



Stormwater Management Report

115 Bayfield Street

Coral-Sophia Lane Housing Inc.

P/N 3103 | Revised February 25, 2021

SBA Skelton Brumwell
& Associates Inc.
ENGINEERING PLANNING ENVIRONMENTAL CONSULTANTS

County of Simcoe
City of Barrie
115 Bayfield Street

93 Bell Farm Road, Suite 107, Barrie, Ontario L4M 5G1
Telephone (705) 726-1141 Toll Free: (877) 726-1141
mail@skeltonbrumwell.ca www.skeltonbrumwell.ca

Table of Contents

	Page
1.0 Introduction.....	1
2.0 Existing Conditions	1
Figure 1 – Site Location.....	2
3.0 Project Stormwater Impacts and Controls	3
3.1 Quantity Control.....	3
3.2 Quality Control	3
3.3 Water Balance	3
3.4 Phosphorous Loading.....	3
4.0 Proposed Stormwater Management.....	4
4.1 Quantity Control.....	4
Table 1 – Summary of Existing and Proposed Peak Flow Rates	5
4.2 Quality Control	5
4.3 Permeable Paving.....	6
4.4 Green Roof	6
4.5 Nutrient Management – Phosphorous Removal	7
4.6 Low Impact Development Treatment Train Tool Summary.....	7
Table 2 – LID TTT Modelling Summary.....	8
4.7 Volume Control	8
5.0 Conveyance	9
5.1 Storm Sewers	9
5.2 Sheet flow, Pavers and Landscaped Area	10
6.0 Maintenance Requirements	11
7.0 Erosion and Sediment Control During Construction	11
8.0 Conclusions and Recommendations.....	13
9.0 Disclaimer of Responsibilities to Third Parties	14

Appendix A - Rational Method Analysis	Appendix D - LID TTT Modelling Results
Appendix B - Storm Sewer Sizing	Appendix E – LSRCA consultation, Volume Control
Appendix C - Hydro International Upflow Filter Sizing	

DRAWINGS

3103–SWM1, Existing Catchment Plan	3103-GP1, Grading Plan
3103-SWM2, Proposed Catchment Plan	3103-SS1, Site Servicing Plan
3103-SWM3, Storm Sewer Catchment Plan	3103-SCP, Sediment Control Plan

Stormwater Management Report

Coral Sophia Lane Housing Inc.

115 Bayfield Street

P/N 17-3103

Revised February 25, 2021

1.0 Introduction

Skelton, Brumwell & Associates Inc. (SBA) were retained by Coral Sophia Lane Housing Inc. (Coral) to prepare civil design drawings and reports for an 8–storey multi-residential rental building at the above noted address. The property is legally described as Part of Lots 9, 10, and 11 on the East Side of Bayfield Street, Registered Plan 31, in the City of Barrie, County of Simcoe. The site address is 113 & 117 Bayfield Street and 6, 8 & 12 Sophia Street East. The subject property has an approximate area of 3,729 m². The subject property is located on the northeast corner of Bayfield Street and Sophia Street East, and is also bounded by Drury Lane on the east side of the property.

The proposed 8–storey building will include approximately 284 m² of amenity (lobby, lounge, and indoor amenity area), and one hundred and eight (108) residential units. Figure 1 shows the location of the project.

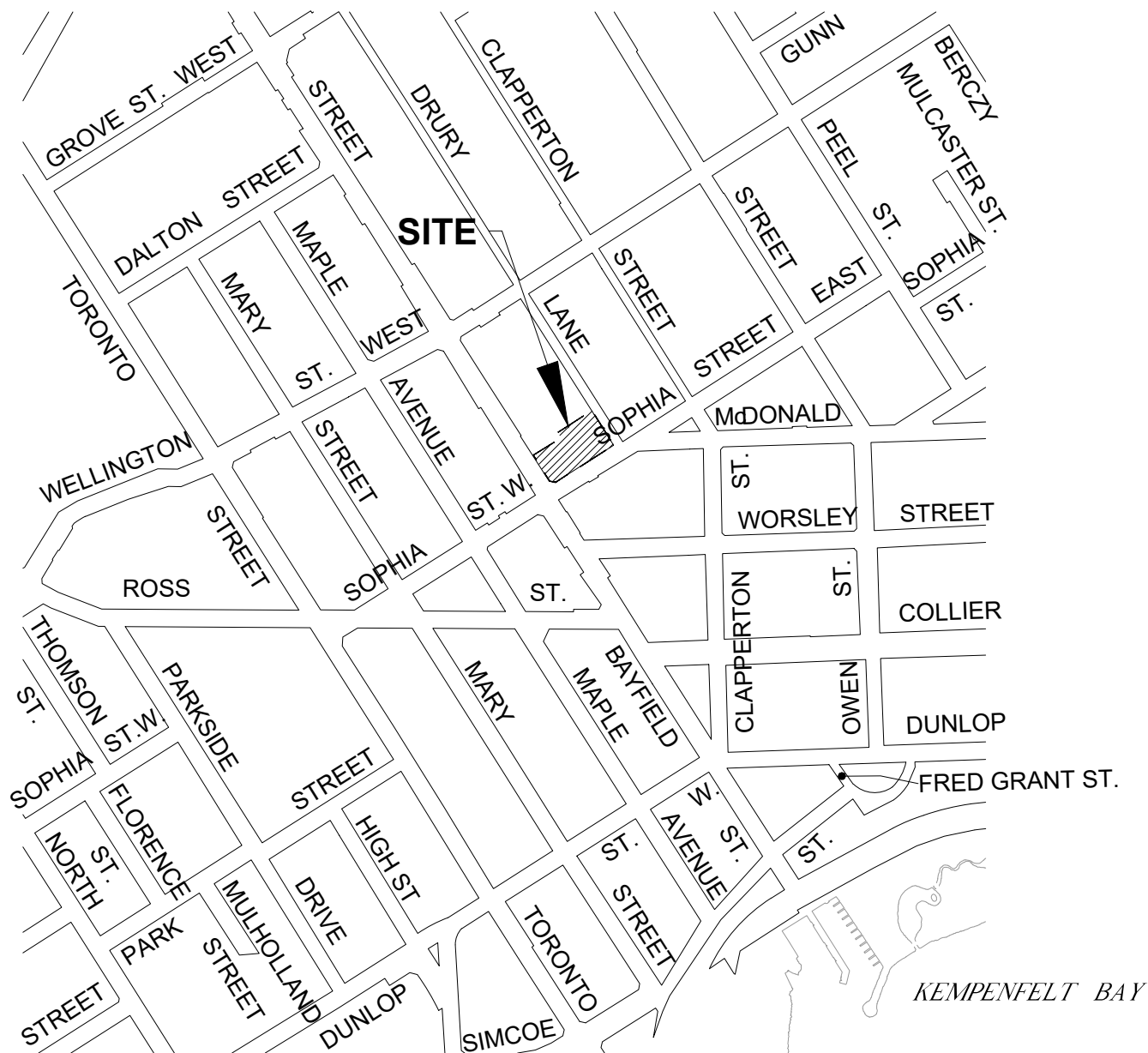
In support of the application for Site Plan Approval for the property, the City of Barrie requires a Stormwater Management Report to be prepared in order to demonstrate that the proposed development can be completed in accordance with City of Barrie and Lake Simcoe Region Conservation Authority requirements.

2.0 Existing Conditions

The property currently had five (5) commercial businesses on it and two (2) entrances, onto Sophia Street East and Drury Lane, respectively. Three (3) of the businesses are serviced from Sophia Street East, and the other two (2) are serviced from Bayfield Street. There is also an existing onsite storm sewer consisting of two (2) catch basins which collect onsite drainage and convey it to the existing storm sewer on Sophia Street East. The site was cleared of the previous buildings and parking in approximately 2017 as part of the re-development and is now vacant. However, this former use will be considered to represent pre-development conditions.

The residential rear yard of the property to the north of the site drains to the site in the existing condition. This 0.6 Ha drainage area consists of approximately half of the residential roof, with the rest of the catchment consisting of grass and landscaping.

Copyright © 2020 Skelton Brumwell & Associates Inc. All rights reserved.
This document is protected by copyright laws and may not be reproduced in any
manner, or for any purpose, except with the written permission of the copyright holder.



CORAL SOPHIA HOUSING
117 BAYFIELD ST.
BARRIE, ONTARIO

FIGURE 1
LOCATION PLAN

Scale 1:7500

P/N 3103 NOV 2020

SBA Skelton Brumwell
& Associates Inc.
ENGINEERING PLANNING ENVIRONMENTAL CONSULTANTS

93 BELL FARM ROAD, SUITE 107
BARRIE, ONTARIO L4M 5G1

TELEPHONE (705) 726-1141
FAX (705) 726-0331

Geotechnical and Hydrogeological studies have been undertaken by WSP Group. These studies have indicated the site soils are a silty sand mix with generally low permeability. Seasonal high groundwater on the site has been noted to be shallow which has significantly influenced the design of the building to-date, precluding the inclusion of a basement for vehicular parking and building mechanical servicing.

3.0 Project Stormwater Impacts and Controls

3.1 Quantity Control

Given that the subject property was developed for commercial use with storm sewer drainage, the net impact on stormwater quality, quantity and water balance is moderate. The overall site imperviousness will not increase and as such, stormwater detention will not be required to maintain peak flows at pre-development levels. This is due to part to the fact that project will make use of permeable pavers around much of the building perimeter and a section of green roof. Both of these measures reduce runoff rates compared to conventional, fully impervious options.

3.2 Quality Control

Stormwater quality controls will be required to implemented in accordance with requirements of the City of Barrie (COB) and Lake Simcoe Region Conservation Authority (LSRCA) with a targeted Total Suspended Solids (TSS) removal of 80% in accordance with provincial policy. With vehicular parking indoors on the ground and second floors, the site impervious area will be largely building roof and permeable pedestrian walkways, which produce lower amounts of contaminates found in stormwater. The site will also have a stormwater filter treatment system for phosphorous control which will also be highly effective in reducing TSS. The change in land use reducing impermeable surfaces used by automobiles and addition of a stormwater treatment system will result in net cleaner runoff leaving the proposed development site than the current condition.

3.3 Water Balance

The water balance analysis for the project has been completed by WSP and summarized in their report dated May 5, 2020 (Ref Proj No: 191-04692-00). Their analysis shows a net increase in infiltration on the site of 65 cu.m./year without implementation of site-specific infiltration measures.

3.4 Phosphorous Loading

LSRCA policies call for zero net phosphorous discharge from development sites, over and above requirements of the Lake Simcoe Protection Act. To achieve this, several LID measures can be implemented, with infiltration being the only one that can potentially reduce phosphorous

loading to zero. As discussed above however, infiltration features cannot be employed due to proximity to foundations. Instead, the site will rely on a Permeable Paving with underdrains and a Hydro International Upflow filter system (UFF-7) installed in an on-line configuration. This unit will treat runoff from the majority of the site and external drainage area and is rated to capture 43.9% of phosphorous on an annual basis.

We have also completed a phosphorus budget analysis of the pre-development condition to compare to the proposed condition per the Lake Simcoe Protection Plan 4.8-DP. This comparison shows that the proposed development reduces the net annual phosphorus load from the site to less than the pre-development condition. As such, the overall development is considered an improvement with respect to phosphorous loading of Lake Simcoe. This is discussed further in Section 4.5.

The LSRCA policy is focused on net proposed development loading. Like water balance, the LSRCA policy allows for the paying financial compensation where a net zero phosphorus export cannot be met. This compensation is calculated as follows:

Annual Phosphorous Load kg/yr x 2.5 x \$35,000.00/kg/yr or simplified; \$87,500.00 per Kg/yr loading, plus a 15% administration fee.

4.0 Proposed Stormwater Management

4.1 Quantity Control

In accordance with COB policies, the existing and proposed drainage conditions for the site have been analysed using the rational method. Peak flows were calculated for the existing condition treating the development site and external area as a single composite catchment. The same approach was taken in an initial analysis of the proposed condition. Flows were both existing and proposed were calculated for the 1 in 2, 5, 10, 25, 50 and 100 year return periods using current COB IDF curve parameters that are increased from historical records by 15% to account for climate change. For all storm events, the calculated post-development peak flows are higher than pre-development. Please refer to Appendix A for calculations. The existing and proposed drainage conditions are illustrated on drawings SWM1 and SWM2 which are included with this report.

These calculations are detailed in Appendix A. The results are summarised in Table 1 below:

Table 1 – Summary of Existing and Proposed Peak Flow Rates

Storm	Existing (cms)	Proposed (cms)	Change Ext to Prop (cms)
2 year	0.073	0.072	-0.001
5 year	0.096	0.094	-0.002
10 year	0.111	0.109	-0.002
25 year	0.137	0.135	--0.002
50 year	0.154	0.153	-0.001
100 year	0.170	0.170	-0.000

As illustrated the proposed development will not result in an increase in peak flows from the site.

4.2 Quality Control

The proposed site has a relatively low proportion of area that is considered to required quality treatment in terms of contaminates (oils, trash, suspended solids). The only exterior area subject to vehicular traffic is the loading space and driveway entrance with a total area of 109 sq.m (0.0109 Ha) which amounts to about 2.95% of the total site area.

Pedestrian hardscape is included in the project; however, this is intended to be surfaced with permeable pavement with an underdrain. This will greatly reduce surface flows and will serve to trap a portion of sediment in the pavement structure itself (which will then necessitate maintenance). The under drains below the permeable pavement will be routed such that flows are directed through the downstream control device described below.

Regardless of low proportions of site area considered to generate contaminates for treatment, all noted areas and the building roof will be routed through an Upflow filter for treatment. The only area to completely by-pass this unit for quality control is the area on the east side of the site. This is largely grassed and is not considered to produce runoff needing treatment for oils and TSS. There is a small section of pavement within the site boundary, 11 sq.m., in this catchment area at the entrance to the under-building parking that is proposed to be allowed to drain uncontrolled.

The Upflow Filer unit has been specified primarily for phosphorous treatment but it also provides substantial treatment for TSS as well as trash and oil like a more conventional hydro-

dynamic filter system. It is rated to trap in the order of 85% of TSS on an average annual basis, thus meeting requirements for quality control by it self.

4.3 Permeable Paving

In order to minimize the nutrient discharge off site it was determined that exterior pedestrian areas should be designed with permeable paving. In an ideal scenario, this paving would be designed to infiltrate at least the first flush (25mm) rainfall event for both water balance and nutrient management. Instead, due to the proximity to the foundation, this project will include an under drain below the permeable paving to collect infiltrating runoff and convey it to the downstream drainage system on site.

The pavement is intended to capture the 25mm first flush rainfall event. The pavement will be made up of interlock stone, either with porous pavers or pavers with significant gaps filled with pea gravel as opposed to sand. The pavers will be supported on 500mm of clear stone. Assuming this provides 40% of void space, this thickness of stone will provide the equivalent of 200 mm of storage depth compared to the 25mm of targeted rainfall depth. A typical section view of the permeable pavers is included on drawing 3103-SS1.

As shown on the site plan, the permeable pavers are largely located adjacent to the building. The exception is the paver section on the north side of the loading space. In all cases, the pavers will be collecting runoff from direct rainfall or from landscaped areas adjacent. No imperviable surfaces will drain to these pavers, greatly reducing concerns of getting plugged with sand and sediment.

The permeable pavement provides the following net benefits to stormwater quality control

- 1) Filtration of runoff from the surface, trapping sediments in the joints between the stones.
- 2) Capturing the 25mm storm event and directing it via under drains to the downstream Upflow filter for further treatment.
- 3) Reduction of winter salt application requirements due to the free draining surface being resistant to icing conditions as compared to conventional asphalt or concrete.

4.4 Green Roof

The project includes a section of green roof totally approximately 340 sq.m. This roof will have several positive environmental impacts such as reducing heat island effects, reducing runoff volume, rate and timing of peak flows as well as filtration of direct rainfall runoff. However,

consistent with guidelines for the LID TTT model, green roofs are considered to be a net generator of phosphorus rather than acting to reduce discharge. LID TTT guidelines suggest a factor of negative 45% be used to model the impact on phosphorus loading.

The green roof area has been included in the site LID TTT model as a bioswale with the removal fraction set to -45%.

4.5 Nutrient Management – Phosphorous Removal

As previously noted, the project site is unable to make use of infiltration measures for nutrient management. Instead, in order to minimize the amount of phosphorous being discharged from the site pedestrian surfaces will be surfaced with permeable pavers with under drain. Using guidelines in the LID TTT model, phosphorus removal for this type of feature is 60%. The under drains will then discharge to the site storm sewer system upstream of the Upflow Filter. This treatment unit has been specified due to its ability to treat phosphorus. According to manufacture's information, this is rated to remove 43.9% of phosphorus. Sizing information for the specified Upflow filter is included in Appendix C.

Modelling of the site shows the net removal efficiency for the site with the two systems in place is estimated to be 61.1% and remaining annual phosphorous load of 0.152 Kg/year. As this is greater than the zero-loading required by the LSRCA, the project will be required to pay compensation in accordance to their policies. The amount of compensation required will be $0.152 \text{ Kg/yr} \times 2.5 \times \$35,000/\text{Kg/yr} = \$13,300.00$ and an additional 15% administration fee of \$1,995.00 for a total of \$15,295.00.

Please note, the LSRCA policies provide compensation fees for both water balance and phosphorus loading shortfalls. Only the larger of the two values is actually collected by the LSRCA.

4.6 Low Impact Development Treatment Train Tool Summary

Modelling results for the LID TTT model are included in Appendix D. Table 2 below summarizes the modelling results for Total Phosphorus (TP) The water balance and TSS results from the LID TTT modelling are ignored as the LSRCA does not accept them.

Note: There is an external drainage area from the neighboring rear yard area that drains through the site. This has not been modelled in LID TTT as this project is not responsible for treatment of this runoff in terms of TP.

Table 2 – LID TTT Modelling Summary

Development Condition	TP Loading (Kg/yr)	TP Removal (%)
Pre	0.422	
Post (no controls)	0.390	
Post (with controls)	0.152	61.1

It should be noted that the change in land use for the proposed development which significantly reduces the exterior impermeable surface for vehicles provides a net reduction in both TSS and TP before controls are even considered.

4.7 Volume Control

LSRCA development guidelines include requirements for stormwater runoff volume control. The ideal target would be capture and infiltrate the runoff from a 25mm rainfall event. Alternative options are provided for sites with adverse conditions which cannot achieve this preferred option.

Alternative #1: retaining runoff from a 12.5mm rainfall event for all impervious surfaces from a site.

Alternative #2: retaining runoff from a 5mm rainfall event for all impervious surfaces from site.

Alternative #3: equivalent to 25mm runoff volume reduction on an off-site location.

For volume reduction techniques considered by the LSRCA may include: infiltration, reuse/rainwater harvesting, canopy interception, evapotranspiration etc. Priority is given to methods that include actual volume reduction. Secondary preferences is for methods that include filtration techniques followed by rate control features (collect and cause the 25mm runoff volume to drain down over a time frame of 24-48 hours.

The following means of achieving this requirement were considered:

Infiltration: not feasible due to the proximity of the building foundation to the property line. This applies to alternative #1 and #2.

Rainwater capture and re-use: it has been determined to not be financially feasible for a project targeting affordable housing. This applies to Alternative #1 and #2.

Equivalent volume reduction on another site in the area: the proponent for this project does not have access to other lands to perform volume reduction.

Rate control, collecting and causing runoff from a 25mm rainfall event to discharge over 24-48 hours: The volume requirement for this actually greatly exceeds the detention volume requirement for the overall site (which is small due to the previously developed nature of the site). Capture of smaller event volumes (12.5mm and 5mm) and delaying discharge over this period of time would require an orifice less than 50mm in diameter which would then be prone to plugging.

Filtering: All site runoff will be routed through an Upflow Filter which provides sediment and oil capture as well as reducing phosphorous. Through discussions with LSRCA technical staff, it has been determined that this will be sufficient on this specific site.

For reference, correspondence regarding this aspect of design is included in Appendix E.

5.0 Conveyance

5.1 Storm Sewers

The majority of the site will drain via a storm sewer system sized for the peak 1 in 100-year flow from the contributing catchment area. This is a conservative design approached based on previous design iterations that involved below grade detention. The pipe sizing resulting is not particularly large so cost savings to size the sewers for a 5-year event would be minimal. Sizing the sewers for the 1 in 100-year event provides great protection to the building as a whole in the event of this magnitude of storm event.

The building sewer will outlet at the north side, and then be routed east under the grade level amenity space to a MH near Drury Lane. From here the site sewer will be routed south parallel to Drury Lane, crossing under a portion of the grade level parking entrance.

At the south east corner of the building, sewer flows will enter the Upflow filter. This structure has been located on the potential future R.O.W. limit for Sophia Street. The filter structure includes an internal by-pass which conveys flows greater than the treatment flow rate through the device and to the downstream system.

From the filter, flow will be conveyed to the trunk storms sewer on Sophia Street. Connection will require breaking into the wall of the concrete box structure that encloses the former Sophia Creek.

Sizing calculations for the storms sewer system are included in Appendix B. Please also refer to drawing 3103-SS1 and SWM3, which are included with this report for a view of the proposed storm sewer.

5.2 Sheet flow, Pavers and Landscaped Area

There will be a vegetated landscaped area on the east side of the site that is proposed to be allowed to drain uncontrolled via sheet flow to the adjacent right-of-way on Drury Lane and Sophia Street.

The proposed permeable pavers on the west and south side of the site will be drained by a 100mm under drain pipe with the intent of collecting runoff from the 25mm rainfall event. It is expected that the actual collection and conveyance may be greater than this, however to be conservative in the sizing of flow controls it will be assumed that all return period storm events (2-100 year) will simply sheet to the Sophia Street right-of-way. Drawing 3103-GP1 shows the proposed grading for the landscaped areas, permeable pavers, amenity space and loading space. Drawing 3103-SS1 provides a typical detail of the permeable paving construction.

We have not completed flow calculations for the underdrain. It is surrounded by clear stone storage media which is well in excess of the volume requirement for a 25mm event. In the event that flow rates from the stone storage to the underdrain are greater than the pipe flow capacity, collected runoff will simply be stored into the stone and drainage will take place over time.

6.0 Maintenance Requirements

In order to ensure continued operation of the site stormwater management features, regular maintenance will be required. The following summarizes the expected maintenance measures:

- a) Annual inspection and cleaning of the Upflow filter
- b) Annual vacuum cleaning of permeable pavers
- c) Annual inspection of site catchbasin structures and hydro-vac cleaning when required (inspection can be done when Upflow inspection is completed and if determined to be required, cleaning at the same time)

7.0 Erosion and Sediment Control During Construction

The construction phase of the project will provide the most significant risk for the site to discharge silt and sediment to the surrounding environment. In order to mitigate this risk, several measures are proposed to be employed:

- a) Sediment control fence is to be installed around the perimeter of the site to contain silt and sediment being discharged during rainfall events. The City of Barrie detail for siltation fence calls for filter fabric supported on wire mesh fencing and steel t-bars. It is expected that the site will have hoarding around the perimeter and this can then also be used to support the sediment control fence.
- b) Existing and proposed catch basins and catch basin manholes are to be protected with Silt Sack sediment control devices which will act to intercept sediment carried in surface runoff.
- c) Stone mud mats are to be employed at all construction vehicle entrances to the site. This is intended to cause mud and sediment to fall off vehicle tires before exiting the site and tracking on area roads. However, given the amount of the site covered by the building, it is not anticipated that vehicles will be traversing the site for much of the construction phase.
- d) Periodic sweeping of area roads may be required in the event that mud and silt are tracked from the site.

