<br>Units | Unit<br>Area | Unit<br>Width | % Area<br>Covered | % Imperv<br>Treated | % Perv<br>Treated |
|--------------|-------------|-----------------|--------------|---------------|-------------------|---------------------|-------------------|
| S9           | LID1        | 1               | 114.00       | 1.50          | 40.28             | 100.00              | 0.00              |

\*\*\*\*\*  
Node Summary  
\*\*\*\*\*

| Name             | Type     | Invert<br>Elev. | Max.<br>Depth | Ponded<br>Area | External<br>Inflow |
|------------------|----------|-----------------|---------------|----------------|--------------------|
| DCBMH01          | JUNCTION | 259.85          | 1.50          | 0.0            |                    |
| DICB4            | JUNCTION | 254.83          | 1.60          | 0.0            |                    |
| J1               | JUNCTION | 257.40          | 0.25          | 0.0            |                    |
| J2               | JUNCTION | 254.37          | 0.86          | 0.0            |                    |
| J4               | JUNCTION | 260.96          | 0.61          | 0.0            |                    |
| J5               | JUNCTION | 258.41          | 0.59          | 0.0            |                    |
| J6               | JUNCTION | 259.67          | 0.66          | 0.0            |                    |
| J7               | JUNCTION | 261.66          | 0.51          | 0.0            |                    |
| J8               | JUNCTION | 261.27          | 0.56          | 0.0            |                    |
| MH02             | JUNCTION | 260.54          | 1.68          | 0.0            |                    |
| MH03             | JUNCTION | 259.80          | 1.88          | 0.0            |                    |
| OGS1             | JUNCTION | 259.80          | 1.58          | 0.0            |                    |
| OS1              | JUNCTION | 259.75          | 1.77          | 0.0            |                    |
| STMH3            | JUNCTION | 254.64          | 3.01          | 0.0            |                    |
| STMH6            | JUNCTION | 254.11          | 2.06          | 0.0            |                    |
| STMH7            | JUNCTION | 253.97          | 2.45          | 0.0            |                    |
| OF1              | OUTFALL  | 253.91          | 1.20          | 0.0            |                    |
| Roof_Infil       | STORAGE  | 260.60          | 1.62          | 0.0            |                    |
| Underground_Stor | STORAGE  | 259.79          | 1.56          | 0.0            |                    |



\*\*\*\*\*

# Link Summary

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| Name | From Node        | To Node          | Type    | Length | %Slope | Roughness |
|------|------------------|------------------|---------|--------|--------|-----------|
| C1   | DICB4            | J2               | CONDUIT | 13.3   | 0.9776 | 0.0130    |
| C10  | MH02             | MH03             | CONDUIT | 52.0   | 1.4222 | 0.0130    |
| C11  | DCBMH01          | OGS1             | CONDUIT | 3.1    | 0.3210 | 0.0130    |
| C12  | OGS1             | Underground_Stor | CONDUIT | 2.8    | 0.3571 | 0.0130    |
| C13  | MH03             | Underground_Stor | CONDUIT | 24.9   | 0.0401 | 0.0130    |
| C14  | Roof_Infil       | MH02             | CONDUIT | 1.8    | 1.6856 | 0.0130    |
| C2   | J2               | STMH6            | CONDUIT | 22.6   | 0.3982 | 0.0130    |
| C3   | STMH6            | STMH7            | CONDUIT | 20.6   | 0.6782 | 0.0130    |
| C4   | STMH7            | OF1              | CONDUIT | 7.6    | 0.7885 | 0.0130    |
| C5   | STMH3            | J2               | CONDUIT | 62.5   | 0.4322 | 0.0130    |
| C6   | OS1              | J6               | CONDUIT | 42.0   | 0.1903 | 0.0130    |
| C6_1 | J7               | J8               | CONDUIT | 25.0   | 1.5697 | 0.0300    |
| C6_4 | J4               | J6               | CONDUIT | 91.5   | 1.4100 | 0.0300    |
| C6_5 | J8               | J4               | CONDUIT | 19.6   | 1.5719 | 0.0130    |
| C7   | J6               | J5               | CONDUIT | 172.6  | 0.7301 | 0.0300    |
| C8   | J5               | DICB4            | CONDUIT | 303.7  | 1.1790 | 0.0300    |
| C9   | J1               | STMH7            | CONDUIT | 81.7   | 1.5053 | 0.0130    |
| OL1  | DICB4            | STMH7            | CONDUIT | 41.6   | 0.0024 | 0.0130    |
| OL2  | J1               | STMH3            | OUTLET  |        |        |           |
| OL3  | Underground_Stor | OS1              | OUTLET  |        |        |           |

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# Cross Section Summary

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| Conduit | Shape         | Full Depth | Full Area | Hyd. Rad. | Max. Width | No. of Barrels | Full Flow |
|---------|---------------|------------|-----------|-----------|------------|----------------|-----------|
| C1      | CIRCULAR      | 0.30       | 0.07      | 0.07      | 0.30       | 1              | 0.10      |
| C10     | CIRCULAR      | 0.30       | 0.07      | 0.07      | 0.30       | 1              | 0.12      |
| C11     | CIRCULAR      | 0.38       | 0.11      | 0.09      | 0.38       | 1              | 0.10      |
| C12     | CIRCULAR      | 0.38       | 0.11      | 0.09      | 0.38       | 1              | 0.10      |
| C13     | DUMMY         | 0.00       | 0.00      | 0.00      | 0.00       | 1              | 0.00      |
| C14     | CIRCULAR      | 0.07       | 0.00      | 0.02      | 0.07       | 1              | 0.00      |
| C2      | HORIZ_ELLIPSE | 0.86       | 0.93      | 0.26      | 1.34       | 1              | 1.85      |
| C3      | CIRCULAR      | 1.20       | 1.13      | 0.30      | 1.20       | 1              | 3.21      |
| C4      | CIRCULAR      | 1.20       | 1.13      | 0.30      | 1.20       | 1              | 3.46      |
| C5      | HORIZ_ELLIPSE | 0.86       | 0.93      | 0.26      | 1.34       | 1              | 1.93      |
| C6      | CIRCULAR      | 0.30       | 0.07      | 0.07      | 0.30       | 1              | 0.04      |
| C6_1    | TRAPEZOIDAL   | 0.50       | 1.25      | 0.30      | 4.00       | 1              | 2.34      |

|      |             |      |      |      |       |   |      |
|------|-------------|------|------|------|-------|---|------|
| C6_4 | TRAPEZOIDAL | 0.50 | 1.25 | 0.30 | 4.00  | 1 | 2.22 |
| C6_5 | CIRCULAR    | 0.45 | 0.16 | 0.11 | 0.45  | 1 | 0.36 |
| C7   | TRAPEZOIDAL | 0.40 | 0.84 | 0.22 | 3.70  | 1 | 0.87 |
| C8   | TRAPEZOIDAL | 0.40 | 0.84 | 0.22 | 3.70  | 1 | 1.11 |
| C9   | Street1     | 0.23 | 2.12 | 0.15 | 18.00 | 1 | 5.53 |
| OL1  | TRIANGULAR  | 0.25 | 7.12 | 0.12 | 57.00 | 1 | 0.67 |

\*\*\*\*\*  
Transect Summary  
\*\*\*\*\*

Transect Street1  
Area:

|        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 0.0005 | 0.0020 | 0.0045 | 0.0080 | 0.0125 |
| 0.0180 | 0.0245 | 0.0319 | 0.0404 | 0.0499 |
| 0.0604 | 0.0719 | 0.0843 | 0.0978 | 0.1123 |
| 0.1278 | 0.1442 | 0.1617 | 0.1802 | 0.1996 |
| 0.2201 | 0.2415 | 0.2632 | 0.2849 | 0.3066 |
| 0.3283 | 0.3500 | 0.3717 | 0.3934 | 0.4151 |
| 0.4368 | 0.4585 | 0.4803 | 0.5029 | 0.5264 |
| 0.5510 | 0.5766 | 0.6032 | 0.6308 | 0.6593 |
| 0.6889 | 0.7195 | 0.7511 | 0.7836 | 0.8172 |
| 0.8518 | 0.8873 | 0.9239 | 0.9614 | 1.0000 |

Hrad:

|        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 0.0155 | 0.0310 | 0.0464 | 0.0619 | 0.0774 |
| 0.0929 | 0.1083 | 0.1238 | 0.1393 | 0.1548 |
| 0.1703 | 0.1857 | 0.2012 | 0.2167 | 0.2322 |
| 0.2476 | 0.2631 | 0.2786 | 0.2941 | 0.3096 |
| 0.3250 | 0.3445 | 0.3751 | 0.4056 | 0.4361 |
| 0.4666 | 0.4970 | 0.5273 | 0.5576 | 0.5878 |
| 0.6180 | 0.6481 | 0.6783 | 0.7072 | 0.7343 |
| 0.7597 | 0.7836 | 0.8061 | 0.8273 | 0.8473 |
| 0.8662 | 0.8841 | 0.9011 | 0.9172 | 0.9326 |
| 0.9472 | 0.9612 | 0.9747 | 0.9876 | 1.0000 |

Width:

|        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 0.0256 | 0.0511 | 0.0767 | 0.1022 | 0.1278 |
| 0.1533 | 0.1789 | 0.2044 | 0.2300 | 0.2556 |
| 0.2811 | 0.3067 | 0.3322 | 0.3578 | 0.3833 |
| 0.4089 | 0.4344 | 0.4600 | 0.4856 | 0.5111 |
| 0.5367 | 0.5556 | 0.5556 | 0.5556 | 0.5556 |
| 0.5556 | 0.5556 | 0.5556 | 0.5556 | 0.5556 |
| 0.5556 | 0.5556 | 0.5656 | 0.5911 | 0.6167 |
| 0.6422 | 0.6678 | 0.6933 | 0.7189 | 0.7444 |
| 0.7700 | 0.7956 | 0.8211 | 0.8467 | 0.8722 |

0.8978      0.9233      0.9489      0.9744      1.0000

\*\*\*\*\*  
NOTE: The summary statistics displayed in this report are  
based on results found at every computational time step,  
not just on results from each reporting time step.  
\*\*\*\*\*

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#### Analysis Options

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Flow Units ..... CMS

#### Process Models:

Rainfall/Runoff ..... YES

RDII ..... NO

Snowmelt ..... NO

Groundwater ..... NO

Flow Routing ..... YES

Ponding Allowed ..... YES

Water Quality ..... NO

Infiltration Method ..... GREEN\_AMPT

Flow Routing Method ..... DYNWAVE

Surcharge Method ..... EXTRAN

Starting Date ..... 10/18/2018 00:00:00

Ending Date ..... 10/22/2018 00:00:00

Antecedent Dry Days ..... 0.0

Report Time Step ..... 00:05:00

Wet Time Step ..... 00:05:00

Dry Time Step ..... 00:05:00

Routing Time Step ..... 5.00 sec

Variable Time Step ..... YES

Maximum Trials ..... 8

Number of Threads ..... 4

Head Tolerance ..... 0.001500 m

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Runoff Quantity Continuity

\*\*\*\*\*

Total Precipitation .....

Evaporation Loss .....

Infiltration Loss .....

Surface Runoff .....

Final Storage .....

Continuity Error (%) .....

Volume

hectare-m

-----

2.431

0.000

0.379

2.032

0.025

-0.212

Depth

mm

-----

112.500

0.000

17.523

94.038

1.177

```

*****
Flow Routing Continuity
*****

```

|                            | Volume<br>hectare-m<br>----- | Volume<br>10^6 ltr<br>----- |
|----------------------------|------------------------------|-----------------------------|
| Dry Weather Inflow .....   | 0.000                        | 0.000                       |
| Wet Weather Inflow .....   | 2.034                        | 20.342                      |
| Groundwater Inflow .....   | 0.000                        | 0.000                       |
| RDII Inflow .....          | 0.000                        | 0.000                       |
| External Inflow .....      | 0.000                        | 0.000                       |
| External Outflow .....     | 2.038                        | 20.380                      |
| Flooding Loss .....        | 0.000                        | 0.000                       |
| Evaporation Loss .....     | 0.000                        | 0.000                       |
| Exfiltration Loss .....    | 0.000                        | 0.000                       |
| Initial Stored Volume .... | 0.000                        | 0.000                       |
| Final Stored Volume .....  | 0.000                        | 0.000                       |
| Continuity Error (%) ..... | -0.189                       |                             |

```

*****
Time-Step Critical Elements
*****
Link C14 (46.96%)
Link C12 (6.63%)
Link C11 (1.61%)

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*****
Highest Flow Instability Indexes
*****
Link OL2 (33)
Link C5 (3)

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*****
Routing Time Step Summary
*****
Minimum Time Step      :    0.50 sec
Average Time Step      :    3.23 sec
Maximum Time Step      :    5.00 sec
Percent in Steady State :   -0.00
Average Iterations per Step :    2.01
Percent Not Converging  :    0.03

```

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*****

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# Subcatchment Runoff Summary

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| Subcatchment | Total<br>Precip<br>mm | Total<br>Runon<br>mm | Total<br>Evap<br>mm | Total<br>Infil<br>mm | Imperv<br>Runoff<br>mm | Perv<br>Runoff<br>mm | Total<br>Runoff<br>mm | Total<br>Runoff<br>10^6 ltr | Peak<br>Runoff<br>CMS | Runoff<br>Coeff |
|--------------|-----------------------|----------------------|---------------------|----------------------|------------------------|----------------------|-----------------------|-----------------------------|-----------------------|-----------------|
| S1           | 112.50                | 0.00                 | 0.00                | 0.00                 | 110.84                 | 0.00                 | 110.84                | 0.10                        | 0.05                  | 0.985           |
| S10          | 112.50                | 0.00                 | 0.00                | 46.57                | 0.00                   | 66.43                | 66.43                 | 0.02                        | 0.02                  | 0.591           |
| S11          | 112.50                | 0.00                 | 0.00                | 46.53                | 0.00                   | 66.48                | 66.48                 | 0.02                        | 0.02                  | 0.591           |
| S2           | 112.50                | 0.00                 | 0.00                | 12.83                | 77.56                  | 20.95                | 98.51                 | 12.40                       | 4.73                  | 0.876           |
| S3           | 112.50                | 14.98                | 0.00                | 26.97                | 43.93                  | 56.09                | 100.01                | 0.23                        | 0.14                  | 0.785           |
| S4           | 112.50                | 13.96                | 0.00                | 40.39                | 6.23                   | 79.93                | 86.16                 | 0.15                        | 0.06                  | 0.681           |
| S5           | 112.50                | 0.00                 | 0.00                | 6.23                 | 94.20                  | 10.71                | 104.91                | 2.05                        | 0.98                  | 0.933           |
| S6           | 112.50                | 0.00                 | 0.00                | 31.69                | 27.68                  | 52.82                | 80.50                 | 4.67                        | 2.06                  | 0.716           |
| S7           | 112.50                | 0.00                 | 0.00                | 6.22                 | 93.96                  | 10.68                | 104.65                | 0.41                        | 0.20                  | 0.930           |
| S8           | 112.50                | 0.00                 | 0.00                | 0.83                 | 108.67                 | 1.43                 | 110.09                | 0.30                        | 0.13                  | 0.979           |
| S9           | 112.50                | 0.00                 | 0.00                | 71.04                | 0.00                   | 41.37                | 41.37                 | 0.01                        | 0.01                  | 0.368           |

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## LID Performance Summary

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| Subcatchment | LID Control | Total<br>Inflow<br>mm | Evap<br>Loss<br>mm | Infil<br>Loss<br>mm | Surface<br>Outflow<br>mm | Drain<br>Outflow<br>mm | Initial<br>Storage<br>mm | Final<br>Storage<br>mm | Continuity<br>Error<br>% |
|--------------|-------------|-----------------------|--------------------|---------------------|--------------------------|------------------------|--------------------------|------------------------|--------------------------|
| S9           | LID1        | 112.50                | 0.00               | 107.43              | 5.22                     | 0.00                   | 0.00                     | 0.00                   | -0.14                    |

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## Node Depth Summary

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| Node    | Type     | Average<br>Depth<br>Meters | Maximum<br>Depth<br>Meters | Maximum<br>HGL<br>Meters | Time of Max<br>Occurrence<br>days hr:min | Reported<br>Max Depth<br>Meters |
|---------|----------|----------------------------|----------------------------|--------------------------|------------------------------------------|---------------------------------|
| DCBMH01 | JUNCTION | 0.06                       | 0.39                       | 260.24                   | 0 06:02                                  | 0.38                            |
| DICB4   | JUNCTION | 0.11                       | 1.48                       | 256.31                   | 0 06:01                                  | 1.47                            |
| J1      | JUNCTION | 0.02                       | 0.21                       | 257.61                   | 0 05:54                                  | 0.21                            |
| J2      | JUNCTION | 0.08                       | 1.38                       | 255.75                   | 0 05:49                                  | 1.08                            |
| J4      | JUNCTION | 0.01                       | 0.12                       | 261.08                   | 0 05:55                                  | 0.12                            |

|                  |          |      |      |        |   |       |      |
|------------------|----------|------|------|--------|---|-------|------|
| J5               | JUNCTION | 0.02 | 0.19 | 258.60 | 0 | 06:03 | 0.19 |
| J6               | JUNCTION | 0.02 | 0.20 | 259.87 | 0 | 05:58 | 0.20 |
| J7               | JUNCTION | 0.01 | 0.12 | 261.78 | 0 | 05:54 | 0.12 |
| J8               | JUNCTION | 0.01 | 0.20 | 261.46 | 0 | 05:54 | 0.19 |
| MH02             | JUNCTION | 0.02 | 0.07 | 260.61 | 0 | 06:06 | 0.07 |
| MH03             | JUNCTION | 0.00 | 0.00 | 259.80 | 0 | 06:06 | 0.00 |
| OGS1             | JUNCTION | 0.08 | 0.45 | 260.25 | 0 | 06:00 | 0.43 |
| OS1              | JUNCTION | 0.04 | 0.26 | 260.01 | 0 | 06:04 | 0.26 |
| STMH3            | JUNCTION | 0.06 | 2.39 | 257.03 | 0 | 05:49 | 0.83 |
| STMH6            | JUNCTION | 0.10 | 1.46 | 255.57 | 0 | 05:49 | 1.33 |
| STMH7            | JUNCTION | 0.11 | 1.40 | 255.37 | 0 | 05:54 | 1.39 |
| OF1              | OUTFALL  | 0.11 | 1.20 | 255.11 | 0 | 05:47 | 1.20 |
| Roof_Infil       | STORAGE  | 0.03 | 0.24 | 260.84 | 0 | 06:06 | 0.24 |
| Underground_Stor | STORAGE  | 0.08 | 0.44 | 260.23 | 0 | 06:04 | 0.44 |

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Node Inflow Summary  
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| Node             | Type     | Maximum<br>Lateral<br>Inflow<br>CMS | Maximum<br>Total<br>Inflow<br>CMS | Time of Max<br>Occurrence<br>days hr:min | Lateral<br>Inflow<br>Volume<br>10^6 ltr | Total<br>Inflow<br>Volume<br>10^6 ltr | Flow<br>Balance<br>Error<br>Percent |
|------------------|----------|-------------------------------------|-----------------------------------|------------------------------------------|-----------------------------------------|---------------------------------------|-------------------------------------|
| DCBMH01          | JUNCTION | 0.134                               | 0.134                             | 0 05:54                                  | 0.305                                   | 0.305                                 | -0.015                              |
| DICB4            | JUNCTION | 0.985                               | 1.079                             | 0 05:54                                  | 2.05                                    | 2.83                                  | 0.000                               |
| J1               | JUNCTION | 4.730                               | 4.730                             | 0 05:54                                  | 12.4                                    | 12.4                                  | -0.358                              |
| J2               | JUNCTION | 0.000                               | 0.562                             | 0 06:08                                  | 0                                       | 6.26                                  | -0.020                              |
| J4               | JUNCTION | 0.000                               | 0.135                             | 0 05:54                                  | 0                                       | 0.23                                  | -0.171                              |
| J5               | JUNCTION | 0.065                               | 0.225                             | 0 06:00                                  | 0.149                                   | 0.787                                 | 0.435                               |
| J6               | JUNCTION | 0.000                               | 0.161                             | 0 05:56                                  | 0                                       | 0.638                                 | -0.120                              |
| J7               | JUNCTION | 0.136                               | 0.136                             | 0 05:54                                  | 0.23                                    | 0.23                                  | -0.000                              |
| J8               | JUNCTION | 0.000                               | 0.135                             | 0 05:54                                  | 0                                       | 0.23                                  | 0.000                               |
| MH02             | JUNCTION | 0.000                               | 0.008                             | 0 06:06                                  | 0                                       | 0.102                                 | 0.001                               |
| MH03             | JUNCTION | 0.000                               | 0.008                             | 0 06:06                                  | 0                                       | 0.102                                 | 0.000                               |
| OGS1             | JUNCTION | 0.000                               | 0.134                             | 0 05:54                                  | 0                                       | 0.305                                 | -0.008                              |
| OS1              | JUNCTION | 0.000                               | 0.051                             | 0 06:04                                  | 0                                       | 0.408                                 | 0.003                               |
| STMH3            | JUNCTION | 0.000                               | 0.426                             | 0 05:49                                  | 0                                       | 3.68                                  | 0.125                               |
| STMH6            | JUNCTION | 2.057                               | 2.396                             | 0 05:53                                  | 4.67                                    | 10.9                                  | 0.008                               |
| STMH7            | JUNCTION | 0.201                               | 7.131                             | 0 05:55                                  | 0.414                                   | 20.4                                  | -0.001                              |
| OF1              | OUTFALL  | 0.000                               | 7.131                             | 0 05:55                                  | 0                                       | 20.4                                  | 0.000                               |
| Roof_Infil       | STORAGE  | 0.047                               | 0.047                             | 0 05:54                                  | 0.102                                   | 0.102                                 | -0.000                              |
| Underground_Stor | STORAGE  | 0.000                               | 0.140                             | 0 05:54                                  | 0                                       | 0.408                                 | 0.001                               |

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Node Surge Summary  
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Surcharging occurs when water rises above the top of the highest conduit.

| Node    | Type     | Hours<br>Surcharged | Max. Height<br>Above Crown<br>Meters | Min. Depth<br>Below Rim<br>Meters |
|---------|----------|---------------------|--------------------------------------|-----------------------------------|
| DCBMH01 | JUNCTION | 0.14                | 0.011                                | 1.114                             |
| J2      | JUNCTION | 0.25                | 0.529                                | 0.000                             |
| OGS1    | JUNCTION | 0.20                | 0.038                                | 1.127                             |
| STMH3   | JUNCTION | 0.01                | 1.538                                | 0.616                             |
| STMH6   | JUNCTION | 0.19                | 0.260                                | 0.600                             |

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Node Flooding Summary  
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No nodes were flooded.

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Storage Volume Summary  
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| Storage Unit     | Average<br>Volume<br>1000 m3 | Avg<br>Pcnt<br>Full | Evap<br>Pcnt<br>Loss | Exfil<br>Pcnt<br>Loss | Maximum<br>Volume<br>1000 m3 | Max<br>Pcnt<br>Full | Time of Max<br>Occurrence<br>days hr:min | Maximum<br>Outflow<br>CMS |
|------------------|------------------------------|---------------------|----------------------|-----------------------|------------------------------|---------------------|------------------------------------------|---------------------------|
| Roof_Infil       | 0.006                        | 9                   | 0                    | 0                     | 0.048                        | 78                  | 0 06:06                                  | 0.008                     |
| Underground_Stor | 0.030                        | 18                  | 0                    | 0                     | 0.162                        | 98                  | 0 06:04                                  | 0.051                     |

\*\*\*\*\*  
Outfall Loading Summary  
\*\*\*\*\*

| Outfall Node | Flow<br>Freq<br>Pcnt | Avg<br>Flow<br>CMS | Max<br>Flow<br>CMS | Total<br>Volume<br>10^6 ltr |
|--------------|----------------------|--------------------|--------------------|-----------------------------|
|--------------|----------------------|--------------------|--------------------|-----------------------------|

|        |       |       |       |        |
|--------|-------|-------|-------|--------|
| OF1    | 78.96 | 0.285 | 7.131 | 20.380 |
| System | 78.96 | 0.285 | 7.131 | 20.380 |

\*\*\*\*\*  
Link Flow Summary  
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| Link | Type    | Maximum<br> Flow <br>CMS | Time of Max<br>Occurrence<br>days hr:min | Maximum<br> Veloc <br>m/sec | Max/<br>Full<br>Flow | Max/<br>Full<br>Depth |
|------|---------|--------------------------|------------------------------------------|-----------------------------|----------------------|-----------------------|
| C1   | CONDUIT | 0.298                    | 0 06:09                                  | 4.22                        | 3.12                 | 1.00                  |
| C10  | CONDUIT | 0.008                    | 0 06:06                                  | 1.83                        | 0.07                 | 0.11                  |
| C11  | CONDUIT | 0.134                    | 0 05:54                                  | 1.44                        | 1.35                 | 1.00                  |
| C12  | CONDUIT | 0.134                    | 0 05:54                                  | 1.31                        | 1.28                 | 1.00                  |
| C13  | DUMMY   | 0.008                    | 0 06:06                                  |                             |                      |                       |
| C14  | CONDUIT | 0.008                    | 0 06:06                                  | 1.81                        | 2.57                 | 1.00                  |
| C2   | CONDUIT | 0.701                    | 0 06:08                                  | 1.56                        | 0.38                 | 1.00                  |
| C3   | CONDUIT | 2.396                    | 0 05:53                                  | 2.12                        | 0.75                 | 1.00                  |
| C4   | CONDUIT | 7.131                    | 0 05:55                                  | 6.30                        | 2.06                 | 1.00                  |
| C5   | CONDUIT | 0.351                    | 0 05:50                                  | 0.95                        | 0.18                 | 1.00                  |
| C6   | CONDUIT | 0.051                    | 0 06:04                                  | 1.05                        | 1.22                 | 0.75                  |
| C6_1 | CONDUIT | 0.135                    | 0 05:54                                  | 0.59                        | 0.06                 | 0.31                  |
| C6_4 | CONDUIT | 0.132                    | 0 05:55                                  | 0.60                        | 0.06                 | 0.31                  |
| C6_5 | CONDUIT | 0.135                    | 0 05:54                                  | 2.73                        | 0.38                 | 0.35                  |
| C7   | CONDUIT | 0.161                    | 0 06:00                                  | 0.69                        | 0.18                 | 0.47                  |
| C8   | CONDUIT | 0.201                    | 0 06:03                                  | 0.41                        | 0.18                 | 0.74                  |
| C9   | CHANNEL | 4.606                    | 0 05:54                                  | 2.52                        | 0.83                 | 0.93                  |
| OL1  | CONDUIT | 0.471                    | 0 06:01                                  | 0.35                        | 0.70                 | 0.43                  |
| OL2  | DUMMY   | 0.100                    | 0 03:19                                  |                             |                      |                       |
| OL3  | DUMMY   | 0.051                    | 0 06:04                                  |                             |                      |                       |

\*\*\*\*\*  
Flow Classification Summary  
\*\*\*\*\*

| Conduit | Adjusted<br>/Actual<br>Length | Fraction of Time in Flow Class |             |             |             |            |              |             |               |
|---------|-------------------------------|--------------------------------|-------------|-------------|-------------|------------|--------------|-------------|---------------|
|         |                               | Up<br>Dry                      | Down<br>Dry | Sub<br>Crit | Sup<br>Crit | Up<br>Crit | Down<br>Crit | Norm<br>Ltd | Inlet<br>Ctrl |



|      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|
| C1   | 1.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.98 | 0.00 | 0.00 |
| C10  | 1.00 | 0.01 | 0.00 | 0.00 | 0.32 | 0.68 | 0.00 | 0.00 | 0.00 | 0.00 |
| C11  | 1.00 | 0.01 | 0.00 | 0.00 | 0.34 | 0.00 | 0.00 | 0.66 | 0.01 | 0.00 |
| C12  | 1.00 | 0.01 | 0.00 | 0.00 | 0.96 | 0.03 | 0.00 | 0.00 | 0.24 | 0.00 |
| C14  | 1.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 | 0.00 |
| C2   | 1.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.96 | 0.00 | 0.00 |
| C3   | 1.00 | 0.01 | 0.00 | 0.00 | 0.59 | 0.40 | 0.00 | 0.00 | 0.05 | 0.00 |
| C4   | 1.00 | 0.01 | 0.00 | 0.00 | 0.52 | 0.47 | 0.00 | 0.00 | 0.86 | 0.00 |
| C5   | 1.00 | 0.01 | 0.00 | 0.00 | 0.99 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 |
| C6   | 1.00 | 0.01 | 0.00 | 0.00 | 0.95 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 |
| C6_1 | 1.00 | 0.01 | 0.59 | 0.00 | 0.41 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 |
| C6_4 | 1.00 | 0.05 | 0.50 | 0.00 | 0.45 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 |
| C6_5 | 1.00 | 0.01 | 0.00 | 0.00 | 0.62 | 0.37 | 0.00 | 0.00 | 0.85 | 0.00 |
| C7   | 1.00 | 0.01 | 0.05 | 0.00 | 0.94 | 0.00 | 0.00 | 0.00 | 0.38 | 0.00 |
| C8   | 1.00 | 0.01 | 0.00 | 0.00 | 0.99 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 |
| C9   | 1.00 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.60 | 0.00 | 0.00 |
| OL1  | 1.00 | 0.98 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 |

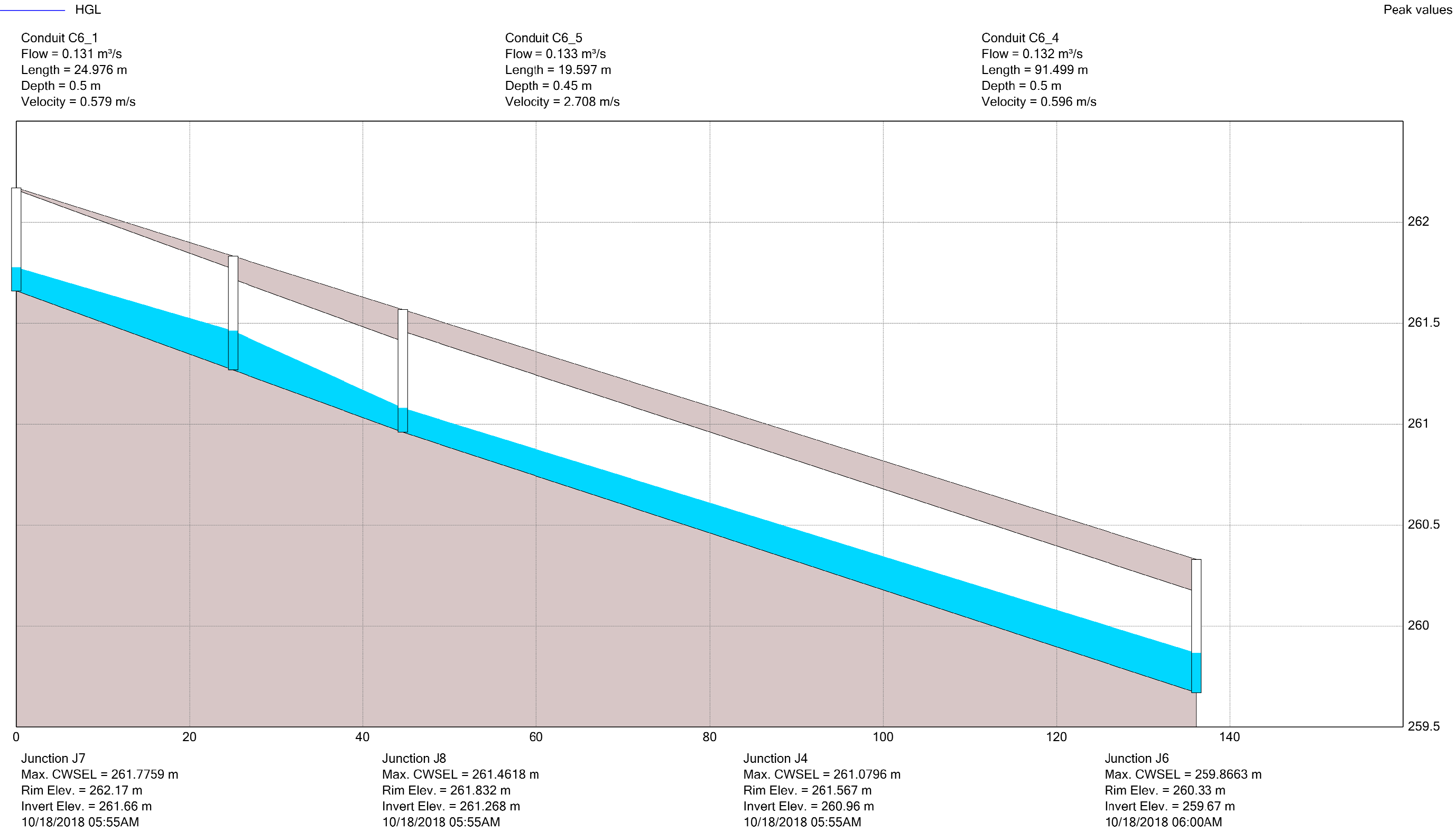
\*\*\*\*\*  
Conduit Surcharge Summary  
\*\*\*\*\*

| Conduit | -----<br>Both Ends | Hours Full<br>Upstream | -----<br>Dnstream | Hours<br>Above Full<br>Normal Flow | Hours<br>Capacity<br>Limited |
|---------|--------------------|------------------------|-------------------|------------------------------------|------------------------------|
| C1      | 1.44               | 2.00                   | 1.44              | 2.17                               | 1.44                         |
| C11     | 0.14               | 0.14                   | 0.20              | 0.17                               | 0.01                         |
| C12     | 0.49               | 0.49                   | 0.55              | 0.13                               | 0.03                         |
| C14     | 1.88               | 2.93                   | 1.88              | 3.31                               | 1.88                         |
| C2      | 0.25               | 0.25                   | 0.32              | 0.01                               | 0.01                         |
| C3      | 0.19               | 0.19                   | 0.31              | 0.01                               | 0.01                         |
| C4      | 0.31               | 0.31                   | 0.34              | 0.35                               | 0.31                         |
| C5      | 0.01               | 0.01                   | 0.25              | 0.01                               | 0.01                         |
| C6      | 0.01               | 0.01                   | 0.01              | 0.33                               | 0.01                         |
| C8      | 0.01               | 0.01                   | 1.76              | 0.01                               | 0.01                         |

Analysis begun on: Fri Apr 24 07:22:26 2020  
Analysis ended on: Fri Apr 24 07:22:30 2020  
Total elapsed time: 00:00:04

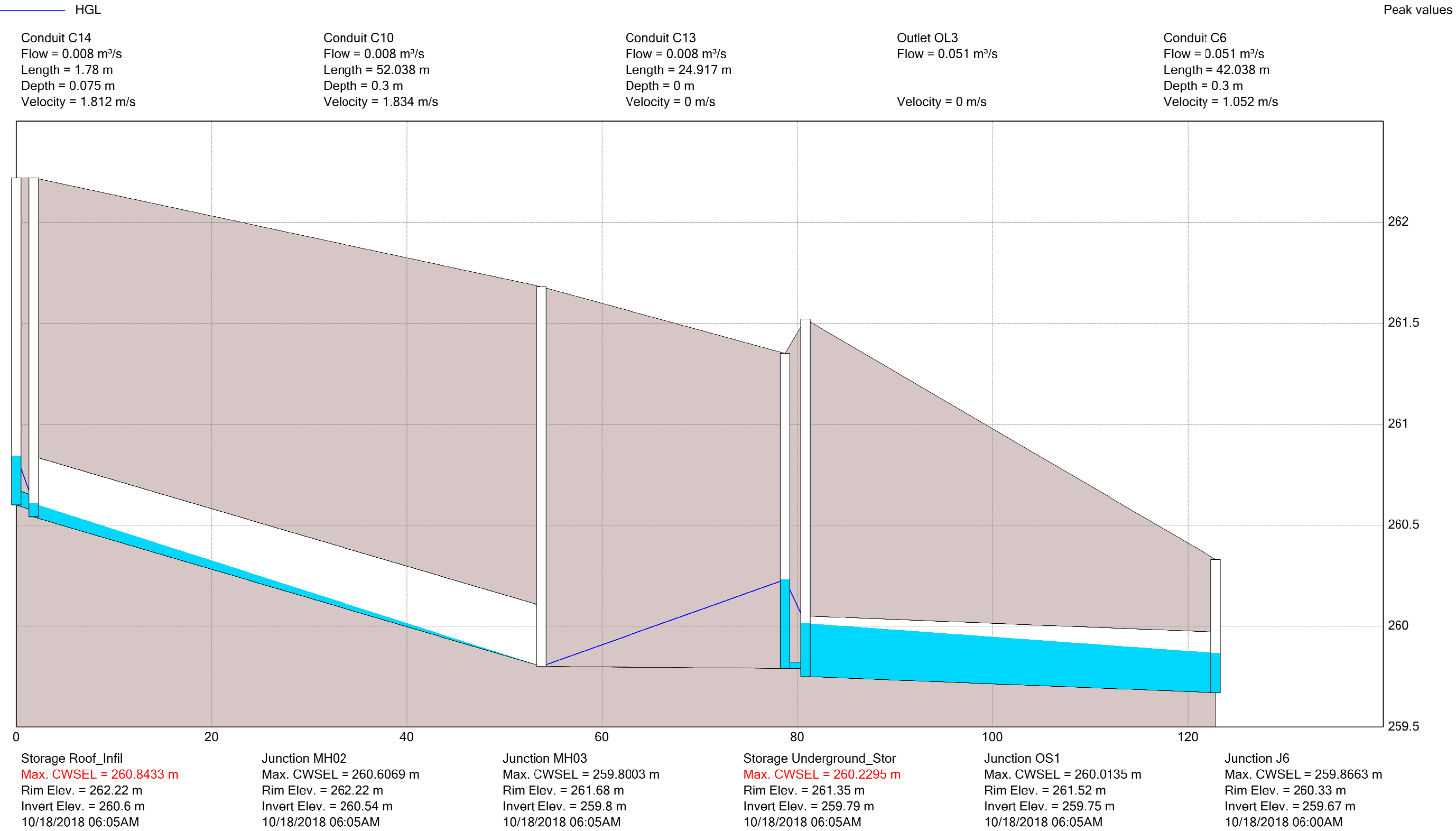
Profile 5 - Post Development Ditch Flow - Huronia Road

100 Year 12 Hr SCS Type II Storm



Profile 4 - Post Development Pipe Flow - 441 Huronia

100 Year 12 Hr SCS Type II Storm



## Appendix F – OGS Information





## Determining Number of Cartridges for Flow Based Systems

Date

4/22/2020

Black Cells = Calculation

### Site Information

Project Name

441 Huronia Road

Project Location

Barrie, ON

OGS ID

Stormfilter

Drainage Area, Ad

0.91 ac (0.3694 ha)

Impervious Area, Ai

0.91 ac

Pervious Area, Ap

0.00

% Impervious

100%

Runoff Coefficient, Rc

0.90

Treatment storm flow rate,  $Q_{treat}$

0.49 cfs (13.85 L/s)

Peak storm flow rate,  $Q_{peak}$

4.59 cfs (130 L/s)

### Filter System

Filtration brand

StormFilter

Cartridge height

18 in

Specific Flow Rate

1.00 gpm/ft<sup>2</sup>

Flow rate per cartridge

7.50 gpm

### SUMMARY

|                      |             |
|----------------------|-------------|
| Number of Cartridges | 30          |
| Media Type           | Phosphosorb |

Event Mean Concentration (EMC)

120 mg/L

Annual TSS Removal

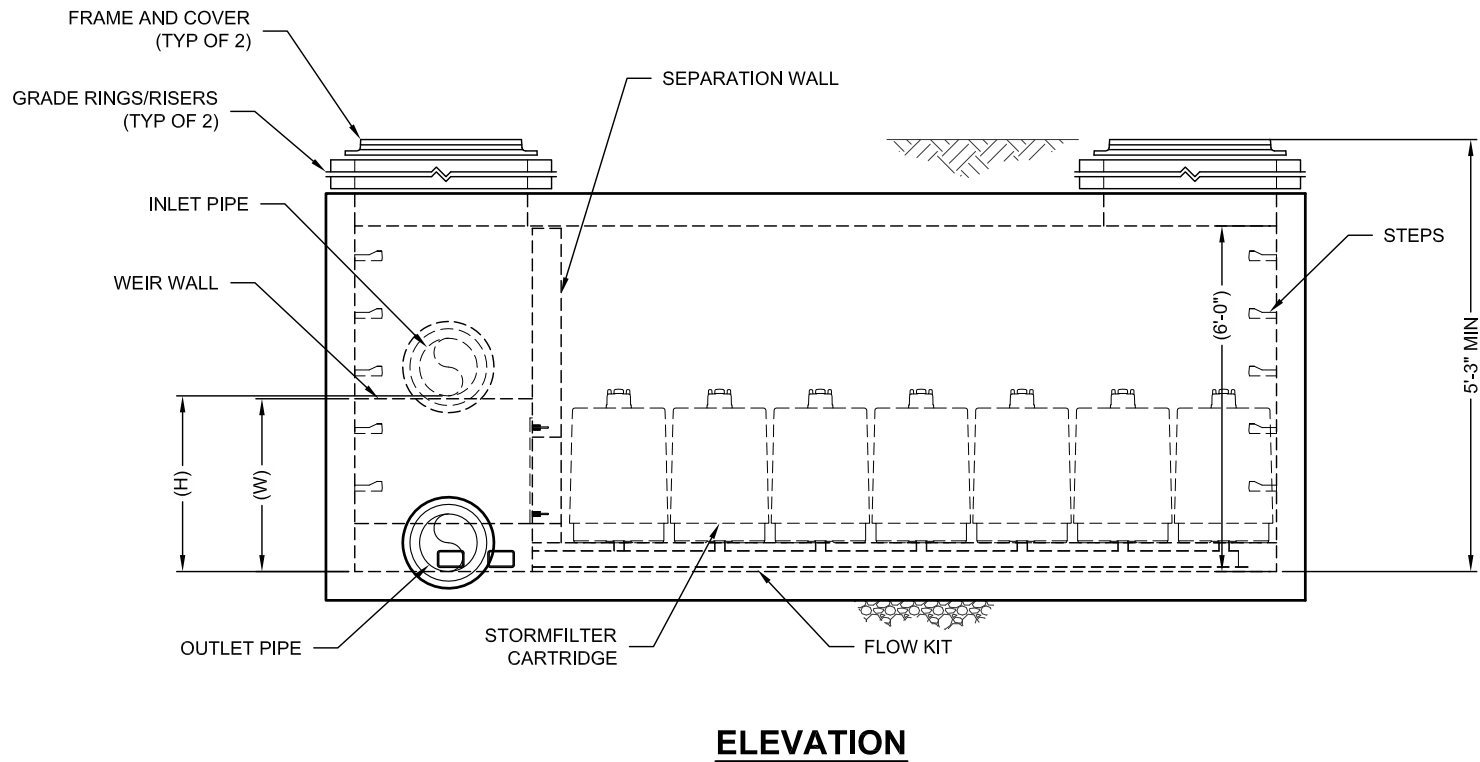
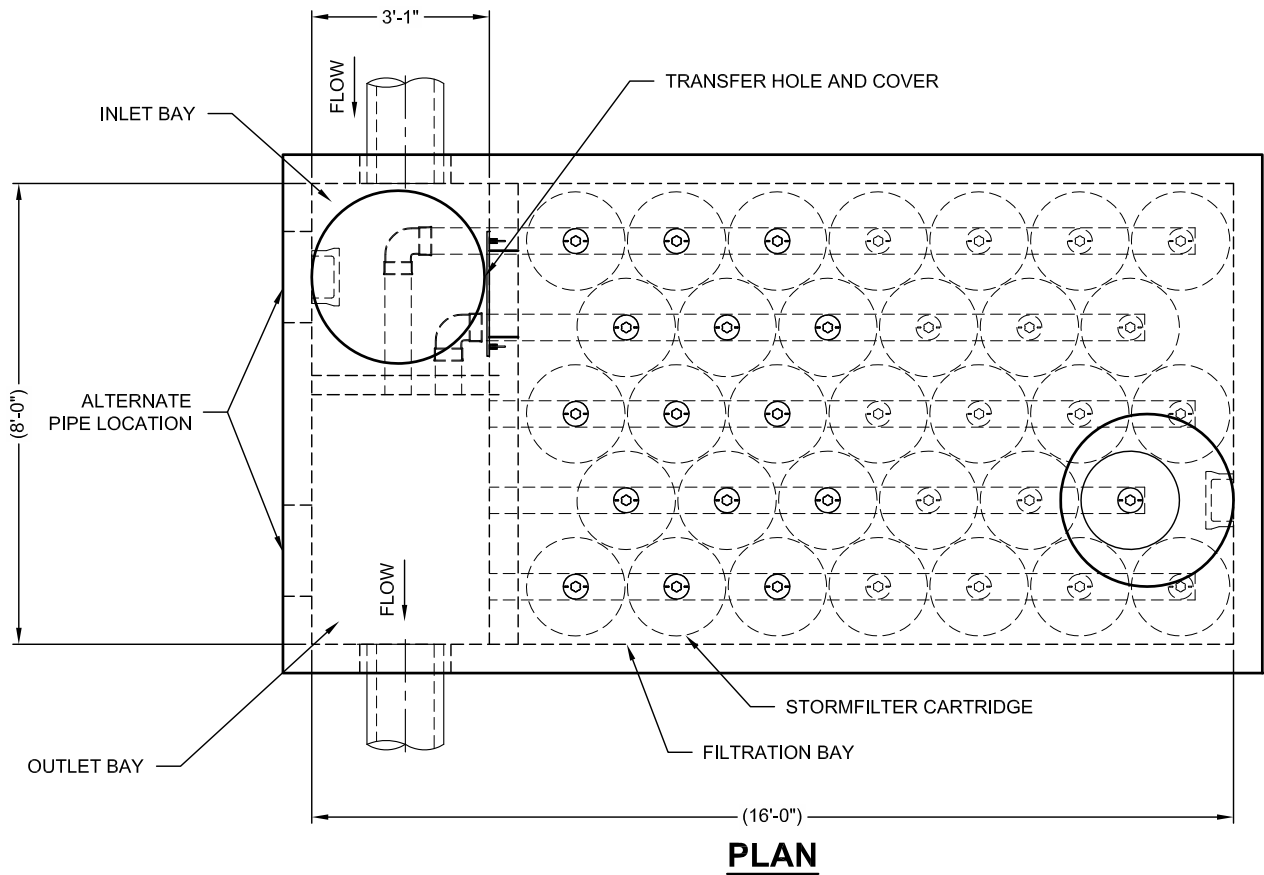
80%

Percent Runoff Capture

90%

Recommend SFPD0816

200 Enterprise Drive  
Scarborough, ME 04074  
Phone 877-907-8676  
Fax 207-885-9825



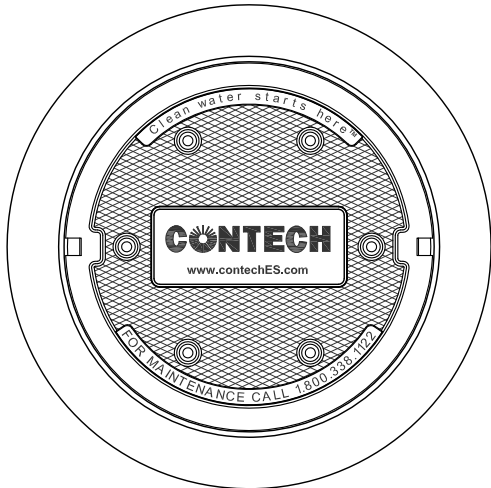
## STORMFILTER DESIGN NOTES

- THE 8' x 16' PEAK DIVERSION STORMFILTER TREATMENT CAPACITY VARIES BY CARTRIDGE COUNT AND LOCALLY APPROVED SURFACE AREA SPECIFIC FLOW RATE. PEAK CONVEYANCE CAPACITY TO BE DETERMINED BY ENGINEER OF RECORD.
- THE PEAK DIVERSION STORMFILTER IS AVAILABLE IN A LEFT INLET (AS SHOWN) OR RIGHT INLET CONFIGURATION.
- ALL PARTS AND INTERNAL ASSEMBLY PROVIDED BY CONTECH UNLESS OTHERWISE NOTED.

