JAN. 23, 2020
PROJECT NO. - 2019-039

380 LOCKHART ROAD
FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

CITY OF BARRIE

CAPES ENGINEERING

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

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Introduction

CAPES Engineering Ltd. has been retained by Kingslea Developments to prepare a functional servicing and stormwater management report in support of a Site Plan Agreement for the 1.38 ha site located at 380 Lockhart Drive in the City of Barrie.

The site is currently vacant and largely covered with forest with some open areas in the middle of the site. It is proposed to construct a 4,539.20 sq. m commercial/light industrial building containing an office area, and warehouse. A total of 72 parking spaces will be provided along with 8 loading docks and 4 at-grade loading spaces. The site will have a single (two) way access point to Lockhart Road (See Site Plan in **Appendix A and Drawings C1-C9**) and will be Municipally serviced with a water connection from Lockhart Road and a sewer connection from Huronia Road.

The majority of the site is zoned "Light Industrial" and a portion of the east side of the site has an "Environmental Protection" designation due to Lovers Creek which is located approximately 60 m east of the site.

We believe that the stormwater management works proposed for the site will require Ministry of the Environment Climate and Parks (MECP) approval as it is to be developed as private site plan with an industrial use. Approvals are also required from the City of Barrie as well as the Lake Simcoe Region Conservation Authority (LSRCA). A permit from the LSRCA will be required as the majority of the site is within their regulated area, with only a small portion in the NW corner of the site outside the 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 1.38 ha site is located at 380 Lockhart Road (or 777 Huronia Road) in the City of Barrie and is legally described as Block 265 Plan 51M-822. Please refer to **Appendix A** for an excerpt of the legal plan.

The site is bound by Huronia Road to the south, Lockhart Road to the west, an environmental protection area and Lovers Creek to the east and a vacant light industrial lot to the north (773 Huronia Road).

The site has a high point approximately 25 m east of the Huronia Road ROW (elevation 253.51) and is largely covered with trees with some natural open areas in the central part of the site.

The site generally slopes in three directions from the high point; north-east and south-east at an average of 6.0% and west at approximately 15% slope to Huronia Road.

Huronia Road has an asphalt surface within a 30.12 m ROW but open ditches on both the east and west sides of the road. Fire hydrants are located on the west side of the road while hydro poles are located on the east side of the road. The ditch on the east side of Huronia flows north from the intersection of Huronia/Lockhart.

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Lockhart Road also has an asphalt surface with open ditches and the City has requested a 6.26 m road widening along the south edge of the development property which will create a 33.96 m ROW. There are hydro poles on both the north and south side of Lockhart Road, although streetlights are only on the north side of the road. Fire hydrants are also on the north side of the road including one at the NE corner of Lockhart and Huronia.

According to the County of Simcoe mapping the site sits within a Highly Vulnerable Aquifer.

Cambium Inc. has been retained by the Owner to complete an EIS for the site and they determined that a portion of the east side of the site has a number of development constraints. The constraints include a regulatory floodline (which only encroaches a small distance in the SE part of the site) and a 30 m field verified setback from a Provincially Significant Wetland (PSW) (which encroaches into the eastern part of the site).

Existing Sanitary Sewer

There is an existing 975 mm dia. concrete sanitary sewer which slopes north at 0.17% on Huronia Rd. (See **Appendix B**) and a 200 mm dia. sanitary service lateral was installed from the sewer into the development site (invert 245.816). We believe from the as-constructed details provided by the City that this sanitary line was installed in 1990.

There is no sanitary sewer on Lockhart Road along the south part of the site.

Existing Watermain

There is a 300 mm dia. watermain on the west side of Huronia Road, however there is no indication on the drawings provided from the City that a water service connection was provided to the development site.

There is also a 300 mm dia. watermain on the north side of Lockhart Road which was installed in 2010, but again there is no indication of a water service connection for the site.

There are fire hydrants on the west side of Huronia Road, including two directly west of the frontage of the site. There is another hydrant extending from the Lockhart Rd. watermain at the NE corner of Lockhart and Huronia Rd.

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 Cambium Inc. in Nov. 2019. Cambium completed 2 boreholes (BH101 & BH102) on the site and determined that there was a 0.15 m layer of topsoil underlain by between 2.5 and 3.5 m of sand. Below the sand is a silty clay/clayey/silt layer which extends down to the bottom of the boreholes at 6.7 m.

The estimated saturated hydraulic conductivity (Ksat) of the near surface sand layer, as determined through Hazens Rule, was 108 mm/hr which translates into an infiltration rate of approximately 125 mm/hr. The deeper clay/silt layer has a much lower saturated hydraulic conductivity at between 0.25 mm/hr and 1.1 mm/hr (infiltration rate of 25 mm/hr to 40 mm/hr). We believe that although the near

surface layers have a high infiltration rate, it will be the deeper silty clay layer that will govern the overall infiltration rate of the soil.

To be conservative we have assumed the silty clay layer will be the dominant soil type for infiltration on the site.

Groundwater was measured in both boreholes at depths between 4.89 and 6.0 m below grade (elevation 247.79 to 247.49) near the west-central part of the site. If the groundwater elevation roughly follows the existing ground surface we would expect the groundwater to be at an approximate elevation of 245.00 on the eastern part of the site. Additional testing on the site is proposed, specifically on the eastern part of the site. We understand this testing will included additional in-situ testing of the saturated hydraulic conductivity as well as the seasonal high groundwater through the Spring of 2020.

The geotechnical information for the site has been included in **Appendix C** of this report and the borehole locations added to **Drawings C1 & C2**.

Existing Stormwater Infrastructure & Background

There are no formal stormwater management controls on the existing site.

The 2019 Drainage Master Plan for the City of Barrie identifies this site as within the Lovers Creek Drainage area but does not provide specific recommendations for this site. There are no existing or proposed centralized stormwater management facilities that provide quality and quantity controls and as such all controls for runoff from the site will be required to be provided on-site.

Stormwater Approval Criteria

The stormwater management for the development lot must conform to the current City of Barrie Engineering Standards (2017), City of Barrie Interim Low Impact Development Guidelines (2019), the general recommendations of the City of Barrie) Drainage Master Plan (2019, 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 MECP (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 (elevation 247.49 to 247.79).

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- Best efforts towards an overall site water balance as per the LSRCA Water Balance Offsetting Policy (Jan. 2019) and/or provide compensation funds.
- 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 industrial use and sits within a Highly Vulnerable and as such infiltration activities are only allowed for rooftop or pervious areas.

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 pre-development site condition. 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 as is PCSWMM), 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 1.38 ha in size and flows by overland sheet flow to the north east (Area A1 = 0.676 ha) to the south east (Area A2 = 0.61 ha) and west (Area A3 = 0.095 ha).

There is no external drainage area as the site is higher than the surrounding lands. Areas A1 and A2 drain overland east to the wetland area adjacent to the west side of Lovers Creek. A portion of Area A2 will contribute flow into the Municipal ditch on the north side of Lockhart Road and flows east in the ditch to Lovers Creek. Area A3 drains to the eastern ditch on Huronia Road and flows north in the Municipal ditch.

Based on the geotechnical analysis the average grain size analysis (0% Gravel, 83% sand, 2% clay, 15% Silt) for the near surface native site soils indicates a “sand” and using the USDA Natural Resources Conservation Service Soil Texture Calculator the dominant soil on site is classified as a “Loamy Sand”

(https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167)

Using the same method as the sand layer the silty clay and clayey silt layer have an average grain size distribution of 1% Gravel, 11% sand, 32% silt, 56% clay and 0% Gravel, 10% sand, 65% silt, 25% clay respectively. These analyses correspond to a “clay” and a “silt loam”.

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Based on the 2019 Geotechnical Investigation completed by Cambium the sand or "Loamy Sand" has an infiltration rate of 125 mm/hr or a Saturated Hydraulic Conductivity (Ksat) of 108 mm/hr, the "clay" has a Ksat of 0.25 mm/hr (25 mm/hr infiltration) and the "silty loam" a Ksat of 1.1 mm/hr (40 mm/hr infiltration).

Although the sandy soil is the dominant soil type within the first 1.0 m of the surface and therefore will govern the near surface infiltration, the lower clay layer will likely form an aquitard and limit infiltration in the deeper soils to a much lower Ksat of 0.25 mm/hr. To be conservative we have assumed the clay layer will be the dominant soil type for infiltration on the site.

We have selected the Green Ampt Method of infiltration for the site for a "clay" 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 = 0.25 mm/hr (Clay) – As per 2019 Geotechnical Report

Suction Head = 320.040 mm (Clay as per Rawls 1983)

Initial Deficit (fraction) = 0.097 (Clay as per Rawls 1983)

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

	Duration (min)								
Return Period	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

	Duration (min)								
Return Period	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) and from UNESCO Manual on Urban Drainage (1987).

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Table 5.9: Manning Roughness Coefficients - Overland Flow

Cover	*n*
Impervious areas	0.013
Woods	
with light underbrush	0.4
with dense underbrush	0.8
Lawns	
Short grass	0.15
Dense grass	0.24
Agriculture Land	0.050-0.170

Ref: Adapted from Soil Conservation Service, Urban Hydrology for Small Watersheds, U.S. Dept. of Agriculture, Soil Conservation Service, Engineering

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 forested with clearings which are naturally regenerating with trees and as such we have calculated an overall Manning's value of 0.40 and depression storage value of 10 mm for the site.

The site overland flow length for Areas A1 and A2 are 100 m with an average slope of 6%, while the overland flow length for A3 is much shorter at 25 m and steeper slope approaching 15%.

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

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Table 1 – Pre-Development Modelling Results

Storm Event	Peak Flow Area A1 (north-east) (m^3/s)	Peak Flow Area A2 (south-east) (m^3/s)	Peak Flow Area A3 (west) (m^3/s)	Total Peak Flow Offsite (m^3/s)
12 Hr SCS Type II				
2-year	0.03	0.03	0.01	0.07
5-year	0.06	0.06	0.02	0.14
10-year	0.09	0.08	0.03	0.20
25-year	0.13	0.11	0.03	0.27
50-year	0.15	0.14	0.04	0.33
100-year	0.18	0.16	0.04	0.38
4 Hr Chicago				
2-year	0.00	0.00	0.00	0.00
5-year	0.00	0.00	0.00	0.00
10-year	0.01	0.01	0.00	0.02
25-year	0.02	0.02	0.01	0.05
50-year	0.02	0.02	0.01	0.05
100-year	0.03	0.03	0.01	0.07
25 mm	0.01	0.00	0.00	0.01
Hazel	0.09	0.08	0.01	0.18
Timmins	0.08	0.07	0.01	0.16

The 100-year 12 hr SCS Type II Storm produces the highest peak flow from the site. 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.

Proposed Site Design

It is proposed to construct a new two-way, 12 m wide, asphalt entrance from Huronia Road at the north-west corner of the site. A new 4,539.20 m^2 light industrial building complete with 371.61 m^2 office area, 4,123.05 m^2 warehouse area and 41.54 m^2 common room will be constructed in the middle of the site.

A total of 72 parking spaces will be provided including 2 handicap spaces. 43 Spaces will be located west of the building adjacent to Huronia Road with the remaining spaces east of the building. 8 loading dock spaces and 4 at grade loading spaces will also be provided on the east side of the building. Landscaped areas will be provided around the perimeter 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 C1** for the proposed site layout and to **Appendix A** for the Site Plan prepared by bnkc.

The site will be serviced by Municipal water and sewer connections from both Huronia Road (existing sewer lateral) and from Lockhart Road (new water service connection).

Stormwater management will be provided by an on-site subsurface chamber system that will provide infiltration for roof runoff and storage for runoff from other pervious areas.

Septic 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 utilize the existing connection point to the 975 mm dia. concrete sanitary sewer on Huronia Road.

Water Servicing

It is proposed to connect the building to the existing 300 mm dia. watermain on Lockhart Road with both a 250 mm dia. pipe for fire protection and a 50 mm dia. line for domestic water use. As no water service connection was provided from either Lockhart or Huronia and the Lockhart Road watermain is on the north side of the road we believe the least amount of disturbance to existing infrastructure will be to connect to Lockhart. A new connection to Huronia Road would require excavating Huronia as the watermain is on the west side of the road opposite to the site.

There are two existing fire hydrants on the west side of Huronia Road across the street from the site as well as a third hydrant at the NE corner of Lockhart Road and Huronia Road. A fourth hydrant is located on the north side of Lockhart south of the site and west of the Lovers Creek Crossing.

No additional fire hydrants will be required outside the building on the site, but a Siamese connection will be provided at the NW corner of the building. A water meter will be provided for the building as per City of Barrie requirements and will be located within the mechanical room on the south side of the building. The water meter is to be provided by the City of Barrie.

As per the City of Barrie Water Transmission and Distribution Policies and Design Guidelines (2017) industrial sites need to meet a minimum fire flow rating of 136 L/s @138 kpa residual but the preferred rate is 152 L/s @ 138 kpa.

Flow testing for the watermain on Huronia and on Lockhart are being undertaken with results included in a follow up submission.

Please refer to **Appendix I** for the calculations of the peak domestic and fire flows for the proposed site. The building is proposed to have 9 toilets, 9 washroom sinks, and 4 kitchen/utility sinks for a total of 9.875 water fixture units. In addition, the site is to have a landscaping sprinkler system which we have assumed would run for 2 hours per day over the pervious area of the site (0.3 ha). The total peak domestic flow is equal to 0.24 L/s.

The required fire flows for the site have been calculated 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) and equate to 150 L/s which matches closely to the City of Barrie preferred supply rate.

Utilities

Hydro is provided on Huronia Road and Lockhart Road from overhead pole lines. 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 but are available on both Lockhart Road and Huronia.

Street lighting will be provided by both on-building lighting and streetlighting on the site and will be dark sky compliant. There will be several light poles along the edge of the fire route and parking areas. Please refer to the Photometric plans and report prepared by TriStar Engineering (submitted separately). The light pole locations have been added to the engineering drawing set.

Stormwater Modelling - Proposed Development

It is proposed to provide on-site quality and quantity controls for stormwater management to meet the requirements of the City, LSRCA and MECP.

Additional quality control (for TSS and Phosphorous removal) as well as infiltration of clean roof and pervious area runoff is required for the site to meet the LSRCA stormwater and water balance requirements.

It is proposed to implement a subsurface infiltration system consisting of Atlantis Flo Double Tanks along the east side of the site under the parking area. This Atlantis infiltration system will only collect and infiltrate runoff from the roof of the building as per the LSRCA policy on infiltration for industrial sites. Due to the very low subsurface 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 300 mm dia. drain will be connected to a second stormwater storage chamber system (also Atlantis Double Flo Tanks) which will not allow infiltration to occur. The infiltration portion of the chamber system will be located a minimum of 1.0 m above the seasonal high groundwater at a maximum elevation of 248.79 as determined in the Cambium geotechnical report. The groundwater may be lower (approximate 245.00) in this area if the elevation is consistently an average of 5 m below ground surface. Cambium will be completing additional boreholes and testing through the Spring of 2020 to confirm the elevations in this area.

Runoff from the remaining impervious areas of the site (asphalt areas) will be collected using a series of catchbasins and storm sewer connecting to an oil, grit separator (OGS) along the east side of the site. The OGS will discharge to the non-infiltration side of the subsurface chamber system to be stored and released at the pre-development discharge rates by the implementation of a control structure.

The control structure will discharge from the south side of the site into the Lockhart RD. ditch onto a dissipation pad to ensure erosion of the ditch to Lovers Creek does not occur.

Please refer to **Appendix E** for the elevation-discharge relationship for the outlet structure for this facility.

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 76% (proposed condition). Approximately 24% of the site will be grassed and/or landscaped or will be left in the existing condition.

The majority of the proposed works will be located outside of the 30 m wetland setback as well as the floodplain limits identified by Cambium Inc. A small area in the NE corner of the parking lot is proposed to encroach within the 30 m setback of the creek. This area is approximately 38 sq. m in size.

We have separated the post development model into nine sub-catchments to better model the proposed LID controls.

Area A4 represents the roof area of the building (33% of the 1.38 ha site). Runoff from the roof will be collected in a series of roof drains and piped east of the building to a subsurface Cultec infiltration chamber system located below the parking area. The infiltration chamber is to be an open Atlantis Double Flo Tank system with a total footprint area of 152 m^2. It will provide a total storage volume of 127 m^3. Any overflow from the infiltration storage system will discharge through a 300 mm dia. pipe to MH06, which in turn will discharge to a second Atlantis Double Flo Tank subsurface chamber, however this chamber system will have an impervious liner to prevent infiltration as it will also be accepting flow from the parking lot. Please refer to **Drawing C6** and to **Appendix D** for details of the Atlantis Flo Tank chamber.

Areas A3 and A7 are small (0.068 ha) landscaped areas along the western parts of the site. These areas can't be graded to send flow to the internal storm sewer system and will discharge flow to the Huronia Road ditch system. Please note that a portion of the pre-development site (0.095 ha) also discharges to the west and we have tried to minimize the post development area discharging to Huronia Rd. and ensure it consists of only pervious landscaped areas as in the existing condition.

Areas A1, A5, A6 and A8 (0.61 ha combined) consist entirely of paved parking areas and represent 44% of the overall site. The minor system flow from these areas will be collected using a storm sewer network which will discharge to an oil, grit separator in the eastern part of the site. The OGS will in turn discharge treated water to a subsurface Atlantis Flo Tank storage chamber system with an impervious liner to prevent infiltration. The storm sewer system has been sized to accommodate the 100-year peak flow and the Atlantis Tank chamber system will have a bottom area of 517.18 m^2 and provide a total volume of 432 m^3. Discharge from the subsurface storage chamber will be controlled using an orifice/weir combination set in MH07 near the SE corner of the site. Please refer to **Drawing C6** and to **Appendix D** for details of the outlet structure and Atlantis Tank system.

Areas A2 and A9 (0.25 ha combined) include both a portion of the landscaped area on the south side of the building as well as the easternmost parts of the site which will not be altered. The landscaped area has been graded to direct flow south to the northern ditch on Lockhart Road which in turn flows east to Lovers Creek. Infiltration is allowed on this pervious section as no asphalt areas are graded to direct flow onto it.

Please refer to **Drawing C4** for the post development drainage plan.

Landscaped areas have been assumed to have a mannings n of 0.3 for a combination of densely installed landscape trees and grasses and a depression storage of 7 mm.

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Green Ampt parameters for the pervious areas of the site have not been changed from the pre-development condition.

The proposed OGS is to be a Contech Model 8x16 Stormfilter system which will provide 80% TSS removal for 90% of the annual flow which is in excess of the LSRCA assumed 50% TSS removal as defined in the Treatment Train Tool. Details for the proposed Stormfilter OGS is included in Appendix F along with 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.

Please refer to **Table 2** for a summary of the Post Development Peak Flows and to **Appendix E** for the Post Development catchment plan, 100-year 12 hr SCS Type II storm, 25 mm 4 hr Chicago (quality control) storm PCSWMM output results and additional details for the post development model.

Table 2 – Post Development Modelling Results

Storm Event	Existing Peak Flow Offsite[1] (m^3/s)	Peak Flow To Infiltration Chamber[2] (m^3/s)	Peak Flow To Storage Chamber[3] (m^3/s)	Peak Flow From Storage Chamber (m^3/s)	Total Peak Flow Offsite[4] (m^3/s)
12 Hr SCS Type II					
2-year	0.07	0.08	0.19	0.01	0.04
5-year	0.14	0.12	0.27	0.03	0.07
10-year	0.20	0.14	0.32	0.06	0.11
25-year	0.27	0.17	0.39	0.07	0.15
50-year	0.33	0.19	0.42	0.13	0.18
100-year	0.38	0.21	0.44	0.16	0.24
4 Hr Chicago					
2-year	0.00	0.06	0.12	0.006	0.009
5-year	0.00	0.09	0.18	0.007	0.015
10-year	0.02	0.10	0.22	0.01	0.02
25-year	0.05	0.13	0.27	0.01	0.03
50-year	0.05	0.15	0.31	0.01	0.04
100-year	0.07	0.17	0.35	0.02	0.05
25 mm	0.01	0.07	0.14	0.007	0.015
Hazel	0.18	0.07	0.16	0.15	0.19
Timmins	0.16	0.06	0.13	0.12	0.16

1 -Includes flow to Huronia Rd.

2 – Assumes no infiltration

3 –Assumes no infiltration in 1st subsurface chamber and 100% of flow enters 2nd chamber.

4- Assumes no subsurface infiltration

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The implementation of two subsurface storage facilities complete with a control outlet structure have reduced the peak flow to below pre-development levels for all but the 2 and 5 year Chicago storm events. The pre-development condition had no runoff in these events and without credit for post development infiltration on the site it is not possible to meet the predevelopment criteria.

We have implemented the smallest orifice size allowable (75 mm as recommended by the MECP) and have reduced the peak runoff by 96%. With infiltration controls in place there is theoretically no significant difference in the 2 and 5 year events as the infiltration rate (Ksat) has been reduced by a 2.5x factor of safety and the Ksat is extremely low (0.1 mm/hr).

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.

We also propose to implement a Tide Flex valve between the infiltration subsurface storage and the non infiltration side to prevent non-roof water from entering the infiltration chamber. The Hydraulic Grade Line plots generated from PCSWMM in Appendix for the worst case 100-year event demonstrate the HGL without the tide flex valve. We would also note that it is not currently possible to model a restrictive valve such as this in PCSWMM and it has not been included in the model.

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 an 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 OGS has been assigned a TSS removal efficiency of 80% and the NJCAT testing which supports this result along with the Removal Efficiency analysis has been included in **Appendix G** We have not assigned an associated TP removal for the OGS as per the LSRCA TTT.

As the site is industrial the LSRCA policies do not allow for any other infiltration based LID and there is no room on the site for additional LID controls due to the setbacks from the wetland and creek to the east and the requirement for screening in the landscaped area to the south.

Based on the design we have provided a greater than an enhanced level of TSS removal at 80% and a 13.62% 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 trench, quality pond and LV02 SWM pond that 0.039 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:

TP (0.039 kg/yr) x 2.5 (offset ratio) x $35,000 = $3,412.50

The total offset cost under the policy for the site is therefore equal to $3412.50, which is to be paid to the LSRCA by the Developer.

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 25 mm retention/treatment/infiltration target for the site is therefore as follows:

LSRCA – 25 mm x 10,488 m^2 = 262 m^3

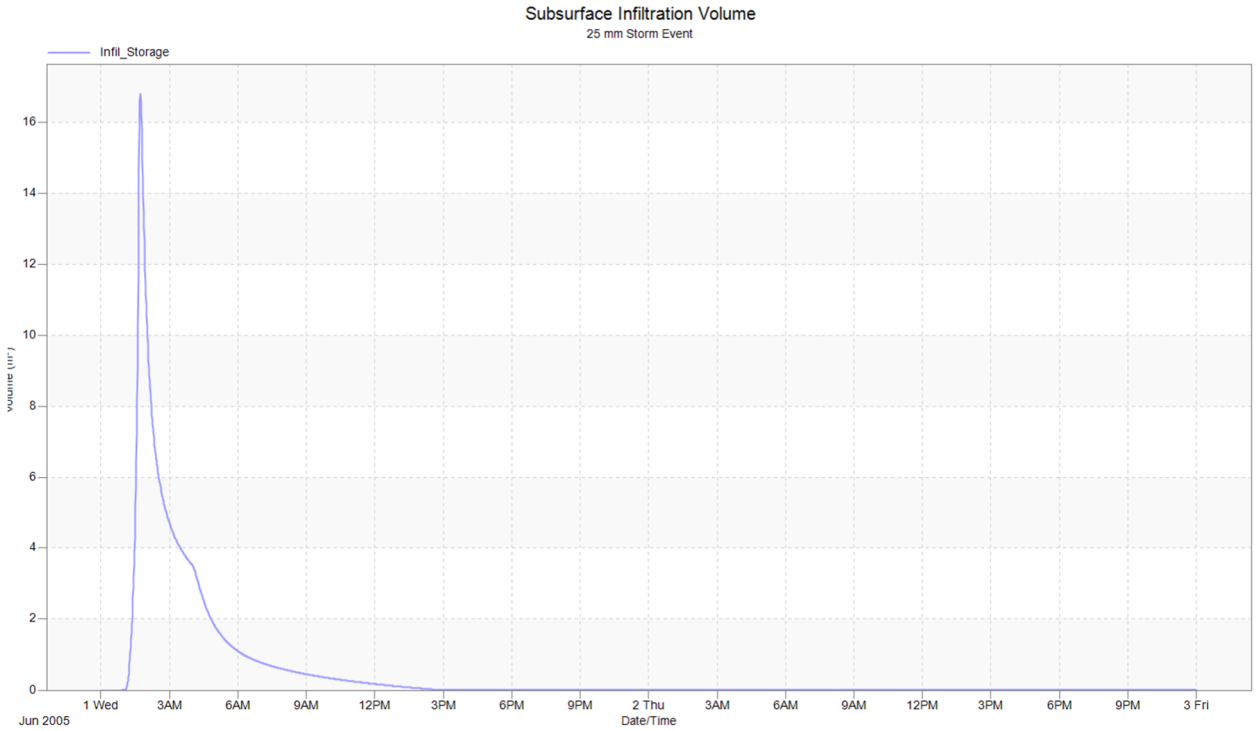
In addition, the LSRCA requires best efforts towards a water balance with any infiltration shortfall subject to the Jan. 1, 2019 LSRCA Water Balance Offsetting Policy.

The subsurface infiltration chamber system provides 127.76 m^3 of storage volume while an additional 432.9 m^3 of storage is provided by the lined subsurface storage chamber system. This equates to a total of 560.66 m^3 of storage volume provided for the treatment of the 25 mm storm. The very 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.

During the 25 mm storm 100% of the roof runoff is directed to the subsurface infiltration system which equates to 105 m^3 of flow. An additional 141 m^3 of runoff is collected from the parking area, routed through the OGS and into the lined subsurface storage area. This equates to a total of 246 m^3 of runoff treated which is 100% of the runoff from the impervious areas of the site. An additional 21.3 m^3 of rainfall is held in depression storage and is not available for detention and "treatment" by the on-site SWM controls.

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 has also been included in **Appendix E**.

We attempted to increase the infiltration volume by decreasing the drain size and or increasing the infiltration tank bottom surface area, however there was no appreciable increase in the performance due to the extremely low Ksat of the subsurface soils (0.1 mm/hr).



We have also 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 is approximately 1,820m^3/year (100% forest, 0% impervious).

The post development condition has been based on the calculated 76% impervious level of the site. In this scenario the infiltration was determined to be 437 m^3/year.

The water balance deficit (assuming no LID on the site) that must be designed for is therefore equal to 1,383 m^3/year. It is proposed that this deficit would be reduced by the implementation of the subsurface infiltration chamber system connected to the rooftop.

Please refer to **Appendix H** for the preliminary water balance information.

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 system.

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

The 4,539 m^2 building alone would need to infiltrate 40% of the annual rainfall to meet the overall site target. We have used a 5 mm event depth to represent 50% of the rainfall events over the year to maximize the infiltration from the building roof. This equates to a required storage volume of 22.7 m^3,

but due to the extremely low infiltration rate on the site a required bottom surface area in the LID facility of 4,728 m^2.

The proposed infiltration system connected to the building roof leader system by a dedicated pipe is to be 0.88 m deep and a bottom surface area equal to 152 m^2 and a volume (at 95% void space as per the Manufactures specifications) of 127.76 m^3. The proposed bottom area of the facility does not meet the LSRCA criteria but does meet the volume criteria. To meet the LSRCA area criteria the infiltration system would need to cover 34% of the site and is not possible.

The proposed infiltration system, based on the PCSWMM analysis, will fully drain within a 48 hr period for the 25 mm storm event.

To determine the total effect of the proposed LID over a year long basis, in discussion with the LSRCA, we have modelled the site using a year of rainfall data in PCSWMM. The rainfall data was obtained for the Barrie Oro Station and spans from June 1, 2005 to May 31, 2006. The total rainfall for this period is approximately 6% higher at 984 mm than the precipitation values used in the Thornthwaite Method (933 mm) but we believe is a good representation of the yearly distribution of rainfall. Please refer to **Appendix H** for the hydrograph of the rainfall event.

We have added in to PCSWMM an external climate file including daily max/min air temperatures obtained from Environment Canada for the same time period as the rainfall data. In addition, we have used the monthly average wind speeds obtained from Environment Canada as follows.

Monthly average wind speed (km/hr)

Jan	Feb	Mar	Apr	May	Jun
11.1	13.5	14.2	13.8	12	8.7
Jul	Aug	Sep	Oct	Nov	Dec
9.4	9.3	10.9	11.8	14.2	11.2

Please refer to **Appendix H** for the PCSWMM output summary for this year long event.

PCSWMM provides a summary of the infiltration, evaporation and runoff for the simulation.

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Initial Snow Cover	0.000	0.000
Total Precipitation	1.358	984.300
Evaporation Loss	0.312	225.782
Infiltration Loss	0.213	154.192
Surface Runoff	0.836	605.955
Snow Removed	0.000	0.000
Final Snow Cover	0.000	0.000
Final Storage	0.000	0.000
Continuity Error (%)	-0.166	

The infiltration component for the site equates to 154.192 mm x 1.38 ha = 2,127 m^3 over the year with the remaining precipitation running off or evaporating.

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The LID results for the infiltration system for the year long time span indicates that 2% of the total volume entering the infiltration chamber over a year (2% of 4,440 m^3) or 88.8 m^3 of rainfall from the rooftop is infiltrated in a year.

The pervious areas of the site therefore infiltrated the remaining 2,374 m^3 of rainfall.

Allowing for the 6% increase in rainfall between the Thornthwaite method and the PCSWMM continuous model the PCSWMM year long infiltration value for the LID should be reduced to approximately 83.77 m^3/s.

Therefore, based on the adjusted PCSWMM Continuous analysis the site has a 1299 m^3/year deficit and does not achieve a water balance, but the LID infiltrates a total of 83.77 m^3 of rainfall over the year which does meet the LSRCA sizing criteria.

The LSRCA Water Balance Offsetting Policy requires that the water balance deficit from the site is subject to an offset cost. This deficit is within the Table 4 Recharge Compensation Fee Schedule but between 1000 m^3/yr and 1500 m^3/yr. We have used a prorated storage volume level between the two levels required from Table 4 for the calculation.

Water Balance Deficit (1299 m^3/yr) = Storage Volume Required 57 m^3

57 m^3 x $1,200 = $68,400

The total water balance offset cost under the policy for the site is therefore equal to $68,400, which is to be paid to the LSRCA by the Developer.

Unfortunately, there are few additional opportunities for infiltration on the site due to the restrictions on infiltration on industrial sites and the extremely low infiltration rate of the subsurface soils. We also completed additional analysis to determine if would be possible to provide a facility large enough to meet the LSRCA criteria and found the facility would need to cover approximately 34% of the site and would be extremely cost prohibitive.

Erosion and Sediment Controls

We recommend that heavy duty silt fence as per OPSD 219.130 be installed along the perimeter of the site 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 1.38 ha site at 380 Lockhart Road in the City of Barrie to provide a 4539 sq. m (footprint) light industrial 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 from Lockhart Road. Fire fighting capabilities are also available via existing fire hydrants on the north side of Lockhart Road and the west side of Huronia Road

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which are within 90 m to meet the OBC requirements. Sewage will be discharged to the existing sanitary sewer on Huronia Road via an existing 200 mm dia. connection.

Stormwater management will be implemented in the form of storm sewers for the minor storm event discharging to an OGS and subsurface storage system consisting of 517.8 m^2 of double Atlantis Flo-Tanks with an impermeable liner to prevent infiltration.

Runoff from the rooftop is considered clean and will be infiltrated into a second infiltration system on the east side of the site consisting of 152 m^2 of double Atlantis Flo-Tanks.

Both the infiltration system tanks, and the storage tanks will discharge through an outlet structure to control peak flows to below pre-development levels. There will be a minor exceedance in the Chicago 4 hr 2 and 5 year storm events, however these are not the design storms for the site and the exceedance is extremely small.

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 the MECP for this site 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.

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Drawings

C1 – Existing Conditions

C2 – Site Grading Plan

C3 – Site Servicing Plan

C4 – Post Development Drainage Area Plan

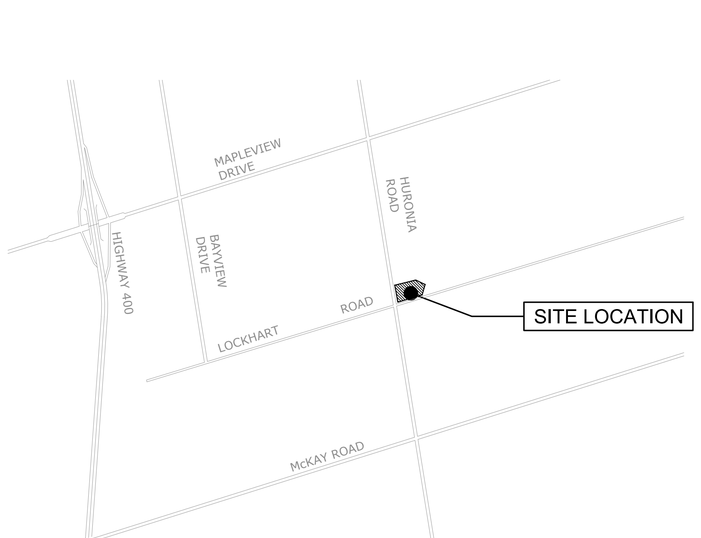
C5 – Erosion & Sediment Control Plan

C6 – C9 – Standard Details

KINGSLEA DEVELOPMENTS

380 LOCKHART ROAD SITE PLAN
CITY OF BARRIE

DRAWING INDEX



KEY PLAN
N.T.S.

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TORONTO, ON
M9W 6Y1

Project No. 2019-039

FUNCTIONAL SERVICING REPORT - 2020/01/22

CAPES ENGINEERING

KINGSLEA DEVELOPMENTS - 380 LOCKHART ROAD SITE PLAN - PROJECT No. 2019-038
FUNCTIONAL SERVICING REPORT - 2020/01/22

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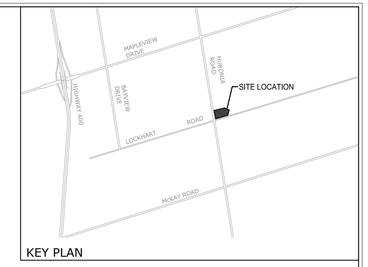

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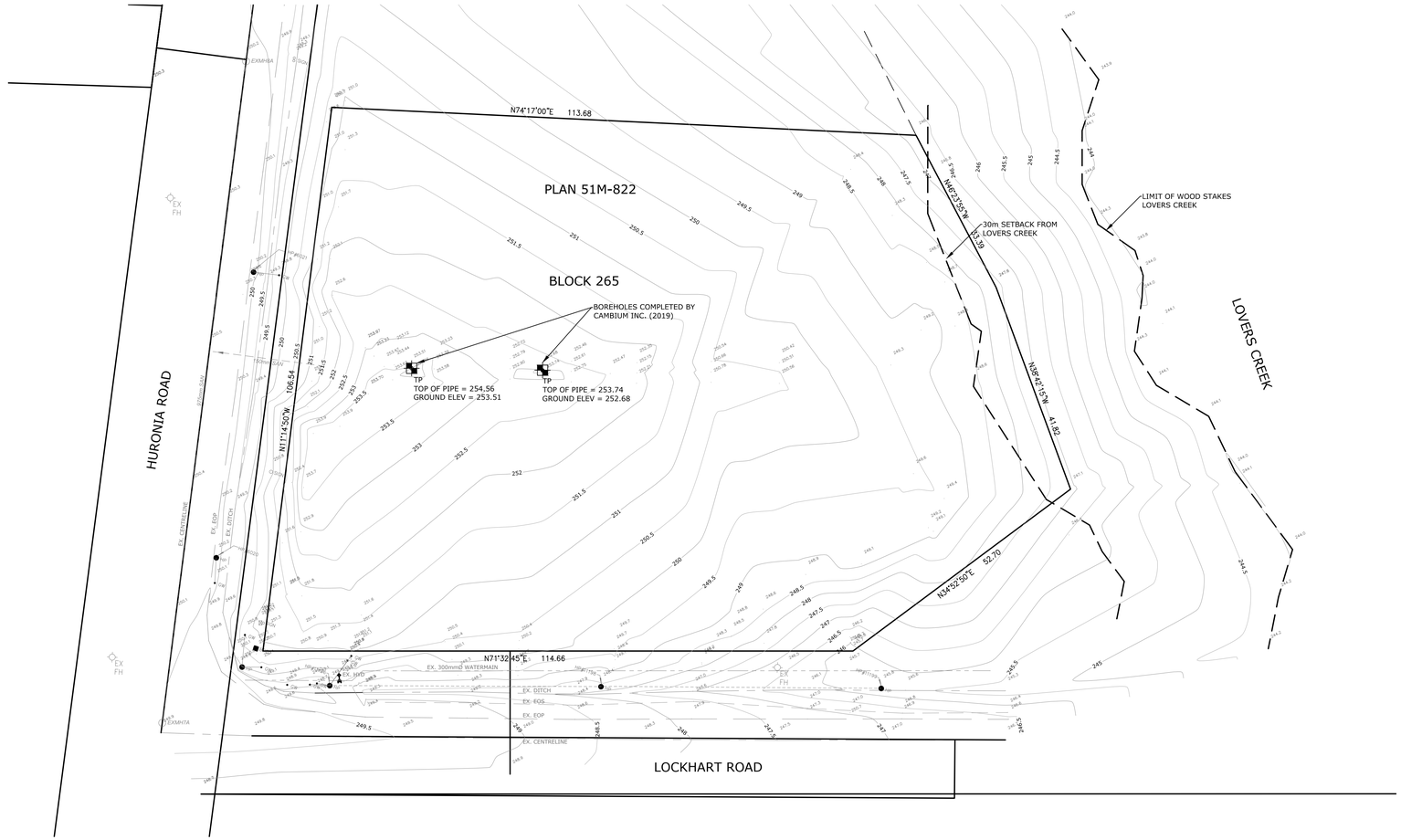

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JAN 23, 2020
PROVINCE OF ONTARIO

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380 LOCKHART ROAD SITE PLAN

EXISTING CONDITIONS

Designed	Checked	Date	Drawing No.
K. GRIFFIN	C. CAPES	20/01/13	C1
Project No. 2019-039		Rev No. 1	
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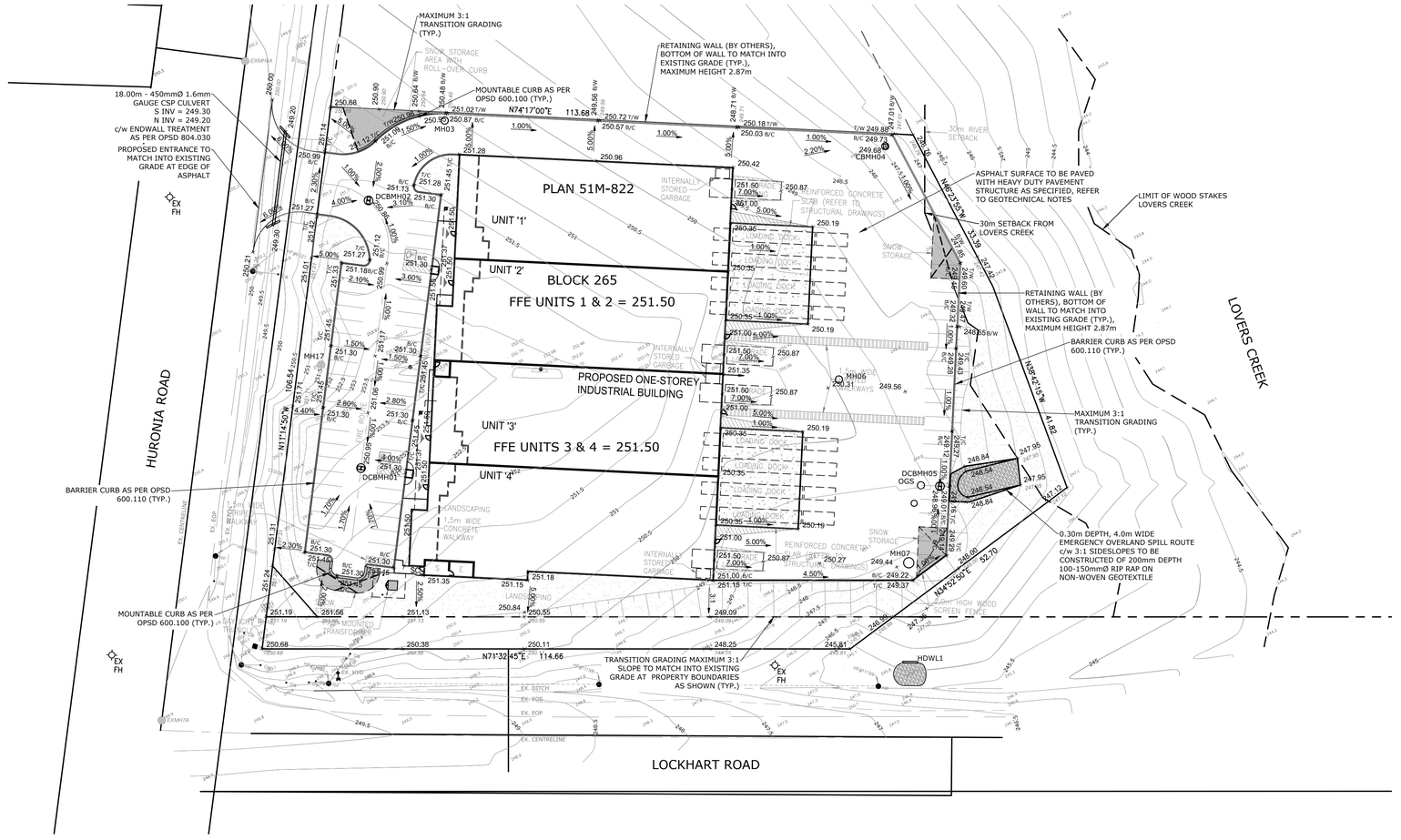

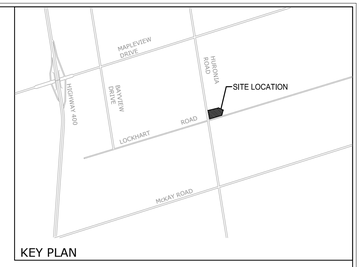

KEY PLAN

LEGEND

- 221.21 — PROPOSED ELEVATION
- 221.21 — EXISTING ELEVATION
- MAXIMUM 3:1 SLOPE UNLESS OTHERWISE NOTED
- SANITARY & STORM MANHOLE
- CS — 50mmØ DOMESTIC WATER SERVICE CURB STOP
- VB — 200mmØ FIRE LINE GATE VALVE
- HYDRANT & VALVE

CAMBIUM INC. GEOTECHNICAL NOTES

SITE PREPARATION

EXISTING TOPSOIL AND ORGANIC MATERIALS ENCOUNTERED SHOULD BE EXCAVATED AND REMOVED FROM BENEATH THE PROPOSED PARKING AND DRIVING AREAS, AND BUILDING FOOTPRINTS; ADDITIONALLY THIS MATERIAL SHOULD BE EXCAVATED AND REMOVED TO A MINIMUM DISTANCE 3m AROUND THE BUILDING FOOTPRINTS. ANY TOPSOIL AND MATERIALS WITH SIGNIFICANT QUANTITIES OF ORGANICS ARE NOT APPROPRIATE FOR USE AS FILL BELOW BUILDINGS OR GRADING AND PARKING AREAS.

ON COMPLETION OF REGRADING, THE EXPOSED SUBGRADE SHOULD BE PROOF-ROLLED AND INSPECTED BY A QUALIFIED GEOTECHNICAL ENGINEER PRIOR TO PLACEMENT OF GRANULAR FILL OR FOUNDATIONS. ANY LOOSE/SOFT SOILS IDENTIFIED AT THE TIME OF PROOF ROLLING THAT ARE UNABLE TO BE UNIFORMLY COMPACTED SHOULD BE SUB-EXCAVATED AND REMOVED. THE EXCAVATIONS CREATED SHOULD BE BACKFILLED WITH APPROVED ENGINEERED FILL.

IN WET CONDITIONS, TEMPORARY USE OF GRANULAR FILL, AND POSSIBLY REINFORCING GEOTEXTILES, MAY BE REQUIRED TO PREVENT RUTTING ON CONSTRUCTION ACCESS ROUTES.

FROST PENETRATION

FROST PENETRATION DEPTH IS ESTIMATED AT 1.5m bgs, EXTERIOR FOOTINGS SHOULD BE LOCATED BELOW THIS DEPTH.

EXCAVATIONS AND BACKFILL

ALL EXCAVATIONS MUST BE CARRIED OUT IN ACCORDANCE WITH THE LATEST EDITION OF THE OHSA. SOILS ENCOUNTERED TO A DEPTH OF APPROXIMATELY 3.5m MAY CLASSIFIED AS TYPE 3 SOILS ABOVE THE GROUNDWATER TABLE. BENEATH THE GROUNDWATER TABLE, SOILS MAY BE CLASSIFIED AS TYPE 4.

DEWATERING

GROUNDWATER WAS ENCOUNTERED AT AN APPROXIMATELY DEPTH OF 5.19-5.72m BGS

GROUNDWATER SEEPAGE IS NOT ANTICIPATED WITHIN THE PROPOSED EXCAVATION DEPTHS. IF ENCOUNTERED, IT SHOULD BE MANAGEABLE WITH FILTERED SUMPS AND PUMPS DEPENDING ON SIZE OF EXCAVATION. IT IS NOTED THAT THE ELEVATION OF THE GROUNDWATER TABLE WILL VARY DUE TO SEASONAL CONDITIONS AND IN RESPONSE TO HEAVY PRECIPITATION EVENTS.

BACKFILL AND COMPACTION

EXCAVATED TOPSOIL FROM THE SITE IS NOT APPROPRIATE FOR US AS FILL BELOW GRADING AND PARKING AREAS. EXCAVATED NATIVE SAND MAY BE APPROPRIATE FOR US AS FILL BELOW GRADING AND PARKING AREAS, PROVIDED THAT THE ACTUAL OR ADJUSTED MOISTURE CONTACT AT THE TIME OF CONSTRUCTION IS WITHIN A RANGE THAT PERMITS COMPACTIONS TO REQUIRED DENSITIES. GEOTECHNICAL TESTING OF ENGINEERED FILL IS REQUIRED TO CONFIRM ACCEPTABLE QUALITY.

ANY ENGINEERED FILL BELOW FOUNDATIONS SHOULD BE PLACED IN LIFTS APPROPRIATE TO THE TYPE OF COMPACTION EQUIPMENT USED, AND BE COMPACTED TO A MINIMUM OF 100% SPMDD. IF NATIVE SOILS FROM SITE ARE NOT USED AS ENGINEERED FILL, IMPORTED MATERIAL FOR ENGINEERING FILL SHOULD CONSIST OF CLEAN, NON-ORGANIC SOILS, FREE OF CHEMICAL CONTAMINATION OR DELETERIOUS MATERIAL. CONSIDERATION COULD BE GIVEN TO USING A MATERIAL MEETING OPSS 1010 GRANULAR 'B' SPECIFICATION. FOUNDATION WALL AND BURIED UTILITY BACKFILL SHOULD CONSIST OF FREE-DRAINAGE IMPORTED GRANULAR MATERIAL.

THE BACKFILL MATERIAL, IF ANY, IN THE UPPER 300mm BELOW THE PAVEMENT SUBGRADE ELEVATION SHOULD BE COMPACTED TO 100% SPMDD

BURIED UTILITIES

BEDDING AND COVER MATERIAL FOR ANY SERVICES SHOULD CONSIST OF OPSS 1010-3 GRANULAR 'A' OR 'B' TYPE II, PLACED IN ACCORDANCE WITH PERTINENT OPSD 802.013. THE BEDDING AND COVER MATERIAL SHALL BE PLACED IN MAXIMUM 200mm THICK LIFTS AND SHOULD BE COMPACTED TO AT LEAST 98% SPMDD. THE COVER MATERIAL SHALL BE PLACED IN MAXIMUM 300MM OVER THE TOP OF PIPE AND SHOULD BE COMPACTED TO AT LEAST 98% SPMDD

PAVEMENT DESIGN

ALL TOPSOIL AND ORGANIC MATERIALS SHOULD BE REMOVED DOWN TO NATIVE MATERIAL AND BACKFILLED WITH APPROVED ENGINEERED FILL OR NATIVE MATERIAL, COMPACTED TO 98% SPMDD. THE SUBGRADE SHOULD BE PROOF ROLLED AND INSPECTED BY A GEOTECHNICAL ENGINEER. ANY AREAS WHERE BOULDERS, RUTTING OR APPRECIABLE DEFLECTION IS NOTED SHOULD BE SUBEXCAVATED AND REPLACED WITH SUITABLE FILL. THE FILL SHOULD BE COMPACTED TO AT LEAST 98% SPMDD.