All of these measures are to remain in place and be maintained by the project contractor until the site is ready to be reinstated.

Timing of construction for drainage works is a key consideration with respect to sediment control and impacts on the system. The permeable paving, and Upflow Filter cannot operate as intended if they are allowed to become impacted with sediment during construction.

- e) Permeable pavement construction to the scheduled immediately prior to final restatement of the site. Permeable pavers are not to be subject to construction traffic or used as a work surface during construction. This timing is important to ensure that the clear stone base of the permeable pavers does not become inundated with silt and sediment which will impede drainage and reduce storage space.
- f) Following site reinstatement, the entire site storm sewer system is to be flushed and cleaned. This includes specifically the Upflow Filter structure.
- g) The filter modules for the Upflow Filter are not to be installed until the site has been reinstated and the Upstream storm sewer system flushed and cleaned.

8.0 Conclusions and Recommendations

Based on the analysis summarized in this report, we conclude that the proposed development at 117 Bayfield Street can be completed while meeting the stormwater management requirements of the City of Barrie, Lake Simcoe Conservation Authority and Ministry of Environment, Conservation and Parks. To this end we recommend the following measures be employed:

- a) No infiltration LID techniques be employed due to proximity to proposed and existing foundations.
- b) Pedestrian walking spaces be surfaced with permeable pavers with under drains.
- c) Storm sewers in site be sized for the peak flow from the 1 in 100-year event.
- d) Flow from site storm sewers and permeable paver under drain be routed through a Hydro International Upflow filter for quality and nutrient management treatment.
- e) Connect site storm sewers to the Sophia Street Trunk storm sewer.
- f) Site landscaped and permeable paver areas on the west, south and east side of the site be allowed to sheet flow to the Sophia Street and Drury Lane right-of-way.
- g) Erosion and Sediment controls as detailed in Section 7.0 be employed during the construction phase of the project.
- h) Maintenance actives as summarised in Section 5.0 be employed once site works are completed.
- i) Financial compensation be paid to the LSRCA for the shortfall in phosphorous loading requirements (post-development phosphorus loading greater than zero).

9.0 Disclaimer of Responsibilities to Third Parties

This report was prepared by Skelton, Brumwell & Associates Inc. for the account of Coral-Sophia Housing Inc. in support of the property rezoning application and future site plan approval from the City of Barrie and Lake Simcoe Region Authority.

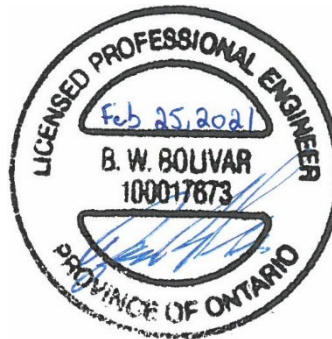
The material in it reflects Skelton, Brumwell & Associates Inc.'s best judgement in light of the information available to it at the time of preparation. Any use which a third party, not listed above, makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.

Skelton, Brumwell & Associates Inc. accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions based on this report.

All of which is respectfully submitted,
SKELTON, BRUMWELL & ASSOCIATES INC.
per:



Bryan W. Bolivar, P.Eng
Senior Project Engineer, Partner



Appendix A

Rational Method Analysis

Soils investigation on site indicates silt at surface, though soils investigation is localized.

CATCHMENT EXT		AREA =	0.06	Ha					
GROUND COVER TYPE				PROPORTION	C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
IMPERVIOUS	0.0066			0.102	0.95	0.95	1.00	1.00	1.00
GRASS	0.058			0.898	0.25	0.25	0.28	0.30	0.31
TOTAL	0.06	Ha		WEIGHTED C	0.32	0.32	0.35	0.37	0.38

PREDEVELOPMENT SITE									
DEVELOPMENT SITE (ext)		AREA =	0.37	Ha					
GROUND COVER TYPE				PROPORTION	C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
IMPERVIOUS	0.2870			0.772	0.95	0.95	1.00	1.00	1.00
Grassed	0.085			0.228	0.25	0.25	0.28	0.30	0.31
TOTAL	0.372	Ha		WEIGHTED C	0.79	0.79	0.83	0.84	0.84

COMBINED EXISTING DRAINAGE AREA		AREA =	0.44	Ha					
GROUND COVER TYPE				PROPORTION	C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
IMPERVIOUS	0.2936			0.673	0.95	0.95	1.00	1.00	1.00
Grassed	0.1424			0.327	0.25	0.25	0.28	0.30	0.31
TOTAL	0.44	Ha		WEIGHTED C	0.72	0.72	0.76	0.77	0.78

City of Barrie IDF Curve Parameters		2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	
a		678.085	856.608	975.855	1146.28	1236.15	1426.41	
b		4.699	4.699	4.699	4.92	4.70	5.27	
c		0.781	0.766	0.76	0.76	0.75	0.76	
t =	10.00							
i = a/(t+b)^c		83.1	109.3	126.5	148.2	164.2	180.2	(mm/hr)
Q = 0.00278 C*I^A		0.073	0.096	0.111	0.137	0.154	0.170	cms

POSTDEVELOPMENT SITE								
DEVELOPMENT SITE		AREA =	0.37	Ha				
GROUND COVER TYPE		PROPORTION			C 2-5 YR	C 10 YR	C 25 YR	C 50 YR C 100 YR
IMPERVIOUS	0.2515	0.680			0.95	0.95	1.00	1.00 1.00
Green Roof	0.0340	0.092			0.55	0.55	0.61	0.66 0.69
Grassed	0.0506	0.137			0.25	0.25	0.28	0.30 0.31
Pervious Paving	0.0339	0.092			0.45	0.45	0.50	0.54 0.56
		1.000						
TOTAL	0.370	Ha	WEIGHTED C		0.77	0.77	0.82	0.83 0.84
COMBINED PROPOSED DRAINAGE AREA		AREA =	0.43	Ha				
GROUND COVER TYPE		PROPORTION			C 2-5 YR	C 10 YR	C 25 YR	C 50 YR C 100 YR
IMPERVIOUS	0.2581	0.594			0.95	0.95	1.00	1.00 1.00
Green Roof	0.0340	0.078			0.55	0.55	0.61	0.66 0.69
Grassed	0.1084	0.250			0.25	0.25	0.28	0.30 0.31
Pervious Paving	0.0339	0.078			0.45	0.45	0.50	0.54 0.56
		1.000						
TOTAL	0.43	Ha	WEIGHTED C		0.71	0.71	0.76	0.77 0.78
City of Barrie IDF Curve Parameters		2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	
a		678.085	856.608	975.855	1146.28	1236.15	1426.41	
b		4.699	4.699	4.699	4.92	4.70	5.27	
c		0.781	0.766	0.76	0.76	0.75	0.76	
t =	10.00							
i = a/(t+b)^c		83.1	109.3	126.5	148.2	164.2	180.2	(mm/hr)
Q = 0.00278 C*i*A		0.072	0.094	0.109	0.135	0.153	0.170	cms

Runoff Coefficient from: Table 3.2 City of Barrie Storm Drainage and Stormwater Management Policies and Design Guidelines

Change from Existing to Proposed (cms)	-0.001	-0.002	-0.002	-0.002	-0.001	0.000
Detention Storage is NOT required maintain peak flows at pre-development magnitudes						

3. Option 3 – Gravity drain or sump pump with discharge to third pipe (foundation drain collector - FDC). A third pipe (FDC) shall be constructed in the right-of-way (ROW) to collect foundation drain flow by gravity (or using a sump pump if grades do not permit) and to convey the flow to a nearby watercourse or other acceptable receiving body. Similar to the option above, an FDC eliminates the risk of basement flooding and surface discharge and nuisance flooding.
4. Option 4 – Sump pump discharge piping in boulevard (retrofit option only). In the event of overactive sump pump activity, a 150 mm diameter PVC DR-28 sewer may be installed, when so directed by the City, along the frontages of designated lots, with an offset of 0.6 m from back of curb. This sewer is to have a cleanout at the upstream end and is to outlet into the nearest catchbasin downstream. The depth of sewer is to be equal to the subdrain depth. The discharge piping shall not be directly connected to the foundation drains.

3.2 Minor System

Storm sewers shall be provided on all roads with curb and gutter. Storm sewers shall be designed to convey, as a minimum, the 1:5 year design storm.

3.2.1 Service Area

The drainage system shall be designed to accommodate all upstream drainage areas plus any external area tributary to the system for the existing, interim and ultimate development conditions, as determined by the delineation of appropriate topographic mapping and the preparation of drainage plans.

3.2.2 Design Flow

Storm sewer systems with a drainage area ≤ 50 ha shall be designed to convey the 1:5 year (minimum) design storm using the Rational Method and the City's IDF regression equation for rainfall intensity unless otherwise approved or directed by the City. Storm sewer systems with a drainage area > 50 ha shall be designed using an approved computer program and verified with the Rational Method. The storm sewer design shall be based on the larger of the two flows calculated using the computer model and the Rational Method. Under no circumstances shall the storm system be designed in a surcharged condition.

The design of the storm sewers shall be computed using the City of Barrie's Storm Sewer Design Sheet as provided in **Appendix A**.

All storm sewers shall be designed according to the Rational Formula where:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow in (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)

The rainfall intensity shall be calculated in accordance with the following table and equation:

Table 3.1: Barrie WPCC IDF Curve Parameters - Adjusted to Account for Climate Change

Parameter	Return Period					
	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
A	678.085	853.608	975.865	1146.275	1236.152	1426.408
B	4.699	4.699	4.699	4.922	4.699	5.273
C	0.781	0.766	0.760	0.757	0.751	0.759

Rainfall Intensity, I (mm/hr) = A/(t+B)^C, where t is time duration in minutes

Parameters based on rain gauge data for the period 1979 – 2003 for the Barrie WPCC Station #6110557

Based on a review of the literature, the IDF intensity values for Barrie WPCC Station were increased by 15% before calculating a, b, c values to account for climate change.

$$i = \frac{A}{(t_d + B)^C}$$

where,

- i = the rainfall intensity (mm/hr)
- t_d = the storm duration (minutes)
- A, B, C = a function of the local intensity-duration data.

The storm duration is set to the time of concentration (i.e. the sewer inlet time plus the time of travel in the pipe or channel) for the total cumulative drainage area to the node of interest. The maximum inlet time for the first pipe of a storm sewer system is 10 minutes.

The runoff coefficient shall be calculated in accordance with the following table:

Table 3.2: Runoff Coefficients (Rational C) (5-yr to 10-yr) Based on Hydrologic Soil Group

Land Use	Runoff Coefficient "C"		
	A-AB	B-BC	C-D
Cultivated Land, 0 - 5% grade	0.22	0.35	0.55
Cultivated Land, 5 - 10% grade	0.30	0.45	0.60
Cultivated Land, 10 - 30% grade	0.40	0.65	0.70
Pasture Land, 0 - 5% grade	0.10	0.28	0.40
Pasture Land, 5 - 10% grade	0.15	0.35	0.45
Pasture Land, 10 - 30% grade	0.22	0.40	0.55
Woodlot or Cutover, 0 - 5% grade	0.08	0.25	0.35
Woodlot or Cutover, 5 - 10% grade	0.12	0.30	0.42
Woodlot or Cutover, 10 - 30% grade	0.18	0.35	0.52
Lakes and Wetlands	0.05	0.05	0.05
Impervious Area (i.e., buildings, roads, parking lots, etc.)	0.95	0.95	0.95
Gravel (not to be used for proposed parking or storage areas)	0.40	0.50	0.60
Residential – Single Family	0.30	0.40	0.50
Residential – Multiple (i.e., semi, townhouse, apartment)	0.50	0.60	0.70
Industrial – light	0.55	0.65	0.75
Industrial – heavy	0.65	0.75	0.85
Commercial	0.60	0.70	0.80
Unimproved Areas	0.10	0.20	0.30
Lawn, < 2% grade	0.05	0.11	0.17
Lawn, 2 - 7% grade	0.10	0.16	0.22
Lawn, > 7% grade	0.15	0.25	0.35

Adapted from Design Chart 1.07, Ontario Ministry of Transportation, "MTO Drainage Management Manual," MTO. (1997)

An approximation of the runoff coefficient can be calculated based on the following relationship with:

$$c = (0.7)(TIMP) + 0.2$$

where,

c = the runoff coefficient

TIMP = total impervious fraction (dimensionless)

The runoff coefficient shall be adjusted for return period events greater than the 10-yr storm per the following table:

Table 3.3: Runoff Coefficient Adjustment for 25-yr to 100-yr Storms

Return Period	Runoff Coefficient "C"
25 years	$C_{25} = 1.1 \cdot C_5$
50 years	$C_{50} = 1.2 \cdot C_5$
100 years	$C_{100} = 1.25 \cdot C_5$

Adapted from Design Chart 1.07, Ontario Ministry of Transportation, "MTO Drainage Management Manual," MTO. (1997).

Note: When applying the runoff coefficient adjustment, the maximum c-value should not exceed 1.0.

Given that the direct connection of foundation drains to the storm sewer is not permitted, a detailed HGL analysis is typically not required unless deemed otherwise by the City due to special circumstances. Refer to **Section 7.3** for details regarding HGL analysis requirements.

The calculation of total percent impervious (TIMP) values for modeling shall be in accordance with **Section 7.2.5 (Table 7.6)**.

3.2.3 Pipe Capacity and Size

The storm sewer capacity shall be calculated using the Manning's equation assuming the pipe is flowing full as follows:

$$Q = \left[\frac{1}{n} \right] A(R)^{\frac{2}{3}} (S)^{\frac{1}{2}}$$

where,

- Q = the pipe capacity (m³/s)
- n = the Manning roughness value
- R = the hydraulic radius (m)
- S = the sewer pipe slope (m/m).

A maximum inlet time of 10 minutes shall be used for the first pipe of a storm sewer system.

The velocity of flow in the storm sewer (assuming pipe flowing full) shall be calculated as follows:

$$v = \left[\frac{Q}{A} \right]$$

where,

- Q = flow in the pipe when flowing full (m³/s)
- A = cross sectional area of the pipe (m²)

The appropriate roughness coefficients shall be used as identified in **Table 3.4**.

The minimum size for a storm sewer (within a street) shall be 300 mm in diameter. No decrease of pipe size from a larger size upstream to a smaller size downstream shall be allowed regardless of the increase in grade.

3.2.4 Roughness Coefficients

The following roughness coefficients shall be used for hydraulic calculations of storm sewers:

Table 3.4: Sewer Pipe Manning's Coefficient

Material	Manning's "n"
Concrete, PVC, Profile Rib Pipe	0.013
Corrugated Metal with 25% Paved Invert	0.021
Corrugated Metal 68 x 13 mm Corrugations	0.024

3.2.5 Flow Velocity

The minimum flow velocity in the storm sewer shall be 0.75 m/s (full flow conditions).

The maximum flow velocity in the storm sewer shall be 4.0 m/s (full flow conditions).

3.2.6 Minimum Slope

The minimum storm sewer slope shall be not less than 0.5% unless specifically approved by the Director of Infrastructure.

3.2.7 Sewer Alignment

The storm sewers shall be laid as per City standard drawings **BSD-01, 03, 04, 06A, 06B, 07A, 07B and 07C** in a straight line between maintenance holes unless radius pipe has been designed.

3.2.8 Curved Sewers (radius pipe)

Curved pipe (radius pipe) shall be allowed for storm sewers 1200 mm in diameter and larger. The minimum center line radius allowable shall be in accordance with the minimum radii table as provided by the manufacturer.

Table 4.7.2 Volumetric runoff reduction¹ from permeable pavement

LID Practice	Location	Runoff Reduction ¹	Reference
Permeable pavement without underdrain	Guelph, Ontario	90%	James (2002)
	Pennsylvania	90%	Kwiatkowski <i>et al.</i> (2007)
	France	97%	Legret and Colandini (1999)
	Washington	97 to 100%	Brattebo and Booth (2003)
	Connecticut	72% ²	Gilbert and Clausen (2006)
Permeable pavement with underdrain	King City, Ontario	99% ⁴	TRCA (2008b)
	North Carolina	98 to 99%	Collins <i>et al.</i> (2008)
	United Kingdom	50%	Jefferies (2004)
	United Kingdom	53 to 66%	Pratt <i>et al.</i> , 1995
	Maryland	45 to 60%	Schueler <i>et al.</i> (1987)
Runoff Reduction Estimate ³		85% without underdrain; 45% with underdrain	
Notes:			
- Runoff reduction estimates are based on differences between runoff volume from the practice and total precipitation over the period of monitoring unless otherwise noted. - Runoff reduction estimates are based on differences in runoff volume between the practice and a conventional impervious surface over the period of monitoring. - This estimate is provided only for the purpose of initial screening of LID practices suitable for achieving stormwater management objectives and targets. Performance of individual facilities will vary depending on site specific contexts and facility design parameters and should be estimated as part of the design process and submitted with other documentation for review by the approval authority. - In this study, there was no underdrain in the pavement base, but an underdrain was located 1 m below the native soils to allow for sampling of infiltrated water.			

Water Quality - Pollutant Removal Capacity

Like other infiltration practices, the capacity of permeable pavements to remove pollutants is closely associated with their ability to infiltrate runoff. Full infiltration designs are more effective because little if any of the pollutants generated on the impermeable surfaces leave the site as surface runoff. Partial infiltration designs with underdrains generate more runoff, and as a result, are often used in studies investigating the water quality impact of permeable pavements on surface waters. These studies show load reductions above 50% for total suspended solids, most metals, and hydrocarbons (Legret and Colandini, 1999; Pratt *et al.*, 1995; Pagotto *et al.*, 2000). A substantial portion of the pollutants are captured in the surface pores and underlying granular base of the permeable pavements (Pratt *et al.*, 1995).

Another group of studies of permeable pavements examines the quality of water infiltrated through soils beneath the installations. In these studies the quality of infiltrated water is used as a measure of the potential for contamination of groundwater. One such study of a permeable interlocking concrete pavement installed in a college parking lot in King City, Ontario, showed that stormwater infiltrated through a 60 cm granular reservoir and 1 metre of native soil had significantly lower concentrations of several typical parking lot contaminants relative to runoff from an adjacent asphalt surface (TRCA, 2008b). These results are consistent with research on the quality of infiltrated water from permeable pavements in Washington (Brattebo and Booth, 2003) and Pennsylvania (Kwiatkowski *et al.*, 2007). As with all stormwater infiltration practices, risk of groundwater contamination from infiltration of runoff laden with road

Table 4.2.1 Ability of green roofs to meet SWM objectives

BMP	Water Balance Benefit	Water Quality Improvement	Stream Channel Erosion Control Benefit
Green Roofs	Yes	Yes	Yes

Water Balance

Green roofs help achieve water balance objectives by reducing total annual runoff volumes. Considerable research has been conducted in recent years to define the runoff reduction capacity of extensive green roofs. Reported rates for runoff reduction have been shown to be a function of media depth, roof slope, annual rainfall and cold season effects. Based on the prevailing climate for the region, a conservative runoff reduction rate for green roofs of 45 to 55% is recommended for initial screening of LID practices. Results from select monitoring studies are provided in Table 4.2.2.

Table 4.2.2 Monitoring results – green roof runoff reduction

Location	Monitoring Period	Substrate Depth (cm)	Runoff Reduction ¹	Reference
Toronto, Ontario	May '03 – Aug.'05 excluding winters	14	63% ²	Van Seters <i>et al.</i> (2009)
Toronto, Ontario	Mar.'03 – Nov.'04 excluding winters	7.5 and 10	57% ²	Liu and Minor (2005)
Ottawa, Ontario	Nov.'00 – Nov.'01	15	54% ²	Liu (2002)
East Lansing, Michigan	Apr.'05 – Nov.'05 & Apr.'06 – Sep.'06	6	75 to 85%	Getter <i>et al.</i> (2007)
East Lansing, Michigan	Aug.'02 – Oct.'03 excluding winter	5.5	61%	VanWoert <i>et al.</i> (2005)
Portland, Oregon	May – Oct.'02	11	69%	Hutchinson <i>et al.</i> (2003)
Germany	Between 1987 and 2003 ³	10 ⁴	50% ⁵	Mentens <i>et al.</i> (2005)
Kinston, North Carolina	July – Aug & Nov.-Dec.'03	10	64%	Hathaway <i>et al.</i> (2008)
Athens, Georgia	Nov.'03 – Nov.'04	11	78%	Carter and Rasmussen (2006)
Runoff Reduction Estimate⁶			45 to 55%	

Notes:

1. Values represent total precipitation retained by the green roof over the monitoring period unless otherwise noted.
2. Value represents reduction in runoff from the green roof relative to a reference roof, not relative to precipitation.
3. Based on summary of 18 different studies examining 121 extensive green roofs.
4. Value represents the median substrate depth from 121 extensive green roofs.
5. Value represents the average runoff reduction as % of total annual precipitation, based on studies of 121 extensive green roofs.
6. This estimate is provided only for the purpose of initial screening of LID practices suitable for achieving stormwater management objectives and targets. Performance of individual facilities will vary depending on site specific contexts and facility design parameters and should be estimated as part of the design process and submitted with other documentation for review by the approval authority.