### CARTRIDGE SELECTION

| CARTRIDGE HEIGHT               | 27"      |              |          | 18"      |              |          | LOW DROP |              |          |
|--------------------------------|----------|--------------|----------|----------|--------------|----------|----------|--------------|----------|
| RECOMMENDED HYDRAULIC DROP (H) | 3.05'    |              |          | 2.3'     |              |          | 1.8'     |              |          |
| HEIGHT OF WEIR (W)             | 3.00'    |              |          | 2.25'    |              |          | 1.75'    |              |          |
| SPECIFIC FLOW RATE (gpm/sf)    | 2 gpm/sf | 1.67* gpm/sf | 1 gpm/sf | 2 gpm/sf | 1.67* gpm/sf | 1 gpm/sf | 2 gpm/sf | 1.67* gpm/sf | 1 gpm/sf |
| CARTRIDGE FLOW RATE (gpm)      | 22.5     | 18.79        | 11.25    | 15       | 12.53        | 7.5      | 10       | 8.35         | 5        |

\* 1.67 gpm/sf SPECIFIC FLOW RATE IS APPROVED WITH PHOSPHOSORB® (PSORB) MEDIA ONLY



**FRAME AND COVER**  
(DIAMETER VARIES)  
N.T.S.

### SITE SPECIFIC DATA REQUIREMENTS

|                                           |      |          |          |
|-------------------------------------------|------|----------|----------|
| STRUCTURE ID                              |      |          | *        |
| WATER QUALITY FLOW RATE (cfs)             |      |          | *        |
| PEAK FLOW RATE (cfs)                      |      |          | *        |
| RETURN PERIOD OF PEAK FLOW (yrs)          |      |          | *        |
| CARTRIDGE HEIGHT (27", 18", LOW DROP(LD)) |      |          | *        |
| NUMBER OF CARTRIDGES REQUIRED             |      |          | *        |
| CARTRIDGE FLOW RATE                       |      |          | *        |
| MEDIA TYPE (PERLITE, ZPG, PSORB)          |      |          | *        |
|                                           |      |          |          |
| PIPE DATA:                                | I.E. | MATERIAL | DIAMETER |
| INLET PIPE                                | *    | *        | *        |
| OUTLET PIPE                               | *    | *        | *        |
| UPSTREAM RIM ELEVATION                    |      |          | *        |
| DOWNSTREAM RIM ELEVATION                  |      |          | *        |
| ANTI-FLOTATION BALLAST                    |      |          |          |
|                                           |      | WIDTH    | HEIGHT   |
|                                           |      | *        | *        |
| NOTES/SPECIAL REQUIREMENTS:               |      |          |          |
|                                           |      |          |          |
| * PER ENGINEER OF RECORD                  |      |          |          |

### PERFORMANCE SPECIFICATION

FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. **RADIAL MEDIA DEPTH SHALL BE 7-INCHES.** FILTER MEDIA CONTACT TIME SHALL BE AT LEAST **38 SECONDS.** SPECIFIC FLOW RATE SHALL BE **2 GPM/SF (MAXIMUM).** SPECIFIC FLOW RATE IS THE MEASURE OF THE FLOW (GPM) DIVIDED BY THE MEDIA SURFACE CONTACT AREA (SF). MEDIA VOLUMETRIC FLOW RATE SHALL BE **6 GPM/CF OF MEDIA (MAXIMUM).**

### GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH REPRESENTATIVE. [www.contechES.com](http://www.contechES.com)
4. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
5. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 5' AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.

### INSTALLATION NOTES

- A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
- B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE (LIFTING CLUTCHES PROVIDED).
- C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL SECTIONS AND ASSEMBLE STRUCTURE.
- D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH OUTLET PIPE INVERT WITH OUTLET BAY FLOOR.
- E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.
- F. CONTRACTOR TO REMOVE THE TRANSFER HOLE COVER WHEN THE SYSTEM IS BROUGHT ONLINE.

**CONTECH®**  
ENGINEERED SOLUTIONS LLC

[www.contechES.com](http://www.contechES.com)

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800-338-1122 513-645-7000 513-645-7993 FAX

THE STORMWATER MANAGEMENT STORMFILTER  
8' x 16' PEAK DIVERSION STORMFILTER  
STANDARD DETAIL

## The Stormwater Management StormFilter®- PhosphoSorb®

### Field Performance Summary

A three year field performance evaluation of The Stormwater Management StormFilter® (StormFilter) with PhosphoSorb® media operating at a specific flow rate of 1.67 gpm/ft<sup>2</sup> was completed at a 0.06 acre roadway site in Zigzag, Oregon. The Quality Assurance Project Plan (QAPP) for this evaluation followed the Guidance for Evaluating Emerging Stormwater Treatment Technologies: Technology Assessment Protocol – Ecology (TAPE, 2011). The StormFilter with PhosphoSorb Technical Evaluation Report resulted in a General Use Level Designation from Washington State Department of Ecology for Total Suspended Solids (TSS) and Total Phosphorus removal.

Results of the field performance evaluation for 17 qualified events are provided in Table 1.

**Table 1. StormFilter with PhosphoSorb Field Evaluation Results**

|           | Parameter                  | Sample population (n) | Average Influent (mg/L) | Average Effluent (mg/L) | Average Removal (%) | Aggregate Pollutant Load Reduction <sup>1</sup> (%) |
|-----------|----------------------------|-----------------------|-------------------------|-------------------------|---------------------|-----------------------------------------------------|
| Solids    | TSS                        | 17                    | 380                     | 40                      | 88                  | 89                                                  |
|           | SSC<500 µm                 | 15                    | 325                     | 40                      | 87                  | 89                                                  |
|           | Silt and Clay <sup>2</sup> | 16                    | 153                     | 32                      | 78                  | 82                                                  |
| Nutrients | Total Phosphorus           | 17                    | 0.33                    | 0.07                    | 73                  | 82                                                  |
|           | Total Nitrogen             | 17                    | 1.14                    | 0.57                    | 43                  | 50                                                  |
| Metals    | Total Zinc                 | 15                    | 0.129                   | 0.024                   | 78                  | 81                                                  |
|           | Dissolved Zinc             | 7                     | 0.016                   | 0.01                    | 28                  | 32                                                  |
|           | Total Copper               | 15                    | 0.026                   | 0.005                   | 79                  | 82                                                  |
|           | Dissolved Copper           | 7                     | 0.004                   | 0.003                   | 30                  | 28                                                  |
|           | Total Aluminum             | 16                    | 5.85                    | 1.08                    | 83                  | 83                                                  |
|           | Total Lead                 | 15                    | 0.009                   | 0.003                   | 64                  | 70                                                  |

<sup>1</sup> Treatment Efficiency Calculation, Method #2 (TAPE, 2008)

<sup>2</sup> Suspended Solids less than 62.5 microns

#### Load Reduction

89% TSS

82% Total Phosphorus

50% Total Nitrogen

Data were analyzed using the TAPE bootstrap confidence interval calculator for TSS and Total Phosphorus. The lower 95% confidence interval for TSS removal efficiency was 85%. The lower 95% confidence interval for total phosphorus removal efficiency was 67%. The upper 95% confidence interval for total phosphorus effluent concentration was 0.084 mg/L.

Over the entire 37 month evaluation period, the total effluent volume recorded at the site was 376,244 gallons. A total of 14,060 gallons were bypassed through the system accounting for 4% of the total recorded volume. A total of 26 events contained bypass flow, with 23 of those events producing peak flows exceeding the design treatment capacity of the system. The three events with bypass flows occurring below the design treatment capacity triggered maintenance. During the evaluation period, the system lasted between 10 and 12 months between maintenance events and retained an average of 291 pounds of sediment per maintenance event.

**References**

Contech Engineered Solutions, LLC. (2015). The Stormwater Management StormFilter® PhosphoSorb® at a Specific Flow Rate of 1.67 gpm/ft<sup>2</sup> General Use Level Designation Technical Evaluation Report. Portland, OR. Author.

Washington State Department of Ecology (Ecology). (2011). Guidance for Evaluating Emerging Stormwater Treatment Technologies: Technology Assessment Protocol – Ecology (TAPE). Olympia, Washington. (Referred to as TAPE, 2011)

Washington State Department of Ecology (Ecology). (2008). Guidance for Evaluating Emerging Stormwater Treatment Technologies: Technology Assessment Protocol – Ecology (TAPE). Olympia, Washington. (Referred to as TAPE, 2008)



## StormFilter Inspection and Maintenance Procedures



## Maintenance Guidelines

The primary purpose of the Stormwater Management StormFilter® is to filter and prevent pollutants from entering our waterways. Like any effective filtration system, periodically these pollutants must be removed to restore the StormFilter to its full efficiency and effectiveness.

Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site. Maintenance activities may be required in the event of a chemical spill or due to excessive sediment loading from site erosion or extreme storms. It is a good practice to inspect the system after major storm events.

## Maintenance Procedures

Although there are many effective maintenance options, we believe the following procedure to be efficient, using common equipment and existing maintenance protocols. The following two-step procedure is recommended::

### 1. Inspection

- Inspection of the vault interior to determine the need for maintenance.

### 2. Maintenance

- Cartridge replacement
- Sediment removal

## Inspection and Maintenance Timing

At least one scheduled inspection should take place per year with maintenance following as warranted.

First, an inspection should be done before the winter season. During the inspection the need for maintenance should be determined and, if disposal during maintenance will be required, samples of the accumulated sediments and media should be obtained.

Second, if warranted, a maintenance (replacement of the filter cartridges and removal of accumulated sediments) should be performed during periods of dry weather.

In addition to these two activities, it is important to check the condition of the StormFilter unit after major storms for potential damage caused by high flows and for high sediment accumulation that may be caused by localized erosion in the drainage area. It may be necessary to adjust the inspection/maintenance schedule depending on the actual operating conditions encountered by the system. In general, inspection activities can be conducted at any time, and maintenance should occur, if warranted, during dryer months in late summer to early fall.

## Maintenance Frequency

The primary factor for determining frequency of maintenance for the StormFilter is sediment loading.

A properly functioning system will remove solids from water by trapping particulates in the porous structure of the filter media inside the cartridges. The flow through the system will naturally decrease as more and more particulates are trapped. Eventually the flow through the cartridges will be low enough to require replacement. It may be possible to extend the usable span of the cartridges by removing sediment from upstream trapping devices on a routine as-needed basis, in order to prevent material from being re-suspended and discharged to the StormFilter treatment system.

The average maintenance lifecycle is approximately 1-5 years. Site conditions greatly influence maintenance requirements. StormFilter units located in areas with erosion or active construction may need to be inspected and maintained more often than those with fully stabilized surface conditions.

Regulatory requirements or a chemical spill can shift maintenance timing as well. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that develop known problems should be inspected more frequently than areas that demonstrate no problems, particularly after major storms. Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual StormFilter system or site. It is recommended that the site owner develop a database to properly manage StormFilter inspection and maintenance programs..





## Inspection Procedures

The primary goal of an inspection is to assess the condition of the cartridges relative to the level of visual sediment loading as it relates to decreased treatment capacity. It may be desirable to conduct this inspection during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, then typically large amounts of sediments will be present and very little flow will be discharged from the drainage pipes. If this is the case, then maintenance is warranted and the cartridges need to be replaced.

**Warning:** In the case of a spill, the worker should abort inspection activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct an inspection:

**Important:** Inspection should be performed by a person who is familiar with the operation and configuration of the StormFilter treatment unit.

1. If applicable, set up safety equipment to protect and notify surrounding vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system vent.
4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.
5. Be sure to record the level of sediment build-up on the floor of the vault, in the forebay, and on top of the cartridges. If flow is occurring, note the flow of water per drainage pipe. Record all observations. Digital pictures are valuable for historical documentation.
6. Close and fasten the access portals.
7. Remove safety equipment.
8. If appropriate, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.
9. Discuss conditions that suggest maintenance and make decision as to whether or not maintenance is needed.

## Maintenance Decision Tree

The need for maintenance is typically based on results of the inspection. The following Maintenance Decision Tree should be used as a general guide. (Other factors, such as Regulatory Requirements, may need to be considered)

1. Sediment loading on the vault floor.
  - a. If  $>4"$  of accumulated sediment, maintenance is required.
2. Sediment loading on top of the cartridge.
  - a. If  $>1/4"$  of accumulation, maintenance is required.
3. Submerged cartridges.
  - a. If  $>4"$  of static water above cartridge bottom for more than 24 hours after end of rain event, maintenance is required. (Catch basins have standing water in the cartridge bay.)
4. Plugged media.
  - a. If pore space between media granules is absent, maintenance is required.
5. Bypass condition.
  - a. If inspection is conducted during an average rain fall event and StormFilter remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges), maintenance is required.
6. Hazardous material release.
  - a. If hazardous material release (automotive fluids or other) is reported, maintenance is required.
7. Pronounced scum line.
  - a. If pronounced scum line (say  $\geq 1/4"$  thick) is present above top cap, maintenance is required.





## Maintenance

Depending on the configuration of the particular system, maintenance personnel will be required to enter the vault to perform the maintenance.

**Important:** If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. It may be necessary to plug the filter inlet pipe if base flows is occurring.

Replacement cartridges can be delivered to the site or customers facility. Information concerning how to obtain the replacement cartridges is available from Contech Engineered Solutions.

**Warning:** In the case of a spill, the maintenance personnel should abort maintenance activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct cartridge replacement and sediment removal maintenance:

1. If applicable, set up safety equipment to protect maintenance personnel and pedestrians from site hazards.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the doors (access portals) to the vault and allow the system to vent.
4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.
5. Make notes about the external and internal condition of the vault. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.
6. Using appropriate equipment offload the replacement cartridges (up to 150 lbs. each) and set aside.
7. Remove used cartridges from the vault using one of the following methods:

### Method 1:

- A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

Using appropriate hoisting equipment, attach a cable from the boom, crane, or tripod to the loose cartridge. Contact Contech Engineered Solutions for suggested attachment devices.

- B. Remove the used cartridges (up to 250 lbs. each) from the vault.



**Important:** Care must be used to avoid damaging the cartridges during removal and installation. The cost of repairing components damaged during maintenance will be the responsibility of the owner.

- C. Set the used cartridge aside or load onto the hauling truck.
- D. Continue steps a through c until all cartridges have been removed.

### Method 2:

- A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.
- B. Unscrew the cartridge cap.
- C. Remove the cartridge hood and float.
- D. At location under structure access, tip the cartridge on its side.
- E. Empty the cartridge onto the vault floor. Reassemble the empty cartridge.
- F. Set the empty, used cartridge aside or load onto the hauling truck.
- G. Continue steps a through e until all cartridges have been removed.



8. Remove accumulated sediment from the floor of the vault and from the forebay. This can most effectively be accomplished by use of a vacuum truck.
9. Once the sediments are removed, assess the condition of the vault and the condition of the connectors.
10. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Once again, take care not to damage connections.
11. Close and fasten the door.
12. Remove safety equipment.
13. Finally, dispose of the accumulated materials in accordance with applicable regulations. Make arrangements to return the used **empty** cartridges to Contech Engineered Solutions.

## Related Maintenance Activities - Performed on an as-needed basis

StormFilter units are often just one of many structures in a more comprehensive stormwater drainage and treatment system.

In order for maintenance of the StormFilter to be successful, it is imperative that all other components be properly maintained. The maintenance/repair of upstream facilities should be carried out prior to StormFilter maintenance activities.

In addition to considering upstream facilities, it is also important to correct any problems identified in the drainage area. Drainage area concerns may include: erosion problems, heavy oil loading, and discharges of inappropriate materials.

## Material Disposal

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. This typically requires coordination with a local landfill for solid waste disposal. For liquid waste disposal a number of options are available including a municipal vacuum truck decant facility, local waste water treatment plant or on-site treatment and discharge.



# Inspection Report

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_

Location: \_\_\_\_\_ System Size: \_\_\_\_\_ Months in Service: \_\_\_\_\_

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: \_\_\_\_\_

Sediment Thickness in Forebay: \_\_\_\_\_ Date: \_\_\_\_\_

Sediment Depth on Vault Floor: \_\_\_\_\_

Sediment Depth on Cartridge Top(s): \_\_\_\_\_

Structural Damage: \_\_\_\_\_

Estimated Flow from Drainage Pipes (if available): \_\_\_\_\_

Cartridges Submerged: Yes ☐ No ☐ Depth of Standing Water: \_\_\_\_\_

StormFilter Maintenance Activities (check off if done and give description)

☐ Trash and Debris Removal: \_\_\_\_\_

☐ Minor Structural Repairs: \_\_\_\_\_

☐ Drainage Area Report \_\_\_\_\_

Excessive Oil Loading: Yes ☐ No ☐ Source: \_\_\_\_\_

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: \_\_\_\_\_

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: \_\_\_\_\_

Items Needing Further Work: \_\_\_\_\_

Owners should contact the local public works department and inquire about how the department disposes of their street waste residuals.

Other Comments:

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Review the condition reports from the previous inspection visits.

# StormFilter Maintenance Report

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_

Location: \_\_\_\_\_ System Size: \_\_\_\_\_

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: \_\_\_\_\_

List Safety Procedures and Equipment Used: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## System Observations

Months in Service: \_\_\_\_\_

Oil in Forebay (if present): Yes ☐ No ☐

Sediment Depth in Forebay (if present): \_\_\_\_\_

Sediment Depth on Vault Floor: \_\_\_\_\_

Sediment Depth on Cartridge Top(s): \_\_\_\_\_

Structural Damage: \_\_\_\_\_

## Drainage Area Report

Excessive Oil Loading: Yes ☐ No ☐ Source: \_\_\_\_\_

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: \_\_\_\_\_

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: \_\_\_\_\_

## StormFilter Cartridge Replacement Maintenance Activities

Remove Trash and Debris: Yes ☐ No ☐ Details: \_\_\_\_\_

Replace Cartridges: Yes ☐ No ☐ Details: \_\_\_\_\_

Sediment Removed: Yes ☐ No ☐ Details: \_\_\_\_\_

Quantity of Sediment Removed (estimate?): \_\_\_\_\_

Minor Structural Repairs: Yes ☐ No ☐ Details: \_\_\_\_\_

Residuals (debris, sediment) Disposal Methods: \_\_\_\_\_

Notes:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



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800-338-1122

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Contech Engineered Solutions LLC provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, stormwater and earth stabilization products. For information on other Contech division offerings, visit [www.ContechES.com](http://www.ContechES.com) or call 800.338.1122.

#### Support

- Drawings and specifications are available at [www.conteches.com](http://www.conteches.com).
- Site-specific design support is available from our engineers.

NOTHING IN THIS CATALOG SHOULD BE CONSTRUED AS A WARRANTY. APPLICATIONS SUGGESTED HEREIN ARE DESCRIBED ONLY TO HELP READERS MAKE THEIR OWN EVALUATIONS AND DECISIONS, AND ARE NEITHER GUARANTEES NOR WARRANTIES OF SUITABILITY FOR ANY APPLICATION. CONTECH MAKES NO WARRANTY WHATSOEVER, EXPRESS OR IMPLIED, RELATED TO THE APPLICATIONS, MATERIALS, COATINGS, OR PRODUCTS DISCUSSED HEREIN. ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND ALL IMPLIED WARRANTIES OF FITNESS FOR ANY PARTICULAR PURPOSE ARE DISCLAIMED BY CONTECH. SEE CONTECH'S CONDITIONS OF SALE (AVAILABLE AT [WWW.CONTECHES.COM/COS](http://WWW.CONTECHES.COM/COS)) FOR MORE INFORMATION.



## The Stormwater Management StormFilter®- PhosphoSorb®

### Field Performance Summary

A three year field performance evaluation of The Stormwater Management StormFilter® (StormFilter) with PhosphoSorb® media operating at a specific flow rate of 1.67 gpm/ft<sup>2</sup> was completed at a 0.06 acre roadway site in Zigzag, Oregon. The Quality Assurance Project Plan (QAPP) for this evaluation followed the Guidance for Evaluating Emerging Stormwater Treatment Technologies: Technology Assessment Protocol – Ecology (TAPE, 2011). The StormFilter with PhosphoSorb Technical Evaluation Report resulted in a General Use Level Designation from Washington State Department of Ecology for Total Suspended Solids (TSS) and Total Phosphorus removal.

Results of the field performance evaluation for 17 qualified events are provided in Table 1.

**Table 1. StormFilter with PhosphoSorb Field Evaluation Results**

|           | Parameter                  | Sample population (n) | Average Influent (mg/L) | Average Effluent (mg/L) | Average Removal (%) | Aggregate Pollutant Load Reduction <sup>1</sup> (%) |
|-----------|----------------------------|-----------------------|-------------------------|-------------------------|---------------------|-----------------------------------------------------|
| Solids    | TSS                        | 17                    | 380                     | 40                      | 88                  | 89                                                  |
|           | SSC<500 µm                 | 15                    | 325                     | 40                      | 87                  | 89                                                  |
|           | Silt and Clay <sup>2</sup> | 16                    | 153                     | 32                      | 78                  | 82                                                  |
| Nutrients | Total Phosphorus           | 17                    | 0.33                    | 0.07                    | 73                  | 82                                                  |
|           | Total Nitrogen             | 17                    | 1.14                    | 0.57                    | 43                  | 50                                                  |
| Metals    | Total Zinc                 | 15                    | 0.129                   | 0.024                   | 78                  | 81                                                  |
|           | Dissolved Zinc             | 7                     | 0.016                   | 0.01                    | 28                  | 32                                                  |
|           | Total Copper               | 15                    | 0.026                   | 0.005                   | 79                  | 82                                                  |
|           | Dissolved Copper           | 7                     | 0.004                   | 0.003                   | 30                  | 28                                                  |
|           | Total Aluminum             | 16                    | 5.85                    | 1.08                    | 83                  | 83                                                  |
|           | Total Lead                 | 15                    | 0.009                   | 0.003                   | 64                  | 70                                                  |

<sup>1</sup> Treatment Efficiency Calculation, Method #2 (TAPE, 2008)

<sup>2</sup> Suspended Solids less than 62.5 microns

#### Load Reduction

**89% TSS**

**82% Total Phosphorus**

**50% Total Nitrogen**

Data were analyzed using the TAPE bootstrap confidence interval calculator for TSS and Total Phosphorus. The lower 95% confidence interval for TSS removal efficiency was 85%. The lower 95% confidence interval for total phosphorus removal efficiency was 67%. The upper 95% confidence interval for total phosphorus effluent concentration was 0.084 mg/L.

Over the entire 37 month evaluation period, the total effluent volume recorded at the site was 376,244 gallons. A total of 14,060 gallons were bypassed through the system accounting for 4% of the total recorded volume. A total of 26 events contained bypass flow, with 23 of those events producing peak flows exceeding the design treatment capacity of the system. The three events with bypass flows occurring below the design treatment capacity triggered maintenance. During the evaluation period, the system lasted between 10 and 12 months between maintenance events and retained an average of 291 pounds of sediment per maintenance event.

**References**

Contech Engineered Solutions, LLC. (2015). The Stormwater Management StormFilter® PhosphoSorb® at a Specific Flow Rate of 1.67 gpm/ft<sup>2</sup> General Use Level Designation Technical Evaluation Report. Portland, OR. Author.

Washington State Department of Ecology (Ecology). (2011). Guidance for Evaluating Emerging Stormwater Treatment Technologies: Technology Assessment Protocol – Ecology (TAPE). Olympia, Washington. (Referred to as TAPE, 2011)

Washington State Department of Ecology (Ecology). (2008). Guidance for Evaluating Emerging Stormwater Treatment Technologies: Technology Assessment Protocol – Ecology (TAPE). Olympia, Washington. (Referred to as TAPE, 2008)



## Determining Number of Cartridges for Flow Based Systems

Date

4/22/2020

Black Cells = Calculation

### Site Information

Project Name

441 Huronia Road

Project Location

Barrie, ON

OGS ID

Stormfilter

Drainage Area, Ad

0.91 ac (0.3694 ha)

Impervious Area, Ai

0.91 ac

Pervious Area, Ap

0.00

% Impervious

100%

Runoff Coefficient, Rc

0.90

Treatment storm flow rate,  $Q_{treat}$

0.49 cfs (13.85 L/s)

Peak storm flow rate,  $Q_{peak}$

4.59 cfs (130 L/s)

### Filter System

Filtration brand

StormFilter

Cartridge height

18 in

Specific Flow Rate

1.00 gpm/ft<sup>2</sup>

Flow rate per cartridge

7.50 gpm

### SUMMARY

|                      |             |
|----------------------|-------------|
| Number of Cartridges | 30          |
| Media Type           | Phosphosorb |

Event Mean Concentration (EMC)

120 mg/L

Annual TSS Removal

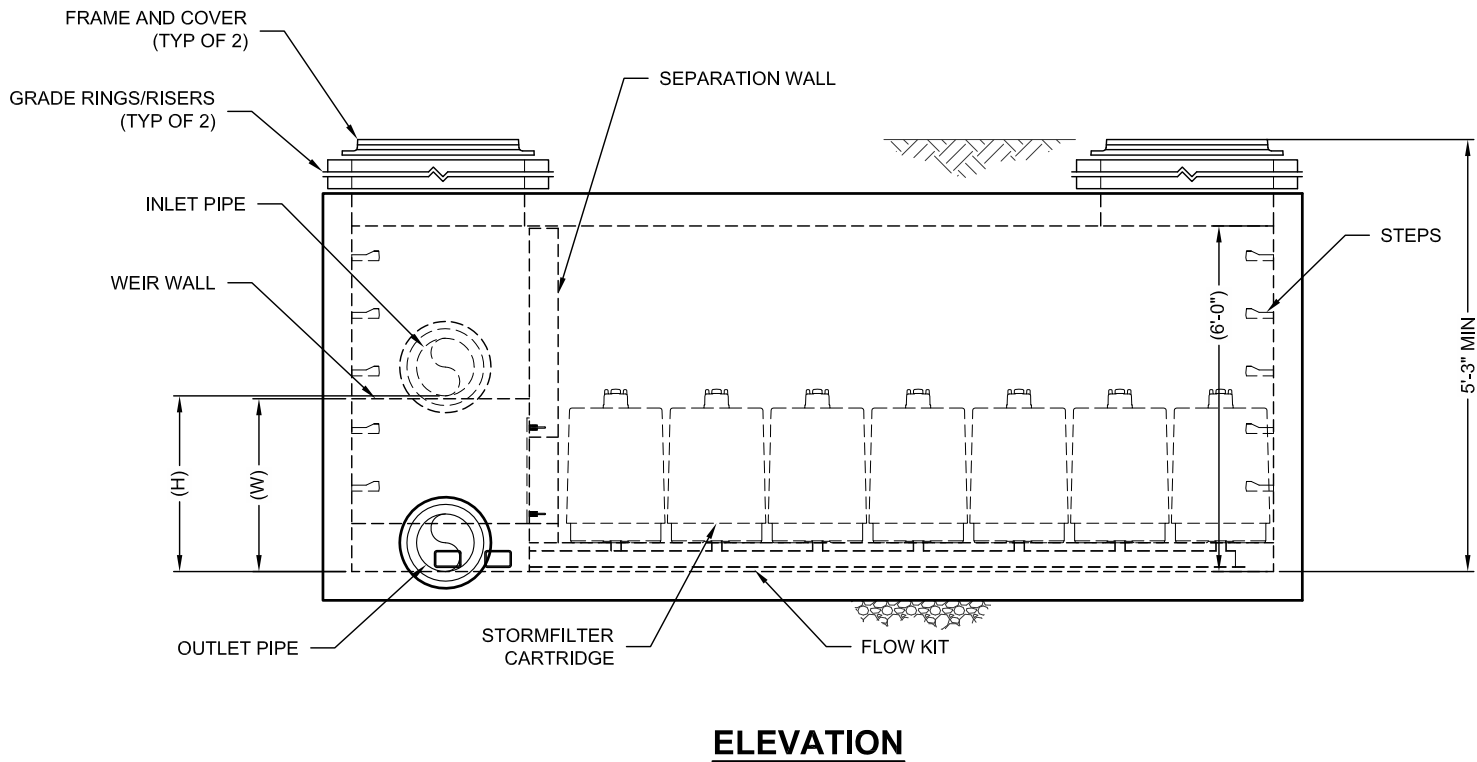
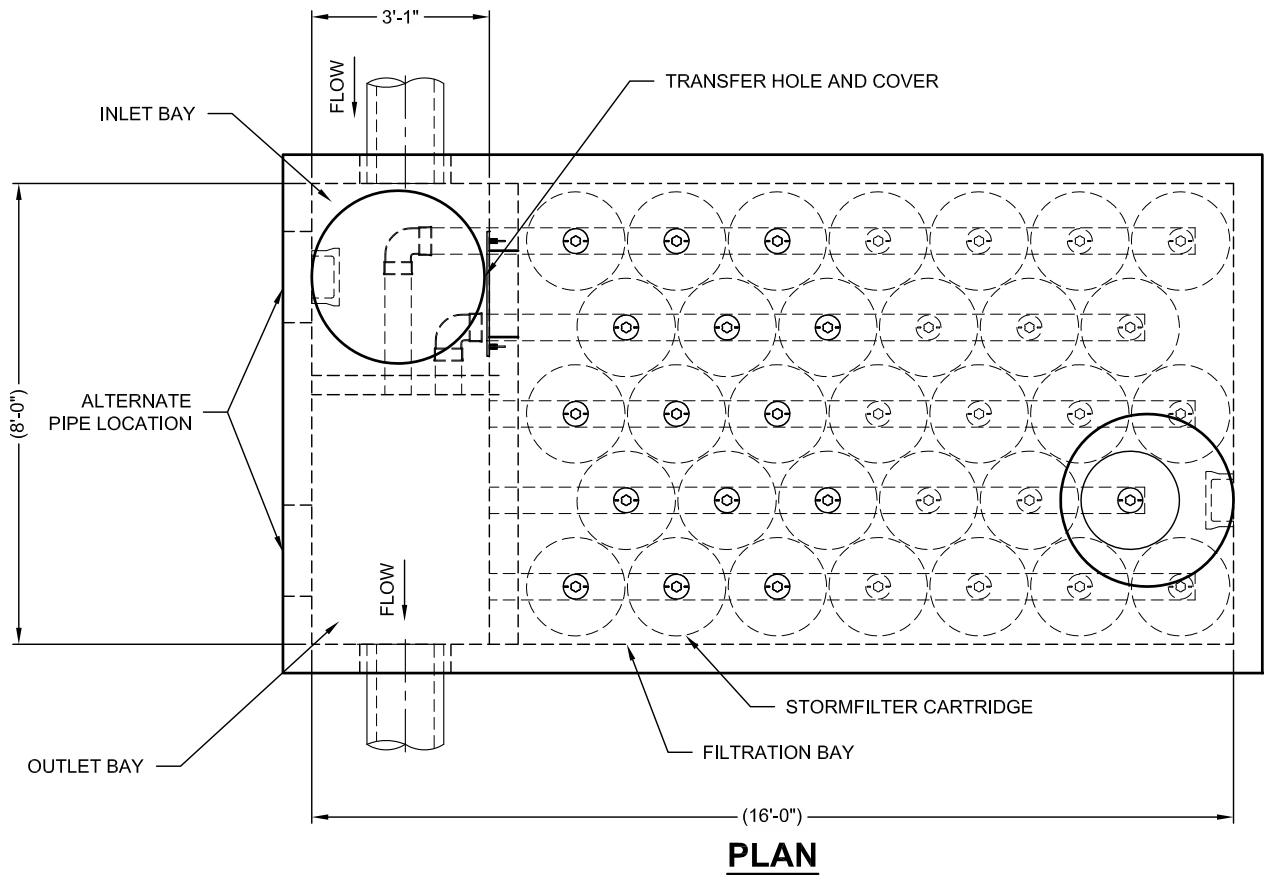
80%

Percent Runoff Capture

90%

Recommend SFPD0816

200 Enterprise Drive  
Scarborough, ME 04074  
Phone 877-907-8676  
Fax 207-885-9825



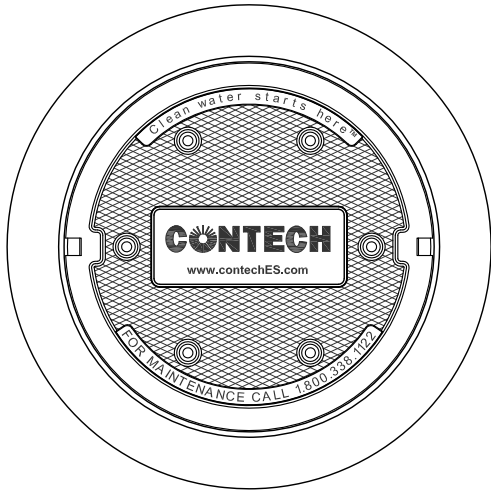
## STORMFILTER DESIGN NOTES

- THE 8' x 16' PEAK DIVERSION STORMFILTER TREATMENT CAPACITY VARIES BY CARTRIDGE COUNT AND LOCALLY APPROVED SURFACE AREA SPECIFIC FLOW RATE. PEAK CONVEYANCE CAPACITY TO BE DETERMINED BY ENGINEER OF RECORD.
- THE PEAK DIVERSION STORMFILTER IS AVAILABLE IN A LEFT INLET (AS SHOWN) OR RIGHT INLET CONFIGURATION.
- ALL PARTS AND INTERNAL ASSEMBLY PROVIDED BY CONTECH UNLESS OTHERWISE NOTED.

### CARTRIDGE SELECTION

| CARTRIDGE HEIGHT               | 27"      |              |          | 18"      |              |          | LOW DROP |              |          |
|--------------------------------|----------|--------------|----------|----------|--------------|----------|----------|--------------|----------|
| RECOMMENDED HYDRAULIC DROP (H) | 3.05'    |              |          | 2.3'     |              |          | 1.8'     |              |          |
| HEIGHT OF WEIR (W)             | 3.00'    |              |          | 2.25'    |              |          | 1.75'    |              |          |
| SPECIFIC FLOW RATE (gpm/sf)    | 2 gpm/sf | 1.67* gpm/sf | 1 gpm/sf | 2 gpm/sf | 1.67* gpm/sf | 1 gpm/sf | 2 gpm/sf | 1.67* gpm/sf | 1 gpm/sf |
| CARTRIDGE FLOW RATE (gpm)      | 22.5     | 18.79        | 11.25    | 15       | 12.53        | 7.5      | 10       | 8.35         | 5        |

\* 1.67 gpm/sf SPECIFIC FLOW RATE IS APPROVED WITH PHOSPHOSORB® (PSORB) MEDIA ONLY



**FRAME AND COVER**  
(DIAMETER VARIES)  
N.T.S.

### SITE SPECIFIC DATA REQUIREMENTS

|                                           |       |          |          |
|-------------------------------------------|-------|----------|----------|
| STRUCTURE ID                              |       |          | *        |
| WATER QUALITY FLOW RATE (cfs)             |       |          | *        |
| PEAK FLOW RATE (cfs)                      |       |          | *        |
| RETURN PERIOD OF PEAK FLOW (yrs)          |       |          | *        |
| CARTRIDGE HEIGHT (27", 18", LOW DROP(LD)) |       |          | *        |
| NUMBER OF CARTRIDGES REQUIRED             |       |          | *        |
| CARTRIDGE FLOW RATE                       |       |          | *        |
| MEDIA TYPE (PERLITE, ZPG, PSORB)          |       |          | *        |
|                                           |       |          |          |
| PIPE DATA:                                | I.E.  | MATERIAL | DIAMETER |
| INLET PIPE                                | *     | *        | *        |
| OUTLET PIPE                               | *     | *        | *        |
| UPSTREAM RIM ELEVATION                    |       |          | *        |
| DOWNSTREAM RIM ELEVATION                  |       |          | *        |
|                                           |       |          |          |
| ANTI-FLOTATION BALLAST                    | WIDTH | HEIGHT   |          |
|                                           | *     | *        |          |
| NOTES/SPECIAL REQUIREMENTS:               |       |          |          |
|                                           |       |          |          |
| * PER ENGINEER OF RECORD                  |       |          |          |

### PERFORMANCE SPECIFICATION

FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. **RADIAL MEDIA DEPTH SHALL BE 7-INCHES.** FILTER MEDIA CONTACT TIME SHALL BE AT LEAST **38 SECONDS.** SPECIFIC FLOW RATE SHALL BE **2 GPM/SF (MAXIMUM).** SPECIFIC FLOW RATE IS THE MEASURE OF THE FLOW (GPM) DIVIDED BY THE MEDIA SURFACE CONTACT AREA (SF). MEDIA VOLUMETRIC FLOW RATE SHALL BE **6 GPM/CF OF MEDIA (MAXIMUM).**

### GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH REPRESENTATIVE. [www.contechES.com](http://www.contechES.com)
4. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
5. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 5' AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.

### INSTALLATION NOTES

- A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
- B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE (LIFTING CLUTCHES PROVIDED).
- C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL SECTIONS AND ASSEMBLE STRUCTURE.
- D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH OUTLET PIPE INVERT WITH OUTLET BAY FLOOR.
- E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.
- F. CONTRACTOR TO REMOVE THE TRANSFER HOLE COVER WHEN THE SYSTEM IS BROUGHT ONLINE.

**CONTECH®**  
ENGINEERED SOLUTIONS LLC

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800-338-1122 513-645-7000 513-645-7993 FAX

THE STORMWATER MANAGEMENT STORMFILTER  
8' x 16' PEAK DIVERSION STORMFILTER  
STANDARD DETAIL



THE PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING:  
U.S. PATENTS: 5,322,229; 5,344,492; 5,757,071; 5,846,185; 6,022,433; 6,049,040;  
RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.



