100989284 Ontario Inc. c/o R.W. Tomlinson Limited

Elmwood Subdivision
Stormwater Management Report

Prepared by:

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Date: August 2025

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August 7, 2025

1000989284 Ontario Inc.
c/o R.W. Tomlinson Limited
Jennifer Ailey, Land Development Manager
100 CitiGate Drive
Nepean, ON K2J 6K7

**Regarding: Elmwood Subdivision
Stormwater Management Report**

Dear Ms. Ailey,

The enclosed report details the existing drainage conditions and provides recommendations for stormwater management and drainage for the proposed Elmwood Subdivision located in the Town of Gananoque.

The proposed Elmwood Subdivision is located in the east end of Gananoque, south of Elizabeth Drive, Churchill Drive, and Arthur Street, and north of the St. Lawrence River. The site is approximately 11.58 ha. and consists of approximately 77 single-detached lots. The subdivision will include the extension of Elmwood Drive, John Street, two new streets, and a proposed parkland.

It is recommended that storm sewers and storm sewer services be installed along the proposed streets.

The development of the Elmwood Subdivision will increase impervious surface coverage, which may affect both the quantity and quality of stormwater runoff. To mitigate potential adverse water quality impacts on downstream infrastructure, the installation of oil grit separators is recommended at the outlet. An enhanced swale is proposed at the discharge point to provide erosion and sediment control.

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

This Report demonstrates that adequate stormwater management controls are available for the proposed subdivision.

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

Sincerely,

FOREFRONT Engineering Inc.

Jeff Homer, P.Eng.
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FOREFRONT Signatures

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Table of Contents

Statement of Qualifications and Limitations

Letter of Transmittal

Appendices

Appendix C

- OWIT Watercourse Catchment Map
- Table 3-1 Surface Cover Parameters
- Pre-Development 100-Year 24-Hour SCS II Modeling
- Post-Development 100-Year 24-Hour SCS II Modeling
- Culvert Report – 1800 x 1200 Culvert Analysis
- Figure 5: Watercourse Improvements
- Figure 6: Enhanced Swale Outlet Details
- Figure 7: Proposed Enhanced Wetland

1. Introduction

Forefront has assembled relevant supporting information for the proposed residential subdivision at Part of Lot 16, Concession 1 in the Town of Gananoque in the County of Leeds.

The proposed Elmwood Subdivision is located in the Town of Gananoque, north of the St. Lawrence River, east of William Street South, and south of Arthur Street. The land to the east is undeveloped, zoned Residential and identified as Significant Woodlands in the Official Plan. The property is bounded by existing residential dwellings to the north and west. Refer to Figure 1: Site Location for reference.

Figure 1: Site Location

The subject site is currently zoned Residential within the Town of Gananoque. The property is currently vacant with no existing structures.

The proposed Elmwood Subdivision is approximately 11.58 ha. and consists of approximately 77 single-detached lots. The subdivision will include the extension of Elmwood Drive, John Street, two new streets, and a proposed parkland.

It is recommended that storm sewers and storm sewer services be installed along the proposed streets, outletting to two oil grit separators and an enhanced swale prior to discharging to the St. Lawrence River.

The development of Elmwood Subdivision will result in an increase in impervious surfaces and could potentially impact stormwater quantity and quality. This Report proposes a plan to address stormwater management concerns and minimize impacts on the natural drainage, downstream infrastructure, and the environment.

Refer to **Appendix A**, **Concept Plan** for the proposed subdivision plan.

2. Existing Site Conditions

The existing subject site is currently vacant. The topography of the subject site generally slopes south overland to the St. Lawrence River. The site is characterized by brush and woodland and a low-lying marsh area near the outlet to the St. Lawrence River. A watercourse traverses the site west to east, outletting to the marsh area prior to discharging to the St. Lawrence River.

The floodplain level of the St. Lawrence River in this area is taken to be 76.10 m (IGLD 85) from the *Cataraqui Conservation Flood Hazard Mapping*, prepared by Zuzek Inc., dated 2024.

The Soil Survey of Leeds County identifies the soil cover of the site as Napanee Clay. Napanee Clay is considered a poorly draining soil, having little opportunity for infiltration.

According to the Cataraqui Source Protection Plan, the subject site and outlet are not located within an intake protection zone (IPZ) or wellhead protection area (WHPA). Parts of the site are considered a significant groundwater recharge area (SGRA) with a score of six. The site is considered a highly vulnerable aquifer (HVA) with a vulnerability score of six. HVA and SGRA account for 90% of the entire Cataraqui Source Protection Area and are characterized by thin soils on fractured bedrock. Refer to the **Source Water Protection Map** in **Appendix A** for reference. As the vulnerability scores are less than eight, the risk is considered low. Where a vulnerability score for HVA and SGRA is four or less, there is no threat. Given that the proposed activity involves small-scale residential stormwater management practices, no source water threats are anticipated from stormwater infiltration or runoff.

The subject site is approximately 11.58 ha in area. Including external lands that drain to the site, a total catchment area of 65.20 ha was reviewed. The development receives external drainage from two external catchment areas, totaling approximately 51.62 ha. These areas are predominantly residential, with some commercial and institutional land cover. The external drainage is divided into two primary outlets:

- **Catchment EX1** contributes approximately 30.68 ha that drains to a watercourse on the subject site. 28.05 ha of this area drains directly to a 750 mm diameter storm sewer along Elizabeth Avenue, which discharges to an open watercourse south of Elizabeth Avenue. The balance drains overland via swales to Elmwood Drive and to the site. The watercourse flows through the development site and outlets to a marsh area prior to discharging to the St. Lawrence River. EX.1 includes drainage from the northern residential neighbourhood, including portions of King Street, Garden Street, Pine Street, Churchill Drive, William Street and Elizabeth Avenue.

- **Catchment EX2** contributes approximately 19.78 ha of drainage from the upstream residential neighbourhood, including Elmwood Drive, McDonald Drive, Maplecroft Court, Arthur Street, Castle Grove subdivision, and several commercial blocks fronting King Street. Under minor storm events, flows from EX.2A and EX.2B are conveyed via the existing municipal storm sewer network and discharge to the site at Arthur Street through a 900 mm diameter storm sewer outlet. During major storm events, only 8.13 ha (EX2B) contributes overland flow to the site, ultimately discharging directly to the marsh located within the subject site. The balance of the drainage from EX2A during major events bypasses the site, discharging eastward along Arthur Street, where it terminates.

For further details regarding the hydrology and hydraulics of the watercourse, refer to **Section 4** of this report. Refer to **Appendix A**, **Figure 2**: **Pre-Development Catchment Areas** for pre-development details. For details regarding the natural heritage of the site, refer to the *Ecological Impact Statement* by WSP.

3. Proposed Development

The proposed Elmwood Subdivision is located north of the St. Lawrence River and is approximately 11.58 ha, consisting of approximately 77 single-detached lots. The development will include the extension of Elmwood Drive, John Street, two new streets, and a proposed parkland.

3.1 Drainage Plan

Site Drainage Plan

Asphalt roads with curbs and gutters and storm sewers are proposed throughout the development. Grading for subdivision should incorporate lot-level conveyance controls that minimize grades to promote reduced peak flows, retention, and infiltration. Lot-level conveyance controls and further details will be provided during the detailed design of the grading and drainage of these areas. These details will be depicted on the final engineering drawings. Preliminary details are provided herein.

Storm sewer and storm sewer services are proposed throughout the subdivision. The proposed storm sewer system is to be sized to convey the minor event outletting to the watercourse before discharging to the St. Lawrence River. Major flows from the subject site (up to and including the 100-year event) are to be conveyed via the right-of-way and overland flow paths. Concentrated outlet locations will be enhanced with rip-rap and geotextile and outlet to an enhanced swale prior to discharging offsite.

Stormwater quality control and erosion and sediment control measures are proposed for the subdivision. Normal Level protection (providing 70% total suspended solids TSS removal) is required for the subject site. To achieve this, storm sewers will outlet to an oil grit separator (OGS) unit, which will provide primary water quality treatment prior to discharge. An enhanced swale is proposed at the outlet to further mitigate sediment transport.

Quantity control in the form of onsite storage is not anticipated to be a requirement, considering the site drains directly to the St. Lawrence River. The existing upstream surrounding area associated outlets are uncontrolled and discharge uncontrolled to the watercourse.

The major flow beyond the capacity of the storm sewer is proposed to be conveyed through overland flow routes. To mitigate major overland flows, the major overland flow for the site is to be maintained within the right-of-way and directed towards sag points in the proposed right-of-way, allowing time for surface runoff to be captured by the storm sewer system. The road profile is designed to ensure that ponding within the proposed right-of-way sag points does not exceed 300 mm.

The design of storm sewers is to adhere to the latest version of the Town of Gananoque guidelines and the Ministry of the Environment, Conservation and Parks (MECP) Consolidated Linear Infrastructure Environmental Compliance Approval (CLI-ECA) guidelines.

The design of the stormwater management facilities is to be designed in accordance with the MECP *Stormwater Management Planning and Design Manual* (2003) and the *Low Impact Development (LID) Stormwater Management Planning and Design Guide* by the Toronto and Region Conservation Authority (TRCA, 2010). Performance criteria are to adhere to Appendix A of the Town of Gananoque CLI-ECA 156-S701.

<u>Water Balance / Low Impact Development</u>

Site constraints for the use of water balance and retention based low-impact development (LID) strategies include poorly draining clay soils. Water balance criteria have not been recommended as part of an area-specific assessment study, natural heritage study, or Class EA. Considering the site drains directly to the St. Lawrence River with no downstream significant recharge area, water balance is not considered a requirement. For all of the above-noted reasons, the use of water balance LIDs is limited onsite and is not recommended for the site. Disconnected roof leaders and lot-level grass swales are proposed throughout to promote infiltration to the extent feasible.

According to the hierarchical approach outlined in Appendix A of the CLI-ECA 156-S701, in cases where site constraints limit LID and water balance implementation, Appendix A of the Town of Gananoque CLI-ECA requires the use of conventional stormwater controls (e.g., normal protection), as proposed.

<u>External Drainage</u>

Upstream drainage from the catchment area EX1 includes stormwater runoff from portions of King Street, Garden Street, Pine Street, Churchill Drive, William Street, and Elizabeth Avenue. Runoff from this area is directed to a 750 mm diameter storm sewer located along Elizabeth Avenue, which outlets to the watercourse west of the site.

The existing watercourse through the site is to be maintained and improved as part of the proposed subdivision. A culvert will be provided at the proposed road crossing, sized to convey flows without impacting the established upstream high-water level of the watercourse. For further details on the high-water level analysis and culvert sizing, refer to **Section 4** of this report.

Upstream drainage from catchment area EX2 is conveyed to the site from the north residential neighbourhoods via a storm sewer system and a 900 mm diameter storm sewer outlet, and the associated major overland flow path within the right-of-way. This catchment includes portions of Elmwood Drive, McDonald Drive, Arthur Street, the Castle Grove subdivision, and several commercial blocks fronting King Street.

As part of the proposed subdivision, the existing 900 mm storm sewer is to be extended through the site to discharge the catchment area EX2 directly to the outlet, bypassing the proposed storm sewer system while maintaining the existing drainage pattern and conveying upstream flows safely to the receiving watercourse.

Please refer to **Appendix A**, **Figure 3**: **Post-development Catchment Areas (Major Event)** for the proposed stormwater management details.

3.2 Storm Sewers

Storm sewers are proposed throughout the subdivision. The storm sewer system is to be designed for the 5-year storm event (minor event) from the subject site based on the Ministry of Transportation (MTO) IDF curve and Manning's equation. Refer to the **MTO IDF Curve Lookup** in **Appendix B** for reference. It is recommended that the design of the storm sewer system provide surcharge protection for all storm events up to and including the major flow event.

Service laterals are to be provided to all lots, with backwater valve devices required at each dwelling.

The storm sewer is to be sized utilizing the rational method and the minor event design storm:

$$Q = 2.78\,AIR$$

where Q = Design flow in l/s,

A = drainage area in hectares.
I = rainfall intensity in mm/hr., and
R = runoff coefficient.

A minimum time of concentration (t_c) of 15 minutes shall be applied for calculating runoff to storm sewers. Runoff coefficients are to be based on the latest version of the MECP CLI-ECA guidelines.

Refer to the **Storm Sewer Design Sheet** calculations in **Appendix B** and **Figure 4: Post-development Catchment Areas (Minor Event)** in **Appendix A** for preliminary storm sewer design details.

3.3 Water Quantity

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

Given the proximity to the St. Lawrence River, quantity control in the form of quantity storage is not required. The proposed stormwater management strategy for the subdivision is to ensure the safe conveyance of runoff, mitigate the risk of flooding, provide water quality treatment, and control erosion and sedimentation. The storm sewer system will be designed to accommodate the 5-year design event, while overland flow routes will be sized to safely convey flows from the 100-year storm event.

3.3.1 Analysis

3.3.2 Design Storm Events

Minor System

Storm sewers are proposed throughout the subdivision to be designed for the 5-year storm event to convey runoff to an OGS before discharging offsite.

Major System

Major flow will be directed to a low point in the right-of-way via the storm sewer and major overland flow path. The combination of the minor system and major system is to convey up to the 100-year event. Ponding under blocked outlet conditions will be limited to a depth of 300 mm within the subdivision.

Preliminary calculations demonstrate that the major overland flow can be maintained within the ROW for all storm events up to the major event.

Quality and Erosion Control Event

In the case of oil grit separators, the *Ministry of Environment Stormwater Management Manual* recommends that for normal protection, oil grit separators be sized to capture and treat a minimum of 85% of the total runoff volume that occurs on a *long-term average basis* and remove 70% of suspended solids as required by enhanced protection.

For enhanced swales, the *Ministry of Environment Stormwater Management Manual* refers to a 12.5mm to 25mm 4-hour Chicago storm event for sizing quality treatment and erosion control facilities in Ontario that are not included in MECP Table 3.2 of the Manual.

The following formula has been developed for the geographic 90th percentile event for use with the rational method, also known as the 25mm- 4-hour design storm, for this area to design for conveyance capacity:

$$I_{25mm} = \frac{498}{(t_c + 9.7)^{0.825}}$$

3.3.3 Hydrology

Runoff Coefficient

The runoff coefficient (R) is a dimensionless coefficient relating the amount of runoff to the amount of precipitation received. It is a larger value for areas with low infiltration and high runoff (pavement, steep gradient), and lower for permeable, well-vegetated areas (forest, flat land). Coefficients were assigned based on surface cover and soil conditions as follows:

Table 3-1 Runoff Coefficients

Urban	
Land Use & Topography	**Runoff Coefficients**
Asphalt, concrete, roof areas	0.90
Grassed area, parkland	0.15 – 0.35
Sandy Soil	0.05 – 0.25
Playground	0.20 – 0.35
Gravel	0.60 – 0.70
Forest and Dense Wooded Areas	0.10 – 0.25
Bare Rock (5% to 30% slopes)	0.40 – 0.85
Note: Values are a combination of the Ministry of Environment, Conservation, and Parks (MECP) CLI-ECA Guidelines Table 3 and the Ministry of Transportation (MTO) Drainage Manual Table 1.07	

To reflect the unique hydrologic properties within each subcatchment, a variety of surface cover types were defined. A runoff coefficient of 0.20 is to be used for grassed and soft landscape surfaces, and 0.90 is proposed for asphalt and rooftops.

The existing subdivision to the west is a semi-urban cross-section with roadside ditches and single detached lots greater than 400 m^2. A coefficient of 0.40 is appropriate for the area. For the fully urbanized development of Castle Grove subdivision, located north of MacDonald Drive, consisting of curb and gutter and townhouse units, a runoff coefficient of 0.55 is used as per the approved Castle Grove plans. For the proposed Elmwood Subdivision, a runoff coefficient of 0.50 is calculated for areas draining to the storm sewer. Refer to the **Composite Runoff Coefficient Calculations** in **Appendix B**.

Time of Concentration

The time of concentration, t_c, is calculated with the Bransby Williams and Kirpich Method, and the shorter duration is selected to provide a conservative flow estimate. Typically, the Bransby Williams method is used for catchment areas with a C factor greater than 0.40, and the Kirpich method is used for catchments with a C factor less than 0.40.

A minimum time of concentration of 15 minutes is to be used for sizing the storm sewer and onsite stormwater management devices.

The results shown in Table 3-2 quantify the peak rate of surface runoff calculated using the rational method and assigned catchment characteristics for the proposed subdivision.

Table 3-2 Peak Flows in Post-Development Conditions

Proposed Conditions	25mm Quality Event		2-Year Design Storm		5-Year Design Storm		100-Year Design Storm	
Description	Intensity I (mm/hr)	Peak Flow Q (m^3/s)	Intensity I (mm/hr)	Peak Flow Q (m^3/s)	Intensity I (mm/hr)	Peak Flow Q (m^3/s)	Intensity I (mm/hr)	Peak Flow Q (m^3/s)
Site + External Areas to OGS 1	33.3	0.14	49	0.21	66	0.29	111	0.48
Site + External Areas to OGS 2	27.6	0.23	38	0.32	52	0.44	88	0.73
Bypass Areas	35.3	0.29	53	0.44	72	0.60	120	1.00

As noted above, the proposed storm sewer is to be sized to convey the minor storm event. The major overland flow for the site is to be maintained within the right-of-way and directed towards sag points in the proposed right-of-way, allowing time for surface runoff to be captured by the storm sewer system, thereby minimizing major overland flow directed downstream.

Ditch inlets and rear yard catch basins are to be sized to convey larger storm events up to the 100-year event where a major overland flow path is not available.

A maximum of 300 mm ponding within the overland flow path is recommended during the major storm event.

Stormwater quality controls are proposed for this subdivision. No formal quantity control in terms of onsite storage is recommended as the site drains directly to the St. Lawrence River. The upstream residential neighbourhoods do not have any formal stormwater management controls beyond lot-level controls. Based on the stormwater management measures, there are no adverse impacts on the downstream environment.

Refer to **Appendix B** for **Rational Method Calculations** and **Major Overland Flow Calculations**. Overland flow calculations are provided for the major flow path at critical locations.

The existing and proposed drainage areas directed to the storm sewer were reviewed as part of the analysis. Preliminary **Storm Sewer Design** calculations in **Appendix B** demonstrate that the full buildout of the storm sewer is capable of conveying up to the 5-year storm event out to the St. Lawrence River (**Outlet 1**).

For details regarding the existing storm sewer on Arthur Street, refer to the **Existing and Proposed Storm Sewer Design Sheet – Castle Grove Subdivision** in **Appendix C**, taken from the *Castle Grove Stormwater Management Report*, dated May 2024, and prepared by Forefront Engineering Inc.

3.4 Water Quality

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

Based on the characteristics of the receiving outlet, level 2 or ‘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.

Oil grit separators (OGS) have been selected as the preferred stormwater quality control measure for this subdivision due to a combination of site constraints and treatment requirements. The site contains two outlets: Outlet 1, with an area of 2.17 ha, and Outlet 2, with an area of 3.05 ha. Given that there are two outlets, and the catchment areas are less than 5 ha, larger end-of-pipe facilities such as a wet pond-type stormwater management facility are not practical.

OGS units are well-suited for treating runoff from urban areas and are capable of achieving normal level protection (70% TSS removal), as required for this subdivision. An enhanced swale is proposed downstream of the outlets to provide supplementary sediment control and promote further water quality enhancement.

The selected OGS units offer a compact footprint, are compatible with the site’s existing grading and outlet constraints and are readily accessible for maintenance via vacuum truck.

3.4.1 Oil Grit Separator

The proposed storm sewers will outlet to two oil grit separators prior to discharging to the outlet. The proposed oil grit separators will provide in excess of 70% total suspended solids removal.

The Stormwater Management Planning and Design Manual recommends that for normal protection, oil grit separators be sized to capture and treat 85% of the total runoff volume that occurs on a *long-term average basis* and remove 70% of suspended solids as required by normal protection.

Drainage from a catchment area of 2.17 ha is to be conveyed to a Rainwater Management pre-cast concrete oil grit separator (OGS-1), model RWM DM 2400 OS, providing a normal level of treatment prior to outletting to the 600 mm diameter storm sewer outlet. The OGS-1 unit has been sized for a treatment flow rate of 88 L/s and a sediment and oil storage capacity of 2.2 m^3.

Drainage from a catchment area of 3.05 ha is to be conveyed to a Rainwater Management pre-cast concrete oil grit separator (OGS-2), model RWM DM 2400 OS, providing a normal level of treatment prior to outletting to the 675 mm diameter storm sewer outlet. The OGS-2 unit has been sized for a treatment flow rate of 88 L/s and a sediment and oil storage capacity of 2.2 m^3.

Refer to **Appendix B**: **Echelon Environmental OGS Sizing Reports and Cumulative Volume Calculations** for further details.

As required in Schedule D of the Town of Gananoque System 156-S701 CLI-ECA, the proposed OGS unit is a verified technology in accordance with TRCA protocol *Procedure for Laboratory Testing of OGS* with the ISO 14034 Environmental Technology Verification (ETV) protocol. Refer to ETV verification statement number GPS-ETV_V2022-09-15 for further details.

3.4.2 Enhanced Swale

Enhanced grass swales are a LID type of stormwater management control. The MECP Stormwater Design Manual (2003), TRCA *Low Impact Development Stormwater Management Planning and Design Guide* (2010), and the Environmental Protection Agency (EPA) website have been used as our terms of reference.

Unlike the general MECP Table 4.3 manual approach, which proposes volume recommendations for quality control and a minimum 24-hour drawdown time, enhanced swales are flow rate-based and are to be designed to certain flow criteria and not actually retain a specific volume for quality control. Enhanced swales treat flows through vegetation, slowing the water to allow sedimentation and filtering through a subsoil matrix. A rock check dam has been included in the design to promote the treatment quality and further reduce velocities to less than 0.5 m/s.

Runoff onsite will be directed to a 1.0 m wide flat-bottom enhanced swale with 3H:1V side slopes. A single 0.3 m high weir rock check dam is proposed at the outlet of each enhanced swale. The enhanced swale and check dam is to be sized to reduce peak flow velocities to 0.5 m/s during the 25 mm storm event.

The proposed storm sewer will outlet to an enhanced swale incorporating a check dam prior to discharging to the watercourse. This configuration is intended to reduce outlet velocities during the 25 mm storm event to below 0.50 m/s, mitigating potential sediment transport and erosion impacts at the discharge point. The enhanced swales with check dams provide additional quality treatment prior to runoff discharging to the outlet.

Refer to **Figure 6: Enhanced Swale Outlet Details** in **Appendix C** for further preliminary details regarding the enhanced swale design. Calculations for the enhanced swale 100-year event and the 25 mm event, demonstrating the maximum velocity less than 0.50 m/s during the 25 mm event, are provided in **Channel Reports** in **Appendix B**.

The proposed subdivision achieves normal (level 2) stormwater quality protection and ensures a safe and controlled conveyance of stormwater up to and including the 100-year event and under blocked outlet conditions to the St. Lawrence River. It incorporates sediment and erosion control measures, along with minimum sediment and erosion control measures. Stormwater runoff from the subdivision will not adversely impact the natural environment or downstream infrastructure.

3.5 Maintenance

Oil Grit Separator and Storm Sewer

The oil grit separator will separate the oils and sediment from runoff onsite and will require annual maintenance and pumper truck access. The Owner shall inspect the OGS at least once a year and, if necessary, after any major spills have occurred and clean and maintain the stormwater works to prevent the excessive build-up of sediments and oil/grit.

Periodic maintenance inspection of the facilities is the responsibility of the Owner. A summary of observations during inspection of the facility over the course of the year should be provided. These observations should include comments on the:

- hydraulic operation of the facilities (detention time, evidence, or occurrence of overflows),
- 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 the inspection and maintenance program for the coming year.

The pipe system will require routine periodic maintenance, including hydro vacuuming, flushing, and debris removal annually. Removal of accumulated sediment will be required.

The system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded; however, it is recommended that the system be cleaned prior to that for easier removal of sediment.

The level of sediment in the OGS is easily determined by measuring from the finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine whether the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of the isolated sump.

The sediment should be tested to determine the disposal options. The MECP publishes sediment disposal guidelines which should be consulted for up-to-date information pertaining to the exact parameters and acceptable levels for the various disposal options.

Oil levels greater than 2.5 cm should be removed immediately by a licensed waste management firm.

The following are instructions and best practices for cleaning the oil grit separator unit:

- Work should take place during dry weather and no flow conditions.
- Vacuum trucks are the most effective means of sediment and pollutant removal.
- Completely drain the system and fully excavate the sediment from the sump.
- The system requires cleaning immediately following a large hydrocarbon spill event.
- Hydrocarbon accumulation should be removed using absorbent pads.
- Trash and debris can be separated from the pollutants.
- Screens should be power-washed.
- Confined space entry procedures should be followed.
- Pollutants should be disposed of and handled as per MECP guidelines.

It is recommended that conditions for testing, inspections, reporting, and monitoring programs be included in the Subdivision Agreement as provided for in Schedule E of the Consolidated Linear Infrastructure Environmental Compliance Approval for the Town of Gananoque Stormwater Management System 156-S701 CLI-ECA to ensure compliance prior to and after assumption by the Town of Gananoque.

The Owner is to prepare an “Operations and Maintenance Manual” prior to the commencement of operation of the stormwater management works to the satisfaction of the Town of Gananoque. The Owner is to maintain the Operations and Maintenance Manual and logbook current and retain a copy at the Owner’s administrative office for the operational life of the facility. The manual is to be read with consideration for the conditions in the Subdivision Agreement and as provided for in the 156-S701 CLI-ECA. The **OGS Maintenance Manual** is provided in **Appendix B** for reference.

<u>OGS 1</u>

Based on a 70% TSS capture efficiency, drainage area of 2.17 ha, runoff coefficient of 0.50, average annual rainfall of 791 mm, influent grit concentration of 150 mg/L (STEP database), and compacted grit density of 1,600 mg/L it can be expected that the OGS will accumulate an estimated 560 L of grit and oil annually. The OGS has 2.2 m^3 of grit and oil storage capacity, requiring a cleanout of the OGS every 4 years on average.

OGS 2

Based on a 70% TSS capture efficiency, drainage area of 3.05 ha, runoff coefficient of 0.50, average annual rainfall of 791 mm, influent grit concentration of 150 mg/L (STEP database), and compacted grit density of 1,600 mg/L it can be expected that the OGS will accumulate an estimated 790 L of grit and oil annually. The OGS has 2.2 m^3 of grit storage capacity, requiring a cleanout of the OGS every 3 years on average.

Enhanced Swale

Maintenance of the enhanced swale will generally be no different than maintenance of lawns and landscape areas. The enhanced swale will require routine periodic maintenance, including weed control and trash removal, which will be required once per year. Removal of accumulated sediment and replacement of plantings should be evaluated annually.

Monitoring Program and Annual Performance Report

As required by Schedule E of the Town of Gananoque CLI-ECA 156-S701, the Owner is to carry out a monitoring program and evaluate the performance of both OGS. The monitoring program is to commence at the initial completion of construction of the treatment facility and continue for a minimum of two (2) years after 90% of the buildings within the subdivision have been constructed or until the subdivision has been assumed by the municipality, whichever occurs first.

