Lansdowne Development Preliminary Stormwater Management Report

Prepared for:

10194549 Canada Ltd. and 10725994 Canada Ltd.
c/o Mr. Shane Kelly

Prepared by:

FOREFRONT Engineering Inc.
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8

613.634.9009 tel
888.884.9392 fax

Date: April 2021

Statement of Qualifications and Limitations

The attached Report has been prepared by Forefront Engineering Inc. (Consultant) for the benefit of the Client in accordance with their Agreement.

The information, data, recommendations and conclusions contained in the Report:

1. is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report;
2. represents Consultant's judgement in light of the limitations and industry standards for the preparation of similar reports;
3. may be based on information provided to Consultant which has not been independently verified;
4. has not been updated since the date of issuance of the Report and its accuracy is limited to the time and circumstances in which it was prepared; and
5. must be read as a whole and sections should not be read out of context.

Consultant shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. Consultant accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared.

Any estimates or opinions regarding expected construction costs or construction schedule provided by Consultant represent Consultant's judgement in light of its experience and the knowledge and information available to it at the time of preparation. Consultant does not make any representations, with respect to such estimates or opinions, and accepts no responsibility for any loss or damage arising from them. Persons relying on such estimates or opinions do so at their own risk.

Except as agreed to in writing by Consultant and Client; as required by law; or to the extent used by governmental reviewing agencies for the purpose of obtaining permits or approvals, the Report and the Information may be used and relied upon only by Client.

Consultant accepts no responsibility to parties other than Client who may obtain access to the Report or the information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report, except to the extent those parties have obtained the prior written consent of Consultant to use and rely upon the Report and the information. Any injury, loss or damages arising from improper use of the Report shall be borne by the party making such use.

Forefront Engineering Inc

1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8

613 634 9009 tel
888.884.9392 fax

April 23, 2021

10194549 Canada Ltd.
& 10725994 Canada Ltd.
c/o Mr. Shane Kelly
377 Cadillac Avenue South
Oshawa, ON
L1H 6A1

Dear Mr. Kelly,

Regarding: Lansdowne Development
Preliminary Stormwater Management Report

The enclosed report details the existing drainage conditions and provides preliminary recommendations for stormwater management and drainage for the proposed Lansdowne development.

The proposed Lansdowne development includes two parcels of land; the West and East parcels. The West parcel is 26.77 ha with approximately 15.25 hectares of developable area and proposes approximately five developable light industrial blocks with complementary commercial and two new municipal streets. The East parcel is 83.34 ha with approximately 14.77 hectares of developable area and proposes approximately 208 residential lots, two low rise multi residential blocks, two commercial blocks, parkland and three new municipal streets.

Post development flows will be limited to pre-development levels for the proposed development. A normal level of quality control is required onsite.

Post development flows are to be controlled by a wet pond type stormwater management facility for the majority of the site.

Detailed design of enhanced roadside ditches, intermittent channel realignment, culvert crossings, outfalls and stormwater management facility outlet structures will be provided during the final engineering design of the subdivision.

Preliminary facility details are contained in this Report along with recommended maintenance procedures.

Individual blocks will be subject to Site Plan Control as development is proposed. Detailed Stormwater Management Reports are required for each block.

If you have any enquiries or wish to discuss further, please contact this office.

Sincerely,
FOREFRONT Engineering Inc.

Kyle Nielissen, P.Eng.
Civil Engineer
Kyle.Nielissen@Forefronteng.ca

FOREFRONT Signatures

Report Prepared By:

Jeff Homer, P. Eng.

Report Reviewed By:

Kyle Nielissen, P.Eng.

Table of Contents

Statement of Qualifications and Limitations
Letter of Transmittal

Appendices

Appendix A

- Draft Plan West
- Draft Plan East
- Figure 2 - Pre-Development Catchment Areas
- Figure 3 - Post-Development Catchment Areas
- Figure 4 – Post Development Storm Sewer
- Figure 5 – Stage 3 Concept Stormwater Management Facility
- Model Schematic
- Source Protection Map

Appendix B

- Brockville Short Duration Rainfall Intensity-Duration-Frequency Data
- Table 3-1: Surface Cover Parameter Calculations
- Impervious Calculations
- 100-Year Event Pre-Development Modeling
- 100-Year Event (Stages 1, 2 and 3) Uncontrolled Post Development Modeling

1. Introduction

Forefront has assembled relevant supporting information for the proposed Lansdowne Development, adjacent to Prince Street (County Road 3), Railway Street, and the Canadian National Railway. The legal description of the land is Parts 1 to 6, Registered Plan 194, Geographic Township of Lansdowne, Township of Leeds and the Thousand Islands, County of Leeds. The property is located north of County Road 2 and bounded by Railway Street to the north and divided by Prince Street. Please refer to Figure 1: Location Plan for the site location.

Figure 1: Location Plan

The subject site includes the west and east proposed draft plans totaling approximately 49.56 hectares.

The west plan is currently zoned Light Industrial and the east plan is currently zoned Residential in the Township of Leeds and the Thousand Islands Zoning Bylaw 07-079.

On the west plan and east plan the lands south of the site are vacant lands. Along Prince Street there are existing residential and commercial land uses. North of the east plan is Railway Street which is fronted by residential dwellings.

The proposed Lansdowne development includes two parcels of land; the West and East parcels. The West parcel is 26.77 ha with approximately 15.25 hectares of developable area and proposes approximately five developable light industrial blocks with complementary commercial and two new municipal streets. The East parcel is 83.34 ha with approximately 14.77 hectares of developable area and proposes approximately 208 residential lots, two low rise multi residential blocks, two commercial blocks, parkland and three new municipal streets.

Outside of the urban boundary adjacent to the West plan is a proposed stormwater facility. Within the East plan but outside of the urban boundary is the proposed parkland.

The general topography of the site slopes southwesterly, with a portion of the east parcel sloping northwesterly

Development of the Lansdowne Development will result in an increase in impervious areas. This Report recommends drainage requirements onsite and stormwater management mitigation measures to accommodate an increase in the imperviousness onsite.

Please refer to Appendix A, for the proposed development Draft Plans.

2. Existing Site Condition

The existing subject site is currently vacant and is not serviced by any storm sewer or stormwater management facilities. There are no storm sewers within the vicinity of the subject site. Stormwater runoff from the site generally sheet drains to the onsite channel, roadside ditches, rear yard ditches and culverts along Prince Street and the CN railway.

Existing drainage conditions include two main catchment areas. The west catchment area eventually drains to the southwest into Landon's Bay via an intermittent seasonal drainage channel. The east catchment drains to Larue Mills Creek to the east of the site.

West Catchment

The west catchment is generally vacant agricultural fields with sparse woodland, draining via sheet flow westerly to an intermittent seasonal channel. The entire site west of Prince Street (Area EX1) drains to the intermittent channel and off-site through **Outlet 1**. Continuing southwesterly the channel crosses under County Road 2 through a culvert adjacent to civic number 805, approximately 2 kilometres southwest of the site. The intermittent channel eventually drains into Landon's Bay.

Drainage area EX4 outlets to a 1200mm culvert crossing under the CN railway and eventually drains into the intermittent channel. Area EX2 consists of residential dwellings and several commercial lots along Prince Street that drain westerly into EX1.

Runoff from areas EX5, EX6, and EX7 drain west via sheet flow, and the rear yard swale of residences along Railway Street all drain to a 1200mm box culvert under Prince Street, eventually outletting to **Outlet 1**.

Catchment areas EX9 and EX10 drain west via sheet flow to a 600mm diameter culvert under Prince Street, eventually outletting to **Outlet 1** to the west.

A total pre-development area of approximately 84.94 hectares drains to **Outlet 1**.

East Catchment

The east catchment is generally vacant agricultural fields with sparse woodland.

Drainage from areas EX11, EX12 and EX13 are directed towards a low lying area and an intermittent seasonal channel that borders the far east property limit, eventually draining north-easterly towards **Outlet 2**. **Outlet 2** consists of three 600mm diameter culverts crossing beneath Railway Street, eventually draining to Larue Mills Creek. The balance of the site (EX15 and EX16) drains south towards a 1200mm box culvert passing under Prince Street.

A total pre-development area of approximately 17.00 hectares drains to **Outlet 2**.

The Soil Survey of Leeds County identifies the soil cover in this area as Napanee Clay (Nc). The soil characteristics of Napanee Clay include low organic content, high clay content, and is considered a poor draining soil.

Please refer to Appendix A, **Figure 2**: Pre-Development Catchment Areas, for the pre-development condition details.

Source Water Protection

The subject site is part of the Cataraqui Source Protection Area (SPA). The site is outside the Wellhead Protection Zone of the Lansdowne deep wells and is not within any Intake Protection Zone. A portion of the east parcel is considered a significant groundwater recharge area with a vulnerability score of 4. Parts of the west parcel are considered a highly vulnerable aquifer with a vulnerability score 6. The outlet for the site is not considered a significant groundwater recharge area. Refer to Appendix A, Source Protection Map for further details.

3. Proposed Development

The proposed Draft Plan development is divided into two parcels of land, the West parcel drainage area is approximately 26.77 ha and the East parcel drainage area is approximately 22.79 ha. Block 44 of Plan 397 is owned by a neighbour. For the purposes of this report, Block 44 lands are considered within the site area. All combined, the site area is 51.48 ha. A total catchment area of 102.63 ha including external areas was analysed.

Development onsite will result in an increase in impervious surfaces and could potentially impact stormwater quantity and quality. This development may have potential impacts on the natural drainage and environment.

Given the topography of the site and number of outlets onsite, a number of conveyance controls are required to maintain the flow regime to pre-development conditions. Outlets that experienced concentrated flows and sheet flows under pre-development condition are expected to maintain relatively similar flow characteristics post development.

3.1 Drainage Plan

It is recommended that stormwater from the proposed development be directed to the two existing outlets. The intermittent seasonal channel (**Outlet 1**) at the far west of the site, and the three 600mm culverts (**Outlet 2**) crossing under Railway Street. Stormwater management controls will limit post-development peak flows to pre-development levels and minimize the impact on downstream properties.

Drainage areas discharging to the west intermittent channel (**Outlet 1**). Approximately 5.92 ha of pre-development area draining to **Outlet 2** will be diverted to **Outlet 1** during post-development. The stormwater management facility is to be sized to over control for the additional area. The balance of area draining to Outlet 2 will continue to do so.

Asphalt roads with roadside ditches are proposed throughout the West parcel. A storm sewer system is proposed on McDonald Drive to convey stormwater to the proposed stormwater management facility. In the suburban portion of the East parcel, storm sewers, and asphalt roads with curb and gutters are proposed throughout. The estate residential portion within the East parcel proposes asphalt roads will be developed with enhanced swales incorporated into the right-of-way.

Grading for the development should incorporate lot level conveyance controls minimizing grades to promote reduced peak flows, retention and infiltration.

Areas draining to Outlet 1 will direct flow to a single wet pond type stormwater management facility. The stormwater management facility will provide quality and quantity control for the entire proposed development outletting to **Outlet 1**, including quality and quantity control for the industrial blocks.

It is recommended that the wet pond type stormwater management facility be constructed in stages. Three stages are proposed for construction of the stormwater management facility. The stage 1 facility is to be sized for the West parcel lands that are proposed for initial development. The stormwater management facility is to be expanded in Stage 2 and be sized for the initial developments proposed within the east parcel. Finally, Stage 3 is to be sized for the full buildout of the development. Refer to **Figure 3** for proposed development areas contributing to each stage.

Major flow path calculations can be provided during the detailed design stage.

The storm sewer system is to be designed to convey the 5 year design storm for the majority of the site. Major flow paths will be directed to a low point along MacDonald Drive within the west parcel, where runoff is to be collected by storm sewers sized for the 100 year event and directed to the stormwater management facility. The intersection of MacDonald Drive and Prince Street is proposed to be urbanized in order to convey major overland flow from the east parcel to the west parcel.

Block Drainage Requirements

Each individual block will be subject to site plan control and be required to complete a grading plan and stormwater management report. Side yard and rear yard swales shall be incorporated into each block. Each block shall not convey drainage onto adjacent blocks. Plans and reports shall be meet or exceed the requirements in this Report and the Township Site Plan Control Guidelines.

Major and minor flows can be directed to the road or roadside ditches. Quality and quantity control for the blocks is to be provided by the stormwater management facility.

Refer to Appendix A, **Figure 3** for post-development catchment details.

3.2 Storm sewers

Storm sewers are proposed throughout the majority of the development. The east parcel storm sewer will be designed for the minor design storm, which is a 5 year design event. Part of the MacDonald Drive storm sewer system will be designed for the 100 year design event. Both storm sewers will provide surcharge protection for all major flow events. Service laterals will be sized through the site plan approval process, all lots are required to have a back water prevention devices installed on the storm sewer lateral where provided.

The Ministry of the Environment, Conservation and Park's (MECP) Guidelines stipulates that the storm water collection system be designed to accommodate runoff as per the formula:

$$Q = 2.78AIR$$

where Q = Design flow in L/s,
A = area in hectares
I = rainfall intensity in mm/hr, and
R = runoff coefficient.

Storm sewers shall be designed for the 5 year or 100 year (where indicated) storm event and intensities based on the Brockville IDF curve and manning's equation for the area as approved by the Township Engineering Department.

A minimum t_c (time of concentration) of 15 minutes is to be used.

Refer to Appendix A **Figure 4**, for storm sewer details.

3.3 Water Quantity

Urbanization leads to an increase in impermeable surfaces (roof tops and parking areas). The resultant increased peak flows increase the risk to life, environment and property damage. Water quantity control is generally required when there will be downstream quantity impacts.

Consistent with general Stormwater Management practices, both stormwater quality and quantity control is proposed for the majority of the site. Post development flows will be maintained to pre-development levels for all storm events up to and including the 100 year design event.

3.3.1 Analysis

The hydrologic and hydraulic analysis for the site was conducted using a recent version of the U.S. Environmental Protection Agency's StormWater Management Model (SWMM5). The model has been widely used in similar stormwater management analyses in Ontario and is recognized as a reliable modeling technique for estimating pre-development and post development hydrologic and hydraulic responses for both rural and urban watersheds.

- Hydrology: the generation of stormwater runoff from the various catchment surfaces in response to rainfall. The hydrologic module of SWMM5 was used in this study to simulate the surface runoff and abstraction characteristics of land surfaces (i.e., evapotranspiration, infiltration, and surface storage) in response to meteorological inputs. It is a dynamic computer model that uses a non-linear reservoir approximation to represent overland flow. The hydrology module requires input data that describes the characteristics of local rainfall, overland flow, land use, and soil properties. Results include flow hydrographs for sub-catchment areas that were used as input to the hydraulic routing module.
- Hydraulics: the conveyance, attenuation, and routing of stormwater through the collection system and storage/treatment facilities. The hydraulic module of SWMM5 was used in this study to represent the complex hydraulics of open channel watercourses, piped collection systems, surface storage, overland flow routes, and SWM facilities (including swales, detention/retention facilities and associated control structures such as orifices and weirs). It is a dynamic computer model that accounts for the conservation of mass and momentum using the Saint-Venant equations for gradually varied unsteady flow.

3.3.1.1 Design Storm Events

Design storm events were based on IDF rainfall statistics that describe the frequency of rainfall depths over a specified duration. Rainfall intensities with various durations and return periods for the site were obtained from Environment Canada, see Appendix B**: Brockville Short Duration Rainfall Intensity-Duration-Frequency Data**. Using these rainfall intensities, rainfall hyetographs were developed for each return period with a 24 SCS Type II Distribution.

The design storm events include:

- 2-year return period / 24-hour duration: 52.5 mm
- 5-year return period / 24-hour duration: 68.1 mm
- 100-year return period / 24-hour duration: 111.0 mm

Note, SCS 6-hour distributions were also analysed and those results are available for review upon request. The SCS Type II 24 hour distribution was the most conservative and appropriate distribution given the catchment characteristics.

An additional "Water Quality" design storm was used in this study, defined as a small, frequent storm representing 25mm of rainfall over a short duration. Based on long- term rainfall observations in Southern Ontario, 90-95 percent of all rainfall events have a total rainfall depth of 25mm or less. This rainfall amount over a 4-hour duration has an approximate 6 month return period in this region.

3.3.1.2 Hydrology

In order to reflect the unique hydrologic properties within each sub-catchment, a variety of surface cover types were defined. The surface cover types used in this study are described as follows:

- Forest: Forest/meadow, heavy vegetation with high transpiration rates and a deep root zone.
- Grass: Grass/turf, light vegetation, cultivated or landscaped areas with a shallow root zone.
- BioRet: Bioretention, rain garden, or planter with engineered soil/media and underdrain system. This can be used to represent LID source control facilities.
- Bare: Un-vegetated soil, loose granular materials, or legacy compacted fill
- GrnRoof:Building structures with vegetated roof. This can be used to represent LID source control facilities.
- RegRoof: Building structures with regular rooftop construction and materials.
- PrmPave: Permeable paved surfaces with underdrain system. This can be used to represent LID source control facilities.
- ImpPave: Regular impermeable paved surfaces with underdrain system. (i.e. roadways, parking, driveways).
- Gravel: Gravel and compacted granular in traffic areas
- Wetland: Hydrologic parameters reflect an area that is roughly half open water and half heavily vegetated.
- Water: Open water surface, including Stormwater Management Facility detention facilities.

For existing and the proposed municipal right-of-way conditions, surface cover types were interpreted using available mapping and aerial imagery of the subject site. Characteristic hydrologic properties were assigned to each surface cover type as shown in Appendix B **Table 3-1**: **Surface Cover Parameter Calculations** based on literature values and similar studies throughout North America.

Infiltration parameters were determined for the Green-Ampt method based on soil texture properties. For this development the clay characteristics were used, which are values taken from the *Handbook of Hydrology* (D.R. Maidment *et al.*., 1993). Infiltration parameters include:

- Capillary tension, a measure of how tightly water is held within the soil pore space;
- Saturated hydraulic conductivity, a measure of how quickly the water can be drained vertically; and
- Porosity (or initial soil water deficit), the volumetric fraction of water within the soil pore space under initially dry conditions.

The parameters for clay are shown in Table 3-2.

Table 3-2 Infiltration Parameters

Texture	Capillary Tension		Saturated Hydr. Conductivity		Porosity
	In	mm	in/hr	mm/hr	
Clay	12.45	315	0.02	0.6	0.203

Based on the drainage characteristics of the soil onsite, there is little opportunity for infiltration.

3.3.1.3 Pre-Development Flows

Based on Table 3-1 in Appendix B and the existing catchment conditions in Table 3-3, pre-development flows were calculated for the existing development.

Table 3-3 Existing Conditions

Lansdowne Development (Pre-Development)						
Hydrologic Units - Existing Conditions						
Hydrologic Unit	Description	% Impervious	Area (ha)	Length (m)	Average Width (m)	Grade (%)
Outlet 1 - West Intermittent Seasonal Channel						
EX.1	Sheet Flow to Outlet 1	4.2%	28.69	720	450	0.30%
EX.2	Residential Sheet Flow	20.8%	2.35	45	430	1.00%
EX.3	Sheet Flow to EX1 Channel	2.0%	4.33	85	370	0.30%
EX.4	Sheet Flow to EX1 Channel	19.9%	35.67	440	600	2.50%
EX.5	Drainage to 1200mm Culvert	25.5%	3.16	65	265	0.50%
EX.6	ROW Drainage to 1200mm Culvert	39.3%	0.23	100	15	1.00%
EX.7	Sheet Flow to 1200mm Culvert	2.4%	5.41	250	350	0.20%
EX.9	ROW Drainage to 600mm Culvert	39.3%	0.31	150	14	0.50%
EX.10	Sheet Flow to 600mm Culvert	2.3%	4.79	230	275	0.60%
		Outlet 1 (ha)	**84.94 ha**			
Outlet 2 - (3) 600mm Culverts on Railway Street						
EX.11	Sheet Flow to Outlet 2	2.3%	9.63	275	220	0.40%
EX.12	Sheet Flow to EX11	3.1%	5.20	200	150	1.50%
EX.13	Sheet Flow to EX12	2.3%	2.28	110	80	2.00%
		Outlet 2 (ha)	**17.00 ha**	+ 18.13 ha		
Drainage to South						
EX.15	Sheet Flow to South Outlet	2.5%	0.43	40	100	1.00%
EX.16	Sheet Flow to South Outlet	2.5%	0.16	60	40	0.50%
		Within Limit of Development Area (ha):	**51.48 ha**			
		Exterior to Limit of Development Area (ha):	**51.04 ha**			
		Total Area (ha):	**102.63 ha**			

Results shown in Table 3-4 quantify the pre-development peak rate of surface runoff that has been routed through the collection system, eventually discharging to the various outlets downstream. Results are grouped by outfall location for all the rainfall events. Note that **Outlet 1** peak flows are also separated by proposed development areas and external site areas. External areas EX2, EX3, EX4, and EX9 are proposed to bypass the stormwater management facility.