# VERIFICATION STATEMENT

## GLOBE Performance Solutions

Verifies the performance of

### The Stormwater Management StormFilter®

Developed by CONTECH Engineered Solutions LLC  
Scarborough, Maine, USA

Registration: GPS-ETV\_2020-06-15\_NJDEP

In accordance with

**ISO 14034:2016**

**Environmental Management —  
Environmental Technology Verification (ETV)**



John D. Wiebe, PhD  
Executive Chairman  
GLOBE Performance Solutions

June 15, 2020  
Vancouver, BC, Canada



Verification Body  
GLOBE Performance Solutions  
404 – 999 Canada Place | Vancouver, B.C | Canada | V6C 3E2

Verification Statement – CONTECH Engineered Solutions LLC – The Stormwater Management StormFilter®

Registration: GPS-ETV\_2020-06-15\_NJDEP

Page 1 of 7

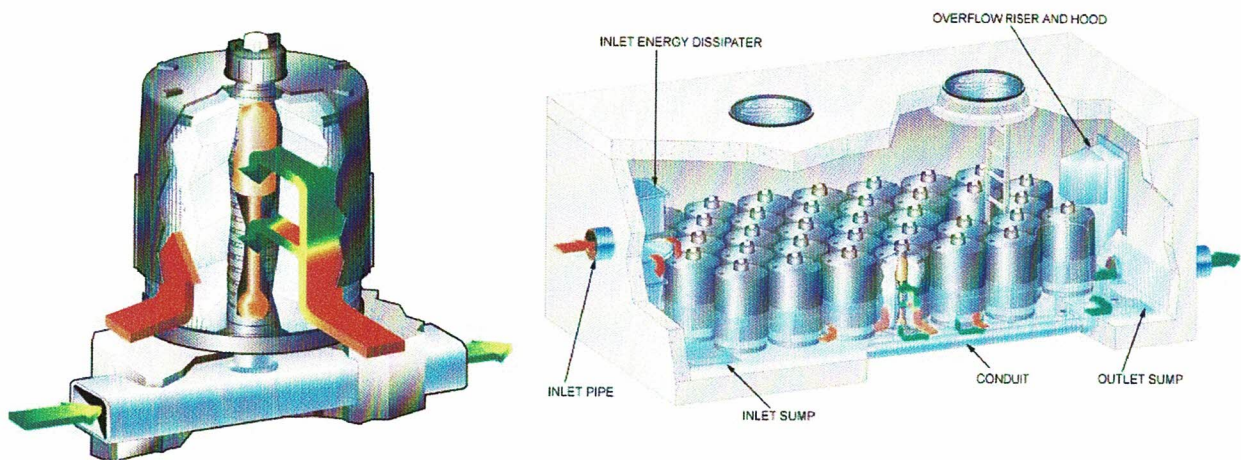


## Verification Overview

This Environmental Technology Verification (ETV) of The Stormwater Management StormFilter® (StormFilter) is the first part of a two-part verification process and entails the verification of performance claims (#1 & 2) based on laboratory testing in accordance with the New Jersey Department of Environmental Protection (NJDEP) *Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device* (January, 2013). This verification complements the subsequent verification of field testing data, collected in accordance with The Washington State Department of Ecology emerging stormwater treatment technologies, in accordance with guidelines identified by Ecology (2011) in the Technology Assessment Protocol – Ecology (TAPE).

## Technology description and application

The Stormwater Management StormFilter® (StormFilter) is a manufactured treatment device that is provided by Contech Engineered Solutions LLC (Contech). The StormFilter improves the quality of stormwater runoff before it enters receiving waterways through the use of its customizable filter media, which removes non-point source pollutants. As illustrated in **Figure 1**, the StormFilter is typically comprised of a vault or manhole structure that houses rechargeable, media-filled filter cartridges. Stormwater entering the system percolates through these media-filled cartridges, which trap particulates and remove pollutants. Once filtered through the media, the treated stormwater is discharged through an outlet pipe to a storm sewer system or receiving water.



**Figure 1 Individual StormFilter Cartridge (Left) and Typical Vault StormFilter Installation (Right)**

Depending on the treatment requirements and expected pollutant characteristics at an individual site, the per cartridge filtration flow rate and driving head can be adjusted. The flow rate is individually controlled for each cartridge by a restrictor disc located at the connection point between the cartridge and the underdrain manifold. Driving head is managed by positioning of the inlet, outlet, and overflow elevations. The StormFilter is typically designed so that the restrictor disc passes the design treatment rate once the water surface reaches the shoulder of the cartridge which is equivalent to the cartridge height. Since the StormFilter uses a restrictor disc to restrict treatment flows below the hydraulic capacity of the media



the system typically operates under consistent driving head for the useful life of the media. Site specific head constraints are also addressed by three different cartridge heights (low drop (effective height of 12 inches), 18, and 27 inches) which operate on the same principal and surface area specific loading rates. The StormFilter requires a minimum of 1.8 ft, 2.3 ft and 3.05 ft of drop between inlet invert and outlet invert to accommodate the low drop, 18 and 27 inch cartridges, respectively, without backing up flow into the upstream piping during operation. When site conditions limit the amount of drop available across the StormFilter then flow is typically backed up into the upstream piping during operation to ensure sufficient driving head is provided. If desirable the StormFilter can be designed to operate under additional driving head.

The StormFilter is offered in multiple configurations including plastic, steel, and concrete catch basins; and precast concrete manholes, and vaults. Other configurations include panel vaults, CON/SPAN®, box culverts, and curb inlets. The filter cartridges operate consistently and act independently regardless of housing which enables linear scaling.

The StormFilter cartridge can house different types of media including perlite, zeolite, granular activated carbon (GAC), CSF® leaf media, MetalRx™, PhosphoSorb® or various media blends such as ZPG™ (perlite, zeolite and GAC). All of the media use processes associated with depth filtration to remove solids. Some media configurations also provide additional treatment mechanisms such as cation exchange, and/or adsorption, chelation, and precipitation. This verification is specific to a laboratory evaluation of the StormFilter using perlite media.

## Performance conditions

The data and results published in this Verification Statement were obtained from the laboratory testing conducted on The Stormwater Management StormFilter® device, in accordance with the New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (January, 2013) (NJDEP Filtration Protocol). Prior to starting the performance testing program, a quality assurance project plan (QAPP) was submitted to and approved by the New Jersey Corporation for Advanced Technology (NJCAT).

## Performance claim(s)

### Performance Claim 1 (NJCAT)

The Stormwater Management StormFilter®, with perlite media, demonstrated at least 80% removal of total suspended solids at a design hydraulic loading rate of 1.44 l/s/m<sup>2</sup> (2.12 gpm/ft<sup>2</sup>) of media surface area and at a constant influent test sediment concentration of 200 mg/L in laboratory testing conducted under the 2013 NJDEP Protocol (removal efficiency test). This performance claim was verified at a 95% level of confidence.

### Performance Claim 2 (NJCAT)

During the load testing (mass sediment load capacity) conducted under the 2013 NJDEP Protocol, The Stormwater Management StormFilter®, with perlite media, maintained at least 80% removal of total suspended solids at a design hydraulic loading rate of 1.44 l/s/m<sup>2</sup> (2.12 gpm/ft<sup>2</sup>) of media surface area to a cumulative mass sediment load of 54.3 lbs by a single 45.72 cm tall and 18in cartridge. This performance claim was verified statistically at a 95% level of confidence.

## Performance results

### Performance Claim I (NJCAT):

Raw data summarizing the percent removal of influent total suspended solids (TSS) by The Stormwater Management StormFilter®, at a concentration of 200 mg/L and a loading rate of 2.12 gpm/sq. ft. of media surface area.

| Run # | Average Influent TSS<br>Concentration<br>(mg/L) | Background<br>(mg/L) | Adjusted<br>Effluent<br>(mg/L) | TSS Removed (%) |
|-------|-------------------------------------------------|----------------------|--------------------------------|-----------------|
| 1     | 203                                             | 2.11                 | 37.7                           | 81.8            |
| 2     | 210                                             | 1.83                 | 35.4                           | 83.7            |
| 3     | 207                                             | 2.84                 | 40.5                           | 81.2            |
| 4     | 213                                             | 2.04                 | 36.8                           | 83.3            |
| 5     | 212                                             | 2.17                 | 35.8                           | 83.7            |
| 6     | 208                                             | 2.34                 | 38.0                           | 82.3            |
| 7     | 212                                             | 2.08                 | 38.4                           | 82.5            |
| 8     | 203                                             | 2.42                 | 35.8                           | 83.0            |
| 9     | 206                                             | 2.86                 | 35.2                           | 83.5            |
| 10    | 207                                             | 3.16                 | 35.6                           | 83.3            |

|                   |       |
|-------------------|-------|
| Sum               | 823   |
| N (COUNT)         | 10    |
| Mean (AVG)        | 82.3  |
| STDEV.s           | 0.871 |
| VAR.s             | 0.758 |
| Z (alpha)         | 1.65  |
| Z (beta)          | 1.29  |
| Hypothesized mean | 80.0  |



**Performance Claim 2 (NJCAT):**

Raw data summarizing the percent removal of influent total suspended solids (TSS) and its capture by The Stormwater Management StormFilter®, at 200 mg/L (Run 1-45) and 400mg/L (Run 46-66).

| Run # | Average Influent TSS Concentration (mg/L) | Background (mg/L) | Adjusted Effluent (mg/L) | Mass Captured (lbs) | TSS Removed (%) |
|-------|-------------------------------------------|-------------------|--------------------------|---------------------|-----------------|
| 1     | 203                                       | 2.11              | 37.7                     | 0.640               | 81.8            |
| 2     | 210                                       | 1.83              | 35.4                     | 1.32                | 83.7            |
| 3     | 207                                       | 2.84              | 40.5                     | 1.96                | 81.2            |
| 4     | 213                                       | 2.04              | 36.8                     | 2.65                | 83.3            |
| 5     | 212                                       | 2.17              | 35.8                     | 3.33                | 83.7            |
| 6     | 208                                       | 2.34              | 38.0                     | 3.99                | 82.3            |
| 7     | 212                                       | 2.08              | 38.4                     | 4.67                | 82.5            |
| 8     | 203                                       | 2.42              | 35.8                     | 5.32                | 83.0            |
| 9     | 206                                       | 2.86              | 35.2                     | 5.98                | 83.5            |
| 10    | 207                                       | 3.16              | 35.6                     | 6.65                | 83.3            |
| 11    | 200                                       | 1.78              | 37.4                     | 7.29                | 81.8            |
| 12    | 209                                       | 1.55              | 36.0                     | 7.96                | 83.4            |
| 13    | 211                                       | 2.29              | 40.9                     | 8.62                | 81.3            |
| 14    | 206                                       | 1.96              | 37.7                     | 9.21                | excluded        |
| 15    | 209                                       | 2.32              | 36.2                     | 9.87                | 83.2            |
| 16    | 202                                       | 2.07              | 36.5                     | 10.5                | 82.6            |
| 17    | 206                                       | 1.97              | 39.9                     | 11.2                | 81.3            |
| 18    | 203                                       | 3.13              | 35.1                     | 11.8                | 83.2            |
| 19    | 204                                       | 2.57              | 37.2                     | 12.5                | 82.4            |
| 20    | 210                                       | 2.64              | 35.6                     | 13.1                | 83.6            |
| 21    | 199                                       | 3.17              | 39.8                     | 13.8                | 80.7            |
| 22    | 206                                       | 3.07              | 40.5                     | 14.4                | 80.9            |
| 23    | 203                                       | 3.32              | 37.1                     | 15.1                | 82.3            |
| 24    | 206                                       | 2.91              | 38.5                     | 15.7                | 81.8            |
| 25    | 203                                       | 3.44              | 37.4                     | 16.3                | 82.1            |
| 26    | 204                                       | 2.77              | 40.4                     | 17.0                | 80.8            |
| 27    | 208                                       | 2.85              | 29.4                     | 17.6                | excluded        |
| 28    | 199                                       | 2.46              | 37.7                     | 18.2                | 81.5            |
| 29    | 199                                       | 3.72              | 37.6                     | 18.8                | 81.6            |
| 30    | 202                                       | 3.66              | 37.6                     | 19.5                | 82.0            |
| 31    | 200                                       | 3.41              | 42.4                     | 20.1                | 79.3            |
| 32    | 202                                       | 3.17              | 43.4                     | 20.7                | 79.1            |
| 33    | 204                                       | 4.52              | 42.5                     | 21.3                | 79.8            |
| 34    | 200                                       | 5.11              | 40.0                     | 22.0                | 80.6            |
| 35    | 198                                       | 4.11              | 44.4                     | 22.5                | 78.1            |
| 36    | 204                                       | 3.90              | 43.1                     | 23.2                | 79.5            |
| 37    | 203                                       | 4.55              | 43.1                     | 23.8                | 79.4            |
| 38    | 202                                       | 4.84              | 41.4                     | 24.4                | 80.0            |
| 39    | 203                                       | 5.55              | 34.8                     | 25.1                | 83.3            |
| 40    | 203                                       | 6.34              | 39.9                     | 25.7                | 80.9            |
| 41    | 199                                       | 3.53              | 43.3                     | 26.3                | 78.7            |
| 42    | 199                                       | 3.21              | 45.1                     | 26.9                | 77.9            |
| 43    | 200                                       | 3.21              | 40.9                     | 27.5                | 80.1            |

|                            |             |      |      |      |          |
|----------------------------|-------------|------|------|------|----------|
| 44                         | 203         | 3.41 | 40.0 | 28.2 | 80.9     |
| 45                         | 202         | 3.61 | 46.6 | 28.8 | 77.4     |
| 46                         | 401         | 1.78 | 79.2 | 30.0 | 80.8     |
| 47                         | 402         | 1.91 | 81.6 | 31.3 | 80.2     |
| 48                         | 401         | 2.38 | 85.6 | 32.5 | 79.2     |
| 49                         | 396         | 2.83 | 87.0 | 33.7 | 78.5     |
| 50                         | 412         | 1.62 | 85.5 | 35.0 | 79.6     |
| 51                         | 396         | 3.66 | 87.6 | 36.2 | 78.3     |
| 52                         | 396         | 4.12 | 90.1 | 37.3 | 77.6     |
| 53                         | 403         | 4.05 | 92.4 | 38.5 | 77.4     |
| 54                         | 403         | 4.85 | 89.9 | 39.8 | 78.1     |
| 55                         | 400         | 3.59 | 86.3 | 41.0 | 78.8     |
| 56                         | 400         | 1.85 | 89.0 | 42.2 | 78.2     |
| 57                         | 403         | 2.33 | 88.7 | 43.4 | 78.5     |
| 58                         | 407         | 3.25 | 89.6 | 44.6 | 78.2     |
| 59                         | 395         | 3.22 | 92.5 | 45.8 | 76.9     |
| 60                         | 404         | 3.01 | 88.2 | 47.0 | 78.5     |
| 61                         | 410         | 1.82 | 90.7 | 48.2 | excluded |
| 62                         | 398         | 2.15 | 86.6 | 49.4 | 78.6     |
| 63                         | 401         | 2.60 | 88.1 | 50.6 | 78.3     |
| 64                         | 402         | 2.75 | 91.5 | 51.9 | 77.6     |
| 65                         | 403         | 4.10 | 89.1 | 53.1 | 78.2     |
| 66                         | 402         | 3.65 | 89.5 | 54.3 | 77.8     |
| <b>Sum</b>                 | <b>5069</b> |      |      |      |          |
| <b>N (COUNT)</b>           | <b>63</b>   |      |      |      |          |
| <b>Median</b>              | <b>80.7</b> |      |      |      |          |
| <b>STDEV.s</b>             | <b>2.03</b> |      |      |      |          |
| <b>VAR.s</b>               | <b>4.12</b> |      |      |      |          |
| <b>Z (alpha)</b>           | <b>1.65</b> |      |      |      |          |
| <b>Z (beta)</b>            | <b>1.29</b> |      |      |      |          |
| <b>Hypothesized median</b> | <b>80.0</b> |      |      |      |          |

Performance Claims were statistically analyzed and verified using the *mean* percent removal values for Claim #1, which utilized normally distributed data. The data set for Claims #2 was not normally distributed, which required the use of the *median* of the data as a surrogate for the mean, in order to be verified statistically at a 95% level of confidence.



## Verification

This verification was completed by the Verification Expert, the Centre for Advancement of Water and Wastewater Technologies (“CAWT”), contracted by GLOBE Performance Solutions, applying the International Standard **ISO 14034:2016 Environmental management – Environmental technology verification (ETV)**. Data and information provided by Contech Engineered Solutions LLC to support the performance claim included the following:

- Performance test report “NJCAT TECHNOLOGY VERIFICATION, Stormwater Management StormFilter® (StormFilter) With Perlite Media” prepared by Contech Engineered Solutions, November 2016. This report is based on a test program was conducted at Contech’s Portland, Oregon laboratory under the direct supervision of *Scott A. Wells, Ph.D. and Associates* in accordance with the New Jersey Department of Environmental Protection (NJDEP) *Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (January, 2013)* and in compliance with the requirements of ISO/IEC 17025.

## What is ISO 14034:2016 Environmental management – Environmental technology verification (ETV)?

ISO 14034:2016 specifies principles, procedures and requirements for environmental technology verification (ETV) and was developed and published by the International Organization for Standardization (ISO). The objective of ETV is to provide credible, reliable and independent verification of the performance of environmental technologies. An environmental technology is a technology that either results in an environmental added value or measures parameters that indicate an environmental impact. Such technologies have an increasingly important role in addressing environmental challenges and achieving sustainable development.

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### **Limitation of verification - Registration: GPS-ETV\_2020-06-15\_NJDEP**

GLOBE Performance Solutions and the Verification Expert provide the verification services solely on the basis of the information supplied by the applicant or vendor and assume no liability thereafter. The responsibility for the information supplied remains solely with the applicant or vendor and the liability for the purchase, installation, and operation (whether consequential or otherwise) is not transferred to any other party as a result of the verification.

# **NJCAT TECHNOLOGY VERIFICATION**

**Stormwater Management StormFilter<sup>®</sup>  
(StormFilter) With Perlite Media**

**Contech Engineered Solutions LLC**

**November, 2016**



## TABLE OF CONTENTS

|                                                           |     |
|-----------------------------------------------------------|-----|
| List of Figures.....                                      | iii |
| List of Tables.....                                       | iv  |
| 1. Description of Technology.....                         | 1   |
| 2. Laboratory Testing.....                                | 2   |
| 2.1 Test Setup.....                                       | 2   |
| 2.2 Test Sediment.....                                    | 4   |
| 2.3 Removal Efficiency Testing Procedure.....             | 5   |
| 2.4 Sediment Mass Loading Capacity Testing Procedure..... | 8   |
| 2.5 Scour Testing.....                                    | 8   |
| 3. Performance Claims.....                                | 8   |
| 4. Supporting Documentation.....                          | 10  |
| 4.1 Test Sediment PSD Analysis.....                       | 10  |
| 4.2 Removal Efficiency (RE) Testing.....                  | 11  |
| Test Water Flow Rate, Temperature and Driving Head.....   | 11  |
| Sediment Feed Rate and Influent Concentration.....        | 12  |
| Drawdown Sampling and Duration.....                       | 13  |
| Background, Effluent and Drawdown TSS.....                | 14  |
| Removal Efficiency (RE) Results.....                      | 15  |
| 4.3 Sediment Mass Loading Capacity.....                   | 16  |
| Test Water Flow Rate, Temperature and Driving Head.....   | 16  |
| Sediment Feed Rate and Influent Concentration.....        | 18  |
| Drawdown Sampling and Duration.....                       | 20  |
| Background, Effluent and Drawdown TSS.....                | 22  |
| Mass Loading Results.....                                 | 24  |
| 4.4 Excluded Results.....                                 | 27  |
| 5. Design Limitations.....                                | 27  |
| 6. Maintenance.....                                       | 29  |

|    |                            |    |
|----|----------------------------|----|
| 7. | Statements.....            | 35 |
| 8. | References.....            | 40 |
|    | Verification Appendix..... | 41 |

## List of Figures

|                                                                                                              | Page |
|--------------------------------------------------------------------------------------------------------------|------|
| Figure 1 Individual StormFilter Cartridge and Typical Vault StormFilter Installation...                      | 1    |
| Figure 2 Graphic of StormFilter Test Apparatus.....                                                          | 3    |
| Figure 3 Schematic of StormFilter Laboratory Test Setup .....                                                | 4    |
| Figure 4 Comparison of Contech Test Sediment to NJDEP PSD Specification.....                                 | 11   |
| Figure 5 Average Removal Efficiency (by mass) and Trial Removal Efficiency vs. Sediment<br>Mass Loading..... | 26   |
| Figure 6 Maximum Driving Head vs. Sediment Mass Loading.....                                                 | 26   |
| Figure 7 Average Flow Rate vs. Sediment Mass Loading .....                                                   | 27   |

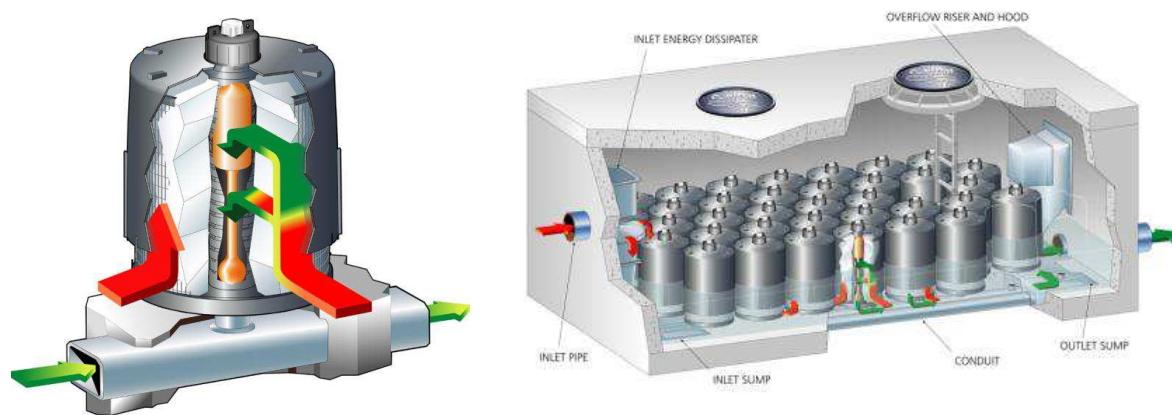
## List of Tables

|                                                                                          | <b>Page</b> |
|------------------------------------------------------------------------------------------|-------------|
| Table 1 Test Run Sampling Plan.....                                                      | 6           |
| Table 2 Water Surface Elevation and Temperature Sampling Times.....                      | 7           |
| Table 3 Sediment Particle Size Distribution Analysis on Contech Test Sediment.....       | 10          |
| Table 4 Removal Efficiency Water Flow Rate, Temperature and Driving Head .....           | 12          |
| Table 5 Removal Efficiency Sediment Feed Rate and Influent Concentration .....           | 13          |
| Table 6 Removal Efficiency Testing Drawdown Duration and Drawdown Sampling<br>Times..... | 14          |
| Table 7 Removal Efficiency Background, Effluent and Drawdown TSS .....                   | 15          |
| Table 8 Removal Efficiency Results.....                                                  | 16          |
| Table 9 Sediment Mass Loading Trial Flow Rate, Temperature and Driving Head ....         | 17          |
| Table 10 Sediment Mass Loading Sediment Feed Rate and Influent Concentration ....        | 19          |
| Table 11 Sediment Mass Loading Drawdown Sampling Times.....                              | 21          |
| Table 12 Sediment Mass Loading Background, Effluent and Drawdown TSS.....                | 22          |
| Table 13 Sediment Mass Loading Results .....                                             | 24          |
| Table A-1 Common StormFilter Model Sizes and New Jersey Treatment Capacities ....        | 44          |
| Table A-2 StormFilter Cartridge Heights and New Jersey Treatment Capacities .....        | 45          |



## 1. Description of Technology

The Stormwater Management StormFilter® (StormFilter) is a manufactured treatment device that is provided by Contech Engineered Solutions LLC (Contech). The StormFilter improves the quality of stormwater runoff before it enters receiving waterways through the use of its customizable filter media, which removes non-point source pollutants. As illustrated in **Figure 1**, the StormFilter is typically comprised of a vault or manhole structure that houses rechargeable, media-filled filter cartridges. Stormwater entering the system percolates through these media-filled cartridges, which trap particulates and remove pollutants. Once filtered through the media, the treated stormwater is discharged through an outlet pipe to a storm sewer system or receiving water.



**Figure 1 Individual StormFilter Cartridge (Left) and Typical Vault StormFilter Installation (Right)**

Depending on the treatment requirements and expected pollutant characteristics at an individual site, the per cartridge filtration flow rate and driving head can be adjusted. The flow rate is individually controlled for each cartridge by a restrictor disc located at the connection point between the cartridge and the underdrain manifold. Driving head is managed by positioning of the inlet, outlet, and overflow elevations. The StormFilter is typically designed so that the restrictor disc passes the design treatment rate once the water surface reaches the shoulder of the cartridge which is equivalent to the cartridge height. Since the StormFilter uses a restrictor disc to restrict treatment flows below the hydraulic capacity of the media the system typically operates under consistent driving head for the useful life of the media. Site specific head constraints are also addressed by three different cartridge heights (low drop (effective height of 12 inches), 18, and 27 inches) which operate on the same principal and surface area specific loading rates. The StormFilter requires a minimum of 1.8 ft, 2.3 ft and 3.05 ft of drop between inlet invert and outlet invert to accommodate the low drop, 18 and 27 inch cartridges, respectively, without backing up flow into the upstream piping during operation. When site conditions limit the amount of drop available across the StormFilter then flow is typically backed up into the upstream piping during operation to ensure sufficient driving head is provided. If desirable the StormFilter can be designed to operate under additional driving head.

The StormFilter is offered in multiple configurations including plastic, steel, and concrete catch basins; and precast concrete manholes, and vaults. Other configurations include panel vaults, CON/SPAN<sup>®</sup>, box culverts, and curb inlets. The filter cartridges operate consistently and act independently regardless of housing which enables linear scaling.

The StormFilter cartridge can house different types of media including perlite, zeolite, granular activated carbon (GAC), CSF<sup>®</sup> leaf media, MetalRx<sup>™</sup>, PhosphoSorb<sup>®</sup> or various media blends such as ZPG<sup>™</sup> (perlite, zeolite and GAC). All of the media use processes associated with depth filtration to remove solids. Some media configurations also provide additional treatment mechanisms such as cation exchange, and/or adsorption, chelation, and precipitation. This verification is specific to perlite media.

## **2. Laboratory Testing**

The test program was conducted at Contech's Portland, Oregon laboratory under the direct supervision of Scott A. Wells, Ph.D. and Associates. Scott A. Wells and Associates provide environmental consulting services focusing on water quality and hydrodynamic models of hydraulic structures, rivers, reservoirs, and estuary systems. All particle size distribution (PSD) analysis and all water quality samples collected during this testing process were analyzed by Apex Labs, 12232 S.W. Garden Place, Tigard, OR 97223, an independent analytical testing facility.

Laboratory testing was done in accordance with the New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (January, 2013) (NJDEP Filtration Protocol). Prior to starting the performance testing program, a quality assurance project plan (QAPP) was submitted to and approved by the New Jersey Corporation for Advanced Technology (NJCAT).

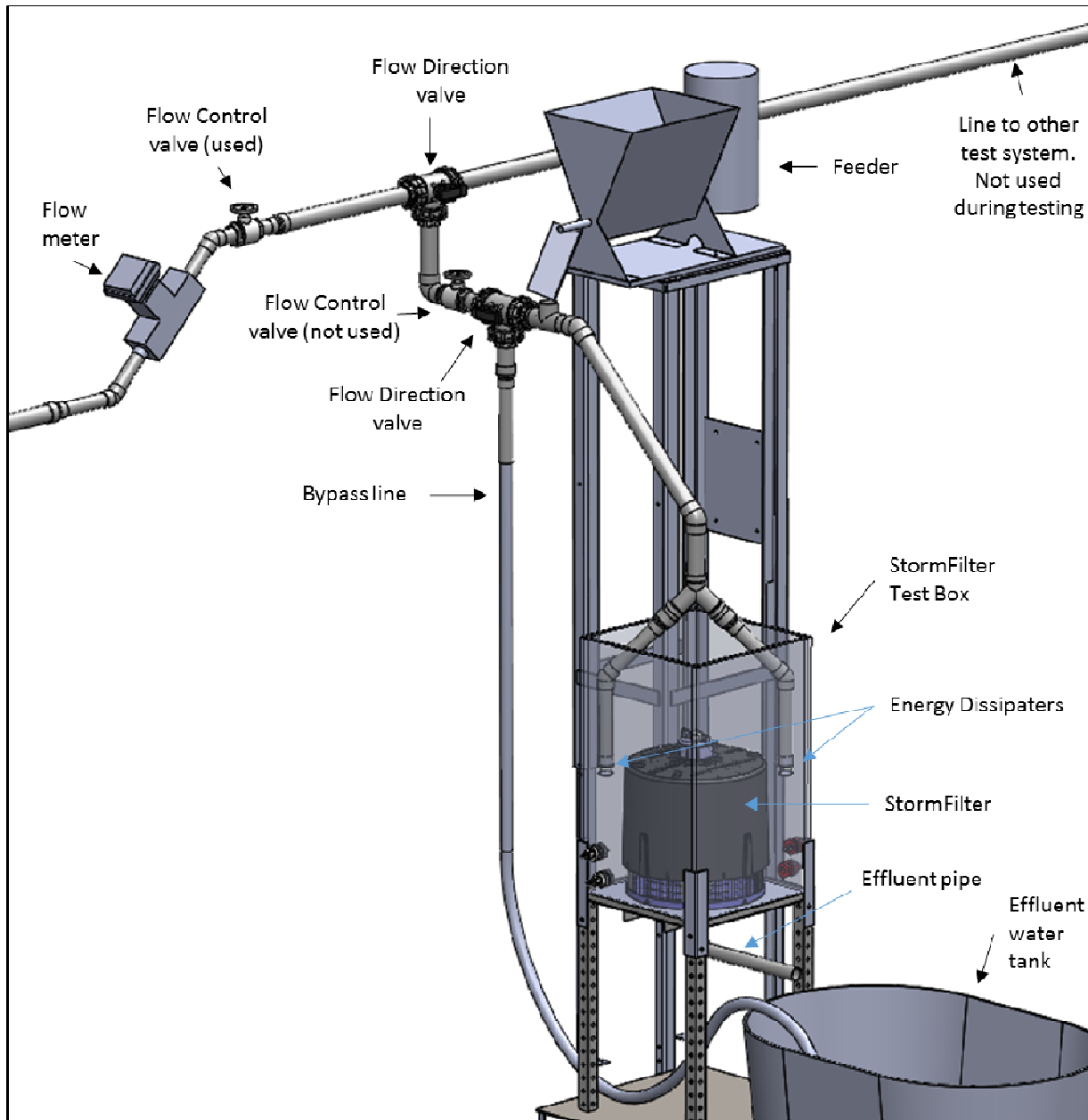
### **2.1 Test Setup**

The laboratory test used a full-scale, 18-inch StormFilter cartridge filled with perlite media that was installed in a test tank in a manner consistent with commercial installations and meeting the criteria established in the NJDEP Filtration Protocol. An illustration of the test apparatus is shown in **Figure 2**. The test tank floor dimension is 3 ft<sup>2</sup>, which is equivalent to the least amount of floor surface area per cartridge in a typical commercial installation.

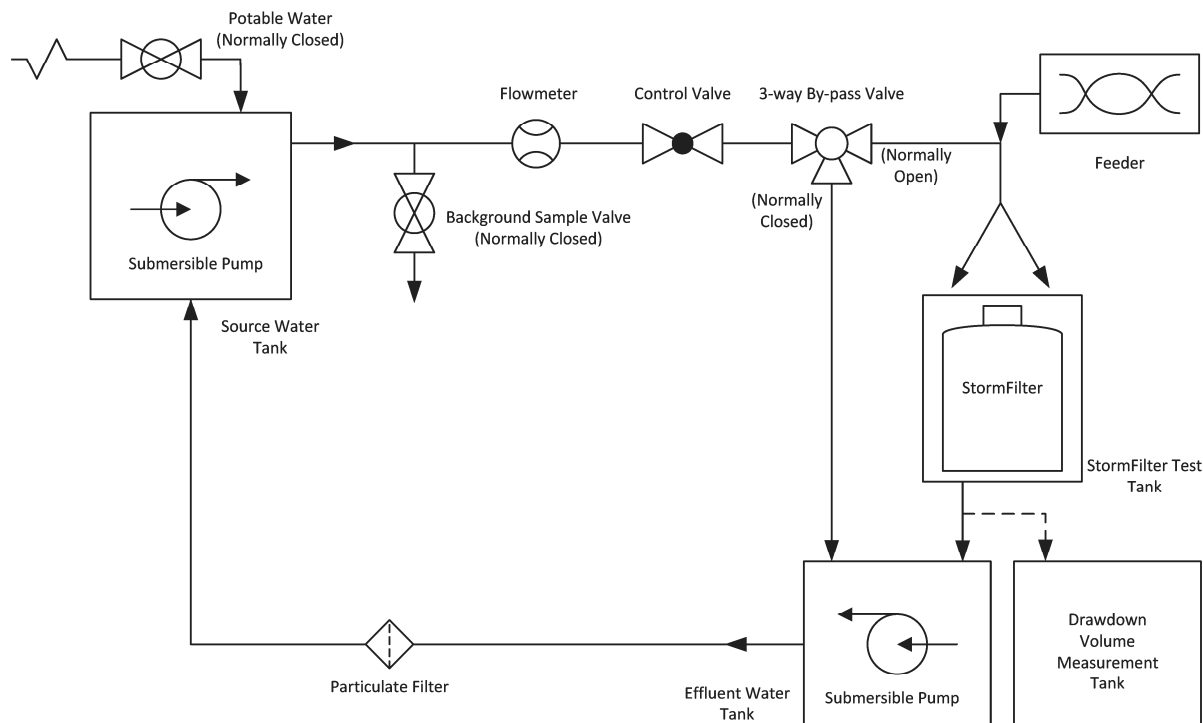
A Zoeller M76 submersible pump delivered water from a source water storage tank to the test unit through PVC piping that included energy dissipation at the points of discharge to deliver water to the test tank in a manner consistent with commercial installations. The flow rate was controlled with a globe valve and monitored with a Seametrics EX810P flow meter and a Seametrics FT420 flow computer, and FlowInspector software. Sediment was dry-fed from a hopper and auger assembly (Acrison 170-M15) through a 2-inch diameter port located upstream of the test unit.

Effluent from the StormFilter was directed into an effluent water tank equipped with a submersible pump. The effluent passed through a particulate filter before being recycled back to

the source water tank (see **Figure 3**). As needed, potable water was brought into the source water tank to supply make-up water.



**Figure 2 Graphic of StormFilter Test Apparatus**



**Figure 3 Schematic of StormFilter Laboratory Test Setup**

## 2.2 Test Sediment

Sediment used for solids removal efficiency testing was high-purity silica ( $\text{SiO}_2$  99.8%) material with a PSD consisting of approximately 55% sand, 40% silt, and 5% clay. A large batch of sediment meeting the NJDEP Filtration Protocol PSD criteria was purchased and stored in 50 lb. bags. Three of the 50 lb. bags were set aside and utilized for this testing. The sediment PSD in the three bags was verified by a randomized sample collection routine. First, the bags of sediment were mixed by rolling the bags several times both end over end in both directions on the laboratory floor. Each bag had a numbered six-section grid overlaid on it. The Microsoft Excel randomizer function was used to select one grid section from each bag. A subsample (three level tablespoons) was selected from the appropriate section of each bag. The subsamples were mixed together to create one sample. The grid section selection and subsample collection was repeated two more times for a total of three composite samples which were submitted for PSD analyses. Finally, after completion of the PSD sampling process the bags were then mixed into a single container and set aside for the verification testing.

The three composite PSD samples were sent to Apex Labs for PSD analysis in accordance with ASTM D422-63 (reapproved 2007). The mean of the three PSD samples was calculated and plotted as a single representative PSD curve. This representative curve is plotted alongside the “Test Sediment PSD” curve specified in section 5, subsection B of the NJDEP Filtration Protocol in Section 4.1. Sediment sampling for PSD analysis was conducted in-house with oversight from Scott Wells, Ph.D. and Associates.



## 2.3 Removal Efficiency Testing Procedure

Removal efficiency (RE) testing was performed at a target influent sediment concentration of 200 mg/L ( $\pm 10\%$ ). The StormFilter was tested at a maximum treatment flow rate (MTFR) of 15 gallons per minute (gpm) which for the 18" cartridge is equivalent to a surface area specific loading rate of 2.12 gpm/ft<sup>2</sup> of filter media surface area. Three water temperature readings were taken per trial to verify the water did not exceed 80 degrees Fahrenheit.

Removal efficiency testing was carried out according to the "Effluent Grab Sampling Method," as described in section 5G of the NJDEP Filtration Protocol. Prior to each test, the flow rate was stabilized while being routed through a bypass line. Once the flow rate was stabilized, the bypass valve was turned to direct flow to the test tank, and feeding of the dry sediment commenced, initiating the testing procedure. The feeder delivered sediment into the flow stream at a rate calculated to yield a target concentration of 200 mg/L ( $\pm 10\%$ ).

Sediment feed rate, background, effluent, and drawdown samples were collected via grab sampling, see **Table 1**. Three sediment feed samples were collected per trial including one sample at the start of dosing, one in the middle of the trial and one toward the end of dosing to allow for 3 residence times to pass before drawdown began. Sediment feed rate samples were collected from the injection point using a clean container and collected for one minute.

Background water quality samples were collected from a 1/4 inch valved sample port (**Figure 3**) in the water supply line located upstream of the test sediment injection point. Background samples were taken in correspondence with the odd-numbered effluent samples (first, third, and fifth).

Five effluent water quality samples were collected during each test run by sampling the free outflow from the discharge pipe. The first effluent sample collection time was scheduled at 7 minutes and the four subsequent effluent samples were scheduled at 6 to 7 minute intervals thereafter. Once the test sediment feed was diverted for measurement, the next effluent sample was collected after a minimum of three detention times had passed. During the first removal efficiency test run (test 1), 7 drawdown samples were collected spanning the entire drawdown time. The two samples collected nearest the correct evenly-spaced drawdown times were sent to Apex lab for TSS analysis and the remaining 5 samples were discarded. Once the appropriate drawdown sample times had been established using the total drawdown time from the first test those same sample times were applied to subsequent test runs. To address changing drawdown times as sediment accumulated in the test box, actual drawdown time data collected from each test was used to predict the drawdown sampling times for the following test. Tests and drawdown were considered complete when the effluent flow slowed to a drip, allowing the next test to begin. Although not included in the total drawdown volume, it is estimated that less than 1 liter of water remains in the test tank after test completion.

The drawdown volume was determined by diverting the effluent to a calibrated drawdown capture tank at the same time the influent was shut off. As the influent flow was shut off, a 4-inch PVC open pipe channel was placed under the effluent pipe to direct the discharge to the drawdown capture tank. Drawdown samples were collected by moving the diversion pipe aside

and capturing the effluent directly in the sample container. After the test was completed, the volume drained from the system was measured and used in the removal efficiency calculation.

**Table 1 Test Run Sampling Plan**

| Scheduled Time (min:sec) | Sample or Reading  |              |                |              | Additional Actions                                                                                        |
|--------------------------|--------------------|--------------|----------------|--------------|-----------------------------------------------------------------------------------------------------------|
|                          | Sediment Feed Rate | Effluent TSS | Background TSS | Drawdown TSS |                                                                                                           |
| 0:00                     |                    |              |                |              | Start sediment feed and introduce influent flow to test tank                                              |
| 1:00                     | X                  |              |                |              |                                                                                                           |
| 7:00                     |                    | X            | X              |              |                                                                                                           |
| 13:00                    |                    | X            |                |              |                                                                                                           |
| 14:00                    | X                  |              |                |              |                                                                                                           |
| 20:00                    |                    | X            | X              |              |                                                                                                           |
| 26:00                    |                    | X            |                |              |                                                                                                           |
| 27:00                    | X                  |              |                |              |                                                                                                           |
| 33:00                    |                    | X            | X              |              |                                                                                                           |
| 34:00                    |                    |              |                |              | Stop sediment feed and divert influent flow from test tank. Divert drawdown flow to drawdown capture tank |
| TBD*                     |                    |              |                | X            |                                                                                                           |
| TBD*                     |                    |              |                | X            |                                                                                                           |
| TBD**                    |                    |              |                |              | End of test run                                                                                           |

\* Times for drawdown TSS samples were determined before each trial, using the previous trial's drawdown duration to determine appropriate spacing

\*\* The end of a test run is the time at which the drawdown effluent stream transitions to a drip. The end time varied from trial to trial.

Flow rate readings were logged every 15 seconds using a Seametrics DL76 data logger and accessed using Seametrics FlowInspector software. The flow meter was calibrated in accordance with the manufacturer's instructions before testing began and the calibration was verified with manual flow measurements (timed bucket method). The entire calibration process was completed in the presence of the third-party observer. A sight tube manometer connected to the test tank was used to take head measurements. Head readings were taken at the beginning and end of each test run, during sample collection, when water temperature was taken and at three minute intervals between sampling (**Table 2**). The driving head readings had an accuracy of  $\pm 0.0625$  inches.

**Table 2 Water Surface Elevation and Temperature Sampling Times**

| Time<br>(min:sec) | Measurement                     |
|-------------------|---------------------------------|
| 0:00              | WSE                             |
| 1:00              | WSE                             |
| 4:00              | WSE                             |
| 7:00              | WSE                             |
| 9:00              | Temperature                     |
| 10:00             | WSE                             |
| 13:00             | WSE                             |
| 14:00             | WSE                             |
| 17:00             | WSE                             |
| 18:00             | Temperature                     |
| 20:00             | WSE                             |
| 23:00             | WSE                             |
| 26:00             | WSE                             |
| 27:00             | WSE                             |
| 28:00             | Temperature                     |
| 30:00             | WSE                             |
| 33:00             | WSE                             |
| 34:00             | WSE                             |
| 37:00             | WSE                             |
| 40:00             | WSE                             |
| 43:00             | WSE                             |
| 46:00             | WSE                             |
| 49:00             | WSE                             |
| 52:00             | WSE                             |
| 55:00 ***         | WSE                             |
| 58:00 ***         | WSE                             |
| 61:00 ***         | WSE                             |
| 64:00 ***         | WSE                             |
| 67:00 ***         | WSE                             |
| 70:00 ***         | WSE                             |
| 73:00 ***         | WSE                             |
| 76:00 ***         | WSE                             |
| 79:00 ***         | WSE                             |
| TBD *             | WSE with drawdown sample        |
| TBD *             | WSE with drawdown sample        |
| TBD **            | WSE at end of trial             |
| TBD **            | Drawdown volume at end of trial |

| Time<br>(min:sec) | Measurement |
|-------------------|-------------|
|-------------------|-------------|

*\*\*\* These measurements may be unnecessary if the drawdown flow has already slowed to a drip and the trial is over*

Following each test, all sediment feed rate samples were weighed in-house on a calibrated balance. The resultant mass of each sample was divided by the duration required to obtain the sample in order to establish the sediment feed rate and ultimately determine the influent concentration. Scott Wells, Ph.D. and Associates oversaw all in-house measurements and calculations. Effluent, background and drawdown samples were sent to Apex labs for TSS analysis in accordance with ASTM D3977-97 (re-approved 2007). The procedure was repeated for 10 test runs and each test had a sediment feed time of 34 minutes, with three 1-minute sample collections, for a total of 31 minutes of sediment injection.

## 2.4 Sediment Mass Loading Capacity Testing Procedure

Sediment mass load capacity testing of the StormFilter was conducted in accordance with the NJDEP Filtration Protocol. After performing the removal efficiency evaluation, additional tests were conducted using a target influent TSS concentration of 200 mg/L until trial 46 at which time the loading concentration was increased to 400 mg/L ( $\pm 10\%$ ). Samples were collected in the same manner as the TSS removal efficiency testing.

Background, effluent and drawdown samples from the sediment mass load trials were transported to the third party analytical laboratory (Apex Labs) for TSS analysis in accordance with ASTM D3977-97 (re-approved 2007).

## 2.5 Scour Testing

No scour testing was conducted, since the StormFilter is only offered for off-line installation at this time.

## 3. Performance Claims

Per the NJDEP verification procedure, the following are the performance claims for the StormFilter based on the results of the laboratory testing conducted.

### *Total Suspended Solids (TSS) Removal Efficiency*

Based on the laboratory testing conducted in accordance with the NJDEP Filter Protocol, the Stormwater Management StormFilter® (StormFilter) achieved greater than 80% removal efficiency of suspended solids. In accordance with the NJDEP Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from NJCAT (January, 2013) (NJDEP Verification Procedure) the TSS removal efficiency is rounded down to 80%.



### *Maximum Treatment Flow Rate (MTFR)*

For all the commercially available model sizes, the hydraulic loading rate used to calculate the MTFR is 2.12 gpm/ft<sup>2</sup> of filter media surface area. This results in an MTFR of 10, 15 and 22.5 gpm for each low drop (effective height is 12 inches), 18 and 27-inch tall filter cartridge respectively.