The monitoring program shall include obtaining annual grab samples at both oil grit separators. Samples must be tested for oil & and grease, and results recorded. The Owner shall maintain records of the results of all monitoring operations undertaken and shall make available the records for inspection by the Town of Gananoque upon request. The records are to include the following:

a. The name of the Stormwater Works;
b. The name of the person who conducted the monitoring, or the name of the inspecting official, where applicable;
c. The date and results of each sample taken under the monitoring program (described above);
d. quantity and frequency of slop oil disposal from the manufactured treatment device, including a copy of the disposal manifest;
e. A summary of all monitoring data along with an interpretation of the data and an overview of the condition and operational performance of the infrastructure and any Adverse Effects on the Natural Environment (Adverse Effect as defined in the Environmental Protection Act, R.S.O. 1990, c. E.19);
f. Includes a summary and interpretation of environmental trends based on all monitoring information and data for the previous years; and
g. Includes a summary of the calibration and maintenance carried out on all monitoring equipment.

The monitoring records are to be signed and sealed annually by the Engineer certifying the records are kept accurate and current and that the facility is operating in compliance with the CLI-ECA SWM Permit and the Town of Gananoque Sewer Use By-Law No. 2005-004. The Engineer is to maintain monitoring records as part of the Annual Performance Report and submit to the Town of Gananoque upon request.

The Owner is to make a request in writing and receive approval from the Municipality to conclude the monitoring program.

3.6 Quality Control (Short Term)

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.

Straw bale filters are to be provided in overland swale systems.

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 are the Owner’s responsibility.

4. Watercourse

4.1 Watercourse Analysis

The watercourse catchment was delineated using a combination of limited-scope field survey data completed by Forefront staff, combined with high-resolution LIDAR and DRAPE imagery provided by the Cataraqui Region Conservation Authority (CRCA). Forefront reviewed the LIDAR data and conducted limited field verification with a topographic survey. Within the site, the watercourse was surveyed to validate the accuracy of the LIDAR data. In areas where a detailed topographic survey was inaccessible to the equipment, LIDAR data was used as a substitute to support the hydrologic and hydraulic analysis.

The subject site is approximately 11.58 hectares in area. When combined with external lands that contribute drainage to the site (approximately 51.62 ha), the total catchment area reviewed for stormwater management is 65.30 ha. Approximately 3.85 ha of the subject site drains directly to the St. Lawrence River, bypassing the watercourse and marsh area. The total drainage area directed to the watercourse and associated marsh area is 59.35 ha.

The subdivision receives runoff from several external catchments, predominantly residential with some commercial and institutional land uses. The drainage is subdivided into the following contributing areas:

<u>Subject Site Catchments</u>

- **Catchment Area E1:** This catchment is the existing site that drains directly to the watercourse. It is primarily brush and woodland. This area is approximately 4.06 ha with 6.4% imperviousness.

- **Catchment Area E2**: This catchment is the existing site that drains directly to the low-lying marsh area. It is primarily low-lying marsh, brush, and woodland. This area is approximately 3.67 ha with 6.4% imperviousness.

- **Catchment Area E3**: This remaining 3.85 ha is the site that drains directly to the St. Lawrence River and is not included in the following analysis.

<u>External Catchments</u>

- **Catchment Area EX1A and EX1B**: The upstream watercourse receives drainage from the northwest by a drainage area of approximately 28.05 ha, which includes stormwater drainage from portions of King Street, Garden Street, Pine Street, Churchill Drive, William Street, and Elizabeth Avenue. Runoff from this area is conveyed via a 750 mm diameter storm sewer along Elizabeth Avenue and a major overland flow path from William Street, which discharges to the existing watercourse west of the site. The King Street catchment area is ±75% impervious, draining to the storm system. The residential neighbourhood is a semi-urban cross-section with roadside grass swales draining to the storm sewer on Elizabeth Avenue, having an imperviousness of ±40%.

- While it is likely that many of the commercial developments along King Street have onsite stormwater management controls capable of attenuating runoff up to the major (100-year) event to an acceptable limit or pre-development limits, for this analysis, the sites have been considered as uncontrolled to reflect a conservative estimate. Runoff from the residential neighbourhood drains uncontrolled to the storm sewer or via roadside ditches and major overland flow paths to the outlet.

- **Catchment Area EX1C:** Runoff from the part of the residential neighbourhood north of the site along Elmwood Drive is directed to the north portion of the subject site, eventually discharging to the watercourse. The residential catchment area is approximately 2.63 ha at 40% impervious.

- **Catchment Area EX2A and EX2B:** Drainage from approximately 19.78 ha of the upstream residential neighbourhood, including Elmwood Drive, Maplecroft Court, McDonald Drive, Arthur Street, Castle Grove subdivision, and several commercial blocks fronting King Street drain to the watercourse and marsh area. Under minor storm events, flows from EX2A and EX2B are conveyed via the existing municipal storm sewer network and discharge to the site at Arthur Street through a 900 mm diameter storm sewer outlet.

- During major storm events, only 8.13 ha from EX2B contributes overland flow to the site, ultimately discharging directly to the marsh located within the subject site. The balance of the overland flow drainage from EX2A during major events bypasses the site, discharging eastward along Arthur Street following the major overland flow path. All runoff from the residential neighbourhoods drains uncontrolled to the outlet. Although the Castle Grove subdivision is not yet fully developed, it has been assessed as if it were fully developed.

- **Catchment Area EX2C**: Drainage from 1.16 ha of the rear of several residential lots drains directly to the low-lying marsh area on the subject site via swales and sheet flow.

Refer to **Figure 2** in **Appendix A** for details regarding the pre-development catchment areas.

The total drainage area draining to the watercourse to the west of the property limit is approximately 28.05 ha. For comparison, the Ministry of Natural Resources and Forestry Ontario Watershed (OWIT) Information map calculates the upstream catchment area from EX1 to be approximately 24.00 ha to the west boundary of the site. Noting that OWIT has limitations and is intended for screening-level analysis only. The tool relies on coarse-scale digital elevation models, which may not capture detailed site topography or account for underground infrastructure, such as storm sewers and culverts. OWIT results were supplemented and verified using high-resolution LIDAR, site-specific topographic survey data, as-built drawings, and field observations to ensure accurate catchment delineation for the proposed subdivision. Refer to **Appendix C** for the **OWIT Watercourse Catchment Map** for reference.

The existing watercourse is wider near its upstream inlet, with a flat bottom width of approximately 2 to 3 m. As it approaches the west property limit of the subject site, the cross section narrows, with the flat bottom width reducing to between 0.5 and 1.0 m. The watercourse is characterized by weedy growth, cobbles, and light brush along the banks, with slight meandering as it flows toward the outlet into the marsh area. Manning's roughness coefficient of 0.045 is considered appropriate for the main channel, increasing to 0.050 in the vicinity of the marsh, where vegetation becomes denser. The watercourse has an approximate depth of 0.9 m at the upstream inlet, gradually decreasing to

±0.4 m to the top of the defined north bank as it traverses the site. The south bank is significantly higher in elevation than the north bank, which transitions to a generally flat terrain beyond the defined channel. The banks of the existing watercourse are typically unstable and susceptible to erosion.

Runoff from the upstream catchment is conveyed via a 750 mm diameter storm sewer along Elizabeth Avenue, which has an average slope of 0.56% and a rated capacity of approximately 0.80 m^3/s, corresponding to the 5-year design storm. Flows exceeding this capacity are conveyed via the major overland flow route. Based on hydrologic modeling, the 100-year peak flow at the west property limit is estimated at 2.05 m^3/s.

Within the site, the watercourse crosses under an existing access road by means of three (3) 500 mm diameter culverts, located near the proposed road crossing. The culverts have an estimated capacity of approximately 0.75 m^3/s, which is generally consistent with the 2-year event. Storm events exceeding this threshold result in overtopping of the crossing.

An additional 900 mm diameter outlet located at Arthur Street conveys stormwater directly to the marsh area. The 100-year peak flow from the contributing catchment to this outlet is estimated at 1.73 m^3/s.

The combined 100-year peak flow directed to the St. Lawrence River, from a contributing drainage area of approximately 59.35 ha, is assessed to be 4.59 m^3/s.

The floodplain elevation of the St. Lawrence River is 76.10 m (IGLD 85), based on the *Cataraqui Conservation Flood Hazard Mapping* prepared by Zuzek Inc. (2024). This elevation has been applied as the downstream initial water level boundary condition in the hydraulic analysis.

Refer to **Figure 4.1** below for details regarding the watercourse alignment and corresponding cross-section stations.

Figure 4.1 – Watercourse Alignment

4.1.1 Hydrology

The hydrologic analysis for the watercourse catchment area was completed using the most recent version of the U.S. Environmental Protection Agency's Storm Water Management Model 5 (SWMM5). SWMM5 is a widely accepted and reliable modelling tool for simulating hydrologic and hydraulic responses in both urban and rural watersheds. It has been extensively applied in stormwater management analyses across Ontario. Regulatory agencies recognize it as an appropriate method for assessing runoff, flow rates, and system performance under various design storm conditions.

The 100-year storm event 24-hour SCS Type II distribution was used to assess the 100-year peak flow and high-water level. A 6-hour SCS Type II was also evaluated, and the 24-hour SCS II had the greater peak flow of the two scenarios. The results of the hydrologic analysis included the following:

- A rainfall depth of 120 mm for the 24-hour 100-year storm event taken from the latest MTO IDF Curve Lookup data.

- Infiltration was considered using the Green-Ampt model. A conservative clay soil type, characterized by a suction head of 290 mm, a saturated hydraulic conductivity of 1 mm/hr, and an initial soil moisture deficit of 0.205, was selected based on the Soil Survey of Leeds County and the soil class for the area, which identifies the soil in the area as Napanee Clay.

- A 100-year, 24-hour SCS Type II peak flow of 2.05 m^3/s was calculated from Catchment Area EX1 to the existing 500 mm diameter culvert crossing, increasing to 2.23 m^3/s downstream of the culvert where flows from EX1C combine with flows from EX1A and EX1B. A peak flow of 1.73 m^3/s is calculated from Catchment Area EX2. Within the marsh area, where flows from the subject site, EX1 and EX2 converge, the combined peak flow reaches approximately 4.59 m^3/s before discharging to the St. Lawrence River.

- Percent Imperviousness for the catchment areas was determined to be approximately 75% impervious with the urban cross-section along King Street, 40% impervious for the residential semi-urban cross-section with roadside ditches in the residential neighbourhoods south of King Street, and up to 55% for the higher density fully urbanized residential cross-sections. Refer to **Table 3-1 Surface Cover Parameters** in **Appendix C** for details.

4.1.2 Hydraulics

Hydraulic analysis was completed using the most recent version of the HEC-RAS River Analysis System software (Version 6.5, released March 2024). The software is widely used in similar open-channel flow analyses 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.

A Steady State Flow analysis with a combination of subcritical and supercritical flow (mixed flow regime) was conducted for the proposed channel re-alignment. 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, Froude Number, and maximum flow depth for the proposed scenario.

The watercourse cross-section is a flat-bottom 2 m wide near the upstream inlet at Elizibeth Avenue and narrows within the site to 0.5 to 1 m width, opening up as it enters the marsh, having an average longitudinal slope of between 0.4% to 1.4% and a Manning's n value of 0.045 for the watercourse, and 0.050 for the marsh area. The average depth of the watercourse is ±0.4 m to the top of the bank through the site. Flows with depths exceeding approximately 0.4 m overtop the north bank, spilling into the adjacent valley area.

The profile and sections utilize information gathered from topographic survey and are supplemented by LIDAR data where survey data is incomplete, particularly in areas with heavier brush.

The following cross-section parameters were input into the geometric module:

- Peak Flow: 2.05 m^3/s – 4.59 m^3/s (100 Year Event)
- Manning's n: 0.045 to 0.050

From MTO Design Chart 2.01, a Manning's n value of 0.045 is appropriate for a natural watercourse having a slight meander, irregular cross section, high grass, weeds, and light brush.

Refer to **Appendix C** for the **Pre-development 100-year Event 24-hour SCS II Modeling** for the SWMM5 model details.

The existing watercourse alignment and reach data were input into HEC-RAS with the critical sections selected from the topographic survey. Refer to Table 4-1 below for the results of the existing watercourse HEC-RAS analysis.

Table 4-1 – Existing Watercourse HEC-RAS Analysis

W.S. = Water Surface, E.G. = Energy Grade Line, Elev. = Elevation, Crit = Critical Flow

Station	Q (m^3/s)	Min. Elev. (m)	W.S. Elev. (m)	W.S. Crit. (m)	W.S. Height (m)	E.G. Elev (m)	E.G. Slope (m/m)	Velocity (m/s)	Flow Area (m^2)	Froude Chl.
570	Elizabeth Avenue & William Street Outlet									
540	2.05	80.12	80.85		0.73	80.94	0.014	1.35	1.52	0.67
520	2.05	79.85	80.73		0.88	80.77	0.005	0.91	2.26	0.42
500	2.05	80.12	80.47	80.47	0.35	80.56	0.037	1.31	1.57	1.01
460	2.05	78.98	79.77		0.79	79.82	0.007	1.05	1.94	0.49
420	2.05	78.75	79.36		0.61	79.42	0.012	1.14	1.80	0.64
400	2.05	78.44	79.30		0.86	79.31	0.003	0.47	4.32	0.28
380	2.05	78.39	79.21	78.85	0.82	79.23	0.008	0.58	3.53	0.46
	3 x 500mm Culvert Crossing (Invert 78.37)									
360	2.05	77.99	78.70		0.71	78.73	0.007	0.71	2.91	0.45
340	2.05	77.84	78.58		0.74	78.60	0.006	0.64	3.18	0.44
320	2.05	77.83	78.40		0.57	78.43	0.011	0.78	2.63	0.56
300	2.05	77.74	78.25		0.51	78.28	0.006	0.68	3.02	0.42
280	2.05	77.68	77.95	77.95	0.27	78.03	0.039	1.30	1.58	1.01
260	2.05	77.36	77.59		0.23	77.61	0.012	0.65	3.15	0.57
240	2.05	76.95	77.39		0.44	77.41	0.009	0.61	3.35	0.48
220	2.23	76.84	77.14		0.30	77.17	0.017	0.78	2.86	0.66
200	2.23	76.44	76.83		0.39	76.86	0.015	0.74	3.03	0.62
180	2.23	76.19	76.61	76.54	0.42	76.62	0.009	0.54	4.09	0.49
160	2.23	75.96	76.30	76.28	0.34	76.32	0.028	0.74	3.01	0.79
	Watercourse Outlet to Marsh									

140	2.23	75.72	76.19		0.47	76.19	0.003	0.31	7.27	0.26
120	2.23	75.80	76.16		0.36	76.17	0.001	0.19	11.52	0.13
100	2.23	75.60	76.16		0.56	76.16	0.000	0.12	18.28	0.08
	Arthur Street Outlet									
1+45	1.73	76.40	76.54	76.54	0.14	76.59	0.940	0.94	1.79	1.01
1+30	1.73	76.20	76.43	76.35	0.23	76.44	0.440	0.44	3.83	0.43
1+15	1.73	76.09	76.25	76.25	0.16	76.29	0.920	0.92	1.83	1.02
	Marsh									
80	4.59	75.57	76.15		0.58	76.16	0.000	0.12	39.30	0.06
60	4.59	75.40	76.15		0.75	76.15	0.000	0.13	34.67	0.05
40	4.59	75.22	76.15		0.93	76.15	0.000	0.21	21.84	0.08
20	4.59	75.40	76.10	75.80	0.70	76.14	0.005	0.86	5.36	0.38
	St. Lawrence River Outlet (Invert 75.20 / HWL 76.10)									

From Table 4-1, it can be seen that the average high-water depth within the watercourse and corresponding floodplain area is approximately 0.4 m to 0.7 m downstream of station 360, with a maximum depth of 0.82 m occurring at the inlet of the 500 mm culvert crossing at Station 380, where overtopping occurs due to energy losses at the culvert. The high-water level generally overtops the north bank of the watercourse channel into the adjacent valley.

4.2 Proposed Watercourse Improvements

As part of the proposed subdivision, improvements are proposed for the existing watercourse within the subject site. The general alignment of the watercourse will be maintained within a dedicated open space block. This block will be conveyed to the municipality as part of the subdivision.

The existing watercourse is currently characterized by an irregular cross-section, unstable side slopes, and localized erosion. The proposed improvements aim to formalize the watercourse channel geometry and enhance long-term conveyance and stability. The improvements will confine high-water levels within a defined cross section, incorporating a consistent channel cross section with 3H:1V side slopes, and provide adequate freeboard under major storm events. The channel is to be grass-lined throughout, and the suitability of the vegetative liner is discussed in the following section. These improvements will mitigate ongoing erosion and ensure a predictable hydraulic response over time.

Hydraulic modeling confirms that the proposed works will maintain or reduce flood elevations under both existing and future conditions, with no increase in flood risk upstream or downstream. The improved channel reduces the overall floodplain extent within the site, while improving flow conveyance and slope stability. The improvements are a proactive measure to ensure long-term resilience and to support the safe integration of subdivision adjacent to the watercourse.

A new street is proposed crossing the watercourse. An 1800 mm by 1200 mm (span/rise) concrete box culvert is proposed to replace the existing 3 x 500 mm diameter culverts. The HEC-RAS model below demonstrates that the upstream high-water level remains the same at the culvert crossing. The proposed box culvert is adequately sized to convey the 100-year event.

The proposed watercourse channel is a 1.0 m flat bottom, with stable 3H:1V side slopes, and will include a freeboard. The minimum depth of the proposed watercourse channel is 1.0 m, including freeboard. The channel is to be sized to ensure velocities during the 100-year event will be less than 1.8 m/s, considered the upper range for natural stable grass-lined banks.

Elmwood Subdivision is proposed to drain uncontrolled to the watercourse. The subject site is to drain to a low point in the proposed street at the culvert crossing, and outlet on the east side of the proposed street. The 100-year 24-hour SCS II peak flow within the watercourse east of the culvert increases from 2.05 m^3/s to 3.09 m^3/s, and to the St. Lawrence River increases from 4.59 m/^{3}s to 5.58 m^3/s.

The subject site is proposed to have a 50% imperviousness. A conservative composite 47% imperviousness is estimated, including the watercourse area and improved marshland.

Refer to **Post-development 100-year Event 24-hour SCS II Modeling** in **Appendix C** for SWMM5 modeling and **Figure 3: Post Development Catchment Areas (Major Event)** in **Appendix A** for details.

The proposed watercourse alignment and reach data were input into HEC-RAS with the critical sections selected from the topographic survey. Refer to Table 4-2 below for the results of the proposed watercourse HEC-RAS analysis.

Table 4-2 – Proposed Watercourse HEC-RAS Analysis

W.S. = Water Surface, E.G. = Energy Grade Line, Elev. = Elevation, Crit = Critical Flow

Station	Q (m^3/s)	Min. Elev. (m)	W.S. Elev. (m)	W.S. Crit. (m)	W.S. Height (m)	E.G. Elev (m)	E.G. Slope (m/m)	Velocity (m/s)	Flow Area (m^2)	Froude Chl.
570	Elizabeth Avenue & William Street Outlet									
540	2.05	80.12	80.85		0.73	80.93	0.011	1.26	1.63	0.62
520	2.05	79.85	80.75		0.90	80.78	0.004	0.79	2.58	0.39
500	2.05	80.12	80.49	80.49	0.37	80.57	0.038	1.29	1.59	1.01
460	2.05	78.98	79.73		0.75	79.80	0.009	1.15	1.79	0.55
420	2.05	78.75	79.43		0.68	79.47	0.005	0.89	2.29	0.44
400	2.05	78.44	79.35	78.96	0.91	79.37	0.002	0.59	3.45	0.28
	1800mm (Span) x 1200mm (Rise) Culvert									
380	3.09	78.40	78.98	78.98	0.58	79.17	0.018	1.89	1.63	1.01
360	3.09	77.99	78.80		0.81	78.87	0.004	1.10	2.80	0.51
340	3.09	77.86	78.75		0.89	78.79	0.003	0.95	3.27	0.42
320	3.09	77.87	78.64		0.77	78.72	0.005	1.19	2.59	0.56
300	3.09	77.74	78.56		0.82	78.62	0.004	1.08	2.86	0.50
280	3.09	77.70	78.34	78.29	0.64	78.48	0.013	1.65	1.87	0.85
260	3.09	77.40	77.99	77.99	0.59	78.17	0.018	1.89	1.63	1.01
240	3.09	77.01	77.76		0.75	77.84	0.006	1.25	2.47	0.60
220	3.09	76.87	77.46	77.46	0.59	77.64	0.018	1.89	1.63	1.01
200	3.09	76.46	77.10		0.64	77.23	0.012	1.62	1.90	0.83
180	3.09	76.20	76.83	76.79	0.63	76.97	0.014	1.71	1.80	0.89
160	3.09	75.95	76.70		0.75	76.78	0.006	1.24	2.49	0.59
	Watercourse Outlet to Marsh									
140	3.54	75.15	76.43		1.28	76.17	0.000	0.12	29.04	1.01
120	3.54	75.15	76.17		1.02	76.17	0.000	0.06	57.94	0.04
100	3.54	75.15	76.17		1.02	76.17	0.000	0.06	59.45	0.01

80	3.54	75.15	76.17		1.02	76.17	0.000	0.07	52.53	0.01
60	3.54	75.15	76.17		1.02	76.17	0.000	0.17	32.05	0.02
	Arthur Street Outlet Extended to Marsh									
40	5.58	75.15	76.16		1.02	76.17	0.000	0.17	32.05	0.06
20	5.58	75.40	76.10		0.70	76.15	0.007	1.04	5.38	0.46
	St. Lawrence River Outlet (Invert 75.20 / HWL 76.10)									

As shown in Table 4-2, the backwater effects on the upstream watercourse are comparable between existing and proposed conditions. The proposed box culvert has been appropriately sized to convey the 100-year design flow through the culvert without overtopping occurring. The average high-water level within the improved channel section remains approximately ±0.7 m and is fully contained within the defined channel banks. While flow velocities increase due to the improved watercourse geometry, they remain within the acceptable range for a grass-lined channel under 100-year flow conditions.

A separate hydraflow **Culvert Analysis** is provided in **Appendix C** for comparison with the HEC-RAS model, and the results are consistent with those assessed by HEC-RAS.

Refer to **Figure 6: Watercourse Improvements** in **Appendix C** for further details regarding the watercourse.

Watercourse Liner

Table 4-3 below summarizes the permissible velocities and shear stresses for several surface materials and vegetation types for use as channel liners.

Table 4-3 Channel Lining Properties

Surface Material and height	**Maximum Permissible Velocity (m/s)**	**Maximum Permissible Shear (N/m²)**
Rock Rip Rap, 150mm to 300mm	2.2 - 3.0	92 - 192
Cobbles	1.1 - 1.5	No data
Course Gravel	1.2 - 1.9	No data
Class A Vegetation height > 600 mm Good Stand	1.8 - 2.4	177
Class B Vegetation height > 600 mm Fair Stand / 250-600 mm Good Stand	1.5 - 2.1	100
Class C Vegetation height 250 – 600 mm Fair Stand / 150-250 mm Good Stand	0.9 - 1.2	48

Source: MTO Drainage Guidelines Design Charts, 2.16, 2.17, and Alberta Transportation Erosion and Sediment Control Manual (2011)

Class A, B, C, D, and E vegetation classifications describe the erosion resistance and hydraulic performance of vegetative cover used in open channels, based on allowable velocity and shear stress. All types of vegetation are assigned a class based on grass species, growth height, and stand density. Class A vegetation refers to dense, well-maintained turf with full ground coverage and no bare spots, typically composed of sod-forming species such as Kentucky bluegrass or Bermuda grass. Class B vegetation represents a moderately dense grass cover with some bare areas and variability in growth, drought-tolerant, hardy, minimal to no maintenance, and commonly includes species such as fescues, clover, and mixed grasses. Class C vegetation is characterized by sparse, patchy, or weedy growth with poor root structure and no maintenance. Classes D and E represent thin ground cover, which would be associated with poor to no meaningful vegetation, and are omitted.

Table 4-4 below summarizes the peak flow for the 2-year, 5-year, and 100-year storm events, along with the corresponding average flow depth, average velocity, and shear stress.

Table 4-4 Watercourse Hydraulic Performance by Storm Event

Storm Event (24 hr SCS II)	Q (m^3/s)	Average Depth (m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Avg. Shear Stress (N/m^2)
2-Year Storm	0.85	0.42	1.0	1.4	22
5-Year Storm	1.30	0.51	1.1	1.6	37
100-Year Storm	3.09	0.71	1.3	1.9	61

As shown in Table 4-4, Class B vegetation is considered a suitable channel liner for all evaluated storm events, as the calculated average velocities and shear stresses for the 100-year event remain below 1.3 m/s and 60 N/m^2, respectively. This includes localized peak velocities up to 1.9 m/s observed between stations 280 and 180. A suitable Class B turf is to be proposed during detailed design.

A minimum 6 m access setback is recommended from the high-water level to buildings.

Lots within 30 m from a watercourse may require a CRCA permit under O.Reg. 41/24. Individual lot developers within 30 m of any watercourse are to confirm with the CRCA when they are applying for a building permit.

4.3 Proposed Enhanced Wetland

Improvements are proposed for the marsh area. Further details regarding the existing marsh area, proposed mitigation measures, and improvements are provided in the *Ecological Impact Statement* prepared by WSP. The proposed mitigation measures and enhancements aim to create an open habitat and provide deeper water and shallow water components that will contribute to habitat diversity.

Refer to **Figure 7: Proposed Enhanced Wetland** in **Appendix C** for further preliminary details.

5. Conclusions

It is recommended that the Elmwood Subdivision proceed with the mitigation measures detailed in this report to address stormwater quality and erosion concerns on site. No formal quantity control is recommended since this site outlets directly to the St. Lawrence River.

The subdivision is designed in accordance with the Ministry of the Environment, Conservation, and Parks, Town of Gananoque Public Works, and CRCA guidelines.

Stormwater runoff within the Elmwood Subdivision is to be directed to oil grit separators, providing a Normal level of protection prior to flow discharging.

Improvements are recommended to the banks of the watercourse within the subject site.

A Consolidated Linear Infrastructure Environmental Compliance Approval (CLI-ECA) is required from the Town of Gananoque prior to installation of the storm sewer works.