LIGHT DUTY PAVEMENT STRUCTURE

SURFACE COURSE ASPHALT - 40mm HL3 OR HL4
BINDER COURSE ASPHALT - 50mm HL8
GRANULAR BASE - 150mm OPSS 1010 GRANULAR A
GRANULAR SUBBASE - 300mm OPSS 1010 GRANULAR B

HEAVY DUTY PAVEMENT STRUCTURE

SURFACE COURSE ASPHALT - 40mm HL3 OR HL4
BINDER COURSE ASPHALT - 90mm HL8 (2 LIFTS)
GRANULAR BASE - 150mm OPSS 1010 GRANULAR A
GRANULAR SUBBASE - 400mm OPSS 1010 GRANULAR B

THICKNESS OF THE SUBBASE COULD BE INCREASED AT THE DISCRETION OF THE ENGINEER. COMPACTION OF THE SUBGRADE SHOULD BE VERIFIED BY THE ENGINEER PRIOR TO PLACING THE GRANULAR FILL. GRANULAR LAYERS SHOULD BE PLACED IN 150mm LIFTS AND COMPACTED TO AT LEAST 98% SPMDD. MATERIALS SHOULD CONFORM TO OPSS STANDARDS

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TEL: 705-994-4818

380 LOCKHART ROAD SITE PLAN

SITE GRADING PLAN

Designed	Checked	Date	Drawing No.
K. GRIFFIN	C. CAPES	20/01/13	C2
Project No. 2019-039		Rev No. 1	
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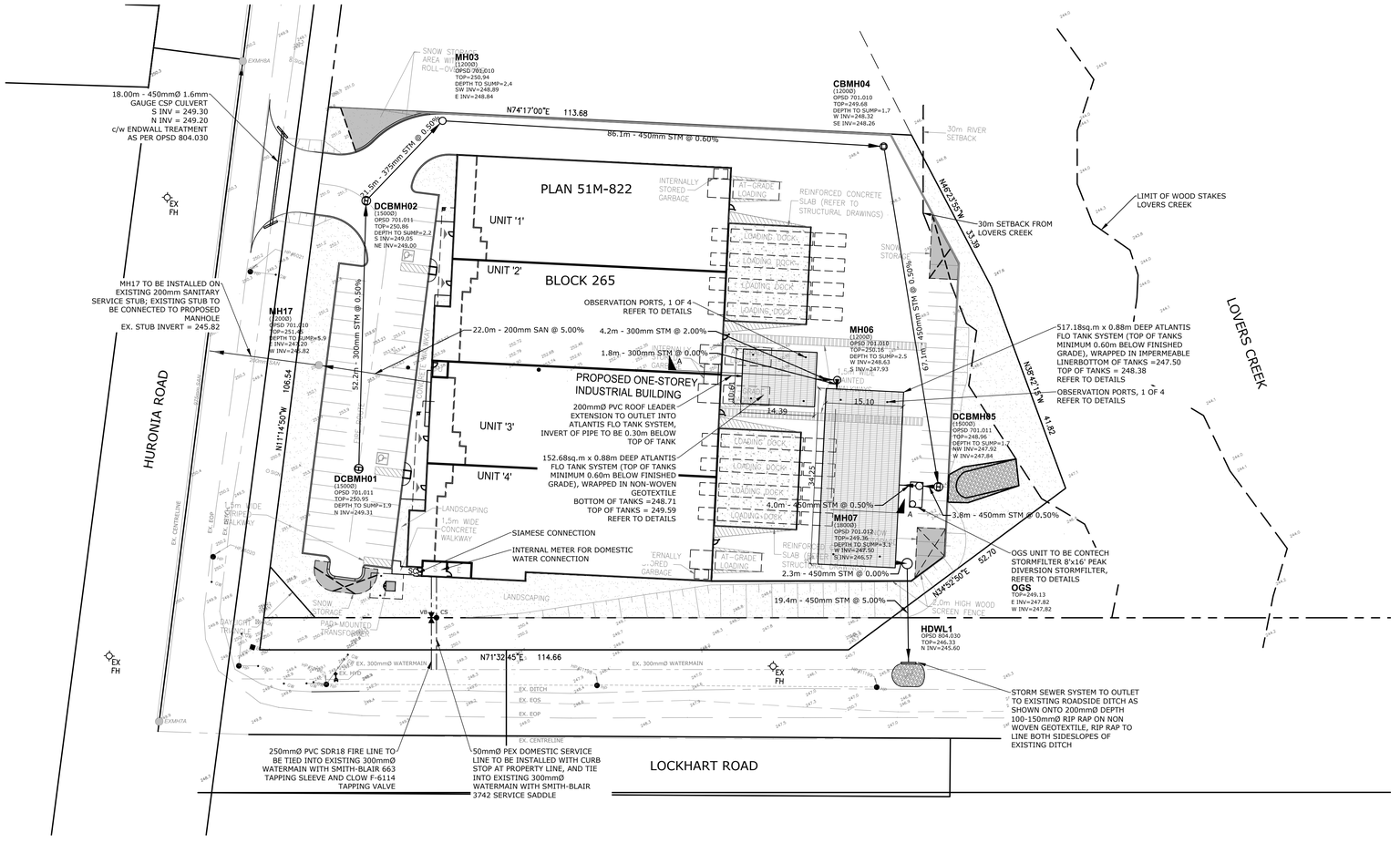

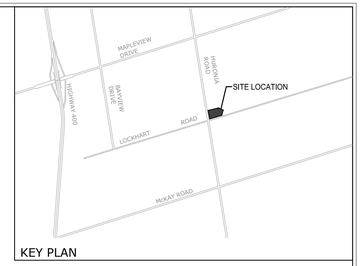

KEY PLAN

LEGEND

- SANITARY & STORM SEWER/MANHOLE
- WATERMAIN/WATER SERVICE
- CS — 50mmØ DOMESTIC WATER SERVICE CURB STOP
- VB — 250mmØ FIRE LINE GATE VALVE
- HYDRANT & VALVE

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380 LOCKHART ROAD SITE PLAN

SITE SERVICING PLAN

Designed	Checked	Date	Drawing No.
K. GRIFFIN	C. CAPES	20/01/13	C3
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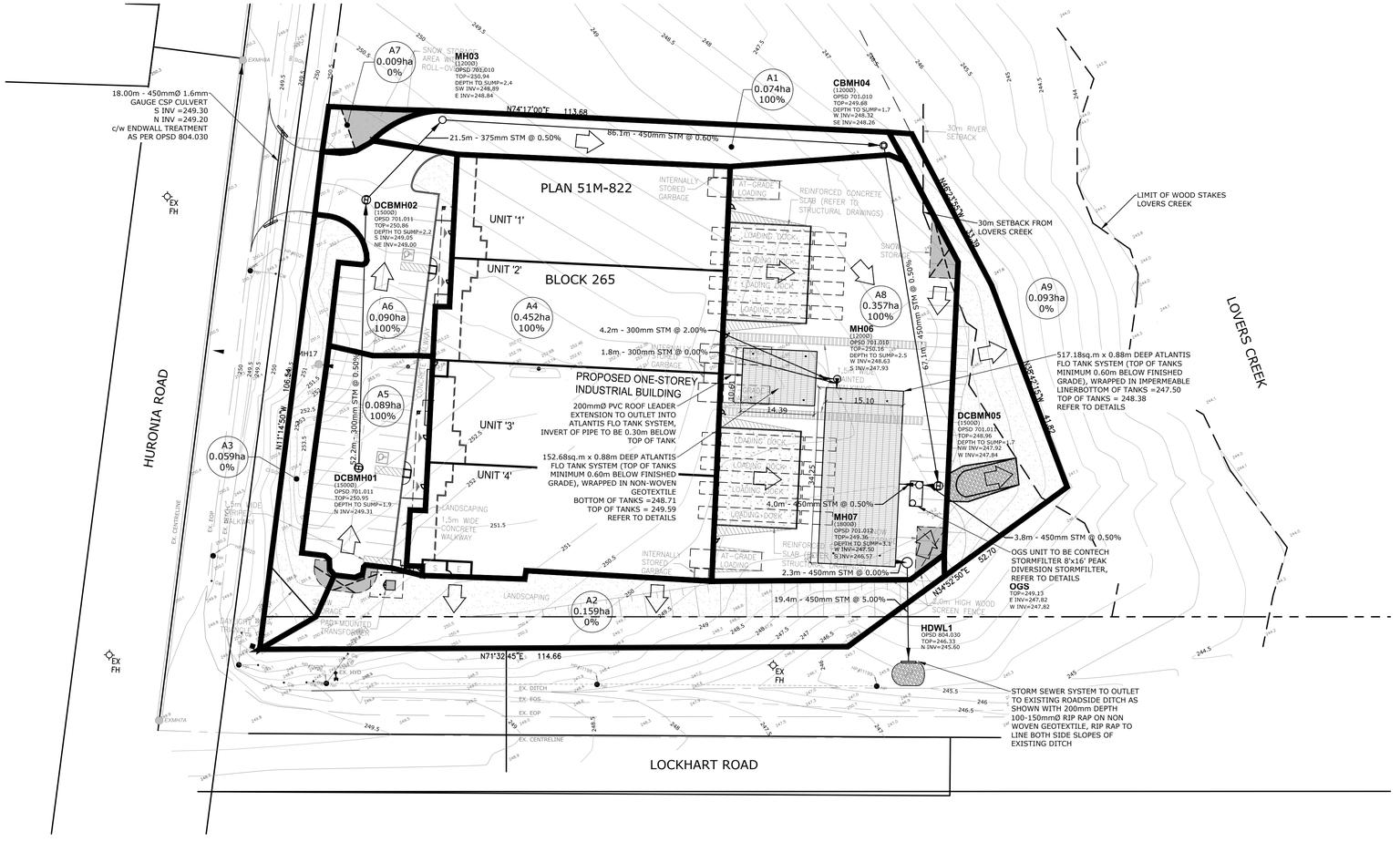

KEY PLAN

LEGEND

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- WATERMAIN/WATER SERVICE
- CS — 50mmØ DOMESTIC WATER SERVICE CURB STOP
- VB — 250mmØ FIRE LINE GATE VALVE
- HYDRANT & VALVE
- A2 / 0.112ha / 0% — DRAINAGE ID, DRAINAGE AREA, PERCENT IMPERVIOUS
- OVERLAND FLOW DIRECTION

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C. CAPES
100056104
JAN 22 2020
PROVINCE OF ONTARIO

Client
KINGSLEA DEVELOPMENTS
16-107 WOODBINE DOWNS
TORONTO, ON
M9W 6Y1

CAPES ENGINEERING
355310 BLUE MOUNTAINS - EUPHRASIA TOWNLINE
CLARKSBURG, ON N0H 1J0
TEL: 705-994-4818

380 LOCKHART ROAD SITE PLAN

POST DEVELOPMENT DRAINAGE AREA PLAN

Designed	Checked	Date	Drawing No.
K. GRIFFIN	C. CAPES	20/01/13	C4
Project No.		Rev No.	
2019-039		1	
Scale			
1:500			

0 5.0 10.0 20.0 30.0m

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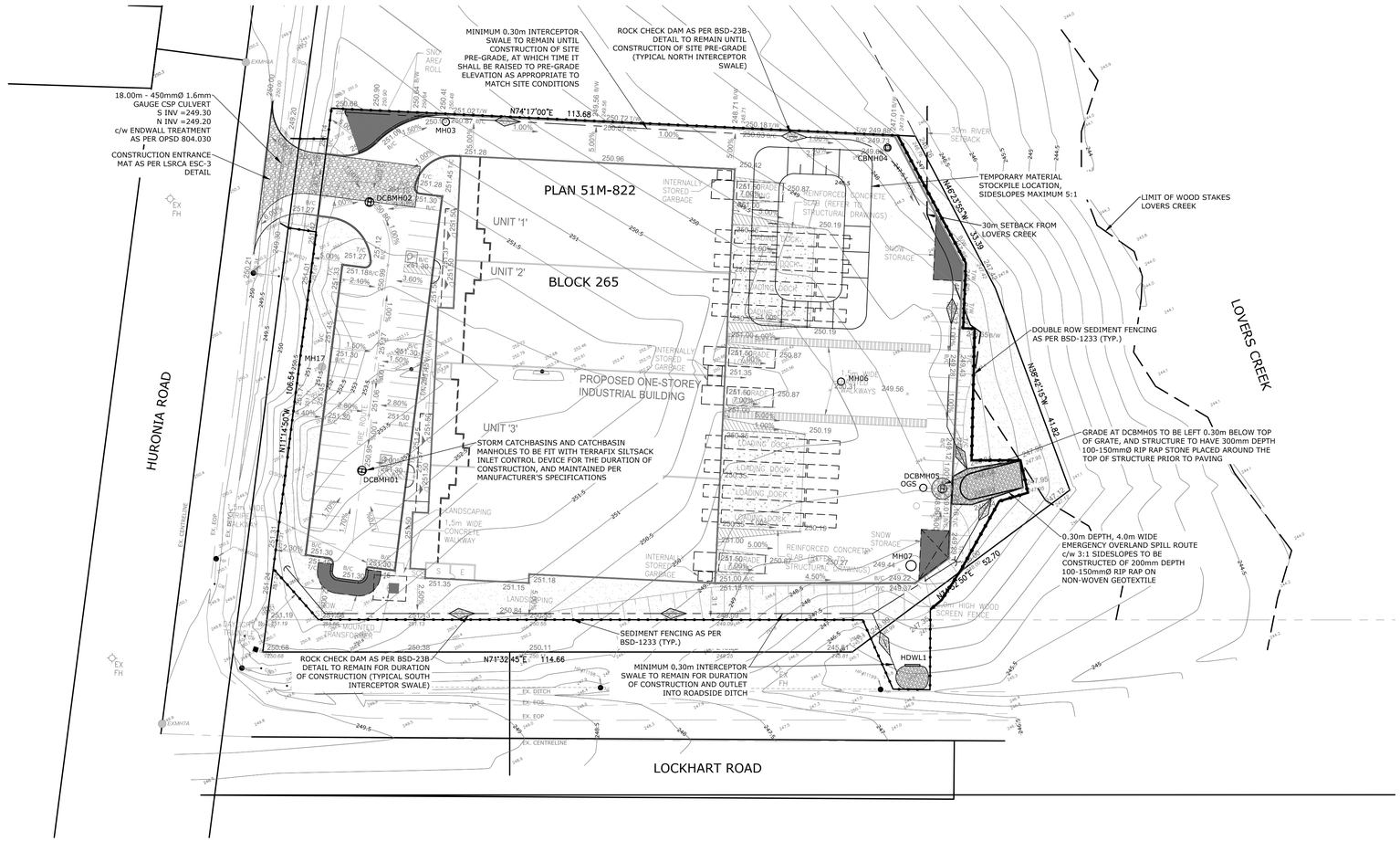
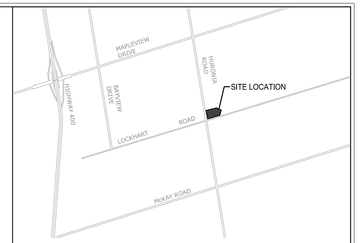
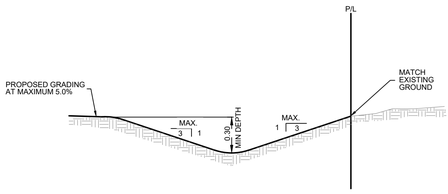




KEY PLAN

LEGEND

- 221.21 — PROPOSED ELEVATION
- 221.21 — EXISTING ELEVATION
- MAXIMUM 3:1 SLOPE UNLESS OTHERWISE NOTED
- SANITARY & STORM MANHOLE
- CS — 50mmØ DOMESTIC WATER SERVICE CURB STOP
- VB — 200mmØ FIRE LINE GATE VALVE
- HYDRANT & VALVE



INTERCEPTOR SWALE

Notes
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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.

No	Issue / Revision	Date	Auth
1	FUNCTIONAL SERVICING REPORT	20/01/22	CC

LICENSED PROFESSIONAL ENGINEER — C. CAPES — 100056104 — JAN 22, 2020 — PROVINCE OF ONTARIO

Client
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TEL: 705-994-4818

380 LOCKHART ROAD SITE PLAN

EROSION & SEDIMENT CONTROL PLAN

Designed	Checked	Date	Drawing No.
K. GRIFFIN	C. CAPES	20/01/13	C5
Project No. 2019-039		Rev No. 1	
Scale 1:500	0 5.0 10.0 20.0 30.0m		

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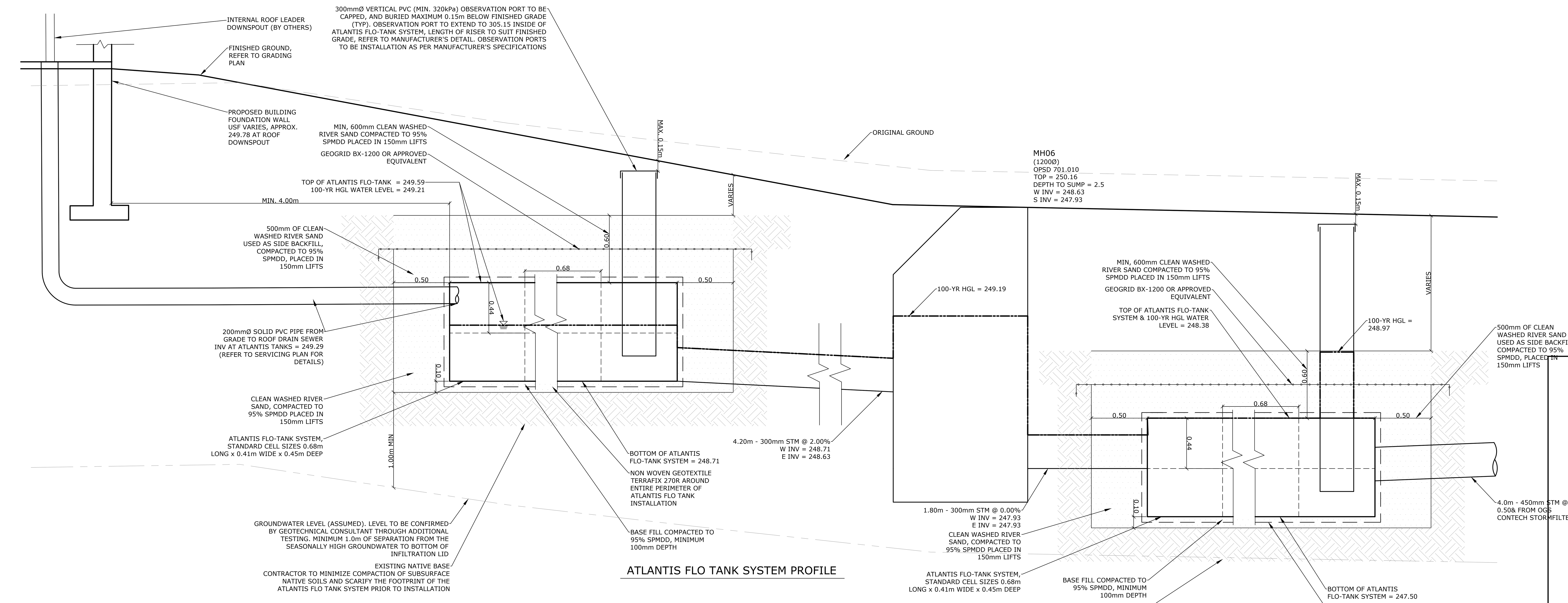


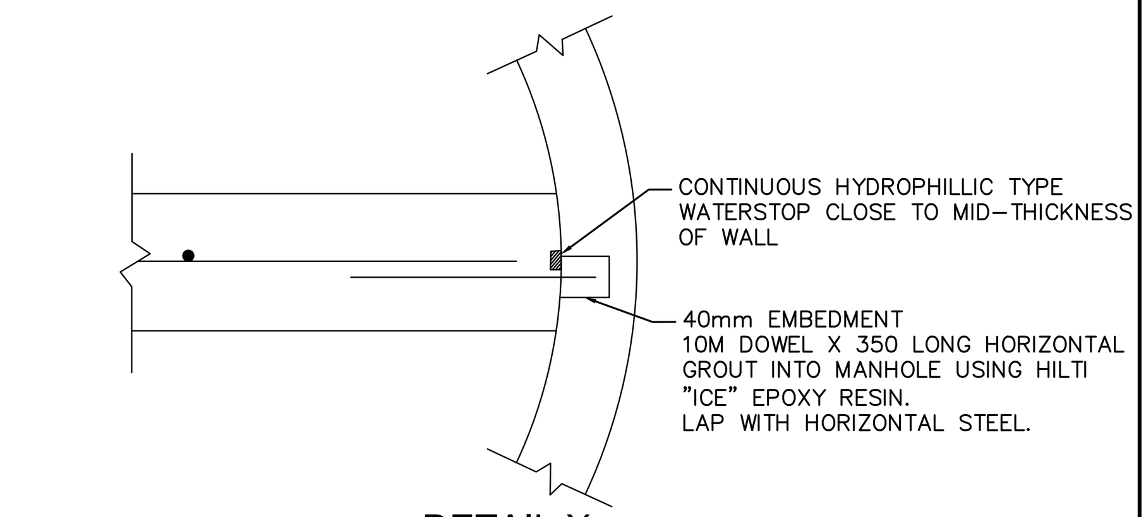
ATLANTIS FLO TANK SYSTEM PROFILE

CAST IN PLACE CONCRETE NOTES:

GENERAL
1. CONFORM TO CSA – A23 SERIES OF STANDARDS, AND THE RSIC MANUAL OF STANDARD PRACTICE (LATEST EDITION) FOR DESIGN, MATERIALS, CONSTRUCTION, CURING, TESTING, TOLERANCES, AND FINISHING CONCRETE.
2. INSTALL, OR SUPPLY AND INSTALL, ANCHORAGE, FASTENINGS AND BLOCKING AS REQUIRED, FOR WORK OF OTHER SECTIONS.

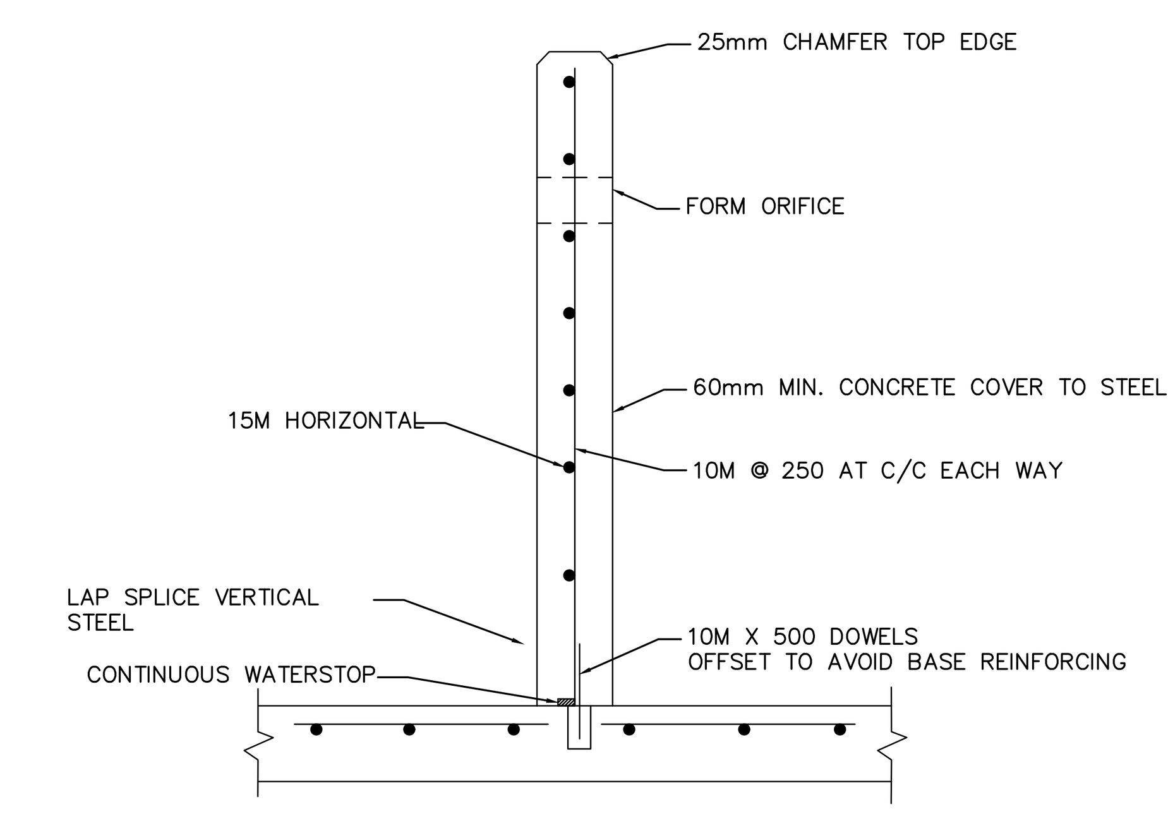
PRODUCTS
1. MATERIALS:
 1.1. CEMENT GENERAL TYPE GU PORTLAND CEMENT TO CSA A3001.
 1.2. WATER, FINE AGGREGATES, COARSE AGGREGATES: TO CSA–A23.1. MAXIMUM COARSE AGGREGATE TO BE 20mm DIAMETER.
 1.3. AIR–ENTRAINING ADMIXTURE: TO ASTM C260.
 1.4. CHEMICAL ADMIXTURES: TO ASTM C494 OR ASTM C1017.
 1.5. CURING–SEALING COMPOUND: WHEN WATER CURING IS NOT PRACTICAL AS APPROVED BY THE ENGINEER, USE A CLEAR LIQUID PRODUCT TO ASTM C–309, TYPE 1. USE SEALTIGHT VOCOMP20 BY W.R. MEADOWS OF CANADA LIMITED.
 1.6. HYDROPHILLIC TYPE WATERSTOP: HYDROTITE CJK – BY MME MULTIURETHANES (1 800 663 6633).
 1.7. REINFORCING STEEL: NEW, DEFORMED, BILLET–STEEL BARS TO CSA STANDARDS G30.18, GRADE 400R.
2. SUPPLY CONCRETE AS PER CSA A23.1–09, **PERFORMANCE BASED SPECIFICATION** CLEARLY COORDINATING MIX DESIGNATIONS WITH STRUCTURAL AND ARCHITECTURAL CRITERIA FOUND WITHIN THE CONTRACT DOCUMENTS. FOR ALL CONCRETE MIXES CLEARLY IDENTIFY AND CONFIRM THE UNDERSTANDING OF THE CONCRETE REQUIREMENTS IN WRITING PRIOR TO PRODUCTION FOR ALL MIXES. SUCH A SUBMISSION SHALL INCLUDE, AS A MINIMUM; THE LOCATION OF EACH MIX DESIGN TO BE USED IN THE STRUCTURE, THE CEMENT TYPE, ALL SUPPLEMENTARY MATERIALS, CLASS OF EXPOSURE, COMPRESSIVE STRENGTHS, AGGREGATE SIZE, AND CONCRETE DENSITY. USE READY–MIXED CONCRETE TO GIVE MINIMUM 28–DAY COMPRESSIVE STRENGTH OF 35 MPa @ 28 DAYS, WITH EXPOSURE CLASS C1. COORDINATE WITH THE GENERAL CONTRACTOR WITH RESPECT TO WORKABILITY ISSUES, AND CONFIRM THE CRITERIA IN THE SUBMISSION (SLUMP, PUMP MIX, DESIGN CONCRETE TEMPERATURE, ETC.).

EXECUTION
1. USE VIBRATORS FOR CONSOLIDATION OF CONCRETE.
2. PROVIDE STEEL CHAIRS OR CONCRETE SPACERS TO MAINTAIN SPECIFIED 60mm COVER TO REINFORCING STEEL.
3. CONCRETE SHALL BE FREE FROM HONEYCOMBING, VOIDS, LOSS OF FINES, VISIBLE FLOW LINES AND COLD JOINTS, CHIPS AND SPALLS. PATCH DEFECTS AND TIE HOLES.
4. LAP ALL REINFORCING WITH CLASS 'B' SPLICES U/N. ALL STEEL MUST BE ADEQUATELY TIED AND ACCURATELY PLACED PRIOR TO THE COMMENCEMENT OF ANY CONCRETE POUR.
5. PROTECT FRESH CONCRETE FROM PREMATURE DRYING, SUNSHINE, EXCESSIVELY HOT OR COLD TEMPERATURES AND MECHANICAL INJURY. MAINTAIN AT A RELATIVELY CONSTANT TEMPERATURE FOR AS LONG AS REQUIRED FOR HYDRATION OF THE CEMENT AND CURING OF THE CONCRETE. REFER TO CSA A23.1 FOR HOT AND COLD WEATHER CONCRETING PRACTICES.
6. PROTECT FRESH CONCRETE FROM COLD TEMPERATURES BELOW 5 DEGREES CELSIUS. PROVIDE TEMPORARY HEAT FOR A MINIMUM OF 3 DAYS TO MAINTAIN A TEMPERATURE OF GREATER THAN 15 DEGREES CELSIUS.



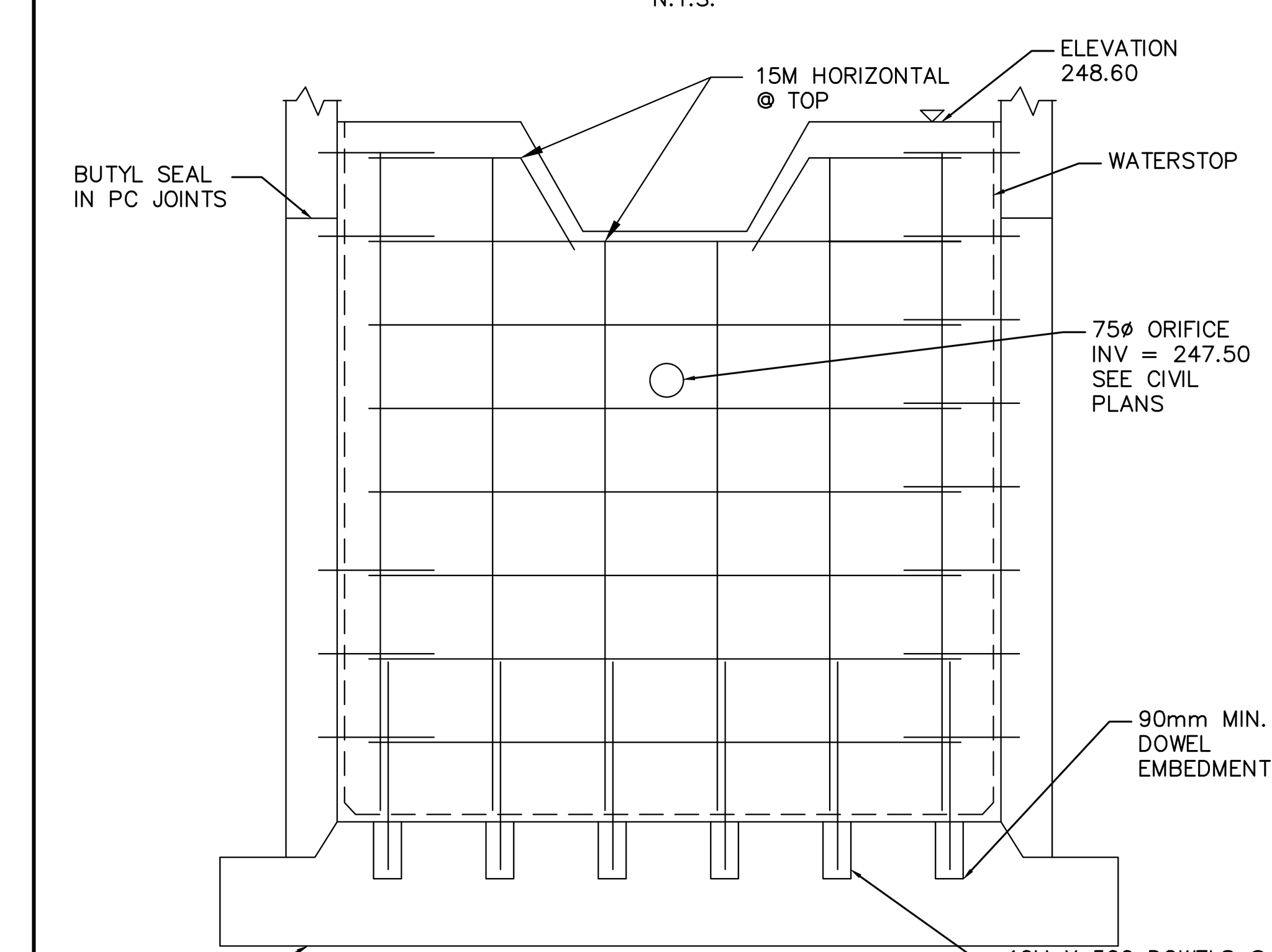
DETAIL X

N.T.S.



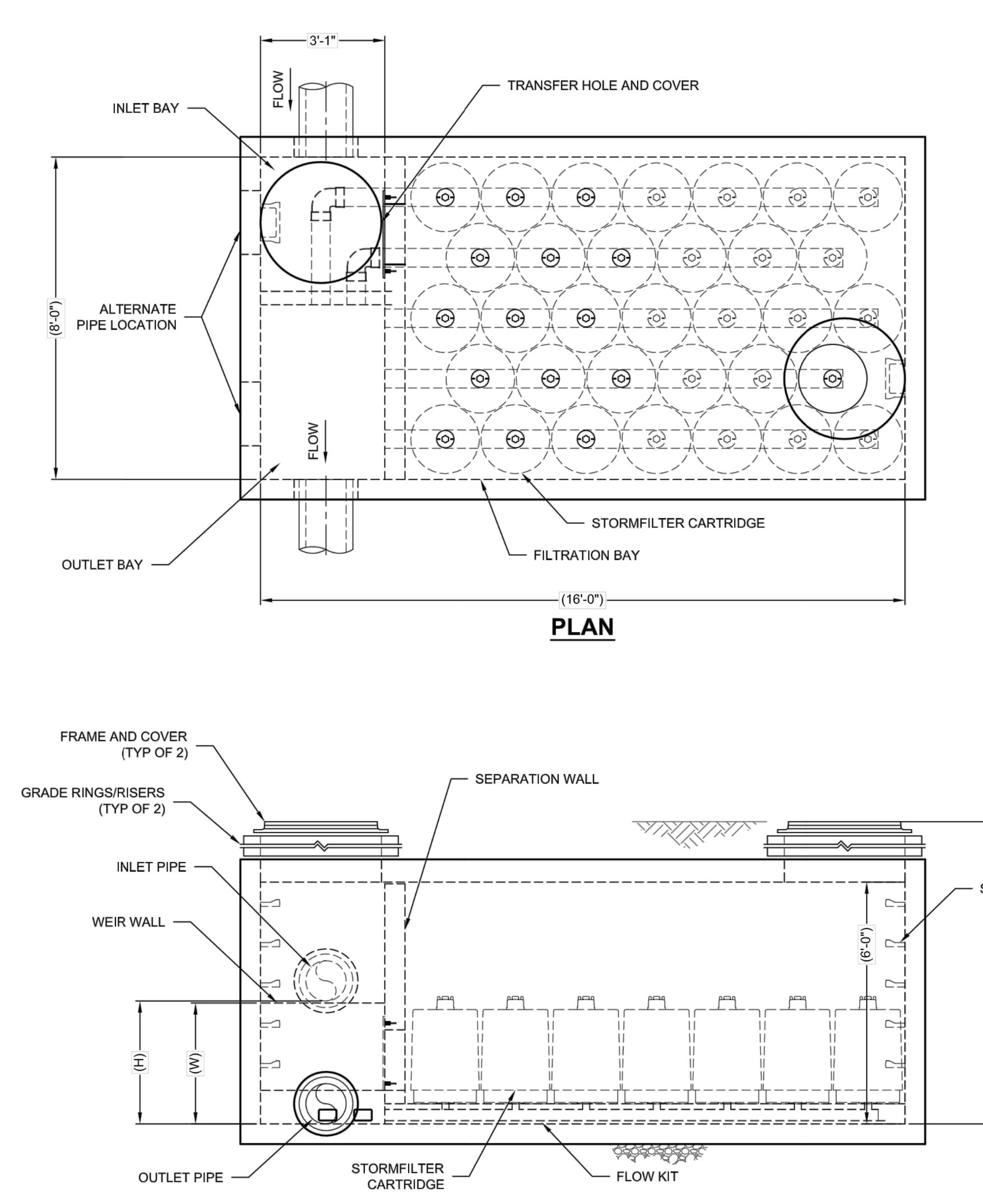
SECTION Y

N.T.S.



SECTION Z-Z

N.T.S.



PLAN

ELEVATION

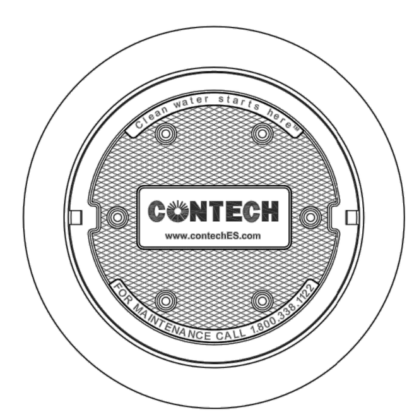
STORMFILTER DESIGN NOTES									

- 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

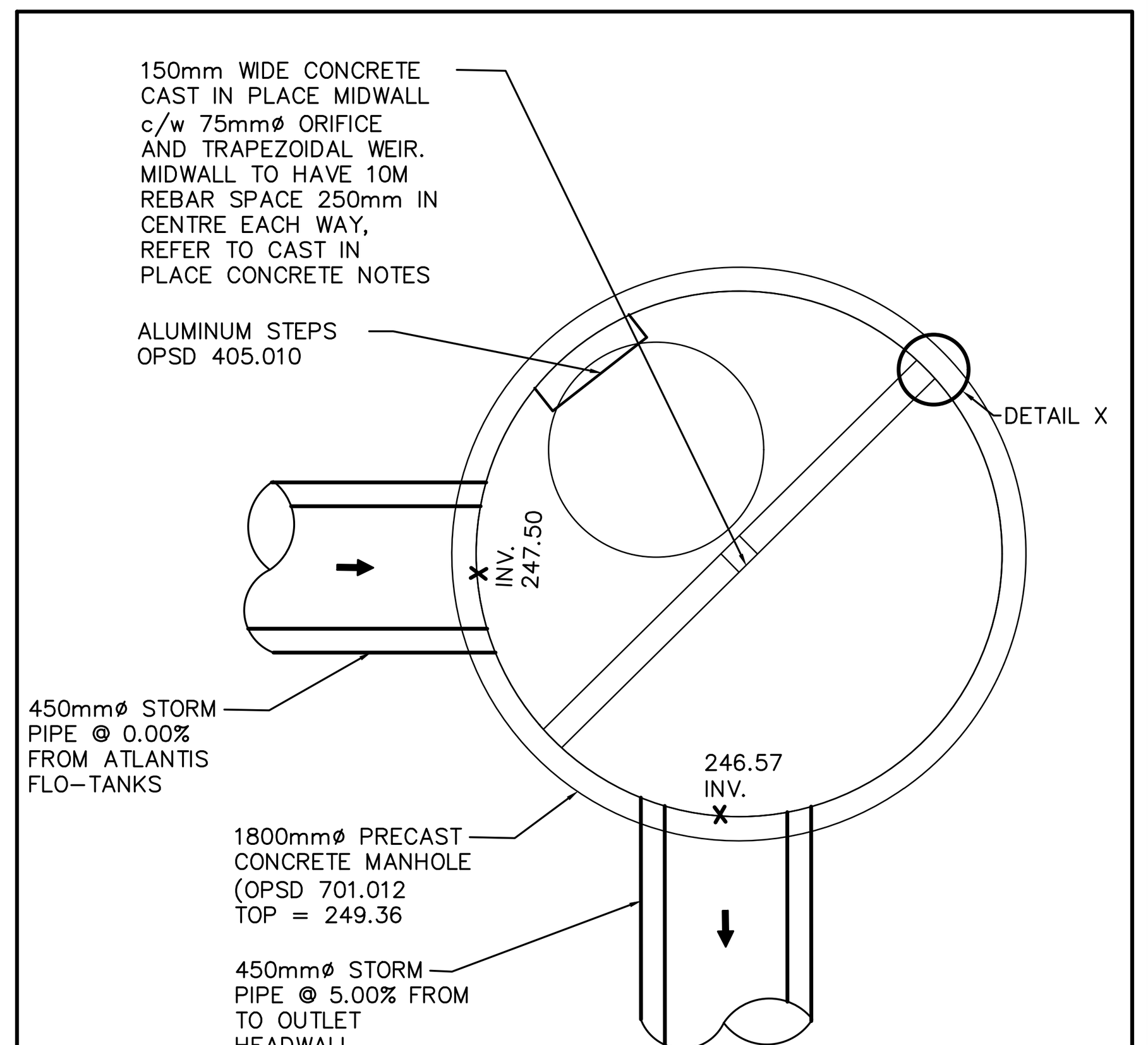
PERFORMANCE SPECIFICATION
FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. **RADIAL MEDIA DEPTH SHALL BE 7-INCHES**. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST **38 SECONDS**. SPECIFIC FLOW RATE SHALL BE 2 **GPM/SF (MAXIMUM)**. SPECIFIC FLOW RATE IS 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
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.

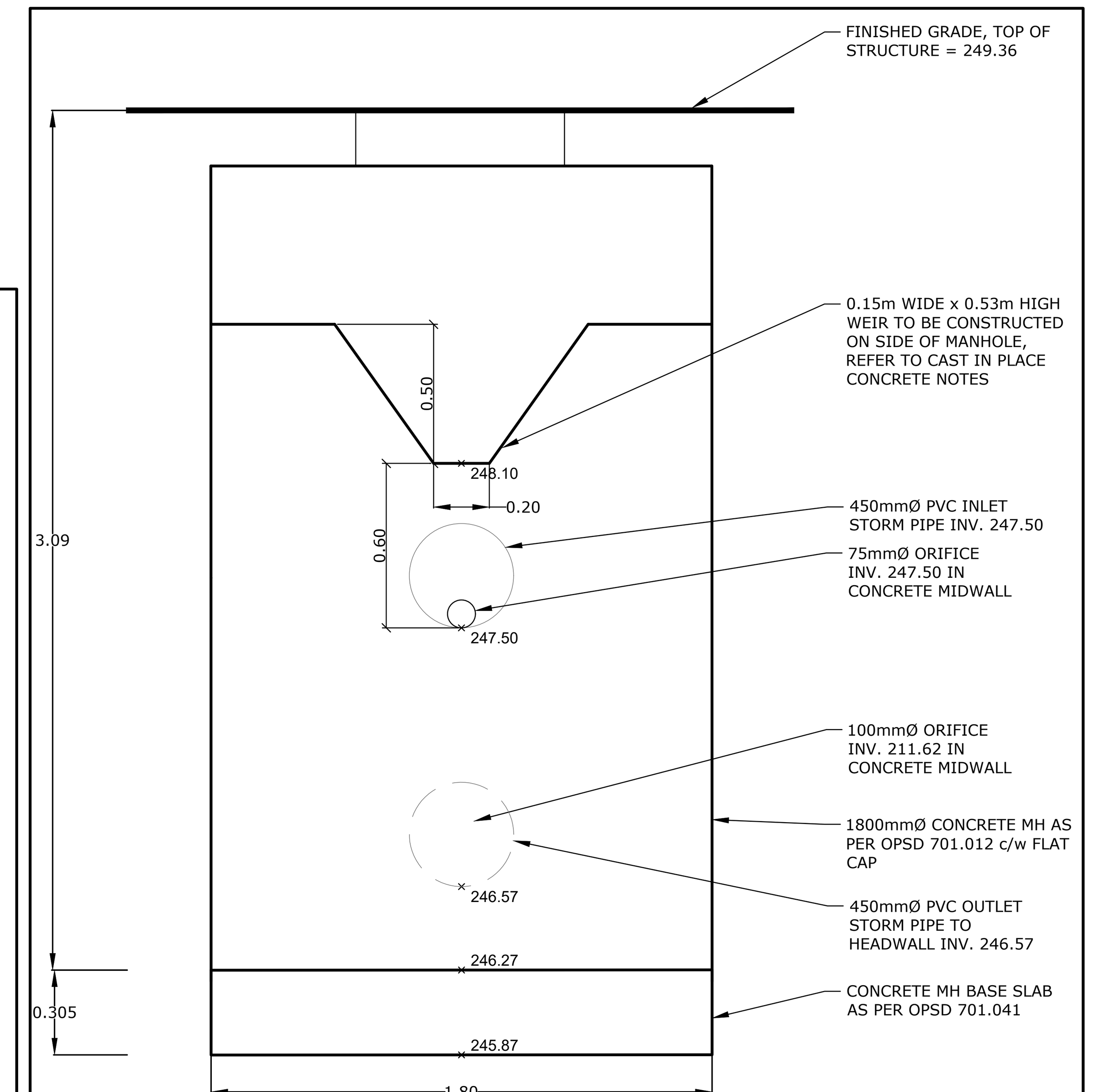
CONTECH ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

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



OUTLET STRUCTURE MH07 - PLAN VIEW

N.T.S.



OUTLET STRUCTURE MH07 - PROFILE VIEW

N.T.S.

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100056104
JAN 22, 2020
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380 LOCKHART ROAD SITE PLAN

STANDARD DETAILS

Designed	Checked	Date	Drawing No.
K. GRIFFIN	C. CAPES	20/01/13	C6
Project No. 2019-039		Rev No. 1	
Scale 1:20	0 400 800 1,200mm		

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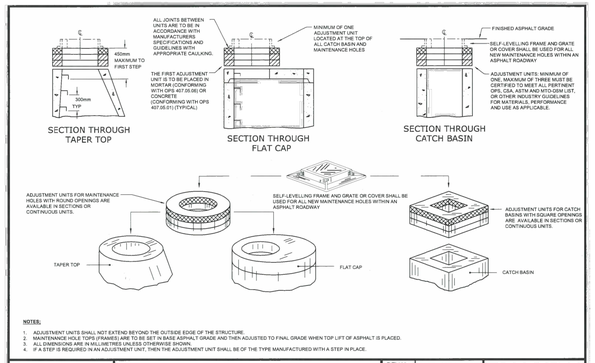
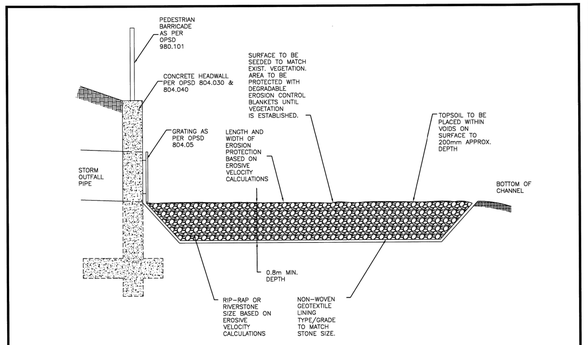
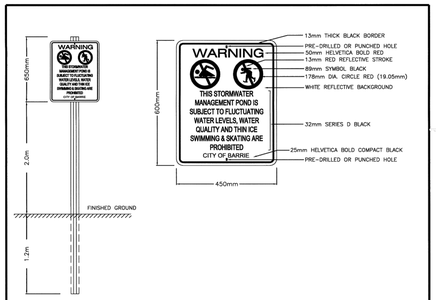


Barrie STANDARD DETAIL	MAINTENANCE HOLE AND CATCH BASIN ADJUSTMENT UNITS	REV No. 2	DATE: OCT 2017	SCALE: N.T.S.	BSD-41

APPROVED DATE Oct 27/17 DIRECTOR OF ENGINEERING



CITY OF BARRIE STANDARD					APPROVED DATE: 09 11 05 K.W. McAllister DIRECTOR OF ENGINEERING
OUTLET EROSION PROTECTION TYPICAL DETAIL	1.				SCALE: N.T.S.
	No.	REVISION	APR'D	DATE	BSD-82



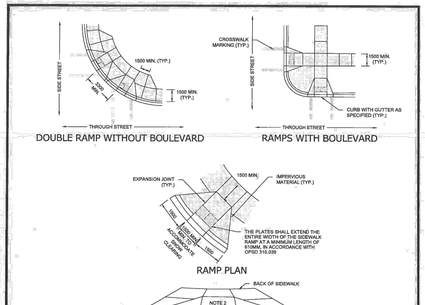
SIGN REQUIREMENTS
SIGN(S) MUST BE PLACED AT ALL POND ENTRANCES.

SIGNAGE FACE
SIGN(S) TO BE MANUFACTURED USING REFLECTIVE FINISH (ENGINEER GRADE)
3.2mm THICK ALUMINUM PANEL (50mm RADIUS CORNERS), WITH TOP AND BOTTOM MOUNT HOLES.

MOUNTING
SIGN(S) TO BE MOUNTED TO 3.65m U-CHANNEL GALVANIZED STEEL POST.

No.	REVISION	APR'D	DATE

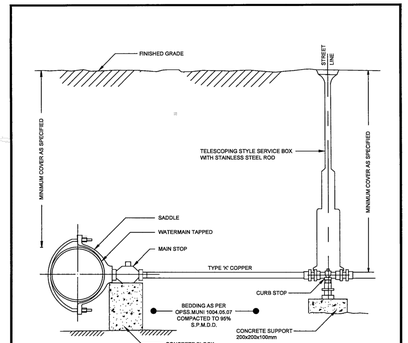
CITY OF BARRIE STANDARD	APPROVED DATE: 09 11 05 K.W. McAllister DIRECTOR OF ENGINEERING
STORMWATER MANAGEMENT POND WARNING SIGN	SCALE: N.T.S. BSD-83



NOTES:
1. SLOPE OF RAMP SHALL NOT EXCEED 8%
2. CROSS SLOPE OF RAMP SHALL NOT EXCEED 2% IN EITHER DIRECTION
3. CROSS SLOPE OF FLARED SIDE OF RAMP SHALL NOT EXCEED 8%
4. DROPPED CURB AT RAMP SHALL BE MODIFIED TO ELIMINATE 10mm STEP AT GUTTER LINE
5. ACCESSIBLE PEDESTRIAN SIGNAL TO HAVE TACTILE ARROW THAT ALIGNS WITH DIRECTION OF CROSSWALK
6. MINIMUM THICKNESS OF RAMP IS 200mm. MINIMUM THICKNESS OF SIDEWALK AND FLARED SIDES ADJACENT TO RAMP IS 150mm.
7. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED
8. FOR CROSSWALK MARKINGS AND SIGNAGE REFER TO OTM BOOK 15

Barrie STANDARD DETAIL	CONCRETE SIDEWALK RAMPS AT UNSIGNALIZED INTERSECTIONS	REV No. 1	DATE: OCT 2017	SCALE: N.T.S.	BSD-318

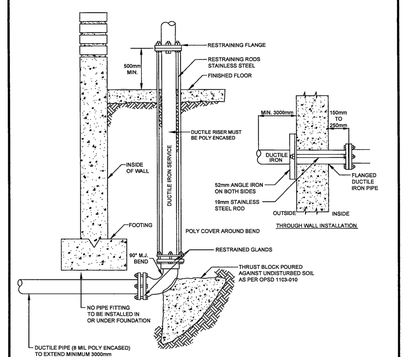
APPROVED DATE Oct 27/17 DIRECTOR OF ENGINEERING



NOTES
1. ANY JUNCTION MADE IN SERVICE PIPE BETWEEN MAIN STOP AND CURB STOP TO BE MADE WITH APPROVED COUPLINGS. (FOR 50mm ONLY)
2. ALL WATER SERVICES TO BE INSTALLED AT RIGHT ANGLE TO THE WATERMAIN.
3. ALL SERVICES TO BE INSTALLED WITH COPPER CONNECTION ONLY.
4. 819mm (36") STAINLESS STEEL SERVICE BOX ROD.
5. SEE BSD-504 FOR 38mm AND 50mm NON-COPPER WATER SERVICES.
6. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.