Table 3-4 Peak Flows in Pre-Development Conditions

Peak Flows in Pre-Development Conditions (cms)					
Outlet	Area (ha)	25mm- Storm	1:2 Year Storm	1:5 Year Storm	1:100 Year Storm
			SCS II-24hr	SCS II-24hr	SCS II-24hr
Outlet 1 - Peak Flow from External Area	46.05	0.19	0.41	0.73	2.35
Outlet 1 - Peak Flow from Site	38.89	0.03	0.10	0.28	0.70
Outlet 1 - Subtotal	**84.94**	**0.22**	**0.51**	**1.01**	**3.05**

Outlet 2 - Site	8.96	0.01	0.04	0.11	0.43
Outlet 2 – External Area	18.13	-	-	-	0.63
Outlet 2 - Subtotal	**27.09**				**1.06**

3.3.1.4 Post Development Flows

The development of this site will increase the imperviousness of the site and hence the runoff. Based on Table 3-1 in Appendix B and the proposed catchment conditions in Table 3-5, post development flows were calculated for the proposed development.

Table 3-5 Proposed Conditions

Lansdowne Development (Pre-Development)								
Hydrologic Units - Post-Development Conditions								
Hydrologic Unit	Description	Stage 1 % Impervious	Stage 2 % Impervious	Stage 3 % Impervious	Area (ha)	Length (m)	Average Width (m)	Grade (%)
Outlet 1 - West Intermittent Seasonal Channel								
P1 - Site	Stormwater Management Facility Area	**8.0%**	**10.0%**	**12.2%**	**8.87**	100	330	0.30%
P2 - Site	Light Industrial to Storm Sewers	**67.5%**	**67.5%**	**67.5%**	**8.99**	210	385	0.50%
P3	Ext. Area to Bypass Swale	2.0%	2.0%	2.0%	4.33	85	370	0.30%
P4	Ext. Area to Bypass Swale	19.9%	19.9%	19.9%	35.67	440	600	2.50%
P5 - Site	Light Industrial to Storm Sewers	4.2%	4.2%	**67.5%**	**8.21**	250	415	0.50%
P6 - Site	Light Industrial to Storm Sewers	4.2%	4.2%	**67.5%**	**2.62**	60	370	0.50%
P7	Ext. Residential to Bypass Swale	20.8%	20.8%	20.8%	2.35	45	430	1.00%
P8	Ext. ROW to Bypass Swale	39.3%	39.3%	39.3%	0.31	150	15	0.50%
P9	Ext. ROW to Bypass Swale	39.3%	39.3%	39.3%	0.23	100	15	1.00%
P10 - Site	Residential to Storm Sewers	2.3%	**55.3%**	**55.3%**	**10.13**	600	170	0.60%
P11 - Site	Commercial to Storm Sewers	2.3%	2.3%	**70.0%**	**2.47**	50	300	0.50%
P12 - Site	Commercial to Storm Sewers	2.3%	2.3%	**70.0%**	**0.47**	30	70	0.50%
P13	Ext. Residential to Storm Sewers	25.5%	25.5%	25.5%	3.16	65	265	0.50%
P15A	Residential to Storm Sewers	2.3%	2.3%	**55.3%**	**4.42**	320	150	0.50%
				Total Development Area (Site) (ha):	**37.31**	**ha**		
				Stormwater Management Facility Lands (Site) (ha):	**8.87**	**ha**		
				Exterior to Limit of Development Area (ha):	**46.05**	**ha**		
				Total Area to Outlet 1 (ha):	**92.23**	**ha**		
Outlet 2 - (3) 600mm Culverts on Railway Street								
P14	Bypass Swale	-	-	3.1%	5.20	185	150	0.50%
P16 - Site	Parkland	-	-	**7.8%**	**1.30**	60	160	0.50%
P15B - Site	Residential Rear Yard	-	-	**26.0%**	**3.90**	400	25	0.50%
				Total Area to Outlet 2 (ha)	**10.40**	**ha**		

Note, areas in **bold** are the subject development area of 51.48 ha.

Results shown in Table 3-6 quantify the peak rate of surface runoff that has been routed through the collection system, ultimately discharging to the various outlets downstream.

Table 3-6 Uncontrolled Peak Flows in Post Development Conditions

Uncontrolled Peak Flows in the Post-Development Conditions (cms)						
Outlet	Ext. Area (ha)	Site Area (ha)	25mm- Storm	1:2 Year Storm	1:5 Year Storm	1:100 Year Storm
				SCS II-24hr	SCS II-24hr	SCS II-24hr
Outlet 1 - Peak Flow from External Area	46.05	0	0.19	0.41	0.73	2.35
Outlet 1 - Stage 1 - SWM	46.05	42.56	0.56	0.83	1.20	2.58
Outlet 1 - Stage 2 - SWM	46.05	42.56	0.60	1.04	1.55	3.44
Outlet 1 - Stage 3 - SWM	46.05	47.68	0.94	1.69	2.53	5.26
Outlet 2 - Stage 3	23.13	5.53	0.06	0.26	0.41	1.02

Note, Outlet 1 bypass peak flows are not included in Table 3-6.

The total pre-development 100 year storm event peak flow at **Outlet 1** is 3.05 m^3/s; of which 2.35 m^3/s is contributed by the bypass flow. An uncontrolled 100 year storm event peak flow of 5.26 m^3/s is estimated by the proposed development during Stage 3 of development. Peak flow to **Outlet 2** is to be maintained to pre-development conditions as the total drainage area contributing to **Outlet 2** has been reduced.

Flows to the stormwater management facility shall be limited to 0.10 m^3/s for the 2 year event, 0.28 m^3/s for the 5 year event and 0.70 m^3/s for the 100 year event. Conveyance controls and storage systems are proposed to limit post-development peak flows shown in table 3-6 to pre-development peak flows. Note, peak flows from external areas are proposed to be redirected around the stormwater management facility.

Results shown in Table 3-7 quantify the quantity control volumes required to limit post development flows to pre-development levels for the proposed development.

Table 3-7 Comparison of Uncontrolled and Controlled Peak Flows in Post Development

Storage Calculation Summary							
Outlet	Site Areas to Facility	1:2 Year Storm		1:5 Year Storm		1:100 Year Storm	
		Post Controlled (cms)	Storage (cm)	Post Controlled (cms)	Storage (cm)	Post Controlled (cms)	Storage (cm)
Outlet 1 - Stage 1 SWMF	P1, P2	0.10	2,536	0.28	2,841	0.70	6,721
Outlet 1 - Stage 2 SWMF	P1, P2, P10	0.10	4,423	0.28	5,086	0.70	10,236
Outlet 1 - Stage 3 SWMF	P1, P2, P5, P6, P10, P11, P12, P15A	0.10	9,560	0.28	10,694	0.70	17,133

Note, Outlet 1 bypass peak flows are not included in Table 3-7.

Outlet 1 storage is to be provided by a proposed wet pond type stormwater management facility. Catchment area P15A is proposed to be directed to Outlet 1 and the stormwater management facility shall be sized and overcontrolled for the additional area. Peak flow to **Outlet 2** is to be reduced from pre-development conditions as the catchment area is reduced.

Roads and major drainage channels are to be designed for the 100 year storm event and are to be protected at the inlet and outlet with rip rap. Culvert sizes can be determined during final detailed design. It is recommended that culverts be a minimum of 400mm in diameter.

The design of grading, drainage, and landscaping works will be finalized during the detailed design / approval process.

Modeling of the 100 year event for the pre-development and post-development conditions are included in Appendix B.

Block Drainage Requirements
Each individual block will be subject to site plan control and be required to complete a grading plan and stormwater management report. Side yard and rear yard swales shall be incorporated into each block. Each block shall not convey drainage onto adjacent blocks. Plans and reports shall be meet or exceed the requirements in this Report and the Township Site Plan Control Guidelines.

Major and minor flows are to be directed to roadside ditches. Quality and quantity control for the blocks is to be provided by the stormwater management facility.

3.4 Water Quality

The Stormwater Management Planning and Design Manual by the MECP describes various levels of protection of water quality, based on a general relationship between the end-of-pipe stormwater management facilities long-term suspended solids removal and the lethal and chronic effects of suspended solids on aquatic life.

Based on the characteristics of the receiving watercourse, Normal Protection (corresponding to the end-of-pipe storage volumes required for the long-term removal of 70% of suspended solids) is required. Stormwater management measures will be implemented to provide in excess of 70% long term removal of suspended solids.

3.4.1 Stormwater Management Facility – Outlet 1

A wet facility is the preferred choice for a Stormwater Management facility as they have been proven to be very effective and can be constructed to aesthetically blend in with the natural and built site. The primary goal of the proposed facility is to address stormwater quality and quantity. The facility will need to consider large flows through the facility.

The Stormwater Management Planning and Design Manual by the MECP suggests that, for receiving waters requiring Level 2 Normal protection, 130 m^3 / ha of water total quality storage for sites with 70% impervious levels is required (permanent pool plus extended detention), for sites with an impervious level of 35%, 90 m^3 / ha is required. 40 m^3 / ha represents the extended detention storage. Impervious levels can be extrapolated and interpolated where appropriate from Table 3.2 in the MECP Design Manual. 80 m^3 / ha of extended detention storage is provided for external and undeveloped lands that discharge to the stormwater management facility.

The stormwater management facility is proposed to be constructed in three stages. Stages indicated for future development are modelled using existing conditions. Interim inlets and ditches can be constructed to collect runoff until the future areas are developed.

Areas P3, P4, P7 and P8 are proposed to bypass the stormwater management facility. No quality or quantity control is proposed for external areas that bypass the stormwater management facility.

The proposed site has varying levels of imperviousness corresponding to the proposed land uses and stages of development. Refer to Table 3-8, 3-9 and 3-10 for a summary of the imperviousness levels and corresponding water quality and quantity volume requirements for the three proposed stages. Detailed impervious calculations have been included for the existing and proposed development, please refer to Appendix B for details.

Stage 1 Stormwater Management Facility Requirements

Table 3-8 Stage 1 Wet Pond Storage Requirements

Stage 1 - Wet Facility Storage Requirements											
Developed Site Area (ha)	Undeveloped Site Area (ha)	External Area directed to SWMF (ha) P9 & P13	Development Areas	Comp. % Imp.	Developed Quality Volume (m^3/ha)	Undeveloped & External Quality Volume (m^3/ha)	Total Quality Volume (m^3)	Permanent Pool Volume (cm)	Extended Detention Volume (cm)	Total Quantity Control Volume 100 yr (cm)	Total Volume (Quantity and Quality) (cm)
Stormwater Management Facility											
8.99	33.57	2.39	P2	68.0	127	80	4,015	779	3,236	6,721	10,736

For Stage 1 development a permanent pool volume of 779m^3 is required for quality control. The volume of extended detention required for quality control is 3,236 m^3 as 80 m^3 / ha of extended detention storage is provided for external and undeveloped lands that discharge to the stormwater management facility. Quantity control volumes required and proposed based on the 2 year, 5 year and 100-year design storms and modeling are 2,536 m^3, 2,841m^3 and 6,721 m^3.

Stage 2 Stormwater Management Facility Requirements

Table 3-9 Stage 2 Wet Pond Storage Requirements

Stage 2 - Wet Facility Storage Requirements											
Developed Area (ha)	Undeveloped Site Area (ha)	External Area directed to SWMF (ha) P9 & P13	Development Areas	Comp. % Imp.	Developed Quality Volume (m^3/ha)	Undeveloped & External Quality Volume (m^3/ha)	Total Quality Volume (m^3)	Permanent Pool Volume (cm)	Extended Detention Volume (cm)	Total Quantity Control Volume 100 yr (cm)	Total Volume (Quantity and Quality) (cm)
Stormwater Management Facility											
19.12	22.27	2.39	P2, P10	61	118	80	4,254	1,487	2,784	10,236	14,408

For Stage 2 development the stormwater management facility is to be expanded. A total permanent pool volume of 1,487 m^3 is required for quality control. The volume of extended detention required for quality control is 2,784 m^3. Note, the quantity of extended detention storage required is less than that required in Stage 1 as a greater portion of the site is developed and is considered within the permanent pool volume. Quantity control volumes required and proposed based on the 2 year, 5 year and 100-year design storms and modeling are 4,423 m^3, 5,086 m^3 and 10,236 m^3.

Stage 3 Stormwater Management Facility Requirements

Table 3-10 Stage 3 Wet Pond Storage Requirements

Stage 3 - Wet Facility Storage Requirements											
Developed Area (ha)	Undeveloped Site Area (ha)	External Area directed to SWMF (ha) P9 & P13	Development Areas	Comp. % Imp.	Developed Quality Volume (m^3/ha)	Undeveloped & External Quality Volume (m^3/ha)	Total Quality Volume (m^3)	Permanent Pool Volume (cm)	Extended Detention Volume (cm)	Total Quantity Control Volume 100 yr (cm)	Total Volume (Quantity and Quality) (cm)
Stormwater Management Facility											
37.31	8.87	2.39	P2, P5, P6, P10, P11, P12, P15A	62	119	80	5,341	2,948	2,393	17,133	22,474

For Stage 3 a total permanent pool volume of 2,948m^3 is required for quality control. The volume of extended detention required for quality control is 2,393 m^3. As noted above, the quantity of extended detention storage required is less than that required in Stage 2 as a greater portion of the site is developed and is considered within the permanent pool volume. Quantity control volumes required and proposed based on the 2 year, 5 year and 100-year design storms and modeling are 9,560m^3, 10,694m^3 and 17,133m^3.

In addition to reviewing Table 3.2 values in the MECP design manual, a 25mm - 4hr storm event was modeled and erosion control volumes calculated for Stages 1, 2, and 3 are 1,650 m^3, 2,570 m^3, and 5,250 m^3. Note, 5,250 m^3 calculated for Stage 3 is greater than the 2,248 m^3 extended detention calculated using the MECP Table 3.2 values. The Stage 3 erosion control volume can be evaluated with the final outlet configuration to determine if the additional extended detention storage is required.

Flows from external drainage areas P3, P7 and P8 are proposed to bypass the stormwater management facility. Flows from drainage area P4 are also proposed to bypass the stormwater management facility, eventually outletting to **Outlet 1**.

The total permittable 100 year storm event peak flow to **Outlet 1** is 3.05 m^3/s, of which 2.35 m^3/s is attributed to external bypass flows and 0.70 m^3/s is the allowable peak outflow from the stormwater management facility.

Quantity and quality control are not proposed for external areas bypassing the facility.

Refer to **Figure 5** in Appendix A for Preliminary Stormwater Management Facility details.

There is more than sufficient quantity and quality control volume available for this development based on the proposed Stage 3 facility characteristics in Table 3-11.

Table 3-11 Stage 3 Stormwater Management Facility Wet Pond Stage Storage Relationship

Stage 3 - Stage - Storage Relationship							
Elevation (m)	Surface Area at Elevation (m^2)	Side Slope (1:run)	Incremental Depth (m)	Incremental Volume (m^3)	Total Depth (m)	Total Volume (m^3)	Comment
95.00	2,526	5	0.00	0	0	0	Bottom of Pond
96.00	7,503	5	1.00	3,065	1.00	3,065	Permanent Pool Required
96.00	7,503	5	1.00	3,065	1.00	3,065	Permanent Pool (NWL)
96.25	12,047	5	0.25	2,452	1.25	5,458	Extended Detention
96.81	19,946	5	0.56	9,560	1.81	15,018	2yr Event
96.88	20,228	5	0.63	10,694	1.88	16,211	5yr Event
97.18	21,369	5	0.30	17,133	2.18	22,591	100yr Event (HWL)
97.48	24,413	5	0.30	24,218	2.48	29,081	FreeBoard (0.3m)

Note: Volume is beyond the Extended Detention

The proposed wet pond type facility should at a minimum provide the following features:

- The permanent pool depth is to a be a minimum of 1.0 m in depth.
- The side slopes on the inner perimeter are to be 5:1 (H:V) or flatter for safety.
- A forebay will promote pre-treatment and retention of sediment and will facilitate maintenance and improve pollutant removal by trapping the larger particles near the facility inlet.
- Minor and some major flows will be directed to the facility by a storm sewer and road network. The majority of the major flows will be conveyed to the stormwater management facility overland via the roadway system, and ditch system within the industrial area.
- A quantity control structure is to be provided at the outlet.
- A perforated drawdown outlet with a reverse slope pipe a minimum of 100mm in diameter and orifice plate to control the drawdown for quality control.
- Rock rip rap will be placed in the major flow paths outlet.
- A minimum drawdown detention time of 24 hours
- Maintenance access to the facility
- In excess of 0.3m of freeboard is to be provided.
- An emergency overflow for storms in excess of a 100-year design storm.

3.5 Maintenance

3.5.1 Stormwater Management Facility

Maintenance access to the facility and the outlet structure is to be provided via the access lane. This area should be accessible using excavators and dump trucks.

Periodic maintenance inspection of the facilities should be undertaken and annual maintenance reports should be completed. The report should provide a summary of the following items:

- Observations resulting from the inspection of the facility over the course of the year. These observations should include comments on the:
  - hydraulic operation of the facilities (detention time, evidence or occurrence of overflows)
  - condition of vegetation in and around facility
  - occurrence of obstructions at the inlet and outlet
  - evidence of spills and oil/grease contamination
  - frequency of trash build-up;
- Measured sediment depths in the facilities;
- Maintenance and operational control undertaken during the year;
- Recommendations for inspection and maintenance program for the coming year.

The wet pond will require routine periodic maintenance including grass cutting and weed control. Trash removal will be required several times per year. Removal of accumulated sediment in the upstream ditches and the facility itself will be required. Upon completion and stabilization of the contributing area, it is expected that removal of accumulated sediment within the wet pond will be required prior to Final Certificate of Approval of the works at a minimum every 10 years by the Municipality thereafter.

Note, each block will be required to provide maintenance details in the site plan specific stormwater management reports.

4. Intermittent Drainage Channel Realignment

4.1 West Catchment

Drainage area EX4 outlets to a 1200mm culvert crossing under the CN railway and eventually drains into the intermittent channel. Area EX2 consists of residential dwellings and several commercial lots along Prince Street that drain westerly into EX1. The intermittent channel proceeds westerly across the subject property to **Outlet 1**.

The intermittent channel is proposed to be realigned at the rear of the proposed blocks and directed to **Outlet 1**.

Hydrology

The upstream drainage area to the intermittent channel is approximately 35.67 ha with a 1200mm culvert crossing under the CN railway. From preliminary calculations it is expected that the 1200mm culvert is inlet controlled and adequately conveys the 100 year flow.

