FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

LONG SAULT LOGISTICS VILLAGE – PHASE A

TOWNSHIP OF SOUTH STORMONT
UNITED COUNTIES OF SOUTH STORMONT, DUNDAS AND GLENGARRY

PREPARED FOR:

AVENUE 31 CAPITAL INC.

PREPARED BY:

C.F. CROZIER & ASSOCIATES INC.
2800 HIGH POINT DRIVE, SUITE 100
MILTON, ON L9T 6P4

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CROZIER
CONSULTING ENGINEERS

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1.0 Introduction

C.F. Crozier & Associates Inc. (Crozier) was retained by Avenue 31 Capital Inc (Proponent) to prepare a Functional Servicing and Stormwater Management Report in support of a Site Plan Application (SPA) for Phase A of the proposed Long Sault Logistics Village (LSLV) in the Township of South Stormont and the United Counties of South Stormont, Dundas and Glengarry. The location of the Phase A Site is illustrated in Figure 1. Refer to the Phase A, Site Plan prepared by Republic Urbanism, dated November 3, 2021 for additional Site Plan details.

Design items referenced for areas <u>outside of the limits of Phase A</u> are provided for completeness only. A separate Site Plan Application and associated engineering reports will be provided under separate cover for the future development on the subject property for the Long Sault Logistics Village. Phase A of the proposed Long Sault Logistics Village consists of a private railyard, intermodal yards, storage yard, an employee shop, and a shipping/receiving yard. Further details of the development proposal are included in Section 3.0.

This report will demonstrate that the proposed Phase A can be developed in accordance with the Township of South Stormont, Raisin River Conservation Authority and the United Counties of South Stormont, Dundas, and Glengarry (SDG) guidelines from a functional servicing and stormwater management (SWM) perspective. This report is intended to support lifting of the Holding Provision for the site for Phase A only. Additional studies and reports will be completed for future phases to support lifting of the remainder of the Holding Provision.

1.1 Related Studies & Reports

The report has been completed in accordance with the guidelines, standards and policies of the Town and County. The relevant background studies and reports include:

- Design Guidelines for Drinking Water Systems (2008) prepared by Ministry of the Environment (MOE)
- Township of South Stormont Site Plan & Subdivision Design Guidelines (June 2015).
- Ministry of Environment Stormwater Management Planning and Design Manual (March 2003).
- MTO Drainage Management Manual Part 4 (1997).
- 348 Moulinette & 5250 Avonmore Rd Headwater Drainage Feature Assessment prepared by Bowfin Environmental Consulting (November 2020).
- 348 Moulinette & 5250 Avonmore Rd Existing Conditions prepared by Bowfin Environmental Consulting (November 2020).
- Low Impact Development Stormwater Management Planning and Design Guide prepared by the Toronto River Conservation Authority & Credit Valley Conservation Authority (CVC) dated 2010.
- City of Ottawa Sewer Design Guidelines (October 2012).

1.2 Proposed Development

Phase A is part of a phased development plan of the Long Sault Logistics Village which is envisioned as a transmodal logistics hub in the Village of Long Sault. According to the Site Plan prepared by Republic Urbanism dated November 3, 2021, the proposed Phase A development encompasses an area of approximately 36 hectares and is located along the southern boundary of the subject property. The proposed development consists of a railyard with spur lines along the existing CNR corridor. The Site Plan is included in Appendix A.

The elements envisioned for this development include:

- Locomotive Shop & Office (9600 sq.ft.)
- 27 parking spaces (at grade)
- Four (4) rail lines a part of the shipping receiving yard
- Nine (9) rail lines as part of the storage yards
- Two (2) rail lines as part of the intermodal yard
- 630 m Avonmore Road Site Access (Street A)
- 300 m Phase A Access Road (Street B)

This report will consider the Phase A development in its entirety (full buildout) to ensure adequate sizing and locations of the required civil engineering services for the ultimate conditions (i.e., stormwater management, water, and sanitary servicing).

The pertinent background information associated with the servicing strategy for Phase A have been reviewed, including:

- Site Plan (November 3, 2021) prepared by Republic Urbanism.
- Phasing Plan for Long Sault Logistics Village (May 2021) prepared by Republic Urbanism.
- Geotechnical Report (WJM Consulting Ltd., March 3, 2021).

2.0 Existing Conditions

The subject property covers an area of approximately 275 ha (680 ac) and is located northwest of Cornwall in the Township of South Stormont, near the Village of Long Sault. The subject property consists of vegetated green space and is bounded by Highway 401 to the north, Moulinette Road (CR 35) to the west, Avonmore Road (CR 15) to the east, and a Canadian National Railway (CNR) corridor to the south. An existing access from Moulinette Road provides entrance to the subject property.

Two overhead electrical transmission lines traverse the eastern portion of the subject property from north to south and one overhead electrical transmission line running east to west bisects the subject property. The trans-northern oil pipeline owned by Canada Energy Regulator crosses the southeast corner of the subject property.

Phase A is located along the southern limits of the subject property and consists of vegetated green space. Phase A encompasses an area of approximately 36 ha (88 ac). Based on review of the Phase A Site topography, Phase A generally slopes to the south and towards the surface drainage features. The topography also identifies a knoll with a height of approximately 11 m, located in the southeast portion of Phase A close to the Canadian National Railway (CNR) tracks.

2.1 Surface Water Conditions

The subject property is traversed by multiple drains, natural watercourses and agricultural drains that are tributary to the South Raisin River. The subject property is located within the jurisdiction of the Raisin Region Conservation Authority (RRCA). An Environmental Study for the Existing Conditions and Headwater Drainage Feature Assessment was completed by Bowfin Environmental Consulting in November 2020 to identify the existing natural features and habitat of the watercourses on the subject property. Please refer to these reports for further details on the existing conditions of the surface water features.

There are six culverts (HWY Culverts 1 to 6) along the north property limits that convey drainage from north to south below Highway 401 to the subject property. There are two culverts (Avonmore Culverts 1-2) along the eastern limits of the Subject Property. There is one culvert (Moulinette Outlet 1) along the western property limits that conveys drainage from the subject property and below Moulinette Road.

There are three existing culverts (Railway Outlet 1 to 3) located along the southern property limits which convey drainage from the subject property across the CNR tracks to the south of the property. The existing surface water features and associated culverts are illustrated on Figure 2.

All existing drains and natural watercourses that transect Phase A will be accommodated as part of the proposed development. Further details on the proposed drainage and stormwater management designs for Phase A.

2.2 Soils and Groundwater

A geotechnical investigation was completed by WJM Consulting Ltd in January 2021, which consisted of excavating fifteen (15) test pits across the subject property to a depth of approximately 5m below existing ground. Four (4) of these test pits were competed within Phase A. Test pits located within Phase A are shown on the Site Grading Plans (GRD-1 to GRD-4).

The geotechnical investigation confirmed the presence of topsoil ranging of a thickness of approximately 0.4 m for the test pits located within the extents of Phase A. Predominately, the soil encountered at these test pits consisted of silty sand, some silty clay and glacial till. Silty clay was found near the outlet of the existing watercourses.

Based on the Geotechnical Report (WJM Consulting, March 2021) groundwater infiltration was observed in one of the test pits located within Phase A during the field investigation. Groundwater infiltration was encountered generally within the sand and silty sand deposits at depths around 3.0m below existing grade.

Based on MTO Design Chart 1.08, hydrologic soil type within the boundary for Phase A was found to be mostly group B with some group D soils and some minor areas with unknown classification. For areas where hydrologic soil group was unknown, an average of the surrounding soils was assumed to calculate the CN as discussed in Section 6.0.

3.0 Water Servicing

The following sections outline the existing and proposed water servicing for Phase A.

3.1 Existing Water Servicing

The subject property is located in a rural area and municipal watermain infrastructure is not located nearby. Currently, the Township does not have plans to provide municipal water servicing in this area.

3.2 Design Water Demand

The preliminary water demand was estimated for the proposed shop building within Phase A. A population density of 8 employees/8 hr. shift was used as per the teleconference with the Rail Consultant on September 22, 2021. Average daily demands of 35 m^3/ha/day for industrial uses were used based on Section 3 of the Design Guidelines for Drinking Water Systems (Ministry of Environment, Conservation and Parks, 2008). The maximum day factor and peak hour factor are based on Table 3-1 of Systems (Ministry of Environment, Conservation and Parks, 2008).

Table 1 summarizes the anticipated water demand and Appendix B contains the detailed water demand calculations.

Table 1: Estimated Design Water Demand

Average Day Demand (L/s)	**Maximum Day Demand** (L/s)	**Peak Hour Demand** (L/s)
0.03	0.10	0.14

As presented in Table 1, the preliminary water demand for the proposed shop is approximately 0.03 L/s in average daily demand, 0.10 L/s in maximum daily demand and approximately 0.14 L/s in peak daily demand.

A future office expansion area is shown on the Site Plan received on September 14, 2021. The population and ground floor area of the office expansion is currently unknown. As such, the future office expansion has not been included in the water demand calculations summarized in Table 1. A separate application will be required for future office expansion.

3.3 On-Site Fire Storage Cistern

Preliminary calculations were completed to estimate the required fire storage volume for the proposed shop building, as there is no municipal water supply for firefighting purposes. The fire storage volume was calculated using the Ontario Fire Marshalls Fire Protection Water Supply Guideline (1999), as is required in Part 3 of the Ontario Building Code.

The fire storage volume for the shop building was calculated using the dimensions and location of fire separations of the proposed and existing buildings. Based on correspondence with the Rail Consultant dated October 19, 2021, the shop building has a classification a Group F Division 3 occupancy for a medium hazard industrial building. Correspondence with the rail consultant is included in Appendix B. Table 2 below summarizes the fire storage volumes calculated for the largest existing and proposed buildings.

Table 2: Fire Storage Volume Requirements

Method	Total Area[1] (m^2)	Height (m)	Volume (m^3)	K[2]	S_{side}[3]	Required Fire Storage Volume, Q (L)
(Part 3 of the OBC)	861	4.0	3,444	31	1	106,764

Notes:
1. The ground floor area of the proposed shop building was estimated based on the Site Plan.
2. K values for the existing buildings are based off assumed construction materials. K values for proposed buildings are based off information provided by the Rail Consultant.
3. S_{side} values determined from distance to other structures using Figure 1 in Section 6.3 of the Ontario Fire Marshalls Guidelines.
4. The height of the shop building has been assumed to be 4.0 m. This is to be confirmed by the Architect at the detailed design stage.

3.4 Proposed Water Servicing

As seen in Table 2, a storage volume of 106,764 L is the required minimum fire storage volume, and it must be supplied at a rate of 45 L/s for 0.5 hours. Refer to Appendix B for preliminary fire storage volume calculations. A 114,000 L precast concrete tank equipped with a dry hydrant is proposed. The Architect and Mechanical engineer will confirm the fire requirements at the detailed design stage.

It is recommended that Phase A be serviced by a new drilled private water supply well. The well should be constructed by a licensed well contractor in accordance with O.Reg. 903 and located a minimum distance of 15 m from any source of pollution and at least 15 m from any of the sewage system components listed in Tables 8.2.1.6A and 8.2.1.6.B of the Ontario Building Code (2012).

The proposed water supply well will need to be tested to determine if it can meet the anticipated water demand for Phase A. If the proposed well cannot meet the anticipated water demand, then a domestic drinking water cistern will be required to provide sufficient water during peak times. The sizing and design of the water cistern, if required, will be completed at the detailed design stage. A preliminary location of the proposed well is shown on the Grading Plan for Servicing Works (Drawing GRD-3). The location and depth of the domestic supply well should be recommended by the Hydrogeologist during the detailed design stage.

A fire protection cistern is proposed to provide the fire protection volume calculated for the property. A dry hydrant will be located on the fire route of the building to provide coverage for the proposed shop building. The fire protection cistern and the dry hydrant are located north of the proposed shop building. The Grading Plan for Servicing Works (DWG GR-3) illustrates conceptual fire storage tank and dry hydrant to provide firefighting flows for the shop building. The specifications for the tank and dry hydrant system shall be confirmed by the mechanical engineer with the Township fire department.

Based on discussions with the Proponent, there may be future opportunities to connect the shop building and future office expansion to municipal water services as the remainder of the subject property is developed as part of the Long Sault Logistics Village. This water servicing option may be explored as part of future development applications.

4.0 Sanitary Servicing

The following sections outline the existing and proposed sanitary servicing for Phase A.

4.1 Existing Sanitary Servicing

The subject property is located in a rural area and municipally owned sanitary infrastructure is not located near Phase A. Currently, the Township does not have plans to provide municipal sanitary servicing in this area.

4.2 Proposed Sanitary Servicing

Municipal sanitary services are not available at Phase A. Therefore, the shop building will be serviced with a privately owned onsite sewage system with subsurface disposal. Sizing of the on-site sewage system and detailed design will be completed by Others and will be submitted under separate cover. The proposed onsite sewage system must be sized and sited in accordance with Part 8 of the Ontario Building Code and should have sufficient capacity to accommodate the proposed population density of 8 employees/8 hr. shift as calculated in accordance with Table 8.2.1.3B of the OBC.

A preliminary location of the proposed area for the onsite sewage system is shown on the Grading for Servicing Works (Drawing GRD-3).

Based on discussions with the Proponent, there may be future opportunities to connect the shop building and future office expansion to municipal sanitary services as the remainder of the subject property is developed as part of the Long Sault Logistics Village. This sanitary servicing option may be explored as part of future development applications.

5.0 Drainage Conditions

The following sections outline the existing drainage conditions for Phase A.

5.1 Existing Drainage Features

The subject property contains several headwater drainage features and watercourses that convey drainage. Phase A is located at the southern property limits and is transected by several watercourses.

Light Detection and Ranging (LiDAR) was used to create a topographic surface for the subject property to identify the onsite drainage flow routes and pre-development drainage conditions of Phase A, Elevations of culverts, headwalls, and railway structures were then surveyed by Annis, O'Sullivan, Vollebekk Ltd (June 2021) and imported into the relevant plans.

Review of this information indicated that the general drainage of the site is consistent with the drainage features delineated by Bowfin Environmental (November 2020). Four existing watercourses flow south across Phase A before discharging to three culverts located along the CNR. The watercourses and railway culverts were given arbitrary names for ease of reference. Existing surface water features and railway structures are shown in Figure 2.

Table 3 provides a summary of the existing hydraulic structures at the railway crossing.

Table 3: Phase A Existing Railway Culverts

Culvert Name	Invert Elevations (masl)		Material	Shape	Length (m)	Diameter (m)	Upstream Watercourses
	Inlet	Outlet					
Railway Outlet #1	74.71	74.7	Corrugated Steel	Circular	26	2.15	F E
Railway Outlet #2	74.21	72.98	Corrugated Steel	Circular	39	0.90	D
Railway Outlet #3	69.24	69.2	Corrugated Steel	Horizontal Ellipse	39	2 X 3	Z

It was noted during field inspection that Railway Outlet #2 has a significant drop between the inlet and outlet, potentially due to settlement or failure. This culvert is under review by CNR to determine the appropriate course of action.

5.2 CNR Culvert Capacities

A detailed hydrologic and hydraulic analysis was completed for the three existing CNR Culverts outlined in Table 3 which serve as outlets for Phase A. It was determined each culvert has capacity for the existing 100-year flow. Therefore, other than the structural condition of Outlet #2, which is being reviewed by CNR, no upsizing of the culverts is necessary. A technical memo confirming the capacities of the existing culverts is found in Appendix G.

Each of the culverts will be extended to accommodate drainage through the proposed rail yard, but the extensions will have similar characteristics to the existing culvert (shape, material, and slope, where feasible). It is noted that length, slope, and orientation of the extensions was taken into consideration to minimize the potential impact on fish habitat.

5.3 Existing Drainage Areas and Parameters

Land use within the subject property was mapped using a combination of aerial imagery and wetlands data mapped by Bowfin Environmental. Land use types included cultivated, lawn, roads, wetlands, and woods. Phase A consists mostly of wooded area, followed by wetlands, and a small section of lawn (grass). The land use areas, combined with the soils data described in Section 2.2, were used to determine the curve number (CN) for each drainage area. CN values were selected from Design Chart 1.09 of the MTO Drainage Management Manual (1995-1997) based on existing conditions. For drainage areas containing multiple land use and soil types, an area-weighted calculation was used. Figure 3 shows the existing conditions drainage area plan and corresponding CN value for each area.

Depression storage, or initial abstraction, is usually calculated based on land use. However, the Township of South Stormont Site Plan and Subdivision Guidelines (June 2015) provides depression storage values based only on pervious or impervious area. The depression storage is 1.57 mm for impervious areas and 4.67 mm for pervious areas.

Based on Table 4 of the Township's guidelines, a runoff coefficient (RC) of 0.25 was selected for undeveloped areas. Time to peak was then calculated using the Airport method based on RC values less than 0.4 and drainage areas less than 1 km^2.

Table 4 provides a summary of the hydrologic parameters used to model the pre-development drainage areas. Figure 3 describes the catchment areas modelled, and their respective outlets.

Detailed calculations for all parameters are found in Appendix C.

Table 4: Phase A Existing Conditions Hydrologic Parameters

Catchment ID	Drainage Area (ha)	Curve Number	Initial Abstraction (mm)	Time to Peak (hours)
102A	2.25	53	4.67	0.77
105A	4.53	60	4.67	0.57
106A	4.21	60	4.67	0.48
107A	3.94	60	4.67	0.42
108A	2.69	61	4.67	0.37
109A	3.10	55	4.67	0.57
110A	2.19	60	4.67	0.45

5.4 Existing Drainage Modelling and Peak Flows

Visual OTTHYMO Version 6.1 (VO6) hydrologic modelling software was used to generate runoff flows from the existing catchments. The 12-hour AES storm was used to model the existing conditions flow rates for each of the drainage areas and outlet, per Township guidelines.

Table 5 provides existing conditions peak flows for the 5-year and 100-year storm events. A schematic of the existing conditions hydrologic model is shown in Appendix D.

Table 5: Existing Conditions Peak Flows

Catchment ID	5-Year Peak Flow (m^3/s)	100-Year Peak Flow (m^3/s)
102A	0.01	0.04
105A	0.03	0.10
106A	0.04	0.11
107A	0.03	0.09
108A	0.02	0.06
109A	0.02	0.06
110A	0.02	0.05

5.5 Proposed Drainage Conditions

As noted in Section 3, the proposed development of Phase A consists of one storage shop/office building, 27 parking spaces, 15 rail lines, Intermodal Yard, Storage Yard, Shipping/Receiving Yard, and two access roads (Street A and Street B). Phase A covers an area of approximately 36 ha of largely hard surfaces. The change in land use is expected to result in increased runoff rates and volumes. This section will outline the measures proposed to alleviate the changes in the runoff conditions and meet the identified design criteria.

5.5.1 Channel Realignments

Watercourses D and E will be realigned to allow for a more efficient development layout.

Watercourse D, at the east edge of Phase A, will be realigned and run parallel to Street B and then directed to a storm sewer that will extend to the southern limit of Phase A (Railway Culvert #2). Watercourse E will also be realigned to accommodate future development phases. Preliminary alignments were completed using detailed topographic mapping and sized to convey the 100-year peak flows for the respective tributaries.

While only a portion of the watercourse realignments fall within the limits of Phase A, the full extents of the proposed alignments were submitted as part of an application to the Department of Fisheries and Oceans (DFO) Canada by Bowfin Environmental and are currently under review. The DFO application is included in Appendix A.

5.6 Proposed Drainage Areas and Parameters

Post-development drainage areas were delineated to reflect the proposed grading plan, watercourse realignments, and conveyance channels. Post-development drainage areas are shown in Figure 4.

Parameters were calculated based on the same methods described in Section 5.3, with the addition of total impervious (TIMP) and directly connected impervious (XIMP) values.

Table 6 provides a summary of the hydrologic parameters used to model the post-development drainage areas. Detailed calculations for all parameters are shown in Appendix C and a schematic of the future conditions hydrologic model is shown in Appendix D.

Table 6: Phase A Proposed Conditions Hydrologic Parameters

Catchment ID	Drainage Area (ha)	Curve Number	Initial Abstraction (mm)	Total Imperviousness	Directly Connected Imperviousness
102F	2.15	95	1.57	75%	75%
105F	5.37	91	1.57	77%	77%
107F_1	4.21	91	1.57	75%	75%
107F_2	1.72	95	1.57	89%	89%
108F	1.57	84	1.57	52%	52%
108F_EX1	1.18	60	1.57	NA	NA
108F_EX2	0.43	62	1.57	NA	NA
109F	2.71	97	1.57	75%	75%
110F	2.65	97	1.57	75%	75%

Notes:
1. Gravel areas were assumed to be 75 % impervious.
2. Enhanced grass swales and watercourses were considered pervious while all other proposed land use was considered 100 % impervious.
3. For impervious areas, Township guidelines specify a depression storage of 1.57 mm.

6.0 Stormwater Management

6.1 Stormwater Management Criteria

The references used to guide the stormwater management of Phase A are found in Section 1.1 of this report. The stormwater management criteria relevant to the development of Phase A were implemented into the hydrologic model and the design of the proposed stormwater management infrastructure.

Stormwater management criteria have been divided into hydrologic modelling, stormwater quantity, and stormwater quality requirements.

Hydrologic Modelling

- Soil Conservations Service (SCS) Curve Number (CN) method shall be used during modelling to accurately represent the land use, soil, and antecedent moisture conditions present within the development area.
- Depression storage, or initial abstraction, values shall be 1.57 mm for impervious areas and 4.67 mm for pervious areas as per Township of South Stormont Site Plan & Subdivision Design Guidelines.
- For developments larger than 15 hectares and/or drainage systems that are more complex, a computer model shall be created using approved software. Visual Otthymo Version 6.1 (VO6) modelling software was used for hydrologic modelling.
- The AES 30 % Southern Ontario – 12-hour storm distribution shall be used in sizing stormwater storage facilities as per Township of South Stormont Site Plan & Subdivision Design Guidelines (2015)
- Culvert sizing calculations shall be based on expected tailwater elevation resulting from existing downstream conditions. Design software may be used in performing calculations. CulvertMaster hydraulic modelling software was used for culvert sizing.

Stormwater Quantity

- Post-development peak runoff must not exceed the corresponding pre-development peak runoff with storm events with return periods of 5 and 100 years. Allowable peak flows are to be calculated from the pre-development condition.
- Storage of stormwater will be required to achieve the pre-development condition.
- The minor system is to be sized to accommodate the 5-year design storm event.
- The major system shall have the capacity to accommodate the 100-year design storm while maintaining 0.3 m freeboard between the 100-year elevation and finished grade at buildings.
- Capacity of the major storm system shall be evaluated using Manning's formula. Roughness coefficient values shall be 0.013 for concrete and 0.024 for corrugated steel pipes.
- Swales will be required along the perimeter of the development to ensure positive drainage of the development.

Stormwater Quality

- A minimum of 70 % total suspended solids (TSS) removal is required for new developments. To be conservative, the analysis assumed a target of 80 % TSS removal.
- The minimum longitudinal swale slope of swales shall be 0.5 %.
- Enhanced swales to have side slopes of 3:1 or less.
- Enhanced swales maximum velocity of 0.5 m/s for the 4-hour 25 mm Chicago storm event.

6.2 Proposed Conditions - Uncontrolled Peak Flows

The introduction of hard surfaces associated with development reduces hydraulic roughness and infiltration capabilities, resulting in increased stormwater runoff potential. A summary of the uncontrolled post-development peak flows for Phase A, estimated by hydrologic modelling, are presented in Table 7. Catchment areas are described in Figure 4.

Table 7: Post-Development Uncontrolled Peak Flows

Catchment ID	5-Year Peak Flow (m^3/s)	100-Year Peak Flow (m^3/s)
102F	0.071	0.136
105F	0.174	0.333
107F_1	0.133	0.252
107F_2	0.064	0.118
108F	0.040	0.083
108F_EX1	0.010	0.028
108F_EX2	0.004	0.010
109F	0.102	0.188
110F	0.089	0.169

6.3 Stormwater Quantity Control

Hydrologic modeling was prepared for both pre-development and post-development site conditions. The 12-Hour AES rainfall distribution was applied to the hydrologic model and peak flow rates were compared under both scenarios. These hydrologic models were used to estimate the stormwater controls to reduce post-development peak flows to pre-development peak flows.

The modelling results were also used for sizing conveyance channels and culverts, as described in the following section.

6.3.1 Storm Sewers, Culverts and Culvert Extensions

According to Township standards, cross-culverts shall be a minimum of 600 mm in diameter and driveway/access culverts shall be a minimum of 400 mm in diameter. No storm sewer shall be less than 200 mm in diameter.

Each of the CNR culverts will need to be extended to accommodate the future tracks. Since there is not sufficient space between each of the tracks to allow for an open channel, the culvert extensions will consist of a solid pipe for approximately 100 m. This length has been minimized as a consideration for fish passage, but it is recognized that this is still a long enclosure.

Additional stormwater inlets may be required along the length of the culvert extensions through the detailed design phase to allow for runoff between the tracks.

All culverts and storm sewers within Phase A were sized to convey 100 Year flows due to a lack of an overland flow route. The cross-culvert (at Street B) and associated storm sewers were sized as per the MOE Design Guidelines for Sewage Works (March 2019) to accommodate the design peak flow while achieving a flow velocity of 0.6 m/s to 3.0 m/s. Culvert capacities and maximum velocity values were determined using CulvertMaster design software. CulvertMaster results are shown in Appendix F.

A schematic of the combined hydrologic model for Phase A, the subject property, and external drainage areas is provided in Appendix D.

A summary of the relevant culvert capacities is provided in Table 8.

Table 8: Storm Sewer and Culvert Sizing

ID	Drainage Area (ha)	Peak Flow (m^3/s)	Material	Diameter (mm)	Maximum Velocity (m/s)	Capacity (m^3/s)
Railway Outlet#1 Extension	322.94	5.26	CSP	2,100	2.89	6.50
Railway Outlet #2 Extension	80.30	0.99	Concrete	1,050	2.24	1.30
Railway Outlet #3	228.49	3.11	CSP	2,000 X 3,000	0.96	11.36
Proposed Cross-Culvert at Street B	0.74	0.05	CSP	600	1.49	0.27

6.3.2 Storage and Conveyance Controls

There are 6 areas within Phase A that will provide flood storage. These areas, referred to as Flood Storage Areas 1 through 6 on Figure 4, are trapezoidal channels with earth berm-type control structures at the outlets.

Each control structure will be fitted with the appropriately sized orifice(s) to ensure that the 5-and 100-year storm events are controlled to their respective predevelopment rate. The flood storage areas are meant to be low maintenance facilities, allowing vegetation to grow naturally.

Table 9 summarizes the approximate storage volume required at each location.

Table 9: Required Stormwater Storage Volume

Storage ID	Approximate Flood Storage Required (m^3)
Stormwater Storage Area 1	1,600
Stormwater Storage Area 2	3,750
Stormwater Storage Area 3	2,550
Stormwater Storage Area 4	1,100
Stormwater Storage Area 5	1,900
Stormwater Storage Area 6	1,800

These storage areas facilities will provide the required storage volumes to control the post-development peak flows to pre-development peak flows. They will also serve as quality control measures, as outlined in Section 7.4.

6.4 Stormwater Quality Control

As stated in Section 6.1, the Township requires a minimum of 70% of Total Suspended Solids (TSS) removal for new developments as per the Site Plan & Subdivision Guidelines (Township of South Stormont, June 2015).

To meet the MECP's water quality requirements (per MOE 2003 Stormwater Management and Planning Manual), it will be necessary to implement Best Management Practices (BMP's) to control the quality of on-site stormwater. Due to the flat nature of Phase A, water quality control will be achieved through extensive use of enhanced grassed swales. Stormwater flowing from the proposed development will be treated through contact with vegetation and retention in the enhanced grassed swale. Retention time can be increased with the use of check dams, if necessary.

Clean runoff will be separated from stormwater to the extent possible. Options for infiltration of clean runoff will be considered at the detailed design stage but high groundwater is expected to be an issue in Phase A.

As discussed in Section 5.5, a trapezoidal ditch is proposed along the northern limits of Phase A to capture and convey flows from the Intermodal Yard, and direct treated flows towards the realigned watercourses. This ditch will incorporate an enhanced grassed swale over its entire length of approximately 1,200 m. Enhanced grassed swales are the preferred means of stormwater treatment for this site due to the linear nature of the development, and the relatively low maintenance requirements. The following design parameters were used to enhance the pollutant removal rate for the grass swale:

- Longitudinal slope of less than 0.5%
- Side slopes of 3:1 or less
- Maximum velocity of 0.5 m/s for the 4-hr, 25 mm Chicago storm event.

The proposed ditches and swales have been designed in accordance with the LID SWMPD Guide (CVC & TRCA, 2010).

East-West Trapezoidal Ditch

The proposed grassed flat-bottomed, trapezoidal ditch is designed for stormwater conveyance and to provide pre-treatment for stormwater runoff to achieve the water quality control requirements of enhanced grassed swales. The east-west ditch is proposed to have the following characteristics.

- Flat-bottom width of 10 m
- Side slopes of 3:1 max
- Maximum depth of 1.5 m (for flood storage)
- Longitudinal slope ranging between 0.1% to 0.3%
- Overall length of approximately 1200 m.

The proposed ditch was modelled in Flowmaster to ensure that the proposed design fulfilled the requirements outlined in the LID Guide. The modelling results indicate that during the 25 mm storm event, flows in the ditch will have a normal depth of approximately 0.02 m and a velocity of 0.08 to 0.11 m/s, which is in conformance with the velocity requirement. As such, the proposed ditch is expected to provide adequate water quality benefits. Detailed Flowmaster calculations and sections that were modelled are included in Appendix F.

North/South Shop Area Swales

The proposed swales along the north and south of the locomotive shop and office are designed for stormwater conveyance and to provide pre-treatment for stormwater runoff. The swale on the north side of the shop will have the following characteristics:

- Side slopes of 3:1 max
- Longitudinal slopes ranging between 1 and 1.2%
- Bottom width of approximately 2 m

The north ditch was modelled in Flowmaster to ensure that the design fulfilled the requirements listed in the LID Guide. The modelling results indicate that during the 25 mm storm event, flows in the ditch will have a maximum depth of less than 0.1m and a velocity of 0.1 to 0.2 m/s. The ditch is in conformance with the velocity requirement for sediment removal. As such, the proposed ditch will provide adequate water quality benefits. Detailed Flowmaster calculations and sections that were modelled are included in Appendix F.

The south swale will be v-shaped but will also have a gentle longitudinal slope to aid in sediment removal, even though it will not receive runoff directly from the driveway.

Based on the information presented above, best efforts have been made to provide an Enhanced Level of Protection in accordance with the MOE SWM Planning and Design Manual (2003) through treatment via contact with vegetation in the enhanced grassed swales.

7.0 Site Grading & Road Access

7.1 Grading Considerations

The grading of Phase A is influenced by the elevation of the new tracks and the receiving watercourses. Railway operations that are expected to take place within Phase A, such as off-loading of containers, require flat surfaces so all grading will be at minimum slopes.

Phase A will be graded with consideration of the following:

- Provide safe overland conveyance of flows to appropriate drainage outlets.
- Ensure positive drainage to minimize nuisance flooding.
- Match grades along property limits.
- Balance cut and fill to avoid excessive removal or importation of material.

7.2 Site Grading

The subject property generally slopes from north to south Based on review of the existing topography. Overall, the subject property consists of low rolling hills in the southern half where Phase A is located, while the northern half is relatively flat. The topography also identifies a knoll located in the southeast portion of the subject property close the CNR track. The elevation of the CNR rail track ranges from approximately between 82 m to 73 m from the west end to the east end, respectively.

The proposed grading strategy for Phase A matches the existing elevations along the southern property limits and ties in the proposed rail tracks grading prepared by J.L. Richards (October 7, 2021). The paved and gravel driveway area will possess a longitudinal gradient as an overland flow route to the trapezoidal ditch along the northern limits of Phase A. the proposed internal driveway slopes range between 0.2% to 1.4%. This approach allows for the relatively flat grades to comply with the stormwater management strategy and to provide access for heavy loaded vehicles. The Grading Plans for Servicing Works (Drawings GRD-1 to GRD-4) illustrate the proposed grading for the driveway.

The proposed shop and parking area have been proposed near the existing knoll and the depression of the existing drains in the southeastern area of the subject property. Typical sloping (maximum 3:1 side slopes) is proposed to accommodate the difference in proposed and existing elevations in the area (maximum 6m differential). A relatively flat gravel access road is provided to the shop area. The access road to the shop building and parking areas is complete with swales to the north and south. The proposed grading strategy for the shop area involves matching to existing grades north of the shop area, and to the southern property limits via maximum 3:1 landscaped side slopes. The Grading Plan for Servicing Works (Drawing GR-4) illustrates the proposed grading for the proposed shop area.

7.3 Site Access & Road Design

As illustrated on the Site Plan prepared by Republic Urbanism (November 3, 2021), primary access to the proposed development will be provided by Street A via Avonmore Road. It is our understanding that Street A will be privately owned in the interim condition as it provides access to Phase A only. Street A will ultimately connect to Moulinette Road and will be assumed by the Township under full build out conditions. The ultimate build out design of Street A will be completed as part of the detailed design of future phases and will be in accordance with the Site Plan & Subdivision Design Guidelines (2012).

Street B will provide a private access from Street B to the Phase A railyard and shop area. Where an internal gravel driveway is proposed to the shop building and parking lot located in the eastern portion of Phase A. The proposed Street A road is designed as a relatively flat road with slopes ranging between 0.5% to 1.6% to the intersection with Street B in the interim condition. Street B is proposed to slope at approximately 0.6% to 1.2% to the railyard area. The proposed street accesses have been graded with respect to the proposed railyard grading.

Both Street A and Street B will be complete with roadside ditches to capture and convey road drainage. The proposed accesses have been graded such that stormwater runoff from the driveways will be self-contained and existing road elevations will be matched. The grading of the proposed Phase A accesses is shown on the Grading Plan (Drawing C104A-104B).

The Phase A access design and locations will be confirmed by the Traffic Impact Study, and will be subject to Township, and County approval. Crozier has completed a Traffic Impact Study (TIS) to support the proposed development and is provided under a separate cover.

Please refer to the Geotechnical Report (WJM Consulting, March 2021) for further details regarding the recommended road and pavement design.

8.0 Erosion & Sediment Controls During Construction

Erosion and sediment controls will be installed prior to the beginning of any construction activities. They will be maintained until the Site is stabilized or as directed by the Site Engineer and/or Township of South Stormont. The Removals, Erosion & Sediment Control Plan (DWG ESC-1 & ESC-2) identifies the location of the recommended control features. Controls will be inspected after each significant rainfall event and maintained in proper working condition. It is noted that the ESC Plans are not a final document and may be revised at any time to suit site conditions.

Any of the following erosion and sediment controls and measures may be provided during construction of the proposed development:

- **Silt Fencing: l**ight duty silt fencing will be installed along the perimeter of the site to delineate the work area and to intercept sheet flow. HD silt fence will be used adjacent to any watercourses. Additional silt fence may be added based on field decisions by the Site Engineer and Proponent, prior to, during and following construction.

- **Rock Mud Mat:** A rock mud mat will be installed at the entrance of the construction zone to prevent mud tracking from the site onto the surrounding lands and perimeter roadway network. All construction traffic will be restricted to this access only.

- **Interceptor Swales:** Drainage will be conveyed by a series of interceptor ditches and swales. The drainage swales will be strategically placed onsite to direct runoff to the erosion and sediment controls. These swales will include flow check dams and rip-rap as required.

- **Flow Check Dams:** Temporary straw bale and rock check dams will be utilized on-site to prevent any silt migration off site during and after construction activities. These dams will promote settling of suspended solids and will reduce flow velocities. Sediment accumulation will be monitored and removed as necessary. The temporary check dams will be constructed in accordance with Ontario Provincial Standards (OPSD 219.180, 219.210 & 219.211). The need for additional flow check dams will be based on the field condition at the discretion of the Engineer and Developer and implemented as necessary.

- **Dust Suppression:** During earthwork activities, the Contractor will be responsible for ensuring dust suppression is maintained via water or calcium chloride, or other methods approved by the Engineer.

- **Excavated Sediment Trap:** Excavated sediment trap(s) or basins may be required to remove sediment from runoff before the runoff discharges to receiving conveyance routes.

- **Erosion Prevention:** During earthwork activities the General Contractor will ensure that the prevention of erosion of exposed soils. Possible measures include the use of straw mulch, erosion control blankets, or terraseeding.

- **Topsoil Stockpiles**: It will be necessary to strip topsoil prior to earth moving. Temporary topsoil stockpiles will be located a minimum of 30 m from the watercourse with appropriate silt fence protection.

9.0 Conclusion and Recommendations

This report was prepared to support the lifting of the Holding Zone and Site Plan Application for Phase A of the Long Sault Logistics Village development in the Township of South Stormont. The proposed development can be serviced for water, sanitary and stormwater in accordance with the Township of South Stormont, and Raisin River Conservation Authority requirements and standards. Our conclusions and recommendations include:

1. The proposed Phase A railyard development comprises of approximately 36 ha, including a proposed shop, internal driveway, intermodal yard, storage yard, shipping/receiving yard, and associated parking.

2. Two watercourses which transect Phase A will be realigned to provide a more efficient development concept. These watercourses are the subject of a report entitled 'Headwater Drainage Feature Assessment' (Bowfin, 2020) which indicates that form and function of the watercourses can be preserved through the realignments. An application for the realignments has been submitted to the Department of Fisheries and Oceans (DFO) for consideration.

3. Access to the Site will be provided by an entrance road from Avonmore Road (Street A) and through a private access road (Street B).

4. The domestic water servicing for the proposed development will be provided by a private well. A preliminary location for the proposed well has been provided.

5. Fire protection for the shop building will be provided by a cistern and a dry hydrant. A preliminary location for the proposed cistern and dry hydrant has been provided.

6. Sanitary servicing for the proposed development will be provided by a privately owned onsite sewage system, designed by others in accordance with the Ontario Building Code. A preliminary footprint for the proposed sewage system has been provided.

7. The proposed stormwater management strategy for Phase A includes the use of multiple enhanced grassed swales to address water quality requirements and over-sized trapezoidal channels for flood storage. It is noted that naturally flat topography lends itself well to the use of enhanced swales which require gentle longitudinal slopes. Infiltration BMP's may be considered at the detailed design stage, but high groundwater is expected to be an issue.

8. The grading of Phase A is governed by the overall drainage system for the proposed development and proposed sanitary forcemain extension. Grades are matched along the eastern, western, and southern property limits and along the northern development limits.

This report has been prepared in support of a Site Plan Application for development of Phase A of the Long Sault Logistics Village. It is our opinion that Phase A can be developed using conventional civil design practices and stormwater management techniques without any adverse impact to the downstream environment. We truly hope that the Township will reach the same conclusion.

Respectfully submitted,

C.F. CROZIER & ASSOCIATES INC.

Brendan Walton, P.Eng.
Project Manager

C.F. CROZIER & ASSOCIATES INC.

Tony Elias, P.Eng.
Senior Project Manager

SA:JW/cj

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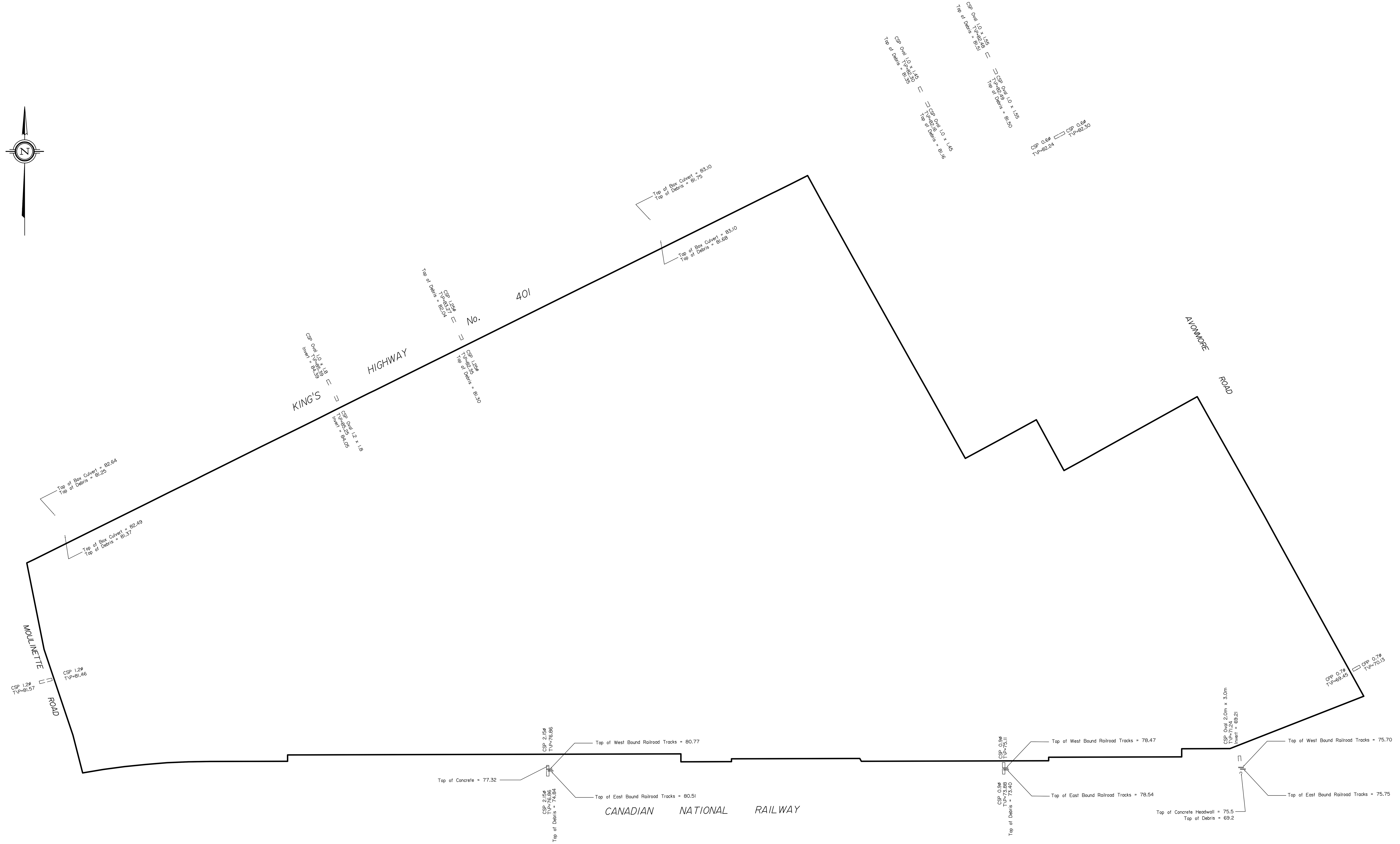
APPENDIX A

Background Documents & Site Plan

A1 – Culvert Survey (Annis, O'Sullivan, Vollebekk Ltd)
A2 – DFO Permit Submitted Application (Bowfin Environmental, August 2021)
A3 – Relevant Geotechnical Report Excerpts
A4 – Site Plan (Republic Urbanism, November 3, 2021)



SKETCH TO ILLUSTRATE CULVERT LOCATIONS ALONG HIGHWAY 401 BETWEEN MOULINETTE ROAD AND AVONMORE ROAD

LONG SAULT, ONTARIO

Surveyed by Annis, O'Sullivan, Vollebekk Ltd.

Scale 1 : 5000

200 150 100 50 0 100 200 Metres

Notes & Legend

CSP	Denotes	Corrugated Steel Pipe
CPP	"	Corrugated Plastic Pipe
Ø	"	Diameter
T/P	"	Top of Pipe

Elevations are geodetic and are referred to the CGVD28 geodetic datum.

BOUNDARY INFORMATION COMPILED FROM PLANS

Ontario Land Surveyors
ANNIS, O'SULLIVAN, VOLLEBEKK LTD.
14 Concourse Gate, Suite 500
Nepean, Ont. K2E 7S6
Phone: (613) 727-0850 / Fax: (613) 727-1079
Email: Nepean@aovltd.com

Job No. 20524-20 Av3l Capital PtLts 31-38 C5 CO Ski

Fisheries and Oceans Canada | Pêches et Océans Canada | Canada

Request for Review

Please note that Guidance on Submitting a Request for Review is available at the end of this form. This guidance explains the requirements for a Request for Review by DFO under the fish and fish habitat protection provisions of the *Fisheries Act*. All information requested must be provided. If you attach documents to your application with additional information, you must still provide appropriate summaries in the spaces provided on the application document or your application will be considered incomplete.

A) Contact information

Proponent	Select additional contact: Contractor/Agency/Consultant *(if applicable):*
Name of Business/Company: Avenue 31 Capital Inc.	Bowfin Environmental Consulting Inc.
Name of Proponent: Jennifer Murray	
Mailing address: 801-250 City Centre Avenue	Mailing address: 168 Montreal Road
City/Town: Ottawa	City/Town: Cornwall
Province/Territory: Ontario	Province/Territory: Ontario
Postal Code: K1R 6K7	Postal Code: K6H 1B3
Tel. No. : 613-799-2422	Tel. No. : 613.935.6139
Fax No.:	Fax No.:
Email: jmurray@ave31.com	Email: m.lavictoire@bowfinenvironmental.ca

Is the Proponent the main/primary contact? ○ Yes ◉ No

If no, please enter information for the primary contact or any additional contact.

**All definitions are provided in Section G of the Guidance on Submitting a Request for Review*

Michelle Lavictoire with Bowfin Enviornmental Consulting (see contact information above)

B) Description of Project

If your project has a title, please provide it.

380 Moulinette and 5400 Avonmore Road

Is the project in response to an emergency circumstance*? ◯ Yes ◉ No

Does your project involve work in water? ◉ Yes ◯ No

If yes, is the work below the High Water Mark*? ◉ Yes ◯ No

What are you planning to do? Briefly describe all project components you are proposing in or near water.

The purpose of this RfR is to introduce this major infrastructure project and to obtain advice from DFO on some of the key elements that will affect the concept plan. At this time, information for the Phase A is available (though some footprints are pending).

General Concepts for Site:
• The watershed boundaries will be respected. No change to the amount of water flowing to the Lake St. Lawrence (Unnamed Tributary to Hoople) or to the Raisin River Watershed (all other channels on site).
• The water originating from the MTO culverts on Highway 401 needs to be accommodated.
• There will be no change in the amount of flow reaching each of the culverts under the railroad. This will ensure that the fish habitat downstream of the railroad is not impacted.
• Since there was no defined channel on Site for the Unnamed Drain 2, one option being considered is urbanizing this area and piping the flow to the railroad culvert.
• It is anticipated that the three Agricultural Drains will be removed but their contributing flow will continue to reach Unnamed Drain 3 (future submission).

Current submission:
1. The lower portions of the South Raisin (Watercourse F on the accompanying drawing) and of the Unnamed Tributary 1 (Watercourse E on the accompanying drawing) will be realigned into a single combined new channel. In the future, the upstream portion of these channels may also be realigned (Table 6).
2. Four culverts will be installed on this new combined channel (Table 7) (locations shown on accompanying drawing).

Please see details in Table 8 of accompanying technical report.

How are you planning to do it? Briefly describe the construction materials, methods and equipment that you plan to use.

Details are to be determined. Anticipated that the new culverts and new channel alignments for Phase A would be built first, followed by fish out of existing channels and then the commissioning of new channels and decommissioning of existing channels.

Include a site plan (figure/drawing) showing all project components in and near water.

Are details attached? ◉ Yes ◯ No

Identify which work categories apply to your project.

- [ ] Aquaculture Operations
- [x] Aquatic Vegetation Removal
- [ ] Beaches
- [ ] Berms
- [ ] Blasting / Explosives
- [ ] Log Handling / Dumps
- [ ] Log Removal
- [ ] Moorings
- [ ] Open Water Disposal
- [ ] Piers

*All definitions are provided in Section G of the Guidance on Submitting a Request for Review

- [ ] Boat Houses
- [ ] Boat Launches / Ramps
- [ ] Breakwaters
- [ ] Bridges
- [ ] Cable Crossings
- [ ] Causeways
- [x] Culverts
- [ ] Dams
- [x] Dewatering / Pumping
- [ ] Docks
- [x] Dredging / Excavation
- [ ] Dykes
- [ ] Fishways / Ladders
- [ ] Flow Modification (hydro)
- [ ] Groundwater Extraction
- [ ] Groynes
- [ ] Habitat Restoration
- [ ] Ice Bridges
- [x] Riparian Vegetation Removal
- [ ] Seismic Work
- [ ] Shoreline Protection
- [ ] Stormwater Management Facilities
- [ ] Surface Water Taking
- [ ] Tailings Impoundment Areas
- [x] Temporary Structures
- [ ] Turbines
- [ ] Water Control Structures
- [ ] Water Intakes / Fish Screens
- [ ] Water Outfalls
- [x] Watercourse Realignment
- [ ] Weirs
- [ ] Wharves
- [ ] Wind Power Structures
- [ ] Other Please Specify

Was your project submitted for review to another federal or provincial department or agency? (•) Yes ( ) No

If yes, indicate to whom and associated file number(s).

Raisin Region Conservation Authority

C) Location of the Project

Coordinates of the proposed project Latitude 45.047199 N Longitude 74.885575 W

OR UTM zone 18T ; 509011 Easting

4988200 Northing

Include a map clearly indicating the location of the project as well as surrounding features.

Name of Nearest Community (City, Town, Village):	Long Sault
Municipality, District, Township, County, Province:	South Stormont
Name of watershed (if applicable):	Lake St. Lawrence and Raisin River
Name of watercourse(s) or waterbody(ies) near the proposed project:	South Raisin River and unnamed drains

Provide detailed directions to access the project site:

*All definitions are provided in Section G of the Guidance on Submitting a Request for Review

From Highway 401 turn south onto Moulinette Road. Access to site is on east side of Moulinette Road

D) Description of the Aquatic Environment

Identify the predominant type of aquatic habitat where the project will take place.

- ○ Estuary (Estuarine)
- ○ Lake (Lacustrine)
- ○ On the bank/shore at the interface between land and water (Riparian)
- ◉ River or stream (Riverine)
- ○ Salt water (Marine)
- ○ Wetlands (Palustrine)

Provide a detailed description of biological and physical characteristics of the proposed project site. This description should include information on aquatic species at risk* (), their residence* and critical habitat* if found in the area. An overview of the distribution of aquatic species at risk and the presence of their critical habitat within Canadian waters can be found here

PLEASE REFER TO ACCOMPANYING REPORT FOR DETAILS AND PHOTOGRAPHS.

3.2 Background Review

The site includes two watersheds: Lake St. Lawrence of the St. Lawrence River (upstream of Moses-Saunders Dam in Cornwall) and Raisin River watershed (which flows into the Lake Francis reach of the St. Lawrence River, downstream of the Moses-Saunders Dam. This river outlets far downstream, roughly 32 km from the site, as the crow flies).

As mentioned in the introduction, while there were eight candidate features, only seven were present on site. The Unnamed Drain 2 had no defined channel on-site. All other seven features were headwaters. There was no nearby information available on the Unnamed Drain to Hoople Bay's classification or its fish community. The remaining six features drain into the South Raisin River. The South Raisin River flows far to the east of the site and doesn't actually reach the St. Lawrence River until Lancaster (to the east of Cornwall, in Lake St. Francis). Information was available for the South Raisin River, Unnamed Drain 1 and Unnamed Drain 3. These are all classed as Class E Drains in the LIO databases. Class E signifies that the drain has been sampled and that sensitive species (native species that are either listed as endangered, threatened, special concern or have intolerance to poor environmental conditions).

Fish community information for these features is available from the Aquatic Resource Area (ARA) data on LIO. The available information does not distinguish between what has been labelled herein as South Raisin River and Unnamed Drain 1. LIO identified 10 species as occurring in these. All are common warm to cool water forage fish (Table 1). Further downstream, to the south of the railroad, information collected by Bowfin for another unrelated project found eight species; all common warm to cool water fish species (central mudminnow, brassy minnow, northern redbelly dace, fathead, creek chub, white sucker, brook stickleback, and johnny darter). Information on LIO for a larger downstream reach list is expanded to include 26 species. That list contains sportfish and pan fish (northern pike, pumpkinseed, rock bass, and yellow perch) as well as the invasive species round goby. Those species are likely to be present within this site, more likely to be restricted to the habitats found much further downstream. There was potential pike spawning habitat on site, but they have note been recorded in this section of these channels.

There is no community information for the Unnamed Drain 2. And as mentioned, there was no defined channel on site.

The Unnamed Drain 3 has community information listing 10 common species consisting mostly of forage fish species with the exception of the pan fish pumpkinseed.

Note that the Class E drain classification may be more applicable to areas further downstream, as the fish encountered by Bowfin on Site (Section 3.4) and off Site (paragraph above) are not on the sensitive list (Mandrak and Bouvier, 2014).

No species at risk or of conservation value were listed in the LIO databases or on the DFO Aquatic Species at Risk Map (NASAR accessed August 26, 2021).

The eight (including photographs of the culvert where Unnamed Drain 2 would outlet to) are described below.

All definitions are provided in Section G of the Guidance on Submitting a Request for Review

Unnamed Drain to Hoople Bay on the St. Lawrence River
The Unnamed Drain to Hoople Bay is situated on the far west side of the site. This feature is approximately 5.9 km long from its origin to Hoople Bay. The origin is roughly 0.8 km upstream of this site. Within the site, the feature consists of the east road ditch for Moulinette Road. Further upstream the feature parallels the Highway 401. The amount of water present in the portion on Site is likely greatly influenced by the Highway 401 water catchment area. The west bank is the very steep embankment of Moulinette Road and the lands on the east (on Site) consist of a wetland (Figure 3). The culvert under Moulinette Road appeared to be properly installed. Note that the downstream side was on a quarry and not accessed. One station was established.

Station 1
Station 1 began at the upstream end of the culvert under Moulinette Road and was 52 m in length. The average channel width was 3.1 m and the average bankfull height 27 cm. The average spring wetted width and depth were 0.8 m and 6 cm, respectively. The station was dry during the summer visit.

The substrate consisted entirely of fines and the stream morphology was a glide. The in-water cover throughout the station was provided by aquatic vegetation (broad and narrow-leaved cattails, reed canary grass, purple loosestrife, and common reed). No signs of erosion were noted.

The tops of the banks were fully vegetated on the east bank and gravel/roadway along the west bank. The most common species were reed canary grass, goldenrod, common burdock, wild red raspberry, staghorn sumac, American elm, ash and willows. The station had moderate canopy cover throughout.

Baited minnow traps were set between the access road and the culvert under Moulinette Road overnight on May 27, 2020. A total of 14 fish brook stickleback were captured (size range: 33-59 mm) in the minnow trap closest to the cross-culvert under Moulinette Road. None were captured in the trap placed further upstream. No sampling took place during the summer as the station was dry (August 31, 2020).

South Raisin River
Moving to the east, the next feature is the South Raisin River. While there is a Highway 401 culvert leading towards this channel, any water from the highway is intercepted by a swamp that does not contain any defined channels (Wetland 2). The feature began near the east-west Hydro One transmission line and travelled south through the disturbed lands to the CN railroad. The South Raisin River travels over 45 km before it reaches the North Raisin River. The portion on the site represents the first 0.8 km of this long watercourse. The culvert under the railroad is well positioned and does not pose a barrier to fish movement. A beaver dam at the downstream end, within 20 m of the railroad, is a temporary barrier to movement outside of the spring freshet. Portions of this feature was heavily impacted by the clearing activities and access roads, with a culvert in poor shape under the main access road, and ruts and slash in the channel. The channel was seasonal. As will be noted herein, fish present in a pool just upstream of the access road demonstrated that movement must be possible during the freshet.

This feature has been divided into two reaches (a and b) because of the disturbances to the riparian habitat and to the feature itself. The downstream section labelled as "a" is a defined natural feature through the wetland and "b" is the area heavily disturbed by ruts and slash.

Station 2
Station 2 began 7.0 m upstream of the confluence with Unnamed Drain 1 and was 43 m in length. A beaver dam was situated on the downstream end and acted as a temporary/seasonal barrier to fish movement.

The average channel width was 1.1 m and the average bankfull height 12 cm. The average wetted width and depth in the spring were 0.9 m and 10 cm, respectively. The station was dry during the summer visit.

The substrate consisted entirely of fines and the stream morphology was a glide. The in-water cover throughout the station was provided by aquatic vegetation (reed canary grass, purple loosestrife and narrow-leaved cattail). No signs of erosion were noted. The tops of the banks were fully vegetated. The most common species were: reed canary grass, goldenrod and slender willow. There was no canopy cover.

Station 3
Station 3 began 465 m upstream of the confluence with Unnamed Drain 1 and was 51 m in length. The average channel width was 2.7 m and the average bankfull height 29 cm. There was a beaver dam or earth barrier upstream of the access road that created a shallow pool during the spring. This pool was also dry later.

The substrate consisted mostly of fines with some gravel and cobble. The morphology was a glide along the station, and a pool upstream of the beaver dam. The in-water cover throughout the station was provided by aquatic and terrestrial vegetation (reed canar grass, grasses, purple loosestrife, goldenrod species and wild parsnip). Areas containing small woody debris (slash) was also present. No signs of erosion were noted.

The tops of the banks were fully vegetated. The most common species were: goldenrod species, reed canary grass, wild parsnip, glossy buckthorn, willow species, American elm and ash species. There was little to no canopy cover.

Baited minnow traps were set in the pools upstream and downstream of the access road on May 27, 2020. Eight fish represented by two species were captured in the upstream pool (no fish were captured in the shallow pool downstream): 7 northern redbelly daces (size range: 37-50 mm), and 1 brook stickleback (size range: 51 mm). No sampling took place during the summer as the station was dry (August 31, 2020).

Unnamed Drain 2
While the background mapping suggests that there is an Unnamed Drain 2, no channel could be found within the wetland on site or at the upstream end. Review of the imagery suggests that the water from upstream may be blocked by the access road for the twin transmission lines. This follows with the detailed topography mapping created by others for the site. The culvert at the railroad is on a steep incline preventing fish access during all but perhaps the early spring. This feature does not provide fish habitat due to the lack of channel. It is anticipated that fish habitat is present immediately downstream of the CN Railroad culvert. Even if the culvert was repaired, there is no upstream channel for fish to access other than the ruts created by the quad trail. Since this quad trail runs east to west and as there are hills on either side, the habitat in the ruts is limited and, currently isolated. One central mudminnow was captured in the pooled water in the ruts next to this culvert.