Appendix A

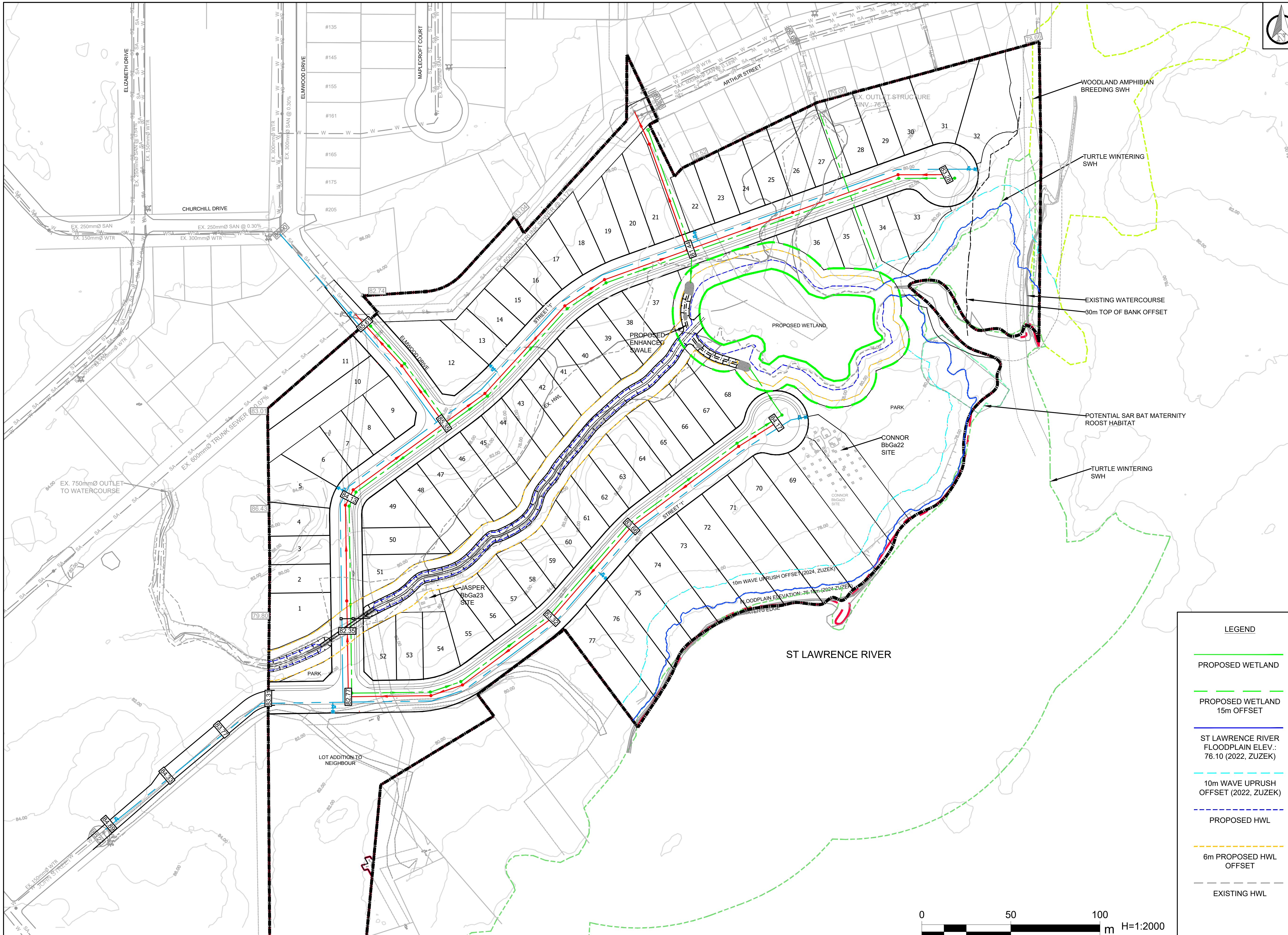
Concept Plan

Figure 2: Pre-Development Catchment Area

Figure 3: Post-Development Catchment Areas (Major Event)

Figure 4: Post-Development Catchment Areas (Minor Sewer)

Source Water Protection Map



LEGEND

PROPOSED WETLAND

PROPOSED WETLAND 15m OFFSET

ST LAWRENCE RIVER FLOODPLAIN ELEV.: 76.10 (2022, ZUZEK)

10m WAVE UPRUSH OFFSET (2022, ZUZEK)

PROPOSED HWL

6m PROPOSED HWL OFFSET

EXISTING HWL

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

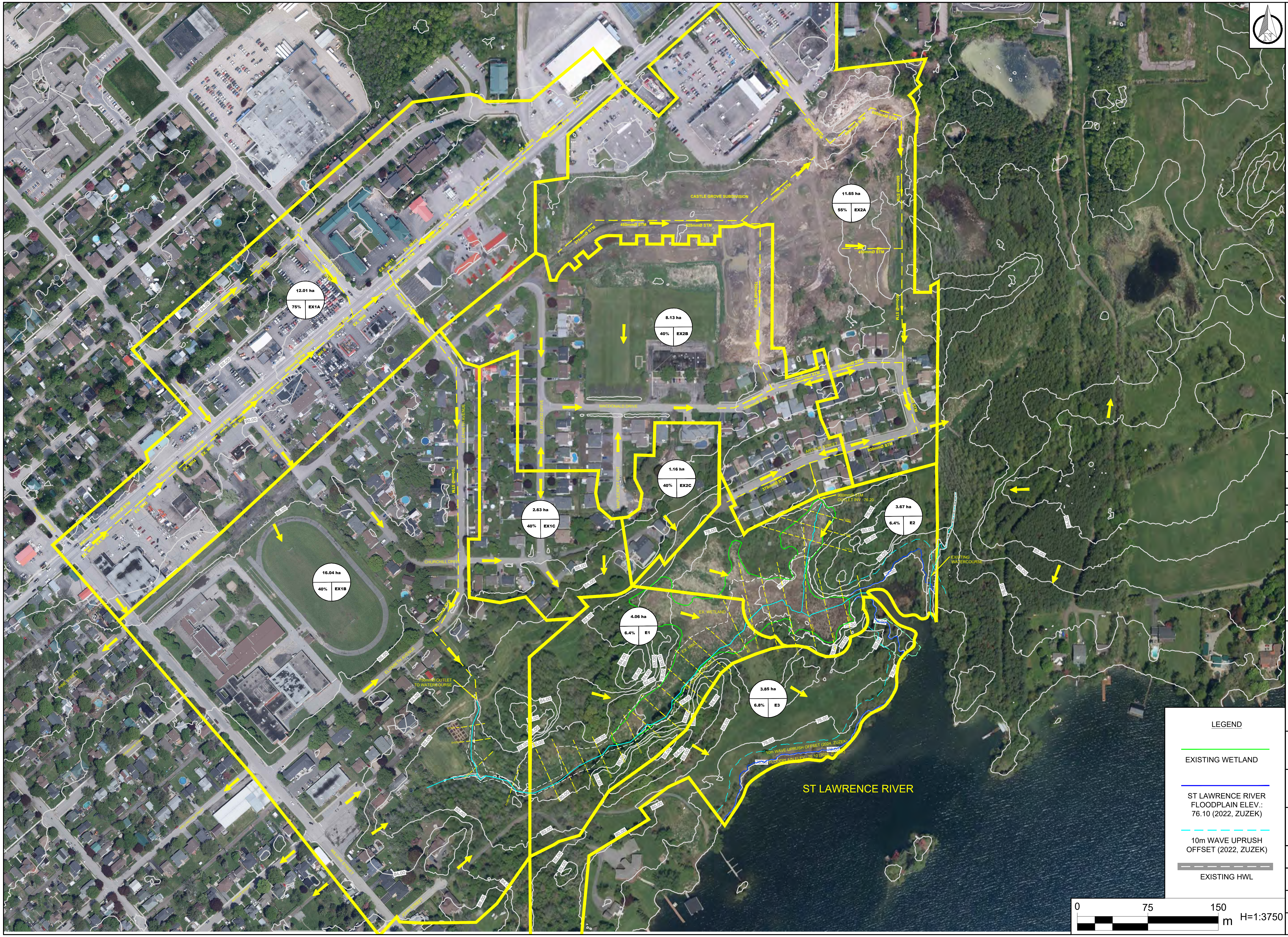
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.866.884.9392 fax.

Client: 1000989284 ONTARIO INC.

Project: ELMWOOD SUBDIVISION

Drawing: CONCEPT PLAN

Drawn by: EP	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.
Date: AUGUST 2025		CP
Scale: 1:2000 ANSI B (11x17)		



XX ha
XX% XX
AREA (hectares)
PERCENT IMPERVIOUS
INLET

MAJOR FLOW PATH

MINOR FLOW PATH

EX. STORM SEWER

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

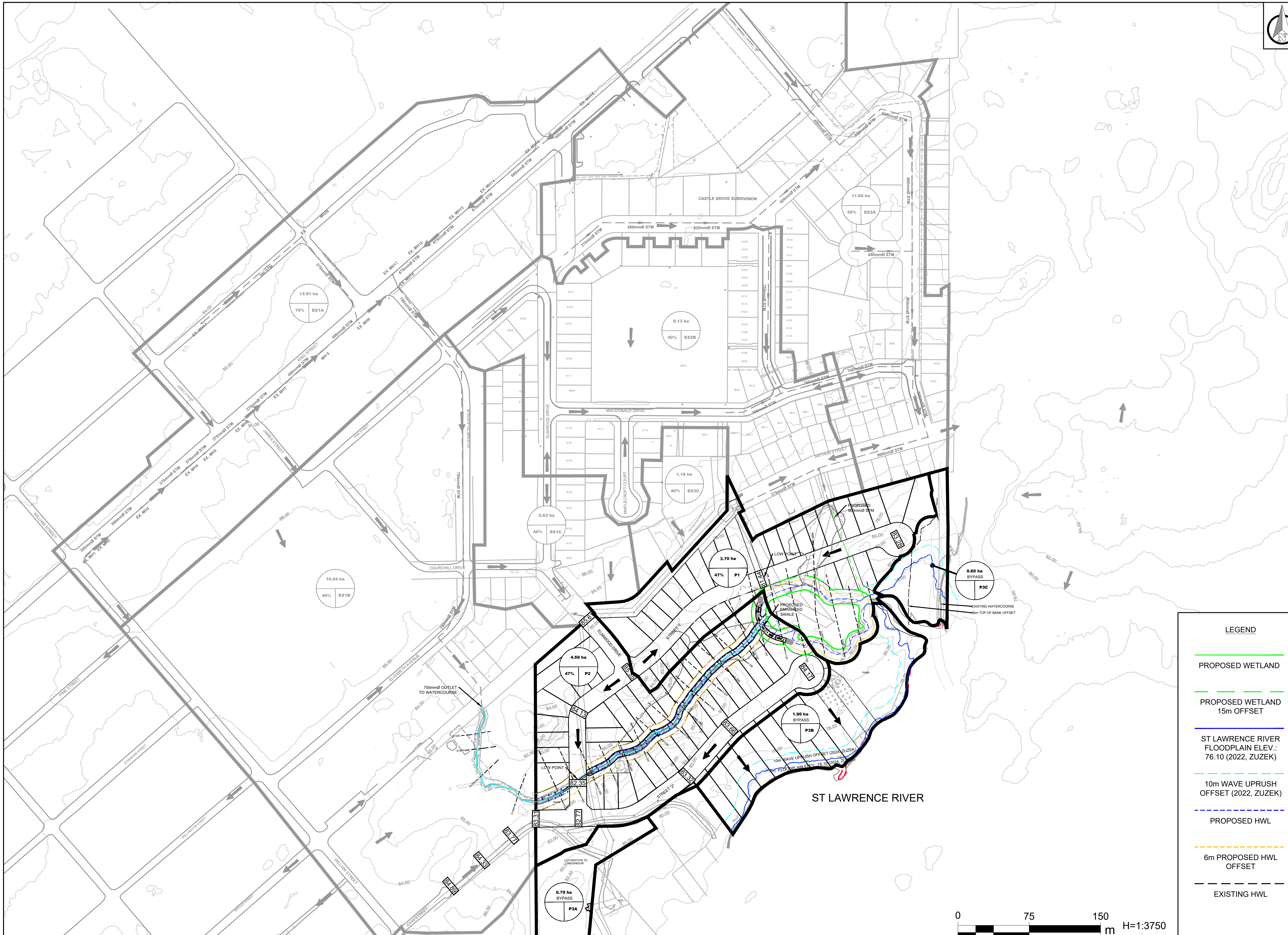
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.866.884.9392 fax.

Client
1000989284 ONTARIO INC.

Project
ELMWOOD SUBDIVISION

Drawing
PRE-DEVELOPMENT CATCHMENT AREAS

Drawn by: EP	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.
Date: AUGUST 2025		FIG.2
Scale: 1:3750 ANSI B (11x17)		



AREA (hectares)

XX ha | XX% | XX

PERCENT IMPERVIOUS

INLET

MAJOR FLOW PATH

MINOR FLOW PATH

EX. STORM SEWER

LEGEND

- PROPOSED WETLAND
- PROPOSED WETLAND 15m OFFSET
- ST LAWRENCE RIVER FLOODPLAIN ELEV.: 76.10 (2022, ZUZEK)
- 10m WAVE UPRUSH OFFSET (2022, ZUZEK)
- PROPOSED HWL
- 6m PROPOSED HWL OFFSET
- EXISTING HWL

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

1329 Gardiners Road, Suite 210
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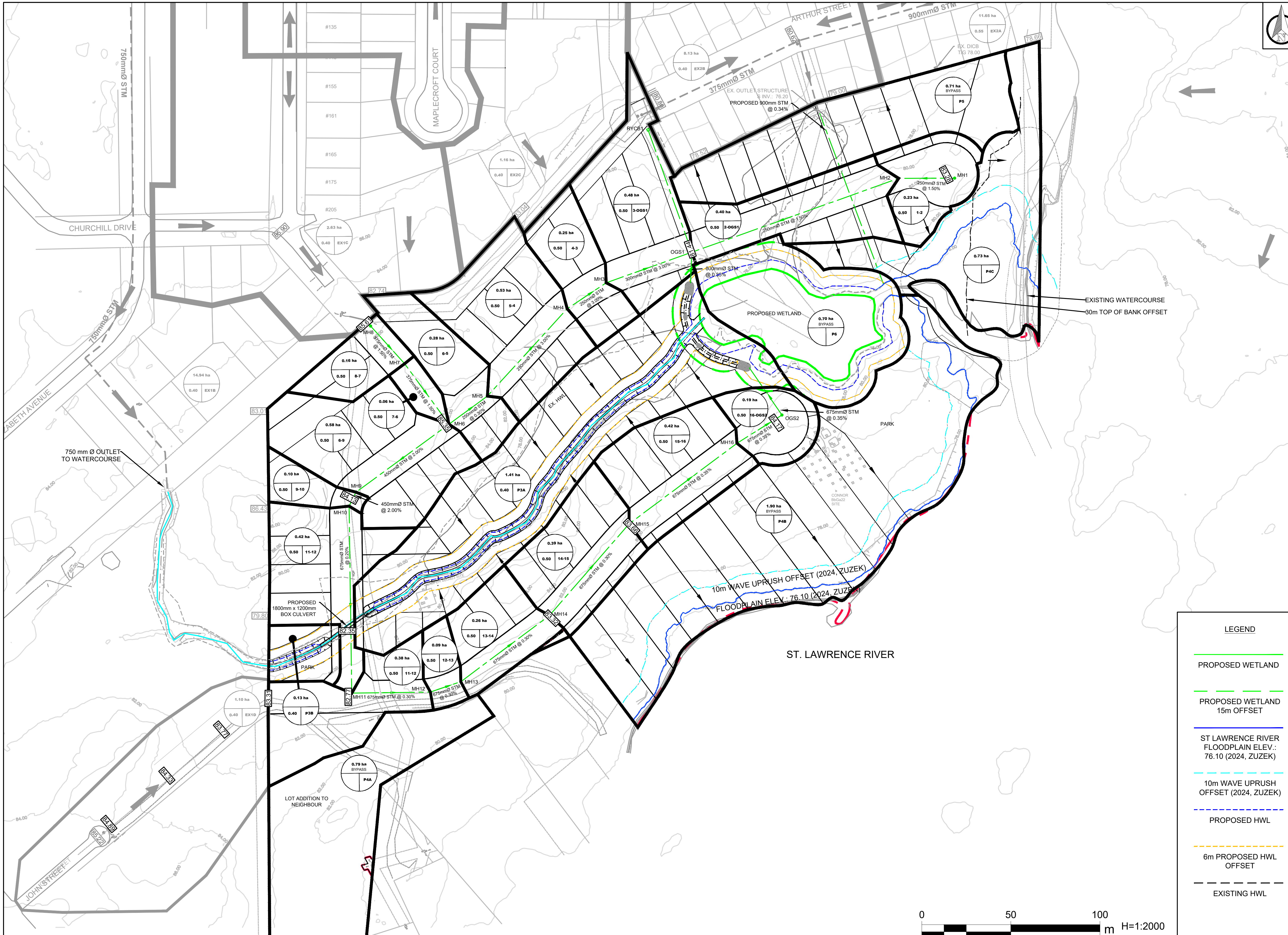
613.634.9009 tel.
1.866.884.9392 fax.

Client
1000989284 ONTARIO INC.

Project
ELMWOOD SUBDIVISION

Drawing
POST DEVELOPMENT CATCHMENT AREAS
MAJOR EVENT

Drawn by: EP	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.
Date: AUGUST 2025		FIG.3
Scale: 1:3750 ANSI B (11x17)		



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: 1000989284 ONTARIO INC.

Project: ELMWOOD SUBDIVISION

Drawing: PROPOSED CATCHMENT AREAS MINOR EVENT

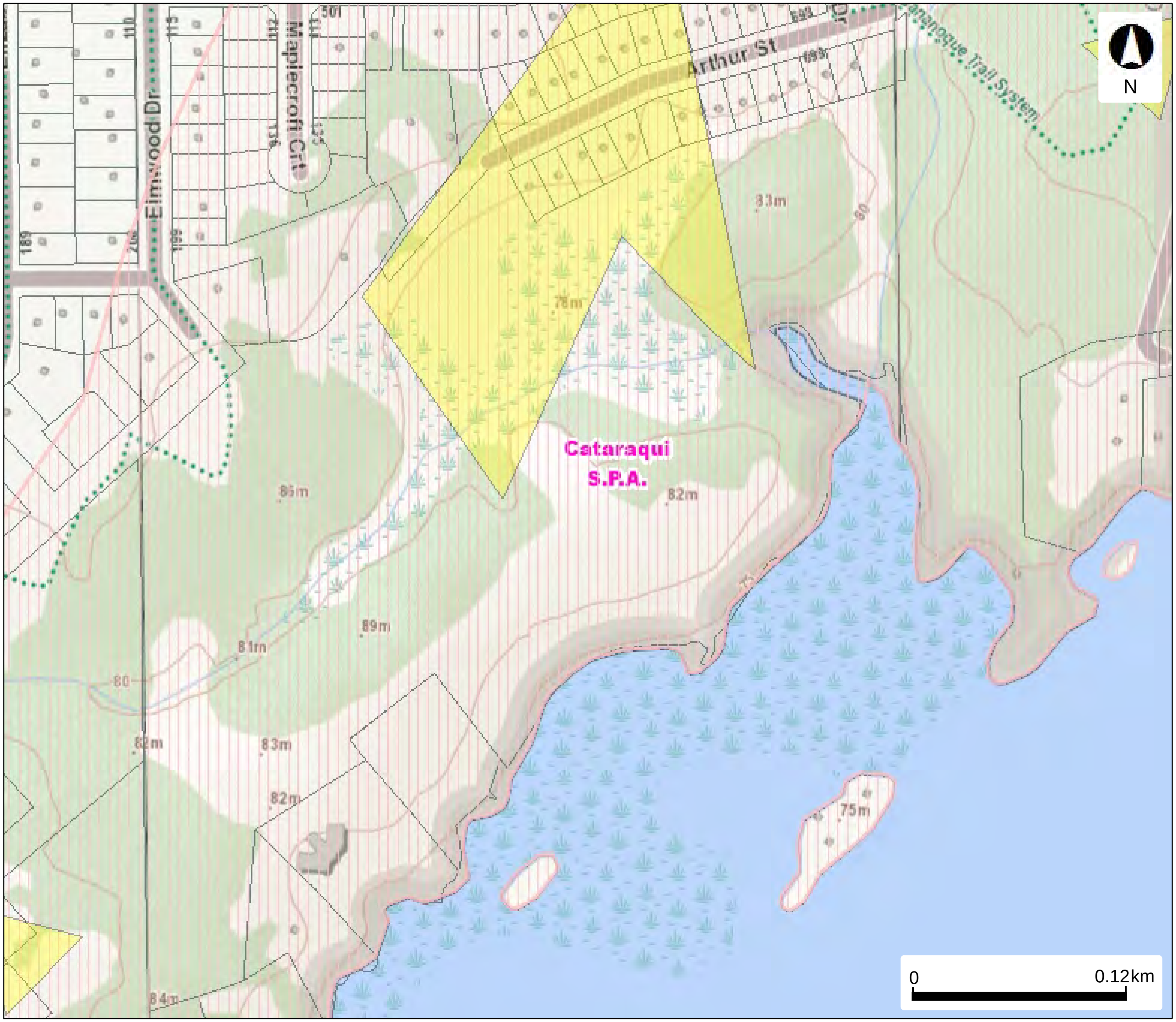
Drawn by: EP	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.

Date: AUGUST 2025

Scale: 1:2000 ANSI B (11x17)

FIG.4

Source Water Protection



Legend

Significant Groundwater Recharge Area
- N/A
- 0
- 2
- 4
- 6

Issue Contributing Areas
Highly Vulnerable Aquifers
WHPA-E
Wellhead Protection Area
- A
- B
- C
- C1
- D
- F

Intake Protection Zone 1
Event Based Areas
Intake Protection Zone 2
Vulnerable Scoring Area - Groundwater
- 2
- 4
- 6
- 8
- 10

Source Protection Areas
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

THIS IS NOT A PLAN OF SURVEY.

Map Created: 7/22/2025
Map Center: 44.33081 N, -76.14942 W

Appendix B

MTO IDF Curve

Composite Runoff Coefficient Calculations

Elmwood Storm Sewer Design Sheet

Castle Grove Storm Sewer Design Sheet

Rational Method Calculations

Major Overland Flow Calculations

OGS-1 Calculations

OGS-2 Calculations

OGS Maintenance Manual

Ontario IDF CURVE LOOKUP

Active coordinate

44° 19' 45" N, 76° 9' 15" W (44.329167,-76.154167)

Retrieved: Thu, 24 Jul 2025 17:23:52 GMT

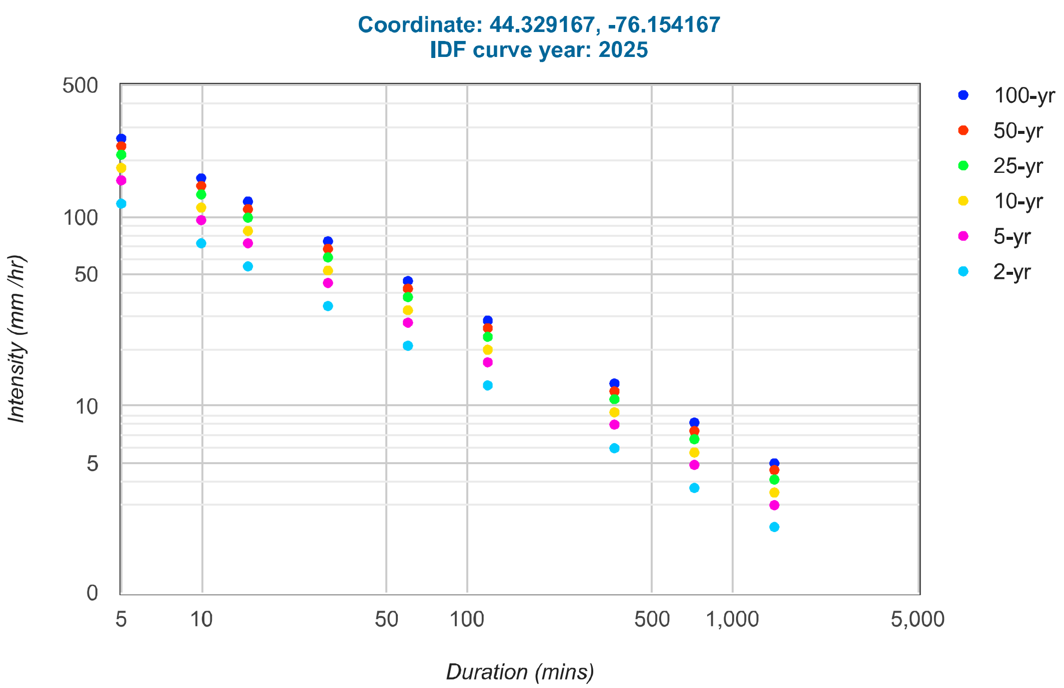
Location summary

These are the locations in the selection.

IDF Curve: 44° 19' 45" N, 76° 9' 15" W (44.329167,-76.154167)

Results

An IDF curve was found.



Coefficient summary

IDF Curve: 44° 19' 45" N, 76° 9' 15" W (44.329167,-76.154167)

Retrieved: Thu, 24 Jul 2025 17:23:52 GMT

Data year: 2010
IDF curve year: 2025

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	117.9	72.7	54.9	33.9	20.9	12.9	6.0	3.7	2.3
5-yr	156.5	96.5	72.8	44.9	27.7	17.1	8.0	4.9	3.0
10-yr	182.1	112.3	84.6	52.2	32.2	19.9	9.3	5.7	3.5
25-yr	213.9	131.9	99.4	61.3	37.8	23.3	10.9	6.7	4.1
50-yr	237.1	146.2	110.2	68.0	41.9	25.9	12.0	7.4	4.6
100-yr	260.4	160.6	121.0	74.6	46.0	28.4	13.2	8.2	5.0

Rainfall depth (mm)

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	9.8	12.1	13.7	16.9	20.9	25.8	36.0	44.4	55.2
5-yr	13.0	16.1	18.2	22.4	27.7	34.2	48.0	58.8	72.0
10-yr	15.2	18.7	21.1	26.1	32.2	39.8	55.8	68.4	84.0
25-yr	17.8	22.0	24.9	30.6	37.8	46.6	65.4	80.4	98.4
50-yr	19.8	24.4	27.6	34.0	41.9	51.8	72.0	88.8	110.4
100-yr	21.7	26.8	30.3	37.3	46.0	56.8	79.2	98.4	120.0

Terms of Use

Composite Runoff Coefficients			
Hydrological Units - Proposed Conditions			
Drainage Area No.	Total Area	Runoff Coefficient -C	Description
Grass	5.59	0.25	
Asphalt/Concrete	1.47	0.9	
Building	1.61	0.9	
Sub Total	**8.67**	**0.48**	Compsosite Coeff.
Bypass Lands			
Lot Addition	0.96	0.25	
Wetland	1.24	0.25	
Park	0.72	0.25	
Sub Total	**2.91**	**0.25**	Compsosite Coeff.
Total	**11.58**	**0.42**	Compsosite Coeff.