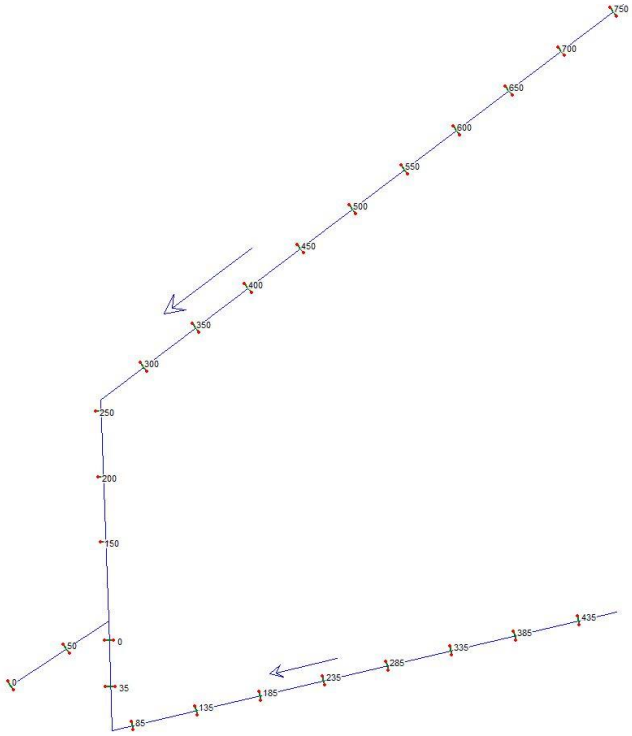
The intermittent channel realignment is proposed to be designed for the 100 year flow of 2.35 m^3/s at the point where the channel enters the proposed subdivision and up to a maximum peak flow of 3.05 m^3/s at **Outlet 1** where the flow combines with the outflow from the proposed stormwater management facility and the south bypass swale. The proposed channel realignment section includes a 1.5m flat bottom, 1.05m in height within the subdivision including for 0.3m of freeboard. Sides slopes are to be a maximum of 3:1 (H:V).

Hydraulics

Further hydraulic analysis for the site was conducted using a recent version of the US Army Corps of Engineers HEC-RAS River Analysis System software (Version 4.0.0, released March 2008). The software has been widely used in similar open channel flow analyses in Ontario and is recognized as a reliable technique for estimating one-dimensional steady state flow, unsteady state flow calculations, sediment transport, bed computations, water temperature modeling and their associated parameters.

- Hydrology: The 100 year peak flow of 2.35 m^3/s up to 3.05 m^3/s was selected for the analysis.
- Hydraulics: A Steady State Flow analysis with a combination of subcritical and supercritical flow (mixed flow regime) was conducted for the proposed channel design. The software utilizes the one-dimensional energy equation and or momentum equations combined with Manning's equation to calculate the water surface profile, critical depth, velocity, shear stress, Froude Number and maximum flow depth for the proposed scenario.

The proposed alignment was selected, and the reach was input into HEC-RAS, refer to the figure below.



West Catchment HEC-RAS Reach

The intermittent channel realignment section stationing is from 0+750 where the channel begins at the 1200mm culvert outlet, to 0+000 at **Outlet 1**. Cross sections are sampled in 50m intervals.

Peak Flow: 2.35 – 3.05 m^3/s (100 Year Event)
Manning's n: 0.035 (Natural Water Course 0.03-0.035)
Side Slopes: 3:1
Bottom Width: 1.5m
Depth including freeboard: 1.05m
Slope: 0.003m/m

It was assumed that the velocities and shear stresses that would be experienced along the channel would result in the selection of lining material with Manning's n values between 0.025 and 0.045, 0.035 was selected for the analysis.

Table 4-1 HEC-RAS Modeling Results

West Catchment - Intermittent Channel Realignment												
Station	**Storm Event**	**Q total (m^3/s)**	**Min Ch El. (m)**	**W.S. Elev. (m)**	**W.S. Height (m)**	**Channel Slopes (m/m)**	**T.O.B. (m) Incl. 300mm Freeboard**	**Vel. Chnl (m/s)**	**Flow Area (m^2)**	**Top Width (m)**	**Froude Chl.**	**Shear Stress N/m^2**
0+750	1:100	2.35	97.24	97.98	0.74	0.003	98.28	0.86	2.72	5.90	0.41	26
0+700	1:100	2.35	97.10	97.84	0.74	0.003	98.14	0.86	2.72	5.90	0.41	26
0+650	1:100	2.35	96.97	97.71	0.74	0.003	98.01	0.86	2.72	5.90	0.40	26
0+600	1:100	2.35	96.83	97.58	0.75	0.003	97.88	0.86	2.72	5.90	0.41	25
0+550	1:100	2.35	96.70	97.44	0.74	0.003	97.74	0.86	2.72	5.90	0.40	26
0+500	1:100	2.35	96.56	97.31	0.75	0.003	97.61	0.85	2.74	5.92	0.40	26
0+450	1:100	2.35	96.43	97.18	0.75	0.003	97.48	0.84	2.77	5.95	0.40	26
0+400	1:100	2.35	96.30	97.06	0.76	0.003	97.36	0.82	2.85	6.03	0.38	26
0+350	1:100	2.35	96.16	96.95	0.79	0.003	97.25	0.77	3.03	6.21	0.35	27
0+300	1:100	2.35	96.03	96.87	0.84	0.003	97.17	0.70	3.35	6.51	0.31	29
0+250	1:100	2.35	95.90	96.68	0.78	0.003	96.98	1.16	2.01	5.61	0.62	18
0+200	1:100	2.35	95.76	96.50	0.74	0.003	96.80	0.86	2.71	5.89	0.41	26
0+150	1:100	2.35	95.62	96.36	0.74	0.003	96.66	0.86	2.72	5.90	0.41	26
0+50	1:100	3.05	95.36	96.16	0.80	0.003	96.46	0.98	3.13	6.30	0.44	28
Outlet 1	1:100	3.05	95.22	95.94	0.72	0.003	96.24	1.16	2.63	5.81	0.55	25

Design Parameters

Depth

Within the proposed subdivision, the average channel depth required for the 100 year event peak flow is 0.75m in height. Including for 300mm of freeboard the minimum channel depth is 1.05m.

Setback

The 100 year water surface elevation is proposed to be confined within the realigned channel. A 6-metre setback is proposed from structures to the proposed high 100 year water surface elevation as recommended in the CRCA guidelines.

4.2 East Catchment

Drainage from areas EX11, EX12, EX13 and EX17 are directed towards a low-lying wetland area and intermittent seasonal channel that borders the far east property limit, eventually draining north-easterly towards **Outlet 2**. **Outlet 2** consists of three 600mm diameter culverts crossing beneath Railway Street, eventually draining to Larue Mills Creek. The south inverts of the three 600mm diameter culverts are approximately 98.35 and have a slope of approximately 1.5%.

A 30m offset is proposed from the low-lying area.

The intermittent seasonal channel is proposed to remain in place with the cross section matching the existing cross section.

Hydrology

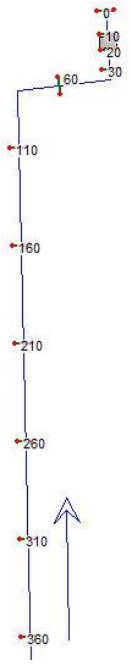
The upstream drainage area (P14, P15B, P16, and P17) directed to the low-lying area and eventually to the intermittent seasonal channel is approximately 27.09 ha. From preliminary review it is expected that the 600mm culverts are inlet controlled, typically partially submerged and the water surface elevation is taken to be approximately 98.95 at the culvert crossing at Railway Street.

The intermittent seasonal channel is proposed to be analyzed for the 100 year flow of 1.02 m^3/s to **Outlet 2**. The channel section includes a 1.0m to 0.5m flat bottom, 0.9m in height including for 0.3m of freeboard. Sides slopes are to be a maximum of 3:1 (H:V).

Hydraulics

- Hydrology: The post development 100 year peak flow of 1.02 m^3/s was selected for the analysis.
- Hydraulics: A Steady State Flow analysis with a combination of subcritical and supercritical flow (mixed flow regime) was conducted for the proposed channel design. The software utilizes the one-dimensional energy equation and or momentum equations combined with Manning's equation to calculate the water surface profile, critical depth, velocity, shear stress, Froude Number and maximum flow depth for the proposed scenario.

The proposed alignment was selected, and the reach was input into HEC-RAS, refer to the figure below.



East Catchment HEC-RAS Reach

Peak Flow: 1.02 m^3/s (100 Year Event)
Manning's n: 0.035 (Natural Water Course 0.03-0.035)
Side Slopes: 3:1

Bottom Width: 1.0m
Depth including freeboard: 0.9m
Slope: 0.003m/m

It was assumed that the velocities and shear stresses that would be experienced along the channel would result in the selection of lining material with Manning's n values between 0.025 and 0.045, 0.035 was selected for the analysis.

Table 4-2 HEC-RAS Modeling Results

East Catchment - Intermittent Channel Realignment												
Station	**Storm Event**	**Q total (m^3/s)**	**Min Ch El. (m)**	**W.S. Elev. (m)**	**W.S. Height (m)**	**Channel Slopes (m/m)**	**T.O.B. (m) Incl. 300mm Freeboard**	**Vel. Chnl (m/s)**	**Flow Area (m^2)**	**Top Width (m)**	**Froude Chl.**	**Shear Stress N/m^2**
1+360	1:100	1.02	99.32	99.87	0.55	0.003	0.85	0.73	1.46	4.30	0.40	17
1+310	1:100	1.02	99.17	99.73	0.56	0.003	0.86	0.72	1.47	4.31	0.40	17
1+260	1:100	1.02	99.03	99.59	0.56	0.003	0.86	0.71	1.49	4.35	0.39	17
1+210	1:100	1.02	98.89	99.47	0.58	0.003	0.88	0.66	1.6	4.49	0.36	18
1+160	1:100	1.02	98.74	99.38	0.64	0.003	0.94	0.57	1.86	4.83	0.29	19
1+110	1:100	1.02	98.60	99.34	0.74	0.003	1.04	0.45	2.35	5.40	0.22	22
1+60	1:100	1.02	98.45	99.31	0.86	0.003	1.16	0.35	3.03	6.11	0.16	25
1+30	1:100	1.02	98.79	99.14	0.35	0.003	0.65	1.44	0.74	3.59	1.01	11
1+20	1:100	1.02	98.33	99.1	0.77	0.003	1.07	0.3	3.52	6.34	0.13	32
Outlet 2	1:100	(3) 600mm Culvert - Partially Submerged - W.S. set to 98.95										

Design Parameters

Depth
The average channel depth required for the 100 year storm event peak flow is 0.60m in height. Including for 300mm of freeboard the minimum channel depth is 0.90m.

Setback
The 100 year water surface elevation is proposed to be confined within the channel. A 6-metre setback is proposed from structures to the proposed high 100 year water surface elevation as recommended in the CRCA guidelines.

5. Quality Control (Short Term)

Erosion and sediment control plans will be provided during the final subdivision design submission.

Silt fencing is to be provided at all side slopes and down gradient locations to ensure sediment and erosion control during construction. Other control devices such as straw bales will also be provided where drainage is concentrated. Sediment and erosion management measures also serve to provide a limit to the grading operations.

The timeframe for land to remain exposed before it is stabilized with sod, mulch, or hydroseeding is to be minimized. Topsoil is to be stockpiled away from watercourses and wetlands.

Rock check dams or straw bale filters are to be provided in overland swale and ditch systems.

Inspection of the sediment control works should be undertaken before and after all rainfall (and snowmelt) events. Maintenance is to be undertaken as required to ensure the proper operation of all sediment and erosion controls. Inspection and maintenance is the developer's responsibility until such time as the Final Certificate of Approval of the Works is issued.

6. Conclusions

Preliminary analysis recommends that the development proceed with the mitigation measures detailed in this report to address storm water quality, storm water quantity, and erosion concerns on the site.

The development is to be designed in accordance with Ministry of the Environment, Conservation and Parks Guidelines and Township and Conservation Authority Guidelines and Technical Standards.

Individual blocks will be subject to Site Plan Control as development is proposed. Detailed Stormwater Management Reports are required for each block prior to development.

Post development flows are to be controlled by the proposed wet pond type stormwater management facility for the majority of the site.

Detailed design of enhanced roadside ditches, intermittent channel realignment, culvert crossings, outfalls and stormwater management facility outlet structures will be provided during the final engineering design of the subdivision.

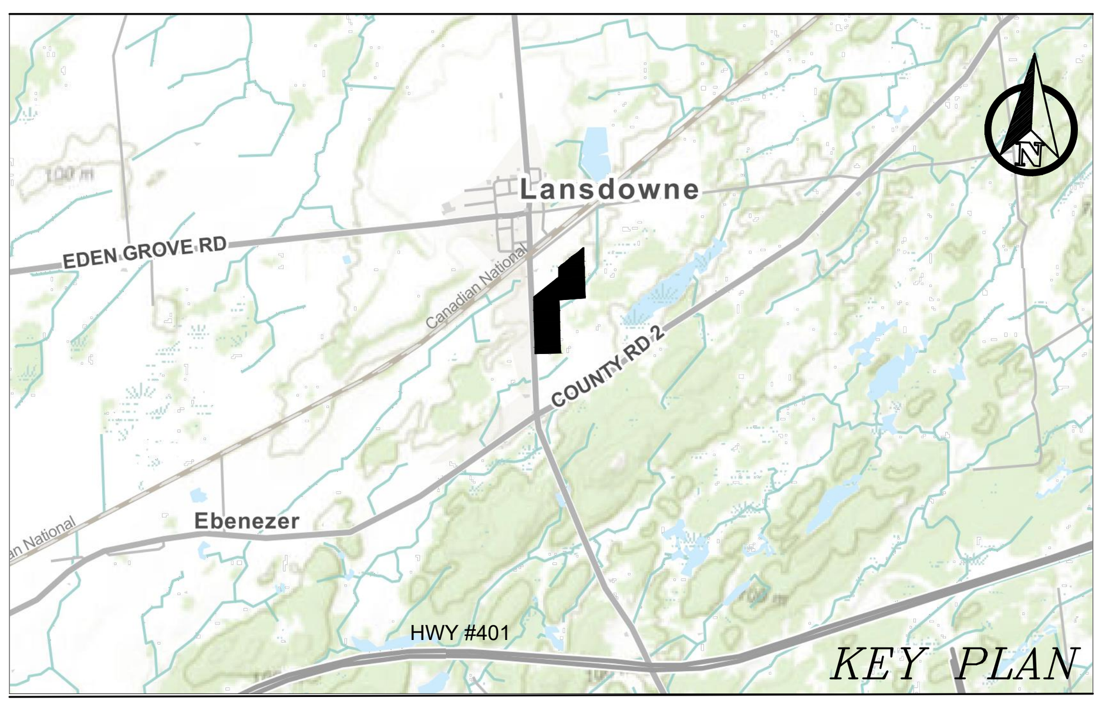
Preliminary facility details are contained in this report.

Appendix A

Draft Plan – West Parcel
Draft Plan – East Parcel
Figure 2 – Predevelopment Catchment Areas
Figure 3 – Post Development Catchment Areas
Figure 4 – Post Development Storm Sewer Design
Figure 5 – Stage 3 Concept Stormwater Management Facility
Model Schematic
Source Protection Map

DRAFT PLAN of SUBDIVISION

ALL of LOTS 56 to 65, 68 to 87, 90 to 109, 112 to 131, 134 to 143, PART of BLOCKS C and D, PART of LOTS 45 to 55, 66, 67, 88, 89, 110, 111, 132, and 133. PART of UNNAMED STREET, CALUMET STREET, ONTARIO STREET, DARLING STREET, LAPPAN STREET AND JOHN STREET
REGISTERED PLAN 194
Geographic Township of Lansdowne
TOWNSHIP of LEEDS and the THOUSAND ISLANDS
COUNTY of LEEDS



KEY PLAN

ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51.17(A–L) OF THE PLANNING ACT

a: Shown On Draft Plan
b: Shown On Draft Plan
c: All Lands Owned , or In Which the Applicants Have An Interest Are Shown On the Key Plan.
d: Residential & Commercial
e: Shown On Draft Plan
f: Shown On Draft Plan
g: Shown On Draft Plan
h: Municipal Water Supply
i: Napanee Clay
j: Shown On Draft Plan
k: Road Maintenance, Garbage Collection, Phone, Cable, Gas, Sanitary and Hydro
l: Shown On Draft Plan

LEGEND

LANDS TO BE SUBDIVIDED
FUTURE EASEMENT

OWNER'S CERTIFICATE

I, SHANE KELLY, HEREBY AUTHORIZE FOREFRONT TO PREPARE AND SUBMIT THIS PLAN FOR REVIEW AND APPROVAL.

SHANE KELLY, PRESIDENT
10194549 CANADA LTD.

DATE

I HAVE THE AUTHORITY TO BIND THE CORPORATION

SURVEYOR'S CERTIFICATE:

I CERTIFY THAT:
1. THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AND THE RELATIONSHIP TO THE ADJACENT LANDS ARE CORRECTLY SHOWN.

HOPKINS CHITTY LAND SURVEYORS INC.

PHIL W. CHITTY – O.L.S.

DATE

SITE DATA

LAND USE	LOTS & BLOCKS	AREA ±	UNITS	DENSITY
RESIDENTIAL	LOTS 1–208	11.09 ha	223	20.11 u/ha.
MULTI UNIT RESIDENTIAL	BLOCK 211	0.75 ha	00	00.00 u/ha.
	BLOCK 212	0.75 ha	00	00.00 u/ha.
SUB–TOTAL RESIDENTIAL		12.59 ha	00	00.00 u/ha.
COMMERCIAL	BLOCK 209	0.46 ha		
	BLOCK 210	1.72 ha		
STREETS/RESERVES	MUNICIPAL RIGHT OF WAY BLOCKS 213	4.48 ha		
PARKLAND	BLOCK 214	1.83 ha		
EASEMENT	BLOCKS 215	0.02 ha		
OPEN SPACE	BLOCKS 216	1.69 ha		
TOTAL		22.79± ha	223	9.78 u/ha.

PARKLAND DEDICATION

LAND USE	AREA ±	REQUIRED	PROVIDED
RESIDENTIAL	12.59 ha	(5%) 0.63ha	
INDUSTRIAL/COMMERCIAL EAST/WEST	17.18 ha	(2%) 0.34ha	
PUBLIC PARK	1.83 ha	0.97 ha	1.83 ha

SCALE = 1:1500

0 40m 200m

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

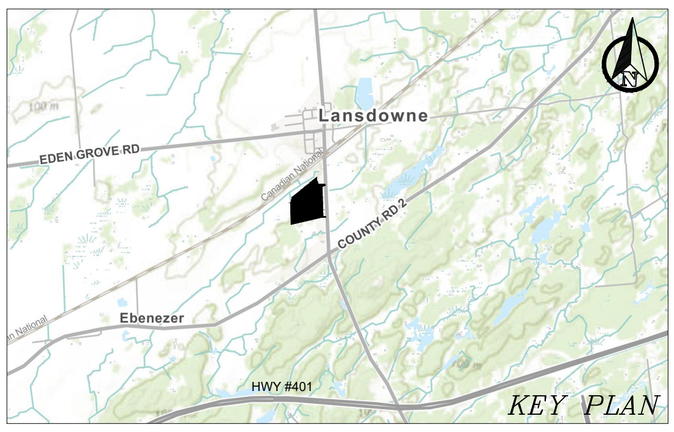
Forefront Engineering Inc
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.888.884.9392 fax.