City of BARRIE STANDARD DETAIL	COPPER WATER SERVICE CONNECTION DETAIL 38mm AND 50mm DIAMETER SIZES	REV No. 1	DATE: FEB 2015	SCALE: N.T.S.	BSD-503 (PREVIOUSLY BSD-49)

APPROVED DATE 6/FEB/2015 DIRECTOR OF ENGINEERING



NOTES:
1. INSTALLATION MUST MEET THE CURRENT NATIONAL FIRE PROTECTION ACT.
2. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN.

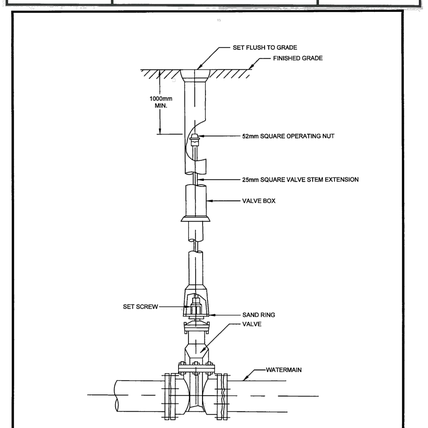
City of BARRIE STANDARD DETAIL	TYPICAL SERVICE ENTRY 100mm TO 300mm DIAMETER PIPE	REV No. 1	DATE: FEB 2015	SCALE: N.T.S.	BSD-505 (PREVIOUSLY BSD-61)

APPROVED DATE 6 FEB 2015 DIRECTOR OF ENGINEERING

NOTES:
1. CROSSFALL OF SIDEWALK 2.0% UNLESS OTHERWISE APPROVED.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
3. UPON THE APPROVAL OF THE DIRECTOR OF ENGINEERING, STEEPER SLOPES MAY BE CONSIDERED WHEN THE BOULEVARD WIDTH IS LESS THAN 2.44M OR DURING ROAD RECONSTRUCTION.
4. REVERSE GRADES ARE NOT APPROVED.

Barrie STANDARD DETAIL	DRIVEWAY AND ENTRANCE DETAIL	REV No. 1	DATE: OCT 2017	SCALE: N.T.S.	BSD-319

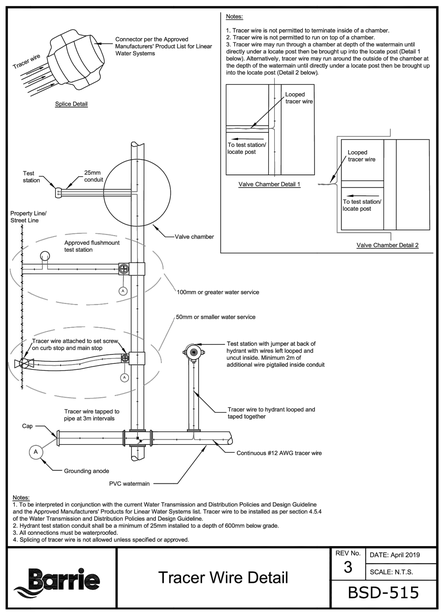
APPROVED DATE Oct 27/17 DIRECTOR OF ENGINEERING



NOTES:
1. EXTENSION REQUIRED WHEN DISTANCE FROM THE TOP OF VALVE TO FINISHED GRADE IS MORE THAN 1.7m.

City of BARRIE STANDARD DETAIL	VALVE STEM EXTENSION IN VALVE BOX	REV No. 1	DATE: FEB 2015	SCALE: N.T.S.	BSD-511 (PREVIOUSLY BSD-48)

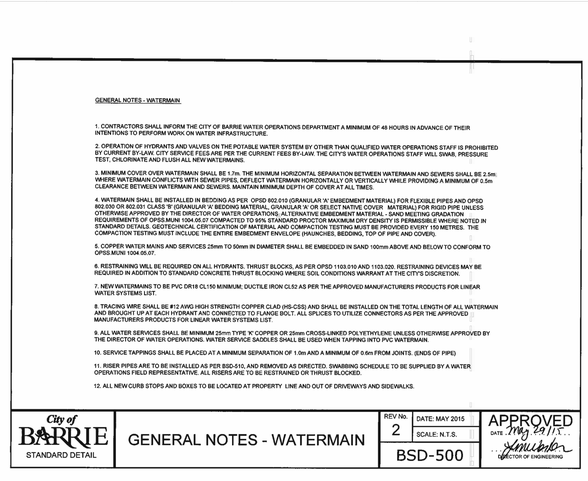
APPROVED DATE 6/FEB/2015 DIRECTOR OF ENGINEERING



Notes:
1. Tracer wire is not permitted to terminate inside of a chamber.
2. Tracer wire is not permitted to run on top of a chamber.
3. Tracer wire may run through a chamber at depth of the watermain until directly under a locate post then be brought up into the locate post (Detail 1 below). Alternatively, tracer wire may run around the outside of the chamber at the depth of the watermain until directly under a locate post then be brought up into the locate post (Detail 2 below).

Notes:
1. To be interpreted in conjunction with the current Water Transmission and Distribution Policies and Design Guideline and the Approved Manufacturers' Products for Linear Water Systems list. Tracer wire to be installed as per section 4.5.4 of the Water Transmission and Distribution Policies and Design Guideline.
2. Hydrant test station conduit shall be a minimum of 25mm installed to a depth of 600mm below grade.
3. All connections must be waterproofed.
4. Splicing of tracer wire is not allowed unless specified or approved.

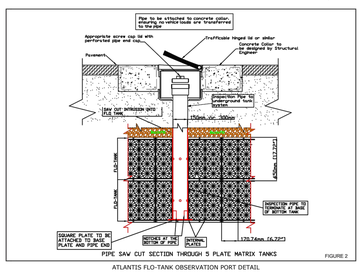
Barrie	Tracer Wire Detail	REV No. 3	DATE: April 2019	SCALE: N.T.S.	BSD-515



City of BARRIE STANDARD DETAIL	GENERAL NOTES - WATERMAIN	REV No. 2	DATE: MAY 2015	SCALE: N.T.S.	BSD-500

APPROVED DATE May 29/15 DIRECTOR OF ENGINEERING

NOTE: REFER TO CITY OF BARRIE LIST OF APPROVED MANUFACTURER'S FOR ALL APPROVED MATERIALS NOT OTHERWISE SPECIFIED ON THE PLANS



ATLANTIS FLO-TANK OBSERVATION PORT DETAIL

Notes
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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.

No	Issue / Revision	Date	Auth
1	FUNCTIONAL SERVICING REPORT	20/01/22	CC

LICENSED PROFESSIONAL ENGINEER C. CAPES 100056104 JAN 22, 2020 PROVINCE OF ONTARIO

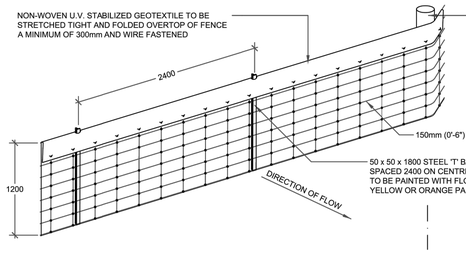
Client
KINGSLEA DEVELOPMENTS
16-107 WOODBINE DOWNS
TORONTO, ON
M9W 6Y1

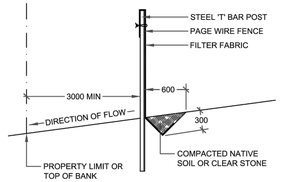
CAPES ENGINEERING
355310 BLUE MOUNTAINS - EUPHRASIA TOWNLINE
CLARKSBURG, ON N0H 1J0
TEL: 705-994-4818

380 LOCKHART ROAD SITE PLAN
STANDARD DETAILS

Designed	Checked	Date	Drawing No.
K. GRIFFIN	C. CAPES	20/01/13	C7
Project No. 2019-039		Rev No. 1	
Scale AS NOTED			

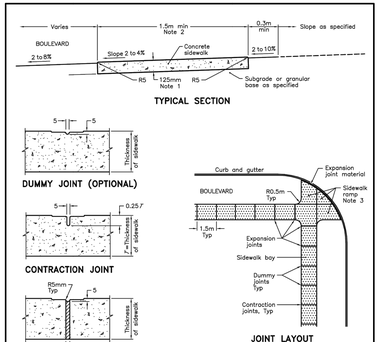
File: C:\Users\kevin\Desktop\capes engineering\Projects\2019\039 lockhart road\Drawings\01 Production\dwg\2019-039 DETAILS.dwg Date Plotted: January 21, 2020 - 11:19 AM





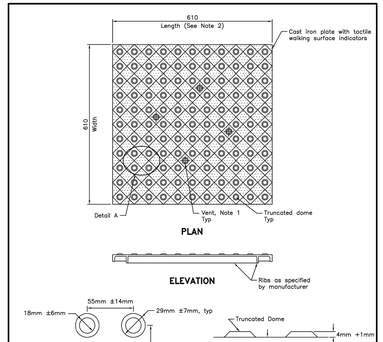
1. THIS STANDARD IS TO BE USED IN ACCORDANCE WITH THE SITE ALTERATION BY-LAW FOR THE DESIGN AND MAINTENANCE OF EROSION CONTROL MEASURES AND IS TO BE ADMINISTERED ACCORDINGLY
2. SILT / SEDIMENT CONTROL FENCE SHOULD BE ALIGNED WITH CONTOURS FOR SHEET OVERLAND FLOW
3. SILTATION CONTROL FENCE IS TO BE LOCATED IN AREAS OF LOW SEDIMENT YIELD ON SLOPES THAT CONFIRM TO M.T.O. DRAINAGE MANUAL VOLUME 2 "CHART F4-3C TOPOGRAPHIC FACTOR LS BASED ON SLOPE LENGTH AND GRADIENT"
4. SILTATION CONTROL FENCE SHALL BE INSTALLED WITH FILTER MEDIA FABRIC TOED INTO THE SOIL 300mm BE EITHER STATIC SLICING OR TRENCHING METHODS WITH COMPACTION OF TRENCH MATERIAL MEETING 95% S.P.D.
5. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN
6. SILT / SEDIMENT CONTROL FENCE MAY BE UTILIZED FOR TREE PRESERVATION AND IS TO BE USED IN CONJUNCTION WITH BSD-1231, BSD-1232 AND BSD-1235

Barrie STANDARD DETAIL	SILTATION CONTROL FENCING	REV No. 2	DATE: OCT 2017	SCALE: N.T.S.	BSD-1233 FORMERLY BSD-23A	APPROVED DATE: Oct 10/17 Original Signed By DIRECTOR OF ENGINEERING



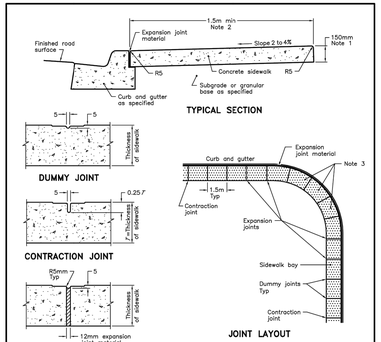
NOTES:
1 Sidewalk thickness at residential driveways and adjacent to curb shall be 150mm. At commercial and industrial driveways, the thickness shall be 200mm.
2 Sidewalk width shall be wider when specified.
3 This OPSD shall be read in conjunction with OPSD 310.030, 310.031, 310.032, 310.033 and 310.039.
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2015	Rev 2
CONCRETE SIDEWALK		
	OPSD 310.010	



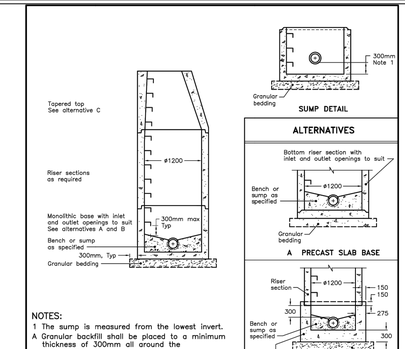
NOTES:
1 Vents shall be as specified by the manufacturer.
2 Length of plate may be increased to suit the curb depression width.
A Adjacent cast iron plates shall be permanently connected using a locking mechanism and any hardware shall be hot dipped galvanized.
B All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2015	Rev 0
CONCRETE SIDEWALK RAMPS TACTILE WALKING SURFACE INDICATORS COMPONENT		
	OPSD 310.039	



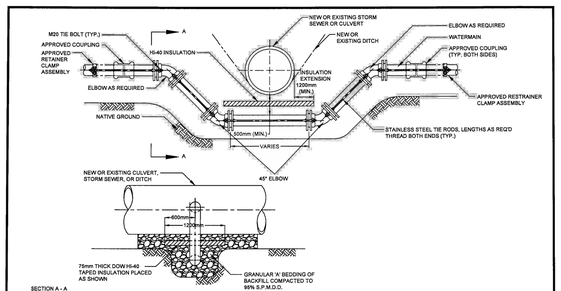
NOTES:
1 All commercial and industrial driveways, the thickness shall be 200mm.
2 Sidewalk width shall be wider when specified.
3 This OPSD shall be read in conjunction with OPSD 310.030, 310.031, 310.032, 310.033 and 310.039.
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2015	Rev 2
CONCRETE SIDEWALK ADJACENT TO CURB AND GUTTER		
	OPSD 310.020	



NOTES:
1 The sump is measured from the lowest invert.
A Granular backfill shall be placed to a minimum thickness of 300mm all around the maintenance hole.
B Precast concrete components shall be according to OPSD 701.030, 701.031, or 701.032.
C Structure exceeding 5.0m in depth shall include safety platform according to OPSD 404.020.
D Pipe support according to OPSD 708.020.
E For benching and pipe opening details, see OPSD 701.021
F For adjustment unit and frame installation, see OPSD 704.010.
G All dimensions are nominal.
H All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2014	Rev 5
PRECAST CONCRETE MAINTENANCE HOLE 1200mm DIAMETER		
	OPSD 701.010	

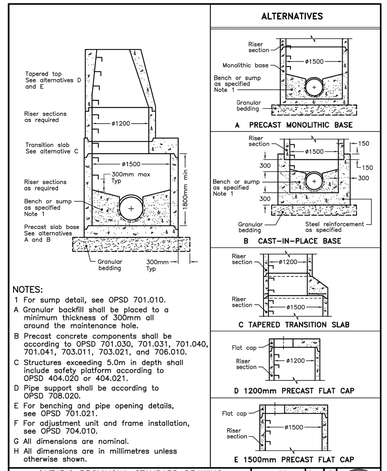


City of BARRIE STANDARD DETAIL	TYPICAL RESTRAINED WATERMAIN DUCTILE IRON OR PVC	REV No. 1	DATE: FEB 2015	SCALE: N.T.S.	BSD-512 (PREVIOUSLY BSD-47)	APPROVED DATE: 6 Feb 2015 DIRECTOR OF ENGINEERING

SECTION A–A

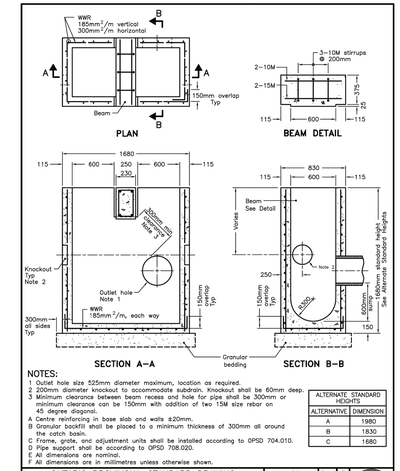
NOTES:
1. LOWERED SECTION OF WATERMAIN TO BE SAME MATERIAL AND CLASS AS EXISTING.
2. ALL JOINTS TO BE MECHANICALLY RESTRAINED, INCLUDING JOINTS ON EXISTING WATERMAIN.
3. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.

City of BARRIE STANDARD DETAIL	LOWERING DETAILOF NEW OR EXIST. WATERMAIN CROSSING NEW OR EXIST. CULVERT, STORM SEWER OR DITCH	REV No. 1	DATE: FEB 2015	SCALE: N.T.S.	BSD-519	APPROVED DATE: 6 Feb 2015 DIRECTOR OF ENGINEERING



NOTES:
1 For sump detail, see OPSD 701.010.
A Granular backfill shall be placed to a minimum thickness of 300mm all around the maintenance hole.
B Precast concrete components shall be according to OPSD 701.030, 701.031, 701.040, 701.041, 703.011, 703.021, and 706.010.
C Structures exceeding 5.0m in depth shall include safety platform according to OPSD 404.020 or 404.021.
D Pipe support shall be according to OPSD 708.020.
E For benching and pipe opening details, see OPSD 701.021.
F For adjustment unit and frame installation, see OPSD 704.010.
G All dimensions are nominal.
H All dimensions are in millimetres unless otherwise shown.

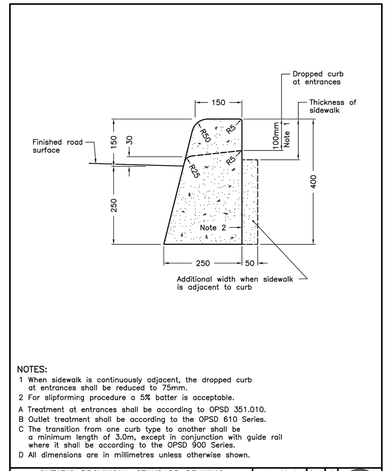
ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2014	Rev 5
PRECAST CONCRETE MAINTENANCE HOLE 1500mm DIAMETER		
	OPSD 701.011	



NOTES:
1 Outlet hole size 525mm diameter maximum, location as required.
2 200mm diameter knockout to accommodate subdrain. Knockout shall be 60mm deep.
3 Minimum clearance between beam recess and hole for pipe shall be 300mm or minimum clearance can be 150mm with addition of two 10M size rebar on 45 degree diagonal.
A Centre reinforcing in base slab and walls ±20mm.
B Granular backfill shall be placed to a minimum thickness of 300mm all around the catch basin.
C Frame, grate, and adjustment units shall be installed according to OPSD 704.010.
D Pipe support shall be according to OPSD 708.020.
E All dimensions are nominal.
F All dimensions are in millimetres unless otherwise shown.

ALTERNATE STANDARD HEIGHTS	
ALTERNATIVE	DIMENSION
A	1980
B	1830
C	1680

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2014	Rev 3
PRECAST CONCRETE TWIN INLET CATCH BASIN 600 x 1450mm		
	OPSD 705.020	



NOTES:
1 When sidewalk is continuously adjacent, the dropped curb at entrances shall be reduced to 75mm.
2 For slipforming procedure a 5% batter is acceptable.
A Treatment at entrances shall be according to OPSD 351.010.
B Outlet treatment shall be according to the OPSD 610 Series.
C The transition from one curb type to another shall be a minimum length of 3.0m, except in conjunction with guide rail where it shall be according to the OPSD 900 Series.
D All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2012	Rev 2
CONCRETE BARRIER CURB		
	OPSD 600.110	

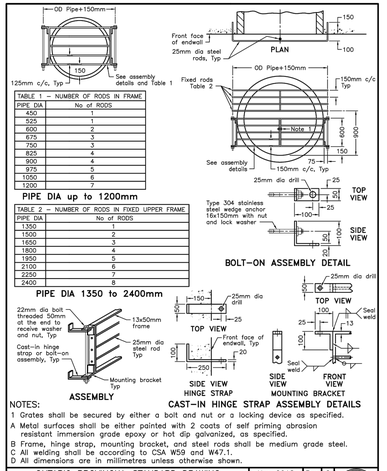


TABLE 1 – NUMBER OF RODS IN FRAME	
PIPE DIA	No. of RODS
450	1
525	1
600	2
675	3
750	3
825	4
900	4
975	5
1050	6
1200	7

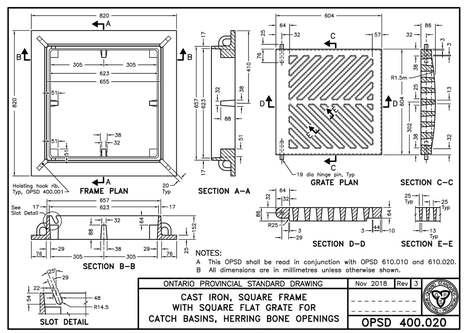
PIPE DIA up to 1200mm

TABLE 2 – NUMBER OF RODS IN FIXED UPPER FRAME	
PIPE DIA	No. of RODS
1350	1
1500	2
1650	3
1800	4
1950	5
2100	6
2250	7
2400	8

PIPE DIA 1350 to 2400mm

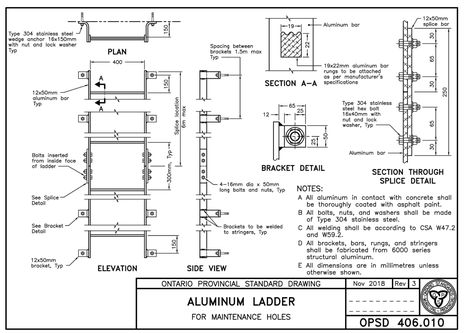
NOTES:
1 Grates shall be secured by either a bolt and nut or a locking device as specified.
A Metal surfaces shall be either painted with 2 coats of self priming abrasion resistant immersion grade epoxy or hot dip galvanized, as specified.
B Frame, hinge strap, mounting bracket, and steel rods shall be medium grade steel.
C All welding shall be according to CSA W59 and W47.1.
D All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2018	Rev 2
GRATING FOR CONCRETE ENDWALL		
	OPSD 804.050	



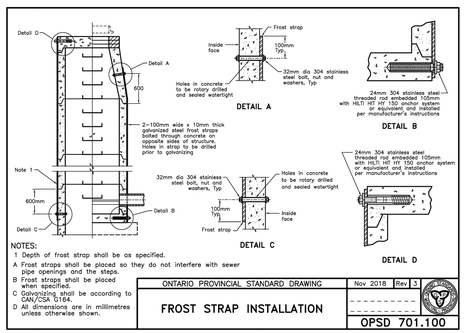
NOTES:
A This OPSD shall be read in conjunction with OPSD 610.010 and 610.020.
B All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2018	Rev 3
CAST IRON, SQUARE FRAME WITH SQUARE FLAT GRATE FOR CATCH BASINS, HERRING BONE OPENINGS		
	OPSD 400.020	



NOTES:
A All aluminum in contact with concrete shall be thoroughly coated with asphalt paint.
B All bolts, nuts, and washers shall be made of Type 304 stainless steel.
C All welding shall be according to CSA W47.2 and W59.2.
D All brackets, bars, rungs, and stringers shall be fabricated from 6000 series structural aluminum.
E All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2018	Rev 3
ALUMINUM LADDER FOR MAINTENANCE HOLES		
	OPSD 406.010	



NOTES:
1 Depth of frost strap shall be as specified.
A Frost straps shall be placed so they do not interfere with sewer pipe openings and the steps.
B Frost straps shall be placed when specified.
C Galvanizing shall be according to CAN/CSA G164.
D All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2018	Rev 3
FROST STRAP INSTALLATION		
	OPSD 701.100	

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No	Issue / Revision	Date	Auth
1	FUNCTIONAL SERVICING REPORT	20/01/22	CC

LICENSED PROFESSIONAL ENGINEER C. CAPES 100056104 JAN 22, 2020 PROVINCE OF ONTARIO

Client
KINGSLEA DEVELOPMENTS
16-107 WOODBINE DOWNS
TORONTO, ON
M9W 6Y1

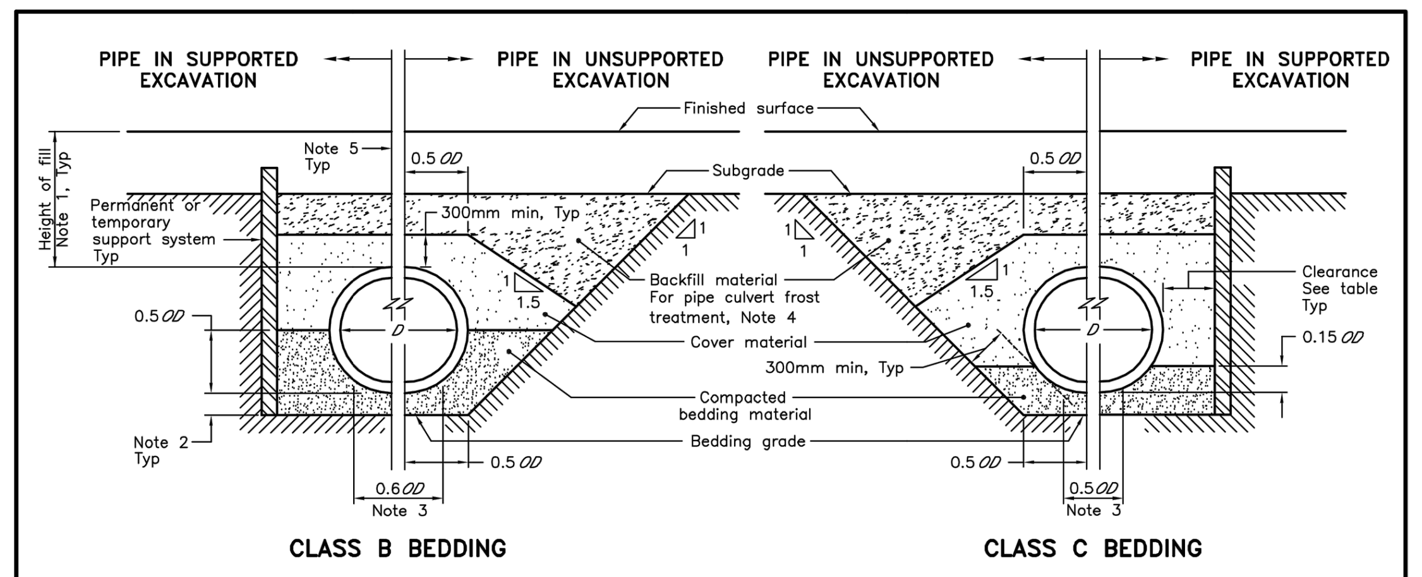
CAPES ENGINEERING
355310 BLUE MOUNTAINS - EUPHRASIA TOWNLINE CLARKSBURG, ON N0H 1J0
TEL: 705-994-4818

380 LOCKHART ROAD SITE PLAN

STANDARD DETAILS

Designed	Checked	Date	Drawing No.
K. GRIFFIN	C. CAPES	20/01/13	C8
Project No. 2019-039		Rev No. 1	
Scale AS NOTED			

File: C:\Users\kgriffin\Desktop\Current engineering\Projects\2019\039 Lockhart Road\Drawings\03 Plans\Civil\Dwg\039-STD DETAILS.dwg Date Plotted: January 21, 2020 - 11:20 AM



NOTES:
1 Height of fill is measured from the finished surface to top of pipe.
2 The minimum bedding depth below the pipe shall be 0.15 OD. In no case shall this dimension be less than 150mm or greater than 300mm.
3 The pipe bed shall be compacted and shaped to receive the bottom of the pipe.
4 Pipe culvert frost treatment shall be according to OPSD 803.030 and 803.031.
5 Condition of excavation is symmetrical about centreline of pipe.
A Soil types as defined in the Occupational Health and Safety Act and Regulations for Construction Projects.
B All dimensions are in metres unless otherwise shown.

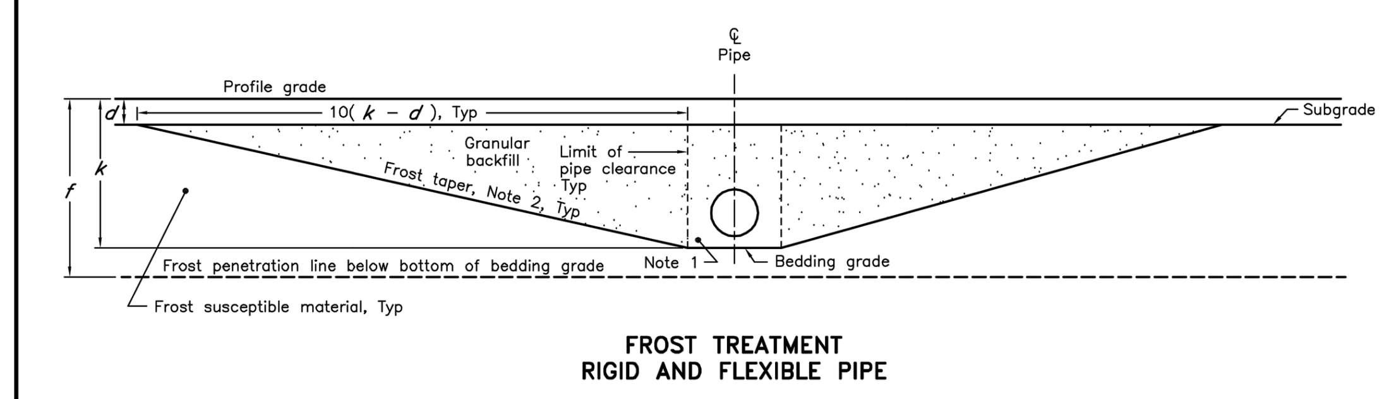
LEGEND:
D – Inside diameter
OD – Outside diameter

CLEARANCE TABLE	
Pipe Inside Diameter mm	Clearance mm
900 or less	300
Over 900	500

ONTARIO PROVINCIAL STANDARD DRAWING — Nov 2015 — Rev 3

RIGID PIPE BEDDING, COVER, AND BACKFILL TYPE 3 SOIL – EARTH EXCAVATION

OPSD 802.031



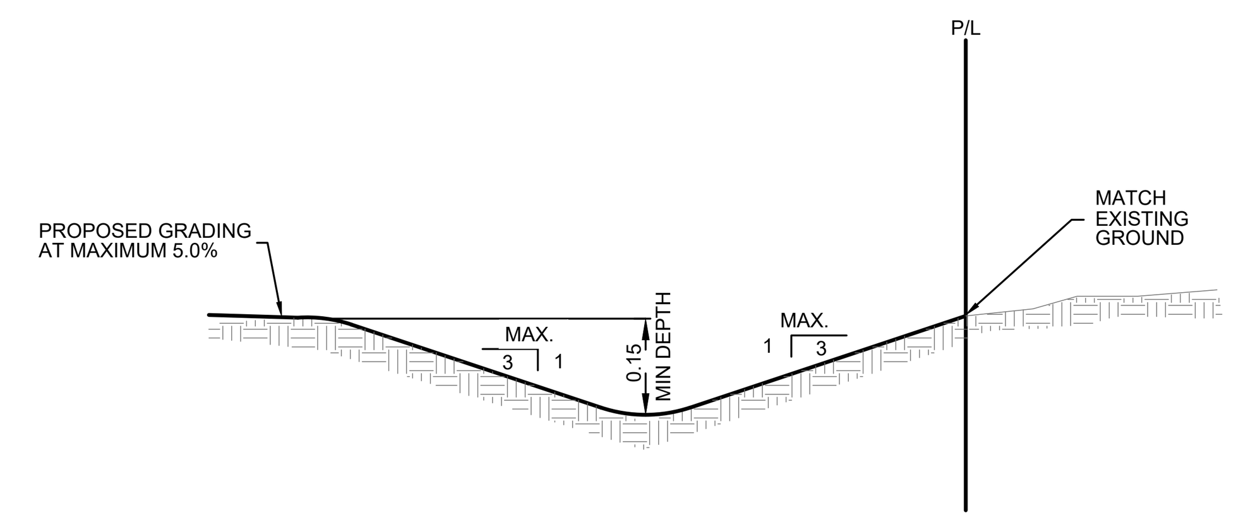
NOTES:
1 Pipe embedment or bedding, cover, and backfill shall be according to:
a) Flexible OPSD 802.010, 802.013, 802.014, 802.020, 802.023, and 802.024.
b) Rigid – OPSD 802.030, 802.031, 802.032, 802.033, 802.034, 802.050, 802.051, 802.052, 802.053, and 802.054.
2 Frost tapers shall start at bedding grade.

LEGEND:
d – depth of roadbed granular
k – depth of frost treatment below profile grade
f – depth of frost penetration below profile grade

ONTARIO PROVINCIAL STANDARD DRAWING — Nov 2015 — Rev 3

FROST TREATMENT – PIPE CULVERTS FROST PENETRATION LINE BELOW BEDDING GRADE

OPSD 803.030



TYPICAL SIDE YARD SWALE

GENERAL NOTES – SANITARY SEWER

SANITARY SEWERS

A. SANITARY SEWER TO BE LOCATED AT THE CENTRELINE OF THE ROAD.

B. SEWERS SHALL BE CONSTRUCTED WITH BEDDINGS AS PER OPSD–802.010, (GRAN. 'A' EMBEDMENT MATERIAL) FOR 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.

C. MAXIMUM DEFLECTION FROM COMBINED LIVE AND DEAD LOADING SHALL NOT EXCEED ANY C.S.A., O.P.S. OR MANUFACTURERS RECOMMENDED SPECIFICATIONS.

D. 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.

E. CONCRETE SANITARY SEWERS SHALL HAVE A MINIMUM STRENGTH OF 50 N/m/mm CONFORMING TO CSA STANDARD A257.2–1982, CLASS 50–D (PREVIOUSLY C.S.A. STANDARD A257.2–1974, CLASS II).

F. 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 PLACE. ALL ADJUSTMENT WILL BE ACCORDANCE WITH BSD–N2.

G. 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.

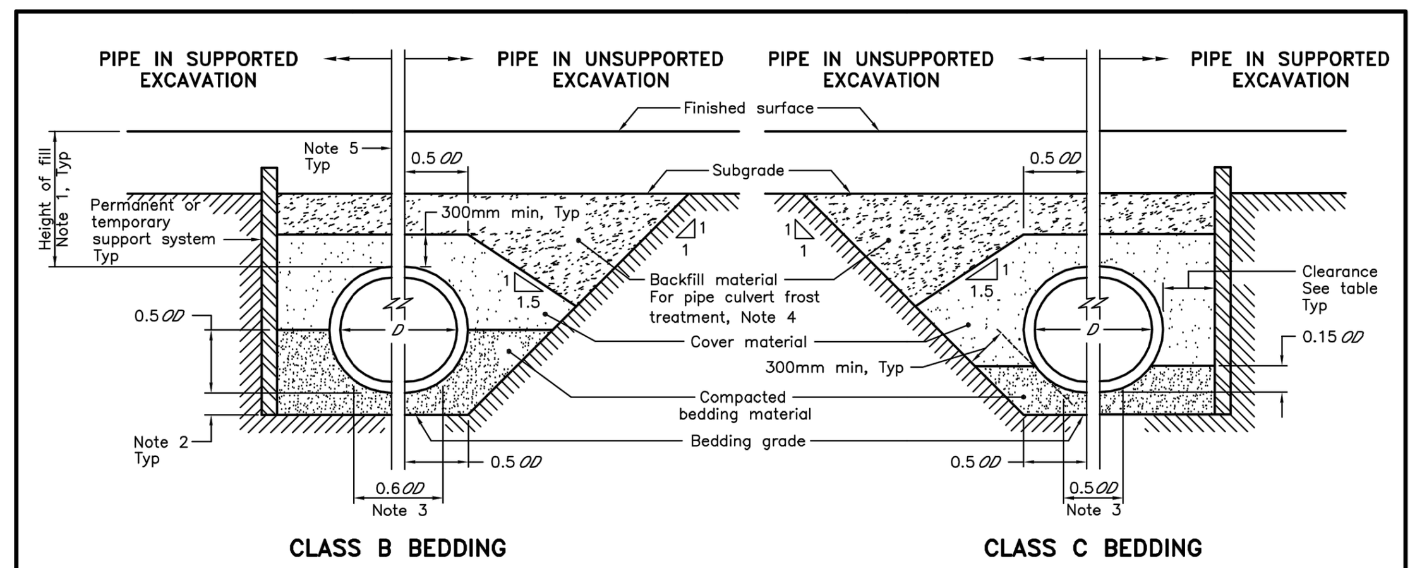
CITY OF BARRIE STANDARD

GENERAL NOTES SANITARY SEWERS

NO.	REVISION	APR'D	DATE
4.	NOTE 'B' – "ENGINEERING"	B.R.	2002.10.28
3.	NOTE 'B' OPSD NUMBER REVISION	K.C.	2000.03.16
2.	NOTE 'F' CHANGED	K.C.	98.03.30
1.	CHANGES TO B. TO G.	K.C.	95.04.24

APR'D: R.G.N. DATE: 92.05.15 DRAWN: L.A.J. SCALE: N.T.S.

BSD-N3



NOTES:
1 Height of fill is measured from the finished surface to top of pipe.
2 The minimum bedding depth below the pipe shall be 0.15 OD. In no case shall this dimension be less than 150mm or greater than 300mm.
3 The pipe bed shall be compacted and shaped to receive the bottom of the pipe.
4 Pipe culvert frost treatment shall be according to OPSD 803.030 and 803.031.
5 Condition of excavation is symmetrical about centreline of pipe.
A Soil types as defined in the Occupational Health and Safety Act and Regulations for Construction Projects.
B All dimensions are in metres unless otherwise shown.

LEGEND:
D – Inside diameter
OD – Outside diameter

ONTARIO PROVINCIAL STANDARD DRAWING — Nov 2015 — Rev 3

RIGID PIPE BEDDING, COVER, AND BACKFILL TYPE 3 SOIL – EARTH EXCAVATION

OPSD 802.031

EROSION AND SEDIMENT CONTROL NOTES:

1. ALL SEDIMENT CONTROL MEASURES SUCH AS SEDIMENT CONTROL FENCE, TEMPORARY PONDS, CONSTRUCTION ACCESS MATS, SEDIMENT TRAPS, SWALES AND CHECK DAMS MUST BE INSTALLED PRIOR TO THE COMMENCEMENT OF SITE WORKS.
2. SEDIMENT CONTROLS SHOULD BE INSPECTED ON A REGULAR BASIS AND AFTER EVERY SIGNIFICANT RAINFALL EVENT. REPAIRS TO ESC MEASURES MUST BE COMPLETED IN A TIMELY MANNER TO PREVENT SEDIMENT MIGRATION.
3. ADDITIONAL MATERIALS SUCH AS CLEAR STONE, FILTER FABRIC, PUMPS, HOSES AND SILTSOXX TO BE KEPT ONSITE AT ALL TIMES FOR CONDUCTING REPAIRS TO SEDIMENT CONTROL MEASURES.
4. ALL DISTURBED AREAS LEFT INACTIVE FOR MORE THAN THIRTY DAYS ARE TO BE STABILIZED.
5. THE STABILIZATION SEED MIXTURE IS TO BE AS SPECIFIED ON THE EROSION AND SEDIMENT CONTROL PLAN.
6. THE STABILIZATION SEED MIXTURE IS TO BE APPLIED AT A MINIMUM RATE OF 25 kg/ha.
7. ENGINEERED CHANGES TO THE ESC MEASURES MAY BE NEEDED AS SITE CONDITIONS CHANGE THROUGHOUT THE CONSTRUCTION PROCESS. THESE UPDATES MUST REFLECT BEST MANAGEMENT PRACTICES TO CONTROL SEDIMENT AND EROSION ONSITE AND SHOULD BE COMPLETED BASED ON DIRECTION FROM THE SITE ENGINEER. ADDITIONAL MEASURES MAY BE REQUIRED AS DIRECTED BY AN ENGINEER THROUGHOUT THE CONSTRUCTION PROCESS.
8. THE CONSTRUCTION ENTRANCE MAT IS TO BE INSTALLED AS THE FIRST STEP IN THE SITE ALTERATION PROCESS.
9. SEDIMENT CONTROL FENCE IS TO BE INSTALLED DOWNSLOPE OF ALL DISTURBED AREAS. A DOUBLE ROW OF SEDIMENT CONTROL FENCE IS TO BE INSTALLED SURROUNDING ALL NATURAL HERITAGE FEATURES AND AS DIRECTED BY THE SITE ENGINEER. SEDIMENT CONTROL FENCE IS TO BE AS PER LSRCA STANDARD ESC-4 or ESC-5 AS A MINIMUM. LIGHT DUTY SEDIMENT CONTROL FENCE IS NOT ACCEPTABLE.
10. CUT-OFF SWALES OR DITCHES ARE TO BE INSTALLED AS SHOWN ON THE ESC PLANS AND AS NECESSARY BASED ON CHANGING SITE CONDITIONS TO DIRECT OVERLAND FLOW TO THE APPROPRIATE SEDIMENT TRAP OR TEMPORARY SEDIMENT POND.
11. CHECK DAMS ARE TO BE INSTALLED IN ALL SWALES AND DITCHES IN ACCORDANCE WITH DRAWING LSRCA ESC-2, AS A MINIMUM
12. TEMPORARY SEDIMENT TRAP(S) ARE TO BE CONSTRUCTED AT THE BEGINNING OF SITE GRADING AND IF THE SITE DRAINAGE CHANGES DURING CONSTRUCTION. IT MAY BE NECESSARY FOR TEMPORARY SWALES TO BE CONSTRUCTED TO DIRECT SITE FLOWS TO THE TEMPORARY SEDIMENT TRAP(S) DURING ROUGH GRADING AND AS CONSTRUCTION PROGRESSES.
13. TEMPORARY SEDIMENT POND(S) ARE TO BE CONSTRUCTED AT THE BEGINNING OF SITE GRADING AND IF THE SITE DRAINAGE CHANGES DURING CONSTRUCTION. IT MAY BE NECESSARY FOR TEMPORARY SWALES TO BE CONSTRUCTED TO DIRECT SITE FLOWS TO THE TEMPORARY SEDIMENT POND(S) DURING ROUGH GRADING AND AS CONSTRUCTION PROGRESSES.
14. FILTREXX SILTSOXX OR APPROVED EQUIVALENT TO BE INSTALLED DOWNSTREAM FROM SEDIMENT TRAP AND TEMPORARY SEDIMENT POND OUTLETS TO A MINIMUM HEIGHT OF 300mm.
15. IF STOCKPILES ARE USED ON-SITE FOR THE STORAGE OF EXCESS MATERIAL, THEY ARE TO BE IN ACCORDANCE WITH DETAIL DRAWING LSRCA ESC-6 OR BETTER.
16. ANY DEWATERING OCCURRING ONSITE MUST BE IN ACCORDANCE WITH AN APPROVED DEWATERING PLAN. ADDITIONAL DEWATERING REQUIREMENTS MAY BE DEEMED NECESSARY AND SHALL BE IMPLEMENTED AS DIRECTED BY THE ENGINEER, CONTRACT ADMINISTRATOR OR LOCAL MUNICIPALITY.
17. THE SITE TRAILER IS TO BE LOCATED ONLY AT THE DESIGNATED LOCATION SHOWN ON THE PLANS.
18. EQUIPMENT AND HYDROCARBON STORAGE IS TO OCCUR ONLY WITHIN THE DESIGNATED AREA SHOWN ON THE PLANS.
19. REFUELING IS TO TAKE PLACE ONLY WITHIN THE DESIGNATED AREA SHOWN ON THE PLANS AND SHALL BE A MINIMUM OF THIRTY METRES FROM ANY WATERCOURSE OR ENVIRONMENTALLY SENSITIVE AREA.
20. AN APPROVED SPILLS MANAGEMENT PLAN IS TO BE KEPT ONSITE.
21. SPILL CLEANUP EQUIPMENT SUCH AS ABSORPTIVE MEDIA IS TO BE MAINTAINED ONSITE FOR IMMEDIATE USE IN THE EVENT OF A SPILL.
22. SPILLS ARE TO BE REPORTED IMMEDIATELY TO THE MOECC SPILLS ACTION CENTRE AT 1-800-268-6060.
23. THE CONTRACTOR WILL BE RESPONSIBLE FOR CLEAN-UP AND RESTORATION, INCLUDING ALL COSTS, DUE TO THE RELEASE OF SEDIMENT FROM THE SITE.
24. LOW IMPACT DEVELOPMENT (LID) MEASURES ARE NOT TO BE USED AS SEDIMENT CONTROL DEVICES.
25. ADDITIONAL SEDIMENT CONTROL DEVICES MAY BE DEEMED NECESSARY AND AS SITE CONDITIONS CHANGE AND SHALL BE INSTALLED AS DIRECTED BY THE SITE ENGINEER, CONTRACT ADMINISTRATOR OR LOCAL MUNICIPALITY.

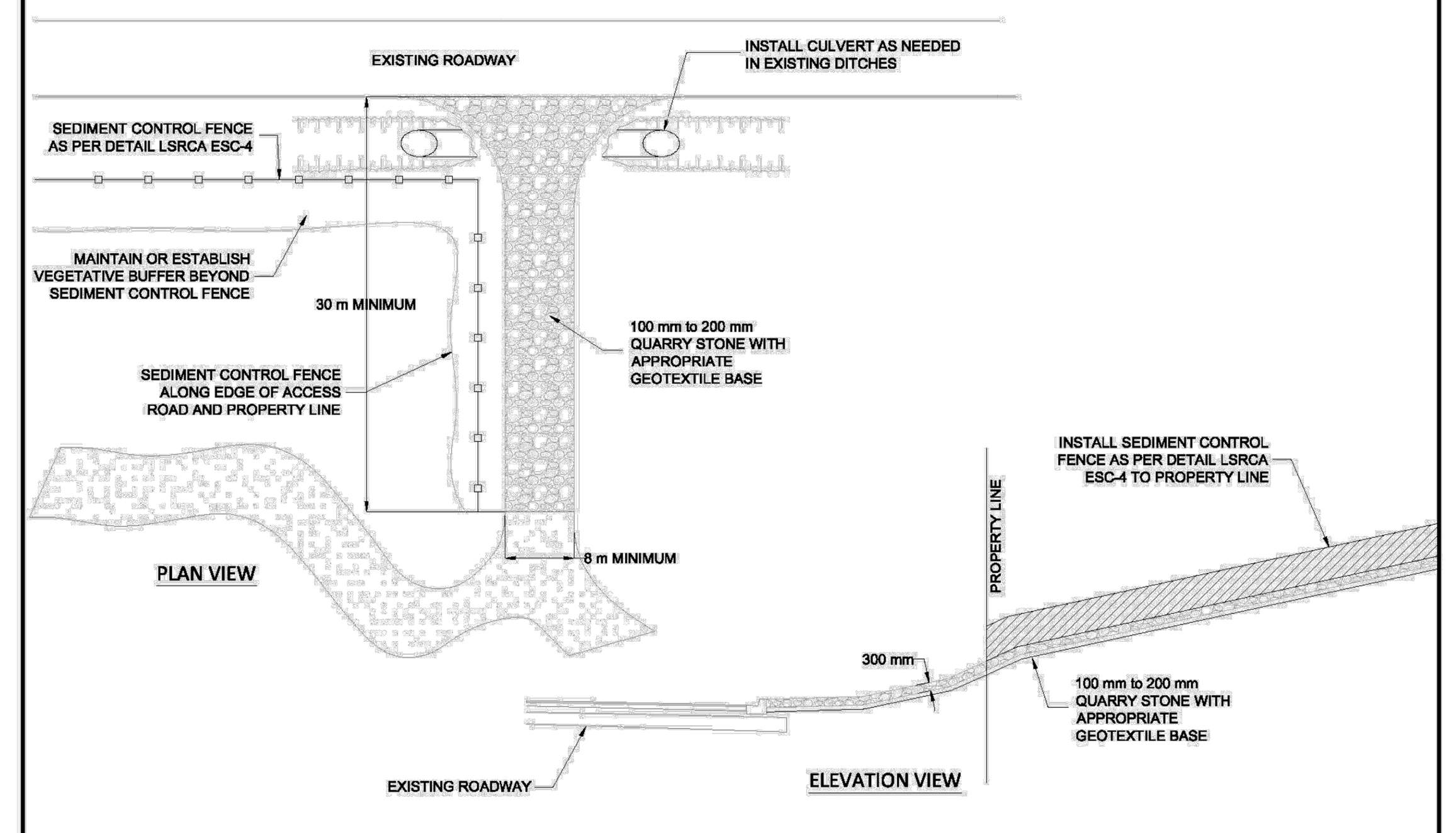
NO.	REVISION	DATE
1	SWM GUIDELINES UPDATE	06.2016

EROSION AND SEDIMENT CONTROL PLAN NOTES

DATE: 06.2016 SCALE: NTS

LSRCA ESC-1

G6



NO.	REVISION	DATE
1	SWM GUIDELINES UPDATE	06.2016

CONSTRUCTION ACCESS MAT

DATE: 06.2016 SCALE: NTS

LSRCA ESC-3

G8

GENERAL NOTES – SANITARY SEWER

SANITARY SERVICE LATERALS

A. SANITARY LATERAL CONNECTION TO BE LOCATED AT THE CENTRELINE OF THE LOT AND CAPPED.

B. LOCATION OF LATERAL TO BE MARKED 2.0m PAST 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. PVC SDR28, RUBBER GASKET TYPE JOINTS AND SHALL CONFORM TO C.S.A. (B–182.2.3.4) (COLOURED) FOR A RESIDENTIAL HOUSE AND 150mm MINIMUM DIA. PVC SDR28 FOR INDUSTRIAL/COMMERCIAL DEVELOPMENT.

D. MINIMUM DEPTH OF LATERAL AT PROPERTY LINE SHALL BE 2.4m MEASURED FROM THE SEWER OBVERT TO FINISHED GROUND SURFACE ELEVATION UNLESS NOTED OTHERWISE.