Unnamed Drain 3
Unnamed Drain 3 originates on the other side of Avonmore Road from what appears to be a small sand pit (about 720 m from the site). The total length of the feature is 1.8 km, and it flows into the South Raisin River, 1.1 km downstream of the railroad. The portion on-site is 0.4 km long and consisted of a channelized drain. The culvert under the railroad was well-positioned and did not represent a barrier to fish movement. The feature was seasonal.

Station 6
Station 6 was located 100 m west of where it crossed Avonmore Road and was 58 m in length. The average channel width was 3.7 m and the average bankfull height 27 cm. The average wetted width and depths in the spring were 3.2 m and 9 cm, respectively. The site was dry by summer.

The substrate consisted entirely of fines and the stream morphology was a glide. The in-water cover throughout the station was provided by aquatic and terrestrial vegetation (reed canary grass, sedges, purple loosestrife, spotted joe-pye weed, goldenrod species and cow vetch). The aquatic vegetation was hummocky within the station causing the channel to flow around the mounds. No signs of erosion were noted.

The tops of the banks were fully vegetated however, on the left bank the vegetation was recently cut creating an 8 m wide path running parallel along much of the station. The most common species were: grasses, reed canary grass, goldenrod, cow vetch and slender willow. There was no canopy cover.

During the May 28, 2020, visit, the station was dip netted over an area of approximately 186 m^2. Three fish were captured representing 2 species: central mudminnow (size: 61 mm) and brook stickleback (size range: 38-40 mm). No sampling took place during the summer as the station was dry (August 31, 2020).
Agricultural Drains
The last three features are dug agricultural drains that flow south into Unnamed Drain 3. None provided direct fish habitat, during the surveys and while the very early spring was missed, based on the habitats, it is unlikely that they provide direct habitat at any time of the year. Note Agricultural Drain 3 is not connected to the Unnamed Drain (blocked by soil – no defined channel) and is not direct fish habitat.

Agricultural Drain 1
Agricultural Drain 1 is on the west side and is 564 m long and well-connected to Unnamed Drain 3 on the downstream end. The channel was seasonal, and portions were already dry by May 12, 2020.

Station 7
Station 7 began 5 m upstream of the confluence of Unnamed Drain 3 and was 75 m in length. The average channel width was 3.6 m and the average bankfull height 27 cm. The average springtime wetted width and depths in the spring were 1.5 m and 10 cm, respectively. The site was dry by summer.

The substrate consisted entirely of fines and the stream morphology was a glide. The upstream half of the station was heavily choked with common reed and slender willow. The in-water cover throughout the station was provided by aquatic vegetation (common reed, sedges, reed canary grass, spotted joe-pye weed, purple loosestrife and slender willow). The aquatic vegetation was hummocky within the station causing the channel to flow around the mounds. No signs of erosion were noted.

The tops of the banks were fully vegetated. The most common species were reed canary grass and slender willow. The shrubs covered the entire channel providing full shade.

During the May 28, 2020, visit, the entire length of the headwater feature (including Station 7) was dip netted. No fish were captured or observed. No sampling took place during the summer as the station was dry (August 31, 2020).

Agricultural Drain 2
Agricultural Drain 2 is in the middle and is 567 m long and also well-connected to Unnamed Drain 3 on the downstream end. This one had a blockage roughly 180 m from the confluence with Unnamed Drain 3 that would be a temporary barrier to fish (until culvert is repaired), but again no fish were ever caught in this feature. This channel was seasonal, and portions were already dry by May 12, 2020.

Station 8
Station 8 began 5 m upstream of the confluence of Unnamed Drain 3 and was 60 m in length. The average channel width was 3.2 m and the average bankfull height 23 cm. The average springtime wetted width and depths in the spring were 1.5 m and 10 cm, respectively. The site was dry by summer.

The substrate consisted entirely of fines and the stream morphology was a glide. The upstream half of the station was heavily choked with common reed and slender willow. The in-water cover throughout the station was provided by aquatic vegetation (common reed, sedges, reed canary grass, spotted joe-pye weed, purple loosestrife and slender willow). The aquatic vegetation was hummocky within the station causing the channel to flow around the mounds.

The tops of the banks were fully vegetated. The most common species were: reed canary grass and slender willow. There was good canopy cover throughout.

During the May 28, 2020, visit, the entire length of the headwater feature (including Station 8) was dip netted. No fish were captured or observed. No sampling took place during the summer as the station was dry (August 31, 2020).

Agricultural Drain 3
Agricultural Drain 3 was on the east side and was blocked at its downstream end. This short 142 m long drain was not connected to Unnamed Drain 3 and was seasonal.

Station 9
Station 9 began 5 m upstream of the confluence of Unnamed Drain 3 and was 58 m in length. The average channel width was 3.2 m and the average bankfull height 15 cm. The feature was dry during both the spring and summer visits.

The substrate consisted entirely of fines and the stream morphology was a glide. The station was heavily choked with common reed and slender willow. The in-water cover throughout the station was provided by aquatic vegetation (common reed, sedges, reed canary grass, purple loosestrife and slender willow). No signs of erosion were noted.

The surrounding area was vegetated on the west side and consisted of reed canary grass and slender willow. The east side was tilled. The dense willows provided full shade.

No sampling took place on either of the May 28 or August 31, 2020, visits as the station was dry.

Include representative photos of affected area (including upstream and downstream area) and clearly identify the location of the project.

E) Potential Effects of the Proposed Project

Have you reviewed the Pathways of Effects (PoE) diagrams) that describe the type of cause-effect relationships that apply to your project? ⦿

If yes, select the PoEs that apply to your project.

- ☑ Addition or removal of aquatic vegetation
- ☑ Change in timing, duration and frequency of flow
- ☐ Cleaning or maintenance of bridges or other structures
- ☑ Dredging
- ☑ Excavation
- ☑ Fish passage issues
- ☑ Grading
- ☐ Marine seismic surveys
- ☐ Organic debris management
- ☐ Placement of marine finfish aquaculture site
- ☑ Placement of material or structures in water
- ☐ Riparian Planting
- ☐ Streamside livestock grazing
- ☐ Structure removal
- ☐ Use of explosives
- ☑ Use of industrial equipment
- ☑ Vegetation Clearing
- ☐ Wastewater management
- ☐ Water extraction

Will there be changes (i.e., alteration) in the fish habitat*? (●) Yes ( ) No ( ) Unknown

If yes, provide a description.

Note all details are available - please see accompanying fisheries technical report Sections 4 and 5 for details.

In general, Phase A will see the realignment of two channels. One will be replaced with similar habitat (but improved in that the existing is impacted by ruts/slask) and the other will become a roadside ditch and not fish habitat.

General Site:
• The watershed boundaries will be respected. No change to the amount of water flowing to the Lake St. Lawrence (Unnamed Tributary to Hoople) or to the Raisin River Watershed (all other channels on site).
• The water originating from the MTO culverts on Highway 401 needs to be accommodated.
• There will be no change in the amount of flow reaching each of the culverts under the railroad. This will ensure that the fish habitat downstream of the railroad is not impacted.
• Since there was no defined channel on Site for the Unnamed Drain 2, one option being considered is urbanizing this area and piping the flow to the railroad culvert.
• It is anticipated that the three Agricultural Drains will be removed but their contributing flow will continue to reach Unnamed Drain 3 (future submission).

Current submission:
1. The lower portions of the South Raisin (Watercourse F on the accompanying drawing) and of the Unnamed Tributary 1 (Watercourse E on the accompanying drawing) will be realigned into a single combined new channel. In the future, the upstream portion of these channels may also be realigned (Table 6).
2. Four culverts will be installed on this new combined channel (Table 7) (locations shown on accompanying drawing).

The next steps are summarized in Table 8 and the preliminary assessment of impacts to fish and fish habitat are discussed below, in Section 5.

Is there likely to be a harmful alteration, disruption or destruction of habitat used by fish? ( ) Yes ( ) No (●) Unknown

Is there likely to be destruction or loss of habitat used by fish? (●) Yes ( ) No ( ) Unknown

What is the footprint (area in square meters) of your project that will take place below the high water mark*?

Phase A will impact

Is your project likely to change water flows or water levels? ( ) Yes (●) No ( ) Unknown

If your project includes withdrawing water, provide source, volume, rate and duration.

3669 sq. m

If your project includes a water control structure, provide the % of flow reduction.

If your project includes discharge of water, provide source, volume and rate.

*All definitions are provided in Section G of the Guidance on Submitting a Request for Review

Will your project cause death of fish? ○ Yes ○ No ◉ Unknown

If yes, how many fish will be killed (for multi-year project, provide average)? What species and lifestages?

Fish salvage will be undertaken to minimize this impact.

What is the time frame of your project?

The construction will start on winter 2021 and end by MM/DD/YYYY

If applicable, the operation will start on MM/DD/YYYY and end by MM/DD/YYYY

If applicable, provide schedule for the maintenance

If applicable, provide schedule for decommissioning

Are there additional effects to fish and fish habitat that will occur outside of the time periods identified above? ◉ Yes ○ No

(If yes, provide details)

Proponent would like to discuss the full Site to help with concept plan.

Can you follow appropriate Timing Windows () for all your project activities below the High Water Mark*? ◉ Yes ○ No

(If no, provide explanations.)

Have you considered and incorporated all options for redesigning and relocating your project to avoid negative effects to fish and fish habitat? ◉

If yes, describe.

The site is also constrained by several existing elements:

• The industrial and logistics village will be built around the railway yard and inter-modal staging area. The grading of the rail yard and storage and transfer area have a very low tolerance and must be kept at approximately less than <0.5-1% grade change.
• The existing grade of the CN tracks must be maintained at less than a 1% change, including a switch that must match existing at the eastern and western end of the side-track lines.
• The CN engineering standards dictate the cover that the rail lines must maintain over culvert crossings, which further constrains the grading design.
• The existing culverts crossing the CN mainline to the south
• The alignment and grade of the natural watercourses and drainage ditches through the site (including a wetland area that the developer is working on maintaining as a naturalized area)
• The existing culvert's crossing Highway 401 on the north side of the site
• There is an at-grade crossing at Avonmore Rd., which must match exactly with existing rail lines and road grades.

Effort was made to improve the potential for fish passage through the proposed new culverts, the velocities remain higher than preferred for the lengths. Because of the constraints listed above, it is unlikely that a solution can be found for these culverts for water volumes estimated for the 1: 2 year.

All definitions are provided in Section G of the Guidance on Submitting a Request for Review

Have you consulted DFO's Fish and Fish Habitat Protection Measures Habitat () to determine which measures apply to your project? (•) Yes ( ) No

Will you be incorporating applicable measures into your project? (•) Yes ( ) No

If yes, identify which ones. If No, identify which ones and provide reasons.

Please see report - the velocities through the new culverts will be too fast for their lengths at the 1:2 year levels.

Measures that can be followed:
Preliminary Mitigation Measures

Planning
• Follow the DFO guidelines in their Standard Code of Practice for temporary cofferdams and end-of-pipe.
• Construct and stabilize the new channels prior to the decommissioning of the existing channels.
• Site instruction will be provided to contractor to highlight that the channel provides fish habitat.
• Clearly demarcate work areas within the riparian habitat in the field.
• All in-water works to occur during the in-water work window (July 1 to March 14, inclusive).
• Erosion and sediment control measures will be installed prior to the clearing of vegetation within 30 m of a watercourse.
• No in-water work will begin until the area has been isolated with measures deemed appropriate by the contract administrator or proponent. These measures must also be sufficient to allow for dewatering and a fish salvage (see below) and to prevent fish from entering the work area.

• The work in the channel is to be completed in the dry.
• Suspend activities that cause muddy environments during periods of heavy rains.
• Minimize clearing of woody vegetation (few woody individuals are present). Where possible, cut the shrubs down (instead of grubbing).
• All or portions of the riparian corridor will be naturalized with native vegetation.

Erosion and Sediment Control
• An erosion and sediment control plan will be developed by contractor and implemented prior to any work within 30 m of the watercourse.
o Provide regular maintenance to the erosion and sediment control measures during construction. Contractor shall be responsible for ensuring that the erosion and sediment control measures are maintained and will monitor the water clarity downstream of the work site throughout the day and during rain events. Water quality is to meet the Canadian Water Quality Guidelines for the Protection of Aquatic Life. Monitoring for visible plumes outside of the work area is to be undertaken.
o At a minimum, the erosion and sediment control plan will include the installation of sediment fencing along the top of banks where vegetation clearing and/or soil disturbance will occur within 30 m of any channel prior to the removal of vegetation. And the installation of a turbidity curtain downstream.
o Additional materials (i.e. rip rap, filter cloth and silt fencing) will be readily available in case they are needed promptly for erosion and/or sediment control.
• Construction of cofferdam dams can create a plume. As such, appropriate measures should be put in place such as placing rock for the cofferdam within a turbidity curtain that isolates just the area where the cofferdam is being built.
• Note that the meter bags can often split when being removed as such it is preferred that gravel be used for metre bags.
• Any stockpiles of soil or fill material will be stored as far as possible from the channel and protected by silt fencing (minimum 30 m).
• The erosion control measures will not be removed until the bank is stabilized (<20% bare soil).
• All equipment working within 30 m of the water will be well maintained, clean and free of leaks.
• The work within the channels will be completed in the dry.
• Water from dewatering will be treated prior to returning it to the system (i.e. straw bale settling ponds covered by geotextiles or sediment sock on the end of hose and situated on top of well vegetated slopes).
• Water from bypass will be released in such a way as to prevent erosion or the transportation of suspended sediments downstream. Note that if this water is taken from upstream of the work area and is the same quality as the receiving waterbody on the downstream side, then it can be released directly into the system (see additional notes under fish and fish habitat protection)
• Where banks/riparian area (area within 30 m of channel) have been stabilized by seeding and/or planting, monitor the revegetation to ensure that the vegetation becomes fully established.
• Any riprap will consist of clean rock free of fines.

Fish and Fish Habitat Protection
• All material introduced for the temporary measures will be fully removed from the water at the completion of the work.
• The methods, sequencing and cofferdam design need to be determined once the project proceeds further in design.

• Fish (and other aquatic fauna) will be salvaged from the isolated channel by a qualified biologist/technologist. The salvage will need to be repeated if the work area becomes flooded.
• Dewatering of water in areas that may contain fish will be completed from hoses placed in fish baskets or covered with clean wash rock or other such method to prevent fish impingement and entrainment. Note that the screens that come on the hoses are not enough to prevent fish from harm.
• Monitor the end of pump frequently for ensure that all fish protection measures are functioning.
• Minimize the size of temporary in-water work areas.
• Bypass flow will be required. The amount of flow bypass should be sufficient to maintain the habitats upstream and downstream of the site (i.e. similar to what would be passed through the culvert). The DFO Standard Code of Practice for End-of-Pipe should be followed to ensure that fish do not become impinged or entrained.
• Installation of rock protection will not impede fish from passing through culverts.

Contaminant and Spill Management
• All equipment working in or near the water should be well maintained, clean and free of leaks. Maintenance on construction equipment such as refueling, oil changes or lubrication would only be permitted in designated area located at a minimum of 30 m from the shoreline in an area where sediment erosion control measures and all precautions have been made to prevent oil, grease, antifreeze or other materials from inadvertently entering the ground or the surface water flow.
• Emergency spill kits will be located on site. The crew will be fully trained on the use of clean-up materials to minimize impacts of any accidental spills. The area would be monitored for leakage and in the unlikely event of a minor spillage the project manager would halt the activity and corrective measures would be implemented.
• If a spill occurs:
o Stop all work
o Spills are to be immediately reported to the MOECC Spills Action Centre (1800 268-6060). Note that under the Fisheries Act deleterious substance includes sediments.
o Clean-up measures are to be appropriate and are not to result in further harm to fish/fish habitat.
o Sediment-laden water will be removed and disposed of appropriately.
• No construction debris will be allowed to enter the watercourse.
• Following the completion of construction, all construction materials will be removed from site.

Have you considered whether DFO standards and codes of practice apply to your project? ○ No ◉ Yes

If Yes, include a list.

End of Pipe; Temporary cofferdam

Have you considered other avoidance and mitigation measures? ○ No ○ Yes

If Yes, include a list.

Are there any relevant measures that you are unable to incorporate? ◉ Yes ○ No

(If yes, identify which ones.)

Velocities through culverts will be too fast for their lengths for the 1:2 year levels. Anticipated that fish will be able to pass during lower levels.

What harmful effects to fish and fish habitat do you foresee after taking into account the avoidance and mitigation measures described above?

The proposed works and design have not been finalized. At this time, the proponent would like to initiate discussions with DFO for the overall Site and then for the Phase A. It is acknowledged, that the current culvert designs may pose an issue for fish passage during 1:2 flows.

Do these include effects on aquatic species at risk*? ○ Yes ◉ No

If yes, please describe, including how many individuals will be harmed, harassed, or otherwise affected by the project, and how?

Do these include effects on areas identified as their residence or critical habitat? ○ Yes ◉ No

If yes, please describe

Are there any aquatic invasive species in the vicinity of your project area? ○ Yes ◉ No

(If yes, identify which ones.)

Does your project aim to, or will it be likely to, effect any of these aquatic invasive species? ○ Yes ◉ No

If yes, how?

F) Signature

I, (print name) certify that the information given on this form is to the best of my knowledge, correct and completed.

Signature

MM/DD/YYYY

Date

Information about the above-noted proposed work or undertaking is collected by DFO under the authority of the *Fisheries Act* for the purpose of administering the Fish and Fish Habitat protection provisions of the *Fisheries Act*. Personal information will be protected under the provisions of the *Privacy Act* and will be stored in the Personal Information Bank DFO-PPU-680. Under the *Privacy Act*, Individuals have a right to, and on request shall be given access to any personal information about them contained in a personal information bank. Instructions for obtaining personal information are contained in the Government of Canada's Info Source publications available at www.infosource.gc.ca or in Government of Canada offices. Information other than "personal" information may be accessible or protected as required by the provision of the *Access to Information Act*.

**All definitions are provided in Section G of the Guidance on Submitting a Request for Review*

Guidance on Submitting a Request for Review

This document explains the requirements for a Request for Review by DFO under the fish and fish habitat protection provisions of the *Fisheries Act*. To determine whether you should request a review, visit DFO's Projects Near Water webpage ().

Incomplete Requests for Review will be returned to the applicant without review by DFO. All information requested must be provided. If you attach documents to your application with additional information, you must still provide appropriate summaries in the spaces provided on the application document or your application will be considered incomplete.

Section A: Contact Information

Provide the full legal name of the proponent and primary mailing address for the proponent. When the proponent is a company, identify the full legal registered name of the company.

If applicable, also provide the contact information of the duly authorized representative of the proponent. Please note that a copy of correspondence to Contractor/Agency/Consultant will also be sent to the Proponent.

Section B: Description of Project

This information is meant to provide background about the proposed project. All components of the proposed project in or near water, must be described.

Proponents should provide information about all appropriate phases of the project, i.e., the construction, operation, maintenance and closure phases for the proposed project.

All details about the construction methods to be used, associated infrastructure, permanent and temporary structure, structure type (e.g. corrugated steel pipe vs box culvert), structures dimension, building materials to be used, machinery and equipment to be used must also be provided. For example, the construction of p**ermanent structures** may require the construction of temporary structures such as temporary dikes, in conjunction with other associated activities like the withdrawal of water, land clearing, excavation, grading, infilling, blasting, dredging, installing structures, draining or removing debris from water. Similarly, the equipment and materials to be used may include hand tools, backhoes, gravel, blocks or armor stone (provide the average diameter), concrete (indicate if pre-cast or poured in-water), steel beams or wood.

Where physical structures in or near water are proposed, provide the plan and specifications of those works which would require a review.

Section C: Location of the Project

The purpose for this information is to describe and illustrate the location of the proposed project, and to provide geographical and spatial context. The information should also facilitate an understanding of how the project will be situated in relation to existing structures.

The details to be provided must include:

- Coordinates of the project (e.g., Latitude and Longitude or Universal Transverse Mercator Grid coordinates);
- A map(s), site plan, or diagrams indicating the high water mark and the location, size and nature of proposed and existing structures (e.g., floating or fixed), landmarks and proposed activities. In a marine setting, it may be helpful to depict the approximate location of the proposed development on a nautical chart or showing the relation of the site to sea marks or other navigational aids. These plans, maps or diagrams should be at an appropriate scale to help determine the relative size of the proposed structures and activities, the proximity to the watercourse or waterbody and the distance from existing structures;
- The community nearest to the location of the proposal as means to provide a general reference point. When possible, proponents should use geographical names recognized by the Geographical Names Board of Canada ().
- If available, provide aerial photographs or satellite imagery of the water source(s) and waterbody(ies);
- Names of the watershed(s), water source(s) and/or waterbody(ies) likely to be affected by the proposal; and
- Brief directions to access the proposed project site.

**All definitions are provided in Section G of the Guidance on Submitting a Request for Review*

Section D: Description of the Aquatic Environment

Proponents must describe the environmental context and aquatic resources present at the proposed site. The information must identify the current state of the fish and fish habitat prior to the carrying on of the project.

It is important to include information about the fish species present, the biological, chemical, physical features present (habitat characteristics), and the fish life-cycle functions (fish characteristics).

The spatial scope for assessing fish and fish habitat should encompass the direct physical footprint of the project, and the upstream and downstream areas affected.

As an example, the following is a non-exhaustive and non-prescriptive list of some common attributes which may characterize the aquatic environment:

- Type of water source or watercourse (groundwater, river, lake, marine, estuary, etc.);
- Characteristics of the water source or waterbody could include:
  - Substrate characterization - describe the types of substrate (e.g., bedrock, boulder, cobble, gravel etc.), identify the predominant substrate type (e.g., 80% cobble, 20% gravel etc.) and provide maps of the substrate;
  - Aquatic and riparian vegetation characterization - identify the prevalent types of vegetation (e.g. rooted, submerged, emergent, etc.), identify the relative abundance of the vegetation (e.g., 10% cattails, 80% grass, 10% sedge) , indicate the predominant vegetation (e.g., by species or types) and identify the vegetation densities (e.g., type of vegetation/area);
  - Flow characterization - specify if the flow is controlled or if it is natural, identify if the flow is permanent or intermittent, identify the current and tide (marine environment) etc.;
  - Physical waterbody characterization - identify the average depth of water for water bodies, identify bathymetry of water bodies, provide bathymetric maps where available, channel width (determine the width of the channel from the high water mark), slope ;
  - Water quality characterization - (e.g., annual or average pH, salinity, alkalinity, total dissolved solids, turbidity, temperature etc.);
  - Biological water quality characterization - (e.g., benthic macro-invertebrates, zooplankton, phytoplankton, etc.)
- Fish species characterization - identify the fish species (including molluscs, crustaceans, etc.) known or suspected to be in the area, predator prey relationships etc. Identify what source of information was used to determine the presence of fish in that area; and
- Estimate the fish abundance - estimate the number of fish present, estimate the year class for each species etc.

There are many different methods and attributes available to characterize fish and fish habitat. Proponents must describe all sources of information used, all fish and environment sampling techniques used, all modelling techniques used and all other approaches used to define the fish and fish habitat. Proponents are encouraged to use recognized fisheries inventory methods such as those approved by DFO or provinces and territories, and/or scientifically defensible methodologies and techniques whenever possible.

Whenever possible, proponents should support descriptions of the aquatic environment with the use of detailed drawings, such as plans or maps and photographs of the habitat features. In an offshore marine setting, photos may not be useful to depict the proposed development site. Instead describe and/or sketch the specific features of the sea floor which may include the presence of submarine features such as canyons, cliffs, caverns, etc.

Section E: Potential Effects of the Proposed Project

The objective of this section is to identify all anticipated effects on fish and fish habitat likely to be caused by the project. Proponents should consider all mitigation or avoidance techniques.

The description must include qualitative and/or quantitative information about the predicted/potential effects to fish species and fish habitat. Some examples of likely effects may include mortality to fish, area of habitat loss, change to flow, changes to habitat function, reduction in prey availability etc.

**All definitions are provided in Section G of the Guidance on Submitting a Request for Review*

The spatial scope of the aquatic effects assessment would include the direct physical "footprint" of the proposed project, and any areas indirectly affected, such as downstream or upstream areas. The footprint of each component of the project below the higher water mark should be provided individually. This may also include areas in or on the water, on the shoreline, coast or bank(s) (i.e., in the riparian zone).

The assessment must include the following attributes:

- Identification of all fish species affected by the proposed project as well as their life stages (e.g., juvenile, yearling, adult, etc.);
- Identification of the type of fish habitat affected (e.g., spawning habitat - gravel and cobble, feeding and rearing areas - side channel slough, small tributaries, etc.), estimate of the affected area (e.g., square meters or hectares);
- Description of the effect (e.g., mortality to fish from entrapment, delayed migration of spawning adults, reduction in prey availability, etc.)
- Probability of the effect - this is the likelihood of the effect occurring (e.g., probability of fish strike from turbines for specific fish sizes, probability of sediment plume within a distance from source, etc., or qualitative assessment: low, medium, high)
- Magnitude of the effect - this is the intensity or severity of the effect (e.g., total number of fish affected, or qualitatively assessment: low, medium, high).
- Geographic extent of the effect - this is the spatial range of the effect (e.g., localized to 100m from the work, channel reach or lake region, entire watershed etc.); and
- Duration of the effect - this is the temporal period for which the effect will persist (e.g., duration of delay to fish migration in hours, days, months or years).

The information to be provided must also describe the methods and techniques used to conduct the assessment. As much as possible, methods and techniques used should be scientifically defensible.

The schedule should, at minimum, identify the proposed start and end dates for carrying out each proposed activity, and where applicable, identify the respective phase of the proposal; i.e., the construction, operation, maintenance and closure phases. In some cases, in order to provide additional context, it may be relevant to identify other information such as the expected life span of permanent and temporary structures.

Proponents must provide comprehensive information about all available measures that are proposed to avoid or mitigate potential harmful alteration, disruption or destruction of fish habitat, or death of fish (e.g., in standards or codes of practice).

Residual harmful impacts that remain after the application of such measures.

It is important to clearly describe and quantify harmful impacts because DFO will use this information as part of its decision making on whether harmful alteration, disruption or destruction of fish habitat or death of fish is likely and an authorization is required under subsection 35(2)(*b*) or 34.4(2)(b) of the *Fisheries Act*.

Section F: Submission and Signature

The proponent must sign their application. A signed original of the Request for Review must be provided to the regional DFO office (), even if an

Section G: Definitions

Aquatic Species at Risk: an extirpated, endangered, threatened species, or a species of special concern. A non-exhaustive list of aquatic species at risk found in Canadian waters can be found here (http://www.dfo-mpo.gc.ca/species-especes/sara-lep/identify-eng.html).

Aquatic Species at Risk Critical Habitat
the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species critical habitat in the recovery strategy or in an action plan for the species.

Aquatic Species at Risk Residence: the specific dwelling place, such as a den, nest or other similar area or a place that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding, or hibernating.

Aquatic invasive species: are fish, invertebrate or plant species that have been introduced into a new aquatic environment, outside of their natural range. Once introduced, aquatic invasive species populations can grow quickly because they don't have natural predators in their new environment. As a result, they can outcompete and harm native species. They can even alter habitats to make them inhospitable for the native species. A non-exhaustive list of aquatic invasive species can be found here (http://www.dfo-mpo.gc.ca/species-especes/ais-eae/identify-eng.html).

Emergency circumstance: If your project must be conducted in response to an emergency, you may apply for an Emergency Authorization. The emergency situations are:

- The project is required as a matter of national security
- The project is being conducted in response to a national emergency where special temporary measures are being taken under the federal *Emergencies Act*
- The project is required to address an emergency that poses a risk to public health or safety or to the environment or property.

Fish habitat: means habitat that can directly or indirectly support life processes. This includes but is not limited to: spawning grounds, nursery, rearing, food supply and migration areas.

Harmful alteration, disruption or destruction means any temporary or permanent change to fish habitat that directly or indirectly impairs the habitat's capacity to support one or more life processes of fish.

High Water Mark: The usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to leave a mark on the land.

**All definitions are provided in Section G of the Guidance on Submitting a Request for Review*

348 Moulinette & 5400 Avonmore Road

Fisheries Technical Report

Prepared for:
Avenue 31 Capital Inc.
801-250 City Centre Avenue
Ottawa, Ontario
K1R 6K7

Prepared by:
Bowfin Environmental Consulting Inc.
168 Montreal Road
Cornwall, Ontario
K6H 1B3

August 2021

List of Acronyms and Definitions

DFO – Fisheries and Oceans Canada
ESA - *Endangered Species Act* (Provincial)
FL – Fork Length
GPS – Global Positioning System
NAD 83: North American Datum 1983
UTM: Universal Transverse Mercator
LIO - Land Information Ontario
NHIC – Natural Heritage Information Centre
MTO – Ministry of Transportation Ontario
NASAR – National Aquatic Species at Risk
OMNR/MNRF - Ontario Ministry of Natural Resources (old name)
-Ministry of Natural Resources and Forestry (new name)
OP – Official Plan
PSW - Provincially Significant Wetland
RRCA - Raisin Region Conservation Authority
SAR - Species at Risk (in this report they refer to species that are provincially or federally listed as endangered or threatened and receive protection under ESA or SARA)
SARA - *Species at Risk Act* (Federal)
SARO - Species at Risk in Ontario
SD&G – Stormont, Dundas, and Glengarry
TL – Total Length

SRANK DEFINITIONS

S1 Critically Imperiled in the nation or state/province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province.
S2 Imperiled in the nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province.
S3 Vulnerable in the nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
S4 Apparently Secure; uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5 Secure; Common, widespread, and abundant in the nation or state/province.
? Inexact Numeric Rank—Denotes inexact numeric rank
SNA Not Applicable, A conservation status rank is not applicable because the species is not a suitable target for conservation activities.
S#B Breeding
S#N Non-Breeding

SARA STATUS DEFINITIONS

END Endangered: a wildlife species facing imminent extirpation or extinction.

THR Threatened: a wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.

SC Special Concern, a wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats.

SARO STATUS DEFINITIONS

END Endangered: A species facing imminent extinction or extirpation in Ontario which is a candidate for regulation under Ontario's ESA.

THR Threatened: A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed.

SC Special concern: A species with characteristics that make it sensitive to human activities or natural events.

Coefficient of Conservatism Ranking Criteria

0 Obligate to ruderal areas.
1 Occurs more frequently in ruderal areas than natural areas.
2 Facultative to ruderal and natural areas.
3 Occurs less frequent in ruderal areas than natural areas.
4 Occurs much more frequently in natural areas than ruderal areas.
5 Obligate to natural areas (quality of area is low).
6 Weak affinity to high-quality natural areas.
7 Moderate affinity to high-quality natural areas.
8 High affinity to high-quality natural areas.
9 Very high affinity to high-quality natural areas.
10 Obligate to high-quality natural areas.

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1.0 INTRODUCTION

Avenue 31 (Capital) Inc. as part of a Joint-Venture with Crews Rail (under the corporation of Camino LVS) is proposing to construct an industrial and logistics village in Long Sault, Ontario. This is a major infrastructure project for Eastern Ontario. The central piece of infrastructure is a large inter-modal rail yard and will include full-length unit train tracks that are connected along 2 km of the existing CN Mainline (Kingston Subdivision). This development is currently in functional design for Phase A, with the proponent working through the detailed engineering design review process with CN for the rail yard and siding tracks. The site is within the settlement area of the Village of Long Sault (Township of South Stormont), and is zoned for Heavy Industrial Development. The developer will be applying for Site Plan Control approval in Fall, 2021 and a Site Alteration permit from the Raisin River Conservation Authority. While details on Phase A are generally understood, the works, activities and/or undertakings that may impact fish and fish habitat for the entire site are still under development. A Site Plan control application for Phase A will be submitted to the Township of South Stormont in October, 2021.

The subject lands are approximately 325 hectares situated on part of Lots 31-37, Concession 5 in the Township of Cornwall, United Counties of Stormont, Dundas, and Glengarry (SD&G). They are bordered by the railroad to the south, Highway 401 to the north, Moulinette Road to the west and Avonmore Road to the east (Figure 1 and Figure 2). Bowfin Environmental Consulting Inc. (Bowfin) has been retained by the proponent to assist with the natural heritage assessments. In 2020, Bowfin completed an Existing Conditions and a Headwater Drainage Features Assessment report. Now that the project is moving forward, the proponent is looking to combine flows from some channels, realign the watercourses and install new culverts. As such, the information pertaining to fish and fish habitat collected previously has been summarized herein for review by Fisheries and Oceans Canada (DFO) and forms the draft Fisheries Impact Assessment (FIA) report. This report is draft, as this is a large site and details on works, undertakings and activities that may impact fish and fish habitat have not been finalized. The preliminary concept is provided herein to provide DFO the opportunity to comment. The local conservation authority (Raisin River Conservation Authority, RRCA) was and continues to be consulted.

The FIA has been completed under the current *Fisheries Act* (FA) which came into force on August 28, 2019. The updated FA returns to wording from the earlier version. It prohibits the following:

- Death of Fish (Section 34.4)
- Harmful alteration, disruption, or destruction of Fish Habitat (Section 35)
- Ministerial powers to ensure the free passage of fish or the protection of fish or fish habitat with respect to existing obstructions (Section 34.3)

The DFO website, accessed on August 26, 2021, indicates that any activity or projects that may affect fish habitat needs to be reviewed by DFO unless there is a Standard Code of Practice. At this time, the Standard Codes of Practice do not cover the works proposed.

Figure 1: General Location of Site

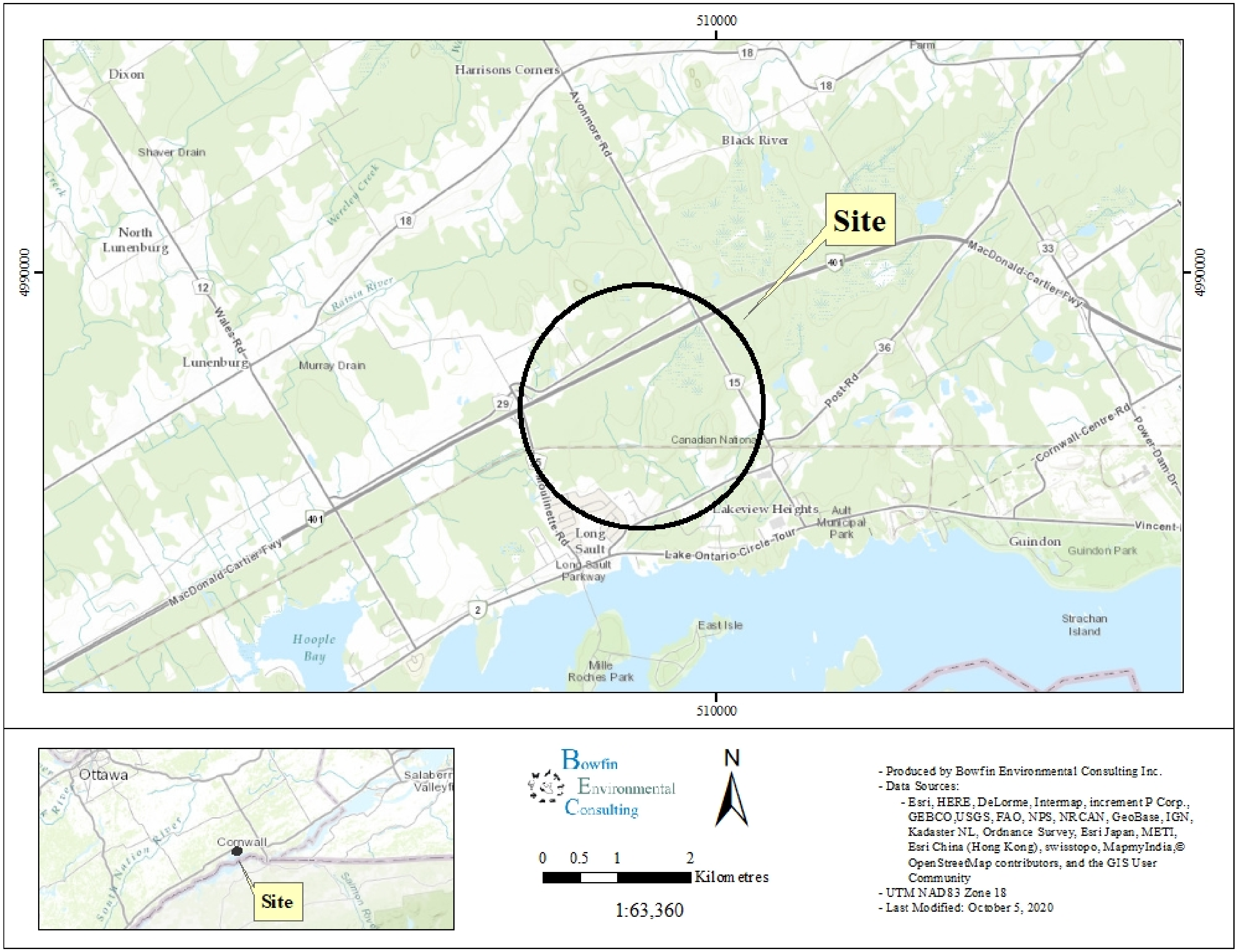
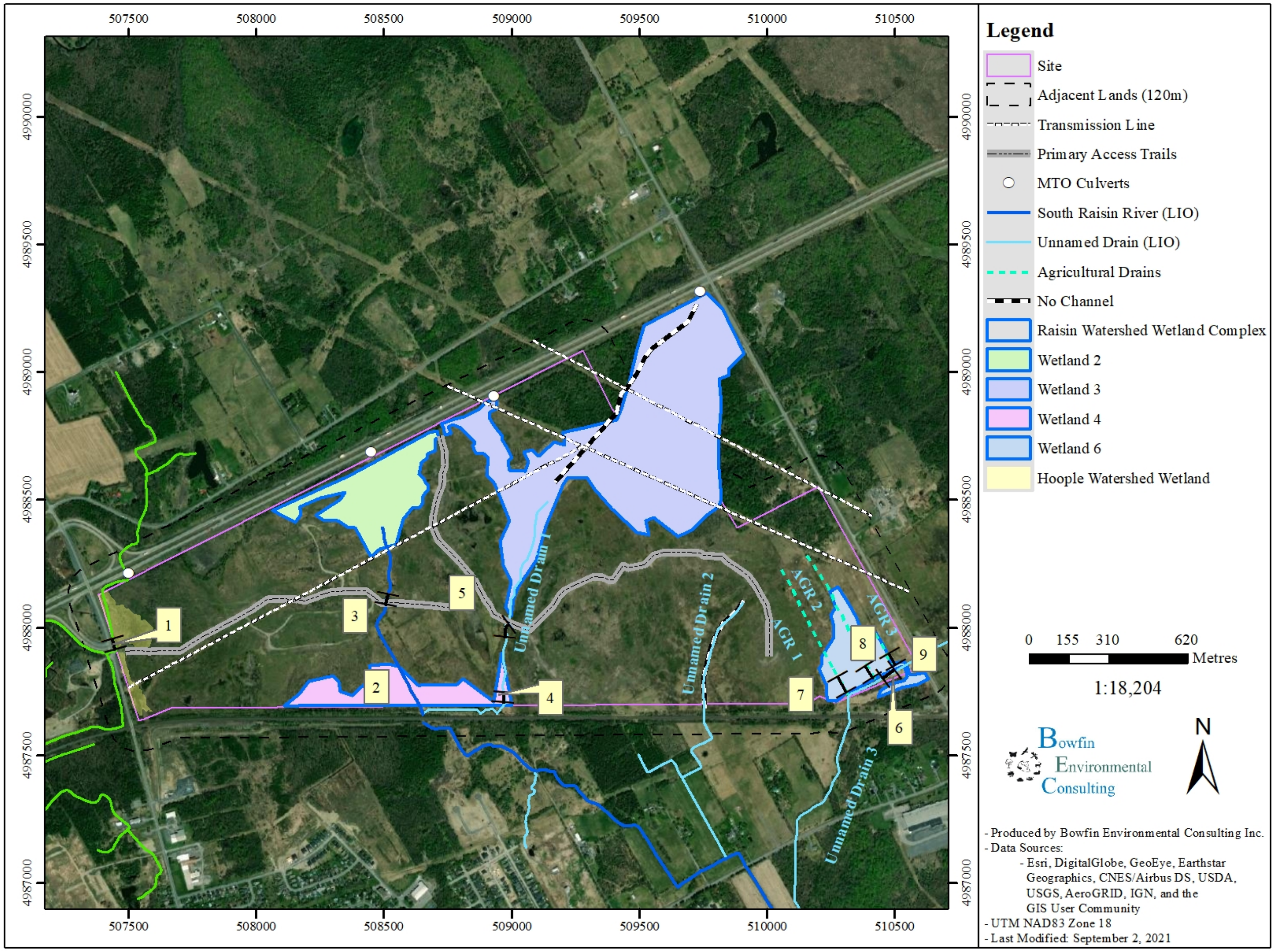


Figure 2: Site Details



Summary of Works

The site includes two watersheds: Lake St. Lawrence of the St. Lawrence River (upstream of Moses-Saunders Dam in Cornwall) and Raisin River watershed (which flows into the Lake Francis reach of the St. Lawrence River, downstream of the Moses-Saunders Dam. The Raisin River outlets far downstream, roughly 32 km from the site, as the crow flies).

As shown on Figure 2, the Existing Conditions and the Headwater Drainage Feature Assessment reports identified eight potential features of which only seven were present:

Lake St. Lawrence Watershed:

1. Unnamed Drain to Hoople Bay (Moulinette Road ditch)

Raisin River Watershed

2. South Raisin River
3. Unnamed Drain 1 (merges with South Raisin River along edge of site)
4. *Unnamed Drain 2 (**no channel present on site and is not fish habitat, there is a channel downstream**)*
5. Unnamed Drain 3 (originates from the northeast side of Avonmore Road)
6. Three agricultural drains that flow into Unnamed Drain 3.

Of these, fish were captured in the Unnamed Drains and the South Raisin River. None were present in the agricultural drains.

The lands through which the channels belonging to the Raisin River Watershed flow were cleared by others and are now heavily disturbed and at various stages of revegetation. There are ruts and slash across parts of these fish bearing channels as well as collapsed culverts. Regardless, fish were captured on the upstream side of the primary access trails of the three watercourses present (Figure 3). Since these areas were dry later in the season, this suggests that all are seasonal, but that fish passage continues to be possible during the early spring.

To help with the review, a brief description of each feature is provided here. More details and photographs collected from the sampling stations is provided further down in the report.

Unnamed Drain to Hoople Bay on the St. Lawrence River

The Unnamed Drain to Hoople Bay is situated on the far west side of the site. This feature is approximately 5.9 km long from its origin to Hoople Bay. The origin is roughly 0.8 km upstream of this site. Within the site, the feature consists of the east road ditch for Moulinette Road. Further upstream the feature parallels the Highway 401. The amount of water present in the portion on-site is greatly influenced by the Highway 401 water catchment area. The west side is the steep embankment of Moulinette Road. The lands on-site consist of a wetland (Figure

2). The culvert under Moulinette Road appeared to be properly installed, note that the downstream side was on a quarry and not accessed.

South Raisin River

Moving to the east, the next feature is the South Raisin River. While there is a Highway 401 culvert leading towards this channel, water from the highway is intercepted by a swamp that does not contain any defined channels. The defined channel began near the east-west Hydro One transmission line and continues south through the disturbed lands to the CN railroad. The South Raisin River travels over 45 km before it reaches the North Raisin River. The portion of the headwaters on the site represents the first 0.8 km of this long feature. The culvert under the railroad is well positioned and does not pose a barrier to fish movement. Temporary barriers in the form of a beaver at the downstream end, within 20 m of the railroad, were present and are a barrier to movement outside of the spring freshet. Portions of this feature was heavily impacted by the clearing activities (undertaken in the past by others) and access roads, with a culvert in poor shape under the primary access trail, and ruts and slash in the channel. The channel was seasonal. As will be noted herein, fish present in a pool just upstream of the primary access trail demonstrated that movement must be possible during the freshet.

Unnamed Drain 1

The next feature is Unnamed Drain 1 which is a tributary to the South Raisin River; connecting on Site, upstream of the CN railroad. Background mapping shows this feature to be 2.6 km long, beginning 0.3 km upstream of Highway 401 and merging with the South Raisin River just upstream of the culvert under the railroad. Investigations completed for this project found that the actual channel was closer to 1.2 km long, originating inside of the wetland found on the northeast side of the site. The wetland both on and offsite was walked, and no defined channels could be found. Like the South Raisin River, any flow that this feature receives from the Highway 401 catchment, or upstream areas, is absorbed by the large wetlands. There were several beaver dams on this feature including a larger one near the railroad which created a pond. While the pond remained wet longer than the rest of the feature, it too was dry by the end of August 2020.

Unnamed Drain 2

While the background mapping suggests that there is an Unnamed Drain 2, no channel could be found within the wetland or further upstream. Review of the imagery suggests that the water from upstream may be blocked by the access road for the twin transmission lines. The culvert at the railroad is on a steep incline preventing fish access. The culvert may have disconnected under the rail road as there is a water line suggesting that it was previously submerged. There is a quad trail running along the railroad that captured water in the ruts, but this area was isolated from all other fish habitat by the hills. A central mudminnow was captured in the quad trail.

Unnamed Drain 3

Unnamed Drain 3 originates on the other side of Avonmore Road from what appears to be a small sand pit (about 720 m from the site). The total length of the feature is 1.8 km, and it flows into the South Raisin River, 1.1 km downstream of the railroad. The portion on-site is 0.4 km long and consisted of a channelized drain. The culvert under the railroad was well-positioned and did not represent a barrier to fish movement. The feature was seasonal.

Three Agricultural Drains

The last three features are dug agricultural drains that flow from north to south into Unnamed Drain 3 (Figure 2). Agricultural Drain 1 is on the west side and is 564 m long and well-connected to Unnamed Drain 3 on the downstream end. The channel was seasonal, and portions were already dry by May 12, 2020.

Agricultural Drain 2 is in the middle and is 567 m long and also well-connected to Unnamed Drain 3 on the downstream end. A blocked culvert, from an old farm crossing, roughly 180 m upstream from the confluence with Unnamed Drain 3, would be a barrier to fish passage (Figure 3). This channel was seasonal, and portions were already dry by May 12, 2020.

Agricultural Drain 3 was on the east side and was blocked at its downstream end. This short 142 m long drain was not connected to Unnamed Drain 3 and had seasonal water (standing) but is not accessible to fish during any part of the year.

2.0 METHODS

Work undertaken for the completion of this project included a background review of existing information and field investigations.

2.1 Background Review

A search through available records and available consulting reports was made to gather existing information on the fish habitat and community within the project area. The following web sources were used during the background review: Land Information Ontario (LIO), Natural Heritage Information Centre (NHIC), Species at Risk (limited to fish species protected under provincial or federal legislation), DFO Aquatic Species at Risk Distribution (on-line). Citizen science database iNaturalist was also consulted.

2.2 Field Studies

2.2.1 Fish Habitat Description

To assess the potential impacts to fish habitat, fish communities or fish species at risk (SAR) the aquatic habitats within the study area were assessed based on the point observation technique used by *Ontario Stream Assessment Protocol* (Stanfield, 2013) and the Ministry of Transportation of Ontario (MTO)'s *Environmental Guide for Fish and Fish Habitat October 2006* (MTO, 2006). The channel morphology was described using evenly spaced transects upon which data was recorded from evenly spaced observation points. The data collected included: channel width, wetted width, bankfull depth, water depth, substrate size, morphological units, and in-stream cover.

2.2.2 Fish Community Sampling

Fish community sampling was performed to document the use of the site by fish during the spring of 2020. The community was sampled using dip net and minnow traps. Minnow traps were baited and set overnight. As this work took place in 2020, due to Covid-19 restrictions, the early spring survey period was missed.

3.0 RESULTS

3.1 Location

The study area is situated between Highway 401, the CN mainline railroad, Moulinette Road and Avonmore Road. It includes parts of Lots 31-37, Concession 5 in the Township of Cornwall (centroid UTM NAD83 18T 509011 m E 4988200 m N or latitude 45.047199° longitude-74.885575°). The Site covers two watersheds. The nearest populated area is Long Sault (Township of South Stormont), situated roughly 0.7 km to the south.

3.2 Background Review

The site includes two watersheds: Lake St. Lawrence of the St. Lawrence River (upstream of Moses-Saunders Dam in Cornwall) and Raisin River watershed (which flows into the Lake Francis reach of the St. Lawrence River, downstream of the Moses-Saunders Dam. This river outlets far downstream, roughly 32 km from the site, as the crow flies).

As mentioned in the introduction, while there were eight candidate features, only seven were present on site. The Unnamed Drain 2 had no defined channel on-site. All other seven features were headwaters. There was no nearby information available on the Unnamed Drain to Hoople Bay's classification or its fish community. The remaining six features drain into the South Raisin River. The South Raisin River flows far to the east of the site and doesn't actually reach the St. Lawrence River until Lancaster (to the east of Cornwall, in Lake St. Francis). Information was available for the South Raisin River, Unnamed Drain 1 and Unnamed Drain 3. These are all classed as Class E Drains in the LIO databases. Class E signifies that the drain has been sampled and that sensitive species (native species that are either listed as endangered, threatened, special concern or have intolerance to poor environmental conditions).

Fish community information for these features is available from the Aquatic Resource Area (ARA) data on LIO. The available information does not distinguish between what has been labelled herein as South Raisin River and Unnamed Drain 1. LIO identified 10 species as occurring in these. All are common warm to cool water forage fish (Table 1). Further downstream, to the south of the railroad, information collected by Bowfin for another unrelated project found eight species; all common warm to cool water fish species (central mudminnow, brassy minnow, northern redbelly dace, fathead, creek chub, white sucker, brook stickleback, and johnny darter). Information on LIO for a larger downstream reach list is expanded to include 26 species. That list contains sportfish and pan fish (northern pike, pumpkinseed, rock bass, and yellow perch) as well as the invasive species round goby. Those species are likely to be present within this site, more likely to be restricted to the habitats found much further downstream. There was potential pike spawning habitat on site, but they have note been recorded in this section of these channels.

There is no community information for the Unnamed Drain 2. And as mentioned, there was no defined channel on site.

The Unnamed Drain 3 has community information listing 10 common species consisting mostly of forage fish species with the exception of the pan fish pumpkinseed.

Note that the Class E drain classification may be more applicable to areas further downstream, as the fish encountered by Bowfin on Site (Section 3.4) and off Site (paragraph above) are not on the sensitive list (Mandrak and Bouvier, 2014).

No species at risk or of conservation value were listed in the LIO databases or on the DFO Aquatic Species at Risk Map (NASAR accessed August 26, 2021).

Table 1: Background Fish Community Information from LIO Databases

Species Name	Scientific Name	Trophic Class	Thermal Regime	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	South Raisin River / Unnamed Drain 1 (onsite)	Unnamed Drain 3	South Raisin River (D/S)	References
Northern Pike	Esox lucius	carnivore	cool	S5	No Status	No Status			Y	LIO, 2018
Central Mudminnow	*Umbra limi*	invertivore	cool	S5	No Status	No Status	Y	Y	Y	LIO, 2018; Bowfin, 2018
Spotfin Shiner	Cyprinella spiloptera	invertivore/ herbivore	warm	S4	No Status	No Status			Y	LIO, 2018
Common Carp	Cyprinus carpio	invertivore/ detritivore	warm	SNA	No Status	No Status			Y	LIO, 2018
Brassy Minnow	*Hybognathus hankinsoni*	planktivore/ detritivore	cool	S5	No Status	No Status		Y		LIO, 2018
Common Shiner	Luxilus cornutus	invertivore	cool	S5	No Status	No Status			Y	LIO, 2018
Golden Shiner	Notemigonus crysoleucas	invertivore/herbivore	cool	S5	No Status	No Status			Y	LIO, 2018
Blacknose Shiner	Notropis heterolepis	invertivore/ herbivore	cool	S5	No Status	No Status			Y	LIO, 2018
Sand Shiner	*Notropis stramineus*	invertivore/ detritivore	warm	S4	No Status	No Status	Y			LIO, 2018
Northern Redbelly Dace	*Chrosomus eos*	invertivore/ planktivore	cool	S5	No Status	No Status	Y		Y	LIO, 2018; Bowfin, 2018
Finescale Dace	*Chrosomus neogaeus*	Invertivore/planktivore	cool	S5	No Status	No Status	Y	Y		LIO, 2018
Bluntnose Minnow	*Pimephales notatus*	detritivore	warm	S5	No Status	No Status	Y		Y	LIO, 2018

Species Name	Scientific Name	Trophic Class	Thermal Regime	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	South Raisin River / Unnamed Drain 1 (onsite)	Unnamed Drain 3	South Raisin River (D/S)	References
Fathead Minnow	Pimephales promelas	detritivore/ invertivore	warm	S5	No Status	No Status			Y	Bowfin , 2018
Creek Chub	*Semotilus atromaculatus*	invertivore/ carnivore	cool	S5	No Status	No Status	Y	Y	Y	LIO, 2018; Bowfin, 2018
White Sucker	*Catostomus commersonii*	invertivore/ detritivore	cool	S5	No Status	No Status	Y	Y	Y	LIO, 2018; Bowfin, 2018
Brown Bullhead	*Ameiurus nebulosus*	invertivore/ herbivore/ carnivore	warm	S5	No Status	No Status		Y	Y	LIO, 2018
Tadpole Madtom	Noturus gyrinus	invertivore/ planktivore	warm	S4	No Status	No Status			Y	LIO, 2018
Banded Killifish	*Fundulus diaphanus*	invertivore/ planktivore	cool	S5	No Status	No Status		Y	Y	LIO, 2018
Brook Stickleback	*Culaea inconstans*	planktivore/ invertivore	cool	S5	No Status	No Status	Y	Y	Y	LIO, 2018; Bowfin, 2018
Rock Bass	Ambloplites rupestris	invertivore/carnivore	cool	S5	No Status	No Status			Y	LIO, 2018
Pumpkinseed	*Lepomis gibbosus*	invertivore/ carnivore	warm	S5	No Status	No Status		Y	Y	LIO, 2018
Largemouth Bass	Micropterus salmoides	invertivore/ carnivore	warm	S5	No Status	No Status			Y	LIO, 2018
Iowa darter	*Etheostoma exile*	invertivore	cool	S5	No Status	No Status	Y	Y	Y	LIO, 2018
Fantail Darter	Etheostoma flabellare	invertivore	cool	S4	No Status	No Status			Y	LIO, 2018

Species Name	Scientific Name	Trophic Class	Thermal Regime	SRank	ESA Reg. 230/08 SARO List Status	SARA Schedule 1 List of Wildlife SAR Status	South Raisin River / Unnamed Drain 1 (onsite)	Unnamed Drain 3	South Raisin River (D/S)	References
Johnny Darter	*Etheostoma nigrum*	invertivore	cool	S5	No Status	No Status	Y		Y	LIO, 2018; Bowfin, 2018
Tessellated Darter	*Etheostoma olmstedi*	invertivore	cool	S4	No Status	No Status				LIO, 2018
Yellow Perch	Perca flavescens	invertivore/ carnivore	cool	S5	No Status	No Status			Y	LIO, 2018
Logperch	Percina caprodes	invertivore	warm	S5	No Status	No Status			Y	LIO, 2018
Round Goby	Neogobius melanostom us	invertivore	cool	SNA	No Status	No Status			Y	LIO, 2018
Number of Species							**10**	**10**	**25**	
Y	Represents a species present in the respective watercourse									

(DFO, 2019; Bowfin, 2018; Eakins, 2018; LIO, 2018; MNRF, 2017; MTO, 2006)

Status Updated: October 2, 2018

<u>SRANK DEFINITIONS</u>

S4 Apparently Secure, Uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5 Secure, Common, widespread, and abundant in the nation or state/province.
SNA Not Applicable, A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

3.3 Site Investigation Summary

As mentioned above, several site visits were undertaken. A summary of the dates, times, ambient conditions, and purpose for the visits that collected information on fish or fish habitat are provided in Table 2.

Table 2: Summary of Dates and Times of Site Investigations

Date	Time (h)	Staff	Air Temperature (Min-Max) °C	Cloud Cover (%) Beaufort Wind Scale [Descriptor (scale)]	Moon Visibility (%)	Purpose
May 11, 2020	1000-1430	M. Lavictoire	8.0 (1.2-10.2)	Overcast Wind: light breeze (2), changing to light air (1)	n/a	- Initial visit -Spring flow assessment
May 12, 2020	0900-1200	M. Lavictoire	5.0-6.0 (-2.8-7.8)	Clear skies Wind: light breeze (2) changing to gentle breeze (3)	n/a	- Initial visit -Spring flow assessment
May 20, 2020	0800-1245 2000-2100	M. Lavictoire	12.0-19.0 (6.0-23.5)	Clear skies Wind: light air (1) changing to calm (0)	n/a	- Feature delineation - Late spring flow assessment
May 27, 2020	1600-1800	M. Lavictoire	36.0 (19.0-34.8)	Partly cloudy Wind: light breeze (2) to gentle breeze (3)	n/a	- Fish community sampling
May 28, 2020	0600-1045 0745-1015	C. Fontaine M. Lavictoire	21.0-29.0 (19.5-30.0)	Partially cloudy changing to cloudy Wind: light breeze (2) changing to calm (0)	n/a	- Fish community sampling
July 10, 2020	0800-0845	S. Lafrance	24.0 (21.2-36.4)	Clear skies Wind: calm (0)	n/a	- Summer flow assessment
August 31, 2020	0830-1315 0900-1130	C. Fontaine M. Lavictoire	14.0-19.0 (9.7-21.5)	Clear skies Wind: calm (0) changing to light breeze (2)	n/a	- Fish habitat description

M. Lavictoire – Michelle (Nunas) Lavictoire – B. Sc. Wildlife Resources and M.Sc. Natural Resources
C. Fontaine - Cody Fontaine - Fisheries and Wildlife Technologist
S. Lafrance – Sophie Lafrance – B.Sc. Biology and graduate diploma in Ecosystem Restoration

*Min-Max Temp Taken From: Environment Canada. National Climate Data and Information Archive. Cornwall. Available http://climate.weatheroffice.gc.ca/ [October 6, 2020]

3.4 Fish Habitat and Fish Communities

The eight (including photographs of the culvert where Unnamed Drain 2 would outlet to) are described below.

Unnamed Drain to Hoople Bay on the St. Lawrence River

The Unnamed Drain to Hoople Bay is situated on the far west side of the site. This feature is approximately 5.9 km long from its origin to Hoople Bay. The origin is roughly 0.8 km upstream of this site. Within the site, the feature consists of the east road ditch for Moulinette Road. Further upstream the feature parallels the Highway 401. The amount of water present in the portion on Site is likely greatly influenced by the Highway 401 water catchment area. The west bank is the very steep embankment of Moulinette Road and the lands on the east (on Site) consist of a wetland (Figure 3). The culvert under Moulinette Road appeared to be properly installed. Note that the downstream side was on a quarry and not accessed. One station was established.