Appendix B

Storm Sewer Sizing

PROPOSED CONDITION CATCHMENTS

CATCHMENT 301		AREA =	0.052	Ha	(Drains via Permeable Pavement w underdrain)				
GROUND COVER TYPE		PROPORTION			C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
Impervious	0.0049		0.094		0.95	0.95	1.00	1.00	1.00
Vegetated	0.017		0.331		0.25	0.25	0.28	0.30	0.31
Permiable Paving	0.030		0.575		0.45	0.45	0.50	0.54	0.56
TOTAL	0.052	Ha	WEIGHTED C		0.43	0.43	0.47	0.50	0.52

CATCHMENT 302		AREA =	0.265	Ha					
GROUND COVER TYPE		PROPORTION			C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
Impervious	0.2310		0.872		0.95	0.95	1.00	1.00	1.00
Green Roof	0.0340		0.128		0.55	0.55	0.61	0.66	0.69
Vegetated	0.000		0.000		0.25	0.25	0.28	0.30	0.31
Permeable Paving	0.000		0.000		0.45	0.45	0.50	0.54	0.56
TOTAL	0.265	Ha	WEIGHTED C		0.90	0.90	0.95	0.96	0.96

CATCHMENT 303		AREA =	0.024	Ha					
GROUND COVER TYPE		PROPORTION			C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
Impervious	0.0014		0.059		0.95	0.95	1.00	1.00	1.00
Vegetated	0.015		0.628		0.25	0.25	0.28	0.30	0.31
Permeable Paving	0.008		0.314		0.45	0.45	0.50	0.54	0.56
TOTAL	0.024	Ha	WEIGHTED C		0.35	0.35	0.39	0.42	0.43

CATCHMENT EXT		AREA =	0.06	Ha					
GROUND COVER TYPE		PROPORTION			C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
Impervious	0.0022		0.037		0.95	0.95	1.00	1.00	1.00
Vegetated	0.058		0.963		0.25	0.25	0.28	0.30	0.31
TOTAL	0.06	Ha	WEIGHTED C		0.28	0.28	0.30	0.33	0.34

CATCHMENT 303 + EXT DRAIN TO CB#1 - CALCULATE COMBINED INPUTS		AREA =	0.084	Ha					
GROUND COVER TYPE		PROPORTION			C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
Impervious	0.0036		0.043		0.95	0.95	1.00	1.00	1.00
Vegetated	0.0728		0.868		0.25	0.25	0.28	0.30	0.31
Permeable Paving	0.008		0.089		0.45	0.45	0.50	0.54	0.56
TOTAL	0.084	Ha	WEIGHTED C		0.30	0.30	0.33	0.35	0.36

CATCHMENT 304		AREA =	0.015	Ha					
GROUND COVER TYPE		PROPORTION			C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
Impervious	0.0105		0.682		0.95	0.95	1.00	1.00	1.00
Vegetated	0.003		0.175		0.25	0.25	0.28	0.30	0.31
Permeable Paving	0.002		0.143		0.45	0.45	0.50	0.54	0.56
TOTAL	0.015	Ha	WEIGHTED C		0.76	0.76	0.80	0.81	0.82

CATCHMENT 305		AREA =	0.020	Ha	(Drains Uncontrolled to Street)				
GROUND COVER TYPE		PROPORTION			C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
Impervious	0.0012		0.060		0.95	0.95	1.00	1.00	1.00
Vegetated	0.019		0.940		0.25	0.25	0.28	0.30	0.31
Permeable Paving	0.000		0.000		0.45	0.45	0.50	0.54	0.56
TOTAL	0.020	Ha	WEIGHTED C		0.29	0.29	0.32	0.34	0.35

Rational Method Storm Sewer Design

Q = 0.00278 C.I.A. - IN C.M.S. (CUBIC METRES /SEC)
C =RUNNOFF COEFFICIENT
A = AREA - IN HECTARES
i = RAINFALL INTENSITY (mm/hr) = A / (t+B)^C

Skelton, Brumwell and Associates Inc.
DATE April 24, 2020
CALCS BWB
Revised February 18, 2021

100 year STORM FLOWS - SEWER SIZING

A (idf) = 1426.41
B (idf) = 5.27
C (idf) = 0.76
t = flow time

initial t = 10 minutes

AREA	LOCATION		PIPE LENGTH (METRES)	INCREMENT		CA	TOTAL CA	FLOW TIME (MIN)		I	TOTAL PEAK Q (CMS)	S (%)	D (mm)	Mannings 'n' for pipe	Q PIPE FULL (CMS)	V PIPE FULL (m/sec)	REMARKS	PIPE CAPACITY GREATER THAN FLOW RATE?
	FROM	TO		C	A			TO SECTION	IN SECTION									
302	Building	STMH#1	1.8	0.96	0.265	0.254	0.254	10.00	0.02	180.15	0.127	2.00	300	0.013	0.137	1.933	PVC 100 YR FLOW	OK
303+Ext	CB#1	Main Line	1.7	0.36	0.084	0.030	0.030	10.00	0.01	180.15	0.015	7.10	250	0.013	0.158	3.225	PVC 100 YR FLOW	OK
	STMH#1	CBMH#1	35.3				0.285	10.02	0.43	180.02	0.142	0.75	375	0.013	0.152	1.374	PVC 100 YR FLOW	OK
304	CBMH#1	STMH#2	5.3	0.88	0.015	0.01	0.298	10.01	0.06	180.08	0.149	1.00	375	0.013	0.175	1.586	PVC 100 YR FLOW	OK
	STMH#2	Filter	36.1				0.298	10.06	0.48	179.58	0.149	0.50	450	0.013	0.201	1.267	PVC 100 YR FLOW	OK
	Filter	Sophia	2.2								0.149	1.00	450	0.013	0.285	1.791	PVC 100 YR FLOW	OK

Appendix C

Hydro International Upflow Filter Sizing

Storm Catchment to Filter

DATE April 17, 2020
CALCS BWB
Revised November 3, 2020

Soils investigation on site indicates silt at surface, though soils investigation is localized.

CATCHMENT EXT		AREA =	0.06	Ha					
GROUND COVER TYPE				PROPORTION	C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
IMPERVIOUS	0.0066			0.102	0.95	0.95	1.00	1.00	1.00
GRASS	0.058			0.898	0.25	0.25	0.28	0.30	0.31
TOTAL	0.06	Ha		WEIGHTED C	0.32	0.32	0.35	0.37	0.38

POSTDEVELOPMENT SITE									
DEVELOPMENT SITE		AREA =	0.37	Ha					
GROUND COVER TYPE		PROPORTION			C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
IMPERVIOUS	0.2786		0.753		0.95	0.95	1.00	1.00	1.00
Grassed	0.0513		0.139		0.25	0.25	0.28	0.30	0.31
Pervious Paving	0.0401		0.108		0.95	0.95	1.05	1.14	1.19
			1.000						
TOTAL	0.370	Ha		WEIGHTED C	0.85	0.85	0.90	0.92	0.93

DRAINAGE TO JELLYFISH FILTER - 25mm EVENTS

COMBINED PROPOSED DRAINAGE AREA		AREA =	0.43	Ha					
GROUND COVER TYPE		PROPORTION			C 2-5 YR	C 10 YR	C 25 YR	C 50 YR	C 100 YR
IMPERVIOUS + Pervious Paving	0.3253		0.749		0.95	0.95	1.00	1.00	1.00
Grassed	0.1091		0.251		0.25	0.25	0.28	0.30	0.31
TOTAL	0.43	Ha		WEIGHTED C	0.77	0.77	0.82	0.82	0.83

ADS UFF Sizing Summary

Project Name:	Coral Sophia (117 Bayfield St.)		
Consulting Engineer:	Skelton Brumwell & Associates		
Location:	Barrie, ON		
Sizing Completed By:	C. Neath	Email:	cody.neath@ads-pipe.com

Recommended Unit	
Recommended Model:	UFF-5
TSS Removal Percentage:	83.0%
Total Site Volume Treated:	92.6%

Site Details	
Site Area:	0.44 ha
% Impervious:	76%
Rational C:	0.76
Rainfall Station:	Barrie, ONT
Particle Size Distribution:	ETV / NJDEP
Peak Storm Flowrate:	170 L/s

Unit Specifications:	
Number of Filter Modules:	5
Maximum Treatment Flowrate:	8 L/s
Inlet - Outlet Drop:	300 mm*
Max. Pipe Diameter:	600 mm

* Drop across unit can be reduced when required.

Site Elevations:	
Rim Elevation:	235.62
Inlet Pipe Elevation:	233.90
Outlet Pipe Elevation:	233.60

Consult approved shop drawings for final elevations. Riser sections (and/or grade rings) may be required to reach final grade on site.

Rainfall Intensity ⁽¹⁾	Fraction of Rainfall ⁽¹⁾	Removal Efficiency ⁽²⁾	Weighted Net-Annual Removal Efficiency
mm/hr	%	%	%
0.50	0.1%	92.3%	0.1%
1.00	18.0%	91.4%	16.5%
1.50	7.5%	90.5%	6.8%
2.00	13.7%	89.6%	12.2%
2.50	4.3%	88.7%	3.8%
3.00	5.1%	87.8%	4.4%
3.50	7.8%	86.9%	6.8%
4.00	3.4%	86.0%	2.9%
4.50	3.2%	85.2%	2.7%
5.00	5.3%	84.3%	4.4%
6.00	4.7%	82.5%	3.8%
7.00	5.4%	80.7%	4.3%
8.00	4.6%	78.9%	3.7%
9.00	2.5%	77.1%	2.0%
10.00	2.8%	75.3%	2.1%
20.00	9.9%	57.4%	5.7%
30.00	1.3%	39.5%	0.5%
40.00	0.2%	21.6%	0.1%
50.00	0.0%	3.8%	0.0%
100.00	0.0%	0.0%	0.0%
Net Annual Treatment			83.0%
Total Runoff Volume Treated:			92.6%

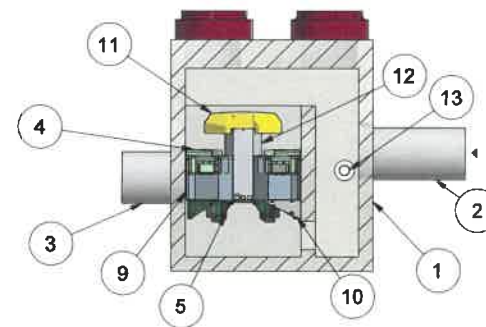
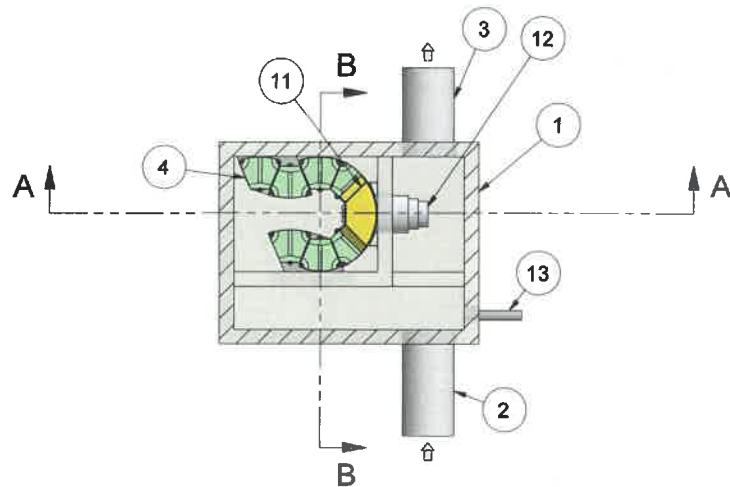
Rainfall Data: 1978:2007, HLY03, Barrie, ONT, 6110557.

Notes:

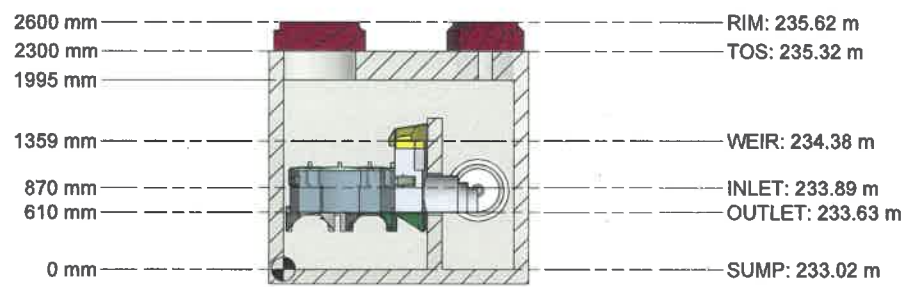
Removal efficiencies are based on NJDEP Test Protocols and independently verified.

TSS removal based on ETV/NJDEP particle size distribution.

All units supplied by ADS have numerous local, provincial, and international certifications (copies of which can be provided upon request). The design engineer is responsible for ensuring compliance with applicable regulations.



SECTION B-B
SCALE 1:50



SECTION A-A
SCALE 1:50

CAPACITIES:

1. Minimum performance: 80% removal. NJDEP - NJDEP Blend; NJCAT, Sil-Co-Sil 106 (d50 = 22 microns) at the peak treatment flow.
2. Maximum number of modules per outlet module: 38 **
3. NJDEP peak treatment flow: .056 cfs (25 gpm) per module, CPZ

ADDITIONAL DESIGN INFORMATION:

1. * Normal operating W.S.E. is 2.46' above the outlet invert at the peak treatment flow of .056 cfs (25 gpm) per module. For a given flow the head requirement can be reduced by adding additional filters.
2. ** Treatment flows that require more modules will require a larger vault design or different arrangement.
3. Media Types Available: New Jersey - Ribbons; Elsewhere - CPZ

ANY WARRANTY GIVEN BY HYDRO INTERNATIONAL WILL APPLY ONLY TO THOSE ITEMS SUPPLIED BY IT. ACCORDINGLY HYDRO INTERNATIONAL CANNOT ACCEPT ANY RESPONSIBILITY FOR ANY STRUCTURE, PLANT, OR EQUIPMENT, (OR THE PERFORMANCE THERE OF) DESIGNED, BUILT, MANUFACTURED, OR SUPPLIED BY ANY THIRD PARTY. HYDRO INTERNATIONAL HAVE A POLICY OF CONTINUOUS DEVELOPMENT AND RESERVE THE RIGHT TO AMEND THE SPECIFICATION. HYDRO INTERNATIONAL CANNOT ACCEPT LIABILITY FOR PERFORMANCE OF ITS EQUIPMENT, (OR ANY PART THEREOF), IF THE EQUIPMENT IS SUBJECT TO CONDITIONS OUTSIDE ANY DESIGN SPECIFICATION. HYDRO INTERNATIONAL OWNS THE COPYRIGHT OF THIS DRAWING, WHICH IS SUPPLIED IN CONFIDENCE. IT MUST NOT BE USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS SUPPLIED AND MUST NOT BE REPRODUCED, IN WHOLE OR IN PART, WITHOUT PRIOR PERMISSION IN WRITING FROM HYDRO INTERNATIONAL.

PARTS LIST				
ITEM	QTY	DESCRIPTION	TYPE	SIZE (mm)
1	1	PRECAST VAULT		1800x2400
2	1	UFF INLET PIPE	HDPE	450
3	1	UFF OUTLET PIPE	HDPE	450
4	7	MODULE LID		
5	4	SUPPORT FRAME		
6	1	COVER 30 IN		750
7	2	COVER 24 IN		600
8	2	WEDGE WALL MOUNT		
9	7	MODULE BODY		
10	2	SUPPORT FRAME LH		
11	1	BYPASS HOOD-S		
12	1	OUTLET MODULE		
13	1	AUX PIPE 1	PVC	100

PROJECTION

IF IN DOUBT ASK

COMMENTS:
 1. STRUCTURE WALL AND SLAB THICKNESSES ARE NOT TO SCALE.
 2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING THE STRUCTURE

REVISION HISTORY			
REV	BY	DESCRIPTION	DATE
-	JLL3	FIRST RELEASE	11/9/2020

DATE: 11/9/2020	SCALE: 1:50
DRAWN BY: JLL3	CHECKED BY: APPROVED BY:

Title
UP-FLO FILTER
1800x2400

7 MODULES

WQCD
CORAL SOPHIA HOUSING
BARRIE, ON

Patent: www.hydro-int.com/patents

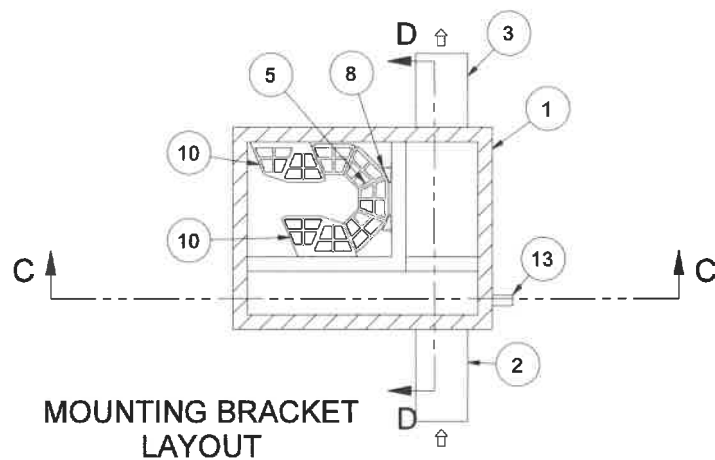
hydro-int.com
HYDRO INTERNATIONAL

DO NOT SCALE DRAWING
STEEL FABRICATION TOLERANCES
 UNLESS OTHERWISE SPECIFIED,
 DIMENSIONS ARE IN INCHES:

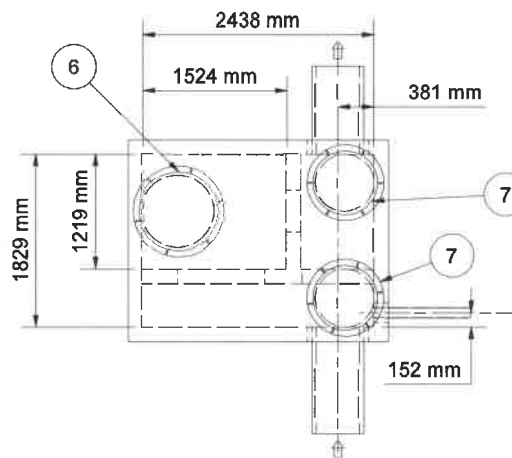
LINEAR	ANGULAR
000 - 012in = ±0.04in	000 - 120in = ±1°
012 - 024in = ±0.08in	120 - 240in = ±0.5°
024 - 048in = ±0.08in	240in >>> = ±0.25°
048 - 120in = ±0.12in	
120in >>> = ±0.20in	

WEIGHT:	MATERIAL:
STOCK NUMBER: 1	
DRAWING NO.: 20_12_3727-UFF-1	
SHEET SIZE: B	SHEET: 1 OF 2

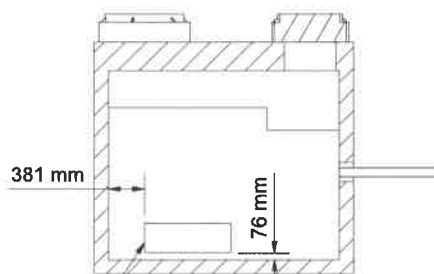
Rev: -



MOUNTING BRACKET
LAYOUT

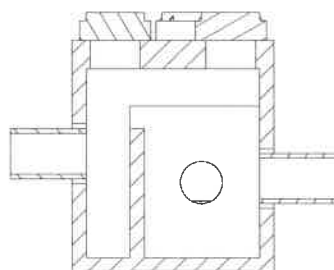


PRECAST DETAIL



300 x 900 TYP
CONVEYANCE SLOT

SECTION C-C
SCALE 1:50



SECTION D-D
SCALE 1:50

PARTS LIST			
ITEM	QTY	DESCRIPTION	SIZE (in)
1	1	PRECAST VAULT	1800x2400
2	1	UFF INLET PIPE	450
3	1	UFF OUTLET PIPE	450
4	7	MODULE LID	
5	4	SUPPORT FRAME	
6	1	COVER 30 IN	750
7	2	COVER 24 IN	600
8	2	WEDGE WALL MOUNT	
9	7	MODULE BODY	
10	2	SUPPORT FRAME LH	
11	1	BYPASS HOOD-S	
12	1	OUTLET MODULE	
13	1	AUX PIPE 1	100



IF IN DOUBT ASK

COMMENTS:

1. STRUCTURE WALL AND SLAB THICKNESSES ARE NOT TO SCALE.

2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING THE STRUCTURE

DATE:
11/9/2020

SCALE:
1:50

DRAWN BY:
JLL3

CHECKED BY:

APPROVED BY

Title
UP-FLO FILTER
1800x2400

7 MODULES

WQCD
CORAL SOPHIA HOUSING
BARRIE, ON

Hydro
International

hydro-int.com

HYDRO INTERNATIONAL

DO NOT SCALE DRAWING
STEEL FABRICATION TOLERANCES
UNLESS OTHERWISE SPECIFIED,
DIMENSIONS ARE IN INCHES.

LINEAR
000 - 012in = ±0.04in
012 - 024in = ±0.06in
024 - 048in = ±0.08in
048 - 120in = ±0.12in
120in >>> = ±0.20in

ANGULAR
000 - 120in = ±1°
120 - 240in = ±0.5°
240in >>> = ±0.25°

WEIGHT:

MATERIAL:

STOCK NUMBER:
1

DRAWING NO.:
20_12_3727-UFF-1

SHEET SIZE:
B

SHEET:
2 OF 2

Rev:
-

ANY WARRANTY GIVEN BY HYDRO INTERNATIONAL WILL APPLY ONLY TO THOSE ITEMS SUPPLIED BY IT. ACCORDINGLY HYDRO INTERNATIONAL CANNOT ACCEPT ANY RESPONSIBILITY FOR ANY STRUCTURE, PLANT, OR EQUIPMENT, (OR THE PERFORMANCE THERE OF) DESIGNED, BUILT, MANUFACTURED, OR SUPPLIED BY ANY THIRD PARTY. HYDRO INTERNATIONAL HAVE A POLICY OF CONTINUOUS DEVELOPMENT AND RESERVE THE RIGHT TO AMEND THE SPECIFICATION. HYDRO INTERNATIONAL CANNOT ACCEPT LIABILITY FOR PERFORMANCE OF ITS EQUIPMENT, (OR ANY PART THEREOF), IF THE EQUIPMENT IS SUBJECT TO CONDITIONS OUTSIDE ANY DESIGN SPECIFICATION. HYDRO INTERNATIONAL OWNS THE COPYRIGHT OF THIS DRAWING, WHICH IS SUPPLIED IN CONFIDENCE. IT MUST NOT BE USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS SUPPLIED AND MUST NOT BE REPRODUCED, IN WHOLE OR IN PART, WITHOUT PRIOR PERMISSION IN WRITING FROM HYDRO INTERNATIONAL.

Verification Statement



Hydro International Up-Flo® Filter with CPZ™ Media

Registration number: (V-2019-06-01)

Date of issue: (2019-June-28)

Technology type	Stormwater Filtration Device		
Application	Technology to remove sediment, nutrients and metals from stormwater runoff		
Company	Hydro International	Website	https://www.hydro-int.com
Address	94 Hutchins Drive, Portland, Maine USA 04102		
E-mail	TechSupport@hydro-int.com	Phone	+1-207-756 6200

This Verification Statement was prepared by VerifiGlobal to summarize the results reported in the Verification Report for the Hydro International Up-Flo® Filter with CPZ™ Media, dated June 26, 2019. The Verification Report was prepared by Good Harbour Laboratories Inc. (GHL) for VerifiGlobal in accordance with the requirements of the International Organization for Standardization (ISO) 14034 Environmental Technology Verification (ETV) standard and the VerifiGlobal Performance Verification Protocol. All the information provided in this Statement are based on the independent, third-party review and verification of technical information, performance test reports, performance data and specific performance claims documented in the Verification Report.

Technology Description

The *Up-Flo® Filter with CPZ™ Media* is a stormwater remedial device that incorporates gravitational separation of floating and settling materials, screening, and filtration of polluted stormwater to offer treatment train capabilities in a standalone device. Each Up-Flo® Filter consists of a highly configurable array of modules that are typically supplied as a complete system housed in a 4-ft (1.2 m) diameter manhole or precast vault. Manhole configurations consist of a single ring assembly containing one to six modules. Vaulted systems are highly configurable and may contain single or multiple arrays each consisting of one to 18 Filter Modules depending on availability of vault sizes.

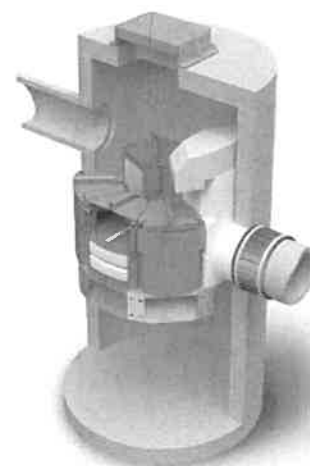


Figure 1: Up-Flo® Filter with CPZ™ Media



Hydro International Up-Flo® Filter with CPZ™ Media Verification Statement

Verified Performance Claims

Verification of the Hydro International Up-Flo® Filter with CPZ™ Media is based on existing performance test data from two different locations with different rainfall characteristics, catchment areas and pollutant loadings. Supporting data were obtained from three independent performance monitoring studies. One was conducted by Engineering School of Sustainable Infrastructure and Environment (ESSIE) at the University of Florida (UF) under the supervision of Dr. John Sansalone and two were conducted by Department of Civil, Construction, and Environmental Engineering (CCEE) at the University of Alabama (UA) under the supervision of Dr. Bob Pitt.