PROPOSED STORM SEWER DESIGN SHEET - ELMWOOD SUBDIVISION

CLIENT	1000989284 Ontario Inc.			DESIGN FREQUENCY	5 Year
PROJECT NAME	Elmwood Subdivision	Min. Full Flow V =	0.75 m/s	RAINFALL STATIONS	Gananoque MTO - Look Up
DATE	August 2025	Max. Full Flow V =	6 m/s	DESIGNED 'n'	0.013

LOCATION: ELMWOOD SUBDIVISION — DRAINAGE AREA = 10.11 ha — RUNOFF 3 — PIPE SELECTION

Area (ha)	Street	Inlet Description	From	To	R = 0.20 ha	R = 0.30 ha	R = 0.40 ha	R = 0.50 ha	R = 0.75 ha	R = 0.80 ha	5 Year Indiv. 2.78AC ha	5 Year Accum. 2.78AC ha	Time of Conc. (min)	5 Year Intensity I (mm/hr)	Peak Flow Q (L/S)	Type of Pipe	Required Pipe Diameter D (m)	Nominal Diameter D (mm)	Pipe Length (m)	Grade S	Full Capacity (L/S)	Full Flow Velocity V (m/s)	Time of Flow (min)	Capacity Used Q/Q(f)	Actual Velocity (m/s)	Normal Depth (mm)	Free Outfall D/S HGL (m)	Fall in Sewer (m)
0.23	Street '1'	MH1	MH1	MH2				0.230			0.319	0.319	15.0	72	23	HDPE	250	250	31	1.50%	73	1.48	0.35	0.32	1.31	96	85.40	0.472
0.40	Street '1'	MH2	MH2	OGS1				0.400			0.556	0.875	15.4	71	62	HDPE	250	300	120	1.50%	118	1.68	1.19	0.52	1.69	154	83.30	1.800
0.28	Street '1'	MH6	MH6 (E.)	MH5				0.280			0.389	0.389	15.0	72	28	HDPE	250	250	27	0.30%	33	0.66	0.67	0.86	0.75	178	85.88	0.080
0.53	Street '1'	MH5	MH5	MH4				0.530			0.736	1.125	15.7	70	79	HDPE	250	250	67	3.00%	103	2.10	0.53	0.76	2.31	164	83.04	1.995
0.25	Street '1'	MH4	MH4	MH3				0.250			0.347	1.472	16.2	68	101	HDPE	250	250	26	3.00%	103	2.10	0.21	0.98	2.39	200	84.34	0.786
0.48	Street '1'	MH3	MH3	OGS1				0.480			0.667	2.139	16.4	68	145	HDPE	300	300	53	3.00%	167	2.37	0.37	0.86	2.66	215	82.59	1.599
1.16	OUTLET 1A	OGS1	OGS1	Enhanced Swale			1.160				1.289	4.303	16.8	67	287	HDPE	600	600	13	0.35%	363	1.28	0.16	0.79	1.42	400	84.40	0.044
2.79	Elmwood Drive	MH8	MH8	MH7			2.630	0.160			3.144	3.144	17.2	65	206	HDPE	375	375	28	1.50%	215	1.94	0.24	0.96	2.21	294	82.98	0.426
0.06	Elmwood Drive	MH7	MH7	MH6 (W)				0.060			0.083	3.228	17.4	65	209	HDPE	375	375	42	1.50%	215	1.94	0.36	0.97	2.22	299	82.55	0.632
0.58	Street '1'	MH6	MH6 (W)	MH9				0.580			0.806	4.033	17.8	64	257	HDPE	450	450	65	2.00%	403	2.54	0.42	0.64	2.68	260	81.22	1.292
0.10	Street '1'	MH9	MH9	MH10				0.100			0.139	4.172	18.2	63	262	HDPE	450	450	9	2.00%	403	2.54	0.06	0.65	2.70	264	81.05	0.174
0.42	Street '1'	MH10	MH10	MH11				0.420			0.583	4.756	18.3	63	299	HDPE	675	675	105	0.20%	376	1.05	1.67	0.80	1.16	453	0.45	0.210
1.48	Street '1'	MH11	MH11	MH12			1.100	0.380			1.750	6.506	20.0	59	384	HDPE	675	675	44	0.30%	460	1.29	0.57	0.83	1.44	469	83.70	0.132
0.09	Street '2'	MH12	MH12	MH13				0.090			0.125	6.631	20.5	58	383	HDPE	675	675	18	0.30%	460	1.29	0.23	0.83	1.44	469	83.65	0.054
0.26	Street '2'	MH13	MH13	MH14				0.260			0.361	6.992	20.8	57	402	HDPE	675	675	62	0.30%	460	1.29	0.80	0.87	1.45	485	82.32	0.186
0.39	Street '2'	MH14	MH14	MH15				0.390			0.542	7.533	21.6	56	421	HDPE	675	675	68	0.30%	460	1.29	0.88	0.92	1.46	506	82.14	0.205
0.42	Street '2'	MH15	MH15	MH16				0.420			0.583	8.117	22.4	54	441	HDPE	675	675	76	0.35%	497	1.39	0.91	0.89	1.57	493	81.86	0.265
0.19	Street '2'	MH16	MH16	OGS2				0.190			0.264	8.381	23.4	53	443	HDPE	675	675	30	0.35%	497	1.39	0.36	0.89	1.57	496	85.92	0.104
	OUTLET 1B	OGS2	OGS2	Enhanced Swale							0.000	8.381	23.7	52	438	HDPE	675	675	16	0.35%	497	1.39	0.19	0.88	1.57	491	84.41	0.055

Notes:
6.30 ha of the Site Area Bypasses the Storm Sewer
4.89 ha of External Area is directed to the Storm Sewer
EX1C has a time of concentration of 17.2 minutes, Refer to Rational Method Calculations
Note that a Q/Qf of 100% represents a pipe at 82% d/D

RAINFALL INTENSITY EQUATION: $I = A \times T^B$
MTO IDF Curve Lookup
I = A*T^B Where I = rainfall intensity (mm/hr)
A,B = rainfall coefficients
T= Time in Hours

	A	B
5 Year	27.3	-0.699

RATIONAL METHOD: Q- 2.78 AIR
Where Q = Peak Flow (L/s)
A = Area (ha)
R - Runoff Coefficient
I - Rainfall Intensity (mm/hr)
Minimum 15 Minute Time of Concentration

EXISTING AND PROPOSED STORM SEWER DESIGN SHEET - CASTLE GROVE SUBDIVISION

CLIENT: Riverton Homes
PROJECT NAME: Castle Grove Subdivision
DATE: April 2024

Min. V = 0.75 m/s
Max. V = 6 m/s

DESIGN FREQUENCY: 5
RAINFALL STATIONS: Gananoque MTO - Look Up
DESIGNED 'n': 0.013

LOCATION: CASTLE GROVE SUBDIVISION						DRAINAGE AREA = 19.64 ha										RUNOFF 3 7						PIPE SELECTION														
												5 Year		100 Year																				
Area (ha)	Proposed (P) Existing (E)	Street	Inlet Description	From	To	R = 0.30 ha	R = 0.40 ha	R = 0.50 ha	R = 0.55 ha	R = 0.75 ha	R = 0.80 ha	Indiv. 2.78AC ha	Accum. 2.78AC ha	Indiv. 2.78AC ha	Accum. 2.78AC ha	Time of Conc. (min)	5 Year Intensity I (mm/hr)	100 Year Intensity I (mm/hr)	Peak Flow Q (L/S)	Type of Pipe	Required Pipe Diameter D (m)	Nominal Diameter D (mm)	Pipe Length (m)	Grade S	Full Capacity (L/S)	Full Flow Velocity V (m/s)	Time of Flow (min)	Capacity Used Q/Q(f)	Actual Velocity (m/s)	Normal Depth (mm)	Free Outfall D/S HGL (m)	Fall in Sewer (m)	US Inv (m)	DS Inv (m)
0.26	P	Pine Street	CB1, CB2, E101B	MH30	MH28		0.170		0.090			0.326	0.326			15.0	70		23	HDPE	250	375	53	1.00%	175	1.59	0.55	0.13	1.09	91	85.04	0.528	85.48	84.95
0.33	P	Pine Street	RYCB1, E101A, E102A	RYCB1	MH28		0.170		0.160			0.189	0.189	0.244	0.244	15.0	70	120	43	HDPE	250	300	44	1.00%	97	1.37	0.54	0.44	1.32	138	85.47	0.444	85.78	85.34
0.44	P	Pine Street	RYCB8, E302	RYCB8	MAIN		0.160		0.280			0.428	0.428	0.178	0.178	15.0	70	120	51	HDPE	300	300	45	0.50%	68	0.97	0.77	0.75	1.06	193	84.92	0.224	84.95	84.73
0.85	P	Pine Street (Shoppers Drug Mart)	RYCB2, E102B	RYCB2	MAIN				0.120	0.730		1.521	1.521	0.183	0.183	17.8	63	107	116	HDPE	300	300	45	3.00%	167	2.37	0.32	0.69	2.55	182	84.61	1.356	85.78	84.42
0.04	P	Pine Street	MH28	MH28	MH26				0.040			0.061	2.525		0.606	17.8	63	107	225	HDPE	450	450	83	1.00%	285	1.79	0.77	0.79	1.98	300	84.35	0.825	84.87	84.05
0.52	P	Pine Street	RYDCB1	RYDCB1	MAIN				0.520					0.794	0.794	15.0	70	120	96	HDPE	250	300	48	2.70%	159	2.25	0.35	0.60	2.35	167	83.81	1.291	84.93	83.64
0.41	P	Pine Street	CB3, CB4	MH26	MH46				0.410			0.626	3.151		1.400	18.6	62	104	341	HDPE	525	525	73	0.80%	385	1.78	0.68	0.89	2.01	384	83.77	0.581	83.97	83.39
	P	Pine Street		MH42	MH44											15.0	70		0	HDPE	250	300	52	0.40%	61	0.87	1.00						84.04	83.84
0.55	P	Pine Street	DCB1, DCB2, E110C	MH44	MH46		0.020		0.530			0.832	0.832			16.0	68		56	HDPE	300	300	52	0.40%	61	0.87	1.00	0.92	0.98	226	83.84	0.207	83.82	83.62
	P	Pine Street	CB14	MH46	OGS-1				0.070			0.107	4.090		1.400	19.2	61	101	389	HDPE	450	600	9	2.00%	868	3.07	0.05	0.45	2.98	279	83.42	0.177	83.32	83.14
0.02	P	Wilmer Avenue	CB5	OGS-1	EX.MH24				0.020			0.031	4.121		1.400	19.3	61	101	391	HDPE	450	600	12	2.00%	868	3.07	0.06	0.45	2.99	282	83.16	0.233	83.12	82.88
0.63	E	Wilmer Avenue	EX.CB22, E110A, E110B	EX.MH24	EX.MH22		0.380		0.250			0.804	4.925		1.400	19.4	60	101	439	HDPE	675	750	72	0.50%	787	1.78	0.67	0.56	1.83	398	82.92	0.360	82.88	82.52
0.76	E	Wilmer Avenue	E111, E112	EX.MH22	EX.MH20		0.360		0.400			1.011	5.936		1.400	20.0	59	98	489	HDPE	675	750	78	0.43%	730	1.65	0.78	0.67	1.77	447	82.63	0.334	82.52	82.19
	E	Wilmer Avenue		EX.MH20	EX.MH16								5.936		1.400	20.8	58	96	477	HDPE	675	750	30	0.50%	787	1.78	0.28	0.61	1.87	421	82.46	0.149	82.19	82.04
1.53	E	MacDonald Drive	E304		EX. CB	1.530						1.275	1.275			Note 1																		
2.84	E	MacDonald Drive	P301, E303	EX.CBMH	EX.MH18		2.800		0.040			3.172	4.447			22.3	55		247	HDPE	375	375	18	2.20%	260	2.35	0.13	0.95	2.68	291	83.52	0.396	83.63	83.23
	E	MacDonald Drive		EX.MH18	EX.MH16								4.447		1.400	22.4	55	91	373	HDPE	450	300	42	1.90%	133	1.89	0.37	2.80	1.89	300	82.73	0.798	83.23	82.43
0.88	E	MacDonald Drive	P211A, E305, E306	EX.MH16	EX.MH14		0.110		0.770			1.299	11.682		1.400	22.8	55	90	766	HDPE	675	750	76	1.20%	1220	2.76	0.46	0.63	2.91	430	81.54	0.912	82.02	81.11
0.49	E	MacDonald Drive	P211B, E309	EX.MH14	EX.MH12		0.050		0.440			0.728	12.410		1.400	23.3	54	89	794	HDPE	675	750	30	1.20%	1220	2.76	0.18	0.65	2.94	440	81.19	0.360	81.11	80.75
0.10	E	MacDonald Drive	EX.CB2	EX.MH12	EX.MH10				0.100			0.153	12.563		1.400	23.4	54	88	798	HDPE	675	750	37	1.20%	1220	2.76	0.22	0.65	2.94	440	80.74	0.444	80.75	80.30
3.05	P	Carmichael Drive (No Frills & Canadian Tire)	E201, CB6	EX.CBMH1	MH40				0.050		3.000	6.743	6.743			18.2	63		422	HDPE	450	450	47	3.00%	494	3.10	0.25	0.85	3.48	318	84.44	1.402	85.53	84.12
0.05	P	Conner Drive	CB7	MH40	MH38				0.050			0.076	6.819			18.5	62		424	HDPE	525	600	58	1.00%	614	2.17	0.44	0.69	2.34	365	83.76	0.575	83.97	83.40
0.35	P	Conner Drive	RYCB3	RYCB3	CB8				0.350					0.535	0.535	15.0	70	120	64	HDPE	300	300	50	0.50%	68	0.97	0.85	0.94	1.10	231	83.60	0.248	83.62	83.37
0.30	P	Conner Drive	CB8, CB9	MH38	MH36				0.300			0.458	7.278		0.535	18.9	61	103	501	HDPE	600	600	34	1.00%	614	2.17	0.26	0.82	2.42	410	84.45	0.336	84.38	84.04
0.28	P	Conner Drive	CB10, CB11	MH36	MH34				0.280			0.428	7.706		0.535	19.2	61	102	522	HDPE	600	600	72	0.80%	549	1.94	0.62	0.95	2.21	466	82.91	0.578	83.02	82.44
0.00	P	Conner Drive		MH34	MH32							0.000	7.706		0.535	19.8	60	99	513	HDPE	600	600	69	0.80%	549	1.94	0.59	0.93	2.21	459	82.33	0.548	82.42	81.88
0.53	P	Veenstra Grove	E209, RYCB7	RYCB7	MH52				0.530					0.810	0.810	15.0	70	120	97	HDPE	375	375	51	0.50%	124	1.12	0.75	0.79	1.24	250	84.00	0.254	84.00	83.75
0.57	P	Veenstra Grove	RYDCB6	RYDCB6	MAIN				0.570					0.871	0.871	15.0	70	120	105	HDPE	300	300	41	1.80%	130	1.84	0.38	0.81	2.04	204	82.74	0.745	83.28	82.53
0.68	P	Veenstra Grove	DCB3, DCB4	MH52	MH32				0.680			1.039	1.039		1.681	15.8	68	116	266	HDPE	450	450	64	1.00%	285	1.79	0.60	0.93	2.04	344	82.37	0.640	82.67	82.03
0.17	P	Conner Drive	DCB5	MH32	MH48				0.170			0.260	9.004		2.215	20.4	59	97	743	HDPE	750	750	65	0.50%	787	1.78	0.60	0.94	2.03	579	81.98	0.323	81.73	81.40
0.18	P	Conner Drive	RYCB5	RYCB5	MAIN				0.180			0.275	0.275			15.0	70		19	HDPE	250	300	37	0.40%	61	0.87	0.71	0.31	0.76	115	81.39	0.148	81.42	81.27
0.41	P	Conner Drive	CB12, DICB1	MH48	OGS-2				0.410			0.626	9.906		2.215	21.0	58	95	782	HDPE	675	750	46	1.50%	1363	3.09	0.25	0.57	3.18	404	81.09	0.690	81.38	80.69
	P	Conner Drive		OGS-2	EX.MH10								9.906		2.215	21.2	57	94	775	HDPE	675	750	11	1.50%	1363	3.09	0.06	0.57	3.18	404	80.91	0.163	80.67	80.51
0.67	E	Conner Drive	E310, E311	EX.MH10	EX.MH8		0.400	0.270				0.819	23.288		3.615	23.7	53	88	1561	CONC.	975	900	75	0.70%	1515	2.38	0.53	1.03	2.71	900	79.71	0.525	79.33	78.81
0.00	E	Conner Drive		EX.MH8	EX.MH6							0.000	23.288		3.615	24.2	53	86	1541	CONC.	975	900	53	0.70%	1515	2.38	0.37	1.02	2.71	900	79.33	0.371	78.81	78.43
0.54	E	Arthur Street	E312, E313	EX.MH6	EX.MH2			0.180	0.360			0.800	24.088		3.615	24.6	52	85	1567	CONC.	900	900	120	0.80%	1619	2.55	0.79	0.97	2.90	711	77.35	0.960	77.60	76.64
1.14	E	Arthur Street (Outlet)	E307, E308	EX.MH2	OUTLET 1			0.490	0.650			1.674	25.761		3.615	25.3	51	83	1620	CONC.	900	900	40	1.00%	1810	2.85	0.23	0.90	3.22	661	76.84	0.400	76.58	76.18

Notes:
1. Refer to Rational Method Calcuatlions in Appendix B for Elmwood Drive time of concentration calculations

EXCERPT FROM CASTLE GROVE STORMWATER MANAGEMENT REPORT, 2024, PREPARED BY FOREFRONT ENGINEERING INC.

Rational Method Calculations - Elmwood Subdivision

Hydrologic Units - Existing Conditions										
Hydrologic Unit	Description	Est'd Composite C	Area (ha)	Watershed Length (m)	Average Grade (%)	Tc (Bransby Williams) (when C = >0.4)	Tc (Kirpich Method) (C<0.4)	Tc (Airport Method) (C<0.4)	Tc Proposed	Indiv. 2.78 AC (ha)
EX1C	Ex. Elmwood Drive Road Side Ditches	0.40	2.63	290	0.5	17.2	11.62	48.8	**17.2**	2.92

Hydrologic Units - Proposed Conditions							25mm Quality Event		2 Year Design Storm		5 Year Design Storm		100 Year Design Storm	
Hydrologic Unit	Description	Est'd Composite C	External Area (ha)	Site Area (ha)	Tc Proposed*	Indiv. 2.78 AC (ha)	Intensity I (mm/hr)	Peak Flow Q (m^3/s)	Intensity I (mm/hr)	Peak Flow Q (m^3/s)	Intensity I (mm/hr)	Peak Flow Q (m^3/s)	Intensity I (mm/hr)	Peak Flow Q (m^3/s)
	Site + External Land to OGS 1	0.47	1.16	2.17	**16.8**	4.30	33.3	0.14	48.7	0.21	66	0.29	111	0.48
	Site + External Land to OGS 2	0.45	3.73	3.05	**23.7**	8.38	27.6	0.23	38.4	0.32	52	0.44	88	0.73
	Bypass Area direct to St. Lawrence River	0.47		6.36	**15.0**	8.30	35.3	0.29	52.7	0.44	72	0.60	120	1.00

*Time of Concentration taken from Storm Sewer Design Sheet

Rational Method Calculations

Formula:

Q (LPS) = 0.002778* C * I * A

Where:

Q = Peak runoff rate, LPS

C = Composite runoff coefficient

I = Rainfall intensity, mm/hr,
MTO Gananoque IDF Look Up Curve (Quantity Event)

t_c = Time of Concentration, (15 minute minimum)

Kirpich Method $0.0192[L^{0.77}/S_{(m/m)}^{0.385}]$

Airport Method $3.26(1.1 - C)* L^{0.5}/ S_w^{0.33}$

Bransby Williams $0.057 \ *L\ [Sw^{0.2} * A^{0.1})$

A = Drainage area, ha

25mm - 4 hr (Quality Event)

$$I_{(25mm)} = \frac{498}{(tc + 9.7)^{0.825}}$$

MTO IDF Curve Lookup

I = A*T^B Where I = rainfall intensity (mm/hr)
A,B = rainfall coefficients
T= Time in Hours

	A	B
2 Year	20	-0.699
5 Year	27.3	-0.699
100 Year	31.7	-0.699

Channel Report

18m ROW - 100 Year Event Peak Flow - 0.73 CMS

User-defined

Invert Elev (m)	=	0.0500
Slope (%)	=	0.5000
N-Value	=	0.016

Calculations

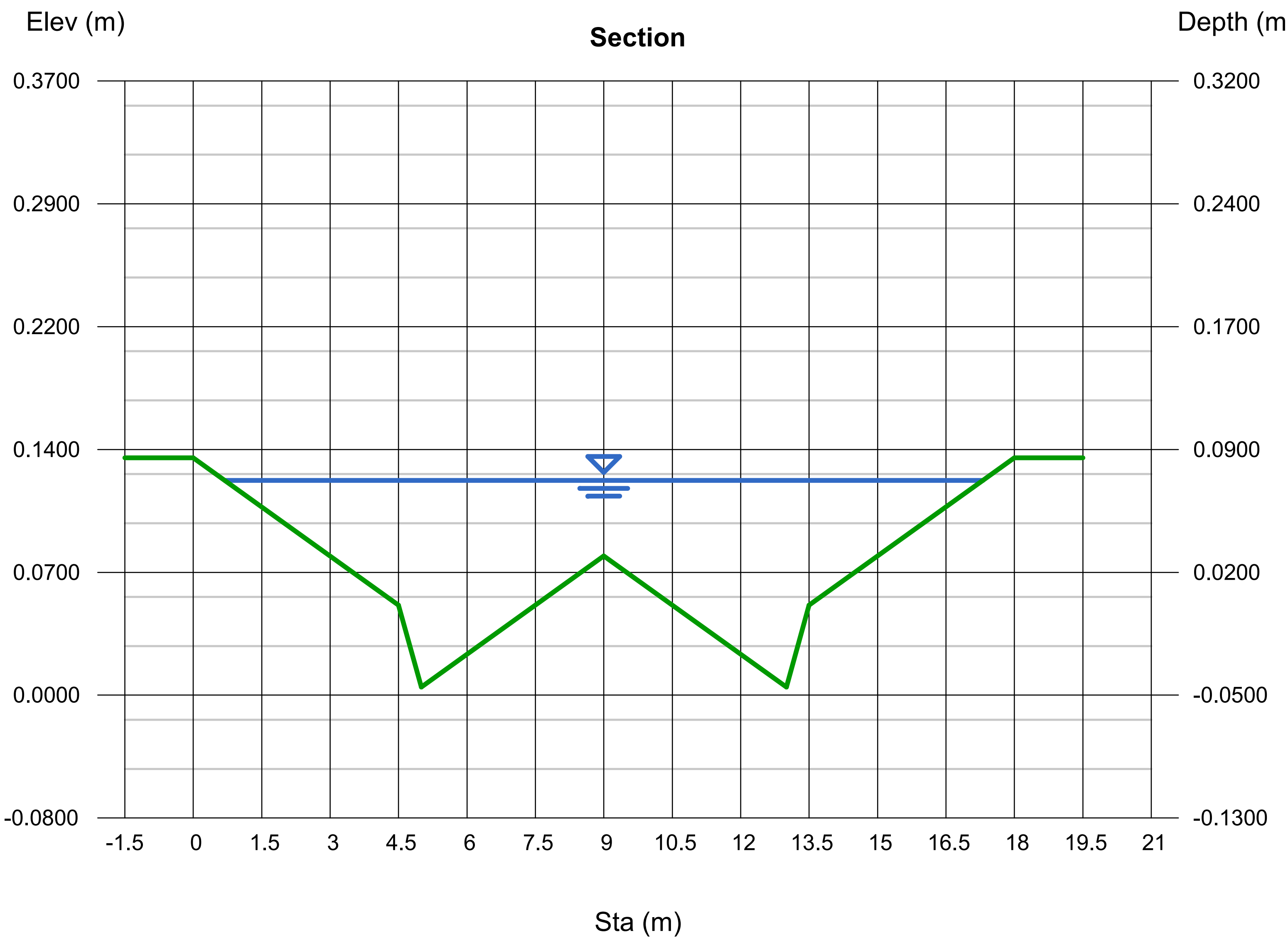
Compute by:		Known Q
Known Q (cms)	=	0.7300

Highlighted

Depth (m)	=	0.0762
Q (cms)	=	0.7300
Area (sqm)	=	1.0811
Velocity (m/s)	=	0.6752
Wetted Perim (m)	=	16.6281
Crit Depth, Yc (m)	=	0.0701
Top Width (m)	=	16.6200
EGL (m)	=	0.0995

(Sta, El, n)-(Sta, El, n)...