Station 1

Station 1 began at the upstream end of the culvert under Moulinette Road and was 52 m in length. The average channel width was 3.1 m and the average bankfull height 27 cm. The average spring wetted width and depth were 0.8 m and 6 cm, respectively. The station was dry during the summer visit.

The substrate consisted entirely of fines and the stream morphology was a glide. The in-water cover throughout the station was provided by aquatic vegetation (broad and narrow-leaved cattails, reed canary grass, purple loosestrife, and common reed). No signs of erosion were noted.

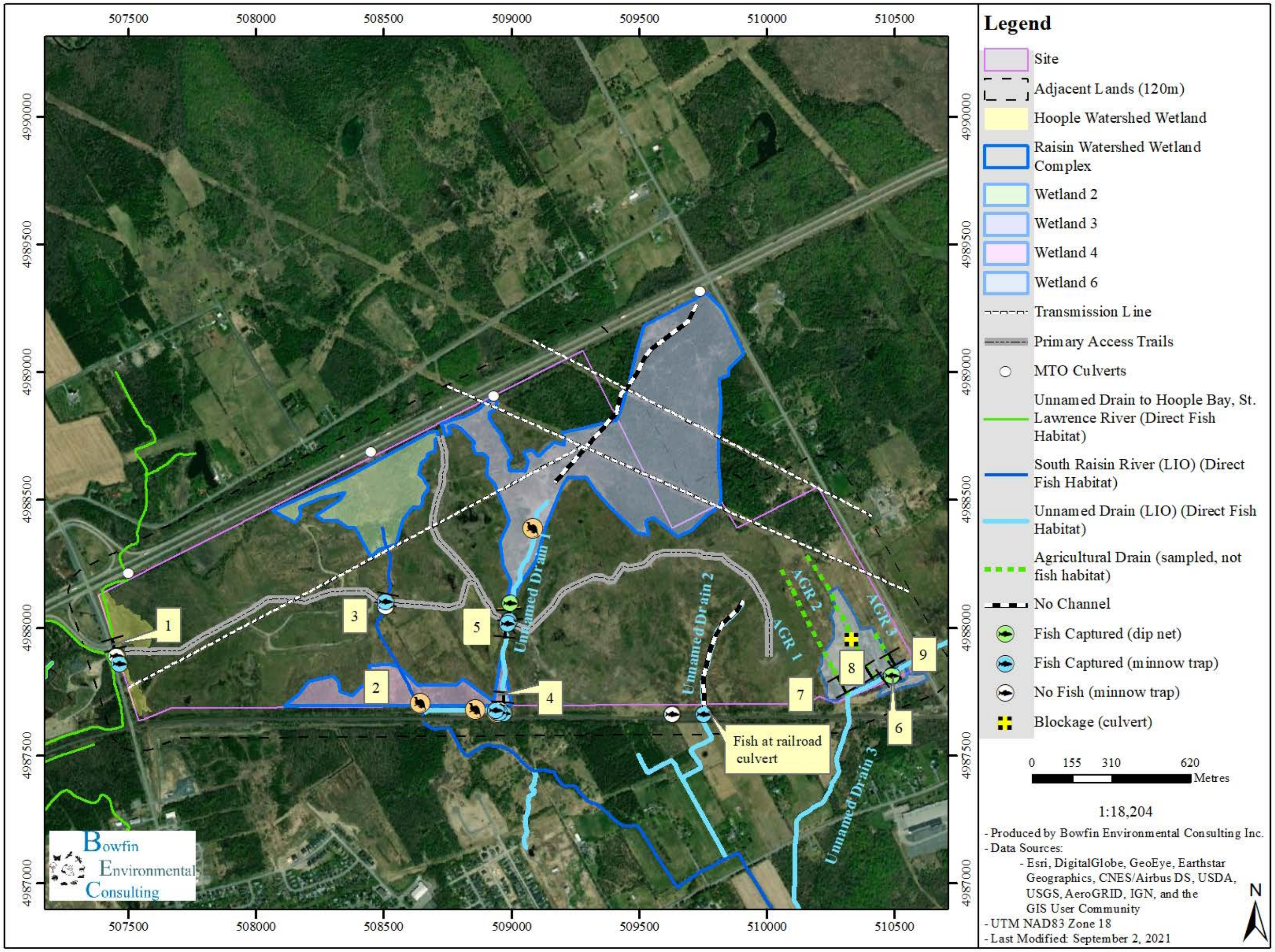
The tops of the banks were fully vegetated on the east bank and gravel/roadway along the west bank. The most common species were reed canary grass, goldenrod, common burdock, wild red raspberry, staghorn sumac, American elm, ash and willows. The station had moderate canopy cover throughout.

Baited minnow traps were set between the access road and the culvert under Moulinette Road overnight on May 27, 2020. A total of 14 fish brook stickleback were captured (size range: 33-59 mm) in the minnow trap closest to the cross-culvert under Moulinette Road. None were captured in the trap placed further upstream. No sampling took place during the summer as the station was dry (August 31, 2020).

Photo 1: Unnamed Drain to Hoople Bay (May 11, 2020)

Photo 2: Station 1 looking upstream from downstream (August 31, 2020)

Figure 3: Fish Habitat and Community Results



South Raisin River

Moving to the east, the next feature is the South Raisin River. While there is a Highway 401 culvert leading towards this channel, any water from the highway is intercepted by a swamp that does not contain any defined channels (Wetland 2). The feature began near the east-west Hydro One transmission line and travelled south through the disturbed lands to the CN railroad. The South Raisin River travels over 45 km before it reaches the North Raisin River. The portion on the site represents the first 0.8 km of this long watercourse. The culvert under the railroad is well positioned and does not pose a barrier to fish movement. A beaver dam at the downstream end, within 20 m of the railroad, is a temporary barrier to movement outside of the spring freshet. Portions of this feature was heavily impacted by the clearing activities and access roads, with a culvert in poor shape under the main access road, and ruts and slash in the channel. The channel was seasonal. As will be noted herein, fish present in a pool just upstream of the access road demonstrated that movement must be possible during the freshet.

This feature has been divided into two reaches (a and b) because of the disturbances to the riparian habitat and to the feature itself. The downstream section labelled as "a" is a defined natural feature through the wetland and "b" is the area heavily disturbed by ruts and slash.

Station 2

Station 2 began 7.0 m upstream of the confluence with Unnamed Drain 1 and was 43 m in length. A beaver dam was situated on the downstream end and acted as a temporary/seasonal barrier to fish movement.

The average channel width was 1.1 m and the average bankfull height 12 cm. The average wetted width and depth in the spring were 0.9 m and 10 cm, respectively. The station was dry during the summer visit.

The substrate consisted entirely of fines and the stream morphology was a glide. The in-water cover throughout the station was provided by aquatic vegetation (reed canary grass, purple loosestrife and narrow-leaved cattail). No signs of erosion were noted. The tops of the banks were fully vegetated. The most common species were: reed canary grass, goldenrod and slender willow. There was no canopy cover.

Photo 3: South Branch Raisin, reach "a" (May 11, 2020)

Photo 4: Station 2 looking downstream from downstream (August 31, 2020)

Station 3

Station 3 began 465 m upstream of the confluence with Unnamed Drain 1 and was 51 m in length. The average channel width was 2.7 m and the average bankfull height 29 cm. There was a beaver dam or earth barrier upstream of the access road that created a shallow pool during the spring. This pool was also dry later.

The substrate consisted mostly of fines with some gravel and cobble. The morphology was a glide along the station, and a pool upstream of the beaver dam. The in-water cover throughout the station was provided by aquatic and terrestrial vegetation (reed canary grass, grasses, purple loosestrife, goldenrod species and wild parsnip). Areas containing small woody debris (slash) was also present. No signs of erosion were noted.

The tops of the banks were fully vegetated. The most common species were: goldenrod species, reed canary grass, wild parsnip, glossy buckthorn, willow species, American elm and ash species. There was little to no canopy cover.

Baited minnow traps were set in the pools upstream and downstream of the access road on May 27, 2020. Eight fish represented by two species were captured in the upstream pool (no fish were captured in the shallow pool downstream): 7 northern redbelly daces (size range: 37-50 mm), and 1 brook stickleback (size range: 51 mm). No sampling took place during the summer as the station was dry (August 31, 2020).

Photo 5: Culvert at access road (May 27, 2020)

Photo 6: South Branch Raisin, reach "b" (May 11, 2020)

Photo 7: Station 3 looking upstream from downstream (August 31, 2020)

Unnamed Drain 1

Unnamed Drain 1 is a tributary to the South Raisin River; reaching the South Raisin River on Site, near the CN railroad. Background mapping shows this feature to be 2.6 km long, beginning 0.3 km upstream of Highway 401 and merging with the South Raisin River just upstream of the culvert under the railroad. Investigations completed for this project found that the actual channel was closer to 1.2 km long, originating inside of the wetland found on the northeast side of the site (Wetland 3). Like the South Raisin River, any flow that this feature receives from the Highway 401 catchment, or upstream areas, is absorbed by the large wetland. There were several beaver dams on this feature. The first ones encountered were in Wetland 3, near the access road. The larger one was near the railroad which created a pond (in Wetland 4). While the pond remained wet longer than the rest of the feature, it too was dry by the end of August.

Also, like the South Raisin River, this feature is separated in sections because of the habitat differences. There are three distinct reaches on site; 1a and c are part of wetlands, and 1b is disturbed by ruts and slash between the two wetlands.

Station 4

Station 4 began 330 m upstream of the confluence of the South Raisin River and was 46 m in length. The average channel width was 2.5 m and the average bankfull height 24 cm. The average wetted width and depth in the spring were 0.6 m and 5 cm, respectively. The station, including the beaver pond, was dry during the summer visit.

The substrate consisted entirely of fines and the morphology was a glide. The beaver dams present, just below station 4, created pool habitat in the spring. The station was choked with aquatic and terrestrial vegetation. The species providing the in-water cover throughout the station were reed canary grass, spotted joe-pye weed, broad-leaved cattail, goldenrod and reed canary grass. No signs of erosion were noted.

The tops of the banks were fully vegetated. The most common species were: goldenrod, reed canary grass, glossy buckthorn, American elm and ash. There was little to no canopy cover.

The beaver pond was sampled with four baited minnow traps on May 27, 2020. A total of 11 fish were captured representing 5 species: central mudminnow, northern redbelly dace, fathead minnow, creek chub, and brook stickleback (Table 3). No sampling took place during the summer as the station was dry (August 31, 2020).

Table 3: Summary of Fish Captured at Station 4

Species Name	Scientific Name	May 27, 2020 No. of fish (size range, mm)
Central Mudminnow	*Umbra limi*	6 (30-72)
Northern Redbelly Dace	*Chrosomus eos*	1 (62)
Fathead Minnow	*Pimephales promelas*	1 (48)
Creek Chub	*Semotilus atromaculatus*	2 (62-86)
Brook Stickleback	*Culaea inconstans*	1 (42)
	Total No. Species	**5**
	Total No. Individuals	**11**

Photo 8: Unnamed Drain 1a (May 11, 2020)

Photo 9: Station 4 looking upstream from the downstream end (August 31, 2020)

Station 5

Station 5 was located just downstream of the access road, beginning roughly 600 m upstream of the confluence of the South Raisin River. The station was 54 m in length. The average channel width was 3.1 m and the average bankfull height 22 cm. Apart from a few instances of pooling with the ruts, the site was dry during the summer. The smaller pool on the downstream end of the access road had 27 cm of water on May 28, 2020.

Additional information from the wetland channel upstream of this site (reach c) provided the following water level information recorded on May 28, 2020. The average wetted widths and depths were 0.8 m and 6 cm, respectively. The pool situated just upstream of the access road culvert had a maximum pool depth of 90 cm.

The substrate consisted mostly of fines with some gravel and cobble. The in-water cover throughout the station was provided by aquatic vegetation and terrestrial vegetation (narrow-leaved cattail, purple loosestrife, reed canary grass, sedges, sensitive fern and cardinal flower). Areas containing large and small woody debris, slash, was also present. No signs of erosion were noted but the channel was impacted by the ruts.

The tops of the banks were fully vegetated. The most common species were: reed canary grass, goldenrod, wild carrot, glossy buckthorn, common buckthorn, willow, American elm and ash. There was little to no canopy cover.

The pools on either side of the access road were sampled with baited minnow traps on May 27, 2020, and the natural channel in the wetland above was dip netted (also in May). The minnow traps (2) catch consisted of 17 fish were captured representing 4 species: 5 central mudminnow, 1 fathead minnow, 6 creek chub, and 5 brook stickleback. The dip netting (along a section of about 40 m) netted 9 fish representing 3 species: central mudminnow, a finescale dace, and 5 brook stickleback.

Table 4: Summary of Catch from Station 5 (May 27, 2021)

Species Name	**Scientific Name**	**May 27, 2020 Pools by the Access Road No. of fish (size range, mm)**	**May 27, 2020 Station 5 No. of fish (size range, mm)**
Central Mudminnow	*Umbra limi*	5 (55-75)	3 (44-55)
Finescale Dace	*Chrosomus eos*	n/a	1 (35)
Fathead Minnow	*Pimephales promelas*	1 (42)	n/a
Creek Chub	*Semotilus atromaculatus*	6 (38-136)	n/a
Brook Stickleback	*Culaea inconstans*	5 (29-50)	5 (30-43)
	Effort	2 Minnow Traps	Dip netting for a length of 40 m
	Total No. Species	**4**	**3**
	Total No. Individuals	**17**	**9**

Photo 10: Unnamed Drain 1c (May 11, 2020)

Photo 11: Unnamed Drain 1b (May 11, 2020)

Photo 12: Station 5 (in section 1b) looking upstream from the downstream end (August 31, 2020)

Unnamed Drain 2

While the background mapping suggests that there is an Unnamed Drain 2, no channel could be found within the wetland on site or at the upstream end. Review of the imagery suggests that the water from upstream may be blocked by the access road for the twin transmission lines. This follows with the detailed topography mapping created by others for the site. The culvert at the railroad is on a steep incline preventing fish access during all but perhaps the early spring. This feature does not provide fish habitat due to the lack of channel. It is anticipated that fish habitat is present immediately downstream of the CN Railroad culvert. Even if the culvert was repaired, there is no upstream channel for fish to access other than the ruts created by the quad trail. Since this quad trail runs east to west and as there are hills on either side, the habitat in the ruts is limited and, currently isolated. One central mudminnow was captured in the pooled water in the ruts next to this culvert.

Photo 13: Culvert Under Railroad at Headwater Feature 2 (May 27, 2020)

Unnamed Drain 3

Unnamed Drain 3 originates on the other side of Avonmore Road from what appears to be a small sand pit (about 720 m from the site). The total length of the feature is 1.8 km, and it flows into the South Raisin River, 1.1 km downstream of the railroad. The portion on-site is 0.4 km long and consisted of a channelized drain. The culvert under the railroad was well-positioned and did not represent a barrier to fish movement. The feature was seasonal.

Station 6

Station 6 was located 100 m west of where it crossed Avonmore Road and was 58 m in length. The average channel width was 3.7 m and the average bankfull height 27 cm. The average wetted width and depths in the spring were 3.2 m and 9 cm, respectively. The site was dry by summer.

The substrate consisted entirely of fines and the stream morphology was a glide. The in-water cover throughout the station was provided by aquatic and terrestrial vegetation (reed canary grass, sedges, purple loosestrife, spotted joe-pye weed, goldenrod species and cow vetch). The aquatic vegetation was hummocky within the station causing the channel to flow around the mounds. No signs of erosion were noted.

The tops of the banks were fully vegetated however, on the left bank the vegetation was recently cut creating an 8 m wide path running parallel along much of the station. The most common species were: grasses, reed canary grass, goldenrod, cow vetch and slender willow. There was no canopy cover.

During the May 28, 2020, visit, the station was dip netted over an area of approximately 186 m². Three fish were captured representing 2 species: central mudminnow (size: 61 mm) and brook stickleback (size range: 38-40 mm). No sampling took place during the summer as the station was dry (August 31, 2020).

Photo 14: Unnamed Drain 3 (May 12, 2020)

Photo 15: Station 6 looking upstream from downstream (August 31, 2020)

Agricultural Drains

The last three features are dug agricultural drains that flow south into Unnamed Drain 3. None provided direct fish habitat, during the surveys and while the very early spring was missed, based on the habitats, it is unlikely that they provide direct habitat at any time of the year. Note Agricultural Drain 3 is not connected to the Unnamed Drain (blocked by soil – no defined channel) and is not direct fish habitat.

Agricultural Drain 1

Agricultural Drain 1 is on the west side and is 564 m long and well-connected to Unnamed Drain 3 on the downstream end. The channel was seasonal, and portions were already dry by May 12, 2020.

Station 7

Station 7 began 5 m upstream of the confluence of Unnamed Drain 3 and was 75 m in length. The average channel width was 3.6 m and the average bankfull height 27 cm. The average springtime wetted width and depths in the spring were 1.5 m and 10 cm, respectively. The site was dry by summer.

The substrate consisted entirely of fines and the stream morphology was a glide. The upstream half of the station was heavily choked with common reed and slender willow. The in-water cover throughout the station was provided by aquatic vegetation (common reed, sedges, reed canary grass, spotted joe-pye weed, purple loosestrife and slender willow). The aquatic vegetation was hummocky within the station causing the channel to flow around the mounds. No signs of erosion were noted.

The tops of the banks were fully vegetated. The most common species were reed canary grass and slender willow. The shrubs covered the entire channel providing full shade.

During the May 28, 2020, visit, the entire length of the headwater feature (including Station 7) was dip netted. No fish were captured or observed. No sampling took place during the summer as the station was dry (August 31, 2020).

Photo 16: Agricultural Drain 1a, looking upstream from near mouth (May 20, 2020)

Photo 17: Agricultural Drain 1b, looking upstream (May 20, 2020)

Agricultural Drain 2

Agricultural Drain 2 is in the middle and is 567 m long and also well-connected to Unnamed Drain 3 on the downstream end. This one had a blockage roughly 180 m from the confluence with Unnamed Drain 3 that would be a temporary barrier to fish (until culvert is repaired), but again no fish were ever caught in this feature. This channel was seasonal, and portions were already dry by May 12, 2020.

Station 8

Station 8 began 5 m upstream of the confluence of Unnamed Drain 3 and was 60 m in length. The average channel width was 3.2 m and the average bankfull height 23 cm. The average springtime wetted width and depths in the spring were 1.5 m and 10 cm, respectively. The site was dry by summer.

The substrate consisted entirely of fines and the stream morphology was a glide. The upstream half of the station was heavily choked with common reed and slender willow. The in-water cover throughout the station was provided by aquatic vegetation (common reed, sedges, reed canary grass, spotted joe-pye weed, purple loosestrife and slender willow). The aquatic vegetation was hummocky within the station causing the channel to flow around the mounds.

The tops of the banks were fully vegetated. The most common species were: reed canary grass and slender willow. There was good canopy cover throughout.

During the May 28, 2020, visit, the entire length of the headwater feature (including Station 8) was dip netted. No fish were captured or observed. No sampling took place during the summer as the station was dry (August 31, 2020).

Photo 18: Agricultural Drain 2a, looking upstream from near mouth (May 20, 2020)

Photo 19: Station 8 (Agr 2a) looking upstream from downstream (August 31, 2020)

Photo 20: Agricultural Drain 2b, looking upstream (May 20, 2020)

Agricultural Drain 3

Agricultural Drain 3 was on the east side and was blocked at its downstream end. This short 142 m long drain was not connected to Unnamed Drain 3 and was seasonal.

Station 9

Station 9 began 5 m upstream of the confluence of Unnamed Drain 3 and was 58 m in length. The average channel width was 3.2 m and the average bankfull height 15 cm. The feature was dry during both the spring and summer visits.

The substrate consisted entirely of fines and the stream morphology was a glide. The station was heavily choked with common reed and slender willow. The in-water cover throughout the station was provided by aquatic vegetation (common reed, sedges, reed canary grass, purple loosestrife and slender willow). No signs of erosion were noted.

The surrounding area was vegetated on the west side and consisted of reed canary grass and slender willow. The east side was tilled. The dense willows provided full shade.

No sampling took place on either of the May 28 or August 31, 2020, visits as the station was dry.

Photo 21: Station 9 looking upstream from downstream (May 28, 2020)

3.5 Fish and Fish Habitat Discussion

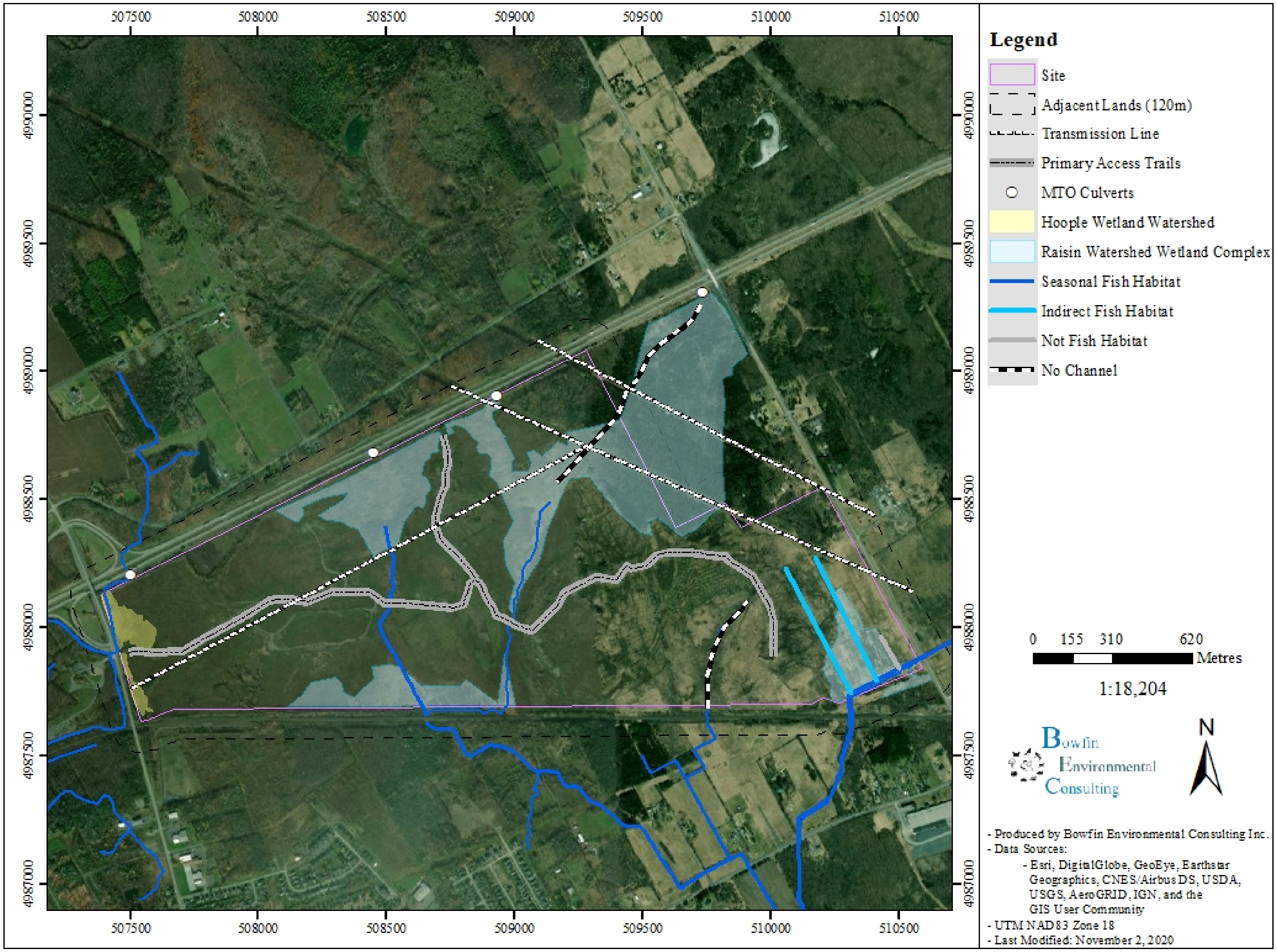
There were eight features with the potential to provide fish habitat. Of these, four were confirmed to provide seasonal fish habitat: Unnamed Drain to Hoople Bay, South Raisin River, Unnamed Drain 1 and Unnamed Drain 3. Unnamed Drain 2 was not present on Site. It is suspected to begin downstream of the CN railroad. The Agricultural Drains 1 and 2 were indirect fish habitat and Agricultural Drain 3 was Not Fish habitat. The results from above are summarized in Table 5 below.

Table 5: Summary of Fish Habitat and Recommendations (including Headwater Assessment Recommendations)

Feature	Classification	Fish Species Caught	Comments
Unnamed Drain to Hoople	Seasonal Fish Habitat	Brook Stickleback	Moulinette Road ditch
South Raisin River	Seasonal Fish Habitat	Northern Redbelly Dace Brook Stickleback	Heavily impacted by clearing (even within some of the wetland)
Unnamed Drain 1	Seasonal Fish Habitat	Central Mudminnow, Northern Redbelly Dace, Fathead Minnow, Creek Chub, Brook Stickleback	Middle portion is heavily impacted by clearing

Feature	Classification	Fish Species Caught	Comments
Unnamed Drain 2	On-Site - Not Fish Habitat	n/a (in quad trails – one Central Mudminnow)	There was no defined channel on Site and the culvert appears to be broken under the railroad track. The quad trail parallel to the track had ponded water but was isolated due to hills on either side.
Unnamed Drain 3	Seasonal Fish Habitat	Central Mudminnow Brook Stickleback	No comments
Agricultural Drain 1	Indirect Fish Habitat	None	Narrow, channel agricultural channel that is connected but offers little contributing flows
Agricultural Drain 2	Indirect Fish Habitat	None	Narrow, channel agricultural channel that is connected but offers little contributing flows
Agricultural Drain 3	Not Fish Habitat	None	Narrow, channel agricultural channel that is NOT connected

Figure 4: Fish Habitat Classification



4.0 SUMMARY OF WORKS, UNDERTAKINGS AND ACTIVITIES

As described in the introduction, Phase A is ready for a more detailed review. The site is within the settlement area of the Village of Long Sault and is zoned for Heavy Industrial Development. The developer will be applying for Site Plan Control approval in Fall, 2021. The general concept for the full site is under concept development and the proponent would like to work with DFO on both the Submission for Phase A and the Site in general. Phase A is the large inter-modal rail yard and will include full-length unit train tracks that are connected along 2 km of the existing CN Mainline (Kingston Subdivision). Clearing of vegetation and the cut and fill activities for Phase A (and possibly some of the rest of the Site) is anticipated to begin in the fall 2021.

General Concepts for Site:

- The watershed boundaries will be respected. No change to the amount of water flowing to the Lake St. Lawrence (Unnamed Tributary to Hoople) or to the Raisin River Watershed (all other channels on site).
- The water originating from the MTO culverts on Highway 401 needs to be accommodated.
- There will be no change in the amount of flow reaching each of the culverts under the railroad. This will ensure that the fish habitat downstream of the railroad is not impacted.
- Since there was no defined channel on Site for the Unnamed Drain 2, one option being considered is urbanizing this area and piping the flow to the railroad culvert.
- It is anticipated that the three Agricultural Drains will be removed but their contributing flow will continue to reach Unnamed Drain 3 (future submission).

Current submission:

1. The lower portions of the South Raisin (Watercourse F on the accompanying drawing) and of the Unnamed Tributary 1 (Watercourse E on the accompanying drawing) will be realigned into a single combined new channel. In the future, the upstream portion of these channels may also be realigned (Table 6).
2. Four culverts will be installed on this new combined channel (Table 7) (locations shown on accompanying drawing).

The next steps are summarized in Table 8 and the preliminary assessment of impacts to fish and fish habitat are discussed below, in Section 5.

Table 6: Summary of Changes to Channels Associated with Phase A

	South Raisin River (Watercourse F)		Unnamed Drain 1 (Watercourse E)	
Existing	Length removed as part of Phase A = 593 m. Total length impacted is 800 m. Channel width 1.1 m	880 m^2 (652 m^2 in Phase A study area, see accompanying drawing)	Length 996 m and channel width 2.8 m	2789 m^2
Proposed	Length 310 m, 1:2 year wetted width 3.3-5.7 m (note this length is only the portion in Phase A, see accompanying drawings)	Will form part of a future road ditch and may be designed to not be fish habitat. Note if this is designed not to be fish habitat, then it will impact the entire length of this watercourse.	Length 945 m, 1:2 year wetted width 3.3-5.7 m	5007 m^2

Table 7: Summary of Proposed Culverts (see accompanying drawing for locations)

Culvert	Length (m)	Width (m)	Height (m)	Estimated Velocities (1:2 Year)	Max. Distance (50% White Sucker 380 mm) (SPOT)
Culvert 4 -Downstream (near CN)	51	12.2	0.5	1.0 m/s	26 m
Culvert 3	75	12.2	0.5	0.9 m/s	35 m
Culvert 2	35	12.2	0.5	1.0 m/s	26 m
Culvert 1 – Street A	32	12.2	0.5	0.8 m/s	50 m

Table 8: Summary of Fish Habitat, and Timing of Works, Activities and Undertakings

Feature	Classification	Fish Species Caught	Comments	Works, Activities, Undertakings Phase A	Works, Activities, Undertakings Future Phases	Next Steps
Unnamed Drain to Hoople	Seasonal Fish Habitat (road ditch)	Brook Stickleback	Moulinette Road ditch	None	Unknown	TBD
South Raisin River / Watercourse F	Seasonal Fish Habitat	Northern Redbelly Dace Brook Stickleback	Heavily impacted by clearing (even within some of the wetland)	Lower portion to become road ditch (not fish habitat) This will indirectly result in the loss of the upstream fish habitat.	Upper portion may be realigned to new single channel with Unnamed Drain 1/ Watercourse E	Discussion with DFO on loss of headwaters (see preliminary analysis below (Section 5))
Unnamed Drain 1 / Watercourse E	Seasonal Fish Habitat	Central Mudminnow, Northern Redbelly Dace, Fathead Minnow, Creek Chub, Brook Stickleback	Middle portion is heavily impacted by clearing	Lower portion to be realigned into new channel with four new culverts. Calculated velocities at 1:2 levels are fast but it is anticipated that this would be short duration	Upper portion may be realigned to new single channel with South Raisin River /Watercourse F if culvert velocities do not negate this being habitat	Discussion with DFO on value of habitat and proposed realignments/culverts (see preliminary analysis below (Section 5))
Unnamed Drain 2 / Watercourse D	On-Site - Not Fish Habitat	n/a (in quad trails – one Central Mudminnow)	There was no defined channel on-site and the culvert appears to be broken under the railroad track. The quad trail parallel to the track had ponded water	To be piped	n/a	Confirmation of assessment with DFO (see preliminary analysis below (Section 5))

Feature	Classification	Fish Species Caught	Comments	Works, Activities, Undertakings Phase A	Works, Activities, Undertakings Future Phases	Next Steps
			but was isolated due to hills on either side.			
Unnamed Drain 3	Seasonal Fish Habitat	Central Mudminnow Brook Stickleback	No comments	None	TBD	Overall concept plan to be discussed with DFO
Agricultural Drain 1	Indirect Fish Habitat	None	Narrow, channel agricultural channel that is connected but offers little contributing flows	None	TBD	Overall concept plan to be discussed with DFO
Agricultural Drain 2	Indirect Fish Habitat	None	Narrow, channel agricultural channel that is connected but offers little contributing flows	None	TBD	Overall concept plan to be discussed with DFO
Agricultural Drain 3	Not Fish Habitat	None	Narrow, channel agricultural channel that is NOT connected	None	TBD	Overall concept plan to be discussed with DFO

5.0 EVALUATION AND ASSESSMENT OF PHASE A

As mentioned above this is a large site and the proponent is moving forward with Phase A. However, the decisions made in Phase A along with those during the concept planning for the remainder of the site will impact how fish and fish habitat are dealt with. As such, a preliminary assessment of the impacts associated with Phase A are included below. The details (i.e. footprints, rip rap, culvert details) will move forward once DFO has provided input on the general concept.

5.1 Preliminary Impact Assessment Methods

The assessment of the potential impacts of the realignment of the lower portions of two watercourses and the installation of the four culverts is completed by analyzing the impact of various activities associated with the project.

- Clearing of terrestrial vegetation
    a. The Site is mostly disturbed and impacted with slash and ruts but has been regenerating. Where treed, the tree heights are 1-3 m. The entire site will likely be cleared and cut and filled for development.
- Installation of cofferdams. Details to be determined but the existing channels are narrow and dry in the summer.
- Dewatering of the work area.
- Bypass flow to maintain the upstream and downstream conditions during construction (if needed).
- Excavation and dredging for construction of new channel and installation of culverts would be completed first followed by the decommissioning of the old alignments.
- Backfilling and stabilization of banks.
- Removal of cofferdams.

The significance of the potential impacts is measured using four criteria:

1. Area affected may be:
    a. local in extent signifying that the impacts will be localized within the project area
    b. regional signifying that the impacts may extend beyond the immediate project area.

2. Nature of Impact:
    a. negative or positive

   b. direct or indirect

3. Duration of the impact may be rated as:
   a. short term (construction phase; one in-water timing window)
   b. medium term (up to 4 years)
   c. long term (>4 years).
   d. permanent

4. Magnitude of the impact may be:
   a. negligible signifying that the impact is not noticeable
   b. minor signifying that the project's impacts are perceivable and require mitigation
   c. moderate signifying that the project's impacts are perceivable and require mitigation as well as monitoring and/or compensation
   d. major signifying that the project's impacts would destroy the environmental component within the project area.

5.2 Phase A - Evaluation of Potential Impacts and Mitigation to Fish and Fish Habitat

5.2.1 Fish and Fish Habitat Discussion

The *Fisheries Act* (FA) (August 28, 2019) prohibits:

- Death of Fish (Section 34.4)
- Harmful alteration, disruption, or destruction of Fish Habitat (Section 35)
- Ministerial powers to ensure the free passage of fish or the protection of fish or fish habitat with respect to existing obstructions (Section 34.3)

Under the updated FA there remain a certain type of waterbodies where DFO review is not required. Generally, these are for projects that will occur on a waterbody that is not connected to fish habitat and does not contain fish at any time of year. It also includes specific activities for which guidelines have been prepared by DFO and if these can be met then no review is required. The guidelines consist of Standard Code of Practice or Mitigation Measures for the Protection of Fish and Fish Habitat. Realignments and the installation of new culverts on fish bearing watercourses does not meet the exemptions and must be reviewed by DFO.

5.2.2 Factors to be Considered

The *Fisheries Act* indicated that the following factors are to be considered during the review:

1. Contribution to the productivity of relevant fisheries by the fish or fish habitat that is likely to be affected;

2. Fisheries management objectives;
3. Whether there are measures and standards to avoid, mitigate or offset depth or HADD of fish habitat.

Contribution to the productivity of relevant fisheries by the fish or fish habitat that is likely to be affected

The existing channels have been impacted by the clearing of the site by others as well as a lack of maintenance on the existing culverts along the primary access trail (north/upstream of Phase A). While the collection of fish from the pools upstream of this primary access trail indicates that fish were able to find their way through the system (system is seasonal with no overwintering habitat), the existing fish passage through the site is not ideal. Currently, the site provides seasonal habitat for common warm to cool water fish and would contribute forage fish to downstream fish habitat.

Fisheries Objectives

There are no stated fisheries management objectives for this system. While sport and pan fish are noted for the South Raisin much further downstream, none were captured downstream by Bowfin during sampling for an unrelated project in the spring of 2018. That work took place downstream of the railroad in an area not impacted by clearing. Eight species were found (Central Mudminnow, White Sucker, Finescale/Northern Redbelly Dace, Brassy Minnow, Fathead Minnow, Creek Chub, Brook Stickleback and Johnny Darter).

Whether there are measures and standards to avoid, mitigate or offset death of fish or HADD of Fish Habitat

Avoidance

The site is also constrained by several existing elements:

- The industrial and logistics village will be built around the railway yard and inter-modal staging area. The grading of the rail yard and storage and transfer area have a very low tolerance and must be kept at approximately less than <0.5-1% grade change.
- The existing grade of the CN tracks must be maintained at less than a 1% change, including a switch that must match existing at the eastern and western end of the side-track lines.
- The CN engineering standards dictate the cover that the rail lines must maintain over culvert crossings, which further constrains the grading design.
- The existing culverts crossing the CN mainline to the south
- The alignment and grade of the natural watercourses and drainage ditches through the site (including a wetland area that the developer is working on maintaining as a naturalized area)

- The existing culvert's crossing Highway 401 on the north side of the site
- There is an at-grade crossing at Avonmore Rd., which must match exactly with existing rail lines and road grades.

Effort was made to improve the potential for fish passage through the proposed new culverts, the velocities remain higher than preferred for the lengths. Because of the constraints listed above, it is unlikely that a solution can be found for these culverts for water volumes estimated for the 1: 2 year.

Mitigation

To explore how best to mitigate the impacts, further understanding of the potential impacts provided through a summary of the work categories and pathways of effect is provided.

Work Categories

- Aquatic Vegetation Removal
- Culverts
- Dewatering/pumping
- Dredging/Excavation
- Riparian vegetation removal
- Shoreline protection
- Temporary structures
- Watercourse realignment

Pathways of Effects

The proposed project has the potential to trigger the following Pathways of Effects (PoE):

- Removal of aquatic vegetation
  - The existing channels have been impacted by clearing activities (by others)
  - The removal of aquatic vegetation will be restricted to the channel to be decommissioned and only once the new channel is commissioned. There may be minor removal of vegetation at the tie-ins.
  - Some aquatic vegetation will be removed by machinery.
  - Work will be completed in an isolated section to prevent suspended sediments from travelling outside of the work area.
  - Fish will be salvaged.

- Use of industrial equipment
    - Potential impacts with erosion and sediment issues will be mitigated (see mitigation measures below)
    - Potential impacts with accidents and malfunctions will be mitigated (see mitigation measures below)

- Vegetation clearing (terrestrial)
    - The new channel will have a buffer of at least 15 m on either side.
    - There will be no use of herbicides
    - Potential impacts with erosion and sediment issues will be mitigated (see mitigation measures below)

- Placement of material or structures in water (Temporary – cofferdams to isolate work area. Permanent – rip rap)
    - Cofferdams would be installed during in-water timing window and would block off the entire channel .
    - Either the existing channel would be left in place, or a flow bypass will be included around the work area. This will be sufficient to maintain upstream and downstream water levels at the time of construction. It will be released in such a way as to prevent erosion or the transportation of suspended sediments downstream. DFO's end of pipe standard code of practice will be followed for the intake.
    - It is anticipated that erosion control in the form of rip rap will be required at the culverts. The rip rap is to be installed in a manner that does not prevent fish passage. Rip rap will provide substrate for benthic invertebrates and fish cover. It is to be free of fines. The footprint of the rip rap is not currently known.

- Change in timing, duration, and frequency of flow (Temporary cofferdams)
    - This watercourse was dry during the summer as such a flow bypass will be required if works are completed prior to the channel drying out (naturally) that construction season. See above.
    - A fish salvage will take place within the isolated area.
    - The duration of the temporary works is short (one construction season)

- Fish passage (Temporary: prevented by cofferdams; Permanent: new culverts).
    - Work will take place during normal in-water period.
    - At this time, the downstream culverts proposed would restrict fish passage based on their lengths and the estimated velocities at a 1:2 year flow. It is anticipated, that the velocities will not be a barrier at lower flows. It was noted that there was

not a large volume of water my mid-May 2020. As such, fish would have access to the upstream habitat during certain times of the year. The design is still being reviewed and will be discussed with DFO.

- Excavation (for new channels)
  - The excavation works are associated with the construction of the new channel alignments.
  - Potential impacts due to the exposure of soils along the banks will be mitigated by stabilizing the banks prior to commissioning the new channels (<20% bare soil).

- Dredging (at tie-ins of the new channel)
  - Minor dredging will be required at the tie-ins of the new alignments to the existing. The dredging will ensure that the final channel bed and culvert inclines match downstream and upstream elevations.
  - Work will take place in isolation to minimize suspension of sediments.
  - During summer water levels, the channels were dry.
  - Potential impacts due to erosion and sediment concerns will be mitigated.

- Grading
  - Potential impacts due to the exposure of soils and bank stability will be mitigated through isolated work areas, erosion and sediment control measures and stabilizing banks once completed and prior to commissioning.

These works and activities have the potential to cause impacts to fish or fish habitat through:

- Increased erosion potential of slopes.
- Sedimentation and/or suspension of fines within watercourse.
- Change in food supply.
- Change in in-water habitat because of the introduction of rip rap within the high-water mark.
- Changes in timing duration, or frequency of flow because of construction of cofferdams during in-water period.
- In-stream structure (culverts, rip rap and temporary isolation of work area) affecting fish movement.
- Displacement or stranding of fish during isolation for construction.
- Contamination of water (i.e. accidents or malfunctions of equipment in or near water, impacts to water quality from turbidity).
- Impacts to fish passage during 1:2 year levels (baseflows not available at this time).

Based on the characteristics of the channel and the proposed work activities this proposal could result in negative direct or indirect impacts to a local area. These would be short term (temporary work area during construction), medium term (rip rap) and permanent (impacts to fish passage). Without mitigation, these impacts would be moderate to major.

Preliminary Mitigation Measures

Planning

- Follow the DFO guidelines in their Standard Code of Practice for temporary cofferdams and end-of-pipe.
- Construct and stabilize the new channels prior to the decommissioning of the existing channels.
- Site instruction will be provided to contractor to highlight that the channel provides fish habitat.
- Clearly demarcate work areas within the riparian habitat in the field.
- All in-water works to occur during the in-water work window (July 1 to March 14, inclusive).
- Erosion and sediment control measures will be installed prior to the clearing of vegetation within 30 m of a watercourse.
- No in-water work will begin until the area has been isolated with measures deemed appropriate by the contract administrator or proponent. These measures must also be sufficient to allow for dewatering and a fish salvage (see below) and to prevent fish from entering the work area.
- The work in the channel is to be completed in the dry.
- Suspend activities that cause muddy environments during periods of heavy rains.
- Minimize clearing of woody vegetation (few woody individuals are present). Where possible, cut the shrubs down (instead of grubbing).
- All or portions of the riparian corridor will be naturalized with native vegetation.

Erosion and Sediment Control

- An erosion and sediment control plan will be developed by contractor and implemented prior to any work within 30 m of the watercourse.
  - Provide regular maintenance to the erosion and sediment control measures during construction. Contractor shall be responsible for ensuring that the erosion and sediment control measures are maintained and will monitor the water clarity downstream of the work site throughout the day and during rain events. Water quality is to meet the *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. Monitoring for visible plumes outside of the work area is to be undertaken.

- At a minimum, the erosion and sediment control plan will include the installation of sediment fencing along the top of banks where vegetation clearing and/or soil disturbance will occur within 30 m of any channel prior to the removal of vegetation. And the installation of a turbidity curtain downstream.
- Additional materials (*i.e.* rip rap, filter cloth and silt fencing) will be readily available in case they are needed promptly for erosion and/or sediment control.

- Construction of cofferdam dams can create a plume. As such, appropriate measures should be put in place such as placing rock for the cofferdam within a turbidity curtain that isolates just the area where the cofferdam is being built.
- Note that the meter bags can often split when being removed as such it is preferred that gravel be used for metre bags.
- Any stockpiles of soil or fill material will be stored as far as possible from the channel and protected by silt fencing (minimum 30 m).
- The erosion control measures will not be removed until the bank is stabilized (<20% bare soil).
- All equipment working within 30 m of the water will be well maintained, clean and free of leaks.
- The work within the channels will be completed in the dry.
- Water from dewatering will be treated prior to returning it to the system (i.e. straw bale settling ponds covered by geotextiles or sediment sock on the end of hose and situated on top of well vegetated slopes).
- Water from bypass will be released in such a way as to prevent erosion or the transportation of suspended sediments downstream. Note that if this water is taken from upstream of the work area and is the same quality as the receiving waterbody on the downstream side, then it can be released directly into the system (see additional notes under fish and fish habitat protection)
- Where banks/riparian area (area within 30 m of channel) have been stabilized by seeding and/or planting, monitor the revegetation to ensure that the vegetation becomes fully established.
- Any riprap will consist of clean rock free of fines.

Fish and Fish Habitat Protection

- All material introduced for the temporary measures will be fully removed from the water at the completion of the work.
- The methods, sequencing and cofferdam design need to be determined once the project proceeds further in design.
- Fish (and other aquatic fauna) will be salvaged from the isolated channel by a qualified biologist/technologist. The salvage will need to be repeated if the work area becomes flooded.

- Dewatering of water in areas that may contain fish will be completed from hoses placed in fish baskets or covered with clean wash rock or other such method to prevent fish impingement and entrainment. Note that the screens that come on the hoses are not enough to prevent fish from harm.
- Monitor the end of pump frequently for ensure that all fish protection measures are functioning.
- Minimize the size of temporary in-water work areas.
- Bypass flow will be required. The amount of flow bypass should be sufficient to maintain the habitats upstream and downstream of the site (i.e. similar to what would be passed through the culvert). The DFO Standard Code of Practice for End-of-Pipe should be followed to ensure that fish do not become impinged or entrained.
- Installation of rock protection will not impede fish from passing through culverts.

Contaminant and Spill Management

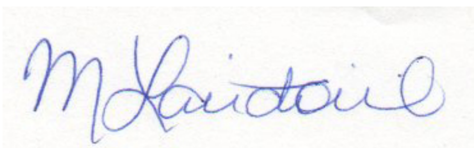
- All equipment working in or near the water should be well maintained, clean and free of leaks. Maintenance on construction equipment such as refueling, oil changes or lubrication would only be permitted in designated area located at a minimum of 30 m from the shoreline in an area where sediment erosion control measures and all precautions have been made to prevent oil, grease, antifreeze or other materials from inadvertently entering the ground or the surface water flow.
- Emergency spill kits will be located on site. The crew will be fully trained on the use of clean-up materials to minimize impacts of any accidental spills. The area would be monitored for leakage and in the unlikely event of a minor spillage the project manager would halt the activity and corrective measures would be implemented.
- If a spill occurs:
    - Stop all work
    - Spills are to be immediately reported to the MOECC Spills Action Centre (1800 268-6060). Note that under the *Fisheries Act* deleterious substance includes sediments.
    - Clean-up measures are to be appropriate and are not to result in further harm to fish/fish habitat.
    - Sediment-laden water will be removed and disposed of appropriately.
- No construction debris will be allowed to enter the watercourse.
- Following the completion of construction, all construction materials will be removed from site.

Residual/Net Impact

The proposed works and design have not been finalized. At this time, the proponent would like to initiate discussions with DFO for the overall Site and then for the Phase A. It is acknowledged, that the current culvert designs may pose an issue for fish passage during 1:2 flows.

Should you have any questions or comments, please contact the undersigned.

Sincerely,



Michelle Lavictoire, Biologist

6.0 REFERENCES

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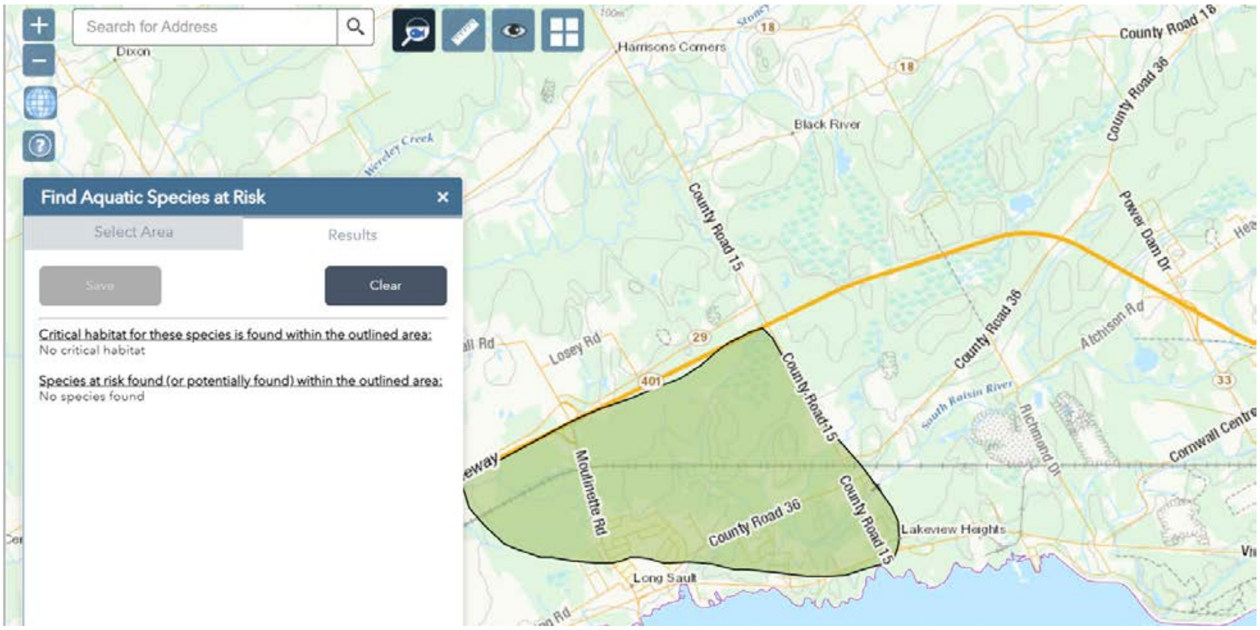
Appendix A: DFO SAR Mapping (NASAR)



Appendix B: Summary of Realignment Information (from Crozier Consulting Engineers)

Please see below for the preliminary cross section length, width, and areas for the proposed Watercourse E alignment. The stations included in the table below correspond with the Watercourse E alignment shown in the figure circulated on Wednesday. Please note that the information shown below is preliminary and is subject to change during the detailed channel design process in the future.

Cross Section Geometry	Start Station	End Station	Length (m)	Wetted Width (m)	Area (m^2)
3:1	0+000	0+045	45	3.3	148.5
1:10	0+045	0+090	45	4.65	209.3
3:1	0+090	0+110	20	3.3	66.0
1:10	0+110	0+130	20	4.65	93.0
3:1	0+130	0+150	20	3.3	66.0
1:10	0+150	0+210	60	4.65	279.0
3:1	0+210	0+245	35	3.3	115.5
1:10	0+245	0+290	45	4.65	209.3
3:1	0+290	0+350.68	60.68	3.3	200.2
Culvert #1	0+350.68	0+382.79	32.11	12.2	391.7
3:1	0+382.79	0+415	32.21	3.84	123.7
1:10	0+415	0+420	5	5.62	28.1
3:1	0+420	0+460	40	3.84	153.6
1:10	0+460	0+490	30	5.62	168.6
3:1	0+490	0+555	65	3.84	249.6
1:10	0+555	0+580	25	5.62	140.5
3:1	0+580	0+625	45	3.84	172.8
1:10	0+625	0+670	45	5.62	252.9
3:1	0+670	0+780	110	3.84	422.4
1:10	0+780	0+788.68	8.68	5.62	48.8
Culvert #2	0+788.68	0+811.49	22.81	12.2	278.3
3:1	0+811.49	0+827.94	16.45	3.84	63.2
Culvert #3	0+827.94	0+878.05	50.11	12.2	611.3
3:1	0+878.05	0+891.5	13.45	3.84	51.6
Culvert #4	0+891.5	0+922.81	31.31	12.2	382.0
3:1	0+922.81	0+944	21.19	3.84	81.4

Ainley Group
1-50 Grant Timmins Drive
Kingston, Ontario
K7M 8N2

Log of Test Pit: TP7

Project No.: 21501-1

Project: Proposed Rail Yard

Client: Willis Kerr Contracting Ltd.

Location: Long Sault, ON

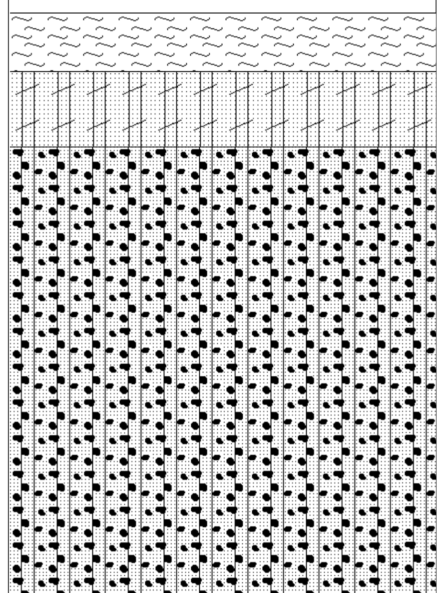
Ground Elevation (masl): 50.6

Water Elevation (masl): NA

Depth to Water (m): NA

SUBSURFACE PROFILE			SAMPLE		Groundwater	Symbol Log
Depth (ft / m)	Elevation	Description	Number	Type		
0 ft / 0 m	0.00	Ground Surface				
	0.35	***Topsoil*** Silty sand some clay and rootlets, dark brown.				
	0.80	***Silty Sand*** Silty sand some clay, trace of gravel, loose, brown.				
	3.50	***Till*** Silty sand some gravel, clay, cobbles and boulders, compact becoming very dense, brown.				
		End of Test Pit at 3.5 m below existing site grades. Note: Groundwater infiltration was not encountered during the test pit excavation.				

Depth scale: ft 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20; m 0, 2, 4, 6



Excavated By: Willis Kerr Contracting Ltd.