All three studies were guided by the New Jersey Department of Environmental Protection (NJDEP) Technology Acceptance Reciprocity Partnership (TARP) Tier II Protocol for Stormwater Best Management Practice Demonstrations (2003) and its 2006 and 2009 amendments. In total, there were 66¹ storms assessed to verify that an Up-Flo® Filter with CPZ™ Media achieves the performance listed in Tables 1 and 2, when designed to the following parameters:

- System hydraulic loading rate of 25 gpm (1.58 L/s) per filter module, with bypass of higher flows.
- Filter flux rate of 22.7 gpm/ft² (15.4 L/s/m²)
- Operating head of ≤30 in. (76.2 cm)
- Effective Sedimentation/ Filtration Treatment Area (ESA/EFTA) –12.6/6.6 (1.91)
- Maximum sediment storage volume of 16.8 ft³ (0.476 m³) at a sediment depth of 16 inches (0.41m).

Table 1. Up-Flo® Filter with CPZ™ Media – Verified Concentration Removal Efficiency

Constituent	Lower 95% Confidence Interval	Median	Upper 95% Confidence Interval
SSC *	85.9%	92.8%	94.7%
SSC **	73.9%	82.8%	86.3%
TSS *	79.0%	89.2%	91.0%
TSS **	72.0%	78.3%	85.2%
TN *	9.0%	28.5%	64.7%
TP *	33.8%	43.9%	50.9%
Zn **	39.4%	50.0%	62.1%
Cu **	72.6%	80.7%	85.2%

* Based on ESSIE (UF) Performance monitoring results
 ** Based on CCEE (UA) Performance monitoring results

Table 2. Up-Flo® Filter with CPZ™ Media – Verified Flow Weighted Mass Removal Efficiency

Constituent	ESSIE (UF) Performance monitoring results		CCEE (UA) Performance monitoring results
	6-month	12-month	12-month
SSC	93%	92%	86%
TSS*	89%	87%	87%
TN **	68%	39%	***
TP **	48%	48%	***
Zn	***	***	59%
Cu	***	***	70%

* TSS results for UF are a function of SSC.
 ** TN and TP load data was time dependent after 6-months
 *** No data submitted

¹Of the total 66 storms (16 storms from UF and 50 storms from UA), 62 were identified as qualifying events having quality data for TSS, and 59 for SSC. Fewer events with metals detected in the runoff limited the metals data sets. There were a total of 28 and 17 storms for Zn and Cu, respectively, solely from the UA data. Total Nitrogen and Total Phosphorous claims were based on the 16 storms recorded solely from the UF data.

Description of Test Procedure

Table 3 shows the target criteria as outlined by the TARP and TAPE programs as well as the results achieved at the two locations. Table 4 provides a more detailed description of the observed operating conditions over the testing period. At the time of testing, the TARP and TAPE programs both allowed for field testing data to be used to obtain certification in participating states. They were the most widely used protocols and were generally accepted as industry standards. The TARP program has since stopped accepting field data, but the TAPE program remains in effect and is currently referenced to benchmark the quality of data obtained from stormwater monitoring programs.

Table 3. Up-Flo® Filter with CPZ™ Media Performance Testing - Specified TARP & TAPE criteria, and achieved results, for storm selection and sampling

Description	TARP Criteria	TAPE Criteria	Achieved value	
			ESSIE - UF	CCEE - UA
Total rainfall/storm	≥2.5 mm (0.1")	≥3.81 mm (0.15")	>2.5 mm (0.1")	≥4.6 mm (0.18")
Minimum inter-event period	6 h	6 h	≥ 6 h	≥ 6 h
Minimum flow-weighted composite sample storm coverage	70% including as much of the first 20% of the storm	75% including as much of the first 20% of the storm	100%	87.6%
Minimum influent/effluent samples	10, but a minimum of 5 subsamples for composite samples	12, but a minimum of 10 subsamples for composite samples	5, whole manual samples	11
Total sampled rainfall	≥ 381 mm (15")	NA	195 mm (7.66")	765 mm (30.07")
Total sampled storms	≥ 20	≥ 12	16	29

Table 4. Up-Flo® Filter with CPZ™ Media Performance Testing - Observed operational conditions for events monitored over each performance test period

Operating parameter	Observed range	
	ESSIE - UF	CCEE - UA Total*
Storm duration	0.35-5.78 h	0.67-64.7 h
Previous dry hours**	6-213	> 6 hrs for the 20 storms in 1 st study and 12-632 hrs for 30 storms in second study
Rainfall depth	0.10-1.64 in	0.18-2.44 in
Runoff volume	223-4095 gal (0.84-15.5 m ³)	2,065-61,131 gal (7.82-231 m ³)
Peak rainfall intensity (5 min)	1.2-5.4 in/h (3.0-13.7 cm)	0.24-4.68 in/h (0.61-11.9 cm)
Peak runoff flow rate	27.7-233 gpm (1.75-14.7 L/s)	68-1023 gpm (4.29-64.5 L/s)
Event median flow rate	2.4-21.4 gpm (0.15-1.35 L/s)	28-175 gpm (1.75-11.0 L/s)

* The UA data ranges cover the storms for both studies; ranges for individual studies might be narrower.

** This is the same as the time period between events, or time since it last rained a qualifying event.



Hydro International Up-Flo® Filter with CPZ™ Media Verification Statement

For the UF study, performance monitoring was conducted at the Reitz Union surface parking lot, which had a drainage area of 0.12-0.20 acres (0.049-0.081 ha), which was 76% impervious, depending on storm intensity and wind direction. The area generated a flow rate in excess of the 150 gpm (9.55 L/s) maximum treatment flow rate (MTFR) in 3 of the 16 storms. The 4-ft diameter (1.2 m) test unit was installed above ground in a temporary installation at the bottom of a hill sloping down from the lot. An inlet catch basin conveyed runoff from the parking lot through a Pashall flume into the filter. Monitoring occurred over a period of 12 months and the UF team recovered the captured mass at the end of the performance monitoring study. No maintenance was required or conducted during the year long monitoring period from 12 September 2015 through 1 September 2016.

The UA performance monitoring studies covered a total of 50 storms, but not all of them yielded useful data for all parameters. The site used in both cases was the Riverwalk parking lot near the Bama Belle in Tuscaloosa, Alabama. The drainage area was about 0.9 acres (0.36 ha), 68% impervious. The unit was installed in a 4 ft. (1.2 m) diameter below-grade catch basin inlet manhole on the site. Monitoring occurred in two stages of approximately 12 months each over a total of 32 months. The first round of testing occurred from July 16, 2010 to April 11, 2011 and the second from May 31st, 2012 to March 30th, 2013.

The UA performance monitoring study used autosamplers to generate the flow-weighted composite samples and the event mean concentration data. This data was used to calculate removal efficiencies. However, in the UF performance monitoring study, sediment removal performance was assessed by taking full cross section samples of the influent and effluent streams at regular intervals for the duration of the storm and combining the samples into flow-weighted composites. The data was converted into event mean concentrations for the purposes of calculating removals.

The following approved analytical methods were used:

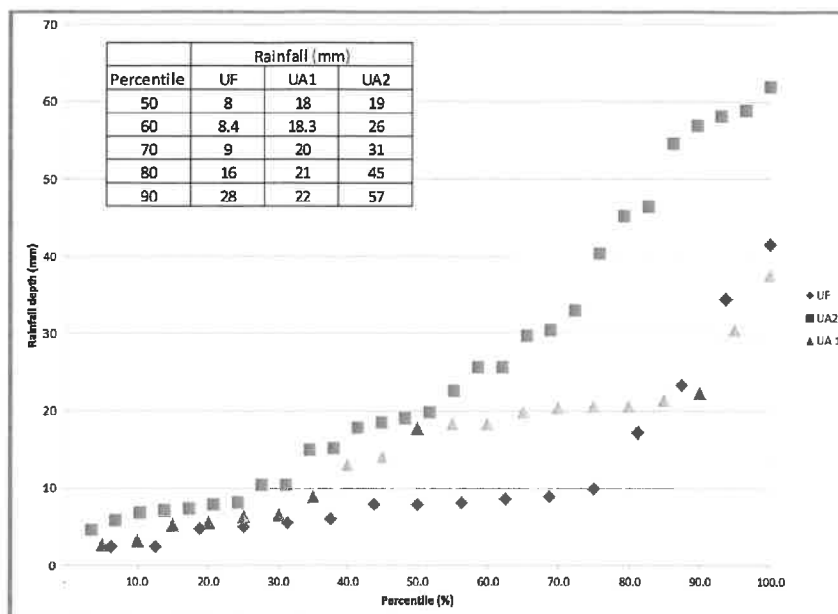
- TSS – ASTM D2540
- SSC – ASTM D3977-97(2013) Standard Test Methods for Determining Sediment Concentration in Water Samples
- PSD – ASTM D422 – 63 Standard Test Method for Particle-Size Analysis of Soils and ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- PSD – ASTM 2560- C, D (UF used 2560D laser diffraction or light-scattering method and UA used 2560C Coulter Counter or light-blocking method)
- TP – S.M.4500-P-B Acid Hydrolysis
- TN – Persulfate Digestion Method
- Cu – EPA 200.8 Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry
- Zn – EPA 200.8 Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry

As part of the mass balance measurements, the UF team allowed all samples to sit for an hour and reported concentrations of suspended solids, measured using ASTM 2540D, as TSS, in addition to the usual SSC measurement using SM3977. In order to be able to report a TSS comparable to other performance monitoring studies, Dr. Sansalone developed a correlation equation for $TSS^* = f(SSC)$ as well as equations for the 95% confidence limits of TSS^* .

Summary of Verification Results

The cumulative frequency of rainfall depths monitored during the three performance monitoring studies is presented in Figure 2. The median rainfall depths in the three performance monitoring studies were 0.31, 0.71, and 0.75 inches (8, 18 & 19 mm) while the 90th percentile rainfall depths were 1.1, 0.9 and 2.2 inches (28, 22 and 57 mm). Thus the data presented covers a comparatively wide range of rain events.

Figure 2. Rainfall depth frequency curves



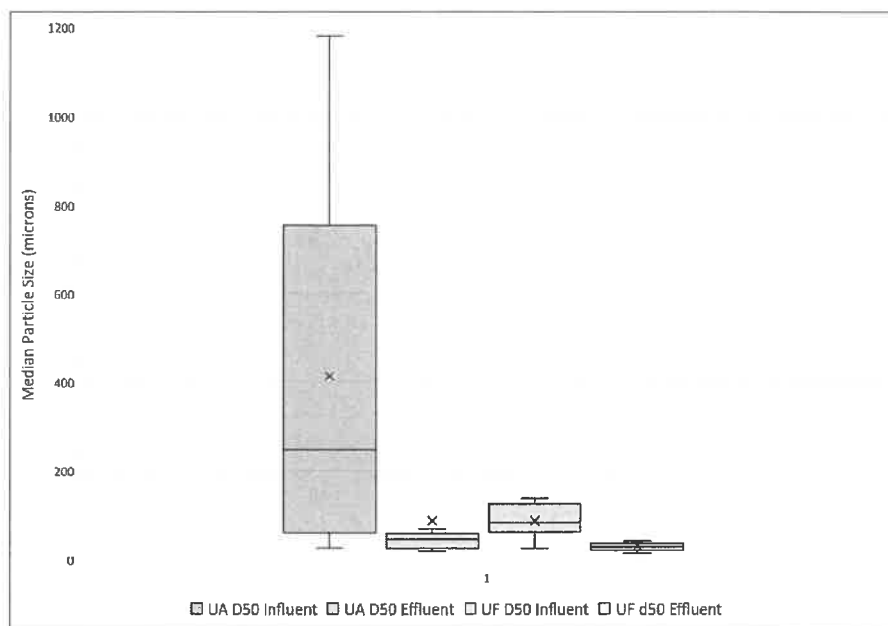
For UF monitoring, a total of 16 storm events, with varying rainfall intensity and runoff volume from event to event, were monitored. The cumulative rainfall depth was 7.66 inches (195 mm) and the cumulative influent runoff volume was 20,022 gallons (7.65 m³). The entire volume was treated by the Up-Flo® Filter system. Of the 16 storms treated, three storms generated flow rates exceeding the MFR of 150 gpm (9.55 L/s) but there was no bypass, because the excess was not sufficient to top the overflow weir, and all sampled flows passed through the filtration media. Median driving head difference for an event never exceeded 13.1 inches (33.3 cm) and peak driving head difference never exceeded 27.1 inches (68.8 cm), which indicates the media was not occluded.

For the UA site, all of the storm events from May 31st, 2012 to March 30th, 2013 were monitored for flow but only 30 events were sampled. The total rainfall depth for this period was 49 inches (124.5 cm) or 982,192 gal. (3,718 m³) of runoff volume that was routed through the filter. Actual storm data from the monitoring period showed about 624,503 gal. (2,364 m³) of runoff (from about 30 inches or 76.2 cm of rainfall) was treated by the media filter system. This included about 28.5 % of bypass flow volume, which was sampled and included in the performance results. Given that the total bypassed volume was almost three times the expected bypass volume at the UA site, the UA results are considered conservative.

Influent particle sizes varied considerably between the two monitored locations and between storm events. Catchment characteristics and available sources, sampling methods (auto sampling vs. grab sampling), storm intensities, duration and volumes all influence the particle size range. The particle size analyses were completed for just the median particle size for each storm. A comparison of statistical descriptive values for influent and effluent median particle sizes for the two monitored sites is illustrated with the Whisker-Box-Plot shown in Figure 3.

Due to larger storm events and curbside erosion, the median UA influent particle size range and d₅₀ were substantially the larger of the two monitored sites. The interquartile range for the influent median particles sizes was 659 µm for UA compared to 59 µm for UF and the UA d₅₀ was 247 µm compared to 85 µm for UF. However, despite the influent particle size differences between locations, the median UA and UF effluent particle size range and d₅₀ were similar. The interquartile range for the effluent median particles sizes was 33 µm for UA compared to 13 µm for UF and the UA d₅₀ was 48 µm compared to 30 µm for UF.

Figure 3. UF and UA Summary of Influent and Effluent Median Particle Sizes



Summary statistics for the influent and effluent concentration removal efficiencies as well as the overall mass load reductions are shown in Table 4 and Table 5 for UF and UA, respectively.

While the flow weighted removal efficiency for TP and TN were 48% and 39%, respectively, TP and TN reduction tended to decrease with the overall volume treated. Results showed that if the filter maintenance cycle is limited to 6-8 months, the long-term load reduction for TP and TN would have been 50% and 70%, respectively.

Table 4: Up-Flo® Filter with CPZ™ Media Performance Testing - Summary statistics for influent and effluent event mean concentrations (EMCs) and the overall mass load reductions for selected constituents (UF Test)

Parameter	Sample Location	Min	Max	Median	SD	Mass Load Reduction
SSC	Influent	146	1584	487	360	92%
	Effluent	19.9	96.5	43.25	20.2	
TSS*	Influent	93.3	870	277	194	87%
	Effluent	25.0	66.4	37.6	10.9	
TP	Influent	0.79	6.05	1.9	1.70	48%
	Effluent	.56	2.19	1.1	0.56	
TN	Influent	.41	7.89	2.1	2.18	39%
	Effluent	.52	3.84	1.2	1.21	

Hydro International Up-Flo® Filter with CPZ™ Media Verification Statement

Table 5. Up-Flo® Filter with CPZ™ Media Performance Testing - Summary statistics for influent and effluent event mean concentrations (EMCs) and the overall mass load reductions for selected constituents (UA Tests)

Parameter	Sample Location	Min	Max	Median	SD	Mass Load Reduction
SSC (mg/L)	Influent	23	879	88	166	86%
	Effluent	3	69	17	18	
TSS (mg/L)	Influent	11	571	89	128	87%
	Effluent	3	64	19	22	
Total Zn (µg/L)	Influent	7.0	157	22.0	0.71	59%
	Effluent	2.5*	72	14.0	0.68	
Total Cu (µg/L)	Influent	6	181	9	42	70%
	Effluent	1.3**	42	1.3	20.9	

* There was a single effluent value that was non-detect (ND). Since it was only 1 value $\frac{1}{2}$ the detection limit 1.3 µg/L, was substituted when calculating statistics.

**The Cu data was highly censored (many non-detect, ND, effluents). Statistics were calculated by substituting $\frac{1}{2}$ the detection limit, 1.3 µg/L, for all ND data then bootstrapping as usual.

As the independent verifier, GHl has confirmed that

- The Hydro International Up-Flo® Filter with CPZ™ Media is based on sound scientific and engineering principles, providing a net environmental benefit.
- Performance testing of the Hydro International Up-Flo® Filter with CPZ™ Media was based on defined parameters and quality-assured performance test results.
- Performance testing of the Hydro International Up-Flo® Filter with CPZ™ Media was performed by a qualified testing organization.
- Sample analyses were carried out as part of the test plan by a third-party analytical laboratory in a manner that meets the quality requirements of ISO 17025. Operating conditions and performance during each testing run were documented.
- Frequency of sampling and duration of each performance test were determined based on the specifications in a credible test plan and the requirements to produce sufficient data to support the performance claim at a 95% confidence level.
- Performance measurements and calculations were based on the technology application and relevant performance parameters as outlined in the Verification Plan.
- Performance calculations were done according to generally accepted test methods described in the test design, including the applicable mathematical and statistical principles and procedures.
- Data storage, transfer and control were adequate, carried out in accordance with the intent of ISO 9001 enabling control and retrieval of documents and records.
- Quality assurance requirements were addressed throughout the performance testing process and in the generation of performance test results. This confirmation included reviewing all data sheets and data downloads, as well as overall management of test system quality.

Quality Assurance

Performance testing and verification of the Hydro International Up-Flo® Filter with CPZ™ Media were performed in accordance with the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. The verifier, Good Harbour Laboratories, has confirmed that quality assurance requirements were addressed throughout the performance testing process and in the generation of performance test results. This includes reviewing all data sheets and data downloads, as well as overall management of the test system, quality control and data integrity.



**Hydro International Up-Flo® Filter with CPZ™ Media
Verification Statement**

References

Technology Acceptance Reciprocity Partnership (TARP) Protocol and New Jersey Department of Environmental Protection (NJDEP) amendments to the TARP Protocol, dated August 5, 2009 and Revised December 5th, 2009

“Development and Testing of Protocols for Evaluating Emerging Technologies for the treatment of Stormwater”, Noboru Togawa, Dissertation, Department of Civil, Construction, Construction, and Environmental Engineering, Graduate School of the University Of Alabama, Tuscaloosa, Alabama, 2011.

“Up-Flo® Filter Verification Testing, Quality Assurance Project Plan, Bama Belle Field Verification Test Site”, Tuscaloosa, AL, Hydro International, July 2012.

“Full-Scale Up-Flo® Filter Field Performance Verification Tests”, Department of Civil, Construction, and Environmental Engineering University of Alabama, Tuscaloosa, AL 35487 USA - December 26, 2013.

“NJCAT Technology Verification Up-Flo® Filter”, January 2015.

Hydro International Up-Flo® Filter with CPZ™ Media Specifications, Hydro International.

Up-Flo® Filter with CPZ™ Media - Performance Claims submitted by Hydro International, 2018-05-15.

“Physical Model Testing and Monitoring of a Hydro International (HI) Up-Flo® Filter Subject to Rainfall-Runoff Loading Events”, University of Florida Engineering School of Sustainable Infrastructure and Environment (ESSIE), University of Florida, Gainesville, FL 32611 USA - Version 7-12-17.

Particulate Matter Fraction Analyses. (Sansalone & Kim: Transport of Particulate Matter Fractions in Runoff, Journal of Environmental Quality • Volume 37 • September–October 2008)

New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device, January 2013

2009 Urban Stormwater BMP Performance Monitoring Guidelines
<http://www.bmpdatabase.org/contacts.html>

Description of Up-Flo® Filter

Up-Flo® Filter Design Manual https://www.hydroint.com/sites/default/files/uff_dg_nashville_f1504.pdf

Up-Flo® Filter Verification Brochure

ISO/IEC 14034, Environmental management – Environmental technology verification

ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories

ISO/IEC 9001, Quality Management Systems.

VerifiGlobal Performance Verification Protocol (Applying ISO 14034:2016)

VerifiGlobal Test Body Assessment – Guidance (2018)



What is ISO 14034?

The purpose of environmental technology verification is to provide a credible and impartial account of the performance of environmental technologies. Environmental technology verification is based on a number of principles to ensure that verifications are performed and reported accurately, clearly, unambiguously and objectively. The International Organization for Standardization (ISO) standard for environmental technology verification (ETV) is ISO 14034, which was published in November 2016.

Benefits of ETV

ETV contributes to protection and conservation of the environment by promoting and facilitating market uptake of innovative environmental technologies, especially those that perform better than relevant alternatives. ETV is particularly applicable to those environmental technologies whose innovative features or performance cannot be fully assessed using existing standards. Through the provision of objective evidence, ETV provides an independent and impartial confirmation of the performance of an environmental technology based on reliable test data. ETV aims to strengthen the credibility of new, innovative technologies by supporting informed decision-making among interested parties.

For more information on the Hydro International Up-Flo® Filter, contact:	For more information on VerifiGlobal, contact:
Hydro International 94 Hutchins Drive, Portland, ME USA 04102 t +1-207-756 6200 e: TechSupport@hydro-int.com w: www.hydro-int.com	VerifiGlobal c/o ETA-Danmark A/S Göteborg Plads 1, DK-2150 Nordhaven t +45 7224 5900 e: info@verifiglobal.com w: www.verifiglobal.com
Signed for Hydro International: <i>Original signed by:</i> <i>Dave Scott</i> David Scott Technical Product Manager, Americas Stormwater	Signed for VerifiGlobal: <i>Original signed by:</i> <i>Thomas Bruun</i> Thomas Bruun, Managing Director <i>Original signed by:</i> <i>John Neate</i> John Neate, Managing Director

NOTICE: Verifications are based on an evaluation of technology performance under specific, predetermined operational conditions and parameters and the appropriate quality assurance procedures. VerifiGlobal and the Verification Expert, Good Harbour Laboratories, make no expressed or implied warranties as to the performance of the technology and do not certify that a technology will always operate as verified. The end user is solely responsible for complying with any and all applicable regulatory requirements. Mention of commercial product names does not imply endorsement.

VerifiGlobal and the Verification Expert, Good Harbour Laboratories, provide the verification services solely on the basis of the information supplied by the applicant or vendor and assume no liability thereafter. The responsibility for the information supplied remains solely with the applicant or vendor and the liability for the purchase, installation, and operation (whether consequential or otherwise) is not transferred to any other party as a result of the verification.