E. 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.

F. MINIMUM PIPE SLOPE TO BE 2.0%, MAXIMUM 8.0% (SEE OPSD–1006.010, 1006.020).

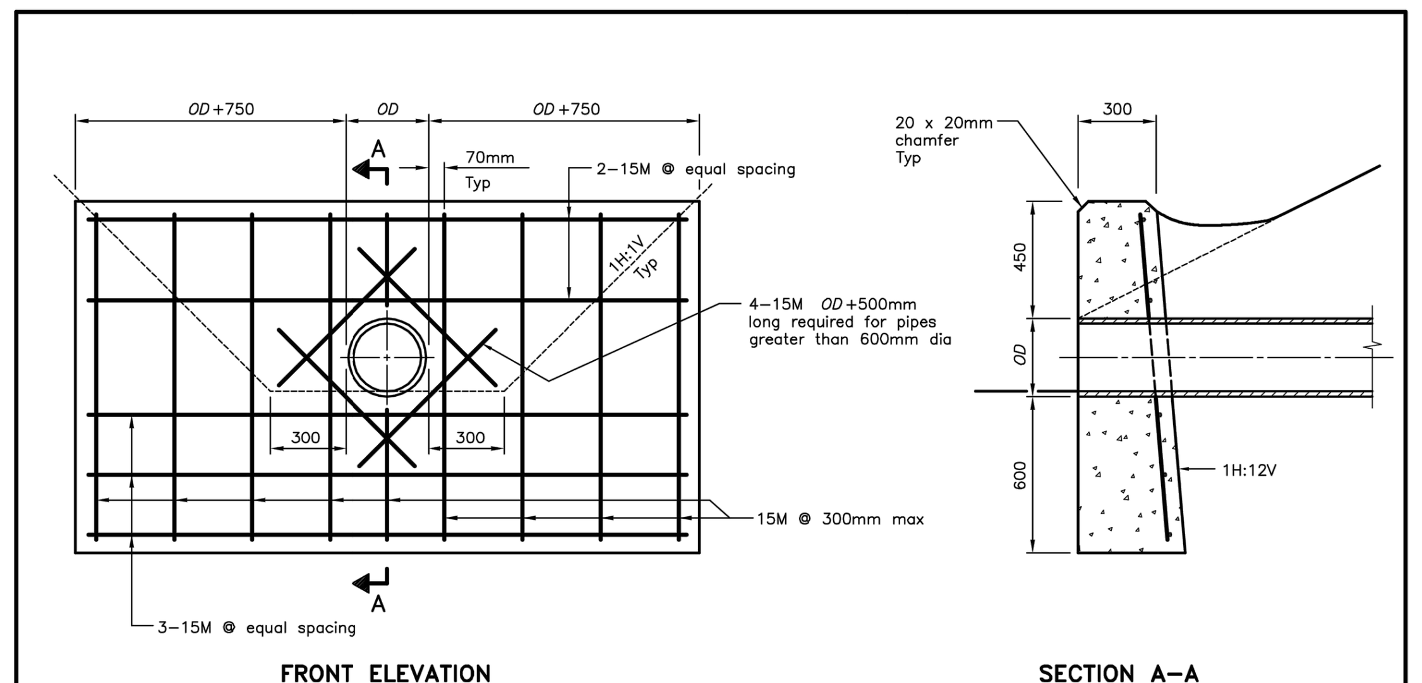
CITY OF BARRIE STANDARD

GENERAL NOTES SANITARY SEWERS

NO.	REVISION	APR'D	DATE
2.	OPSD NUMBERS REVISED	K.C.	2000.08.17
1.	CHANGES TO B. TO G.	K.C.	95.04.24

APR'D: R.G.N. DATE: 92.05.15 DRAWN: L.A.J. SCALE: N.T.S.

BSD-N4



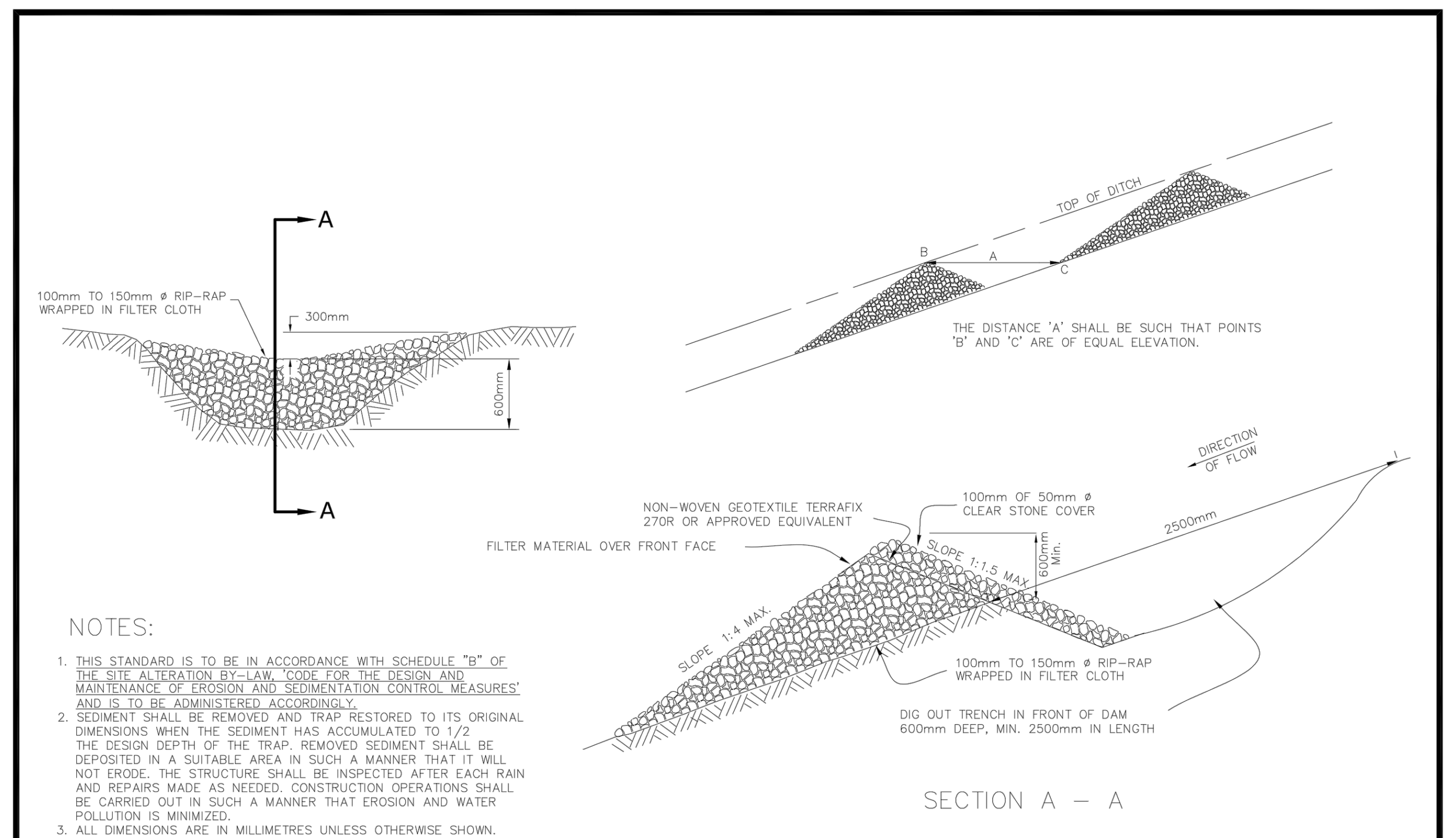
LEGEND:
OD – Outside diameter of pipe

NOTES:
A This OPSD to be read in conjunction with OPSD 3940.150.
B If a steel grate is required, refer to OPSD 804.05.
C Class of concrete: 30MPa.
D Cover to reinforcing bars 70mm ± 20mm.
E All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING — Nov 2017 — Rev 2

CONCRETE HEADWALL FOR PIPE LESS THAN 900mm DIAMETER

OPSD 804.030



CITY OF BARRIE STANDARD

TYPICAL GRANULAR EROSION CONTROL DEVICE

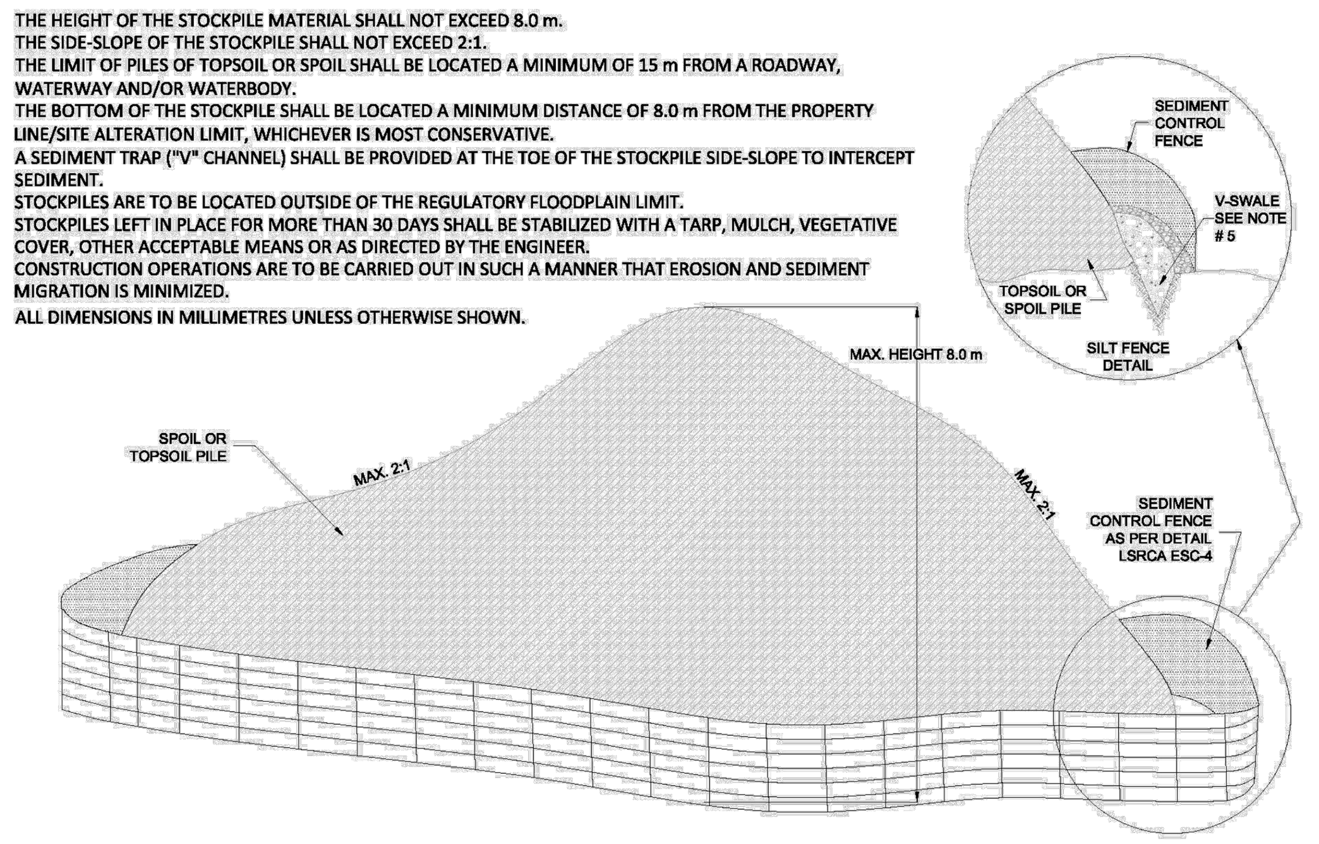
NO.	REVISION	APR'D	DATE
2	MODIFICATIONS BY ENV. SER.		2004.04.06
1	TRENCH ADDED AND FABRIC EXTENDED INTO IT	B.R.	2003.02.19

APR'D: R.G.N. DATE: 04.03.16 DRAWN: L.A.J. SCALE: N.T.S.

BSD-23B

NOTES:

4. THE HEIGHT OF THE STOCKPILE MATERIAL SHALL NOT EXCEED 8.0 m.
5. THE SIDE-SLOPE OF THE STOCKPILE SHALL NOT EXCEED 2:1.
6. THE LIMIT OF PILES OF TOPSOIL OR SPOIL SHALL BE LOCATED A MINIMUM OF 15 m FROM A ROADWAY, WATERWAY AND/OR WATERBODY.
7. THE BOTTOM OF THE STOCKPILE SHALL BE LOCATED A MINIMUM DISTANCE OF 8.0 m FROM THE PROPERTY LINE/SITE ALTERATION LIMIT, WHICHEVER IS MOST CONSERVATIVE.
5. A SEDIMENT TRAP ("V" CHANNEL) SHALL BE PROVIDED AT THE TOE OF THE STOCKPILE SIDE-SLOPE TO INTERCEPT SEDIMENT.
6. STOCKPILES ARE TO BE LOCATED OUTSIDE OF THE REGULATORY FLOODPLAIN LIMIT.
4. STOCKPILES LEFT IN PLACE FOR MORE THAN 30 DAYS SHALL BE STABILIZED WITH A TARP, MULCH, VEGETATIVE COVER, OTHER ACCEPTABLE MEANS OR AS DIRECTED BY THE ENGINEER.
5. CONSTRUCTION OPERATIONS ARE TO BE CARRIED OUT IN SUCH A MANNER THAT EROSION AND SEDIMENT MIGRATION IS MINIMIZED.
6. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.



NO.	REVISION	DATE
1	SWM GUIDELINES UPDATE	06.2016

STOCKPILE SILTATION CONTROL

DATE: 06.2016 SCALE: NTS

LSRCA ESC-6

G11

GENERAL NOTES – STORM SEWER

STORM SEWER

A. STORM SEWER TO BE PROVIDED ON ALL ROADS WITH CURB AND GUTTER.

B. PLACE ALL CATCH BASIN LATERALS AT 2% GRADE UNLESS OTHERWISE NOTED. PIPE SIZE MINIMUM 250mm DIA. SINGLE , 300mm DIA. DOUBLE.

C. STORM SEWERS SHALL BE CONSTRUCTED WITH BEDDING AS PER OPSD–802.010 (GRAN. 'A' EMBEDMENT MATERIAL) FOR 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.

D. MAINTENANCE HOLE TOPS (FRAMES) AND CATCH BASIN (FRAMES) ARE TO BE SET TO BASE COURSE ASPHALT GRADE AND THEN ADJUSTED TO FINAL GRADE WHEN THE TOP LIFT OF ASPHALT IS PLACED. ALL ADJUSTMENT WILL BE ACCORDANCE WITH BSD–N2.

E. STORM SEWER TO BE LOCATED OFFSET 3.0m SOUTH OR EAST OF CENTRELINE UNLESS OTHERWISE SPECIFIED.

F. ALL CONNECTIONS TO THE STORM MAIN SHALL BE MADE WITH A STORM MANHOLE OR APPROVED FACTORY TEE CONNECTION AS PER OPSD–708.01 OR 708.03.

G. PIPE MATERIAL TO BE REINFORCED CONCRETE WITH A MINIMUM STRENGTH OF 50 N/m/mm CERTIFIED TO C.S.A. STANDARD A247.2–1982, CLASS 50–D (PREVIOUSLY C.S.A. STANDARD A257.2–1974, CLASS II) OR PVC CERTIFIED TO C.S.A. STANDARDS 182.2 AND 182.4.

H. STORM SEWER TO BE MINIMUM 300mm DIAMETER WITH JOINTS CONFORMING TO C.S.A. STANDARD A257.3.

I. 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.

J. ALL PIPE HANDLING INSTALLATIONS MUST BE IN STRICT COMPLIANCE WITH MANUFACTURES INSTALLATION GUIDES AND THE O.C.P.A. OR UNIBELL GUIDELINES.

K. SUMP PUMP DISCHARGE PIPING IN BOULEVARD:
IN THE EVENT OF OVERACTIVE SUMP PUMP ACTIVITY, A 150mm DIAMETER PVC DR–28 SEWER MAY BE INSTALLED, WHEN SO DIRECTED BY THE DIRECTOR OF ENGINEERING, ALONG THE FRONTAGES OF DESIGNATED LOTS, WITH AN OFFSET OF 0.6m FROM BACK OF CURB. THIS SEWER IS TO BE CAPPED AT THE UPSTREAM END AND IS TO OUTLET INTO THE NEAREST CATCHBASIN DOWNSTREAM. DEPTH OF SEWER IS TO BE EQUAL TO SUBDRAIN DEPTH. NOT TO BE DIRECTLY CONNECTED TO FOUNDATION DRAINS.

CITY OF BARRIE STANDARD

GENERAL NOTES STORM SEWERS

NO.	REVISION	APR'D	DATE
4.	NOTE 'K' – SUMP PUMP DISCHARGE PIPING	B.R.	2003.01.07
3.	NOTE 'I' & 'C' – "DIRECTOR OF ENGINEERING"	B.R.	2002.10.28
2.	NOTE 'C' OPSD NUMBER REVISION	K.C.	2000.03.16
1.	NOTE 'D' CHANGED	K.C.	98.03.30

APR'D: R.G.N. DATE: 92.05.15 DRAWN: L.A.J. SCALE: N.T.S.

BSD-N5

Notes
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.

No	Issue / Revision	Date	Auth
1	FUNCTIONAL SERVICING REPORT	20/01/22	CC

LICENSED PROFESSIONAL ENGINEER C. CAPES 100056104 JAN 22 2020 PROVINCE OF ONTARIO

Client
KINGSLEA DEVELOPMENTS
16-107 WOODBINE DOWNS
TORONTO, ON
M9W 6Y1

CAPES ENGINEERING
355310 BLUE MOUNTAINS - EUPHRASIA TOWNLINE
CLARKSBURG, ON N0H 1J0
TEL: 705-994-4818

380 LOCKHART ROAD SITE PLAN

STANDARD DETAILS

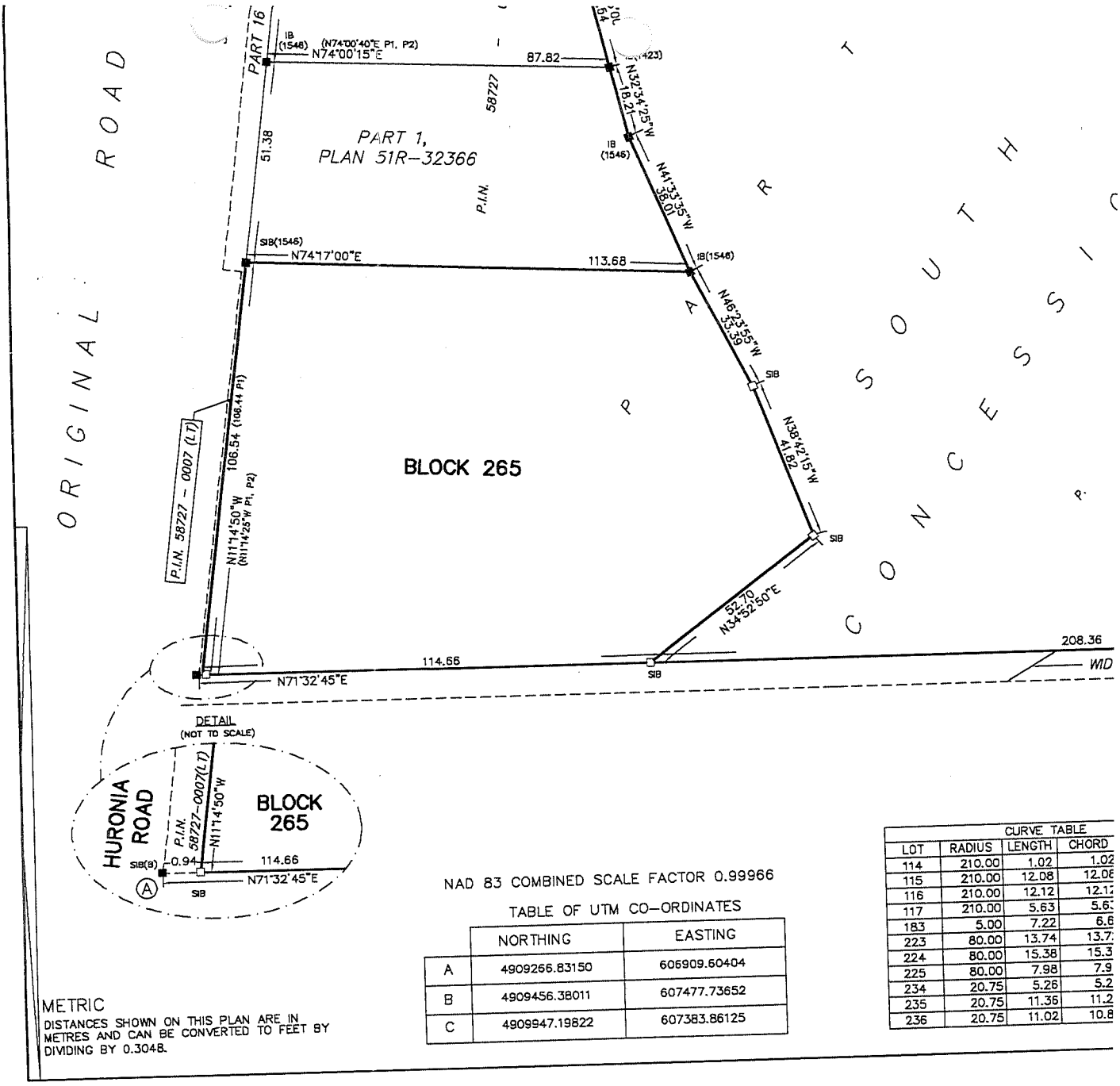
Designed	Checked	Date	Drawing No.
K. GRIFFIN	C. CAPES	20/01/13	C9
Project No. 2019-039		Rev No. 1	
Scale AS NOTED			

File: c:\Users\kevin\Desktop\capes engineering\Projects\2019-039 lockhart road\Drawings\03_ProductionDwg\2019-039 DETAILS.dwg Date Plotted: January 23, 2020 - 11:20 AM

Appendices

Appendix A – Legal & Site Plan

CAPES Engineering Ltd.
355310 Blue Mountains-Euphrasia Townline
Clarksburg, ON
N0H 1J0



NAD 83 COMBINED SCALE FACTOR 0.99966

TABLE OF UTM CO-ORDINATES

	NORTHING	EASTING
A	4909256.83150	606909.60404
B	4909456.38011	607477.73652
C	4909947.19822	607383.86125

CURVE TABLE

LOT	RADIUS	LENGTH	CHORD
114	210.00	1.02	1.02
115	210.00	12.08	12.08
116	210.00	12.12	12.12
117	210.00	5.63	5.63
183	5.00	7.22	6.6
223	80.00	13.74	13.7
224	80.00	15.38	15.3
225	80.00	7.98	7.9
234	20.75	5.26	5.2
235	20.75	11.36	11.2
236	20.75	11.02	10.8

METRIC

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

Block ~~226~~ 265

Plan 51M-822

CORNER OF HURONIA & LOCKHART

6 / A001 **KEY PLAN**
SCALE - N.T.S.

ABBREVIATION LEGEND

EX	EXISTING ELEMENT ON SITE
U	UNIVERSAL WASHROOM
S	SPRINKLER ROOM
E	ELECTRICAL ROOM
C/L	CENTERLINE
BOL	BOLLARD
CR	BARRIER-FREE CURB RAMP
BFS	BARRIER-FREE SIGN
FH	FIRE HYDRANT
SC	SIAMESE FIRE CONNECTION
MH	MANHOLE
CB	CATCH BASIN
NFHB	NON-FREEZE HOSEBIB
LP	LIGHT POLE

HATCHING/TONE LEGEND

- LANDSCAPING
- SNOW STORAGE AREA
- PROPOSED BUILDING
- PAINTED ASPHALT STRIPING
- PAINTED CROSSWALKS
- REINFORCED CONCRETE LOADING SLAB

5 / A001 **SITE PLAN LEGEND**
SCALE - N/A

ZONING MATRIX

1.0	**ZONING DESIGNATION:**		
1.1	ZONING DESIGNATION:	"LI" (LIGHT INDUSTRIAL)	OFFICE-WAREHOUSE USES PROPOSED
2.0	**LOT AREA & COVERAGE:**		
2.1	LOT AREA (min):	700sm	13,810.32sm PROPOSED
2.2	LOT COVERAGE (min):	60%	32.87% PROPOSED
2.3	BUILDING HEIGHT (max):	14m	9,2m PROPOSED
3.0	**SETBACKS & BUFFERS:**		
3.1	LOT FRONTAGE (min):	15m	106,54m PROPOSED
3.2	FRONT YARD (min):	7m	22,58m TO 23,80m PROPOSED
3.3	SIDE YARD (min):	3m	8,00m PROPOSED
3.4	SIDE YARD ADJOINING A STREET (min):	7m	7,34m TO 8,03m PROPOSED
3.5	REAR YARD (min):	7m	27,26m TO 67,98m PROPOSED
3.6	LANDSCAPE BUFFER ADJOINING AN ARTERIAL ROAD (min):	6m	6m PROPOSED ALONG HURONIA ROAD & ALONG LOCKHART ROAD

3 / A001 **ZONING MATRIX**
SCALE - N/A

PARKING STATISTICS

1.0	**PARKING (OFFICE AREA):**	
1.1	PARKING RATE:	1/30sm
1.2	OFFICE G.F.A.:	371.61sm
1.2	REQUIRED:	13 spaces
2.0	**PARKING (WAREHOUSE AREA):**	
2.1	PARKING RATE:	1/1000sm
2.2	WAREHOUSE G.F.A.:	4,126.05sm
2.3	REQUIRED:	5 spaces
3.0	**TOTAL PARKING:**	
3.1	REQUIRED:	18 spaces
3.2	PROVIDED:	72 spaces
3.3	SURPLUS:	54 spaces
4.0	**BARRIER-FREE PARKING:**	
4.1	REQUIRED:	1 TYPE-A & 1 TYPE-B
4.2	PROVIDED:	1 TYPE-A & 1 TYPE-B
5.0	**LOADING SPACES:**	
5.1	REQUIRED:	1 spaces
5.2	PROVIDED:	8 loading docks & 4 at-grade loading spaces

SITE & BUILDING STATISTICS

1.0	**SITE AREA:**	
1.1	SITE AREA:	13,810.32sm
2.0	**BUILDING AREA:**	
2.1	TOTAL OFFICE AREA:	371.61sm
2.2	TOTAL WAREHOUSE AREA:	4,126.05sm
2.3	TOTAL COMMON ROOM AREA:	41.54sm
2.4	TOTAL BUILDING AREA:	4,539.20sm

2 / A001 **SITE STATISTICS**
SCALE - N/A

SITE PLAN DRAWING NOTES

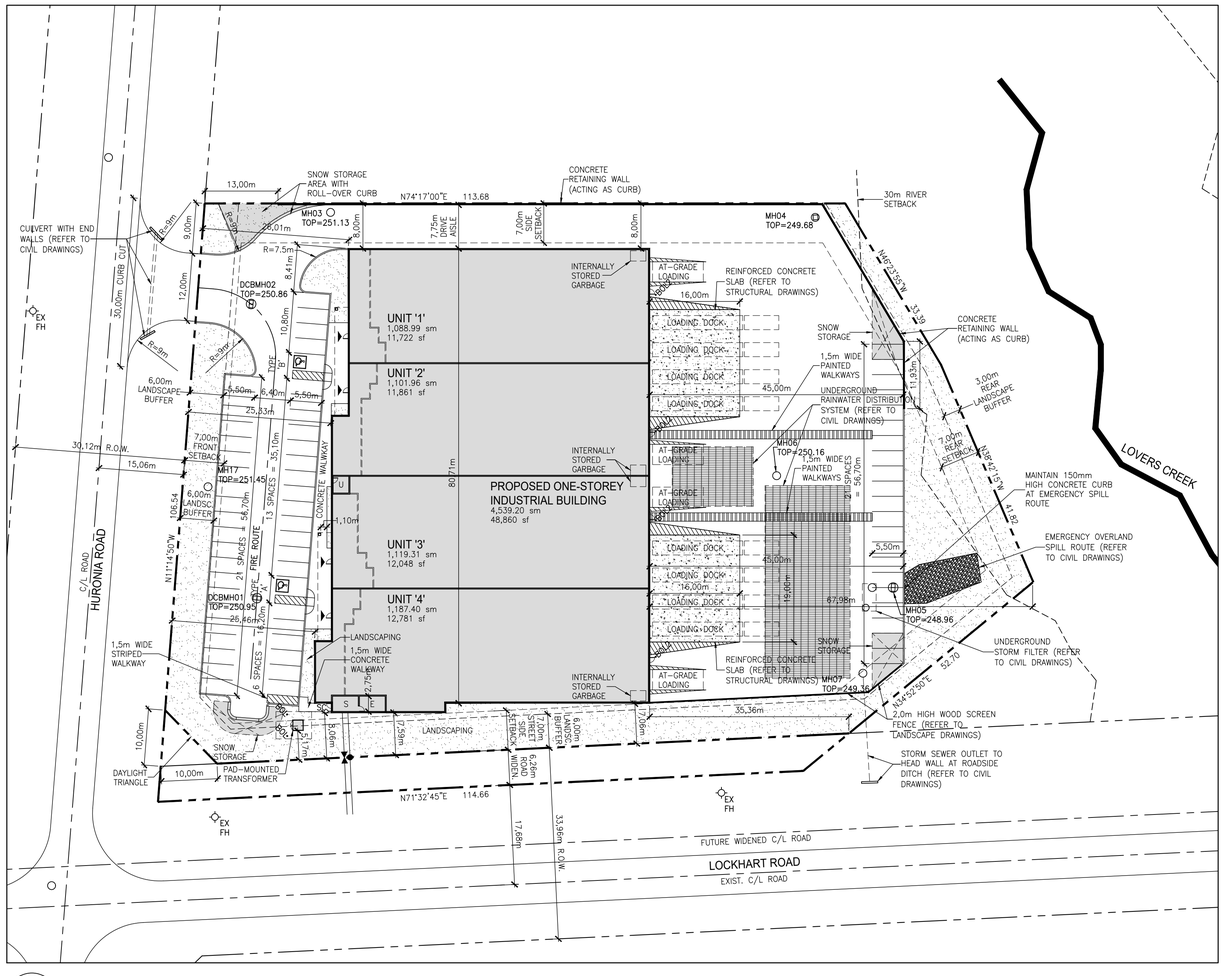
1.0 SITE PLAN INFORMATION:

1.1 EXISTING SITE & PROPERTY BOUNDARY INFORMATION WAS PROVIDED BY THE OWNER/APPLICANT.
1.2 SITE SERVICES, SITE GRADING, LANDSCAPING, LIGHTING & SITE ELECTRICAL WORK ARE SHOWN FOR COORDINATION PURPOSES ONLY.
1.3 REFER TO DRAWINGS PREPARED BY CAPES ENGINEERING FOR SITE SERVICES AND GRADING WORK.
1.4 REFER TO DRAWINGS PREPARED BY POPOVICH ASSOCIATES FOR LANDSCAPE WORK.
1.5 REFER TO DRAWINGS PREPARED BY TRISTAR ENGINEERING FOR SITE LIGHTING & SITE ELECTRICAL WORK.

2.0 SITE PLAN NOTES:

2.1 ALL BUILDING DIMENSIONS ARE TO FLAT FACE OF CLADDING, UNLESS NOTED OTHERWISE.
2.2 CURVED PORTIONS OF CONCRETE CURBS SHALL HAVE A RADIUS OF R=1,2m UNLESS NOTED OTHERWISE.
2.3 FIRE ROUTES, TRUCK ROUTES, LOADING DOCKS & AT-GRADE LOADING AREAS SHALL BE SURFACED WITH HEAVY-DUTY ASPHALT, UNLESS NOTED OTHERWISE.
2.4 GARBAGE SHALL BE STORED INTERNALLY & PICK-UP IN EACH (FUTURE) TENANT'S LOADING SPACE.

4 / A001 **SITE NOTES & STATISTICS**
SCALE - N/A



1 / A001 **SITE PLAN**
SCALE - 1:500

bnkc ARCHITECTURE + URBAN DESIGN
410 - 672 Dupont St.,
Toronto, ON, Canada.
M6G 1Z6
T. 416.531.7717
www.bncarchitects.ca

REV. NO:	DATE:	ISSUED FOR:
01	06 SEP 2019	PRELIMINARY PROJECT REVIEW
02	03 JAN 2020	ISSUED FOR SITE PLAN APPLICATION
03	--	--

ARCHITECT
bnkc Architecture + Urban Design
410 - 672 Dupont St., Toronto, ON, Canada, M6G 1Z6
T. 416.531.7717

GRADING & SITE SERVICES
Capes Engineering
355310 Blue Mountains-Euphrasia Townline, Clarksburg, Ontario, N0H 1J0
T. 705.994.4818

LANDSCAPE
Popovich Associates
1 Robert Speck Parkway, Suite 100, Mississauga, Ontario, L4Z 3M3
T. 905.270.2229

SITE ELECTRICAL
TriStar Engineering
8901 Woodbine Avenue, Suite 116, Markham, Ontario
T. 905-604-3801

CLIENT
KINGSLEA DEVELOPMENTS LTD.
107 Woodbine Downs Blvd., Unit 16
Etobicoke, Ontario
T. 416.213.0120

777 HURONIA ROAD INDUSTRIAL

777 Huronia Road, Barrie, Ontario

PLAN NORTH

SITE PLAN, NOTES & STATISTICS

DMC	DMC		
DRAWN BY	CHECKED BY		
19051	**AS NOTED**	**ARCH D**	**03 JAN 2020**
PROJ NO	SCALE	FORMAT	PLOT DATE

A001

Appendix B – Background Information

SOUTH LIMIT OF WORK SEE DWG 7

LOCKHART ROAD

STYROFOAM INSULATION

STONE SEDIMENT TRAP (SEE DWG. 1)

EX. INV. 245.971

EX. 1400ø CULVERT

EX. INV. 245.839

INV. 247.90

INV. 248.50

STA. 0+220 300 X 150 HYD. ANCHOR TEE & 150 GATE VALVE & HYD. TOP OF FLANGE = 250.430

STA. 0+100 300 X 150 HYD. ANCHOR TEE & 150 GATE VALVE & HYD. TOP OF FLANGE = 250.460 C/W 8.5m -450ø CSP. @ 1.0%

STA. 0+145 300 X 150 HYD. ANCHOR TEE & 150 GATE VALVE & HYD. TOP OF FLANGE = 250.010 C/W 8.5m -450ø CSP. @ 2.0%

SEE DWG. E6

BLOCK 94 (WIDENING)

35

34

33

EASEMENT ACCESS(SEE DETAIL ON DWG.STD.8) 10.0m – 450ø CSP. @ 1.0%

PLUG INV 246.925

PLUG INV 246.69

EXISTING FENCE TO BE REMOVED.

5.5m (TYP)

130.170

35.000

39.988

3.0 3.0 3.0

3.0 11.0

STA. 0+220

249.60 0.50% 249.24 249.15 0.50% 248.98 248.88 1.3% 248.46 248.35 1.30%

300 WM

300 CROSS

MH 7A

MH 8A

975 SAN

2.0% 249.60 0.6% 248.75 2.0% 248.45

GUIDE RAIL (SEE DWG 5)

FUTURE WIDENING

INV. 245.816

INV. 245.711

INV. 245.357

EXISTING FENCE TO REMAIN IF REMOVED FOR CONSTRUCTION FENCE IS TO BE REINSTATED OR REPLACED AFTER COMPLETION OF CONSTRUCTION.

10.6 2.0 8.0 4.5 17.5 17.5 35.00m

SEE DWG 5

HURONIA ROAD

BELL PED 249.01 10.6m

5.5m

100.0m VERTICAL CURVE

VERTICAL CURVE DATA

DESIGN SPEED	= 80 km/hr
G1	= 2.0%
G2	= 0.5%
K	= 39.5
L	= 100

EXIST. GROUND ALONG ℄ ROAD

STA. 0+003 MH TOP (OPSD 401.01) TYPE A

STA. 0+130 MH TOP (OPSD 401.01) TYPE A

250.349 P.V.I. EL. 250.665 STA. 0+045

250.464 HP STA. 0+075.2

NOTES FOR WATERMAINS

1.) PRIOR TO THE INSTALLATION OF WATERMAINS, FILL IS TO BE PLACED TO SUBGRADE LEVEL AND TO BE 300mm EITHER SIDE COMPACTED TO 95% STANDARD PROCTOR DENSITY IN 300mm LIFTS.
2.) WATERMAIN JOINTS ARE TO BE RESTRAINED WITH UNDERGROUND BELL CLAMP AND FACTORY WELDED RING BY CANADA VALVE OR EQUAL.
3.) ALL DISTURBED AREAS ARE TO BE REINSTATED TO ORIGINAL CONDITION.
4.) EXISTING H.P.'s, SEWERS & UTILITIES ARE TO BE SUPPORTED AND PROTECTED.
5.) FOR HYDRANT ACCESS PLATFORM DETAIL SEE DWG. STD.4

NOTES:

1. SAN CONNECTIONS TO BE 200mm DIA. AT 2.0% CONC. CL.3,RISER TO HAVE 150mm THICK 15Mpa CONC. ENCASEMENT. PIPE IS TO EXTEND 2m BEYOND STREET LIMIT WITH 50x100mm WOOD STAKE PAINTED GREEN AND EXTENDING MIN. 900mm ABOVE PROP GROUND.
2. ALL EXISTING UTILITIES ARE TO BE PROTECTED OR RELOCATED WHERE REQUIRED.

3. PROVISIONAL ITEM

UPON INSTRUCTION BY CITY ENGINEER, CONTRACTOR IS TO INSTALL 10-200mm SANITARY CONNECTIONS ALONG EAST SIDE OF HURONIA ROAD WITH CONNECTION LOCATION AS DIRECTED BY CITY ENGINEER.

CONNECTIONS ARE TO BE AS PER NOTE 1, INVERT AT STREET LIMIT 4.0m BELOW ROAD CENTRE LINE ELEVATION.

N

SAUNDERS ROAD

HURONIA ROAD

LOCKHART ROAD

KEY PLAN

2.5:1 to DITCH INVERT ℄ ROAD TOPSOIL & SODDED

℄ DITCH

R.O.W.

17.5m

4.0m 2.0m SHLD. 2.5:1 MAX. TO MATCH GRADE AT ℄ ROAD

2.0m SODDED 5.5m SEEDED

2.0% 6.0% 2.3m 2.5 300 2.5:1 SLOPE

3.0% SUBGRADE

HYDRANT LEAD INSULATION

10.6m

HL3 40mm(FUTURE)
HL4 80mm
GRAN 'A' 150mm
GRAN 'B' 450mm (TYPE II)

ROAD CROSS SECTION
35.0m R.O.W.– HURONIA ROAD ONLY

N.T.S.

252 251 250 249 248 247 246 245 244 243 242 241 240

EX. 1.0% ± 249.05 ± 30.0m – 2.0% 249.250 249.650 249.748 249.840 250.005 250.145 250.260 250.290 250.190 250.090 249.990 249.890 249.790 125.0m – 0.50%

PROP EAST DITCH

PROP WEST DITCH

3:1 SLOPE

INV. 248.50

STYROFOAM INSULATION

INV. 247.90

REGRADE TO MEET EXIST DITCH

20.0m–800ø CSP. @ 3.0% 2mm THICK

EX. 9.0m 1400ø CULVERT

300 WM DI CL.52 WITH RESTRAINED JOINT(SEE DETAIL ON DWG.STD.5)

PROP. EAST DITCH

PROP. WEST DITCH

EXISTING WEST DITCH GRADE

EXISTING EAST DITCH GRADE

SAFETY PLATFORM (OPSD 404.02) EL. 245.00

SAFETY PLATFORMS (OPSD 404.02) EL.246.80 EL.243.40

20 m VERT. PIPE DEFLECTION

200 SAN CONNECTION RISER (TYP)

127.0m – 975 SAN – 0.17% CONC. CL. 140–D O.P.S.D. 1006.01 CLASS A BEDDING

SAN MH 8A (POURED SEE DWG.DET–1) 975 S 239.970 975 N 239.938

140.0m – 975 SAN –0.17% CONC. CL 140–D OPSD 1006.01 CLASS A BEDDING

300 (TYP)

SAN MH 7A (POURED SEE DWG. DET–1) 450 W 246.000 375 W (DROP PIPE) 240.786 975 N 240.186

251.47 251.83 251.75 251.50 251.14 250.77 250.40 250.00 249.62 249.35

0+000 ℄ LOCKHART ROAD

0+100

0+200

0+220

BARRIE PUC DWG. N°: 002,950

GENERAL NOTES

1. ALL SEWERS TO HAVE CLASS 'B' BEDDING (EXCEPT AS NOTED) TO OPSD STD. 802.01,802.02, OR 1005.01.
2. ALL CONC. SEWER PIPE TO HAVE RUBBER GASKET JOINTS.
3. ALL SEWER AND WATERMAIN CROSSINGS SHALL BE SUPPORTED BY CONCRETE ENCASEMENT OR GRANULAR MATERIAL AS APPROVED BY CITY ENGINEER.
4. ALL SANITARY MANHOLES TO BE OPSD STD. 1001.01 UNLESS OTHERWISE NOTED.
5. ALLWORKMANSHIP AND MATERIALS TO BE TO THE SATISFACTION OF THE CITY ENGINEER AND IN ACCORDANCE WITH CURRENT CITY AND OPSD STANDARDS.
6. ALL EXISTING SERVICES TO BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION.
7. ANY RELOCATION OF EXISTING SERVICES SHALL BE DONE BY THE UTILITY CONCERNED.

ROADS

1. ROAD BASE THICKNESS INDUSTRIAL ROADS– 450 GRANULAR 'B' 150 GRANULAR 'A' 80 HL 4 ASPHALT FUTURE 40 HL 3 ASPHALT

WATERMAINS

1. ALL PIPE SHALL BE DUCTILE IRON PRESSURE PIPE CLASS 52 WITH TYTON JOINTS AS MANUFACTURED TO A.W.W.A. SPECIFICATION C 151 CL. 52 (CEMENT LINED).
2. FITTINGS SHALL BE MECHANICAL JOINT ONLY AND SHALL CONFORM TO A.W.W.A. SPECIFICATION C–110.

BENCH MARK
293.871–S.C.M. ON SOUTH SIDE MAPLEVIEW DRIVE EAST , 100m WESTERLY OF BAYVIEW DRIVE.

BARRIE PUC APPROVED FOR WATER ONLY
DATE .....
.....

NO.	REVISION	DATE	APPROVED

CITY OF BARRIE APPROVED
DATE 96-09-22
CITY ENGINEER

REGISTERED PROFESSIONAL ENGINEER C.F. CHU PROVINCE OF ONTARIO
96-02-16

R.E.Winter & Associates Ltd.
Consulting Engineers, Architect, Planners and Landscape Architects
4255 Sherwoodtowne Blvd., Mississauga, Ont. L4Z 1Y5 TEL. (416) 276 0110

SOUTH BARRIE BUSINESS PARK PHASE 6B

HURONIA ROAD
300mm D.I. Wm
STA. 0+000 TO STA. 0+220

CITY OF BARRIE INCORPORATED 1853
CITY of BARRIE
ENGINEERING DEPARTMENT
REWAL 8552

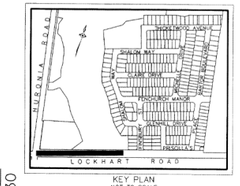
DESIGN C.F.C.	SCALES 1:500 HOR , 1:50 VER	DWG. NO. 4
DRAWN AL.B.	CHECKED C.F.C.	
DATE MAY 89	SHEET No. 1 of 3	

002-950

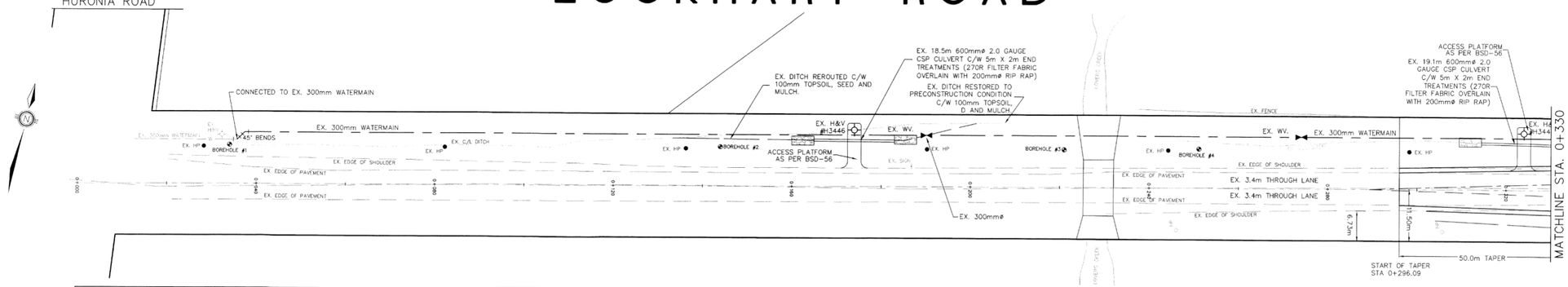
1989-525-006

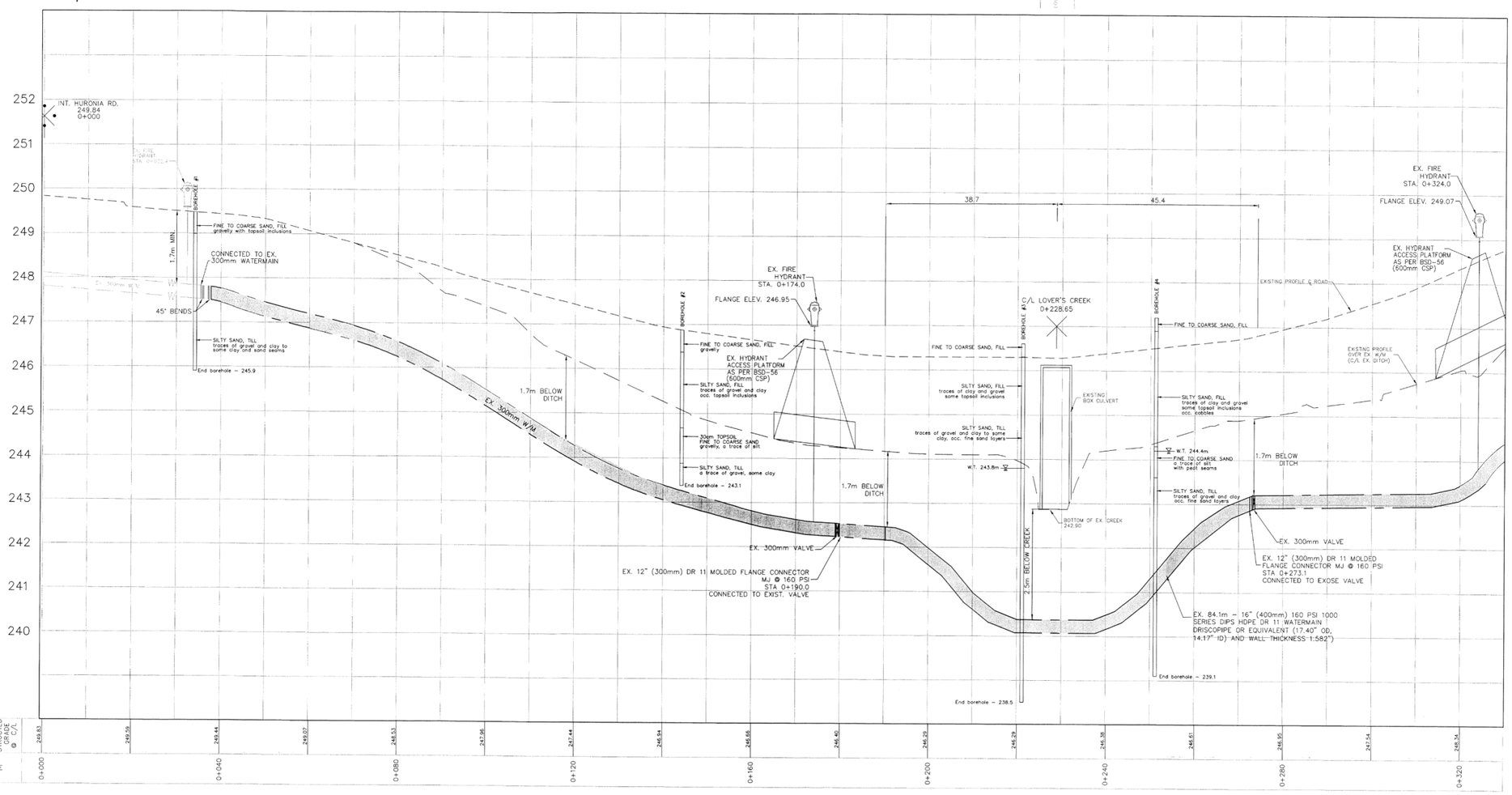
LOCKHART ROAD

HURONIA ROAD



KEY PLAN
NOT TO SCALE





GENERAL NOTES

REFER TO CURRENT CITY OF BARRIE STANDARDS AND DWG. 0441-GN FOR APPLICABLE GENERAL NOTES.

IN EVENT OF DISCREPANCY DWG. 0441-GN APPLIES.

BENCH MARKS

DISTANCE NOTE
DISTANCES SHOWN HEREON ARE GROUND DISTANCES AND CAN BE CONVERTED TO GRID DISTANCES BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.9996684

BEARING NOTE
BEARINGS HEREIN ARE GRID BEARINGS AND ARE DERIVED FROM CONTROL MONUMENTS 010860433 (N=4909431.455, E=607442.202), 031910017 (N=4909253.265, E=606886.130, AND 031910018 (N=4909581.127, E=606836.269) AND ARE REFERRED TO THE CENTRAL MERIDIAN (81 DEGREES OF LONGITUDE) IN ZONE, 17 AND ARE BASED ON NAD83.

BENCH MARK V010865453
245.946 -CONCRETE BRIDGE CARRYING LOCKHART ROAD OVER LOVERS CREEK, 0.25km EAST OF HURONIA ROAD. TABLET IS SET HORIZONTALLY IN THE WEST FACE OF COPING AT THE WEST END OF THE BRIDGE, 6.95m SOUTH OF CENTERLINE OF ROAD, 18cm BELOW TOP OF COPING.

BENCH MARKS WILL BE FROM CITY OF BARRIE VERTICAL CONTROL NETWORK. INITIAL BENCH MARK TO BE OF 2nd ORDER ACCURACY

NO.	REVISIONS	DATE	APPROVED
1.	"AS-CONSTRUCTED"	FEB. 02/10	B.R.