Excavation Method: 324E Excavator

Excavation Date: January 6-7, 2021

Project Engineer: Bill Mclatchie, P.Eng

Project Technician: Josh Charlton, C.Tech

Sheet: 1 of 1

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Preliminary Geotechnical Investigation
Prop. Commercial Development, County Road 15
Long Sault, Ontario

DATUM Geodetic

FILE NO. PG5376

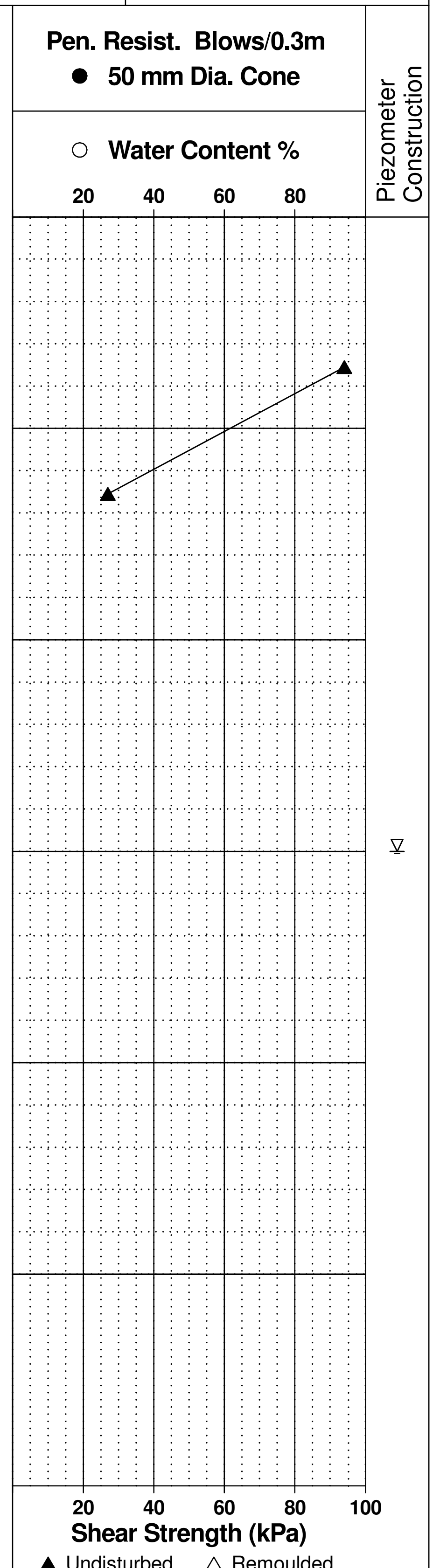
REMARKS

HOLE NO. TP 7

BORINGS BY Excavator

DATE August 5, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	75.70
TOPSOIL 0.40		G	1				
Stiff, brown **SILTY CLAY,** trace sand		G	2			1	74.70
- firm and grey by 1.3m depth 2.60		G	3			2	73.70
GLACIAL TILL: Grey silty clay, trace sand, gravel, cobbles and boulders		G	4			3	72.70
						4	71.70
5.00		G	5			5	70.70
End of Test Pit							
(Groundwater infiltration at 3.0m depth)							



patersongroup Consulting Engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Preliminary Geotechnical Investigation
Prop. Commercial Development, County Road 15
Long Sault, Ontario

DATUM Geodetic
REMARKS
BORINGS BY Excavator
DATE August 6, 2020

FILE NO. PG5376
HOLE NO. TP17

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	85.23		
TOPSOIL (to 0.40)		G	1						
		G	2			1	84.23		
GLACIAL TILL: Brown silty sand, trace clay, gravel, cobbles and boulders (to 3.60)						2	83.23		
						3	82.23		
		G	3						
End of Test Pit Practical refusal to excavation at 3.60m depth (TP dry upon completion)									

Shear Strength (kPa): 20 40 60 80 100
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Preliminary Geotechnical Investigation
Prop. Commercial Development, County Road 15
Long Sault, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE August 7, 2020

FILE NO. PG5376

HOLE NO. TP19

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	79.81		
TOPSOIL (to 0.40)		G	1						
GLACIAL TILL: Brown silty sand, trace gravel, cobbles and boulders		G	2			1	78.81		
						2	77.81		
		G	3			3	76.81		
						4	75.81		
(to 5.00) End of Test Pit						5	74.81		
(TP dry upon completion)									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Preliminary Geotechnical Investigation
Prop. Commercial Development, County Road 15
Long Sault, Ontario

DATUM Geodetic

FILE NO. PG5376

REMARKS

HOLE NO. TP23

BORINGS BY Excavator

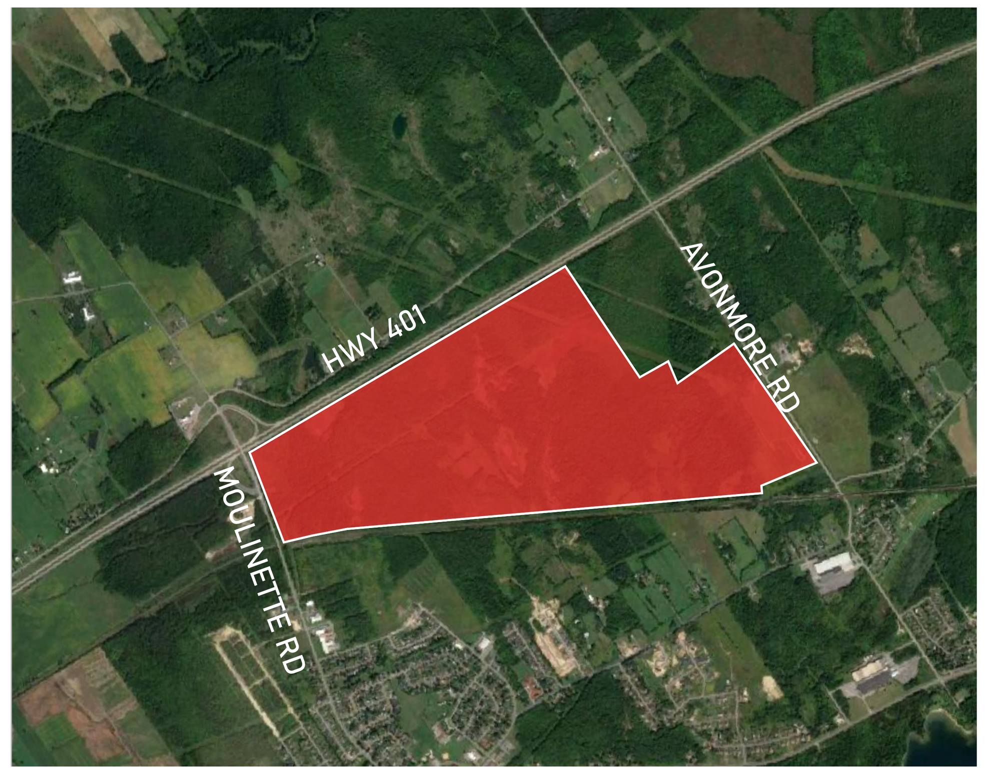
DATE August 7, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	83.39		
TOPSOIL (to 0.40)		G	1						
GLACIAL TILL: Brown silty sand, trace gravel, cobbles and boulders (to 3.10)		G	2			1	82.39		
						2	81.39		
						3	80.39		
End of Test Pit Practical refusal to excavation at 3.10m depth. (TP dry upon completion)									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

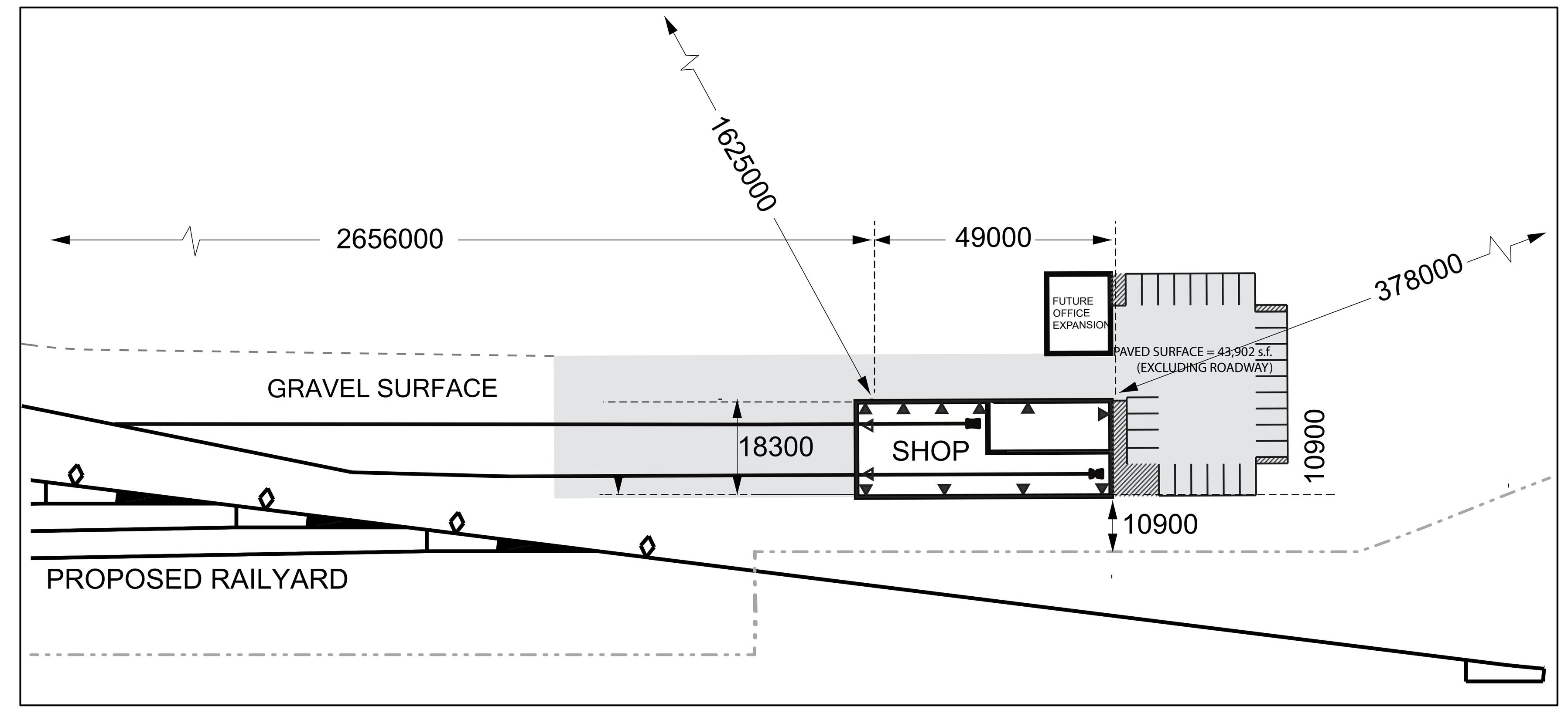
Development Standards		
i.) Development on private services		
	Required	Provided
Lot Area (minimum)	1 ha (2.5 acres)	271.6 ha
Lot Frontage (minimum)	60 m (196.85 ft.)	(Cty 15) 824 m (Cty 35) 523 m (401) 2,100 m
Yard Requirements (minimum)		
Front	12 m (39.37 ft.)	378 m
Rear	12 m (39.37 ft.)	2656 m
Exterior Side	12 m (39.37 ft.)	1625 m
Interior Side	7.5 m (24.61 ft.)	10.9 m
Building Height (maximum)	30 m (98.43 ft.)	8.8 m (mean)
Accessory Building	12 m (39.37 ft.)	0
Lot Coverage (maximum)	20%	<0.5%
Parking Requirements (spaces)	1 per 80 s.m. GFA (11 Spaces)	27 Spaces (1 BF Incl.)
Parking Space Dimensions: 6.1 m (L) x 3.1 m (W) Parking Aisle Width: 9.2 m (W)		



1 A01 LOCATION PLAN SCALE N.T.S.

SITE PLAN LEGEND

ICON	DESCRIPTION
	Paved Roadway
	Proposed Buildings
	Proposed Rail Line



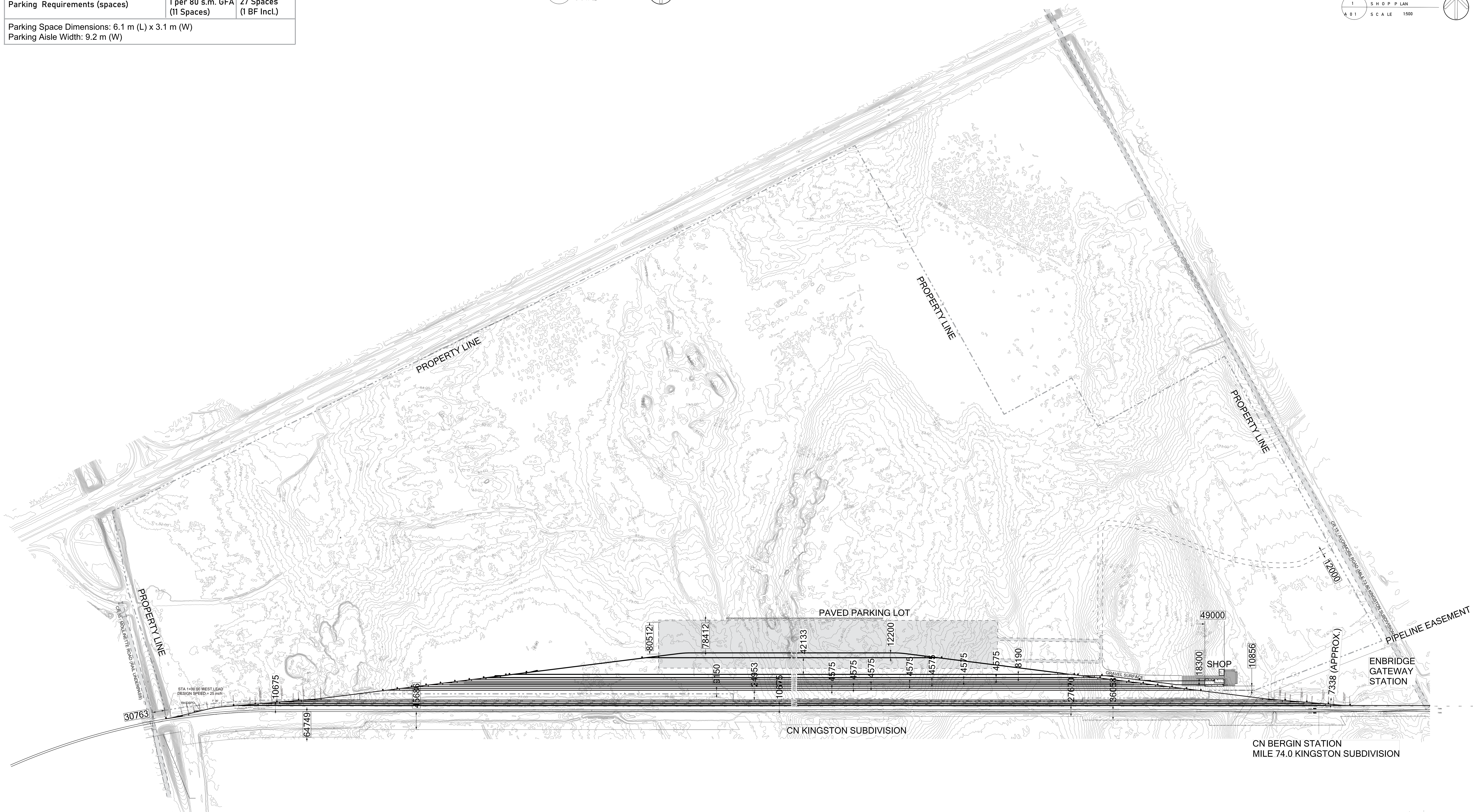
1 A01 SHOP PLAN SCALE 1:500

NOTES:

Contractor shall check and verify all dimensions on site and report any discrepancies to the Architect before proceeding.

GENERAL SITE PLAN NOTES:

1. Exterior site lighting shall be directed onto the site



1 A01 SITE PLAN SCALE 1:5000

0 25 50 100 200 250 300 350 400 450 500 550

SHEET SIZE: ARCH D (24"x36")

no.	revision	date
01	ISSUED FOR COORDINATION	

north nord

Re:

Re:PUBLIC URBANISM
PHONE 514.503.2614
EMAIL hicks@republicurbanism.com

detail no. 1 détail no.
sheet no. A1 feuille no.

project / projet: LONG SAULT RAILYARDS SITE PLAN

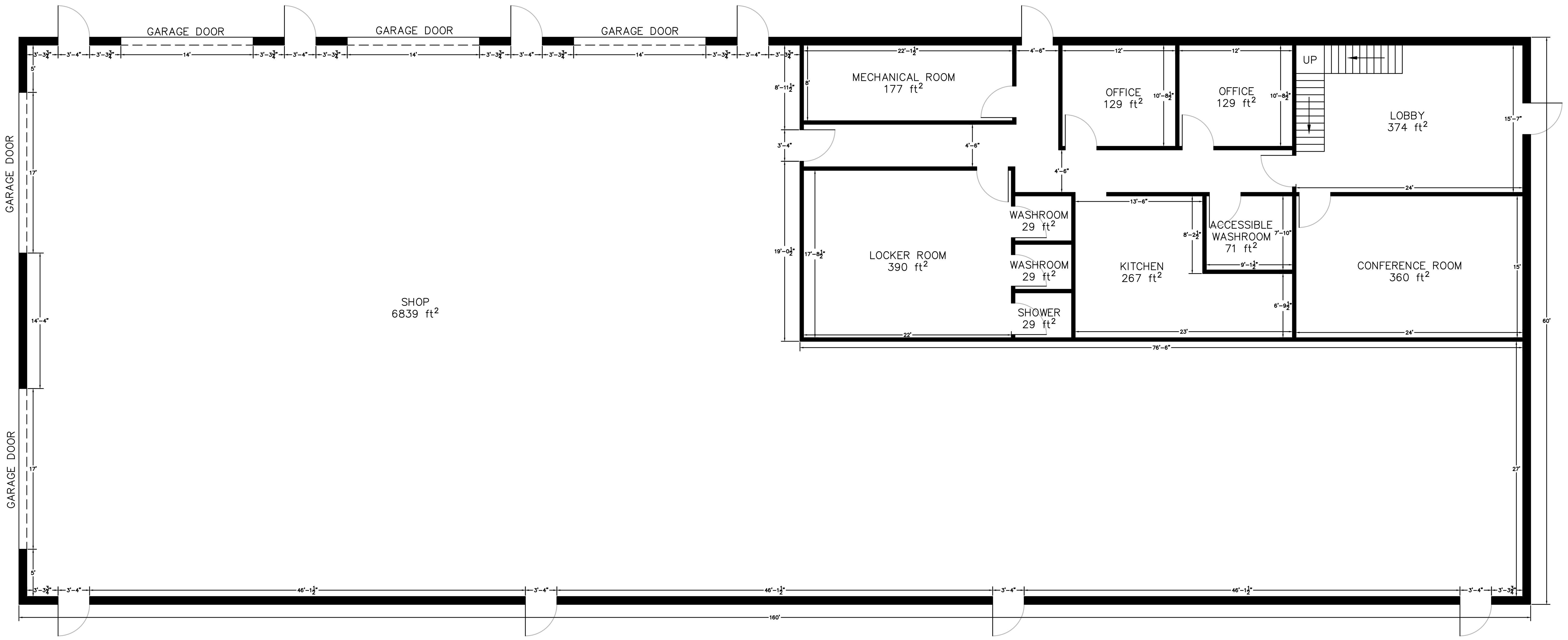
LONG SAULT, ON

designed by / conçu par	JM	approved by / approuvé par	PH
drawn by / dessiné par	MB	project no. / no. du projet	
date	2021/09/20	scale	as noted

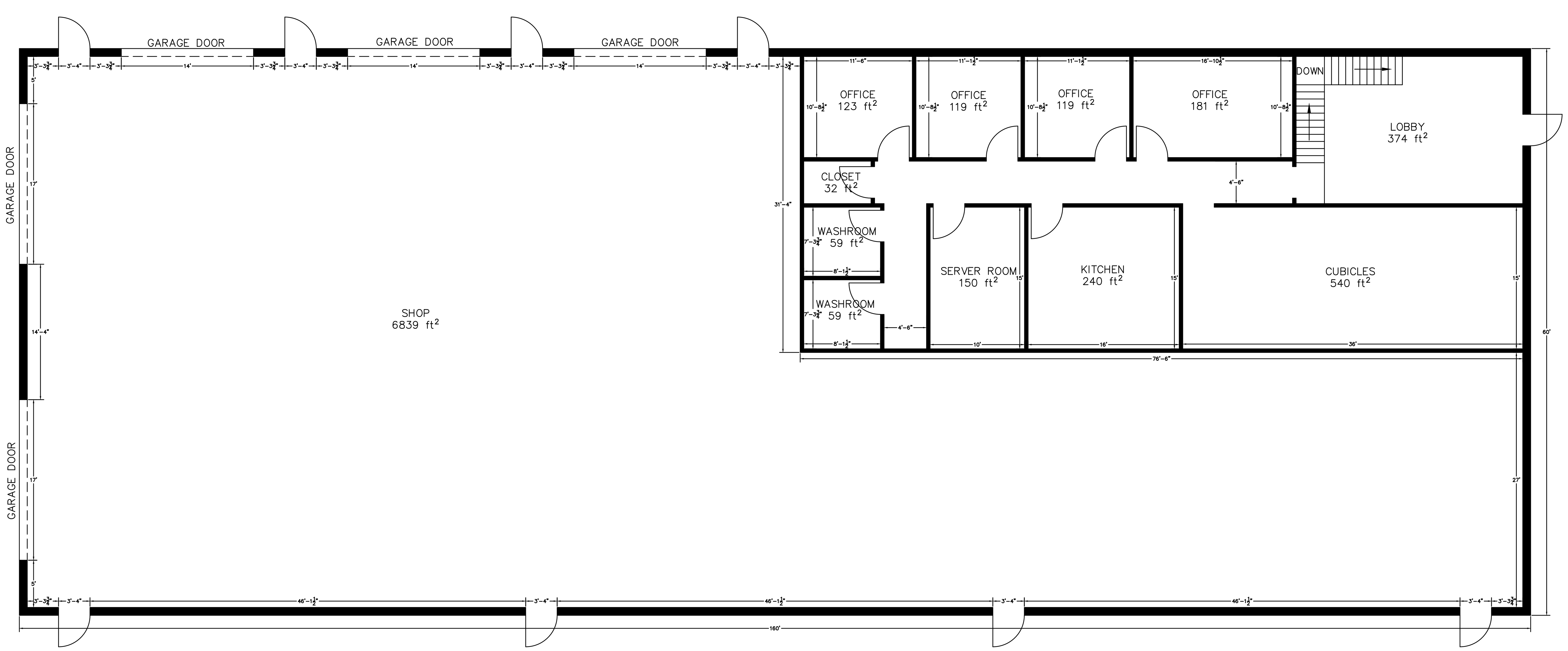
drawing / dessin: SITE PLAN

revision / révision: 02 sheet no. / no. de la feuille: A 01

GROUND FLOOR



SECOND FLOOR (OFFICE ONLY)



SHEET SIZE: ARCH D (24"x36")

NOTES:

Contractor shall check and verify all dimensions on site and report any discrepancies to the Architect before proceeding.

GENERAL SITE PLAN NOTES:

no.	revision	date
01	ISSUED FOR COORDINATION	

north nord

Re:PUBLIC URBANISM
PHONE 514.503.2614
EMAIL hicks@republicurbanism.com

detail no. 1 détail no.
sheet no. A2 feuille no.

project / projet: LONG SAULT RAILYARDS SITE PLAN

LONG SAULT, ON

designed by / conçu par	KJ (CREWS)	approved by / approuvé par	PH
drawn by / dessiné par	KJ (CREWS)	project no. / no. du projet	
date	2021/10/26	scale	as noted

drawing / dessin: BUILDING DETAIL

revision / révision: 01 sheet no. / no. de la feuille: A02

APPENDIX B

Water Demand Calculations

B1 – Fire Protection Communication
B2 – Water Demand Calculations
B3 – Ontario Building Code: Fire Flow

Sehrish Ahmad

From:	Nick Giroux <Nick.Giroux@crewsrail.com>
Sent:	October 19, 2021 3:43 PM
To:	Sehrish Ahmad; Kyle Jones
Cc:	Katherine Rentsch; Jennifer Murray
Subject:	RE: Long Sault Phase A - Fire Protection Requirements (1909-5629)
Follow Up Flag:	Follow up
Flag Status:	Completed

Good afternoon Sehrish,

Approximate SF of the shop building is 9600 ft^2 (building footprint). The floor plan is currently under internal review; we will forward as soon as it is finalized. As for OBC classification, the shop building at our Johnstown site falls under Group F, Division 2 (Medium-hazard industrial occupancy). Occupancy type should be the same for the shop building at the Long Sault site.

Regards,

Nick Giroux
Operations/Logistics Support
T: (613) 258-6919 Ext. 114
C: (613) 298-0143
Email: nick.giroux@crewsrail.com

CREWS Canadian Rail Equipment Works & Services Inc.

From: Sehrish Ahmad <sahmad@cfcrozier.ca>
Sent: October 19, 2021 9:17 AM
To: Kyle Jones <Kyle.Jones@crewsrail.com>; Nick Giroux <Nick.Giroux@crewsrail.com>
Cc: Katherine Rentsch <krentsch@cfcrozier.ca>; Jennifer Murray <jmurray@ave31.com>
Subject: RE: Long Sault Phase A - Fire Protection Requirements (1909-5629)

Good Morning Kyle and Nick,

I’m emailing to follow up this email chain regarding fire protection requirements. As requested previously, please share further details on the shop building (i.e. building classification, and square footage).

Thank you,

Sehrish

Sehrish Ahmad | Engineering Intern
2800 High Point Drive, Suite 100 | Milton, ON L9T 6P4
T: 905.875.0026

Crozier Connections:

Read our latest news and announcements here.

From: Jennifer Murray <jmurray@ave31.com>
Sent: October 13, 2021 11:12 AM
To: Kyle Jones <Kyle.Jones@crewsrail.com>; Nick Giroux <Nick.Giroux@crewsrail.com>
Cc: Sehrish Ahmad <sahmad@cfcrozier.ca>
Subject: FW: Long Sault Phase A - Fire Protection Requirements (1909-5629)

Kyle / Nick,

See below from the Township. Please forward any detailed information about the SF of the building, etc. so we can confirm fire requirements.

We can start with a 'draft' building design to start and we can update as we go through Site Plan Approval to be the actual building design.

Jennifer Murray, P. Eng, MBA
Vice President, Land Development
Vice-présidente, Développment de terrains

Avenue 31 Capital Inc.
801-250 City Centre
Ottawa, ON
K1R 6K7

E jmurray@ave31.com
C 613-799-2422

From: Karl Doyle <karl@southstormont.ca>
Sent: October 13, 2021 10:43 AM
To: Sehrish Ahmad <sahmad@cfcrozier.ca>; Ross Gellately <ross@southstormont.ca>; Hilton Cryderman <hilton@southstormont.ca>
Cc: Brendan Walton <bwalton@cfcrozier.ca>; Katherine Rentsch <krentsch@cfcrozier.ca>; Jennifer Murray <jmurray@ave31.com>
Subject: RE: Long Sault Phase A - Fire Protection Requirements (1909-5629)

Hi Sehrish,

Did you provide design specifics of the proposed build so we can evaluate?

Regards,

Karl Doyle
Director of Planning/Building

Come see for yourself!
Township of South Stormont
2 Mille Roches Rd., P.O. Box 84
Long Sault, ON K0C 1P0
Email: karl@southstormont.ca
Office: 613-534-8889 ext. 217
Fax: 613-534-2280

Like Us On Facebook

From: Sehrish Ahmad <sahmad@cfcrozier.ca>
Sent: October 13, 2021 10:31 AM
To: Ross Gellately <ross@southstormont.ca>
Cc: Karl Doyle <karl@southstormont.ca>; Brendan Walton <bwalton@cfcrozier.ca>; Katherine Rentsch <krentsch@cfcrozier.ca>; Jennifer Murray <jmurray@ave31.com>
Subject: RE: Long Sault Phase A - Fire Protection Requirements (1909-5629)

Good Morning Ross and Karl,

I hope you are both doing well and enjoyed the long weekend! I am emailing to follow up on my previous request regarding fire suppression requirements for the shop building which is proposed as part of the Phase A works for the railyard.

We are considering a typical fire cistern complete with a stand pipe to provide fire protection for the proposed shop building. The fire cistern would be sized based on the *Office of the Fire Marshal Fire Protection Water Supply Guideline for Part 3 in the Ontario Building Code*. The proposed building will be a pre-fabricated steel building and will be used for office space and equipment storage.

Please advise whether this will be acceptable for fire flow suppression for the shop building.

Let me know if you need anything else from us.

Kind Regards,

Sehrish

Sehrish Ahmad | Engineering Intern
2800 High Point Drive, Suite 100 | Milton, ON L9T 6P4
T: 905.875.0026

Crozier Connections:

Read our latest news and announcements here.

From: Sehrish Ahmad
Sent: October 7, 2021 1:52 PM
To: Ross Gellately <ross@southstormont.ca>
Cc: Karl Doyle <karl@southstormont.ca>; Brendan Walton <bwalton@cfcrozier.ca>; Katherine Rentsch <krentsch@cfcrozier.ca>; Jennifer Murray <jmurray@ave31.com>
Subject: Long Sault Phase A - Fire Protection Requirements (1909-5629)

Good Afternoon Ross,

We are working on Phase A of the Long Sault Logistics Village and are reviewing the fire suppression requirements ahead of the Site Plan submission. We require some input from the Township as Phase A will be complete with a small shop building which will be used for office space and equipment storage. Kindly advise on the Town's fire protection requirements for the building.

Let me know if you have any questions or concerns.

Kind Regards,

Sehrish

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Project: Phase A - Long Sault
Project No.: 1909-5629
Date: 2021-10-20
Designed By: SA
Checked By: KR

WATER DEMAND CALCULATIONS
LONG SAULT LOGISTICS VILLAGE – PHASE A
TOWNSHIP OF SOUTH STORMONT, UNITED COUNTIES OF SOUTH STORMONT, DUNDAS & GLENGARRY

			References
Phase A Site Area:	**35.6**	**ha**	The Phase A Site Area is approximated based on the Site Plan received from Republic Urbanism dated July 17, 2021 and the proposed shop GFA is approximated based on correspondance with CREWS on October 19, 2021.
Proposed Building GFA:	**861**	**m^2**	
Occupancy:	Industrial		The Design Population is based on input from the CREWS from the teleconferene dated September 22, 2021.
Design Population:	**8**	**employee/ 8hr Shift**	
Average Dailyy Demand:	35	m^3/ha/day	Average Day Demand for Light Industrial from Section 3.4.4 from the Design Guidelines for Drinking Water Systems (MOE, 2008)
Max Day Factor:	2.75		Peak Hour Factor and Maximum Day Factor based on Table 3-1 (500-1000) of Design Guidelines for Drinking Water Systems (MOE, 2008)
Peak Hour Factor:	4.13		
Average Day Flow:	3,010	L/day	
	0.03	**L/s**	
Maximum Day Flow:	8,278	L/day	
	0.10	**L/s**	
Peak hour flow:	12,430	L/day	
	0.14	**L/s**	

Note: A future office expansion area is shown on the Site Plan received on September 14, 2021. The population and ground floor area of the office expansion is unknown at this time. As such, the future office expansion has not been included in the water demand calculations. A separate application will be required for the future office expansion.

PROJECT NAME: Phase A - Shop Long Sault Logistics Village **October 20, 2021**

Fire Protection Volume Calculation

CFCA File: 1909-5629 **Page 1**

Fire Protection Water Supply Guideline
Part 3 of the Ontario Building Code (2006)

$$Q = KVS_{TOT}$$

Q = minimum supply of water in litres (L)
K = water supply coefficient
V = total building volume in cubic metres
S_{TOT} = total of spatial coefficient values from property line exposures on all sides

K =	31.0	Group F, Division 3 building with combustible construction conforming to OBC 3.2.2 (Table 1)	Spacial Coefficients [1]	
	861	m^2, floor area	S1	0
	4.0	m, assumed height of ceiling	S2	0
V =	3444	m^3, total building volume	S3	0
S_{TOT} =	1	S_{TOT} = 1 + Sum (Spacial Coefficients), Need Not Exceed 2.0	S4	0
			Sum	0

Q = 106764 L

Based on ranges listed in Table 2, the required minimum water supply flow rate is **2700 L/min**
Assumptions used above in calculations are to be confirmed by the Architect and Mechanical Engineer.
45 L/s

Notes:
1 Spacial coefficients based on Figure 1 found on Page 1. Each spacial coefficient represents the exposure distance from other buildings on the north, east, south, and west sides of the building.
2 The building area and classification is based on correspondance with CREWS dated October 19, 2021.

Table 2

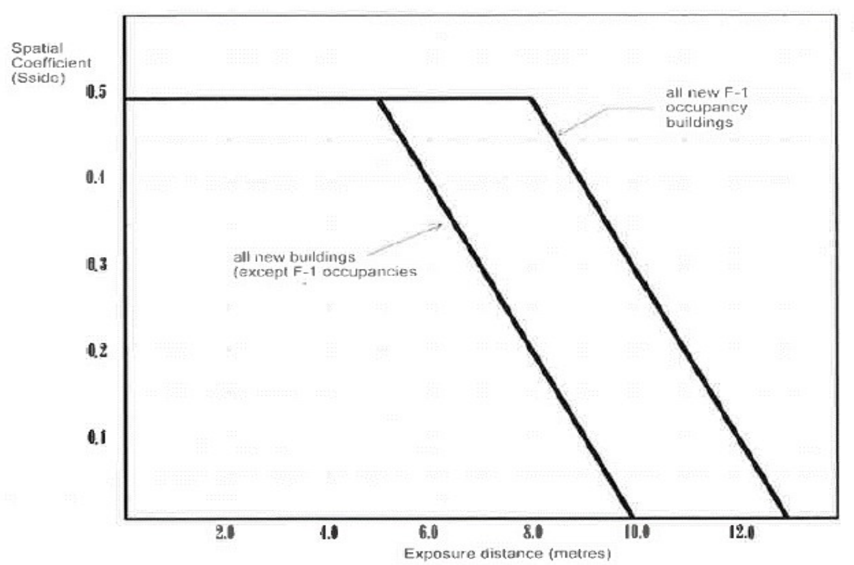
Q	F (L/min)
<=108000	2700
108,000 to 135,000	3600
135,000 to 162,000	4500
162,000 to 190,000	5400
190,000 to 270,000	6300
270,000+	9000

Table 1

Water Supply Coefficient - K

Type of Construction	Classification by Group or Division in Accordance with Table 3.1.2.1. of the Building Code				
	A-2 B-1 B-2 B-3 C D	A-4 F-3	A-1 A-3	E F-2	F-1
Building is of noncombustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2., including loadbearing walls, columns and arches.	10	12	14	17	23
Building is of noncombustible construction or of heavy timber construction conforming to Article 3.1.4.6. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	16	19	22	27	37
Building is of combustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2., including loadbearing walls, columns and arches. Noncombustible construction may be used in lieu of fire-resistance rating where permitted in Subsection 3.2.2.	18	22	25	31	41
Building is of combustible construction. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	23	28	32	39	53
Column 1	2	3	4	5	6

Figure 1



APPENDIX C

Hydrologic Modelling Parameters

Project Name:	Long Sault
Project Number:	1909-5629
Date:	2021-10-18
By:	AG
Check By:	JW

D.A. NAME **102A**
D.A. AREA (ha) **2.25**

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment 102A

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	36%	0.80
D	-	D	63%	1.41
N = BD	-	BD	2%	0.04
Total Area				2.25

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	0	98	0.0	98	0	98	0	0
- - D		98	0	98	0	98	0.0	98	0	98	0	0
- - BD		98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area			0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B	0.38	60			0.43	50					0.81	44.30
- - D	0.09	79			1.32	50					1.41	73.11
- - BD	0.01	69.5			0.03	50					0.03	1.60
Subtotal Area	2.25											

Composite Area Calculations	Total Pervious Area	2.25
	Total Impervious Area	0
	% Impervious	0.00%
	Composite Curve Number	52.9
	Total Area Check	2.25

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
				B		D		BD				
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	4.67	0.475	2.21825	0.25	0.80	0.35	1.41	0.30	0.04			0.7055
Meadow		0	0									0
Wetland		1.775	8.28925									0
Lawn		0	0									0
Cultivated		0.00	0									0.00
Impervious		0	0									0
Composite IA		2.25	4.67	Composite Runoff Coefficient								0.31356

*Township of South Stormont recommends IA of 4.67 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	575	4	0.7%	NA	Na	NA	NA	NA	0.54	0.36	1.15	0.77

Appropriate calculated time to peak:	0.77	Appropriate Method:	Airport

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name:	Long Sault
Project Number:	1909-5629
Date:	2021-10-18
By:	AG
Check By:	JW

D.A. NAME	**102F**
D.A. AREA (ha)	**2.15**

Hydrologic Parameters: CALIB STANHYD Command
Post Development Drainage Area: Catchment 102F

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	34%	0.74
D	-	D	66%	1.41
N = BD	-	BD	0%	0.00
Total Area				2.15

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	0.56	98	0.0	98	0	98	0.56	54.88
- - D		98	0	98	1.28	98	0.0	98	0	98	1.28	125.44
- - BD		98	0	98	0.00	98	0.0	98	0	98	0	0
Subtotal Area			0		1.84		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B							0.18	69			0.18	12.42
- - D							0.13	84			0.13	10.92
- - BD											0.00	0.00
Subtotal Area							0.31					

	Composite Area Calculations	Total Pervious Area	0.31	
		Total Impervious Area	1.84	
		% Impervious	85.58%	* 75%
		Composite Curve Number	94.7	
		Total Area Check	2.15	

*Note: Assumed that area is compacted gravel. Percent imperviousness reduced to 75%.

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	B		D		BD				
				RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	1.57	0	0	0.90	0.74	0.90	1.41	0.90	0.00			1.935
Meadow		0	0									0
Wetland		0	0									0
Lawn		0.31	0.4867									0
Cultivated		0.00	0									0.00
Impervious		1.84	2.8888									0
Composite IA*		2.15	0	Composite Runoff Coefficient								0.9

*Township of South Stormont recommends IA of 1.57 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated			NA				NA		NA	NA	NA	NA

Appropriate calculated time to	NA	Appropriate Method:	Bransby

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

Project Name:	Long Sault
Project Number:	1909-5629
Date:	2021-10-18
By:	AG
Check By:	JW

D.A. NAME	**105A**
D.A. AREA (ha)	**4.53**

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment 105A

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	95%	4.31
N = BD	-	BD	5%	0.22
	-		0%	
Total Area				4.53

Impervious Landuses Present:	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B		98	0	98	0	98	0.0	98	0	98	0	0
- - BD		98	0	98	0	98	0.0	98	0	98	0	0
- -		98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area			0		0		0.0		0			

Pervious Landuses Present:	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	4.01	60			0.30	50					4.31	255.60
- - BD	0.15	69.5			0.07	50					0.22	13.93
	0.00										0.00	0.00
Subtotal Area	4.16				0.37							

Composite Area Calculations	Total Pervious Area	4.53
	Total Impervious Area	0
	% Impervious	0.00%
	Composite Curve Number	59.5
	Total Area Check	4.53

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
				B		N = BD		D				
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	4.67	4.16	19.4272	0.25	4.31	0.35	0.22	0.30	0.00			1.15275
Meadow		0	0									0
Wetland		0.37	1.7279									0
Lawn		0	0									0
Cultivated		0	0									0.00
Impervious		0	0									0
Composite IA		4.53	4.67	Composite Runoff Coefficient								0.25447

*Township of South Stormont recommends IA of 4.67 for pervious areas.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	Total Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	546.3	11	2.0%	NA	NA	NA	NA	NA	0.39	0.26	0.85	0.57

Appropriate calculated time to peak:	0.57	Appropriate Method:	Airport

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

Crozier & Associates
Consulting Engineers

Project Name: Long Sault
Project Number: 1909-5629
Date: 2021-10-18
By: AG
Check By: JW

D.A. NAME **105F**
D.A. AREA (ha) **5.37**

Hydrologic Parameters: CALIB STANHYD Command
Post Development Drainage Area: Catchment 105F

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	95%	5.12
N = BD	-	BD	5%	0.25
	-			
Total Area				5.37

Impervious Landuses Present:	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	3.87	98	0.0	98	0	98	3.87	379.26
- - BD		98	0	98	0.25	98	0.0	98	0	98	0.25	24.5
- -		98	0	98	0.00	98	0.0	98	0	98	0	0
Subtotal Area			0		4.12		0.0		0			

Pervious Landuses Present:	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B							1.25	69			1.25	86.25
- - BD											0.00	0.00
- -											0.00	0.00
Subtotal Area							1.25					

Composite Area Calculations	Total Pervious Area	1.25
	Total Impervious Area	4.12
	% Impervious	76.72%
	Composite Curve Number	91.2
	Total Area Check	5.37

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
				B		N = BD		BD				
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland		0	0	0.90	5.12	0.90	0.25		0.00			4.833
Meadow		0	0									0
Wetland	1.57	0	0									0
Lawn		1.25	1.9625									0
Cultivated		0.00	0									0.00
Impervious		4.12	6.4684									0
Composite IA		5.37	1.57	Composite Runoff Coefficient								0.9

*Township of South Stormont recommends IA of 1.57 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
NA	NA					NA			NA	NA	NA	NA

Appropriate calculated time to peak:	NA	Appropriate Method:	Bransby

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

Project Name: Long Sault
Project Number: 1909-5629
Date: 2021-10-18
By: AG
Check By: JW

D.A. NAME 106A
D.A. AREA (ha) 4.21

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment 106A

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	100%	4.21
	-		0%	
	-		0%	
Total Area				4.21

Impervious Landuses Present:	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B		98	0	98	0	98	0.0	98	0	98	0	0
- -		98	0	98	0	98	0.0	98	0	98	0	0
- -		98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area			0		0		0.0		0			

Pervious Landuses Present:	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	4.21	60									4.21	252.60
- -	0.00										0.00	0.00
	0.00										0.00	0.00
Subtotal Area	4.21											

Composite Area Calculations	Total Pervious Area	4.21
	Total Impervious Area	0
	% Impervious	0.00%
	Composite Curve Number	60.0
	Total Area Check	4.21

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
				B		BD		B				
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	4.67	4.21	19.6607	0.25	4.21	0.35	0.00	0.30	0.00			1.0525
Meadow		0	0									0
Wetland		0	0									0
Lawn		0	0									0
Cultivated		0	0									0.00
Impervious		0	0									0
Composite IA		4.21	4.67	Composite Runoff Coefficient								0.25

*Township of South Stormont recommends IA of 4.67 for pervious areas.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	467.7	13	NA	NA	NA	NA	NA	NA	0.31	0.21	0.71	0.48

Appropriate calculated time to peak:	0.48	Appropriate Method:	Airport

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name: Long Sault
Project Number: 1909-5629
Date: 2021-10-18
By: AG
Check By:

D.A. NAME **107A**
D.A. AREA (ha) **3.94**

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment 107A

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	100%	3.94
	-		0%	
	-		0%	
Total Area				3.94

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B		98	0	98	0	98	0.0	98	0	98	0	0
- -		98	0	98	0	98	0.0	98	0	98	0	0
- -		98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area			0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	3.94	60									3.94	236.40
- -	0.00										0.00	0.00
	0.00										0.00	0.00
Subtotal Area	3.94											

Composite Area Calculations	Total Pervious Area	3.94
	Total Impervious Area	0
	% Impervious	0.00%
	Composite Curve Number	60.0
	Total Area Check	3.94

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	B		BD		B				
				RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	4.67	3.94	18.3998	0.25	3.94	0.35	0.00	0.30	0.00			0.985
Meadow		0	0									0
Wetland		0	0									0
Lawn		0	0									0
Cultivated		0.00	0									0.00
Impervious		0	0									0
Composite IA		3.94	4.67	Composite Runoff Coefficient								0.25

*Township of South Stormont recommends IA of 4.67 for pervious areas.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	388.4	12	3.1%	0.7396	0.13	0.83	0.556043	0.56	0.26	0.17	0.63	0.42

Appropriate calculated time to peak:	0.42	Appropriate Method:	Airport

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name:	Long Sault	**D.A. NAME**	**107F_1**
Project Number:	1909-5629	**D.A. AREA (ha)**	**4.21**
Date:	2021-10-18		
By:	AG		
Check By:			

Hydrologic Parameters: CALIB STANHYD Command
Post Development Drainage Area: Catchment 107F_1

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	100%	4.21
	-			
	-			
Total Area				4.21

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	3.15	98	0.0	98	0	98	3.15	308.7
- -		98	0	98	0.00	98	0.0	98	0	98	0	0
- -		98	0	98	0.00	98	0.0	98	0	98	0	0
Subtotal Area			0		3.15		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B							1.06	69			1.06	73.14
- -											0.00	0.00
- -											0.00	0.00
Subtotal Area							1.06					

	Composite Area Calculations	Total Pervious Area	1.06
		Total Impervious Area	3.15
		% Impervious	74.82%
		Composite Curve Number	90.7
		Total Area Check	4.21

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	B		0		BD				
				RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	4.67	0	0	0.90	4.21	0.90	0.00		0.00			3.789
Meadow		0	0									0
Wetland		0	0									0
Lawn		1.06	4.9502									0
Cultivated		0.00	0									0.00
Impervious		3.15	14.7105									0
Composite IA		4.21	4.67	Composite Runoff Coefficient								0.9

*Township of South Stormont recommends IA of 4.67 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
NA	NA					NA			NA	NA	NA	NA

Appropriate calculated time to peak:	NA	Appropriate Method:	NA

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name:	Long Sault	**D.A. NAME**	**107F_2**
Project Number:	1909-5629	**D.A. AREA (ha)**	**1.72**
Date:	2021-10-18		
By:	AG		
Check By:	JW		

Hydrologic Parameters: CALIB STANHYD Command
Post Development Drainage Area: Catchment 107F_2

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	100%	1.72
	-		0%	
	-			
Total Area				1.72

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	1.53	98	0.0	98	0	98	1.53	149.94
- -		98	0	98	0.00	98	0.0	98	0	98	0	0
- -		98	0	98	0.00	98	0.0	98	0	98	0	0
Subtotal Area			0		1.53		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B							0.19	0.69			0.19	0.13
- -											0.00	0.00
- -											0.00	0.00
Subtotal Area							0.19					

Composite Area Calculations	Total Pervious Area	0.19
	Total Impervious Area	1.53
	% Impervious	88.95%
	Composite Curve Number	87.3
	Total Area Check	1.72

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	B		0		BD				
				RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	4.67	0	0	0.90	1.72	0.90	0.00		0.00			1.548
Meadow		0	0									0
Wetland		0	0									0
Lawn		0.19	0									0
Cultivated		0.00	0.00									0.00
Impervious		1.53	0									0
Composite IA		1.72	0	Composite Runoff Coefficient								0.9

*Township of South Stormont recommends IA of 4.67 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
NA	NA					NA			NA	NA	NA	NA

Appropriate calculated time to peak:	NA	Appropriate Method:	NA

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name: Long Sault
Project Number: 1909-5629
Date: 2021-10-18
By: AG
Check By: JW

D.A. NAME **108A**
D.A. AREA (ha) **2.69**

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment 108A

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	100%	2.69
D	-		0%	
	-		0%	
Total Area				2.69

Impervious Landuses Present:	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B		98	0	98	0	98	0.0	98	0	98	0	0
- -		98	0	98	0	98	0.0	98	0	98	0	0
- -		98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area			0		0		0.0		0			

Pervious Landuses Present:	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	2.51	60					0.19	69			2.69	163.07
- -	0.00										0.00	0.00
	0.00										0.00	0.00
Subtotal Area	2.51						0.19					

Composite Area Calculations	Total Pervious Area	2.69
	Total Impervious Area	0
	% Impervious	0.00%
	Composite Curve Number	60.6
	Total Area Check	2.69

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
				B		D		BD				
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	2.505	25.05	0.25	2.69	0.35	0.00	0.30	0.00			0.6725
Meadow	8	0	0									0
Wetland	16	0	0									0
Lawn	5	0.185	0.925									0
Cultivated	7	0.00	0.00									0.00
Impervious	2	0	0									0
Composite IA		2.69	9.65613	Composite Runoff Coefficient								0.25

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	350.3	14	4.0%	0.6503	0.13	0.75	0.501498	0.50	0.23	0.15	0.55	0.37

Appropriate calculated time to peak:	0.37	Appropriate Method:	Airport

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

Project Name:	Long Sault
Project Number:	1909-5629
Date:	2021-10-18
By:	AG
Check By:	JW

D.A. NAME	**108F**
D.A. AREA (ha)	**1.57**

Hydrologic Parameters: CALIB STANHYD Command
Post Development Drainage Area: Catchment 108F

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	100%	1.57
	-		0%	
	-			
Total Area				1.57

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	0.82	98	0.0	98	0	98	0.82	80.36
- -		98	0	98	0.00	98	0.0	98	0	98	0	0
- -		98	0	98	0.00	98	0.0	98	0	98	0	0
Subtotal Area			0		0.82		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B							0.75	69			0.75	51.75
- -											0.00	0.00
- -											0.00	0.00
Subtotal Area							0.75					

	Composite Area Calculations	Total Pervious Area	0.75
		Total Impervious Area	0.82
		% Impervious	52.23%
		Composite Curve Number	84.1
		Total Area Check	1.57

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
				B		0		BD				
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland		0	0	0.90	1.57	0.90	0.00		0.00			1.413
Meadow		0	0									0
Wetland	1.57	0	0									0
Lawn		0.75	1.1775									0
Cultivated		0.00	0									0.00
Impervious		0.82	1.2874									0
Composite IA		1.57	1.57	Composite Runoff Coefficient								0.9

*Township of South Stormont recommends IA of 1.57 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
NA	NA					NA			NA	NA	NA	NA

Appropriate calculated time to peak:	NA	Appropriate Method:	Bransby

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name:	Long Sault	D.A. NAME	108F_EX
Project Number:	1909-5629	D.A. AREA (ha)	1.18
Date:	2021-10-18		
By:	AG		
Check By:	JW		

Hydrologic Parameters: CALIB NASHYD Command
Post Development Drainage Area: Catchment 108F_EX2

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	100%	1.18
	-		0%	
	-			
Total Area				1.18

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	0	98	0.0	98	0	98	0	0
- -		98	0	98	0	98	0.0	98	0	98	0	0
- -		98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area			0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B	1.16	60					0.02	69			1.18	70.98
- -											0.00	0.00
- -											0.00	0.00
Subtotal Area												

Composite Area Calculations	Total Pervious Area	1.18
	Total Impervious Area	0
	% Impervious	0.00%
	Composite Curve Number	60.2
	Total Area Check	1.18

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	B		BD		D				
				RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	4.67	1.16	5.4	0.25	1.18	0.35	0.00	0.30	0.00			0.295
Meadow		0.00	0.0									0
Wetland		0.00	0.0									0
Lawn		0.02	0.1									0
Cultivated		0.00	0.0									0
Impervious		0.00	0.0									0
Composite IA		1.18	4.67	Composite Runoff Coefficient								0.25

*Township of South Stormont recommends IA of 4.67 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
									0.28	0.19	0.63	0.42
Concentrated	377	11	2.9%	NA	NA	NA	NA	NA				

Appropriate calculated time to peak:	0.42	Appropriate Method:	Airport

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name:	Long Sault	**D.A. NAME**	**108F_EX**
Project Number:	1909-5629	**D.A. AREA (ha)**	**0.43**
Date:	2021-10-18		
By:	AG		
Check By:	JW		

Hydrologic Parameters: CALIB NASHYD Command
Post Development Drainage Area: Catchment 108F_EX2

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	100%	0.43
	-		0%	
	-			
Total Area				0.43

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	0	98	0.0	98	0	98	0	0
- -		98	0	98	0	98	0.0	98	0	98	0	0
- -		98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area			0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B	0.34	60					0.09	69			0.43	26.61
- -											0.00	0.00
- -											0.00	0.00
Subtotal Area												

	Composite Area Calculations	Total Pervious Area	0.43
		Total Impervious Area	0
		% Impervious	0.00%
		Composite Curve Number	61.9
		Total Area Check	0.43

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	B		BD		D				
				RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	4.67	1.16	5.4	0.25	0.43	0.35	0.00	0.30	0.00			0.1075
Meadow		0.00	0.0									0
Wetland		0.00	0.0									0
Lawn		0.02	0.1									0
Cultivated		0.00	0.0									0.00
Impervious		0.00	0.0									0
Composite IA		1.18	4.67	Composite Runoff Coefficient								0.25

IA AREAS *Township of South Stormont recommends IA of 4.67 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
									0.38	0.26	0.78	0.53
Concentrated	410	7	1.7%	0.9949	0.13	0.88	0.586966	0.59				

Appropriate calculated time to peak:	0.53	Appropriate Method:	Airport

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

Project Name:	Long Sault
Project Number:	1909-5629
Date:	2021-10-18
By:	AG
Check By:	JW

D.A. NAME **109A**
D.A. AREA (ha) **3.10**

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment 109A

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	76%	2.35
D	-	D	8%	0.26
N = BD	-	BD	16%	0.49
Total Area				3.10

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B		98	0	98	0	98	0.0	98	0	98	0	0
- - D		98	0	98	0	98	0.0	98	0	98	0	0
- - BD		98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area			0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	1.57	60			0.78	50					2.35	133.20
- - D	0.00	79			0.26	50					0.26	13.00
- - BD	0.00	69.5			0.49	50					0.49	24.50
Subtotal Area	1.57				1.53							

	Composite Area Calculations	Total Pervious Area	3.10
		Total Impervious Area	0
		% Impervious	0.00%
		Composite Curve Number	55.1
		Total Area Check	3.1

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	B		D		BD				
				RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	4.67	1.57	7.3	0.25	2.35	0.35	0.26	0.30	0.49			0.8255
Meadow		0.00	0.0									0
Wetland		1.53	7.1									0
Lawn		0.00	0.0									0
Cultivated		0.00	0.0									0.00
Impervious		0.00	0.0									0
Composite IA		3.1	4.67	Composite Runoff Coefficient								0.26629

*Township of South Stormont recommends IA of 4.67 for pervious areas.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	568	12	2.1%	0					0.41	0.28	0.84	0.57

Appropriate calculated time to peak:	0.57	Appropriate Method:	Airport

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name: Long Sault
Project Number: 1909-5629
Date: 2021-10-18
By: AG
Check By: JW

D.A. NAME 110A
D.A. AREA (ha) 2.19

Hydrologic Parameters: CALIB STANHYD Command
Post Development Drainage Area: Catchment 110A

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	100%	2.19
				0.00
				0.00
Total Area				2.19

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	0.00	98	0.0	98	0	98	0	0
-		98	0	98	0.00	98	0.0	98	0	98	0	0
-		98	0	98	0.00	98	0.0	98	0	98	0	0
Subtotal Area			0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B	2.19	60		65		50	0.00	69		74	2.19	131.40
-											0.00	0.00
-											0.00	0.00
Subtotal Area	2.19				0.00							

Composite Area Calculations		
	Total Pervious Area	2.19
	Total Impervious Area	0
	% Impervious	0.00%
	Composite Curve Number	60.0
	Total Area Check	2.19

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
				B		BD		D				
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	4.67	2.19	10.2273	0.25	2.19	0.35	0.00	0.30	0.00			0.5475
Meadow		0	0									0
Wetland		0	0									0
Lawn		0	0									0
Cultivated		0.00	0									0.00
Impervious		0	0									0
Composite IA		2.19	4.67	Composite Runoff Coefficient								0.25

*Township of South Stormont recommends IA of 4.67 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	418	12	2.9%				NA		0.30	0.20	0.67	0.45

Appropriate calculated time to peak:	0.45	Appropriate Method:	Airport

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

Project Name: Long Sault
Project Number: 1909-5629
Date: 2021-10-18
By: AG
Check By: JW

D.A. NAME 109F
D.A. AREA (ha) 1.25

Hydrologic Parameters: CALIB STANHYD Command
Post Development Drainage Area: Catchment 109F

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	40%	0.50
D	-	D	21%	0.26
N = BD	-	BD	39%	0.49
Total Area				1.25

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	0.50	98	0.0	98	0	98	0.5	49
- - D		98	0	98	0.26	98	0.0	98	0	98	0.26	25.48
- - BD		98	0	98	0.49	98	0.0	98	0	98	0.49	48.02
Subtotal Area			0		1.25		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B											0	0
- - D											0	0
Subtotal Area												

	Composite Area Calculations	Total Pervious Area	0.00	
		Total Impervious Area	1.25	
		% Impervious	100.00%	* 75%
		Composite Curve Number	98.0	*96.6
		Total Area Check	1.25	

*Note: Assumed that area is compacted gravel. Percent imperviousness reduced to 75%.
Assumed that area is 5 % pervious. Curve number reduced to 96.6.

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	B		D		BD				
				RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	1.57	0	0	0.90	0.50	0.90	0.26	0.90	0.49			1.125
Meadow		0	0									0
Wetland		0	0									0
Lawn		0	0									0
Cultivated		0.00	0									0.00
Impervious		1.25	1.9625									0
Composite IA		1.25	1.57	Composite Runoff Coefficient								0.9

*Township of South Stormont recommends IA of 1.57 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated			NA				NA		NA	NA	NA	NA

Appropriate calculated time to peak:	NA	Appropriate Method:	Bransby

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name: Long Sault
Project Number: 1909-5629
Date: 2021-10-18
By: AG
Check By: JW

D.A. NAME **110F**
D.A. AREA (ha) **2.84**

Hydrologic Parameters: CALIB STANHYD Command
Post Development Drainage Area: Catchment 110F

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	100%	2.84
				0.00
				0.00
Total Area				2.84

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	2.84	98	0.0	98	0	98	2.84	278.32
-		98	0	98	0.00	98	0.0	98	0	98	0	0
-		98	0	98	0.00	98	0.0	98	0	98	0	0
Subtotal Area			0		2.84		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B											0	0
-											0	0
Subtotal Area												

Composite Area Calculations		Total Pervious Area	0.00	
		Total Impervious Area	2.84	
		% Impervious	100.00%	*75%
		Composite Curve Number	98.0	*96.6
		Total Area Check	2.84	

*Note: Assumed that area is compacted gravel. Percent imperviousness reduced to 75%.
Assumed that area is 5 % pervious. Curve number reduced to 96.6.

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	B		0		BD				
				RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	1.57	0	0	0.90	2.84	0.90	0.00		0.00			2.556
Meadow		0	0									0
Wetland		0	0									0
Lawn		0	0									0
Cultivated		0.00	0									0.00
Impervious		2.84	4.4588									0
Composite IA		2.84	1.57	Composite Runoff Coefficient								0.9

*Township of South Stormont recommends IA of 1.57 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
NA	NA					NA			NA	NA	NA	NA

Appropriate calculated time to peak:	NA	Appropriate Method:	Bransby

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name:	Long Sault	D.A. NAME	110F
Project Number:	1909-5629	D.A. AREA (ha)	1.25
Date:	2021-10-18		
By:	AG		
Check By:	JW		

Hydrologic Parameters: CALIB STANHYD Command
Post Development Drainage Area: Catchment 110F

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
B	-	B	100%	1.25
				0.00
				0.00
Total Area				1.25

Impervious Landuses Present:	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B		98	0	98	1.25	98	0.0	98	0	98	1.25	122.5
-		98	0	98	0.00	98	0.0	98	0	98	0	0
-		98	0	98	0.00	98	0.0	98	0	98	0	0
Subtotal Area					1.25							

Pervious Landuses Present:	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	CN	Area	A*CN
- - B											0	0
-											0	0
Subtotal Area												

Composite Area Calculations	Total Pervious Area	0.00	
	Total Impervious Area	1.25	
	% Impervious	100.00%	*75%
	Composite Curve Number	98.0	*96.6
	Total Area Check	1.25	

*Note: Assumed that area is compacted gravel. Percent imperviousness reduced to 75%.
Assumed that area is 5 % pervious. Curve number reduced to 96.6.

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
				B		0		BD				
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland		0	0	0.90	1.25	0.90	0.00		0.00			1.125
Meadow		0	0									0
Wetland	1.57	0	0									0
Lawn		0	0									0
Cultivated		0.00	0									0.00
Impervious		1.25	1.9625									0
Composite IA		1.25	1.57	Composite Runoff Coefficient								0.9

*Township of South Stormont recommends IA of 1.57 for pervious areas.