Appendix D

LID TTT Modelling Results

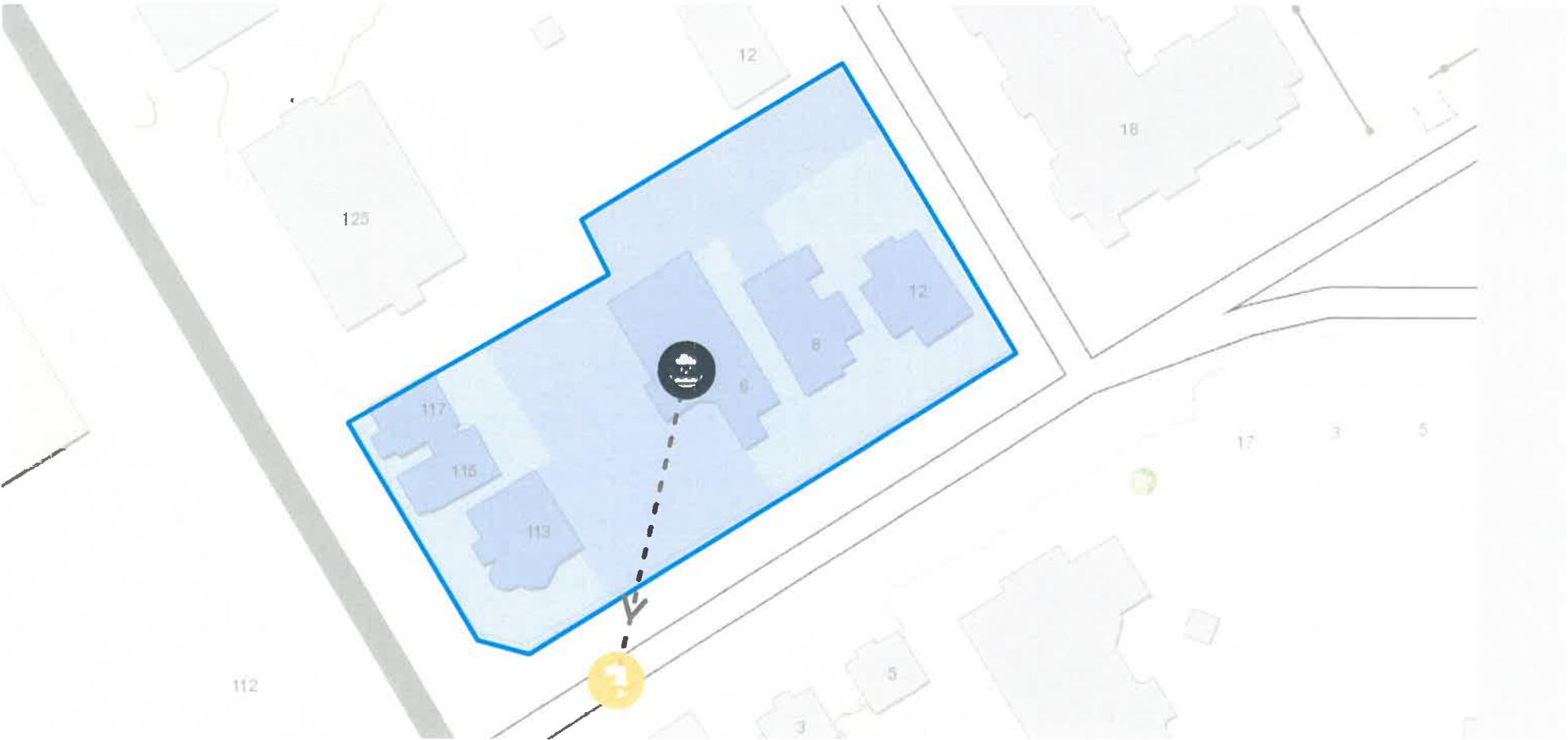
DATE April 23, 2020
CALCS BWB
Revised February 18, 2021

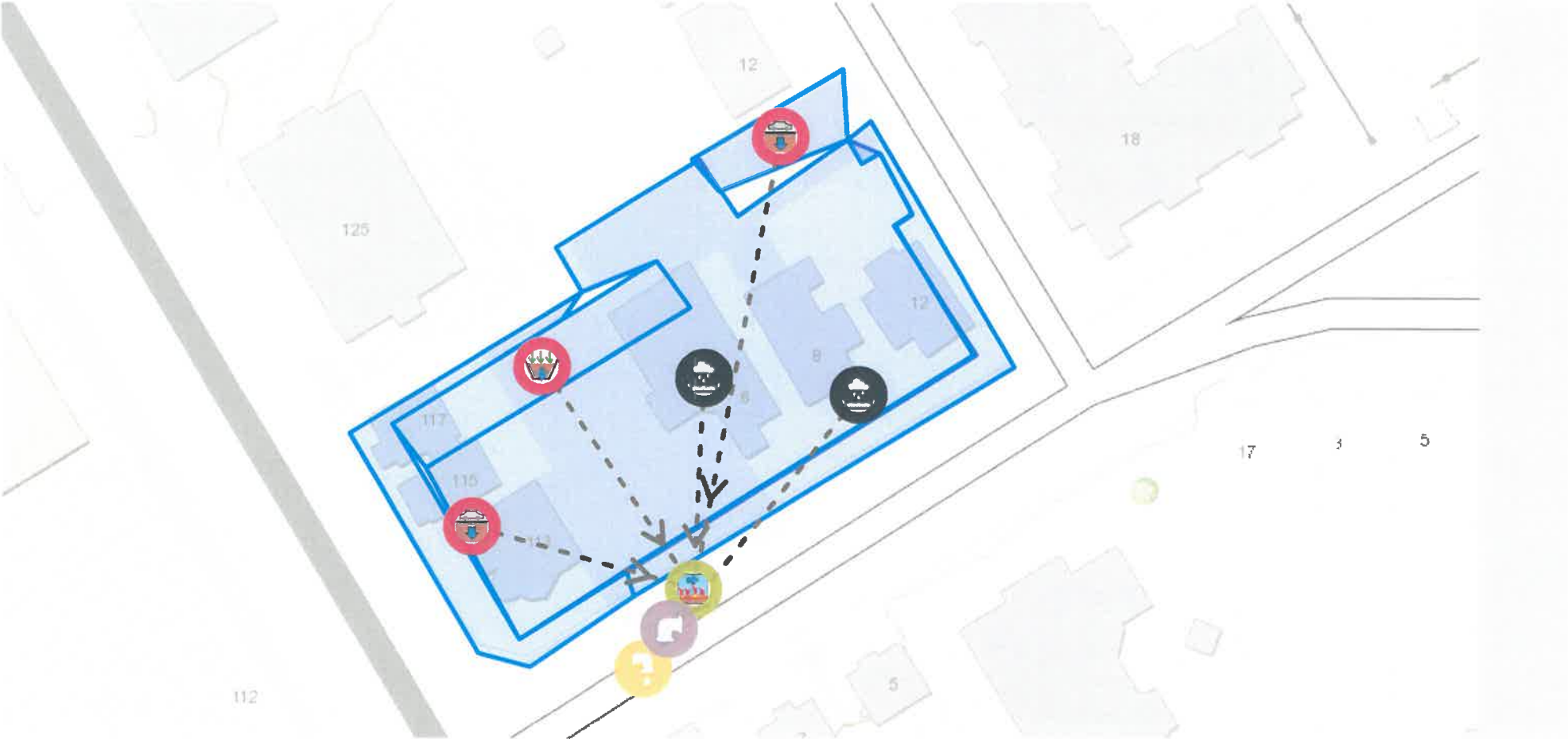
PROPOSED LID Catchments

Perm Pave #1	AREA =	0.035	Ha	Permeable Pavement and west landscape area draining to filter			
GROUND COVER TYPE	PROPORTION			Berm:	0	Soil	nil
				Pavement	70 mm	Storage	500 mm
Permeable Paved	0.0248	71.9%		Slope	2.50 %	Void	0.4
Grassed Open Space	0.010	28.1%		Void	0.40	Seepage	10 mm/hr
				Imp Ratio	0.9	Draw down	48 hrs
TOTAL	0.035	Ha		Permiability	10.00 mm/hr	Drain	yes
Perm Pave #2	AREA =	0.016	Ha	Permeable Pavement on North side of building and areas that drain to it, drains to filter			
GROUND COVER TYPE	PROPORTION			Berm:	0	Soil	nil
				Pavement	70 mm	Storage	500 mm
Permeable Paved	0.0121	75.8%		Slope	2.50 %	Void	0.4
Grassed Open Space	0.004	24.2%		Void	0.50	Seepage	10 mm/hr
				Imp Ratio	0.9	Draw down	48 hrs
TOTAL	0.016	Ha		Permiability	10.00 mm/hr	Drain	yes
East& South Landscaped Area	AREA =	0.038	Ha	Grass, Landscaped, Sidewalk @ South and East limit of site Does not drain to any control features			
GROUND COVER TYPE	PROPORTION						
Paved	0.0165	44.0%					
Grassed Open Space	0.021	56.0%					
TOTAL	0.038	Ha					
Building, Dog Park, Loading	AREA =	0.250	Ha	Building Roof, grassed surface at dog park, paved loading space, drains to filter			
GROUND COVER TYPE	PROPORTION						
Paved	0.0100	4.0%					
Roof Area	0.2310	92.4%					
Grassed Open Space	0.009	3.6%					
TOTAL	0.250	Ha					
Green Roof	AREA =	0.250	Ha	Portion of Roof Area, Drains to Filter (modelled as Bioretention; TP removal -45%)			
GROUND COVER TYPE	PROPORTION			Width	43	Soil	150 mm
				Berm:	150 mm	Storage	5 mm
Paved	0.0100	4.0%		Slope	0.50 %	Void	0.4
Roof Area	0.2310	92.4%		Porosity	0.50	Seepage	10 mm/hr
Grassed Open Space	0.009	3.6%				Draw down	1 hrs
				Permiability	10.00 mm/hr	Drain	yes
TOTAL	0.250	Ha					

Summary

Site	Project Name	Project Title	Storm Type
Pre-Development	3103	Coral Sophia	avg-annual
Post-Development	3103 Coral Sophia Proposed	Coral Sophia Proposed	avg-annual





LID Summary | Post-Development

Element	Type	LID Area	Drawdown Time	Effective Impervious to Pervious Ratio	FLOW	TSS	TP
					Flow In (m³)	Load In (kg)	Load In (kg)
					Flow Out (m³)	Load Out (kg)	Load Out (kg)
					Actual Reduction (%)	Actual Reduction (%)	Actual Reduction (%)
Filter	Sorbitive-Media				1,980.000 m³	22.642 kg	0.204 kg
					1,980.000 m³	3.396 kg	0.115 kg
					0.000 %	85.000 %	43.900 %
Per pave#1	Perm-Pavement	0.035 ha	20.000 hrs	1.000	330.645 m³	23.905 kg	0.073 kg
					110.000 m³	1.988 kg	0.010 kg
					66.732 %	91.683 %	86.693 %
Perm Pave #2	Perm-Pavement	0.016 ha	20.000 hrs	1.000	151.152 m³	10.918 kg	0.033 kg
					10.000 m³	0.181 kg	0.001 kg
					93.384 %	98.346 %	97.354 %
green roof	Bioretention	0.034 ha	0.200 hrs	1.000	321.198 m³	8.672 kg	0.064 kg
					40.000 m³	0.270 kg	0.012 kg
					87.547 %	96.887 %	81.943 %

Loading Summary TP | Pre Development

Catchment	Total Catchment TP Removal	Peak Outflow	Generated	Outgoing
			Total Flow (m ³)	Total Flow (m ³)
			Average Concentration (mg/l)	Average Concentration (mg/l)
			Total Load (kg)	Total Load (kg)
Catchment 1	0.000 %	0.047 m ³ /s	2,330.000 m ³	2,327.000 m ³
			0.190 mg/l	0.190 mg/l
			0.442 kg	0.442 kg
Total	0.000 %	0.047 m ³ /s	2,330.000 m ³	2,327.000 m ³
			0.190 mg/l	0.190 mg/l
			0.442 kg	0.442 kg

Loading Summary TP | Post Development

Catchment	Total Catchment TP Removal	Peak Outflow	Generated	Outgoing
			Total Flow (m ³)	Total Flow (m ³)
			Average Concentration (mg/l)	Average Concentration (mg/l)
			Total Load (kg)	Total Load (kg)
Catchment 1	61.076 %	0.044 m ³ /s	2,792.995 m ³	2,143.000 m ³
			0.140 mg/l	0.071 mg/l
			0.390 kg	0.152 kg
Total	61.076 %	0.044 m ³ /s	2,792.995 m ³	2,143.000 m ³
			0.140 mg/l	0.071 mg/l
			0.390 kg	0.152 kg

Peak Flow | Pre-Development

Catchment	Element	Description	Peak outflow
1	Sophia Street Storm	MAXIMUM FLOW at	0.047 m ³ /s
	Pre-Development Site	PEAK RUNOFF FLOW from	0.05 m ³ /s

Peak Flow | Post-Development

Catchment	Element	Description	Peak outflow
1	Sophia Street Storm	MAXIMUM FLOW at	0.044 m ³ /s
	Filter	MAXIMUM LATERAL INFLOW at	0.040 m ³ /s
	Storm Outfall	MAXIMUM FLOW in	0.040 m ³ /s
	Per pave#1	PEAK RUNOFF FLOW from	0.00 m ³ /s
	Building, Dog Patch, Loading Bay	PEAK RUNOFF FLOW from	0.03 m ³ /s
	East & South Landscaped Area	PEAK RUNOFF FLOW from	0.00 m ³ /s
	Perm Pave #2	PEAK RUNOFF FLOW from	0.00 m ³ /s
	green roof	PEAK RUNOFF FLOW from	0.00 m ³ /s

Loading TSS | Pre Development

TSS - Catchment 1

Name	LID Type (removal)	Peak Outflow	Incoming	Outgoing
			Total Flow (m ³)	Total Flow (m ³)
			Concentration (mg/l)	Concentration (mg/l)
			Total Load (kg)	Total Load (kg)
Pre-Development Site	0 %	0.05 m ³ /s	3,514.284 m ³	2,330.000 m ³
			55.643 mg/l	55.643 mg/l
			195.547 kg	129.649 kg
Sophia Street Storm	0 %	0.047 m ³ /s	2,327.000 m ³	2,327.000 m ³
			55.715 mg/l	55.715 mg/l
			129.649 kg	129.649 kg

Loading TSS | Post Development

TSS - Catchment 1

Name	LID Type (removal)	Peak Outflow	Incoming	Outgoing
			Total Flow (m ³)	Total Flow (m ³)
			Concentration (mg/l)	Concentration (mg/l)
			Total Load (kg)	Total Load (kg)
Building, Dog Patch, Loading Bay	0 %	0.03 m ³ /s	2,333.409 m ³	1,830.000 m ³
			11.040 mg/l	11.040 mg/l
			25.761 kg	20.203 kg
East & South Landscaped Area	0 %	0 m ³ /s	349.539 m ³	160.000 m ³
			57.420 mg/l	57.420 mg/l
			20.071 kg	9.187 kg
Per pave#1	75 %	0 m ³ /s	330.645 m ³	110.000 m ³
			72.297 mg/l	18.074 mg/l
			23.905 kg	1.983 kg
Perm Pave #2	75 %	0 m ³ /s	151.152 m ³	10.000 m ³
			72.234 mg/l	18.059 mg/l
			10.918 kg	0.181 kg
green roof	75 %	0 m ³ /s	321.198 m ³	40.000 m ³

			27.000 mg/l	6.750 mg/l
			8.672 kg	0.270 kg
Filter	85 %	0.04 m ³ /s	1,980.000 m ³	1,980.000 m ³
			11.435 mg/l	1.715 mg/l
			22.642 kg	3.396 kg
Storm Outfall	0 %	0.04 m ³ /s	1,980.000 m ³	1,980.000 m ³
			1.715 mg/l	1.715 mg/l
			3.396 kg	3.396 kg
Sophia Street Storm	0 %	0.044 m ³ /s	2,143.000 m ³	2,143.000 m ³
			5.872 mg/l	5.872 mg/l
			12.583 kg	12.583 kg

Loading TP | Pre Development

TP - Catchment 1

Name	LID Type	Peak Outflow	Incoming	Outgoing
			Total Flow (m ³)	Total Flow (m ³)
			Concentration (mg/l)	Concentration (mg/l)
			Total Load (kg)	Total Load (kg)
Pre-Development Site	0 %	0.05 m ³ /s	3,514.284 m ³	2,330.000 m ³
			0.190 mg/l	0.190 mg/l
			0.666 kg	0.442 kg
Sophia Street Storm	0 %	0.047 m ³ /s	2,327.000 m ³	2,327.000 m ³
			0.190 mg/l	0.190 mg/l
			0.442 kg	0.442 kg

Loading TP | Post Development

TP - Catchment 1

Name	LID Type	Peak Outflow	Incoming	Outgoing
			Total Flow (m ³)	Total Flow (m ³)
			Concentration (mg/l)	Concentration (mg/l)
			Total Load (kg)	Total Load (kg)
Building, Dog Patch, Loading Bay	0 %	0.03 m ³ /s	2,333.409 m ³	1,830.000 m ³
			0.100 mg/l	0.100 mg/l
			0.232 kg	0.182 kg
East & South Landscaped Area	0 %	0 m ³ /s	349.539 m ³	160.000 m ³
			0.233 mg/l	0.233 mg/l
			0.082 kg	0.037 kg
Per pave#1	60 %	0 m ³ /s	330.645 m ³	110.000 m ³
			0.222 mg/l	0.089 mg/l
			0.073 kg	0.010 kg
Perm Pave #2	60 %	0 m ³ /s	151.152 m ³	10.000 m ³
			0.222 mg/l	0.089 mg/l
			0.033 kg	0.001 kg
green roof	-45 %	0 m ³ /s	321.198 m ³	40.000 m ³

			0.200 mg/l	0.290 mg/l
			0.064 kg	0.012 kg
Filter	43.9 %	0.04 m ³ /s	1,980.000 m ³	1,980.000 m ³
			0.103 mg/l	0.058 mg/l
			0.204 kg	0.115 kg
Storm Outfall	0 %	0.04 m ³ /s	1,980.000 m ³	1,980.000 m ³
			0.058 mg/l	0.058 mg/l
			0.115 kg	0.115 kg
Sophia Street Storm	0 %	0.044 m ³ /s	2,143.000 m ³	2,143.000 m ³
			0.071 mg/l	0.071 mg/l
			0.152 kg	0.152 kg

Detailed Report Parameters | Pre Development

Sophia Street Storm

Field	Value
Name	Sophia Street Storm
Catchment	1
Outfall Elevation (m)	232.9

Pre-Development Site

Field	Value
Subcatchment name	Pre-Development Site
Catchment	1
Total AREA (HA)	0.372
Impervious area (HA)	0.197346
Roof area (HA)	0.0888708
Landscaped area (HA)	0
Row Crop area (HA)	0
Open Space / Parkland area (HA)	0.0857832
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	76

Detailed Report Parameters | Post Development

Sophia Street Storm

Field	Value
Name	Sophia Street Storm
Catchment	1
Outfall Elevation (m)	232.9

Filter

Field	Value
Name	Filter
Junction Type	sorbitive-media
Catchment	1
Invert Elevation (m)	233
Depth to Surface (m)	1.5

Storm Outfall

Field	Value
Name	Storm Outfall
Catchment	1
Upstream Node	Filter

Downstream Node	Sophia-Street-Storm
Length (m)	14
Manning's Roughness	0.013
Upstream Invert (m)	233
Downstream Invert (m)	232.9
Pipe Diameter (m)	0.3

Per pave#1

Field	Value
Name	Per pave#1
LID type	perm-pavement
Catchment	1
Outlet (name)	5
% Imperv	100
Width (m)	4
Paved surface (HA)	0.025165000000000007
Roof (HA)	0
Landscaped Area (HA)	0
Row Crop (HA)	0
Open Space/Parkland (HA)	0.009835000000000002
Forest (HA)	0

Wetland (HA)	0
(HA)	0
Berm Height (mm)	0
Surface Slope (%)	2.5
Thickness (mm)	500
Void Ratio	0.4
Impervious Surface Fraction	0.9
Permeability (mm/hr)	10
Clogging Factor	0
Soil	
Porosity (Fraction)	0.5
Field Capacity (Fraction)	0.3
Wilting Point (Fraction)	0.1
Conductivity (mm/hr)	10
Conductivity Slope (Dimensionless)	45
Suction Head (mm)	200
Seepage Rate (mm/hr)	10
Flow Coefficient	1
Flow Exponent	1
Offset Height (mm)	0
Mannings Roughness	

Building, Dog Patch, Loading Bay

Field	Value
Subcatchment name	Building, Dog Patch, Loading Bay
Catchment	1
Total AREA (HA)	0.247
Impervious area (HA)	0.00988
Roof area (HA)	0.228228000000000001
Landscaped area (HA)	0
Row Crop area (HA)	0
Open Space / Parkland area (HA)	0.008892
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	76

East & South Landscaped Area

Field	Value
-------	-------

Subcatchment name	East & South Landscaped Area
Catchment	1
Total AREA (HA)	0.037
Impervious area (HA)	0.01628
Roof area (HA)	0
Landscaped area (HA)	0
Row Crop area (HA)	0
Open Space / Parkland area (HA)	0.02442
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	76

Perm Pave #2

Field	Value
Name	Perm Pave #2
LID type	perm-pavement

Catchment	1
Outlet (name)	5
% Imperv	100
Width (m)	100
Paved surface (HA)	0.011488
Roof (HA)	0
Landscaped Area (HA)	0
Row Crop (HA)	0
Open Space/Parkland (HA)	0.0045119999999999995
Forest (HA)	0
Wetland (HA)	0
(HA)	0
Berm Height (mm)	0
Surface Slope (%)	1
Thickness (mm)	500
Void Ratio	0.4
Impervious Surface Fraction	0.9
Permeability (mm/hr)	10
Clogging Factor	0
Soil	
Porosity (Fraction)	0.5

Field Capacity (Fraction)	0.3
Wilting Point (Fraction)	0.1
Conductivity (mm/hr)	10
Conductivity Slope (Dimensionless)	45
Suction Head (mm)	200
Seepage Rate (mm/hr)	10
Flow Coefficient	1
Flow Exponent	1
Offset Height (mm)	50
Mannings Roughness	

green roof

Field	Value
Name	green roof
LID type	bioretention
Catchment	1
Outlet (name)	5
% Imperv	100
Width (m)	43
Paved surface (HA)	0
Roof (HA)	0
Landscaped Area (HA)	0

Row Crop (HA)	0
Open Space/Parkland (HA)	0.034
Forest (HA)	0
Wetland (HA)	0
(HA)	0
Berm Height (mm)	150
Surface Slope (%)	0.5
Thickness (mm)	5
Void Ratio	0.4
Impervious Surface Fraction	
Permeability (mm/hr)	
Clogging Factor	0
Soil	
Porosity (Fraction)	0.5
Field Capacity (Fraction)	0.3
Wilting Point (Fraction)	0.1
Conductivity (mm/hr)	10
Conductivity Slope (Dimensionless)	45
Suction Head (mm)	200
Seepage Rate (mm/hr)	10
Flow Coefficient	1

Flow Exponent	1
Offset Height (mm)	0
Mannings Roughness	

Appendix E

LSRCA consultation, Volume Control

Bryan Bolivar

From: Stephen Troan <S.Troan@lsrca.on.ca>
Sent: January 29, 2021 3:03 PM
To: Bryan Bolivar
Subject: RE: 3103 Coral Sophia - D11-026-2020: Volume Control

Bryan;

We will this time.

Please document the volume control as per the instructions in the LSRCA Guidelines.

Please note: the LSRCA Board of Directors approved a change to our Fee Policy. The new fees will take effect on January 1, 2021. Please click [here](#) for the new fee schedule.

Stephen Troan, C.E.T.
Engineering Technologist
Lake Simcoe Region Conservation Authority
120 Bayview Parkway,
Newmarket, Ontario L3Y 3W3
905-895-1281, ext. 306 | 1-800-465-0437
s.troan@LSRCA.on.ca | www.LSRCA.on.ca

The information in this message (including attachments) is directed in confidence solely to the person(s) named above and may not be otherwise distributed, copied or disclosed. The message may contain information that is privileged, confidential and exempt from disclosure under the Municipal Freedom of Information and Protection of Privacy Act and by the Personal Information Protection Electronic Documents Act. If you have received this message in error, please notify the sender immediately and delete the message without making a copy. Thank you.