(0.0000, 0.1400)-(4.5000, 0.0500, 0.016)-(9.0000, 0.0800, 0.016)-(13.5000, 0.0500, 0.016)-(18.0000, 0.1400, 0.016)



Channel Report

Enhanced Swale - 1:100 Year Event - 0.73 CMS

Trapezoidal

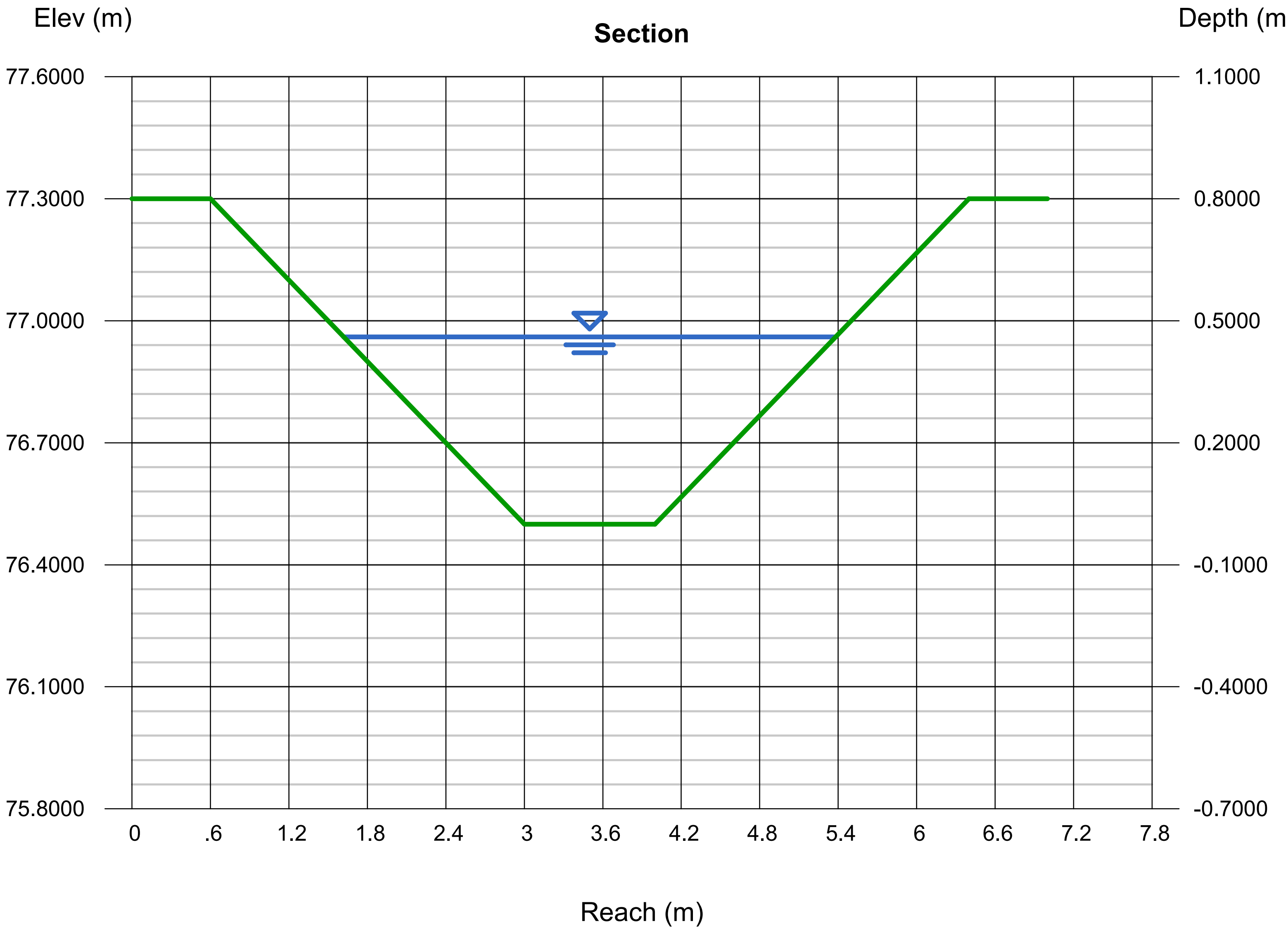
Bottom Width (m)	=	1.0000
Side Slopes (z:1)	=	3.0000, 3.0000
Total Depth (m)	=	0.8000
Invert Elev (m)	=	76.5000
Slope (%)	=	0.5000
N-Value	=	0.045

Calculations

Compute by:		Known Q
Known Q (cms)	=	0.7300

Highlighted

Depth (m)	=	0.4602
Q (cms)	=	0.7300
Area (sqm)	=	1.0957
Velocity (m/s)	=	0.6662
Wetted Perim (m)	=	3.9109
Crit Depth, Yc (m)	=	0.2865
Top Width (m)	=	3.7615
EGL (m)	=	0.4829



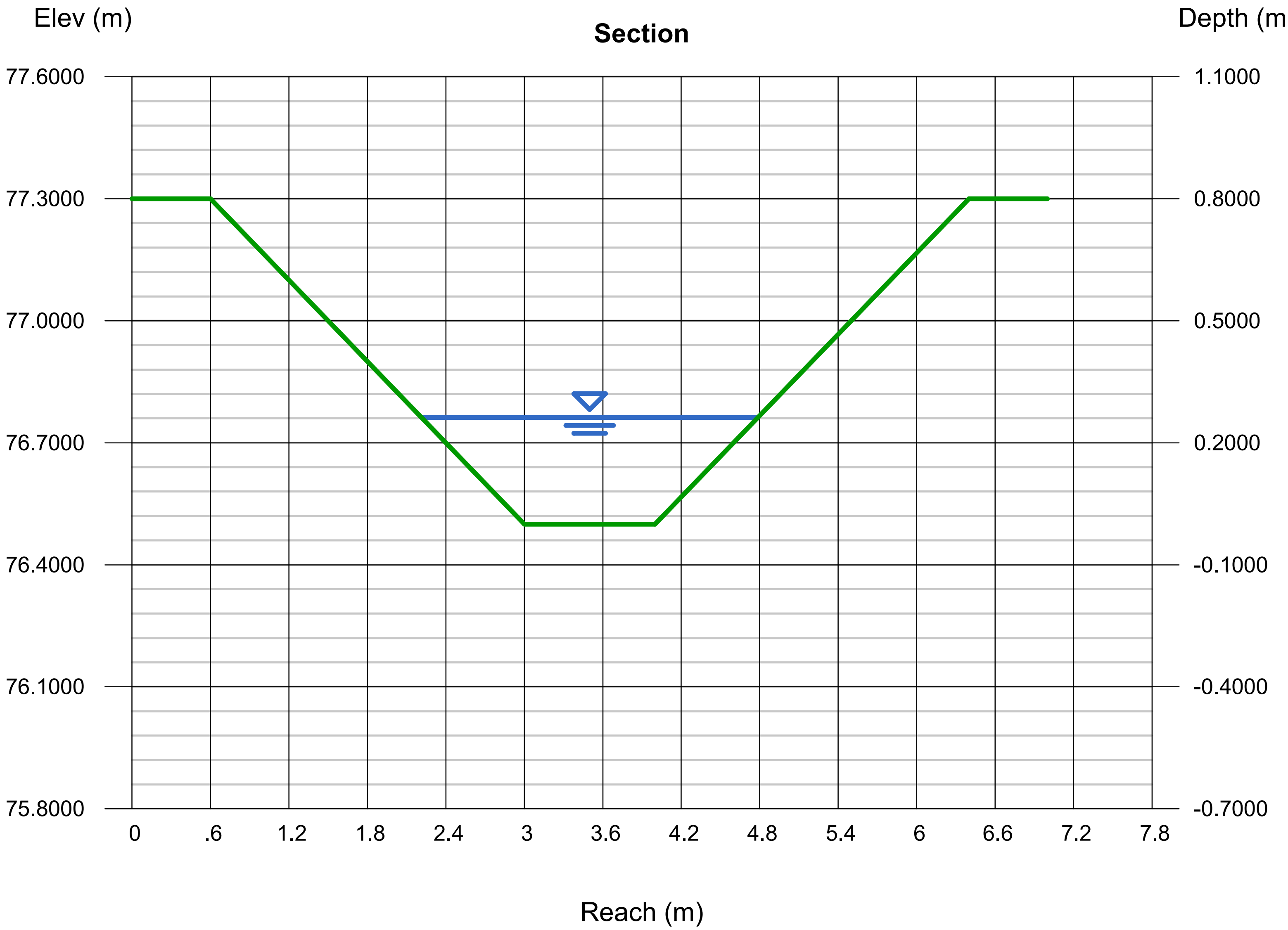
Channel Report

Enhanced Swale - 25mm Event - 0.23 CMS

Trapezoidal		**Highlighted**	
Bottom Width (m)	= 1.0000	Depth (m)	= 0.2621
Side Slopes (z:1)	= 3.0000, 3.0000	Q (cms)	= 0.230
Total Depth (m)	= 0.8000	Area (sqm)	= 0.4683
Invert Elev (m)	= 76.5000	Velocity (m/s)	= 0.4912
Slope (%)	= 0.5000	Wetted Perim (m)	= 2.6578
N-Value	= 0.045	Crit Depth, Yc (m)	= 0.1524
		Top Width (m)	= 2.5728
		EGL (m)	= 0.2744

Calculations

Compute by:	Known Q
Known Q (cms)	= 0.2300



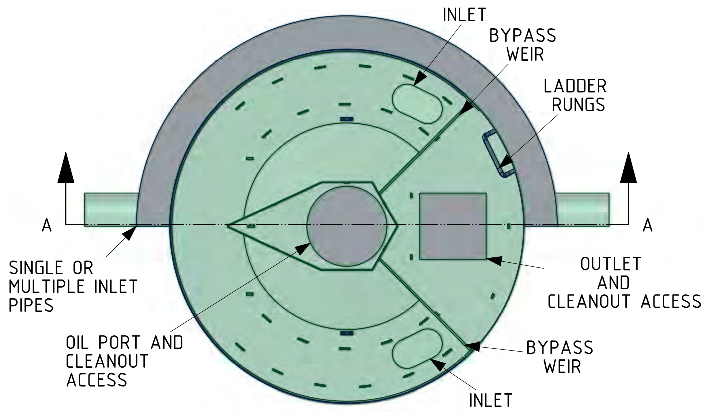
ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON ETV PARTICLE SIZE

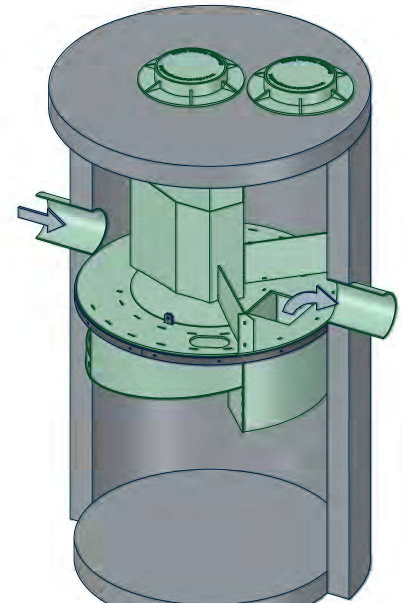
Area:	2.17	ha	**Project:**	Elmwood Subdivision
Runoff C:	0.50		**OGS Site ID:**	OGS-1
RWM Model:	RWM DM 2400 OS		**Location:**	Gananoque, ON
Manhole Dia.	2438	mm	**Engineer:**	Forefront Engineering

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Surface Loading Rate (L/min/m^2)	Removal Efficiency[2] (%)	Incremental Removal (%)
0.5	9.9%	9.9%	1.7	21	76.4	7.6
1.0	10.8%	20.7%	3.3	43	76.2	8.2
1.5	10.1%	30.8%	5.0	64	75.1	7.6
2.0	9.1%	39.9%	6.7	86	73.9	6.7
2.5	7.0%	46.9%	8.3	107	72.8	5.1
3.0	6.9%	53.9%	10.0	129	71.7	5.0
3.5	4.5%	58.4%	11.7	150	70.6	3.2
4.0	4.5%	62.9%	13.3	172	69.5	3.1
4.5	4.1%	67.0%	15.0	193	68.5	2.8
5.0	3.8%	70.8%	16.7	214	67.4	2.6
6.0	5.7%	76.5%	20.0	257	65.5	3.7
7.0	4.5%	81.0%	23.4	300	63.5	2.9
8.0	3.6%	84.5%	26.7	343	61.5	2.2
9.0	2.3%	86.8%	30.0	386	59.5	1.3
10.0	1.9%	88.7%	33.4	429	58.7	1.1
15.0	6.1%	94.8%	50.0	643	57.1	3.5
20.0	2.6%	97.5%	66.7	858	53.7	1.4
25.0	2.0%	99.4%	83.4	1072	50.5	1.0
30.0	0.4%	99.9%	100.1	1287	47.6	0.2
35.0	0.1%	100.0%	116.8	1501	43.6	0.1
40.0	0.0%	100.0%	133.4	1716	40.2	0.0
45.0	0.0%	100.0%	150.1	1930	36.8	0.0
50.0	0.0%	100.0%	166.8	2145	33.5	0.0
					Predicted Net Annual Load Removal Efficiency =	**69%**
					Annual Runoff Treated	**100%**

1 - Based on 44 years of hourly rainfall data from Canadian Station 6104175, Kingston ON

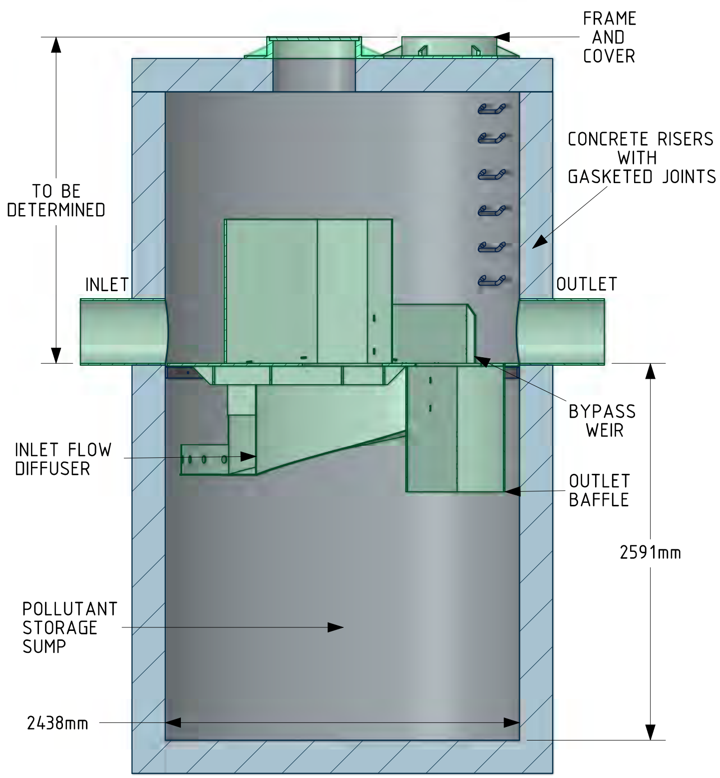
2- Removal Efficiency based on constant sediment influent concentration at all flow rates





TYPICAL DRAWING NOT FOR CONSTRUCTION

SCALE 1:68



SECTION A-A

DESIGN NOTES

1. INLET AND OUTLET PIPE CAN BE UP TO 90 DEGREES APART DEPENDING ON PIPE AND MANHOLE SIZE. IF IN DOUBT, PLEASE CONTACT RAINWATER MANAGEMENT.

2. THE RWM DM-OS UNIT CAN HANDLE MULTIPLE INLET PIPES AS WELL AS A TOP INLET.

GENERAL NOTES

1. RAINWATER MANAGEMENT TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.

2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS.

3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, CONTACT RAINWATER MANAGEMENT. www.rainwatermanagement.ca

4. RWM WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.

5. STRUCTURE AND CASTINGS SHALL MEET REQUIRED LOAD RATINGS, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.

6. MANHOLE MANUFACTURED TO LOCAL SPECIFICATIONS.

INSTALLATION NOTES

1. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY THE ENGINEER OF RECORD.

2. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE MANHOLE STRUCTURE (LIFTING DEVICES NOT PROVIDED). HEAVIEST LIFT DEPENDS ON RISER HEIGHTS.

3. CONTRACTOR TO ADD GASKETS OR JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE AS REQUIRED.

4. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES, MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.

5. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

rainwater MANAGEMENT
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604-944-9265

FILE: RWM-DM-2400-OS TYPICAL		MODEL: RWM-DM-2400-OS			
JOB / IDENTIFIER: DM-OS		REV:	CREATOR: AG	APPROVED:	SHEET: 1 of 1
MATERIAL: --	THICKNESS:	SCALE: 1:52	CREATED: 1/9/2023	LAST SAVED: 1/9/2023 3:44:47 PM	

ECHELON ENVIRONMENTAL

rainwater MANAGEMENT

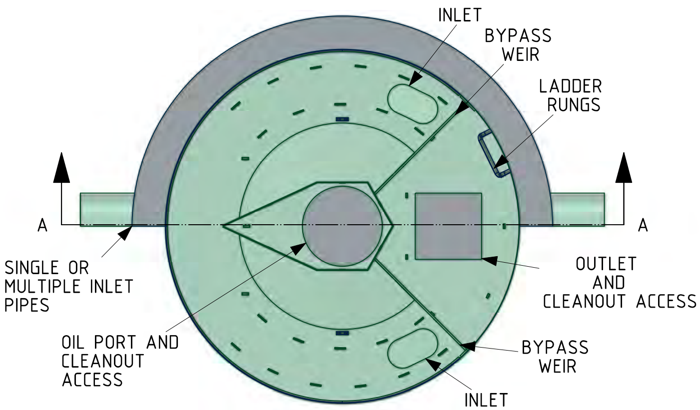
ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON ETV PARTICLE SIZE

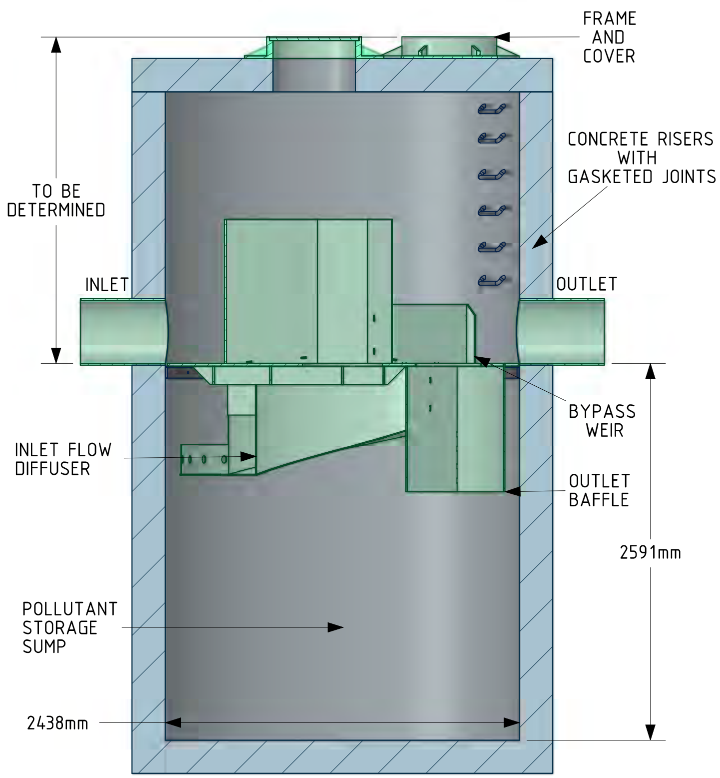
Area:	3.05	ha	**Project:**	Elmwood Subdivision
Runoff C:	0.50		**OGS Site ID:**	OGS-2
RWM Model:	RWM DM 2400 OS		**Location:**	Gananoque, ON
Manhole Dia.	2438	mm	**Engineer:**	Forefront Engineering

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Surface Loading Rate (L/min/m^2)	Removal Efficiency[2] (%)	Incremental Removal (%)
0.5	9.9%	9.9%	2.0	26	76.4	7.6
1.0	10.8%	20.7%	4.0	52	75.7	8.2
1.5	10.1%	30.8%	6.0	78	74.3	7.5
2.0	9.1%	39.9%	8.1	104	73.0	6.6
2.5	7.0%	46.9%	10.1	130	71.7	5.1
3.0	6.9%	53.9%	12.1	156	70.4	4.9
3.5	4.5%	58.4%	14.1	181	69.0	3.1
4.0	4.5%	62.9%	16.1	207	67.8	3.0
4.5	4.1%	67.0%	18.1	233	66.6	2.7
5.0	3.8%	70.8%	20.2	259	65.4	2.5
6.0	5.7%	76.5%	24.2	311	63.0	3.6
7.0	4.5%	81.0%	28.2	363	60.6	2.7
8.0	3.6%	84.5%	32.2	415	58.8	2.1
9.0	2.3%	86.8%	36.3	467	58.5	1.3
10.0	1.9%	88.7%	40.3	518	58.2	1.1
15.0	6.1%	94.8%	60.5	778	55.0	3.4
20.0	2.6%	97.5%	80.6	1037	51.0	1.3
25.0	2.0%	99.4%	100.8	1296	47.4	0.9
30.0	0.4%	99.9%	120.9	1555	42.8	0.2
35.0	0.1%	100.0%	141.1	1814	38.7	0.1
40.0	0.0%	100.0%	161.2	2073	34.6	0.0
45.0	0.0%	100.0%	181.4	2333	30.5	0.0
50.0	0.0%	100.0%	201.6	2592	26.4	0.0
					Predicted Net Annual Load Removal Efficiency =	**68%**
					Annual Runoff Treated	**100%**

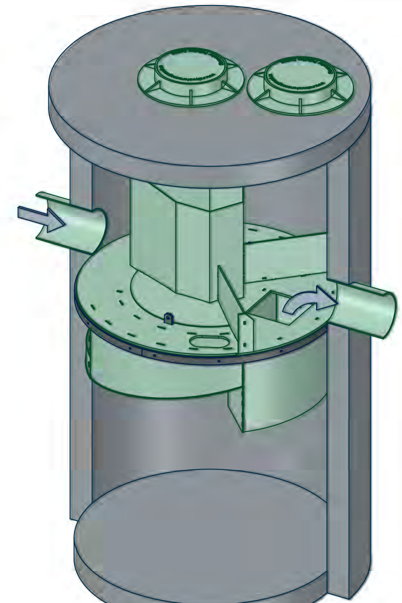
1 - Based on 44 years of hourly rainfall data from Canadian Station 6104175, Kingston ON

2- Removal Efficiency based on constant sediment influent concentration at all flow rates





SECTION A-A



SCALE 1:68

TYPICAL DRAWING NOT FOR CONSTRUCTION

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FILE		MODEL			
RWM-DM-2400-OS TYPICAL		RWM-DM-2400-OS			
JOB / IDENTIFIER: DM-OS		REV	CREATOR: AG	APPROVED	SHEET: 1 of 1
MATERIAL: --	THICKNESS	SCALE: 1:52	CREATED: 1/9/2023	LAST SAVED: 1/9/2023 3:44:47 PM	

RWM-DM1 AND DM1-OS TECHNICAL AND OPERATION MANUAL

Made In:

Canada

Contact: p: 604-944-9265 I e: info@rainwatermanagement.ca
Website: www.rainwatermanagement.ca

Overview

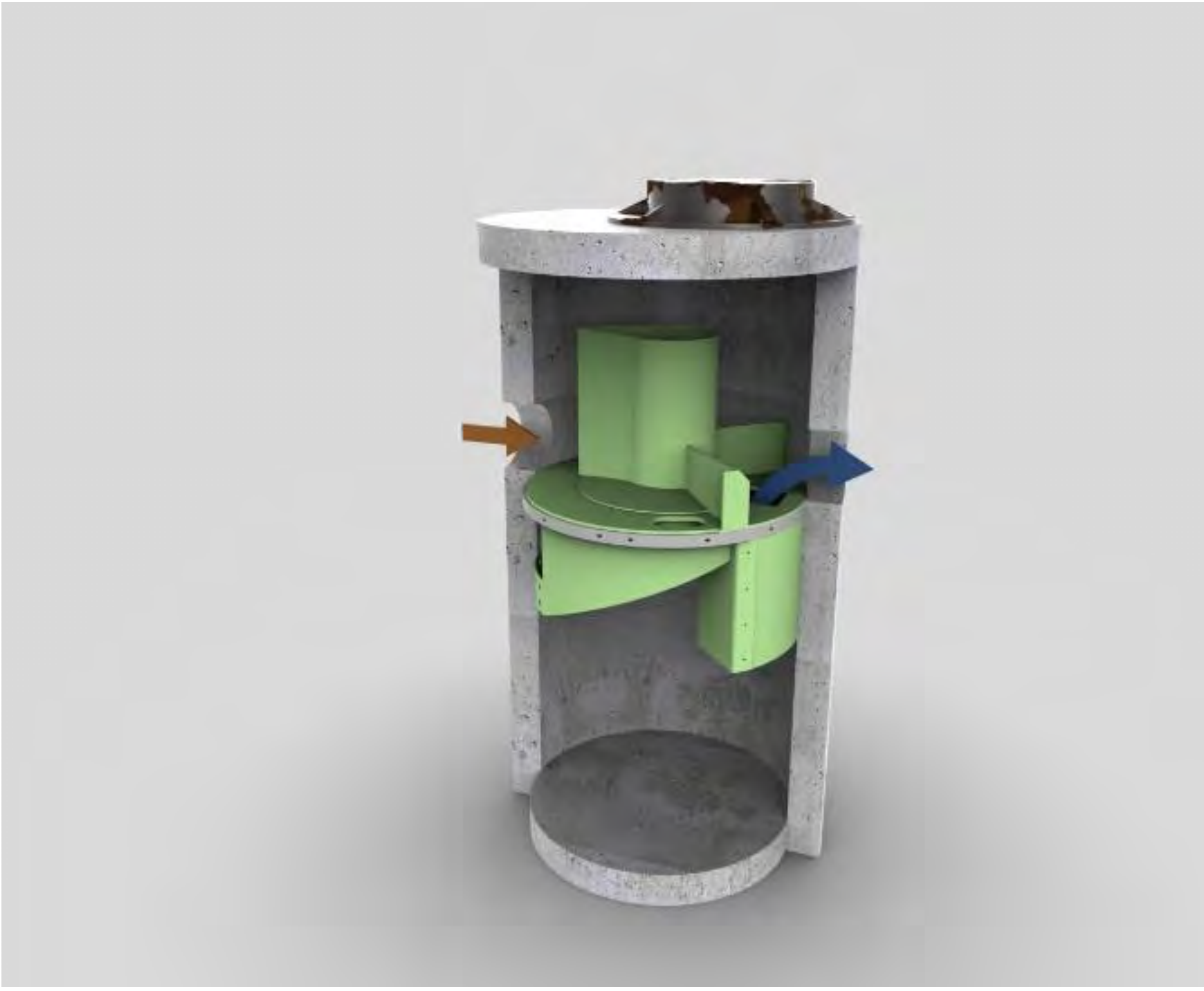
The Rainwater Management RWM-DM1 Stormwater Treatment System is a hydrodynamic oil/grit separator (OGS) that provides a unique flow path inside the treatment chamber that effectively promotes gravity settling to remove solids from stormwater runoff. The RWM-DM1 design is such that it minimizes energy loss so does not significantly back up the incoming water in the upstream pipe system. This means that it captures and retains the sediment in the treatment manhole and sump rather than settling the majority in the inlet pipe system. This may seem intuitive but most of the current OGS systems on the market utilize upstream pipe settling to achieve their claimed TSS removals. The RWM-DM1 is also very effective in removing and retaining other pollutants such as free oil and other particulate material like nutrients and metals either attached to sediment or heavy enough to settle in the removal process.

The RWM-DM1 utilizes an internal bypass that directs the treatment flows into the treatment/storage chamber and bypasses the peak events without scouring previously captured pollutants. The RWM-DM1 can be installed in an inline configuration knowing that the scour prevention technology is second to none.

This RWM-DM1 is quite versatile in that it can be installed as a bend structure, can accommodate multiple inlets and/or a top inlet (grated lid), and does not require an elevation difference between the inlet and outlet pipes. Rainwater Management is innovative in that we can create custom designs for almost any application that you may have. Contact us with your configuration requirements.

The RWM-DM1 unit has been fully third-party tested by an ETV-approved laboratory.

How It Works



Water enters the upper inlet chamber of the RWM-DM[1] OGS where it is split by a deflector to minimize turbulence, maximize the effective flowpath and smoothly and efficiently direct the flow to the 2 inlet openings. The flow path and weir configuration minimizes the energy loss to almost completely eliminate any settling of sediment in the inlet pipe and upstream pipe system. The purpose of the OGS is to capture the sediment in the treatment manhole, not the inlet pipe. The RWM-DM[1] is specifically designed for that purpose.

It is at the weirs that the water enters the treatment chamber on either side of the center access cylinder directed via chutes designed to enhance the settling of sediment. A vortex is formed at each inlet opening so that any floatabe oil or trash will get drawn down into the treatment chamber where it will float to the underside of the sealed disk. Oil and floatables are stored out of the flow path and will be retained for removal by a vacuum truck.

The design of the system creates a longer flow path and a quiescent zone to maximize settling of pollutants inside the sump. Water then flows up the outlet duct and out the outlet pipe, leaving behind any captured sediment, oil, and trash.

During higher intensity events, the incoming water begins to overflow the internal bypass weirs which allows the unit to continue treating the design flow (which will continue to remove any bedload of heavier pollutants that flow in the bottom of the pipe) while bypassing the additional flows. As the scour testing results show, there is virtually no scour of previously trapped pollutants ensuring retention of previously capture pollutants.