Date Issued:

CANADIAN NATIONAL RAILWAY
RAILWAY STREET
(Per Registered Plan 194)
7.748
29.593
39.078
58.489
78.053
39.029
30.370
85.588
93.470
186.516
119.460
152.019
173.081
119.785
172.625
131.064
74.346
224.966
53.027
178.974
6.000
156.131
163.273
82.092
64.308
STREET A
STREET B
STREET C
STREET D
STREET E
STREET F
BLOCK 209
COMMERCIAL
COMMERCIAL
BLOCK 210
BLOCK 211
RESIDENTIAL
BLOCK 212
BLOCK 213
PARKLAND
BLOCK 214
BLOCK 215
OPEN SPACE
BLOCK 216
APPROXIMATE WETLAND BOUNDARY
APPROXIMATE 30m OFFSET
6m - 100yr OFFSET
EXISTING INTERMITTENT CHANNEL
ZONED RURAL
ZONED RESIDENTIAL
RESIDENTIAL
COMMERCIAL
INSTITUTIONAL
COUNTY ROAD 3 (PRINCE STREET)
COUNTY ROAD NO. 2 (HIGHWAY
BLOCK E
BLOCK C
BLOCK A
PART 1 PLAN 28R-13040
PIN 44220-0111 (LT)
PIN 44220-0169 (LT)
PIN 44220-0101 (LT)
PIN 44220-0246
PART 1 PLAN 28R-8363 PIN 44220-0171
PART 1 PLAN 28R-5859 PIN 44220-0171 Part 3 (P9)
REGISTERED PLAN No. 397
PART 1, PLAN 28R-7388
Expropriation Plan 4407
Road Allowance between Lots 18 & 19
John St.
Darling St.
Lappan St.
Ontario St.
Calumet St.
Woodbine St.
Dominion St.
Swastika St.
Unnamed Street

DRAFT PLAN of SUBDIVISION

PART of BLOCKS Q and S
REGISTERED PLAN No. 194
ALL of LOTS 1 to 42, ALL of BLOCKS 43, 45, 46 and 47 and ALL of MACDONALD DRIVE, BOWEN AVENUE, SLITER STREET and ARMSTRONG AVENUE
REGISTERED PLAN No. 397
Geographic Township of Lansdowne
TOWNSHIP of LEEDS and the THOUSAND ISLANDS
COUNTY of LEEDS



ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51.17(A–L) OF THE PLANNING ACT

a: Shown On Draft Plan
b: Shown On Draft Plan
c: All Lands Owned , or In Which the Applicants Have An Interest Are Shown On the Key Plan.
d: Residential & Commercial
e: Shown On Draft Plan
f: Shown On Draft Plan
g: Shown On Draft Plan
h: Municipal Water Supply
i: Napanee Clay
j: Shown On Draft Plan
k: Road Maintenance, Garbage Collection, Phone, Cable, Gas, Sanitary and Hydro
l: Shown On Draft Plan

LEGEND

——— LANDS TO BE SUBDIVIDED
– – – FUTURE EASEMENT

OWNER'S CERTIFICATE

I, SHANE KELLY, HEREBY AUTHORIZE FOREFRONT TO PREPARE AND SUBMIT THIS PLAN FOR REVIEW AND APPROVAL.

_____ _____
SHANE KELLY, PRESIDENT — DATE
10725994 CANADA LTD.

I HAVE THE AUTHORITY TO BIND THE CORPORATION

OWNER'S CERTIFICATE

I, _____, HEREBY AUTHORIZE FOREFRONT TO PREPARE AND SUBMIT THIS PLAN FOR REVIEW AND APPROVAL.

_____ _____
DATE

_____
REPRESENTATIVE FOR THE TOWNSHIP OF LEEDS AND THOUSAND ISLANDS

I HAVE THE AUTHORITY TO BIND THE CORPORATION

SURVEYOR'S CERTIFICATE:

I CERTIFY THAT:

1. THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AND THE RELATIONSHIP TO THE ADJACENT LANDS ARE CORRECTLY SHOWN.

HOPKINS CHITTY LAND SURVEYORS INC.

_____ _____
PHIL W. CHITTY – O.L.S. — DATE

SITE DATA

LAND USE	LOTS & BLOCKS	AREA ±	UNITS	DENSITY
INDUSTRIAL/COMMERCIAL	BLOCK 1	0.69 ha		
	BLOCK 2	5.35 ha		
	BLOCK 3	4.30 ha		
	BLOCK 4	3.30 ha		
	BLOCK 5	1.61 ha		
STORMWATER MANAGEMENT FACILITY	BLOCK 6	2.69 ha		
DRAINAGE EASEMENT	BLOCK 7	0.25 ha		
FUTURE DEVELOPMENT		5.93 ha		
STREETS/RESERVES	MUNICIPAL RIGHT OF WAY	2.65 ha		
TOTAL		26.77± ha		

SCALE = 1:1500

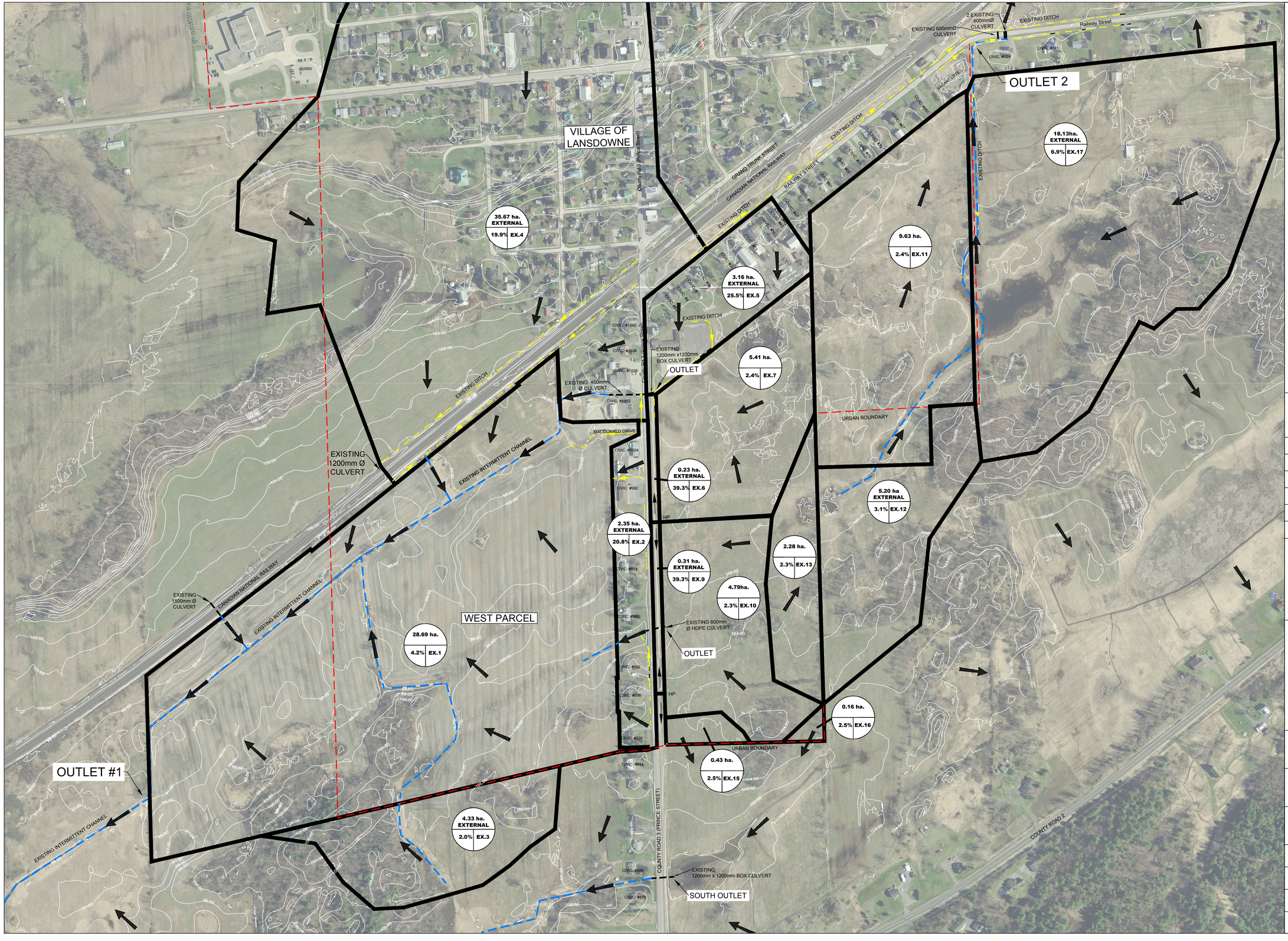
0 40m 200m

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

Forefront Engineering Inc
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.888.884.9392 fax.

Date Issued:

RESIDENTIAL
COMMERCIAL
INSTITUTIONAL
ZONED LIGHT INDUSTRIAL
CANADIAN NATIONAL RAILWAY
EXISTING INTERMITTENT CHANNEL
MACDONALD DRIVE
COUNTY ROAD 3 (PRINCE STREET)
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
BLOCK 5
BLOCK 6
BLOCK 7
STREET A
FUTURE DEVELOPMENT
STORM WATER POND
RESIDENTIAL
COMMERCIAL
RESIDENTIAL
ZONED LIGHT INDUSTRIAL
LOT 16, CONCESSION 2
REGISTERED PLAN 194
PART 1, PLAN 28R – 6736
PART 2 PLAN (P7)



LEGEND:

EX. DENOTES EXISTING
HP HIGH POINT
MINOR FLOW DIRECTION
MAJOR FLOW DIRECTION
##.## ha — AREA (hectares)
0.50 — % IMPERVIOUS
CB# — INLET

0 50 100 m H=1:2500

Benchmark

No.	Revision/Issue	Date

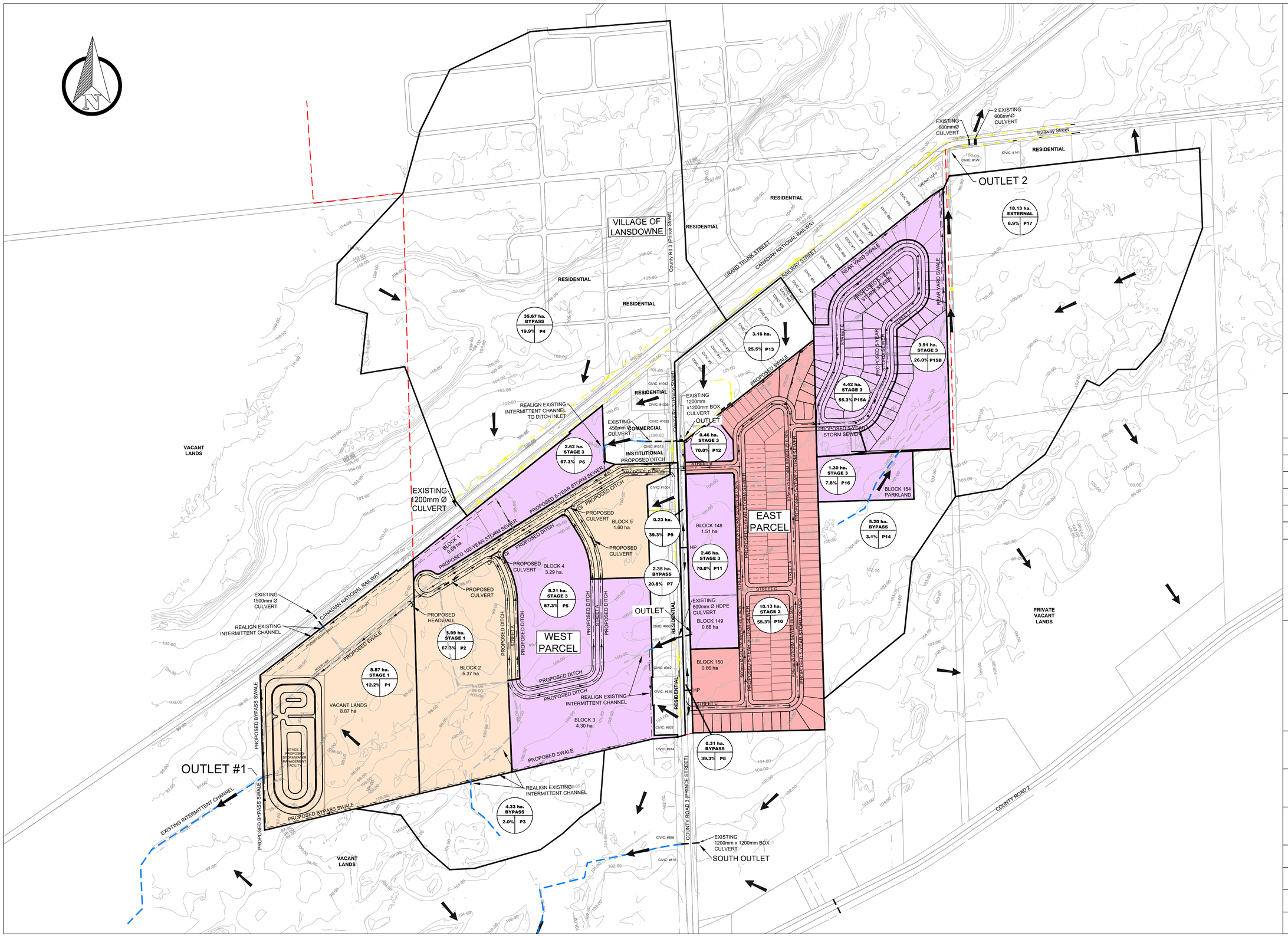
Forefront Engineering Inc
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.888.884.9392 fax.

Client
10194549 CANADA
c/o SHANE KELLY

Project
LANSDOWNE DEVELOPMENT

Drawing
PREDEVLOPMENT CATCHMENT AREAS

Drawn by:	Checked by:	Project No.
JB	KMN	
Designed by:	Approved by:	Drawing No.
KMN	KMN	FIG.2
Date: MARCH 2020		
Scale: 1:2500 (ANSI D)		



LEGEND:

EX. DENOTES EXISTING

DI DITCH INLET

HP HIGH POINT

MINOR FLOW DIRECTION

MAJOR FLOW DIRECTION

##.## ha (AREA (hectares))
STAGE # (STAGE)
0.50 (% IMPERVIOUS) CB# (INLET)

STAGE 1

STAGE 2

STAGE 3

0 60 120 m H=1:3000

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

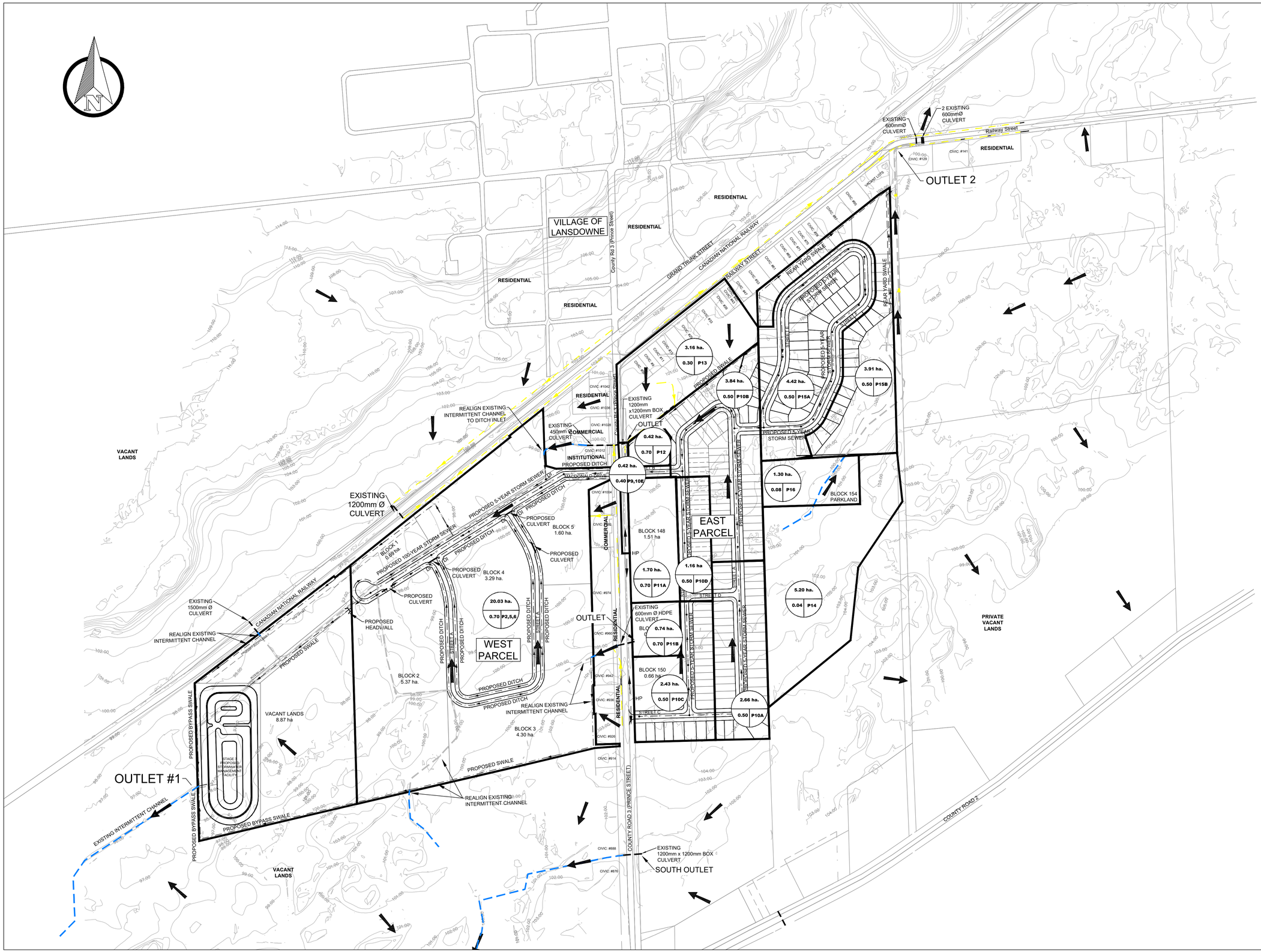
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.888.884.9392 fax.

Client
10194549 CANADA
c/o SHANE KELLY

Project
LANSDOWNE DEVELOPMENT

Drawing
POST DEVLOPMENT CATCHMENT AREAS

Drawn by:	Checked by:	Project No.
JB	KMN	
Designed by:	Approved by:	Drawing No.
KMN	KMN	FIG.3
Date: APRIL 2021		
Scale: 1:3000 (ANSI D)		



Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

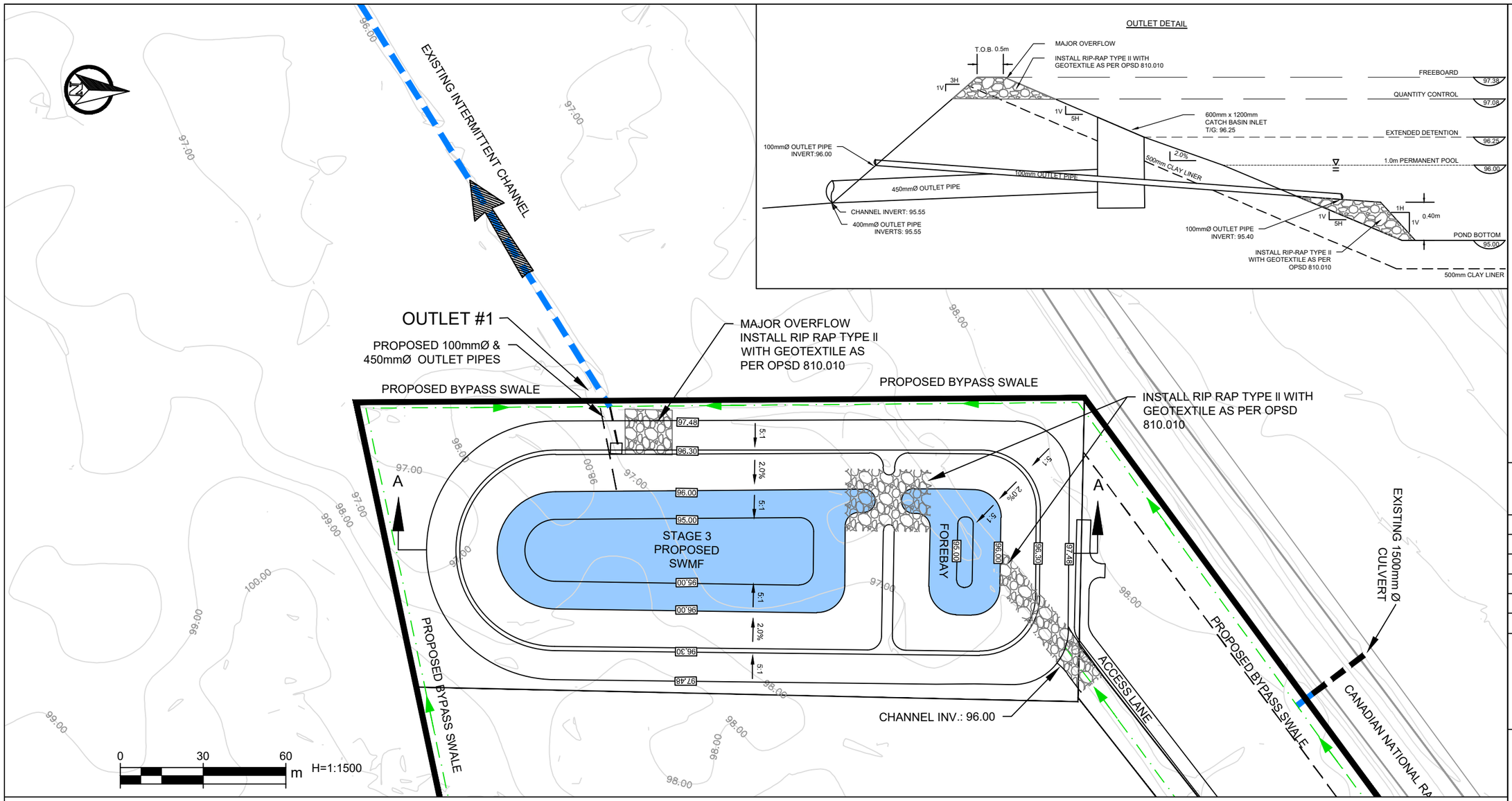
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.888.884.9392 fax.