From: Bryan Bolivar <bbolivar@skeltonbrumwell.ca>
Sent: January 29, 2021 2:00 PM
To: Stephen Troan <S.Troan@lsrca.on.ca>
Subject: RE: 3103 Coral Sophia - D11-026-2020: Volume Control

CAUTION: This email originated outside of LSRCA. DO NOT click links or open attachments unless you recognize the sender and trusted content. If in doubt, contact the IT Helpdesk at ITHelpdesk@lsrca.on.ca

Steve

Per our discussion, the problem with trying to detain the 5mm rainfall for 24 hours is that it's such a small volume to begin with, the size of the flow restriction becomes impractically small. Well under 25mm on such small site.

Now, from my reading of the guidelines, filtration is acceptable and the site is using an Up Flo Filter for phosphorus reduction. This is a filter.

Can the LSRCA accept this as filtration in the context of volume reduction?

Bryan W. Bolivar, P.Eng | Senior Project Engineer, Associate
Skelton, Brumwell & Associates Inc.
Engineering Planning Environmental Consultants
93 Bell Farm Rd, Suite 107, Barrie, ON L4M 5G1

Tel: 705-726-1141*106 | Toll Free: 877-726-1141
Cell: 705-715-6997
www.skeltonbrumwell.ca
"innovation with integrity"



Due to the Covid-19 outbreak many staff are now working remotely. Skelton, Brumwell remains open for business and continues to provide quality service to our clients.

From: Stephen Troan <S.Troan@lsrca.on.ca>
Sent: January 29, 2021 1:37 PM
To: Bryan Bolivar <bbolivar@skeltonbrumwell.ca>
Subject: RE: 3103 Coral Sophia - D11-026-2020: Volume Control

Bryan;

Could you do alternative #2 for 5mm?

Please note: the LSRCA Board of Directors approved a change to our Fee Policy. The new fees will take effect on January 1, 2021. Please click [here](#) for the new fee schedule.

Stephen Troan, C.E.T.
Engineering Technologist
Lake Simcoe Region Conservation Authority
120 Bayview Parkway,
Newmarket, Ontario L3Y 3W3
905-895-1281, ext. 306 | 1-800-465-0437
s.troan@LSRCA.on.ca | www.LSRCA.on.ca

The information in this message (including attachments) is directed in confidence solely to the person(s) named above and may not be otherwise distributed, copied or disclosed. The message may contain information that is privileged, confidential and exempt from disclosure under the Municipal Freedom of Information and Protection of Privacy Act and by the Personal Information Protection Electronic Documents Act. If you have received this message in error, please notify the sender immediately and delete the message without making a copy. Thank you.

From: Bryan Bolivar <bbolivar@skeltonbrumwell.ca>
Sent: January 29, 2021 9:44 AM
To: Stephen Troan <S.Troan@lsrca.on.ca>
Cc: Melinda Bessey <M.Bessey@lsrca.on.ca>; Gary Matthie <Gary.Matthie@barrie.ca>;
rduhamel@jonesconsulting.com; Nick Savino <nsavino@dmsproperty.com> <nsavino@dmsproperty.com>
Subject: RE: 3103 Coral Sophia - D11-026-2020: Volume Control

CAUTION: This email originated outside of LSRCA. DO NOT click links or open attachments unless you recognize the sender and trusted content. If in doubt, contact the IT Helpdesk at ITHelpdesk@lsrca.on.ca

Steve

We can also get some delayed draw down from the permeable pavement at the west and south sides, but this does not amount to much of the site, so it really doesn't achieve what is intended.

I think the option this is feasible is to restrict the roof flows to drain a 25mm rain event over 24 hours. We don't have enough room outside the building below grade to store that much runoff.

Would that be acceptable in principle to your office?

Bryan W. Bolivar, P.Eng | Senior Project Engineer, Associate
Skelton, Brumwell & Associates Inc.
Engineering Planning Environmental Consultants
93 Bell Farm Rd, Suite 107, Barrie, ON L4M 5G1
Tel: 705-726-1141*106 | Toll Free: 877-726-1141
Cell: 705-715-6997
www.skeltonbrumwell.ca
"innovation with integrity"



Due to the Covid-19 outbreak many staff are now working remotely. Skelton, Brumwell remains open for business and continues to provide quality service to our clients.

From: Bryan Bolivar
Sent: January 28, 2021 3:21 PM
To: s.troan@lsrca.on.ca
Cc: Melinda Bessey <M.Bessey@lsrca.on.ca>; Gary Matthie <Gary.Matthie@barrie.ca>; rduhamel@jonesconsulting.com; Nick Savino (nsavino@dmsproperty.com) <nsavino@dmsproperty.com>; Scott Brumwell <sbrumwell@skeltonbrumwell.ca>
Subject: 3103 Coral Sophia - D11-026-2020: Volume Control

Steve

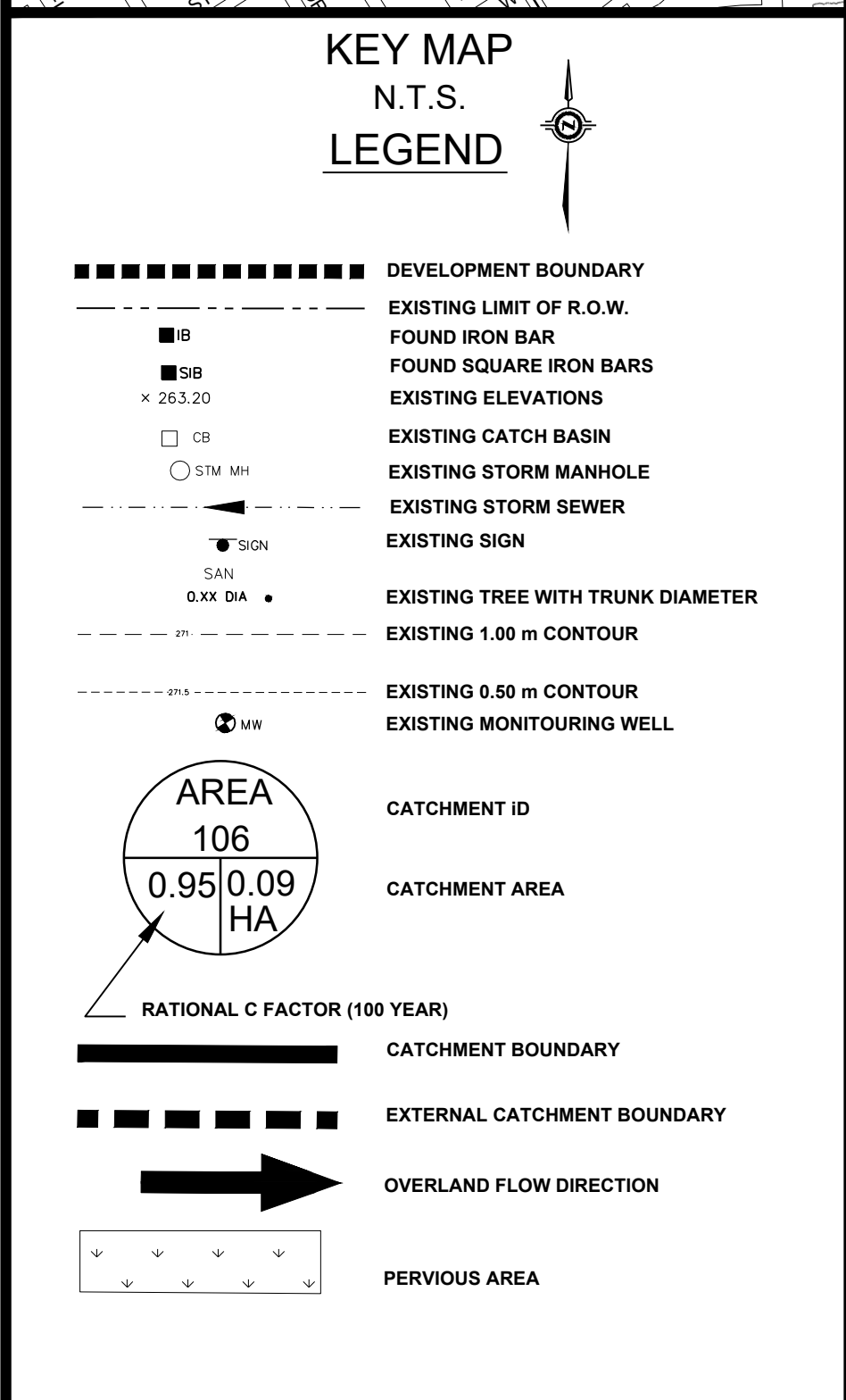
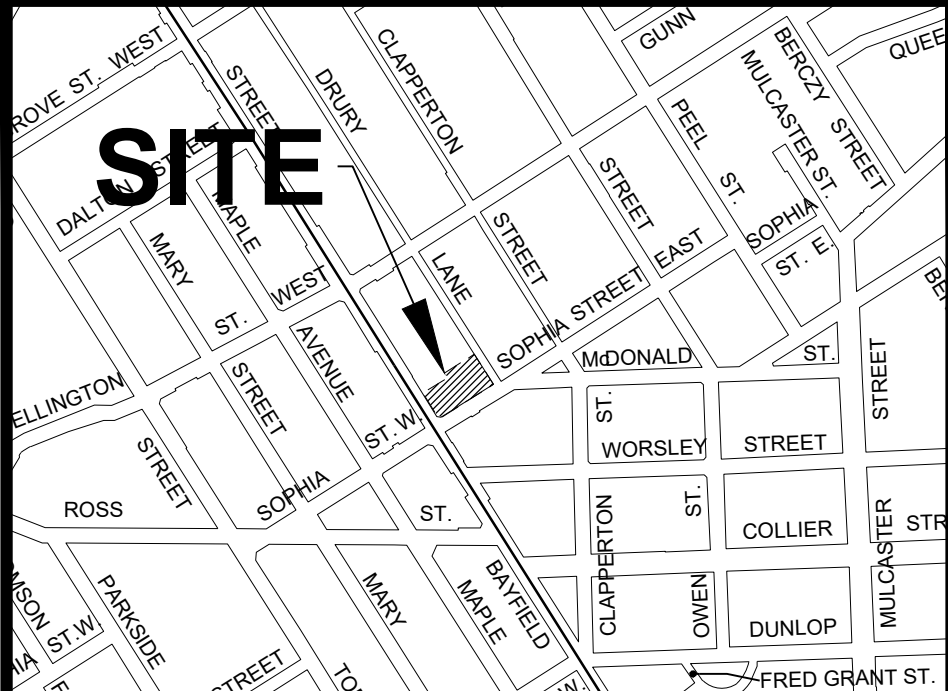
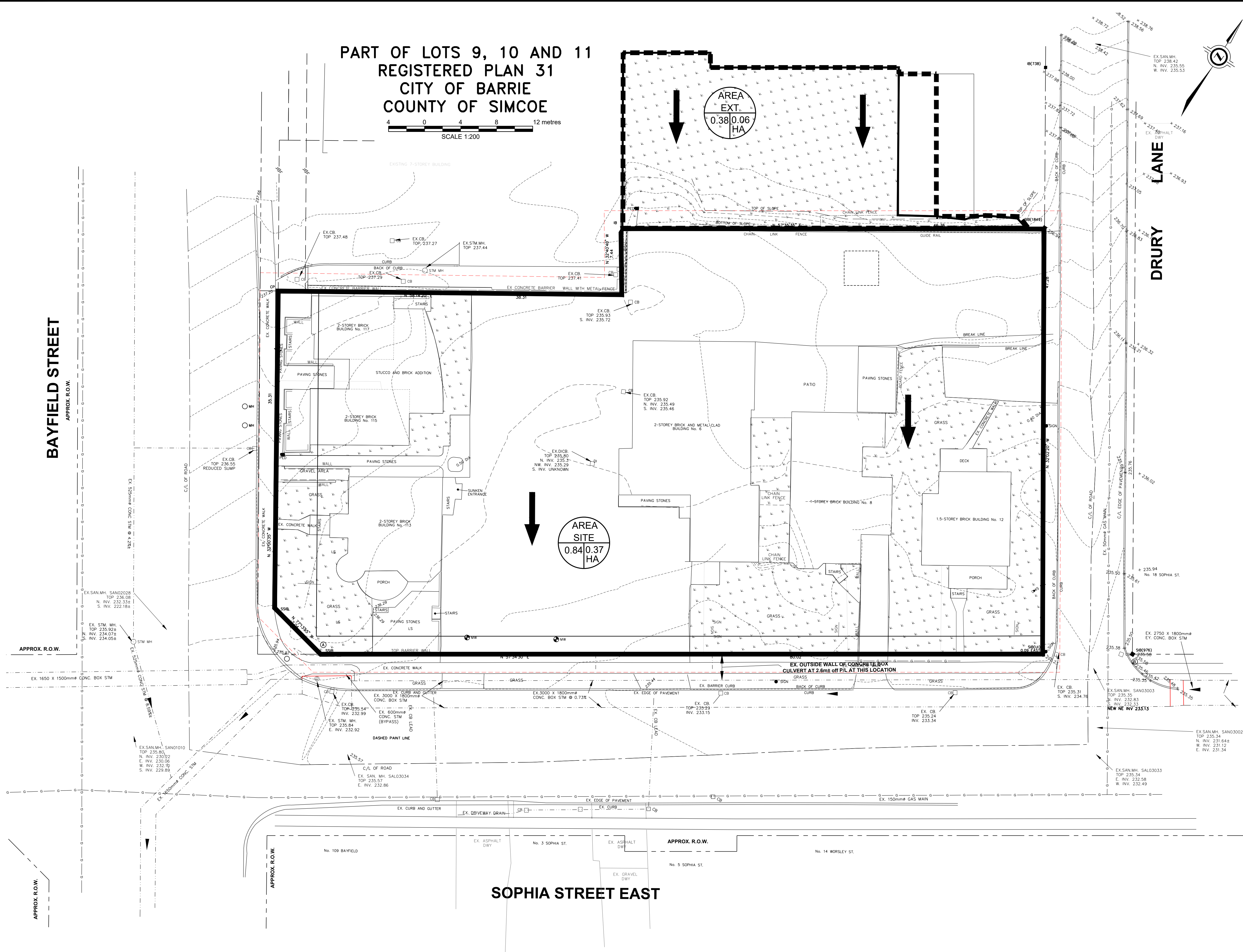
Thank-you for the call. We will investigate options to demonstrate reducing 25mm runoff rates such that this volume drains over a 24 hour time frame.

We understand that this will be an acceptable alternative method to address Section 2.2.2 Volume Control from the LSRCA Technical Guidelines.

Bryan W. Bolivar, P.Eng | Senior Project Engineer, Associate
Skelton, Brumwell & Associates Inc.
Engineering Planning Environmental Consultants
93 Bell Farm Rd, Suite 107, Barrie, ON L4M 5G1
Tel: 705-726-1141*106 | Toll Free: 877-726-1141
Cell: 705-715-6997
www.skeltonbrumwell.ca
"innovation with integrity"

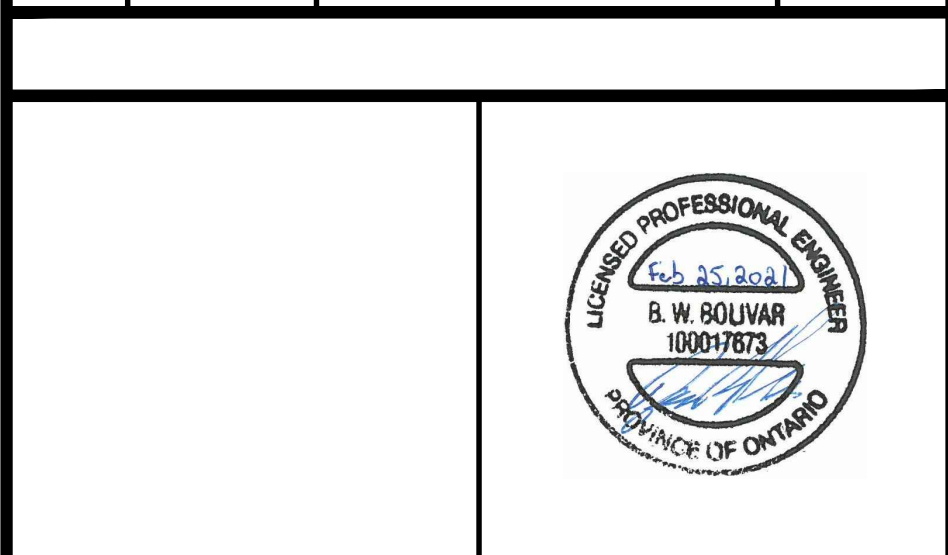


Due to the Covid-19 outbreak many staff are now working remotely. Skelton, Brumwell remains open for business and continues to provide quality service to our clients.



SCHEDULE OF REVISIONS

NO.	DATE	DESCRIPTION	CHECKED
1	APRIL 2020	SUBMISSION FOR REZONING	BWB
2	2020 11 16	ISSUED FOR SITE PLAN APPROVAL	BWB
3	2021 02 25	RE-ISSUED FOR SITE PLAN APPROVAL	BWB



CORAL SOPHIA HOUSING
115 BAYFIELD ST.
BARRIE, ONTARIO
COUNTY OF SIMCOE

EXISTING DRAINAGE CATCHMENT PLAN

PROJECT NO. 17-3103	DRWG NO. SWM1
DATE APRIL 2020	SCALE: 1:200 HOR.
DRAWN: BDD/BWB	CHECKED: APPROVED:

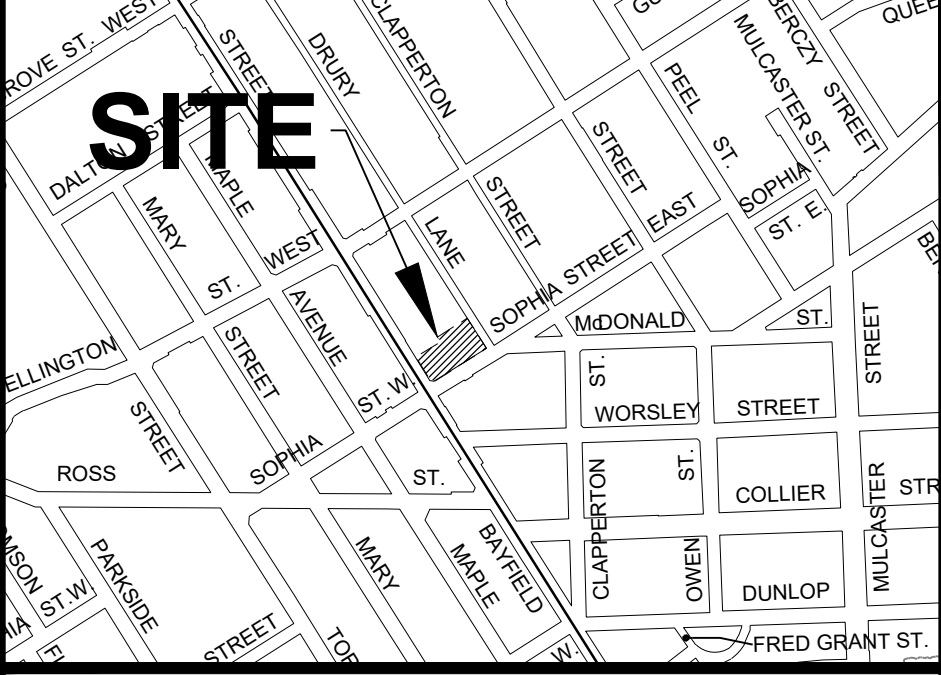
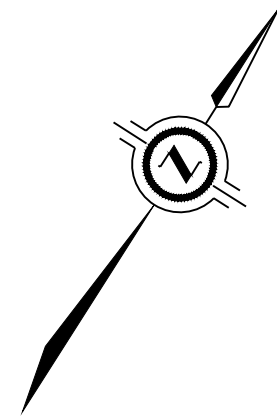
SBA Skelton Brumwell & Associates Inc.
ENGINEERING PLANNING ENVIRONMENTAL CONSULTANTS

93 BELL FARM ROAD, SUITE 107
BARRIE, ONTARIO L4M 5G1
www.skeltonbrumwell.ca

TELEPHONE (705) 726-1141
FAX (705) 726-0331
TOLL FREE (877) 726-1141

PART OF LOTS 9, 10 AND 11
REGISTERED PLAN 31
CITY OF BARRIE
COUNTY OF SIMCOE

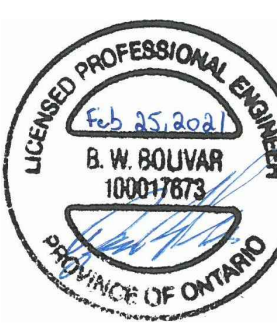
SCALE 1:200
4 0 4 8 12 metres



KEY MAP
N.T.S.
LEGEND

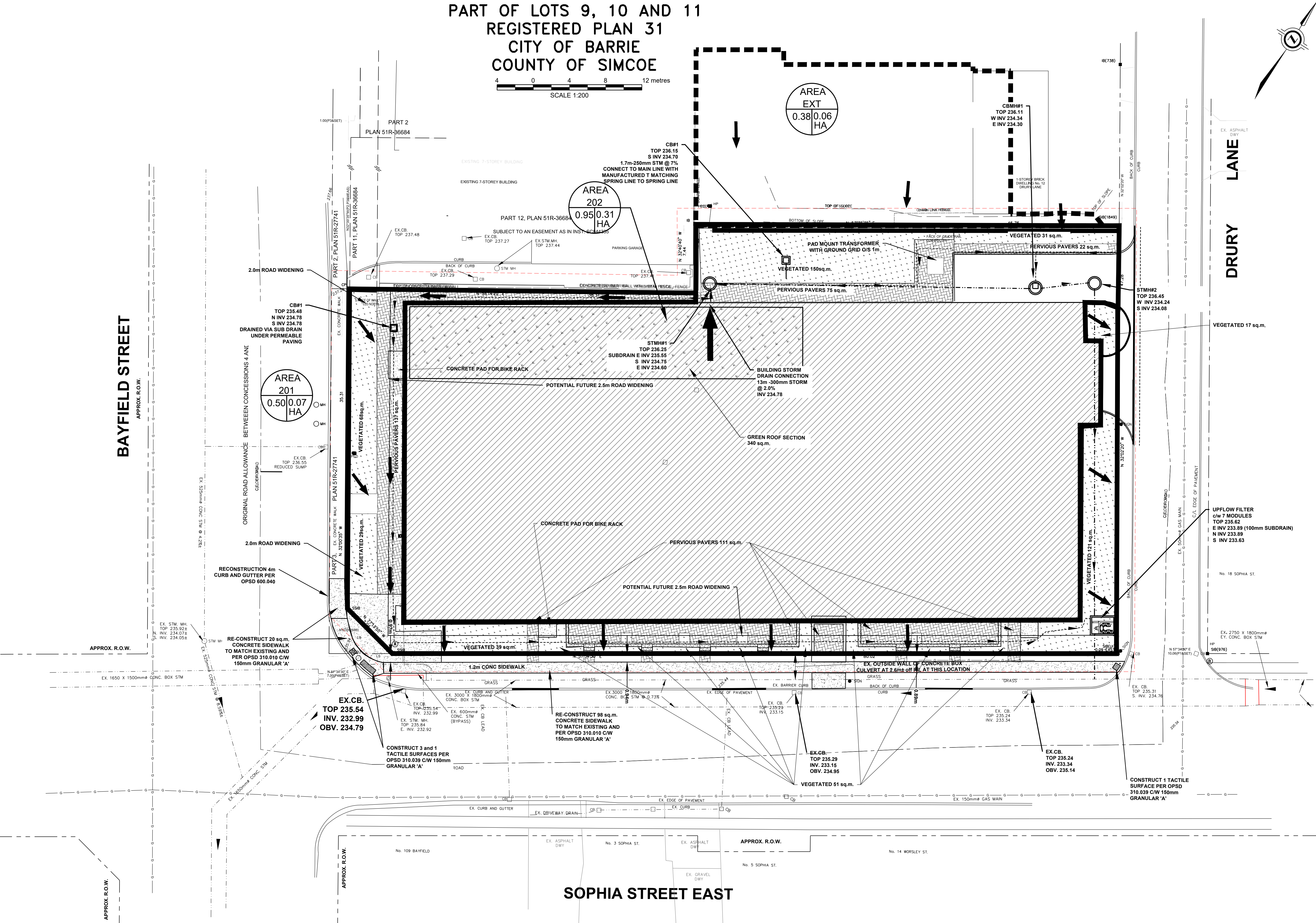
- DEVELOPMENT BOUNDARY
- EXISTING LIMIT OF R.O.W.
- FOUND IRON BAR
- FOUND SQUARE IRON BARS
- EXISTING ELEVATIONS
- EXISTING CATCH BASIN
- EXISTING STORM MANHOLE
- EXISTING STORM SEWER
- EXISTING SIGN
- EXISTING TREE WITH TRUNK DIAMETER
- EXISTING 1.00 m CONTOUR
- EXISTING 0.50 m CONTOUR
- EXISTING MONITORING WELL
- CATCHMENT ID
- CATCHMENT AREA
- RATIONAL C FACTOR (100 YEAR)
- CATCHMENT BOUNDARY
- EXTERNAL CATCHMENT BOUNDARY
- OVERLAND FLOW DIRECTION
- PERVIOUS AREA
- PROPOSED BUILDING