### *Effective treatment/Sedimentation Area*

The single 18-inch cartridge StormFilter test unit had an effective sedimentation area (horizontal footprint) of 3 ft<sup>2</sup>. All commercially available StormFilter models have a minimum of 3 ft<sup>2</sup> of effective (horizontal) sedimentation area per 18" filter cartridge. This is equivalent to 0.42 ft<sup>2</sup> of sedimentation area per square foot of filtration surface area.

### *Detention Time and Wet Volume*

Detention time of the StormFilter will vary with model size and configuration. The detention time of the 18-inch single cartridge test unit was 1 minute and 20 seconds. Since the test unit represents the smallest allowable ratio of effective sedimentation area per filter cartridge and the surface area specific hydraulic loading rate of all cartridges remains constant at 2.12 gpm/ft<sup>2</sup> of media surface area the detention time for commercially available units will be the same or longer than the detention time of the tested unit.

The StormFilter does not maintain a permanent wet volume. The operational wet volume for the test unit was approximately 20 gallons. The system drains down between each storm event.

### *Effective Filtration Treatment Area*

The effective filtration treatment area of the 18" StormFilter cartridge used during the testing is 7.07 ft<sup>2</sup>.

### *Sediment Mass Load Capacity*

The sediment mass loading capacity varies with the StormFilter model size, the number of cartridges and the size of cartridges installed. Based on the laboratory testing results, the 18 inch StormFilter cartridge has a mass loading capacity of 54.5 lbs. This is equivalent to a sediment mass loading capacity of 7.71 lbs/ft<sup>2</sup> of filter surface area.

### *Maximum Allowable Inflow Drainage Area*

Based on the NJDEP requirement to determine maximum allowable inflow area using 600 lbs of sediment per acre annually and the tested sediment mass loading capacity for the StormFilter of 54.5 lbs per 18-inch cartridge (7.71 lbs/ft<sup>2</sup> of filter surface area), the StormFilter has a maximum allowable inflow drainage area of 0.09 acres per 18-inch cartridge. This is equivalent to a maximum allowable inflow drainage area of 0.061 acres for each low drop (12 inch) cartridge and 0.136 acres for each 27-inch cartridge.

#### 4. Supporting Documentation

The NJDEP Procedure (NJDEP, 2013a) for obtaining verification of a stormwater manufactured treatment device (MTD) from the New Jersey Corporation for Advanced Technology (NJCAT) requires that “copies of the laboratory test reports, including all collected and measured data; all data from performance evaluation test runs; spreadsheets containing original data from all performance test runs; all pertinent calculations; etc.” be included in this section. This was discussed with NJDEP and it was agreed that as long as such documentation could be made available by NJCAT upon request that it would not be prudent or necessary to include all this information in this verification report. This information was provided to NJCAT and is available upon request.

##### 4.1 Test Sediment PSD Analysis

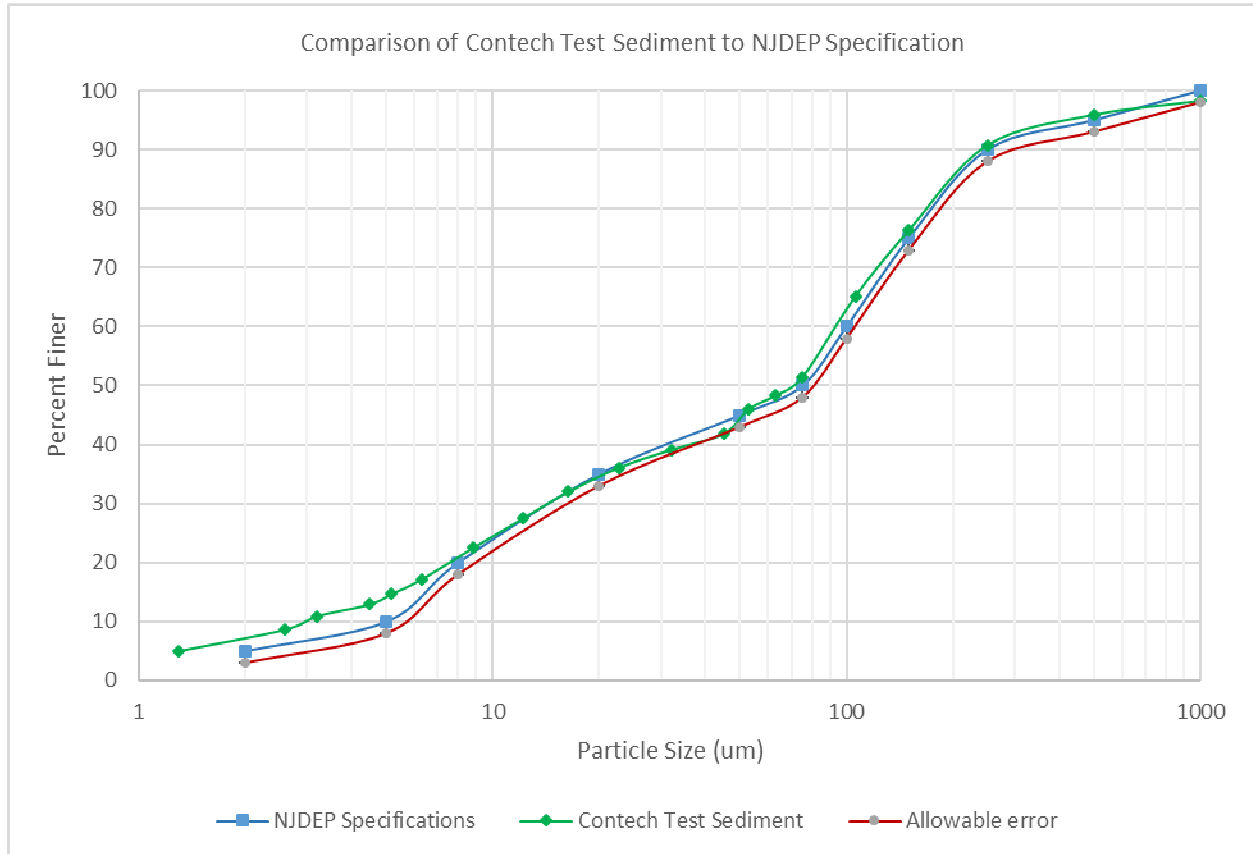
The PSD’s of the three randomly collected sediment samples are shown in **Table 3** and plotted in **Figure 4**. The test sediment met or exceeded the NJDEP PSD sediment specifications across the entire distribution. The average median particle size ( $d_{50}$ ) of the three samples is ~70 microns.

**Table 3 Sediment Particle Size Distribution Analysis on Contech Test Sediment**

| NJDEP Sediment Specifications |               |                               | Contech Test Sediment |               |                    |               |                    |               |                    |
|-------------------------------|---------------|-------------------------------|-----------------------|---------------|--------------------|---------------|--------------------|---------------|--------------------|
| Particle size (um)            | Percent Finer | Allowable error Percent Finer | Sample 1              |               | Sample 2           |               | Sample 3           |               | Percent Finer Mean |
|                               |               |                               | Particle size (um)    | Percent Finer | Particle size (um) | Percent Finer | Particle size (um) | Percent Finer |                    |
| 1000                          | 100           | 98                            | 1000.0                | 98.2          | 1000               | 98.16         | 1000               | 98.3          | 98.2               |
| 500                           | 95            | 93                            | 500.0                 | 96.0          | 500                | 95.78         | 500                | 95.8          | 95.9               |
| 250                           | 90            | 88                            | 250.0                 | 90.8          | 250                | 90.59         | 250                | 90.8          | 90.7               |
| 150                           | 75            | 73                            | 150.0                 | 76.3          | 150                | 76.11         | 150                | 76.4          | 76.3               |
| 100                           | 60            | 58                            | 106.0                 | 65.1          | 106                | 65.15         | 106                | 65.1          | 65.1               |
| 75                            | 50            | 48                            | 75.0                  | 51.6          | 75                 | 51.34         | 75                 | 51.2          | 51.4               |
| 50                            | 45            | 43                            | 63.0                  | 48.5          | 63                 | 48.2          | 63                 | 48.3          | 48.3               |
| 20                            | 35            | 33                            | 53.0                  | 46.3          | 53                 | 45.87         | 53                 | 46.0          | 46.0               |
| 8                             | 20            | 18                            | 44.7                  | 42.9          | 45                 | 41.5          | 45                 | 41.0          | 41.8               |
| 5                             | 10            | 8                             | 31.9                  | 40.1          | 33                 | 38.59         | 32                 | 39.1          | 39.1               |
| 2                             | 5             | 3                             | 22.8                  | 36.3          | 23                 | 34.7          | 23                 | 37.2          | 36.1               |
|                               |               |                               | 16.4                  | 33.4          | 17                 | 30.82         | 16                 | 32.5          | 32.0               |
|                               |               |                               | 12.2                  | 27.7          | 12                 | 26.93         | 12                 | 27.7          | 27.5               |
|                               |               |                               | 8.7                   | 24.0          | 9                  | 21.16         | 9                  | 22.2          | 22.4               |
|                               |               |                               | 6.3                   | 17.4          | 6                  | 17.37         | 6                  | 16.6          | 17.1               |
|                               |               |                               | 5.2                   | 14.6          | 5                  | 14.6          | 5                  | 14.8          | 14.7               |
|                               |               |                               | 4.5                   | 13.0          | 5                  | 12.71         | 5                  | 13.1          | 12.9               |
|                               |               |                               | 3.2                   | 10.7          | 3                  | 11.21         | 3                  | 10.9          | 10.9               |

|     |     |   |      |   |     |     |
|-----|-----|---|------|---|-----|-----|
| 2.6 | 8.5 | 3 | 8.83 | 3 | 8.6 | 8.7 |
| 1.3 | 5.1 | 1 | 4.69 | 1 | 5.2 | 5.0 |

\*Linear interpolation was used to determine percent finer results when particle sizes differed from sample to sample.



**Figure 4 Comparison of Contech Test Sediment to NJDEP PSD Specification**

## 4.2 Removal Efficiency (RE) Testing

Ten (10) test runs were completed as part of the removal efficiency testing following the procedures detailed in Section 2.0 of this report. The results from all 10 runs were used to calculate the average removal efficiency of the 18-inch StormFilter test system. Average removal efficiency and RE for each trial is listed in **Table 8** and shown in **Figure 5**.

### *Test Water Flow Rate, Temperature and Driving Head*

The target flow rate for each test run was 15.0 gpm. The average flow rate during each test run was within  $\pm 10\%$  of the target, with a maximum coefficient of variation (COV) of 0.01. The highest test water temperature measured during any test run was 74.6 °F, which is below the maximum allowed 80°F. Reported driving head measurements represent the distance from the

crown of the effluent pipe to the water surface elevation. The system did not exceed the maximum available driving head for the test unit of 27.6 inches during any of the test runs. As intended, the system operated at relatively consistent driving head throughout the test process. Summary flow data, water temperature, driving head and QA/QC compliance results are summarized in **Table 4**. Average flow rate and maximum driving head are shown graphically in **Figure 6** and **Figure 7**.

**Table 4 Removal Efficiency Water Flow Rate, Temperature and Driving Head**

| Test Run | Average Flow Rate (gpm) | Flow Rate COV | Maximum Water Temperature (°F) | Maximum Driving Head (in) | QA/QC Compliant (YES/NO) |                                    |
|----------|-------------------------|---------------|--------------------------------|---------------------------|--------------------------|------------------------------------|
| -        | Target: 15.0 gpm        | -             | ≤ 80 °F                        | -                         | -                        | <i>Target or QA/QC Requirement</i> |
| 1        | 14.9                    | 0.01          | 73.7                           | 23.7                      | YES                      |                                    |
| 2        | 15.0                    | 0.01          | 73.5                           | 23.8                      | YES                      |                                    |
| 3        | 14.9                    | 0.01          | 73.9                           | 23.7                      | YES                      |                                    |
| 4        | 14.9                    | 0.01          | 74.2                           | 23.6                      | YES                      |                                    |
| 5        | 14.9                    | 0.01          | 74.1                           | 23.8                      | YES                      |                                    |
| 6        | 15.0                    | 0.01          | 74.6                           | 24.0                      | YES                      |                                    |
| 7        | 15.0                    | 0.01          | 74.5                           | 23.7                      | YES                      |                                    |
| 8        | 14.9                    | 0.01          | 74.2                           | 23.5                      | YES                      |                                    |
| 9        | 14.9                    | 0.01          | 74.2                           | 23.4                      | YES                      |                                    |
| 10       | 15.0                    | 0.01          | 74.2                           | 23.9                      | YES                      |                                    |

#### *Sediment Feed Rate and Influent Concentration*

Sediment was fed into the test water stream at a rate calculated to yield a target influent concentration of 200 mg/L. Three feed rate samples were collected per trial to verify the sediment delivery rate and resulting influent concentration. All sediment feed rate samples were collected in clean sampling containers over an interval of 1 minute. Average influent TSS was calculated using **Equation 1** and **Equation 2**. During all test runs, influent TSS was maintained within ±10% of target, with a maximum COV of 0.03. The total sediment injection time during each run was 31 minutes, exceeding the minimum test length requirement of 30 minutes. Sediment feed rates, resulting influent TSS and QA/QC compliance results are summarized in **Table 5**.

#### **Equation 1: Average Feed Rate**

*Average Feed Rate (g/min) = Sediment Moisture Correction Factor x Average Measured Feed Rate (g/min)*



### Equation 2: Average Influent TSS

$$\text{Average Influent TSS } \left( \frac{\text{mg}}{\text{L}} \right) = \frac{\text{Average Feed Rate } \left( \frac{\text{g}}{\text{min}} \right) \times \frac{1000 \text{ mg}}{\text{g}}}{\text{Average Water Flow Rate } \left( \frac{\text{gal}}{\text{min}} \right) \times \frac{3.785 \text{ L}}{\text{gal}}}$$

**Table 5 Removal Efficiency Sediment Feed Rate and Influent Concentration**

| Test Run | Sediment Injection Time (min) | Average Feed Rate (g/min) | Feed Rate COV | Feed Rate Sampling Duration (min) | Average Influent TSS (mg/L) | Minimum Influent TSS (mg/L) | Maximum Influent TSS (mg/L) | QA/QC Compliant (YES/NO) |                             |
|----------|-------------------------------|---------------------------|---------------|-----------------------------------|-----------------------------|-----------------------------|-----------------------------|--------------------------|-----------------------------|
| -        | ≥ 30 min                      | Target: 11.4 g/min        | ≤ 0.1         | ≤ 1 min                           | Target: 200 mg/L            | ≥ -10% of Target: 180 mg/L  | ≤ +10% of Target: 220 mg/L  | -                        | Target or QA/QC Requirement |
| 1        | 31.0                          | 11.5                      | 0.02          | 1.0                               | 203                         | 198                         | 205                         | YES                      |                             |
| 2        | 31.0                          | 11.9                      | 0.02          | 1.0                               | 210                         | 206                         | 213                         | YES                      |                             |
| 3        | 31.0                          | 11.7                      | 0.01          | 1.0                               | 207                         | 204                         | 210                         | YES                      |                             |
| 4        | 31.0                          | 12.0                      | 0.02          | 1.0                               | 213                         | 209                         | 216                         | YES                      |                             |
| 5        | 31.0                          | 12.0                      | 0.01          | 1.0                               | 212                         | 210                         | 216                         | YES                      |                             |
| 6        | 31.0                          | 11.8                      | 0.03          | 1.0                               | 208                         | 203                         | 213                         | YES                      |                             |
| 7        | 31.0                          | 12.0                      | 0.02          | 1.0                               | 212                         | 208                         | 215                         | YES                      |                             |
| 8        | 31.0                          | 11.5                      | 0.01          | 1.0                               | 203                         | 202                         | 205                         | YES                      |                             |
| 9        | 31.0                          | 11.7                      | 0.01          | 1.0                               | 206                         | 203                         | 208                         | YES                      |                             |
| 10       | 31.0                          | 11.8                      | 0.03          | 1.0                               | 207                         | 202                         | 213                         | YES                      |                             |

### Drawdown Sampling and Duration

Drawdown TSS sampling and drawdown volume quantification were performed to determine the amount of influent mass that exited the system during the drawdown period. Drawdown TSS sampling times were determined using the drawdown duration from the previous trial. Sampling times and drawdown durations are presented in **Table 6**.

**Table 6 Removal Efficiency Testing Drawdown Duration and Drawdown Sampling Times**

| Test Run | Drawdown Duration<br>(min from pump shutoff) | Drawdown TSS<br>Sample 1 Time<br>(min from pump shutoff) | Drawdown TSS<br>Sample 2 Time<br>(min from pump shutoff) |
|----------|----------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|
| 1        | 38                                           | 12                                                       | 21                                                       |
| 2        | 34                                           | 13                                                       | 25                                                       |
| 3        | 30                                           | 11                                                       | 23                                                       |
| 4        | 27                                           | 10                                                       | 20                                                       |
| 5        | 26                                           | 10                                                       | 20                                                       |
| 6        | 26                                           | 9                                                        | 17                                                       |
| 7        | 26                                           | 9                                                        | 18                                                       |
| 8        | 26                                           | 9                                                        | 17                                                       |
| 9        | 26                                           | 9                                                        | 17                                                       |
| 10       | 26                                           | 9                                                        | 17                                                       |

*Background, Effluent and Drawdown TSS*

Background, effluent and drawdown TSS samples were collected in clean 1-liter bottles, with each sample exceeding the minimum required 500 mL sample volume. With the exception of test run 10, effluent and drawdown TSS samples were collected no less than three residence times, or 4 total minutes after the sediment injection stream was interrupted for feed rate sampling. During test run 10, an effluent sample was collected 5 seconds early; as this was such a small error in timing, no data from this test run was excluded from calculations. Background TSS samples were taken with odd numbered effluent TSS samples as required by the NJDEP Filtration Protocol. The highest measured background TSS was 4 mg/L, which is below the maximum allowed concentration of 20 mg/L. Average effluent TSS and average drawdown TSS values were adjusted for background levels using **Equation 3** and **Equation 4**, respectively. Background TSS, effluent TSS, drawdown TSS and QA/QC compliance results are presented in **Table 7**.

**Equation 3: Average Adjusted Effluent TSS**

$$\text{Average Adjusted Effluent TSS} \left( \frac{\text{mg}}{\text{L}} \right) = \text{Average Effluent TSS} \left( \frac{\text{mg}}{\text{L}} \right) - \text{Average Background TSS} \left( \frac{\text{mg}}{\text{L}} \right)$$

**Equation 4: Average Adjusted Drawdown TSS**

$$\begin{aligned} \text{Average Adjusted Drawdown TSS} \left( \frac{\text{mg}}{\text{L}} \right) \\ = \text{Average Drawdown TSS} \left( \frac{\text{mg}}{\text{L}} \right) - \text{Average Background TSS} \left( \frac{\text{mg}}{\text{L}} \right) \end{aligned}$$

**Table 7 Removal Efficiency Background, Effluent and Drawdown TSS**

| Test Run | Average Background TSS (mg/L) | Maximum Background TSS (mg/L) | Minimum Background Sample Volume (mL) | Average Adjusted Effluent TSS (mg/L) | Minimum Effluent Sample Volume (mL) | Average Adjusted Drawdown TSS (mg/L) | Minimum Drawdown Sample Volume (mL) | QA/QC Compliant (YES/NO) |                             |
|----------|-------------------------------|-------------------------------|---------------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|--------------------------|-----------------------------|
| -        | -                             | ≤ 20 mg/L                     | ≥ 500 mL                              | -                                    | ≥ 500 mL                            | -                                    | ≥ 500 mL                            | -                        | Target or QA/QC Requirement |
| 1        | 2                             | 3                             | 740                                   | 38                                   | 930                                 | 20                                   | 590                                 | YES                      |                             |
| 2        | 2                             | 2                             | 790                                   | 35                                   | 820                                 | 8                                    | 580                                 | YES                      |                             |
| 3        | 3                             | 3                             | 770                                   | 41                                   | 880                                 | 8                                    | 580                                 | YES                      |                             |
| 4        | 2                             | 2                             | 730                                   | 37                                   | 870                                 | 8                                    | 600                                 | YES                      |                             |
| 5        | 2                             | 2                             | 700                                   | 36                                   | 910                                 | 6                                    | 560                                 | YES                      |                             |
| 6        | 2                             | 3                             | 720                                   | 38                                   | 830                                 | 10                                   | 540                                 | YES                      |                             |
| 7        | 2                             | 2                             | 720                                   | 38                                   | 780                                 | 11                                   | 545                                 | YES                      |                             |
| 8        | 2                             | 3                             | 750                                   | 36                                   | 850                                 | 9                                    | 550                                 | YES                      |                             |
| 9        | 3                             | 3                             | 780                                   | 35                                   | 880                                 | 8                                    | 580                                 | YES                      |                             |
| 10       | 3                             | 4                             | 740                                   | 36                                   | 850                                 | 9                                    | 560                                 | YES                      |                             |

#### Removal Efficiency (RE) Results

Average RE at the end of the test run 10 was 83%. **Equation 5** through **Equation 7** were used to calculate RE for each test run. Sediment mass loading per trial and mass captured per trial were calculated using **Equation 8** and **Equation 9**, respectively. Cumulative sediment mass loading and cumulative mass captured by the StormFilter were calculated by summing the mass loading per trial and mass captured per trial values. The total mass loading for the removal efficiency test runs was 8.0 lbs and the mass captured by the system was 6.7 lbs. The summary of RE results is reported in **Table 8**.

#### Equation 5: Influent Volume

$$\text{Influent Volume (L)} = \text{Sediment Injection Time (min)} \times \text{Average Flow Rate} \left( \frac{\text{gal}}{\text{min}} \right) \times \frac{3.785 \text{ L}}{\text{gal}}$$

#### Equation 6: Effluent Volume

$$\text{Effluent Volume (L)} = \text{Influent Volume (L)} - \text{Drawdown Volume (L)}$$

#### Equation 7: Removal Efficiency (RE)

RE (%)

$$= (100\%) \times \frac{\left[ \text{Average Influent TSS} \left( \frac{\text{mg}}{\text{L}} \right) \times \text{Influent Volume (L)} \right] - \left[ \text{Average Adjusted Effluent TSS} \left( \frac{\text{mg}}{\text{L}} \right) \times \text{Effluent Volume (L)} \right] - \left[ \text{Average Adjusted Drawdown TSS} \left( \frac{\text{mg}}{\text{L}} \right) \times \text{Drawdown Volume (L)} \right]}{\left[ \text{Average Influent TSS} \left( \frac{\text{mg}}{\text{L}} \right) \times \text{Influent Volume (L)} \right]}$$

#### Equation 8: Sediment Mass Loading per Trial

*Sediment Mass Loading per Trial (lb)*

$$= \text{Average Influent TSS} \left( \frac{\text{mg}}{\text{L}} \right) \times \text{Influent Volume (L)} \times \frac{2.20\text{E-6 mg}}{\text{lb}}$$

#### Equation 9: Mass Captured per Trial

$$\text{Mass Captured per Trial (lb)} = \frac{\text{Sediment Mass Loading per Trial (lb)} \times \text{RE (\%)}}{(100\%)}$$

**Table 8 Removal Efficiency Results**

| Test Run | Average Influent TSS (mg/L) | Average Adjusted Effluent TSS (mg/L) | Average Adjusted Drawdown TSS (mg/L) | Influent Volume (L) | Effluent Volume (L) | Drawdown Volume (L) | Mass Loading (lb) | Mass Captured (lb) | Trial Removal Efficiency (%) | Average Removal Efficiency (%) |
|----------|-----------------------------|--------------------------------------|--------------------------------------|---------------------|---------------------|---------------------|-------------------|--------------------|------------------------------|--------------------------------|
| 1        | 203                         | 38                                   | 20                                   | 1751                | 1673                | 78                  | 0.8               | 0.6                | 82%                          | 82%                            |
| 2        | 210                         | 35                                   | 8                                    | 1758                | 1677                | 81                  | 1.6               | 1.3                | 84%                          | 83%                            |
| 3        | 207                         | 41                                   | 8                                    | 1745                | 1666                | 79                  | 2.4               | 2.0                | 81%                          | 82%                            |
| 4        | 213                         | 37                                   | 8                                    | 1753                | 1674                | 79                  | 3.2               | 2.6                | 83%                          | 83%                            |
| 5        | 212                         | 36                                   | 6                                    | 1754                | 1679                | 75                  | 4.0               | 3.3                | 84%                          | 83%                            |
| 6        | 208                         | 38                                   | 10                                   | 1757                | 1678                | 79                  | 4.8               | 4.0                | 82%                          | 83%                            |
| 7        | 212                         | 38                                   | 11                                   | 1758                | 1679                | 79                  | 5.6               | 4.7                | 82%                          | 83%                            |
| 8        | 203                         | 36                                   | 9                                    | 1753                | 1674                | 79                  | 6.4               | 5.3                | 83%                          | 83%                            |
| 9        | 206                         | 35                                   | 8                                    | 1754                | 1675                | 79                  | 7.2               | 6.0                | 84%                          | 83%                            |
| 10       | 207                         | 36                                   | 9                                    | 1766                | 1686                | 79                  | 8.0               | 6.7                | 83%                          | 83%                            |

### 4.3 Sediment Mass Loading Capacity

Mass loading capacity testing was conducted as a continuation of removal efficiency (RE) testing. Mass loading test runs were conducted using identical testing procedures and targets as those used in the RE runs, the only change was to increase the target influent concentration to 400 mg/L after test run 45. Testing concluded after 67 test runs, 57 of which were completed during mass loading and 10 during RE testing. The system did not occlude or reach maximum driving head during the test process, but the average removal efficiency (on a mass basis) dropped below 80% so testing was suspended and deemed complete at trial 66 as per the QAPP and protocol. The mass loading test data and QA/QC compliance results are summarized in **Table 9** through **Table 13**.

#### *Test Water Flow Rate, Temperature and Driving Head*

The average flow rate during each test run was within  $\pm 10\%$  of the target 15 gpm and the maximum observed COV was 0.01 (excluding test run 14, see Section 4.4 for discussion). The test water temperature remained below the maximum allowed 80°F during all runs and the



maximum available driving head was not reached or exceed at any time. During test run 15, driving head readings were not taken with drawdown TSS samples. The missing data points do not affect any computations, (including maximum driving head), so all data for test run 15 is included in calculations. Test run 29 did not include a driving head measurement at the scheduled time of 10 minutes, which caused the measurement spacing to exceed the maximum 5-minute interval. The driving head readings prior to and following the missing measurement show the driving head remained consistent and indicate that the system was not operating at or near the maximum design driving head, so all data from test run 29 is included in reported results.

**Table 9** includes summary flow data, water temperature and driving head results. Average flow rate and maximum driving head are also shown in **Figure 6** and **Figure 7**.

**Table 9 Sediment Mass Loading Trial Flow Rate, Temperature and Driving Head**

| Test Run | Average Flow Rate (gpm) | Flow Rate COV | Maximum Water Temperature (°F) | Maximum Driving Head (in) | QA/QC Compliant (YES/NO) |
|----------|-------------------------|---------------|--------------------------------|---------------------------|--------------------------|
| -        | Target: 15.0 gpm        | -             | ≤ 80 °F                        | -                         | -                        |
| 11       | 15.0                    | 0.01          | 71.1                           | 23.8                      | YES                      |
| 12       | 15.0                    | 0.01          | 70.5                           | 24.2                      | YES                      |
| 13       | 15.0                    | 0.01          | 71.6                           | 23.9                      | YES                      |
| 14       | 14.9                    | 0.07          | 70.5                           | 23.7                      | NO*                      |
| 15       | 14.8                    | 0.01          | 71.4                           | 23.0                      | NO                       |
| 16       | 14.9                    | 0.01          | 71.1                           | 23.6                      | YES                      |
| 17       | 14.9                    | 0.01          | 71.1                           | 23.7                      | YES                      |
| 18       | 14.9                    | 0.01          | 71.2                           | 23.6                      | YES                      |
| 19       | 15.0                    | 0.01          | 71.3                           | 23.9                      | YES                      |
| 20       | 15.0                    | 0.01          | 71.6                           | 23.7                      | YES                      |
| 21       | 15.0                    | 0.01          | 71.4                           | 23.7                      | YES                      |
| 22       | 14.9                    | 0.01          | 72.1                           | 23.5                      | YES                      |
| 23       | 14.9                    | 0.01          | 71.2                           | 23.6                      | YES                      |
| 24       | 15.0                    | 0.01          | 71.4                           | 24.0                      | YES                      |
| 25       | 15.0                    | 0.01          | 71.8                           | 23.7                      | YES                      |
| 26       | 15.0                    | 0.01          | 71.0                           | 23.6                      | YES                      |
| 27       | 15.0                    | 0.01          | 71.4                           | 23.7                      | YES                      |
| 28       | 14.9                    | 0.01          | 71.4                           | 23.4                      | YES                      |
| 29       | 15.0                    | 0.01          | 71.9                           | 23.7                      | NO                       |
| 30       | 15.0                    | 0.01          | 71.8                           | 24.0                      | YES                      |
| 31       | 15.0                    | 0.01          | 71.0                           | 23.7                      | YES                      |
| 32       | 15.0                    | 0.01          | 71.4                           | 23.7                      | YES                      |
| 33       | 15.0                    | 0.01          | 71.1                           | 23.8                      | YES                      |
| 34       | 15.0                    | 0.01          | 71.3                           | 24.3                      | YES                      |
| 35       | 15.0                    | 0.01          | 71.0                           | 23.9                      | YES                      |

| Test Run | Average Flow Rate (gpm) | Flow Rate COV | Maximum Water Temperature (°F) | Maximum Driving Head (in) | QA/QC Compliant (YES/NO) |
|----------|-------------------------|---------------|--------------------------------|---------------------------|--------------------------|
| 36       | 15.0                    | 0.01          | 73.6                           | 23.7                      | YES                      |
| 37       | 15.0                    | 0.01          | 73.0                           | 24.0                      | YES                      |
| 38       | 15.0                    | 0.01          | 72.9                           | 23.8                      | YES                      |
| 39       | 15.0                    | 0.01          | 73.0                           | 23.6                      | YES                      |
| 40       | 14.9                    | 0.01          | 73.1                           | 23.5                      | YES                      |
| 41       | 15.0                    | 0.01          | 72.7                           | 23.7                      | YES                      |
| 42       | 15.0                    | 0.01          | 72.2                           | 23.7                      | YES                      |
| 43       | 15.0                    | 0.01          | 71.0                           | 23.7                      | YES                      |
| 44       | 15.0                    | 0.01          | 71.4                           | 23.8                      | YES                      |
| 45       | 15.0                    | 0.01          | 71.1                           | 24.3                      | YES                      |
| 46       | 14.9                    | 0.01          | 73.0                           | 23.4                      | YES                      |
| 47       | 14.9                    | 0.01          | 72.1                           | 23.6                      | YES                      |
| 48       | 15.0                    | 0.01          | 72.1                           | 23.8                      | YES                      |
| 49       | 14.9                    | 0.01          | 71.6                           | 23.4                      | YES                      |
| 50       | 15.0                    | 0.01          | 72.2                           | 23.6                      | YES                      |
| 51       | 14.9                    | 0.01          | 72.4                           | 23.4                      | YES                      |
| 52       | 14.9                    | 0.01          | 72.6                           | 23.7                      | YES                      |
| 53       | 15.0                    | 0.01          | 72.4                           | 23.5                      | YES                      |
| 54       | 15.0                    | 0.01          | 72.5                           | 23.5                      | YES                      |
| 55       | 14.9                    | 0.01          | 72.5                           | 23.5                      | YES                      |
| 56       | 15.0                    | 0.01          | 72.9                           | 23.7                      | YES                      |
| 57       | 15.0                    | 0.01          | 72.4                           | 23.7                      | YES                      |
| 58       | 15.0                    | 0.01          | 72.2                           | 23.7                      | YES                      |
| 59       | 15.0                    | 0.01          | 71.2                           | 23.7                      | YES                      |
| 60       | 15.0                    | 0.01          | 71.3                           | 23.7                      | YES                      |
| 61       | 15.0                    | 0.01          | 71.4                           | 23.7                      | YES                      |
| 62       | 15.0                    | 0.01          | 71.7                           | 23.7                      | YES                      |
| 63       | 15.0                    | 0.01          | 72.4                           | 23.7                      | YES                      |
| 64       | 15.0                    | 0.01          | 71.9                           | 23.5                      | YES                      |
| 65       | 15.0                    | 0.01          | 72.1                           | 23.7                      | YES                      |
| 66       | 15.0                    | 0.01          | 72.1                           | 23.6                      | YES                      |
| 67       | 15.0                    | 0.01          | 72.5                           | 23.4                      | YES                      |

*\*See Section 4.4 for discussion*

#### *Sediment Feed Rate and Influent Concentration*

During test runs 11 through 45, sediment was introduced at a target feed rate of 11.4 g/min to yield a 200 mg/L influent concentration. All feed rates and resulting influent concentrations during these trials were within  $\pm 10\%$  of target, with a maximum COV of 0.05. The target feed

rate was increased to 22.7 g/min for test runs 46 through 67 in order to provide a 400 mg/L influent concentration. Feed rates during runs 46 through 67 were also within  $\pm 10\%$  of target and the maximum COV was 0.04. The influent TSS data for test run 27 was excluded from calculations (see Section 4.4 for discussion). **Table 10** shows the feed rate data, influent concentration data and QA/QC results for all mass loading test runs.

**Table 10 Sediment Mass Loading Sediment Feed Rate and Influent Concentration**

| Test Run | Sediment Injection Time (min) | Average Feed Rate (g/min)  | Feed Rate COV | Maximum Feed Rate Sampling Duration (min) | Average Influent TSS (mg/L) | Minimum Influent TSS (mg/L) | Maximum Influent TSS (mg/L) | QA/QC Compliant (YES/NO) |
|----------|-------------------------------|----------------------------|---------------|-------------------------------------------|-----------------------------|-----------------------------|-----------------------------|--------------------------|
| -        | $\geq 30$ min                 | Target: 11.4 or 22.7 g/min | $\leq 0.1$    | $\leq 1$ min                              | Target: 200 or 400 mg/L     | $\geq -10\%$ of Target      | $\leq +10\%$ of Target      | -                        |
| 11       | 31.0                          | 11.3                       | 0.02          | 1.0                                       | 200                         | 196                         | 205                         | YES                      |
| 12       | 31.0                          | 11.9                       | 0.01          | 1.0                                       | 209                         | 206                         | 212                         | YES                      |
| 13       | 31.0                          | 12.0                       | 0.01          | 1.0                                       | 211                         | 210                         | 213                         | YES                      |
| 14       | 31.0                          | 11.7                       | 0.02          | 1.0                                       | 206                         | 203                         | 212                         | YES                      |
| 15       | 31.0                          | 11.7                       | 0.01          | 1.0                                       | 209                         | 205                         | 210                         | YES                      |
| 16       | 31.0                          | 11.4                       | 0.01          | 1.0                                       | 202                         | 200                         | 205                         | YES                      |
| 17       | 31.0                          | 11.7                       | 0.01          | 1.0                                       | 206                         | 203                         | 209                         | YES                      |
| 18       | 31.0                          | 11.5                       | 0.01          | 1.0                                       | 203                         | 202                         | 205                         | YES                      |
| 19       | 31.0                          | 11.6                       | 0.01          | 1.0                                       | 204                         | 202                         | 206                         | YES                      |
| 20       | 31.0                          | 11.9                       | 0.01          | 1.0                                       | 210                         | 208                         | 212                         | YES                      |
| 21       | 31.0                          | 11.3                       | 0.05          | 1.0                                       | 199                         | 192                         | 210                         | YES                      |
| 22       | 31.0                          | 11.6                       | 0.03          | 1.0                                       | 206                         | 198                         | 211                         | YES                      |
| 23       | 31.0                          | 11.5                       | 0.01          | 1.0                                       | 203                         | 202                         | 204                         | YES                      |
| 24       | 31.0                          | 11.7                       | 0.01          | 1.0                                       | 206                         | 204                         | 207                         | YES                      |
| 25       | 31.0                          | 11.5                       | 0.02          | 1.0                                       | 203                         | 197                         | 206                         | YES                      |
| 26       | 31.0                          | 11.6                       | 0.02          | 1.0                                       | 204                         | 201                         | 210                         | YES                      |
| 27       | 31.0                          | 11.8                       | 0.04          | 1.0                                       | 208                         | 198                         | 215                         | NO*                      |
| 28       | 31.0                          | 11.2                       | 0.02          | 1.0                                       | 199                         | 195                         | 200                         | YES                      |
| 29       | 31.0                          | 11.3                       | 0.03          | 1.0                                       | 199                         | 192                         | 203                         | YES                      |
| 30       | 31.0                          | 11.5                       | 0.01          | 1.0                                       | 202                         | 199                         | 204                         | YES                      |
| 31       | 31.0                          | 11.3                       | 0.01          | 1.0                                       | 200                         | 198                         | 201                         | YES                      |
| 32       | 31.0                          | 11.5                       | 0.01          | 1.0                                       | 202                         | 201                         | 203                         | YES                      |
| 33       | 31.0                          | 11.6                       | 0.02          | 1.0                                       | 204                         | 201                         | 208                         | YES                      |
| 34       | 31.0                          | 11.4                       | 0.02          | 1.0                                       | 200                         | 196                         | 204                         | YES                      |
| 35       | 31.0                          | 11.2                       | 0.02          | 1.0                                       | 198                         | 194                         | 201                         | YES                      |
| 36       | 31.0                          | 11.6                       | 0.01          | 1.0                                       | 204                         | 203                         | 206                         | YES                      |
| 37       | 31.0                          | 11.5                       | 0.01          | 1.0                                       | 203                         | 202                         | 204                         | YES                      |

| Test Run | Sediment Injection Time (min) | Average Feed Rate (g/min) | Feed Rate COV | Maximum Feed Rate Sampling Duration (min) | Average Influent TSS (mg/L) | Minimum Influent TSS (mg/L) | Maximum Influent TSS (mg/L) | QA/QC Compliant (YES/NO) |
|----------|-------------------------------|---------------------------|---------------|-------------------------------------------|-----------------------------|-----------------------------|-----------------------------|--------------------------|
| 38       | 31.0                          | 11.5                      | 0.02          | 1.0                                       | 202                         | 201                         | 206                         | YES                      |
| 39       | 31.0                          | 11.5                      | 0.02          | 1.0                                       | 203                         | 199                         | 208                         | YES                      |
| 40       | 31.0                          | 11.5                      | 0.01          | 1.0                                       | 203                         | 201                         | 205                         | YES                      |
| 41       | 31.0                          | 11.3                      | 0.01          | 1.0                                       | 199                         | 196                         | 201                         | YES                      |
| 42       | 31.0                          | 11.3                      | 0.03          | 1.0                                       | 199                         | 195                         | 206                         | YES                      |
| 43       | 31.0                          | 11.4                      | 0.01          | 1.0                                       | 200                         | 199                         | 202                         | YES                      |
| 44       | 31.0                          | 11.5                      | 0.01          | 1.0                                       | 203                         | 201                         | 206                         | YES                      |
| 45       | 31.0                          | 11.5                      | 0.01          | 1.0                                       | 202                         | 201                         | 202                         | YES                      |
| 46       | 31.0                          | 22.6                      | 0.02          | 1.0                                       | 401                         | 395                         | 410                         | YES                      |
| 47       | 31.0                          | 22.7                      | 0.02          | 1.0                                       | 402                         | 398                         | 410                         | YES                      |
| 48       | 31.0                          | 22.7                      | 0.00          | 1.0                                       | 401                         | 399                         | 403                         | YES                      |
| 49       | 31.0                          | 22.4                      | 0.01          | 1.0                                       | 396                         | 393                         | 398                         | YES                      |
| 50       | 31.0                          | 23.3                      | 0.01          | 1.0                                       | 412                         | 410                         | 415                         | YES                      |
| 51       | 31.0                          | 22.4                      | 0.01          | 1.0                                       | 396                         | 394                         | 400                         | YES                      |
| 52       | 31.0                          | 22.4                      | 0.02          | 1.0                                       | 396                         | 389                         | 405                         | YES                      |
| 53       | 31.0                          | 22.8                      | 0.02          | 1.0                                       | 403                         | 393                         | 411                         | YES                      |
| 54       | 31.0                          | 22.8                      | 0.01          | 1.0                                       | 403                         | 399                         | 408                         | YES                      |
| 55       | 31.0                          | 22.6                      | 0.02          | 1.0                                       | 400                         | 394                         | 408                         | YES                      |
| 56       | 31.0                          | 22.7                      | 0.01          | 1.0                                       | 400                         | 395                         | 405                         | YES                      |
| 57       | 31.0                          | 22.9                      | 0.02          | 1.0                                       | 403                         | 399                         | 411                         | YES                      |
| 58       | 31.0                          | 23.1                      | 0.02          | 1.0                                       | 407                         | 398                         | 417                         | YES                      |
| 59       | 31.0                          | 22.4                      | 0.01          | 1.0                                       | 395                         | 389                         | 400                         | YES                      |
| 60       | 31.0                          | 22.9                      | 0.01          | 1.0                                       | 404                         | 401                         | 408                         | YES                      |
| 61       | 31.0                          | 23.3                      | 0.03          | 1.0                                       | 410                         | 401                         | 422                         | YES                      |
| 62       | 31.0                          | 22.6                      | 0.03          | 1.0                                       | 398                         | 388                         | 411                         | YES                      |
| 63       | 31.0                          | 22.8                      | 0.02          | 1.0                                       | 401                         | 394                         | 410                         | YES                      |
| 64       | 31.0                          | 22.8                      | 0.03          | 1.0                                       | 402                         | 389                         | 412                         | YES                      |
| 65       | 31.0                          | 22.9                      | 0.01          | 1.0                                       | 403                         | 402                         | 407                         | YES                      |
| 66       | 31.0                          | 22.8                      | 0.02          | 1.0                                       | 402                         | 395                         | 409                         | YES                      |
| 67       | 31.0                          | 23.0                      | 0.01          | 1.0                                       | 405                         | 402                         | 409                         | YES                      |

*\*See Section 4.4 for discussion*

#### *Drawdown Sampling and Duration*

Drawdown TSS sampling times and drawdown durations are presented in **Table 11**. Sampling times were determined prior to each test run using the drawdown duration from the previous trial.