CITY OF BARRIE
APPROVED
DATE SIGNED: APR. 25/05
DIRECTOR OF ENGINEERING

PRATT DEVELOPMENT SUBDIVISION

LOCKHART ROAD
STA. 0+000 TO 0+330

DS No. D12-223

CITY of BARRIE
ENGINEERING DEPARTMENT

SCALE HOR.	1:500	VERT.	1:50
DESIGN	GM	DRAWN	GM
REVIEWED	BR	DATE	2004.08.27

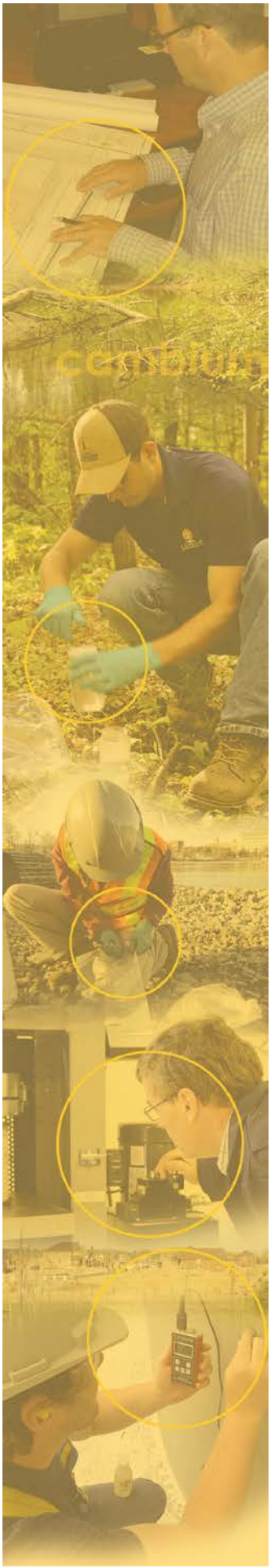
SHEET NO. 26
DRAWING NO. 0441-P11

RICHARDSON FOSTER
CONSULTING ENGINEERS
A Trow Global Company
4 CEDAR POINTE DRIVE, UNIT 1
BARRIE, ONTARIO
L4N 5R7
PHONE: (705) 728-0009 TOLL FREE (1-877) 220-2461 FAX: (705) 727-7774

LICENSED PROFESSIONAL ENGINEER
B.T. RICHARDSON
PROVINCE OF ONTARIO

2004-103-024

Appendix C – Geotechnical Reports



Geotechnical Investigation Report 380 Lockhart Road, Barrie, Ontario

Cambium Reference No.: 9121-003

January 22, 2020

Prepared for: Kingslea Developments Ltd.

Cambium Inc.

74 Cedar Pointe Drive, Unit 1009
Barrie, Ontario, L4N 5R7

Telephone: (866) 217.7900
Facsimile: (705) 742.7907

cambium-inc.com

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1.0 INTRODUCTION

Cambium Inc. (Cambium) was retained by Kingslea Developments (Client) to complete a preliminary geotechnical investigation in support of the design and construction of a single storey industrial building and associated parking and driving areas at 380 Lockhart Road in Barrie, Ontario (Site).

The property is irregularly shaped, approximately 1.4 hectares in size and appears to be a historically planted treed lot. Rows of mature trees were noted throughout the property with a clearing near the centre consisting of deadfall and shrubs. The general topography of the site is higher than the adjacent Lockhart Road and Huronia Road with a downstream slope towards Lovers Creek which is situated east of the site boundary. Based on discussions with the Client, it is understood that any proposed development will be outside of the Lake Simcoe Region Conservation Authority (LSRCA) development constraints.

The geotechnical investigation was required to confirm the subsurface conditions at the Site to provide geotechnical design parameters as input into the design and construction of the proposed industrial development and associated infrastructure. A Site Plan, including borehole locations, is included as Figure 1 of this report.

2.0 METHODOLOGY

2.1 BOREHOLE INVESTIGATION

A borehole investigation was completed on November 8th, 2019 to assess subsurface conditions at the Site. Due to the site access constraints, the scope of work had to be modified following approval by the Client. A total of two (2) boreholes were advanced within the property limits, designated as BH101-19 and BH102-19. The boreholes were terminated at a depth of 6.7 m below ground surface (mbgs). Each of the boreholes were equipped with monitoring wells to determine the static groundwater level at the site.

The borehole locations and elevations were surveyed by the Client. The borehole UTMs and elevations are provided on the borehole logs in Appendix A. Borehole locations are shown on Figure 1.

Drilling and sampling was completed using a track-mounted drill rig, under the supervision of a Cambium Geotechnical Analyst. The boreholes were advanced to the pre-determined depths by means of continuous flight hollow stem augers with 50 mm O.D. split spoon samplers. Standard Penetration Test (SPT) N values were recorded for the sampled intervals as the number of blows required to drive a split spoon (SS) sampler 305 mm into the soil using a 63.5 kg drop hammer falling 750 mm, as per ASTM D1586 procedures. Soil samples were collected at 0.75 m intervals from 0 to 3 m and at 1.5 m intervals after 3 m. The encountered soil units were logged in the field using visual and tactile methods, and samples were placed in labelled plastic bags for transport, future reference, laboratory testing, and storage. Open boreholes were checked for groundwater and general stability prior to backfilling.

Borehole logs are provided in Appendix A. Site soil and groundwater conditions are described and geotechnical recommendations are discussed in the following sections of this report.

2.2 PHYSICAL LABORATORY TESTING

Physical laboratory testing, including three (3) sieve and hydrometer analyses (LS-702, 705), was completed on selected soil samples to confirm textural classification and to assess geotechnical parameters. Natural moisture content testing (LS-701) was completed on all retrieved soil samples. Results are presented in Appendix B and are discussed in Section 3.0.

2.3 SOIL CHEMICAL TESTING

Samples of soil were collected from boreholes BH101-19 and BH102-19 to be assessed for potential contamination from historical pesticide and land uses. Samples were sent to Caduceon Laboratories in Barrie, ON for analysis of select parameters including: Petroleum Hydrocarbons (PHCs), Volatile Organic Compounds (VOCs), Metals and Inorganics, and Organochlorine (OC) Pesticides. The results of the soil testing are presented in Appendix D and discussed in Section 4.11.

3.0 SUBSURFACE CONDITIONS

The subsurface conditions at the site consist of topsoil overlying sand and silty clay to clayey silt deposits. These soils were encountered throughout the boreholes to the termination depths of 6.7 mbgs. Per available mapping from the Ontario Geological Survey (OGS) the primary on site soils consist of glaciofluvial ice contact deposits, predominantly gravel and sand and minor till. (OGS, Accessed 2019)

The borehole locations are shown on Figure 1 and the individual soil units are described in detail below with the borehole logs provided in Appendix A.

3.1 TOPSOIL AND ORGANICS

A layer of dark brown to black sandy topsoil was encountered at the surface of each of the borehole locations. The topsoil was approximately 150 mm in thickness where encountered.

The topsoil was generally loose in relative density and moist at the time of the investigation. Analysis of the organic or nutrient content of the topsoil was not part of the scope of work for this investigation. Delineation of topsoil thickness would require shallow test pits spaced in a grid pattern.

3.2 NATIVE SOILS

Beneath the topsoil discussed above, the native soils predominately consisted of sand overlying silty clay to clayey silt soils in each of the borehole locations.

3.2.1 SAND

Native sand soils were encountered beneath surficial topsoil in each of the boreholes advanced at the site and extended to depths of 2.4 mbgs to 3.7 mbgs. The sand was brown in colour and contained traces of silt and gravel. The sand was generally moist at the time of the investigation with natural moisture content varying from 3% to 12% based on laboratory testing. The SPT N values in the sand soils ranged from 4 to 11 blows, indicating a loose to compact relative density.

A laboratory particle size distribution analysis was completed for one (1) sample of the sand soils, taken from the borehole and depth provided in Table 1 in order to identify the varying textures encountered throughout the overburden material. The testing results are provided in Appendix B and are summarized in Table 1 based on the Unified Soil Classification System (USCS).

Table 1 Particle Size Distribution – Sand Soils

Borehole ID	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay
BH101-19	1.5 - 2.0	Sand some Silt trace Clay	0	83	15	2

3.2.2 SILTY CLAY AND CLAYEY SILT

Silty clay and clayey silt soils were encountered in each of the boreholes beneath sand deposits, extending to the borehole termination depths of 6.7 mbgs. The silty clay and clayey silt soils were generally brown in colour and contained varying amounts of sand and gravel. The silty clay and clayey silt soils had a firm to very stiff consistency based on SPT N values between 4 and 19 blows. The natural moisture content of the silty clay and clayey silt soils was between 9% and 28% based on laboratory testing.

Laboratory particle size distribution analyses were completed for two (2) samples of the silty clay and clayey silt soils, taken from the boreholes and depths provided in Table 2 in order to identify the varying textures encountered throughout the overburden material. The testing results are provided in Appendix B and are summarized in Table 2 based on the USCS.

Table 2 Particle Size Distribution – Silty Clay and Clayey Silt Soils

Borehole ID	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay
BH101-19	3.0 – 3.5	Silty Clay some Sand trace Gravel	1	11	32	56
BH102-19	4.6 – 5.0	Clayey Silt trace Sand	0	10	65	25

3.3 BEDROCK

Bedrock was not encountered within the investigation depths. Each of the boreholes were terminated at a depth of 6.7 mbgs in native soils. The termination depth and elevation of each borehole is summarized in Table 3.

Table 3 Borehole Termination Depth and Elevation

Borehole ID	Borehole Elevation (mASL)	Borehole Termination Depth (mbgs)	Borehole Termination Elevation (mASL)
BH101-19	252.68	6.7	245.98
BH102-19	253.51	6.7	246.81

3.4 GROUNDWATER

The presence of groundwater (free water) and caving (sloughing) was not observed in either of the boreholes advanced at the Site on completion of drilling. The moisture content of the soils generally ranged from 3% to 28%.

A Cambium technician recorded groundwater level measurements from each of the monitoring wells installed at the site on November 15th, 2019; the measurements are summarized in Table 4.

It should be noted that soil moisture and groundwater levels at the Site may fluctuate seasonally and in response to climatic events.

Table 4 Monitoring Well Groundwater Measurements

Date	Monitoring Well ID	Borehole Elevation (mASL)	Top of Standpipe (TOS) Elevation (mASL)	Groundwater Depth (mbTOS)	Groundwater Elevation (mASL)
November 15th, 2019	BH101-19	252.68	253.74	6.69	247.57
	BH102-19	253.51	254.56	6.17	247.87

4.0 GEOTECHNICAL CONSIDERATIONS

The following recommendations are based on borehole information and are intended to assist designers. Recommendations should not be construed as providing instructions to contractors, who should form their own opinions about site conditions. It is possible that subsurface conditions beyond the borehole locations may vary from those observed. In addition, due to the soil sampling procedures and the limited size of samples, the depth/elevation demarcations on the borehole logs must be viewed as "transitional" zones, and cannot be construed as exact geologic boundaries between layers. If significant variations are found before or during construction, Cambium should be contacted so that we can reassess our findings.

4.1 SITE PREPARATION

It is understood that significant regrading of the site will likely occur to accommodate the proposed development. The existing topsoil and any organic materials encountered should be excavated and removed from beneath the proposed parking and driving areas, and building footprints; additionally this material should be excavated and removed to a minimum distance of 3 m around the building footprints. Any topsoil and materials with significant quantities of organics are not appropriate for use as fill below buildings or grading and parking areas.

On completion of regrading, the exposed subgrade should be proof-rolled and inspected by a qualified Geotechnical Engineer prior to placement of granular fill or foundations. Any loose/soft soils identified at the time of proof-rolling that are unable to uniformly be compacted should be sub-excavated and removed. The excavations created through the removal of these materials should be backfilled with approved engineered fill consistent with the recommendations provided below.

The near surface sand soils can become unstable if they are wet or saturated. Such conditions are common in the spring and late fall. Under these conditions, temporary use of granular fill, and possible reinforcing geotextiles, may be required to prevent severe rutting on construction access routes.

4.2 FROST PENETRATION

Based on climate data and design charts, the maximum frost penetration depth below the surface at the site is estimated at 1.5 mbgs.

Exterior footings for the proposed structures should be situated at or below this depth for frost penetration or should be appropriately protected.

Any services should be located below the frost penetration depth or be appropriately insulated.

4.3 EXCAVATIONS AND BACKFILL

All excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA). The generally loose to compact sand soils and soft to stiff silty clay soils encountered to approximately 3.5 m depth may be classified as Type 3 soils above the groundwater table in accordance with OHSA. Type 3 soils may be excavated with side slopes no steeper than 1H:1V. Beneath the groundwater table the soils may be classified as Type 4 soils and may be excavated with side slopes no steeper than 3H:1V.

4.4 DEWATERING

Groundwater was measured in each of the two (2) monitoring wells at elevations of 247.57 metres above sea level (mASL) to 247.87 mASL. Based on these observations, groundwater seepage is not anticipated within the proposed excavation depths. If groundwater seepage is encountered it should be manageable with filtered sumps and pumps depending on size of excavation. It is noted that the elevation of the groundwater table will vary due to seasonal conditions and in response to heavy precipitation events. In order to minimize predictable water issues and costs, it is recommended that excavation and in-ground construction be performed in drier seasons. Consideration can be given to measuring the water levels in the wells during seasonally wetter times to identify any change in groundwater levels, as it is noted that groundwater levels fluctuate with seasonal conditions and rainfall events.

4.5 BACKFILL AND COMPACTION

Excavated topsoil from the Site is not appropriate for use as fill below grading and parking areas. Excavated native sand may be appropriate for use as fill below grading and parking areas, provided that the actual or adjusted moisture content at the time of construction is within a range that permits compaction to required densities. Some moisture content adjustments may be required depending upon seasonal conditions. Geotechnical inspections and testing of engineered fill are required to confirm acceptable quality.

Any engineered fill below foundations should be placed in lifts appropriate to the type of compaction equipment used, and be compacted to a minimum of 100% of standard Proctor maximum dry density (SPMDD), as confirmed by nuclear densometer testing. If native soils from the site are not used as engineered fill, imported material for engineered fill should consist of clean, non-organic soils, free of chemical contamination or deleterious material. The moisture content of the engineered fill will need to be close enough to optimum at the time of placement to allow for adequate compaction. Consideration could be given to using a material meeting the specifications of OPSS 1010 Granular B or an approved equivalent. Foundation wall and any buried utility backfill material should consist of free-draining imported granular material.

The backfill material, if any, in the upper 300 mm below the pavement subgrade elevation should be compacted to 100 percent of SPMDD in all areas.

4.6 FOUNDATION DESIGN

We understand that some regrading of the Site will occur prior to construction of the proposed development.

Overall, assuming the site is prepared as outlined above, the native subsoils are competent to support the industrial building on conventional strip and spread footings. Any new exterior footings must be placed a minimum of 1.5 m below final adjacent grade for frost protection.

If the footings are to be found on compact native sand silt or sand and firm to very stiff silty clay, they may be designed for an allowable bearing capacity of 75 kPa at serviceability limit state (SLS) and 110 kPa at ultimate limit state (ULS).

Any required grade raises can be accomplished with engineered fill placed in accordance with the recommendations in Section 4.5. If footings are to be found entirely on engineered fill overlying approved native soils, they may be designed for an allowable bearing capacity of 75 kPa at (SLS) and 110 kPa at ULS. It is noted that in some areas the near surface sand soils are relatively loose, provisions should be made by the Contractor to excavate to the compact or stiff native soils stipulated above. A minimum thickness of 1.2 m of engineered fill is recommended where it is placed on loose soils. If engineered fill is to be constructed above cohesive soils (i.e., soils with significant clay deposits), Cambium would recommend waiting at least six months following completion of fill placement prior to construction of major structures in order to allow initial settlement to occur within the cohesive soils.

If footings are found on differing surfaces (i.e., engineered fill and/or native soils) the footings and foundation walls should be appropriately reinforced as determined by the structural engineer.

The quality of the subgrade should be inspected by Cambium during construction, prior to constructing the footings, to confirm bearing capacity estimates and suitability of any engineered fill. Settlement potential at the above-noted SLS loadings is less than 25 mm and differential settlement should be less than 10 mm.

4.7 LATERAL EARTH PRESSURE

Lateral earth pressure coefficients (K) are shown in Table 5. It is assumed that potential lateral loads will result from cohesionless, frictional materials, such as granular backfill.

Table 5 Lateral Earth Pressure Coefficients

K	Unfactored
Ko (at rest)	0.42
Ka (active)	0.27
Kp (passive)	3.70

The coefficients provided in Table 5 assume that the surface of the granular backfill is horizontal against any proposed retaining wall, and the wall is vertical and smooth. Cambium should be contacted to provide updated

lateral earth pressure coefficients should the assumptions differ to those noted and if the soil slopes at an angle against the retaining wall.

A unit weight of 22 kN/m^3 should be assumed for compacted granular backfill loadings.

4.8 FLOOR SLABS

To create a stable working surface, to distribute loadings, and for drainage purposes, an allowance should be made to provide at least 200 mm of OPSS 1010 Granular A compacted to 98% of SPMDD beneath all floor slabs.

4.9 SUBDRAINAGE

Given the site grading information is unknown, but will likely involve the removal of soil. Geotextile wrapped perforated pipe subdrains set in a trench of clear stone and connected to a sump or other frost-free positive outlet are recommended below floor slabs and around the perimeter of building foundations. This recommendation may be revisited depending on the regrading plans.

4.10 BURIED UTILITIES

Trench excavations above the groundwater table and in the loose to compact sandy silt soils and firm to stiff silty clay or clayey silt soils should generally consider Type 3 which require side slopes no steeper than 1H:1V. Beneath the groundwater table the soils may be classified as Type 4 soils and may be excavated with side slopes no steeper than 3H:1V.

Bedding and cover material for any services should consist of OPSS 1010-3 Granular A or B Type II, placed in accordance with pertinent Ontario Provincial Standard Drawings (OPSD 802.013). The bedding and cover material shall be placed in maximum 200 mm thick lifts and should be compacted to at least 98 percent of SPMDD. The cover material shall be a minimum of 300 mm over the top of the pipe and compacted to 98 percent of SPMDD, taking care not to damage the utility pipes during compaction.

4.11 SOIL CHEMICAL TESTING RESULTS

The Ministry of the Environment (MOE) document *Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act* (Ministry of the Environment, 2011), herein referred to as the *Standard*, was referenced in determining the applicable criteria for the Site. The soil samples collected from BH101-19 and BH102-19 were analyzed per the requirements in Table 1 Standards - Full Depth Background Site Condition Standards - Agricultural or Other Property Use is applicable for comparison of the analytical results.

From the results of the testing, no exceedances were discovered. It should be noted that due to access limitations, the samples gathered were from the western edge of the site and conditions throughout other portions of the site may differ.

Based on the test results, the following handling options are available for soils sampled and analyzed under this program:

- Remain on-site to be appropriately reused as backfill or for re-grading, under the guidance of a Qualified Person (QP) as defined by the MOECC and as approved by a geotechnical engineer;

- Accepted by a Receiving Site with specifications for receipt of soil based on the above test results under the guidance of the receiving site's QP and Fill Management Plan, and subject to the municipality's fill bylaw;

- Disposed of at a waste disposal landfill appropriately certified by the MOECC. Additional testing may be required for O. Reg. 347 waste characterization analysis as directed by the Receiver.

It is noted that the chemical parameters tested and the number of samples likely do not meet the requirements of a Record of Site Condition nor meet the requirements of the intended receiving site. This report should not be construed as an Environmental Site Assessment. Handling options provided herein are based solely on the chemical analysis of soil located at site, and does not represent acceptance or suitability of this material on behalf of the intended receiving site. Should conditions encountered or the proposed work scopes vary from those described in this report, Cambium should be notified to evaluate the need for further work.

Test results and associated samples detailed within this report do not represent any areas or soil depths beyond the aforementioned sampling event.

Handling options provided herein are based solely on the chemical analysis of the sampled soil located at Site, specifically soil from all of the boreholes advanced on the Site, and does not represent acceptance or suitability of this material on behalf of an intended receiving site. Should conditions encountered or the proposed work scopes vary from those described in this report, Cambium should be notified to evaluate the need for further work.

4.12 SEISMIC SITE CLASSIFICATION

The Ontario Building Code (OBC) specifies that the structures should be designed to withstand forces due to earthquakes. For the purpose of earthquake design, geotechnical information shall be used to determine the "Site Class". Based on the explored soil properties and in accordance with Table 4.1.8.4.A of the OBC (2006), it is recommended that Site Class "E" (soft soil) be applied for structural design at the Site. This recommendation may be revisited depending on the regrading plans.

Peak ground acceleration and spectral acceleration (period of 0.2 seconds) for the site are calculated to be 0.065g and 0.109g respectively using the 2015 National Building Code Seismic Hazard Calculation. A detailed report of the calculation and its results can be found in Appendix D.

4.13 PAVEMENT DESIGN

The performance of the pavement is dependent upon proper subgrade preparation. All topsoil and organic materials should be removed down to native material and backfilled with approved engineered fill or native material, compacted to 98 percent SPMDD. The subgrade should be proof rolled and inspected by a Geotechnical Engineer. Any areas where boulders, rutting, or appreciable deflection is noted should be subexcavated and replaced with suitable fill. The fill should be compacted to at least 98 percent SPMDD.

The recommended pavement structure should satisfy applicable standards for parking and driving areas and should, as a minimum, consist of the pavement layers identified in Table 6. The light duty pavement structure is intended for parking areas while the heavy duty pavement structure is appropriate for areas where heavy traffic, heavy loads are anticipated.

Table 6 Recommended Minimum Pavement Structure

Pavement Layer	Light Duty	Heavy Duty
Surface Course Asphalt	40 mm HL3 or HL4	40 mm HL3 or HL4
Binder Course Asphalt	50 mm HL8	90 mm HL8 (2 lifts)
Granular Base	150 mm OPSS 1010 Granular A	150 mm OPSS 1010 Granular A
Granular Subbase	300 mm OPSS 1010 Granular B	400 mm OPSS 1010 Granular B

Material and thickness substitutions must be approved by the Design Engineer.

The thickness of the subbase layer could be increased at the discretion of the Engineer, to accommodate site conditions at the time of construction, including soft or weak subgrade soil replacement.

Compaction of the subgrade should be verified by the Engineer prior to placing the granular fill. Granular layers should be placed in 150 mm maximum loose lifts and compacted to at least 98% of SPMDD (ASTM D698) standard. The granular materials specified should conform to OPSS standards, as confirmed by appropriate materials testing.

Subdrains are recommended beneath the pavement structure, connecting to the storm sewer or an alternate frost-free outlet as outlined above, to extend the lifespan of the structure.

The final asphalt surface should be sloped to shed runoff. Abutting pavements should be sawcut to provide clean vertical joints with new pavement areas.

4.14 INFILTRATION TESTING

In order to help determine the infiltration rate of site soils a particle size distribution test (sieve and hydrometer analyses) were completed on three (3) samples from boreholes located at differing depths from the surface. In order to determine the rate at which water will be absorbed into the soil (“T” time), the soil was classified according to the USCS and the T Time was interpolated based on the USCS gradation charts for a particle size

distribution test (hydrometer analyses). Hydraulic conductivity values were calculated using Hazen's equation for sand soils and Puckett's equation for finer grained soils.

Percolation rates for three (3) samples are provided in Table 7 and results are attached in Appendix B.

Table 7 Infiltration Test Results

Borehole	Depth (mbgs)	Soil	Percolation Time (min/cm)	Hydraulic Conductivity, K_{fs} (cm/s)
BH101-19	1.5 – 2.1	Sand some Silt trace Clay	8	3.0×10^{-3}
BH101-19	3.0 – 3.7	Silty Clay some Sand trace Gravel	>50	6.9×10^{-8}
BH102-19	4.6 – 5.2	Clayey Silt some Sand	48	3.1×10^{-5}

4.15 DESIGN REVIEW AND INSPECTIONS

Cambium should be retained to complete testing and inspections during construction operations to examine and approve subgrade conditions, placement and compaction of fill materials, granular base courses, and asphaltic concrete.

We should be contacted to review and approve design drawings, prior to tendering or commencing construction, to ensure that all pertinent geotechnical-related factors have been addressed. It is important that onsite geotechnical supervision be provided at this site for excavation and backfill procedures, deleterious soil removal, subgrade inspections and compaction testing.

5.0 CLOSING

We trust that the information contained in this report meets your current requirements. If you have questions or comments regarding this document, please do not hesitate to contact the undersigned at (705) 719-0700 ext. 405.

Respectfully submitted,

CAMBIUM INC.

Jacob Bell, EIT
Project Coordinator

Rob Gethin, P.Eng.
Senior Project Manager

LICENSED PROFESSIONAL ENGINEER
R. L. GETHIN
100196175
Jan 22, 2020
PROVINCE OF ONTARIO

RLG/jsb

\\camfile\Projects\9100 to 9199\9121-003 Kingslea Developments - GEO - 380 Lockhart Road, Barrie, ON\Deliverables\2020-01-22 RPT 380 Lockhart Geotech.docx

Appended Figures

GEOTECHNICAL INVESTIGATION

KINGSLEA DEVELOPMENTS LTD.
380 Lockhart Road,
Barrie, Ontario

LEGEND

- Borehole with Monitoring Well
- Site (approximate)

Notes:
- Subject Property is approximate and was obtained from the County of Simcoe online GIS.
- Base mapping features are © Queen's Printer of Ontario, 2019 (this does not constitute an endorsement by the Ministry of Natural Resources or the Ontario Government).
- Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.
- Cambium Inc. makes every effort to ensure this map is free from errors but cannot be held responsible for any damages due to error or omissions. This map should not be used for navigation or legal purposes. It is intended for general reference use only.

CAMBIUM
P.O. Box 325, 52 Hunter Street East
Peterborough, Ontario, K9H 1G5
Tel: (705) 742.7900 Fax: (705) 742.7907
www.cambium-inc.com

SITE PLAN

Project No.: 9121-003		Date: November 2019 Rev.:	
Scale: 1:1,000		Projection: NAD 1983 UTM Zone 17N	
Created by: TLC	Checked by: RLG	Figure:	1

O:\GIS\project_MXDs\9100-9199\9121-003 Kingslea Developments - Geotechnical - 380 Lockhart Road, Barrie, ON\2019-11-25 FIG 1 - Site Plan.mxd

Appendix A
Borehole Logs

Peterborough
Barrie
Oshawa
Kingston
T: 866-217-7900
www.cambium-inc.com

Log of Borehole: BH101-19

Client: Kingslea Developments Ltd. **Project Name:** Geotech Investigation - 380 Lockhart Road **Project No.:** 9121-003

Contractor: Landshark Drilling **Method:** Hollow Stem Augers **Date Completed:** November 8th, 2019

Location: 380 Lockhart Road, Barrie, ON **UTM:** 17T 606949, 4909338 **Elevation:** 101.41 m Rel. El

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
101 / 0		Topsoil: Dark brown sandy topsoil, moist, loose	1A / 1B	SS	75	8			Cap; Bentonite Plug	Top of Standpipe (TOS) elevation; 102.38 m Rel. El. Groundwater measured at 5.19 mbgs (96.21 m Rel. El.) on November 15th, 2019
		Sand: Brown sand, some silt, trace clay, moist, loose								
100 / 1			2	SS	75	4				
100 / 2			3	SS	75	7			Cuttings; PVC Standpipe	GSA SS3: 0% Gravel 83% Sand 15% Silt 2% Clay
99 / 2		Compact	4A / 4B	SS	95	11				
		Silty Clay: Brown silty clay, some sand, trace gravel, moist, stiff								
98 / 3			5	SS	95	13			Bentonite Plug	GSA SS5: 1% Gravel 11% Sand 32% Silt 56% Clay
97 / 4		Grey, increased sand content, wet, firm	6	SS	95	4			Sand Pack; PVC Screen	
96 / 5										
95 / 6			7	SS	95	8			Cap	
94 / 7		Borehole terminated at 6.7 mbgs								

Logged By: JB **Input By:** CM

Peterborough
Barrie
Oshawa
Kingston
T: 866-217-7900
www.cambium-inc.com

Log of Borehole: BH102-19

Client: Kingslea Developments Ltd. **Project Name:** Geotech Investigation - 380 Lockhart Road **Project No.:** 9121-003

Contractor: Landshark Drilling **Method:** Hollow Stem Augers **Date Completed:** November 8th, 2019

Location: 380 Lockhart Road, Barrie, ON **UTM:** 17T 606918, 4909326 **Elevation:** 102.24 m Rel. El.

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
102 / 0		Topsoil: Dark brown sandy topsoil, moist, loose	1A						Cap	Top of Standpipe (TOS) elevation; 103.21 m Rel. El. Groundwater measured at 5.72 mbgs (96.52 m Rel. El) on November 15th, 2019
		Sand: Brown sand, trace gravel, trace silt, moist, loose	1B	SS	40	6			Bentonite Plug	
101 / 1			2	SS	40	7				
			3	SS	45	5			Cuttings	
100 / 2									PVC Standpipe	
			4	SS	50	8				
99 / 3			5	SS	50	8			Bentonite Plug	
		Clayey Silt: Brown-grey clayey silt, some sand, moist, firm								
98 / 4			6	SS	90	8			Sand Pack	GSA SS6: 0% Gravel 10% Sand 65% Silt 25% Clay
97 / 5									PVC Screen	
96 / 6		Very Stiff	7	SS	90	19			Cap	
95 / 7		Borehole terminated at 6.7 mbgs								

Logged By: JB **Input By:** CM

Appendix B

Physical Laboratory Testing Results

Grain Size Distribution Chart

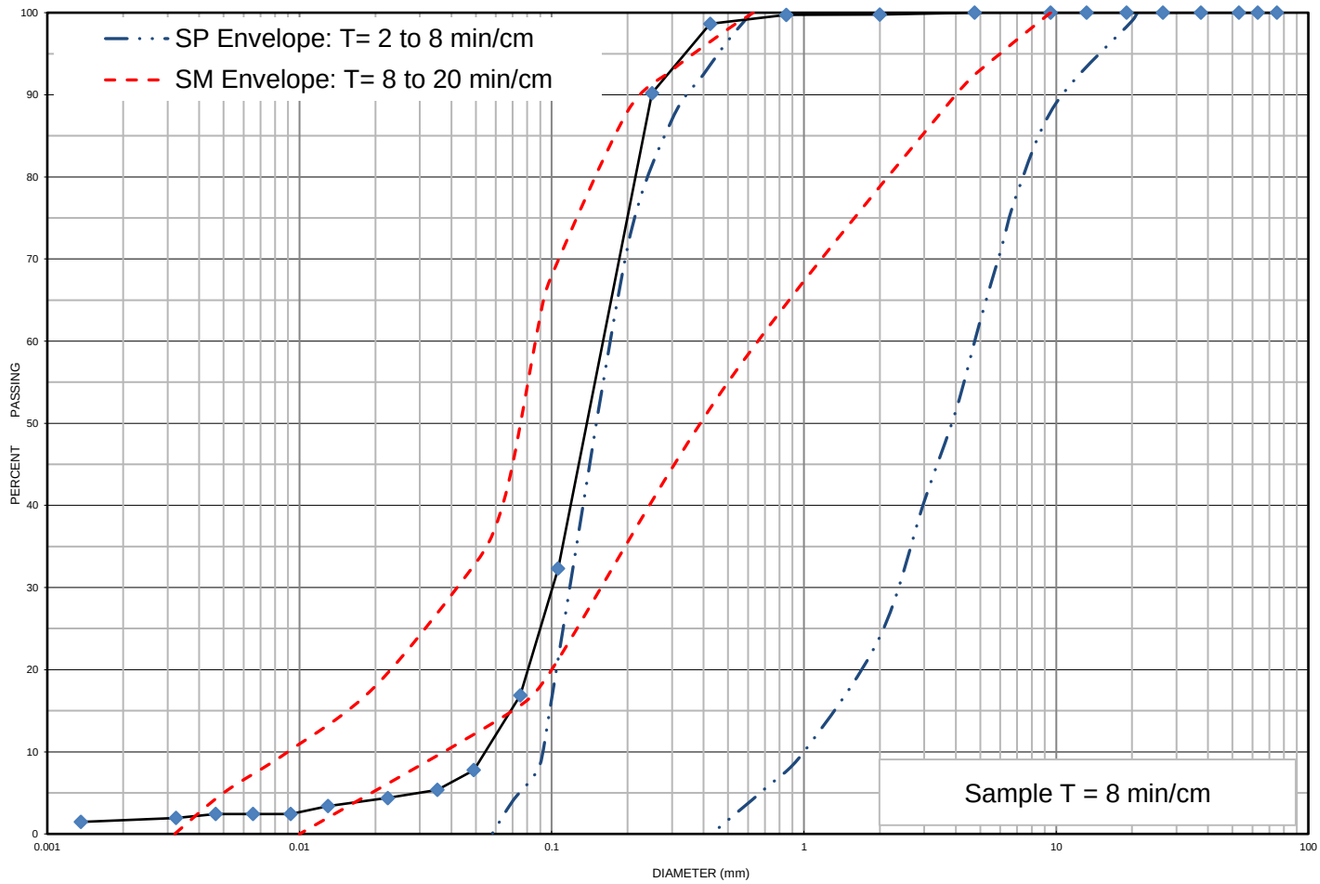
Project Number: *9121-003* **Client:** *Kingslea Developments Ltd.*

Project Name: *380 Lockhart Road, Barrie, ON*

Sample Date: *November 11, 2019* **Sampled By:** *Jacob Bell - Cambium Inc.*

Location: *BH 101-19 SS 3* **Depth:** *1.5 m to 2.1 m* **Lab Sample No:** *S-19-0973*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-19	SS 3	1.5 m to 2.1 m	0	83	17		4.4

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand some Silt trace Clay	SP	0.165	0.100	0.054	3.06	1.12

Issued By: _____ *Date Issued:* *November 25, 2019*

(Senior Project Manager)

Cambium Inc. (Laboratory)

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Grain Size Distribution Chart

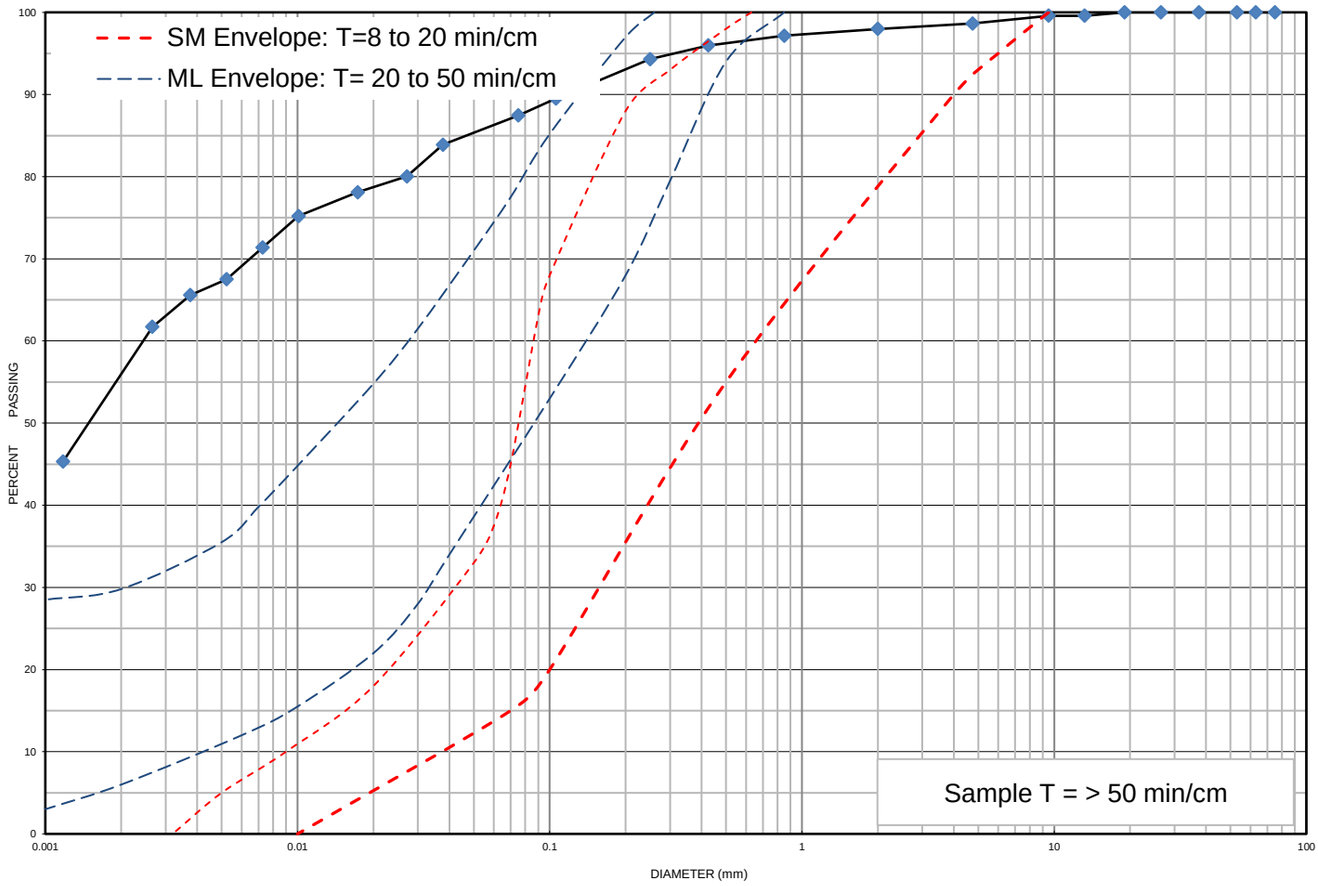
Project Number: *9121-003* **Client:** *Kingslea Developments Ltd.*

Project Name: *380 Lockhart Road, Barrie, ON*

Sample Date: *November 11, 2019* **Sampled By:** *Jacob Bell - Cambium Inc.*

Location: *BH 101-19 SS 5* **Depth:** *3 m to 3.7 m* **Lab Sample No:** *S-19-0974*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-19	SS 5	3 m to 3.7 m	1	11	87		21.5

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Clay some Sand trace Gravel	ML-CL	0.0025	0.0000	0.0000		

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(Senior Project Manager)

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Grain Size Distribution Chart

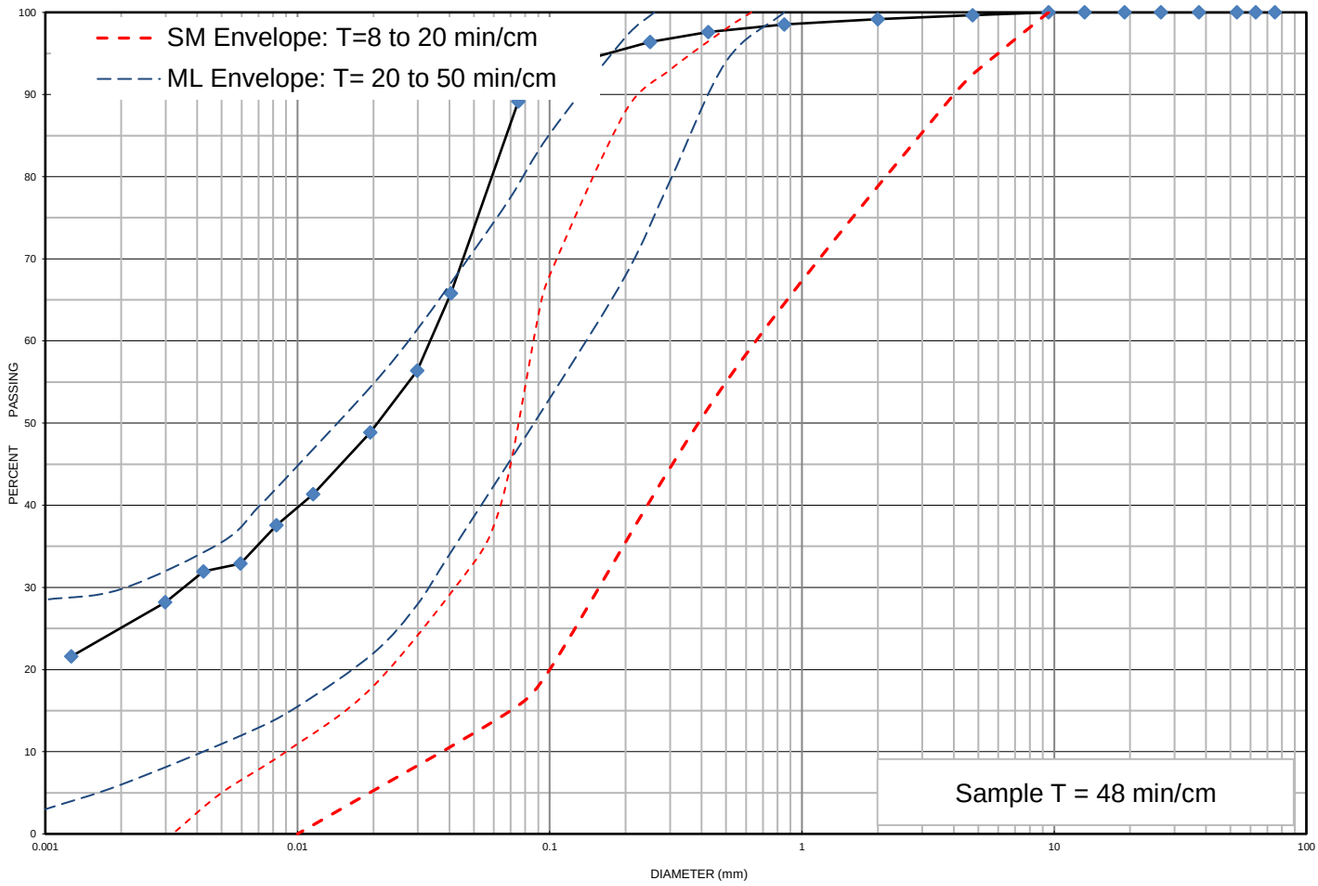
Project Number: *9121-003* **Client:** *Kingslea Developments Ltd.*

Project Name: *380 Lockhart Road, Barrie, ON*

Sample Date: *November 11, 2019* **Sampled By:** *Jacob Bell - Cambium Inc.*

Location: *BH 102-19 SS 6* **Depth:** *4.6 m to 5.2 m* **Lab Sample No:** *S-19-0975*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-19	SS 6	4.6 m to 5.2 m	0	10	89		19.6

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Clayey Silt some Sand	ML	0.0330	0.0035	0.0000		

Issued By: _____ *Date Issued:* *November 25, 2019*

(Senior Project Manager)

Cambium Inc. (Laboratory)

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Appendix C

2015 National Building Code Seismic Hazard Values

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 44.329N 79.658W **User File Reference:** 380 Lockhart Road, Barrie, ON 2019-11-21 19:46 UT

Requested by: Cambium Inc.

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.082	0.051	0.033	0.011
Sa (0.1)	0.113	0.072	0.048	0.017
Sa (0.2)	0.109	0.072	0.049	0.019
Sa (0.3)	0.093	0.063	0.043	0.017
Sa (0.5)	0.077	0.052	0.036	0.013
Sa (1.0)	0.047	0.031	0.021	0.006
Sa (2.0)	0.025	0.016	0.010	0.003
Sa (5.0)	0.006	0.004	0.002	0.001
Sa (10.0)	0.003	0.002	0.001	0.000
PGA (g)	0.065	0.041	0.027	0.009
PGV (m/s)	0.064	0.040	0.026	0.008

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Appendix D

Results of Chemical Soil Testing

Appendix D - Summary of Soil Quality

Sample Location	Note	Units	RDL	Table 1 Agricultural Standards	BH101-19	BH101-19 and BH102-19
Sample ID					SS1B	SS1
Sample Date (dd-mmm-yy)					11-Nov-19	11-Nov-19
Sample Depth (mbgs)					0.15 - 0.45	0 - 0.15
Antimony		µg/g	0.5	1	< 0.5	-
Arsenic		µg/g	0.5	11	< 0.5	-
Barium		µg/g	1	210	11	-
Beryllium		µg/g	0.2	2.5	< 0.2	-
Boron		µg/g	0.5	36	< 0.5	-
Cadmium		µg/g	0.5	1	< 0.5	-
Chromium		µg/g	1	67	6	-
Cobalt		µg/g	1	19	2	-
Copper		µg/g	1	62	3	-
Lead		µg/g	5	45	< 5	-
Mercury		µg/g	0.005	0.16	0.009	-
Molybdenum		µg/g	1	2	< 1	-
Nickel		µg/g	1	37	3	-
Selenium		µg/g	0.5	1.2	< 0.5	-
Silver		µg/g	0.2	0.5	< 0.2	-
Thallium		µg/g	0.1	1	< 0.1	-
Uranium		µg/g	0.1	1.9	0.2	-
Vanadium		µg/g	1	86	14	-
Zinc		µg/g	3	290	13	-
Acetone		µg/g	0.5	0.5	< 0.5	-
Benzene		µg/g	0.02	0.02	< 0.02	-
Bromodichloromethane		µg/g	0.02	0.05	< 0.02	-
Bromoform		µg/g	0.02	0.05	< 0.02	-
Bromomethane		µg/g	0.05	0.05	< 0.05	-
Carbon Tetrachloride		µg/g	0.05	0.05	< 0.05	-
Monochlorobenzene (Chlorobenzene)		µg/g	0.02	0.05	< 0.02	-
Chloroform		µg/g	0.02	0.05	< 0.02	-
Dibromochloromethane		µg/g	0.02	0.05	< 0.02	-
Dichlorobenzene,1,2-		µg/g	0.05	0.05	< 0.05	-
Dichlorobenzene,1,3-		µg/g	0.05	0.05	< 0.05	-
Dichlorobenzene,1,4-		µg/g	0.05	0.05	< 0.05	-
Dichlorodifluoromethane		µg/g	0.05	0.05	< 0.05	-
Dichloroethane,1,1-		µg/g	0.02	0.05	< 0.02	-
Dichloroethane,1,2-		µg/g	0.02	0.05	< 0.02	-
Dichloroethylene,1,1-		µg/g	0.02	0.05	< 0.02	-
Dichloroethene, cis-1,2-		µg/g	0.02	0.05	< 0.02	-
Dichloroethene, trans-1,2-		µg/g	0.02	0.05	< 0.02	-
Dichloropropane,1,2-		µg/g	0.02	0.05	< 0.02	-
Dichloropropene, cis-1,3-		µg/g	0.02	NV	< 0.02	-
Dichloropropene, trans-1,3-		µg/g	0.02	NV	< 0.02	-
Dichloropropene 1,3- cis+trans		µg/g	0.02	NV	< 0.02	-
Ethylbenzene		µg/g	0.05	0.05	< 0.05	-
Dibromoethane,1,2- (Ethylene Dibromide)		µg/g	0.02	0.05	< 0.02	-
Hexane		µg/g	0.02	0.05	< 0.02	-
Methyl Ethyl Ketone		µg/g	0.5	0.5	< 0.5	-
Methyl Isobutyl Ketone		µg/g	0.5	0.5	< 0.5	-
Methyl-t-butyl Ether		µg/g	0.05	0.05	< 0.05	-

Dichloromethane (Methylene Chloride)		µg/g	0.05	0.05	< 0.05	-
Styrene		µg/g	0.05	0.05	< 0.05	-
Tetrachloroethane,1,1,1,2-		µg/g	0.02	0.05	< 0.02	-
Tetrachloroethane,1,1,2,2-		µg/g	0.05	0.05	< 0.05	-
Tetrachloroethylene		µg/g	0.05	0.05	< 0.05	-
Toluene		µg/g	0.2	0.2	< 0.2	-
Trichloroethane,1,1,1-		µg/g	0.02	0.05	< 0.02	-
Trichloroethane,1,1,2-		µg/g	0.02	0.05	< 0.02	-
Trichloroethylene		µg/g	0.05	0.05	< 0.05	-
Trichlorofluoromethane		µg/g	0.02	0.05	< 0.02	-
Vinyl Chloride		µg/g	0.02	0.02	< 0.02	-
Xylene, m,p-		µg/g	0.03	NV	< 0.03	-
Xylene, o-		µg/g	0.03	NV	< 0.03	-
Xylene, m,p,o-		µg/g	0.03	0.05	< 0.03	-
PHC F1 (C6-C10)		µg/g	10	17	< 10	-
PHC F2 (>C10-C16)		µg/g	5	10	< 5	-
PHC F3 (>C16-C34)		µg/g	10	240	< 10	-
PHC F4 (>C34-C50)		µg/g	10	120	< 10	-
Aldrin		µg/g	0.05	0.05	-	< 0.05
Chlordane (Total)		µg/g	0.05	0.05	-	< 0.05
DDD		µg/g	0.05	0.05	-	< 0.05
DDE		µg/g	0.05	0.05	-	< 0.05
DDT		µg/g	0.05	0.078	-	< 0.05
Dieldrin		µg/g	0.05	0.05	-	< 0.05
Lindane (Hexachlorocyclohexane, Gamma)		µg/g	0.01	0.01	-	< 0.01
Endosulfan		µg/g	0.04	0.04	-	< 0.04
Endrin		µg/g	0.04	0.04	-	< 0.04
Heptachlor		µg/g	0.05	0.05	-	< 0.05
Heptachlor Epoxide		µg/g	0.05	0.05	-	< 0.05
Hexachlorobenzene		µg/g	0.01	0.01	-	< 0.01
Hexachlorobutadiene		µg/g	0.01	0.01	-	< 0.01
Hexachloroethane		µg/g	0.01	0.01	-	< 0.01
Methoxychlor		µg/g	0.05	0.05	-	< 0.05

Notes:
Table 1 Standards - Full Depth Background Site Condition Standards - Agricultural or Other Property Use
N/A - not applicable
NC - The duplicate RPD was not calculated. One or both samples < 5x RDL.
NV - no value
"-" not analyzed
Bold and shaded - value exceeds standard
Bold and underline - RDL exceeds standard
1 - Standard for Boron (HWS) is applicable only to surface soil (<1.5 mbgs).
2 - Standard is applicable to 1-methylnaphthallene and 2- methylnaphthalene, with the provision that if both are detected the sum of the two must not exceed the standard.
3 - Standard is applicable to PHC in the F1 range minus BTEX.
4 - Standard is applicable to PHC F2 minus naphthalene. If naphthalene is not analyzed, the standard is applied to F2.
5 - Standard is applicable to PHC F3 minus PAHs (other than naphthalene). If PAHs have not been measured, the standard is applied to F3.
6 - Standard is applicable to total xylenes, and m & p-xylenes and o-xylenes should be summed for comparison.
7 - Standard is applicable to 1,3-Dichloropropene, and the individual isomers (cis + trans) should be added for comparison.
8 - Standard is applicable to total PCBs, and the individual Aroclors should be added for comparison.
9 - Standard is for benzo(b)fluoranthene; however, the laboratory can not distinguish between benzo(b)fluoranthene and benzo(k)fluoranthene.
10 - Analysis for methyl mercury applies only when standard for mercury (total) is exceeded .