Client
10194549 CANADA
c/o SHANE KELLY

Project
LANSDOWNE DEVELOPMENT

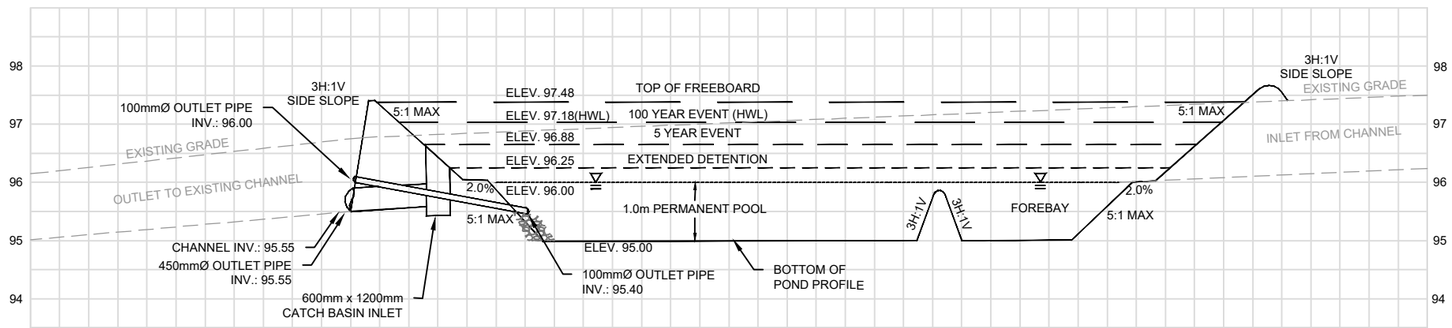
Drawing
POST DEVLOPMENT STORM SEWER DESIGN

Drawn by:	Checked by:	Project No.
JB	KMN	
Designed by:	Approved by:	Drawing No.
KMN	KMN	FIG.4
Date: APRIL 2021		
Scale: 1:3000 (ANSI D)		



OUTLET DETAIL

SWM PROFILE - SECTION A-A



Benchmark

No.	Revision/Issue	Date

PRELIMINARY
NOT APPROVED FOR CONSTRUCTION

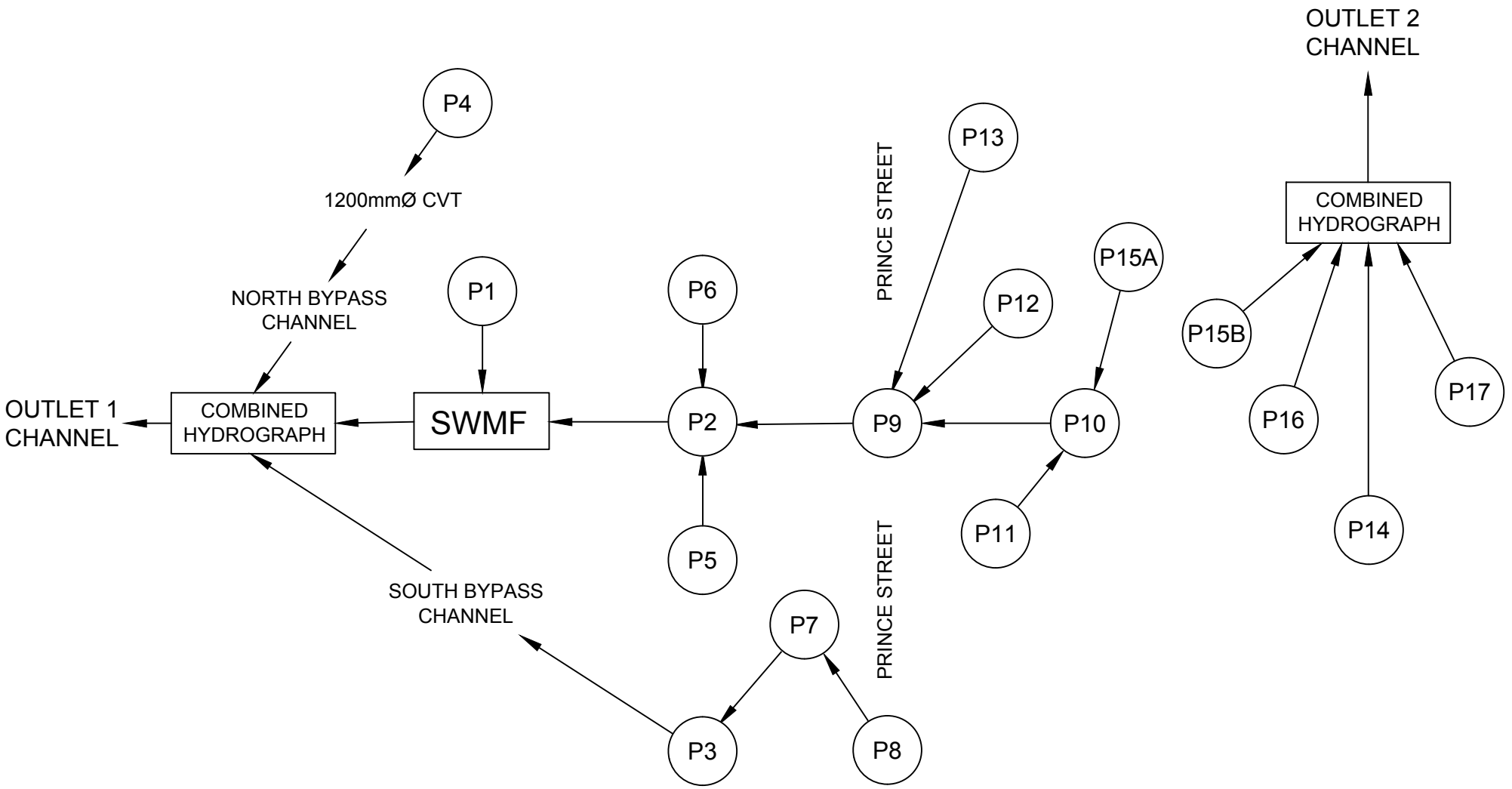
Forefront Engineering Inc
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.866.884.9392 fax.

Client
10194549 CANADA
c/o SHANE KELLY

Project
LANSDOWNE DEVELOPMENT

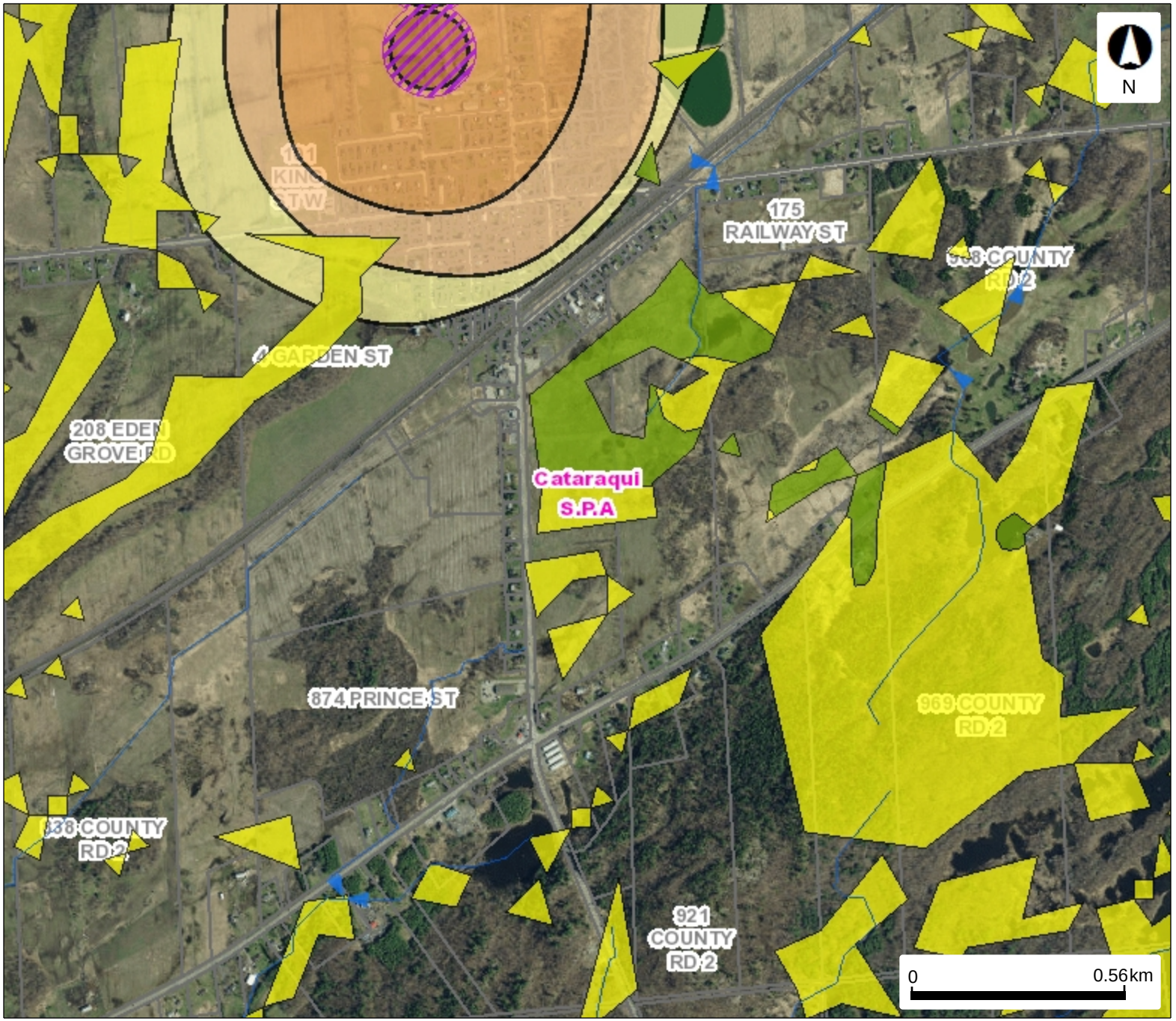
Drawing
STAGE 3 CONCEPT
STORMWATER MANAGMENT FACILITY

Drawn by:	Checked by:	Project No.
JB	JH	
Designed by:	Approved by:	Drawing No.
KMN	KMN	FIG.5
Date: MARCH 2021		
Scale:		



LANSDOWNE SUBDIVISION
FULL-BUILDOUT SWMM5 SCHEMATIC

-Map Title-



Legend

- Source Protection Areas
- Watercourse Direction
- Issue Contributing Areas
- Significant Groundwater Recharge Area
  - 0
  - 2
  - 4
  - 6
- WHPA Groundwater Under Direct Influence (WHPA-E)
- Wellhead Protection Area
  - A
  - B
  - C
  - C1
  - D
  - F
- Intake Protection Zone 1
- Event Based Areas
- Intake Protection Zone 2
- Assessment Parcel

This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Environment, Conservation and Parks (MECP) shall not be liable in any way for the use or any information on this map. of, or reliance upon, this map.

Ontario

© Queen's Printer for Ontario, 2020

Map Created: 3/10/2020
Map Center: 44.39864 N, -76.01578 W

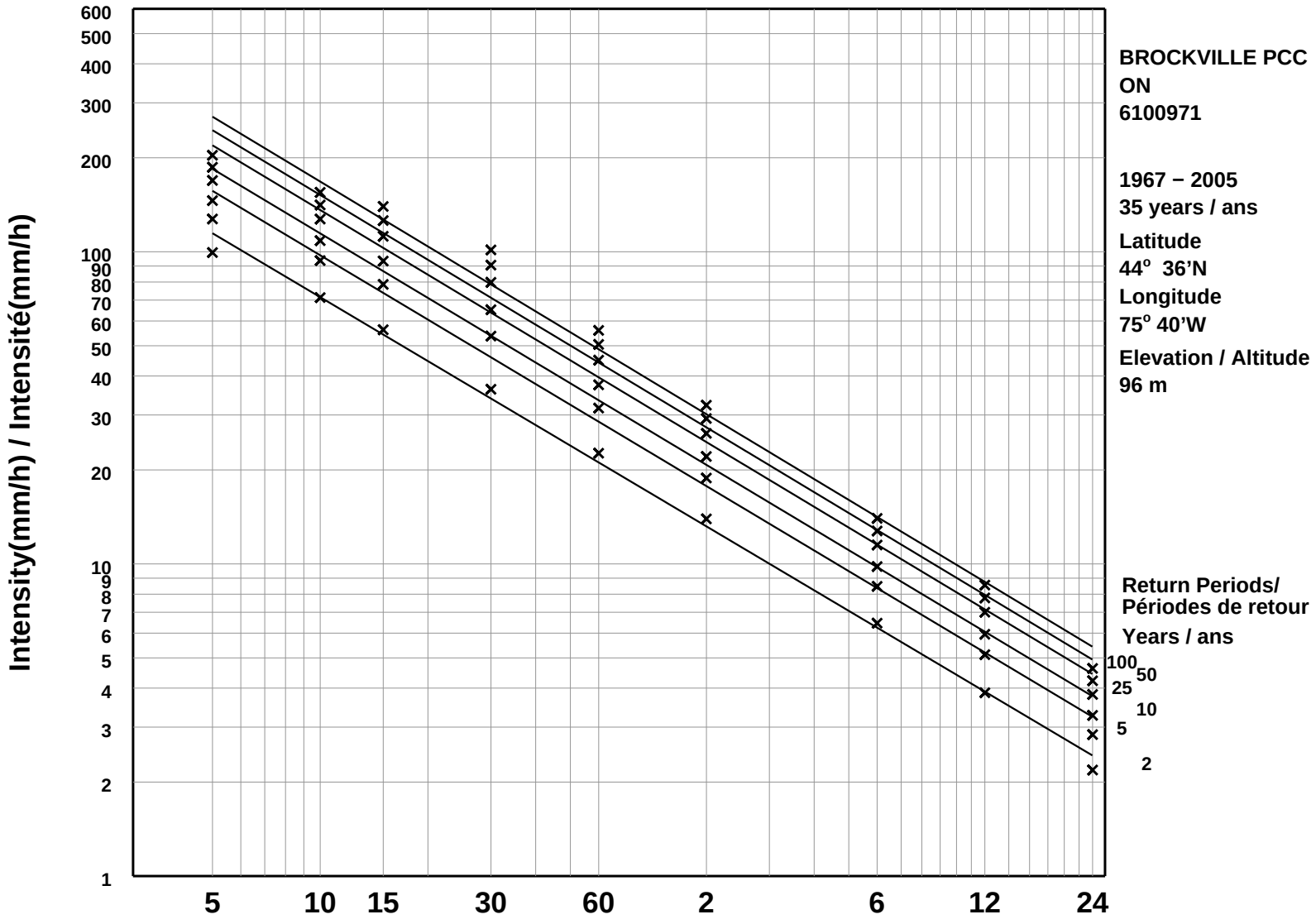
Appendix B

Brockville Short Duration Rainfall IDF
Table 3-1: Surface Cover Parameter Calculations
Imperviousness Calculations
100-Year Event Pre-Development Modeling
100-Year Event (Stages 1, 2, and 3) Uncontrolled Post Development Modeling

Short Duration Rainfall Intensity−Duration−Frequency Data

2019/02/27

Données sur l’intensité, la durée et la fréquence des chutes de pluie de courte durée



Environment Canada Environnement Canada

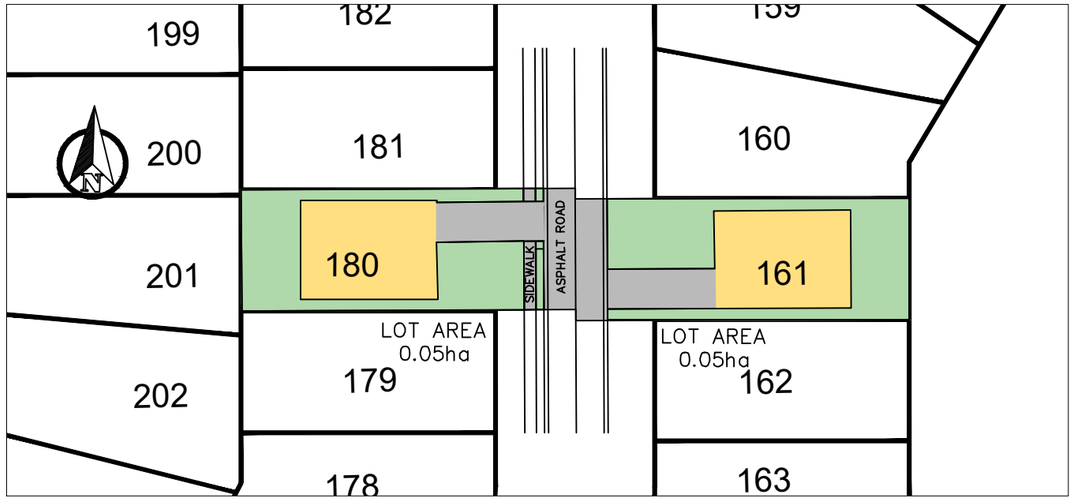
Canada

Table 3-1: Surface Cover Parameter Calculations - Lansdowne Development

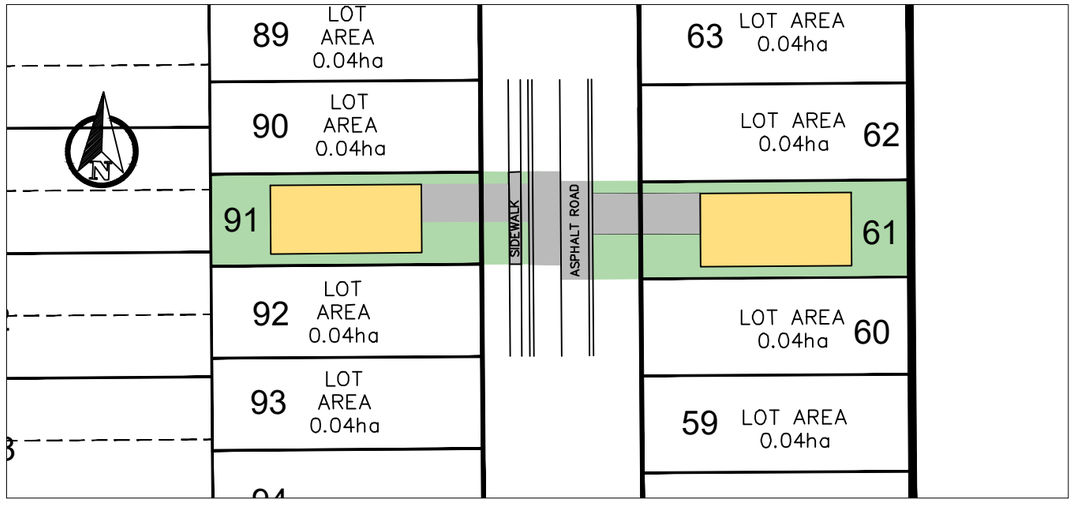
Surface Cover Type	Manning's "n"		Dep. Storage (mm)		% Impervious	Subarea Routing	% Routed	% Impervious without Storage
	Impervious	Pervious	Impervious	Pervious				
Forest	0.03	0.4	10	15	1		100	10
Grass	0.025	0.25	5	10	2.5		75	10
BioRet	0.025	0.3	25	30	2.5		75	10
Bare	0.02	0.15	5	7.5	5		50	10
GrnRoof	0.025	0.3	17.5	20	25		25	15
Ex Bed Rock	0.025	0.2	5	7.5	90		25	20
RegRoof	0.015	0.15	2.5	5	95		10	25
PrmPave	0.02	0.2	12.5	15	50		25	15
ImpPave	0.015	0.15	2.5	5	95		10	20
Gravel	0.025	0.2	5	7.5	90		25	20
Wetland	0.015	0.35	0	15	50		50	10
Water	0.015	0.015	0	0	100		0	0