**Table 11 Sediment Mass Loading Drawdown Sampling Times**

| Test Run | Drawdown Duration (min from pump shutoff) | Drawdown TSS Sample 1 Time (min from pump shutoff) | Drawdown TSS Sample 2 Time (min from pump shutoff) |
|----------|-------------------------------------------|----------------------------------------------------|----------------------------------------------------|
| 11       | 24                                        | 9                                                  | 17                                                 |
| 12       | 27                                        | 8                                                  | 16                                                 |
| 13       | 26                                        | 9                                                  | 19                                                 |
| 14       | 26                                        | 9                                                  | 17                                                 |
| 15       | 24                                        | 9                                                  | 17                                                 |
| 16       | 25                                        | 8                                                  | 16                                                 |
| 17       | 25                                        | 8                                                  | 16                                                 |
| 18       | 24                                        | 8                                                  | 17                                                 |
| 19       | 25                                        | 8                                                  | 16                                                 |
| 20       | 25                                        | 8                                                  | 16                                                 |
| 21       | 23                                        | 8                                                  | 16                                                 |
| 22       | 24                                        | 8                                                  | 16                                                 |
| 23       | 23                                        | 8                                                  | 16                                                 |
| 24       | 24                                        | 8                                                  | 15                                                 |
| 25       | 23                                        | 8                                                  | 16                                                 |
| 26       | 22                                        | 8                                                  | 15                                                 |
| 27       | 23                                        | 7                                                  | 15                                                 |
| 28       | 21                                        | 8                                                  | 15                                                 |
| 29       | 22                                        | 7                                                  | 14                                                 |
| 30       | 21                                        | 7                                                  | 14                                                 |
| 31       | 20                                        | 7                                                  | 14                                                 |
| 32       | 21                                        | 7                                                  | 14                                                 |
| 33       | 21                                        | 7                                                  | 14                                                 |
| 34       | 21                                        | 7                                                  | 14                                                 |
| 35       | 21                                        | 7                                                  | 14                                                 |
| 36       | 21                                        | 7                                                  | 14                                                 |
| 37       | 20                                        | 7                                                  | 14                                                 |
| 38       | 21                                        | 7                                                  | 13                                                 |
| 39       | 20                                        | 7                                                  | 14                                                 |

| Test Run | Drawdown Duration (min from pump shutoff) | Drawdown TSS Sample 1 Time (min from pump shutoff) | Drawdown TSS Sample 2 Time (min from pump shutoff) |
|----------|-------------------------------------------|----------------------------------------------------|----------------------------------------------------|
| 40       | 21                                        | 7                                                  | 14                                                 |
| 41       | 20                                        | 7                                                  | 14                                                 |
| 42       | 19                                        | 7                                                  | 13                                                 |
| 43       | 18                                        | 6                                                  | 12                                                 |
| 44       | 19                                        | 6                                                  | 12                                                 |
| 45       | 18                                        | 6                                                  | 13                                                 |
| 46       | 18                                        | 6                                                  | 12                                                 |
| 47       | 18                                        | 6                                                  | 12                                                 |
| 48       | 19                                        | 6                                                  | 12                                                 |
| 49       | 19                                        | 6                                                  | 13                                                 |
| 50       | 17                                        | 6                                                  | 12                                                 |
| 51       | 18                                        | 6                                                  | 11                                                 |
| 52       | 16                                        | 6                                                  | 12                                                 |
| 53       | 17                                        | 5                                                  | 10                                                 |
| 54       | 17                                        | 6                                                  | 11                                                 |
| 55       | 15                                        | 6                                                  | 11                                                 |
| 56       | 15                                        | 5                                                  | 10                                                 |
| 57       | 16                                        | 5                                                  | 10                                                 |
| 58       | 15                                        | 5                                                  | 10                                                 |
| 59       | 16                                        | 5                                                  | 10                                                 |
| 60       | 15                                        | 5                                                  | 11                                                 |
| 61       | 10                                        | 5                                                  | (not sampled)                                      |
| 62       | 16                                        | 5                                                  | 10                                                 |
| 63       | 15                                        | 5                                                  | 11                                                 |
| 64       | 15                                        | 5                                                  | 10                                                 |
| 65       | 15                                        | 5                                                  | 10                                                 |
| 66       | 15                                        | 5                                                  | 10                                                 |
| 67       | 15                                        | 5                                                  | 10                                                 |

### *Background, Effluent and Drawdown TSS*

Background, effluent and drawdown TSS samples were collected in clean 1-liter bottles and all samples exceeded the minimum required volume. Effluent and drawdown TSS samples were taken no less than three residence times (4 minutes) after the sediment injection stream was interrupted for feed rate sampling. Background TSS samples were taken concurrently with odd numbered effluent samples. The highest background TSS level was 9 mg/L, which is below the allowable concentration of 20 mg/L. Data from test run 61 was excluded from calculations (see Section 4.4 for discussion).

**Table 12 Sediment Mass Loading Background, Effluent and Drawdown TSS**

| Test Run | Average Background TSS (mg/L) | Maximum Background TSS (mg/L) | Minimum Background Sample Volume (mL) | Average Adjusted Effluent TSS (mg/L) | Minimum Effluent Sample Volume (mL) | Average Adjusted Drawdown TSS (mg/L) | Minimum Drawdown Sample Volume (mL) | QA/QC Compliant (YES/NO) |
|----------|-------------------------------|-------------------------------|---------------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|--------------------------|
| -        | -                             | ≤ 20 mg/L                     | ≥ 500 mL                              | -                                    | ≥ 500 mL                            | -                                    | ≥ 500 mL                            | -                        |
| 11       | 2                             | 2                             | 750                                   | 37                                   | 900                                 | 11                                   | 560                                 | YES                      |
| 12       | 2                             | 2                             | 720                                   | 36                                   | 820                                 | 12                                   | 580                                 | YES                      |
| 13       | 2                             | 3                             | 740                                   | 41                                   | 880                                 | 11                                   | 540                                 | YES                      |
| 14       | 2                             | 2                             | 710                                   | 38                                   | 900                                 | 11                                   | 510                                 | YES                      |
| 15       | 2                             | 3                             | 850                                   | 36                                   | 880                                 | 10                                   | 570                                 | YES                      |
| 16       | 2                             | 2                             | 840                                   | 36                                   | 850                                 | 11                                   | 600                                 | YES                      |
| 17       | 2                             | 2                             | 590                                   | 40                                   | 770                                 | 12                                   | 670                                 | YES                      |
| 18       | 3                             | 4                             | 500                                   | 35                                   | 600                                 | 13                                   | 690                                 | YES                      |
| 19       | 3                             | 3                             | 625                                   | 37                                   | 600                                 | 10                                   | 680                                 | YES                      |
| 20       | 3                             | 3                             | 750                                   | 36                                   | 535                                 | 10                                   | 670                                 | YES                      |
| 21       | 3                             | 4                             | 640                                   | 40                                   | 700                                 | 12                                   | 700                                 | YES                      |
| 22       | 3                             | 3                             | 700                                   | 41                                   | 610                                 | 12                                   | 670                                 | YES                      |
| 23       | 3                             | 4                             | 680                                   | 37                                   | 570                                 | 12                                   | 680                                 | YES                      |
| 24       | 3                             | 3                             | 680                                   | 39                                   | 570                                 | 14                                   | 610                                 | YES                      |
| 25       | 3                             | 4                             | 640                                   | 37                                   | 730                                 | 11                                   | 690                                 | YES                      |
| 26       | 3                             | 3                             | 600                                   | 40                                   | 540                                 | 14                                   | 660                                 | YES                      |
| 27       | 3                             | 3                             | 640                                   | 29                                   | 790                                 | 8                                    | 680                                 | YES                      |
| 28       | 2                             | 3                             | 640                                   | 38                                   | 690                                 | 14                                   | 660                                 | YES                      |
| 29       | 4                             | 4                             | 730                                   | 38                                   | 550                                 | 14                                   | 660                                 | YES                      |
| 30       | 4                             | 4                             | 730                                   | 38                                   | 630                                 | 12                                   | 660                                 | YES                      |
| 31       | 3                             | 4                             | 680                                   | 42                                   | 750                                 | 19                                   | 690                                 | YES                      |
| 32       | 3                             | 3                             | 700                                   | 43                                   | 650                                 | 18                                   | 710                                 | YES                      |
| 33       | 5                             | 5                             | 620                                   | 43                                   | 720                                 | 15                                   | 690                                 | YES                      |

| Test Run | Average Background TSS (mg/L) | Maximum Background TSS (mg/L) | Minimum Background Sample Volume (mL) | Average Adjusted Effluent TSS (mg/L) | Minimum Effluent Sample Volume (mL) | Average Adjusted Drawdown TSS (mg/L) | Minimum Drawdown Sample Volume (mL) | QA/QC Compliant (YES/NO) |
|----------|-------------------------------|-------------------------------|---------------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|--------------------------|
| 34       | 5                             | 5                             | 670                                   | 40                                   | 670                                 | 14                                   | 680                                 | YES                      |
| 35       | 4                             | 4                             | 600                                   | 44                                   | 720                                 | 18                                   | 680                                 | YES                      |
| 36       | 4                             | 4                             | 670                                   | 43                                   | 860                                 | 20                                   | 600                                 | YES                      |
| 37       | 5                             | 5                             | 690                                   | 43                                   | 890                                 | 16                                   | 590                                 | YES                      |
| 38       | 5                             | 6                             | 750                                   | 41                                   | 840                                 | 19                                   | 600                                 | YES                      |
| 39       | 6                             | 6                             | 680                                   | 35                                   | 870                                 | 15                                   | 610                                 | YES                      |
| 40       | 6                             | 7                             | 720                                   | 40                                   | 870                                 | 15                                   | 570                                 | YES                      |
| 41       | 4                             | 4                             | 690                                   | 43                                   | 890                                 | 21                                   | 630                                 | YES                      |
| 42       | 3                             | 3                             | 720                                   | 45                                   | 870                                 | 22                                   | 610                                 | YES                      |
| 43       | 3                             | 3                             | 690                                   | 41                                   | 760                                 | 17                                   | 740                                 | YES                      |
| 44       | 3                             | 4                             | 700                                   | 40                                   | 780                                 | 16                                   | 620                                 | YES                      |
| 45       | 4                             | 4                             | 670                                   | 47                                   | 850                                 | 24                                   | 610                                 | YES                      |
| 46       | 2                             | 2                             | 720                                   | 79                                   | 630                                 | 31                                   | 660                                 | YES                      |
| 47       | 2                             | 2                             | 720                                   | 82                                   | 660                                 | 35                                   | 660                                 | YES                      |
| 48       | 2                             | 3                             | 685                                   | 86                                   | 791                                 | 37                                   | 630                                 | YES                      |
| 49       | 3                             | 5                             | 640                                   | 87                                   | 660                                 | 38                                   | 670                                 | YES                      |
| 50       | 2                             | 2                             | 720                                   | 86                                   | 670                                 | 45                                   | 670                                 | YES                      |
| 51       | 4                             | 4                             | 650                                   | 88                                   | 770                                 | 48                                   | 700                                 | YES                      |
| 52       | 4                             | 4                             | 740                                   | 90                                   | 650                                 | 56                                   | 690                                 | YES                      |
| 53       | 4                             | 4                             | 680                                   | 92                                   | 700                                 | 62                                   | 690                                 | YES                      |
| 54       | 5                             | 6                             | 770                                   | 90                                   | 690                                 | 50                                   | 670                                 | YES                      |
| 55       | 4                             | 4                             | 700                                   | 86                                   | 660                                 | 53                                   | 660                                 | YES                      |
| 56       | 2                             | 2                             | 730                                   | 89                                   | 830                                 | 50                                   | 670                                 | YES                      |
| 57       | 2                             | 3                             | 770                                   | 89                                   | 830                                 | 40                                   | 650                                 | YES                      |
| 58       | 3                             | 3                             | 760                                   | 90                                   | 910                                 | 67                                   | 640                                 | YES                      |
| 59       | 3                             | 4                             | 740                                   | 93                                   | 890                                 | 65                                   | 670                                 | YES                      |
| 60       | 3                             | 3                             | 690                                   | 88                                   | 860                                 | 58                                   | 640                                 | YES                      |
| 61       | 2                             | 2                             | 730                                   | 91                                   | 900                                 | 58                                   | 555                                 | NO*                      |
| 62       | 2                             | 2                             | 750                                   | 87                                   | 900                                 | 51                                   | 610                                 | YES                      |
| 63       | 3                             | 3                             | 770                                   | 88                                   | 860                                 | 56                                   | 600                                 | YES                      |
| 64       | 3                             | 3                             | 710                                   | 91                                   | 860                                 | 62                                   | 630                                 | YES                      |
| 65       | 4                             | 4                             | 740                                   | 89                                   | 890                                 | 63                                   | 630                                 | YES                      |
| 66       | 4                             | 4                             | 780                                   | 89                                   | 850                                 | 82                                   | 560                                 | YES                      |
| 67       | 4                             | 4                             | 770                                   | 95                                   | 680                                 | 67                                   | 740                                 | YES                      |

*\*See Section 4.4 for discussion*

## Mass Loading Results

The total influent mass loaded at the conclusion of the testing process (Trial 66) was 68.1 lbs and the total mass captured by the StormFilter was 54.5 lbs. There was an average of 3-3.5 inches of sediment on the bottom of the test tank after testing. No maintenance was performed on the test system during the entire testing program. The average TSS RE (on a mass basis) was 80% after all testing was complete. The RE results were excluded from test runs 14, 27 and 61 due to equipment issues and one sampling error (see Section 4.4 for discussion), so the average TSS RE from the trial before and following trials 14, 27 and 61 was used to determine the mass captured. **Table 13** and **Figure 5** summarize the removal efficiency and mass loading results.

**Table 13 Sediment Mass Loading Results**

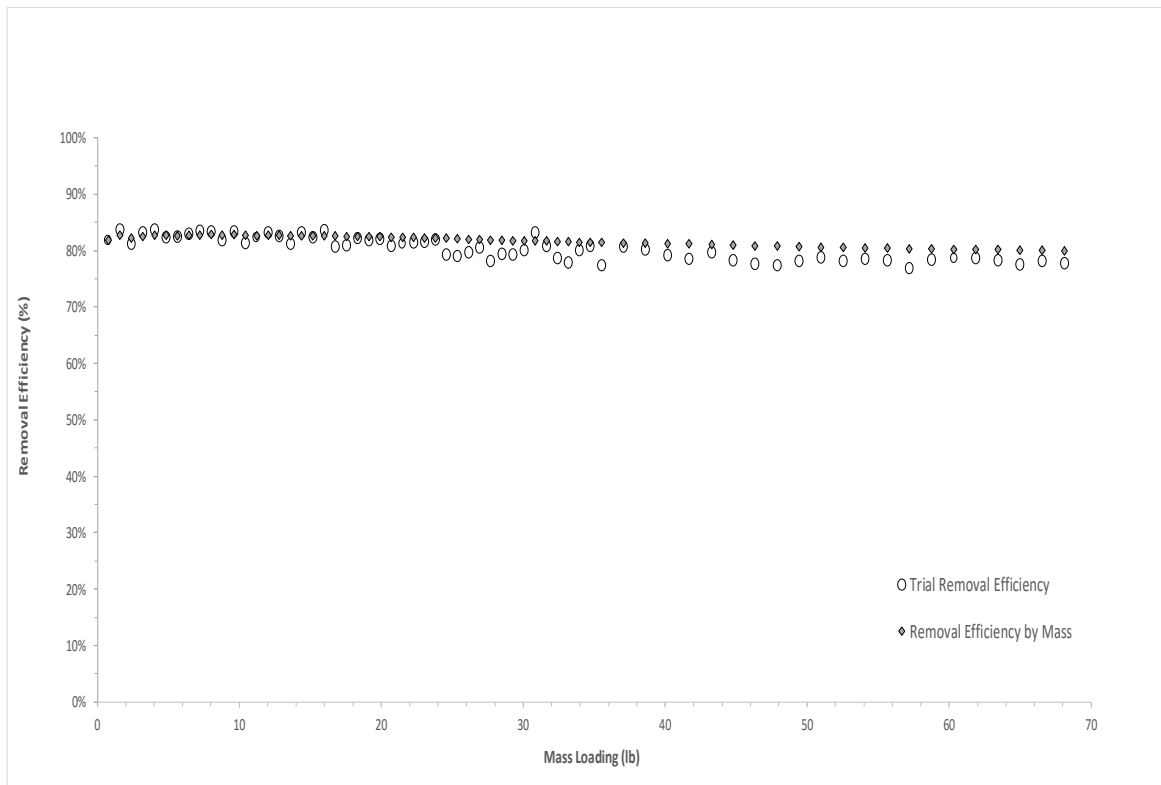
| Test Run | Average Influent TSS (mg/L) | Average Adjusted Effluent TSS (mg/L) | Average Adjusted Drawdown TSS (mg/L) | Influent Volume (L) | Effluent Volume (L) | Drawdown Volume (L) | Mass Loading (lb.) | Mass Captured (lb.) | Trial Removal Efficiency (%) | Average Removal Efficiency by Mass (%) |
|----------|-----------------------------|--------------------------------------|--------------------------------------|---------------------|---------------------|---------------------|--------------------|---------------------|------------------------------|----------------------------------------|
| 11       | 200                         | 37                                   | 11                                   | 1758                | 1681                | 77                  | 8.8                | 7.3                 | 81.8%                        | 82.8%                                  |
| 12       | 209                         | 36                                   | 12                                   | 1756                | 1674                | 82                  | 9.6                | 8.0                 | 83.4%                        | 82.8%                                  |
| 13       | 211                         | 41                                   | 11                                   | 1758                | 1677                | 81                  | 10.4               | 8.6                 | 81.3%                        | 82.7%                                  |
| 14       | 206                         | 38                                   | 11                                   | 1754                | 1674                | 79                  | 11.2               | 9.3                 | 82.2%**                      | 82.7%                                  |
| 15       | 209                         | 36                                   | 10                                   | 1738                | 1663                | 75                  | 12.0               | 9.9                 | 83.2%                        | 82.7%                                  |
| 16       | 202                         | 36                                   | 11                                   | 1750                | 1671                | 79                  | 12.8               | 10.6                | 82.6%                        | 82.7%                                  |
| 17       | 206                         | 40                                   | 12                                   | 1753                | 1672                | 81                  | 13.6               | 11.2                | 81.3%                        | 82.6%                                  |
| 18       | 203                         | 35                                   | 13                                   | 1750                | 1670                | 79                  | 14.4               | 11.9                | 83.2%                        | 82.6%                                  |
| 19       | 204                         | 37                                   | 10                                   | 1760                | 1678                | 82                  | 15.2               | 12.5                | 82.4%                        | 82.6%                                  |
| 20       | 210                         | 36                                   | 10                                   | 1757                | 1677                | 80                  | 16.0               | 13.2                | 83.6%                        | 82.7%                                  |
| 21       | 199                         | 40                                   | 12                                   | 1757                | 1679                | 77                  | 16.8               | 13.8                | 80.7%                        | 82.6%                                  |
| 22       | 206                         | 41                                   | 12                                   | 1749                | 1669                | 79                  | 17.5               | 14.5                | 80.9%                        | 82.5%                                  |
| 23       | 203                         | 37                                   | 12                                   | 1749                | 1673                | 76                  | 18.3               | 15.1                | 82.3%                        | 82.5%                                  |
| 24       | 206                         | 39                                   | 14                                   | 1763                | 1682                | 81                  | 19.1               | 15.8                | 81.8%                        | 82.5%                                  |
| 25       | 203                         | 37                                   | 11                                   | 1758                | 1679                | 79                  | 19.9               | 16.4                | 82.1%                        | 82.5%                                  |
| 26       | 204                         | 40                                   | 14                                   | 1758                | 1679                | 79                  | 20.7               | 17.1                | 80.8%                        | 82.4%                                  |
| 27       | 208                         | 29                                   | 8                                    | 1756                | 1679                | 77                  | 21.5               | 17.7                | 81.2%**                      | 82.3%                                  |
| 28       | 199                         | 38                                   | 14                                   | 1748                | 1671                | 77                  | 22.3               | 18.3                | 81.5%                        | 82.3%                                  |
| 29       | 199                         | 38                                   | 14                                   | 1756                | 1675                | 80                  | 23.0               | 19.0                | 81.6%                        | 82.3%                                  |
| 30       | 202                         | 38                                   | 12                                   | 1761                | 1679                | 81                  | 23.8               | 19.6                | 82.0%                        | 82.3%                                  |
| 31       | 200                         | 42                                   | 19                                   | 1754                | 1678                | 76                  | 24.6               | 20.2                | 79.3%                        | 82.2%                                  |
| 32       | 202                         | 43                                   | 18                                   | 1757                | 1680                | 77                  | 25.4               | 20.8                | 79.1%                        | 82.1%                                  |
| 33       | 204                         | 43                                   | 15                                   | 1758                | 1678                | 80                  | 26.2               | 21.5                | 79.8%                        | 82.0%                                  |
| 34       | 200                         | 40                                   | 14                                   | 1759                | 1680                | 78                  | 26.9               | 22.1                | 80.6%                        | 82.0%                                  |



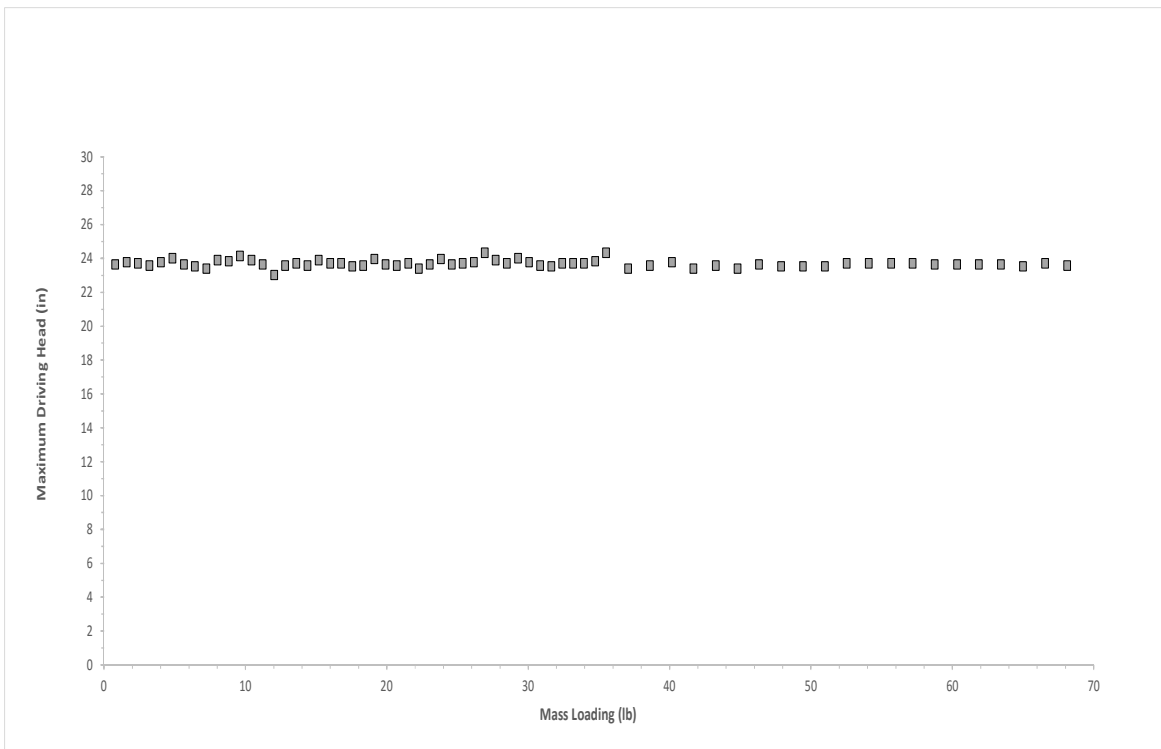
| Test Run | Average Influent TSS (mg/L) | Average Adjusted Effluent TSS (mg/L) | Average Adjusted Drawdown TSS (mg/L) | Influent Volume (L) | Effluent Volume (L) | Drawdown Volume (L) | Mass Loading (lb.) | Mass Captured (lb.) | Trial Removal Efficiency (%) | Average Removal Efficiency by Mass (%) |
|----------|-----------------------------|--------------------------------------|--------------------------------------|---------------------|---------------------|---------------------|--------------------|---------------------|------------------------------|----------------------------------------|
| 35       | 198                         | 44                                   | 18                                   | 1760                | 1680                | 79                  | 27.7               | 22.7                | 78.1%                        | 81.9%                                  |
| 36       | 204                         | 43                                   | 20                                   | 1758                | 1678                | 80                  | 28.5               | 23.3                | 79.5%                        | 81.8%                                  |
| 37       | 203                         | 43                                   | 16                                   | 1762                | 1682                | 80                  | 29.3               | 23.9                | 79.4%                        | 81.7%                                  |
| 38       | 202                         | 41                                   | 19                                   | 1762                | 1683                | 79                  | 30.1               | 24.6                | 80.0%                        | 81.7%                                  |
| 39       | 203                         | 35                                   | 15                                   | 1760                | 1682                | 78                  | 30.8               | 25.2                | 83.3%                        | 81.7%                                  |
| 40       | 203                         | 40                                   | 15                                   | 1754                | 1676                | 78                  | 31.6               | 25.8                | 80.9%                        | 81.7%                                  |
| 41       | 199                         | 43                                   | 21                                   | 1758                | 1677                | 80                  | 32.4               | 26.4                | 78.7%                        | 81.6%                                  |
| 42       | 199                         | 45                                   | 22                                   | 1762                | 1683                | 79                  | 33.2               | 27.0                | 77.9%                        | 81.6%                                  |
| 43       | 200                         | 41                                   | 17                                   | 1761                | 1682                | 79                  | 33.9               | 27.7                | 80.1%                        | 81.5%                                  |
| 44       | 203                         | 40                                   | 16                                   | 1759                | 1679                | 80                  | 34.7               | 28.3                | 80.9%                        | 81.5%                                  |
| 45       | 202                         | 47                                   | 24                                   | 1760                | 1681                | 79                  | 35.5               | 28.9                | 77.4%                        | 81.4%                                  |
| 46       | 401                         | 79                                   | 31                                   | 1747                | 1672                | 75                  | 37.1               | 30.2                | 80.8%                        | 81.4%                                  |
| 47       | 402                         | 82                                   | 35                                   | 1754                | 1678                | 76                  | 38.6               | 31.4                | 80.2%                        | 81.3%                                  |
| 48       | 401                         | 86                                   | 37                                   | 1754                | 1677                | 78                  | 40.2               | 32.6                | 79.2%                        | 81.3%                                  |
| 49       | 396                         | 87                                   | 38                                   | 1753                | 1676                | 76                  | 41.7               | 33.8                | 78.5%                        | 81.2%                                  |
| 50       | 412                         | 86                                   | 45                                   | 1754                | 1678                | 76                  | 43.3               | 35.1                | 79.6%                        | 81.1%                                  |
| 51       | 396                         | 88                                   | 48                                   | 1752                | 1677                | 75                  | 44.8               | 36.3                | 78.3%                        | 81.0%                                  |
| 52       | 396                         | 90                                   | 56                                   | 1754                | 1679                | 75                  | 46.3               | 37.5                | 77.6%                        | 80.9%                                  |
| 53       | 403                         | 92                                   | 62                                   | 1757                | 1681                | 75                  | 47.9               | 38.7                | 77.4%                        | 80.8%                                  |
| 54       | 403                         | 90                                   | 50                                   | 1757                | 1681                | 75                  | 49.4               | 39.9                | 78.1%                        | 80.7%                                  |
| 55       | 400                         | 86                                   | 53                                   | 1754                | 1679                | 75                  | 51.0               | 41.1                | 78.8%                        | 80.6%                                  |
| 56       | 400                         | 89                                   | 50                                   | 1759                | 1684                | 75                  | 52.5               | 42.3                | 78.2%                        | 80.6%                                  |
| 57       | 403                         | 89                                   | 40                                   | 1757                | 1680                | 76                  | 54.1               | 43.5                | 78.5%                        | 80.5%                                  |
| 58       | 407                         | 90                                   | 67                                   | 1760                | 1684                | 75                  | 55.7               | 44.8                | 78.2%                        | 80.4%                                  |
| 59       | 395                         | 93                                   | 65                                   | 1759                | 1682                | 76                  | 57.2               | 45.9                | 76.9%                        | 80.3%                                  |
| 60       | 404                         | 88                                   | 58                                   | 1756                | 1683                | 73                  | 58.7               | 47.2                | 78.5%                        | 80.3%                                  |
| 61       | 410                         | 91                                   | 58                                   | 1762                | 1687                | 76                  | 60.3               | 48.4                | 78.5%**                      | 80.2%                                  |
| 62       | 398                         | 87                                   | 51                                   | 1755                | 1680                | 75                  | 61.9               | 49.6                | 78.6%                        | 80.2%                                  |
| 63       | 401                         | 88                                   | 56                                   | 1763                | 1690                | 72                  | 63.4               | 50.8                | 78.3%                        | 80.2%                                  |
| 64       | 402                         | 91                                   | 62                                   | 1759                | 1685                | 73                  | 65.0               | 52.1                | 77.6%                        | 80.1%                                  |
| 65       | 403                         | 89                                   | 63                                   | 1759                | 1686                | 73                  | 66.5               | 53.3                | 78.2%                        | 80.1%                                  |
| 66       | 402                         | 89                                   | 82                                   | 1759                | 1686                | 73                  | 68.1               | 54.5                | 77.8%                        | 80.0%                                  |
| 67       | 405                         | 95                                   | 67                                   | 1756                | 1686                | 70                  | 69.7               | 55.7                | 76.9%                        | 79.9%                                  |

*\*See Section 4.4 for discussion*

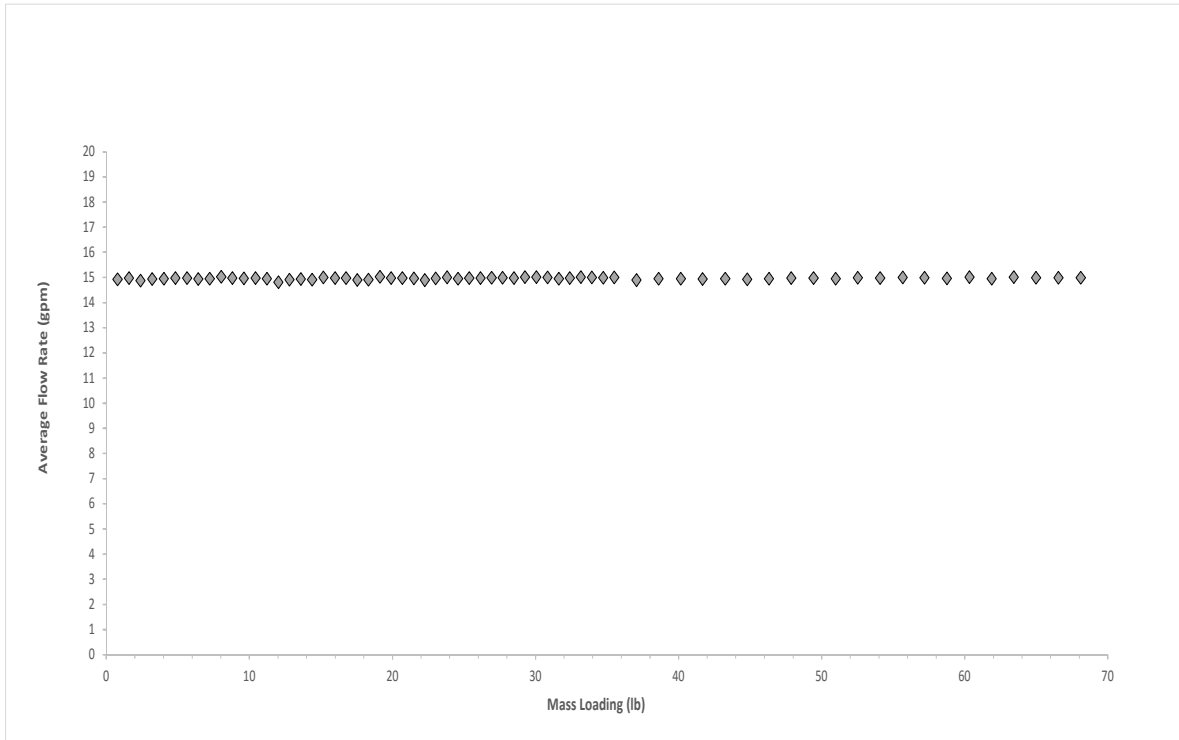
*\*\* RE value assigned using the average of the trial immediately before and following this trial*



**Figure 5 Average Removal Efficiency (by mass) and Trial Removal Efficiency vs. Sediment Mass Loading**



**Figure 6 Maximum Driving Head vs. Sediment Mass Loading**



**Figure 7 Average Flow Rate vs. Sediment Mass Loading**

#### 4.4 Excluded Results

The RE results of test runs 14, 27 and 61 were excluded to either sample collection or equipment errors. As required, all data collected during these trials are disclosed in **Table 4** through **Table 13**. During test run 14, the data logger battery failed, which compromised the flow rate data for that trial. Test run 27 showed correct sediment feed rates, but an equipment setup error prevented the sediment from being injected at a constant influent dosing of 200 mg/L over the entirety of the trial. It was verified that a portion of sediment intended for (but not injected during) run 27 entered the test box during the start of test run (28). The drawdown period of test run 61 was shorter than anticipated because the cartridge float valve did not fully close. As a result of the shorter duration, the second drawdown TSS sample could not be collected before the test run concluded.

The mass captured calculation (**Equation 9**) uses individual test run RE values and could not be performed for test runs 14, 27 and 61 with the stated data exclusions. Instead, the average removal efficiency from the trial immediately prior to and proceeding the impacted trials was substituted for the purpose of calculating the mass captured. This approach is consistent with the policy established by NJDEP and NJCAT.

#### 5. Design Limitations

##### *Required Soil Characteristics*

The StormFilter is suitable for installation in all types of soils.

#### *Slope*

The StormFilter is recommended to be installed at 0% slope. Steep pipe slopes (>25 degrees) may present a fabrication or installation challenge and are likely to create inlet velocities that even at low flows may cause excess turbulence or resuspension of settled pollutants. However, due to the wide variety of configurations available for both the structure and the internal components, the StormFilter may be able to accommodate pipes with such aggressive slopes with minimal impact to the overall system performance. Inlet configurations such as the catch basin can be designed to accommodate sloping surface grades. Contech's engineering team should be consulted during the design process with questions relative to slope.

#### *Maximum Flow Rate*

The maximum treatment flow rate for the StormFilter is a function of model size and the number and size of the filter cartridges contained in the unit. The StormFilter is rated for a hydraulic loading rate of 2.12 gpm/ft<sup>2</sup> of filter media surface area.

#### *Maintenance Requirements*

As is true of all stormwater best management practices, maintenance requirements for each individual StormFilter installation will be influenced by site specific pollutant loading. Detailed maintenance information is provided in **Section 6**.

#### *Driving Head*

The amount of driving head required for normal operation of the StormFilter is typically fixed and dependent on the cartridge height. The minimum drop required across a StormFilter system is typically 1.8 ft, 2.3 ft and 3.05 ft for the low drop, 18 and 27-inch tall cartridges respectively. When site conditions limit the amount of drop available across the StormFilter then flow is typically backed up into the upstream piping during operation to ensure sufficient driving head is provided. The StormFilter can be designed to accommodate much higher drop/driving head where applicable.

#### *Installation Limitations*

The StormFilter is subject to few installation limitations. Contech's engineering team works with the site design engineer and support is provided to the contractor to ensure each unit is properly designed and installed given the unique conditions of each site.

#### *Configurations*

The StormFilter is typically comprised of a vault or manhole structure that house the rechargeable, media-filled filter cartridges. The StormFilter is also offered in plastic, steel, and concrete catch basins. Other configurations include panel vaults, CON/SPAN<sup>®</sup>, box culverts, and curb inlets. The filter cartridges operate consistently and act independently, regardless of



housing, which enables linear scaling.

#### *Structural Load Limitations*

Most StormFilter configurations are designed for H-20 traffic loading. Contech's engineering team ensures that the configuration is appropriate for the site specific loading conditions during the design process.

#### *Pre-treatment Requirements*

The StormFilter does not require additional pretreatment. If desirable, pretreatment may be provided upstream of the StormFilter to reduce the pollutant load reaching the filter media and extend the useful life of the cartridges. However, all sediment capacity and maintenance recommendations assume no additional pretreatment is provided.

#### *Limitations in Tailwater*

Tailwater has the potential to impact the operation of the StormFilter. Any applications where the StormFilter will be subject to tailwater conditions should be reviewed with Contech's engineering team to evaluate the potential impact on proper functionality and performance.

#### *Depth to Seasonal High Water Table*

The operation and performance of the StormFilter is not typically impacted by high ground water since the unit is fully contained in a vault, manhole or other closed structure. Contech's engineering team is available to consult on the need for water tightness and/or concerns related to buoyancy.

## **6. Maintenance**

#### *Maintenance Procedures*

Although there are many effective maintenance options, Contech believes the following procedure to be efficient, using common equipment and existing maintenance protocols. The following two-step procedure is recommended and can also be found at: <http://www.conteches.com/DesktopModules/Bring2mind/DMX/Download.aspx?EntryId=2813&PortalId=0&DownloadMethod=attachment>.

1. Inspection - vault interior to determine the need for maintenance.
2. Maintenance - cartridge replacement and sediment removal

#### *Inspection and Maintenance*

At least one scheduled inspection should take place per year, followed by maintenance if necessary. First, an inspection should be performed before the winter season. During the inspection, the need for maintenance should be determined. If disposal during maintenance will be required, samples of the accumulated sediments and filtration media should be collected.

Second, if necessary, maintenance (replacement of the filter cartridges and removal of accumulated sediments) should be performed during periods of dry weather. In addition to these two activities, it is important to check the condition of the StormFilter unit after major storms for potential damage caused by high flows and for high sediment accumulation that may be caused by localized erosion in the drainage area. It may be necessary to adjust the inspection/maintenance schedule depending on the actual operating conditions encountered by the system. In general, inspection activities can be conducted at any time, and maintenance should occur, if warranted, during dryer months in late summer to early fall.

### *Maintenance Frequency*

The primary factor for determining frequency of maintenance for the StormFilter is sediment loading. A properly functioning system will remove solids from water by trapping particulates in the porous structure of the filter media inside the cartridges. The flow through the system will naturally decrease as more and more particulates are trapped. Eventually the flow through the cartridges will be low enough to require replacement. It may be possible to extend the usable span of the cartridges by removing sediment from upstream trapping devices on a routine, as-needed basis in order to prevent material from being re-suspended and discharged to the StormFilter treatment system.

The average maintenance lifecycle is approximately 1-5 years. Site conditions greatly influence maintenance requirements. StormFilter units located in areas with erosion or active construction may need to be inspected and maintained more often than those with fully stabilized surface conditions.

Regulatory requirements or a chemical spill can shift maintenance timing as well. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that consistently develop problems should be inspected more frequently than areas that experience fewer problems, particularly after major storms. Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual StormFilter system or site. It is recommended that the site owner develop a database to properly manage StormFilter inspection and maintenance programs.

### *Inspection Procedures*

The primary goal of an inspection is to assess the condition of the cartridges relative to the level of visual sediment loading as it relates to decreased treatment capacity. It may be desirable to conduct this inspection during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, then large amounts of sediments will typically be present and very little flow will be discharged from the drainage pipes. If this is the case, then maintenance is warranted and the cartridges need to be replaced.

**Warning:** In the case of a spill, the worker should abort inspection activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

**Important:** Inspection should be performed by a person who is familiar with the operation and configuration of the StormFilter treatment unit.

To conduct an inspection:

1. If applicable, set up safety equipment to protect and notify surrounding vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system to vent.
4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.
5. Be sure to record the level of sediment build-up on the floor of the vault, in the forebay, and on top of the cartridges. If flow is occurring, note the flow of water per drainage pipe. Record all observations. Digital pictures are valuable for historical documentation.
6. Close and fasten the access portals.
7. Remove safety equipment.
8. If appropriate, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.
9. Discuss conditions that suggest maintenance and make decision as to whether or not maintenance is needed.

### *Maintenance Decision Tree*

The need for maintenance is typically based on results of the inspection. The following Maintenance Decision Tree should be used as a general guide. (Other factors, such as regulatory requirements, may need to be considered).

1. Sediment loading on the vault floor.
  - If >4" of accumulated sediment, maintenance is required.
2. Sediment loading on top of the cartridge.
  - If >1/4" of accumulation, maintenance is required. (Note that this indicator is not always applicable to volume StormFilter designs)
3. Submerged cartridges.
  - If >4" of static water above cartridge bottom for more than 24 hours after end of rain event, maintenance is required. (Catch basins have standing water in the cartridge bay.)
4. Plugged media.

- If pore space between media granules is absent, maintenance is required.
5. Bypass condition.
    - If inspection is conducted during an average rain fall event and StormFilter remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges), maintenance is required.
  6. Hazardous material release.
    - If hazardous material release (automotive fluids or other) is reported, maintenance is required.
  7. Pronounced scum line.
    - If pronounced scum line ( $\geq 1/4$ " thick) is present above top cap, maintenance is required.

### *Maintenance*

Depending on the configuration of the particular system, maintenance personnel will be required to enter the vault to perform the maintenance.

**Important:** If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. It may be necessary to plug the filter inlet pipe if base flows is occurring.

Replacement cartridges can be delivered to the site or customers facility. Information concerning how to obtain the replacement cartridges is available from Contech Engineered Solutions.

**Warning:** In the case of a spill, the maintenance personnel should abort maintenance activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct cartridge replacement and sediment removal maintenance:

1. If applicable, set up safety equipment to protect maintenance personnel and pedestrians from site hazards.
2. Visually inspect the external condition of the unit and take notes concerning defects and/or problems.
3. Open the doors (access portals) to the vault and allow the system to vent.
4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.



5. Make notes about the external and internal condition of the vault. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.
6. Using appropriate equipment offload the replacement cartridges (up to 150 lbs. each) and set aside.
7. Remove used cartridges from the vault using one of the following methods:

#### *Method 1*

1. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

Using appropriate hoisting equipment, attach a cable from the boom, crane, or tripod to the loose cartridge. Contact Contech Engineered Solutions for suggested attachment devices.

2. Remove the used cartridges (up to 250 lbs. each) from the vault.  
**Important:** Care must be used to avoid damaging the cartridges during removal and installation. The cost of repairing components damaged during maintenance will be the responsibility of the owner.
3. Set the used cartridge aside or load onto the hauling truck.
4. Continue steps 1 through 3 until all cartridges have been removed.

#### *Method 2*

1. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.
2. Unscrew the cartridge cap.
3. Remove the cartridge hood and float.
4. At location under structure access, tip the cartridge on its side.

5. Empty the cartridge onto the vault floor. Reassemble the empty cartridge.
6. Set the empty, used cartridge aside or load onto the hauling truck.
7. Continue steps 1 through 5 until all cartridges have been removed.
8. Remove accumulated sediment from the floor of the vault and from the forebay. This can most effectively be accomplished by use of a vacuum truck.
9. Once the sediments are removed, assess the condition of the vault and the condition of the connectors.
10. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Once again, take care not to damage connections.
11. Close and fasten the door.
12. Remove safety equipment.
13. Finally, dispose of the accumulated materials in accordance with applicable regulations. Make arrangements to return the used empty cartridges to Contech Engineered Solutions.

#### *Related Maintenance Activities - Performed on an As-needed Basis*

StormFilter units are often just one of many structures in a more comprehensive stormwater drainage and treatment system. In order for maintenance of the StormFilter to be successful, it is imperative that all other components be properly maintained. The maintenance/repair of upstream facilities should be carried out prior to StormFilter maintenance activities. In addition to considering upstream facilities, it is also important to correct any problems identified in the drainage area. Drainage area concerns may include: erosion problems, heavy oil loading, and discharges of inappropriate materials.

#### *Material Disposal*

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. This typically requires coordination with a local landfill for solid waste

disposal. For liquid waste disposal a number of options are available including a municipal vacuum truck decant facility, local waste water treatment plant or on-site treatment and discharge.

## **7. Statements**

The following signed statements from the manufacturer (Contech Engineered Solutions, LLC), third-party observer (Scott A. Wells and Associates) and NJCAT are required to complete the NJCAT verification process.

In addition, it should be noted that this report has been subjected to public review (e.g. stormwater industry) and all comments and concerns have been satisfactorily addressed.

8/25/2016

Dr. Richard Magee  
Technical Director  
New Jersey Corporation for Advanced Technology  
c/o Center for Environmental Systems  
Stevens Institute of Technology  
One Castle Point on Hudson  
Hoboken, NJ 07030

**RE: 2016 Verification of the Stormwater Management StormFilter® (StormFilter)**

Dr. Magee,

This correspondence is being sent to you in accordance with the “*Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology*” (Process Document) dated January 25, 2013. Specifically, the process document requires that manufacturers submit a signed statement confirming that all of the procedures and requirements identified in the aforementioned process document and the accompanying NJDEP Filter Laboratory Testing Protocol have been met. We believe that the testing executed at Contech’s laboratory in Portland, Oregon on the StormFilter during the summer of 2016 under the direct supervision of Dr. Scott Wells, Ph.D. and Associates was conducted in full compliance with all applicable protocol and process criteria. Additionally, we believe that all of the required documentation of the testing and resulting performance calculations has been provided within the submittal accompanying this correspondence.