Time to Peak Inputs						Uplands			Bransby		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
NA	NA					NA			NA	NA	NA	NA

Appropriate calculated time to peak:	NA	Appropriate Method:	Bransby

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

APPENDIX D

Visual Otthymo Model Schematics

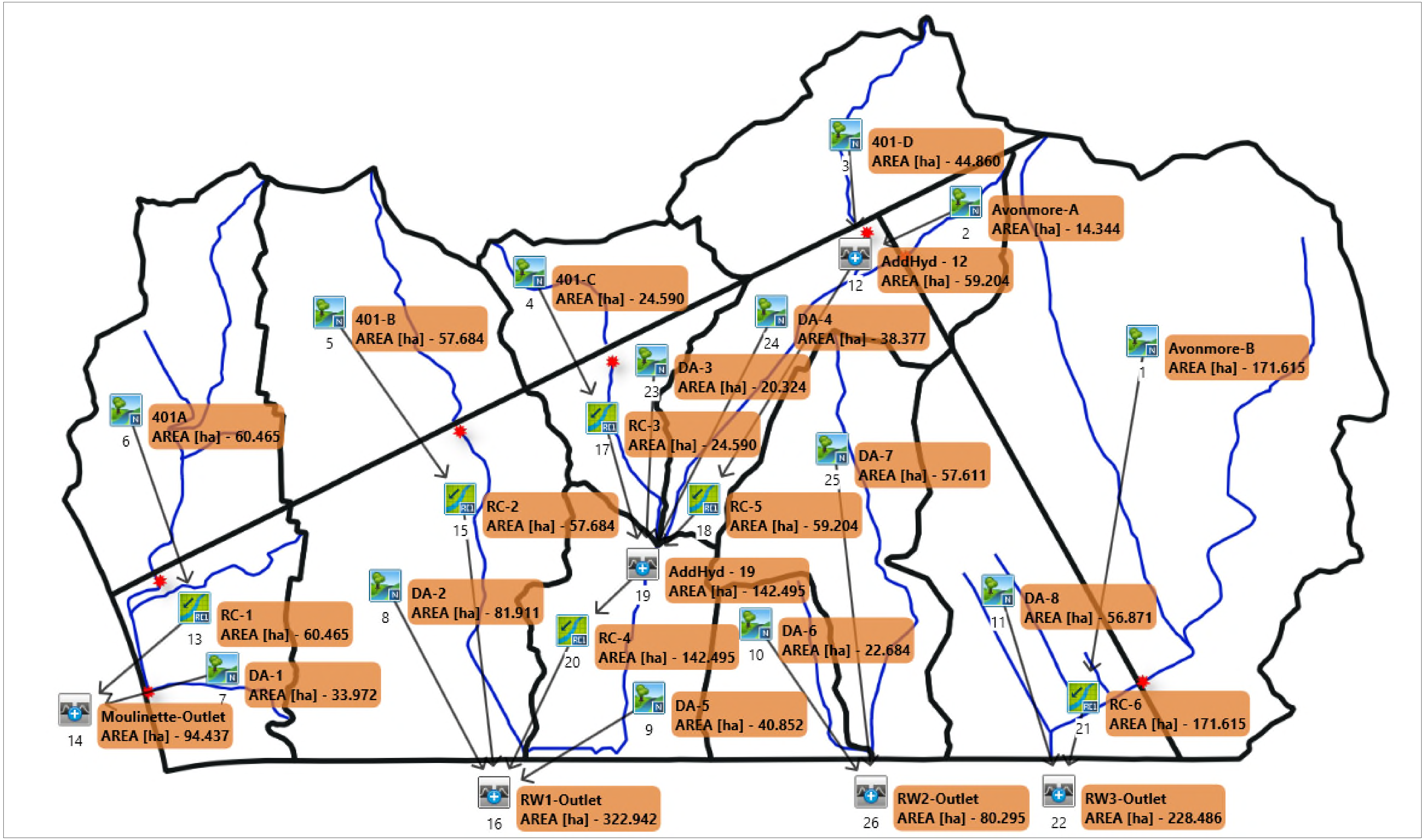


Figure 1: VO6 Schematic of Subject Property and External Drainage

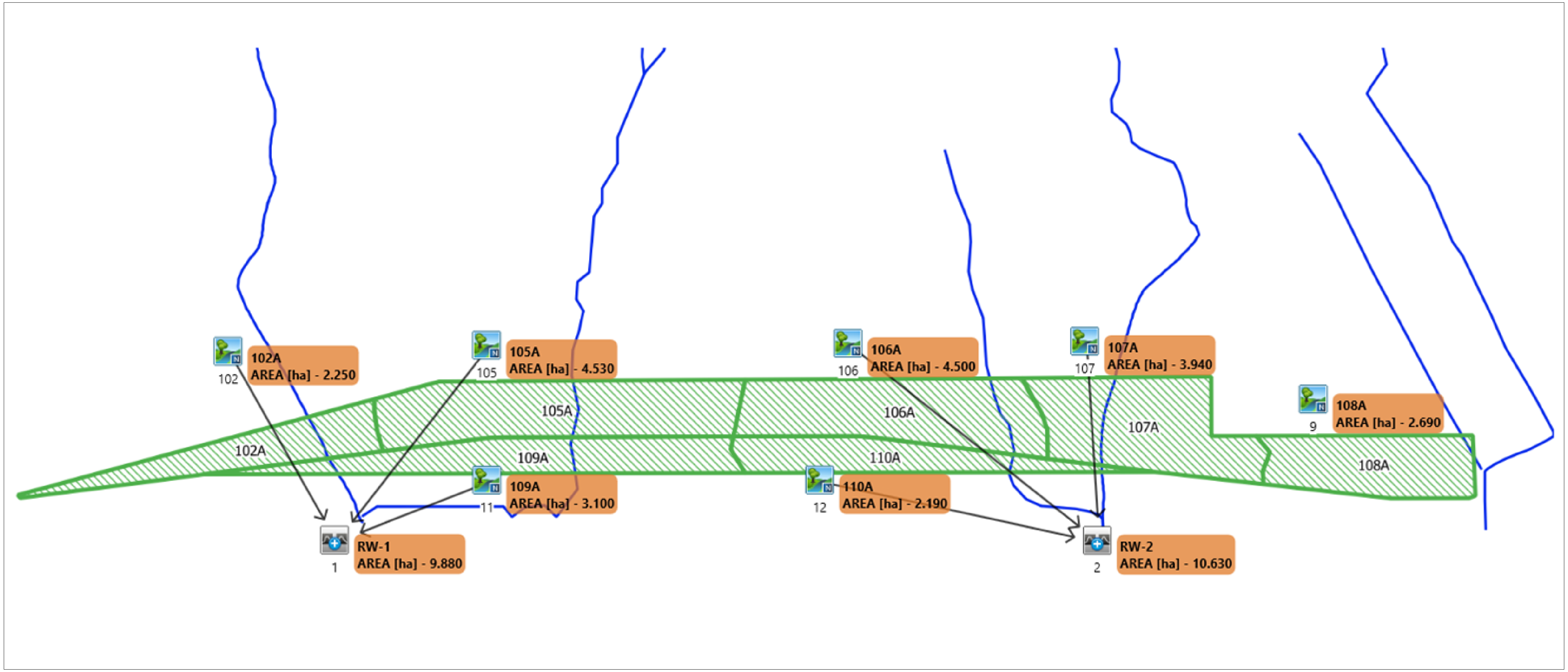


Figure 2: VO6 Schematic of Phase A Existing Conditions

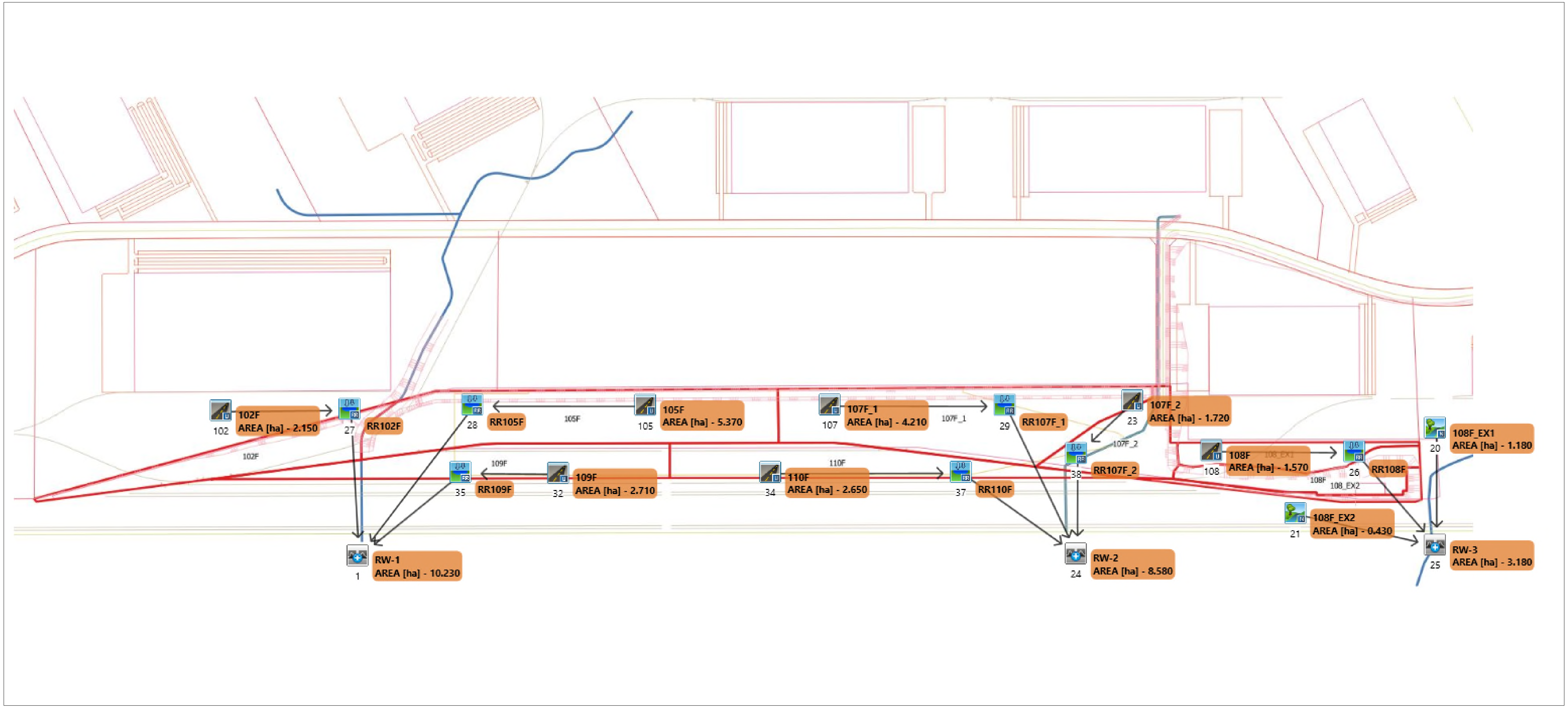


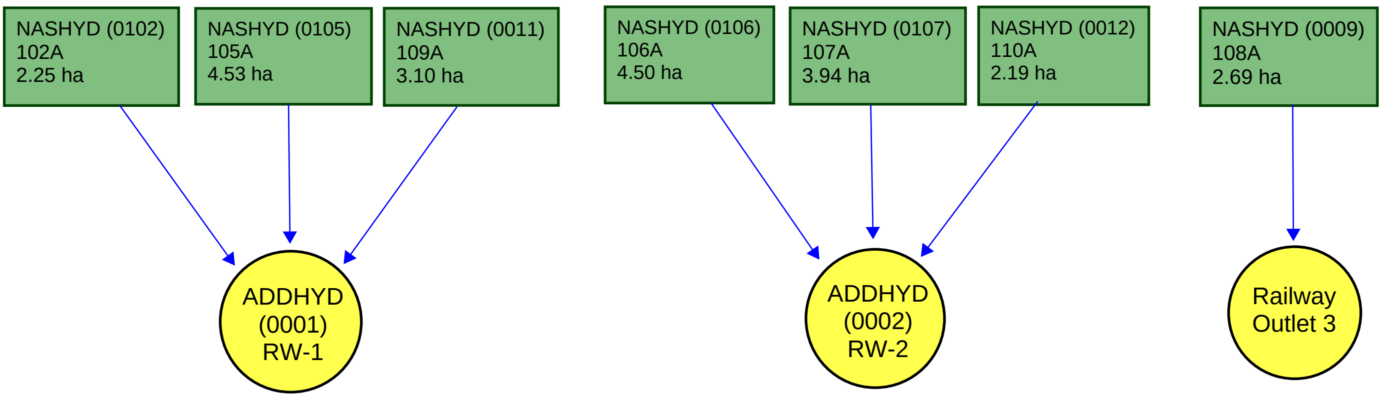
Figure 3: VO6 Schematic of Phase A Proposed Conditions

APPENDIX E

Visual Otthymo Output

E1 – Pre-development Visual Otthymo Output
E2 – Post-Development Visual Otthymo Output

Phase A Pre-Development
Stormwater Management Schematic
1909-5629



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         V  V    I    SS    U   U AAAAA  L
         V  V    I     SS   U   U A   A  L
          VV     I   SSSSS  UUUUU A   A  LLLLL

         OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
        O   O    T      T    H   H   Y Y   MM MM  O   O
        O   O    T      T    H   H    Y    M   M  O   O
         OOO     T      T    H   H    Y    M   M   OOO
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                   *****  D E T A I L E D   O U T P U T *****

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DATE: 10-26-2021                           TIME: 02:23:18

USER:

COMMENTS: ____________________________________________________________

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  ** SIMULATION : 01-AES-5yr                    **
  ************************************************

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| Ptotal= 56.82 mm |    Comments: 5 Year
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 1.00    0.00 |  5.00    7.80 |  9.00    0.57 | 13.00    0.00
                 2.00    8.55 |  6.00    6.84 | 10.00    0.00 |
                 3.00   14.25 |  7.00    4.56 | 11.00    0.00 |
                 4.00   12.54 |  8.00    1.71 | 12.00    0.00 |

-------------------------------------------------------------------------------------
```

```
--------------------
| CALIB              |
| NASHYD   (  0102)|   Area    (ha)=   2.25   Curve Number   (CN)= 52.9
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.77

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	12.54	6.583	4.56	9.83	0.00
0.167	0.00	3.417	12.54	6.667	4.56	9.92	0.00
0.250	0.00	3.500	12.54	6.750	4.56	10.00	0.00
0.333	0.00	3.583	12.54	6.833	4.56	10.08	0.00
0.417	0.00	3.667	12.54	6.917	4.56	10.17	0.00
0.500	0.00	3.750	12.54	7.000	4.56	10.25	0.00
0.583	0.00	3.833	12.54	7.083	1.71	10.33	0.00
0.667	0.00	3.917	12.54	7.167	1.71	10.42	0.00
0.750	0.00	4.000	12.54	7.250	1.71	10.50	0.00
0.833	0.00	4.083	7.80	7.333	1.71	10.58	0.00
0.917	0.00	4.167	7.80	7.417	1.71	10.67	0.00
1.000	0.00	4.250	7.80	7.500	1.71	10.75	0.00
1.083	8.55	4.333	7.80	7.583	1.71	10.83	0.00
1.167	8.55	4.417	7.80	7.667	1.71	10.92	0.00
1.250	8.55	4.500	7.80	7.750	1.71	11.00	0.00
1.333	8.55	4.583	7.80	7.833	1.71	11.08	0.00
1.417	8.55	4.667	7.80	7.917	1.71	11.17	0.00
1.500	8.55	4.750	7.80	8.000	1.71	11.25	0.00
1.583	8.55	4.833	7.80	8.083	0.57	11.33	0.00
1.667	8.55	4.917	7.80	8.167	0.57	11.42	0.00
1.750	8.55	5.000	7.80	8.250	0.57	11.50	0.00
1.833	8.55	5.083	6.84	8.333	0.57	11.58	0.00
1.917	8.55	5.167	6.84	8.417	0.57	11.67	0.00
2.000	8.55	5.250	6.84	8.500	0.57	11.75	0.00
2.083	14.25	5.333	6.84	8.583	0.57	11.83	0.00
2.167	14.25	5.417	6.84	8.667	0.57	11.92	0.00
2.250	14.25	5.500	6.84	8.750	0.57	12.00	0.00
2.333	14.25	5.583	6.84	8.833	0.57	12.08	0.00
2.417	14.25	5.667	6.84	8.917	0.57	12.17	0.00
2.500	14.25	5.750	6.84	9.000	0.57	12.25	0.00
2.583	14.25	5.833	6.84	9.083	0.00	12.33	0.00
2.667	14.25	5.917	6.84	9.167	0.00	12.42	0.00
2.750	14.25	6.000	6.84	9.250	0.00	12.50	0.00
2.833	14.25	6.083	4.56	9.333	0.00	12.58	0.00
2.917	14.25	6.167	4.56	9.417	0.00	12.67	0.00
3.000	14.25	6.250	4.56	9.500	0.00	12.75	0.00
3.083	12.54	6.333	4.56	9.583	0.00	12.83	0.00
3.167	12.54	6.417	4.56	9.667	0.00	12.92	0.00
3.250	12.54	6.500	4.56	9.750	0.00	13.00	0.00

```
Unit Hyd Qpeak  (cms)=   0.112

PEAK FLOW       (cms)=   0.013 (i)
TIME TO PEAK    (hrs)=   4.917
RUNOFF VOLUME    (mm)=   9.771
TOTAL RAINFALL   (mm)=  56.820
```

```
     RUNOFF COEFFICIENT   =   0.172

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| NASHYD   (  0105)|   Area    (ha)=   4.53   Curve Number   (CN)= 59.5
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.57

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	12.54	6.583	4.56	9.83	0.00
0.167	0.00	3.417	12.54	6.667	4.56	9.92	0.00
0.250	0.00	3.500	12.54	6.750	4.56	10.00	0.00
0.333	0.00	3.583	12.54	6.833	4.56	10.08	0.00
0.417	0.00	3.667	12.54	6.917	4.56	10.17	0.00
0.500	0.00	3.750	12.54	7.000	4.56	10.25	0.00
0.583	0.00	3.833	12.54	7.083	1.71	10.33	0.00
0.667	0.00	3.917	12.54	7.167	1.71	10.42	0.00
0.750	0.00	4.000	12.54	7.250	1.71	10.50	0.00
0.833	0.00	4.083	7.80	7.333	1.71	10.58	0.00
0.917	0.00	4.167	7.80	7.417	1.71	10.67	0.00
1.000	0.00	4.250	7.80	7.500	1.71	10.75	0.00
1.083	8.55	4.333	7.80	7.583	1.71	10.83	0.00
1.167	8.55	4.417	7.80	7.667	1.71	10.92	0.00
1.250	8.55	4.500	7.80	7.750	1.71	11.00	0.00
1.333	8.55	4.583	7.80	7.833	1.71	11.08	0.00
1.417	8.55	4.667	7.80	7.917	1.71	11.17	0.00
1.500	8.55	4.750	7.80	8.000	1.71	11.25	0.00
1.583	8.55	4.833	7.80	8.083	0.57	11.33	0.00
1.667	8.55	4.917	7.80	8.167	0.57	11.42	0.00
1.750	8.55	5.000	7.80	8.250	0.57	11.50	0.00
1.833	8.55	5.083	6.84	8.333	0.57	11.58	0.00
1.917	8.55	5.167	6.84	8.417	0.57	11.67	0.00
2.000	8.55	5.250	6.84	8.500	0.57	11.75	0.00
2.083	14.25	5.333	6.84	8.583	0.57	11.83	0.00
2.167	14.25	5.417	6.84	8.667	0.57	11.92	0.00
2.250	14.25	5.500	6.84	8.750	0.57	12.00	0.00
2.333	14.25	5.583	6.84	8.833	0.57	12.08	0.00
2.417	14.25	5.667	6.84	8.917	0.57	12.17	0.00
2.500	14.25	5.750	6.84	9.000	0.57	12.25	0.00
2.583	14.25	5.833	6.84	9.083	0.00	12.33	0.00
2.667	14.25	5.917	6.84	9.167	0.00	12.42	0.00
2.750	14.25	6.000	6.84	9.250	0.00	12.50	0.00
2.833	14.25	6.083	4.56	9.333	0.00	12.58	0.00
2.917	14.25	6.167	4.56	9.417	0.00	12.67	0.00
3.000	14.25	6.250	4.56	9.500	0.00	12.75	0.00
3.083	12.54	6.333	4.56	9.583	0.00	12.83	0.00
3.167	12.54	6.417	4.56	9.667	0.00	12.92	0.00
3.250	12.54	6.500	4.56	9.750	0.00	13.00	0.00

```
     Unit Hyd Qpeak  (cms)=   0.304
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```
PEAK FLOW       (cms)=   0.034 (i)
TIME TO PEAK    (hrs)=   4.333
RUNOFF VOLUME    (mm)=  12.084
TOTAL RAINFALL   (mm)=  56.820
RUNOFF COEFFICIENT   =   0.213

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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--------------------
| CALIB              |
| NASHYD   (  0011)|   Area    (ha)=   3.10   Curve Number   (CN)= 55.1
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.57

    NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	' TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	12.54	6.583	4.56	9.83	0.00
0.167	0.00	3.417	12.54	6.667	4.56	9.92	0.00
0.250	0.00	3.500	12.54	6.750	4.56	10.00	0.00
0.333	0.00	3.583	12.54	6.833	4.56	10.08	0.00
0.417	0.00	3.667	12.54	6.917	4.56	10.17	0.00
0.500	0.00	3.750	12.54	7.000	4.56	10.25	0.00
0.583	0.00	3.833	12.54	7.083	1.71	10.33	0.00
0.667	0.00	3.917	12.54	7.167	1.71	10.42	0.00
0.750	0.00	4.000	12.54	7.250	1.71	10.50	0.00
0.833	0.00	4.083	7.80	7.333	1.71	10.58	0.00
0.917	0.00	4.167	7.80	7.417	1.71	10.67	0.00
1.000	0.00	4.250	7.80	7.500	1.71	10.75	0.00
1.083	8.55	4.333	7.80	7.583	1.71	10.83	0.00
1.167	8.55	4.417	7.80	7.667	1.71	10.92	0.00
1.250	8.55	4.500	7.80	7.750	1.71	11.00	0.00
1.333	8.55	4.583	7.80	7.833	1.71	11.08	0.00
1.417	8.55	4.667	7.80	7.917	1.71	11.17	0.00
1.500	8.55	4.750	7.80	8.000	1.71	11.25	0.00
1.583	8.55	4.833	7.80	8.083	0.57	11.33	0.00
1.667	8.55	4.917	7.80	8.167	0.57	11.42	0.00
1.750	8.55	5.000	7.80	8.250	0.57	11.50	0.00
1.833	8.55	5.083	6.84	8.333	0.57	11.58	0.00
1.917	8.55	5.167	6.84	8.417	0.57	11.67	0.00
2.000	8.55	5.250	6.84	8.500	0.57	11.75	0.00
2.083	14.25	5.333	6.84	8.583	0.57	11.83	0.00
2.167	14.25	5.417	6.84	8.667	0.57	11.92	0.00
2.250	14.25	5.500	6.84	8.750	0.57	12.00	0.00
2.333	14.25	5.583	6.84	8.833	0.57	12.08	0.00
2.417	14.25	5.667	6.84	8.917	0.57	12.17	0.00
2.500	14.25	5.750	6.84	9.000	0.57	12.25	0.00
2.583	14.25	5.833	6.84	9.083	0.00	12.33	0.00
2.667	14.25	5.917	6.84	9.167	0.00	12.42	0.00
2.750	14.25	6.000	6.84	9.250	0.00	12.50	0.00
2.833	14.25	6.083	4.56	9.333	0.00	12.58	0.00
2.917	14.25	6.167	4.56	9.417	0.00	12.67	0.00
3.000	14.25	6.250	4.56	9.500	0.00	12.75	0.00
3.083	12.54	6.333	4.56	9.583	0.00	12.83	0.00
3.167	12.54	6.417	4.56	9.667	0.00	12.92	0.00

```
             3.250   12.54 | 6.500    4.56 | 9.750    0.00 | 13.00    0.00

     Unit Hyd Qpeak  (cms)=   0.208

     PEAK FLOW       (cms)=   0.020 (i)
     TIME TO PEAK    (hrs)=   4.333
     RUNOFF VOLUME    (mm)=  10.495
     TOTAL RAINFALL   (mm)=  56.820
     RUNOFF COEFFICIENT   =   0.185

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0001)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0102):     2.25   0.013     4.92     9.77
      + ID2= 2 (  0105):     4.53   0.034     4.33    12.08
        ====================================================
        ID = 3 (  0001):     6.78   0.047     4.42    11.32

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| ADD HYD  (  0001)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0001):     6.78   0.047     4.42    11.32
      + ID2= 2 (  0011):     3.10   0.020     4.33    10.49
        ====================================================
        ID = 1 (  0001):     9.88   0.067     4.42    11.06

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| CALIB            |
| NASHYD   (  0106)|   Area    (ha)=   4.50   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.48

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                          ---- TRANSFORMED HYETOGRAPH ----
              TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
               hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
             0.083    0.00 | 3.333   12.54 | 6.583    4.56 |  9.83    0.00
             0.167    0.00 | 3.417   12.54 | 6.667    4.56 |  9.92    0.00
             0.250    0.00 | 3.500   12.54 | 6.750    4.56 | 10.00    0.00
             0.333    0.00 | 3.583   12.54 | 6.833    4.56 | 10.08    0.00
             0.417    0.00 | 3.667   12.54 | 6.917    4.56 | 10.17    0.00
             0.500    0.00 | 3.750   12.54 | 7.000    4.56 | 10.25    0.00
             0.583    0.00 | 3.833   12.54 | 7.083    1.71 | 10.33    0.00
             0.667    0.00 | 3.917   12.54 | 7.167    1.71 | 10.42    0.00
             0.750    0.00 | 4.000   12.54 | 7.250    1.71 | 10.50    0.00
             0.833    0.00 | 4.083    7.80 | 7.333    1.71 | 10.58    0.00
```

```
                0.917    0.00 | 4.167    7.80 | 7.417    1.71 | 10.67    0.00
                1.000    0.00 | 4.250    7.80 | 7.500    1.71 | 10.75    0.00
                1.083    8.55 | 4.333    7.80 | 7.583    1.71 | 10.83    0.00
                1.167    8.55 | 4.417    7.80 | 7.667    1.71 | 10.92    0.00
                1.250    8.55 | 4.500    7.80 | 7.750    1.71 | 11.00    0.00
                1.333    8.55 | 4.583    7.80 | 7.833    1.71 | 11.08    0.00
                1.417    8.55 | 4.667    7.80 | 7.917    1.71 | 11.17    0.00
                1.500    8.55 | 4.750    7.80 | 8.000    1.71 | 11.25    0.00
                1.583    8.55 | 4.833    7.80 | 8.083    0.57 | 11.33    0.00
                1.667    8.55 | 4.917    7.80 | 8.167    0.57 | 11.42    0.00
                1.750    8.55 | 5.000    7.80 | 8.250    0.57 | 11.50    0.00
                1.833    8.55 | 5.083    6.84 | 8.333    0.57 | 11.58    0.00
                1.917    8.55 | 5.167    6.84 | 8.417    0.57 | 11.67    0.00
                2.000    8.55 | 5.250    6.84 | 8.500    0.57 | 11.75    0.00
                2.083   14.25 | 5.333    6.84 | 8.583    0.57 | 11.83    0.00
                2.167   14.25 | 5.417    6.84 | 8.667    0.57 | 11.92    0.00
                2.250   14.25 | 5.500    6.84 | 8.750    0.57 | 12.00    0.00
                2.333   14.25 | 5.583    6.84 | 8.833    0.57 | 12.08    0.00
                2.417   14.25 | 5.667    6.84 | 8.917    0.57 | 12.17    0.00
                2.500   14.25 | 5.750    6.84 | 9.000    0.57 | 12.25    0.00
                2.583   14.25 | 5.833    6.84 | 9.083    0.00 | 12.33    0.00
                2.667   14.25 | 5.917    6.84 | 9.167    0.00 | 12.42    0.00
                2.750   14.25 | 6.000    6.84 | 9.250    0.00 | 12.50    0.00
                2.833   14.25 | 6.083    4.56 | 9.333    0.00 | 12.58    0.00
                2.917   14.25 | 6.167    4.56 | 9.417    0.00 | 12.67    0.00
                3.000   14.25 | 6.250    4.56 | 9.500    0.00 | 12.75    0.00
                3.083   12.54 | 6.333    4.56 | 9.583    0.00 | 12.83    0.00
                3.167   12.54 | 6.417    4.56 | 9.667    0.00 | 12.92    0.00
                3.250   12.54 | 6.500    4.56 | 9.750    0.00 | 13.00    0.00

     Unit Hyd Qpeak  (cms)=   0.358

     PEAK FLOW       (cms)=   0.036 (i)
     TIME TO PEAK    (hrs)=   4.250
     RUNOFF VOLUME    (mm)=  12.278
     TOTAL RAINFALL   (mm)=  56.820
     RUNOFF COEFFICIENT   =   0.216

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB             |
| NASHYD   (  0107)|   Area    (ha)=   3.94   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.42

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                             ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 3.333   12.54 | 6.583    4.56 |  9.83    0.00
                0.167    0.00 | 3.417   12.54 | 6.667    4.56 |  9.92    0.00
                0.250    0.00 | 3.500   12.54 | 6.750    4.56 | 10.00    0.00
                0.333    0.00 | 3.583   12.54 | 6.833    4.56 | 10.08    0.00
                0.417    0.00 | 3.667   12.54 | 6.917    4.56 | 10.17    0.00
                0.500    0.00 | 3.750   12.54 | 7.000    4.56 | 10.25    0.00
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               0.583    0.00 | 3.833   12.54 | 7.083    1.71 | 10.33    0.00
               0.667    0.00 | 3.917   12.54 | 7.167    1.71 | 10.42    0.00
               0.750    0.00 | 4.000   12.54 | 7.250    1.71 | 10.50    0.00
               0.833    0.00 | 4.083    7.80 | 7.333    1.71 | 10.58    0.00
               0.917    0.00 | 4.167    7.80 | 7.417    1.71 | 10.67    0.00
               1.000    0.00 | 4.250    7.80 | 7.500    1.71 | 10.75    0.00
               1.083    8.55 | 4.333    7.80 | 7.583    1.71 | 10.83    0.00
               1.167    8.55 | 4.417    7.80 | 7.667    1.71 | 10.92    0.00
               1.250    8.55 | 4.500    7.80 | 7.750    1.71 | 11.00    0.00
               1.333    8.55 | 4.583    7.80 | 7.833    1.71 | 11.08    0.00
               1.417    8.55 | 4.667    7.80 | 7.917    1.71 | 11.17    0.00
               1.500    8.55 | 4.750    7.80 | 8.000    1.71 | 11.25    0.00
               1.583    8.55 | 4.833    7.80 | 8.083    0.57 | 11.33    0.00
               1.667    8.55 | 4.917    7.80 | 8.167    0.57 | 11.42    0.00
               1.750    8.55 | 5.000    7.80 | 8.250    0.57 | 11.50    0.00
               1.833    8.55 | 5.083    6.84 | 8.333    0.57 | 11.58    0.00
               1.917    8.55 | 5.167    6.84 | 8.417    0.57 | 11.67    0.00
               2.000    8.55 | 5.250    6.84 | 8.500    0.57 | 11.75    0.00
               2.083   14.25 | 5.333    6.84 | 8.583    0.57 | 11.83    0.00
               2.167   14.25 | 5.417    6.84 | 8.667    0.57 | 11.92    0.00
               2.250   14.25 | 5.500    6.84 | 8.750    0.57 | 12.00    0.00
               2.333   14.25 | 5.583    6.84 | 8.833    0.57 | 12.08    0.00
               2.417   14.25 | 5.667    6.84 | 8.917    0.57 | 12.17    0.00
               2.500   14.25 | 5.750    6.84 | 9.000    0.57 | 12.25    0.00
               2.583   14.25 | 5.833    6.84 | 9.083    0.00 | 12.33    0.00
               2.667   14.25 | 5.917    6.84 | 9.167    0.00 | 12.42    0.00
               2.750   14.25 | 6.000    6.84 | 9.250    0.00 | 12.50    0.00
               2.833   14.25 | 6.083    4.56 | 9.333    0.00 | 12.58    0.00
               2.917   14.25 | 6.167    4.56 | 9.417    0.00 | 12.67    0.00
               3.000   14.25 | 6.250    4.56 | 9.500    0.00 | 12.75    0.00
               3.083   12.54 | 6.333    4.56 | 9.583    0.00 | 12.83    0.00
               3.167   12.54 | 6.417    4.56 | 9.667    0.00 | 12.92    0.00
               3.250   12.54 | 6.500    4.56 | 9.750    0.00 | 13.00    0.00

    Unit Hyd Qpeak  (cms)=   0.358

    PEAK FLOW       (cms)=   0.032 (i)
    TIME TO PEAK    (hrs)=   4.167
    RUNOFF VOLUME    (mm)=  12.278
    TOTAL RAINFALL   (mm)=  56.820
    RUNOFF COEFFICIENT   =   0.216

    (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| NASHYD   (  0012)|   Area    (ha)=   2.19   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.45

        NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                   ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.083    0.00 | 3.333   12.54 | 6.583    4.56 |  9.83    0.00
               0.167    0.00 | 3.417   12.54 | 6.667    4.56 |  9.92    0.00
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```
 0.250    0.00 | 3.500   12.54 | 6.750    4.56 | 10.00    0.00
 0.333    0.00 | 3.583   12.54 | 6.833    4.56 | 10.08    0.00
 0.417    0.00 | 3.667   12.54 | 6.917    4.56 | 10.17    0.00
 0.500    0.00 | 3.750   12.54 | 7.000    4.56 | 10.25    0.00
 0.583    0.00 | 3.833   12.54 | 7.083    1.71 | 10.33    0.00
 0.667    0.00 | 3.917   12.54 | 7.167    1.71 | 10.42    0.00
 0.750    0.00 | 4.000   12.54 | 7.250    1.71 | 10.50    0.00
 0.833    0.00 | 4.083    7.80 | 7.333    1.71 | 10.58    0.00
 0.917    0.00 | 4.167    7.80 | 7.417    1.71 | 10.67    0.00
 1.000    0.00 | 4.250    7.80 | 7.500    1.71 | 10.75    0.00
 1.083    8.55 | 4.333    7.80 | 7.583    1.71 | 10.83    0.00
 1.167    8.55 | 4.417    7.80 | 7.667    1.71 | 10.92    0.00
 1.250    8.55 | 4.500    7.80 | 7.750    1.71 | 11.00    0.00
 1.333    8.55 | 4.583    7.80 | 7.833    1.71 | 11.08    0.00
 1.417    8.55 | 4.667    7.80 | 7.917    1.71 | 11.17    0.00
 1.500    8.55 | 4.750    7.80 | 8.000    1.71 | 11.25    0.00
 1.583    8.55 | 4.833    7.80 | 8.083    0.57 | 11.33    0.00
 1.667    8.55 | 4.917    7.80 | 8.167    0.57 | 11.42    0.00
 1.750    8.55 | 5.000    7.80 | 8.250    0.57 | 11.50    0.00
 1.833    8.55 | 5.083    6.84 | 8.333    0.57 | 11.58    0.00
 1.917    8.55 | 5.167    6.84 | 8.417    0.57 | 11.67    0.00
 2.000    8.55 | 5.250    6.84 | 8.500    0.57 | 11.75    0.00
 2.083   14.25 | 5.333    6.84 | 8.583    0.57 | 11.83    0.00
 2.167   14.25 | 5.417    6.84 | 8.667    0.57 | 11.92    0.00
 2.250   14.25 | 5.500    6.84 | 8.750    0.57 | 12.00    0.00
 2.333   14.25 | 5.583    6.84 | 8.833    0.57 | 12.08    0.00
 2.417   14.25 | 5.667    6.84 | 8.917    0.57 | 12.17    0.00
 2.500   14.25 | 5.750    6.84 | 9.000    0.57 | 12.25    0.00
 2.583   14.25 | 5.833    6.84 | 9.083    0.00 | 12.33    0.00
 2.667   14.25 | 5.917    6.84 | 9.167    0.00 | 12.42    0.00
 2.750   14.25 | 6.000    6.84 | 9.250    0.00 | 12.50    0.00
 2.833   14.25 | 6.083    4.56 | 9.333    0.00 | 12.58    0.00
 2.917   14.25 | 6.167    4.56 | 9.417    0.00 | 12.67    0.00
 3.000   14.25 | 6.250    4.56 | 9.500    0.00 | 12.75    0.00
 3.083   12.54 | 6.333    4.56 | 9.583    0.00 | 12.83    0.00
 3.167   12.54 | 6.417    4.56 | 9.667    0.00 | 12.92    0.00
 3.250   12.54 | 6.500    4.56 | 9.750    0.00 | 13.00    0.00

     Unit Hyd Qpeak  (cms)=   0.186

     PEAK FLOW       (cms)=   0.018 (i)
     TIME TO PEAK    (hrs)=   4.167
     RUNOFF VOLUME    (mm)=  12.278
     TOTAL RAINFALL   (mm)=  56.820
     RUNOFF COEFFICIENT   =   0.216

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0002)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0106):     4.50   0.036     4.25    12.28
      + ID2= 2 (  0107):     3.94   0.032     4.17    12.28
        ===================================================
        ID = 3 (  0002):     8.44   0.068     4.17    12.28
```

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     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| ADD HYD  (  0002)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0002):     8.44   0.068     4.17    12.28
      + ID2= 2 (  0012):     2.19   0.018     4.17    12.28
        ====================================================
        ID = 1 (  0002):    10.63   0.086     4.17    12.28

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| CALIB            |
| NASHYD   (  0009)|   Area    (ha)=   2.69   Curve Number   (CN)= 55.9
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.37

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	12.54	6.583	4.56	9.83	0.00
0.167	0.00	3.417	12.54	6.667	4.56	9.92	0.00
0.250	0.00	3.500	12.54	6.750	4.56	10.00	0.00
0.333	0.00	3.583	12.54	6.833	4.56	10.08	0.00
0.417	0.00	3.667	12.54	6.917	4.56	10.17	0.00
0.500	0.00	3.750	12.54	7.000	4.56	10.25	0.00
0.583	0.00	3.833	12.54	7.083	1.71	10.33	0.00
0.667	0.00	3.917	12.54	7.167	1.71	10.42	0.00
0.750	0.00	4.000	12.54	7.250	1.71	10.50	0.00
0.833	0.00	4.083	7.80	7.333	1.71	10.58	0.00
0.917	0.00	4.167	7.80	7.417	1.71	10.67	0.00
1.000	0.00	4.250	7.80	7.500	1.71	10.75	0.00
1.083	8.55	4.333	7.80	7.583	1.71	10.83	0.00
1.167	8.55	4.417	7.80	7.667	1.71	10.92	0.00
1.250	8.55	4.500	7.80	7.750	1.71	11.00	0.00
1.333	8.55	4.583	7.80	7.833	1.71	11.08	0.00
1.417	8.55	4.667	7.80	7.917	1.71	11.17	0.00
1.500	8.55	4.750	7.80	8.000	1.71	11.25	0.00
1.583	8.55	4.833	7.80	8.083	0.57	11.33	0.00
1.667	8.55	4.917	7.80	8.167	0.57	11.42	0.00
1.750	8.55	5.000	7.80	8.250	0.57	11.50	0.00
1.833	8.55	5.083	6.84	8.333	0.57	11.58	0.00
1.917	8.55	5.167	6.84	8.417	0.57	11.67	0.00
2.000	8.55	5.250	6.84	8.500	0.57	11.75	0.00
2.083	14.25	5.333	6.84	8.583	0.57	11.83	0.00
2.167	14.25	5.417	6.84	8.667	0.57	11.92	0.00
2.250	14.25	5.500	6.84	8.750	0.57	12.00	0.00
2.333	14.25	5.583	6.84	8.833	0.57	12.08	0.00
2.417	14.25	5.667	6.84	8.917	0.57	12.17	0.00
2.500	14.25	5.750	6.84	9.000	0.57	12.25	0.00
2.583	14.25	5.833	6.84	9.083	0.00	12.33	0.00
2.667	14.25	5.917	6.84	9.167	0.00	12.42	0.00
2.750	14.25	6.000	6.84	9.250	0.00	12.50	0.00

```
                2.833   14.25 | 6.083    4.56 | 9.333    0.00 | 12.58    0.00
                2.917   14.25 | 6.167    4.56 | 9.417    0.00 | 12.67    0.00
                3.000   14.25 | 6.250    4.56 | 9.500    0.00 | 12.75    0.00
                3.083   12.54 | 6.333    4.56 | 9.583    0.00 | 12.83    0.00
                3.167   12.54 | 6.417    4.56 | 9.667    0.00 | 12.92    0.00
                3.250   12.54 | 6.500    4.56 | 9.750    0.00 | 13.00    0.00

     Unit Hyd Qpeak  (cms)=   0.278

     PEAK FLOW       (cms)=   0.020 (i)
     TIME TO PEAK    (hrs)=   4.083
     RUNOFF VOLUME    (mm)=  10.767
     TOTAL RAINFALL   (mm)=  56.820
     RUNOFF COEFFICIENT   =   0.189

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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       V    V   I    SSSSS  U   U    A    L             (v 6.1.2003)
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
Developed and Distributed by Smart City Water Inc
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                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 6.1\VO2\voin.dat

  Output  filename: C:\Users\agiampuzzi\AppData\Local\Civica\VH5\94083ae8-c3cd-
4c22-9e28-a8fff57a7688\03840c27-690d-42c1-b6ce-89ac84adf415\s
  Summary filename: C:\Users\agiampuzzi\AppData\Local\Civica\VH5\94083ae8-c3cd-
4c22-9e28-a8fff57a7688\03840c27-690d-42c1-b6ce-89ac84adf415\s


DATE: 10-20-2021                           TIME: 12:25:39

USER:


COMMENTS: ____________________________________________________________


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  ************************************************
  ** SIMULATION : 02-AES-100yr                  **
  ************************************************


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|    READ STORM    |    Filename: C:\Users\agiampuzzi\AppD
|                  |              ata\Local\Temp\
|                  |              53c8c437-0cd4-4ad4-8de7-8eaea93c3e33\a509c388
| Ptotal=101.80 mm |    Comments: 100 Year
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 1.00    0.00 |  5.00   14.25 |  9.00    1.02 | 13.00    0.00
                 2.00   15.27 |  6.00   12.22 | 10.00    0.00 |
                 3.00   25.45 |  7.00    8.14 | 11.00    0.00 |
                 4.00   22.40 |  8.00    3.05 | 12.00    0.00 |

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| CALIB              |
| NASHYD   (  0102)|   Area    (ha)=   2.25   Curve Number   (CN)= 52.9
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.77

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
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---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	22.40	6.583	8.14	9.83	0.00
0.167	0.00	3.417	22.40	6.667	8.14	9.92	0.00
0.250	0.00	3.500	22.40	6.750	8.14	10.00	0.00
0.333	0.00	3.583	22.40	6.833	8.14	10.08	0.00
0.417	0.00	3.667	22.40	6.917	8.14	10.17	0.00
0.500	0.00	3.750	22.40	7.000	8.14	10.25	0.00
0.583	0.00	3.833	22.40	7.083	3.05	10.33	0.00
0.667	0.00	3.917	22.40	7.167	3.05	10.42	0.00
0.750	0.00	4.000	22.40	7.250	3.05	10.50	0.00
0.833	0.00	4.083	14.25	7.333	3.05	10.58	0.00
0.917	0.00	4.167	14.25	7.417	3.05	10.67	0.00
1.000	0.00	4.250	14.25	7.500	3.05	10.75	0.00
1.083	15.27	4.333	14.25	7.583	3.05	10.83	0.00
1.167	15.27	4.417	14.25	7.667	3.05	10.92	0.00
1.250	15.27	4.500	14.25	7.750	3.05	11.00	0.00
1.333	15.27	4.583	14.25	7.833	3.05	11.08	0.00
1.417	15.27	4.667	14.25	7.917	3.05	11.17	0.00
1.500	15.27	4.750	14.25	8.000	3.05	11.25	0.00
1.583	15.27	4.833	14.25	8.083	1.02	11.33	0.00
1.667	15.27	4.917	14.25	8.167	1.02	11.42	0.00
1.750	15.27	5.000	14.25	8.250	1.02	11.50	0.00
1.833	15.27	5.083	12.22	8.333	1.02	11.58	0.00
1.917	15.27	5.167	12.22	8.417	1.02	11.67	0.00
2.000	15.27	5.250	12.22	8.500	1.02	11.75	0.00
2.083	25.45	5.333	12.22	8.583	1.02	11.83	0.00
2.167	25.45	5.417	12.22	8.667	1.02	11.92	0.00
2.250	25.45	5.500	12.22	8.750	1.02	12.00	0.00
2.333	25.45	5.583	12.22	8.833	1.02	12.08	0.00
2.417	25.45	5.667	12.22	8.917	1.02	12.17	0.00
2.500	25.45	5.750	12.22	9.000	1.02	12.25	0.00
2.583	25.45	5.833	12.22	9.083	0.00	12.33	0.00
2.667	25.45	5.917	12.22	9.167	0.00	12.42	0.00
2.750	25.45	6.000	12.22	9.250	0.00	12.50	0.00
2.833	25.45	6.083	8.14	9.333	0.00	12.58	0.00
2.917	25.45	6.167	8.14	9.417	0.00	12.67	0.00
3.000	25.45	6.250	8.14	9.500	0.00	12.75	0.00
3.083	22.40	6.333	8.14	9.583	0.00	12.83	0.00
3.167	22.40	6.417	8.14	9.667	0.00	12.92	0.00
3.250	22.40	6.500	8.14	9.750	0.00	13.00	0.00

```
Unit Hyd Qpeak  (cms)=   0.112

PEAK FLOW       (cms)=   0.039 (i)
TIME TO PEAK    (hrs)=   4.667
RUNOFF VOLUME    (mm)=  29.182
TOTAL RAINFALL   (mm)= 101.800
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RUNOFF COEFFICIENT   =   0.287

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| NASHYD   (  0105)|   Area    (ha)=   4.53   Curve Number   (CN)= 59.5
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.57

    NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	22.40	6.583	8.14	9.83	0.00
0.167	0.00	3.417	22.40	6.667	8.14	9.92	0.00
0.250	0.00	3.500	22.40	6.750	8.14	10.00	0.00
0.333	0.00	3.583	22.40	6.833	8.14	10.08	0.00
0.417	0.00	3.667	22.40	6.917	8.14	10.17	0.00
0.500	0.00	3.750	22.40	7.000	8.14	10.25	0.00
0.583	0.00	3.833	22.40	7.083	3.05	10.33	0.00
0.667	0.00	3.917	22.40	7.167	3.05	10.42	0.00
0.750	0.00	4.000	22.40	7.250	3.05	10.50	0.00
0.833	0.00	4.083	14.25	7.333	3.05	10.58	0.00
0.917	0.00	4.167	14.25	7.417	3.05	10.67	0.00
1.000	0.00	4.250	14.25	7.500	3.05	10.75	0.00
1.083	15.27	4.333	14.25	7.583	3.05	10.83	0.00
1.167	15.27	4.417	14.25	7.667	3.05	10.92	0.00
1.250	15.27	4.500	14.25	7.750	3.05	11.00	0.00
1.333	15.27	4.583	14.25	7.833	3.05	11.08	0.00
1.417	15.27	4.667	14.25	7.917	3.05	11.17	0.00
1.500	15.27	4.750	14.25	8.000	3.05	11.25	0.00
1.583	15.27	4.833	14.25	8.083	1.02	11.33	0.00
1.667	15.27	4.917	14.25	8.167	1.02	11.42	0.00
1.750	15.27	5.000	14.25	8.250	1.02	11.50	0.00
1.833	15.27	5.083	12.22	8.333	1.02	11.58	0.00
1.917	15.27	5.167	12.22	8.417	1.02	11.67	0.00
2.000	15.27	5.250	12.22	8.500	1.02	11.75	0.00
2.083	25.45	5.333	12.22	8.583	1.02	11.83	0.00
2.167	25.45	5.417	12.22	8.667	1.02	11.92	0.00
2.250	25.45	5.500	12.22	8.750	1.02	12.00	0.00
2.333	25.45	5.583	12.22	8.833	1.02	12.08	0.00
2.417	25.45	5.667	12.22	8.917	1.02	12.17	0.00
2.500	25.45	5.750	12.22	9.000	1.02	12.25	0.00
2.583	25.45	5.833	12.22	9.083	0.00	12.33	0.00
2.667	25.45	5.917	12.22	9.167	0.00	12.42	0.00
2.750	25.45	6.000	12.22	9.250	0.00	12.50	0.00
2.833	25.45	6.083	8.14	9.333	0.00	12.58	0.00
2.917	25.45	6.167	8.14	9.417	0.00	12.67	0.00
3.000	25.45	6.250	8.14	9.500	0.00	12.75	0.00
3.083	22.40	6.333	8.14	9.583	0.00	12.83	0.00
3.167	22.40	6.417	8.14	9.667	0.00	12.92	0.00
3.250	22.40	6.500	8.14	9.750	0.00	13.00	0.00

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Unit Hyd Qpeak  (cms)=   0.304
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```
     PEAK FLOW       (cms)=   0.101 (i)
     TIME TO PEAK    (hrs)=   4.250
     RUNOFF VOLUME    (mm)=  34.938
     TOTAL RAINFALL   (mm)= 101.800
     RUNOFF COEFFICIENT   =   0.343

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| NASHYD   (  0011)|   Area    (ha)=   3.10   Curve Number   (CN)= 55.1
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.57