RWM-DM^1 and DM^1-OS Details

RWM Model	Inside Diameter (mm)	Sump Depth Below Outlet Invert (mm)	Minimum Rim-Invert Distance[1] (mm)	Total Liquid Volume[2] (litres)	ETV Sediment Depth[3] (mm)	Oil Storage Capacity[4] (litres)	ETV Verified Treatment Flow Rate[5] (l/s)
DM^1-900/ DM^1-900-OS	914	1321	600	867	600	140	12 / 7.5
DM^1-1050/ DM-^{1}1050-OS	1066	1422	600	1270	650	220	16.3 / 10
DM^1-1200/ DM^1-1200-OS	1219	1524	610	2134	750	270	22 / 13.7
DM^1-1500/ DM^1-1500-OS	1524	1750	750	3738	800	560	33 / 21
DM^1-1800/ DM^1-1800-OS	1829	1900	850	5828	875	950	49 / 30.4
DM^1-2100/ DM^1-2100-OS	2134	2250	950	8755	950	1570	65 / 41
DM^1-2400/ DM^1-2400-OS	2438	2438	1050	12275	1100	2293	88 / 55
DM^1-3000/ DM^1-3000-OS	3048	2950	1200	24212	1100	4520	137 / 85
DM^1-3600/ DM-^{1}3600-OS	3658	340	1350	39277	1200	7800	191 / 119

1. This distance is dependent upon many factors. Contact RWM with your project details so we can provide a minimum distance based on your specific project.
2. This volume is the total volume below invert. This can be increased if needed.
3. This capacity is based on ETV approved testing with additional sump a.
4. This capacity is from the bottom of the outlet baffle to the underside of the bypass chamber. This can be increased if needed. Dry weather spill volume.
5. Flow rates are for the RWM-DM^1 product only. Contact RWM if you would like a design report and/or to utilize a coarser particle size or testing criteria. Either of these cases could result in a downsized unit to meet local requirements.
6. This table represents the standard capacities. Capacities can be adjusted to meet site specific requirements.

RWM-DM[1] and DM[1]-OS Design

The RWM-DM[1] and RWM-DM[1]-OS are sized depending on the Federal, Provincial, or Municipal requirements. The ETV Particle size removal is derived from Third Party lab testing based on the 2013 version of the Canadian Environmental Technology Verification Programs Procedure for Laboratory Testing of Oil-Grit Separators (ISO14034) utilizing the following specific site parameters:

- Drainage area
- Local rainfall data
- Site imperviousness
- Scour protection for high flows
- Onsite flow control for runoff
- Oil spill requirements
- Sediment storage capacity
- ETV particle size distribution Capture
- Third party testing at ETV approved laboratory
- ETV verification (pending)

Many areas within Canada have different requirements for sizing OGS units and interpretations of how they want details applied. Contact Rainwater Management for design assistance or visit our website.

Application

The RWM[1]-DM and DM[1]-OS units are suited to any commercial, residential, or industrial application where pollution removal and retention is required. The units are normally deployed in concrete manhole below ground but they can be configured for above ground use in Stainless Steel, Fiberglass or HDPE tanks. The RWM[1]-DM testing shows that the captured pollutants will be removed and stored in the manhole without allowing any to be released during peak events. Scour testing showed virtually 100% retention of captured pollutants over all flows. For sites where oil spill capture and greater than 99% retention is needed the RWM-DM[1]-OS unit should be utilized. The RWM-DM[1] also captures oil but the RWM-DM[1]-OS has been specifically designed for oil spill capture and retention even during peak events.

Canadian ETV - ISO 14034 Information

Particle Size Distribution

The ISO 14034 (Canadian ETV) Particle Size Distribution that is utilized for testing all OGS units is shown below. This is the particle size distribution utilized in whole or in part for this sizing.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Third-Party Testing and Verification

The Rainwater Management RWM-DM[1] and RWM-DM[1] OS units are the latest development by RWM that are designed to capture a wide range of pollutants. The technology has been tested following the 2013 (Canadian ETV) Procedure for Laboratory Testing of Oil-Grit Separators and is currently being verified.

Scour Testing

RWM-DM[1] and RWM-DM[1]-OS units have an internal bypass that directs the treatment flows into the treatment/storage chamber and bypasses the peak events without scouring previously capture pollutants. This has been third-party verified during the Canadian ETV (ISO-14034) testing. The RWM-DM[1] OGS units can be installed in an inline configuration knowing that the scour prevention technology is second to none.

Oil Capture and Scour

The RWM DM[1]-OS unit effectively achieved 100 % oil retention for all flows during the third-party testing of the Light Liquid Retention Simulation Test Protocol of the ISO 14034 Procedure for Laboratory Testing of Oil-Grit Separator.

Installation

The RWM-DM[1] internals will arrive onsite pre-installed in the manhole. Ensure that you have the shop drawings for your specific project to ensure proper installation orientation and depth. The design allows for the inlet and outlet inverts to be the same elevation but there are variances allowed that must be confirmed during the design phase. The installation of the manhole must follow the recommendations of the specifying engineer as well as all local, provincial and federal requirements in terms of supporting soil, backfill and anti-floatation requirements. The inlet/outlet pipe installation into the manholes must also follow the recommendations of the specifying engineer as well as the local requirements. The required opening types (gasketed, pipe stub, rough opening, cored opening) will be provided by RWM as specified during the order process. All local, provincial and federal safety procedures for manhole installation must be followed.

Inspection

The most important part of the inspection and maintenance is that all local, Provincial, Federal and OSHA health and safety requirements are followed. Under no circumstance should there be entry into the units without the proper procedures in place.

Inspection of the RWM-DM[1] units is conducted from the surface and does not require entry into the manhole. We provide easy access for the vacuum hose through the outlet opening in the bypass disk to check for sediment depth. Oil storage can be checked through the center opening. Visual inspection of the internal components is also necessary to ensure nothing is damaged or blocked.

Maintenance

Maintenance is completed with a vacuum truck from the surface and also does not require entry into the manhole. The sediment in the lower treatment chamber can be removed with a vacuum truck through either the outlet opening or through the center access. If there is oil present, the typical procedure is to remove the oil from the water surface through the center access opening and dispose of it according to local regulations.

ETV Depth of Sediment for Maintenance	
Model	Depth (mm)
DM[1]-900/ DM[1]-900-OS	550
DM[1]-1050/ DM[1]-1050-OS	550
DM[1]-1200/ DM[1]-1200-OS	610
DM[1]-1500/ DM-[1]1500-OS	700
DM[1]-1800/ DM[1]-1800-OS	750
DM[1]-2100/ DM[1]-2100-OS	750
DM[1]-2400/ DM[1]-2400-OS	750
DM[1]-3000/ DM[1]-3000-OS	763
DM[1]-3600/ DM[1]-3600-OS	900

Note that maintenance frequency is dependent on the site conditions. For example, units installed before construction is completed will require more frequent cleanout than post-construction. It is recommended that the unit is inspected every six months post-install while observing the site conditions and changes to site conditions to determine the proper maintenance frequency. The cost of maintenance, cleanout, and disposal is also dependent on the location and requirements.

The RWM-DM[1]-OS system is recommended for areas where the possibility of a hydrocarbon spill may occur. Please also refer to the Rainwater Management Coalescing Plate Oil Water separators where 15 mg/l or lower oil effluent discharge is required. It is recommended that if hydrocarbons are present during inspection that they are removed immediately. The RWM-DM[1]-OS system in the ETV light liquid test shows greater than 99% retention but it is still recommended to remove any captured oil immediately. Contact Rainwater Management if you want to add oil sensing alarms.

Disposal of all captured pollutants needs to conform to all local, provincial and federal disposal guidelines. For any modifications to the existing design where additional pollutant capacity or any other modification is desired contact RWM with your requirements.

Appendix C

OWIT Watercourse Catchment Map

Table 3-1 Surface Cover Parameters

Pre-Development and Post-Development 100-Year 24-Hour SCS II Modeling

Culvert Report – 1800 x 1200 Culvert Analysis

Figure 5: Watercourse Improvements

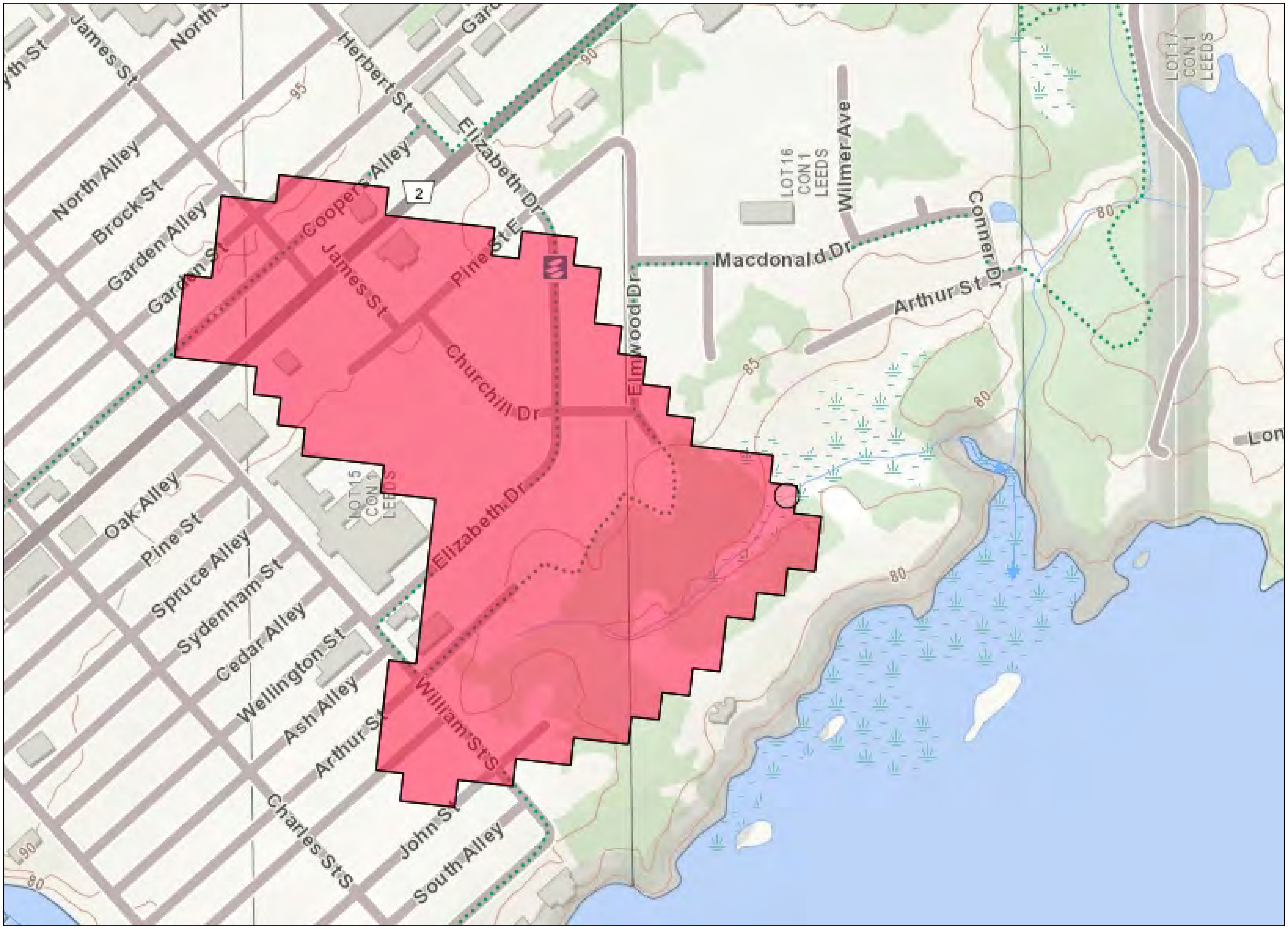
Figure 6: Enhanced Swale Outlet Details

Figure 7: Proposed Enhanced Wetland

MINISTRY OF NATURAL RESOURCES
Ontario Watershed Information Tool

OWIT Watercourse Catchment Map

Notes:



Legend

- Assessment Parcel
- Secondary Watershed
- Tertiary Watershed
- Quaternary Watershed
- Great Lakes - St. Lawrence Basin
- Hudson - James Bay Basin
- Nelson River Basin
- Hydrometric Monitoring Station
- Diversions
- Waterbody Outlet
- Conservation Authority Dam
- Provincial Dam
- Federal Dam
- OPG Dam
- Other Dam
- Virtual Flow Segment

Land Cover Compilation

- Other
- Cloud/Shadow
- Clear Open Water
- Turbid Water
- Shoreline
- Mudflats
- Marsh
- Swamp
- Fen
- Bog
- Heath
- Sparse Treed
- Treed Upland
- Deciduous Treed
- Mixed Treed
- Coniferous Treed
- Plantations - Treed Cultivated
- Hedge Rows
- Disturbance
- Open Cliff and Talus
- Alvar
- Sand Barren and Dune
- Open Tallgrass Prairie
- Tallgrass Savannah
- Tallgrass Woodland
- Sand/Gravel/Mine Tailings/Extraction
- Bedrock
- Community/Infrastructure
- Agriculture and Undifferentiated Rural Land Use

0.3 0 km 0.16 0.3

Scale: 1 : 6,458

Projection: Web Mercator

The Ontario Ministry of Natural Resources shall not be liable in any way for the use of, or reliance upon, this map or any information on this map. This map should not be used for: navigation, a plan of survey, routes, nor locations. THIS IS NOT A PLAN OF SURVEY.

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Table 3-1: Surface Cover Parameter Calculations

Surface Cover Type	Manning's "n"		Dep. Storage (mm)		% Impervious	% 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			
(Pre-Development)																					
E1	60.00%	30.00%									10.00%		100.00%	6.4	0.027	0.35	7.5	13.5	10	88	Impervious to Pervious
E2	60.00%	30.00%									10.00%		100.00%	6.4	0.027	0.35	7.5	13.5	10	88	Impervious to Pervious
E3	30.00%	60.00%									10.00%		100.00%	6.8	0.0255	0.305	6	12	10	80	Impervious to Pervious
EX1A		22.00%					17.00%		61.00%				100.00%	74.7	0.0172	0.172	3.05	6.1	18.65	24	Pervious to Impervious
EX1B	13.00%	46.50%					10.00%		30.50%				100.00%	39.8	0.0216	0.229	4.6375	8.625	14.55	52	Impervious to Pervious
EX1C		59.50%					10.00%		30.50%				100.00%	40.0	0.02095	0.2095	3.9875	7.975	14.55	49	Impervious to Pervious
EX2A		43.00%					15.00%		42.00%				100.00%	55.2	0.0193	0.193	3.575	7.15	16.45	38	Impervious to Pervious
EX2B		59.50%					10.00%		30.50%				100.00%	40.0	0.02095	0.2095	3.9875	7.975	14.55	49	Impervious to Pervious
EX2C		59.50%					10.00%		30.50%				100.00%	40.0	0.02095	0.2095	3.9875	7.975	14.55	49	Impervious to Pervious
(Post Development)																					
P1		52.00%					23.00%		25.00%				100.00%	46.9	0.0202	0.202	3.8	7.6	15.95	44	Impervious to Pervious
P2		52.00%					23.00%		25.00%				100.00%	46.9	0.0202	0.202	3.8	7.6	15.95	44	Impervious to Pervious
EX1A		22.00%					17.00%		61.00%				100.00%	74.7	0.0172	0.172	3.05	6.1	18.65	24	Pervious to Impervious
EX1B	13.00%	46.50%					10.00%		30.50%				100.00%	39.8	0.0216	0.229	4.6375	8.625	14.55	52	Impervious to Pervious
EX1C		59.50%					10.00%		30.50%				100.00%	40.0	0.02095	0.2095	3.9875	7.975	14.55	49	Impervious to Pervious
EX2A		43.00%					15.00%		42.00%				100.00%	55.2	0.0193	0.193	3.575	7.15	16.45	38	Impervious to Pervious
EX2B		59.50%					10.00%		30.50%				100.00%	40.0	0.02095	0.2095	3.9875	7.975	14.55	49	Impervious to Pervious
EX2C		59.50%					10.00%		30.50%				100.00%	40.0	0.02095	0.2095	3.9875	7.975	14.55	49	Impervious to Pervious

Pre-development 100-Year 24 Hour SCS II Modeling

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.4.304 (Build 0)

```
*******************
Project Description
*******************
File Name ................ Pre Development Elmwood SWMM5.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 ............ AUG-01-2025 00:00:00
Ending Date .............. AUG-05-2025 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 ....... 8
Number of nodes ........... 9
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
E1	4.06	90.00	6.40	1.0000	-
E2	3.61	315.00	6.40	3.0000	-
EX1A	12.01	160.00	75.00	0.4000	-
EX1B	16.04	240.00	40.00	0.5000	-
EX1C	2.63	80.00	40.00	0.4000	-
EX2A	11.65	200.00	55.20	1.5000	-
EX2B	8.19	150.00	40.00	0.5000	-
EX2C	1.16	100.00	40.00	5.0000	-

```
************
Node Summary
************
```

Node ID	Element Type	Invert Elevation (m)	Maximum Elev. (m)	Ponded Area (m²)	External Inflow
750_OUTFALL	JUNCTION	81.88	82.90	0.000	
900_OUT	JUNCTION	76.20	78.20	0.000	
900mm_IN	JUNCTION	76.58	78.65	0.000	
MARSH_IN	JUNCTION	76.15	76.90	0.000	

Watercourse_N1	JUNCTION	78.37	79.50	0.000
Watercourse_N2	JUNCTION	77.70	78.70	0.000
EAST_BYPASS	OUTFALL	78.30	78.60	0.000
OUTLET1	OUTFALL	74.90	75.50	0.000
Diversion-04	DIVIDER	77.60	80.80	0.000

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
Arthur_OUT	900_OUT	MARSH_IN	CHANNEL	50.2	0.0995	0.0350
Arthur_ROW	Diversion-04	EAST_BYPASS	CHANNEL	50.0	0.4000	0.0320
ASTM_ARTHUR_900	Diversion-04	900mm_IN	CONDUIT	92.9	1.0228	0.0130
BSTM_ARTHUR_900	900mm_IN	900_OUT	CONDUIT	25.9	1.4666	0.0130
MARSH_OUT	MARSH_IN	OUTLET1	CHANNEL	25.2	4.9682	0.0320
Watercourse_a	750_OUTFALL	Watercourse_N1	CHANNEL	80.2	4.3777	0.0450
Watercourse_b	Watercourse_N1	Watercourse_N2	CHANNEL	133.0	0.5039	0.0450
Watercourse_c	Watercourse_N2	MARSH_IN	CHANNEL	165.8	0.9048	0.0450

****
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
Arthur_OUT	TRAPEZOIDAL	0.50	8.00	1	3.25	0.40	1.59
Arthur_ROW	RECT_OPEN	0.30	20.00	1	6.00	0.29	5.21
ASTM_ARTHUR_900	CIRCULAR	0.90	0.90	1	0.64	0.23	1.83
BSTM_ARTHUR_900	CIRCULAR	0.90	0.90	1	0.64	0.23	2.19
MARSH_OUT	TRAPEZOIDAL	0.60	18.60	1	10.08	0.54	46.36
Watercourse_a	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	12.43
Watercourse_b	TRAPEZOIDAL	0.90	9.50	1	4.50	0.46	4.26
Watercourse_c	TRAPEZOIDAL	0.70	8.00	1	3.15	0.39	3.54

************************** Runoff Quantity Continuity **************************	Volume hectare-m	Depth mm
Total Precipitation	7.122	120.000
Evaporation Loss	0.000	0.000
Infiltration Loss	2.448	41.241
Surface Runoff	4.597	77.453
Final Surface Storage	0.085	1.438
Continuity Error (%)	-0.110	

```
*************************         Volume         Volume
Flow Routing Continuity         hectare-m        Mliters
*************************       ---------      ---------
Dry Weather Inflow .......          0.000          0.000
Wet Weather Inflow .......          4.598         45.985
Groundwater Inflow .......          0.000          0.000
RDII Inflow ..............          0.000          0.000
External Inflow ..........          0.000          0.000
External Outflow .........          4.611         46.111
Surface Flooding .........          0.000          0.000
Evaporation Loss .........          0.000          0.000
Initial Stored Volume ....          0.000          0.000
Final Stored Volume ......          0.000          0.000
Continuity Error (%) .....         -0.276


**************************************************
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 E1
--------------

        Flow length (m):                            451.11
        Pervious Manning's Roughness:              0.35000
        Impervious Manning's Roughness:            0.02700
        Pervious Rainfall Intensity (mm/hr):       5.00000
        Impervious Rainfall Intensity (mm/hr):     5.00000
        Slope (%):                                 1.00000
        Computed TOC (minutes):                     303.40

--------------
Subbasin E2
--------------

        Flow length (m):                            114.60
        Pervious Manning's Roughness:              0.35000
        Impervious Manning's Roughness:            0.02700
        Pervious Rainfall Intensity (mm/hr):       5.00000
        Impervious Rainfall Intensity (mm/hr):     5.00000
        Slope (%):                                 3.00000
        Computed TOC (minutes):                      95.93

----------------
Subbasin EX1A
----------------

        Flow length (m):                            750.63
        Pervious Manning's Roughness:              0.17200
        Impervious Manning's Roughness:            0.01720
        Pervious Rainfall Intensity (mm/hr):       5.00000
        Impervious Rainfall Intensity (mm/hr):     5.00000
        Slope (%):                                 0.40000
        Computed TOC (minutes):                     213.00
```

```
----------------
Subbasin EX1B
----------------

        Flow length (m):                          668.33
        Pervious Manning's Roughness:             0.21925
        Impervious Manning's Roughness:           0.02127
        Pervious Rainfall Intensity (mm/hr):      5.00000
        Impervious Rainfall Intensity (mm/hr):    5.00000
        Slope (%):                                0.50000
        Computed TOC (minutes):                   270.89

----------------
Subbasin EX1C
----------------

        Flow length (m):                          328.75
        Pervious Manning's Roughness:             0.20950
        Impervious Manning's Roughness:           0.02095
        Pervious Rainfall Intensity (mm/hr):      5.00000
        Impervious Rainfall Intensity (mm/hr):    5.00000
        Slope (%):                                0.40000
        Computed TOC (minutes):                   180.59

----------------
Subbasin EX2A
----------------

        Flow length (m):                          582.50
        Pervious Manning's Roughness:             0.19300
        Impervious Manning's Roughness:           0.01930
        Pervious Rainfall Intensity (mm/hr):      5.00000
        Impervious Rainfall Intensity (mm/hr):    5.00000
        Slope (%):                                1.50000
        Computed TOC (minutes):                   156.44

----------------
Subbasin EX2B
----------------

        Flow length (m):                          546.00
        Pervious Manning's Roughness:             0.20950
        Impervious Manning's Roughness:           0.02095
        Pervious Rainfall Intensity (mm/hr):      5.00000
        Impervious Rainfall Intensity (mm/hr):    5.00000
        Slope (%):                                0.50000
        Computed TOC (minutes):                   229.20

----------------
Subbasin EX2C
----------------

        Flow length (m):                          116.00
        Pervious Manning's Roughness:             0.20950
        Impervious Manning's Roughness:           0.02095
        Pervious Rainfall Intensity (mm/hr):      5.00000
        Impervious Rainfall Intensity (mm/hr):    5.00000
        Slope (%):                                5.00000
        Computed TOC (minutes):                    44.79

***********************
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
E1	120.00	48.96	0.00	77.34	91.23	0.22	0.540	0 05:03:24
E2	120.00	25.17	0.00	67.35	77.55	0.74	0.534	0 01:35:55
EX1A	120.00	0.00	0.00	15.98	102.20	2.43	0.852	0 03:32:59
EX1B	120.00	76.60	0.00	50.74	144.48	2.05	0.735	0 04:30:53
EX1C	120.00	0.00	0.00	43.25	75.53	0.33	0.629	0 03:00:35
EX2A	120.00	52.23	0.00	30.85	139.83	2.95	0.812	0 02:36:26
EX2B	120.00	0.00	0.00	44.50	74.24	0.84	0.619	0 03:49:11
EX2C	120.00	0.00	0.00	40.67	78.24	0.36	0.652	0 00:44:47

****

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 Time Flooded minutes	Retention Time hh:mm:ss
750_OUTFALL	0.10	0.45	82.33	0	12:06	0	0	0:00:00
900_OUT	0.10	0.50	76.70	0	12:06	0	0	0:00:00
900mm_IN	0.14	0.92	77.50	0	12:06	0	0	0:00:00
MARSH_IN	0.03	0.16	76.31	0	12:12	0	0	0:00:00
Watercourse_N1	0.17	0.71	79.08	0	12:07	0	0	0:00:00
Watercourse_N2	0.17	0.66	78.36	0	12:17	0	0	0:00:00
EAST_BYPASS	0.00	0.07	78.37	0	12:06	0	0	0:00:00
OUTLET1	0.03	0.15	75.05	0	12:12	0	0	0:00:00
Diversion-04	0.14	1.06	78.66	0	12:06	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
750_OUTFALL	JUNCTION	2.050	2.050	0	12:06	0.00		
900_OUT	JUNCTION	0.000	1.725	0	12:06	0.00		

900mm_IN	JUNCTION	0.000	1.726	0	12:06	0.00
MARSH_IN	JUNCTION	0.738	4.528	0	12:11	0.00
Watercourse_N1	JUNCTION	0.000	2.045	0	12:06	0.00
Watercourse_N2	JUNCTION	0.222	2.251	0	12:10	0.00
EAST_BYPASS	OUTFALL	0.000	1.197	0	12:06	0.00
OUTLET1	OUTFALL	0.000	4.528	0	12:12	0.00
Diversion-04	DIVIDER	2.949	2.949	0	12:06	0.00

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
EAST_BYPASS	3.20	0.550	1.197
OUTLET1	77.26	0.722	4.528
System	40.23	1.272	5.351

****
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 Surcharged minutes	Reported Condition
Arthur_OUT	CHANNEL	0 12:07	0.94	1.00	1.725	1.586	1.09	0.65	0	> CAPACITY
Arthur_ROW	CHANNEL	0 12:06	0.52	1.00	1.197	5.211	0.23	0.38	0	Calculated
ASTM_ARTHUR_900	CONDUIT	0 12:06	2.76	1.00	1.726	1.831	0.94	0.97	0	Calculated
BSTM_ARTHUR_900	CONDUIT	0 12:06	3.29	1.00	1.725	2.193	0.79	0.78	0	Calculated
MARSH_OUT	CHANNEL	0 12:12	1.89	1.00	4.528	46.355	0.10	0.26	0	Calculated
Watercourse_a	CHANNEL	0 12:06	1.32	1.00	2.045	12.428	0.16	0.58	0	Calculated
Watercourse_b	CHANNEL	0 12:09	0.80	1.00	2.075	4.261	0.49	0.75	0	Calculated
Watercourse_c	CHANNEL	0 12:17	1.07	1.00	2.199	3.537	0.62	0.78	0	Calculated

****
Flow Classification Summary
****

--- Fraction of Time in Flow Class ---- Avg. Avg.