Code	Description
Forest	Forest/meadow, heavy vegetation with high transpiration/deep root zone
Grass	Grass/turf, light vegetation/landscaped areas with shallow roots
BioRet	Bioretention/rain garden/planter, engineered with underdrain
Bare	Un-vegetated soil or loos granular materials
GrnRoof	Green roof
RegRoof	Regular roof
Ex Bed Rock	Exposed bedrock
PrmPave	Permeable paved surfaces (with underdrain)
ImpPave	Impermeable paved surfaces (i.e. roadways, parking, driveways)
Gravel	Gravel and compacted granular in traffic areas
Wetland	Roughly half open water and half heavily vegetated
Water	Open water surface

Hydrologic Unit Name	Percent by Surface Cover Type													% Impervious	Manning's "N"		Dep. Storage (mm)		% Impervious without Storage	% Routed	Subarea Routing
	Forest	Grass	BioRet	Bare	GrnRoof	Ex Bed Rock	RegRoof	PrmPave	ImpPave	Gravel	Wetland	Water	Total		Impervious	Pervious	Impervious	Pervious			
Lansdowne Development (Pre-Development)																					
EX.1	10.00%	85.00%		3.00%					1.00%	1.00%			100.00%	4.2	0.02525	0.2605	5.475	10.35	10.20	76	Impervious to Pervious
EX.2		80.00%					5.00%		10.00%	5.00%			100.00%	20.8	0.0235	0.2325	4.625	9.125	12.25	63	Impervious to Pervious
EX.3	40.00%	55.00%		5.00%									100.00%	2.0	0.02675	0.305	7	11.875	10.00	84	Impervious to Pervious
EX.4	2.00%	79.00%					8.00%		9.00%	2.00%			100.00%	19.9	0.0234	0.235	4.675	9.2	12.3	63	Impervious to Pervious
EX.5		70.00%		5.00%			5.00%		15.00%	5.00%			100.00%	25.5	0.02275	0.2225	4.5	8.75	12.75	58	Impervious to Pervious
EX.6		60.00%							35.00%	5.00%			100.00%	39.3	0.0215	0.2125	4.125	8.125	14	50	Impervious to Pervious
EX.7	10.00%	90.00%											100.00%	2.4	0.0255	0.265	5.5	10.5	10	78	Impervious to Pervious
EX.9		60.00%							35.00%	5.00%			100.00%	39.3	0.0215	0.2125	4.125	8.125	14.00	50	Impervious to Pervious
EX.10	15.00%	85.00%											100.00%	2.3	0.02575	0.2725	5.75	10.75	10.00	79	Impervious to Pervious
EX.11	15.00%	85.00%											100.00%	2.3	0.02575	0.2725	5.75	10.75	10.00	79	Impervious to Pervious
EX.12	35.00%	58.00%		5.00%							2.00%		100.00%	3.1	0.0263	0.2995	6.65	11.725	10.00	82	Impervious to Pervious
EX.13	15.00%	85.00%											100.00%	2.3	0.02575	0.2725	5.75	10.75	10.00	79	Impervious to Pervious
EX.15		100.00%											100.00%	2.5	0.025	0.25	5	10	10.00	75	Impervious to Pervious
EX.16		100.00%											100.00%	2.5	0.025	0.25	5	10	10	75	Impervious to Pervious
EX.17	35.00%	53.00%		5.00%			1.00%				4.00%	2.00%	100.00%	6.9	0.0258	0.2958	6.425	11.575	9.95	79	Impervious to Pervious
Lansdowne Development (Post-Development)																					
P1	5.00%	85.00%										10.00%	100.00%	12.2	0.02425	0.234	4.75	9.25	9.00	69	Impervious to Pervious
P2		30.00%					30.00%		40.00%				100.00%	67.3	0.018	0.18	3.25	6.5	18.50	30	Pervious to Impervious
P3	40.00%	55.00%		5.00%									100.00%	2.0	0.02675	0.305	7	11.875	10.00	84	Impervious to Pervious
P4	2.00%	79.00%					8.00%		9.00%	2.00%			100.00%	19.9	0.0234	0.235	4.675	9.2	12.3	63	Impervious to Pervious
P5		30.00%					30.00%		40.00%				100.00%	67.3	0.018	0.18	3.25	6.5	18.5	30	Pervious to Impervious
P6		30.00%					30.00%		40.00%				100.00%	67.3	0.018	0.18	3.25	6.5	18.5	30	Pervious to Impervious
P7		80.00%					5.00%		10.00%	5.00%			100.00%	20.8	0.0235	0.2325	4.625	9.125	12.25	63	Impervious to Pervious
P8		60.00%							35.00%	5.00%			100.00%	39.3	0.0215	0.2125	4.125	8.125	14.00	50	Impervious to Pervious
P9		60.00%							35.00%	5.00%			100.00%	39.3	0.0215	0.2125	4.125	8.125	14.00	50	Impervious to Pervious
P10		43.00%					32.00%		25.00%				100.00%	55.2	0.0193	0.193	3.575	7.15	17.30	38	Pervious to Impervious
P11		30.00%					30.00%		40.00%				100.00%	67.3	0.018	0.18	3.25	6.5	18.50	30	Pervious to Impervious
P12		27.00%					30.00%		43.00%				100.00%	70.0	0.0177	0.177	3.175	6.35	18.80	28	Pervious to Impervious
P13		70.00%		5.00%			5.00%		15.00%	5.00%			100.00%	25.5	0.02275	0.2225	4.5	8.75	12.75	58	Impervious to Pervious
P14	35.00%	58.00%		5.00%							2.00%		100.00%	3.1	0.0263	0.2995	6.65	11.725	10.00	82	Impervious to Pervious
P15A		43.00%					32.00%		25.00%				100.00%	55.2	0.0193	0.193	3.575	7.15	17.30	38	Pervious to Impervious
P15B		70.00%					20.00%				10.00%		100.00%	25.8	0.022	0.24	4	9.5	13.00	60	Impervious to Pervious
P16		94.00%								6.00%			100.00%	7.8	0.025	0.247	5	9.85	10.60	72	Impervious to Pervious
P17	35.00%	53.00%		5.00%			1.00%				4.00%	2.00%	100.00%	6.9	0.0258	0.2958	6.425	11.575	9.95	79	Impervious to Pervious



East Parcel (Lot 161 & Lot 180) (Detached)	Impervious Areas (m2)	Pervious Areas (m2)	Direct Connected Impervious Areas (m2)
House roof			416.1
Driveway	135.0		
Street	122.1		
Lawn		583.7	
Sidewalk	15.4		
Sub Totals	272.5	583.7	416.1
Total Lot Area	1272.3		
% Impervious Areas	54.1		
% Pervious Areas		45.9	
% Direct Connected Impervious Areas			32.7



East Parcel (Lot 61 & Lot 91) (Detached)	Impervious Areas (m2)	Pervious Areas (m2)	Direct Connected Impervious Areas (m2)
House roof			337.9
Driveway	130.9		
Street	95.9		
Lawn		475.8	
Sidewalk	16.0		
Sub Totals	242.8	475.8	337.9
Total Lot Area	1056.5		
% Impervious Areas	55.0		
% Pervious Areas		45.0	
% Direct Connected Impervious Areas			32.0

PERMEABLE AREA

IMPERVIOUS AREA

DIRECTLY CONNECTED IMPERVIOUS AREA

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc
1329 Gardiners Road. Suite 210
Kingston. ON. Canada K7P 0L8
613.634.9009 tel.
1.866.884.9392 fax.

Client
10194549 CANADA
c/o SHANE KELLY

Project
LANSDOWNE DEVELOPMENT

Drawing
PERVIOUS/IMPERVIOUS AREA CALCULATION

Drawn by:	Checked by:	Project No.
CGD	JH	
Designed by:	Approved by:	Drawing No.
KMN	KMN	SK1
Date: APRIL 2021		
Scale: N.T.S.		

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.0.94 (Build 0)

****
Project Description
****
File Name ..... Lansdowne Pre.SPF

****
Analysis Options
****
Flow Units ..... cms
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... Green-Ampt
Link Routing Method ..... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date MAR-05-2020 00:00:00
Ending Date MAR-06-2020 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step ..... 30.00 sec

****
Element Count
****
Number of rain gages 1
Number of subbasins 12
Number of nodes 10
Number of links 8
Number of pollutants 0
Number of land uses 0

****
Subbasin Summary
****

Subbasin ID	Total Area hectares	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
EX1	28.69	720.00	4.20	0.3000	-
EX10	4.79	230.00	2.30	0.6000	-
EX11	8.33	275.00	2.30	0.4000	-
EX12	6.39	200.00	3.10	1.5000	-
EX13	2.28	110.00	2.30	2.0000	-
EX2	2.35	45.00	20.80	1.0000	-
EX3	4.33	415.00	2.00	0.3000	-
EX4	35.67	440.00	19.90	2.4000	-
EX5	3.16	65.00	25.50	0.5000	-
EX6	0.23	100.00	39.30	1.0000	-
EX7	5.41	250.00	2.40	0.2000	-
EX9	0.31	150.00	39.30	0.5000	-

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow

---

450_OUT	JUNCTION	98.40	99.70	0.000
BOX_CULV_IN	JUNCTION	98.75	100.75	0.000
BOX_CULV_OUT	JUNCTION	98.65	100.75	0.000
CHANNEL_1	JUNCTION	97.05	99.00	0.000
CN_1200_IN	JUNCTION	98.25	99.50	0.000
CN_1200_OUT	JUNCTION	97.95	99.50	0.000
EX5_CHANNEL_IN	JUNCTION	99.75	101.00	0.000
OUTLET2_INLET	JUNCTION	98.55	100.00	0.000
OUTLET_1	OUTFALL	95.55	96.55	0.000
OUTLET_2	OUTFALL	98.45	99.05	0.000

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
3-600_DIA_CULV	OUTLET2_INLET	OUTLET_2	CONDUIT	20.0	0.5000	0.0150
450_PIPE	BOX_CULV_OUT	450_OUT	CONDUIT	45.0	0.5553	0.0150
BOX_CULV	BOX_CULV_IN	BOX_CULV_OUT	CONDUIT	16.5	0.6057	0.0150
CN_1200_CULV	CN_1200_IN	CN_1200_OUT	CONDUIT	27.3	1.0993	0.0150
DUMMY_LINK2	CN_1200_OUT	CHANNEL_1	DIRECT	109.7	-87.2755	0.0320
EX1_INT_CHANNEL	450_OUT	CHANNEL_1	CHANNEL	350.0	0.3857	0.0320
EX5_CHANNEL	EX5_CHANNEL_IN	BOX_CULV_IN	CHANNEL	150.2	0.6659	0.0320
OUTLET_CHANNEL	CHANNEL_1	OUTLET_1	CHANNEL	520.0	0.2885	0.0320

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity cms
3-600_DIA_CULV	CIRCULAR	0.60	0.60	3	0.28	0.15	0.38
450_PIPE	CIRCULAR	0.45	0.45	1	0.16	0.11	0.18
BOX_CULV	RECT_CLOSED	1.20	1.20	1	1.44	0.30	3.35
CN_1200_CULV	CIRCULAR	1.20	1.20	1	1.13	0.30	3.54
DUMMY_LINK2	DUMMY	0.00	0.00	1	0.00	0.00	0.00
EX1_INT_CHANNEL	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	5.19
EX5_CHANNEL	TRAPEZOIDAL	1.20	7.95	1	5.22	0.63	9.74
OUTLET_CHANNEL	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	4.49

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	11.313	110.980
Evaporation Loss	0.000	0.000
Infiltration Loss	4.111	40.329

Surface Runoff	5.447	53.436
Final Surface Storage	1.763	17.296
Continuity Error (%)	-0.073	

Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	5.439	54.386
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	5.424	54.237
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.002	0.023
Final Stored Volume	0.021	0.215
Continuity Error (%)	-0.078	

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin EX1

Flow length (m):	398.47
Pervious Manning's Roughness:	0.26050
Impervious Manning's Roughness:	0.02525
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.30000
Computed TOC (minutes):	351.74

Subbasin EX10

Flow length (m):	208.26
Pervious Manning's Roughness:	0.27250
Impervious Manning's Roughness:	0.02575
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.60000
Computed TOC (minutes):	199.83

Subbasin EX11

Flow length (m):	302.91
Pervious Manning's Roughness:	0.27250

Impervious Manning's Roughness:	0.02575
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.40000
Computed TOC (minutes):	282.55

Subbasin EX12

Flow length (m):	319.50
Pervious Manning's Roughness:	0.29200
Impervious Manning's Roughness:	0.02550
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	1.50000
Computed TOC (minutes):	204.01

Subbasin EX13

Flow length (m):	207.27
Pervious Manning's Roughness:	0.27250
Impervious Manning's Roughness:	0.02375
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	2.00000
Computed TOC (minutes):	138.68

Subbasin EX2

Flow length (m):	522.22
Pervious Manning's Roughness:	0.23250
Impervious Manning's Roughness:	0.02350
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	1.00000
Computed TOC (minutes):	241.29

Subbasin EX3

Flow length (m):	104.34
Pervious Manning's Roughness:	0.33250
Impervious Manning's Roughness:	0.02775
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.30000
Computed TOC (minutes):	183.23

Subbasin EX4

Flow length (m):	810.68
Pervious Manning's Roughness:	0.23500
Impervious Manning's Roughness:	0.02340
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	2.40000
Computed TOC (minutes):	245.37

Subbasin EX5

Flow length (m):	486.15
Pervious Manning's Roughness:	0.22250
Impervious Manning's Roughness:	0.02275
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	264.29

Subbasin EX6

Flow length (m):	23.00
Pervious Manning's Roughness:	0.21250
Impervious Manning's Roughness:	0.02150
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	1.00000
Computed TOC (minutes):	28.98

Subbasin EX7

Flow length (m):	216.40
Pervious Manning's Roughness:	0.26500
Impervious Manning's Roughness:	0.02550
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.20000
Computed TOC (minutes):	279.55

Subbasin EX9

Flow length (m):	20.67
Pervious Manning's Roughness:	0.21250
Impervious Manning's Roughness:	0.02150
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	34.63

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff cms	Runoff Coefficient	Time of Concentration days hh:mm:ss
EX1	110.98	22.19	0.00	43.26	66.98	0.90	0.503	0

05:51:44
  EX10 110.98 0.00 0.00 43.41 53.56 0.28 0.483 0
03:19:49
  EX11 110.98 55.18 0.00 44.07 99.97 0.43 0.602 0
04:42:32
  EX12 110.98 19.85 0.00 43.22 71.91 0.40 0.550 0
03:24:00
  EX13 110.98 0.00 0.00 43.22 55.57 0.22 0.501 0
02:18:40
  EX2 110.98 119.12 0.00 36.41 175.17 0.25 0.761 0
04:01:17
  EX3 110.98 0.00 0.00 43.54 51.98 0.26 0.468 0
03:03:13
  EX4 110.98 0.00 0.00 36.13 61.68 2.44 0.556 0
04:05:21
  EX5 110.98 0.00 0.00 33.76 63.92 0.23 0.576 0
04:24:17
  EX6 110.98 1188.30 0.00 27.16 1263.18 0.21 0.972 0
00:28:59
  EX7 110.98 0.00 0.00 43.57 50.53 0.20 0.455 0
04:39:33
  EX9 110.98 828.10 0.00 27.89 902.95 0.29 0.962 0
00:34:37

****
Node Depth Summary
****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume ha-mm	Total Flooded Time minutes	Retention Time hh:mm:ss
450_OUT	0.15	0.28	98.68	0	12:58	0	0	0:00:00
BOX_CULV_IN	0.32	1.05	99.80	0	12:53	0	0	0:00:00
BOX_CULV_OUT	0.39	1.14	99.79	0	12:53	0	0	0:00:00
CHANNEL_1	0.47	0.91	97.96	0	12:20	0	0	0:00:00
CN_1200_IN	0.35	1.07	99.32	0	12:06	0	0	0:00:00
CN_1200_OUT	0.20	0.27	98.22	0	12:06	0	0	0:00:00
EX5_CHANNEL_IN	0.09	0.25	100.00	0	00:00	0	0	0:00:00
OUTLET2_INLET	0.17	0.29	98.84	0	13:06	0	0	0:00:00
OUTLET_1	0.23	0.50	96.05	0	12:20	0	0	0:00:00
OUTLET_2	0.14	0.24	98.69	0	13:06	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cms	Peak Inflow cms	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow cms	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
450_OUT	JUNCTION	0.000	0.317	0	12:53	0.00		
BOX_CULV_IN	JUNCTION	0.213	0.431	0	12:06	0.00		
BOX_CULV_OUT	JUNCTION	0.000	0.317	0	12:51	0.00		
CHANNEL_1	JUNCTION	0.000	2.616	0	12:06	0.00		
CN_1200_IN	JUNCTION	2.444	2.444	0	12:06	0.00		
CN_1200_OUT	JUNCTION	0.000	2.441	0	12:06	0.00		

EX5_CHANNEL_IN	JUNCTION	0.227	0.227	0	12:06	0.00
OUTLET2_INLET	JUNCTION	0.430	0.430	0	13:06	0.00
OUTLET_1	OUTFALL	0.904	3.049	0	12:24	0.00
OUTLET_2	OUTFALL	0.000	0.430	0	13:06	0.00

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
OUTLET_1	99.65	1.146	3.049
OUTLET_2	96.31	0.208	0.430
System	97.98	1.354	3.429

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis cms	Design Flow Capacity cms	Ratio of Maximum Flow /Design Flow	Ratio of Maximum Depth	Total Time Reported Condition minutes
3-600_DIA_CULV	CONDUIT	0 13:06	1.17	1.00	0.430	1.129	0.38	0.45	0 Calculated
450_PIPE	CONDUIT	0 12:53	2.31	1.00	0.317	0.184	1.72	0.81	0 > CAPACITY
BOX_CULV	CONDUIT	0 12:51	0.48	1.00	0.317	3.349	0.09	0.91	0 Calculated
CN_1200_CULV	CONDUIT	0 12:06	3.78	1.00	2.441	3.543	0.69	0.56	0 Calculated
DUMMY_LINK2	DIRECT	0 12:06			2.442				
EX1_INT_CHANNEL	CHANNEL	0 12:58	0.23	1.00	0.317	5.188	0.06	0.59	0 Calculated
EX5_CHANNEL	CHANNEL	0 12:07	0.87	1.00	0.219	9.742	0.02	0.51	0 Calculated
OUTLET_CHANNEL	CHANNEL	0 12:20	0.99	1.00	2.187	4.486	0.49	0.71	0 Calculated

****
Flow Classification Summary
****

Link	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
3-600_DIA_CULV	0.00	0.00	0.00	0.95	0.05	0.00	0.00	0.81	0.0003

450_PIPE	0.00	0.00	0.00	0.08	0.92	0.00	0.00	1.16	0.0005
BOX_CULV	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.20	0.0000
CN_1200_CULV	0.00	0.00	0.00	0.13	0.87	0.00	0.00	1.46	0.0002
EX1_INT_CHANNEL	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.10	0.0000
EX5_CHANNEL	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.25	0.0000
OUTLET_CHANNEL	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.42	0.0001

****
Time-Step Critical Elements
****
Link CN_1200_CULV (42.44%)
Link BOX_CULV (22.83%)
Link 3-600_DIA_CULV (13.54%)
Link 450_PIPE (4.98%)

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

****
Routing Time Step Summary
****
Minimum Time Step : 3.25 sec
Average Time Step : 10.48 sec
Maximum Time Step : 30.00 sec
Percent in Steady State : 0.00
Average Iterations per Step : 2.01