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G85541 **REPORT No. B19-36634 (i)**

Report To:

Cambium Environmental
74 Cedar Pointe Drive, Unit 1009
Barrie ON L4N 5R7
Attention: Rob Gethin

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

DATE RECEIVED: 11-Nov-19
DATE REPORTED: 15-Nov-19
SAMPLE MATRIX: Soil

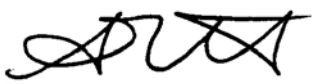
JOB/PROJECT NO.:
P.O. NUMBER: 9121-001
WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
Mercury	1	Holly Lane	PBK	14-Nov-19	D-HG-01 (o)	EPA 7471A
Metals - ICP-OES	1	Holly Lane	AHM	14-Nov-19	D-ICP-02 (o)	EPA 6010
Metals - ICP-MS	1	Holly Lane	TPR	14-Nov-19	D-ICPMS-01 (o)	EPA 6020

µg/g = micrograms per gram (parts per million) and is equal to mg/Kg
F1 C6-C10 hydrocarbons in µg/g, (F1-btex if requested)
F2 C10-C16 hydrocarbons in µg/g, (F2-napth if requested)
F3 C16-C34 hydrocarbons in µg/g, (F3-pah if requested)
F4 C34-C50 hydrocarbons in µg/g
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
Any deviations from the method are noted and reported for any particular sample.
nC6 and nC10 response factor is within 30% of response factor for toluene:
nC10,nC16 and nC34 response factors within 10% of each other:
C50 response factors within 70% of nC10+nC16+nC34 average:
Linearity is within 15%:
All results expressed on a dry weight basis.
Unless otherwise noted all chromatograms returned to baseline by the retention time of nC50.

Unless otherwise noted all extraction, analysis, QC requirements and limits for holding time were met.
If analyzed for F4 and F4G they are not to be summed but the greater of the two numbers are to be used in application to the CWS PHC
QC will be made available upon request.

O. Reg. 153 - Soil, Ground Water and Sediment Standards
Tbl. 1 - Agricultural - Table 1 - Agricultural/Other Soil Std
Tbl. 1 - All - Table 1 - Res/Park/Institutional/Indus/Com/Commun



Steve Garrett
Director of Laboratory Services

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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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G85541 **REPORT No. B19-36634 (i)**

Report To:

Cambium Environmental
74 Cedar Pointe Drive, Unit 1009
Barrie ON L4N 5R7
Attention: Rob Gethin

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

DATE RECEIVED: 11-Nov-19
DATE REPORTED: 15-Nov-19
SAMPLE MATRIX: Soil

JOB/PROJECT NO.:
P.O. NUMBER: 9121-001
WATERWORKS NO.

	Client I.D. / Sample I.D. / Date Collected		Sample B B19-36634-2 11-Nov-19				O. Reg. 153 Tbl. 1 - Agricultural	Tbl. 1 - All
Parameter	**Units**	**R.L.**						
Antimony	µg/g	0.5	< 0.5				1	1.3
Arsenic	µg/g	0.5	< 0.5				11	18
Barium	µg/g	1	11				210	220
Beryllium	µg/g	0.2	< 0.2				2.5	2.5
Boron	µg/g	0.5	< 0.5				36	36
Cadmium	µg/g	0.5	< 0.5				1	1.2
Chromium	µg/g	1	6				67	70
Cobalt	µg/g	1	2				19	21
Copper	µg/g	1	3				62	92
Lead	µg/g	5	< 5				45	120
Mercury	µg/g	0.005	0.009				0.16	0.27
Molybdenum	µg/g	1	< 1				2	2
Nickel	µg/g	1	3				37	82
Selenium	µg/g	0.5	< 0.5				1.2	1.5
Silver	µg/g	0.2	< 0.2				0.5	0.5
Thallium	µg/g	0.1	< 0.1				1	1
Uranium	µg/g	0.1	0.2				1.9	2.5
Vanadium	µg/g	1	14				86	86
Zinc	µg/g	3	13				290	290

O. Reg. 153 - Soil, Ground Water and Sediment Standards
Tbl. 1 - Agricultural - Table 1 - Agricultural/Other Soil Std
Tbl. 1 - All - Table 1 - Res/Park/Institutional/Indus/Com/Commun

Steve Garrett
Director of Laboratory Services

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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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G85541 **REPORT No. B19-36634 (i)**

Report To:

Cambium Environmental
74 Cedar Pointe Drive, Unit 1009
Barrie ON L4N 5R7
Attention: Rob Gethin

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

DATE RECEIVED: 11-Nov-19
DATE REPORTED: 15-Nov-19
SAMPLE MATRIX: Soil

JOB/PROJECT NO.:
P.O. NUMBER: 9121-001
WATERWORKS NO.

Summary of Exceedances

O. Reg. 153 - Soil, Ground Water and Sediment Standards
Tbl. 1 - Agricultural - Table 1 - Agricultural/Other Soil Std
Tbl. 1 - All - Table 1 - Res/Park/Institutional/Indus/Com/Commun

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Final Report

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Report To:

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Attention: Rob Gethin

Caduceon Environmental Laboratories
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Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 11-Nov-19
DATE REPORTED: 15-Nov-19
SAMPLE MATRIX: Soil

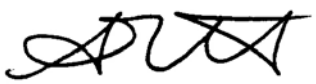
JOB/PROJECT NO.:
P.O. NUMBER: 9121-001
WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
% Moisture	1	Richmond Hill	FAL	14-Nov-19	A-% moisture RH	
PHC(F2-F4)	1	Kingston	KPR	13-Nov-19	C-PHC-S-001 (k)	CWS Tier 1
VOC's	1	Richmond Hill	FAL	13-Nov-19	C-VOC-02 (rh)	EPA 8260
PHC(F1)	1	Richmond Hill	FAL	13-Nov-19	C-VPHS-01 (rh)	CWS Tier 1

µg/g = micrograms per gram (parts per million) and is equal to mg/Kg
F1 C6-C10 hydrocarbons in µg/g, (F1-btex if requested)
F2 C10-C16 hydrocarbons in µg/g, (F2-napth if requested)
F3 C16-C34 hydrocarbons in µg/g, (F3-pah if requested)
F4 C34-C50 hydrocarbons in µg/g
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
Any deviations from the method are noted and reported for any particular sample.
nC6 and nC10 response factor is within 30% of response factor for toluene:
nC10,nC16 and nC34 response factors within 10% of each other:
C50 response factors within 70% of nC10+nC16+nC34 average:
Linearity is within 15%:
All results expressed on a dry weight basis.
Unless otherwise noted all chromatograms returned to baseline by the retention time of nC50.

Unless otherwise noted all extraction, analysis, QC requirements and limits for holding time were met.
If analyzed for F4 and F4G they are not to be summed but the greater of the two numbers are to be used in application to the CWS PHC
QC will be made available upon request.

O. Reg. 153 - Soil, Ground Water and Sediment Standards
Tbl. 1 - Agricultural - Table 1 - Agricultural/Other Soil Std
Tbl. 1 - All - Table 1 - Res/Park/Institutional/Indus/Com/Commun



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Director of Laboratory Services

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Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 11-Nov-19
DATE REPORTED: 15-Nov-19
SAMPLE MATRIX: Soil

JOB/PROJECT NO.:
P.O. NUMBER: 9121-001
WATERWORKS NO.

	Client I.D. / Sample I.D. / Date Collected		Sample B B19-36634-2 11-Nov-19				O. Reg. 153 Tbl. 1 - Agricultural	Tbl. 1 - All
Parameter	**Units**	**R.L.**						
Acetone	µg/g	0.5	< 0.5				0.5	0.5
Benzene	µg/g	0.02	< 0.02				0.02	0.02
Bromodichloromethane	µg/g	0.02	< 0.02				0.05	0.05
Bromoform	µg/g	0.02	< 0.02				0.05	0.05
Bromomethane	µg/g	0.05	< 0.05				0.05	0.05
Carbon Tetrachloride	µg/g	0.05	< 0.05				0.05	0.05
Monochlorobenzene (Chlorobenzene)	µg/g	0.02	< 0.02				0.05	0.05
Chloroform	µg/g	0.02	< 0.02				0.05	0.05
Dibromochloromethane	µg/g	0.02	< 0.02				0.05	0.05
Dichlorobenzene,1,2-	µg/g	0.05	< 0.05				0.05	0.05
Dichlorobenzene,1,3-	µg/g	0.05	< 0.05				0.05	0.05
Dichlorobenzene,1,4-	µg/g	0.05	< 0.05				0.05	0.05
Dichlorodifluoromethane	µg/g	0.05	< 0.05				0.05	0.05
Dichloroethane,1,1-	µg/g	0.02	< 0.02				0.05	0.05
Dichloroethane,1,2-	µg/g	0.02	< 0.02				0.05	0.05
Dichloroethylene,1,1-	µg/g	0.02	< 0.02				0.05	0.05
Dichloroethene, cis-1,2-	µg/g	0.02	< 0.02				0.05	0.05
Dichloroethene, trans-1,2-	µg/g	0.02	< 0.02				0.05	0.05
Dichloropropane,1,2-	µg/g	0.02	< 0.02				0.05	0.05
Dichloropropene, cis-1,3-	µg/g	0.02	< 0.02					
Dichloropropene, trans-1,3-	µg/g	0.02	< 0.02					
Dichloropropene 1,3-cis+trans	µg/g	0.02	< 0.02				0.05	0.05
Ethylbenzene	µg/g	0.05	< 0.05				0.05	0.05

O. Reg. 153 - Soil, Ground Water and Sediment Standards
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Steve Garrett
Director of Laboratory Services

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G85541 **REPORT No. B19-36634 (ii)**

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Cambium Environmental
74 Cedar Pointe Drive, Unit 1009
Barrie ON L4N 5R7
Attention: Rob Gethin

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

DATE RECEIVED: 11-Nov-19
DATE REPORTED: 15-Nov-19
SAMPLE MATRIX: Soil

JOB/PROJECT NO.:
P.O. NUMBER: 9121-001
WATERWORKS NO.

	Client I.D. / Sample I.D. / Date Collected		Sample B B19-36634-2 11-Nov-19				O. Reg. 153 Tbl. 1 - Agricultural	 Tbl. 1 - All
Parameter	**Units**	**R.L.**						
Dibromoethane,1,2- (Ethylene Dibromide)	µg/g	0.02	< 0.02				0.05	0.05
Hexane	µg/g	0.02	< 0.02				0.05	0.05
Methyl Ethyl Ketone	µg/g	0.5	< 0.5				0.5	0.5
Methyl Isobutyl Ketone	µg/g	0.5	< 0.5				0.5	0.5
Methyl-t-butyl Ether	µg/g	0.05	< 0.05				0.05	0.05
Dichloromethane (Methylene Chloride)	µg/g	0.05	< 0.05				0.05	0.05
Styrene	µg/g	0.05	< 0.05				0.05	0.05
Tetrachloroethane,1,1,1,2-	µg/g	0.02	< 0.02				0.05	0.05
Tetrachloroethane,1,1,2,2-	µg/g	0.05	< 0.05				0.05	0.05
Tetrachloroethylene	µg/g	0.05	< 0.05				0.05	0.05
Toluene	µg/g	0.2	< 0.2				0.2	0.2
Trichloroethane,1,1,1-	µg/g	0.02	< 0.02				0.05	0.05
Trichloroethane,1,1,2-	µg/g	0.02	< 0.02				0.05	0.05
Trichloroethylene	µg/g	0.05	< 0.05				0.05	0.05
Trichlorofluoromethane	µg/g	0.02	< 0.02				0.05	0.25
Vinyl Chloride	µg/g	0.02	< 0.02				0.02	0.02
Xylene, m,p-	µg/g	0.03	< 0.03					
Xylene, o-	µg/g	0.03	< 0.03					
Xylene, m,p,o-	µg/g	0.03	< 0.03				0.05	0.05
PHC F1 (C6-C10)	µg/g	10	< 10				17	25
PHC F2 (>C10-C16)	µg/g	5	< 5				10	10
PHC F3 (>C16-C34)	µg/g	10	< 10				240	240
PHC F4 (>C34-C50)	µg/g	10	< 10				120	120
% moisture	%		6.0					

O. Reg. 153 - Soil, Ground Water and Sediment Standards
Tbl. 1 - Agricultural - Table 1 - Agricultural/Other Soil Std
Tbl. 1 - All - Table 1 - Res/Park/Institutional/Indus/Com/Commun

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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

Steve Garrett
Director of Laboratory Services

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C.O.C.: G85541 **REPORT No. B19-36634 (ii)**

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Attention: Rob Gethin

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

DATE RECEIVED: 11-Nov-19
DATE REPORTED: 15-Nov-19
SAMPLE MATRIX: Soil

JOB/PROJECT NO.:
P.O. NUMBER: 9121-001
WATERWORKS NO.

Summary of Exceedances

O. Reg. 153 - Soil, Ground Water and Sediment Standards
Tbl. 1 - Agricultural - Table 1 - Agricultural/Other Soil Std
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Attention: Rob Gethin

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Barrie ON L4N 8W8
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Fax: 705-252-5746

DATE RECEIVED: 11-Nov-19
DATE REPORTED: 15-Nov-19
SAMPLE MATRIX: Soil

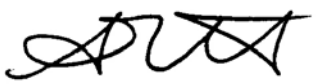
JOB/PROJECT NO.:
P.O. NUMBER: 9121-001
WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
OC Pesticides	1	Kingston	CS	15-Nov-19	C-PESTCL-01 K	EPA 8080

µg/g = micrograms per gram (parts per million) and is equal to mg/Kg
F1 C6-C10 hydrocarbons in µg/g, (F1-btex if requested)
F2 C10-C16 hydrocarbons in µg/g, (F2-napth if requested)
F3 C16-C34 hydrocarbons in µg/g, (F3-pah if requested)
F4 C34-C50 hydrocarbons in µg/g
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
Any deviations from the method are noted and reported for any particular sample.
nC6 and nC10 response factor is within 30% of response factor for toluene:
nC10,nC16 and nC34 response factors within 10% of each other:
C50 response factors within 70% of nC10+nC16+nC34 average:
Linearity is within 15%:
All results expressed on a dry weight basis.
Unless otherwise noted all chromatograms returned to baseline by the retention time of nC50.

Unless otherwise noted all extraction, analysis, QC requirements and limits for holding time were met.
If analyzed for F4 and F4G they are not to be summed but the greater of the two numbers are to be used in application to the CWS PHC
QC will be made available upon request.

O. Reg. 153 - Soil, Ground Water and Sediment Standards
Tbl. 1 - Agricultural - Table 1 - Agricultural/Other Soil Std
Tbl. 1 - All - Table 1 - Res/Park/Institutional/Indus/Com/Commun



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SAMPLE MATRIX: Soil

JOB/PROJECT NO.:
P.O. NUMBER: 9121-001
WATERWORKS NO.

	Client I.D. / Sample I.D. / Date Collected		Sample A B19-36634-1 11-Nov-19				O. Reg. 153 Tbl. 1 - Agricultural	 Tbl. 1 - All
Parameter	**Units**	**R.L.**						
Aldrin	µg/g	0.05	< 0.05				0.05	0.05
Chlordane (alpha)	µg/g	0.05	< 0.05					
Chlordane (Gamma)	µg/g	0.05	< 0.05					
Chlordane Total (alpha+gamma)	µg/g	0.05	< 0.05				0.05	0.05
DDD, 2,4-	µg/g	0.05	< 0.05					
DDD, 4,4-	µg/g	0.05	< 0.05					
DDD Total	µg/g	0.05	< 0.05				0.05	0.05
DDE, 2,4-	µg/g	0.05	< 0.05					
DDE, 4,4-	µg/g	0.05	< 0.05					
DDE Total	µg/g	0.05	< 0.05				0.05	0.05
DDT, 2,4-	µg/g	0.05	< 0.05					
DDT, 4,4-	µg/g	0.05	< 0.05					
DDT Total	µg/g	0.05	< 0.05				0.078	1.4
Dieldrin	µg/g	0.05	< 0.05				0.05	0.05
Lindane (Hexachlorocyclohexane, Gamma)	µg/g	0.01	< 0.01				0.01	0.01
Endosulfan I	µg/g	0.04	< 0.04					
Endosulfan II	µg/g	0.04	< 0.04					
Endosulfan I/II	µg/g	0.04	< 0.04				0.04	0.04
Endrin	µg/g	0.04	< 0.04				0.04	0.04
Heptachlor	µg/g	0.05	< 0.05				0.05	0.05
Heptachlor Epoxide	µg/g	0.05	< 0.05				0.05	0.05
Hexachlorobenzene	µg/g	0.01	< 0.01				0.01	0.01
Hexachlorobutadiene	µg/g	0.01	< 0.01				0.01	0.01
Hexachloroethane	µg/g	0.01	< 0.01				0.01	0.01

O. Reg. 153 - Soil, Ground Water and Sediment Standards
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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 11-Nov-19
DATE REPORTED: 15-Nov-19
SAMPLE MATRIX: Soil

JOB/PROJECT NO.:
P.O. NUMBER: 9121-001
WATERWORKS NO.

	Client I.D. / Sample I.D. / Date Collected		Sample A B19-36634-1 11-Nov-19				O. Reg. 153 Tbl. 1 - Agricultural	Tbl. 1 - All
Parameter	**Units**	**R.L.**						
Methoxychlor	µg/g	0.05	< 0.05				0.05	0.05

O. Reg. 153 - Soil, Ground Water and Sediment Standards
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JOB/PROJECT NO.:
P.O. NUMBER: 9121-001
WATERWORKS NO.

Summary of Exceedances

O. Reg. 153 - Soil, Ground Water and Sediment Standards
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TESTING REQUIREMENTS

- [x] O.Reg 153 — Table 1 — [ ] Medium/Fine — [x] Coarse — [ ] MISA Guidelines
- [x] RPI — [ ] ICC — [ ] Agricultural (O.Reg 153) — [ ] O.Reg 558 Leachate Analysis
- [ ] Yes — [ ] No — Record of Site Condition (O.Reg 153) — Disposal Site: _____
- [ ] Provincial Water Quality Objectives — [ ] Landfill Monitoring
- [ ] Sewer Use By-Law: _____ — [ ] Other: _____

REPORT NUMBER (Lab Use): B19-36634.

Are any samples to be submitted intended for Human Consumption under any Drinking Water Regulations? [ ] Yes [x] No (If yes, submit all Drinking Water Samples on a Drinking Water Chain of Custody)

Indicate Laboratory Samples are submitted to: [ ] Kingston [ ] Ottawa [ ] Richmond Hill [ ] Windsor [x] Barrie [ ] London

Organization: CAMBIUM	Address and Invoicing Address (if different): 74 CEDAR POINTE DRIVE BARRIE, ON L4N 5R7	
Contact: ROB GETHIN		
Tel:		
Fax:	Quote No.:	Project Name: 9121-001
Email:	P.O. No.:	Additional Info:

ANALYSES REQUESTED (Print Test in Boxes)

Metals - Suite 1 | PHCs/VOCs | OC Pesticides | Suspected Highly Contaminated

TURNAROUND SERVICE REQUESTED (see back page)

- [ ] Platinum — 200% Surcharge
- [ ] Gold — 100% Surcharge
- [ ] Silver — 50% Surcharge
- [ ] Bronze — 25% Surcharge
- [x] Standard — 5-7 days
- [ ] Specific Date: _____

* Sample Matrix Legend: WW=Waste Water, SW=Surface Water, GW=Groundwater, LS=Liquid Sludge, SS=Solid Sludge, S=Soil, Sed=Sediment, PC=Paint Chips, F=Filter, Oil = Oil

Lab No:	Sample Identification	S.P.L.	Sample Matrix *	Date Collected (yy-mm-dd)	Time Collected	Indicate Test For Each Sample By Using A Check Mark In The Box Provided	✓	Field pH	Field Temp.	# Bottles Sample	Field Filtered(Y/N)
1	Bh 101 - 19		S	19-11-08	11:00 AM	Metals, PHCs/VOCs					
1	Sample A					OC Pesticides					
2	Sample B					Metals, PHCs/VOCs					
	250mL jar a Sm jar → KO										
	jar → O										
	Metals - RH										

as per client email 08.

SAMPLE SUBMISSION INFORMATION

	Sampled by:	Submitted by:
Print:	Jacob Bell	R GETHIN
Sign:		
Date (yy-mm-dd)/Time:	19-11-11 15:15	19-11-11 17:00

SHIPPING INFORMATION

- [ ] Client's Courier
- [ ] Caduceon's Courier
- [ ] Drop Off
- [ ] Caduceon (Pick-up)

Invoice: [ ]

# of Pieces: 1

REPORTING / INVOICING

- [ ] Report by Fax
- [x] Report by Email
- [x] Invoice by Email
- [ ] Invoice by Mail

SAMPLE RECEIVING INFORMATION (LABORATORY USE ONLY)

Received By (print): S.Te. Signature:
Date Received (yy-mm-dd): 19/11/11 Time Received: 17:00
Laboratory Prepared Bottles: [x] Yes [ ] No
Sample Temperature °C: 13.0 Labeled by:

Comments: OC Pesticides is composite sample from Bh 101-19 and Bh 102-19

Page 1 of 1

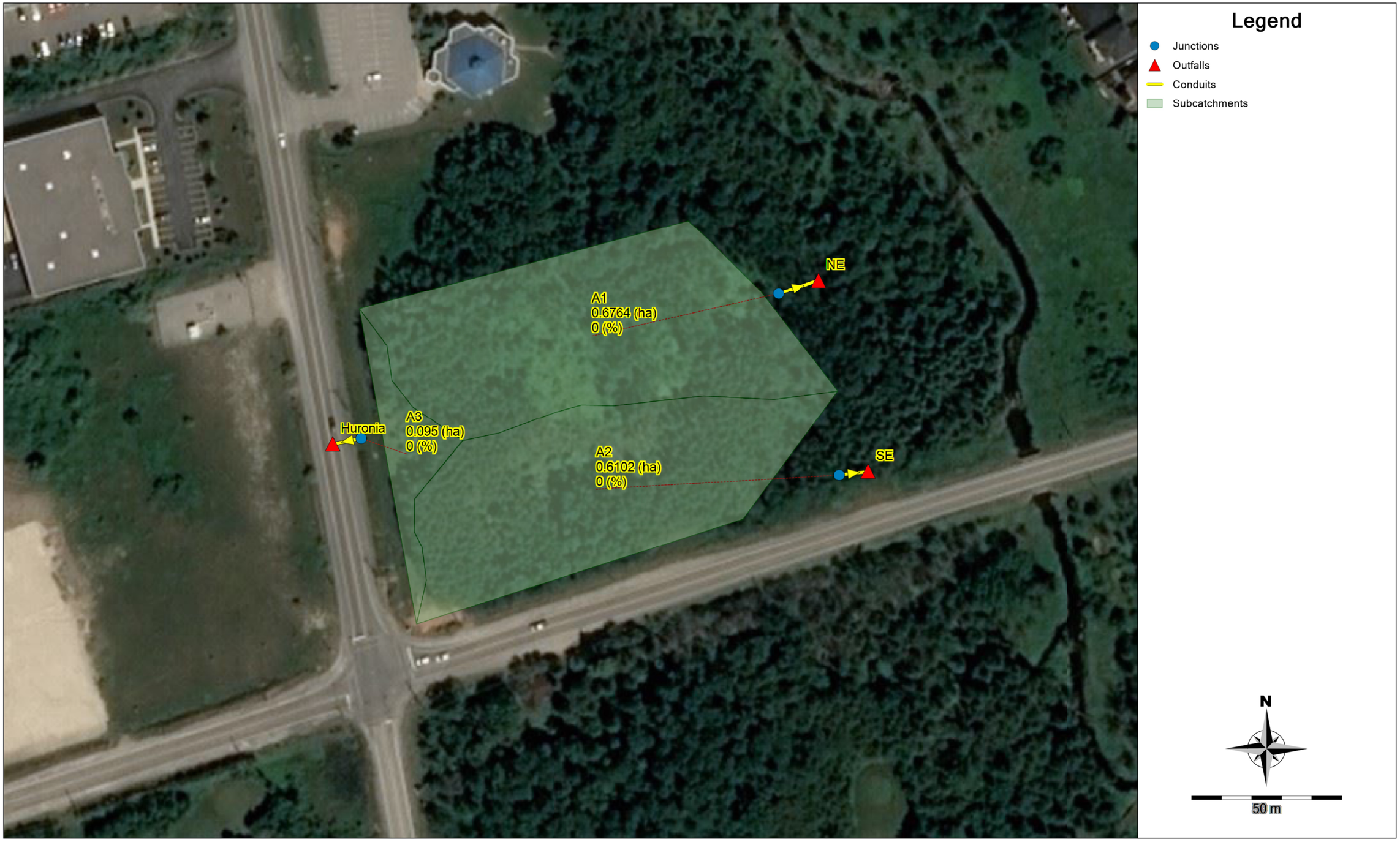
G 85541

White: Lab Copy / Yellow: Invoicing Copy / Pink: Client Copy

CofC, May 2019, Revision No: 22

Appendix D – Pre Development SWM Information

Existing Conditions PCSWMM Catchment Plan



Existing Condition - 100 Year 12 Hr SCS Type II Storm

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

WARNING 04: minimum elevation drop used for Conduit C1
WARNING 04: minimum elevation drop used for Conduit C2
WARNING 04: minimum elevation drop used for Conduit C3

*************
Element Count
*************
Number of rain gages ...... 16
Number of subcatchments ... 3
Number of nodes ........... 6
Number of links ........... 3
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                  Data       Recording
Name                 Data Source                  Type       Interval
------------------------------------------------------------------------
100YR12HRSCS         100YR12HRSCS                 INTENSITY    6 min.
100YR4HRCHIC         100YR4HRCHIC                 INTENSITY    5 min.
10YR4HRCHIC          10YR4HRCHIC                  INTENSITY    5 min.
10YR4HRSCS           10YR12HRSCS                  INTENSITY    6 min.
25mm                 25mm                         INTENSITY    5 min.
25YR12HRSCS          25YR12HRSCS                  INTENSITY    6 min.
25YR4HRCHIC          25YR4HRCHIC                  INTENSITY    5 min.
2YR12HRSCS           2YR12HRSCS                   INTENSITY    6 min.
2YR4HRCHIC           2YR4HRCHIC                   INTENSITY    5 min.
50YR12HRSCS          50YR12HRSCS                  INTENSITY    6 min.
50YR4HRCHIC          50YR4HRCHIC                  INTENSITY    5 min.
5YR12HRSCS           5YR12HRSCS                   INTENSITY    6 min.
5YR4HRCHIC           5YR4HRCHIC                   INTENSITY    5 min.
Continuous           Continuous                   INTENSITY   60 min.
Hurricane_Hazel_(0-25) Hurricane_Hazel_(0-25)       INTENSITY   60 min.
Timmins_Storm_(0-25) Timmins_Storm_(0-25)         INTENSITY   60 min.


********************
Subcatchment Summary
********************
```

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
A1	0.68	67.64	0.00	6.0000	100YR12HRSCS	J1
A2	0.61	61.02	0.00	6.0000	100YR12HRSCS	J3
A3	0.10	38.00	0.00	15.0000	100YR12HRSCS	J2

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	0.00	0.00	0.0	
J2	JUNCTION	0.00	0.00	0.0	
J3	JUNCTION	0.00	0.00	0.0	
Huronia	OUTFALL	0.00	0.00	0.0	
NE	OUTFALL	0.00	0.00	0.0	
SE	OUTFALL	0.00	0.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	J1	NE	CONDUIT	13.9	0.0022	0.0130
C2	J2	Huronia	CONDUIT	9.6	0.0032	0.0130
C3	J3	SE	CONDUIT	9.8	0.0031	0.0130

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C2	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C3	DUMMY	0.00	0.00	0.00	0.00	1	0.00

****
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 ..... NO
  Water Quality ..... NO
Infiltration Method ..... GREEN_AMPT
Flow Routing Method ..... DYNWAVE
Surcharge Method ..... EXTRAN
Starting Date 12/19/2019 00:00:00
Ending Date 12/20/2019 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
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 ..... 0.001524 m

**********	Volume	Depth
Runoff Quantity Continuity	hectare-m	mm
**********	---------	-------
Total Precipitation	0.155	112.500
Evaporation Loss	0.000	0.000
Infiltration Loss	0.032	23.457
Surface Runoff	0.117	84.972
Final Storage	0.006	4.179
Continuity Error (%)	-0.096	

**********	Volume	Volume
Flow Routing Continuity	hectare-m	10^6 ltr
**********	---------	---------
Dry Weather Inflow	0.000	0.000

Wet Weather Inflow	0.117	1.175
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.117	1.175
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 (%)	0.000	

****
Time-Step Critical Elements
****
None

****
Highest Flow Instability Indexes
****
All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	4.50 sec
Average Time Step	:	5.00 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 Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
A1	112.50	0.00	0.00	23.46	0.00	84.85	84.85	0.57	0.18	0.754

A2	112.50	0.00	0.00	23.46	0.00	84.85	84.85	0.52	0.16	0.754
A3	112.50	0.00	0.00	23.38	0.00	86.67	86.67	0.08	0.04	0.770

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.00	0.00	0.00	0 00:00	0.00
J2	JUNCTION	0.00	0.00	0.00	0 00:00	0.00
J3	JUNCTION	0.00	0.00	0.00	0 00:00	0.00
Huronia	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
NE	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
SE	OUTFALL	0.00	0.00	0.00	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.176	0.176	0 06:00	0.574	0.574	0.000
J2	JUNCTION	0.042	0.042	0 05:54	0.0824	0.0824	0.000
J3	JUNCTION	0.159	0.159	0 06:00	0.518	0.518	0.000
Huronia	OUTFALL	0.000	0.042	0 05:54	0	0.0824	0.000
NE	OUTFALL	0.000	0.176	0 06:00	0	0.574	0.000
SE	OUTFALL	0.000	0.159	0 06:00	0	0.518	0.000

****
Node Surcharge Summary
****

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

	Max. Height	Min. Depth

Node	Type	Hours Surcharged	Above Crown Meters	Below Rim Meters
J1	JUNCTION	24.00	0.000	0.000
J2	JUNCTION	24.00	0.000	0.000
J3	JUNCTION	24.00	0.000	0.000

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
Huronia	32.71	0.003	0.042	0.082
NE	41.38	0.016	0.176	0.574
SE	41.31	0.015	0.159	0.518
System	38.46	0.034	0.159	1.175

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	DUMMY	0.176	0 06:00			
C2	DUMMY	0.042	0 05:54			
C3	DUMMY	0.159	0 06:00			

****

Flow Classification Summary
****

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

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Fri Dec 20 15:17:21 2019
Analysis ended on: Fri Dec 20 15:17:21 2019
Total elapsed time: < 1 sec

Appendix E – Post Development SWM Information

Project Name: 380 Lockhart Rd
Project No.: 2019-039
Location: City of Barrie
Created By: CC
Checked By: CC
Date Created: Jan. 2, 2020
Date Modified: 22-Jan-20

CAPES ENGINEERING

Outlet From Storage Chamber

Outlet Type	Elevation (m)	Head (m)	δ h (m)	h (m)	P (m)	H (m)	Outlet from Structure: Orifice m^3/s	Trap. Weir m^3/s		Total m^3/s	Storm Event	Hydraulic Gradeline
Orifice	247.50	0.00	0.00				0.000			0.000		
Orifice	247.55	0.05	0.01				0.001			0.001		
Orifice	247.60	0.10	0.06				0.003			0.003		
Orifice	247.65	0.15	0.11				0.004			0.004		
Orifice	247.70	0.20	0.16				0.005			0.005		
Orifice	247.75	0.25	0.21				0.006			0.006		
Orifice	247.80	0.30	0.26				0.006			0.006		
Orifice	247.85	0.35	0.31				0.007			0.007		
Orifice	247.90	0.40	0.36				0.007			0.007		
Orifice	247.95	0.45	0.41				0.008			0.008		
Orifice	248.00	0.50	0.46				0.008			0.008		
Orifice	248.05	0.55	0.51				0.009			0.009		
Orifice + Trap. W	248.10	0.60	0.56	0.00	0.56		0.009	0.000		0.009	2	248.12
Orifice + Trap. W	248.15	0.65	0.61	0.05	0.56		0.010	0.004		0.014		
Orifice + Trap. W	248.20	0.70	0.66	0.10	0.56		0.010	0.012		0.022		
Orifice + Trap. W	248.25	0.75	0.71	0.15	0.56		0.010	0.022		0.032	5	248.26
Orifice + Trap. W	248.28	0.775	0.74	0.18	0.56		0.011	0.027		0.038		
Orifice + Trap. W	248.33	0.825	0.79	0.23	0.56		0.011	0.040		0.051		
Orifice + Trap. W	248.38	0.880	0.84	0.28	0.56		0.011	0.055		0.066	10	248.36
Orifice + Trap. W	248.43	0.925	0.89	0.33	0.56		0.012	0.069		0.081		
Orifice + Trap. W	248.48	0.975	0.94	0.38	0.56		0.012	0.085		0.097		
Orifice + Trap. W	248.53	1.025	0.99	0.43	0.56		0.012	0.103		0.115	25	248.51
Orifice + Trap. W	248.58	1.075	1.04	0.48	0.56		0.013	0.122		0.134	50	248.57
Orifice + Trap. W	248.63	1.125	1.09	0.53	0.56		0.013	0.142		0.154	Hazel	248.63
Orifice + Trap. W	248.68	1.175	1.14	0.58	0.56		0.013	0.162		0.175		
Orifice + Trap. W	248.73	1.225	1.19	0.63	0.56		0.013	0.184		0.197		
Orifice + Trap. W	248.78	1.275	1.24	0.68	0.56		0.014	0.206		0.220		
Orifice + Trap. W	248.83	1.325	1.29	0.73	0.56		0.014	0.230		0.244		
Orifice + Trap. W	248.88	1.375	1.34	0.78	0.56		0.014	0.254		0.268		
Orifice + Trap. W	248.93	1.425	1.39	0.83	0.56		0.015	0.279		0.293		
Orifice + Trap. W	248.98	1.475	1.44	0.88	0.56		0.015	0.304		0.319	100	248.97
Orifice + Trap. W	249.03	1.525	1.49	0.93	0.56		0.015	0.331		0.346		
Orifice + Trap. W	249.08	1.575	1.54	0.98	0.56		0.015	0.358		0.373		
Orifice + Trap. W	249.13	1.625	1.59	1.03	0.56		0.016	0.386		0.402		
Orifice + Trap. W	249.18	1.675	1.64	1.08	0.56		0.016	0.415		0.430		
Orifice + Trap. W	249.23	1.725	1.69	1.13	0.56		0.016	0.444		0.460		
Orifice + Trap. W	249.25	1.745	1.71	1.15	0.56		0.016	0.456		0.472		

Orifice $Q = Cd*Ao*SQRT(2g*\delta h)$

Q = Peak Runoff (m^3/s)
Cd = Constant (0.63 orifice, 0.8 for orifice tube)
Ao = Cross sectional Area of Orifice (m^2)
g = gravity, 9.8 m/s^2
δ h = change in elevation between middle of the discharge pipe and the water surface (m)

Cd	0.63
Orifice Dia. (m)	0.075

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

Q = Peak Runoff (m^3/s)
b = width of weir bottom (m)
h = distance from weir opening to top of water surface (m)

b	0.20

Post Development 100 yr 12 Hr SCS Results

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

No LID

WARNING 04: minimum elevation drop used for Conduit C2

*************
Element Count
*************
Number of rain gages ...... 16
Number of subcatchments ... 9
Number of nodes ........... 14
Number of links ........... 12
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                  Data       Recording
Name                 Data Source                  Type       Interval
------------------------------------------------------------------------
100YR12HRSCS         100YR12HRSCS                 INTENSITY    6 min.
100YR4HRCHIC         100YR4HRCHIC                 INTENSITY    5 min.
10YR4HRCHIC          10YR4HRCHIC                  INTENSITY    5 min.
10YR4HRSCS           10YR12HRSCS                  INTENSITY    6 min.
25mm                 25mm                         INTENSITY    5 min.
25YR12HRSCS          25YR12HRSCS                  INTENSITY    6 min.
25YR4HRCHIC          25YR4HRCHIC                  INTENSITY    5 min.
2YR12HRSCS           2YR12HRSCS                   INTENSITY    6 min.
2YR4HRCHIC           2YR4HRCHIC                   INTENSITY    5 min.
50YR12HRSCS          50YR12HRSCS                  INTENSITY    6 min.
50YR4HRCHIC          50YR4HRCHIC                  INTENSITY    5 min.
5YR12HRSCS           5YR12HRSCS                   INTENSITY    6 min.
5YR4HRCHIC           5YR4HRCHIC                   INTENSITY    5 min.
Continuous           Continuous                   INTENSITY   60 min.
Hurricane_Hazel_(0-25) Hurricane_Hazel_(0-25)       INTENSITY   60 min.
Timmins_Storm_(0-25) Timmins_Storm_(0-25)         INTENSITY   60 min.


********************
Subcatchment Summary
********************
```

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
A1	0.07	7.78	100.00	1.0000	100YR12HRSCS	CBMH04
A2	0.16	15.88	0.00	6.0000	100YR12HRSCS	SE
A3	0.06	98.00	0.00	2.0000	100YR12HRSCS	J2
A4	0.45	51.90	100.00	0.5000	100YR12HRSCS	Infil_Storage
A5	0.09	44.70	100.00	3.0000	100YR12HRSCS	DCBMH01
A6	0.09	29.83	100.00	2.0000	100YR12HRSCS	DCBMH02
A7	0.01	17.80	0.00	2.0000	100YR12HRSCS	J2
A8	0.36	54.06	100.00	1.0000	100YR12HRSCS	DCBMH05
A9	0.09	61.67	0.00	5.0000	100YR12HRSCS	SE

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
CBMH04	JUNCTION	248.26	1.42	0.0	
DCBMH01	JUNCTION	249.31	1.64	0.0	
DCBMH02	JUNCTION	249.00	1.86	0.0	
DCBMH05	JUNCTION	247.84	1.12	0.0	
HDWL1	JUNCTION	245.60	0.73	0.0	
J2	JUNCTION	0.00	0.00	0.0	
MH03	JUNCTION	248.84	2.10	0.0	
MH06	JUNCTION	247.93	2.23	0.0	
MH07	JUNCTION	246.57	2.68	0.0	
OGS	JUNCTION	247.82	1.31	0.0	
Huronia	OUTFALL	0.00	0.00	0.0	
SE	OUTFALL	245.00	0.00	0.0	
Infil_Storage	STORAGE	248.71	1.48	0.0	
Storage	STORAGE	247.50	1.73	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	HDWL1	SE	CONDUIT	36.2	1.6578	0.0130
C10_1	Infil_Storage	MH06	CONDUIT	2.3	3.4474	0.0130
C10_2	MH06	Storage	CONDUIT	24.7	1.7407	0.0130
C12	MH07	HDWL1	CONDUIT	21.0	4.6280	0.0130
C2	J2	Huronia	CONDUIT	9.6	0.0032	0.0130
C4	DCBMH01	DCBMH02	CONDUIT	52.3	0.4971	0.0130

C5	DCBMH02	MH03	CONDUIT	21.6	0.5098	0.0130
C6	MH03	CBMH04	CONDUIT	86.1	0.6041	0.0130
C7	CBMH04	DCBMH05	CONDUIT	67.3	0.5048	0.0130
C8	DCBMH05	OGS	CONDUIT	3.9	0.5176	0.0130
C9	OGS	Storage	CONDUIT	4.0	8.0970	0.0130
C11	Storage	MH07	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C10_1	CIRCULAR	0.30	0.07	0.07	0.30	1	0.18
C10_2	CIRCULAR	0.30	0.07	0.07	0.30	1	0.13
C12	CIRCULAR	0.45	0.16	0.11	0.45	1	0.61
C2	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C4	CIRCULAR	0.30	0.07	0.07	0.30	1	0.07
C5	CIRCULAR	0.38	0.11	0.09	0.38	1	0.13
C6	CIRCULAR	0.45	0.16	0.11	0.45	1	0.22
C7	CIRCULAR	0.45	0.16	0.11	0.45	1	0.20
C8	CIRCULAR	0.45	0.16	0.11	0.45	1	0.21
C9	CIRCULAR	0.45	0.16	0.11	0.45	1	0.81

****
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 ............ 06/01/2005 00:00:00
Ending Date .............. 06/03/2005 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
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
```

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Initial Snow Cover	0.000	0.000
Total Precipitation	0.155	112.500
Evaporation Loss	0.000	0.000
Infiltration Loss	0.008	5.674
Surface Runoff	0.146	105.607
Snow Removed	0.000	0.000
Final Snow Cover	0.000	0.000
Final Storage	0.002	1.539
Continuity Error (%)	-0.285	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.146	1.459
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.146	1.459
Flooding Loss	0.000	0.001
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.002
Continuity Error (%)	-0.136	

****
Highest Continuity Errors
****
Node MH03 (1.12%)

****
Time-Step Critical Elements
****
Link C10_1 (72.22%)
Link C9 (4.51%)
Link C8 (1.68%)

****
Highest Flow Instability Indexes
****
Link C8 (2)

****
Routing Time Step Summary
****
Minimum Time Step   :   0.42 sec
Average Time Step   :   2.43 sec
Maximum Time Step   :   5.00 sec
Percent in Steady State   :   0.00
Average Iterations per Step :   2.01
Percent Not Converging   :   0.03

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
A1	112.50	0.00	0.00	0.00	110.89	0.00	110.89	0.08	0.04	0.986
A2	112.50	0.00	0.00	24.32	0.00	88.29	88.29	0.14	0.05	0.785
A3	112.50	0.00	0.00	22.86	0.00	90.04	90.04	0.05	0.03	0.800
A4	112.50	0.00	0.00	0.00	110.86	0.00	110.86	0.50	0.21	0.985
A5	112.50	0.00	0.00	0.00	110.62	0.00	110.62	0.10	0.05	0.983

A6	112.50	0.00	0.00	0.00	110.74	0.00	110.74	0.10	0.05	0.984
A7	112.50	0.00	0.00	22.81	0.00	90.10	90.10	0.01	0.00	0.801
A8	112.50	0.00	0.00	0.00	110.89	0.00	110.89	0.40	0.18	0.986
A9	112.50	0.00	0.00	26.18	0.00	86.64	86.64	0.08	0.04	0.770

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
CBMH04	JUNCTION	0.04	1.42	249.68	0 05:56	0.82
DCBMH01	JUNCTION	0.02	0.18	249.49	0 05:53	0.18
DCBMH02	JUNCTION	0.03	0.23	249.23	0 05:54	0.23
DCBMH05	JUNCTION	0.17	1.16	249.00	0 05:59	1.16
HDWL1	JUNCTION	0.00	0.00	245.60	0 06:00	0.00
J2	JUNCTION	0.00	0.00	0.00	0 00:00	0.00
MH03	JUNCTION	0.02	0.29	249.13	0 05:58	0.29
MH06	JUNCTION	0.13	1.26	249.19	0 06:02	1.25
MH07	JUNCTION	0.04	0.33	246.90	0 05:56	0.33
OGS	JUNCTION	0.16	1.16	248.98	0 05:59	1.16
Huronia	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
SE	OUTFALL	0.00	0.00	245.00	0 00:00	0.00
Infil_Storage	STORAGE	0.03	0.50	249.21	0 06:02	0.50
Storage	STORAGE	0.36	1.47	248.97	0 05:55	1.46

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
CBMH04	JUNCTION	0.036	0.181	0 05:56	0.082	0.279	-0.772
DCBMH01	JUNCTION	0.046	0.046	0 05:54	0.099	0.099	0.056
DCBMH02	JUNCTION	0.046	0.091	0 05:54	0.0992	0.198	0.069
DCBMH05	JUNCTION	0.177	0.298	0 05:54	0.396	0.677	-0.178
HDWL1	JUNCTION	0.000	0.359	0 05:56	0	1.18	-0.002

J2	JUNCTION	0.033	0.033	0	05:54	0.061	0.061	0.000
MH03	JUNCTION	0.000	0.091	0	05:54	0	0.198	1.129
MH06	JUNCTION	0.000	0.155	0	05:52	0	0.501	-0.037
MH07	JUNCTION	0.000	0.317	0	05:55	0	1.18	-0.003
OGS	JUNCTION	0.000	0.297	0	05:54	0	0.677	-0.115
Huronia	OUTFALL	0.000	0.033	0	05:54	0	0.061	0.000
SE	OUTFALL	0.081	0.440	0	05:56	0.221	1.4	0.000
Infil_Storage	STORAGE	0.214	0.214	0	05:54	0.501	0.501	0.008
Storage	STORAGE	0.000	0.448	0	05:54	0	1.18	-0.001

****
Node Surcharge Summary
****

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

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
CBMH04	JUNCTION	0.14	0.910	0.000
DCBMH05	JUNCTION	0.67	0.633	0.000
J2	JUNCTION	48.00	0.000	0.000
MH06	JUNCTION	0.32	0.259	0.971
OGS	JUNCTION	1.65	0.709	0.151

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
CBMH04	0.01	0.144	0	05:56	0.001	0.000
Infil_Storage	48.00	0.000	0	00:00	0.000	-0.978
Storage	48.00	0.000	0	00:00	0.000	-0.258

****
Storage Volume Summary

****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
Infil_Storage	0.005	0	0	0	0.000	0	0 00:00	0.155
Storage	0.137	0	0	0	0.000	0	0 00:00	0.317

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
Huronia	42.80	0.003	0.033	0.061
SE	98.60	0.018	0.440	1.398
System	70.70	0.020	0.440	1.459

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	DUMMY	0.359	0 05:56			
C10_1	CONDUIT	0.155	0 05:52	2.85	0.86	1.00
C10_2	CONDUIT	0.152	0 05:52	2.15	1.19	1.00
C12	CONDUIT	0.359	0 05:56	8.53	0.58	0.37
C2	DUMMY	0.033	0 05:54			
C4	CONDUIT	0.046	0 05:53	1.02	0.67	0.60
C5	CONDUIT	0.091	0 05:54	1.30	0.73	0.61
C6	CONDUIT	0.090	0 05:54	1.32	0.41	0.82
C7	CONDUIT	0.124	0 05:54	1.03	0.61	1.00
C8	CONDUIT	0.297	0 05:54	2.02	1.45	1.00
C9	CONDUIT	0.297	0 05:54	2.21	0.37	1.00

C11 DUMMY 0.317 0 05:55

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
		---------- Fraction of Time in Flow Class ----------								
C10_1	1.00	0.01	0.00	0.00	0.01	0.01	0.00	0.97	0.00	0.00
C10_2	1.00	0.01	0.10	0.00	0.84	0.05	0.00	0.00	0.76	0.00
C12	1.00	0.01	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.00
C4	1.00	0.01	0.00	0.00	0.01	0.00	0.00	0.98	0.00	0.00
C5	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00
C6	1.00	0.01	0.00	0.00	0.03	0.00	0.00	0.96	0.01	0.00
C7	1.00	0.01	0.00	0.00	0.42	0.00	0.00	0.57	0.18	0.00
C8	1.00	0.01	0.00	0.00	0.75	0.24	0.00	0.00	0.10	0.00
C9	1.00	0.01	0.13	0.00	0.79	0.07	0.00	0.00	0.71	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C10_1	0.26	0.26	0.32	0.01	0.01
C10_2	2.21	2.21	12.98	0.08	0.08
C6	0.01	0.01	0.14	0.01	0.01
C7	0.18	0.18	0.67	0.01	0.01
C8	1.44	1.44	1.65	0.17	0.12
C9	1.65	1.65	9.40	0.01	0.01

Analysis begun on: Wed Jan 22 14:35:22 2020
Analysis ended on: Wed Jan 22 14:35:23 2020
Total elapsed time: 00:00:01

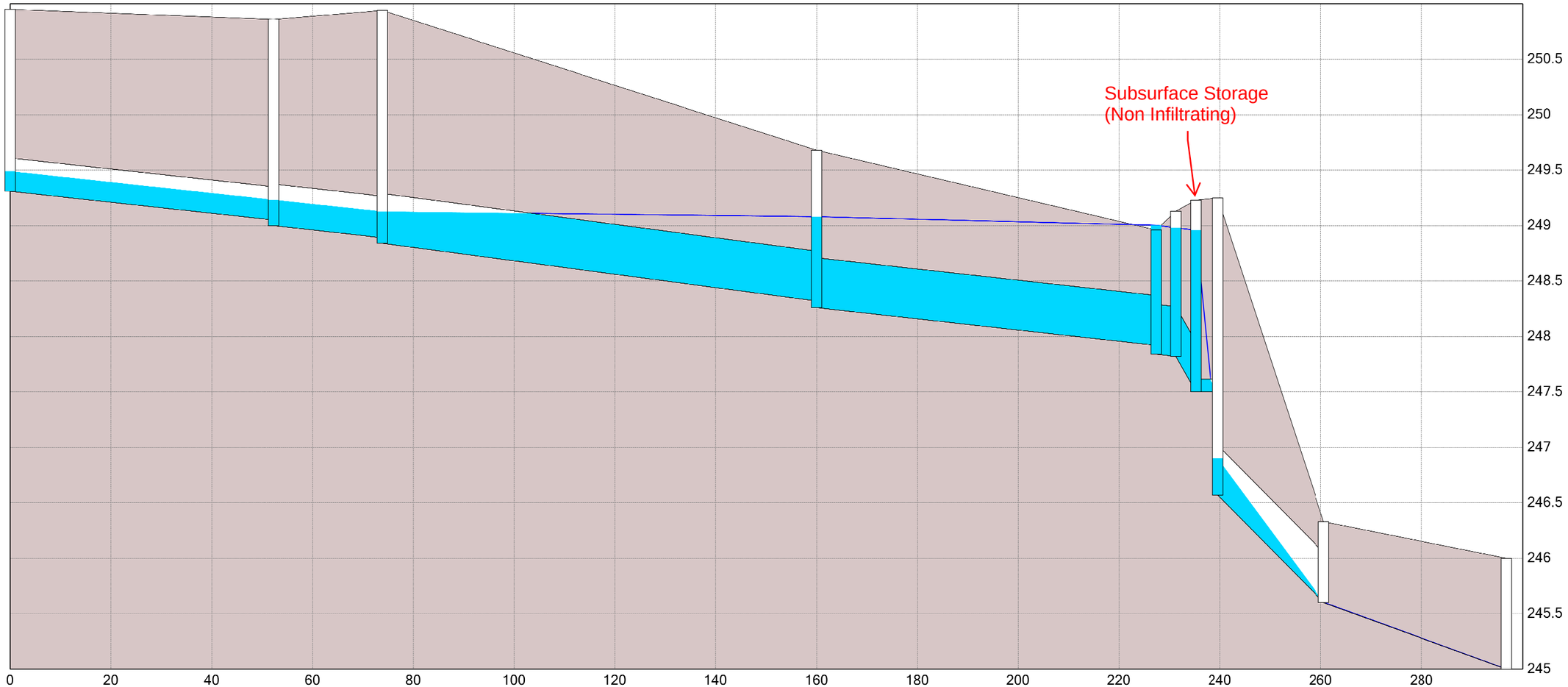
380 Lockhart Rd. - Storm Sewer Profile

100 Year 12 Hr SCS Hydraulic Grade Line

HGL

Peak values

Links:	C4	C5	C6	C7	C8	C9	C11	C12	C1
	Q=0.046 m³/s	Q=0.091 m³/s	Q=0.09 m³/s	Q=0.123 m³/s	Q=0.297 m³/s	Q=0.297 m³/s	Q=0.312 m³/s	Q=0.315 m³/s	Q=0.315 m³/s
	L=52.307 m	L=21.579 m	L=86.075 m	L=67.349 m	L=3.864 m	L=3.965 m		L=20.982 m	L=36.198 m
	D=0.3 m	D=0.375 m	D=0.45 m	D=0.45 m	D=0.45 m	D=0.45 m		D=0.45 m	D=0 m
	V=1.021 m/s	V=1.301 m/s	V=1.321 m/s	V=1.03 m/s	V=2.009 m/s	V=2.207 m/s	V=0 m/s	V=7.382 m/s	V=0 m/s



Nodes:	DCBMH01	DCBMH02	MH03	CBMH04	DCBMH05	OGS	Storage	MH07	HDWL1	SE
	M=249.4893 m	M=249.2328 m	M=249.1269 m	M=249.0802 m	M=249.0023 m	M=248.9787 m	M=248.9581 m	M=246.8999 m	M=245.6035 m	M=245 m
	R=250.95 m	R=250.86 m	R=250.94 m	R=249.68 m	R=248.96 m	R=249.13 m	R=249.23 m	R=249.25 m	R=246.33 m	R=246 m
	I=249.31 m	I=249 m	I=248.84 m	I=248.26 m	I=247.84 m	I=247.82 m	I=247.5 m	I=246.57 m	I=245.6 m	I=245 m

380 Lockhart Rd. - Storm Sewer Profile 2

100 Year 12 Hr SCS Hydraulic Grade Line

HGL

Peak values

Conduit C10_1
Flow = 0.153 m³/s
Length = 2.322 m
Depth = 0.3 m
Velocity = 2.828 m/s

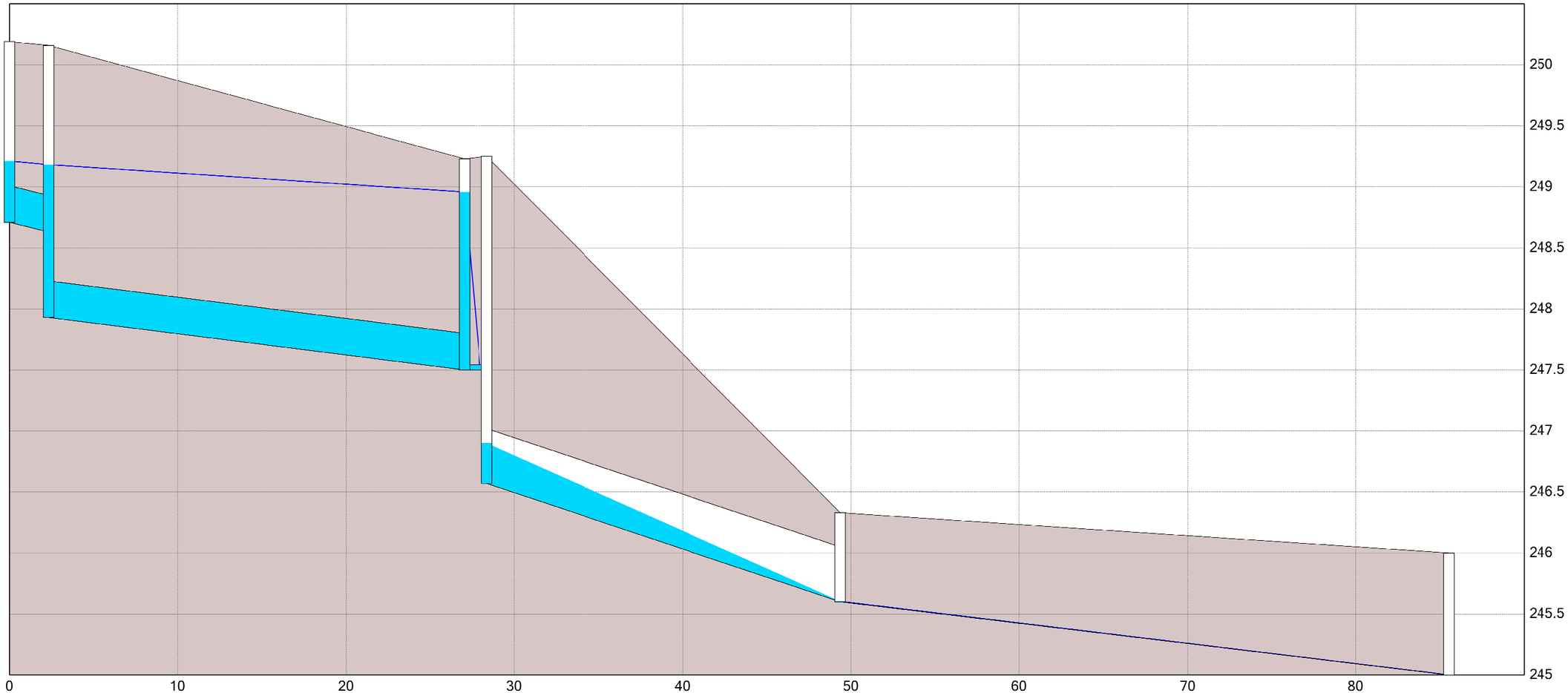
Conduit C10_2
Flow = 0.152 m³/s
Length = 24.706 m
Depth = 0.3 m
Velocity = 2.152 m/s

Outlet C11
Flow = 0.312 m³/s

Velocity = 0 m/s

Conduit C12
Flow = 0.315 m³/s
Length = 20.982 m
Depth = 0.45 m
Velocity = 7.382 m/s

Conduit C1
Flow = 0.315 m³/s
Length = 36.198 m
Depth = 0 m
Velocity = 0 m/s



Storage Infil_Storage
Max. CWSEL = 249.2118 m
Rim Elev. = 250.19 m
Invert Elev. = 248.71 m
06/01/2005 06:03AM

Junction MH06
Max. CWSEL = 249.1818 m
Rim Elev. = 250.16 m
Invert Elev. = 247.93 m
06/01/2005 06:03AM

Storage Storage
Max. CWSEL = 248.9581 m
Rim Elev. = 249.23 m
Invert Elev. = 247.5 m
06/01/2005 05:56AM

Junction MH07
Max. CWSEL = 246.8999 m
Rim Elev. = 249.25 m
Invert Elev. = 246.57 m
06/01/2005 05:56AM

Junction HDWL1
Max. CWSEL = 245.6035 m
Rim Elev. = 246.33 m
Invert Elev. = 245.6 m
06/01/2005 06:00AM

Outfall SE
Max. CWSEL = 245 m
Rim Elev. = 246 m
Invert Elev. = 245 m
06/01/2005 12:01AM

Post Development 25 mm Storm Results (with Infiltration)

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

No LID

WARNING 04: minimum elevation drop used for Conduit C2

*************
Element Count
*************
Number of rain gages ...... 16
Number of subcatchments ... 9
Number of nodes ........... 14
Number of links ........... 12
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                  Data       Recording
Name                 Data Source                  Type       Interval
------------------------------------------------------------------------
100YR12HRSCS         100YR12HRSCS                 INTENSITY    6 min.
100YR4HRCHIC         100YR4HRCHIC                 INTENSITY    5 min.
10YR4HRCHIC          10YR4HRCHIC                  INTENSITY    5 min.
10YR4HRSCS           10YR12HRSCS                  INTENSITY    6 min.
25mm                 25mm                         INTENSITY    5 min.
25YR12HRSCS          25YR12HRSCS                  INTENSITY    6 min.
25YR4HRCHIC          25YR4HRCHIC                  INTENSITY    5 min.
2YR12HRSCS           2YR12HRSCS                   INTENSITY    6 min.
2YR4HRCHIC           2YR4HRCHIC                   INTENSITY    5 min.
50YR12HRSCS          50YR12HRSCS                  INTENSITY    6 min.
50YR4HRCHIC          50YR4HRCHIC                  INTENSITY    5 min.
5YR12HRSCS           5YR12HRSCS                   INTENSITY    6 min.
5YR4HRCHIC           5YR4HRCHIC                   INTENSITY    5 min.
Continuous           Continuous                   INTENSITY   60 min.
Hurricane_Hazel_(0-25) Hurricane_Hazel_(0-25)       INTENSITY   60 min.
Timmins_Storm_(0-25) Timmins_Storm_(0-25)         INTENSITY   60 min.


********************
Subcatchment Summary
********************
```