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	22.40	6.583	8.14	9.83	0.00
0.167	0.00	3.417	22.40	6.667	8.14	9.92	0.00
0.250	0.00	3.500	22.40	6.750	8.14	10.00	0.00
0.333	0.00	3.583	22.40	6.833	8.14	10.08	0.00
0.417	0.00	3.667	22.40	6.917	8.14	10.17	0.00
0.500	0.00	3.750	22.40	7.000	8.14	10.25	0.00
0.583	0.00	3.833	22.40	7.083	3.05	10.33	0.00
0.667	0.00	3.917	22.40	7.167	3.05	10.42	0.00
0.750	0.00	4.000	22.40	7.250	3.05	10.50	0.00
0.833	0.00	4.083	14.25	7.333	3.05	10.58	0.00
0.917	0.00	4.167	14.25	7.417	3.05	10.67	0.00
1.000	0.00	4.250	14.25	7.500	3.05	10.75	0.00
1.083	15.27	4.333	14.25	7.583	3.05	10.83	0.00
1.167	15.27	4.417	14.25	7.667	3.05	10.92	0.00
1.250	15.27	4.500	14.25	7.750	3.05	11.00	0.00
1.333	15.27	4.583	14.25	7.833	3.05	11.08	0.00
1.417	15.27	4.667	14.25	7.917	3.05	11.17	0.00
1.500	15.27	4.750	14.25	8.000	3.05	11.25	0.00
1.583	15.27	4.833	14.25	8.083	1.02	11.33	0.00
1.667	15.27	4.917	14.25	8.167	1.02	11.42	0.00
1.750	15.27	5.000	14.25	8.250	1.02	11.50	0.00
1.833	15.27	5.083	12.22	8.333	1.02	11.58	0.00
1.917	15.27	5.167	12.22	8.417	1.02	11.67	0.00
2.000	15.27	5.250	12.22	8.500	1.02	11.75	0.00
2.083	25.45	5.333	12.22	8.583	1.02	11.83	0.00
2.167	25.45	5.417	12.22	8.667	1.02	11.92	0.00
2.250	25.45	5.500	12.22	8.750	1.02	12.00	0.00
2.333	25.45	5.583	12.22	8.833	1.02	12.08	0.00
2.417	25.45	5.667	12.22	8.917	1.02	12.17	0.00
2.500	25.45	5.750	12.22	9.000	1.02	12.25	0.00
2.583	25.45	5.833	12.22	9.083	0.00	12.33	0.00
2.667	25.45	5.917	12.22	9.167	0.00	12.42	0.00
2.750	25.45	6.000	12.22	9.250	0.00	12.50	0.00
2.833	25.45	6.083	8.14	9.333	0.00	12.58	0.00
2.917	25.45	6.167	8.14	9.417	0.00	12.67	0.00
3.000	25.45	6.250	8.14	9.500	0.00	12.75	0.00
3.083	22.40	6.333	8.14	9.583	0.00	12.83	0.00
3.167	22.40	6.417	8.14	9.667	0.00	12.92	0.00

```
           3.250   22.40 | 6.500    8.14 | 9.750    0.00 | 13.00    0.00

     Unit Hyd Qpeak  (cms)=   0.208

     PEAK FLOW       (cms)=   0.061 (i)
     TIME TO PEAK    (hrs)=   4.250
     RUNOFF VOLUME    (mm)=  31.021
     TOTAL RAINFALL   (mm)= 101.800
     RUNOFF COEFFICIENT   =   0.305

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0001)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0102):     2.25   0.039     4.67    29.18
      + ID2= 2 (  0105):     4.53   0.101     4.25    34.94
        ====================================================
        ID = 3 (  0001):     6.78   0.139     4.33    33.03

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0001)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0001):     6.78   0.139     4.33    33.03
      + ID2= 2 (  0011):     3.10   0.061     4.25    31.02
        ====================================================
        ID = 1 (  0001):     9.88   0.200     4.33    32.40

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0106)|   Area    (ha)=   4.50   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.48

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
            TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
             hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
           0.083    0.00 | 3.333   22.40 | 6.583    8.14 |  9.83    0.00
           0.167    0.00 | 3.417   22.40 | 6.667    8.14 |  9.92    0.00
           0.250    0.00 | 3.500   22.40 | 6.750    8.14 | 10.00    0.00
           0.333    0.00 | 3.583   22.40 | 6.833    8.14 | 10.08    0.00
           0.417    0.00 | 3.667   22.40 | 6.917    8.14 | 10.17    0.00
           0.500    0.00 | 3.750   22.40 | 7.000    8.14 | 10.25    0.00
           0.583    0.00 | 3.833   22.40 | 7.083    3.05 | 10.33    0.00
           0.667    0.00 | 3.917   22.40 | 7.167    3.05 | 10.42    0.00
           0.750    0.00 | 4.000   22.40 | 7.250    3.05 | 10.50    0.00
           0.833    0.00 | 4.083   14.25 | 7.333    3.05 | 10.58    0.00
```

```
                0.917    0.00 | 4.167   14.25 | 7.417    3.05 | 10.67    0.00
                1.000    0.00 | 4.250   14.25 | 7.500    3.05 | 10.75    0.00
                1.083   15.27 | 4.333   14.25 | 7.583    3.05 | 10.83    0.00
                1.167   15.27 | 4.417   14.25 | 7.667    3.05 | 10.92    0.00
                1.250   15.27 | 4.500   14.25 | 7.750    3.05 | 11.00    0.00
                1.333   15.27 | 4.583   14.25 | 7.833    3.05 | 11.08    0.00
                1.417   15.27 | 4.667   14.25 | 7.917    3.05 | 11.17    0.00
                1.500   15.27 | 4.750   14.25 | 8.000    3.05 | 11.25    0.00
                1.583   15.27 | 4.833   14.25 | 8.083    1.02 | 11.33    0.00
                1.667   15.27 | 4.917   14.25 | 8.167    1.02 | 11.42    0.00
                1.750   15.27 | 5.000   14.25 | 8.250    1.02 | 11.50    0.00
                1.833   15.27 | 5.083   12.22 | 8.333    1.02 | 11.58    0.00
                1.917   15.27 | 5.167   12.22 | 8.417    1.02 | 11.67    0.00
                2.000   15.27 | 5.250   12.22 | 8.500    1.02 | 11.75    0.00
                2.083   25.45 | 5.333   12.22 | 8.583    1.02 | 11.83    0.00
                2.167   25.45 | 5.417   12.22 | 8.667    1.02 | 11.92    0.00
                2.250   25.45 | 5.500   12.22 | 8.750    1.02 | 12.00    0.00
                2.333   25.45 | 5.583   12.22 | 8.833    1.02 | 12.08    0.00
                2.417   25.45 | 5.667   12.22 | 8.917    1.02 | 12.17    0.00
                2.500   25.45 | 5.750   12.22 | 9.000    1.02 | 12.25    0.00
                2.583   25.45 | 5.833   12.22 | 9.083    0.00 | 12.33    0.00
                2.667   25.45 | 5.917   12.22 | 9.167    0.00 | 12.42    0.00
                2.750   25.45 | 6.000   12.22 | 9.250    0.00 | 12.50    0.00
                2.833   25.45 | 6.083    8.14 | 9.333    0.00 | 12.58    0.00
                2.917   25.45 | 6.167    8.14 | 9.417    0.00 | 12.67    0.00
                3.000   25.45 | 6.250    8.14 | 9.500    0.00 | 12.75    0.00
                3.083   22.40 | 6.333    8.14 | 9.583    0.00 | 12.83    0.00
                3.167   22.40 | 6.417    8.14 | 9.667    0.00 | 12.92    0.00
                3.250   22.40 | 6.500    8.14 | 9.750    0.00 | 13.00    0.00

     Unit Hyd Qpeak  (cms)=   0.358

     PEAK FLOW       (cms)=   0.106 (i)
     TIME TO PEAK    (hrs)=   4.167
     RUNOFF VOLUME    (mm)=  35.403
     TOTAL RAINFALL   (mm)= 101.800
     RUNOFF COEFFICIENT   =   0.348

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0107)|   Area    (ha)=   3.94   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.42

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                  ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 3.333   22.40 | 6.583    8.14 |  9.83    0.00
                0.167    0.00 | 3.417   22.40 | 6.667    8.14 |  9.92    0.00
                0.250    0.00 | 3.500   22.40 | 6.750    8.14 | 10.00    0.00
                0.333    0.00 | 3.583   22.40 | 6.833    8.14 | 10.08    0.00
                0.417    0.00 | 3.667   22.40 | 6.917    8.14 | 10.17    0.00
                0.500    0.00 | 3.750   22.40 | 7.000    8.14 | 10.25    0.00
```

```
             0.583    0.00 | 3.833   22.40 | 7.083    3.05 | 10.33    0.00
             0.667    0.00 | 3.917   22.40 | 7.167    3.05 | 10.42    0.00
             0.750    0.00 | 4.000   22.40 | 7.250    3.05 | 10.50    0.00
             0.833    0.00 | 4.083   14.25 | 7.333    3.05 | 10.58    0.00
             0.917    0.00 | 4.167   14.25 | 7.417    3.05 | 10.67    0.00
             1.000    0.00 | 4.250   14.25 | 7.500    3.05 | 10.75    0.00
             1.083   15.27 | 4.333   14.25 | 7.583    3.05 | 10.83    0.00
             1.167   15.27 | 4.417   14.25 | 7.667    3.05 | 10.92    0.00
             1.250   15.27 | 4.500   14.25 | 7.750    3.05 | 11.00    0.00
             1.333   15.27 | 4.583   14.25 | 7.833    3.05 | 11.08    0.00
             1.417   15.27 | 4.667   14.25 | 7.917    3.05 | 11.17    0.00
             1.500   15.27 | 4.750   14.25 | 8.000    3.05 | 11.25    0.00
             1.583   15.27 | 4.833   14.25 | 8.083    1.02 | 11.33    0.00
             1.667   15.27 | 4.917   14.25 | 8.167    1.02 | 11.42    0.00
             1.750   15.27 | 5.000   14.25 | 8.250    1.02 | 11.50    0.00
             1.833   15.27 | 5.083   12.22 | 8.333    1.02 | 11.58    0.00
             1.917   15.27 | 5.167   12.22 | 8.417    1.02 | 11.67    0.00
             2.000   15.27 | 5.250   12.22 | 8.500    1.02 | 11.75    0.00
             2.083   25.45 | 5.333   12.22 | 8.583    1.02 | 11.83    0.00
             2.167   25.45 | 5.417   12.22 | 8.667    1.02 | 11.92    0.00
             2.250   25.45 | 5.500   12.22 | 8.750    1.02 | 12.00    0.00
             2.333   25.45 | 5.583   12.22 | 8.833    1.02 | 12.08    0.00
             2.417   25.45 | 5.667   12.22 | 8.917    1.02 | 12.17    0.00
             2.500   25.45 | 5.750   12.22 | 9.000    1.02 | 12.25    0.00
             2.583   25.45 | 5.833   12.22 | 9.083    0.00 | 12.33    0.00
             2.667   25.45 | 5.917   12.22 | 9.167    0.00 | 12.42    0.00
             2.750   25.45 | 6.000   12.22 | 9.250    0.00 | 12.50    0.00
             2.833   25.45 | 6.083    8.14 | 9.333    0.00 | 12.58    0.00
             2.917   25.45 | 6.167    8.14 | 9.417    0.00 | 12.67    0.00
             3.000   25.45 | 6.250    8.14 | 9.500    0.00 | 12.75    0.00
             3.083   22.40 | 6.333    8.14 | 9.583    0.00 | 12.83    0.00
             3.167   22.40 | 6.417    8.14 | 9.667    0.00 | 12.92    0.00
             3.250   22.40 | 6.500    8.14 | 9.750    0.00 | 13.00    0.00

     Unit Hyd Qpeak  (cms)=   0.358

     PEAK FLOW       (cms)=   0.094 (i)
     TIME TO PEAK    (hrs)=   4.167
     RUNOFF VOLUME    (mm)=  35.402
     TOTAL RAINFALL   (mm)= 101.800
     RUNOFF COEFFICIENT   =   0.348

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0012)|   Area    (ha)=   2.19   Curve Number   (CN)= 60.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.45

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
              TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
               hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
             0.083    0.00 | 3.333   22.40 | 6.583    8.14 |  9.83    0.00
             0.167    0.00 | 3.417   22.40 | 6.667    8.14 |  9.92    0.00
```

```
            0.250    0.00 | 3.500   22.40 | 6.750    8.14 | 10.00    0.00
            0.333    0.00 | 3.583   22.40 | 6.833    8.14 | 10.08    0.00
            0.417    0.00 | 3.667   22.40 | 6.917    8.14 | 10.17    0.00
            0.500    0.00 | 3.750   22.40 | 7.000    8.14 | 10.25    0.00
            0.583    0.00 | 3.833   22.40 | 7.083    3.05 | 10.33    0.00
            0.667    0.00 | 3.917   22.40 | 7.167    3.05 | 10.42    0.00
            0.750    0.00 | 4.000   22.40 | 7.250    3.05 | 10.50    0.00
            0.833    0.00 | 4.083   14.25 | 7.333    3.05 | 10.58    0.00
            0.917    0.00 | 4.167   14.25 | 7.417    3.05 | 10.67    0.00
            1.000    0.00 | 4.250   14.25 | 7.500    3.05 | 10.75    0.00
            1.083   15.27 | 4.333   14.25 | 7.583    3.05 | 10.83    0.00
            1.167   15.27 | 4.417   14.25 | 7.667    3.05 | 10.92    0.00
            1.250   15.27 | 4.500   14.25 | 7.750    3.05 | 11.00    0.00
            1.333   15.27 | 4.583   14.25 | 7.833    3.05 | 11.08    0.00
            1.417   15.27 | 4.667   14.25 | 7.917    3.05 | 11.17    0.00
            1.500   15.27 | 4.750   14.25 | 8.000    3.05 | 11.25    0.00
            1.583   15.27 | 4.833   14.25 | 8.083    1.02 | 11.33    0.00
            1.667   15.27 | 4.917   14.25 | 8.167    1.02 | 11.42    0.00
            1.750   15.27 | 5.000   14.25 | 8.250    1.02 | 11.50    0.00
            1.833   15.27 | 5.083   12.22 | 8.333    1.02 | 11.58    0.00
            1.917   15.27 | 5.167   12.22 | 8.417    1.02 | 11.67    0.00
            2.000   15.27 | 5.250   12.22 | 8.500    1.02 | 11.75    0.00
            2.083   25.45 | 5.333   12.22 | 8.583    1.02 | 11.83    0.00
            2.167   25.45 | 5.417   12.22 | 8.667    1.02 | 11.92    0.00
            2.250   25.45 | 5.500   12.22 | 8.750    1.02 | 12.00    0.00
            2.333   25.45 | 5.583   12.22 | 8.833    1.02 | 12.08    0.00
            2.417   25.45 | 5.667   12.22 | 8.917    1.02 | 12.17    0.00
            2.500   25.45 | 5.750   12.22 | 9.000    1.02 | 12.25    0.00
            2.583   25.45 | 5.833   12.22 | 9.083    0.00 | 12.33    0.00
            2.667   25.45 | 5.917   12.22 | 9.167    0.00 | 12.42    0.00
            2.750   25.45 | 6.000   12.22 | 9.250    0.00 | 12.50    0.00
            2.833   25.45 | 6.083    8.14 | 9.333    0.00 | 12.58    0.00
            2.917   25.45 | 6.167    8.14 | 9.417    0.00 | 12.67    0.00
            3.000   25.45 | 6.250    8.14 | 9.500    0.00 | 12.75    0.00
            3.083   22.40 | 6.333    8.14 | 9.583    0.00 | 12.83    0.00
            3.167   22.40 | 6.417    8.14 | 9.667    0.00 | 12.92    0.00
            3.250   22.40 | 6.500    8.14 | 9.750    0.00 | 13.00    0.00

     Unit Hyd Qpeak  (cms)=   0.186

     PEAK FLOW       (cms)=   0.052 (i)
     TIME TO PEAK    (hrs)=   4.167
     RUNOFF VOLUME    (mm)=  35.402
     TOTAL RAINFALL   (mm)= 101.800
     RUNOFF COEFFICIENT   =   0.348

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0002)|
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0106):      4.50   0.106     4.17    35.40
      + ID2= 2 (  0107):      3.94   0.094     4.17    35.40
        =====================================================
        ID = 3 (  0002):      8.44   0.200     4.17    35.40
```

```
     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
 -------------------------------------------------------------------------------

 --------------------
 | ADD HYD  (  0002)|
 |   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
 --------------------         (ha)    (cms)    (hrs)     (mm)
         ID1= 3 (  0002):      8.44   0.200     4.17    35.40
       + ID2= 2 (  0012):      2.19   0.052     4.17    35.40
         ====================================================
         ID = 1 (  0002):     10.63   0.252     4.17    35.40

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
 -------------------------------------------------------------------------------
 --------------------
 | CALIB            |
 | NASHYD   (  0009)|   Area    (ha)=   2.69   Curve Number   (CN)= 55.9
 |ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
 --------------------   U.H. Tp(hrs)=   0.37

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                       ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.083    0.00 | 3.333   22.40 | 6.583    8.14 |  9.83    0.00
                 0.167    0.00 | 3.417   22.40 | 6.667    8.14 |  9.92    0.00
                 0.250    0.00 | 3.500   22.40 | 6.750    8.14 | 10.00    0.00
                 0.333    0.00 | 3.583   22.40 | 6.833    8.14 | 10.08    0.00
                 0.417    0.00 | 3.667   22.40 | 6.917    8.14 | 10.17    0.00
                 0.500    0.00 | 3.750   22.40 | 7.000    8.14 | 10.25    0.00
                 0.583    0.00 | 3.833   22.40 | 7.083    3.05 | 10.33    0.00
                 0.667    0.00 | 3.917   22.40 | 7.167    3.05 | 10.42    0.00
                 0.750    0.00 | 4.000   22.40 | 7.250    3.05 | 10.50    0.00
                 0.833    0.00 | 4.083   14.25 | 7.333    3.05 | 10.58    0.00
                 0.917    0.00 | 4.167   14.25 | 7.417    3.05 | 10.67    0.00
                 1.000    0.00 | 4.250   14.25 | 7.500    3.05 | 10.75    0.00
                 1.083   15.27 | 4.333   14.25 | 7.583    3.05 | 10.83    0.00
                 1.167   15.27 | 4.417   14.25 | 7.667    3.05 | 10.92    0.00
                 1.250   15.27 | 4.500   14.25 | 7.750    3.05 | 11.00    0.00
                 1.333   15.27 | 4.583   14.25 | 7.833    3.05 | 11.08    0.00
                 1.417   15.27 | 4.667   14.25 | 7.917    3.05 | 11.17    0.00
                 1.500   15.27 | 4.750   14.25 | 8.000    3.05 | 11.25    0.00
                 1.583   15.27 | 4.833   14.25 | 8.083    1.02 | 11.33    0.00
                 1.667   15.27 | 4.917   14.25 | 8.167    1.02 | 11.42    0.00
                 1.750   15.27 | 5.000   14.25 | 8.250    1.02 | 11.50    0.00
                 1.833   15.27 | 5.083   12.22 | 8.333    1.02 | 11.58    0.00
                 1.917   15.27 | 5.167   12.22 | 8.417    1.02 | 11.67    0.00
                 2.000   15.27 | 5.250   12.22 | 8.500    1.02 | 11.75    0.00
                 2.083   25.45 | 5.333   12.22 | 8.583    1.02 | 11.83    0.00
                 2.167   25.45 | 5.417   12.22 | 8.667    1.02 | 11.92    0.00
                 2.250   25.45 | 5.500   12.22 | 8.750    1.02 | 12.00    0.00
                 2.333   25.45 | 5.583   12.22 | 8.833    1.02 | 12.08    0.00
                 2.417   25.45 | 5.667   12.22 | 8.917    1.02 | 12.17    0.00
                 2.500   25.45 | 5.750   12.22 | 9.000    1.02 | 12.25    0.00
                 2.583   25.45 | 5.833   12.22 | 9.083    0.00 | 12.33    0.00
                 2.667   25.45 | 5.917   12.22 | 9.167    0.00 | 12.42    0.00
                 2.750   25.45 | 6.000   12.22 | 9.250    0.00 | 12.50    0.00
```

```
            2.833   25.45 | 6.083    8.14 | 9.333    0.00 | 12.58    0.00
            2.917   25.45 | 6.167    8.14 | 9.417    0.00 | 12.67    0.00
            3.000   25.45 | 6.250    8.14 | 9.500    0.00 | 12.75    0.00
            3.083   22.40 | 6.333    8.14 | 9.583    0.00 | 12.83    0.00
            3.167   22.40 | 6.417    8.14 | 9.667    0.00 | 12.92    0.00
            3.250   22.40 | 6.500    8.14 | 9.750    0.00 | 13.00    0.00

     Unit Hyd Qpeak  (cms)=   0.278

     PEAK FLOW       (cms)=   0.058 (i)
     TIME TO PEAK    (hrs)=   4.083
     RUNOFF VOLUME    (mm)=  31.705
     TOTAL RAINFALL   (mm)= 101.800
     RUNOFF COEFFICIENT   =   0.311

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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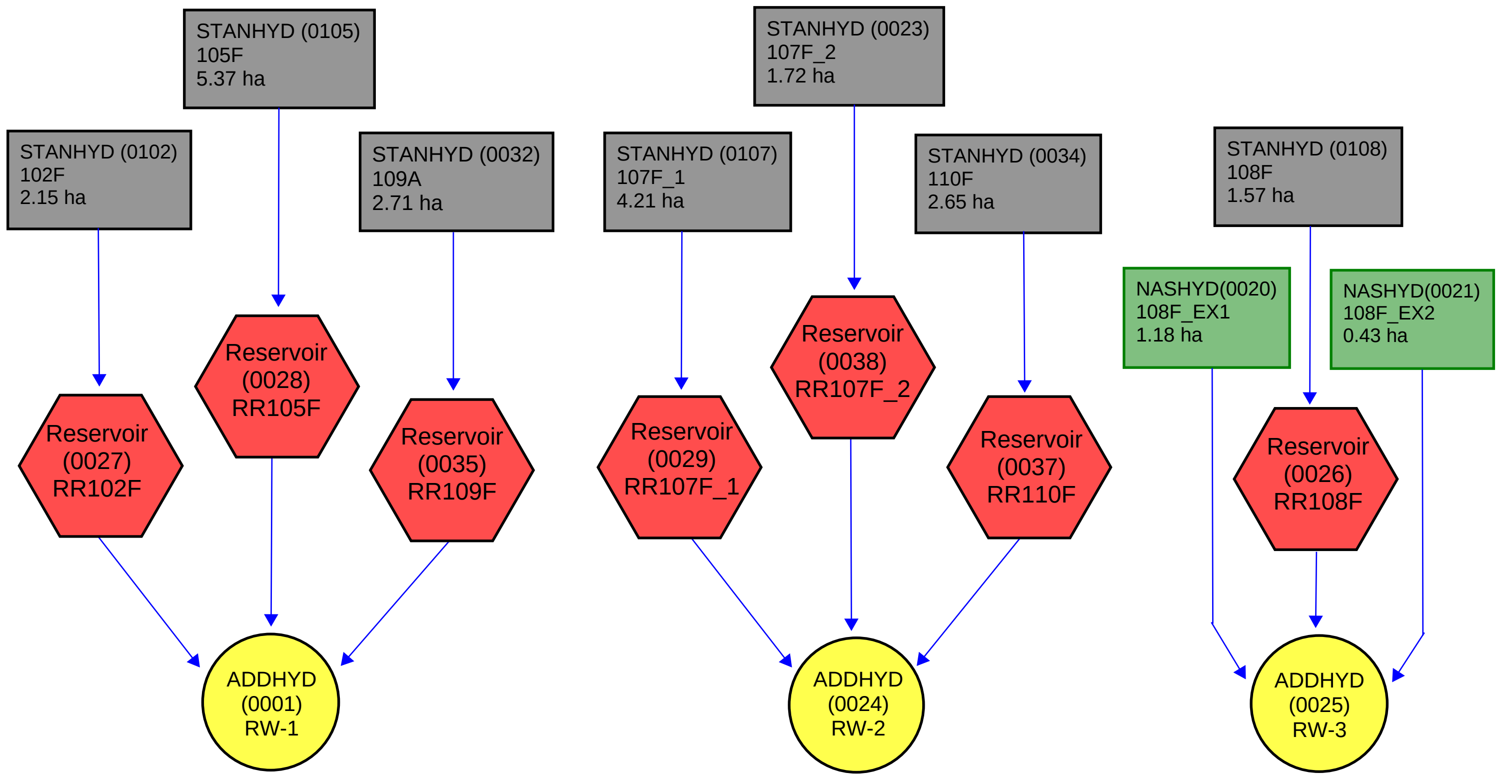
Phase A Post-Development
Stormwater Management Schematic
1909-5629



```
========================================================================================================

       V    V   I    SSSSS  U   U    A    L             (v 6.1.2003)
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
Developed and Distributed by Smart City Water Inc
```


```
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DATE: 10-26-2021                           TIME: 02:24:38

USER:


COMMENTS: ____________________________________________________________


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  ************************************************
  ** SIMULATION : 01-AES-5yr                   **
  ************************************************


--------------------
|    READ STORM    |    Filename: C:\Users\agiampuzzi\AppD
|                  |              ata\Local\Temp\
|                  |              7ac3cc91-ada5-4407-a88e-b2e97255f693\c11a765b
| Ptotal= 56.82 mm |    Comments: 5 Year
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 1.00    0.00 |  5.00    7.80 |  9.00    0.57 | 13.00    0.00
                 2.00    8.55 |  6.00    6.84 | 10.00    0.00 |
                 3.00   14.25 |  7.00    4.56 | 11.00    0.00 |
                 4.00   12.54 |  8.00    1.71 | 12.00    0.00 |

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--------------------
| CALIB            |
| STANDHYD (  0102)|   Area    (ha)=   2.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.61          0.54
     Dep. Storage     (mm)=       1.00          1.57
     Average Slope     (%)=       0.50          0.50
     Length            (m)=     119.72        587.00
     Mannings n           =      0.013         0.050

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	12.54	6.583	4.56	9.83	0.00
0.167	0.00	3.417	12.54	6.667	4.56	9.92	0.00
0.250	0.00	3.500	12.54	6.750	4.56	10.00	0.00
0.333	0.00	3.583	12.54	6.833	4.56	10.08	0.00
0.417	0.00	3.667	12.54	6.917	4.56	10.17	0.00
0.500	0.00	3.750	12.54	7.000	4.56	10.25	0.00
0.583	0.00	3.833	12.54	7.083	1.71	10.33	0.00
0.667	0.00	3.917	12.54	7.167	1.71	10.42	0.00
0.750	0.00	4.000	12.54	7.250	1.71	10.50	0.00
0.833	0.00	4.083	7.80	7.333	1.71	10.58	0.00
0.917	0.00	4.167	7.80	7.417	1.71	10.67	0.00
1.000	0.00	4.250	7.80	7.500	1.71	10.75	0.00
1.083	8.55	4.333	7.80	7.583	1.71	10.83	0.00
1.167	8.55	4.417	7.80	7.667	1.71	10.92	0.00
1.250	8.55	4.500	7.80	7.750	1.71	11.00	0.00
1.333	8.55	4.583	7.80	7.833	1.71	11.08	0.00
1.417	8.55	4.667	7.80	7.917	1.71	11.17	0.00
1.500	8.55	4.750	7.80	8.000	1.71	11.25	0.00
1.583	8.55	4.833	7.80	8.083	0.57	11.33	0.00
1.667	8.55	4.917	7.80	8.167	0.57	11.42	0.00
1.750	8.55	5.000	7.80	8.250	0.57	11.50	0.00
1.833	8.55	5.083	6.84	8.333	0.57	11.58	0.00
1.917	8.55	5.167	6.84	8.417	0.57	11.67	0.00
2.000	8.55	5.250	6.84	8.500	0.57	11.75	0.00
2.083	14.25	5.333	6.84	8.583	0.57	11.83	0.00
2.167	14.25	5.417	6.84	8.667	0.57	11.92	0.00
2.250	14.25	5.500	6.84	8.750	0.57	12.00	0.00
2.333	14.25	5.583	6.84	8.833	0.57	12.08	0.00
2.417	14.25	5.667	6.84	8.917	0.57	12.17	0.00
2.500	14.25	5.750	6.84	9.000	0.57	12.25	0.00
2.583	14.25	5.833	6.84	9.083	0.00	12.33	0.00
2.667	14.25	5.917	6.84	9.167	0.00	12.42	0.00
2.750	14.25	6.000	6.84	9.250	0.00	12.50	0.00
2.833	14.25	6.083	4.56	9.333	0.00	12.58	0.00
2.917	14.25	6.167	4.56	9.417	0.00	12.67	0.00
3.000	14.25	6.250	4.56	9.500	0.00	12.75	0.00
3.083	12.54	6.333	4.56	9.583	0.00	12.83	0.00
3.167	12.54	6.417	4.56	9.667	0.00	12.92	0.00
3.250	12.54	6.500	4.56	9.750	0.00	13.00	0.00

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     Max.Eff.Inten.(mm/hr)=      14.25        11.14
                over (min)       10.00        60.00
     Storage Coeff.  (min)=       7.64 (ii)   56.74 (ii)
     Unit Hyd. Tpeak (min)=      10.00        60.00
     Unit Hyd. peak  (cms)=       0.13         0.02
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.06         0.01          0.071 (iii)
     TIME TO PEAK    (hrs)=       3.00         4.50           3.00
     RUNOFF VOLUME    (mm)=      55.82        43.94          52.84
     TOTAL RAINFALL   (mm)=      56.82        56.82          56.82
     RUNOFF COEFFICIENT   =       0.98         0.77           0.93


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  94.7    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0027)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0390      0.1600
                          0.0130     0.1000   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0102)      2.150      0.071      3.00      52.84
   OUTFLOW: ID= 1 (  0027)      2.150      0.012      8.08      51.93
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                 TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                 CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                 PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                 PEAK   FLOW   REDUCTION [Qout/Qin](%)= 16.78
                 TIME SHIFT OF PEAK FLOW         (min)=305.00
                 MAXIMUM  STORAGE   USED       (ha.m.)=  0.0917

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--------------------
| CALIB            |
| STANDHYD (  0105)|   Area    (ha)=   5.37
|ID= 1 DT= 5.0 min |   Total Imp(%)=  77.00   Dir. Conn.(%)=  77.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       4.13         1.24
     Dep. Storage     (mm)=       1.00         1.57
     Average Slope     (%)=       0.40         0.40
     Length            (m)=     189.21       604.00
     Mannings n           =      0.013        0.050

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                ---- TRANSFORMED HYETOGRAPH ----
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	12.54	6.583	4.56	9.83	0.00
0.167	0.00	3.417	12.54	6.667	4.56	9.92	0.00
0.250	0.00	3.500	12.54	6.750	4.56	10.00	0.00
0.333	0.00	3.583	12.54	6.833	4.56	10.08	0.00
0.417	0.00	3.667	12.54	6.917	4.56	10.17	0.00
0.500	0.00	3.750	12.54	7.000	4.56	10.25	0.00
0.583	0.00	3.833	12.54	7.083	1.71	10.33	0.00
0.667	0.00	3.917	12.54	7.167	1.71	10.42	0.00
0.750	0.00	4.000	12.54	7.250	1.71	10.50	0.00
0.833	0.00	4.083	7.80	7.333	1.71	10.58	0.00
0.917	0.00	4.167	7.80	7.417	1.71	10.67	0.00
1.000	0.00	4.250	7.80	7.500	1.71	10.75	0.00
1.083	8.55	4.333	7.80	7.583	1.71	10.83	0.00
1.167	8.55	4.417	7.80	7.667	1.71	10.92	0.00
1.250	8.55	4.500	7.80	7.750	1.71	11.00	0.00
1.333	8.55	4.583	7.80	7.833	1.71	11.08	0.00
1.417	8.55	4.667	7.80	7.917	1.71	11.17	0.00
1.500	8.55	4.750	7.80	8.000	1.71	11.25	0.00
1.583	8.55	4.833	7.80	8.083	0.57	11.33	0.00
1.667	8.55	4.917	7.80	8.167	0.57	11.42	0.00
1.750	8.55	5.000	7.80	8.250	0.57	11.50	0.00
1.833	8.55	5.083	6.84	8.333	0.57	11.58	0.00
1.917	8.55	5.167	6.84	8.417	0.57	11.67	0.00
2.000	8.55	5.250	6.84	8.500	0.57	11.75	0.00
2.083	14.25	5.333	6.84	8.583	0.57	11.83	0.00
2.167	14.25	5.417	6.84	8.667	0.57	11.92	0.00
2.250	14.25	5.500	6.84	8.750	0.57	12.00	0.00
2.333	14.25	5.583	6.84	8.833	0.57	12.08	0.00
2.417	14.25	5.667	6.84	8.917	0.57	12.17	0.00
2.500	14.25	5.750	6.84	9.000	0.57	12.25	0.00
2.583	14.25	5.833	6.84	9.083	0.00	12.33	0.00
2.667	14.25	5.917	6.84	9.167	0.00	12.42	0.00
2.750	14.25	6.000	6.84	9.250	0.00	12.50	0.00
2.833	14.25	6.083	4.56	9.333	0.00	12.58	0.00
2.917	14.25	6.167	4.56	9.417	0.00	12.67	0.00
3.000	14.25	6.250	4.56	9.500	0.00	12.75	0.00
3.083	12.54	6.333	4.56	9.583	0.00	12.83	0.00
3.167	12.54	6.417	4.56	9.667	0.00	12.92	0.00
3.250	12.54	6.500	4.56	9.750	0.00	13.00	0.00

Max.Eff.Inten.(mm/hr)=	14.25	10.24	
over (min)	10.00	70.00	
Storage Coeff. (min)=	10.75 (ii)	65.99 (ii)	
Unit Hyd. Tpeak (min)=	10.00	70.00	
Unit Hyd. peak (cms)=	0.11	0.02	
			TOTALS
PEAK FLOW (cms)=	0.16	0.03	0.174 (iii)
TIME TO PEAK (hrs)=	3.00	4.75	3.00
RUNOFF VOLUME (mm)=	55.82	40.41	52.27
TOTAL RAINFALL (mm)=	56.82	56.82	56.82
RUNOFF COEFFICIENT =	0.98	0.71	0.92

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 92.6 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.

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     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0028)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1010      0.3750
                          0.0340     0.2200   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0105)      5.370      0.174      3.00       52.27
   OUTFLOW: ID= 1 (  0028)      5.370      0.034      8.00       51.96
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00        0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 19.34
                   TIME SHIFT OF PEAK FLOW         (min)=300.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2182

------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0032)|   Area    (ha)=   2.71
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.03          0.68
     Dep. Storage     (mm)=       1.00          1.57
     Average Slope     (%)=       1.00          2.00
     Length            (m)=     134.41         30.00
     Mannings n          =      0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 3.333   12.54 | 6.583    4.56 |  9.83    0.00
                0.167    0.00 | 3.417   12.54 | 6.667    4.56 |  9.92    0.00
                0.250    0.00 | 3.500   12.54 | 6.750    4.56 | 10.00    0.00
                0.333    0.00 | 3.583   12.54 | 6.833    4.56 | 10.08    0.00
                0.417    0.00 | 3.667   12.54 | 6.917    4.56 | 10.17    0.00
                0.500    0.00 | 3.750   12.54 | 7.000    4.56 | 10.25    0.00
                0.583    0.00 | 3.833   12.54 | 7.083    1.71 | 10.33    0.00
                0.667    0.00 | 3.917   12.54 | 7.167    1.71 | 10.42    0.00
                0.750    0.00 | 4.000   12.54 | 7.250    1.71 | 10.50    0.00
                0.833    0.00 | 4.083    7.80 | 7.333    1.71 | 10.58    0.00
                0.917    0.00 | 4.167    7.80 | 7.417    1.71 | 10.67    0.00
                1.000    0.00 | 4.250    7.80 | 7.500    1.71 | 10.75    0.00
                1.083    8.55 | 4.333    7.80 | 7.583    1.71 | 10.83    0.00
                1.167    8.55 | 4.417    7.80 | 7.667    1.71 | 10.92    0.00
                1.250    8.55 | 4.500    7.80 | 7.750    1.71 | 11.00    0.00
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                 1.333    8.55 | 4.583    7.80 | 7.833    1.71 | 11.08    0.00
                 1.417    8.55 | 4.667    7.80 | 7.917    1.71 | 11.17    0.00
                 1.500    8.55 | 4.750    7.80 | 8.000    1.71 | 11.25    0.00
                 1.583    8.55 | 4.833    7.80 | 8.083    0.57 | 11.33    0.00
                 1.667    8.55 | 4.917    7.80 | 8.167    0.57 | 11.42    0.00
                 1.750    8.55 | 5.000    7.80 | 8.250    0.57 | 11.50    0.00
                 1.833    8.55 | 5.083    6.84 | 8.333    0.57 | 11.58    0.00
                 1.917    8.55 | 5.167    6.84 | 8.417    0.57 | 11.67    0.00
                 2.000    8.55 | 5.250    6.84 | 8.500    0.57 | 11.75    0.00
                 2.083   14.25 | 5.333    6.84 | 8.583    0.57 | 11.83    0.00
                 2.167   14.25 | 5.417    6.84 | 8.667    0.57 | 11.92    0.00
                 2.250   14.25 | 5.500    6.84 | 8.750    0.57 | 12.00    0.00
                 2.333   14.25 | 5.583    6.84 | 8.833    0.57 | 12.08    0.00
                 2.417   14.25 | 5.667    6.84 | 8.917    0.57 | 12.17    0.00
                 2.500   14.25 | 5.750    6.84 | 9.000    0.57 | 12.25    0.00
                 2.583   14.25 | 5.833    6.84 | 9.083    0.00 | 12.33    0.00
                 2.667   14.25 | 5.917    6.84 | 9.167    0.00 | 12.42    0.00
                 2.750   14.25 | 6.000    6.84 | 9.250    0.00 | 12.50    0.00
                 2.833   14.25 | 6.083    4.56 | 9.333    0.00 | 12.58    0.00
                 2.917   14.25 | 6.167    4.56 | 9.417    0.00 | 12.67    0.00
                 3.000   14.25 | 6.250    4.56 | 9.500    0.00 | 12.75    0.00
                 3.083   12.54 | 6.333    4.56 | 9.583    0.00 | 12.83    0.00
                 3.167   12.54 | 6.417    4.56 | 9.667    0.00 | 12.92    0.00
                 3.250   12.54 | 6.500    4.56 | 9.750    0.00 | 13.00    0.00

     Max.Eff.Inten.(mm/hr)=      14.25        12.83
                over (min)        5.00        25.00
     Storage Coeff.  (min)=       6.65 (ii)   20.15 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.18         0.05
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.08         0.02           0.102 (iii)
     TIME TO PEAK    (hrs)=       3.00         3.33            3.00
     RUNOFF VOLUME    (mm)=      55.82        47.56           53.75
     TOTAL RAINFALL   (mm)=      56.82        56.82           56.82
     RUNOFF COEFFICIENT   =       0.98         0.84            0.95


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  96.6    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0035)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0610      0.1900
                          0.0200     0.1200   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0032)      2.710      0.102      3.00       53.75
   OUTFLOW: ID= 1 (  0035)      2.710      0.019      7.25       53.19
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00        0.00
```

```
                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 18.65
                   TIME SHIFT OF PEAK FLOW         (min)=255.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1139

 ------------------------------------------------------------------------------

 --------------------
 | ADD HYD  (  0001)|
 |   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
 --------------------         (ha)    (cms)    (hrs)     (mm)
         ID1= 1 (  0027):      2.15   0.012     8.08    51.93
       + ID2= 2 (  0028):      5.37   0.034     8.00    51.96
         ====================================================
         ID = 3 (  0001):      7.52   0.046     8.08    51.95

      NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
 ------------------------------------------------------------------------------

 --------------------
 | ADD HYD  (  0001)|
 |   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
 --------------------         (ha)    (cms)    (hrs)     (mm)
         ID1= 3 (  0001):      7.52   0.046     8.08    51.95
       + ID2= 2 (  0035):      2.71   0.019     7.25    53.19
         ====================================================
         ID = 1 (  0001):     10.23   0.064     7.75    52.28

      NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
 ------------------------------------------------------------------------------
 --------------------
 | CALIB            |
 | STANDHYD (  0107)|   Area    (ha)=   4.21
 |ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
 --------------------
                               IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=       3.16         1.05
      Dep. Storage     (mm)=       1.00         1.57
      Average Slope     (%)=       0.35         0.35
      Length            (m)=     167.53       593.00
      Mannings n          =      0.013        0.050

          NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                  ---- TRANSFORMED HYETOGRAPH ----
                     TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                      hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                    0.083    0.00 | 3.333   12.54 | 6.583    4.56 |  9.83    0.00
                    0.167    0.00 | 3.417   12.54 | 6.667    4.56 |  9.92    0.00
                    0.250    0.00 | 3.500   12.54 | 6.750    4.56 | 10.00    0.00
                    0.333    0.00 | 3.583   12.54 | 6.833    4.56 | 10.08    0.00
                    0.417    0.00 | 3.667   12.54 | 6.917    4.56 | 10.17    0.00
                    0.500    0.00 | 3.750   12.54 | 7.000    4.56 | 10.25    0.00
                    0.583    0.00 | 3.833   12.54 | 7.083    1.71 | 10.33    0.00
                    0.667    0.00 | 3.917   12.54 | 7.167    1.71 | 10.42    0.00
```

```
                    0.750    0.00 | 4.000   12.54 | 7.250    1.71 | 10.50    0.00
                    0.833    0.00 | 4.083    7.80 | 7.333    1.71 | 10.58    0.00
                    0.917    0.00 | 4.167    7.80 | 7.417    1.71 | 10.67    0.00
                    1.000    0.00 | 4.250    7.80 | 7.500    1.71 | 10.75    0.00
                    1.083    8.55 | 4.333    7.80 | 7.583    1.71 | 10.83    0.00
                    1.167    8.55 | 4.417    7.80 | 7.667    1.71 | 10.92    0.00
                    1.250    8.55 | 4.500    7.80 | 7.750    1.71 | 11.00    0.00
                    1.333    8.55 | 4.583    7.80 | 7.833    1.71 | 11.08    0.00
                    1.417    8.55 | 4.667    7.80 | 7.917    1.71 | 11.17    0.00
                    1.500    8.55 | 4.750    7.80 | 8.000    1.71 | 11.25    0.00
                    1.583    8.55 | 4.833    7.80 | 8.083    0.57 | 11.33    0.00
                    1.667    8.55 | 4.917    7.80 | 8.167    0.57 | 11.42    0.00
                    1.750    8.55 | 5.000    7.80 | 8.250    0.57 | 11.50    0.00
                    1.833    8.55 | 5.083    6.84 | 8.333    0.57 | 11.58    0.00
                    1.917    8.55 | 5.167    6.84 | 8.417    0.57 | 11.67    0.00
                    2.000    8.55 | 5.250    6.84 | 8.500    0.57 | 11.75    0.00
                    2.083   14.25 | 5.333    6.84 | 8.583    0.57 | 11.83    0.00
                    2.167   14.25 | 5.417    6.84 | 8.667    0.57 | 11.92    0.00
                    2.250   14.25 | 5.500    6.84 | 8.750    0.57 | 12.00    0.00
                    2.333   14.25 | 5.583    6.84 | 8.833    0.57 | 12.08    0.00
                    2.417   14.25 | 5.667    6.84 | 8.917    0.57 | 12.17    0.00
                    2.500   14.25 | 5.750    6.84 | 9.000    0.57 | 12.25    0.00
                    2.583   14.25 | 5.833    6.84 | 9.083    0.00 | 12.33    0.00
                    2.667   14.25 | 5.917    6.84 | 9.167    0.00 | 12.42    0.00
                    2.750   14.25 | 6.000    6.84 | 9.250    0.00 | 12.50    0.00
                    2.833   14.25 | 6.083    4.56 | 9.333    0.00 | 12.58    0.00
                    2.917   14.25 | 6.167    4.56 | 9.417    0.00 | 12.67    0.00
                    3.000   14.25 | 6.250    4.56 | 9.500    0.00 | 12.75    0.00
                    3.083   12.54 | 6.333    4.56 | 9.583    0.00 | 12.83    0.00
                    3.167   12.54 | 6.417    4.56 | 9.667    0.00 | 12.92    0.00
                    3.250   12.54 | 6.500    4.56 | 9.750    0.00 | 13.00    0.00

     Max.Eff.Inten.(mm/hr)=      14.25         9.53
                over (min)       10.00        70.00
     Storage Coeff.  (min)=      10.40 (ii)   68.92 (ii)
     Unit Hyd. Tpeak (min)=      10.00        70.00
     Unit Hyd. peak  (cms)=       0.11         0.02
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.12         0.02           0.133 (iii)
     TIME TO PEAK    (hrs)=       3.00         4.83            3.00
     RUNOFF VOLUME    (mm)=      55.82        37.55           51.24
     TOTAL RAINFALL   (mm)=      56.82        56.82           56.82
     RUNOFF COEFFICIENT   =       0.98         0.66            0.90


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  90.7    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0029)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1060      0.2550
                          0.0360     0.1600   |   0.0000      0.0000
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                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0107)      4.210      0.133      3.00      51.24
   OUTFLOW: ID= 1 (  0029)      4.210      0.035      7.33      50.98
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                 TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                 CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                 PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                 PEAK   FLOW   REDUCTION [Qout/Qin](%)= 26.06
                 TIME SHIFT OF PEAK FLOW         (min)=260.00
                 MAXIMUM  STORAGE   USED       (ha.m.)=  0.1537

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| CALIB              |
| STANDHYD (  0023)|   Area    (ha)=   1.72
|ID= 1 DT= 5.0 min |   Total Imp(%)=  89.00   Dir. Conn.(%)=  89.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.53          0.19
     Dep. Storage     (mm)=       1.00          1.57
     Average Slope     (%)=       1.00          2.00
     Length            (m)=     107.08        136.00
     Mannings n           =      0.013         0.050

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.083    0.00 | 3.333   12.54 | 6.583    4.56 |  9.83    0.00
               0.167    0.00 | 3.417   12.54 | 6.667    4.56 |  9.92    0.00
               0.250    0.00 | 3.500   12.54 | 6.750    4.56 | 10.00    0.00
               0.333    0.00 | 3.583   12.54 | 6.833    4.56 | 10.08    0.00
               0.417    0.00 | 3.667   12.54 | 6.917    4.56 | 10.17    0.00
               0.500    0.00 | 3.750   12.54 | 7.000    4.56 | 10.25    0.00
               0.583    0.00 | 3.833   12.54 | 7.083    1.71 | 10.33    0.00
               0.667    0.00 | 3.917   12.54 | 7.167    1.71 | 10.42    0.00
               0.750    0.00 | 4.000   12.54 | 7.250    1.71 | 10.50    0.00
               0.833    0.00 | 4.083    7.80 | 7.333    1.71 | 10.58    0.00
               0.917    0.00 | 4.167    7.80 | 7.417    1.71 | 10.67    0.00
               1.000    0.00 | 4.250    7.80 | 7.500    1.71 | 10.75    0.00
               1.083    8.55 | 4.333    7.80 | 7.583    1.71 | 10.83    0.00
               1.167    8.55 | 4.417    7.80 | 7.667    1.71 | 10.92    0.00
               1.250    8.55 | 4.500    7.80 | 7.750    1.71 | 11.00    0.00
               1.333    8.55 | 4.583    7.80 | 7.833    1.71 | 11.08    0.00
               1.417    8.55 | 4.667    7.80 | 7.917    1.71 | 11.17    0.00
               1.500    8.55 | 4.750    7.80 | 8.000    1.71 | 11.25    0.00
               1.583    8.55 | 4.833    7.80 | 8.083    0.57 | 11.33    0.00
               1.667    8.55 | 4.917    7.80 | 8.167    0.57 | 11.42    0.00
               1.750    8.55 | 5.000    7.80 | 8.250    0.57 | 11.50    0.00
               1.833    8.55 | 5.083    6.84 | 8.333    0.57 | 11.58    0.00
               1.917    8.55 | 5.167    6.84 | 8.417    0.57 | 11.67    0.00
               2.000    8.55 | 5.250    6.84 | 8.500    0.57 | 11.75    0.00
               2.083   14.25 | 5.333    6.84 | 8.583    0.57 | 11.83    0.00
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                2.167   14.25 | 5.417    6.84 | 8.667    0.57 | 11.92    0.00
                2.250   14.25 | 5.500    6.84 | 8.750    0.57 | 12.00    0.00
                2.333   14.25 | 5.583    6.84 | 8.833    0.57 | 12.08    0.00
                2.417   14.25 | 5.667    6.84 | 8.917    0.57 | 12.17    0.00
                2.500   14.25 | 5.750    6.84 | 9.000    0.57 | 12.25    0.00
                2.583   14.25 | 5.833    6.84 | 9.083    0.00 | 12.33    0.00
                2.667   14.25 | 5.917    6.84 | 9.167    0.00 | 12.42    0.00
                2.750   14.25 | 6.000    6.84 | 9.250    0.00 | 12.50    0.00
                2.833   14.25 | 6.083    4.56 | 9.333    0.00 | 12.58    0.00
                2.917   14.25 | 6.167    4.56 | 9.417    0.00 | 12.67    0.00
                3.000   14.25 | 6.250    4.56 | 9.500    0.00 | 12.75    0.00
                3.083   12.54 | 6.333    4.56 | 9.583    0.00 | 12.83    0.00
                3.167   12.54 | 6.417    4.56 | 9.667    0.00 | 12.92    0.00
                3.250   12.54 | 6.500    4.56 | 9.750    0.00 | 13.00    0.00

     Max.Eff.Inten.(mm/hr)=      14.25         8.96
                over (min)        5.00        25.00
     Storage Coeff.  (min)=       5.80 (ii)   20.50 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.20         0.05
                                                             *TOTALS*
     PEAK FLOW       (cms)=       0.06         0.00           0.064 (iii)
     TIME TO PEAK    (hrs)=       3.00         4.08            3.00
     RUNOFF VOLUME    (mm)=      55.82        33.11           53.32
     TOTAL RAINFALL   (mm)=      56.82        56.82           56.82
     RUNOFF COEFFICIENT   =       0.98         0.58            0.94


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  87.3    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| RESERVOIR(  0038)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0940      0.0600
                          0.0320     0.0450   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0023)      1.720      0.064      3.00      53.32
   OUTFLOW: ID= 1 (  0038)      1.720      0.031      6.00      53.11
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 47.95
                   TIME SHIFT OF PEAK FLOW         (min)=180.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0431

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| CALIB              |
| STANDHYD (  0034)|   Area    (ha)=   2.65
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.99          0.66
     Dep. Storage     (mm)=       1.00          1.57
     Average Slope     (%)=       1.00          2.00
     Length            (m)=     132.92         30.00
     Mannings n          =      0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	12.54	6.583	4.56	9.83	0.00
0.167	0.00	3.417	12.54	6.667	4.56	9.92	0.00
0.250	0.00	3.500	12.54	6.750	4.56	10.00	0.00
0.333	0.00	3.583	12.54	6.833	4.56	10.08	0.00
0.417	0.00	3.667	12.54	6.917	4.56	10.17	0.00
0.500	0.00	3.750	12.54	7.000	4.56	10.25	0.00
0.583	0.00	3.833	12.54	7.083	1.71	10.33	0.00
0.667	0.00	3.917	12.54	7.167	1.71	10.42	0.00
0.750	0.00	4.000	12.54	7.250	1.71	10.50	0.00
0.833	0.00	4.083	7.80	7.333	1.71	10.58	0.00
0.917	0.00	4.167	7.80	7.417	1.71	10.67	0.00
1.000	0.00	4.250	7.80	7.500	1.71	10.75	0.00
1.083	8.55	4.333	7.80	7.583	1.71	10.83	0.00
1.167	8.55	4.417	7.80	7.667	1.71	10.92	0.00
1.250	8.55	4.500	7.80	7.750	1.71	11.00	0.00
1.333	8.55	4.583	7.80	7.833	1.71	11.08	0.00
1.417	8.55	4.667	7.80	7.917	1.71	11.17	0.00
1.500	8.55	4.750	7.80	8.000	1.71	11.25	0.00
1.583	8.55	4.833	7.80	8.083	0.57	11.33	0.00
1.667	8.55	4.917	7.80	8.167	0.57	11.42	0.00
1.750	8.55	5.000	7.80	8.250	0.57	11.50	0.00
1.833	8.55	5.083	6.84	8.333	0.57	11.58	0.00
1.917	8.55	5.167	6.84	8.417	0.57	11.67	0.00
2.000	8.55	5.250	6.84	8.500	0.57	11.75	0.00
2.083	14.25	5.333	6.84	8.583	0.57	11.83	0.00
2.167	14.25	5.417	6.84	8.667	0.57	11.92	0.00
2.250	14.25	5.500	6.84	8.750	0.57	12.00	0.00
2.333	14.25	5.583	6.84	8.833	0.57	12.08	0.00
2.417	14.25	5.667	6.84	8.917	0.57	12.17	0.00
2.500	14.25	5.750	6.84	9.000	0.57	12.25	0.00
2.583	14.25	5.833	6.84	9.083	0.00	12.33	0.00
2.667	14.25	5.917	6.84	9.167	0.00	12.42	0.00
2.750	14.25	6.000	6.84	9.250	0.00	12.50	0.00
2.833	14.25	6.083	4.56	9.333	0.00	12.58	0.00
2.917	14.25	6.167	4.56	9.417	0.00	12.67	0.00
3.000	14.25	6.250	4.56	9.500	0.00	12.75	0.00
3.083	12.54	6.333	4.56	9.583	0.00	12.83	0.00
3.167	12.54	6.417	4.56	9.667	0.00	12.92	0.00
3.250	12.54	6.500	4.56	9.750	0.00	13.00	0.00

```
     Max.Eff.Inten.(mm/hr)=      14.25          8.23
                over (min)        5.00         25.00
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```
     Storage Coeff.  (min)=       6.61 (ii)   22.73 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.18         0.05
                                                       *TOTALS*
     PEAK FLOW       (cms)=       0.08         0.01        0.089 (iii)
     TIME TO PEAK    (hrs)=       3.00         4.08         3.00
     RUNOFF VOLUME    (mm)=      55.82        30.50        49.49
     TOTAL RAINFALL   (mm)=      56.82        56.82        56.82
     RUNOFF COEFFICIENT   =       0.98         0.54         0.87


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  85.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0037)|      OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   |   0.0520      0.1800
                           0.0180     0.1100   |   0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0034)      2.650      0.089      3.00      49.49
   OUTFLOW: ID= 1 (  0037)      2.650      0.017      7.25      48.90
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 18.95
                   TIME SHIFT OF PEAK FLOW         (min)=255.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1029

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--------------------
| ADD HYD  (  0024)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0029):     4.21   0.035     7.33    50.98
      + ID2= 2 (  0037):     2.65   0.017     7.25    48.90
        ====================================================
        ID = 3 (  0024):     6.86   0.051     7.33    50.17

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------


--------------------
| ADD HYD  (  0024)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0024):     6.86   0.051     7.33    50.17
```

```
  + ID2= 2 (  0038):     1.72   0.031     6.00    53.11
    ====================================================
    ID = 1 (  0024):     8.58   0.080     7.00    50.76

 NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
--------------------
| CALIB             |
| NASHYD   (  0020)|   Area    (ha)=   1.18   Curve Number   (CN)= 60.2
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.42

     NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	12.54	6.583	4.56	9.83	0.00
0.167	0.00	3.417	12.54	6.667	4.56	9.92	0.00
0.250	0.00	3.500	12.54	6.750	4.56	10.00	0.00
0.333	0.00	3.583	12.54	6.833	4.56	10.08	0.00
0.417	0.00	3.667	12.54	6.917	4.56	10.17	0.00
0.500	0.00	3.750	12.54	7.000	4.56	10.25	0.00
0.583	0.00	3.833	12.54	7.083	1.71	10.33	0.00
0.667	0.00	3.917	12.54	7.167	1.71	10.42	0.00
0.750	0.00	4.000	12.54	7.250	1.71	10.50	0.00
0.833	0.00	4.083	7.80	7.333	1.71	10.58	0.00
0.917	0.00	4.167	7.80	7.417	1.71	10.67	0.00
1.000	0.00	4.250	7.80	7.500	1.71	10.75	0.00
1.083	8.55	4.333	7.80	7.583	1.71	10.83	0.00
1.167	8.55	4.417	7.80	7.667	1.71	10.92	0.00
1.250	8.55	4.500	7.80	7.750	1.71	11.00	0.00
1.333	8.55	4.583	7.80	7.833	1.71	11.08	0.00
1.417	8.55	4.667	7.80	7.917	1.71	11.17	0.00
1.500	8.55	4.750	7.80	8.000	1.71	11.25	0.00
1.583	8.55	4.833	7.80	8.083	0.57	11.33	0.00
1.667	8.55	4.917	7.80	8.167	0.57	11.42	0.00
1.750	8.55	5.000	7.80	8.250	0.57	11.50	0.00
1.833	8.55	5.083	6.84	8.333	0.57	11.58	0.00
1.917	8.55	5.167	6.84	8.417	0.57	11.67	0.00
2.000	8.55	5.250	6.84	8.500	0.57	11.75	0.00
2.083	14.25	5.333	6.84	8.583	0.57	11.83	0.00
2.167	14.25	5.417	6.84	8.667	0.57	11.92	0.00
2.250	14.25	5.500	6.84	8.750	0.57	12.00	0.00
2.333	14.25	5.583	6.84	8.833	0.57	12.08	0.00
2.417	14.25	5.667	6.84	8.917	0.57	12.17	0.00
2.500	14.25	5.750	6.84	9.000	0.57	12.25	0.00
2.583	14.25	5.833	6.84	9.083	0.00	12.33	0.00
2.667	14.25	5.917	6.84	9.167	0.00	12.42	0.00
2.750	14.25	6.000	6.84	9.250	0.00	12.50	0.00
2.833	14.25	6.083	4.56	9.333	0.00	12.58	0.00
2.917	14.25	6.167	4.56	9.417	0.00	12.67	0.00
3.000	14.25	6.250	4.56	9.500	0.00	12.75	0.00
3.083	12.54	6.333	4.56	9.583	0.00	12.83	0.00
3.167	12.54	6.417	4.56	9.667	0.00	12.92	0.00
3.250	12.54	6.500	4.56	9.750	0.00	13.00	0.00

```
 Unit Hyd Qpeak  (cms)=   0.107
```

```
     PEAK FLOW       (cms)=   0.010 (i)
     TIME TO PEAK    (hrs)=   4.167
     RUNOFF VOLUME    (mm)=  12.355
     TOTAL RAINFALL   (mm)=  56.820
     RUNOFF COEFFICIENT   =   0.217

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0021)|   Area    (ha)=   0.43   Curve Number   (CN)= 61.9
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.53

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	12.54	6.583	4.56	9.83	0.00
0.167	0.00	3.417	12.54	6.667	4.56	9.92	0.00
0.250	0.00	3.500	12.54	6.750	4.56	10.00	0.00
0.333	0.00	3.583	12.54	6.833	4.56	10.08	0.00
0.417	0.00	3.667	12.54	6.917	4.56	10.17	0.00
0.500	0.00	3.750	12.54	7.000	4.56	10.25	0.00
0.583	0.00	3.833	12.54	7.083	1.71	10.33	0.00
0.667	0.00	3.917	12.54	7.167	1.71	10.42	0.00
0.750	0.00	4.000	12.54	7.250	1.71	10.50	0.00
0.833	0.00	4.083	7.80	7.333	1.71	10.58	0.00
0.917	0.00	4.167	7.80	7.417	1.71	10.67	0.00
1.000	0.00	4.250	7.80	7.500	1.71	10.75	0.00
1.083	8.55	4.333	7.80	7.583	1.71	10.83	0.00
1.167	8.55	4.417	7.80	7.667	1.71	10.92	0.00
1.250	8.55	4.500	7.80	7.750	1.71	11.00	0.00
1.333	8.55	4.583	7.80	7.833	1.71	11.08	0.00
1.417	8.55	4.667	7.80	7.917	1.71	11.17	0.00
1.500	8.55	4.750	7.80	8.000	1.71	11.25	0.00
1.583	8.55	4.833	7.80	8.083	0.57	11.33	0.00
1.667	8.55	4.917	7.80	8.167	0.57	11.42	0.00
1.750	8.55	5.000	7.80	8.250	0.57	11.50	0.00
1.833	8.55	5.083	6.84	8.333	0.57	11.58	0.00
1.917	8.55	5.167	6.84	8.417	0.57	11.67	0.00
2.000	8.55	5.250	6.84	8.500	0.57	11.75	0.00
2.083	14.25	5.333	6.84	8.583	0.57	11.83	0.00
2.167	14.25	5.417	6.84	8.667	0.57	11.92	0.00
2.250	14.25	5.500	6.84	8.750	0.57	12.00	0.00
2.333	14.25	5.583	6.84	8.833	0.57	12.08	0.00
2.417	14.25	5.667	6.84	8.917	0.57	12.17	0.00
2.500	14.25	5.750	6.84	9.000	0.57	12.25	0.00
2.583	14.25	5.833	6.84	9.083	0.00	12.33	0.00
2.667	14.25	5.917	6.84	9.167	0.00	12.42	0.00
2.750	14.25	6.000	6.84	9.250	0.00	12.50	0.00
2.833	14.25	6.083	4.56	9.333	0.00	12.58	0.00
2.917	14.25	6.167	4.56	9.417	0.00	12.67	0.00
3.000	14.25	6.250	4.56	9.500	0.00	12.75	0.00
3.083	12.54	6.333	4.56	9.583	0.00	12.83	0.00

```
          3.167   12.54 | 6.417    4.56 | 9.667    0.00 | 12.92    0.00
          3.250   12.54 | 6.500    4.56 | 9.750    0.00 | 13.00    0.00

     Unit Hyd Qpeak  (cms)=   0.031

     PEAK FLOW       (cms)=   0.004 (i)
     TIME TO PEAK    (hrs)=   4.250
     RUNOFF VOLUME    (mm)=  13.041
     TOTAL RAINFALL   (mm)=  56.820
     RUNOFF COEFFICIENT   =   0.230

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0108)|   Area    (ha)=   1.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  52.00   Dir. Conn.(%)=  52.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.82         0.75
     Dep. Storage     (mm)=       1.00         1.57
     Average Slope     (%)=       0.50         0.50
     Length            (m)=     102.31       387.00
     Mannings n           =      0.013        0.050

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
           TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
            hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
          0.083    0.00 | 3.333   12.54 | 6.583    4.56 |  9.83    0.00
          0.167    0.00 | 3.417   12.54 | 6.667    4.56 |  9.92    0.00
          0.250    0.00 | 3.500   12.54 | 6.750    4.56 | 10.00    0.00
          0.333    0.00 | 3.583   12.54 | 6.833    4.56 | 10.08    0.00
          0.417    0.00 | 3.667   12.54 | 6.917    4.56 | 10.17    0.00
          0.500    0.00 | 3.750   12.54 | 7.000    4.56 | 10.25    0.00
          0.583    0.00 | 3.833   12.54 | 7.083    1.71 | 10.33    0.00
          0.667    0.00 | 3.917   12.54 | 7.167    1.71 | 10.42    0.00
          0.750    0.00 | 4.000   12.54 | 7.250    1.71 | 10.50    0.00
          0.833    0.00 | 4.083    7.80 | 7.333    1.71 | 10.58    0.00
          0.917    0.00 | 4.167    7.80 | 7.417    1.71 | 10.67    0.00
          1.000    0.00 | 4.250    7.80 | 7.500    1.71 | 10.75    0.00
          1.083    8.55 | 4.333    7.80 | 7.583    1.71 | 10.83    0.00
          1.167    8.55 | 4.417    7.80 | 7.667    1.71 | 10.92    0.00
          1.250    8.55 | 4.500    7.80 | 7.750    1.71 | 11.00    0.00
          1.333    8.55 | 4.583    7.80 | 7.833    1.71 | 11.08    0.00
          1.417    8.55 | 4.667    7.80 | 7.917    1.71 | 11.17    0.00
          1.500    8.55 | 4.750    7.80 | 8.000    1.71 | 11.25    0.00
          1.583    8.55 | 4.833    7.80 | 8.083    0.57 | 11.33    0.00
          1.667    8.55 | 4.917    7.80 | 8.167    0.57 | 11.42    0.00
          1.750    8.55 | 5.000    7.80 | 8.250    0.57 | 11.50    0.00
          1.833    8.55 | 5.083    6.84 | 8.333    0.57 | 11.58    0.00
          1.917    8.55 | 5.167    6.84 | 8.417    0.57 | 11.67    0.00
          2.000    8.55 | 5.250    6.84 | 8.500    0.57 | 11.75    0.00
          2.083   14.25 | 5.333    6.84 | 8.583    0.57 | 11.83    0.00
          2.167   14.25 | 5.417    6.84 | 8.667    0.57 | 11.92    0.00
          2.250   14.25 | 5.500    6.84 | 8.750    0.57 | 12.00    0.00
```

```
                2.333   14.25 | 5.583    6.84 | 8.833    0.57 | 12.08    0.00
                2.417   14.25 | 5.667    6.84 | 8.917    0.57 | 12.17    0.00
                2.500   14.25 | 5.750    6.84 | 9.000    0.57 | 12.25    0.00
                2.583   14.25 | 5.833    6.84 | 9.083    0.00 | 12.33    0.00
                2.667   14.25 | 5.917    6.84 | 9.167    0.00 | 12.42    0.00
                2.750   14.25 | 6.000    6.84 | 9.250    0.00 | 12.50    0.00
                2.833   14.25 | 6.083    4.56 | 9.333    0.00 | 12.58    0.00
                2.917   14.25 | 6.167    4.56 | 9.417    0.00 | 12.67    0.00
                3.000   14.25 | 6.250    4.56 | 9.500    0.00 | 12.75    0.00
                3.083   12.54 | 6.333    4.56 | 9.583    0.00 | 12.83    0.00
                3.167   12.54 | 6.417    4.56 | 9.667    0.00 | 12.92    0.00
                3.250   12.54 | 6.500    4.56 | 9.750    0.00 | 13.00    0.00

     Max.Eff.Inten.(mm/hr)=      14.25         7.66
               over (min)         5.00        55.00
     Storage Coeff.  (min)=       6.95 (ii)   51.38 (ii)
     Unit Hyd. Tpeak (min)=       5.00        55.00
     Unit Hyd. peak  (cms)=       0.17         0.02
                                                               *TOTALS*
     PEAK FLOW       (cms)=       0.03         0.01             0.040 (iii)
     TIME TO PEAK    (hrs)=       3.00         4.58              4.00
     RUNOFF VOLUME    (mm)=      55.82        29.56             43.20
     TOTAL RAINFALL   (mm)=      56.82        56.82             56.82
     RUNOFF COEFFICIENT   =       0.98         0.52              0.76


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  84.1     Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0026)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0200      0.1100
                          0.0060     0.0600   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0108)      1.570      0.040      4.00      43.20
   OUTFLOW: ID= 1 (  0026)      1.570      0.006      8.50      41.58
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 14.15
                   TIME SHIFT OF PEAK FLOW         (min)=270.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0568

-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0025)|
```

```
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0020):      1.18   0.010     4.17    12.36
      + ID2= 2 (  0021):      0.43   0.004     4.25    13.04
        ====================================================
        ID = 3 (  0025):      1.61   0.013     4.17    12.54

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0025)|
|   3 +  2 =  1    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0025):      1.61   0.013     4.17    12.54
      + ID2= 2 (  0026):      1.57   0.006     8.50    41.58
        ====================================================
        ID = 1 (  0025):      3.18   0.016     4.25    26.88

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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=====================================================================================
========================

       V    V   I    SSSSS  U   U    A    L            (v 6.1.2003)
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 6.1\VO2\voin.dat

  Output  filename: C:\Users\agiampuzzi\AppData\Local\Civica\VH5\94083ae8-c3cd-
4c22-9e28-a8fff57a7688\5c8c4d89-563c-48f8-83f6-11708c733ed2\s
  Summary filename: C:\Users\agiampuzzi\AppData\Local\Civica\VH5\94083ae8-c3cd-
4c22-9e28-a8fff57a7688\5c8c4d89-563c-48f8-83f6-11708c733ed2\s


DATE: 10-26-2021                           TIME: 02:24:38

USER:



COMMENTS: ____________________________________________________________


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------------------------
  ************************************************
  ** SIMULATION : 02-AES-100yr                  **
  ************************************************


--------------------
|    READ STORM    |    Filename: C:\Users\agiampuzzi\AppD
|                  |              ata\Local\Temp\
|                  |              7ac3cc91-ada5-4407-a88e-b2e97255f693\a509c388
| Ptotal=101.80 mm |    Comments: 100 Year
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 1.00    0.00 |  5.00   14.25 |  9.00    1.02 | 13.00    0.00
                 2.00   15.27 |  6.00   12.22 | 10.00    0.00 |
                 3.00   25.45 |  7.00    8.14 | 11.00    0.00 |
                 4.00   22.40 |  8.00    3.05 | 12.00    0.00 |

-------------------------------------------------------------------------------
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--------------------
| CALIB            |
| STANDHYD (  0102)|   Area    (ha)=   2.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.61          0.54
     Dep. Storage     (mm)=       1.00          1.57
     Average Slope     (%)=       0.50          0.50
     Length            (m)=     119.72        587.00
     Mannings n           =      0.013         0.050

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	22.40	6.583	8.14	9.83	0.00
0.167	0.00	3.417	22.40	6.667	8.14	9.92	0.00
0.250	0.00	3.500	22.40	6.750	8.14	10.00	0.00
0.333	0.00	3.583	22.40	6.833	8.14	10.08	0.00
0.417	0.00	3.667	22.40	6.917	8.14	10.17	0.00
0.500	0.00	3.750	22.40	7.000	8.14	10.25	0.00
0.583	0.00	3.833	22.40	7.083	3.05	10.33	0.00
0.667	0.00	3.917	22.40	7.167	3.05	10.42	0.00
0.750	0.00	4.000	22.40	7.250	3.05	10.50	0.00
0.833	0.00	4.083	14.25	7.333	3.05	10.58	0.00
0.917	0.00	4.167	14.25	7.417	3.05	10.67	0.00
1.000	0.00	4.250	14.25	7.500	3.05	10.75	0.00
1.083	15.27	4.333	14.25	7.583	3.05	10.83	0.00
1.167	15.27	4.417	14.25	7.667	3.05	10.92	0.00
1.250	15.27	4.500	14.25	7.750	3.05	11.00	0.00
1.333	15.27	4.583	14.25	7.833	3.05	11.08	0.00
1.417	15.27	4.667	14.25	7.917	3.05	11.17	0.00
1.500	15.27	4.750	14.25	8.000	3.05	11.25	0.00
1.583	15.27	4.833	14.25	8.083	1.02	11.33	0.00
1.667	15.27	4.917	14.25	8.167	1.02	11.42	0.00
1.750	15.27	5.000	14.25	8.250	1.02	11.50	0.00
1.833	15.27	5.083	12.22	8.333	1.02	11.58	0.00
1.917	15.27	5.167	12.22	8.417	1.02	11.67	0.00
2.000	15.27	5.250	12.22	8.500	1.02	11.75	0.00
2.083	25.45	5.333	12.22	8.583	1.02	11.83	0.00
2.167	25.45	5.417	12.22	8.667	1.02	11.92	0.00
2.250	25.45	5.500	12.22	8.750	1.02	12.00	0.00
2.333	25.45	5.583	12.22	8.833	1.02	12.08	0.00
2.417	25.45	5.667	12.22	8.917	1.02	12.17	0.00
2.500	25.45	5.750	12.22	9.000	1.02	12.25	0.00
2.583	25.45	5.833	12.22	9.083	0.00	12.33	0.00
2.667	25.45	5.917	12.22	9.167	0.00	12.42	0.00
2.750	25.45	6.000	12.22	9.250	0.00	12.50	0.00
2.833	25.45	6.083	8.14	9.333	0.00	12.58	0.00
2.917	25.45	6.167	8.14	9.417	0.00	12.67	0.00
3.000	25.45	6.250	8.14	9.500	0.00	12.75	0.00
3.083	22.40	6.333	8.14	9.583	0.00	12.83	0.00
3.167	22.40	6.417	8.14	9.667	0.00	12.92	0.00
3.250	22.40	6.500	8.14	9.750	0.00	13.00	0.00

```
     Max.Eff.Inten.(mm/hr)=      25.45         22.80
                over (min)        5.00         45.00
     Storage Coeff.  (min)=       6.06 (ii)    42.93 (ii)
     Unit Hyd. Tpeak (min)=       5.00         45.00
     Unit Hyd. peak  (cms)=       0.19          0.03
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.11          0.03            0.136 (iii)
     TIME TO PEAK    (hrs)=       3.00          4.17             3.00
     RUNOFF VOLUME    (mm)=     100.80         87.78            97.53
     TOTAL RAINFALL   (mm)=     101.80        101.80           101.80
     RUNOFF COEFFICIENT   =       0.99          0.86             0.96


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  94.7    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0027)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0390      0.1600
                          0.0130     0.1000   |   0.0000      0.0000

                                AREA      QPEAK     TPEAK       R.V.
                                (ha)      (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0102)      2.150      0.136      3.00      97.53
   OUTFLOW: ID= 1 (  0027)      2.150      0.037      7.08      96.62
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                 TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                 CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                 PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                 PEAK   FLOW   REDUCTION [Qout/Qin](%)= 27.49
                 TIME SHIFT OF PEAK FLOW         (min)=245.00
                 MAXIMUM  STORAGE   USED       (ha.m.)=  0.1564

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0105)|   Area    (ha)=   5.37
|ID= 1 DT= 5.0 min |   Total Imp(%)=  77.00   Dir. Conn.(%)=  77.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       4.13          1.24
     Dep. Storage     (mm)=       1.00          1.57
     Average Slope     (%)=       0.40          0.40
     Length            (m)=     189.21        604.00
     Mannings n           =      0.013         0.050

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                ---- TRANSFORMED HYETOGRAPH ----
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	22.40	6.583	8.14	9.83	0.00
0.167	0.00	3.417	22.40	6.667	8.14	9.92	0.00
0.250	0.00	3.500	22.40	6.750	8.14	10.00	0.00
0.333	0.00	3.583	22.40	6.833	8.14	10.08	0.00
0.417	0.00	3.667	22.40	6.917	8.14	10.17	0.00
0.500	0.00	3.750	22.40	7.000	8.14	10.25	0.00
0.583	0.00	3.833	22.40	7.083	3.05	10.33	0.00
0.667	0.00	3.917	22.40	7.167	3.05	10.42	0.00
0.750	0.00	4.000	22.40	7.250	3.05	10.50	0.00
0.833	0.00	4.083	14.25	7.333	3.05	10.58	0.00
0.917	0.00	4.167	14.25	7.417	3.05	10.67	0.00
1.000	0.00	4.250	14.25	7.500	3.05	10.75	0.00
1.083	15.27	4.333	14.25	7.583	3.05	10.83	0.00
1.167	15.27	4.417	14.25	7.667	3.05	10.92	0.00
1.250	15.27	4.500	14.25	7.750	3.05	11.00	0.00
1.333	15.27	4.583	14.25	7.833	3.05	11.08	0.00
1.417	15.27	4.667	14.25	7.917	3.05	11.17	0.00
1.500	15.27	4.750	14.25	8.000	3.05	11.25	0.00
1.583	15.27	4.833	14.25	8.083	1.02	11.33	0.00
1.667	15.27	4.917	14.25	8.167	1.02	11.42	0.00
1.750	15.27	5.000	14.25	8.250	1.02	11.50	0.00
1.833	15.27	5.083	12.22	8.333	1.02	11.58	0.00
1.917	15.27	5.167	12.22	8.417	1.02	11.67	0.00
2.000	15.27	5.250	12.22	8.500	1.02	11.75	0.00
2.083	25.45	5.333	12.22	8.583	1.02	11.83	0.00
2.167	25.45	5.417	12.22	8.667	1.02	11.92	0.00
2.250	25.45	5.500	12.22	8.750	1.02	12.00	0.00
2.333	25.45	5.583	12.22	8.833	1.02	12.08	0.00
2.417	25.45	5.667	12.22	8.917	1.02	12.17	0.00
2.500	25.45	5.750	12.22	9.000	1.02	12.25	0.00
2.583	25.45	5.833	12.22	9.083	0.00	12.33	0.00
2.667	25.45	5.917	12.22	9.167	0.00	12.42	0.00
2.750	25.45	6.000	12.22	9.250	0.00	12.50	0.00
2.833	25.45	6.083	8.14	9.333	0.00	12.58	0.00
2.917	25.45	6.167	8.14	9.417	0.00	12.67	0.00
3.000	25.45	6.250	8.14	9.500	0.00	12.75	0.00
3.083	22.40	6.333	8.14	9.583	0.00	12.83	0.00
3.167	22.40	6.417	8.14	9.667	0.00	12.92	0.00
3.250	22.40	6.500	8.14	9.750	0.00	13.00	0.00

			TOTALS
Max.Eff.Inten.(mm/hr)=	25.45	21.15	
over (min)	10.00	50.00	
Storage Coeff. (min)=	8.52 (ii)	49.85 (ii)	
Unit Hyd. Tpeak (min)=	10.00	50.00	
Unit Hyd. peak (cms)=	0.12	0.02	
PEAK FLOW (cms)=	0.29	0.06	0.333 (iii)
TIME TO PEAK (hrs)=	3.00	4.25	3.00
RUNOFF VOLUME (mm)=	100.80	83.35	96.78
TOTAL RAINFALL (mm)=	101.80	101.80	101.80
RUNOFF COEFFICIENT =	0.99	0.82	0.95

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 92.6 Ia = Dep. Storage (Above)

(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.