Link	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Froude Number	Flow Change
Arthur_OUT	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.21	0.0002
Arthur_ROW	0.97	0.00	0.00	0.03	0.00	0.00	0.00	0.01	0.0000
ASTM_ARTHUR_900	0.00	0.00	0.00	0.03	0.05	0.00	0.91	1.16	0.0001
BSTM_ARTHUR_900	0.00	0.00	0.00	0.41	0.59	0.00	0.00	1.24	0.0001
MARSH_OUT	0.01	0.01	0.00	0.44	0.54	0.00	0.00	0.95	0.0000
Watercourse_a	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.35	0.0000
Watercourse_b	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.26	0.0001
Watercourse_c	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.36	0.0001

****
Time-Step Critical Elements
****

Link BSTM_ARTHUR_900 (33.51%)

****
Highest Flow Instability Indexes
****

All links are stable.

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

Minimum Time Step	:	3.10 sec
Average Time Step	:	21.70 sec
Maximum Time Step	:	30.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.01

Analysis began on: Fri Aug 1 15:25:33 2025
Analysis ended on: Fri Aug 1 15:25:35 2025
Total elapsed time: 00:00:02

Forefront Engineering Inc

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Post-development 100-Year 24 Hour SCS II Modeling

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Autodesk® Storm and Sanitary Analysis 2016 - Version 13.4.304 (Build 0)
-----------------------------------------------------------------------------------------

*******************
Project Description
*******************
File Name ................ Post Development Elmwood SWMM5.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 ............ AUG-01-2025 00:00:00
Ending Date .............. AUG-04-2025 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 ....... 8
Number of nodes ........... 10
Number of links ........... 9
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Subbasin Summary
****************
Subbasin                 Total    Equiv.   Imperv.   Average    Raingage
                          Area     Width      Area     Slope
ID                    hectares         m         %         %
---------------------------------------------------------------------------
EX1A                     12.01    160.00     75.00    0.4000    -
EX1B                     16.04    240.00     40.00    0.5000    -
EX1C                      2.63     80.00     40.00    0.4000    -
EX2A                     11.65    200.00     55.20    1.5000    -
EX2B                      8.19    150.00     40.00    0.5000    -
EX2C                      1.16    100.00     40.00    5.0000    -
P1                        3.64    120.00     47.00    1.5000    -
P2                        4.59    110.00     47.00    1.0000    -


************
Node Summary
************
Node                Element              Invert   Maximum    Ponded    External
ID                  Type              Elevation     Elev.      Area      Inflow
                                              m         m        m²
------------------------------------------------------------------------------
750_OUTFALL         JUNCTION              81.88     82.90     0.000
900_OUT             JUNCTION              76.20     78.20     0.000
900mm_IN            JUNCTION              76.58     78.65     0.000
MARSH_IN            JUNCTION              76.15     77.20     0.000
```

MARSH_OUT	JUNCTION	76.10	77.10	0.000
Watercourse_N1	JUNCTION	78.37	79.50	0.000
Watercourse_N2	JUNCTION	77.70	78.70	0.000
East_Bypass	OUTFALL	78.30	78.60	0.000
OUTLET1	OUTFALL	74.90	75.50	0.000
Diversion-04	DIVIDER	77.60	80.80	0.000

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
Arthur_OUT	900_OUT	MARSH_OUT	CHANNEL	50.2	0.0995	0.0350
Arthur_ROW	Diversion-04	East_Bypass	CHANNEL	50.0	0.4000	0.0320
ASTM_ARTHUR_900	Diversion-04	900mm_IN	CONDUIT	92.9	1.0228	0.0130
BSTM_ARTHUR_900	900mm_IN	900_OUT	CONDUIT	25.9	1.4666	0.0130
TO_MARSH	MARSH_IN	MARSH_OUT	CHANNEL	44.7	0.1118	0.0450
Watercourse_a	750_OUTFALL	Watercourse_N1	CHANNEL	80.2	4.3777	0.0350
Watercourse_b	Watercourse_N1	Watercourse_N2	CHANNEL	133.0	0.5039	0.0450
Watercourse_c	Watercourse_N2	MARSH_IN	CHANNEL	165.8	0.9048	0.0450
WETLAND_OUT	MARSH_OUT	OUTLET1	CHANNEL	25.2	4.7695	0.0450

****
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
Arthur_OUT	TRAPEZOIDAL	0.50	8.00	1	3.25	0.40	1.59
Arthur_ROW	RECT_OPEN	0.30	20.00	1	6.00	0.29	5.21
ASTM_ARTHUR_900	CIRCULAR	0.90	0.90	1	0.64	0.23	1.83
BSTM_ARTHUR_900	CIRCULAR	0.90	0.90	1	0.64	0.23	2.19
TO_MARSH	TRAPEZOIDAL	0.60	18.60	1	10.08	0.54	4.95
Watercourse_a	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	15.98
Watercourse_b	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	4.22
Watercourse_c	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	5.65
WETLAND_OUT	TRAPEZOIDAL	0.60	18.60	1	10.08	0.54	32.30

************************* Runoff Quantity Continuity *************************	Volume hectare-m	Depth mm
Total Precipitation	7.189	120.000
Evaporation Loss	0.000	0.000
Infiltration Loss	2.180	36.385
Surface Runoff	4.923	82.169

```
Final Surface Storage ....         0.095         1.581
Continuity Error (%) .....        -0.113


**************************        Volume        Volume
Flow Routing Continuity         hectare-m       Mliters
**************************       ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         4.925        49.247
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         4.934        49.343
Surface Flooding .........         0.000         0.000
Evaporation Loss .........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.001
Continuity Error (%) .....        -0.195


**************************************************
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 EX1A
----------------

        Flow length (m):                             750.63
        Pervious Manning's Roughness:               0.17200
        Impervious Manning's Roughness:             0.01720
        Pervious Rainfall Intensity (mm/hr):        5.00000
        Impervious Rainfall Intensity (mm/hr):      5.00000
        Slope (%):                                  0.40000
        Computed TOC (minutes):                      213.00

----------------
Subbasin EX1B
----------------

        Flow length (m):                             668.33
        Pervious Manning's Roughness:               0.21925
        Impervious Manning's Roughness:             0.02127
        Pervious Rainfall Intensity (mm/hr):        5.00000
        Impervious Rainfall Intensity (mm/hr):      5.00000
        Slope (%):                                  0.50000
        Computed TOC (minutes):                      270.89

----------------
Subbasin EX1C
----------------

        Flow length (m):                             328.75
        Pervious Manning's Roughness:               0.20950
        Impervious Manning's Roughness:             0.02095
```

```
        Pervious Rainfall Intensity (mm/hr):      5.00000
        Impervious Rainfall Intensity (mm/hr):    5.00000
        Slope (%):                                0.40000
        Computed TOC (minutes):                    180.59

----------------
Subbasin EX2A
----------------

        Flow length (m):                           582.50
        Pervious Manning's Roughness:             0.19300
        Impervious Manning's Roughness:           0.01930
        Pervious Rainfall Intensity (mm/hr):      5.00000
        Impervious Rainfall Intensity (mm/hr):    5.00000
        Slope (%):                                1.50000
        Computed TOC (minutes):                    156.44

----------------
Subbasin EX2B
----------------

        Flow length (m):                           546.00
        Pervious Manning's Roughness:             0.20950
        Impervious Manning's Roughness:           0.02095
        Pervious Rainfall Intensity (mm/hr):      5.00000
        Impervious Rainfall Intensity (mm/hr):    5.00000
        Slope (%):                                0.50000
        Computed TOC (minutes):                    229.20

----------------
Subbasin EX2C
----------------

        Flow length (m):                           116.00
        Pervious Manning's Roughness:             0.20950
        Impervious Manning's Roughness:           0.02095
        Pervious Rainfall Intensity (mm/hr):      5.00000
        Impervious Rainfall Intensity (mm/hr):    5.00000
        Slope (%):                                5.00000
        Computed TOC (minutes):                     44.79

--------------
Subbasin P1
--------------

        Flow length (m):                           303.33
        Pervious Manning's Roughness:             0.20200
        Impervious Manning's Roughness:           0.02020
        Pervious Rainfall Intensity (mm/hr):      5.00000
        Impervious Rainfall Intensity (mm/hr):    5.00000
        Slope (%):                                1.50000
        Computed TOC (minutes):                    114.58