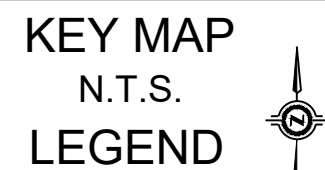
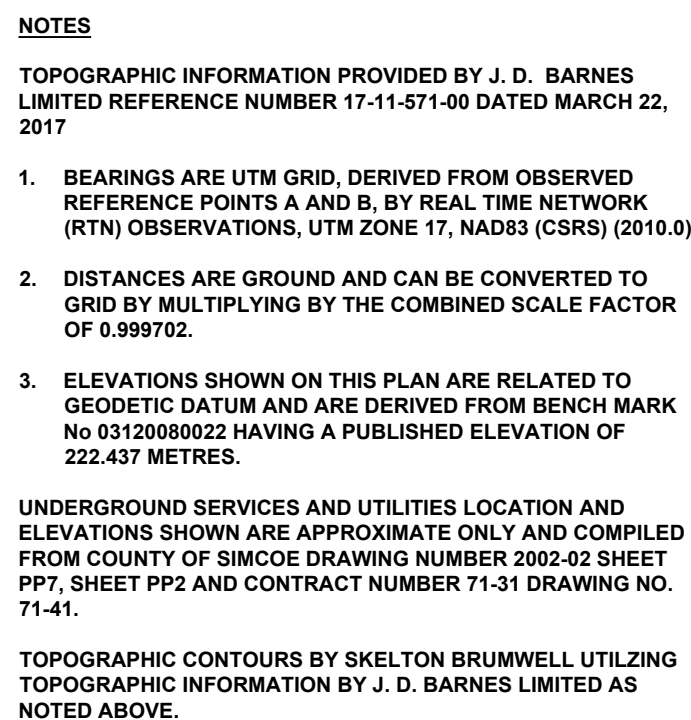
SCHEDULE OF REVISIONS			
NO.	DATE	DESCRIPTION	CHECKED
1	APRIL 2020	SUBMISSION FOR REZONING	BWB
2	2020 11 16	ISSUED FOR SITE PLAN APPROVAL	BWB
3	2021 02 25	RE-ISSUED FOR SITE PLAN APPROVAL	BWB



CORAL SOPHIA HOUSING
115 BAYFIELD ST.
BARRIE, ONTARIO
COUNTY OF SIMCOE

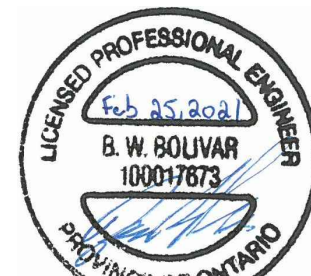
PROPOSED CATCHMENT PLAN			
PROJECT NO. 17-3103		DRWG NO. SWM2	
DATE APRIL 2020		SCALE: 1:200 HOR.	
DRAWN: BDD/BWB		CHECKED:	APPROVED:
			
ENGINEERING PLANNING ENVIRONMENTAL CONSULTANTS			
93 BELL FARM ROAD, SUITE 107 BARRIE, ONTARIO L4M 5G1 www.skeltonbrumwell.ca		TELEPHONE (705) 726-1141 FAX (705) 726-0331 TOLL FREE (877) 726-1141	





- ## SCHEDULE OF REVISIONS

NO.	DATE	DESCRIPTION	CHECKED
1	APRIL 2020	SUBMISSION FOR REZONING	BWB
2	2020 11 16	ISSUED FOR SITE PLAN APPROVAL	BWB
3	2021 02 25	RE-ISSUED FOR SITE PLAN APPROVAL	BWB



CORAL SOPHIA HOUSING
115 BAYFIELD ST.
BARRIE, ONTARIO
COUNTY OF SIMCOE

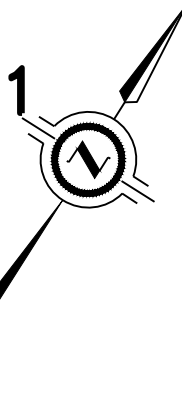
STORM SEWER CATCHMENT PLAN

PROJECT NO. 17-3103		DRWG NO. SWM3	
DATE APRIL 2020		SCALE: 1:200 HOR.	
DRAWN: BDD/BWB	CHECKED:	APPROVED:	

SBA Skelton Brumwell
& Associates Inc.
 ENGINEERING PLANNING ENVIRONMENTAL CONSULTANTS

93 BELL FARM ROAD, SUITE 107
BARRIE, ONTARIO L4M 5G1
www.skeltonbrumwell.ca

TELEPHONE (705) 726-1141
FAX (705) 726-0331
TOLL FREE (877) 726-1141

PART OF LOTS 9, 10 AND 11
REGISTERED PLAN 31
CITY OF BARRIE
COUNTY OF SIMCOE4 0 4 8 12 metres
SCALE 1:200BAYFIELD STREET
APPROX. R.O.W.

DRURY LANE

SOPHIA STREET EAST

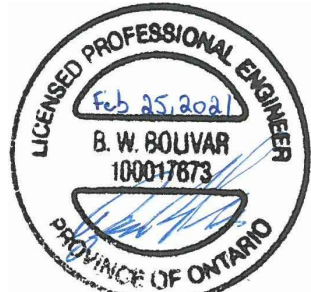
SITE

KEY MAP
N.T.S.
LEGEND

■	EXISTING LIMIT OF R.O.W.
■	FOUND SQUARE IRON BAR
■	EXISTING ELEVATIONS
○	EXISTING CATCH BASIN
○	EXISTING STORM MANHOLE
○	EXISTING STORM SEWER
○	EXISTING SANITARY MANHOLE
○	EXISTING SANITARY SEWER
○	EXISTING SANITARY SERVICE
○	EXISTING FIRE HYDRANT PER TOPO SURVEY
○	EXISTING WATER VALVE PER TOPO SURVEY
○	EXISTING CURB STOP PER TOPO SURVEY
○	EXISTING WATERMAIN
○	EXISTING ELECTRICAL MANHOLE
○	EXISTING LIGHT STANDARD
○	EXISTING HYDRO POLE
○	EXISTING OVERHEAD HYDRO
○	EXISTING BELL PEDESTAL
○	EXISTING SIGN
○	EXISTING 1.00 m CONTOUR
○	EXISTING 0.50 m CONTOUR
○	EXISTING MONITORING WELL
○	PROP. SPOT ELEVATION
○	PROP. TOP OF CURB SPOT ELEVATION
○	PROP. TOP OF WALL SPOT ELEVATION
○	PROP. BOTTOM OF WALL SPOT ELEVATION
○	PROPOSED GRADE
○	PROPOSED TREES AND/OR SHRUBS
○	PROPOSED VEGETATED SURFACE
○	PROPOSED PERMEABLE PAVING WITH UNDERDRAIN

SCHEDULE OF REVISIONS

NO.	DATE	DESCRIPTION	CHECKED
1.	MARCH 20, 2020	ISSUED FOR PRE-CONSULTATION	BWB
2.	APRIL 2020	SUBMISSION FOR REZONING	BWB
3.	2020 11 16	ISSUED FOR SITE PLAN APPROVAL	BWB
4.	2021 02 25	RE-ISSUED FOR SITE PLAN APPROVAL	BWB

CORAL SOPHIA HOUSING
115 BAYFIELD ST.
BARRIE, ONTARIO
COUNTY OF SIMCOE

SITE GRADING PLAN

PROJECT NO. 17-3103	DRWG NO. 3103-GP1
DATE: APRIL 2020	SCALE: 1:200 HOR.
DRAWN: BDD/BWB	CHECKED: APPROVED:

SBA Skelton Brumwell & Associates Inc.
ENGINEERING PLANNING ENVIRONMENTAL CONSULTANTS93 BELL FARM ROAD, SUITE 107
BARRIE, ONTARIO L4M 5G1
www.skeltonbrumwell.ca
TELEPHONE (705) 726-1141
FAX (705) 726-0331
TOLL FREE (877) 726-1141

NOTES

TOPOGRAPHIC INFORMATION PROVIDED BY J. D. BARNES
LIMITED REFERENCE NUMBER 17-11-571-00 DATED MARCH 22, 2017

- BEARINGS ARE UTM GRID, DERIVED FROM OBSERVED REFERENCE POINTS A AND B, BY REAL TIME NETWORK (RTN) OBSERVATIONS, UTM ZONE 17, NAD83 (CSRS) (2010.0).
- DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.999702.
- ELEVATIONS SHOWN ON THIS PLAN ARE RELATED TO GEODETIC DATUM AND ARE DERIVED FROM BENCH MARK NO. 03120080022 HAVING A PUBLISHED ELEVATION OF 222.437 METRES.

UNDERGROUND SERVICES AND UTILITIES LOCATION AND ELEVATIONS SHOWN ARE APPROXIMATE ONLY AND COMPILED FROM COUNTY OF SIMCOE DRAWING NUMBER 2002-02 SHEET PP7, SHEET PP2 AND CONTRACT NUMBER 71-31 DRAWING NO. 71-41.

TOPOGRAPHIC CONTOURS BY SKELTON BRUMWELL UTILIZING TOPOGRAPHIC INFORMATION BY J. D. BARNES LIMITED AS NOTED ABOVE.

CONTROL MONUMENTS

HORIZONTAL CONTROL MONUMENT

THE HORIZONTAL MONUMENT 01019860463

THE HORIZONTAL MONUMENT IS LOCATED IN PAVED DRIVEWAY UNDER WATER VALVE COVER ON THE WEST SIDE OF MULCASTER STREET AND APPROXIMATELY 13M FROM CENTERLINE OF MULCASTER STREET.

NORTHING (SECOND ORDER): 4916487.811
EASTING (SECOND ORDER): 604671.596

COMBINED CONTROL MONUMENTS

THE HORIZONTAL MONUMENT 03120080022

LOCATED ON THE SE CORNER OF INNISFIL STREET AND VESPERA STREET APPROXIMATELY 18.5M FROM CENTERLINE OF INNISFIL STREET AND APPROXIMATELY 13M FROM CENTERLINE OF VESPERA STREET.

NOTE: A PROTECTIVE WATER VALVE COVER HAS BEEN PLACED OVER MONUMENT CAP.

NORTHING (SECOND ORDER): 4915161.491
EASTING (SECOND ORDER): 603262.428
VERTICAL (SECOND ORDER): 222.437EXISTING GRADE IN SW CORNER OF RESIDENTIAL LOT MATCHES SITE GRADE
RETAINING WALL NOT REQUIRED HERE
FENCING ONLY, WITH 150mm GAP AT BOTTOM TO ALLOW DRAINAGE TO PASS THROUGH45m-PROPOSED BLOCK RETAINING WALL
HEIGHT: 0.05-0.55m
DRAINAGE FROM NEIGHBORING RESIDENTIAL LOT TO BE CONVEYED OVER WALL AND/OR VIA WALL DRAINAGE SYSTEM (DESIGN BY LANDSCAPE ARCH)PAD MOUNT TRANSFORMER
W GROUND GRID @ 1m O/S

SLOPE GARAGE FLOOR AT ENTRYWAY TO ACHIEVE DRIVEWAY SLOPE < MAXIMUM

FOUNDATION DEPTH AT E SIDE OF BUILDING TO BE AT ELEVATION SUFFICIENT TO PROVIDE BEARING CAPACITY BELOW SITE SERVICES STRUCTURAL ENGINEER TO REVIEW DEPTHS OF SERVICES AND STRUCTURES

SITE AREA: 0.37HA
DEVELOPMENT AREA (BUILDING, DRIVEWAY, PAVEMENT): 0.32 Ha (86.5%)MINIMUM UNDERSIDE OF FOOTING
233.40m (DEPTH 3.0m)