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    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0028)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1010      0.3750
                          0.0340     0.2200   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0105)      5.370      0.333      3.00       96.78
   OUTFLOW: ID= 1 (  0028)      5.370      0.100      7.17       96.48
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00        0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 30.05
                   TIME SHIFT OF PEAK FLOW         (min)=250.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3727

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0032)|   Area    (ha)=   2.71
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.03          0.68
     Dep. Storage     (mm)=       1.00          1.57
     Average Slope     (%)=       1.00          2.00
     Length            (m)=     134.41         30.00
     Mannings n          =      0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 3.333   22.40 | 6.583    8.14 |  9.83    0.00
                0.167    0.00 | 3.417   22.40 | 6.667    8.14 |  9.92    0.00
                0.250    0.00 | 3.500   22.40 | 6.750    8.14 | 10.00    0.00
                0.333    0.00 | 3.583   22.40 | 6.833    8.14 | 10.08    0.00
                0.417    0.00 | 3.667   22.40 | 6.917    8.14 | 10.17    0.00
                0.500    0.00 | 3.750   22.40 | 7.000    8.14 | 10.25    0.00
                0.583    0.00 | 3.833   22.40 | 7.083    3.05 | 10.33    0.00
                0.667    0.00 | 3.917   22.40 | 7.167    3.05 | 10.42    0.00
                0.750    0.00 | 4.000   22.40 | 7.250    3.05 | 10.50    0.00
                0.833    0.00 | 4.083   14.25 | 7.333    3.05 | 10.58    0.00
                0.917    0.00 | 4.167   14.25 | 7.417    3.05 | 10.67    0.00
                1.000    0.00 | 4.250   14.25 | 7.500    3.05 | 10.75    0.00
                1.083   15.27 | 4.333   14.25 | 7.583    3.05 | 10.83    0.00
                1.167   15.27 | 4.417   14.25 | 7.667    3.05 | 10.92    0.00
                1.250   15.27 | 4.500   14.25 | 7.750    3.05 | 11.00    0.00
```

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                  1.333   15.27 | 4.583   14.25 | 7.833    3.05 | 11.08    0.00
                  1.417   15.27 | 4.667   14.25 | 7.917    3.05 | 11.17    0.00
                  1.500   15.27 | 4.750   14.25 | 8.000    3.05 | 11.25    0.00
                  1.583   15.27 | 4.833   14.25 | 8.083    1.02 | 11.33    0.00
                  1.667   15.27 | 4.917   14.25 | 8.167    1.02 | 11.42    0.00
                  1.750   15.27 | 5.000   14.25 | 8.250    1.02 | 11.50    0.00
                  1.833   15.27 | 5.083   12.22 | 8.333    1.02 | 11.58    0.00
                  1.917   15.27 | 5.167   12.22 | 8.417    1.02 | 11.67    0.00
                  2.000   15.27 | 5.250   12.22 | 8.500    1.02 | 11.75    0.00
                  2.083   25.45 | 5.333   12.22 | 8.583    1.02 | 11.83    0.00
                  2.167   25.45 | 5.417   12.22 | 8.667    1.02 | 11.92    0.00
                  2.250   25.45 | 5.500   12.22 | 8.750    1.02 | 12.00    0.00
                  2.333   25.45 | 5.583   12.22 | 8.833    1.02 | 12.08    0.00
                  2.417   25.45 | 5.667   12.22 | 8.917    1.02 | 12.17    0.00
                  2.500   25.45 | 5.750   12.22 | 9.000    1.02 | 12.25    0.00
                  2.583   25.45 | 5.833   12.22 | 9.083    0.00 | 12.33    0.00
                  2.667   25.45 | 5.917   12.22 | 9.167    0.00 | 12.42    0.00
                  2.750   25.45 | 6.000   12.22 | 9.250    0.00 | 12.50    0.00
                  2.833   25.45 | 6.083    8.14 | 9.333    0.00 | 12.58    0.00
                  2.917   25.45 | 6.167    8.14 | 9.417    0.00 | 12.67    0.00
                  3.000   25.45 | 6.250    8.14 | 9.500    0.00 | 12.75    0.00
                  3.083   22.40 | 6.333    8.14 | 9.583    0.00 | 12.83    0.00
                  3.167   22.40 | 6.417    8.14 | 9.667    0.00 | 12.92    0.00
                  3.250   22.40 | 6.500    8.14 | 9.750    0.00 | 13.00    0.00

     Max.Eff.Inten.(mm/hr)=      25.45        24.44
               over (min)         5.00        20.00
     Storage Coeff.  (min)=       5.27 (ii)   15.71 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.21         0.07
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.14         0.04          0.188 (iii)
     TIME TO PEAK    (hrs)=       3.00         3.08           3.00
     RUNOFF VOLUME    (mm)=     100.80        92.02          98.60
     TOTAL RAINFALL   (mm)=     101.80       101.80         101.80
     RUNOFF COEFFICIENT   =       0.99         0.90           0.97


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  96.6    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0035)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0610      0.1900
                          0.0200     0.1200   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0032)      2.710      0.188      3.00      98.60
   OUTFLOW: ID= 1 (  0035)      2.710      0.059      7.00      98.04
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00
```

```
                 TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                 CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                 PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                 PEAK   FLOW   REDUCTION [Qout/Qin](%)= 31.24
                 TIME SHIFT OF PEAK FLOW         (min)=240.00
                 MAXIMUM  STORAGE   USED       (ha.m.)=  0.1861

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--------------------
| ADD HYD  (  0001)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0027):      2.15   0.037     7.08    96.62
      + ID2= 2 (  0028):      5.37   0.100     7.17    96.48
        ====================================================
        ID = 3 (  0001):      7.52   0.137     7.17    96.52

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| ADD HYD  (  0001)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0001):      7.52   0.137     7.17    96.52
      + ID2= 2 (  0035):      2.71   0.059     7.00    98.04
        ====================================================
        ID = 1 (  0001):     10.23   0.196     7.08    96.92

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0107)|   Area    (ha)=   4.21
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       3.16          1.05
     Dep. Storage     (mm)=       1.00          1.57
     Average Slope     (%)=       0.35          0.35
     Length            (m)=     167.53        593.00
     Mannings n           =      0.013         0.050

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                       ---- TRANSFORMED HYETOGRAPH ----
                    TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                     hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                   0.083    0.00 | 3.333   22.40 | 6.583    8.14 |  9.83    0.00
                   0.167    0.00 | 3.417   22.40 | 6.667    8.14 |  9.92    0.00
                   0.250    0.00 | 3.500   22.40 | 6.750    8.14 | 10.00    0.00
                   0.333    0.00 | 3.583   22.40 | 6.833    8.14 | 10.08    0.00
                   0.417    0.00 | 3.667   22.40 | 6.917    8.14 | 10.17    0.00
                   0.500    0.00 | 3.750   22.40 | 7.000    8.14 | 10.25    0.00
                   0.583    0.00 | 3.833   22.40 | 7.083    3.05 | 10.33    0.00
                   0.667    0.00 | 3.917   22.40 | 7.167    3.05 | 10.42    0.00
```

```
                      0.750    0.00 | 4.000   22.40 | 7.250    3.05 | 10.50    0.00
                      0.833    0.00 | 4.083   14.25 | 7.333    3.05 | 10.58    0.00
                      0.917    0.00 | 4.167   14.25 | 7.417    3.05 | 10.67    0.00
                      1.000    0.00 | 4.250   14.25 | 7.500    3.05 | 10.75    0.00
                      1.083   15.27 | 4.333   14.25 | 7.583    3.05 | 10.83    0.00
                      1.167   15.27 | 4.417   14.25 | 7.667    3.05 | 10.92    0.00
                      1.250   15.27 | 4.500   14.25 | 7.750    3.05 | 11.00    0.00
                      1.333   15.27 | 4.583   14.25 | 7.833    3.05 | 11.08    0.00
                      1.417   15.27 | 4.667   14.25 | 7.917    3.05 | 11.17    0.00
                      1.500   15.27 | 4.750   14.25 | 8.000    3.05 | 11.25    0.00
                      1.583   15.27 | 4.833   14.25 | 8.083    1.02 | 11.33    0.00
                      1.667   15.27 | 4.917   14.25 | 8.167    1.02 | 11.42    0.00
                      1.750   15.27 | 5.000   14.25 | 8.250    1.02 | 11.50    0.00
                      1.833   15.27 | 5.083   12.22 | 8.333    1.02 | 11.58    0.00
                      1.917   15.27 | 5.167   12.22 | 8.417    1.02 | 11.67    0.00
                      2.000   15.27 | 5.250   12.22 | 8.500    1.02 | 11.75    0.00
                      2.083   25.45 | 5.333   12.22 | 8.583    1.02 | 11.83    0.00
                      2.167   25.45 | 5.417   12.22 | 8.667    1.02 | 11.92    0.00
                      2.250   25.45 | 5.500   12.22 | 8.750    1.02 | 12.00    0.00
                      2.333   25.45 | 5.583   12.22 | 8.833    1.02 | 12.08    0.00
                      2.417   25.45 | 5.667   12.22 | 8.917    1.02 | 12.17    0.00
                      2.500   25.45 | 5.750   12.22 | 9.000    1.02 | 12.25    0.00
                      2.583   25.45 | 5.833   12.22 | 9.083    0.00 | 12.33    0.00
                      2.667   25.45 | 5.917   12.22 | 9.167    0.00 | 12.42    0.00
                      2.750   25.45 | 6.000   12.22 | 9.250    0.00 | 12.50    0.00
                      2.833   25.45 | 6.083    8.14 | 9.333    0.00 | 12.58    0.00
                      2.917   25.45 | 6.167    8.14 | 9.417    0.00 | 12.67    0.00
                      3.000   25.45 | 6.250    8.14 | 9.500    0.00 | 12.75    0.00
                      3.083   22.40 | 6.333    8.14 | 9.583    0.00 | 12.83    0.00
                      3.167   22.40 | 6.417    8.14 | 9.667    0.00 | 12.92    0.00
                      3.250   22.40 | 6.500    8.14 | 9.750    0.00 | 13.00    0.00

     Max.Eff.Inten.(mm/hr)=      25.45        19.97
                over (min)       10.00        55.00
     Storage Coeff.  (min)=       8.25 (ii)   51.78 (ii)
     Unit Hyd. Tpeak (min)=      10.00        55.00
     Unit Hyd. peak  (cms)=       0.13         0.02
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.22         0.05          0.252 (iii)
     TIME TO PEAK    (hrs)=       3.00         4.42           3.00
     RUNOFF VOLUME    (mm)=     100.80        79.56          95.48
     TOTAL RAINFALL   (mm)=     101.80       101.80         101.80
     RUNOFF COEFFICIENT   =       0.99         0.78           0.94


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  90.7    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0029)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1060      0.2550
                          0.0360     0.1600   |   0.0000      0.0000
```

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                               AREA     QPEAK     TPEAK       R.V.
                               (ha)     (cms)     (hrs)       (mm)
  INFLOW : ID= 2 (  0107)      4.210      0.252      3.00      95.48
  OUTFLOW: ID= 1 (  0029)      4.210      0.103      6.92      95.22
  OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                  TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                  CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                  PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 40.95
                  TIME SHIFT OF PEAK FLOW         (min)=235.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.2513

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--------------------
| CALIB              |
| STANDHYD (  0023)|   Area    (ha)=   1.72
|ID= 1 DT= 5.0 min |   Total Imp(%)=  89.00   Dir. Conn.(%)=  89.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.53          0.19
     Dep. Storage     (mm)=       1.00          1.57
     Average Slope     (%)=       1.00          2.00
     Length            (m)=     107.08        136.00
     Mannings n           =      0.013         0.050

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	22.40	6.583	8.14	9.83	0.00
0.167	0.00	3.417	22.40	6.667	8.14	9.92	0.00
0.250	0.00	3.500	22.40	6.750	8.14	10.00	0.00
0.333	0.00	3.583	22.40	6.833	8.14	10.08	0.00
0.417	0.00	3.667	22.40	6.917	8.14	10.17	0.00
0.500	0.00	3.750	22.40	7.000	8.14	10.25	0.00
0.583	0.00	3.833	22.40	7.083	3.05	10.33	0.00
0.667	0.00	3.917	22.40	7.167	3.05	10.42	0.00
0.750	0.00	4.000	22.40	7.250	3.05	10.50	0.00
0.833	0.00	4.083	14.25	7.333	3.05	10.58	0.00
0.917	0.00	4.167	14.25	7.417	3.05	10.67	0.00
1.000	0.00	4.250	14.25	7.500	3.05	10.75	0.00
1.083	15.27	4.333	14.25	7.583	3.05	10.83	0.00
1.167	15.27	4.417	14.25	7.667	3.05	10.92	0.00
1.250	15.27	4.500	14.25	7.750	3.05	11.00	0.00
1.333	15.27	4.583	14.25	7.833	3.05	11.08	0.00
1.417	15.27	4.667	14.25	7.917	3.05	11.17	0.00
1.500	15.27	4.750	14.25	8.000	3.05	11.25	0.00
1.583	15.27	4.833	14.25	8.083	1.02	11.33	0.00
1.667	15.27	4.917	14.25	8.167	1.02	11.42	0.00
1.750	15.27	5.000	14.25	8.250	1.02	11.50	0.00
1.833	15.27	5.083	12.22	8.333	1.02	11.58	0.00
1.917	15.27	5.167	12.22	8.417	1.02	11.67	0.00
2.000	15.27	5.250	12.22	8.500	1.02	11.75	0.00
2.083	25.45	5.333	12.22	8.583	1.02	11.83	0.00

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            2.167   25.45 | 5.417   12.22 | 8.667    1.02 | 11.92    0.00
            2.250   25.45 | 5.500   12.22 | 8.750    1.02 | 12.00    0.00
            2.333   25.45 | 5.583   12.22 | 8.833    1.02 | 12.08    0.00
            2.417   25.45 | 5.667   12.22 | 8.917    1.02 | 12.17    0.00
            2.500   25.45 | 5.750   12.22 | 9.000    1.02 | 12.25    0.00
            2.583   25.45 | 5.833   12.22 | 9.083    0.00 | 12.33    0.00
            2.667   25.45 | 5.917   12.22 | 9.167    0.00 | 12.42    0.00
            2.750   25.45 | 6.000   12.22 | 9.250    0.00 | 12.50    0.00
            2.833   25.45 | 6.083    8.14 | 9.333    0.00 | 12.58    0.00
            2.917   25.45 | 6.167    8.14 | 9.417    0.00 | 12.67    0.00
            3.000   25.45 | 6.250    8.14 | 9.500    0.00 | 12.75    0.00
            3.083   22.40 | 6.333    8.14 | 9.583    0.00 | 12.83    0.00
            3.167   22.40 | 6.417    8.14 | 9.667    0.00 | 12.92    0.00
            3.250   22.40 | 6.500    8.14 | 9.750    0.00 | 13.00    0.00

     Max.Eff.Inten.(mm/hr)=      25.45        19.12
               over (min)         5.00        10.00
     Storage Coeff.  (min)=       4.60 (ii)    8.80 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.23         0.12
                                                         *TOTALS*
     PEAK FLOW       (cms)=       0.11         0.01        0.118 (iii)
     TIME TO PEAK    (hrs)=       3.00         4.00         3.00
     RUNOFF VOLUME    (mm)=     100.80        73.23        97.77
     TOTAL RAINFALL   (mm)=     101.80       101.80       101.80
     RUNOFF COEFFICIENT   =       0.99         0.72         0.96

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  87.3    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0038)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0940      0.0600
                          0.0320     0.0450   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0023)      1.720     0.118      3.00      97.77
   OUTFLOW: ID= 1 (  0038)      1.720     0.093      4.08      97.56
   OVERFLOW:ID= 3 (  0003)      0.000     0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 78.88
                   TIME SHIFT OF PEAK FLOW         (min)= 65.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0599

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--------------------
| CALIB              |
| STANDHYD (  0034)|   Area    (ha)=   2.65
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.99          0.66
     Dep. Storage     (mm)=       1.00          1.57
     Average Slope     (%)=       1.00          2.00
     Length            (m)=     132.92         30.00
     Mannings n          =      0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	22.40	6.583	8.14	9.83	0.00
0.167	0.00	3.417	22.40	6.667	8.14	9.92	0.00
0.250	0.00	3.500	22.40	6.750	8.14	10.00	0.00
0.333	0.00	3.583	22.40	6.833	8.14	10.08	0.00
0.417	0.00	3.667	22.40	6.917	8.14	10.17	0.00
0.500	0.00	3.750	22.40	7.000	8.14	10.25	0.00
0.583	0.00	3.833	22.40	7.083	3.05	10.33	0.00
0.667	0.00	3.917	22.40	7.167	3.05	10.42	0.00
0.750	0.00	4.000	22.40	7.250	3.05	10.50	0.00
0.833	0.00	4.083	14.25	7.333	3.05	10.58	0.00
0.917	0.00	4.167	14.25	7.417	3.05	10.67	0.00
1.000	0.00	4.250	14.25	7.500	3.05	10.75	0.00
1.083	15.27	4.333	14.25	7.583	3.05	10.83	0.00
1.167	15.27	4.417	14.25	7.667	3.05	10.92	0.00
1.250	15.27	4.500	14.25	7.750	3.05	11.00	0.00
1.333	15.27	4.583	14.25	7.833	3.05	11.08	0.00
1.417	15.27	4.667	14.25	7.917	3.05	11.17	0.00
1.500	15.27	4.750	14.25	8.000	3.05	11.25	0.00
1.583	15.27	4.833	14.25	8.083	1.02	11.33	0.00
1.667	15.27	4.917	14.25	8.167	1.02	11.42	0.00
1.750	15.27	5.000	14.25	8.250	1.02	11.50	0.00
1.833	15.27	5.083	12.22	8.333	1.02	11.58	0.00
1.917	15.27	5.167	12.22	8.417	1.02	11.67	0.00
2.000	15.27	5.250	12.22	8.500	1.02	11.75	0.00
2.083	25.45	5.333	12.22	8.583	1.02	11.83	0.00
2.167	25.45	5.417	12.22	8.667	1.02	11.92	0.00
2.250	25.45	5.500	12.22	8.750	1.02	12.00	0.00
2.333	25.45	5.583	12.22	8.833	1.02	12.08	0.00
2.417	25.45	5.667	12.22	8.917	1.02	12.17	0.00
2.500	25.45	5.750	12.22	9.000	1.02	12.25	0.00
2.583	25.45	5.833	12.22	9.083	0.00	12.33	0.00
2.667	25.45	5.917	12.22	9.167	0.00	12.42	0.00
2.750	25.45	6.000	12.22	9.250	0.00	12.50	0.00
2.833	25.45	6.083	8.14	9.333	0.00	12.58	0.00
2.917	25.45	6.167	8.14	9.417	0.00	12.67	0.00
3.000	25.45	6.250	8.14	9.500	0.00	12.75	0.00
3.083	22.40	6.333	8.14	9.583	0.00	12.83	0.00
3.167	22.40	6.417	8.14	9.667	0.00	12.92	0.00
3.250	22.40	6.500	8.14	9.750	0.00	13.00	0.00

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     Max.Eff.Inten.(mm/hr)=      25.45         18.20
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              over (min)        5.00         20.00
     Storage Coeff.  (min)=       5.24 (ii)   16.98 (ii)
     Unit Hyd. Tpeak (min)=       5.00         20.00
     Unit Hyd. peak  (cms)=       0.21          0.06
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.14          0.03            0.169 (iii)
     TIME TO PEAK    (hrs)=       3.00          4.00             3.00
     RUNOFF VOLUME    (mm)=     100.80         69.26            92.91
     TOTAL RAINFALL   (mm)=     101.80        101.80           101.80
     RUNOFF COEFFICIENT   =       0.99          0.68             0.91


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  85.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0037)|      OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   |   0.0520      0.1800
                           0.0180     0.1100   |   0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0034)      2.650      0.169      3.00       92.91
   OUTFLOW: ID= 1 (  0037)      2.650      0.050      7.00       92.33
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00        0.00

                    TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                    CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                    PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 29.70
                    TIME SHIFT OF PEAK FLOW         (min)=240.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.1763

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--------------------
| ADD HYD  (  0024)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0029):     4.21   0.103     6.92    95.22
      + ID2= 2 (  0037):     2.65   0.050     7.00    92.33
        ====================================================
        ID = 3 (  0024):     6.86   0.153     7.00    94.10

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| ADD HYD  (  0024)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
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```
        ID1= 3 (  0024):      6.86   0.153     7.00    94.10
      + ID2= 2 (  0038):      1.72   0.093     4.08    97.56
        ==================================================
        ID = 1 (  0024):      8.58   0.210     6.08    94.79

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| CALIB              |
| NASHYD   (  0020)|   Area    (ha)=   1.18   Curve Number   (CN)= 60.2
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.42

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                            ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.083    0.00 | 3.333   22.40 | 6.583    8.14 |  9.83    0.00
                 0.167    0.00 | 3.417   22.40 | 6.667    8.14 |  9.92    0.00
                 0.250    0.00 | 3.500   22.40 | 6.750    8.14 | 10.00    0.00
                 0.333    0.00 | 3.583   22.40 | 6.833    8.14 | 10.08    0.00
                 0.417    0.00 | 3.667   22.40 | 6.917    8.14 | 10.17    0.00
                 0.500    0.00 | 3.750   22.40 | 7.000    8.14 | 10.25    0.00
                 0.583    0.00 | 3.833   22.40 | 7.083    3.05 | 10.33    0.00
                 0.667    0.00 | 3.917   22.40 | 7.167    3.05 | 10.42    0.00
                 0.750    0.00 | 4.000   22.40 | 7.250    3.05 | 10.50    0.00
                 0.833    0.00 | 4.083   14.25 | 7.333    3.05 | 10.58    0.00
                 0.917    0.00 | 4.167   14.25 | 7.417    3.05 | 10.67    0.00
                 1.000    0.00 | 4.250   14.25 | 7.500    3.05 | 10.75    0.00
                 1.083   15.27 | 4.333   14.25 | 7.583    3.05 | 10.83    0.00
                 1.167   15.27 | 4.417   14.25 | 7.667    3.05 | 10.92    0.00
                 1.250   15.27 | 4.500   14.25 | 7.750    3.05 | 11.00    0.00
                 1.333   15.27 | 4.583   14.25 | 7.833    3.05 | 11.08    0.00
                 1.417   15.27 | 4.667   14.25 | 7.917    3.05 | 11.17    0.00
                 1.500   15.27 | 4.750   14.25 | 8.000    3.05 | 11.25    0.00
                 1.583   15.27 | 4.833   14.25 | 8.083    1.02 | 11.33    0.00
                 1.667   15.27 | 4.917   14.25 | 8.167    1.02 | 11.42    0.00
                 1.750   15.27 | 5.000   14.25 | 8.250    1.02 | 11.50    0.00
                 1.833   15.27 | 5.083   12.22 | 8.333    1.02 | 11.58    0.00
                 1.917   15.27 | 5.167   12.22 | 8.417    1.02 | 11.67    0.00
                 2.000   15.27 | 5.250   12.22 | 8.500    1.02 | 11.75    0.00
                 2.083   25.45 | 5.333   12.22 | 8.583    1.02 | 11.83    0.00
                 2.167   25.45 | 5.417   12.22 | 8.667    1.02 | 11.92    0.00
                 2.250   25.45 | 5.500   12.22 | 8.750    1.02 | 12.00    0.00
                 2.333   25.45 | 5.583   12.22 | 8.833    1.02 | 12.08    0.00
                 2.417   25.45 | 5.667   12.22 | 8.917    1.02 | 12.17    0.00
                 2.500   25.45 | 5.750   12.22 | 9.000    1.02 | 12.25    0.00
                 2.583   25.45 | 5.833   12.22 | 9.083    0.00 | 12.33    0.00
                 2.667   25.45 | 5.917   12.22 | 9.167    0.00 | 12.42    0.00
                 2.750   25.45 | 6.000   12.22 | 9.250    0.00 | 12.50    0.00
                 2.833   25.45 | 6.083    8.14 | 9.333    0.00 | 12.58    0.00
                 2.917   25.45 | 6.167    8.14 | 9.417    0.00 | 12.67    0.00
                 3.000   25.45 | 6.250    8.14 | 9.500    0.00 | 12.75    0.00
                 3.083   22.40 | 6.333    8.14 | 9.583    0.00 | 12.83    0.00
                 3.167   22.40 | 6.417    8.14 | 9.667    0.00 | 12.92    0.00
                 3.250   22.40 | 6.500    8.14 | 9.750    0.00 | 13.00    0.00
```

```
     Unit Hyd Qpeak  (cms)=   0.107

     PEAK FLOW       (cms)=   0.028 (i)
     TIME TO PEAK    (hrs)=   4.167
     RUNOFF VOLUME    (mm)=  35.589
     TOTAL RAINFALL   (mm)= 101.800
     RUNOFF COEFFICIENT   =   0.350

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| NASHYD   (  0021)|   Area    (ha)=   0.43   Curve Number   (CN)= 61.9
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.67   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.53

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	3.333	22.40	6.583	8.14	9.83	0.00
0.167	0.00	3.417	22.40	6.667	8.14	9.92	0.00
0.250	0.00	3.500	22.40	6.750	8.14	10.00	0.00
0.333	0.00	3.583	22.40	6.833	8.14	10.08	0.00
0.417	0.00	3.667	22.40	6.917	8.14	10.17	0.00
0.500	0.00	3.750	22.40	7.000	8.14	10.25	0.00
0.583	0.00	3.833	22.40	7.083	3.05	10.33	0.00
0.667	0.00	3.917	22.40	7.167	3.05	10.42	0.00
0.750	0.00	4.000	22.40	7.250	3.05	10.50	0.00
0.833	0.00	4.083	14.25	7.333	3.05	10.58	0.00
0.917	0.00	4.167	14.25	7.417	3.05	10.67	0.00
1.000	0.00	4.250	14.25	7.500	3.05	10.75	0.00
1.083	15.27	4.333	14.25	7.583	3.05	10.83	0.00
1.167	15.27	4.417	14.25	7.667	3.05	10.92	0.00
1.250	15.27	4.500	14.25	7.750	3.05	11.00	0.00
1.333	15.27	4.583	14.25	7.833	3.05	11.08	0.00
1.417	15.27	4.667	14.25	7.917	3.05	11.17	0.00
1.500	15.27	4.750	14.25	8.000	3.05	11.25	0.00
1.583	15.27	4.833	14.25	8.083	1.02	11.33	0.00
1.667	15.27	4.917	14.25	8.167	1.02	11.42	0.00
1.750	15.27	5.000	14.25	8.250	1.02	11.50	0.00
1.833	15.27	5.083	12.22	8.333	1.02	11.58	0.00
1.917	15.27	5.167	12.22	8.417	1.02	11.67	0.00
2.000	15.27	5.250	12.22	8.500	1.02	11.75	0.00
2.083	25.45	5.333	12.22	8.583	1.02	11.83	0.00
2.167	25.45	5.417	12.22	8.667	1.02	11.92	0.00
2.250	25.45	5.500	12.22	8.750	1.02	12.00	0.00
2.333	25.45	5.583	12.22	8.833	1.02	12.08	0.00
2.417	25.45	5.667	12.22	8.917	1.02	12.17	0.00
2.500	25.45	5.750	12.22	9.000	1.02	12.25	0.00
2.583	25.45	5.833	12.22	9.083	0.00	12.33	0.00
2.667	25.45	5.917	12.22	9.167	0.00	12.42	0.00
2.750	25.45	6.000	12.22	9.250	0.00	12.50	0.00
2.833	25.45	6.083	8.14	9.333	0.00	12.58	0.00
2.917	25.45	6.167	8.14	9.417	0.00	12.67	0.00
3.000	25.45	6.250	8.14	9.500	0.00	12.75	0.00

```
             3.083   22.40 | 6.333    8.14 | 9.583    0.00 | 12.83    0.00
             3.167   22.40 | 6.417    8.14 | 9.667    0.00 | 12.92    0.00
             3.250   22.40 | 6.500    8.14 | 9.750    0.00 | 13.00    0.00

     Unit Hyd Qpeak  (cms)=   0.031

     PEAK FLOW       (cms)=   0.010 (i)
     TIME TO PEAK    (hrs)=   4.250
     RUNOFF VOLUME    (mm)=  37.216
     TOTAL RAINFALL   (mm)= 101.800
     RUNOFF COEFFICIENT   =   0.366

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| STANDHYD (  0108)|   Area    (ha)=   1.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  52.00   Dir. Conn.(%)=  52.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.82          0.75
     Dep. Storage     (mm)=       1.00          1.57
     Average Slope     (%)=       0.50          0.50
     Length            (m)=     102.31        387.00
     Mannings n           =      0.013         0.050

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                ---- TRANSFORMED HYETOGRAPH ----
              TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
               hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
             0.083    0.00 | 3.333   22.40 | 6.583    8.14 |  9.83    0.00
             0.167    0.00 | 3.417   22.40 | 6.667    8.14 |  9.92    0.00
             0.250    0.00 | 3.500   22.40 | 6.750    8.14 | 10.00    0.00
             0.333    0.00 | 3.583   22.40 | 6.833    8.14 | 10.08    0.00
             0.417    0.00 | 3.667   22.40 | 6.917    8.14 | 10.17    0.00
             0.500    0.00 | 3.750   22.40 | 7.000    8.14 | 10.25    0.00
             0.583    0.00 | 3.833   22.40 | 7.083    3.05 | 10.33    0.00
             0.667    0.00 | 3.917   22.40 | 7.167    3.05 | 10.42    0.00
             0.750    0.00 | 4.000   22.40 | 7.250    3.05 | 10.50    0.00
             0.833    0.00 | 4.083   14.25 | 7.333    3.05 | 10.58    0.00
             0.917    0.00 | 4.167   14.25 | 7.417    3.05 | 10.67    0.00
             1.000    0.00 | 4.250   14.25 | 7.500    3.05 | 10.75    0.00
             1.083   15.27 | 4.333   14.25 | 7.583    3.05 | 10.83    0.00
             1.167   15.27 | 4.417   14.25 | 7.667    3.05 | 10.92    0.00
             1.250   15.27 | 4.500   14.25 | 7.750    3.05 | 11.00    0.00
             1.333   15.27 | 4.583   14.25 | 7.833    3.05 | 11.08    0.00
             1.417   15.27 | 4.667   14.25 | 7.917    3.05 | 11.17    0.00
             1.500   15.27 | 4.750   14.25 | 8.000    3.05 | 11.25    0.00
             1.583   15.27 | 4.833   14.25 | 8.083    1.02 | 11.33    0.00
             1.667   15.27 | 4.917   14.25 | 8.167    1.02 | 11.42    0.00
             1.750   15.27 | 5.000   14.25 | 8.250    1.02 | 11.50    0.00
             1.833   15.27 | 5.083   12.22 | 8.333    1.02 | 11.58    0.00
             1.917   15.27 | 5.167   12.22 | 8.417    1.02 | 11.67    0.00
             2.000   15.27 | 5.250   12.22 | 8.500    1.02 | 11.75    0.00
             2.083   25.45 | 5.333   12.22 | 8.583    1.02 | 11.83    0.00
             2.167   25.45 | 5.417   12.22 | 8.667    1.02 | 11.92    0.00
```

```
                    2.250   25.45 | 5.500   12.22 | 8.750    1.02 | 12.00    0.00
                    2.333   25.45 | 5.583   12.22 | 8.833    1.02 | 12.08    0.00
                    2.417   25.45 | 5.667   12.22 | 8.917    1.02 | 12.17    0.00
                    2.500   25.45 | 5.750   12.22 | 9.000    1.02 | 12.25    0.00
                    2.583   25.45 | 5.833   12.22 | 9.083    0.00 | 12.33    0.00
                    2.667   25.45 | 5.917   12.22 | 9.167    0.00 | 12.42    0.00
                    2.750   25.45 | 6.000   12.22 | 9.250    0.00 | 12.50    0.00
                    2.833   25.45 | 6.083    8.14 | 9.333    0.00 | 12.58    0.00
                    2.917   25.45 | 6.167    8.14 | 9.417    0.00 | 12.67    0.00
                    3.000   25.45 | 6.250    8.14 | 9.500    0.00 | 12.75    0.00
                    3.083   22.40 | 6.333    8.14 | 9.583    0.00 | 12.83    0.00
                    3.167   22.40 | 6.417    8.14 | 9.667    0.00 | 12.92    0.00
                    3.250   22.40 | 6.500    8.14 | 9.750    0.00 | 13.00    0.00

     Max.Eff.Inten.(mm/hr)=      25.45        17.51
               over (min)         5.00        40.00
     Storage Coeff.  (min)=       5.51 (ii)   37.42 (ii)
     Unit Hyd. Tpeak (min)=       5.00        40.00
     Unit Hyd. peak  (cms)=       0.20         0.03
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.06         0.03         0.083 (iii)
     TIME TO PEAK    (hrs)=       3.00         4.25          4.00
     RUNOFF VOLUME    (mm)=     100.80        67.76         84.93
     TOTAL RAINFALL   (mm)=     101.80       101.80        101.80
     RUNOFF COEFFICIENT   =       0.99         0.67          0.83


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  84.1    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0026)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0200      0.1100
                          0.0060     0.0600   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0108)      1.570      0.083      4.00      84.93
   OUTFLOW: ID= 1 (  0026)      1.570      0.019      7.75      83.31
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                 TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                 CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                 PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                 PEAK   FLOW   REDUCTION [Qout/Qin](%)= 22.40
                 TIME SHIFT OF PEAK FLOW         (min)=225.00
                 MAXIMUM  STORAGE   USED       (ha.m.)=  0.1051

-------------------------------------------------------------------------------

--------------------
```

```
| ADD HYD  (  0025)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0020):     1.18   0.028     4.17    35.59
      + ID2= 2 (  0021):     0.43   0.010     4.25    37.22
        ====================================================
        ID = 3 (  0025):     1.61   0.039     4.17    36.02

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0025)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0025):     1.61   0.039     4.17    36.02
      + ID2= 2 (  0026):     1.57   0.019     7.75    83.31
        ====================================================
        ID = 1 (  0025):     3.18   0.046     4.25    59.37

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------

 FINISH
====================================================================================
========================
```

APPENDIX F

Capacity Calculations

F1 – Culvert Master Calculations
F2 – Flow Master Calculations

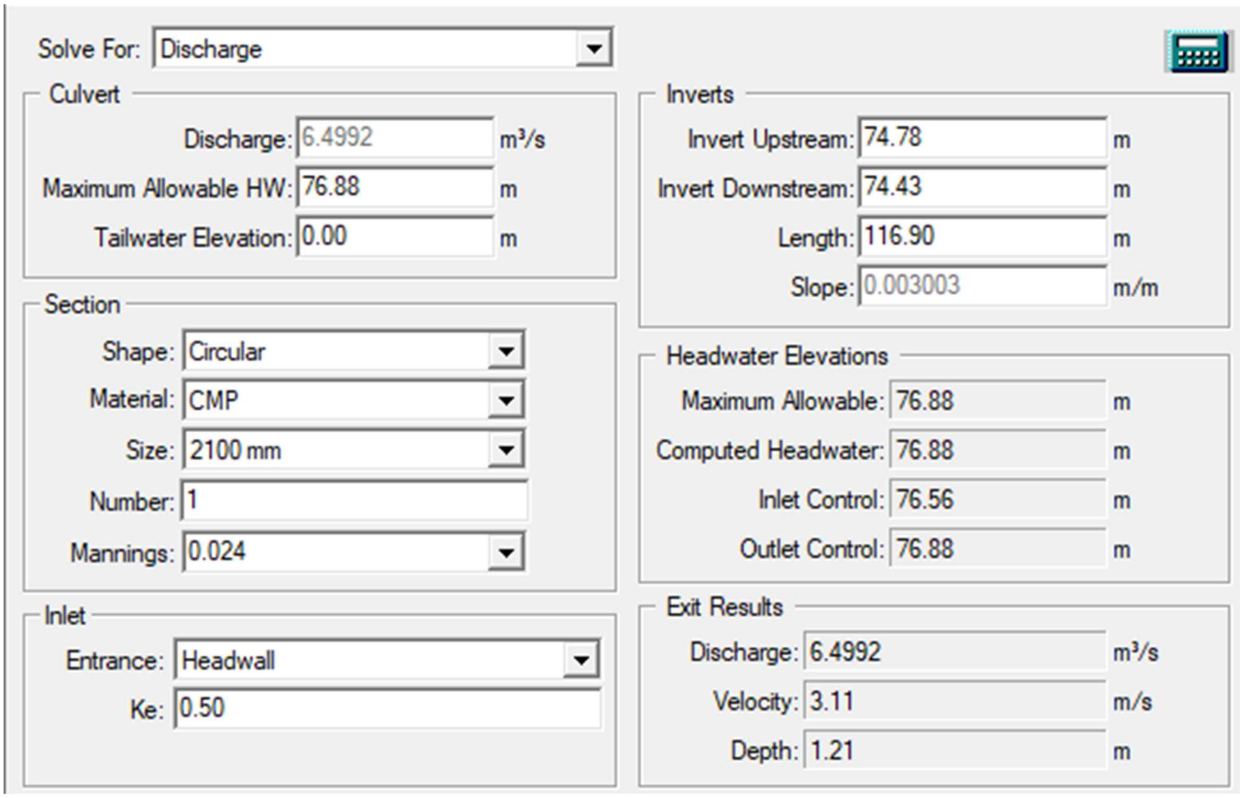

Figure 1: Railway Culvert #1 - Maximum Capacity

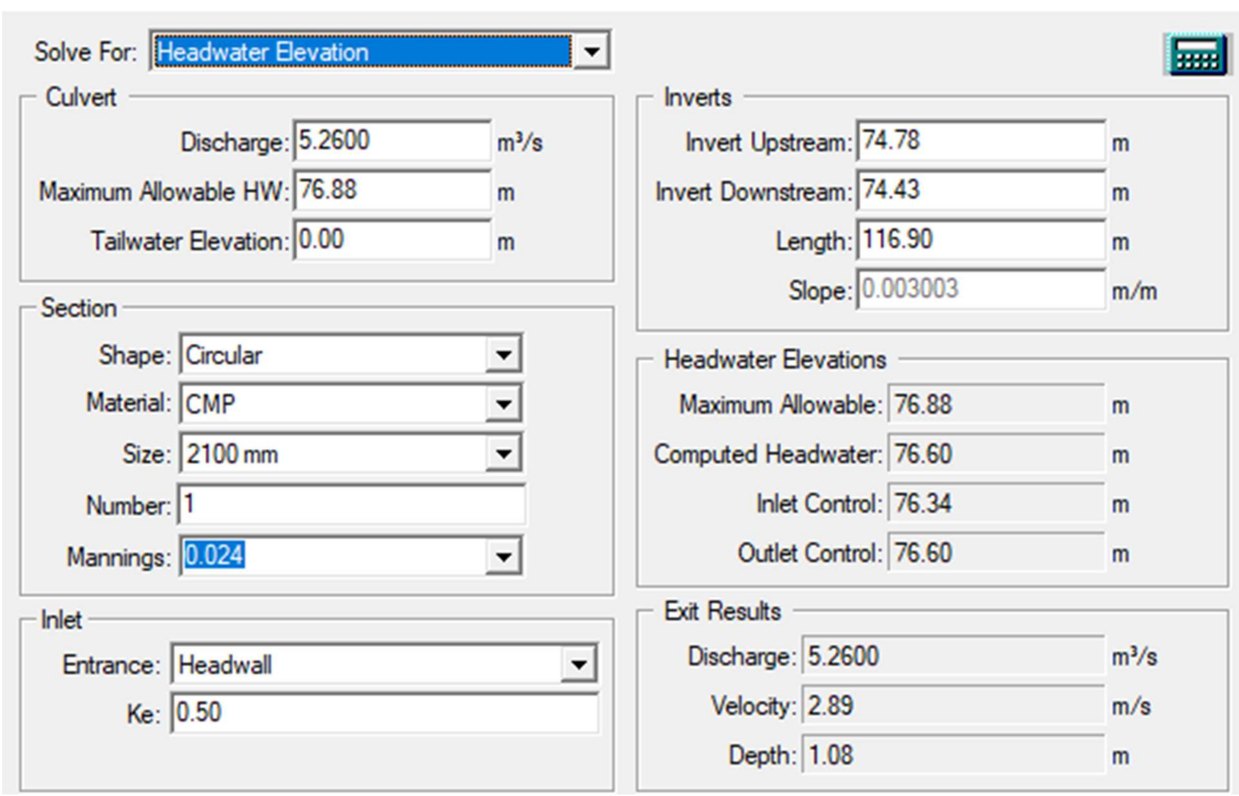

Figure 2: Railway Culvert #1 - Maximum Velocity

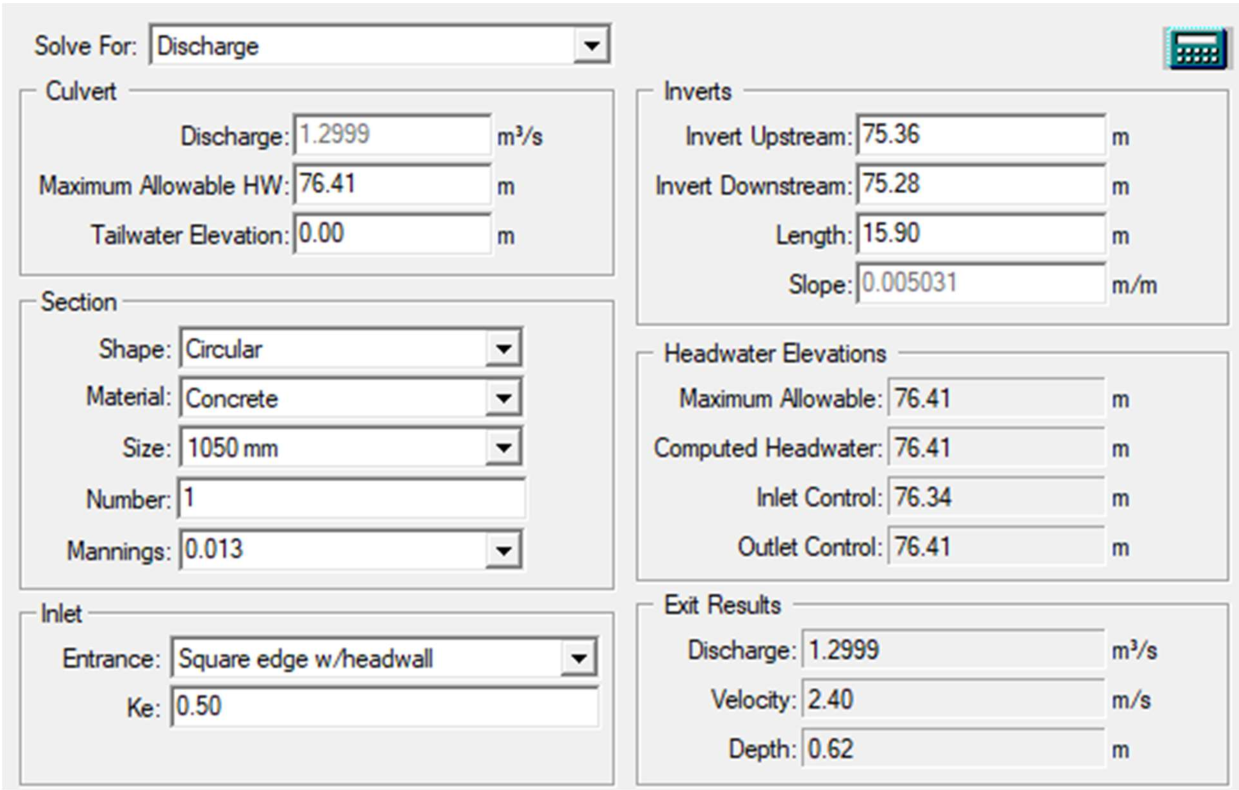

Figure 3: Railway Culvert #2 - Maximum Capacity

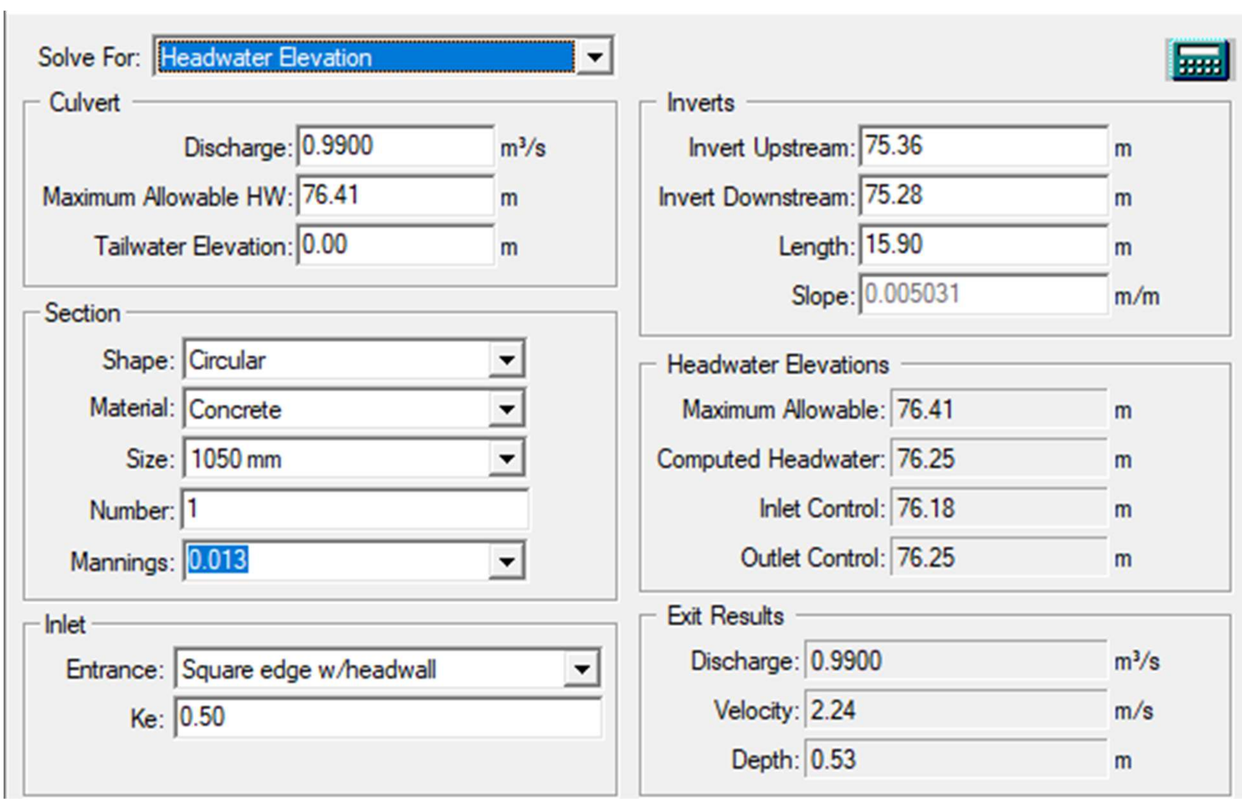

Figure 4: Railway Outlet #2 - Maximum Velocity

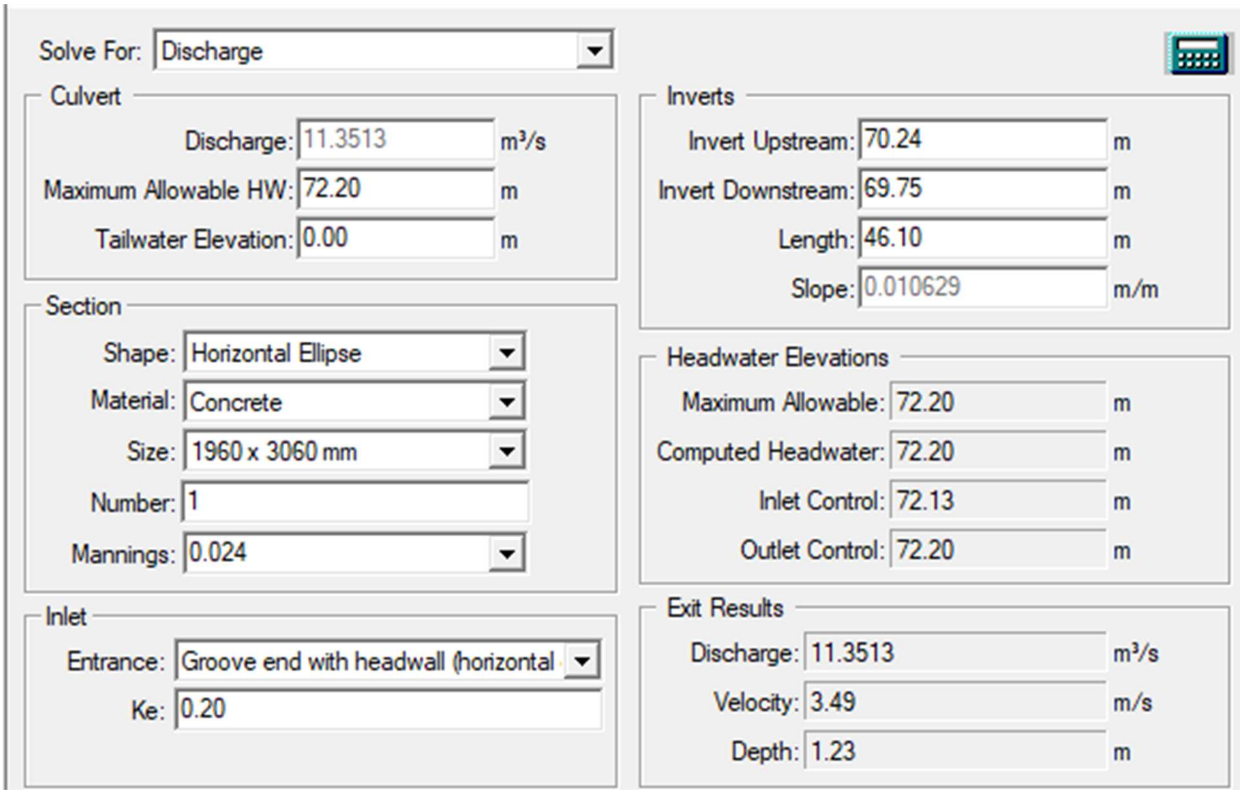

Figure 5: Railway Outlet #3 - Maximum Capacity

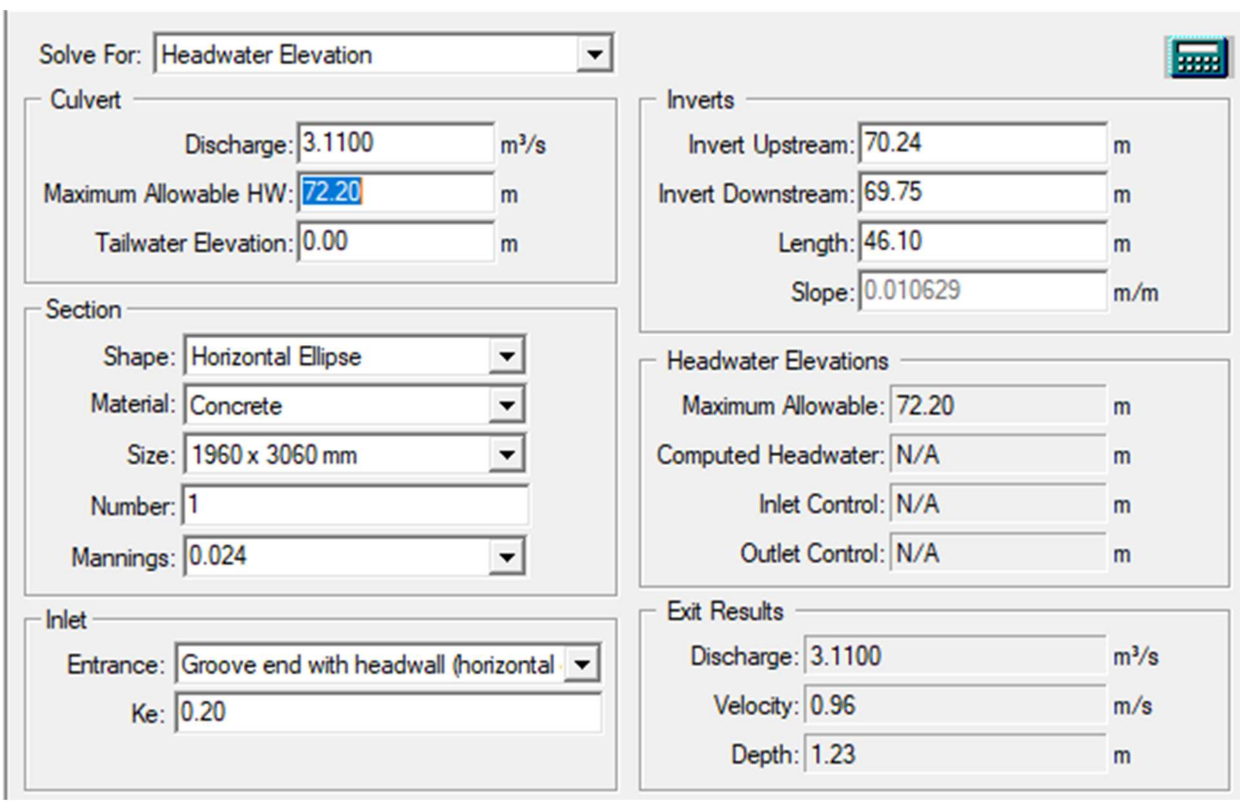

Figure 6 Railway Outlet #3 - Maximum Velocity

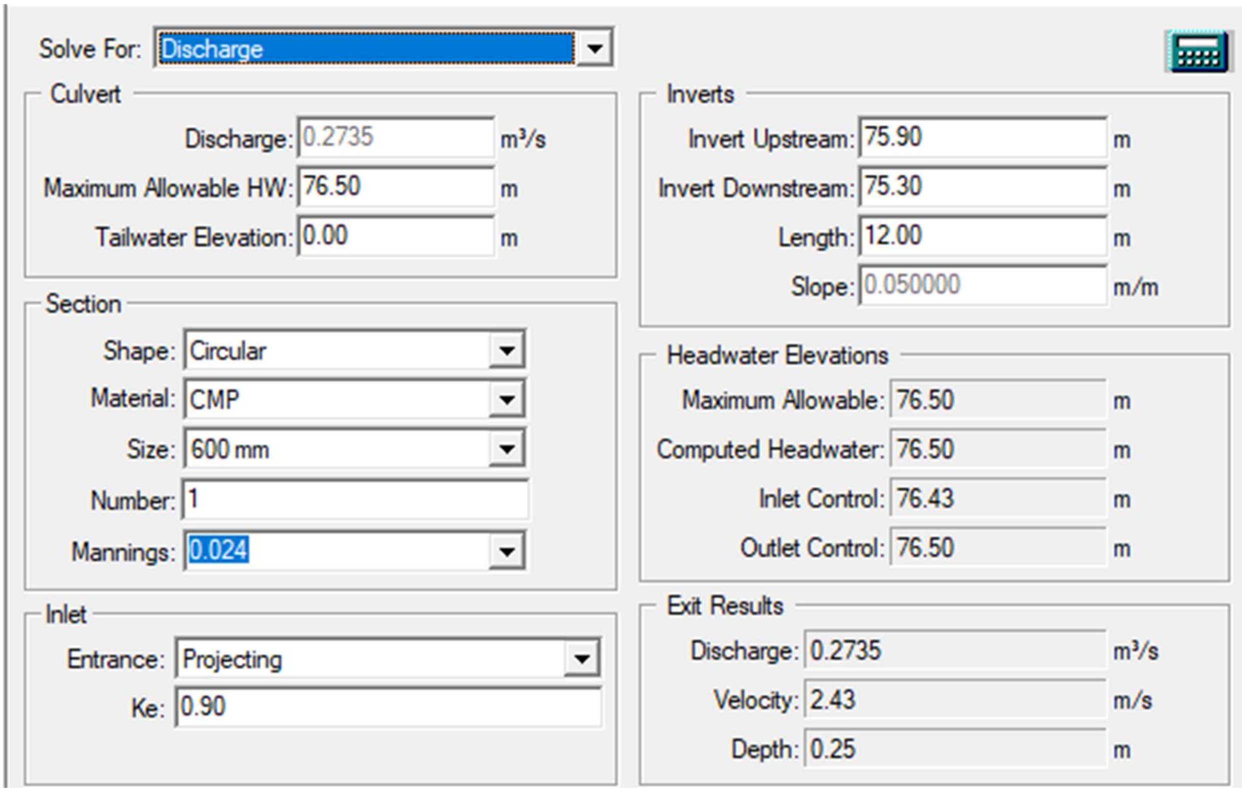

Figure 7: Street B - Maximum Capacity

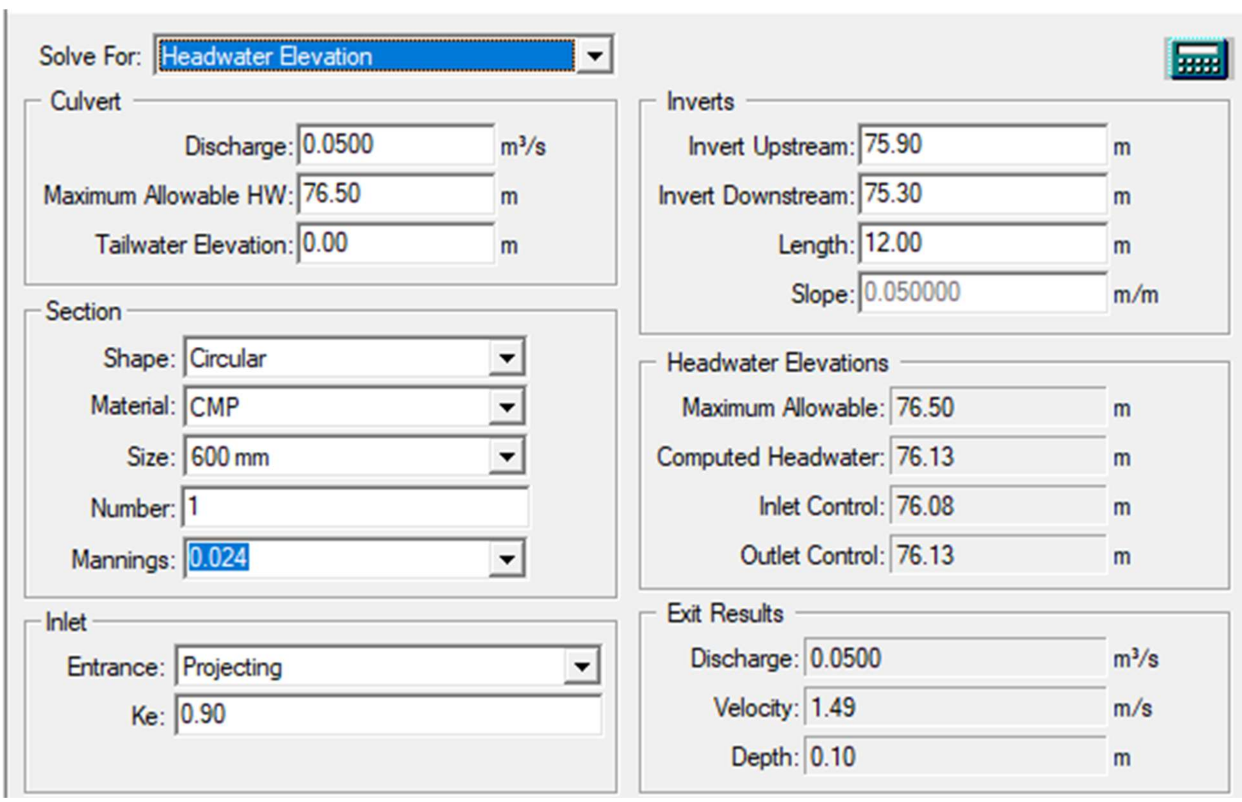

Figure 8: Street B - Maximum Velocity

VO Output Results of the 4hr 25 mm Chicago Storm for the proposed ditches and swales for Phase A.