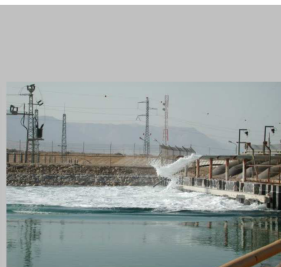
Please do not hesitate to contact me with any additional questions related to this matter.

**RE:**

Respectfully,



Derek M. Berg  
Director – Stormwater Regulatory Management – East  
CONTECH Engineered Solutions LLC  
71 US Route 1, Suite F | Scarborough, ME 04074  
T: 207.885.6174 F: 207.885.9825  
[DBerg@conteches.com](mailto:DBerg@conteches.com)  
[www.ContechES.com](http://www.ContechES.com)



**Scott A. Wells and Associates**

Environmental Engineering and Modeling  
2382 SW Cedar Street  
Portland, OR 97205 USA

September 7, 2016

Deborah Beck  
Contech Engineered Solutions LLC  
11815 NE Glenn Widing Dr.  
Portland, OR 97220

Re: NJCAT Technology Verification of Stormwater Management Stormfilter

Dear Deborah:

NJCAT technology verification testing of the Contech Stormwater Management Stormfilter were overseen by Scott A. Wells and Associates during June-July, 2016 at the Contech Portland, Oregon laboratory. Except for the effluent, background, and drawdown sample TSS analysis which was conducted by an outside laboratory, all phases of the test were observed. This included sediment particle size distribution sampling, calibration of the flow meter, weighing of the sediment feed rate samples, and in-house calculations. The frequency of water surface elevation measurements, temperature measurements, sediment feed rate sampling, background sampling, effluent sampling, and drawdown sampling reported for the test were also observed and are reported accurately. The test used applicable NJCAT protocol and that their report accurately reflects the testing observed by Scott A. Wells and Associates.

Truly,

Scott A. Wells, P.E., Ph.D.

Christopher J. Berger, P. E., Ph.D.

503-935-6379

[drswells@outlook.com](mailto:drswells@outlook.com)





**Center for Environmental Systems  
Stevens Institute of Technology  
One Castle Point  
Hoboken, NJ 07030-0000**

November 15, 2016

Titus Magnanao  
NJDEP  
Division of Water Quality  
Bureau of Non-Point Pollution Control  
401-02B  
PO Box 420  
Trenton, NJ 08625-0420

Dear Mr. Magnanao,

Based on my review, evaluation and assessment of the testing conducted on the Contech Stormwater Management StormFilter<sup>®</sup> (StormFilter) under the direct supervision of Scott A. Wells, Ph.D. and Associates, the test protocol requirements contained in the “New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device” (NJDEP Filter Protocol, January 2013) were met or exceeded. Specifically:

*Test Sediment Feed*

Sediment used for solids removal efficiency testing was high-purity silica (SiO<sub>2</sub> 99.8%) material with a PSD consisting of approximately 55% sand, 40% silt, and 5% clay. Three composite PSD samples were sent to Apex Labs, Tigard, OR, an independent analytical testing laboratory. The sediment was found to meet the NJDEP particle size specification and was acceptable for use.

*Removal Efficiency Testing*

Sixty-seven (67) removal efficiency testing runs were completed in accordance with the NJDEP test protocol. Fifty-seven (57) of the 67 test runs were conducted during mass loading and 10 during RE testing. The target flow rate and influent sediment concentration were 15 gpm and 200 mg/L (increased to 400 mg/L after run 45) respectively. The system did not occlude or reach

maximum driving head during the test process, but the average removal efficiency (on a mass basis) dropped below 80% after run 66 so testing was suspended and deemed complete as per the QAPP and protocol. The StormFilter demonstrated an average sediment removal efficiency on a mass basis of 80% over the course of the 66 test runs.

#### *Sediment Mass Loading Capacity*

Mass loading capacity testing was conducted as a continuation of removal efficiency (RE) testing. Mass loading test runs were conducted using identical testing procedures and targets as those used in the RE runs, the only change was to increase the target influent concentration to 400 mg/L after test run 45. Testing concluded after 67 test runs.

The total influent mass loaded through run 66 was 68.1 lbs and the total mass captured by the StormFilter was 54.5 lbs. This is equivalent to a sediment mass loading capacity of 7.71 lbs/ft<sup>2</sup> of filter surface area.

No maintenance was performed on the test system during the entire testing program.

#### *Scour Testing*

The StormFilter is designed for off-line installation. Consequently, scour testing is not required.

Sincerely,



Richard S. Magee, Sc.D., P.E., BCEE

## 8. References

ASTM D422-63. *Standard Test Method for Particle-Size Analysis of Soils*.

ASTM D3977-97. *Standard Test Methods for Determining Concentrations in Water Samples*.

Contech Engineered Solutions, LLC 2016. *Quality Assurance Project Plan for Verification of the Stormwater Management StormFilter®*. Prepared by Contech Engineered Solutions. May, 2016.

Contech Engineered Solutions, LLC 2016. *NJCAT Technology Verification: StormFilter*. Prepared by Contech Engineered Solutions. August 2016.

NJDEP 2013a. *New Jersey Department of Environmental Protection Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology*. Trenton, NJ. January 25, 2013.

NJDEP 2013b. *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device*. Trenton, NJ. January 25, 2013.

## **VERIFICATION APPENDIX**

## ***Introduction***

- Manufacturer – Contech Engineered Solutions LLC, 9025 Centre Pointe Drive, West Chester, OH 45069. *General Phone:* 800-338-1122. *Website:* <http://www.conteches.com/>
- MTD - The Stormwater Management StormFilter® (StormFilter) available cartridge heights and their verified capacities as well as standard models are shown in **Table A-1 and A-2**. Additional models are available when designed per the applicable capacities and conditions of this verification.
- TSS Removal Rate – 80%
- Media - Perlite
- Off-line installation

## ***Detailed Specification***

- NJDEP sizing tables and physical dimensions of StormFilter verified models are attached (**Table A-1**). These Sizing Tables are valid for NJ following NJDEP Water Quality Design Storm Event of 1.25" in 2 hours (NJAC 7:8-5.5(a)).
- Maximum inflow drainage area
  - For flow through designs, the maximum inflow drainage area is typically governed by the maximum treatment flow rate of each model as presented in **Table A-1 and Table A-2**.
  - When installed downstream of a detention system that reduces the release rate for the water quality storm the maximum inflow drainage area is often governed by the mass capture capacity. These capacities are expressed as the maximum treatable area in **Table A-1 and Table A-2**
- The flow rate is individually controlled for each cartridge by a restrictor disc located at the connection point between the cartridge and the underdrain manifold. Driving head is managed by positioning of the inlet, outlet, and overflow elevations. The StormFilter is typically designed so that the restrictor disc passes the design treatment rate once the water surface reaches the shoulder of the cartridge which is equivalent to the cartridge height. Since the StormFilter uses a restrictor disc to restrict treatment flows below the hydraulic capacity of the media the system typically operates under consistent driving head for the useful life of the media. Site specific head constraints are also addressed by three different cartridge heights (low drop (effective height of 12 inches), 18, and 27 inches) which operate on the same principal and surface area specific loading rates. The StormFilter requires a minimum of 1.8 ft, 2.3 ft and 3.05 ft of drop between inlet invert and outlet invert to accommodate the low drop, 18 and 27 inch cartridges, respectively, without backing up flow into the upstream piping during operation. When site conditions limit the amount of drop available across the StormFilter then flow is typically backed up



into the upstream piping during operation to ensure sufficient driving head is provided. If desirable the StormFilter can be designed to operate under additional driving head.

- The drain down flow is regulated by a drain down orifice, sized so that a clean filter drains down in approximately 25 minutes.
- StormFilter Inspection and Maintenance Procedures can be found at: <http://www.conteches.com/DesktopModules/Bring2mind/DMX/Download.aspx?EntryId=2813&PortalId=0&DownloadMethod=attachment>.
- This certification does not extend to the enhanced removal rates under NJAC 7:8-5.5 through the addition of settling chambers (such as hydrodynamic separators) or media filtration practices (such as a sand filter).

**Table A-1 Common StormFilter Model Sizes and New Jersey Treatment Capacities**

| Common StormFilter Model Sizes and New Jersey Treatment Capacities                                                                                                                                                                                                                                          |            |                                    |                                       |                                                                       |                                     |                          |                          |                                       |                                                     |                                          |                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------------------------------|---------------------------------------|-----------------------------------------------------------------------|-------------------------------------|--------------------------|--------------------------|---------------------------------------|-----------------------------------------------------|------------------------------------------|------------------------------------------|
| Configuration                                                                                                                                                                                                                                                                                               | Model Size | Max. # Cartridges (Low Drop & 18") | Sedimentation Area (ft <sup>2</sup> ) | Min. Sedimentation Area Per Cartridge <sup>1</sup> (ft <sup>2</sup> ) | MTFR Low Drop (12") Cartridge (gpm) | MTFR 18" Cartridge (gpm) | Max. # of 27" Cartridges | MTFR 27" Cartridge <sup>2</sup> (gpm) | Max. Treatable Area Low Drop (12") Cartridge (acre) | Max. Treatable Area 18" Cartridge (acre) | Max. Treatable Area 27" Cartridge (acre) |
| CATCHBASIN STEEL                                                                                                                                                                                                                                                                                            | SFCB1      | 1                                  | 4.00                                  | 4.00                                                                  | 10.0                                | 15.0                     | 0                        | N/A                                   | 0.061                                               | 0.090                                    | N/A                                      |
|                                                                                                                                                                                                                                                                                                             | SFCB2      | 2                                  | 8.00                                  | 4.00                                                                  | 20.0                                | 30.0                     | 1                        | 22.5                                  | 0.122                                               | 0.180                                    | 0.136                                    |
|                                                                                                                                                                                                                                                                                                             | SFCB3      | 3                                  | 11.33                                 | 3.78                                                                  | 30.0                                | 45.0                     | 2                        | 45.0                                  | 0.183                                               | 0.270                                    | 0.272                                    |
|                                                                                                                                                                                                                                                                                                             | SFCB4      | 4                                  | 14.67                                 | 3.67                                                                  | 40.0                                | 60.0                     | 3                        | 67.5                                  | 0.244                                               | 0.360                                    | 0.408                                    |
| MANHOLE                                                                                                                                                                                                                                                                                                     | SFMH48     | 3                                  | 12.56                                 | 4.19                                                                  | 30.0                                | 45.0                     | 2                        | 45.0                                  | 0.183                                               | 0.270                                    | 0.272                                    |
|                                                                                                                                                                                                                                                                                                             | SFMH60     | 4                                  | 19.63                                 | 4.91                                                                  | 40.0                                | 60.0                     | 4                        | 90.0                                  | 0.244                                               | 0.360                                    | 0.544                                    |
|                                                                                                                                                                                                                                                                                                             | SFMH72     | 7                                  | 28.27                                 | 4.04                                                                  | 70.0                                | 105.0                    | 6                        | 135.0                                 | 0.427                                               | 0.630                                    | 0.816                                    |
|                                                                                                                                                                                                                                                                                                             | SFMH96     | 14                                 | 50.26                                 | 3.59                                                                  | 140.0                               | 210.0                    | 11                       | 247.5                                 | 0.854                                               | 1.260                                    | 1.496                                    |
| VAULT                                                                                                                                                                                                                                                                                                       | SF0806     | 11                                 | 48.00                                 | 4.36                                                                  | 110.0                               | 165.0                    | 10                       | 225.0                                 | 0.671                                               | 0.990                                    | 1.360                                    |
|                                                                                                                                                                                                                                                                                                             | SF0811     | 26                                 | 88.00                                 | 3.38                                                                  | 260.0                               | 390.0                    | 19                       | 427.5                                 | 1.586                                               | 2.340                                    | 2.584                                    |
|                                                                                                                                                                                                                                                                                                             | SF0814     | 34                                 | 112.00                                | 3.29                                                                  | 340.0                               | 510.0                    | 24                       | 540.0                                 | 2.074                                               | 3.060                                    | 3.264                                    |
|                                                                                                                                                                                                                                                                                                             | SF0816     | 39                                 | 128.00                                | 3.28                                                                  | 390.0                               | 585.0                    | 28                       | 630.0                                 | 2.379                                               | 3.510                                    | 3.808                                    |
|                                                                                                                                                                                                                                                                                                             | SF0818     | 44                                 | 144.00                                | 3.27                                                                  | 440.0                               | 660.0                    | 32                       | 720.0                                 | 2.684                                               | 3.960                                    | 4.352                                    |
|                                                                                                                                                                                                                                                                                                             | SF0820     | 51                                 | 160.00                                | 3.14                                                                  | 510.0                               | 765.0                    | 35                       | 787.5                                 | 3.111                                               | 4.590                                    | 4.760                                    |
|                                                                                                                                                                                                                                                                                                             | SF0822     | 56                                 | 176.00                                | 3.14                                                                  | 560.0                               | 840.0                    | 39                       | 877.5                                 | 3.416                                               | 5.040                                    | 5.304                                    |
|                                                                                                                                                                                                                                                                                                             | SF0824     | 61                                 | 192.00                                | 3.15                                                                  | 610.0                               | 915.0                    | 42                       | 945.0                                 | 3.721                                               | 5.490                                    | 5.712                                    |
| LINEAR GRATE                                                                                                                                                                                                                                                                                                | SFLG0408   | 4                                  | 23.33                                 | 5.83                                                                  | 40.0                                | 60.0                     | 4                        | 90.0                                  | 0.244                                               | 0.360                                    | 0.544                                    |
|                                                                                                                                                                                                                                                                                                             | SFLG0608   | 9                                  | 38.67                                 | 4.30                                                                  | 90.0                                | 135.0                    | 8                        | 180.0                                 | 0.549                                               | 0.810                                    | 1.088                                    |
|                                                                                                                                                                                                                                                                                                             | SFLG0610   | 11                                 | 49.67                                 | 4.52                                                                  | 110.0                               | 165.0                    | 10                       | 225.0                                 | 0.671                                               | 0.990                                    | 1.360                                    |
|                                                                                                                                                                                                                                                                                                             | SFLG0612   | 15                                 | 60.67                                 | 4.04                                                                  | 150.0                               | 225.0                    | 13                       | 292.5                                 | 0.915                                               | 1.350                                    | 1.768                                    |
|                                                                                                                                                                                                                                                                                                             | SFLG0614   | 18                                 | 71.67                                 | 3.98                                                                  | 180.0                               | 270.0                    | 15                       | 337.5                                 | 1.098                                               | 1.620                                    | 2.040                                    |
|                                                                                                                                                                                                                                                                                                             | SFLG0616   | 21                                 | 82.67                                 | 3.94                                                                  | 210.0                               | 315.0                    | 18                       | 405.0                                 | 1.281                                               | 1.890                                    | 2.448                                    |
|                                                                                                                                                                                                                                                                                                             | SFLG0618   | 24                                 | 90.67                                 | 3.78                                                                  | 240.0                               | 360.0                    | 20                       | 450.0                                 | 1.464                                               | 2.160                                    | 2.720                                    |
|                                                                                                                                                                                                                                                                                                             | SFLG0816   | 25                                 | 110.67                                | 4.43                                                                  | 250.0                               | 375.0                    | 24                       | 540.0                                 | 1.525                                               | 2.250                                    | 3.264                                    |
| PEAK DIVERSION                                                                                                                                                                                                                                                                                              | SFLG0818   | 29                                 | 121.29                                | 4.18                                                                  | 290.0                               | 435.0                    | 26                       | 585.0                                 | 1.769                                               | 2.610                                    | 3.536                                    |
|                                                                                                                                                                                                                                                                                                             | SFPD0806   | 8                                  | 34.28                                 | 4.28                                                                  | 80.0                                | 120.0                    | 7                        | 157.5                                 | 0.488                                               | 0.720                                    | 0.952                                    |
|                                                                                                                                                                                                                                                                                                             | SFPD0612   | 11                                 | 55.58                                 | 5.05                                                                  | 110.0                               | 165.0                    | 11                       | 247.5                                 | 0.671                                               | 0.990                                    | 1.496                                    |
|                                                                                                                                                                                                                                                                                                             | SFPD0811   | 18                                 | 68.83                                 | 3.82                                                                  | 180.0                               | 270.0                    | 15                       | 337.5                                 | 1.098                                               | 1.620                                    | 2.040                                    |
|                                                                                                                                                                                                                                                                                                             | SFPD0814   | 25                                 | 92.83                                 | 3.71                                                                  | 250.0                               | 375.0                    | 20                       | 450.0                                 | 1.525                                               | 2.250                                    | 2.720                                    |
|                                                                                                                                                                                                                                                                                                             | SFPD0816   | 33                                 | 108.83                                | 3.30                                                                  | 330.0                               | 495.0                    | 24                       | 540.0                                 | 2.013                                               | 2.970                                    | 3.264                                    |
|                                                                                                                                                                                                                                                                                                             | SFPD0818   | 38                                 | 124.83                                | 3.29                                                                  | 380.0                               | 570.0                    | 27                       | 607.5                                 | 2.318                                               | 3.420                                    | 3.672                                    |
|                                                                                                                                                                                                                                                                                                             | SFPD0820   | 43                                 | 140.83                                | 3.28                                                                  | 430.0                               | 645.0                    | 31                       | 697.5                                 | 2.623                                               | 3.870                                    | 4.216                                    |
|                                                                                                                                                                                                                                                                                                             | SFPD0822   | 48                                 | 156.83                                | 3.27                                                                  | 480.0                               | 720.0                    | 34                       | 765.0                                 | 2.928                                               | 4.320                                    | 4.624                                    |
|                                                                                                                                                                                                                                                                                                             | SFPD0824   | 55                                 | 172.83                                | 3.14                                                                  | 550.0                               | 825.0                    | 38                       | 855.0                                 | 3.355                                               | 4.950                                    | 5.168                                    |
| 1 - Sedimentation Area shown references maximum # cartridges column.<br>2 - MTFR 27" Cartridges uses reduced maximum cartridge count associated with maintaining 4.50 sqft/cartridge sedimentation area lower limit.<br>NOTE: ADDITIONAL SIZES AND CONFIGURATIONS AVAILABLE, CONSULT CONTECH FOR ASSISTANCE |            |                                    |                                       |                                                                       |                                     |                          |                          |                                       |                                                     |                                          |                                          |

**Table A-2 StormFilter Cartridge Heights and New Jersey Treatment Capacities**

| <b>StormFilter Cartridge Heights and New Jersey Treatment Capacities</b> |                                                 |                    |                                    |                                              |
|--------------------------------------------------------------------------|-------------------------------------------------|--------------------|------------------------------------|----------------------------------------------|
| <b>StormFilter Cartridge Height</b>                                      | <b>Filtration Surface Area (ft<sup>2</sup>)</b> | <b>MTFR* (GPM)</b> | <b>Mass Capture Capacity (lbs)</b> | <b>Maximum Allowable Inflow Area (acres)</b> |
| Low Drop (12")                                                           | 4.71                                            | 10                 | 36.3                               | 0.061                                        |
| 18"                                                                      | 7.07                                            | 15                 | 54.5                               | 0.09                                         |
| 27"                                                                      | 10.61                                           | 22.5               | 81.8                               | 0.136                                        |
| *2.12 gpm/ft <sup>2</sup> of filter surface                              |                                                 |                    |                                    |                                              |

## StormFilter Inspection and Maintenance Procedures



## Maintenance Guidelines

The primary purpose of the Stormwater Management StormFilter® is to filter and prevent pollutants from entering our waterways. Like any effective filtration system, periodically these pollutants must be removed to restore the StormFilter to its full efficiency and effectiveness.

Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site. Maintenance activities may be required in the event of a chemical spill or due to excessive sediment loading from site erosion or extreme storms. It is a good practice to inspect the system after major storm events.

## Maintenance Procedures

Although there are many effective maintenance options, we believe the following procedure to be efficient, using common equipment and existing maintenance protocols. The following two-step procedure is recommended::

### 1. Inspection

- Inspection of the vault interior to determine the need for maintenance.

### 2. Maintenance

- Cartridge replacement
- Sediment removal

## Inspection and Maintenance Timing

At least one scheduled inspection should take place per year with maintenance following as warranted.

First, an inspection should be done before the winter season. During the inspection the need for maintenance should be determined and, if disposal during maintenance will be required, samples of the accumulated sediments and media should be obtained.

Second, if warranted, a maintenance (replacement of the filter cartridges and removal of accumulated sediments) should be performed during periods of dry weather.

In addition to these two activities, it is important to check the condition of the StormFilter unit after major storms for potential damage caused by high flows and for high sediment accumulation that may be caused by localized erosion in the drainage area. It may be necessary to adjust the inspection/maintenance schedule depending on the actual operating conditions encountered by the system. In general, inspection activities can be conducted at any time, and maintenance should occur, if warranted, during dryer months in late summer to early fall.

## Maintenance Frequency

The primary factor for determining frequency of maintenance for the StormFilter is sediment loading.

A properly functioning system will remove solids from water by trapping particulates in the porous structure of the filter media inside the cartridges. The flow through the system will naturally decrease as more and more particulates are trapped. Eventually the flow through the cartridges will be low enough to require replacement. It may be possible to extend the usable span of the cartridges by removing sediment from upstream trapping devices on a routine as-needed basis, in order to prevent material from being re-suspended and discharged to the StormFilter treatment system.

The average maintenance lifecycle is approximately 1-5 years. Site conditions greatly influence maintenance requirements. StormFilter units located in areas with erosion or active construction may need to be inspected and maintained more often than those with fully stabilized surface conditions.

Regulatory requirements or a chemical spill can shift maintenance timing as well. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that develop known problems should be inspected more frequently than areas that demonstrate no problems, particularly after major storms. Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual StormFilter system or site. It is recommended that the site owner develop a database to properly manage StormFilter inspection and maintenance programs..







## Inspection Procedures

The primary goal of an inspection is to assess the condition of the cartridges relative to the level of visual sediment loading as it relates to decreased treatment capacity. It may be desirable to conduct this inspection during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, then typically large amounts of sediments will be present and very little flow will be discharged from the drainage pipes. If this is the case, then maintenance is warranted and the cartridges need to be replaced.

**Warning:** In the case of a spill, the worker should abort inspection activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct an inspection:

**Important:** Inspection should be performed by a person who is familiar with the operation and configuration of the StormFilter treatment unit.

1. If applicable, set up safety equipment to protect and notify surrounding vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system vent.
4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.
5. Be sure to record the level of sediment build-up on the floor of the vault, in the forebay, and on top of the cartridges. If flow is occurring, note the flow of water per drainage pipe. Record all observations. Digital pictures are valuable for historical documentation.
6. Close and fasten the access portals.
7. Remove safety equipment.
8. If appropriate, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.
9. Discuss conditions that suggest maintenance and make decision as to whether or not maintenance is needed.

## Maintenance Decision Tree

The need for maintenance is typically based on results of the inspection. The following Maintenance Decision Tree should be used as a general guide. (Other factors, such as Regulatory Requirements, may need to be considered)

1. Sediment loading on the vault floor.
  - a. If  $>4"$  of accumulated sediment, maintenance is required.
2. Sediment loading on top of the cartridge.
  - a. If  $>1/4"$  of accumulation, maintenance is required.
3. Submerged cartridges.
  - a. If  $>4"$  of static water above cartridge bottom for more than 24 hours after end of rain event, maintenance is required. (Catch basins have standing water in the cartridge bay.)
4. Plugged media.
  - a. If pore space between media granules is absent, maintenance is required.
5. Bypass condition.
  - a. If inspection is conducted during an average rain fall event and StormFilter remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges), maintenance is required.
6. Hazardous material release.
  - a. If hazardous material release (automotive fluids or other) is reported, maintenance is required.
7. Pronounced scum line.
  - a. If pronounced scum line (say  $\geq 1/4"$  thick) is present above top cap, maintenance is required.



## Maintenance

Depending on the configuration of the particular system, maintenance personnel will be required to enter the vault to perform the maintenance.

**Important:** If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. It may be necessary to plug the filter inlet pipe if base flows is occurring.

Replacement cartridges can be delivered to the site or customers facility. Information concerning how to obtain the replacement cartridges is available from Contech Engineered Solutions.

**Warning:** In the case of a spill, the maintenance personnel should abort maintenance activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct cartridge replacement and sediment removal maintenance:

1. If applicable, set up safety equipment to protect maintenance personnel and pedestrians from site hazards.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the doors (access portals) to the vault and allow the system to vent.
4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.
5. Make notes about the external and internal condition of the vault. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.
6. Using appropriate equipment offload the replacement cartridges (up to 150 lbs. each) and set aside.
7. Remove used cartridges from the vault using one of the following methods:

### Method 1:

- A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

Using appropriate hoisting equipment, attach a cable from the boom, crane, or tripod to the loose cartridge. Contact Contech Engineered Solutions for suggested attachment devices.

- B. Remove the used cartridges (up to 250 lbs. each) from the vault.



**Important:** Care must be used to avoid damaging the cartridges during removal and installation. The cost of repairing components damaged during maintenance will be the responsibility of the owner.

- C. Set the used cartridge aside or load onto the hauling truck.
- D. Continue steps a through c until all cartridges have been removed.

### Method 2:

- A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.
- B. Unscrew the cartridge cap.
- C. Remove the cartridge hood and float.
- D. At location under structure access, tip the cartridge on its side.
- E. Empty the cartridge onto the vault floor. Reassemble the empty cartridge.
- F. Set the empty, used cartridge aside or load onto the hauling truck.
- G. Continue steps a through e until all cartridges have been removed.

8. Remove accumulated sediment from the floor of the vault and from the forebay. This can most effectively be accomplished by use of a vacuum truck.
9. Once the sediments are removed, assess the condition of the vault and the condition of the connectors.
10. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Once again, take care not to damage connections.
11. Close and fasten the door.
12. Remove safety equipment.
13. Finally, dispose of the accumulated materials in accordance with applicable regulations. Make arrangements to return the used **empty** cartridges to Contech Engineered Solutions.

## Related Maintenance Activities - Performed on an as-needed basis

StormFilter units are often just one of many structures in a more comprehensive stormwater drainage and treatment system.

In order for maintenance of the StormFilter to be successful, it is imperative that all other components be properly maintained. The maintenance/repair of upstream facilities should be carried out prior to StormFilter maintenance activities.

In addition to considering upstream facilities, it is also important to correct any problems identified in the drainage area. Drainage area concerns may include: erosion problems, heavy oil loading, and discharges of inappropriate materials.

## Material Disposal

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. This typically requires coordination with a local landfill for solid waste disposal. For liquid waste disposal a number of options are available including a municipal vacuum truck decant facility, local waste water treatment plant or on-site treatment and discharge.



# Inspection Report

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_

Location: \_\_\_\_\_ System Size: \_\_\_\_\_ Months in Service: \_\_\_\_\_

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: \_\_\_\_\_

Sediment Thickness in Forebay: \_\_\_\_\_ Date: \_\_\_\_\_

Sediment Depth on Vault Floor: \_\_\_\_\_

Sediment Depth on Cartridge Top(s): \_\_\_\_\_

Structural Damage: \_\_\_\_\_

Estimated Flow from Drainage Pipes (if available): \_\_\_\_\_

Cartridges Submerged: Yes ☐ No ☐ Depth of Standing Water: \_\_\_\_\_

StormFilter Maintenance Activities (check off if done and give description)

☐ Trash and Debris Removal: \_\_\_\_\_

☐ Minor Structural Repairs: \_\_\_\_\_

☐ Drainage Area Report \_\_\_\_\_

Excessive Oil Loading: Yes ☐ No ☐ Source: \_\_\_\_\_

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: \_\_\_\_\_

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: \_\_\_\_\_

Items Needing Further Work: \_\_\_\_\_

Owners should contact the local public works department and inquire about how the department disposes of their street waste residuals.

Other Comments:

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Review the condition reports from the previous inspection visits.

# StormFilter Maintenance Report

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_

Location: \_\_\_\_\_ System Size: \_\_\_\_\_

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: \_\_\_\_\_

List Safety Procedures and Equipment Used: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## System Observations

Months in Service: \_\_\_\_\_

Oil in Forebay (if present): Yes ☐ No ☐

Sediment Depth in Forebay (if present): \_\_\_\_\_

Sediment Depth on Vault Floor: \_\_\_\_\_

Sediment Depth on Cartridge Top(s): \_\_\_\_\_

Structural Damage: \_\_\_\_\_

## Drainage Area Report

Excessive Oil Loading: Yes ☐ No ☐ Source: \_\_\_\_\_

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: \_\_\_\_\_

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: \_\_\_\_\_

## StormFilter Cartridge Replacement Maintenance Activities

Remove Trash and Debris: Yes ☐ No ☐ Details: \_\_\_\_\_

Replace Cartridges: Yes ☐ No ☐ Details: \_\_\_\_\_

Sediment Removed: Yes ☐ No ☐ Details: \_\_\_\_\_

Quantity of Sediment Removed (estimate?): \_\_\_\_\_

Minor Structural Repairs: Yes ☐ No ☐ Details: \_\_\_\_\_

Residuals (debris, sediment) Disposal Methods: \_\_\_\_\_

Notes:

\_\_\_\_\_

\_\_\_\_\_

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\_\_\_\_\_

\_\_\_\_\_





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## Appendix G – LSRCA TTT P Budget Results

Summary

| Site             | Project Name              | Project Title             | Storm Type  |
|------------------|---------------------------|---------------------------|-------------|
| Pre-Development  | 441 Huronia Road Existing | 441 Huronia Road Existing | storm-event |
| Post-Development | 441 Huronia Rd Proposed   | 441 Huronia Rd Proposed   | storm-event |

Design Storm Performance Goal | Pre-Development

|                                         |                       |
|-----------------------------------------|-----------------------|
| Rainfall Depth Control/Reduction Target | 25.00 mm              |
| Runoff Volume Control/Reduction Target  | 128.25 m <sup>3</sup> |
| Runoff Volume Control Provided          | 125.35 m <sup>3</sup> |
| Runoff Volume Reduction Provided        | 125.35 m <sup>3</sup> |
| Runoff Volume Treated                   | 0.00 m <sup>3</sup>   |
| Runoff Volume Untreated                 | 0.00 m <sup>3</sup>   |
| Runoff Volume Control / Reduction Met?  | No                    |

Design Storm Performance Goal | Post-Development

|                                         |          |
|-----------------------------------------|----------|
| Rainfall Depth Control/Reduction Target | 25.00 mm |
|-----------------------------------------|----------|

|                                        |                       |
|----------------------------------------|-----------------------|
| Runoff Volume Control/Reduction Target | 117.50 m <sup>3</sup> |
| Runoff Volume Control Provided         | 109.50 m <sup>3</sup> |
| Runoff Volume Reduction Provided       | 29.59 m <sup>3</sup>  |
| Runoff Volume Treated                  | 79.91 m <sup>3</sup>  |
| Runoff Volume Untreated                | 8.16 m <sup>3</sup>   |
| Runoff Volume Control / Reduction Met? | No                    |

Water Balance Comparison

| Site                   | Site Area | Site Rainfall In          | Site Infiltration         | Site Evapotranspiration   | External Outflow          | Rainfall Reduction |
|------------------------|-----------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------|
|                        |           | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(%)        |
| Pre-Development Total  | 0.51 ha   | 25.02 mm                  | 23.24 mm                  | 0.00 mm                   | 0.57 mm                   | 24.45 mm           |
|                        |           | 128.35 m <sup>3</sup>     | 119.22 m <sup>3</sup>     | 0.00 m <sup>3</sup>       | 2.90 m <sup>3</sup>       | 97.74 %            |
| Post-Development Total | 0.47 ha   | 25.02 mm                  | 4.92 mm                   | 0.00 mm                   | 18.74 mm                  | 6.28 mm            |
|                        |           | 117.59 m <sup>3</sup>     | 23.14 m <sup>3</sup>      | 0.00 m <sup>3</sup>       | 88.10 m <sup>3</sup>      | 25.08 %            |
| Difference             | -0.04 ha  | 0.00 mm                   | -18.32 mm                 | 0.00 mm                   | 18.18 mm                  | -18.18 mm          |
|                        |           | -10.76 m <sup>3</sup>     | -96.08 m <sup>3</sup>     | 0.00 m <sup>3</sup>       | 85.20 m <sup>3</sup>      | -72.66 %           |
| Difference             | -8.38 %   | 0.00 %                    | -78.82 %                  | NaN %                     | 3215.87 %                 | -74.34 %           |



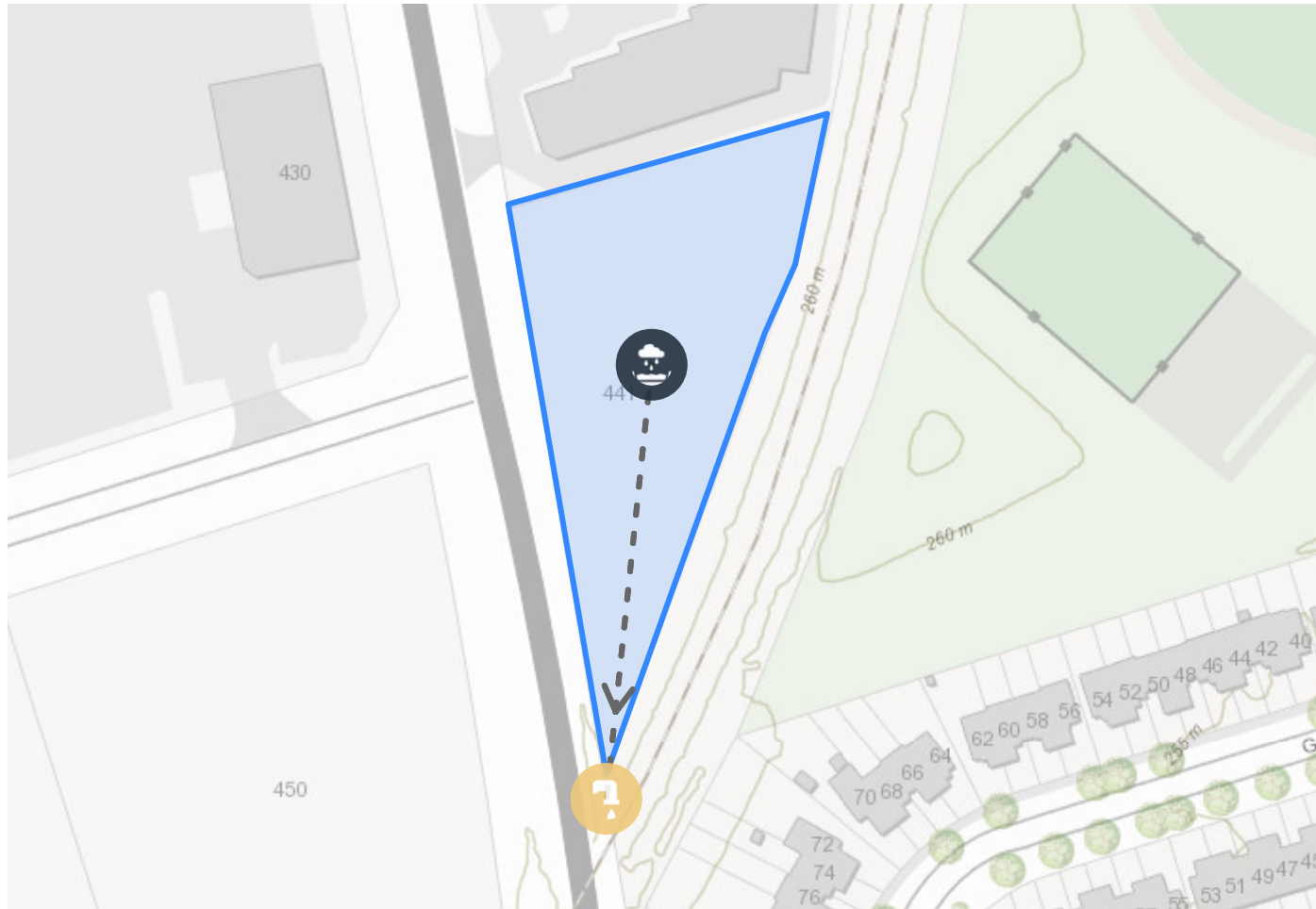
Water Balance | Pre-Development

| Catchment | Site Area | Site Rainfall In          | Site Infiltration         | Site Evapotranspiration   | External Outflow          | Rainfall Reduction |
|-----------|-----------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------|
|           |           | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(%)        |
| 1         | 0.51 ha   | 25.02 mm                  | 23.24 mm                  | 0.00 mm                   | 0.57 mm                   | 24.45 mm           |
|           |           | 128.35 m <sup>3</sup>     | 119.22 m <sup>3</sup>     | 0.00 m <sup>3</sup>       | 2.90 m <sup>3</sup>       | 97.74 %            |
| TOTAL     | 0.51 ha   | 25.02 mm                  | 23.24 mm                  | 0.00 mm                   | 0.57 mm                   | 24.45 mm           |
|           |           | 128.35 m <sup>3</sup>     | 119.22 m <sup>3</sup>     | 0.00 m <sup>3</sup>       | 2.90 m <sup>3</sup>       | 97.74 %            |

Water Balance | Post-Development

| Catchment | Site Area | Site Rainfall In          | Site Infiltration         | Site Evapotranspiration   | External Outflow          | Rainfall Reduction |
|-----------|-----------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------|
|           |           | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(m <sup>3</sup> ) | (mm)<br>(%)        |
| 1         | 0.47 ha   | 25.02 mm                  | 4.92 mm                   | 0.00 mm                   | 18.74 mm                  | 6.28 mm            |
|           |           | 117.59 m <sup>3</sup>     | 23.14 m <sup>3</sup>      | 0.00 m <sup>3</sup>       | 88.10 m <sup>3</sup>      | 25.08 %            |
| TOTAL     | 0.47 ha   | 25.02 mm                  | 4.92 mm                   | 0.00 mm                   | 18.74 mm                  | 6.28 mm            |
|           |           | 117.59 m <sup>3</sup>     | 23.14 m <sup>3</sup>      | 0.00 m <sup>3</sup>       | 88.10 m <sup>3</sup>      | 25.08 %            |

## Map | Pre-Development





LID Summary | Post-Development

| Element      | Type         | LID Area | Drawdown Time | Effective Impervious to Pervious Ratio | FLOW                       | TSS                  | TP                   |
|--------------|--------------|----------|---------------|----------------------------------------|----------------------------|----------------------|----------------------|
|              |              |          |               |                                        | Flow In (m <sup>3</sup> )  | Load In (kg)         | Load In (kg)         |
|              |              |          |               |                                        | Flow Out (m <sup>3</sup> ) | Load Out (kg)        | Load Out (kg)        |
|              |              |          |               |                                        | Actual Reduction (%)       | Actual Reduction (%) | Actual Reduction (%) |
| Infiltration | Infiltration | 0.002 ha | 326.563 hrs   | 40.968                                 | 20.500 m <sup>3</sup>      | 0.190 kg             | 0.002 kg             |
|              |              |          |               |                                        | 20.000 m <sup>3</sup>      | 0.046 kg             | 0.001 kg             |
|              |              |          |               |                                        | 2.441 %                    | 75.610 %             | 60.976 %             |
| OGS          | Media-Filter |          |               |                                        | 64.800 m <sup>3</sup>      | 5.412 kg             | 0.014 kg             |
|              |              |          |               |                                        | 64.800 m <sup>3</sup>      | 1.082 kg             | 0.003 kg             |
|              |              |          |               |                                        | 0.000 %                    | 80.000 %             | 82.000 %             |

Loading Summary TSS | Pre Development

| Catchment   | Total Catchment TSS Removal | Peak Outflow | Generated                    | Outgoing                     |
|-------------|-----------------------------|--------------|------------------------------|------------------------------|
|             |                             |              | Total Flow (m³)              | Total Flow (m³)              |
|             |                             |              | Average Concentration (mg/l) | Average Concentration (mg/l) |
|             |                             |              | Total Load (kg)              | Total Load (kg)              |
| Catchment 1 | 0.000 %                     | 0.001 m³/s   | 0.000 m³                     | 3.000 m³                     |
|             |                             |              | 0.000 mg/l                   | 0.000 mg/l                   |
|             |                             |              | 0.000 kg                     | 0.000 kg                     |
| Total       | %                           | 0.001 m³/s   | 0.000 m³                     | 3.000 m³                     |
|             |                             |              | 0.000 mg/l                   | 0.000 mg/l                   |
|             |                             |              | 0.000 kg                     | 0.000 kg                     |



Loading Summary TSS | Post Development

| Catchment   | Total Catchment TSS Removal | Peak Outflow            | Generated                    | Outgoing                     |
|-------------|-----------------------------|-------------------------|------------------------------|------------------------------|
|             |                             |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|             |                             |                         | Average Concentration (mg/l) | Average Concentration (mg/l) |
|             |                             |                         | Total Load (kg)              | Total Load (kg)              |
| Catchment 1 | 79.851 %                    | 0.004 m <sup>3</sup> /s | 80.500 m <sup>3</sup>        | 88.000 m <sup>3</sup>        |
|             |                             |                         | 69.590 mg/l                  | 12.827 mg/l                  |
|             |                             |                         | 5.602 kg                     | 1.129 kg                     |
| Total       | 79.851 %                    | 0.004 m <sup>3</sup> /s | 80.500 m <sup>3</sup>        | 88.000 m <sup>3</sup>        |
|             |                             |                         | 69.590 mg/l                  | 12.827 mg/l                  |
|             |                             |                         | 5.602 kg                     | 1.129 kg                     |

Loading Summary TP | Pre Development

| Catchment   | Total Catchment TP Removal | Peak Outflow            | Generated                    | Outgoing                     |
|-------------|----------------------------|-------------------------|------------------------------|------------------------------|
|             |                            |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|             |                            |                         | Average Concentration (mg/l) | Average Concentration (mg/l) |
|             |                            |                         | Total Load (kg)              | Total Load (kg)              |
| Catchment 1 | 0.000 %                    | 0.001 m <sup>3</sup> /s | 0.000 m <sup>3</sup>         | 3.000 m <sup>3</sup>         |
|             |                            |                         | 0.000 mg/l                   | 0.000 mg/l                   |
|             |                            |                         | 0.000 kg                     | 0.000 kg                     |
| Total       | %                          | 0.001 m <sup>3</sup> /s | 0.000 m <sup>3</sup>         | 3.000 m <sup>3</sup>         |
|             |                            |                         | 0.000 mg/l                   | 0.000 mg/l                   |
|             |                            |                         | 0.000 kg                     | 0.000 kg                     |

Loading Summary TP | Post Development

| Catchment   | Total Catchment TP Removal | Peak Outflow            | Generated                    | Outgoing                     |
|-------------|----------------------------|-------------------------|------------------------------|------------------------------|
|             |                            |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|             |                            |                         | Average Concentration (mg/l) | Average Concentration (mg/l) |
|             |                            |                         | Total Load (kg)              | Total Load (kg)              |
| Catchment 1 | 79.403 %                   | 0.004 m <sup>3</sup> /s | 80.500 m <sup>3</sup>        | 88.000 m <sup>3</sup>        |
|             |                            |                         | 0.197 mg/l                   | 0.037 mg/l                   |
|             |                            |                         | 0.016 kg                     | 0.003 kg                     |
| Total       | 79.403 %                   | 0.004 m <sup>3</sup> /s | 80.500 m <sup>3</sup>        | 88.000 m <sup>3</sup>        |
|             |                            |                         | 0.197 mg/l                   | 0.037 mg/l                   |
|             |                            |                         | 0.016 kg                     | 0.003 kg                     |

Peak Flow | Pre-Development

| Catchment | Element    | Description           | Peak outflow            |
|-----------|------------|-----------------------|-------------------------|
| 1         | A1         | PEAK RUNOFF FLOW from | 0.00 m <sup>3</sup> /s  |
|           | Huronia Rd | MAXIMUM FLOW at       | 0.001 m <sup>3</sup> /s |