CITY OF BARRIE AQUIFER DEPTH: 60m±

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

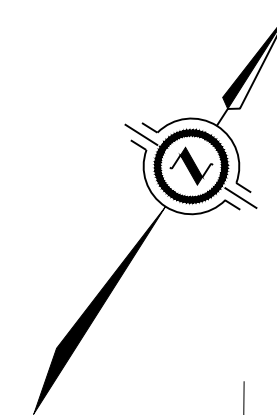
FINISHED FLOOR 236.40

POTENTIAL FUTURE 2.5m ROAD WIDENING

FINISHED FLOOR 236.40



4 0 4 8 12 metres
SCALE 1:200



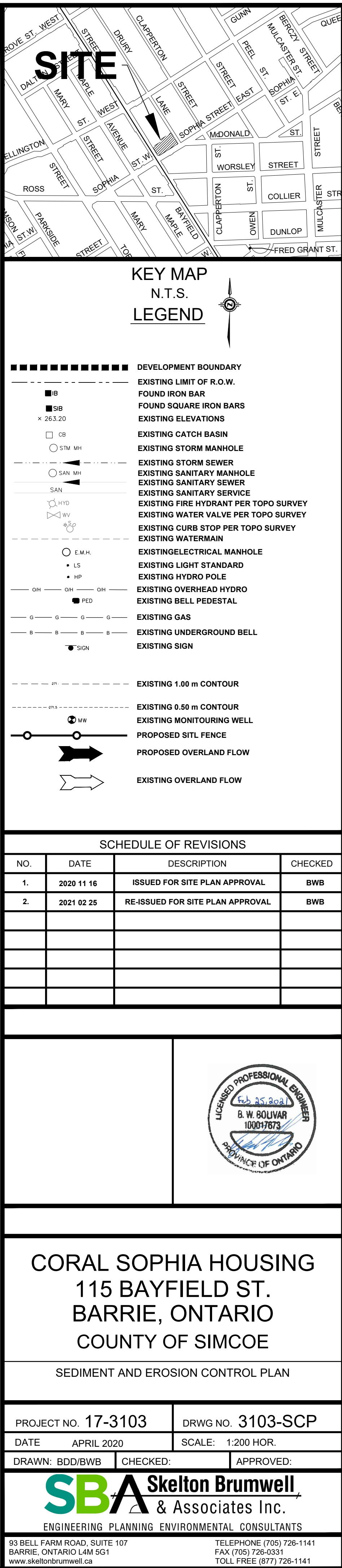
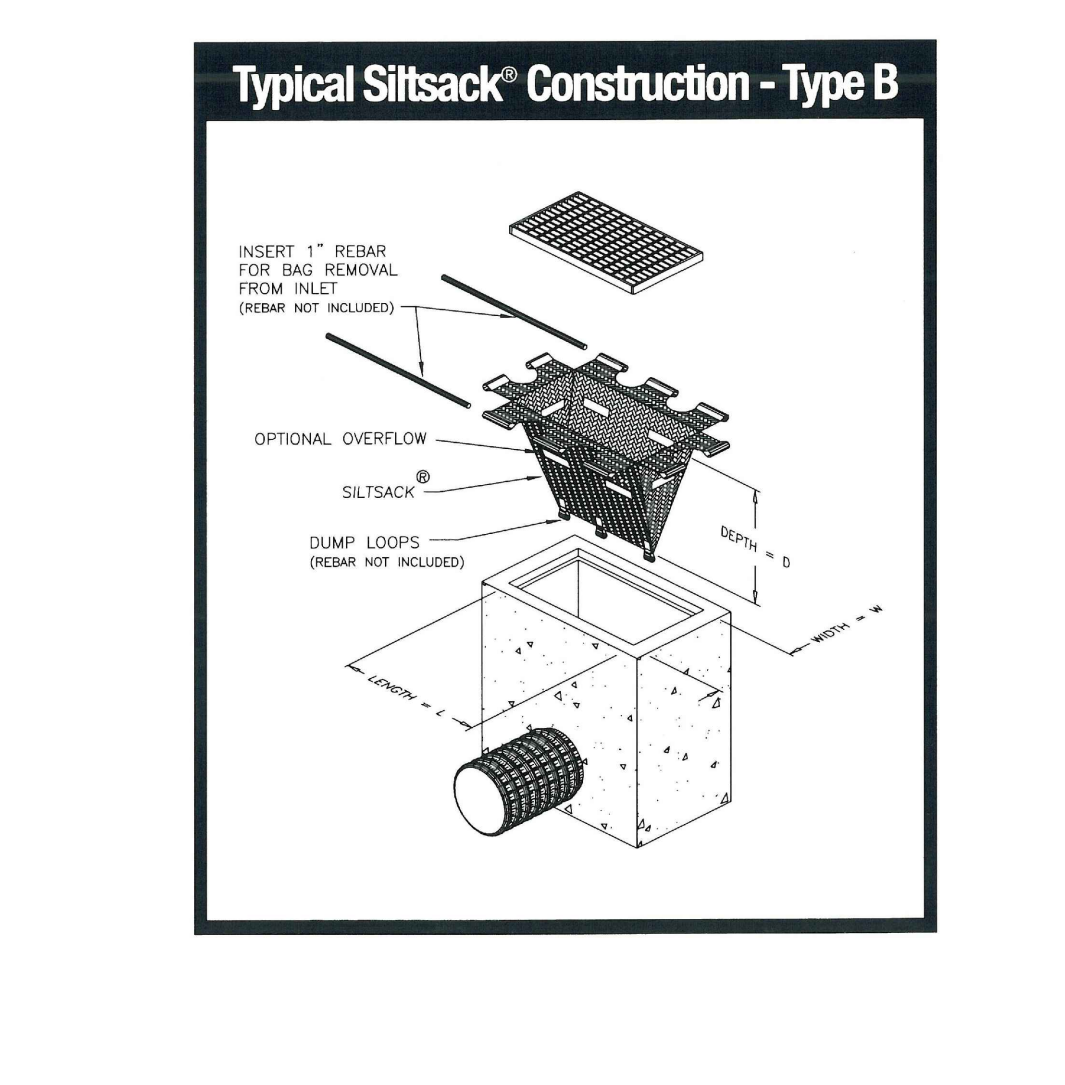
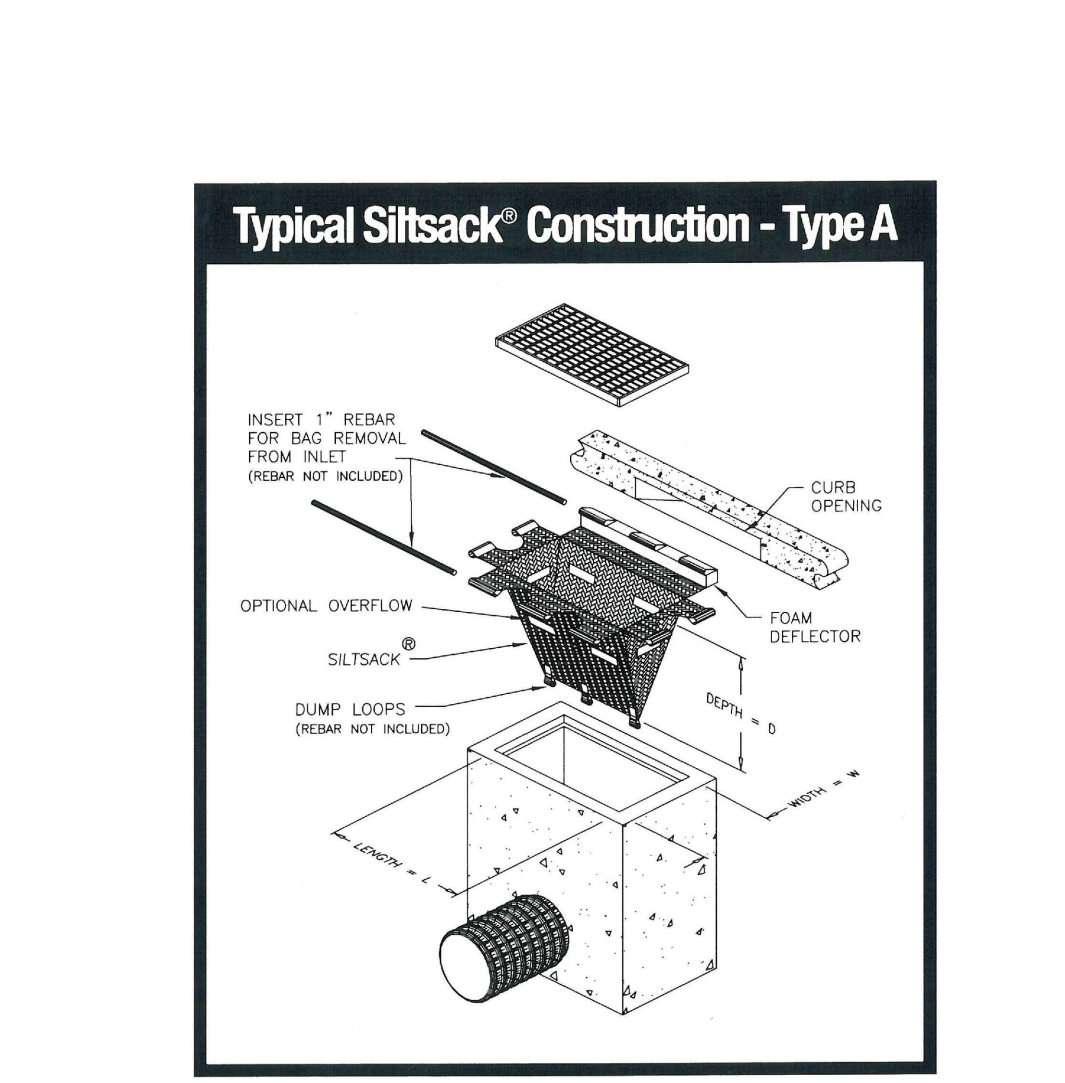
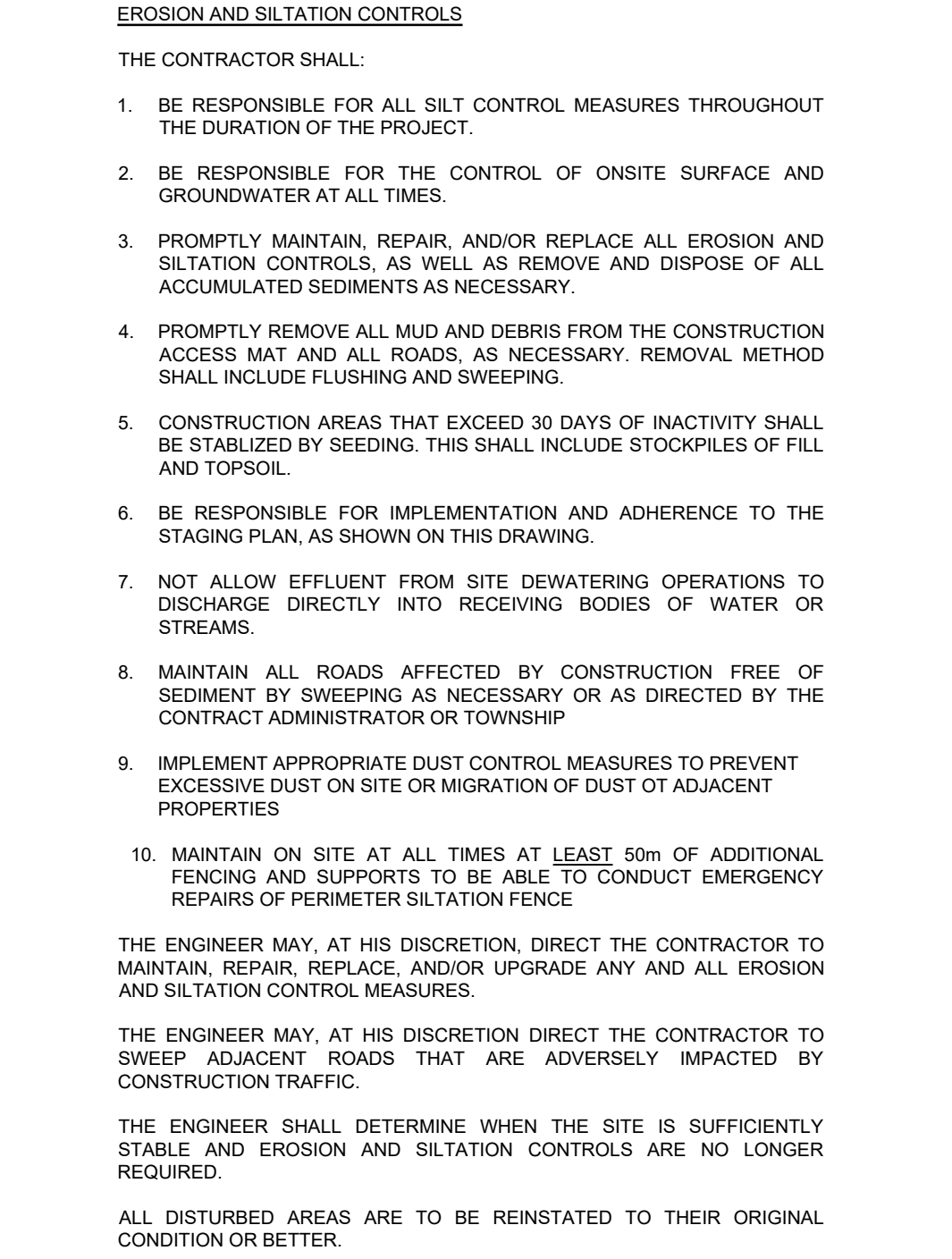
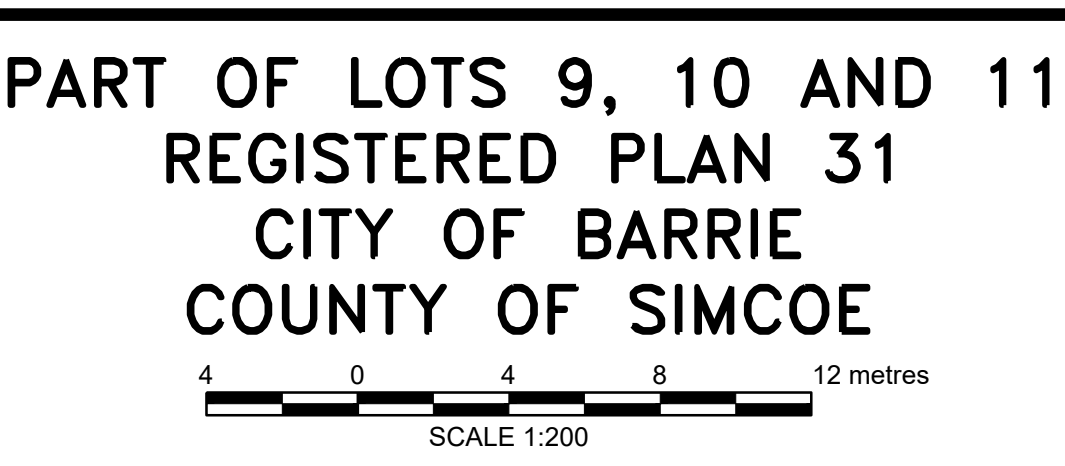
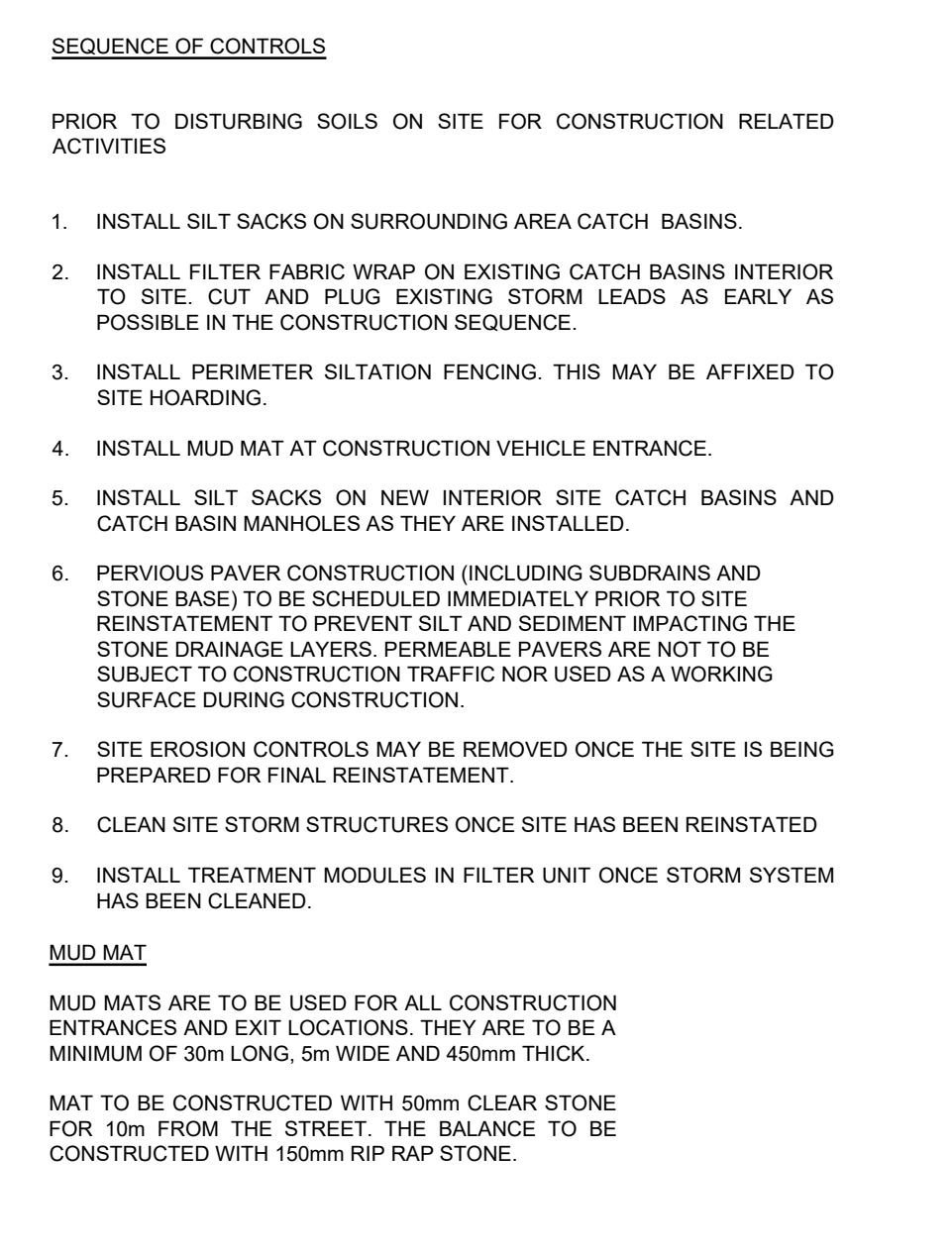
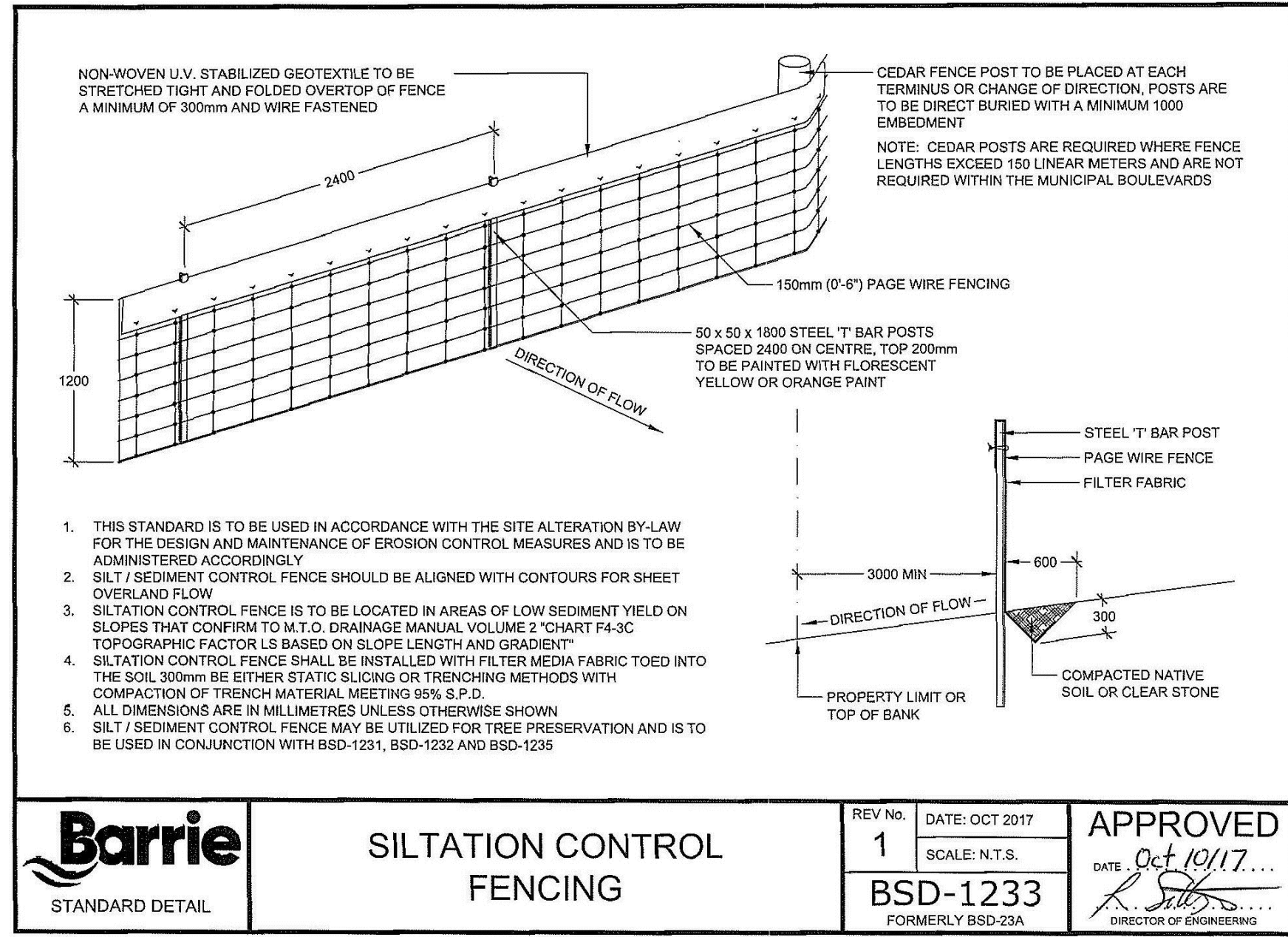
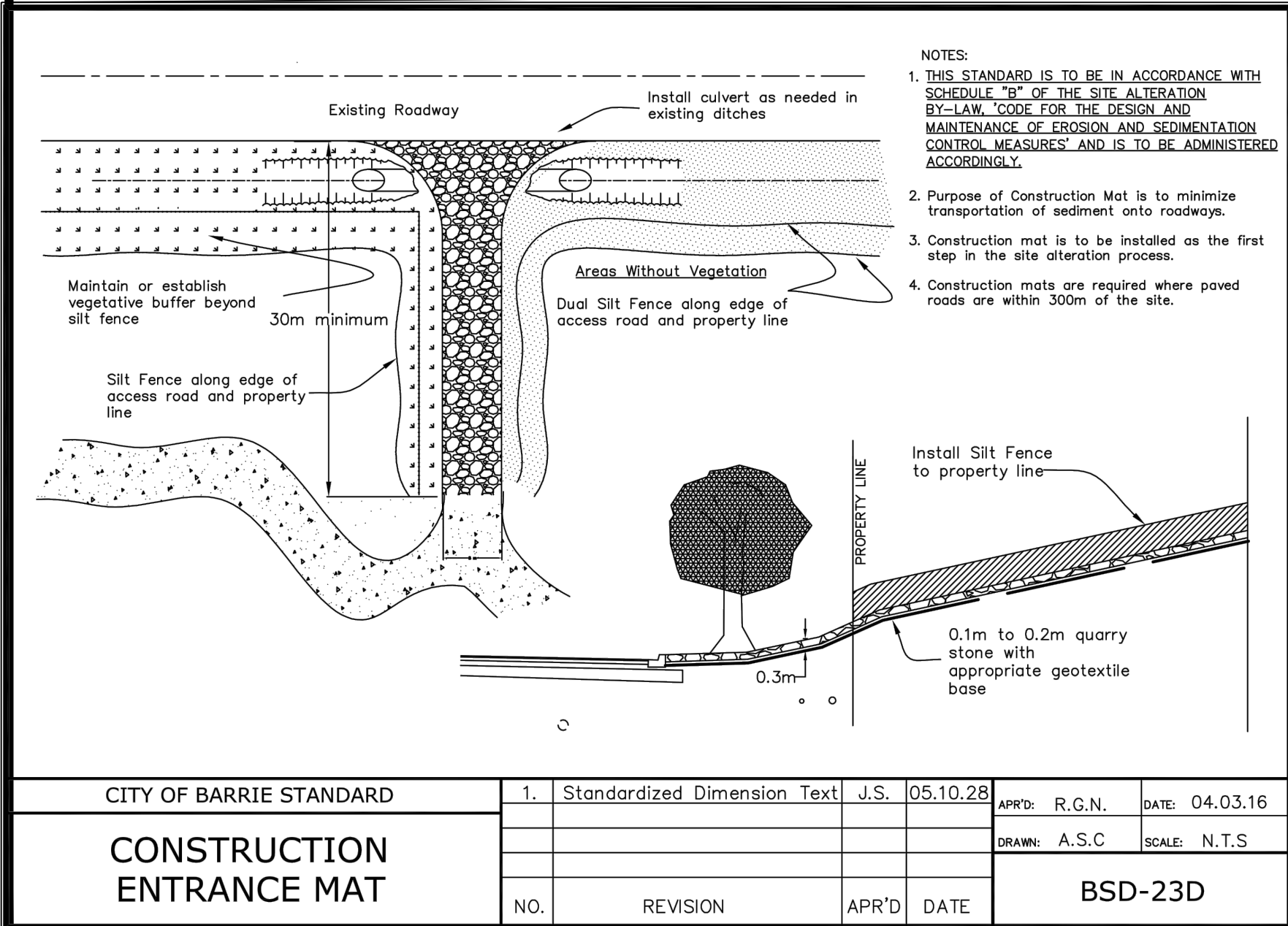
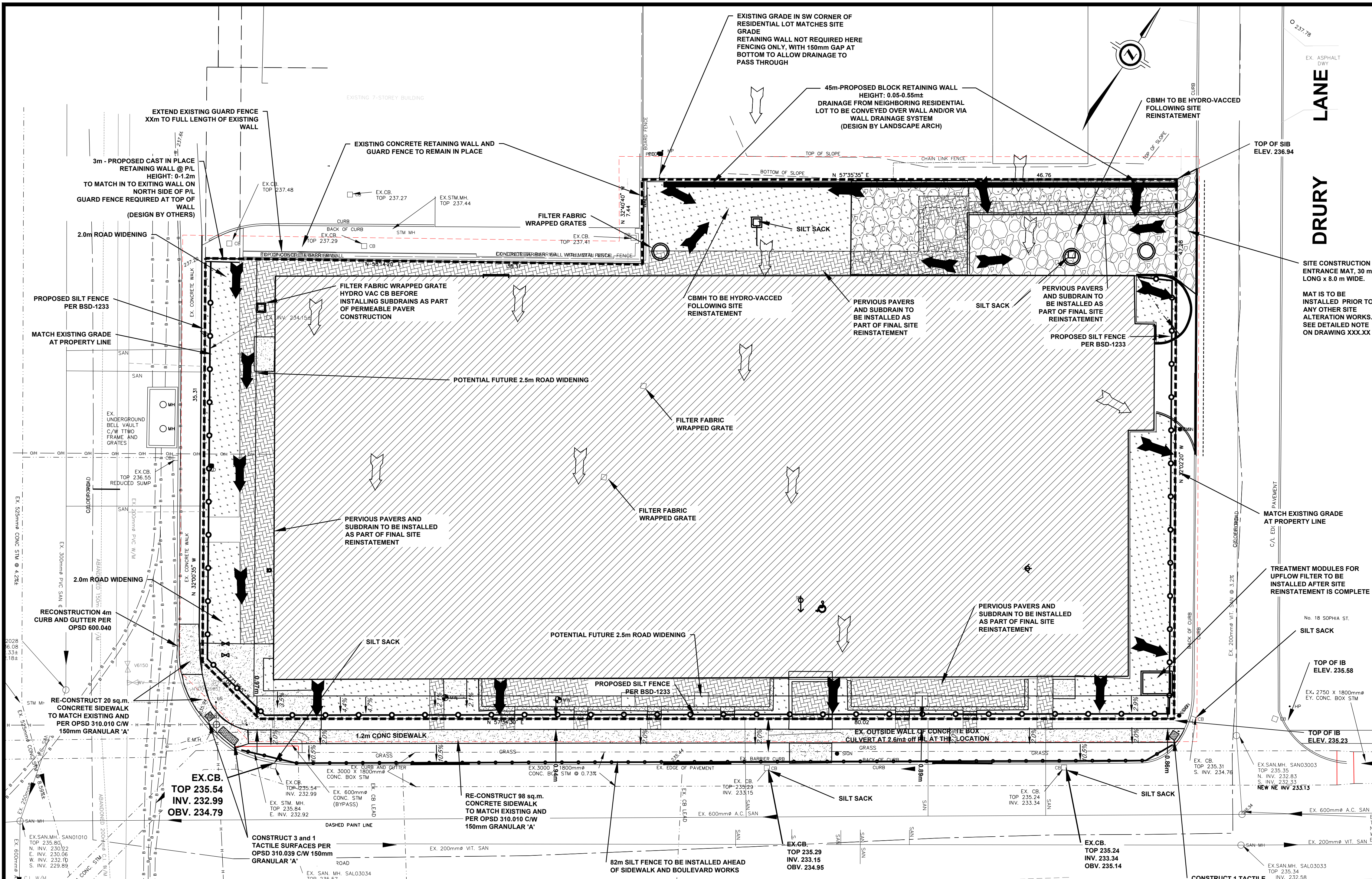
- ## SCHEDULE OF REVISIONS

SITE SERVICING PLAN ABOVE GROUND

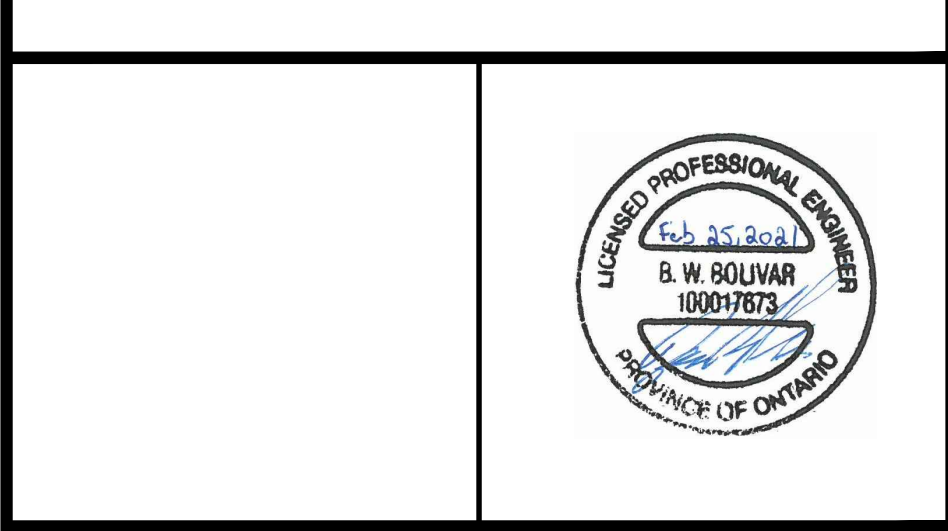
SBA Skelton Brumwell
& Associates Inc.
 ENGINEERING PLANNING ENVIRONMENTAL CONSULTANTS

93 BELL FARM ROAD, SUITE 107
BARRIE, ONTARIO L4M 5G1
www.skeltonbrumwell.ca

TELEPHONE (705) 726-1141
FAX (705) 726-0331
TOLL FREE (877) 726-1141



SCHEDULE OF REVISIONS			
NO.	DATE	DESCRIPTION	CHECKED
1.	2020 11 16	ISSUED FOR SITE PLAN APPROVAL	BWB
2.	2021 02 25	RE-ISSUED FOR SITE PLAN APPROVAL	BWB



CORAL SOPHIA HOUSING 115 BAYFIELD ST. BARRIE, ONTARIO COUNTY OF SIMCOE			
SEDIMENT AND EROSION CONTROL PLAN			
PROJECT NO. 17-3103		DRWG NO. 3103-SCP	
DATE APRIL 2020		SCALE: 1:200 HOR.	
DRAWN: BDD/BWB		CHECKED:	APPROVED:
			
ENGINEERING PLANNING ENVIRONMENTAL CONSULTANTS			
93 BELL FARM ROAD, SUITE 107 BARRIE, ONTARIO L4M 5G1 www.skeltonbrumwell.ca		TELEPHONE (705) 726-1141 FAX (705) 726-0331 TOLL FREE (877) 726-1141	