Analysis began on: Wed Mar 18 16:26:41 2020
Analysis ended on: Wed Mar 18 16:26:42 2020
Total elapsed time: 00:00:01

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.0.94 (Build 0)

****
Project Description
****
File Name ..... Lansdowne Post Stage 1.SPF

****
Analysis Options
****
Flow Units ..... cms
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... Green-Ampt
Link Routing Method ..... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date MAR-05-2020 00:00:00
Ending Date MAR-06-2020 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step ..... 30.00 sec

****
Element Count
****
Number of rain gages 1
Number of subbasins 13
Number of nodes 7
Number of links 6
Number of pollutants 0
Number of land uses 0

****
Subbasin Summary
****

Subbasin ID	Total Area hectares	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
P1	8.87	100.00	8.00	0.3000	-
P10	11.30	250.00	2.30	0.6000	-
P11	2.15	50.00	2.40	0.5000	-
P12	0.42	30.00	2.30	0.5000	-
P13	3.16	65.00	25.50	0.5000	-
P2	8.99	210.00	67.30	0.5000	-
P3	4.33	85.00	2.00	0.3000	-
P4	35.67	450.00	19.90	2.5000	-
P5	8.21	250.00	4.20	0.5000	-
P6	2.62	60.00	4.20	0.5000	-
P7	2.35	45.00	20.80	1.0000	-
P8	0.31	150.00	39.30	0.5000	-
P9	0.23	100.00	39.30	1.0000	-

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow

CN_1200_IN	JUNCTION	98.25	99.50	0.000	
CN_1200_OUT	JUNCTION	97.95	99.50	0.000	
CN_BYPASS_OUT	JUNCTION	95.55	97.50	0.000	
OUTLET_1_IN	JUNCTION	95.55	97.50	0.000	
SOUTHWEST_BYPASS	JUNCTION	95.55	97.00	0.000	
SWMF_IN	JUNCTION	96.00	98.00	0.000	
OUTLET_1	OUTFALL	95.45	96.45	0.000	

Link Summary

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
CN_1200_CULV	CN_1200_IN	CN_1200_OUT	CONDUIT	27.3	1.0993	0.0150
CN_BYPASS_CHANNEL	CN_1200_OUT	CN_BYPASS_OUT	CHANNEL	473.1	0.5073	0.0320
NORTH_BYPASS	CN_BYPASS_OUT	OUTLET_1_IN	CHANNEL	43.6	0.4590	0.0320
OUTLET_1_CHANNEL	OUTLET_1_IN	OUTLET_1	CHANNEL	18.9	0.5299	0.0320
SOUTH_BYPASS	SOUTHWEST_BYPASS	OUTLET_1_IN	CHANNEL	49.1	0.4070	0.0320
UNCONTROLLED_SWM_OUT	SWMF_IN	OUTLET_1_IN	CHANNEL	15.0	3.0000	0.0320

Cross Section Summary

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity cms
CN_1200_CULV	CIRCULAR	1.20	1.20	1	1.13	0.30	3.54
CN_BYPASS_CHANNEL	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	5.95
NORTH_BYPASS	TRAPEZOIDAL	1.50	10.00	1	8.25	0.79	14.89
OUTLET_1_CHANNEL	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	6.08
SOUTH_BYPASS	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	5.33
UNCONTROLLED_SWM_OUT	TRAPEZOIDAL	1.00	6.50	1	3.50	0.51	12.14

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	9.834	110.980
Evaporation Loss	0.000	0.000
Infiltration Loss	3.260	36.792
Surface Runoff	5.112	57.687
Final Surface Storage	1.469	16.578
Continuity Error (%)	-0.069	

Flow Routing Continuity	Volume hectare-m	Volume Mliters

************************	---------	---------
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	5.104	51.043
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	5.083	50.833
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.022	0.220
Continuity Error (%)	-0.019	

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin P1

Flow length (m):	887.00
Pervious Manning's Roughness:	0.24000
Impervious Manning's Roughness:	0.02400
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.30000
Computed TOC (minutes):	530.72

Subbasin P10

Flow length (m):	452.00
Pervious Manning's Roughness:	0.27525
Impervious Manning's Roughness:	0.02575
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.60000
Computed TOC (minutes):	319.96

Subbasin P11

Flow length (m):	430.00
Pervious Manning's Roughness:	0.26500
Impervious Manning's Roughness:	0.02550
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	320.59

Subbasin P12

Flow length (m):	140.00
Pervious Manning's Roughness:	0.27250
Impervious Manning's Roughness:	0.02575
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	166.29

Subbasin P13

Flow length (m):	486.15
Pervious Manning's Roughness:	0.22250
Impervious Manning's Roughness:	0.02275
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	238.83

Subbasin P2

Flow length (m):	428.10
Pervious Manning's Roughness:	0.18000
Impervious Manning's Roughness:	0.01800
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	167.69

Subbasin P3

Flow length (m):	509.41
Pervious Manning's Roughness:	0.33250
Impervious Manning's Roughness:	0.02775
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.30000
Computed TOC (minutes):	474.40

Subbasin P4

Flow length (m):	792.67
Pervious Manning's Roughness:	0.23500
Impervious Manning's Roughness:	0.02340
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	2.50000
Computed TOC (minutes):	239.16

Subbasin P5

Flow length (m):	328.40
Pervious Manning's Roughness:	0.26000
Impervious Manning's Roughness:	0.02525

Pervious Rainfall Intensity (mm/hr): 4.62415
Impervious Rainfall Intensity (mm/hr): 4.62415
Slope (%): 0.50000
Computed TOC (minutes): 268.35

Subbasin P6

Flow length (m): 436.67
Pervious Manning's Roughness: 0.26000
Impervious Manning's Roughness: 0.02600
Pervious Rainfall Intensity (mm/hr): 4.62415
Impervious Rainfall Intensity (mm/hr): 4.62415
Slope (%): 0.50000
Computed TOC (minutes): 318.52

Subbasin P7

Flow length (m): 522.22
Pervious Manning's Roughness: 0.23250
Impervious Manning's Roughness: 0.02350
Pervious Rainfall Intensity (mm/hr): 4.62415
Impervious Rainfall Intensity (mm/hr): 4.62415
Slope (%): 1.00000
Computed TOC (minutes): 241.29

Subbasin P8

Flow length (m): 20.67
Pervious Manning's Roughness: 0.21250
Impervious Manning's Roughness: 0.02150
Pervious Rainfall Intensity (mm/hr): 4.62415
Impervious Rainfall Intensity (mm/hr): 4.62415
Slope (%): 0.50000
Computed TOC (minutes): 34.63

Subbasin P9

Flow length (m): 23.00
Pervious Manning's Roughness: 0.21250
Impervious Manning's Roughness: 0.02150
Pervious Rainfall Intensity (mm/hr): 4.62415
Impervious Rainfall Intensity (mm/hr): 4.62415
Slope (%): 1.00000
Computed TOC (minutes): 28.98

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall	Total Runon	Total Evap.	Total Infil.	Total Runoff	Peak Runoff	Runoff Coefficient	Time of Concentration
	mm	mm	mm	mm	mm	cms		days

hh:mm:ss

P1	110.98	0.00	0.00	41.73	42.62	0.19	0.384	0 08:50:43
P10	110.98	9.33	0.00	43.83	55.97	0.35	0.465	0 05:19:57
P11	110.98	0.00	0.00	43.68	49.07	0.07	0.442	0 05:20:35
P12	110.98	0.00	0.00	43.31	54.74	0.03	0.493	0 02:46:17
P13	110.98	0.00	0.00	33.13	65.55	0.31	0.591	0 03:58:49
P2	110.98	159.82	0.00	14.65	247.24	2.40	0.913	0 02:47:41
P3	110.98	39.04	0.00	44.87	69.82	0.11	0.465	0 07:54:23
P4	110.98	0.00	0.00	36.12	61.92	2.51	0.558	0 03:59:09
P5	110.98	0.00	0.00	42.80	52.23	0.33	0.471	0 04:28:21
P6	110.98	0.00	0.00	42.92	49.94	0.08	0.450	0 05:18:31
P7	110.98	10.18	0.00	35.89	71.94	0.19	0.594	0 04:01:17
P8	110.98	0.00	0.00	27.42	77.02	0.10	0.694	0 00:34:37
P9	110.98	3748.62	0.00	29.42	3818.68	0.68	0.989	0 00:28:59

****
Node Depth Summary
****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume ha-mm	Total Flooded Time minutes	Retention Time hh:mm:ss
CN_1200_IN	0.33	0.97	99.22	0	12:06	0	0	0:00:00
CN_1200_OUT	0.28	0.67	98.62	0	12:08	0	0	0:00:00
CN_BYPASS_OUT	0.50	0.99	96.54	0	12:11	0	0	0:00:00
OUTLET_1_IN	0.43	0.90	96.45	0	12:10	0	0	0:00:00
SOUTHWEST_BYPASS	0.44	0.91	96.46	0	12:10	0	0	0:00:00
SWMF_IN	0.24	0.57	96.57	0	12:06	0	0	0:00:00
OUTLET_1	0.32	0.71	96.16	0	12:10	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cms	Peak Inflow cms	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow cms	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
CN_1200_IN	JUNCTION	2.509	2.509	0	12:06	0.00		
CN_1200_OUT	JUNCTION	0.000	2.509	0	12:06	0.00		

CN_BYPASS_OUT	JUNCTION	0.000	2.344	0	12:08	0.00
OUTLET_1_IN	JUNCTION	0.000	4.483	0	12:09	0.00
SOUTHWEST_BYPASS	JUNCTION	0.115	0.115	0	13:41	0.00
SWMF_IN	JUNCTION	2.583	2.583	0	12:06	0.00
OUTLET_1	OUTFALL	0.000	4.475	0	12:10	0.00

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
OUTLET_1	99.41	1.178	4.475
System	99.41	1.178	4.475

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis cms	Design Flow Capacity cms	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time minutes	Reported Condition
CN_1200_CULV	CONDUIT	0 12:06	3.09	1.00	2.509	3.543	0.71	0.68	0	Calculated
CN_BYPASS_CHANNEL	CHANNEL	0 12:08	0.85	1.00	2.344	5.949	0.39	0.82	0	Calculated
NORTH_BYPASS	CHANNEL	0 12:12	0.77	1.00	2.260	14.888	0.15	0.56	0	Calculated
OUTLET_1_CHANNEL	CHANNEL	0 12:10	1.63	1.00	4.475	6.081	0.74	0.81	0	Calculated
SOUTH_BYPASS	CHANNEL	0 13:37	0.13	1.00	0.118	5.329	0.02	0.80	0	Calculated
UNCONTROLLED_SWM_OUT	CHANNEL	0 12:06	1.49	1.00	2.584	12.140	0.21	0.72	0	Calculated

****
Flow Classification Summary
****

Link	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
CN_1200_CULV	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.24	0.0002
CN_BYPASS_CHANNEL	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.26	0.0001
NORTH_BYPASS	0.00	0.08	0.00	0.92	0.00	0.00	0.00	0.26	0.0000
OUTLET_1_CHANNEL	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.67	0.0002

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.0.94 (Build 0)

****
Project Description
****
File Name ..... Lansdowne Post Stage 2.SPF

****
Analysis Options
****
Flow Units ..... cms
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... Green-Ampt
Link Routing Method ..... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date MAR-05-2020 00:00:00
Ending Date MAR-06-2020 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step ..... 30.00 sec

****
Element Count
****
Number of rain gages 1
Number of subbasins 13
Number of nodes 7
Number of links 6
Number of pollutants 0
Number of land uses 0

****
Subbasin Summary
****

Subbasin ID	Total Area hectares	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
P1	8.87	100.00	12.20	0.3000	-
P10	10.13	170.00	55.30	0.6000	-
P11	2.46	50.00	2.40	0.5000	-
P12	0.46	30.00	70.00	0.5000	-
P13	3.16	65.00	25.50	0.5000	-
P2	8.99	210.00	67.30	0.5000	-
P3	4.33	85.00	2.00	0.3000	-
P4	35.67	450.00	19.90	2.5000	-
P5	8.21	250.00	4.20	0.5000	-
P6	2.62	60.00	4.20	0.5000	-
P7	2.35	45.00	20.80	1.0000	-
P8	0.31	150.00	39.30	0.5000	-
P9	0.23	100.00	39.30	1.0000	-

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow

CN_1200_IN	JUNCTION	98.25	99.50	0.000	
CN_1200_OUT	JUNCTION	97.95	99.50	0.000	
CN_BYPASS_OUT	JUNCTION	95.55	97.50	0.000	
OUTLET_1_IN	JUNCTION	95.55	97.50	0.000	
SOUTHWEST_BYPASS	JUNCTION	95.55	97.00	0.000	
SWMF_IN	JUNCTION	96.00	98.00	0.000	
OUTLET_1	OUTFALL	95.45	96.45	0.000	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
CN_1200_CULV	CN_1200_IN	CN_1200_OUT	CONDUIT	27.3	1.0993	0.0150
CN_BYPASS_CHANNEL	CN_1200_OUT	CN_BYPASS_OUT	CHANNEL	473.1	0.5073	0.0320
NORTH_BYPASS	CN_BYPASS_OUT	OUTLET_1_IN	CHANNEL	43.6	0.4590	0.0320
OUTLET_1_CHANNEL	OUTLET_1_IN	OUTLET_1	CHANNEL	18.9	0.5299	0.0320
SOUTH_BYPASS	SOUTHWEST_BYPASS	OUTLET_1_IN	CHANNEL	49.1	0.4070	0.0320
UNCONTROLLED_SWM_OUT	SWMF_IN	OUTLET_1_IN	CHANNEL	15.0	3.0000	0.0320

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity cms
CN_1200_CULV	CIRCULAR	1.20	1.20	1	1.13	0.30	3.54
CN_BYPASS_CHANNEL	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	5.95
NORTH_BYPASS	TRAPEZOIDAL	1.50	10.00	1	8.25	0.79	14.89
OUTLET_1_CHANNEL	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	6.08
SOUTH_BYPASS	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	5.33
UNCONTROLLED_SWM_OUT	TRAPEZOIDAL	1.00	6.50	1	3.50	0.51	12.14

********** Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	9.743	110.980
Evaporation Loss	0.000	0.000
Infiltration Loss	2.966	33.786
Surface Runoff	5.469	62.302
Final Surface Storage	1.315	14.975
Continuity Error (%)	-0.074	

********** Flow Routing Continuity	Volume hectare-m	Volume Mliters

************************	---------	---------
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	5.462	54.623
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	5.441	54.412
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.022	0.220
Continuity Error (%)	-0.016	

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin P1

Flow length (m):	887.00
Pervious Manning's Roughness:	0.24000
Impervious Manning's Roughness:	0.02400
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.30000
Computed TOC (minutes):	518.66

Subbasin P10

Flow length (m):	595.88
Pervious Manning's Roughness:	0.19300
Impervious Manning's Roughness:	0.01930
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.60000
Computed TOC (minutes):	213.04

Subbasin P11

Flow length (m):	492.00
Pervious Manning's Roughness:	0.26500
Impervious Manning's Roughness:	0.02550
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	347.57

Subbasin P12

Flow length (m):	153.33
Pervious Manning's Roughness:	0.27250
Impervious Manning's Roughness:	0.02575
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	103.58

Subbasin P13

Flow length (m):	486.15
Pervious Manning's Roughness:	0.22250
Impervious Manning's Roughness:	0.02275
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	238.83

Subbasin P2

Flow length (m):	428.10
Pervious Manning's Roughness:	0.18000
Impervious Manning's Roughness:	0.01800
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	167.69

Subbasin P3

Flow length (m):	509.41
Pervious Manning's Roughness:	0.33250
Impervious Manning's Roughness:	0.02775
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.30000
Computed TOC (minutes):	474.40

Subbasin P4

Flow length (m):	792.67
Pervious Manning's Roughness:	0.23500
Impervious Manning's Roughness:	0.02340
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	2.50000
Computed TOC (minutes):	239.16

Subbasin P5

Flow length (m):	328.40
Pervious Manning's Roughness:	0.26000
Impervious Manning's Roughness:	0.02525

Pervious Rainfall Intensity (mm/hr): 4.62415
Impervious Rainfall Intensity (mm/hr): 4.62415
Slope (%): 0.50000
Computed TOC (minutes): 268.35

Subbasin P6

Flow length (m): 436.67
Pervious Manning's Roughness: 0.26000
Impervious Manning's Roughness: 0.02600
Pervious Rainfall Intensity (mm/hr): 4.62415
Impervious Rainfall Intensity (mm/hr): 4.62415
Slope (%): 0.50000
Computed TOC (minutes): 318.52

Subbasin P7

Flow length (m): 522.22
Pervious Manning's Roughness: 0.23250
Impervious Manning's Roughness: 0.02350
Pervious Rainfall Intensity (mm/hr): 4.62415
Impervious Rainfall Intensity (mm/hr): 4.62415
Slope (%): 1.00000
Computed TOC (minutes): 241.29

Subbasin P8

Flow length (m): 20.67
Pervious Manning's Roughness: 0.21250
Impervious Manning's Roughness: 0.02150
Pervious Rainfall Intensity (mm/hr): 4.62415
Impervious Rainfall Intensity (mm/hr): 4.62415
Slope (%): 0.50000
Computed TOC (minutes): 34.63

Subbasin P9

Flow length (m): 23.00
Pervious Manning's Roughness: 0.21250
Impervious Manning's Roughness: 0.02150
Pervious Rainfall Intensity (mm/hr): 4.62415
Impervious Rainfall Intensity (mm/hr): 4.62415
Slope (%): 1.00000
Computed TOC (minutes): 28.98

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall	Total Runon	Total Evap.	Total Infil.	Total Runoff	Peak Runoff	Runoff Coefficient	Time of Concentration
	mm	mm	mm	mm	mm	cms		days

hh:mm:ss

P1	110.98	0.00	0.00	39.93	45.37	0.22	0.409	0 08:38:39
P10	110.98	11.59	0.00	19.79	94.79	1.78	0.773	0 03:33:02
P11	110.98	0.00	0.00	43.73	47.77	0.07	0.430	0 05:47:34
P12	110.98	0.00	0.00	14.06	88.20	0.10	0.795	0 01:43:34
P13	110.98	0.00	0.00	33.13	65.55	0.31	0.591	0 03:58:49
P2	110.98	197.30	0.00	15.19	284.34	3.22	0.922	0 02:47:41
P3	110.98	39.04	0.00	44.87	69.82	0.11	0.465	0 07:54:23
P4	110.98	0.00	0.00	36.12	61.92	2.51	0.558	0 03:59:09
P5	110.98	0.00	0.00	42.80	52.23	0.33	0.471	0 04:28:21
P6	110.98	0.00	0.00	46.54	47.05	0.08	0.424	0 05:18:31
P7	110.98	10.18	0.00	35.89	71.94	0.19	0.594	0 04:01:17
P8	110.98	0.00	0.00	27.42	77.02	0.10	0.694	0 00:34:37
P9	110.98	5252.24	0.00	31.07	5321.05	2.20	0.992	0 00:28:59

****
Node Depth Summary
****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume ha-mm	Total Flooded Time minutes	Retention Time hh:mm:ss
CN_1200_IN	0.33	0.97	99.22	0	12:06	0	0	0:00:00
CN_1200_OUT	0.28	0.67	98.62	0	12:08	0	0	0:00:00
CN_BYPASS_OUT	0.51	1.04	96.59	0	12:12	0	0	0:00:00
OUTLET_1_IN	0.45	0.99	96.54	0	12:12	0	0	0:00:00
SOUTHWEST_BYPASS	0.45	0.99	96.54	0	12:12	0	0	0:00:00
SWMF_IN	0.26	0.67	96.67	0	12:06	0	0	0:00:00
OUTLET_1	0.33	0.78	96.23	0	12:12	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cms	Peak Inflow cms	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow cms	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
CN_1200_IN	JUNCTION	2.509	2.509	0	12:05	0.00		
CN_1200_OUT	JUNCTION	0.000	2.510	0	12:06	0.00		