Peak Flow | Post-Development

| Catchment | Element      | Description               | Peak outflow            |
|-----------|--------------|---------------------------|-------------------------|
| 1         | Huronia Rd   | MAXIMUM FLOW at           | 0.004 m <sup>3</sup> /s |
|           | Storage      | MAXIMUM OUTFLOW from      | 0.004 m <sup>3</sup> /s |
|           | S8           | PEAK RUNOFF FLOW from     | 0.07 m <sup>3</sup> /s  |
|           | S9-S11       | PEAK RUNOFF FLOW from     | 0.00 m <sup>3</sup> /s  |
|           | S1           | PEAK RUNOFF FLOW from     | 0.03 m <sup>3</sup> /s  |
|           | Infiltration | PEAK RUNOFF FLOW from     | 0.03 m <sup>3</sup> /s  |
|           | OGS          | MAXIMUM LATERAL INFLOW at | 0.072 m <sup>3</sup> /s |
|           | Pipe         | MAXIMUM FLOW in           | 0.088 m <sup>3</sup> /s |



TSS - Catchment 1

| Name        | LID Type<br>(removal) | Peak Outflow            | Incoming                     | Outgoing                     |
|-------------|-----------------------|-------------------------|------------------------------|------------------------------|
|             |                       |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|             |                       |                         | Concentration (mg/l)         | Concentration (mg/l)         |
|             |                       |                         | Total Load (kg)              | Total Load (kg)              |
| A1          | 0 %                   | 0 m <sup>3</sup> /s     | 128.353 m <sup>3</sup>       | 0.000 m <sup>3</sup>         |
|             |                       |                         | 27.000 mg/l                  | 27.000 mg/l                  |
|             |                       |                         | 3.466 kg                     | 0.000 kg                     |
| Huronian Rd | 0 %                   | 0.001 m <sup>3</sup> /s | 3.000 m <sup>3</sup>         | 3.000 m <sup>3</sup>         |
|             |                       |                         | 0.000 mg/l                   | 0.000 mg/l                   |
|             |                       |                         | 0.000 kg                     | 0.000 kg                     |

Loading TSS | Post Development

TSS - Catchment 1

| Name         | LID Type<br>(removal) | Peak Outflow            | Incoming                                          | Outgoing                                         |
|--------------|-----------------------|-------------------------|---------------------------------------------------|--------------------------------------------------|
|              |                       |                         | Total Flow (m <sup>3</sup> )                      | Total Flow (m <sup>3</sup> )                     |
|              |                       |                         | Concentration (mg/l)                              | Concentration (mg/l)                             |
|              |                       |                         | Total Load (kg)                                   | Total Load (kg)                                  |
| S8           | 0 %                   | 0.07 m <sup>3</sup> /s  | 69.806 m <sup>3</sup><br>90.200 mg/l<br>6.296 kg  | 60.000 m <sup>3</sup><br>90.200 mg/l<br>5.412 kg |
| S9-S11       | 0 %                   | 0 m <sup>3</sup> /s     | 21.517 m <sup>3</sup><br>100.000 mg/l<br>2.152 kg | 0.000 m <sup>3</sup><br>100.000 mg/l<br>0.000 kg |
| S1           | 0 %                   | 0.03 m <sup>3</sup> /s  | 25.771 m <sup>3</sup><br>7.000 mg/l<br>0.180 kg   | 20.000 m <sup>3</sup><br>7.000 mg/l<br>0.140 kg  |
| Infiltration | 75 %                  | 0.03 m <sup>3</sup> /s  | 20.500 m <sup>3</sup><br>9.270 mg/l<br>0.190 kg   | 20.000 m <sup>3</sup><br>2.318 mg/l<br>0.046 kg  |
| OGS          | 80 %                  | 0.072 m <sup>3</sup> /s | 64.800 m <sup>3</sup>                             | 64.800 m <sup>3</sup>                            |

|             |     |                         |                       |                       |
|-------------|-----|-------------------------|-----------------------|-----------------------|
|             |     |                         | 83.519 mg/l           | 16.704 mg/l           |
|             |     |                         | 5.412 kg              | 1.082 kg              |
| Storage     | 0 % | 0.004 m <sup>3</sup> /s | 88.100 m <sup>3</sup> | 88.100 m <sup>3</sup> |
|             |     |                         | 12.812 mg/l           | 12.812 mg/l           |
|             |     |                         | 1.129 kg              | 1.129 kg              |
| Pipe        | 0 % | 0.088 m <sup>3</sup> /s | 64.800 m <sup>3</sup> | 64.800 m <sup>3</sup> |
|             |     |                         | 16.704 mg/l           | 16.704 mg/l           |
|             |     |                         | 1.082 kg              | 1.082 kg              |
| Control     | 0 % | 0.004 m <sup>3</sup> /s | 88.100 m <sup>3</sup> | 88.100 m <sup>3</sup> |
|             |     |                         | 12.812 mg/l           | 12.812 mg/l           |
|             |     |                         | 1.129 kg              | 1.129 kg              |
| Huronion Rd | 0 % | 0.004 m <sup>3</sup> /s | 88.000 m <sup>3</sup> | 88.000 m <sup>3</sup> |
|             |     |                         | 12.827 mg/l           | 12.827 mg/l           |
|             |     |                         | 1.129 kg              | 1.129 kg              |

TP - Catchment 1

| Name       | LID Type | Peak Outflow            | Incoming                     | Outgoing                     |
|------------|----------|-------------------------|------------------------------|------------------------------|
|            |          |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|            |          |                         | Concentration (mg/l)         | Concentration (mg/l)         |
|            |          |                         | Total Load (kg)              | Total Load (kg)              |
| A1         | 0 %      | 0 m <sup>3</sup> /s     | 128.353 m <sup>3</sup>       | 0.000 m <sup>3</sup>         |
|            |          |                         | 0.200 mg/l                   | 0.200 mg/l                   |
|            |          |                         | 0.026 kg                     | 0.000 kg                     |
| Huronia Rd | 0 %      | 0.001 m <sup>3</sup> /s | 3.000 m <sup>3</sup>         | 3.000 m <sup>3</sup>         |
|            |          |                         | 0.000 mg/l                   | 0.000 mg/l                   |
|            |          |                         | 0.000 kg                     | 0.000 kg                     |

TP - Catchment 1

| Name         | LID Type | Peak Outflow            | Incoming                     | Outgoing                     |
|--------------|----------|-------------------------|------------------------------|------------------------------|
|              |          |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|              |          |                         | Concentration (mg/l)         | Concentration (mg/l)         |
|              |          |                         | Total Load (kg)              | Total Load (kg)              |
| S8           | 0 %      | 0.07 m <sup>3</sup> /s  | 69.806 m <sup>3</sup>        | 60.000 m <sup>3</sup>        |
|              |          |                         | 0.232 mg/l                   | 0.232 mg/l                   |
|              |          |                         | 0.016 kg                     | 0.014 kg                     |
| S9-S11       | 0 %      | 0 m <sup>3</sup> /s     | 21.517 m <sup>3</sup>        | 0.000 m <sup>3</sup>         |
|              |          |                         | 0.320 mg/l                   | 0.320 mg/l                   |
|              |          |                         | 0.007 kg                     | 0.000 kg                     |
| S1           | 0 %      | 0.03 m <sup>3</sup> /s  | 25.771 m <sup>3</sup>        | 20.000 m <sup>3</sup>        |
|              |          |                         | 0.090 mg/l                   | 0.090 mg/l                   |
|              |          |                         | 0.002 kg                     | 0.002 kg                     |
| Infiltration | 60 %     | 0.03 m <sup>3</sup> /s  | 20.500 m <sup>3</sup>        | 20.000 m <sup>3</sup>        |
|              |          |                         | 0.096 mg/l                   | 0.038 mg/l                   |
|              |          |                         | 0.002 kg                     | 0.001 kg                     |
| OGS          | 82 %     | 0.072 m <sup>3</sup> /s | 64.800 m <sup>3</sup>        | 64.800 m <sup>3</sup>        |



|          |     |            |            |            |
|----------|-----|------------|------------|------------|
|          |     |            | 0.215 mg/l | 0.039 mg/l |
|          |     |            | 0.014 kg   | 0.003 kg   |
| Storage  | 0 % | 0.004 m³/s | 88.100 m³  | 88.100 m³  |
|          |     |            | 0.037 mg/l | 0.037 mg/l |
|          |     |            | 0.003 kg   | 0.003 kg   |
| Pipe     | 0 % | 0.088 m³/s | 64.800 m³  | 64.800 m³  |
|          |     |            | 0.039 mg/l | 0.039 mg/l |
|          |     |            | 0.003 kg   | 0.003 kg   |
| Control  | 0 % | 0.004 m³/s | 88.100 m³  | 88.100 m³  |
|          |     |            | 0.037 mg/l | 0.037 mg/l |
|          |     |            | 0.003 kg   | 0.003 kg   |
| Huron Rd | 0 % | 0.004 m³/s | 88.000 m³  | 88.000 m³  |
|          |     |            | 0.037 mg/l | 0.037 mg/l |
|          |     |            | 0.003 kg   | 0.003 kg   |

Detailed Report Parameters | Pre Development

A1

| Field                                        | Value |
|----------------------------------------------|-------|
| Subcatchment name                            | A1    |
| Catchment                                    | 1     |
| Total AREA (HA)                              | 0.513 |
| Impervious area (HA)                         | 0     |
| Roof area (HA)                               | 0     |
| Landscaped area (HA)                         | 0     |
| Row Crop area (HA)                           | 0     |
| Open Space / Parkland area (HA)              | 0.513 |
| Forest area (HA)                             | 0     |
| Wetland area (HA)                            | 0     |
| Other area (HA)                              | 0     |
| Manning's n for impervious areas             | 0.013 |
| Manning's n for pervious areas               | 0.15  |
| Depression storage for impervious areas (mm) | 2     |
| Depression storage for pervious areas (mm)   | 5     |
| Weighted Curve Number                        | 79    |

Huronion Rd

| Field                 | Value       |
|-----------------------|-------------|
| Name                  | Huronion Rd |
| Catchment             | 1           |
| Outfall Elevation (m) | 259.67      |

| Detailed Report Parameters   Post Development |            |
|-----------------------------------------------|------------|
| Huronia Rd                                    |            |
| Field                                         | Value      |
| Name                                          | Huronia Rd |
| Catchment                                     | 1          |
| Outfall Elevation (m)                         | 259.67     |
| Storage                                       |            |
| Field                                         | Value      |
| Name                                          | Storage    |
| Catchment                                     | 1          |
| Bottom Elevation (m)                          | 259.79     |
| Maximum Depth (m)                             | 1.56       |
| Initial Water Depth (m)                       | 0          |
| Underlying Soil                               |            |
| Evaporation Factor                            | 1          |
| Suction Head (mm)                             |            |
| Saturated Conductivity (mm/hr)                |            |
| Initial Soil Moisture Deficit (Fraction)      |            |
|                                               |            |

|      |         |
|------|---------|
| Type | Storage |
|------|---------|

S8

| Field                                        | Value                 |
|----------------------------------------------|-----------------------|
| Subcatchment name                            | S8                    |
| Catchment                                    | 1                     |
| Total AREA (HA)                              | 0.279                 |
| Impervious area (HA)                         | 0.27342               |
| Roof area (HA)                               | 0                     |
| Landscaped area (HA)                         | 0.0055800000000000001 |
| Row Crop area (HA)                           | 0                     |
| Open Space / Parkland area (HA)              | 0                     |
| Forest area (HA)                             | 0                     |
| Wetland area (HA)                            | 0                     |
| Other area (HA)                              | 0                     |
| Manning's n for impervious areas             | 0.013                 |
| Manning's n for pervious areas               | 0.15                  |
| Depression storage for impervious areas (mm) | 2                     |
| Depression storage for pervious areas (mm)   | 5                     |
| Weighted Curve Number                        | 84                    |

Control



| Field               | Value      |
|---------------------|------------|
| Name                | Control    |
| Catchment           | 1          |
| Upstream Node       | Storage    |
| Downstream Node     | Huronia-Rd |
| Length (m)          | 46         |
| Upstream offset (m) | 0          |

S9-S11

| Field                            | Value  |
|----------------------------------|--------|
| Subcatchment name                | S9-S11 |
| Catchment                        | 1      |
| Total AREA (HA)                  | 0.086  |
| Impervious area (HA)             | 0      |
| Roof area (HA)                   | 0      |
| Landscaped area (HA)             | 0.086  |
| Row Crop area (HA)               | 0      |
| Open Space / Parkland area (HA)  | 0      |
| Forest area (HA)                 | 0      |
| Wetland area (HA)                | 0      |
| Other area (HA)                  | 0      |
| Manning's n for impervious areas | 0.013  |

|                                              |     |
|----------------------------------------------|-----|
| Manning's n for pervious areas               | 0.4 |
| Depression storage for impervious areas (mm) | 2   |
| Depression storage for pervious areas (mm)   | 10  |
| Weighted Curve Number                        | 84  |

S1

| Field                                        | Value |
|----------------------------------------------|-------|
| Subcatchment name                            | S1    |
| Catchment                                    | 1     |
| Total AREA (HA)                              | 0.103 |
| Impervious area (HA)                         | 0     |
| Roof area (HA)                               | 0.103 |
| Landscaped area (HA)                         | 0     |
| Row Crop area (HA)                           | 0     |
| Open Space / Parkland area (HA)              | 0     |
| Forest area (HA)                             | 0     |
| Wetland area (HA)                            | 0     |
| Other area (HA)                              | 0     |
| Manning's n for impervious areas             | 0.013 |
| Manning's n for pervious areas               | 0.15  |
| Depression storage for impervious areas (mm) | 2     |
|                                              |       |

|                                            |   |
|--------------------------------------------|---|
| Depression storage for pervious areas (mm) | 5 |
| Weighted Curve Number                      | 0 |

Infiltration

| Field                    | Value        |
|--------------------------|--------------|
| Name                     | Infiltration |
| LID type                 | infiltration |
| Catchment                | 1            |
| Outlet (name)            | 3            |
| % Imperv                 | 100          |
| Width (m)                | 10           |
| Paved surface (HA)       | 0            |
| Roof (HA)                | 0            |
| Landscaped Area (HA)     | 0.002        |
| Row Crop (HA)            | 0            |
| Open Space/Parkland (HA) | 0            |
| Forest (HA)              | 0            |
| Wetland (HA)             | 0            |
| (HA)                     | 0            |
| Berm Height (mm)         | 150          |
| Surface Slope (%)        | 1            |
| Thickness (mm)           | 440          |

|                                    |      |
|------------------------------------|------|
| Void Ratio                         | 0.95 |
| Impervious Surface Fraction        |      |
| Permeability (mm/hr)               |      |
| Clogging Factor                    | 0    |
| Soil                               |      |
| Porosity (Fraction)                |      |
| Field Capacity (Fraction)          |      |
| Wilting Point (Fraction)           |      |
| Conductivity (mm/hr)               |      |
| Conductivity Slope (Dimensionless) |      |
| Suction Head (mm)                  |      |
| Seepage Rate (mm/hr)               | 1.28 |
| Flow Coefficient                   | 1    |
| Flow Exponent                      | 1    |
| Offset Height (mm)                 | 140  |
| Mannings Roughness                 |      |

OGS

| Field         | Value        |
|---------------|--------------|
| Name          | OGS          |
| Junction Type | media-filter |
|               |              |

|                      |       |
|----------------------|-------|
| Catchment            | 1     |
| Invert Elevation (m) | 259.8 |
| Depth to Surface (m) | 1.58  |

Pipe

| Field                 | Value   |
|-----------------------|---------|
| Name                  | Pipe    |
| Catchment             | 1       |
| Upstream Node         | OGS     |
| Downstream Node       | Storage |
| Length (m)            | 14      |
| Manning's Roughness   | 0.013   |
| Upstream Invert (m)   | 259.8   |
| Downstream Invert (m) | 259.7   |
| Pipe Diameter (m)     | 0.375   |



Summary

| Site             | Project Name              | Project Title             | Storm Type |
|------------------|---------------------------|---------------------------|------------|
| Pre-Development  | 441 Huronia Road Existing | 441 Huronia Road Existing | avg-annual |
| Post-Development | 441 Huronia Rd Proposed   | 441 Huronia Rd Proposed   | avg-annual |

Water Balance Comparison

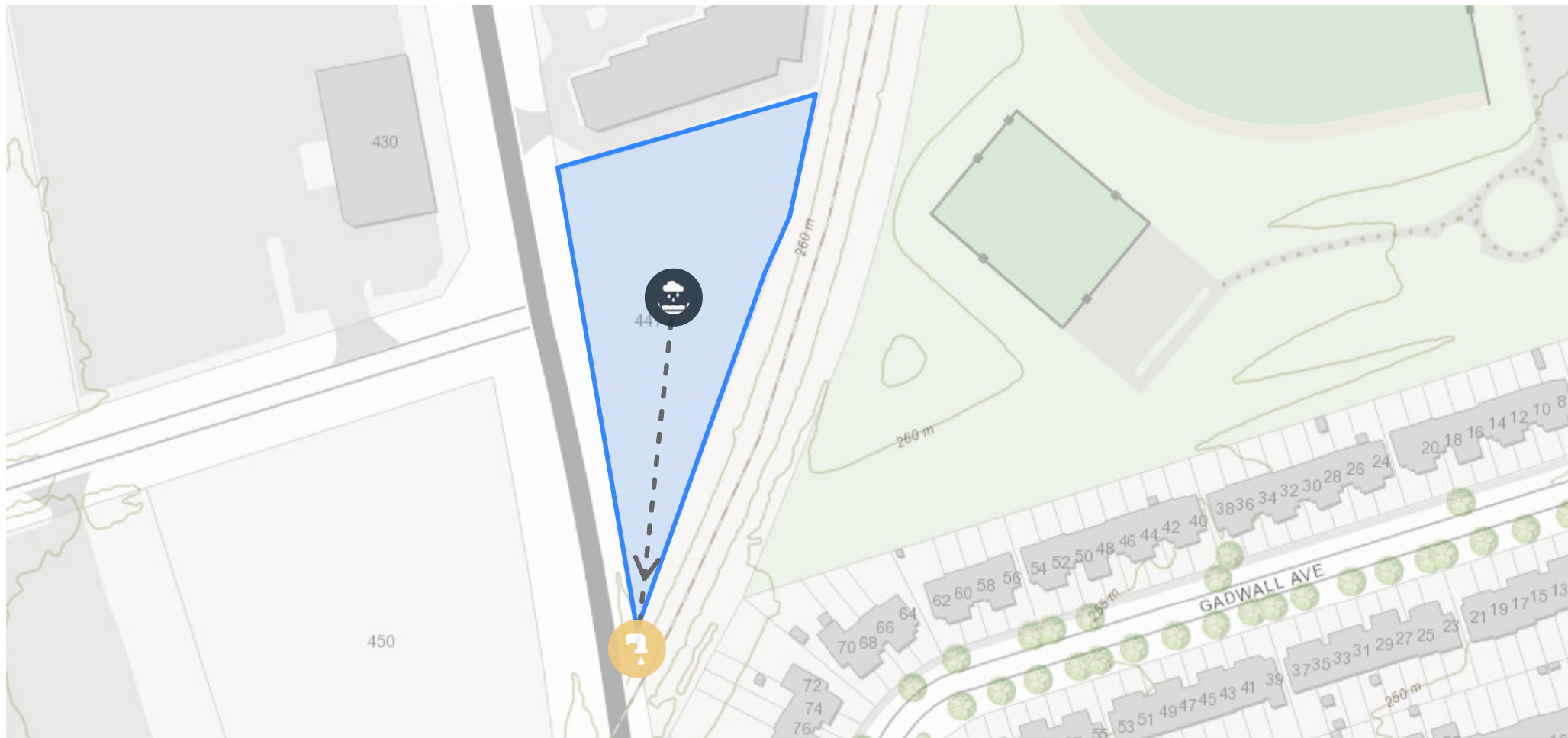
| Site                   | Site Area | Site Rainfall In | Site Infiltration | Site Evapotranspiration | External Outflow | Rainfall Reduction |
|------------------------|-----------|------------------|-------------------|-------------------------|------------------|--------------------|
|                        |           | (mm)<br>(m³)     | (mm)<br>(m³)      | (mm)<br>(m³)            | (mm)<br>(m³)     | (mm)<br>(%)        |
| Pre-Development Total  | 0.51 ha   | 944.70 mm        | 167.24 mm         | 608.79 mm               | 168.03 mm        | 776.67 mm          |
|                        |           | 4,846.31 m³      | 857.94 m³         | 3,123.09 m³             | 862.00 m³        | 82.21 %            |
| Post-Development Total | 0.47 ha   | 944.70 mm        | 17.12 mm          | 283.23 mm               | 645.30 mm        | 299.40 mm          |
|                        |           | 4,421.20 m³      | 80.13 m³          | 1,325.54 m³             | 3,020.00 m³      | 31.69 %            |
| Difference             | -0.05 ha  | 0.00 mm          | -150.12 mm        | -325.56 mm              | 477.27 mm        | -477.27 mm         |
|                        |           | -425.12 m³       | -777.81 m³        | -1,797.56 m³            | 2,158.00 m³      | -50.52 %           |
| Difference             | -8.77 %   | -0.00 %          | -89.76 %          | -53.48 %                | 284.04 %         | -61.45 %           |

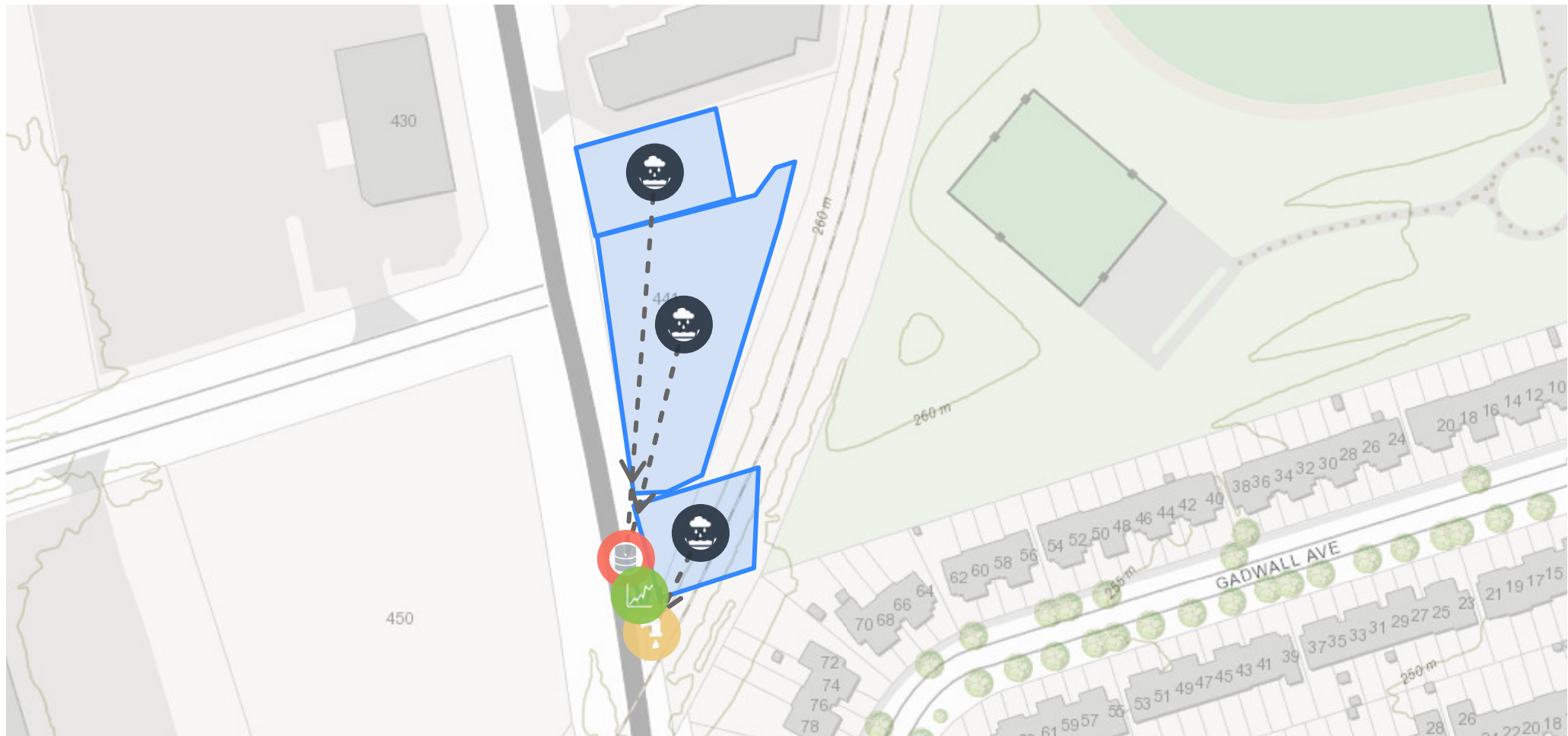
Water Balance | Pre-Development

| Catchment | Site Area | Site Rainfall In                     | Site Infiltration                  | Site Evapotranspiration              | External Outflow                   | Rainfall Reduction   |
|-----------|-----------|--------------------------------------|------------------------------------|--------------------------------------|------------------------------------|----------------------|
|           |           | (mm)<br>(m <sup>3</sup> )            | (mm)<br>(m <sup>3</sup> )          | (mm)<br>(m <sup>3</sup> )            | (mm)<br>(m <sup>3</sup> )          | (mm)<br>(%)          |
| 1         | 0.51 ha   | 944.70 mm<br>4,846.31 m <sup>3</sup> | 167.24 mm<br>857.94 m <sup>3</sup> | 608.79 mm<br>3,123.09 m <sup>3</sup> | 168.03 mm<br>862.00 m <sup>3</sup> | 776.67 mm<br>82.21 % |
| TOTAL     | 0.51 ha   | 944.70 mm<br>4,846.31 m <sup>3</sup> | 167.24 mm<br>857.94 m <sup>3</sup> | 608.79 mm<br>3,123.09 m <sup>3</sup> | 168.03 mm<br>862.00 m <sup>3</sup> | 776.67 mm<br>82.21 % |

Water Balance | Post-Development

| Catchment | Site Area | Site Rainfall In                     | Site Infiltration                | Site Evapotranspiration              | External Outflow                     | Rainfall Reduction   |
|-----------|-----------|--------------------------------------|----------------------------------|--------------------------------------|--------------------------------------|----------------------|
|           |           | (mm)<br>(m <sup>3</sup> )            | (mm)<br>(m <sup>3</sup> )        | (mm)<br>(m <sup>3</sup> )            | (mm)<br>(m <sup>3</sup> )            | (mm)<br>(%)          |
| 1         | 0.47 ha   | 944.70 mm<br>4,421.20 m <sup>3</sup> | 17.12 mm<br>80.13 m <sup>3</sup> | 283.23 mm<br>1,325.54 m <sup>3</sup> | 645.30 mm<br>3,020.00 m <sup>3</sup> | 299.40 mm<br>31.69 % |
| TOTAL     | 0.47 ha   | 944.70 mm<br>4,421.20 m <sup>3</sup> | 17.12 mm<br>80.13 m <sup>3</sup> | 283.23 mm<br>1,325.54 m <sup>3</sup> | 645.30 mm<br>3,020.00 m <sup>3</sup> | 299.40 mm<br>31.69 % |







LID Summary | Post-Development

|  |                      |                      |                      |
|--|----------------------|----------------------|----------------------|
|  | Flow In (m³)         | Load In (kg)         | Load In (kg)         |
|  | Flow Out (m³)        | Load Out (kg)        | Load Out (kg)        |
|  | Actual Reduction (%) | Actual Reduction (%) | Actual Reduction (%) |

Loading Summary TSS | Pre Development

| Catchment   | Total Catchment TSS Removal | Peak Outflow            | Generated                    | Outgoing                     |
|-------------|-----------------------------|-------------------------|------------------------------|------------------------------|
|             |                             |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|             |                             |                         | Average Concentration (mg/l) | Average Concentration (mg/l) |
|             |                             |                         | Total Load (kg)              | Total Load (kg)              |
| Catchment 1 | 0.000 %                     | 0.021 m <sup>3</sup> /s | 860.000 m <sup>3</sup>       | 862.000 m <sup>3</sup>       |
|             |                             |                         | 27.000 mg/l                  | 26.937 mg/l                  |
|             |                             |                         | 23.220 kg                    | 23.220 kg                    |
| Total       | 0.000 %                     | 0.021 m <sup>3</sup> /s | 860.000 m <sup>3</sup>       | 862.000 m <sup>3</sup>       |
|             |                             |                         | 27.000 mg/l                  | 26.937 mg/l                  |
|             |                             |                         | 23.220 kg                    | 23.220 kg                    |

Loading Summary TSS | Post Development

| Catchment   | Total Catchment TSS Removal | Peak Outflow            | Generated                    | Outgoing                     |
|-------------|-----------------------------|-------------------------|------------------------------|------------------------------|
|             |                             |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|             |                             |                         | Average Concentration (mg/l) | Average Concentration (mg/l) |
|             |                             |                         | Total Load (kg)              | Total Load (kg)              |
| Catchment 1 | 1.804 %                     | 0.033 m <sup>3</sup> /s | 3,070.000 m <sup>3</sup>     | 3,019.000 m <sup>3</sup>     |
|             |                             |                         | 69.732 mg/l                  | 69.631 mg/l                  |
|             |                             |                         | 214.076 kg                   | 210.214 kg                   |
| Total       | 1.804 %                     | 0.033 m <sup>3</sup> /s | 3,070.000 m <sup>3</sup>     | 3,019.000 m <sup>3</sup>     |
|             |                             |                         | 69.732 mg/l                  | 69.631 mg/l                  |
|             |                             |                         | 214.076 kg                   | 210.214 kg                   |

Loading Summary TP | Pre Development

| Catchment   | Total Catchment TP Removal | Peak Outflow            | Generated                    | Outgoing                     |
|-------------|----------------------------|-------------------------|------------------------------|------------------------------|
|             |                            |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|             |                            |                         | Average Concentration (mg/l) | Average Concentration (mg/l) |
|             |                            |                         | Total Load (kg)              | Total Load (kg)              |
| Catchment 1 | 0.000 %                    | 0.021 m <sup>3</sup> /s | 860.000 m <sup>3</sup>       | 862.000 m <sup>3</sup>       |
|             |                            |                         | 0.200 mg/l                   | 0.200 mg/l                   |
|             |                            |                         | 0.172 kg                     | 0.172 kg                     |
| Total       | 0.000 %                    | 0.021 m <sup>3</sup> /s | 860.000 m <sup>3</sup>       | 862.000 m <sup>3</sup>       |
|             |                            |                         | 0.200 mg/l                   | 0.200 mg/l                   |
|             |                            |                         | 0.172 kg                     | 0.172 kg                     |

Loading Summary TP | Post Development

| Catchment   | Total Catchment TP Removal | Peak Outflow            | Generated                    | Outgoing                     |
|-------------|----------------------------|-------------------------|------------------------------|------------------------------|
|             |                            |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|             |                            |                         | Average Concentration (mg/l) | Average Concentration (mg/l) |
|             |                            |                         | Total Load (kg)              | Total Load (kg)              |
| Catchment 1 | 1.783 %                    | 0.033 m <sup>3</sup> /s | 3,070.000 m <sup>3</sup>     | 3,019.000 m <sup>3</sup>     |
|             |                            |                         | 0.202 mg/l                   | 0.202 mg/l                   |
|             |                            |                         | 0.620 kg                     | 0.608 kg                     |
| Total       | 1.783 %                    | 0.033 m <sup>3</sup> /s | 3,070.000 m <sup>3</sup>     | 3,019.000 m <sup>3</sup>     |
|             |                            |                         | 0.202 mg/l                   | 0.202 mg/l                   |
|             |                            |                         | 0.620 kg                     | 0.608 kg                     |



Peak Flow | Pre-Development

| Catchment | Element    | Description           | Peak outflow            |
|-----------|------------|-----------------------|-------------------------|
| 1         | A1         | PEAK RUNOFF FLOW from | 0.02 m <sup>3</sup> /s  |
|           | Huronia Rd | MAXIMUM FLOW at       | 0.021 m <sup>3</sup> /s |

Peak Flow | Post-Development

| Catchment | Element    | Description           | Peak outflow            |
|-----------|------------|-----------------------|-------------------------|
| 1         | Huronia Rd | MAXIMUM FLOW at       | 0.033 m <sup>3</sup> /s |
|           | Storage    | MAXIMUM OUTFLOW from  | 0.032 m <sup>3</sup> /s |
|           | S8         | PEAK RUNOFF FLOW from | 0.04 m <sup>3</sup> /s  |
|           | S9-S11     | PEAK RUNOFF FLOW from | 0.00 m <sup>3</sup> /s  |
|           | S1         | PEAK RUNOFF FLOW from | 0.01 m <sup>3</sup> /s  |

TSS - Catchment 1

| Name        | LID Type<br>(removal) | Peak Outflow            | Incoming                     | Outgoing                     |
|-------------|-----------------------|-------------------------|------------------------------|------------------------------|
|             |                       |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|             |                       |                         | Concentration (mg/l)         | Concentration (mg/l)         |
|             |                       |                         | Total Load (kg)              | Total Load (kg)              |
| A1          | 0 %                   | 0.02 m <sup>3</sup> /s  | 4,846.311 m <sup>3</sup>     | 860.000 m <sup>3</sup>       |
|             |                       |                         | 27.000 mg/l                  | 27.000 mg/l                  |
|             |                       |                         | 130.850 kg                   | 23.220 kg                    |
| Huronion Rd | 0 %                   | 0.021 m <sup>3</sup> /s | 862.000 m <sup>3</sup>       | 862.000 m <sup>3</sup>       |
|             |                       |                         | 26.937 mg/l                  | 26.937 mg/l                  |
|             |                       |                         | 23.220 kg                    | 23.220 kg                    |

Loading TSS | Post Development

TSS - Catchment 1

| Name    | LID Type<br>(removal) | Peak Outflow            | Incoming                     | Outgoing                     |
|---------|-----------------------|-------------------------|------------------------------|------------------------------|
|         |                       |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|         |                       |                         | Concentration (mg/l)         | Concentration (mg/l)         |
|         |                       |                         | Total Load (kg)              | Total Load (kg)              |
| S8      | 0 %                   | 0.04 m <sup>3</sup> /s  | 2,635.713 m <sup>3</sup>     | 2,080.000 m <sup>3</sup>     |
|         |                       |                         | 90.200 mg/l                  | 90.200 mg/l                  |
|         |                       |                         | 237.741 kg                   | 187.616 kg                   |
| S9-S11  | 0 %                   | 0 m <sup>3</sup> /s     | 812.442 m <sup>3</sup>       | 210.000 m <sup>3</sup>       |
|         |                       |                         | 100.000 mg/l                 | 100.000 mg/l                 |
|         |                       |                         | 81.244 kg                    | 21.000 kg                    |
| S1      | 0 %                   | 0.01 m <sup>3</sup> /s  | 973.041 m <sup>3</sup>       | 780.000 m <sup>3</sup>       |
|         |                       |                         | 7.000 mg/l                   | 7.000 mg/l                   |
|         |                       |                         | 6.811 kg                     | 5.460 kg                     |
| Storage | 0 %                   | 0.032 m <sup>3</sup> /s | 2,860.000 m <sup>3</sup>     | 2,802.800 m <sup>3</sup>     |
|         |                       |                         | 67.509 mg/l                  | 67.509 mg/l                  |
|         |                       |                         | 193.076 kg                   | 189.214 kg                   |
| Control | 0 %                   | 0.032 m <sup>3</sup> /s | 2,802.800 m <sup>3</sup>     | 2,802.800 m <sup>3</sup>     |

|            |     |                         |                          |                          |
|------------|-----|-------------------------|--------------------------|--------------------------|
|            |     |                         | 67.509 mg/l              | 67.509 mg/l              |
|            |     |                         | 189.214 kg               | 189.214 kg               |
| Huronia Rd | 0 % | 0.033 m <sup>3</sup> /s | 3,019.000 m <sup>3</sup> | 3,019.000 m <sup>3</sup> |
|            |     |                         | 69.631 mg/l              | 69.631 mg/l              |
|            |     |                         | 210.214 kg               | 210.214 kg               |



TP - Catchment 1

| Name        | LID Type | Peak Outflow            | Incoming                     | Outgoing                     |
|-------------|----------|-------------------------|------------------------------|------------------------------|
|             |          |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|             |          |                         | Concentration (mg/l)         | Concentration (mg/l)         |
|             |          |                         | Total Load (kg)              | Total Load (kg)              |
| A1          | 0 %      | 0.02 m <sup>3</sup> /s  | 4,846.311 m <sup>3</sup>     | 860.000 m <sup>3</sup>       |
|             |          |                         | 0.200 mg/l                   | 0.200 mg/l                   |
|             |          |                         | 0.969 kg                     | 0.172 kg                     |
| Huronian Rd | 0 %      | 0.021 m <sup>3</sup> /s | 862.000 m <sup>3</sup>       | 862.000 m <sup>3</sup>       |
|             |          |                         | 0.200 mg/l                   | 0.200 mg/l                   |
|             |          |                         | 0.172 kg                     | 0.172 kg                     |

TP - Catchment 1

| Name    | LID Type | Peak Outflow            | Incoming                     | Outgoing                     |
|---------|----------|-------------------------|------------------------------|------------------------------|
|         |          |                         | Total Flow (m <sup>3</sup> ) | Total Flow (m <sup>3</sup> ) |
|         |          |                         | Concentration (mg/l)         | Concentration (mg/l)         |
|         |          |                         | Total Load (kg)              | Total Load (kg)              |
| S8      | 0 %      | 0.04 m <sup>3</sup> /s  | 2,635.713 m <sup>3</sup>     | 2,080.000 m <sup>3</sup>     |
|         |          |                         | 0.232 mg/l                   | 0.232 mg/l                   |
|         |          |                         | 0.611 kg                     | 0.482 kg                     |
| S9-S11  | 0 %      | 0 m <sup>3</sup> /s     | 812.442 m <sup>3</sup>       | 210.000 m <sup>3</sup>       |
|         |          |                         | 0.320 mg/l                   | 0.320 mg/l                   |
|         |          |                         | 0.260 kg                     | 0.067 kg                     |
| S1      | 0 %      | 0.01 m <sup>3</sup> /s  | 973.041 m <sup>3</sup>       | 780.000 m <sup>3</sup>       |
|         |          |                         | 0.090 mg/l                   | 0.090 mg/l                   |
|         |          |                         | 0.088 kg                     | 0.070 kg                     |
| Storage | 0 %      | 0.032 m <sup>3</sup> /s | 2,860.000 m <sup>3</sup>     | 2,802.800 m <sup>3</sup>     |
|         |          |                         | 0.193 mg/l                   | 0.193 mg/l                   |
|         |          |                         | 0.552 kg                     | 0.541 kg                     |
| Control | 0 %      | 0.032 m <sup>3</sup> /s | 2,802.800 m <sup>3</sup>     | 2,802.800 m <sup>3</sup>     |

|          |     |            |              |              |
|----------|-----|------------|--------------|--------------|
|          |     |            | 0.193 mg/l   | 0.193 mg/l   |
|          |     |            | 0.541 kg     | 0.541 kg     |
| Huron Rd | 0 % | 0.033 m³/s | 3,019.000 m³ | 3,019.000 m³ |
|          |     |            | 0.202 mg/l   | 0.202 mg/l   |
|          |     |            | 0.608 kg     | 0.608 kg     |

Detailed Report Parameters | Pre Development

A1

| Field                                        | Value |
|----------------------------------------------|-------|
| Subcatchment name                            | A1    |
| Catchment                                    | 1     |
| Total AREA (HA)                              | 0.513 |
| Impervious area (HA)                         | 0     |
| Roof area (HA)                               | 0     |
| Landscaped area (HA)                         | 0     |
| Row Crop area (HA)                           | 0     |
| Open Space / Parkland area (HA)              | 0.513 |
| Forest area (HA)                             | 0     |
| Wetland area (HA)                            | 0     |
| Other area (HA)                              | 0     |
| Manning's n for impervious areas             | 0.013 |
| Manning's n for pervious areas               | 0.15  |
| Depression storage for impervious areas (mm) | 2     |
| Depression storage for pervious areas (mm)   | 5     |
| Weighted Curve Number                        | 79    |

Huronion Rd

| Field                 | Value       |
|-----------------------|-------------|
| Name                  | Huronion Rd |
| Catchment             | 1           |
| Outfall Elevation (m) | 259.67      |



Detailed Report Parameters | Post Development

Huronia Rd

| Field                 |  | Value      |
|-----------------------|--|------------|
| Name                  |  | Huronia Rd |
| Catchment             |  | 1          |
| Outfall Elevation (m) |  | 259.67     |

Storage

| Field                                    |  | Value   |
|------------------------------------------|--|---------|
| Name                                     |  | Storage |
| Catchment                                |  | 1       |
| Bottom Elevation (m)                     |  | 259.79  |
| Maximum Depth (m)                        |  | 1.56    |
| Initial Water Depth (m)                  |  | 0       |
| Underlying Soil                          |  |         |
| Evaporation Factor                       |  | 1       |
| Suction Head (mm)                        |  |         |
| Saturated Conductivity (mm/hr)           |  |         |
| Initial Soil Moisture Deficit (Fraction) |  |         |
|                                          |  |         |

|      |         |
|------|---------|
| Type | Storage |
|------|---------|

S8

| Field                                        | Value                 |
|----------------------------------------------|-----------------------|
| Subcatchment name                            | S8                    |
| Catchment                                    | 1                     |
| Total AREA (HA)                              | 0.279                 |
| Impervious area (HA)                         | 0.27342               |
| Roof area (HA)                               | 0                     |
| Landscaped area (HA)                         | 0.0055800000000000001 |
| Row Crop area (HA)                           | 0                     |
| Open Space / Parkland area (HA)              | 0                     |
| Forest area (HA)                             | 0                     |
| Wetland area (HA)                            | 0                     |
| Other area (HA)                              | 0                     |
| Manning's n for impervious areas             | 0.013                 |
| Manning's n for pervious areas               | 0.15                  |
| Depression storage for impervious areas (mm) | 2                     |
| Depression storage for pervious areas (mm)   | 5                     |
| Weighted Curve Number                        | 84                    |

Control

| Field               | Value      |
|---------------------|------------|
| Name                | Control    |
| Catchment           | 1          |
| Upstream Node       | Storage    |
| Downstream Node     | Huronia-Rd |
| Length (m)          | 22         |
| Upstream offset (m) | 0          |

S9-S11

| Field                            | Value  |
|----------------------------------|--------|
| Subcatchment name                | S9-S11 |
| Catchment                        | 1      |
| Total AREA (HA)                  | 0.086  |
| Impervious area (HA)             | 0      |
| Roof area (HA)                   | 0      |
| Landscaped area (HA)             | 0.086  |
| Row Crop area (HA)               | 0      |
| Open Space / Parkland area (HA)  | 0      |
| Forest area (HA)                 | 0      |
| Wetland area (HA)                | 0      |
| Other area (HA)                  | 0      |
| Manning's n for impervious areas | 0.013  |

|                                              |     |
|----------------------------------------------|-----|
| Manning's n for pervious areas               | 0.4 |
| Depression storage for impervious areas (mm) | 2   |
| Depression storage for pervious areas (mm)   | 10  |
| Weighted Curve Number                        | 84  |

S1

| Field                                        | Value |
|----------------------------------------------|-------|
| Subcatchment name                            | S1    |
| Catchment                                    | 1     |
| Total AREA (HA)                              | 0.103 |
| Impervious area (HA)                         | 0     |
| Roof area (HA)                               | 0.103 |
| Landscaped area (HA)                         | 0     |
| Row Crop area (HA)                           | 0     |
| Open Space / Parkland area (HA)              | 0     |
| Forest area (HA)                             | 0     |
| Wetland area (HA)                            | 0     |
| Other area (HA)                              | 0     |
| Manning's n for impervious areas             | 0.013 |
| Manning's n for pervious areas               | 0.15  |
| Depression storage for impervious areas (mm) | 2     |
|                                              |       |

|                                            |   |
|--------------------------------------------|---|
| Depression storage for pervious areas (mm) | 5 |
| Weighted Curve Number                      | 0 |



## Appendix H – Water Balance

# LSRCA Water Balance Worksheet

## Step 1: Determine Water Balance Deficit

Water Balance Deficit: m3/yr 1241

## Step 2: Determine drainage area and runoff volume from impervious surface to be infiltrated

Impervious Area: m2 900

Rainfall: mm/yr 933  
Evaporation: mm/yr 186.6  
Surplus : mm/yr 746.4  
Volume m3/yr 671.76

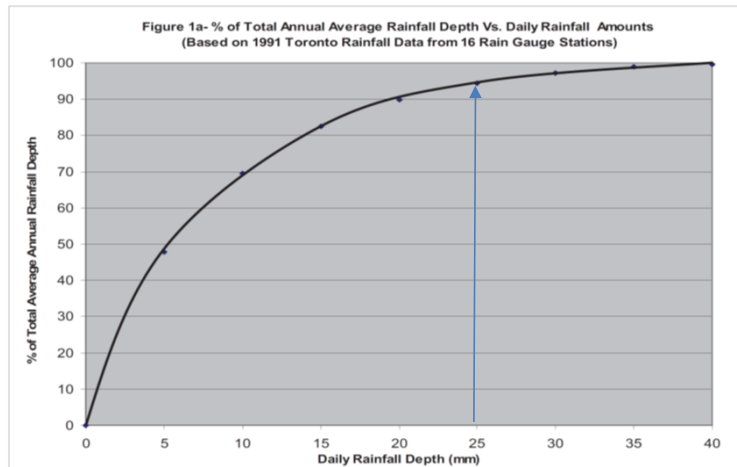
Richmond Hill

## Step 3: Determine percentage of rainfall over the drainage area that needs to be infiltrated to meet water balance deficit

% of rainfall % 184.74

## Step 4: Determine Event Depth based on 1991 Toronto Rainfall Data

Event depth required: mm 25



## Step 5: Determine required volume of storage facility

Drainage area: m2 900  
event depth: mm 25  
Volume: m3 22.5

## Step 6: Determine required bottom surface area of

Infiltration rate: mm/hr 3.2  
Safety Factor 2.5  
P 1.28  
Time Hr 48  
Porosity 1  
Volume of facility m3 22.5  
Area m2 366.2

Use 1.0 for open storage volume (Atlantis Tanks, Cultec Chamber tec.)