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
A1	0.07	7.78	100.00	1.0000	25mm	CBMH04
A2	0.16	15.88	0.00	6.0000	25mm	SE
A3	0.06	98.00	0.00	2.0000	25mm	J2
A4	0.45	51.90	100.00	0.5000	25mm	Infil_Storage
A5	0.09	44.70	100.00	3.0000	25mm	DCBMH01
A6	0.09	29.83	100.00	2.0000	25mm	DCBMH02
A7	0.01	17.80	0.00	2.0000	25mm	J2
A8	0.36	54.06	100.00	1.0000	25mm	DCBMH05
A9	0.09	61.67	0.00	5.0000	25mm	SE

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
CBMH04	JUNCTION	248.26	1.42	0.0	
DCBMH01	JUNCTION	249.31	1.64	0.0	
DCBMH02	JUNCTION	249.00	1.86	0.0	
DCBMH05	JUNCTION	247.84	1.12	0.0	
HDWL1	JUNCTION	245.60	0.73	0.0	
J2	JUNCTION	0.00	0.00	0.0	
MH03	JUNCTION	248.84	2.10	0.0	
MH06	JUNCTION	247.93	2.23	0.0	
MH07	JUNCTION	246.57	2.68	0.0	
OGS	JUNCTION	247.82	1.31	0.0	
Huronia	OUTFALL	0.00	0.00	0.0	
SE	OUTFALL	245.00	0.00	0.0	
Infil_Storage	STORAGE	248.71	1.48	0.0	
Storage	STORAGE	247.50	1.73	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	HDWL1	SE	CONDUIT	36.2	1.6578	0.0130
C10_1	Infil_Storage	MH06	CONDUIT	2.3	3.4474	0.0130
C10_2	MH06	Storage	CONDUIT	24.7	1.7407	0.0130
C12	MH07	HDWL1	CONDUIT	21.0	4.6280	0.0130
C2	J2	Huronia	CONDUIT	9.6	0.0032	0.0130
C4	DCBMH01	DCBMH02	CONDUIT	52.3	0.4971	0.0130

C5	DCBMH02	MH03	CONDUIT	21.6	0.5098	0.0130
C6	MH03	CBMH04	CONDUIT	86.1	0.6041	0.0130
C7	CBMH04	DCBMH05	CONDUIT	67.3	0.5048	0.0130
C8	DCBMH05	OGS	CONDUIT	3.9	0.5176	0.0130
C9	OGS	Storage	CONDUIT	4.0	8.0970	0.0130
C11	Storage	MH07	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C10_1	CIRCULAR	0.30	0.07	0.07	0.30	1	0.18
C10_2	CIRCULAR	0.30	0.07	0.07	0.30	1	0.13
C12	CIRCULAR	0.45	0.16	0.11	0.45	1	0.61
C2	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C4	CIRCULAR	0.30	0.07	0.07	0.30	1	0.07
C5	CIRCULAR	0.38	0.11	0.09	0.38	1	0.13
C6	CIRCULAR	0.45	0.16	0.11	0.45	1	0.22
C7	CIRCULAR	0.45	0.16	0.11	0.45	1	0.20
C8	CIRCULAR	0.45	0.16	0.11	0.45	1	0.21
C9	CIRCULAR	0.45	0.16	0.11	0.45	1	0.81

****
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 ............ 06/01/2005 00:00:00
Ending Date .............. 06/03/2005 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
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
```

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Initial Snow Cover	0.000	0.000
Total Precipitation	0.035	24.999
Evaporation Loss	0.000	0.000
Infiltration Loss	0.005	3.863
Surface Runoff	0.027	19.756
Snow Removed	0.000	0.000
Final Snow Cover	0.000	0.000
Final Storage	0.002	1.539
Continuity Error (%)	-0.633	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.027	0.273
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.027	0.271
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.002
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-0.033	

****
Time-Step Critical Elements
****
Link C10_1 (38.80%)
Link C9 (4.21%)

****
Highest Flow Instability Indexes
****
Link C8 (6)
Link C9 (2)

****
Routing Time Step Summary
****
Minimum Time Step   :   0.56 sec
Average Time Step   :   3.72 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 Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
A1	25.00	0.00	0.00	0.00	23.17	0.00	23.17	0.02	0.01	0.927
A2	25.00	0.00	0.00	16.54	0.00	8.52	8.52	0.01	0.00	0.341
A3	25.00	0.00	0.00	15.01	0.00	10.48	10.48	0.01	0.00	0.419
A4	25.00	0.00	0.00	0.00	23.15	0.00	23.15	0.10	0.07	0.926
A5	25.00	0.00	0.00	0.00	23.10	0.00	23.10	0.02	0.02	0.924
A6	25.00	0.00	0.00	0.00	23.15	0.00	23.15	0.02	0.02	0.926
A7	25.00	0.00	0.00	14.97	0.00	10.60	10.60	0.00	0.00	0.424
A8	25.00	0.00	0.00	0.00	23.18	0.00	23.18	0.08	0.06	0.927
A9	25.00	0.00	0.00	18.25	0.00	6.80	6.80	0.01	0.00	0.272

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
CBMH04	JUNCTION	0.01	0.14	248.40	0 01:41	0.14
DCBMH01	JUNCTION	0.01	0.10	249.41	0 01:40	0.10
DCBMH02	JUNCTION	0.01	0.13	249.13	0 01:40	0.13
DCBMH05	JUNCTION	0.02	0.22	248.06	0 01:40	0.22
HDWL1	JUNCTION	0.00	0.00	245.60	0 03:14	0.00
J2	JUNCTION	0.00	0.00	0.00	0 00:00	0.00
MH03	JUNCTION	0.01	0.12	248.96	0 01:41	0.11
MH06	JUNCTION	0.01	0.13	248.06	0 01:43	0.13
MH07	JUNCTION	0.02	0.04	246.61	0 03:14	0.04
OGS	JUNCTION	0.01	0.11	247.93	0 01:40	0.11
Huronia	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
SE	OUTFALL	0.00	0.00	245.00	0 00:00	0.00
Infil_Storage	STORAGE	0.01	0.11	248.82	0 01:43	0.11
Storage	STORAGE	0.11	0.35	247.85	0 03:14	0.35

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
CBMH04	JUNCTION	0.012	0.042	0 01:41	0.0171	0.0585	-0.559
DCBMH01	JUNCTION	0.017	0.017	0 01:40	0.0206	0.0206	-0.008
DCBMH02	JUNCTION	0.017	0.033	0 01:40	0.0207	0.0414	-0.002
DCBMH05	JUNCTION	0.061	0.098	0 01:40	0.0827	0.142	0.171
HDWL1	JUNCTION	0.000	0.007	0 03:14	0	0.244	-0.003
J2	JUNCTION	0.004	0.004	0 01:45	0.00711	0.00711	0.000
MH03	JUNCTION	0.000	0.033	0 01:40	0	0.0414	-0.010
MH06	JUNCTION	0.000	0.052	0 01:43	0	0.103	-0.058
MH07	JUNCTION	0.000	0.007	0 03:14	0	0.244	0.001
OGS	JUNCTION	0.000	0.098	0 01:40	0	0.141	0.026
Huronia	OUTFALL	0.000	0.004	0 01:45	0	0.00711	0.000

SE	OUTFALL	0.005	0.011	0	01:55	0.0198	0.264	0.000
Infil_Storage	STORAGE	0.065	0.065	0	01:40	0.105	0.105	0.000
Storage	STORAGE	0.000	0.143	0	01:41	0	0.244	0.014

****
Node Surcharge Summary
****

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

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
J2	JUNCTION	48.00	0.000	0.000

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
Infil_Storage	48.00	0.000	0 00:00	0.000	-1.370
Storage	48.00	0.000	0 00:00	0.000	-1.380

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
Infil_Storage	0.002	0	0	2	0.000	0	0 00:00	0.052
Storage	0.058	0	0	0	0.000	0	0 00:00	0.007

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
Huronia	19.57	0.001	0.004	0.007
SE	87.31	0.003	0.011	0.264
System	53.44	0.004	0.011	0.271

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	DUMMY	0.007	0 03:14			
C10_1	CONDUIT	0.052	0 01:43	2.20	0.29	0.37
C10_2	CONDUIT	0.052	0 01:43	1.80	0.41	0.62
C12	CONDUIT	0.007	0 03:14	2.51	0.01	0.05
C2	DUMMY	0.004	0 01:45			
C4	CONDUIT	0.017	0 01:40	0.81	0.24	0.33
C5	CONDUIT	0.033	0 01:40	0.97	0.27	0.35
C6	CONDUIT	0.032	0 01:41	0.99	0.14	0.26
C7	CONDUIT	0.042	0 01:41	1.00	0.21	0.31
C8	CONDUIT	0.098	0 01:40	1.89	0.48	0.36
C9	CONDUIT	0.098	0 01:40	3.77	0.12	0.43
C11	DUMMY	0.007	0 03:14			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl

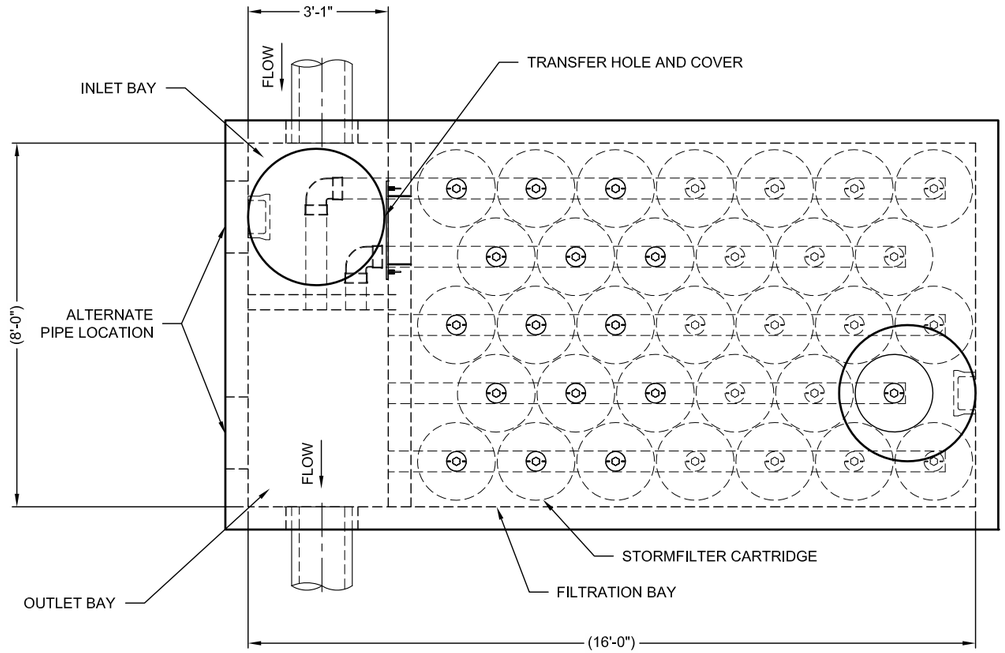
C10_1	1.00	0.53	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00
C10_2	1.00	0.02	0.53	0.00	0.40	0.06	0.00	0.00	0.97	0.00
C12	1.00	0.02	0.00	0.00	0.00	0.98	0.00	0.00	0.00	0.00
C4	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00
C5	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00
C6	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00
C7	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
C8	1.00	0.01	0.00	0.00	0.68	0.30	0.00	0.00	0.04	0.00
C9	1.00	0.01	0.31	0.00	0.61	0.07	0.00	0.00	0.94	0.00

****
Conduit Surcharge Summary
****

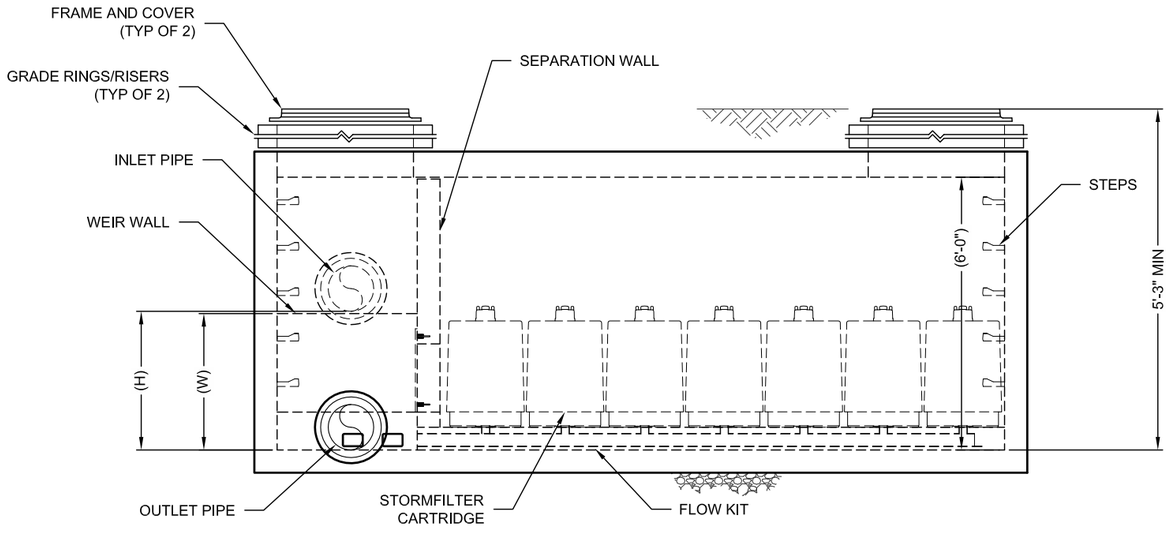
	Hours Full			Hours Above Full	Hours Capacity
Conduit	Both Ends	Upstream	Dnstream	Normal Flow	Limited
C10_2	0.01	0.01	3.18	0.01	0.01

Analysis begun on: Wed Jan 22 15:43:04 2020
Analysis ended on: Wed Jan 22 15:43:05 2020
Total elapsed time: 00:00:01

Appendix F – OGS Information



PLAN



ELEVATION

The Stormwater Management StormFilter®

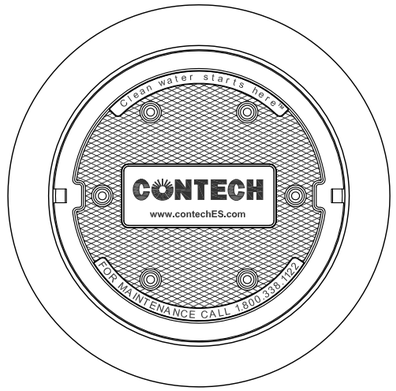
STORMFILTER DESIGN NOTES

- 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
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
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

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

Determining Number of Cartridges for Flow Based Systems

Date	**1/9/2020**	**Black Cells =**	**Calculation**

Site Information

Project Name	**Lockhart Ave 380**		
Project Location	**Barrie, ON**		
OGS ID	**OGS**		
Drainage Area, Ad	**1.51**	ac	(0.61 ha)
Impervious Area, Ai	**1.51**	ac	
Pervious Area, Ap	**0.00**		
% Impervious	**100%**		
Runoff Coefficient, Rc	**0.95**		
Treatment storm flow rate, Q_{treat}	**0.74**	cfs	(20.93 L/s)
Peak storm flow rate, Q_{peak}	**TBD**	cfs	

Filter System

Filtration brand	**StormFilter**	
Cartridge height	**18**	in
Specific Flow Rate	**2.00**	gpm/ft^2
Flow rate per cartridge	**15.00**	gpm

SUMMARY

Number of Cartridges	28
Media Type	Perlite

Event Mean Concentration (EMC)	**150**	mg/L
Annual TSS Removal	**80%**	
Percent Runoff Capture	**90%**	

Recommended vault SFPD0816

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

NJCAT TECHNOLOGY VERIFICATION

Stormwater Management StormFilter® (StormFilter) With Perlite Media

Contech Engineered Solutions LLC

November, 2016

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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.

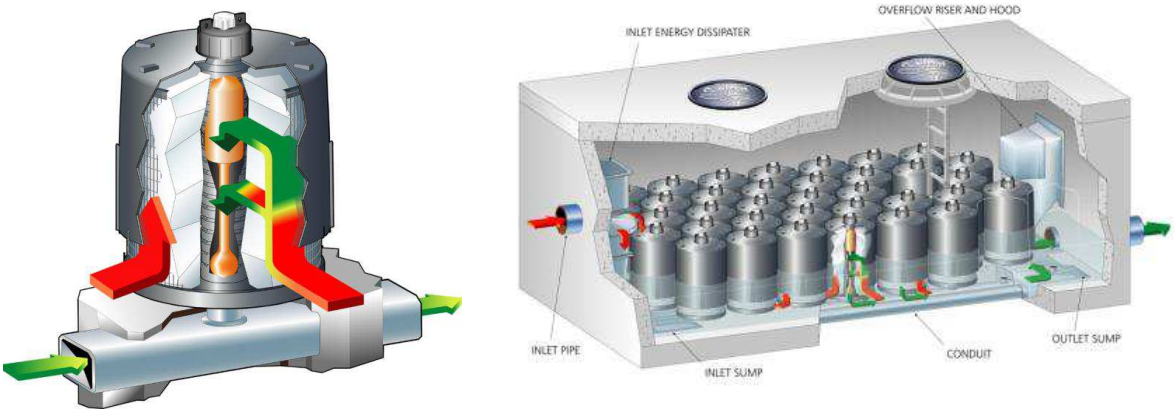


Figure 1 Individual StormFilter Cartridge (Left) and Typical Vault StormFilter Installation (Right)

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®, 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 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^2, 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.

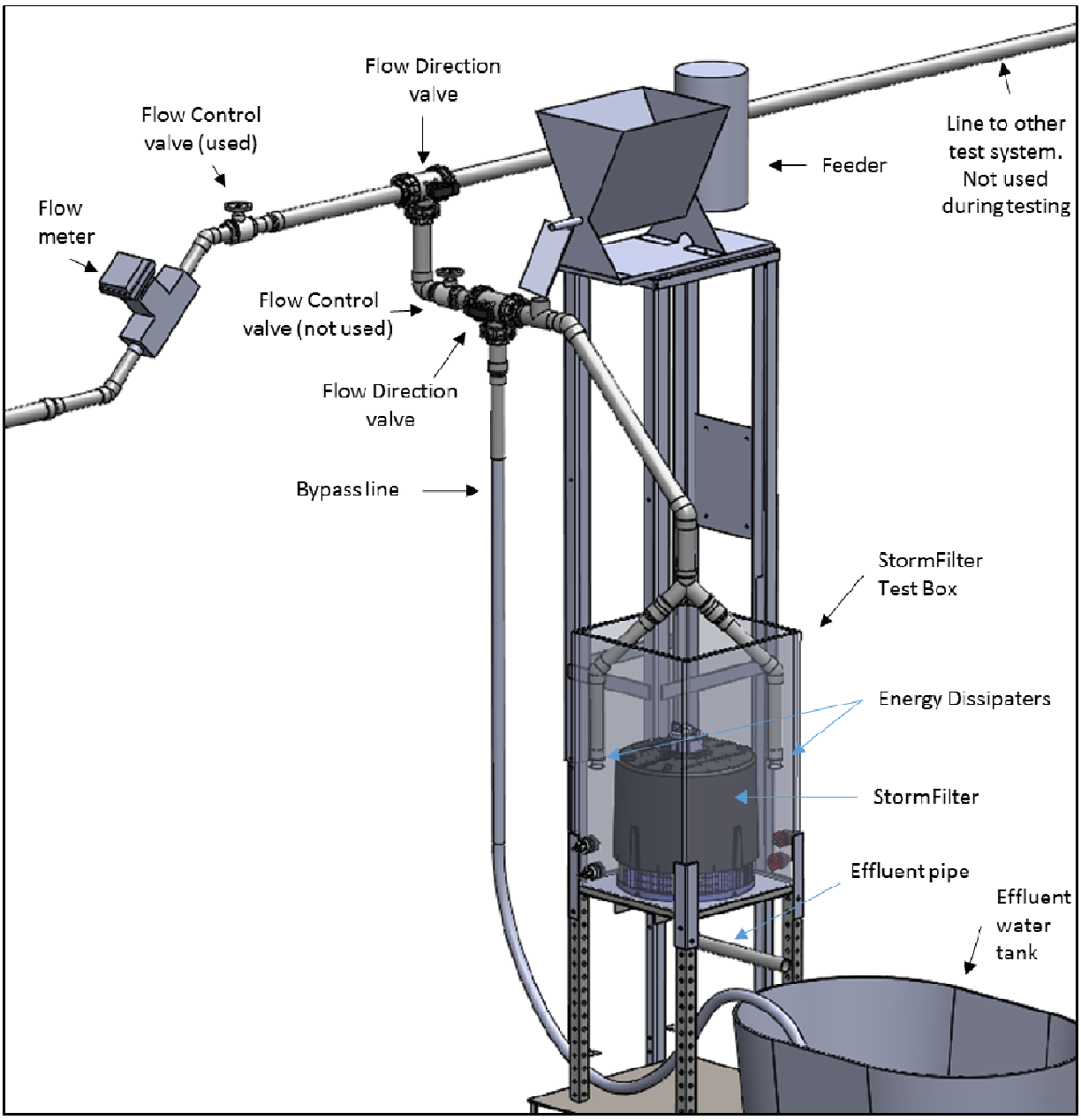


Figure 2 Graphic of StormFilter Test Apparatus

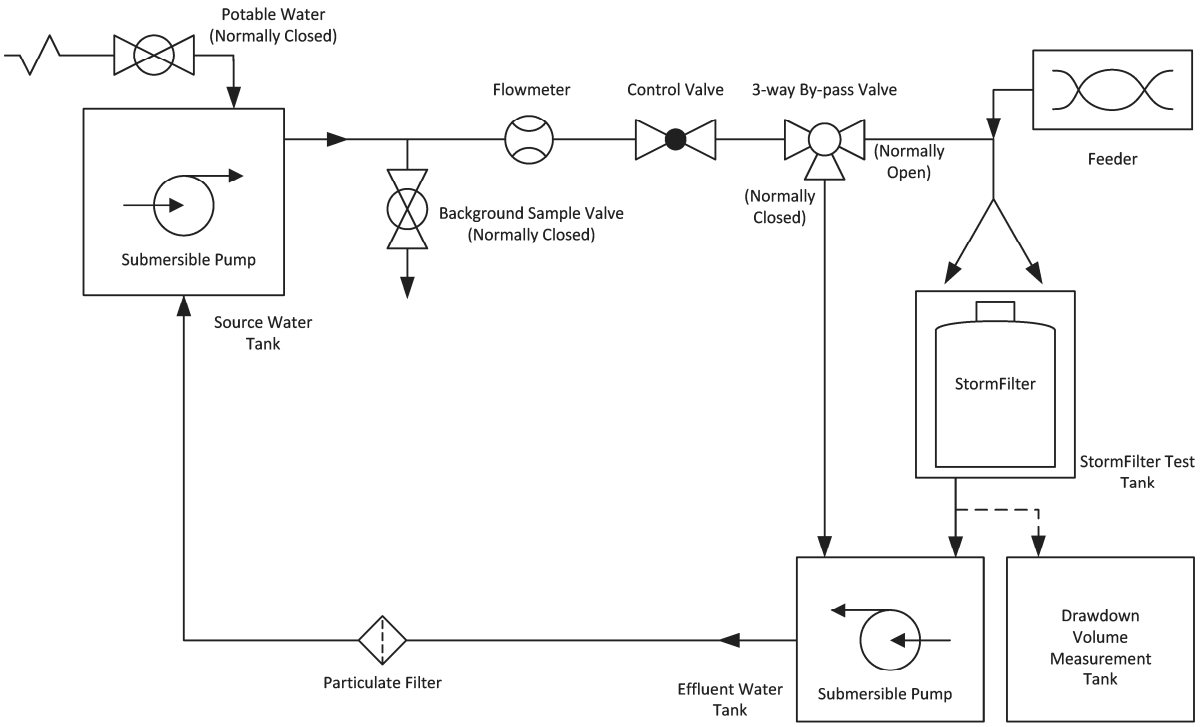


Figure 3 Schematic of StormFilter Laboratory Test Setup

2.2 Test Sediment

Sediment used for solids removal efficiency testing was high-purity silica (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 (±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^2 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 (±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 ±0.0625 inches.

Table 2 Water Surface Elevation and Temperature Sampling Times

Time (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 (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 (±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^2 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^2. All commercially available StormFilter models have a minimum of 3 ft^2 of effective (horizontal) sedimentation area per 18" filter cartridge. This is equivalent to 0.42 ft^2 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^2 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^2.

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^2 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^2 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		
Particle size (um)	Percent Finer	Allowable error Percent Finer
1000	100	98
500	95	93
250	90	88
150	75	73
100	60	58
75	50	48
50	45	43
20	35	33
8	20	18
5	10	8
2	5	3

Contech Test Sediment						
Sample 1		Sample 2		Sample 3		
Particle size (um)	Percent Finer	Particle size (um)	Percent Finer	Particle size (um)	Percent Finer	Percent Finer Mean
1000.0	98.2	1000	98.16	1000	98.3	98.2
500.0	96.0	500	95.78	500	95.8	95.9
250.0	90.8	250	90.59	250	90.8	90.7
150.0	76.3	150	76.11	150	76.4	76.3
106.0	65.1	106	65.15	106	65.1	65.1
75.0	51.6	75	51.34	75	51.2	51.4
63.0	48.5	63	48.2	63	48.3	48.3
53.0	46.3	53	45.87	53	46.0	46.0
44.7	42.9	45	41.5	45	41.0	41.8
31.9	40.1	33	38.59	32	39.1	39.1
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.

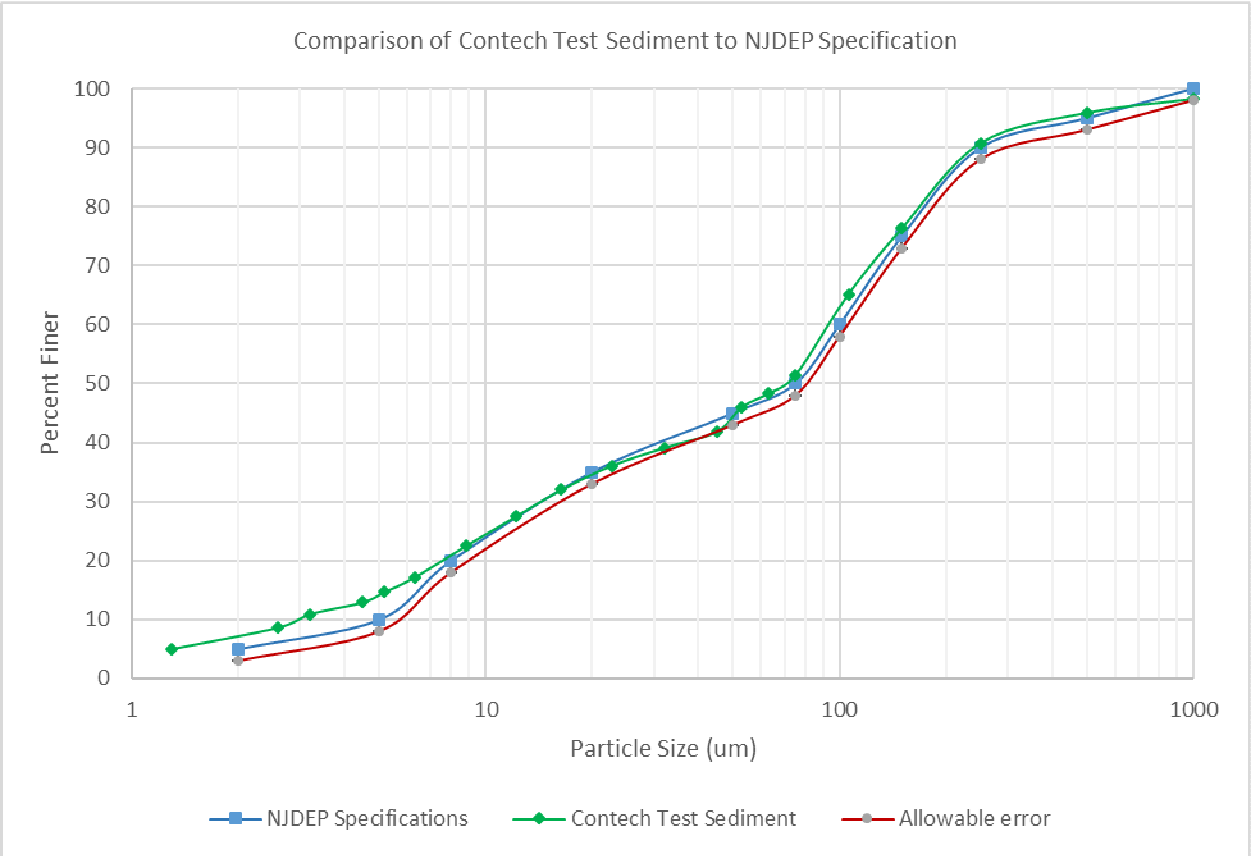


Figure 4 Comparison of Contech Test Sediment to NJDEP PSD Specification

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 ±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	-	-	*Target or QA/QC Requirement*
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

$$Average\ Influent\ TSS\ \left(\frac{mg}{L}\right) = \frac{Average\ Feed\ Rate\ \left(\frac{g}{min}\right) \times \frac{1000\ mg}{g}}{Average\ Water\ Flow\ Rate\ \left(\frac{gal}{min}\right) \times \frac{3.785\ L}{gal}}$$

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 (min from pump shutoff)	Drawdown TSS Sample 1 Time (min from pump shutoff)	Drawdown TSS Sample 2 Time (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

$$Average\ Adjusted\ Effluent\ TSS\left(\frac{mg}{L}\right) = Average\ Effluent\ TSS\ \left(\frac{mg}{L}\right) - Average\ Background\ TSS\ \left(\frac{mg}{L}\right)$$

Equation 4: Average Adjusted Drawdown TSS

$$Average\ Adjusted\ Drawdown\ TSS\ \left(\frac{mg}{L}\right) = Average\ Drawdown\ TSS\ \left(\frac{mg}{L}\right) - Average\ Background\ TSS\ \left(\frac{mg}{L}\right)$$

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

$$Influent\ Volume\ (L) = Sediment\ Injection\ Time\ (min) \times Average\ Flow\ Rate\ \left(\frac{gal}{min}\right) \times \frac{3.785\ L}{gal}$$

Equation 6: Effluent Volume

$$Effluent\ Volume\ (L) = Influent\ Volume\ (L) - Drawdown\ Volume\ (L)$$

Equation 7: Removal Efficiency (RE)

$$RE\ (\%) = (100\%) \times \frac{\left[Average\ Influent\ TSS\ \left(\frac{mg}{L}\right) \times Influent\ Volume\ (L)\right] - \left[Average\ Adjusted\ Effluent\ TSS\ \left(\frac{mg}{L}\right) \times Effluent\ Volume\ (L)\right] - \left[Average\ Adjusted\ Drawdown\ TSS\ \left(\frac{mg}{L}\right) \times Drawdown\ Volume\ (L)\right]}{\left[Average\ Influent\ TSS\ \left(\frac{mg}{L}\right) \times Influent\ Volume\ (L)\right]}$$

Equation 8: Sediment Mass Loading per Trial

$$Sediment\ Mass\ Loading\ per\ Trial\ (lb) = Average\ Influent\ TSS\ \left(\frac{mg}{L}\right) \times Influent\ Volume\ (L) \times \frac{2.20\text{E-}6\ mg}{lb}$$

Equation 9: Mass Captured per Trial

$$Mass\ Captured\ per\ Trial\ (lb) = \frac{Sediment\ Mass\ Loading\ per\ Trial\ (lb) \times RE\ (\%)}{(100\%)}$$

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 ±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 ±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 ±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)
-	≥ 30 min	Target: 11.4 or 22.7 g/min	≤ 0.1	≤ 1 min	Target: 200 or 400 mg/L	≥ -10% of Target	≤ +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***

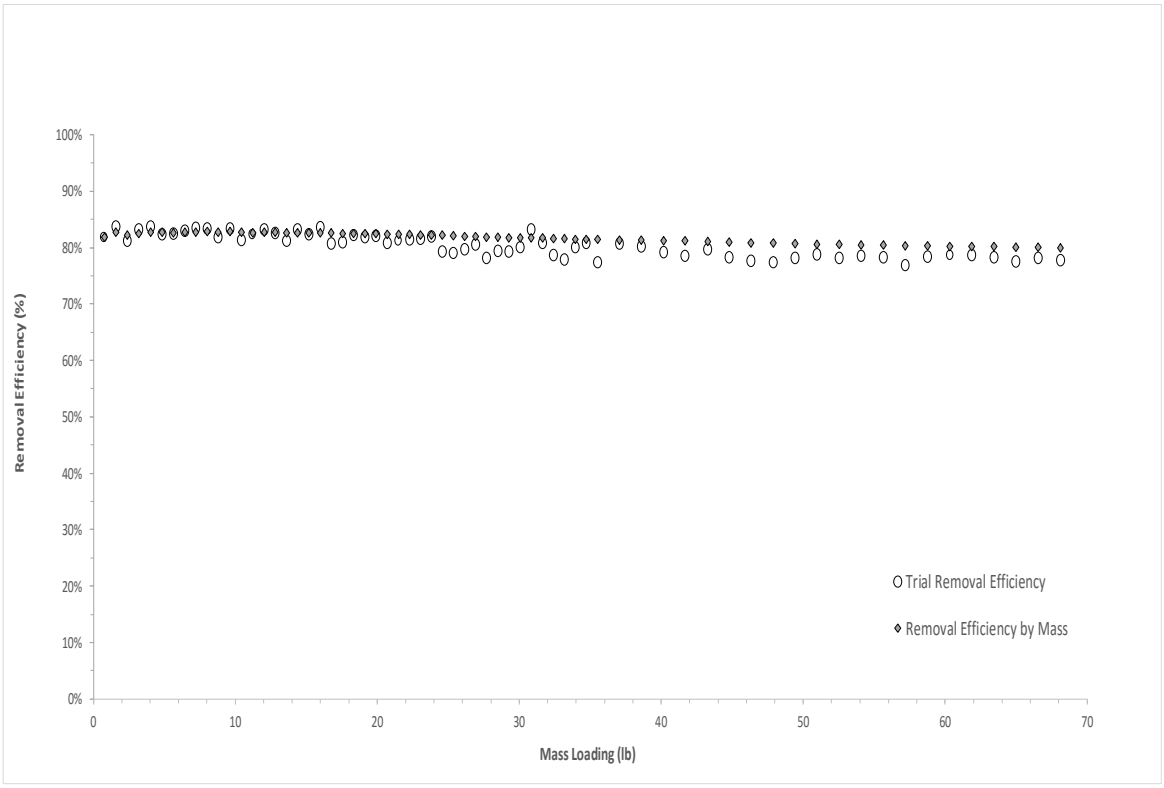


Figure 5 Average Removal Efficiency (by mass) and Trial Removal Efficiency vs. Sediment Mass Loading

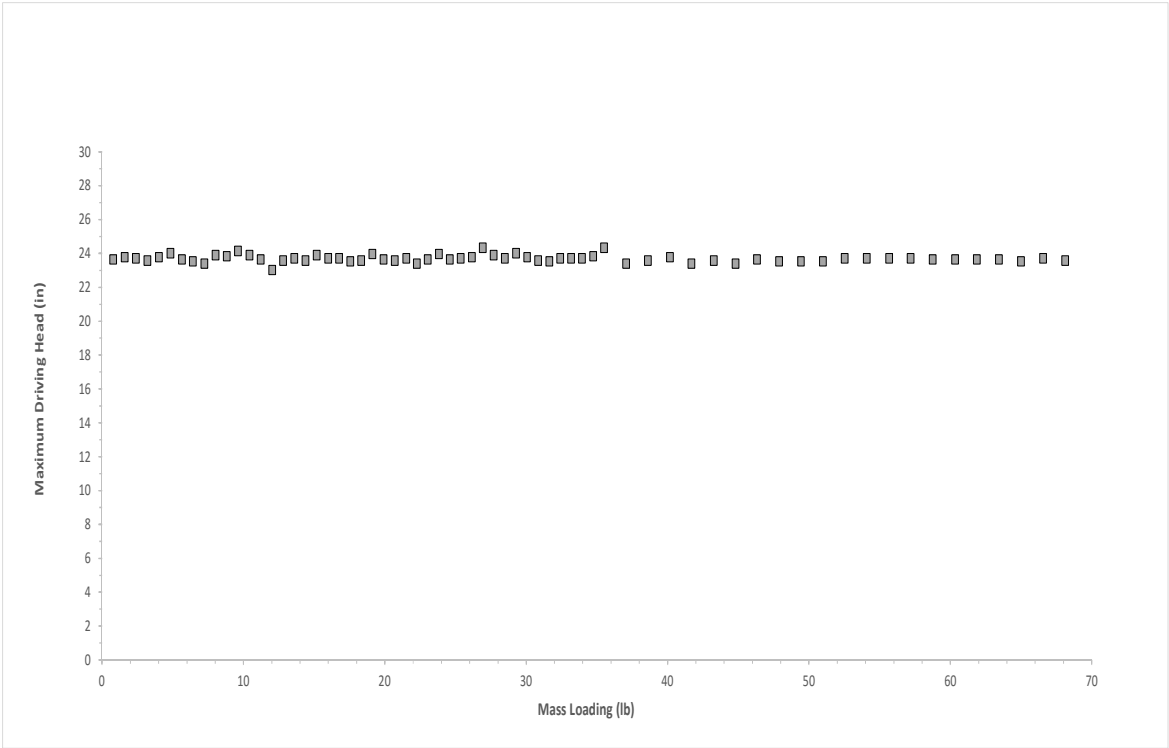


Figure 6 Maximum Driving Head vs. Sediment Mass Loading

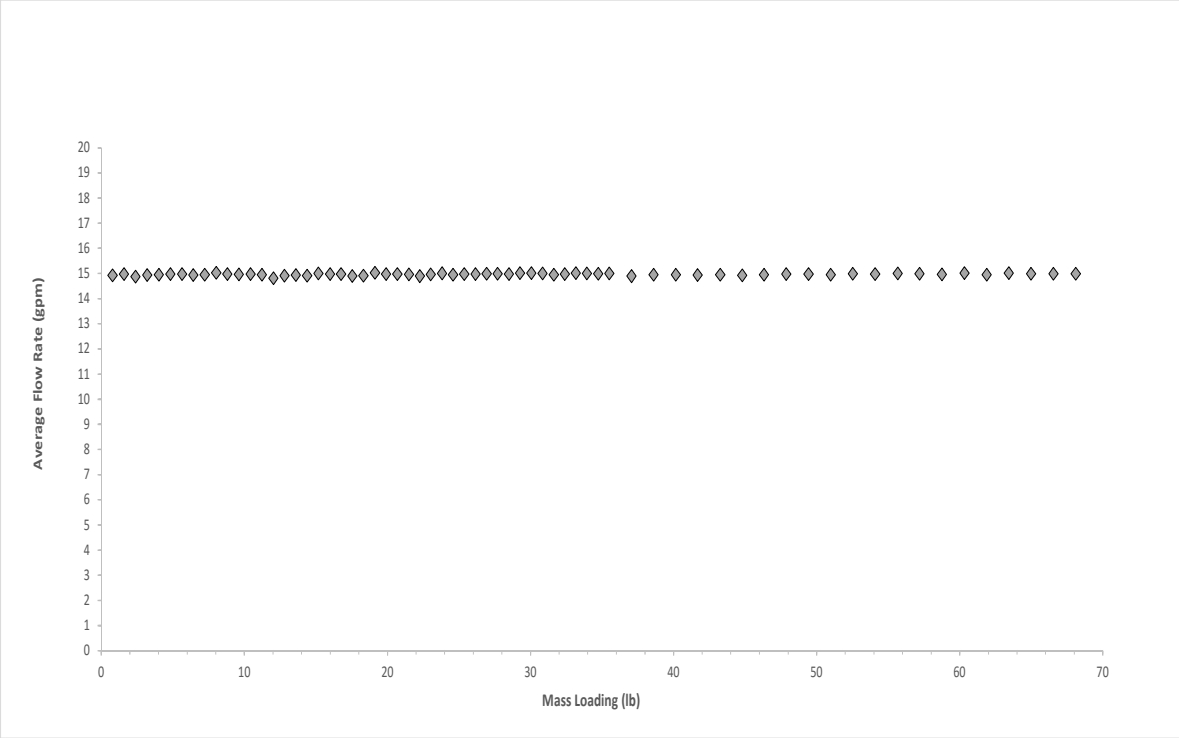


Figure 7 Average Flow Rate vs. Sediment Mass Loading

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^2 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®, 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 (≥ 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.

CONTECH ENGINEERED SOLUTIONS

Contech Engineered Solutions LLC
71 US Route 1, Suite F
Scarborough, Maine 04074
Phone: (207) 885-9830
Fax: (207) 885-9825
www.ContechES.com

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

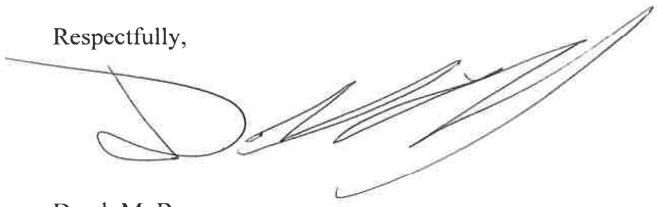
RE: 2016 Verification of the Stormwater Management StormFilter® (StormFilter)

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
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DBerg@conteches.com
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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

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® (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_2 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^2 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^2)	Min. Sedimentation Area Per Cartridge[1] (ft^2)	MTFR Low Drop (12") Cartridge (gpm)	MTFR 18" Cartridge (gpm)	Max. # of 27" Cartridges	MTFR 27" Cartridge[2] (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
	SFLG0818	29	121.29	4.18	290.0	435.0	26	585.0	1.769	2.610	3.536
PEAK DIVERSION	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.

2 - MTFR 27" Cartridges uses reduced maximum cartridge count associated with maintaining 4.50 sqft/cartridge sedimentation area lower limit.

NOTE: ADDITIONAL SIZES AND CONFIGURATIONS AVAILABLE, CONSULT CONTECH FOR ASSISTANCE

Table A-2 StormFilter Cartridge Heights and New Jersey Treatment Capacities

StormFilter Cartridge Heights and New Jersey Treatment Capacities				
StormFilter Cartridge Height	**Filtration Surface Area (ft^2)**	**MTFR* (GPM)**	**Mass Capture Capacity (lbs)**	**Maximum Allowable Inflow Area (acres)**
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^2 of filter surface				

Appendix G – LSRCA TTT P Budget Results

CAPES Engineering Ltd.
355310 Blue Mountains-Euphrasia Townline
Clarksburg, ON
N0H 1J0

Summary

Site	Project Name	Project Title	Storm Type
Pre-Development	380 Lockhart Road	380 Lockhart Road	storm-event
Post-Development	380 Lockhart Road	380 Lockhart Road	storm-event

Design Storm Performance Goal | Pre-Development

Rainfall Depth Control/Reduction Target	25.00 mm
Runoff Volume Control/Reduction Target	344.50 m^3
Runoff Volume Control Provided	344.78 m^3
Runoff Volume Reduction Provided	344.78 m^3
Runoff Volume Treated	0.00 m^3
Runoff Volume Untreated	0.00 m^3
Runoff Volume Control / Reduction Met?	Yes

Design Storm Performance Goal | Post-Development

Rainfall Depth Control/Reduction Target	25.00 mm

Runoff Volume Control/Reduction Target	344.25 m^3
Runoff Volume Control Provided	297.84 m^3
Runoff Volume Reduction Provided	92.53 m^3
Runoff Volume Treated	205.31 m^3
Runoff Volume Untreated	46.31 m^3
Runoff Volume Control / Reduction Met?	No

Water Balance Comparison

Site	Site Area	Site Rainfall In	Site Infiltration	Site Evapotranspiration	External Outflow	Rainfall Reduction
		(mm) (m^3)	(mm) (m^3)	(mm) (m^3)	(mm) (m^3)	(mm) (%)
Pre-Development Total	1.38 ha	25.02 mm 344.78 m^3	23.80 mm 327.96 m^3	0.00 mm 0.00 m^3	0.00 mm 0.00 m^3	25.02 mm 100.00 %
Post-Development Total	1.38 ha	25.02 mm 344.53 m^3	5.23 mm 72.08 m^3	0.00 mm 0.00 m^3	18.30 mm 252.00 m^3	6.72 mm 26.86 %
Difference	**0.00 ha**	**0.00 mm** **-0.25 m^3**	**-18.57 mm** **-255.89 m^3**	**0.00 mm** **0.00 m^3**	**18.30 mm** **252.00 m^3**	**-18.30 mm** **-73.14 %**
Difference	**-0.07 %**	**0.00 %**	**-78.01 %**	**NaN %**	**Infinity %**	**-73.14 %**

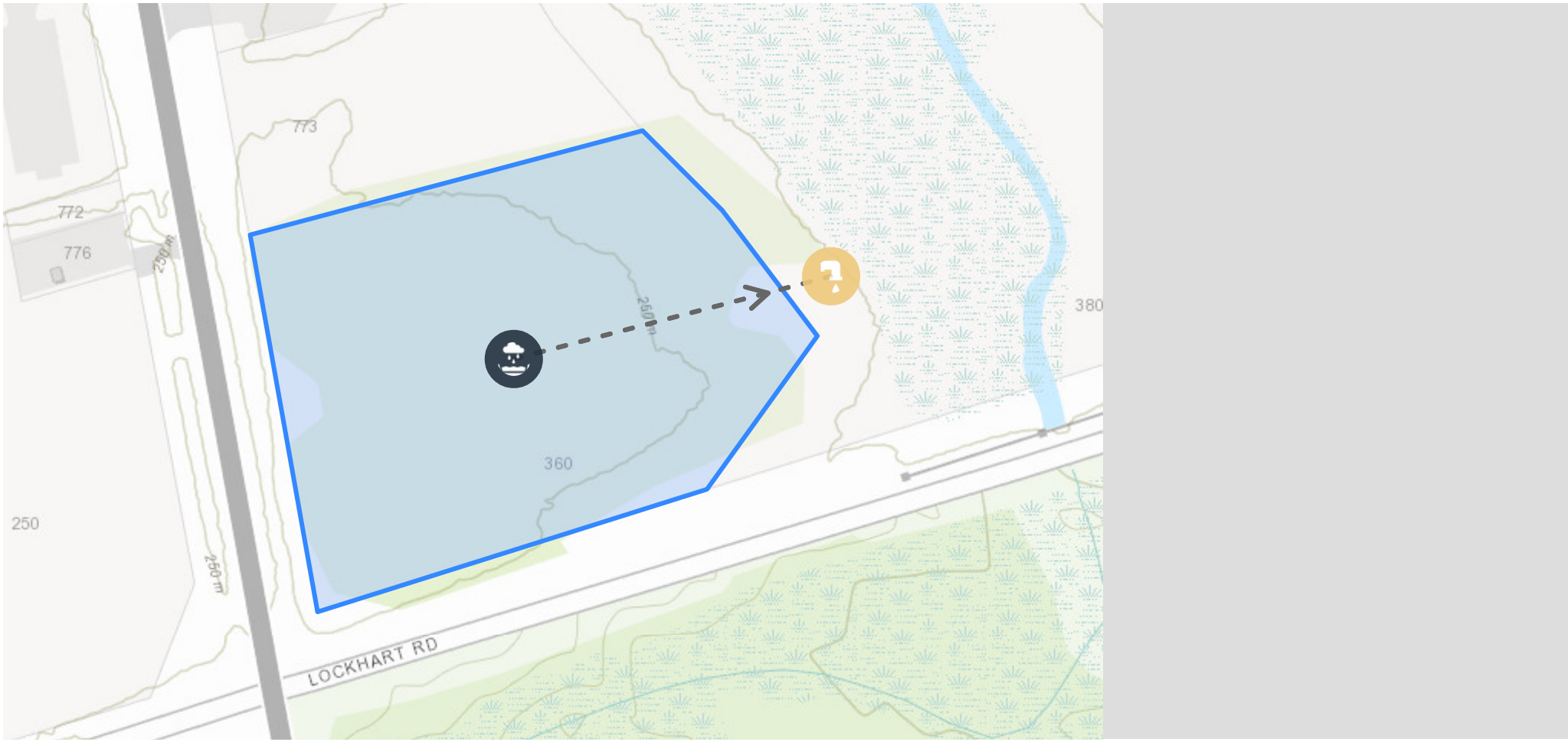
Water Balance | Pre-Development

Catchment	Site Area	Site Rainfall In (mm) (m^3)	Site Infiltration (mm) (m^3)	Site Evapotranspiration (mm) (m^3)	External Outflow (mm) (m^3)	Rainfall Reduction (mm) (%)
1	1.38 ha	25.02 mm 344.78 m^3	23.80 mm 327.96 m^3	0.00 mm 0.00 m^3	0.00 mm 0.00 m^3	25.02 mm 100.00 %
TOTAL	**1.38 ha**	**25.02 mm** **344.78 m^3**	**23.80 mm** **327.96 m^3**	**0.00 mm** **0.00 m^3**	**0.00 mm** **0.00 m^3**	**25.02 mm** **100.00 %**

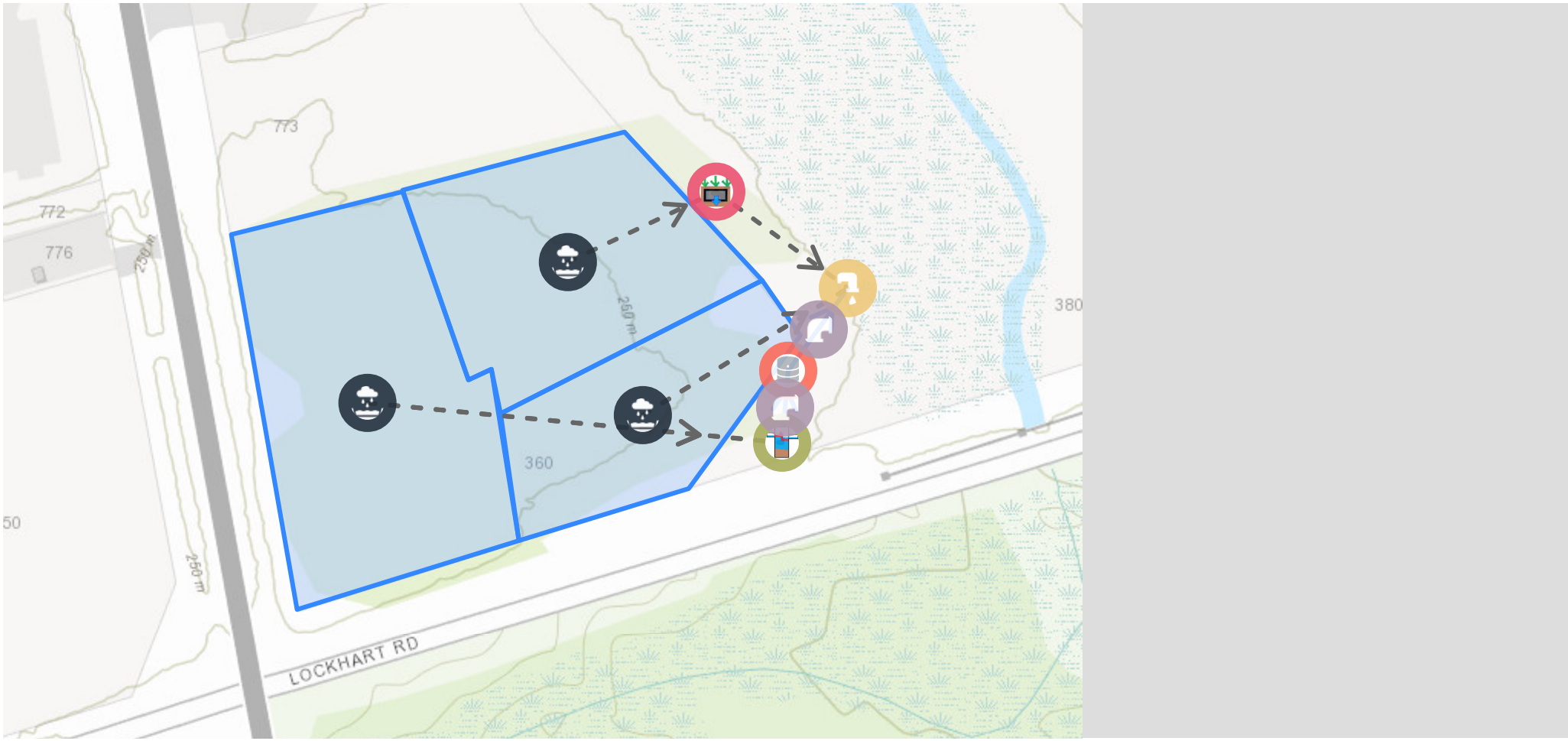
Water Balance | Post-Development

Catchment	Site Area	Site Rainfall In (mm) (m^3)	Site Infiltration (mm) (m^3)	Site Evapotranspiration (mm) (m^3)	External Outflow (mm) (m^3)	Rainfall Reduction (mm) (%)
1	1.38 ha	25.02 mm 344.53 m^3	5.23 mm 72.08 m^3	0.00 mm 0.00 m^3	18.30 mm 252.00 m^3	6.72 mm 26.86 %
TOTAL	**1.38 ha**	**25.02 mm** **344.53 m^3**	**5.23 mm** **72.08 m^3**	**0.00 mm** **0.00 m^3**	**18.30 mm** **252.00 m^3**	**6.72 mm** **26.86 %**

Map | Pre-Development



Map | Post-Development



LID Summary | Post-Development

Element	Type	LID Area	Drawdown Time	Effective Impervious to Pervious Ratio	FLOW	TSS	TP
					Flow In (m^3)	Load In (kg)	Load In (kg)
					Flow Out (m^3)	Load Out (kg)	Load Out (kg)
					Actual Reduction (%)	Actual Reduction (%)	Actual Reduction (%)
Infiltration	Infiltration	0.003 ha	8,624.000 hrs	147.549	110.751 m^3	0.838 kg	0.010 kg
					110.000 m^3	0.208 kg	0.004 kg
					0.678 %	75.169 %	60.271 %
OGS	Oil-Grit-Separator				145.000 m^3	13.500 kg	0.035 kg
					145.000 m^3	2.700 kg	0.035 kg
					0.000 %	80.000 %	0.000 %

Loading Summary TSS | Pre Development

Catchment	Total Catchment TSS Removal	Peak Outflow	Generated Total Flow (m^3) Average Concentration (mg/l) Total Load (kg)	Outgoing Total Flow (m^3) Average Concentration (mg/l) Total Load (kg)
Catchment 1	0.000 %	0.000 m^3/s	0.000 m^3 0.000 mg/l 0.000 kg	0.000 m^3 0.000 mg/l 0.000 kg
Total	**%**	**0.000 m^3/s**	**0.000 m^3** **0.000 mg/l** **0.000 kg**	**0.000 m^3** **0.000 mg/l** **0.000 kg**

Loading Summary TSS | Post Development

Catchment	Total Catchment TSS Removal	Peak Outflow	Generated Total Flow (m^3) Average Concentration (mg/l) Total Load (kg)	Outgoing Total Flow (m^3) Average Concentration (mg/l) Total Load (kg)
Catchment 1	79.718 %	0.192 m^3/s	260.751 m^3 54.986 mg/l 14.338 kg	252.000 m^3 11.540 mg/l 2.908 kg
Total	**79.718 %**	**0.192 m^3/s**	**260.751 m^3** **54.986 mg/l** **14.338 kg**	**252.000 m^3** **11.540 mg/l** **2.908 kg**

Loading Summary TP | Pre Development

Catchment	Total Catchment TP Removal	Peak Outflow	Generated Total Flow (m^3) Average Concentration (mg/l) Total Load (kg)	Outgoing Total Flow (m^3) Average Concentration (mg/l) Total Load (kg)
Catchment 1	0.000 %	0.000 m^3/s	0.000 m^3 0.000 mg/l 0.000 kg	0.000 m^3 0.000 mg/l 0.000 kg
Total	**%**	**0.000 m^3/s**	**0.000 m^3** **0.000 mg/l** **0.000 kg**	**0.000 m^3** **0.000 mg/l** **0.000 kg**

Loading Summary TP | Post Development

Catchment	Total Catchment TP Removal	Peak Outflow	Generated Total Flow (m^3) Average Concentration (mg/l) Total Load (kg)	Outgoing Total Flow (m^3) Average Concentration (mg/l) Total Load (kg)
Catchment 1	13.620 %	0.192 m^3/s	260.751 m^3 0.171 mg/l 0.045 kg	252.000 m^3 0.153 mg/l 0.039 kg
Total	**13.620 %**	**0.192 m^3/s**	**260.751 m^3** **0.171 mg/l** **0.045 kg**	**252.000 m^3** **0.153 mg/l** **0.039 kg**

Peak Flow | Pre-Development

Catchment	Element	Description	Peak outflow
1	Pre Dev	PEAK RUNOFF FLOW from	0.00 m^3/s
	Offsite	MAXIMUM FLOW at	0.000 m^3/s

Peak Flow | Post-Development

Catchment	Element	Description	Peak outflow
1	Parking Area	PEAK RUNOFF FLOW from	0.16 m^3/s
	Roof Area	PEAK RUNOFF FLOW from	0.15 m^3/s
	Pervious	PEAK RUNOFF FLOW from	0.00 m^3/s
	Outfall	MAXIMUM FLOW at	0.192 m^3/s
	Infiltration	PEAK RUNOFF FLOW from	0.15 m^3/s
	OGS	MAXIMUM LATERAL INFLOW at	0.157 m^3/s
	Storage	MAXIMUM OUTFLOW from	0.042 m^3/s
	Pipe 1	MAXIMUM FLOW in	0.158 m^3/s
	Pipe 2	MAXIMUM FLOW in	0.042 m^3/s

Loading TSS | Pre Development

TSS - Catchment 1

Name	LID Type (removal)	Peak Outflow	Incoming Total Flow (m^3) Concentration (mg/l) Total Load (kg)	Outgoing Total Flow (m^3) Concentration (mg/l) Total Load (kg)
Pre Dev	0 %	0 m^3/s	344.776 m^3 55.000 mg/l 18.963 kg	0.000 m^3 55.000 mg/l 0.000 kg
Offsite	0 %	0 m^3/s	0.000 m^3 0.000 mg/l 0.000 kg	0.000 m^3 0.000 mg/l 0.000 kg

Loading TSS | Post Development

TSS - Catchment 1

Name	LID Type (removal)	Peak Outflow	Incoming Total Flow (m^3) Concentration (mg/l) Total Load (kg)	Outgoing Total Flow (m^3) Concentration (mg/l) Total Load (kg)
Parking Area	0 %	0.16 m^3/s	154.123 m^3 90.000 mg/l 13.871 kg	150.000 m^3 90.000 mg/l 13.500 kg
Roof Area	0 %	0.15 m^3/s	112.340 m^3 7.000 mg/l 0.786 kg	110.000 m^3 7.000 mg/l 0.770 kg
Pervious	0 %	0 m^3/s	77.312 m^3 86.500 mg/l 6.687 kg	0.000 m^3 86.500 mg/l 0.000 kg
Infiltration	75 %	0.15 m^3/s	110.751 m^3 7.563 mg/l 0.838 kg	110.000 m^3 1.891 mg/l 0.208 kg
OGS	80 %	0.157 m^3/s	145.000 m^3	145.000 m^3

			93.103 mg/l 13.500 kg	18.621 mg/l 2.700 kg
Storage	0 %	0.042 m^3/s	145.000 m^3 18.621 mg/l 2.700 kg	145.000 m^3 18.621 mg/l 2.700 kg
Pipe 1	0 %	0.158 m^3/s	145.000 m^3 18.621 mg/l 2.700 kg	145.000 m^3 18.621 mg/l 2.700 kg
Pipe 2	0 %	0.042 m^3/s	145.000 m^3 18.621 mg/l 2.700 kg	145.000 m^3 18.621 mg/l 2.700 kg
Outfall	0 %	0.192 m^3/s	252.000 m^3 11.540 mg/l 2.908 kg	252.000 m^3 11.540 mg/l 2.908 kg

Loading TP | Pre Development

TP - Catchment 1

Name	LID Type	Peak Outflow	Incoming Total Flow (m^3) Concentration (mg/l) Total Load (kg)	Outgoing Total Flow (m^3) Concentration (mg/l) Total Load (kg)
Pre Dev	0 %	0 m^3/s	344.776 m^3 0.230 mg/l 0.079 kg	0.000 m^3 0.230 mg/l 0.000 kg
Offsite	0 %	0 m^3/s	0.000 m^3 0.000 mg/l 0.000 kg	0.000 m^3 0.000 mg/l 0.000 kg

Loading TP | Post Development

TP - Catchment 1

Name	LID Type	Peak Outflow	Incoming Total Flow (m^3) Concentration (mg/l) Total Load (kg)	Outgoing Total Flow (m^3) Concentration (mg/l) Total Load (kg)
Parking Area	0 %	0.16 m^3/s	154.123 m^3 0.230 mg/l 0.035 kg	150.000 m^3 0.230 mg/l 0.035 kg
Roof Area	0 %	0.15 m^3/s	112.340 m^3 0.090 mg/l 0.010 kg	110.000 m^3 0.090 mg/l 0.010 kg
Pervious	0 %	0 m^3/s	77.312 m^3 0.293 mg/l 0.023 kg	0.000 m^3 0.293 mg/l 0.000 kg
Infiltration	60 %	0.15 m^3/s	110.751 m^3 0.091 mg/l 0.010 kg	110.000 m^3 0.036 mg/l 0.004 kg
OGS	0 %	0.157 m^3/s	145.000 m^3	145.000 m^3

			0.238 mg/l 0.035 kg	0.238 mg/l 0.035 kg
Storage	0 %	0.042 m^3/s	145.000 m^3 0.238 mg/l 0.035 kg	145.000 m^3 0.238 mg/l 0.035 kg
Pipe 1	0 %	0.158 m^3/s	145.000 m^3 0.238 mg/l 0.035 kg	145.000 m^3 0.238 mg/l 0.035 kg
Pipe 2	0 %	0.042 m^3/s	145.000 m^3 0.238 mg/l 0.035 kg	145.000 m^3 0.238 mg/l 0.035 kg
Outfall	0 %	0.192 m^3/s	252.000 m^3 0.153 mg/l 0.039 kg	252.000 m^3 0.153 mg/l 0.039 kg

Detailed Report Parameters | Pre Development

Pre Dev

Field	Value
Subcatchment name	Pre Dev
Catchment	1
Total AREA (HA)	1.378
Impervious area (HA)	0
Roof area (HA)	0
Landscaped area (HA)	0
Row Crop area (HA)	0
Open Space / Parkland area (HA)	0
Forest area (HA)	1.378
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	77

Offsite

Field	Value
Name	Offsite
Catchment	1
Outfall Elevation (m)	247.2

Detailed Report Parameters | Post Development

Parking Area

Field	Value
Subcatchment name	Parking Area
Catchment	1
Total AREA (HA)	0.616
Impervious area (HA)	0.616
Roof area (HA)	0
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

Roof Area

Field	Value
Subcatchment name	Roof Area
Catchment	1
Total AREA (HA)	0.449
Impervious area (HA)	0
Roof area (HA)	0.449
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	0.01
Manning's n for pervious areas	0.1
Depression storage for impervious areas (mm)	2
Depression storage for pervious areas (mm)	2.54
Weighted Curve Number	0

Pervious

Field	Value

Subcatchment name	Pervious
Catchment	1
Total AREA (HA)	0.309
Impervious area (HA)	0
Roof area (HA)	0
Landscaped area (HA)	0.2163
Row Crop area (HA)	0
Open Space / Parkland area (HA)	0
Forest area (HA)	0.09269999999999999
Wetland area (HA)	0
Other area (HA)	0
Manning's n for impervious areas	0.013
Manning's n for pervious areas	0.3
Depression storage for impervious areas (mm)	2
Depression storage for pervious areas (mm)	7
Weighted Curve Number	83.3

Outfall

Field	Value
Name	Outfall
Catchment	1

Outfall Elevation (m)	247.2

Infiltration

Field	Value
Name	Infiltration
LID type	infiltration
Catchment	1
Outlet (name)	4
% Imperv	100
Width (m)	100
Paved surface (HA)	0.003
Roof (HA)	0
Landscaped Area (HA)	0
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)	880
Void Ratio	0.98

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)	0.1
Flow Coefficient	1
Flow Exponent	1
Offset Height (mm)	0
Mannings Roughness	

OGS

Field	Value
Name	OGS
Junction Type	oil-grit-separator
Catchment	1

Invert Elevation (m)	248.31
Depth to Surface (m)	1.37

Storage

Field	Value
Name	Storage
Catchment	1
Bottom Elevation (m)	247.5
Maximum Depth (m)	0.88
Initial Water Depth (m)	0
Underlying Soil	
Evaporation Factor	1
Suction Head (mm)	
Saturated Conductivity (mm/hr)	
Initial Soil Moisture Deficit (Fraction)	
Type	Storage

Pipe 1

Field	Value
Name	Pipe 1
Catchment	1
Upstream Node	OGS

Downstream Node	Storage
Length (m)	20
Manning's Roughness	0.013
Upstream Invert (m)	247.86
Downstream Invert (m)	247.5
Pipe Diameter (m)	0.45

Pipe 2

Field	Value
Name	Pipe 2
Catchment	1
Upstream Node	Storage
Downstream Node	Outfall
Length (m)	29
Manning's Roughness	0.013
Upstream Invert (m)	247.5
Downstream Invert (m)	247.3
Pipe Diameter (m)	0.45

Appendix H – Water Balance

CAPES Engineering Ltd.
355310 Blue Mountains-Euphrasia Townline
Clarksburg, ON
N0H 1J0

THORNTHWAITE WATER BALANCE CALCULATIONS

PROJECT No. 2019-039
380 Lockhart Road
City of Barrie

CAPES ENGINEERING

TABLE 1

Pre- and Post-Development Monthly Water Balance Components

Potential Evapotranspiration Calculation	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Average Temperature (Degree C) [1]	-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)$^{1.514}$	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)	0.00	0.00	0.00	25.18	58.76	88.02	103.48	97.59	74.33	40.47	11.47	0.00	**499**
Adjusting Factor for U (Latitude 44° 22' N)[2]	0.81	0.82	1.02	1.13	1.27	1.29	1.3	1.2	1.04	0.95	0.8	0.76	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
PRE-DEVELOPMENT WATER BALANCE	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)[3]	83	62	58	62	82	85	77	90	84	78	89	74	**923**
Potential Evapotranspiration (PET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
P - PET	83	62	58	34	8	-29	-57	-27	7	39	80	74	**330**
Change in Soil Moisture Storage	0	0	0	0	0	-29	-57	-27	7	39	68	0	**0**
Soil Moisture Storage max 350 mm	350	350	350	350	350	321	264	237	243	282	350	350	
Actual Evapotranspiration (AET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
Soil Moisture Deficit max 350 mm	0	0	0	0	0	29	86	113	107	68	0	0	
Water Surplus - available for infiltration or runoff	83	62	58	34	8	0	0	0	0	0	12	74	**330**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	33	25	23	13	3	0	0	0	0	0	5	29	**132**
Potential Direct Surface Water Runoff (independent of temperature)	50	37	35	20	5	0	0	0	0	0	7	44	**198**
POST-DEVELOPMENT WATER BALANCE	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	83	62	58	62	82	85	77	90	84	78	89	74	**923**
Potential Evaporation (PE) from impervious areas (assume 20%)	17	12	12	12	16	17	15	18	17	16	18	15	**185**
P-PE (surplus available for runoff from impervious areas)	66	49	46	50	66	68	62	72	67	62	71	59	**738**
Water surplus change compared to pre-condition (for areas that change from vegetated open areas to impervious areas)	-17	-12	-12	16	58	68	62	72	67	62	59	-15	**409**

Soil Moisture Storage: 350 mm <-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003

Forest	100%
Urban Lawn	0%
Pasture	0%
Crops	0%
Impervious	0%

*MOE SWM infiltration calculations

topography - hilly land	0.1	<-- Infiltration Factors from Table 3.1, MOE SWMPDM, 2003
soils - clay	0.1	<-- Infiltration Factors from Table 3.1, MOE SWMPDM, 2003
cover - 100% Forest	0.2	<-- Infiltration Factors from Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.4**	

Latitude of site (or climate station): 44 ° N.

USER INPUTS

THORNTHWAITE WATER BALANCE CALCULATIONS

PROJECT No. 2019-039
380 Lockhart Road
City of Barrie

CAPES ENGINEERING

Thornthwaite Water Balance

Land Use Description	Approx. Land Area* (m^2)	Estimated Impervious Fraction for Land Use	Estimated Impervious Area (m^2)	Runoff from Impervious Area (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area (m/a)	Runoff Volume from Pervious Area (m^3/a)	Recharge from Pervious Area (m/a)	Recharge Volume from Pervious Area (m^3/a)	Total Runoff (Direct and Indirect) Volume (m^3/a)	Total Recharge Volume (m^3/a)
Pre Development Site	13,800	0.00	0	0.738	0	13,800	0.198	2,730	0.132	1,820	2,730	1,820
TOTAL PRE-DEVELOPMENT	**13,800**		**0**		**0**	**13,800**		**2,730**		**1,820**	**2,730**	**1,820**
Post Development Site	13,800	0.76	10,488	0.738	7,744	3,312	0.198	655	0.132	437	8,399	437
TOTAL POST-DEVELOPMENT	**13,800**		**10,488**		**7,744**	**3,312**		**655**		**437**	**8,399**	**437**
										% Change from Pre to Post	308	76
										Effect of development (**with no mitigation**)	**3.08 times increase in runoff**	**76% reduction of recharge**

To balance pre- to post-, the recharge target (m^3/a)= **1,383**

LSRCA Water Balance Worksheet

Step 1: Determine Water Balance Deficit

Water Balance Deficit:	m3/yr	1383

Step 2: Determine drainage area and runoff volume from impervious surface to be infiltrated

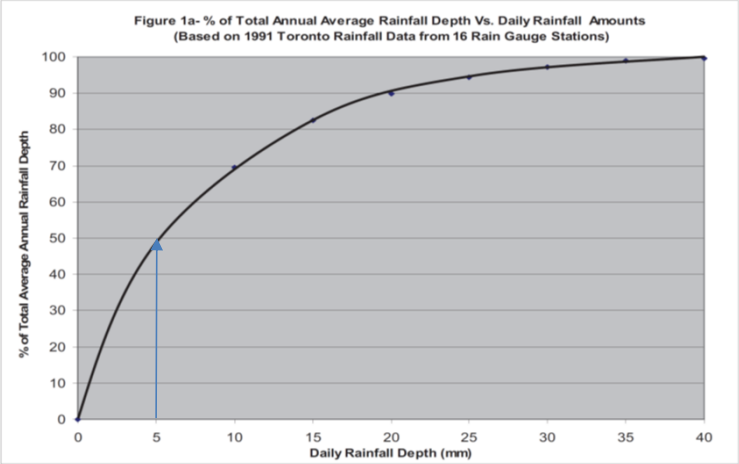
Impervious Area:	m2	4539	
Rainfall:	mm/yr	933	Richmond Hill
Evaporation:	mm/yr	186.6	
Surplus :	mm/yr	746.4	
Volume	m3/yr	3387.91	

Step 3: Determine percentage of rainfall over the drainage area that needs to be infiltrated to meet water balance deficit

% of rainfall	%	40.82

Step 4: Determine Event Depth based on 1991 Toronto Rainfall Data

Event depth required:	mm	5



Step 5: Determine required volume of storage facility

Drainage area:	m2	4539
event depth:	mm	5
Volume:	m3	22.695

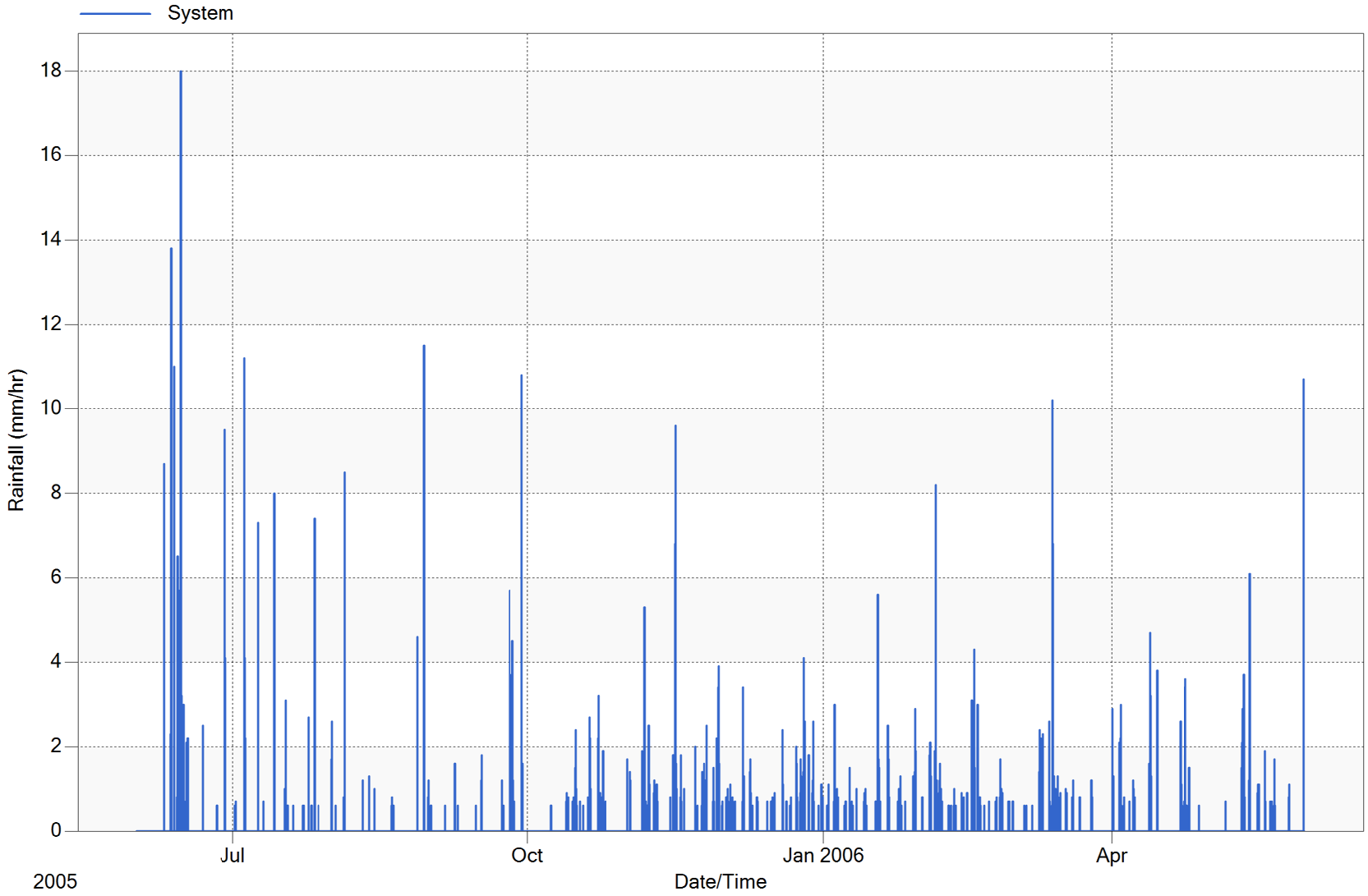
Step 6: Determine required bottom surface area of

Infiltration rate:	mm/hr	0.25	
Safety Factor		2.5	
P		0.1	
Time	Hr	48	
Porosity		1	Use 1.0 for open storage volume (Atlantis Tanks, Cultec Chamber tec.)
Volume of facility	m3	22.695	
Area	m2	4728.1	

Therefore the required area to infiltrate within 48 hours is : 4728.1

Continuous Rainfall Series

June 2005 to May 31, 2006



984 mm Continuous Simulation Model Results with Infiltration LID

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


WARNING 04: minimum elevation drop used for Conduit C2

*************
Element Count
*************
Number of rain gages ...... 16
Number of subcatchments ... 9
Number of nodes ........... 14
Number of links ........... 12
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                  Data       Recording
Name                 Data Source                  Type       Interval
------------------------------------------------------------------------
100YR12HRSCS         100YR12HRSCS                 INTENSITY    6 min.
100YR4HRCHIC         100YR4HRCHIC                 INTENSITY    5 min.
10YR4HRCHIC          10YR4HRCHIC                  INTENSITY    5 min.
10YR4HRSCS           10YR12HRSCS                  INTENSITY    6 min.
25mm                 25mm                         INTENSITY    5 min.
25YR12HRSCS          25YR12HRSCS                  INTENSITY    6 min.
25YR4HRCHIC          25YR4HRCHIC                  INTENSITY    5 min.
2YR12HRSCS           2YR12HRSCS                   INTENSITY    6 min.
2YR4HRCHIC           2YR4HRCHIC                   INTENSITY    5 min.
50YR12HRSCS          50YR12HRSCS                  INTENSITY    6 min.
50YR4HRCHIC          50YR4HRCHIC                  INTENSITY    5 min.
5YR12HRSCS           5YR12HRSCS                   INTENSITY    6 min.
5YR4HRCHIC           5YR4HRCHIC                   INTENSITY    5 min.
Continuous           Continuous                   INTENSITY   60 min.
Hurricane_Hazel_(0-25) Hurricane_Hazel_(0-25)       INTENSITY   60 min.
Timmins_Storm_(0-25) Timmins_Storm_(0-25)         INTENSITY   60 min.


********************
Subcatchment Summary
********************
```