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

        Flow length (m):                           417.27
        Pervious Manning's Roughness:             0.20200
        Impervious Manning's Roughness:           0.02020
        Pervious Rainfall Intensity (mm/hr):      5.00000
        Impervious Rainfall Intensity (mm/hr):    5.00000
        Slope (%):                                1.00000
        Computed TOC (minutes):                    152.94
```

****
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
EX1A	120.00	0.00	0.00	15.98	102.19	2.43	0.852	0 03:32:59
EX1B	120.00	76.58	0.00	50.72	144.48	2.05	0.735	0 04:30:53
EX1C	120.00	0.00	0.00	43.25	75.53	0.33	0.629	0 03:00:35
EX2A	120.00	52.23	0.00	30.85	139.82	2.95	0.812	0 02:36:26
EX2B	120.00	0.00	0.00	44.50	74.24	0.84	0.619	0 03:49:11
EX2C	120.00	0.00	0.00	40.67	78.24	0.36	0.652	0 00:44:47
P1	120.00	0.00	0.00	33.75	84.91	0.83	0.708	0 01:54:34
P2	120.00	43.31	0.00	36.31	125.60	1.06	0.769	0 02:32:56

****
Node Depth Summary
****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss
750_OUTFALL	0.10	0.40	82.28	0	12:06	0	0	0:00:00
900_OUT	0.12	0.55	76.75	0	12:06	0	0	0:00:00
900mm_IN	0.17	0.92	77.50	0	12:06	0	0	0:00:00
MARSH_IN	0.10	0.43	76.58	0	12:09	0	0	0:00:00
MARSH_OUT	0.04	0.22	76.32	0	12:08	0	0	0:00:00
Watercourse_N1	0.23	0.90	79.27	0	12:07	0	0	0:00:00
Watercourse_N2	0.24	0.86	78.56	0	12:10	0	0	0:00:00
East_Bypass	0.00	0.07	78.37	0	12:06	0	0	0:00:00
OUTLET1	0.04	0.21	75.11	0	12:08	0	0	0:00:00
Diversion-04	0.17	1.06	78.66	0	12:06	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral	Peak Inflow	Time of Peak Inflow	Maximum Flooding	Time of Peak Flooding

		Inflow cms	cms	Occurrence days	hh:mm	Overflow cms	Occurrence days	hh:mm
750_OUTFALL	JUNCTION	2.050	2.050	0	12:06	0.00		
900_OUT	JUNCTION	0.363	2.086	0	12:05	0.00		
900mm_IN	JUNCTION	0.000	1.725	0	12:06	0.00		
MARSH_IN	JUNCTION	0.831	3.530	0	12:08	0.00		
MARSH_OUT	JUNCTION	0.000	5.561	0	12:08	0.00		
Watercourse_N1	JUNCTION	1.061	3.091	0	12:06	0.00		
Watercourse_N2	JUNCTION	0.000	3.060	0	12:07	0.00		
East_Bypass	OUTFALL	0.000	1.198	0	12:06	0.00		
OUTLET1	OUTFALL	0.000	5.560	0	12:08	0.00		
Diversion-04	DIVIDER	2.949	2.949	0	12:05	0.00		

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
East_Bypass	3.89	0.549	1.198
OUTLET1	97.63	0.753	5.560
System	50.76	1.302	6.654

****
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 Surcharged Time minutes	Reported Condition
Arthur_OUT	CHANNEL	0	12:06	0.91	1.00	2.084	1.586	1.31	0.75	0	> CAPACITY
Arthur_ROW	CHANNEL	0	12:06	0.52	1.00	1.198	5.211	0.23	0.38	0	Calculated
ASTM_ARTHUR_900	CONDUIT	0	12:06	2.76	1.00	1.725	1.831	0.94	0.97	0	Calculated
BSTM_ARTHUR_900	CONDUIT	0	12:06	3.30	1.00	1.725	2.193	0.79	0.80	0	Calculated
TO_MARSH	CHANNEL	0	12:09	0.68	1.00	3.526	4.946	0.71	0.54	0	Calculated
Watercourse_a	CHANNEL	0	12:06	1.16	1.00	2.046	15.979	0.13	0.65	0	Calculated
Watercourse_b	CHANNEL	0	12:07	0.98	1.00	3.060	4.216	0.73	0.87	0	Calculated
Watercourse_c	CHANNEL	0	12:10	1.30	1.00	2.942	5.650	0.52	0.72	0	Calculated
WETLAND_OUT	CHANNEL	0	12:08	1.64	1.00	5.560	32.298	0.17	0.36	0	Calculated

****
Flow Classification Summary
****

Link	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
	--- Fraction of Time in Flow Class ----								
Arthur_OUT	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.24	0.0002
Arthur_ROW	0.96	0.00	0.00	0.04	0.00	0.00	0.00	0.02	0.0000
ASTM_ARTHUR_900	0.00	0.00	0.00	0.04	0.06	0.00	0.89	1.26	0.0001
BSTM_ARTHUR_900	0.00	0.00	0.00	0.30	0.70	0.00	0.00	1.35	0.0001
TO_MARSH	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.19	0.0001
Watercourse_a	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.43	0.0000
Watercourse_b	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.26	0.0001
Watercourse_c	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.41	0.0001
WETLAND_OUT	0.02	0.00	0.00	0.75	0.22	0.00	0.00	0.73	0.0001

****
Time-Step Critical Elements
****
Link BSTM_ARTHUR_900 (40.93%)
Link ASTM_ARTHUR_900 (1.11%)

****
Highest Flow Instability Indexes
****
Link WETLAND_OUT (5)
Link TO_MARSH (4)
Link BSTM_ARTHUR_900 (1)

****
Routing Time Step Summary
****
Minimum Time Step : 3.13 sec
Average Time Step : 19.86 sec
Maximum Time Step : 30.00 sec
Percent in Steady State : 0.00
Average Iterations per Step : 2.01

Analysis began on: Fri Aug 1 15:16:05 2025
Analysis ended on: Fri Aug 1 15:16:08 2025
Total elapsed time: 00:00:03

Culvert Report

1800mm X 1200mm Box Culvert - 1:100 Year Event - 2.05 cms

Invert Elev Dn (m)	=	78.3800
Pipe Length (m)	=	25.0000
Slope (%)	=	0.3000
Invert Elev Up (m)	=	78.4550
Rise (mm)	=	1200.0
Shape	=	Box
Span (mm)	=	1800.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Rectagular Concrete
Culvert Entrance	=	Side tapered, less favorable edges
Coeff. K,M,c,Y,k	=	0.56, 0.667, 0.0446, 0.85, 0.5

Embankment

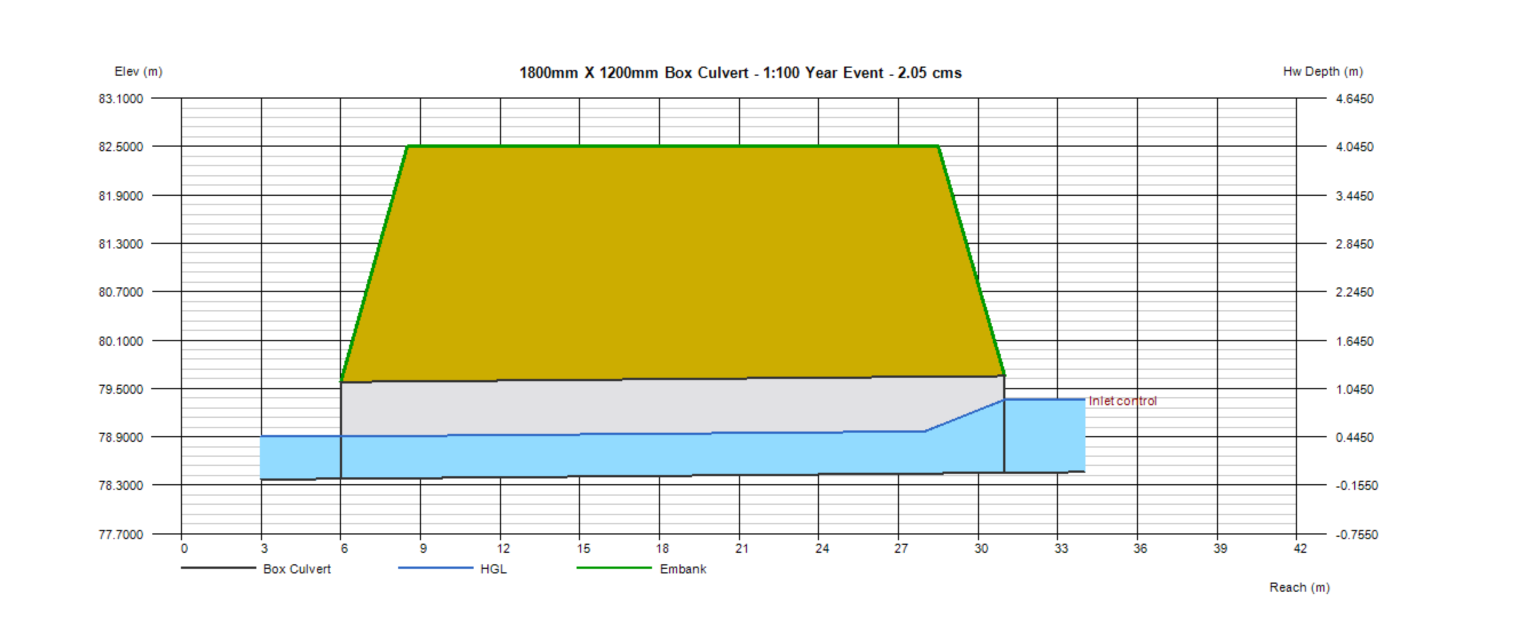
Top Elevation (m)	=	82.5000
Top Width (m)	=	20.0000
Crest Width (m)	=	40.0000

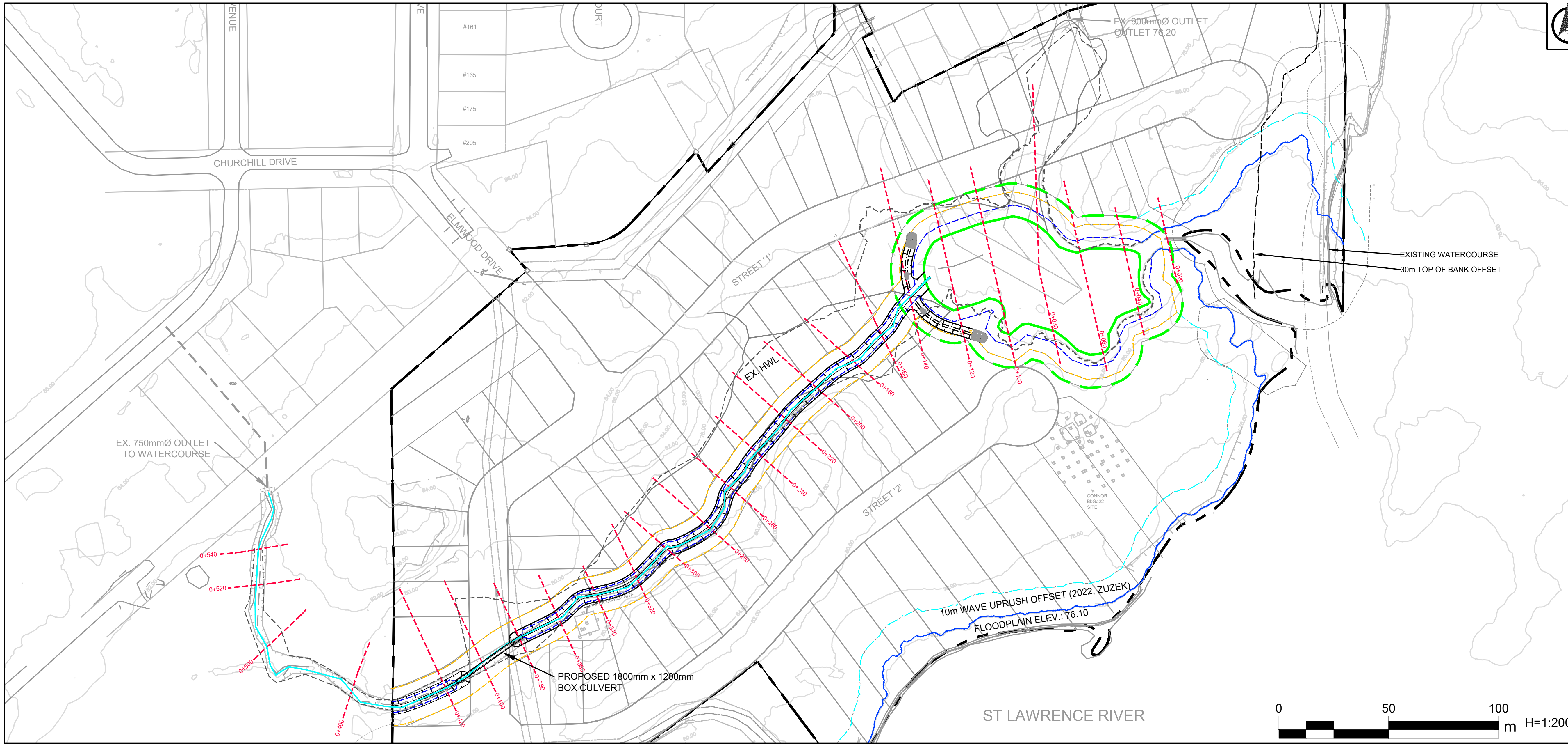
Calculations

Qmin (cms)	=	2.0500
Qmax (cms)	=	2.0500
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	2.0500
Qpipe (cms)	=	2.0500
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	2.1724
Veloc Up (m/s)	=	2.1826
HGL Dn (m)	=	78.9043
HGL Up (m)	=	78.9768
Hw Elev (m)	=	79.3626
Hw/D (m)	=	0.7563
Flow Regime	=	Inlet Control





LEGEND

PROPOSED WETLAND

PROPOSED WETLAND 15m OFFSET

ST LAWRENCE RIVER FLOODPLAIN ELEV.: 76.10 (2022, ZUZEK)

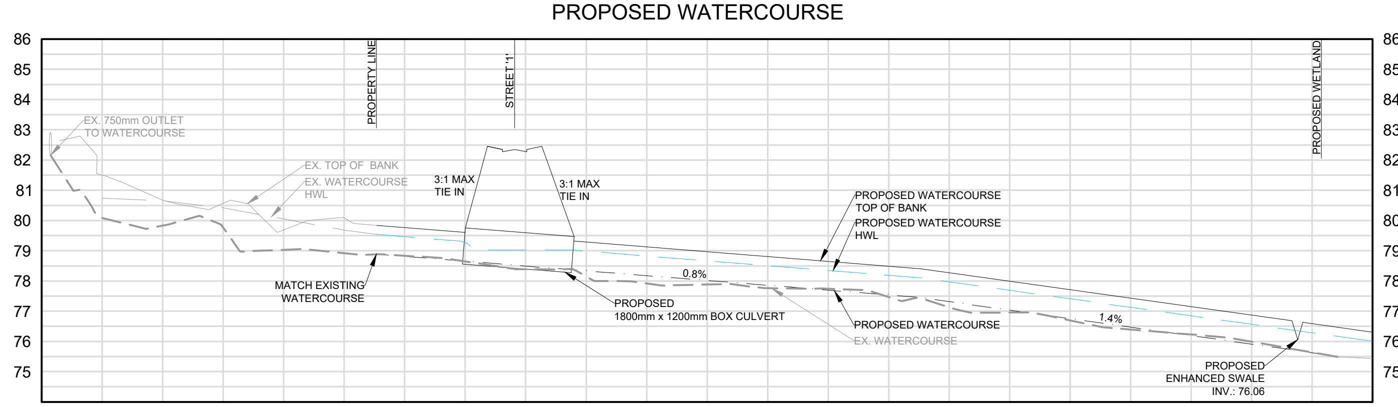
10m WAVE UPRUSH OFFSET (2022, ZUZEK)

PROPOSED HWL

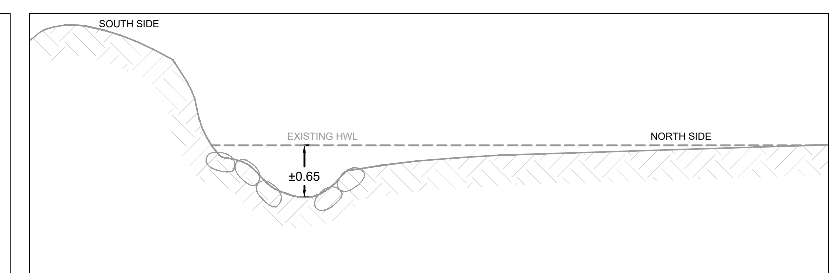
6m PROPOSED HWL OFFSET

EXISTING HWL

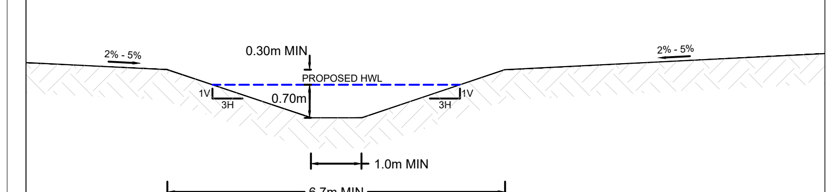
PROPOSED WATERCOURSE



STATION	0+560	0+540	0+520	0+500	0+480	0+460	0+440	0+420	0+400	0+380	0+360	0+340	0+320	0+300	0+280	0+260	0+240	0+220	0+200	0+180	0+160	0+140	0+120
EXISTING ELEVATION	80.08	79.85	80.12	79.03	79.98	78.84	78.75	78.44	78.39	77.99	77.84	77.83	77.74	77.68	77.36	76.95	76.84	76.44	76.19	75.96	75.72	75.80	



EXISTING WATERCOURSE DETAIL
N.T.S.



PROPOSED WATERCOURSE DETAIL
N.T.S.

No.	Revision/Issue	Date

Benchmark

Forefront Engineering Inc

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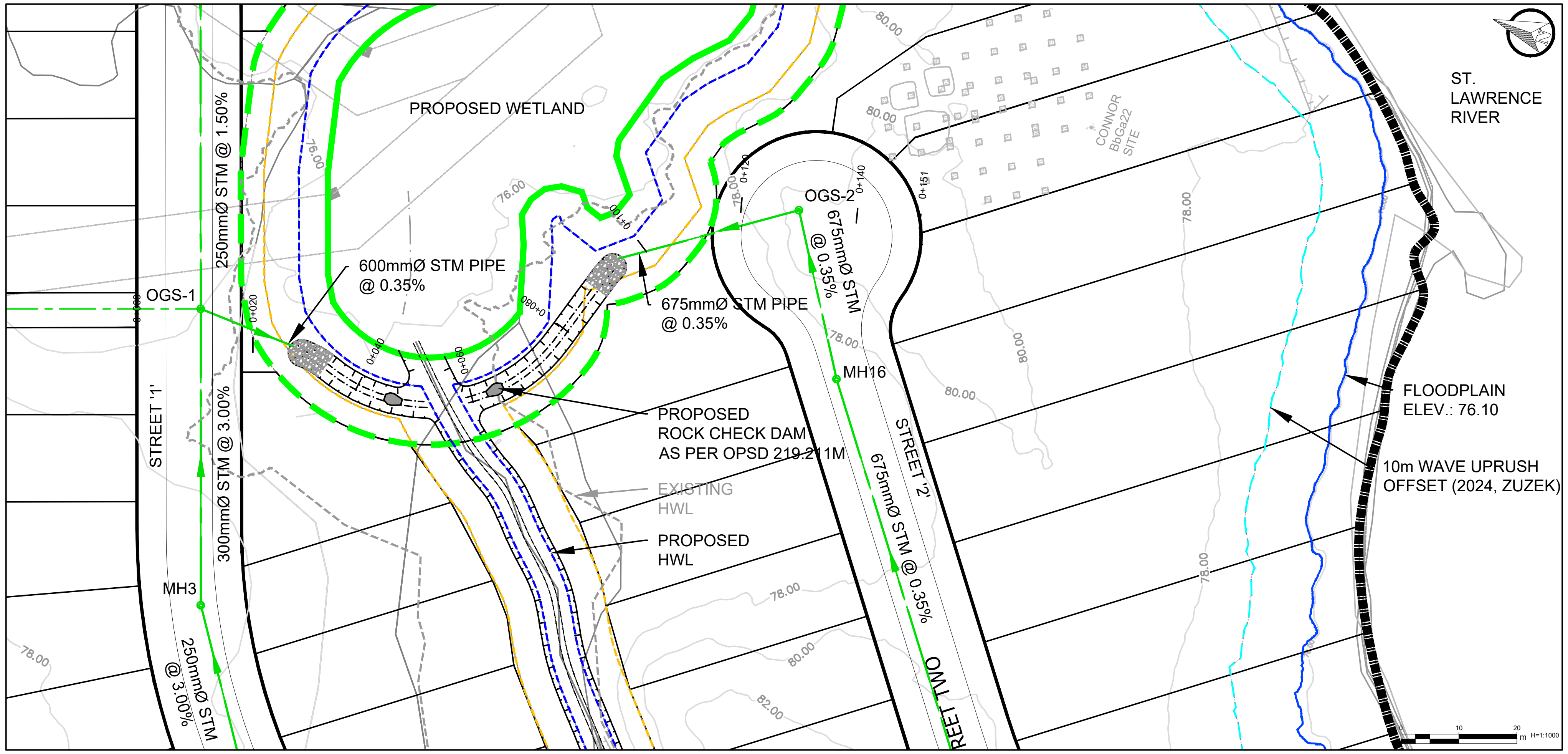
1.866.884.9392 fax.

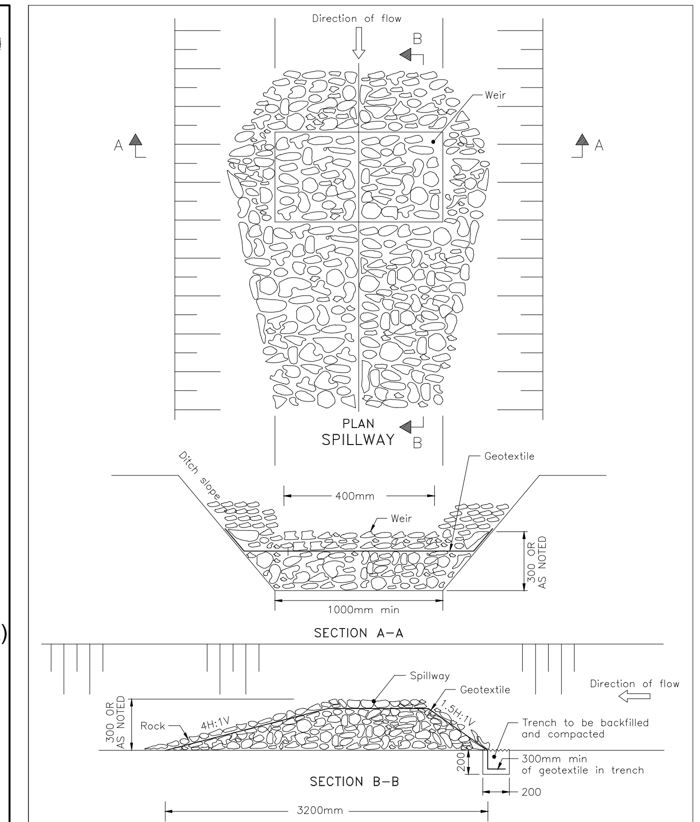
Client
1000989284 ONTARIO INC.

Project
ELMWOOD SUBDIVISION

Drawing
WATERCOURSE IMPROVEMENTS

Drawn by: EP	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.
Date: AUGUST 2025		FIG.5
Scale: 1:2000 ANSI B (11x17)		





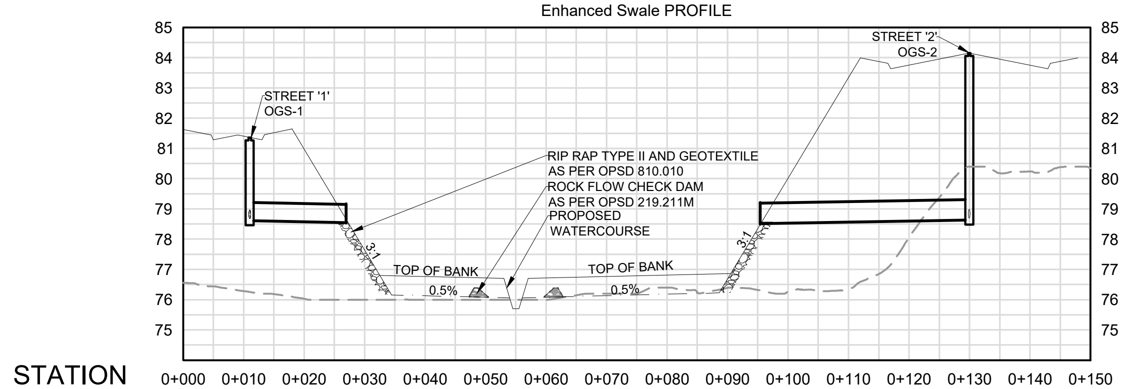
NOTE:
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING | Nov 2006 | Rev 1

ROCK FLOW CHECK DAM
FLAT BOTTOM DITCH

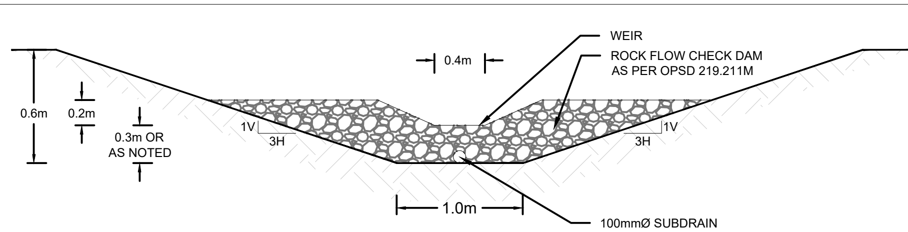
OPSD 219.211M

Enhanced Swale PROFILE

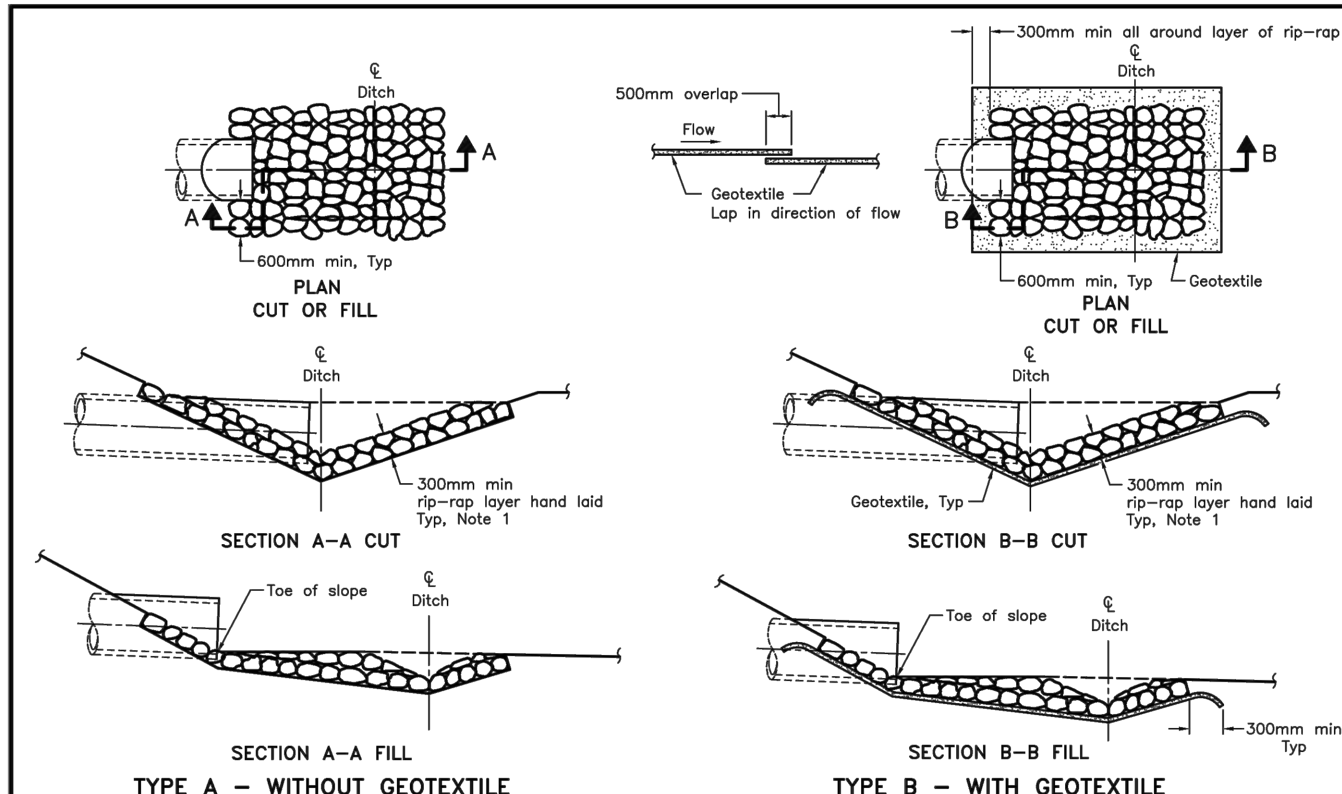


STATION: 0+000, 0+010, 0+020, 0+030, 0+040, 0+050, 0+060, 0+070, 0+080, 0+090, 0+100, 0+110, 0+120, 0+130, 0+140, 0+150

EXISTING ELEVATION																																
	76.55	76.55	76.28	76.28	76.03	76.03	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.20	76.20	76.40	76.40	76.39	76.39	76.26	76.26	76.35	76.35	78.05	78.05	80.40	80.40	80.24	80.24	80.35	80.35



TYPICAL ENHANCED SWALE DETAIL
N.T.S.



TYPE A – WITHOUT GEOTEXTILE

TYPE B – WITH GEOTEXTILE

NOTES:
1 The thickness of the rip–rap layer shall be at least 1.5 times the rip–rap mean diameter.
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING | Nov 2018 | Rev 3

GENERAL RIP–RAP LAYOUT FOR SEWER AND CULVERT OUTLETS

OPSD 810.010

Benchmark

No.	Revision/Issue	Date

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1.866.884.9392 fax.

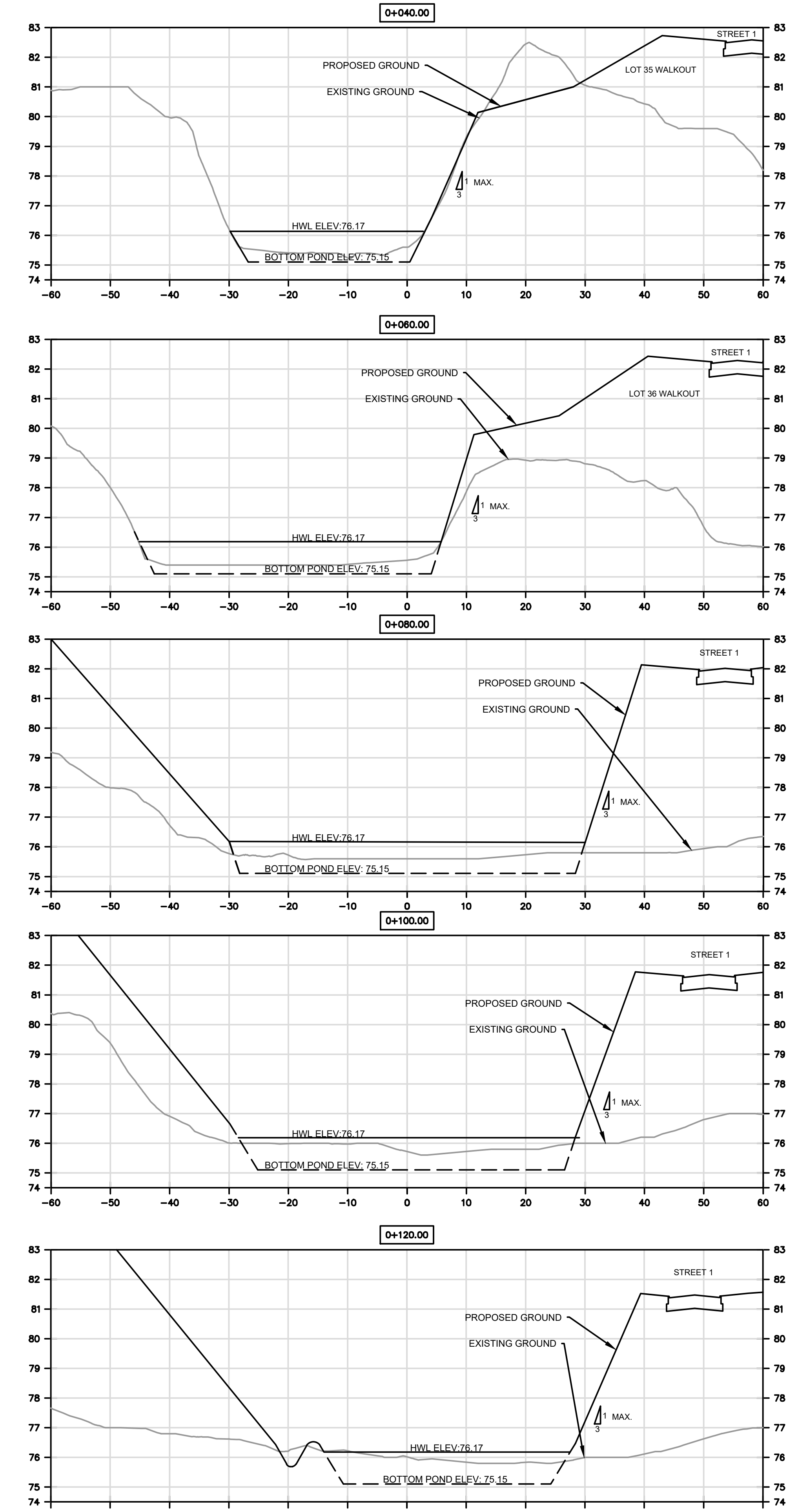
Client: 1000989284 ONTARIO INC.

Project: ELMWOOD SUBDIVISION

Drawing: ENHANCED SWALE OUTLET DETAILS

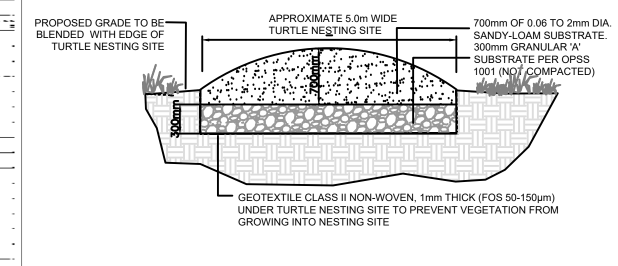
Drawn by: EP | Checked by: JH | Project No.
Designed by: KMN | Approved by: KMN | Drawing No.
Date: AUGUST 2025
Scale: 1:1000

FIG.6

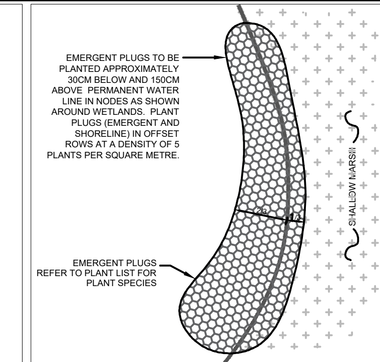


PLANT MATERIAL SCHEDULE - ELMWOOD SUBDIVISION

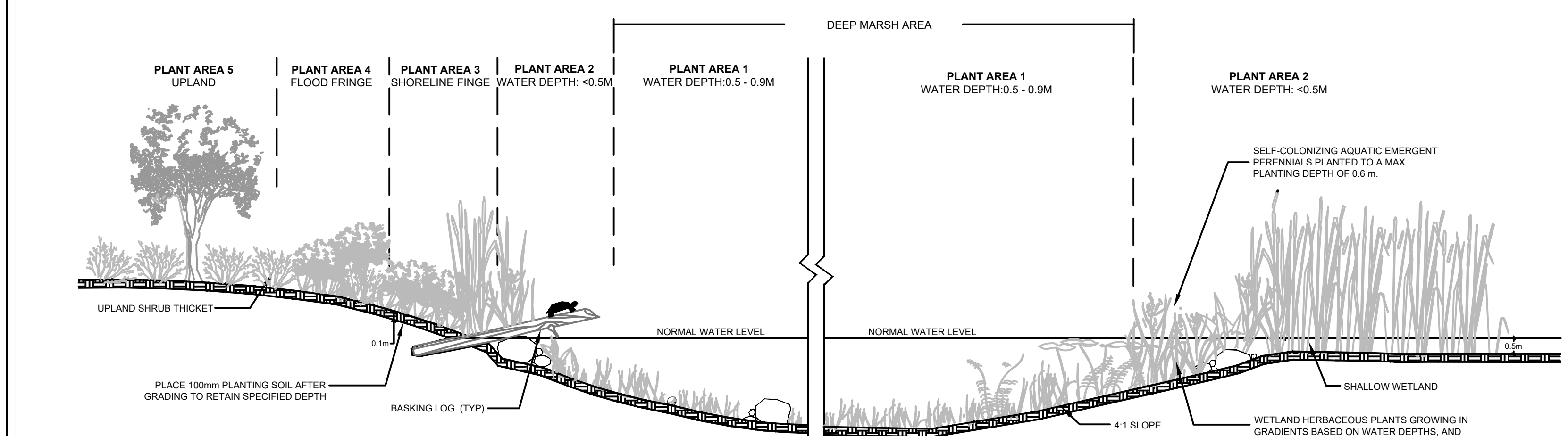
SYMBOL	QUANTITY	BOTANICAL NAME	COMMON NAME	SIZE/CALIPER/HEIGHT	ROOT	REMARKS
TREES						
Ar	[illegible]	Alnus rugosa	Speckled Alder	[illegible]	[illegible]	[illegible]
Ar	[illegible]	Acer rubrum	Red Maple	[illegible]	[illegible]	[illegible]
As	[illegible]	Acer saccharinum	Silver Maple	[illegible]	[illegible]	[illegible]
Sn	[illegible]	Salix nigra	Black Willow	[illegible]	[illegible]	[illegible]
Ps	4	Pinus strobus	White Pine	[illegible]	[illegible]	[illegible]
SHRUBS						
Co	[illegible]	Cephalanthus occidentalis	Buttonbush	[illegible]	[illegible]	[illegible]
Cr	[illegible]	Cornus racemosa	Gray Dogwood	[illegible]	[illegible]	[illegible]
Cs	[illegible]	Cornus sericea	Red Osier Dogwood	[illegible]	[illegible]	[illegible]
Mg	4	Myrica gale	Sweet Gale	[illegible]	[illegible]	[illegible]
Sc	4	Salix cordata	Heart-leaved Willow	[illegible]	[illegible]	[illegible]
Sd	[illegible]	Salix discolor	Pussy Willow	[illegible]	[illegible]	[illegible]
Vt	[illegible]	Viburnum trilobum	Highbush Cranberry	[illegible]	[illegible]	[illegible]
EMERGENT (EM), SUBMERGENT (SB) - HERBACEOUS PLUGS						
EM	[illegible]	Acorus americanus	Sweet Flag		Plug	5 per square metre
EM	[illegible]	Sagittaria latifolia	Broadleaf Arrowhead		Plug	5 per square metre
EM	[illegible]	Schoenoplectus pungens	Three-square bulrush		Plug	5 per square metre
EM	[illegible]	Schoenoplectus tabernaemontani	Softstem bulrush		Plug	5 per square metre
SB	[illegible]	Typha latifolia	Common Cattail		Plug	5 per square metre
SB	[illegible]	Alisma plantago-aquatica	Water Plantain		Plug	5 per square metre
SB	[illegible]	Nuphar variegata	Yellow Pond-lily		Plug	5 per square metre
SB	[illegible]	Potamogeton natans	Floating Pondweed		Plug	5 per square metre



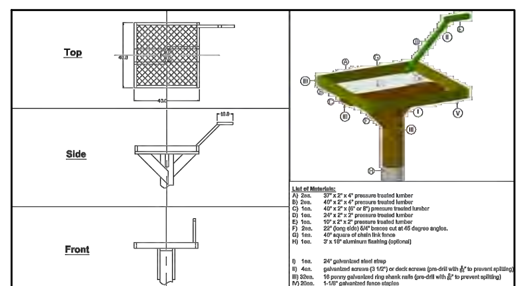
1 FIG.7 TYPICAL TURTLE NESTING MOUND DETAIL



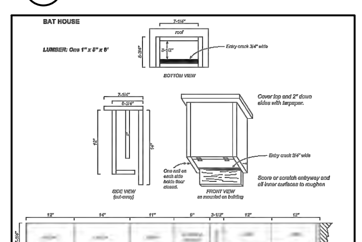
2 FIG.7 TYPICAL HERBACEOUS PLUG DETAIL



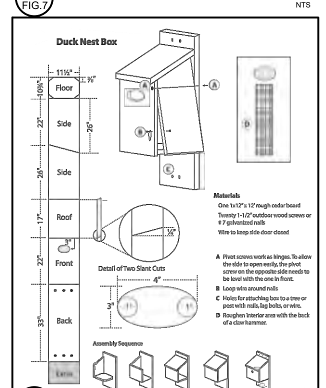
3 FIG.7 CREATED WETLAND - TYPICAL EDGE ENHANCEMENT SECTION PLANTING DETAIL



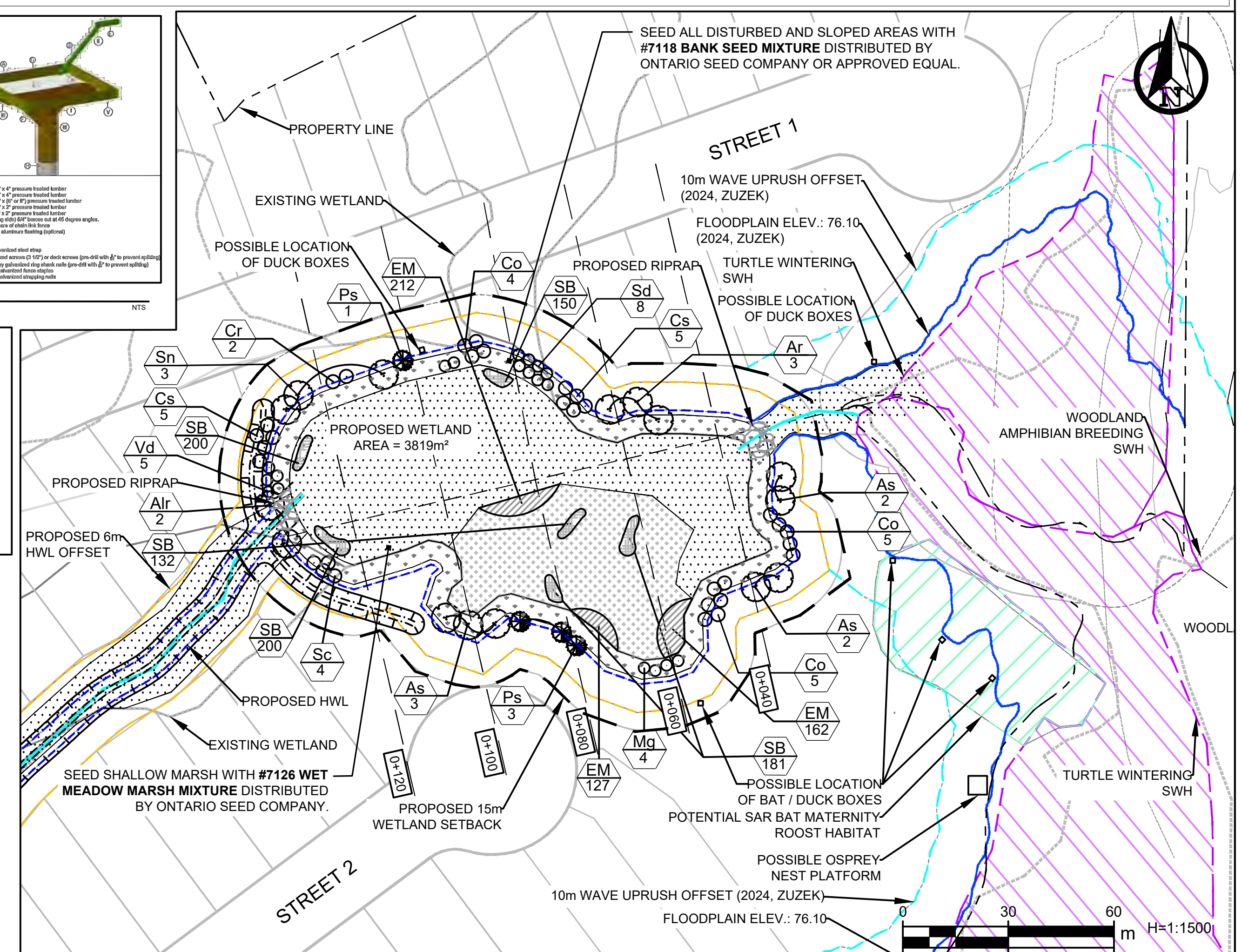
4 FIG.7 TYPICAL OSPREY PLATFORM DETAIL



5 FIG.7 TYPICAL BAT BOX DETAIL



6 FIG.7 TYPICAL DUCK BOX DETAIL



LEGEND

- 15m PROPOSED WETLAND SETBACK
- EXISTING WETLAND LIMIT
- EXISTING FLOODPLAIN
- PROPOSED 6m HWL OFFSET
- PROPOSED HWL
- 10m WAVE UPRUSH
- POTENTIAL SAR BAT MATERNITY ROOST
- TURTLE WINTERING SWH
- OSC#7126 CUSTOM WET MEADOW MARSH MIX
- DEEP MARSH TO NATURALIZE
- OSC#7118 CUSTOM BANK SEED MIXTURE
- PROPOSED SHRUBS
- PROPOSED TREES
- PLANT KEY: Xx = SPECIES, - = QUANTITY

Benchmark

No.	Revision/Issue	Date

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1.866.884.9392 fax.

Client: 1000989284 ONTARIO INC.

Project: ELMWOOD SUBDIVISION

Drawing: PROPOSED ENHANCED WETLAND

Drawn by: EP	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.

Date: AUGUST 2025

Scale: 1:1500 ANSI B (11x17)

FIG.7