Therefore the required area to infiltrate within 48 hours is : 366.2

## Post Development 25 mm 4 Hr Chicago Storm - PCSWMM Output

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

\*\*\*\*\*

Element Count

\*\*\*\*\*

Number of rain gages ..... 15  
 Number of subcatchments ... 11  
 Number of nodes ..... 19  
 Number of links ..... 20  
 Number of pollutants ..... 0  
 Number of land uses ..... 0

\*\*\*\*\*

Raingage Summary

\*\*\*\*\*

| Name                      | Data Source               | Data Type | Recording Interval |
|---------------------------|---------------------------|-----------|--------------------|
| 100Yr4HrChic              | CHIC4Hr100Yr              | INTENSITY | 5 min.             |
| 10Yr4HrChic               | CHIC4Hr10Yr               | INTENSITY | 5 min.             |
| 25mm                      | 25mm                      | INTENSITY | 5 min.             |
| 25Yr4HrChic               | CHIC4Hr25Yr               | INTENSITY | 5 min.             |
| 2Yr4HrChic                | CHIC4Hr2Yr                | INTENSITY | 5 min.             |
| 50Yr4HrChic               | CHIC4Hr50Yr               | INTENSITY | 5 min.             |
| 5Yr4HrChic                | CHIC4Hr5Yr                | INTENSITY | 5 min.             |
| Hurricane_Hazel_(0-25)    | Hurricane_Hazel_(0-25)    | INTENSITY | 60 min.            |
| SCS_Type_II_101.7mm_50Yr  | SCS_Type_II_101.7mm_50Yr  | INTENSITY | 6 min.             |
| SCS_Type_II_112.5mm_100Yr | SCS_Type_II_112.5mm_100Yr | INTENSITY | 6 min.             |
| SCS_Type_II_46.7mm_2Yr    | SCS_Type_II_46.7mm_2Yr    | INTENSITY | 6 min.             |
| SCS_Type_II_64.3mm_5Yr    | SCS_Type_II_64.3mm_5Yr    | INTENSITY | 6 min.             |
| SCS_Type_II_76mm_10Yr     | SCS_Type_II_76mm_10Yr     | INTENSITY | 6 min.             |
| SCS_Type_II_90.7mm_25Yr   | SCS_Type_II_90.7mm_25Yr   | INTENSITY | 6 min.             |
| Timmins_Storm_(0-25)      | Timmins_Storm_(0-25)      | INTENSITY | 60 min.            |

\*\*\*\*\*

Subcatchment Summary

\*\*\*\*\*

| Name | Area | Width | %Imperv | %Slope | Rain Gage | Outlet     |
|------|------|-------|---------|--------|-----------|------------|
| S1   | 0.09 | 26.40 | 100.00  | 1.0000 | 25mm      | Roof_Infil |
| S10  | 0.03 | 84.75 | 0.00    | 2.0000 | 25mm      | S3         |

|     |       |        |       |        |      |         |
|-----|-------|--------|-------|--------|------|---------|
| S11 | 0.04  | 120.33 | 0.00  | 2.0000 | 25mm | S4      |
| S2  | 12.59 | 298.30 | 70.00 | 2.0000 | 25mm | J1      |
| S3  | 0.23  | 382.17 | 35.00 | 2.0000 | 25mm | J7      |
| S4  | 0.17  | 17.23  | 5.00  | 2.0000 | 25mm | J5      |
| S5  | 1.95  | 355.14 | 85.00 | 2.0000 | 25mm | DICB4   |
| S6  | 5.80  | 579.92 | 25.00 | 2.0000 | 25mm | STMH6   |
| S7  | 0.40  | 395.30 | 85.00 | 2.0000 | 25mm | STMH7   |
| S8  | 0.28  | 27.70  | 98.00 | 1.0000 | 25mm | DCBMH01 |
| S9  | 0.03  | 94.33  | 0.00  | 2.0000 | 25mm | S3      |

\*\*\*\*\*  
LID Control Summary  
\*\*\*\*\*

| Subcatchment | LID Control | No. of<br>Units | Unit<br>Area | Unit<br>Width | % Area<br>Covered | % Imperv<br>Treated | % Perv<br>Treated |
|--------------|-------------|-----------------|--------------|---------------|-------------------|---------------------|-------------------|
| S9           | LID1        | 1               | 114.00       | 1.50          | 40.28             | 100.00              | 0.00              |

\*\*\*\*\*  
Node Summary  
\*\*\*\*\*

| Name             | Type     | Invert<br>Elev. | Max.<br>Depth | Ponded<br>Area | External<br>Inflow |
|------------------|----------|-----------------|---------------|----------------|--------------------|
| DCBMH01          | JUNCTION | 259.85          | 1.50          | 0.0            |                    |
| DICB4            | JUNCTION | 254.83          | 1.60          | 0.0            |                    |
| J1               | JUNCTION | 257.40          | 0.25          | 0.0            |                    |
| J2               | JUNCTION | 254.37          | 0.86          | 0.0            |                    |
| J4               | JUNCTION | 260.96          | 0.61          | 0.0            |                    |
| J5               | JUNCTION | 258.41          | 0.59          | 0.0            |                    |
| J6               | JUNCTION | 259.67          | 0.66          | 0.0            |                    |
| J7               | JUNCTION | 261.66          | 0.51          | 0.0            |                    |
| J8               | JUNCTION | 261.27          | 0.56          | 0.0            |                    |
| MH02             | JUNCTION | 260.54          | 1.68          | 0.0            |                    |
| MH03             | JUNCTION | 259.80          | 1.88          | 0.0            |                    |
| OGS1             | JUNCTION | 259.80          | 1.58          | 0.0            |                    |
| OS1              | JUNCTION | 259.75          | 1.77          | 0.0            |                    |
| STMH3            | JUNCTION | 254.64          | 3.01          | 0.0            |                    |
| STMH6            | JUNCTION | 254.11          | 2.06          | 0.0            |                    |
| STMH7            | JUNCTION | 253.97          | 2.45          | 0.0            |                    |
| OF1              | OUTFALL  | 253.91          | 1.20          | 0.0            |                    |
| Roof_Infil       | STORAGE  | 260.46          | 1.76          | 0.0            |                    |
| Underground_Stor | STORAGE  | 259.79          | 1.56          | 0.0            |                    |

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Link Summary

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| Name | From Node        | To Node          | Type    | Length | %Slope | Roughness |
|------|------------------|------------------|---------|--------|--------|-----------|
| C1   | DICB4            | J2               | CONDUIT | 13.3   | 0.9776 | 0.0130    |
| C10  | MH02             | MH03             | CONDUIT | 52.0   | 1.4222 | 0.0130    |
| C11  | DCBMH01          | OGS1             | CONDUIT | 3.1    | 0.3210 | 0.0130    |
| C12  | OGS1             | Underground_Stor | CONDUIT | 2.8    | 0.3571 | 0.0130    |
| C13  | MH03             | Underground_Stor | CONDUIT | 24.9   | 0.0401 | 0.0130    |
| C14  | Roof_Infil       | MH02             | CONDUIT | 1.8    | 1.6856 | 0.0130    |
| C2   | J2               | STMH6            | CONDUIT | 22.6   | 0.3982 | 0.0130    |
| C3   | STMH6            | STMH7            | CONDUIT | 20.6   | 0.6782 | 0.0130    |
| C4   | STMH7            | OF1              | CONDUIT | 7.6    | 0.7885 | 0.0130    |
| C5   | STMH3            | J2               | CONDUIT | 62.5   | 0.4322 | 0.0130    |
| C6   | OS1              | J6               | CONDUIT | 42.0   | 0.1903 | 0.0130    |
| C6_1 | J7               | J8               | CONDUIT | 25.0   | 1.5697 | 0.0300    |
| C6_4 | J4               | J6               | CONDUIT | 91.5   | 1.4100 | 0.0300    |
| C6_5 | J8               | J4               | CONDUIT | 19.6   | 1.5719 | 0.0130    |
| C7   | J6               | J5               | CONDUIT | 172.6  | 0.7301 | 0.0300    |
| C8   | J5               | DICB4            | CONDUIT | 303.7  | 1.1790 | 0.0300    |
| C9   | J1               | STMH7            | CONDUIT | 81.7   | 1.5053 | 0.0130    |
| OL1  | DICB4            | STMH7            | CONDUIT | 41.6   | 0.0024 | 0.0130    |
| OL2  | J1               | STMH3            | OUTLET  |        |        |           |
| OL3  | Underground_Stor | OS1              | OUTLET  |        |        |           |

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Cross Section Summary

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| Conduit | Shape         | Full Depth | Full Area | Hyd. Rad. | Max. Width | No. of Barrels | Full Flow |
|---------|---------------|------------|-----------|-----------|------------|----------------|-----------|
| C1      | CIRCULAR      | 0.30       | 0.07      | 0.07      | 0.30       | 1              | 0.10      |
| C10     | CIRCULAR      | 0.30       | 0.07      | 0.07      | 0.30       | 1              | 0.12      |
| C11     | CIRCULAR      | 0.38       | 0.11      | 0.09      | 0.38       | 1              | 0.10      |
| C12     | CIRCULAR      | 0.38       | 0.11      | 0.09      | 0.38       | 1              | 0.10      |
| C13     | DUMMY         | 0.00       | 0.00      | 0.00      | 0.00       | 1              | 0.00      |
| C14     | CIRCULAR      | 0.07       | 0.00      | 0.02      | 0.07       | 1              | 0.00      |
| C2      | HORIZ_ELLIPSE | 0.86       | 0.93      | 0.26      | 1.34       | 1              | 1.85      |
| C3      | CIRCULAR      | 1.20       | 1.13      | 0.30      | 1.20       | 1              | 3.21      |
| C4      | CIRCULAR      | 1.20       | 1.13      | 0.30      | 1.20       | 1              | 3.46      |
| C5      | HORIZ_ELLIPSE | 0.86       | 0.93      | 0.26      | 1.34       | 1              | 1.93      |
| C6      | CIRCULAR      | 0.30       | 0.07      | 0.07      | 0.30       | 1              | 0.04      |
| C6_1    | TRAPEZOIDAL   | 0.50       | 1.25      | 0.30      | 4.00       | 1              | 2.34      |

|      |             |      |      |      |       |   |      |
|------|-------------|------|------|------|-------|---|------|
| C6_4 | TRAPEZOIDAL | 0.50 | 1.25 | 0.30 | 4.00  | 1 | 2.22 |
| C6_5 | CIRCULAR    | 0.45 | 0.16 | 0.11 | 0.45  | 1 | 0.36 |
| C7   | TRAPEZOIDAL | 0.40 | 0.84 | 0.22 | 3.70  | 1 | 0.87 |
| C8   | TRAPEZOIDAL | 0.40 | 0.84 | 0.22 | 3.70  | 1 | 1.11 |
| C9   | Street1     | 0.23 | 2.12 | 0.15 | 18.00 | 1 | 5.53 |
| OL1  | TRIANGULAR  | 0.25 | 7.12 | 0.12 | 57.00 | 1 | 0.67 |

\*\*\*\*\*  
Transect Summary  
\*\*\*\*\*

Transect Street1  
Area:

|        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 0.0005 | 0.0020 | 0.0045 | 0.0080 | 0.0125 |
| 0.0180 | 0.0245 | 0.0319 | 0.0404 | 0.0499 |
| 0.0604 | 0.0719 | 0.0843 | 0.0978 | 0.1123 |
| 0.1278 | 0.1442 | 0.1617 | 0.1802 | 0.1996 |
| 0.2201 | 0.2415 | 0.2632 | 0.2849 | 0.3066 |
| 0.3283 | 0.3500 | 0.3717 | 0.3934 | 0.4151 |
| 0.4368 | 0.4585 | 0.4803 | 0.5029 | 0.5264 |
| 0.5510 | 0.5766 | 0.6032 | 0.6308 | 0.6593 |
| 0.6889 | 0.7195 | 0.7511 | 0.7836 | 0.8172 |
| 0.8518 | 0.8873 | 0.9239 | 0.9614 | 1.0000 |

Hrad:

|        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 0.0155 | 0.0310 | 0.0464 | 0.0619 | 0.0774 |
| 0.0929 | 0.1083 | 0.1238 | 0.1393 | 0.1548 |
| 0.1703 | 0.1857 | 0.2012 | 0.2167 | 0.2322 |
| 0.2476 | 0.2631 | 0.2786 | 0.2941 | 0.3096 |
| 0.3250 | 0.3445 | 0.3751 | 0.4056 | 0.4361 |
| 0.4666 | 0.4970 | 0.5273 | 0.5576 | 0.5878 |
| 0.6180 | 0.6481 | 0.6783 | 0.7072 | 0.7343 |
| 0.7597 | 0.7836 | 0.8061 | 0.8273 | 0.8473 |
| 0.8662 | 0.8841 | 0.9011 | 0.9172 | 0.9326 |
| 0.9472 | 0.9612 | 0.9747 | 0.9876 | 1.0000 |

Width:

|        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 0.0256 | 0.0511 | 0.0767 | 0.1022 | 0.1278 |
| 0.1533 | 0.1789 | 0.2044 | 0.2300 | 0.2556 |
| 0.2811 | 0.3067 | 0.3322 | 0.3578 | 0.3833 |
| 0.4089 | 0.4344 | 0.4600 | 0.4856 | 0.5111 |
| 0.5367 | 0.5556 | 0.5556 | 0.5556 | 0.5556 |
| 0.5556 | 0.5556 | 0.5556 | 0.5556 | 0.5556 |
| 0.5556 | 0.5556 | 0.5656 | 0.5911 | 0.6167 |
| 0.6422 | 0.6678 | 0.6933 | 0.7189 | 0.7444 |
| 0.7700 | 0.7956 | 0.8211 | 0.8467 | 0.8722 |



0.8978      0.9233      0.9489      0.9744      1.0000

\*\*\*\*\*  
NOTE: The summary statistics displayed in this report are  
based on results found at every computational time step,  
not just on results from each reporting time step.  
\*\*\*\*\*

\*\*\*\*\*

Analysis Options

\*\*\*\*\*

Flow Units ..... CMS

Process Models:

Rainfall/Runoff ..... YES

RDII ..... NO

Snowmelt ..... NO

Groundwater ..... NO

Flow Routing ..... YES

Ponding Allowed ..... YES

Water Quality ..... NO

Infiltration Method ..... GREEN\_AMPT

Flow Routing Method ..... DYNWAVE

Surcharge Method ..... EXTRAN

Starting Date ..... 10/18/2018 00:00:00

Ending Date ..... 10/22/2018 00:00:00

Antecedent Dry Days ..... 0.0

Report Time Step ..... 00:05:00

Wet Time Step ..... 00:05:00

Dry Time Step ..... 00:05:00

Routing Time Step ..... 5.00 sec

Variable Time Step ..... YES

Maximum Trials ..... 8

Number of Threads ..... 4

Head Tolerance ..... 0.001500 m

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Runoff Quantity Continuity

\*\*\*\*\*

Total Precipitation .....

Evaporation Loss .....

Infiltration Loss .....

Surface Runoff .....

Final Storage .....

Continuity Error (%) .....

Volume

hectare-m

-----

0.540

0.000

0.217

0.300

0.025

-0.368

Depth

mm

-----

24.999

0.000

10.046

13.868

1.177

| *****                      | Volume    | Volume   |
|----------------------------|-----------|----------|
| Flow Routing Continuity    | hectare-m | 10^6 ltr |
| *****                      | -----     | -----    |
| Dry Weather Inflow .....   | 0.000     | 0.000    |
| Wet Weather Inflow .....   | 0.300     | 2.996    |
| Groundwater Inflow .....   | 0.000     | 0.000    |
| RDII Inflow .....          | 0.000     | 0.000    |
| External Inflow .....      | 0.000     | 0.000    |
| External Outflow .....     | 0.302     | 3.020    |
| Flooding Loss .....        | 0.000     | 0.000    |
| Evaporation Loss .....     | 0.000     | 0.000    |
| Exfiltration Loss .....    | 0.002     | 0.021    |
| Initial Stored Volume .... | 0.000     | 0.000    |
| Final Stored Volume .....  | 0.000     | 0.000    |
| Continuity Error (%) ..... | -1.519    |          |

\*\*\*\*\*  
Highest Continuity Errors  
\*\*\*\*\*  
Node J5 (3.79%)

\*\*\*\*\*  
Time-Step Critical Elements  
\*\*\*\*\*  
Link C12 (8.03%)  
Link C4 (2.14%)

\*\*\*\*\*  
Highest Flow Instability Indexes  
\*\*\*\*\*  
Link OL2 (46)  
Link C5 (6)

\*\*\*\*\*  
Routing Time Step Summary  
\*\*\*\*\*  
Minimum Time Step : 0.89 sec  
Average Time Step : 4.70 sec  
Maximum Time Step : 5.00 sec  
Percent in Steady State : 0.00

Average Iterations per Step : 2.00  
 Percent Not Converging : 0.00

\*\*\*\*\*  
 Subcatchment Runoff Summary  
 \*\*\*\*\*

| Subcatchment | Total<br>Precip<br>mm | Total<br>Runon<br>mm | Total<br>Evap<br>mm | Total<br>Infil<br>mm | Imperv<br>Runoff<br>mm | Perv<br>Runoff<br>mm | Total<br>Runoff<br>mm | Total<br>Runoff<br>10^6 ltr | Peak<br>Runoff<br>CMS | Runoff<br>Coeff |
|--------------|-----------------------|----------------------|---------------------|----------------------|------------------------|----------------------|-----------------------|-----------------------------|-----------------------|-----------------|
| S1           | 25.00                 | 0.00                 | 0.00                | 0.00                 | 23.18                  | 0.00                 | 23.18                 | 0.02                        | 0.02                  | 0.927           |
| S10          | 25.00                 | 0.00                 | 0.00                | 25.00                | 0.00                   | 0.00                 | 0.00                  | 0.00                        | 0.00                  | 0.000           |
| S11          | 25.00                 | 0.00                 | 0.00                | 25.00                | 0.00                   | 0.00                 | 0.00                  | 0.00                        | 0.00                  | 0.000           |
| S2           | 25.00                 | 0.00                 | 0.00                | 7.37                 | 16.19                  | 0.13                 | 16.32                 | 2.05                        | 1.03                  | 0.653           |
| S3           | 25.00                 | 0.00                 | 0.00                | 14.94                | 8.07                   | 1.54                 | 9.61                  | 0.02                        | 0.02                  | 0.384           |
| S4           | 25.00                 | 0.00                 | 0.00                | 23.25                | 1.15                   | 0.51                 | 1.66                  | 0.00                        | 0.00                  | 0.067           |
| S5           | 25.00                 | 0.00                 | 0.00                | 3.49                 | 19.70                  | 0.29                 | 19.99                 | 0.39                        | 0.31                  | 0.799           |
| S6           | 25.00                 | 0.00                 | 0.00                | 18.29                | 5.78                   | 0.48                 | 6.26                  | 0.36                        | 0.29                  | 0.251           |
| S7           | 25.00                 | 0.00                 | 0.00                | 3.42                 | 19.60                  | 0.46                 | 20.06                 | 0.08                        | 0.07                  | 0.802           |
| S8           | 25.00                 | 0.00                 | 0.00                | 0.46                 | 22.70                  | 0.05                 | 22.76                 | 0.06                        | 0.04                  | 0.910           |
| S9           | 25.00                 | 0.00                 | 0.00                | 25.00                | 0.00                   | 0.00                 | 0.00                  | 0.00                        | 0.00                  | 0.000           |

\*\*\*\*\*  
 LID Performance Summary  
 \*\*\*\*\*

| Subcatchment | LID Control | Total<br>Inflow<br>mm | Evap<br>Loss<br>mm | Infil<br>Loss<br>mm | Surface<br>Outflow<br>mm | Drain<br>Outflow<br>mm | Initial<br>Storage<br>mm | Final<br>Storage<br>mm | Continuity<br>Error<br>% |
|--------------|-------------|-----------------------|--------------------|---------------------|--------------------------|------------------------|--------------------------|------------------------|--------------------------|
| S9           | LID1        | 25.00                 | 0.00               | 25.00               | 0.00                     | 0.00                   | 0.00                     | 0.00                   | 0.00                     |

\*\*\*\*\*  
 Node Depth Summary  
 \*\*\*\*\*

| Node | Type | Average<br>Depth<br>Meters | Maximum<br>Depth<br>Meters | Maximum<br>HGL<br>Meters | Time of Max<br>Occurrence<br>days hr:min | Reported<br>Max Depth<br>Meters |
|------|------|----------------------------|----------------------------|--------------------------|------------------------------------------|---------------------------------|
|------|------|----------------------------|----------------------------|--------------------------|------------------------------------------|---------------------------------|

|                  |          |      |      |        |   |       |      |
|------------------|----------|------|------|--------|---|-------|------|
| DCBMH01          | JUNCTION | 0.01 | 0.15 | 260.00 | 0 | 01:40 | 0.15 |
| DICB4            | JUNCTION | 0.02 | 0.40 | 255.23 | 0 | 01:46 | 0.40 |
| J1               | JUNCTION | 0.00 | 0.11 | 257.51 | 0 | 01:40 | 0.11 |
| J2               | JUNCTION | 0.02 | 0.22 | 254.59 | 0 | 01:46 | 0.22 |
| J4               | JUNCTION | 0.00 | 0.04 | 261.00 | 0 | 01:42 | 0.03 |
| J5               | JUNCTION | 0.00 | 0.04 | 258.45 | 0 | 02:06 | 0.04 |
| J6               | JUNCTION | 0.00 | 0.07 | 259.74 | 0 | 01:49 | 0.07 |
| J7               | JUNCTION | 0.00 | 0.04 | 261.70 | 0 | 01:40 | 0.04 |
| J8               | JUNCTION | 0.00 | 0.07 | 261.34 | 0 | 01:40 | 0.07 |
| MH02             | JUNCTION | 0.00 | 0.00 | 260.54 | 0 | 00:00 | 0.00 |
| MH03             | JUNCTION | 0.00 | 0.00 | 259.80 | 0 | 00:00 | 0.00 |
| OGS1             | JUNCTION | 0.01 | 0.17 | 259.97 | 0 | 01:40 | 0.16 |
| OS1              | JUNCTION | 0.01 | 0.06 | 259.81 | 0 | 02:16 | 0.06 |
| STMH3            | JUNCTION | 0.01 | 0.15 | 254.79 | 0 | 02:38 | 0.15 |
| STMH6            | JUNCTION | 0.02 | 0.39 | 254.50 | 0 | 01:40 | 0.38 |
| STMH7            | JUNCTION | 0.02 | 0.54 | 254.51 | 0 | 01:40 | 0.54 |
| OF1              | OUTFALL  | 0.03 | 0.54 | 254.45 | 0 | 01:40 | 0.53 |
| Roof_Infil       | STORAGE  | 0.02 | 0.09 | 260.55 | 0 | 04:05 | 0.09 |
| Underground_Stor | STORAGE  | 0.01 | 0.11 | 259.90 | 0 | 02:30 | 0.11 |

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Node Inflow Summary  
\*\*\*\*\*

| Node    | Type     | Maximum<br>Lateral<br>Inflow<br>CMS | Maximum<br>Total<br>Inflow<br>CMS | Time of Max<br>Occurrence<br>days hr:min | Lateral<br>Inflow<br>Volume<br>10^6 ltr | Total<br>Inflow<br>Volume<br>10^6 ltr | Flow<br>Balance<br>Error<br>Percent |
|---------|----------|-------------------------------------|-----------------------------------|------------------------------------------|-----------------------------------------|---------------------------------------|-------------------------------------|
| DCBMH01 | JUNCTION | 0.042                               | 0.042                             | 0 01:40                                  | 0.063                                   | 0.063                                 | -0.005                              |
| DICB4   | JUNCTION | 0.314                               | 0.314                             | 0 01:40                                  | 0.39                                    | 0.475                                 | -0.643                              |
| J1      | JUNCTION | 1.034                               | 1.034                             | 0 01:40                                  | 2.05                                    | 2.05                                  | -2.503                              |
| J2      | JUNCTION | 0.000                               | 0.236                             | 0 01:46                                  | 0                                       | 1.42                                  | -0.003                              |
| J4      | JUNCTION | 0.000                               | 0.018                             | 0 01:41                                  | 0                                       | 0.022                                 | -0.384                              |
| J5      | JUNCTION | 0.002                               | 0.013                             | 0 01:52                                  | 0.00287                                 | 0.0881                                | 3.936                               |
| J6      | JUNCTION | 0.000                               | 0.018                             | 0 01:42                                  | 0                                       | 0.0851                                | -0.178                              |
| J7      | JUNCTION | 0.019                               | 0.019                             | 0 01:40                                  | 0.022                                   | 0.022                                 | -0.017                              |
| J8      | JUNCTION | 0.000                               | 0.018                             | 0 01:40                                  | 0                                       | 0.022                                 | 0.012                               |
| MH02    | JUNCTION | 0.000                               | 0.000                             | 0 00:00                                  | 0                                       | 0                                     | 0.000 ltr                           |
| MH03    | JUNCTION | 0.000                               | 0.000                             | 0 00:00                                  | 0                                       | 0                                     | 0.000 ltr                           |
| OGS1    | JUNCTION | 0.000                               | 0.042                             | 0 01:40                                  | 0                                       | 0.063                                 | 0.022                               |
| OS1     | JUNCTION | 0.000                               | 0.003                             | 0 02:30                                  | 0                                       | 0.063                                 | 0.032                               |
| STMH3   | JUNCTION | 0.000                               | 0.100                             | 0 01:25                                  | 0                                       | 0.952                                 | 0.738                               |
| STMH6   | JUNCTION | 0.286                               | 0.498                             | 0 01:40                                  | 0.363                                   | 1.79                                  | 0.004                               |

|                  |          |       |       |   |       |        |        |        |
|------------------|----------|-------|-------|---|-------|--------|--------|--------|
| STMH7            | JUNCTION | 0.069 | 1.454 | 0 | 01:40 | 0.0793 | 3.02   | 0.007  |
| OF1              | OUTFALL  | 0.000 | 1.454 | 0 | 01:40 | 0      | 3.02   | 0.000  |
| Roof_Infil       | STORAGE  | 0.017 | 0.017 | 0 | 01:40 | 0.0214 | 0.0214 | -0.001 |
| Underground_Stor | STORAGE  | 0.000 | 0.042 | 0 | 01:40 | 0      | 0.063  | -0.004 |

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Node Surcharge Summary  
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No nodes were surcharged.

\*\*\*\*\*  
Node Flooding Summary  
\*\*\*\*\*

No nodes were flooded.

\*\*\*\*\*  
Storage Volume Summary  
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| Storage Unit     | Average<br>Volume<br>1000 m3 | Avg<br>Pcnt<br>Full | Evap<br>Pcnt<br>Loss | Exfil<br>Pcnt<br>Loss | Maximum<br>Volume<br>1000 m3 | Max<br>Pcnt<br>Full | Time of Max<br>Occurrence<br>days hr:min | Maximum<br>Outflow<br>CMS |
|------------------|------------------------------|---------------------|----------------------|-----------------------|------------------------------|---------------------|------------------------------------------|---------------------------|
| Roof_Infil       | 0.004                        | 5                   | 0                    | 100                   | 0.017                        | 19                  | 0 04:05                                  | 0.001                     |
| Underground_Stor | 0.004                        | 3                   | 0                    | 0                     | 0.042                        | 25                  | 0 02:30                                  | 0.003                     |

\*\*\*\*\*  
Outfall Loading Summary  
\*\*\*\*\*

| Outfall Node | Flow<br>Freq<br>Pcnt | Avg<br>Flow<br>CMS | Max<br>Flow<br>CMS | Total<br>Volume<br>10^6 ltr |
|--------------|----------------------|--------------------|--------------------|-----------------------------|
| OF1          | 60.35                | 0.047              | 1.454              | 3.020                       |
| System       | 60.35                | 0.047              | 1.454              | 3.020                       |

Link Flow Summary  
\*\*\*\*\*

| Link | Type    | Maximum      | Time of Max |             | Maximum         | Max/         | Max/          |
|------|---------|--------------|-------------|-------------|-----------------|--------------|---------------|
|      |         | Flow <br>CMS | Occurrence  | days hr:min | Veloc <br>m/sec | Full<br>Flow | Full<br>Depth |
| C1   | CONDUIT | 0.136        | 0           | 01:46       | 1.95            | 1.42         | 0.96          |
| C10  | CONDUIT | 0.000        | 0           | 00:00       | 0.00            | 0.00         | 0.00          |
| C11  | CONDUIT | 0.042        | 0           | 01:40       | 1.02            | 0.42         | 0.40          |
| C12  | CONDUIT | 0.042        | 0           | 01:40       | 1.67            | 0.40         | 0.29          |
| C13  | DUMMY   | 0.000        | 0           | 00:00       |                 |              |               |
| C14  | CONDUIT | 0.000        | 0           | 00:00       | 0.00            | 0.00         | 0.00          |
| C2   | CONDUIT | 0.236        | 0           | 01:47       | 1.35            | 0.13         | 0.26          |
| C3   | CONDUIT | 0.492        | 0           | 01:40       | 1.48            | 0.15         | 0.39          |
| C4   | CONDUIT | 1.454        | 0           | 01:40       | 2.93            | 0.42         | 0.45          |
| C5   | CONDUIT | 0.100        | 0           | 01:35       | 0.95            | 0.05         | 0.22          |
| C6   | CONDUIT | 0.003        | 0           | 02:29       | 0.49            | 0.08         | 0.20          |
| C6_1 | CONDUIT | 0.018        | 0           | 01:40       | 0.29            | 0.01         | 0.11          |
| C6_4 | CONDUIT | 0.017        | 0           | 01:42       | 0.35            | 0.01         | 0.10          |
| C6_5 | CONDUIT | 0.018        | 0           | 01:41       | 1.63            | 0.05         | 0.12          |
| C7   | CONDUIT | 0.012        | 0           | 01:52       | 0.35            | 0.01         | 0.12          |
| C8   | CONDUIT | 0.009        | 0           | 02:06       | 0.15            | 0.01         | 0.52          |
| C9   | CHANNEL | 0.909        | 0           | 01:40       | 1.46            | 0.16         | 0.49          |
| OL1  | CONDUIT | 0.000        | 0           | 00:00       | 0.00            | 0.00         | 0.00          |
| OL2  | DUMMY   | 0.100        | 0           | 01:25       |                 |              |               |
| OL3  | DUMMY   | 0.003        | 0           | 02:30       |                 |              |               |

```
*****
Flow Classification Summary
*****
```

[illegible]



|      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|
| C2   | 1.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 | 0.00 |
| C3   | 1.00 | 0.01 | 0.00 | 0.00 | 0.86 | 0.13 | 0.00 | 0.00 | 0.02 | 0.00 |
| C4   | 1.00 | 0.01 | 0.00 | 0.00 | 0.82 | 0.17 | 0.00 | 0.00 | 0.94 | 0.00 |
| C5   | 1.00 | 0.01 | 0.00 | 0.00 | 0.99 | 0.00 | 0.00 | 0.00 | 0.98 | 0.00 |
| C6   | 1.00 | 0.01 | 0.00 | 0.00 | 0.99 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| C6_1 | 1.00 | 0.01 | 0.87 | 0.00 | 0.12 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 |
| C6_4 | 1.00 | 0.11 | 0.74 | 0.00 | 0.15 | 0.00 | 0.00 | 0.00 | 0.98 | 0.00 |
| C6_5 | 1.00 | 0.01 | 0.00 | 0.00 | 0.90 | 0.09 | 0.00 | 0.00 | 0.93 | 0.00 |
| C7   | 1.00 | 0.04 | 0.07 | 0.00 | 0.89 | 0.00 | 0.00 | 0.00 | 0.52 | 0.00 |
| C8   | 1.00 | 0.01 | 0.04 | 0.00 | 0.95 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 |
| C9   | 1.00 | 0.65 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.35 | 0.00 | 0.00 |
| OL1  | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

\*\*\*\*\*

# Conduit Surcharge Summary

\*\*\*\*\*

| Conduit | Hours Full |          |          | Hours                  | Hours            |
|---------|------------|----------|----------|------------------------|------------------|
|         | Both Ends  | Upstream | Dnstream | Above Full Normal Flow | Capacity Limited |
| C1      | 0.01       | 0.36     | 0.01     | 0.48                   | 0.01             |
| C8      | 0.01       | 0.01     | 0.02     | 0.01                   | 0.01             |

Analysis begun on: Fri Apr 24 07:32:31 2020

Analysis ended on: Fri Apr 24 07:32:33 2020

Total elapsed time: 00:00:02

## Appendix I – Water Demand

|              |                |
|--------------|----------------|
| Prepared by: | C. Capes       |
| Checked by:  | C. Capes       |
| Project No:  | 2019-083       |
| Date:        | April 24, 2020 |

**Domestic Flow Calculations**

|                                     |                 |                                                                                                   |
|-------------------------------------|-----------------|---------------------------------------------------------------------------------------------------|
| Number of Water Fixture Units =     | <260            |                                                                                                   |
| Water Demand =                      | 2360 L          | OBC Table 7.4.10.5 Conversion of WFSU to Litres/day (minimum = 2360 L/day for less than 260 WFSU) |
| Operating Hours =                   | 10 hrs          |                                                                                                   |
| Lawn Sprinkler System =             | 0.38 L/s        | Assume 1 L/s/ha & 2 hours of Sprinkling/day                                                       |
| =                                   | 2736 L/d        |                                                                                                   |
| Average Day Demand =                | 5,096 L/d       |                                                                                                   |
| =                                   | 0.06 L/s        |                                                                                                   |
| Peak Factor =                       | 4               | MECP Recommended Range 2 to 4                                                                     |
| Peak Demand =                       | 0.24 L/s        |                                                                                                   |
| <b>Total Domestic Peak Demand =</b> | <b>0.24 L/s</b> |                                                                                                   |

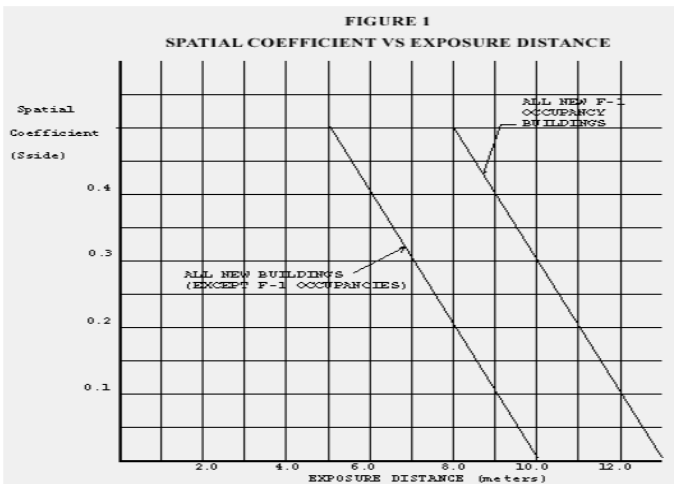
**Fire Flow Calculations**

Office of the Fire Marshal, OFM Guideline, Fire Protection Water Supply Guideline for Part 3 in the Ontario Building Code (Oct 1999)  
Subsection 3.2.2 of the Ontario Building Code, 2012

**Q=KVS<sub>Total</sub>** where

Q = Minimum supply of water in Litres (L)  
K = water supply coefficient from Table 1  
V = total building volume in cubic meters  
S<sub>Tot</sub> = total of the spacial coefficient values from the property line exposures on all sides as obtained from the formula:  
 $S_{Tot} = 1.0 + [(S_{Side1}) + (S_{Side2}) + (S_{Side3}) + \dots \text{etc.}]$

where S<sub>Side</sub> values are obtained from Figure 1, as modified by Sections 6.39(e) and 6.3(f) of the OBC Guideline  
S<sub>Tot</sub> need not exceed 2.0



1 Building Classification:

Building is of noncombustible construction with fire separations and fire resistance ratings provided in accordance with Subsection 3.2.2 of the OBC, including loadbearing walls, columns and arches.

Water Supply Coefficient - K

Table 1 of OBC A.3.2.5.7

K = 10

Type B, OBC Table 3.1.2.1

2 Building Volumes

| Bldg.        | Area              | Height | Volume            |
|--------------|-------------------|--------|-------------------|
|              | (m <sup>2</sup> ) | (m)    | (m <sup>3</sup> ) |
| Bldg. 1      | 900               | 14.00  | 12600             |
|              |                   |        |                   |
|              |                   |        |                   |
|              |                   |        |                   |
|              |                   |        |                   |
|              |                   |        |                   |
| <b>Total</b> |                   |        | <b>12600</b>      |

← Total Building Volume

3 Exposure Distances

$S_{Tot} = 1.0 + [(S_{Side1}) + (S_{Side2}) + (S_{Side3}) + \dots \text{etc.}]$

| Bldg.   | North | S <sub>Side</sub> (N) | East  | S <sub>Side</sub> (E) | South | S <sub>Side</sub> (S) | West  | S <sub>Side</sub> (W) | S <sub>Tot</sub> |
|---------|-------|-----------------------|-------|-----------------------|-------|-----------------------|-------|-----------------------|------------------|
|         | (m)   |                       | (m)   |                       | (m)   |                       | (m)   |                       |                  |
| Bldg. 1 | >10 m | 0                     | >10 m | 0                     | >10 m | 0                     | >10 m | 0                     | 0                |
|         |       |                       |       |                       |       |                       |       |                       |                  |
|         |       |                       |       |                       |       |                       |       |                       |                  |
|         |       |                       |       |                       |       |                       |       |                       |                  |
|         |       |                       |       |                       |       |                       |       |                       |                  |
|         |       |                       |       |                       |       |                       |       |                       |                  |

← Max S<sub>Tot</sub>

S<sub>Tot</sub> = 1.00

Max. Value = 2.0

4 Minimum Fire Water Supply

**Q=KVS<sub>Total</sub>** = 126000 Litres

5 Fire Water Supply Flow Rate

= 3600 L/min

Table 2 Required Minimum Water Supply Flow Rate (L/min), provided in the OBC A.3.2.5.7

= 60.00 L/s

6 Domestic + Fire Flow Rate

= 60.24 L/s

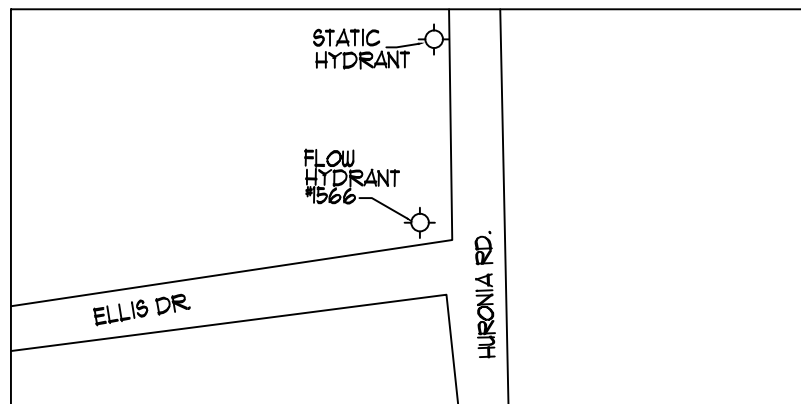
# FLOW TEST RESULTS



DATE : JULY 21, 2020 TIME : 11:30 AM

LOCATION : ELLIS DRIVE AND HURONIA  
BARRIE  
ONTARIO

TEST BY : VIPOND FIRE PROTECTION AND LOCAL PUC



STATIC PRESSURE : 68 PSI UNDERGROUND TYPE & SIZE : 200 mm D.I.

| TEST NO. | NO. OF NOZZLES | NOZZLE DIAMETER (INCHES) | DISCHARGE CO-EFFICIENT | RESIDUAL PRESSURE (PSI) | PITOT PRESSURE (PSI) | DISCHARGE (U.S.GPM) |
|----------|----------------|--------------------------|------------------------|-------------------------|----------------------|---------------------|
| 1        | 1              | 1 3/4"                   | 0.995                  | 67                      | 45                   | 597                 |
| 2        | 1              | 2 1/2"                   | 0.90                   | 67                      | 25                   | 843                 |
| 3        | 2              | 2 1/2"                   | 0.90                   | 66                      | 20                   | 1508                |



|                         |                 |               |
|-------------------------|-----------------|---------------|
| ELLIS DRIVE AND HURONIA | BY :            | LEN K.        |
| BARRIE                  | VIPOND OFFICE : | BARRIE        |
| ONTARIO                 | TEST BY :       | VIPOND & PUC  |
|                         | DATE :          | JULY 21, 2020 |

|               |        |               |   |                 |
|---------------|--------|---------------|---|-----------------|
| STATIC:       |        | RESIDUAL:     |   | FLOW:           |
| <u>68</u> PSI | TEST#1 | <u>61</u> PSI | @ | <u>597</u> GPM  |
|               | TEST#2 | <u>61</u> PSI | @ | <u>843</u> GPM  |
|               | TEST#3 | <u>66</u> PSI | @ | <u>1508</u> GPM |