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
A1	0.07	7.78	100.00	1.0000	Continuous	CBMH04
A2	0.16	15.88	0.00	6.0000	Continuous	SE
A3	0.06	98.00	0.00	2.0000	Continuous	J2
A4	0.45	51.90	100.00	0.5000	Continuous	Infil_Storage
A5	0.09	44.70	100.00	3.0000	Continuous	DCBMH01
A6	0.09	29.83	100.00	2.0000	Continuous	DCBMH02
A7	0.01	17.80	0.00	2.0000	Continuous	J2
A8	0.36	54.06	100.00	1.0000	Continuous	DCBMH05
A9	0.09	61.67	0.00	5.0000	Continuous	SE

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
CBMH04	JUNCTION	248.26	1.42	0.0	
DCBMH01	JUNCTION	249.31	1.64	0.0	
DCBMH02	JUNCTION	249.00	1.86	0.0	
DCBMH05	JUNCTION	247.84	1.12	0.0	
HDWL1	JUNCTION	245.60	0.73	0.0	
J2	JUNCTION	0.00	0.00	0.0	
MH03	JUNCTION	248.84	2.10	0.0	
MH06	JUNCTION	247.93	2.23	0.0	
MH07	JUNCTION	246.57	2.68	0.0	
OGS	JUNCTION	247.82	1.31	0.0	
Huronia	OUTFALL	0.00	0.00	0.0	
SE	OUTFALL	245.00	0.00	0.0	
Infil_Storage	STORAGE	248.71	1.48	0.0	
Storage	STORAGE	247.50	1.73	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	HDWL1	SE	CONDUIT	36.2	1.6578	0.0130
C10_1	Infil_Storage	MH06	CONDUIT	2.3	3.4474	0.0130
C10_2	MH06	Storage	CONDUIT	24.7	1.7407	0.0130
C12	MH07	HDWL1	CONDUIT	21.0	4.6280	0.0130
C2	J2	Huronia	CONDUIT	9.6	0.0032	0.0130
C4	DCBMH01	DCBMH02	CONDUIT	52.3	0.4971	0.0130

C5	DCBMH02	MH03	CONDUIT	21.6	0.5098	0.0130
C6	MH03	CBMH04	CONDUIT	86.1	0.6041	0.0130
C7	CBMH04	DCBMH05	CONDUIT	67.3	0.5048	0.0130
C8	DCBMH05	OGS	CONDUIT	3.9	0.5176	0.0130
C9	OGS	Storage	CONDUIT	4.0	8.0970	0.0130
C11	Storage	MH07	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C10_1	CIRCULAR	0.30	0.07	0.07	0.30	1	0.18
C10_2	CIRCULAR	0.30	0.07	0.07	0.30	1	0.13
C12	CIRCULAR	0.45	0.16	0.11	0.45	1	0.61
C2	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C4	CIRCULAR	0.30	0.07	0.07	0.30	1	0.07
C5	CIRCULAR	0.38	0.11	0.09	0.38	1	0.13
C6	CIRCULAR	0.45	0.16	0.11	0.45	1	0.22
C7	CIRCULAR	0.45	0.16	0.11	0.45	1	0.20
C8	CIRCULAR	0.45	0.16	0.11	0.45	1	0.21
C9	CIRCULAR	0.45	0.16	0.11	0.45	1	0.81

****
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 ............ 06/01/2005 00:00:00
Ending Date .............. 05/31/2006 10:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
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
```

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Initial Snow Cover	0.000	0.000
Total Precipitation	1.358	984.300
Evaporation Loss	0.312	225.782
Infiltration Loss	0.213	154.192
Surface Runoff	0.836	605.955
Snow Removed	0.000	0.000
Final Snow Cover	0.000	0.000
Final Storage	0.000	0.000
Continuity Error (%)	-0.166	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.836	8.362
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.830	8.304
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.005	0.049
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.001	0.007
Continuity Error (%)	0.027	

****
Time-Step Critical Elements
****
Link C10_1 (30.00%)
Link C9 (2.27%)

****
Highest Flow Instability Indexes
****
Link C8 (3)

****
Routing Time Step Summary
****
Minimum Time Step   :   0.52 sec
Average Time Step   :   4.25 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 Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
A1	984.30	0.00	254.82	0.00	730.77	0.00	730.77	0.54	0.00	0.742
A2	984.30	0.00	132.39	658.63	0.00	194.31	194.31	0.31	0.01	0.197
A3	984.30	0.00	123.07	642.79	0.00	220.15	220.15	0.13	0.00	0.224
A4	984.30	0.00	256.35	0.00	729.04	0.00	729.04	3.29	0.02	0.741
A5	984.30	0.00	247.90	0.00	740.90	0.00	740.90	0.66	0.00	0.753
A6	984.30	0.00	249.16	0.00	738.37	0.00	738.37	0.66	0.00	0.750
A7	984.30	0.00	122.79	642.02	0.00	221.26	221.26	0.02	0.00	0.225
A8	984.30	0.00	252.99	0.00	732.93	0.00	732.93	2.62	0.02	0.745
A9	984.30	0.00	139.95	699.46	0.00	146.08	146.08	0.14	0.00	0.148

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Node Depth Summary
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Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
CBMH04	JUNCTION	0.00	0.08	248.34	13 18:51	0.08
DCBMH01	JUNCTION	0.00	0.05	249.36	13 19:00	0.05
DCBMH02	JUNCTION	0.00	0.07	249.07	13 19:00	0.07
DCBMH05	JUNCTION	0.01	0.20	248.04	13 19:19	0.20
HDWL1	JUNCTION	0.00	0.00	245.60	168 01:04	0.00
J2	JUNCTION	0.00	0.00	0.00	0 00:00	0.00
MH03	JUNCTION	0.00	0.06	248.90	13 19:00	0.06
MH06	JUNCTION	0.00	0.11	248.04	13 19:19	0.11
MH07	JUNCTION	0.01	0.05	246.62	13 19:19	0.05
OGS	JUNCTION	0.00	0.34	248.16	13 19:03	0.29
Huronia	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
SE	OUTFALL	0.00	0.00	245.00	0 00:00	0.00
Infil_Storage	STORAGE	0.00	0.07	248.78	13 19:00	0.07
Storage	STORAGE	0.02	0.54	248.04	13 19:19	0.54

****
Node Inflow Summary
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Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
CBMH04	JUNCTION	0.004	0.012	13 19:00	0.54	1.86	0.031
DCBMH01	JUNCTION	0.004	0.004	13 19:00	0.662	0.662	-0.007
DCBMH02	JUNCTION	0.004	0.009	13 19:00	0.661	1.32	-0.002
DCBMH05	JUNCTION	0.018	0.035	13 19:03	2.61	4.5	-0.027
HDWL1	JUNCTION	0.000	0.009	13 19:19	0	7.71	-0.003
J2	JUNCTION	0.003	0.003	13 19:00	0.149	0.149	0.000
MH03	JUNCTION	0.000	0.009	13 19:00	0	1.32	-0.004
MH06	JUNCTION	0.000	0.022	13 19:00	0	3.24	-0.038
MH07	JUNCTION	0.000	0.009	13 19:18	0	7.71	0.001
OGS	JUNCTION	0.000	0.116	13 19:03	0	4.62	0.135
Huronia	OUTFALL	0.000	0.003	13 19:00	0	0.149	0.000
SE	OUTFALL	0.012	0.020	13 19:00	0.444	8.15	0.000

Infil_Storage	STORAGE	0.022	0.022	13	19:00	3.29	3.29	0.000
Storage	STORAGE	0.000	0.138	13	18:57	0	7.84	-0.023

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

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
J2	JUNCTION	8746.00	0.000	0.000

****
Node Flooding Summary
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Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
Infil_Storage	8746.00	0.000	0 00:00	0.000	-1.409
Storage	8746.00	0.000	0 00:00	0.000	-1.194

****
Storage Volume Summary
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Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
Infil_Storage	0.001	0	0	1	0.000	0	0 00:00	0.022
Storage	0.010	0	0	0	0.000	0	0 00:00	0.068

****

Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
Huronia	3.91	0.001	0.003	0.149
SE	43.51	0.001	0.020	8.155
System	23.71	0.002	0.020	8.304

****
Link Flow Summary
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Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	DUMMY	0.009	13 19:19			
C10_1	CONDUIT	0.022	13 19:00	1.73	0.12	0.24
C10_2	CONDUIT	0.022	13 19:00	1.20	0.17	0.68
C12	CONDUIT	0.009	13 19:19	2.68	0.01	0.05
C2	DUMMY	0.003	13 19:00			
C4	CONDUIT	0.004	13 19:00	0.56	0.06	0.17
C5	CONDUIT	0.009	13 19:00	0.67	0.07	0.18
C6	CONDUIT	0.009	13 19:00	0.68	0.04	0.14
C7	CONDUIT	0.013	13 18:52	0.71	0.06	0.19
C8	CONDUIT	0.062	13 19:00	1.62	0.30	0.56
C9	CONDUIT	0.116	13 18:57	3.31	0.14	0.87
C11	DUMMY	0.009	13 19:18			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl

C10_1	1.00	0.62	0.00	0.00	0.00	0.00	0.00	0.38	0.00	0.00
C10_2	1.00	0.40	0.25	0.00	0.30	0.05	0.00	0.00	0.96	0.00
C12	1.00	0.02	0.00	0.00	0.42	0.56	0.00	0.00	0.48	0.00
C4	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
C5	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
C6	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
C7	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
C8	1.00	0.02	0.00	0.00	0.80	0.18	0.00	0.00	0.02	0.00
C9	1.00	0.36	0.36	0.00	0.22	0.06	0.00	0.00	0.96	0.00

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Conduit Surcharge Summary
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Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C10_2	0.01	0.01	19.64	0.01	0.01
C9	0.01	0.01	4.18	0.01	0.01

Analysis begun on: Wed Jan 22 16:02:33 2020
Analysis ended on: Wed Jan 22 16:03:35 2020
Total elapsed time: 00:01:02

Appendix I – Water Demand

CAPES Engineering Ltd.
355310 Blue Mountains-Euphrasia Townline
Clarksburg, ON
N0H 1J0

CAPES ENGINEERING

Domestic & Fire Protection Water Supply/Storage

Project: **Kingslea Developments**
380 Lockhart Road, Barrie

Prepared by:	C. Capes
Checked by:	C. Capes
Project No:	2019-039
Date:	January 22, 2020

Domestic Flow Calculations

Number of Water Fixture Units =	9.875		OBC Table 7.6.3.2 Hydraulic Load
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	
Total Domestic Peak Demand =	**0.24**	**L/s**	

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

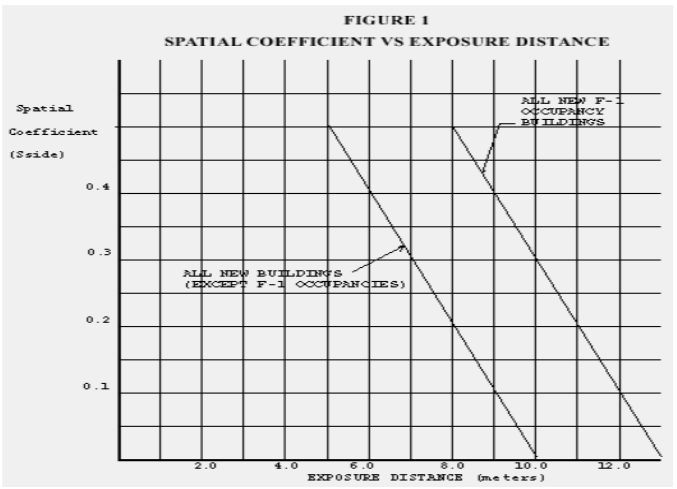
$Q=KVS_{Total}$ where

Q = Minimum supply of water in Litres (L)
K = water supply coefficient from Table 1
V = total building volume in cubic meters
S_{Tot} = total of the spacial coefficient values from the property line exposures on all sides as obtained from the formula:

$S_{Tot} = 1.0 + [(S_{Side1}) + (S_{Side2}) + (S_{Side3}) + \ldots etc.]$

where S_{Side} values are obtained from Figure 1, as modified by Sections 6.39(e) and 6.3(f) of the OBC Guideline
S_{Tot} need not exceed 2.0

FIGURE 1
SPATIAL COEFFICIENT VS EXPOSURE DISTANCE



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 = 12 — Type F3, OBC Table 3.1.2.1

2 Building Volumes

Bldg.	Area (m^2)	Height (m)	Volume (m^3)
Bldg. 1	4,539	14.00	63549
Total			**63549**

← Total Building Volume

3 Exposure Distances $S_{Tot} = 1.0 + [(S_{Side1}) + (S_{Side2}) + (S_{Side3}) + \ldots etc.]$

Bldg.	North	S_{Side} (N)	East	S_{Side} (E)	South	S_{Side} (S)	West	S_{Side} (W)	S_{Tot}
	(m)		(m)		(m)		(m)		
Bldg. 1	7.00	0.3	>10 m	0.1	>10 m	0	>10 m	0	**0.4**

← Max S_{Tot}

S_{Tot} = 1.40 — Max. Value = 2.0

4 **Minimum Fire Water Supply**

$Q=KVS_{Total}$ = **1067619.84** Litres

5 **Fire Water Supply Flow Rate** = **9000** L/min — Table 2 Required Minimum Water Supply Flow Rate (L/min), provided in the OBC A.3.2.5.7

= **150.00** L/s

6 **Domestic + Fire Flow Rate** = **150.24** L/s