CN_BYPASS_OUT	JUNCTION	0.000	2.340	0	12:08	0.00
OUTLET_1_IN	JUNCTION	0.000	5.480	0	12:12	0.00
SOUTHWEST_BYPASS	JUNCTION	0.115	0.115	0	13:42	0.00
SWMF_IN	JUNCTION	3.440	3.440	0	12:06	0.00
OUTLET_1	OUTFALL	0.000	5.477	0	12:12	0.00

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
OUTLET_1	99.42	1.289	5.477
System	99.42	1.289	5.477

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis cms	Design Flow Capacity cms	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time minutes	Reported Condition
CN_1200_CULV	CONDUIT	0 12:06	3.09	1.00	2.510	3.543	0.71	0.68	0	Calculated
CN_BYPASS_CHANNEL	CHANNEL	0 12:08	0.80	1.00	2.340	5.949	0.39	0.83	0	Calculated
NORTH_BYPASS	CHANNEL	0 12:14	0.68	1.00	2.234	14.888	0.15	0.61	0	Calculated
OUTLET_1_CHANNEL	CHANNEL	0 12:12	1.70	1.00	5.477	6.081	0.90	0.88	0	Calculated
SOUTH_BYPASS	CHANNEL	0 13:35	0.14	1.00	0.119	5.329	0.02	0.89	0	Calculated
UNCONTROLLED_SWM_OUT	CHANNEL	0 12:06	1.57	1.00	3.442	12.140	0.28	0.81	0	Calculated

****
Flow Classification Summary
****

Link	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
CN_1200_CULV	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.25	0.0002
CN_BYPASS_CHANNEL	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.26	0.0001
NORTH_BYPASS	0.00	0.08	0.00	0.92	0.00	0.00	0.00	0.25	0.0000
OUTLET_1_CHANNEL	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.68	0.0002

```
SOUTH_BYPASS      0.00  0.09  0.00  0.91  0.00  0.00  0.00     0.06   0.0000
UNCONTROLLED_SWM_OUT  0.00  0.00  0.00  1.00  0.00  0.00  0.00     0.63   0.0001


**************************
Time-Step Critical Elements
**************************
Link OUTLET_1_CHANNEL (64.86%)
Link UNCONTROLLED_SWM_OUT (17.13%)


******************************
Highest Flow Instability Indexes
******************************
Link UNCONTROLLED_SWM_OUT (9)
Link OUTLET_1_CHANNEL (5)
Link CN_1200_CULV (3)
Link SOUTH_BYPASS (1)


************************
Routing Time Step Summary
************************
Minimum Time Step           :     3.23 sec
Average Time Step           :     9.66 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.06


Analysis began on:  Thu Mar 25 15:27:37 2021
Analysis ended on:  Thu Mar 25 15:27:38 2021
Total elapsed time: 00:00:01
```

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.0.94 (Build 0)

****
Project Description
****
File Name ..... Lansdowne Post Stage 3.SPF

****
Analysis Options
****
Flow Units ..... cms
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... Green-Ampt
Link Routing Method ..... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date MAR-05-2020 00:00:00
Ending Date MAR-06-2020 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step ..... 30.00 sec

****
Element Count
****
Number of rain gages 1
Number of subbasins 18
Number of nodes 10
Number of links 8
Number of pollutants 0
Number of land uses 0

****
Subbasin Summary
****

Subbasin ID	Total Area hectares	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
P1	8.87	100.00	12.20	0.3000	-
P10	10.13	170.00	55.30	0.6000	-
P11	2.46	50.00	70.00	0.5000	-
P12	0.46	30.00	70.00	0.5000	-
P13	3.16	65.00	25.50	0.5000	-
P14	5.00	185.00	3.10	0.5000	-
P15A	4.42	150.00	55.30	0.5000	-
P15B	4.18	25.00	26.00	0.5000	-
P16	1.39	60.00	7.80	0.5000	-
P17	18.13	350.00	6.90	0.3000	-
P2	8.99	210.00	67.30	0.5000	-
P3	4.33	85.00	2.00	0.3000	-
P4	35.67	450.00	19.90	2.5000	-
P5	8.21	250.00	67.30	0.5000	-
P6	2.62	60.00	67.30	0.5000	-
P7	2.35	45.00	20.80	1.0000	-
P8	0.31	150.00	39.30	0.5000	-
P9	0.23	100.00	39.30	1.0000	-

****

Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
CN_1200_IN	JUNCTION	98.25	99.50	0.000	
CN_1200_OUT	JUNCTION	97.95	99.50	0.000	
CN_BYPASS_OUT	JUNCTION	95.55	97.50	0.000	
OUTLET_1_IN	JUNCTION	95.55	97.50	0.000	
OUTLET_2_IN	JUNCTION	98.65	100.55	0.000	
P15_REAR_SWALE	JUNCTION	101.00	102.00	0.000	
SOUTHWEST_BYPASS	JUNCTION	95.55	97.00	0.000	
SWMF_IN	JUNCTION	96.00	98.00	0.000	
OUTLET_1	OUTFALL	95.45	96.95	0.000	
OUTLET_2	OUTFALL	98.55	99.55	0.000	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
CN_1200_CULV	CN_1200_IN	CN_1200_OUT	CONDUIT	27.3	1.0993	0.0150
CN_BYPASS_CHANNEL	CN_1200_OUT	CN_BYPASS_OUT	CHANNEL	473.1	0.5073	0.0320
DUMMY_LINK6	OUTLET_2_IN	OUTLET_2	CHANNEL	4.8	2.0833	0.0320
ENHANCED_SWALE2	P15_REAR_SWALE	OUTLET_2_IN	CHANNEL	400.0	0.5875	0.0320
NORTH_BYPASS	CN_BYPASS_OUT	OUTLET_1_IN	CHANNEL	43.6	0.4590	0.0320
OUTLET_1_CHANNEL	OUTLET_1_IN	OUTLET_1	CHANNEL	18.9	0.5299	0.0320
SOUTH_BYPASS	SOUTHWEST_BYPASS	OUTLET_1_IN	CHANNEL	49.1	0.4070	0.0320
UNCONTROLLED_SWM_OUT	SWMF_IN	OUTLET_1_IN	CHANNEL	15.0	3.0000	0.0320

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity cms
CN_1200_CULV	CIRCULAR	1.20	1.20	1	1.13	0.30	3.54
CN_BYPASS_CHANNEL	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	5.95
DUMMY_LINK6	TRAPEZOIDAL	1.00	8.00	1	5.00	0.60	16.06
ENHANCED_SWALE2	TRAPEZOIDAL	0.75	5.00	1	2.06	0.39	2.65
NORTH_BYPASS	TRAPEZOIDAL	1.50	10.00	1	8.25	0.79	14.89
OUTLET_1_CHANNEL	TRAPEZOIDAL	1.50	10.00	1	8.25	0.79	16.00
SOUTH_BYPASS	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	5.33
UNCONTROLLED_SWM_OUT	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	14.47

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	13.419	110.980
Evaporation Loss	0.000	0.000
Infiltration Loss	3.807	31.488
Surface Runoff	7.755	64.142
Final Surface Storage	1.869	15.456
Continuity Error (%)	-0.096	

Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	7.744	77.442
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	7.717	77.167
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.029	0.288
Continuity Error (%)	-0.017	

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin P1

Flow length (m):	887.00
Pervious Manning's Roughness:	0.24000
Impervious Manning's Roughness:	0.02400
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.30000
Computed TOC (minutes):	518.66

Subbasin P10

Flow length (m):	595.88
Pervious Manning's Roughness:	0.19300
Impervious Manning's Roughness:	0.01930
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.60000
Computed TOC (minutes):	213.04

Subbasin P11

Flow length (m):	492.00
Pervious Manning's Roughness:	0.17000
Impervious Manning's Roughness:	0.01700
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	160.96

Subbasin P12

Flow length (m):	153.33
Pervious Manning's Roughness:	0.17000
Impervious Manning's Roughness:	0.01700
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	82.00

Subbasin P13

Flow length (m):	486.15
Pervious Manning's Roughness:	0.22250
Impervious Manning's Roughness:	0.02275
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	238.83

Subbasin P14

Flow length (m):	270.27
Pervious Manning's Roughness:	0.29200
Impervious Manning's Roughness:	0.02550
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	256.56

Subbasin P15A

Flow length (m):	294.67
Pervious Manning's Roughness:	0.19300
Impervious Manning's Roughness:	0.01930
Pervious Rainfall Intensity (mm/hr):	4.62415
Impervious Rainfall Intensity (mm/hr):	4.62415
Slope (%):	0.50000
Computed TOC (minutes):	120.08

Subbasin P15B

Flow length (m):	1672.00

```
        Pervious Manning's Roughness:             0.24000
        Impervious Manning's Roughness:           0.02200
        Pervious Rainfall Intensity (mm/hr):      4.62415
        Impervious Rainfall Intensity (mm/hr):    4.62415
        Slope (%):                                0.50000
        Computed TOC (minutes):                    573.96

---------------
Subbasin P16
---------------

        Flow length (m):                           231.67
        Pervious Manning's Roughness:             0.24700
        Impervious Manning's Roughness:           0.02500
        Pervious Rainfall Intensity (mm/hr):      4.62415
        Impervious Rainfall Intensity (mm/hr):    4.62415
        Slope (%):                                0.50000
        Computed TOC (minutes):                    207.81

---------------
Subbasin P17
---------------

        Flow length (m):                           518.00
        Pervious Manning's Roughness:             0.29580
        Impervious Manning's Roughness:           0.02580
        Pervious Rainfall Intensity (mm/hr):      4.62415
        Impervious Rainfall Intensity (mm/hr):    4.62415
        Slope (%):                                0.30000
        Computed TOC (minutes):                    424.84

--------------
Subbasin P2
--------------

        Flow length (m):                           428.10
        Pervious Manning's Roughness:             0.18000
        Impervious Manning's Roughness:           0.01800
        Pervious Rainfall Intensity (mm/hr):      4.62415
        Impervious Rainfall Intensity (mm/hr):    4.62415
        Slope (%):                                0.50000
        Computed TOC (minutes):                    167.69

--------------
Subbasin P3
--------------

        Flow length (m):                           509.41
        Pervious Manning's Roughness:             0.33250
        Impervious Manning's Roughness:           0.02775
        Pervious Rainfall Intensity (mm/hr):      4.62415
        Impervious Rainfall Intensity (mm/hr):    4.62415
        Slope (%):                                0.30000
        Computed TOC (minutes):                    474.40

--------------
Subbasin P4
--------------

        Flow length (m):                           792.67
        Pervious Manning's Roughness:             0.23500
        Impervious Manning's Roughness:           0.02340
        Pervious Rainfall Intensity (mm/hr):      4.62415
        Impervious Rainfall Intensity (mm/hr):    4.62415
        Slope (%):                                2.50000
        Computed TOC (minutes):                    246.33
```

```
--------------
Subbasin P5
--------------

        Flow length (m):                            328.40
        Pervious Manning's Roughness:              0.18000
        Impervious Manning's Roughness:            0.01800
        Pervious Rainfall Intensity (mm/hr):       4.62415
        Impervious Rainfall Intensity (mm/hr):     4.62415
        Slope (%):                                 0.50000
        Computed TOC (minutes):                     146.63

--------------
Subbasin P6
--------------

        Flow length (m):                            436.67
        Pervious Manning's Roughness:              0.18000
        Impervious Manning's Roughness:            0.01800
        Pervious Rainfall Intensity (mm/hr):       4.62415
        Impervious Rainfall Intensity (mm/hr):     4.62415
        Slope (%):                                 0.50000
        Computed TOC (minutes):                     160.10

--------------
Subbasin P7
--------------

        Flow length (m):                            522.22
        Pervious Manning's Roughness:              0.23250
        Impervious Manning's Roughness:            0.02350
        Pervious Rainfall Intensity (mm/hr):       4.62415
        Impervious Rainfall Intensity (mm/hr):     4.62415
        Slope (%):                                 1.00000
        Computed TOC (minutes):                     241.29

--------------
Subbasin P8
--------------

        Flow length (m):                             20.67
        Pervious Manning's Roughness:              0.21250
        Impervious Manning's Roughness:            0.02150
        Pervious Rainfall Intensity (mm/hr):       4.62415
        Impervious Rainfall Intensity (mm/hr):     4.62415
        Slope (%):                                 0.50000
        Computed TOC (minutes):                      34.63

--------------
Subbasin P9
--------------

        Flow length (m):                             23.00
        Pervious Manning's Roughness:              0.21250
        Impervious Manning's Roughness:            0.02150
        Pervious Rainfall Intensity (mm/hr):       4.62415
        Impervious Rainfall Intensity (mm/hr):     4.62415
        Slope (%):                                 1.00000
        Computed TOC (minutes):                      28.98


**********************
Subbasin Runoff Summary
**********************
```

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff cms	Runoff Coefficient	Time of Concentration days hh:mm:ss
P1	110.98	0.00	0.00	39.93	45.37	0.22	0.409	0 08:38:39
P10	110.98	58.94	0.00	20.40	140.73	2.40	0.828	0 03:33:02
P11	110.98	0.00	0.00	13.18	92.39	0.54	0.833	0 02:40:57
P12	110.98	0.00	0.00	13.13	93.68	0.14	0.844	0 01:22:00
P13	110.98	0.00	0.00	33.13	65.55	0.31	0.591	0 03:58:49
P14	110.98	0.00	0.00	43.25	50.96	0.20	0.459	0 04:16:33
P15A	110.98	0.00	0.00	20.49	83.60	0.82	0.753	0 02:00:04
P15B	110.98	0.00	0.00	16.36	63.54	0.17	0.573	0 09:33:57
P16	110.98	0.00	0.00	41.13	56.79	0.09	0.512	0 03:27:48
P17	110.98	0.00	0.00	43.42	44.16	0.65	0.398	0 07:04:50
P2	110.98	298.02	0.00	15.64	384.21	5.07	0.939	0 02:47:41
P3	110.98	39.04	0.00	44.87	69.82	0.11	0.465	0 07:54:23
P4	110.98	0.00	0.00	36.25	61.58	2.26	0.555	0 04:06:20
P5	110.98	0.00	0.00	14.36	91.46	1.93	0.824	0 02:26:37
P6	110.98	0.00	0.00	14.38	91.13	0.57	0.821	0 02:40:05
P7	110.98	10.18	0.00	35.89	71.94	0.19	0.594	0 04:01:17
P8	110.98	0.00	0.00	27.42	77.02	0.10	0.694	0 00:34:37
P9	110.98	7286.25	0.00	31.29	7354.08	2.85	0.994	0 00:28:59

****
Node Depth Summary
****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume ha-mm	Total Flooded Time minutes	Retention Time hh:mm:ss
CN_1200_IN	0.40	0.90	99.15	0	12:06	0	0	0:00:00
CN_1200_OUT	0.32	0.64	98.59	0	12:10	0	0	0:00:00
CN_BYPASS_OUT	0.59	1.15	96.70	0	12:14	0	0	0:00:00

OUTLET_1_IN	0.55	1.12	96.67	0	12:13	0	0	0:00:00
OUTLET_2_IN	0.15	0.30	98.95	0	12:09	0	0	0:00:00
P15_REAR_SWALE	0.36	0.59	101.59	0	12:07	0	0	0:00:00
SOUTHWEST_BYPASS	0.55	1.12	96.67	0	12:13	0	0	0:00:00
SWMF_IN	0.30	0.83	96.83	0	12:11	0	0	0:00:00
OUTLET_1	0.41	0.89	96.34	0	12:13	0	0	0:00:00
OUTLET_2	0.13	0.25	98.80	0	12:09	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cms	Peak Inflow cms	Time of Peak Inflow Occurrence days	hh:mm	Maximum Flooding Overflow cms	Time of Flooding Occurrence days	hh:mm
CN_1200_IN	JUNCTION	2.261	2.261	0	12:06	0.00		
CN_1200_OUT	JUNCTION	0.000	2.262	0	12:06	0.00		
CN_BYPASS_OUT	JUNCTION	0.000	2.125	0	12:10	0.00		
OUTLET_1_IN	JUNCTION	0.000	7.271	0	12:13	0.00		
OUTLET_2_IN	JUNCTION	0.000	1.042	0	12:07	0.00		
P15_REAR_SWALE	JUNCTION	1.108	1.108	0	12:05	0.00		
SOUTHWEST_BYPASS	JUNCTION	0.115	0.115	0	13:41	0.00		
SWMF_IN	JUNCTION	5.264	5.264	0	12:11	0.00		
OUTLET_1	OUTFALL	0.000	7.267	0	12:13	0.00		
OUTLET_2	OUTFALL	0.000	1.023	0	12:09	0.00		

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
OUTLET_1	99.35	2.100	7.267
OUTLET_2	98.26	0.396	1.023
System	98.80	2.495	8.210

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days	hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis cms	Design Flow Capacity cms	Ratio of Maximum /Design Flow	Total Reported Condition Ratio of Maximum Depth	Time Surcharged minutes
CN_1200_CULV	CONDUIT	0	12:06	3.02	1.00	2.262	3.543	0.64	0.63	0 Calculated

```
  CN_BYPASS_CHANNEL    CHANNEL      0  12:10      0.75    1.00       2.125       5.949      0.36
0.82           0  Calculated
  DUMMY_LINK6          CHANNEL      0  12:09      1.33    1.00       1.023      16.057      0.06
0.27           0  Calculated
  ENHANCED_SWALE2      CHANNEL      0  12:07      1.30    1.00       1.042       2.653      0.39
0.59           0  Calculated
  NORTH_BYPASS         CHANNEL      0  12:19      0.62    1.00       2.187      14.888      0.15
0.69           0  Calculated
  OUTLET_1_CHANNEL     CHANNEL      0  12:13      1.81    1.00       7.267      15.997      0.45
0.67           0  Calculated
  SOUTH_BYPASS         CHANNEL      0  13:29      0.13    1.00       0.120       5.329      0.02
0.96           0  Calculated
  UNCONTROLLED_SWM_OUT CHANNEL      0  12:11      1.61    1.00       5.259      14.468      0.36
0.92           0  Calculated


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

  ------------------------------------------------------------------------------
                     --- Fraction of Time in Flow Class ----   Avg.     Avg.
                          Up    Down  Sub   Sup   Up    Down   Froude   Flow
  Link               Dry  Dry   Dry   Crit  Crit  Crit  Crit   Number   Change
  ------------------------------------------------------------------------------
  CN_1200_CULV      0.00  0.00  0.00  0.00  0.99  0.00  0.00     1.23   0.0002
  CN_BYPASS_CHANNEL  0.00  0.00  0.00  1.00  0.00  0.00  0.00     0.26   0.0001
  DUMMY_LINK6       0.01  0.00  0.00  0.99  0.00  0.00  0.00     0.86   0.0000
  ENHANCED_SWALE2   0.00  0.00  0.00  1.00  0.00  0.00  0.00     0.70   0.0001
  NORTH_BYPASS      0.00  0.10  0.00  0.90  0.00  0.00  0.00     0.22   0.0000
  OUTLET_1_CHANNEL  0.00  0.00  0.00  1.00  0.00  0.00  0.00     0.69   0.0001
  SOUTH_BYPASS      0.00  0.09  0.00  0.90  0.00  0.00  0.00     0.04   0.0000
  UNCONTROLLED_SWM_OUT  0.00  0.00  0.00  1.00  0.00  0.00  0.00     0.55   0.0002


  **************************
  Time-Step Critical Elements
  **************************
  Link OUTLET_1_CHANNEL (38.85%)
  Link CN_1200_CULV (12.96%)
  Link UNCONTROLLED_SWM_OUT (12.64%)
  Link DUMMY_LINK6 (11.29%)


  ******************************
  Highest Flow Instability Indexes
  ******************************
  Link UNCONTROLLED_SWM_OUT (22)
  Link OUTLET_1_CHANNEL (19)
  Link SOUTH_BYPASS (10)
  Link CN_1200_CULV (6)
  Link NORTH_BYPASS (2)


  ************************
  Routing Time Step Summary
  ************************
  Minimum Time Step           :     1.30 sec
  Average Time Step           :    10.67 sec
  Maximum Time Step           :    30.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.17


  Analysis began on:  Fri Apr 23 16:14:08 2021
  Analysis ended on:  Fri Apr 23 16:14:10 2021
```

```
Total elapsed time: 00:00:02
```