Swale	Category	VO Catchment		Area	4hr Chicago 25mm	
					Runoff Vol	Discharge
				ha	mm	cms
West Ditch	Enhanced / Storage	105F	Uncontrolled	5.37	21.36	0.491
		RR105F	Controlled	5.37	21.06	0.015
East Ditch	Enhanced / Storage	107F_1	Uncontrolled	4.21	20.77	0.379
		RR107F_1	Controlled	4.21	20.5	0.016
Street B Ditch	Conveyance	107F_2	Uncontrolled	1.53	22.36	0.214
		RR107F_2	Controlled	1.53	22.16	0.019
North Swale	Enhanced	108F	Uncontrolled	1.57	16.15	0.109
		RR108F	Controlled	1.57	14.53	0.002
South Swale	Conveyance	108F_EX2	Uncontrolled	0.43	2.337	0.002

The east and west trapezoidal ditch and north swale have been modelling Flowmaster to assess whether the velocity of the stormwater flowing through these swales provides water quality benefits.

Worksheet for West Channel Cross Section 1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00100	m/m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Bottom Width	10.00	m
Discharge	0.015	m³/s

Results

Normal Depth	0.02	m
Flow Area	0.20	m²
Wetted Perimeter	10.12	m
Hydraulic Radius	0.02	m
Top Width	10.12	m
Critical Depth	0.01	m
Critical Slope	0.04812	m/m
Velocity	0.08	m/s
Velocity Head	0.00	m
Specific Energy	0.02	m
Froude Number	0.17	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.02	m
Critical Depth	0.01	m
Channel Slope	0.00100	m/m

Worksheet for West Channel Cross Section 1

GVF Output Data

Critical Slope	0.04812	m/m

Worksheet for East Channel Cross Section 2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00300	m/m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Bottom Width	10.00	m
Discharge	0.016	m³/s

Results

Normal Depth	0.01	m
Flow Area	0.15	m²
Wetted Perimeter	10.09	m
Hydraulic Radius	0.01	m
Top Width	10.09	m
Critical Depth	0.01	m
Critical Slope	0.04755	m/m
Velocity	0.11	m/s
Velocity Head	0.00	m
Specific Energy	0.02	m
Froude Number	0.29	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.01	m
Critical Depth	0.01	m
Channel Slope	0.00300	m/m

Worksheet for East Channel Cross Section 2

GVF Output Data

Critical Slope	0.04755	m/m

Worksheet for East Channel Cross Section 3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00100	m/m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Bottom Width	10.00	m
Discharge	0.016	m³/s

Results

Normal Depth	0.02	m
Flow Area	0.20	m²
Wetted Perimeter	10.13	m
Hydraulic Radius	0.02	m
Top Width	10.12	m
Critical Depth	0.01	m
Critical Slope	0.04744	m/m
Velocity	0.08	m/s
Velocity Head	0.00	m
Specific Energy	0.02	m
Froude Number	0.18	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.02	m
Critical Depth	0.01	m
Channel Slope	0.00100	m/m

Worksheet for East Channel Cross Section 3

GVF Output Data

Critical Slope	0.04744	m/m

Worksheet for North Swale Cross Section 4

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.01200	m/m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Bottom Width	2.00	m
Discharge	0.002	m³/s

Results

Normal Depth	0.01	m
Flow Area	0.01	m²
Wetted Perimeter	2.05	m
Hydraulic Radius	0.01	m
Top Width	2.04	m
Critical Depth	0.00	m
Critical Slope	0.05297	m/m
Velocity	0.14	m/s
Velocity Head	0.00	m
Specific Energy	0.01	m
Froude Number	0.51	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.01	m
Critical Depth	0.00	m
Channel Slope	0.01200	m/m

Worksheet for North Swale Cross Section 4

GVF Output Data

Critical Slope	0.05297	m/m

APPENDIX G

Existing Culvert Capacities Memo

2800 High Point Drive
Suite 100, Milton, ON
L9T 6P4
T. 905.875.0026
F. 905.875.4915
cfcrozier.ca

EXISTING CULVERT CAPACITIES MEMO

DATE	November 1, 2021	**PROJECT NO.**	1909-5629
RE	Long Sault Logistics Village Existing Culvert Capacities		
TO	Jennifer Murray, P.Eng. MBA		
FROM	Tony Elias, P.Eng. Josh Wagemaker, E.I.T.		

The purpose of this memorandum is to confirm the capacities of the existing railway culverts located on the south side of the Long Sault Business Park (the Site). There are three culverts which require analysis. The information for the existing culverts is shown below:

Table 1: Canadian National Railway Culverts

	Railway Outlet #1	Railway Outlet #2	Railway Outlet #3
Material	Corrugated Steel	Corrugated Steel	Corrugated Steel
Shape	Circular	Circular	Horizontal Ellipse
Dimensions (m)	2.15	0.90	2 x 3
Length (m)	26	39	39
Inlet Invert (masl)	74.71	74.21	69.24
Outlet Invert (masl)	74.70	72.98	69.20

It was noted during field inspection that Railway Outlet #2 has a significant drop between the inlet and outlet elevations, potentially due to settlement. This culvert is under review by Canadian Nation Railway (CNR) to determine the appropriate course of action.

A Visual Otthymo (VO) hydrologic model was created to estimate the peak flows at each culvert based on the runoff generated from an AES 30% Southern Ontario 12-hour storm distribution. The VO model captures the drainage area within the Site as well as the external drainage areas contributing to the Site from outside the property boundaries. Drainage areas were delineated based on a surface prepared from Light Detection and Ranging (LiDAR) data. A schematic of the VO model is shown below:

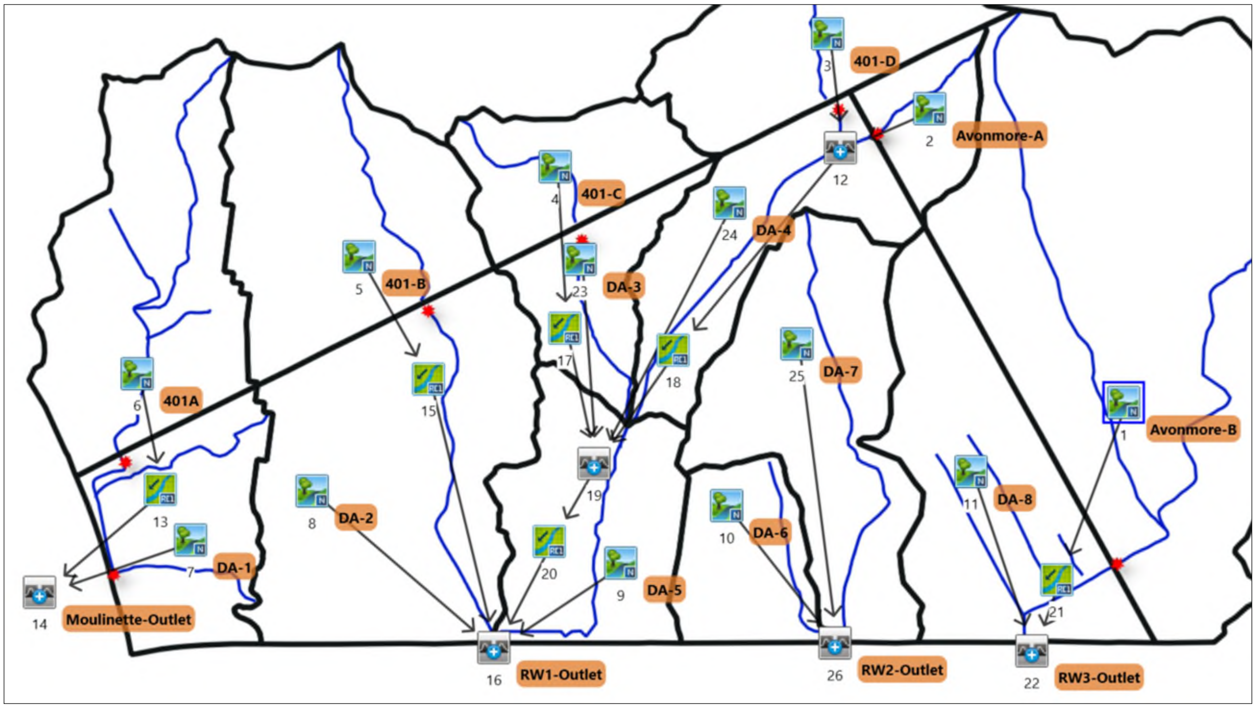

Figure 1: Visual Otthymo Model Schematic

VO model parameters were calculated for each drainage area based on the requirements outlined in the Site Plan & Subdivision Guidelines (June 2015) prepared by the Township of South Stormont. Modelling guidelines are listed below:

- Soil Conservations Service (SCS) Curve Number (CN) method shall be used during modelling to accurately represent the land use, soil, and antecedent moisture conditions present within the development area.
- Depression storage, or initial abstraction values shall be 1.57 mm for impervious areas and 4.67 mm for pervious areas.
- For developments larger than 15 hectares and/or drainage systems that are more complex, a computer model shall be created using approved software.
- The AES 30 % Southern Ontario – 12-hour storm distribution shall be used in sizing stormwater storage facilities.

Upland's Method was used to calculate the Time to Peak parameter of each drainage area. Upland's Method considers the overland slope and landcover for each catchment. The method is ideal for larger drainage areas like those delineated for the Site.

Hydrologic parameters used by the model were calculated based on soils, land use, and contour data. Soil data was collected from the Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA) Soil Survey Complex. Land use was determined based on the review of aerial imagery and wetland features delineated by Bowfin Environmental. Attachment I contains detailed calculations of the hydrologic parameters. Drainage area parameters are summarized in Table 2.

Table 2: Existing Drainage Area Parameters

Drainage Area ID	Area (ha)	Curve Number	Initial Abstraction (mm)	Time to Peak (hours)
DA-1	33.97	66.8	4.67	1.64
DA-2	81.91	60.9	4.67	1.64
DA-3	20.32	54.5	4.67	2.5
DA-4	38.38	52.9	4.67	4.84
DA-5	40.85	59.1	4.67	2.7
DA-6	22.68	60	4.67	1.81
DA-7	57.61	56.4	4.67	3.53
DA-8	56.87	64.3	4.67	3.53
401A	60.47	63	4.67	3.53
401-B	57.68	61.6	4.67	1.37
401-C	24.59	66.2	4.67	0.74
401-D	44.86	67.1	4.67	1.65
Avonmore-A	14.34	55.3	4.67	1.05
Avonmore-B	171.62	68.1	4.67	4.18

The Visual Otthymo model was run using the 100-year AES 30 % Southern Ontario – 12-hour storm distribution and peak flows were generated at the location of each CNR culvert. The 100-year peak flows for each culvert are summarized in Table 3.

Table 3 – CNR Peak Flows, 100-Year AES 30 % Southern Ontario – 12-hour Distribution

	Railway Outlet #1	Railway Outlet #2	Railway Outlet #3
Peak Flow (m^3/s)	5.26	0.99	3.11

Culvert hydraulics were analyzed using CulvertMaster design software. Culvert properties described in Table 1 were input into CulvertMaster. Culvert capacities were determined assuming that the headwater elevation of each culvert will not rise above the obvert of the corresponding inlet pipe (no surcharge). CulvertMaster output data is found in Attachment II. A summary of the culvert capacities is shown in Table 4.

Table 4 – CNR Culvert Existing Capacities

	Railway Outlet #1	Railway Outlet #2	Railway Outlet #3
Peak Flow (m^3/s)	6.75	0.75	11.57

Based on the above results, Railway Outlet #1 and Railway Outlet #3 meet the capacity requirements. Railway Outlet #2 does not have enough capacity to convey the existing 100-year flow. A 1050 mm corrugated steel pipe with a capacity of 1.11 m^3/s would satisfy the 100-year flow requirement. Analysis of the proposed culvert capacity is found in Attachment II.

The conditions at Railway Outlet #1 and Railway Outlet #3 are acceptable; thus, no changes are recommended at these locations. While deciding on an appropriate course of action for the possible settlement issues at Railway Outlet #2, CNR should also consider increasing the pipe size from a 900 mm to 1050 mm.

Sincerely,

C.F. CROZIER & ASSOCIATES INC.

Tony Elias, P.Eng.
Senior Project Manager

JW/stm

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ATTACHMENT I

Model Parameter Calculations – Visual Otthymo

CROZIER &ASSOCIATES Consulting Engineers

Project Name:	Long Sault	D.A.	DA-1
Project Number:	1909-5629	D.A.	34.0
Date:	6/8/2021		
By:	JW		
Check By:	RSA		

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment DA-1

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
	-	B	70%	23.7
	-	D	28%	9.5
	-	C	2%	0.8
Total Area				34.0

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	2.153	98	0	98	0	98	0.0	98	0	98	2.153	210.994
- - D	0.079	98	0	98	0	98	0.0	98	0	98	0.079	7.742
- - C	0.014	98	0	98	0	98	0.0	98	0	98	0.014	1.372
Subtotal Area	2.246		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	14.95	60	0.00	65	2.77	50	3.76	69	0.00	74	21.48	1294.95
- - D	8.79	79	0.00	81	0.66	50	0.00	84	0.00	86	9.45	727.73
- - C	0.79	32	0.00	38	0.00	50	0.00	49	0.00	62	0.79	25.31
Subtotal Area	24.54		0.00		3.43		3.76		0.00			

	Composite Area Calculations	Total Pervious Area	31.73
		Total Impervious Area	2.246
		% Impervious	6.61%
		Composite Curve Number	66.8
		Total Area Check	33.97

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	24.537	245.37	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	3.432	54.912	0.05						0.05		0
Lawn	5	3.757	18.785	0.18						0.18		0
Cultivated	7	0.00	0.00	0.22						0.22		0
Impervious	2	2.246	4.492	0.95						0.95		0
Composite IA	4.67*	33.972	9.52428	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description		Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	1144.12	8	0.7%	1.5547	0.13	2.44	1.6379496	1.64	NA	NA	NA	NA

Appropriate calculated time to peak:	1.64	Appropriate Method:	Uplands

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

Project Name:	Long Sault	D.A.	DA-2
Project Number:	1909-5629	D.A.	81.9
Date:	6/8/2021		
By:	JW		
Check By:	RSA		

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment DA-2

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
	-	B	64%	52.2
	-	D	22%	18.1
	-	BC	14%	11.6
Total Area				81.9

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	0.661	98	0	98	0	98	0.0	98	0	98	0.661	64.778
- - D	0	98	0	98	0	98	0.0	98	0	98	0	0
- - BC	1.892	98	0	98	0	98	0.0	98	0	98	1.892	185.416
Subtotal Area	2.553		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	44.23	60	0.00	65	7.46	50	0.00	69	0.00	74	51.70	3027.13
- - D	13.886	79	0.00	81	4.10	50	0.00	84	0.00	86	17.99	1302.14
- - BC	4.15	32	0.00	38	5.53	50	0.00	49	0.00	62	9.67	408.99
Subtotal Area	62.27		0.00		17.09		0.00		0.00			

Composite Area Calculations		
	Total Pervious Area	79.36
	Total Impervious Area	2.553
	% Impervious	3.12%
	Composite Curve Number	60.9
	Total Area Check	81.91

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	62.267	622.67	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	17.091	273.456	0.05						0.05		0
Lawn	5	0	0	0.18						0.18		0
Cultivated	7	0.00	0.00	0.22						0.22		0
Impervious	2	2.553	5.106	0.95						0.95		0
Composite IA	4.67*	81.911	11.0026	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	1144.12	8	0.7%	1.5547	0.13	2.44	1.6379496	1.64	NA	NA	NA	NA

Appropriate calculated time to peak:	1.64	Appropriate Method:	Uplands

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name:	Long Sault	D.A.	DA-3
Project Number:	1909-5629	D.A.	20.3
Date:	6/8/2021		
By:	JW		
Check By:	RSA		

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment DA-3

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
		B	60%	12.1
		BC	40%	8.2
Total Area				20.324

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- B	0	98	0	98	0	98	0.0	98	0	98	0	0
- BC	2.213	98	0	98	0	98	0.0	98	0	98	2.213	216.874
Subtotal Area	2.213		0		0		0.0		0			
Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- B	5.46	60	0.00	65	5.83	50	0.66	69	0.00	74	11.95	664.78
- BC	4.58	32	0.00	38	1.08	50	0.49	49	0.00	62	6.16	225.00
Subtotal Area	10.04		0.00		6.91		1.16		0.00			

Composite Area Calculations		
	Total Pervious Area	18.111
	Total Impervious Area	2.213
	% Impervious	10.89%
	Composite Curve Number	54.5
	Total Area Check	20.324

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	10.043	100.43	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	6.913	110.608	0.05						0.05		0
Lawn	5	1.155	5.775	0.18						0.18		0
Cultivated	7	0.00	0.00	0.22						0.22		0
Impervious	2	2.213	4.426	0.95						0.95		0
Composite IA	4.67*	20.324	10.8856	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	645.32	2	0.1%	1.5825	0.05	3.73	2.5021088	2.50	NA	NA	NA	NA

Appropriate calculated time to peak:	2.50	Appropriate Method:	Uplands

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

Project Name:	Long Sault
Project Number:	1909-5629
Date:	6/8/2021
By:	JW
Check By:	RSA

D.A.	DA-4
D.A.	38.4

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment DA-4

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
		B	78%	30.0
		BC	22%	8.4
Total Area				38.377

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- B	0.274	98	0	98	0	98	0.0	98	0	98	0.274	26.852
- BC	1.164	98	0	98	0	98	0.0	98	0	98	1.164	114.072
Subtotal Area	1.438		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- B	11.52	60	0.00	65	17.59	50	0.66	69	0.00	74	29.77	1616.01
- BC	4.72	32	0.00	38	1.96	50	0.49	49	0.00	62	7.17	273.12
Subtotal Area	16.24		0.00		19.55		1.16		0.00			

Composite Area Calculations	Total Pervious Area	36.939
	Total Impervious Area	1.438
	% Impervious	3.75%
	Composite Curve Number	52.9
	Total Area Check	38.377

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	16.239	162.39	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	19.545	312.72	0.05						0.05		0
Lawn	5	1.155	5.775	0.18						0.18		0
Cultivated	7	0.00	0.00	0.22						0.22		0
Impervious	2	1.438	2.876	0.95						0.95		0
Composite IA	4.67*	38.377	12.6055	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	1248	2	0.1%	1.5825	0.05	7.22	4.8388889	4.84	NA	NA	NA	NA

Appropriate calculated time to peak:	4.84	Appropriate Method:	Uplands

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)

5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name:	Long Sault	D.A.	DA-5
Project Number:	1909-5629	D.A.	40.9
Date:	6/8/2021		
By:	JW		
Check By:	RSA		

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment DA-5

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
	-	B	93%	38.2
	-	D	1%	0.3
	-	CD	6%	2.3
Total Area				40.9

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	0	98	0	98	0	98	0.0	98	0	98	0	0
- - D	0	98	0	98	0	98	0.0	98	0	98	0	0
- - CD	0	98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area	0		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	34.10	60	0.00	65	4.07	50	0.00	69	0.00	74	38.17	2249.23
- - D	0.314	79	0.00	81	0.02	50	0.00	84	0.00	86	0.33	25.81
- - CD	1.33	67	0.00	71	1.02	50	0.00	74	0.00	78	2.35	140.31
Subtotal Area	35.75		0.00		5.11		0.00		0.00			

Composite Area Calculations		
	Total Pervious Area	40.85
	Total Impervious Area	0
	% Impervious	0.00%
	Composite Curve Number	59.1
	Total Area Check	40.85

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	35.745	357.45	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	5.107	81.712	0.05						0.05		0
Lawn	5	0	0	0.18						0.18		0
Cultivated	7	0.00	0.00	0.22						0.22		0
Impervious	2	0	0	0.95						0.95		0
Composite IA	4.67*	40.852	10.7501	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)		Tp(hr)
Concentrated	1015.5	5	0.5%	0.9976	0.07	4.03	2.6999511	2.70	NA	NA	NA	NA

Appropriate calculated time to peak:	2.70	Appropriate Method:	Uplands

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES
Consulting Engineers

Project Name:	Long Sault	D.A.	DA-6
Project Number:	1909-5629	D.A.	22.7
Date:	6/8/2021		
By:	JW		
Check By:	RSA		

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment DA-6

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
Sandy Loam	-	B	100%	22.7
Total Area				22.684

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	0	98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area	0		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	22.68	60	0.00	65	0.00	50	0.00	69	0.00	74	22.68	1361.04
Subtotal Area	22.68		0.00		0.00		0.00		0.00			

	Composite Area Calculations	Total Pervious Area	22.684
		Total Impervious Area	0
		% Impervious	0.00%
		Composite Curve Number	60.0
		Total Area Check	22.684

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	Sandy Loam								
				RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	22.684	226.84	0.08								0
Meadow	8	0	0	0.10								0
Wetland	16	0	0	0.05								0
Lawn	5	0	0	0.18								0
Cultivated	7	0.00	0.00	0.22								0
Impervious	2	0	0	0.95								0
Composite IA	4.67*	22.684	10	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	679.399	11	1.6%	0.5501	0.07	2.70	1.8063386	1.81	NA	NA	NA	NA

Appropriate calculated time to peak:	1.81	Appropriate Method:	Uplands

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name: Long Sault
Project Number: 1909-5629
Date: 6/8/2021
By: JW
Check By: RSA

D.A.	DA-7
D.A.	57.6

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment DA-7

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
Sandy Loam	-	B	100%	57.6
Total Area				57.611

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	0	98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area	0		0		0		0.0		0			
Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	35.70	60	0.00	65	21.32	50	0.59	69	0.00	74	57.61	3248.76
Subtotal Area	35.70		0.00		21.32		0.59		0.00			

Composite Area Calculations		
	Total Pervious Area	57.611
	Total Impervious Area	0
	% Impervious	0.00%
	Composite Curve Number	56.4
	Total Area Check	57.611

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	Sandy Loam RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	35.702	357.02	0.08								0
Meadow	8	0	0	0.10								0
Wetland	16	21.32	341.12	0.05								0
Lawn	5	0.589	2.945	0.18								0
Cultivated	7	0.00	0.00	0.22								0
Impervious	2	0	0	0.95								0
Composite IA	4.67*	57.611	12.1693	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	1517	15	1.0%	0.8045	0.08	5.27	3.5291319	3.53	NA	NA	NA	NA

Appropriate calculated time to peak:	3.53	Appropriate Method:	Uplands

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name:	Long Sault	D.A.	DA-8
Project Number:	1909-5629	D.A.	56.9
Date:	6/8/2021		
By:	JW		
Check By:	RSA		

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment DA-8

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
	-	B	86%	49.1
	-	D	2%	1.4
	-	CD	11%	6.4
Total Area				56.9

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	0	98	0	98	0	98	0.0	98	0	98	0	0
- - D	0	98	0	98	0	98	0.0	98	0	98	0	0
- - CD	0	98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area	0		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	32.86	60	0.00	65	0.00	50	16.12	69	0.00	74	48.98	3083.84
- - D	0.491	79	0.00	81	0.00	50	0.96	84	0.00	86	1.45	119.51
- - CD	3.15	67	0.00	71	0.00	50	3.29	74	0.00	78	6.44	454.46
Subtotal Area	36.50		0.00		0.00		20.37		0.00			

Composite Area Calculations		
	Total Pervious Area	56.87
	Total Impervious Area	0
	% Impervious	0.00%
	Composite Curve Number	64.3
	Total Area Check	56.87

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	36.501	365.01	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	0	0	0.05						0.05		0
Lawn	5	20.37	101.85	0.18						0.18		0
Cultivated	7	0.00	0.00	0.22						0.22		0
Impervious	2	0	0	0.95						0.95		0
Composite IA	4.67*	56.871	8.2091	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	1442.23	13	0.9%	0.8005	0.08	5.27	3.5317718	3.53	NA	NA	NA	NA

Appropriate calculated time to peak:	3.53	Appropriate Method:	Uplands

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

Project Name:	Long Sault
Project Number:	1909-5629
Date:	6/8/2021
By:	JW
Check By:	RSA

D.A.	401A
D.A.	60.5

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment 401A

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
Sandy Loam	-	B	86%	52.3
Sandy Loam		A	14%	8.2
Total Area				60.465

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	2.159	98	0	98	0	98	0.0	98	0	98	2.159	211.582
- A	0	98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area	2.159		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	28.17	60	0.00	65	0.00	50	15.90	69	6.17	74	50.24	3243.98
- A	2.39	32	0.00	38	0.00	50	5.68	49	0.00	62	8.06	354.56
Subtotal Area	30.56		0.00		0.00		21.58		6.17			

Composite Area Calculations	Total Pervious Area	58.306
	Total Impervious Area	2.159
	% Impervious	3.57%
	Composite Curve Number	63.0
	Total Area Check	60.465

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	Sandy Loam RC	Sandy Loam Area	A*RC
Woodland	10	30.558	305.58	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	0	0	0.05						0.05		0
Lawn	5	21.576	107.88	0.18						0.18		0
Cultivated	7	6.17	43.20	0.22						0.22		0
Impervious	2	2.159	4.318	0.95						0.95		0
Composite IA	4.67*	60.465	7.62395	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	1517	15	1.0%	0.8045	0.08	5.27	3.5291319	3.53	NA	NA	NA	NA

Appropriate calculated time to peak:	3.53	Appropriate Method:	Uplands

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name:	Long Sault	D.A.	401B
Project Number:	1909-5629	D.A.	57.7
Date:	6/8/2021		
By:	JW		
Check By:	RSA		

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment 401B

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
Sandy Loam	-	B	74%	42.5
Sandy Loam	-	A	22%	12.7
	-	BC	4%	2.5
Total Area				57.7

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	0.651	98	0	98	0	98	0.0	98	0	98	0.651	63.798
- - A	0	98	0	98	0	98	0.0	98	0	98	0	0
- - BC	1.497	98	0	98	0	98	0.0	98	0	98	1.497	146.706
Subtotal Area	2.148		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	22.69	60	0.00	65	0.00	50	19.17	69	0.00	74	41.86	2683.94
- - A	1.86	32	0.00	38	0.00	50	10.77	49	0.00	62	12.63	587.18
- - BC	1.05	67	0.00	71	0.00	50	0.00	74	0.00	78	1.05	70.28
Subtotal Area	25.60		0.00		0.00		29.94		0.00			

Composite Area Calculations		
	Total Pervious Area	55.54
	Total Impervious Area	2.148
	% Impervious	3.72%
	Composite Curve Number	61.6
	Total Area Check	57.68

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	25.601	256.01	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	0	0	0.05						0.05		0
Lawn	5	29.935	149.675	0.18						0.18		0
Cultivated	7	0.00	0.00	0.22						0.22		0
Impervious	2	2.148	4.296	0.95						0.95		0
Composite IA	*4.67	57.684	7.10736	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	954.857	6	0.6%	1.64	0.13	2.04	1.3669961	1.37	NA	NA	NA	NA

Appropriate calculated time to peak:	1.37	Appropriate Method:	Uplands

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2qqq
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name: Long Sault
Project Number: 1909-5629
Date: 6/8/2021
By: JW
Check By: RSA

D.A.	401C
D.A.	24.6

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment 401C

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
	-	B	73%	17.9
	-	A	0%	0.0
	-	BC	27%	6.7
Total Area				24.6

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	0.482	98	0	98	0	98	0.0	98	0	98	0.482	47.236
- - A	0	98	0	98	0	98	0.0	98	0	98	0	0
- - BC	1.621	98	0	98	0	98	0.0	98	0	98	1.621	158.858
Subtotal Area	2.103		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	13.78	60	0.00	65	0.00	50	3.53	69	0.00	74	17.31	1070.37
- - A	0	32	0.00	38	0.00	50	0.00	49	0.00	62	0.00	0.00
- - BC	4.64	67	0.00	71	0.00	50	0.54	74	0.00	78	5.18	350.61
Subtotal Area	18.42		0.00		0.00		4.07		0.00			

Composite Area Calculations	Total Pervious Area	22.49
	Total Impervious Area	2.103
	% Impervious	8.55%
	Composite Curve Number	66.2
	Total Area Check	24.59

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	18.421	184.21	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	0	0	0.05						0.05		0
Lawn	5	4.066	20.33	0.18						0.18		0
Cultivated	7	0.00	0.00	0.22						0.22		0
Impervious	2	2.103	4.206	0.95						0.95		0
Composite IA	4.67*	24.59	8.48906	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	600.276	21	3.5%	0.802	0.15	1.11	0.7447869	0.74	NA	NA	NA	NA

Appropriate calculated time to peak:	0.74	Appropriate Method:	Uplands

Notes:

1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER & ASSOCIATES Consulting Engineers

Project Name: Long Sault
Project Number: 1909-5629
Date: 6/8/2021
By: JW
Check By: RSA

D.A. 401D
D.A. 44.9

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment 401D

Curve Number Calculation

44.895

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
	-	B	72%	32.2
	-	D	5%	2.2
	-	BC	23%	10.5
Total Area				44.9

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	0.241	98	0	98	0	98	0.0	98	0	98	0.241	23.618
- - D	0.763	98	0	98	0	98	0.0	98	0	98	0.763	74.774
- - BC	0.904	98	0	98	0	98	0.0	98	0	98	0.904	88.592
Subtotal Area	1.908		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	18.63	60	0.00	65	0.00	50	9.15	69	4.04	74	31.83	2048.45
- - D	1.536	79	0.00	81	0.00	50	0.00	84	0.00	86	1.54	121.34
- - BC	8.45	67	0.00	71	0.00	50	0.45	74	0.69	78	9.59	653.33
Subtotal Area	28.62		0.00		0.00		9.60		4.73			

Composite Area Calculations	Total Pervious Area	42.95
	Total Impervious Area	1.908
	% Impervious	4.25%
	Composite Curve Number	67.1
	Total Area Check	44.86

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	28.621	286.21	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	0	0	0.05						0.05		0
Lawn	5	9.598	47.99	0.18						0.18		0
Cultivated	7	4.73	33.13	0.22						0.22		0
Impervious	2	1.908	3.816	0.95						0.95		0
Composite IA	4.67*	44.86	8.27345	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	797.19	10	1.3%	0.8036	0.09	2.46	1.6485102	1.65	NA	NA	NA	NA

Appropriate calculated time to peak:	1.65	Appropriate Method:	Uplands

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER &ASSOCIATES Consulting Engineers

Project Name: Long Sault
Project Number: 1909-5629
Date: 6/8/2021
By: JW
Check By: RSA

D.A. Avonmore-A
D.A. 14.3

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment Avonmore-A

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
Sandy Loam	-	B	63%	9.0
Sandy Loam		D	37%	5.4
Total Area				14.344

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	0.403	98	0	98	0	98	0.0	98	0	98	0.403	39.494
- D	1.032	98	0	98	0	98	0.0	98	0	98	1.032	101.136
Subtotal Area	1.435		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	8.55	60	0.00	65	0.00	50	0.00	69	0.00	74	8.55	512.94
- D	4.36	32	0.00	38	0.00	50	0.00	49	0.00	62	4.36	139.52
Subtotal Area	12.91		0.00		0.00		0.00		0.00			

	Composite Area Calculations	Total Pervious Area	12.909
		Total Impervious Area	1.435
		% Impervious	10.00%
		Composite Curve Number	55.3
		Total Area Check	14.344

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
										Sandy Loam		
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	12.909	129.09	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	0	0	0.05						0.05		0
Lawn	5	0	0	0.18						0.18		0
Cultivated	7	0.00	0.00	0.22						0.22		0
Impervious	2	1.435	2.87	0.95						0.95		0
Composite IA	4.67*	14.344	9.19967	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	450.4	7	0.1%	2.6375	0.08	1.56	1.0478056	1.05	NA	NA	NA	NA

Appropriate calculated time to peak:	1.05	Appropriate Method:	Uplands

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

CROZIER &ASSOCIATES Consulting Engineers

Project Name: Long Sault
Project Number: 1909-5629
Date: 6/8/2021
By: JW
Check By: RSA

D.A. Avonmore-B
D.A. 171.6

Hydrologic Parameters: CALIB NASHYD Command
Pre Development Drainage Area: Catchment Avonmore-B

Curve Number Calculation

Soil Types Present:				
Type	ID	Hydrologic Group	% Area	Area
	-	B	62%	105.9
	-	D	22%	37.5
	-	CD	16%	28.2
Total Area				171.6

Impervious Landuses Present:												
	Roadway		Sidewalk		Driveway		Building		SWMF		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	0	98	0	98	0	98	0.0	98	0	98	0	0
- - D	0.383	98	0	98	0	98	0.0	98	0	98	0.383	37.534
- - CD	0	98	0	98	0	98	0.0	98	0	98	0	0
Subtotal Area	0.383		0		0		0.0		0			

Pervious Landuses Present:												
	Woodland		Meadow		Wetland		Lawn		Cultivated		Subtotals	
Soils	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area (ha)	CN	Area	A*CN
- - B	65.78	60	0.00	65	0.00	50	40.29	69	0.00	74	106.08	6727.20
- - D	35.755	79	0.00	81	0.00	50	1.17	84	0.00	86	36.92	2922.76
- - CD	12.81	67	0.00	71	0.00	50	15.43	74	0.00	78	28.23	1999.60
Subtotal Area	114.34		0.00		0.00		56.89		0.00			

Composite Area Calculations	Total Pervious Area	171.23
	Total Impervious Area	0.383
	% Impervious	0.22%
	Composite Curve Number	68.1
	Total Area Check	171.6

Initial Abstraction and Tp Calculations

Initial Abstraction				Composite Runoff Coefficient								
Landuse	IA (mm)	Area (ha)	A * IA	RC	Area	RC	Area	RC	Area	RC	Area	A*RC
Woodland	10	114.34	1143.44	0.08						0.08		0
Meadow	8	0	0	0.10						0.10		0
Wetland	16	0	0	0.05						0.05		0
Lawn	5	56.888	284.44	0.18						0.18		0
Cultivated	7	0.00	0.00	0.22						0.22		0
Impervious	2	0.383	0.766	0.95						0.95		0
Composite IA	4.67*	171.62	8.32472	Composite Runoff Coefficient								0

Initial abstraction is 4.67 mm based on Township guidelines.

Time to Peak Inputs						Uplands			Bransby Williams		Airport	
Flow Path Description	Length (m)	Drop (m)	Slope (%)	$V/S^{0.5}$	Velocity (m/s)	Tc (hr)	Tp(hr)	TOTAL Tp (hr)	Tc (hr)	Tp(hr)	Tc (hr)	Tp(hr)
Concentrated	1996.86	21	1.1%	0.8679	0.09	6.23	4.1756955	4.18	NA	NA	NA	NA

Appropriate calculated time to peak:	4.18	Appropriate Method:	Uplands

Notes:
1. Hydrologic soil group classification from Design Chart 1.08, MTO Drainage Management Manual (1997)
2. Runoff Curve Numbers obtained from Table 10.1, NVCA Stormwater Technical Guide (2013)
3. Runoff coefficients obtained from Design Chart 1.07, MTO Drainage Management Manual (1997)
4. As per the NVCA Stormwater Technical Guide (2013), the Bransby Williams Method should be used for Tc calculations where the runoff coefficient is greater than 0.4. The values obtained using the Bransby Williams method seem low relative to the catchment areas, and the values calculated using the Airport Method yield more conservative Tc values, and as such the Airport Method Tc values are used.
5. Initial Abstraction values obtained from Table 10.2, NVCA Stormwater Technical Guide (2013)

ATTACHMENT II

Railway Culvert Capacity Results – CulvertMaster

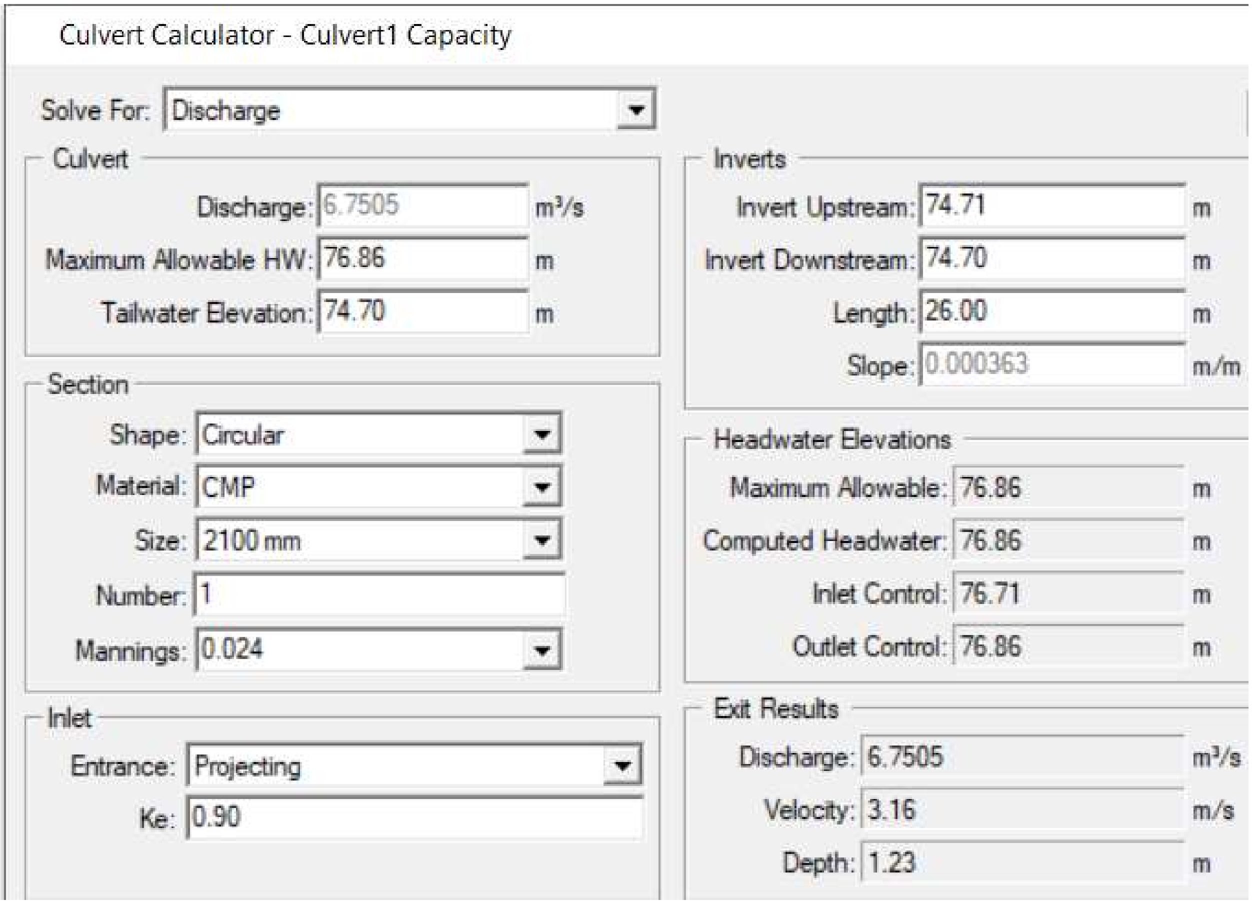


Figure 1: Railway Culvert #1 Capacity

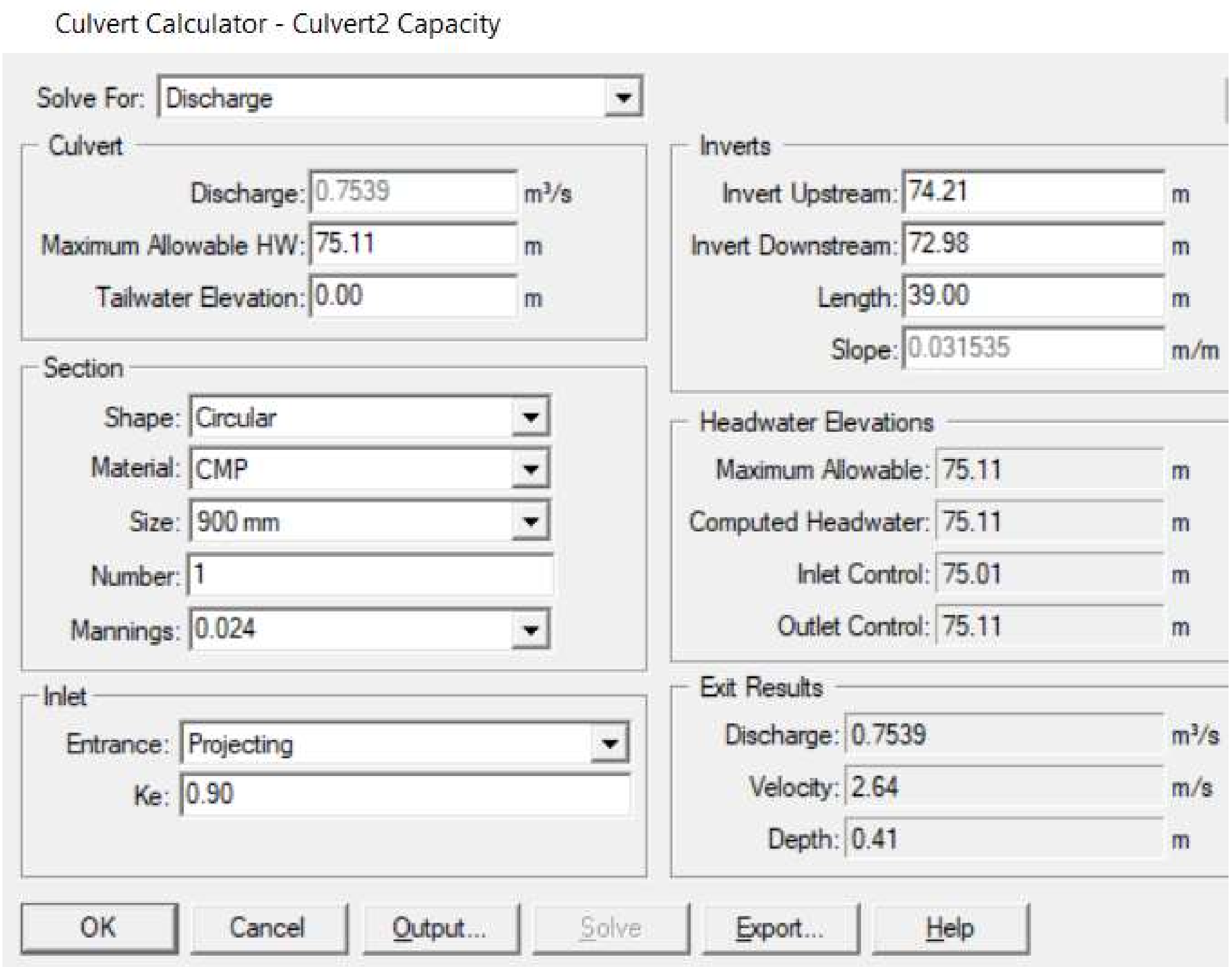


Figure 2: Railway Culvert #2 Capacity

Culvert Calculator - Culvert 3 Capacity

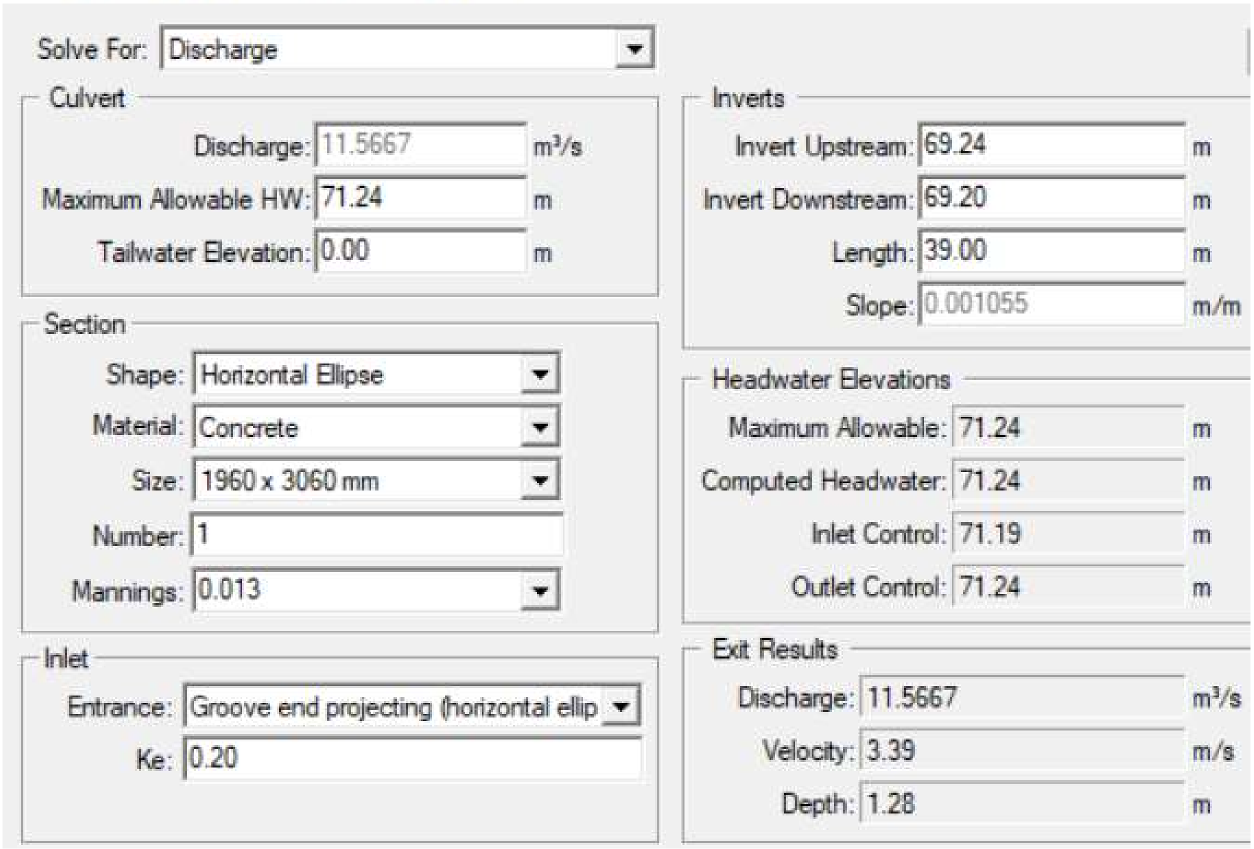


Figure 3: Railway Culvert #3 Capacity, Existing Pipe Size

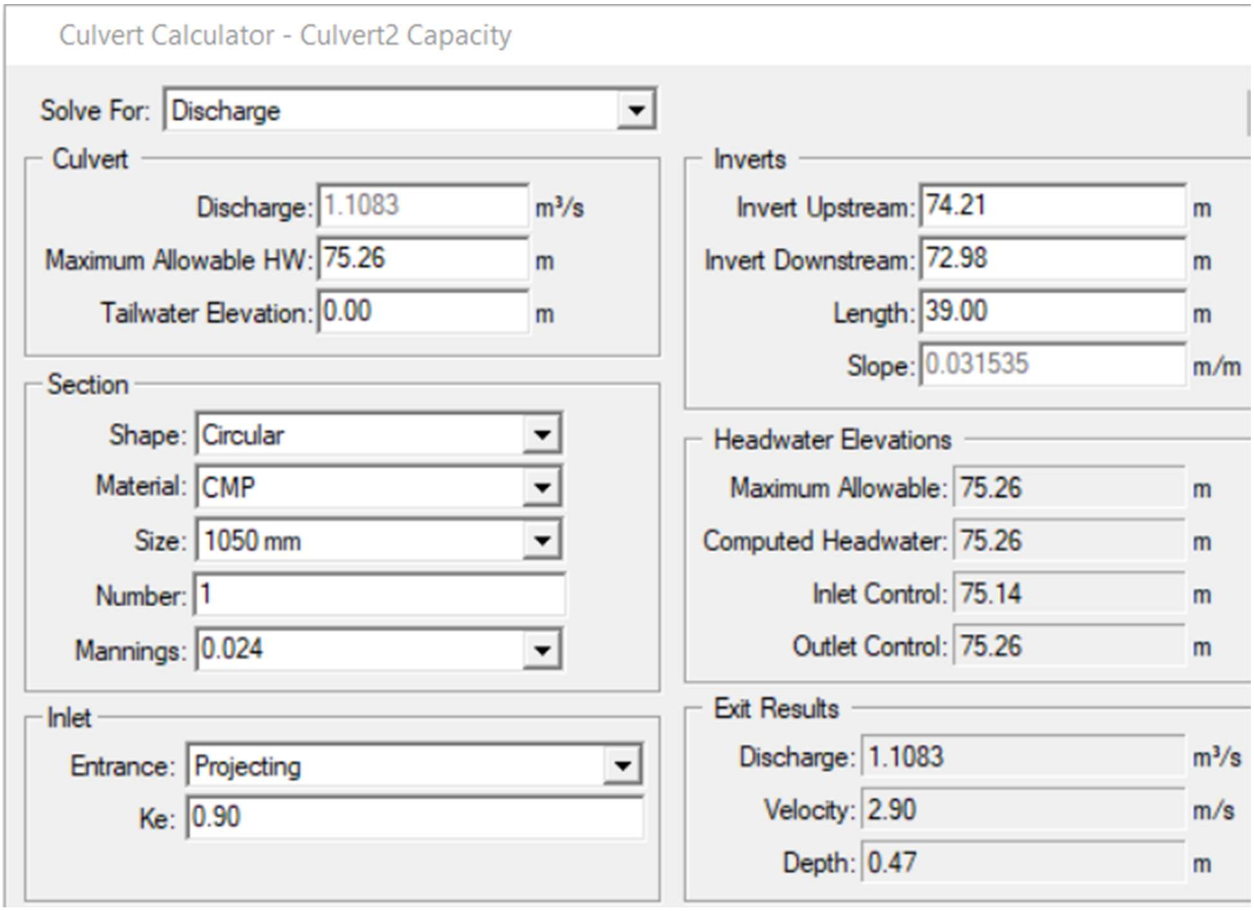
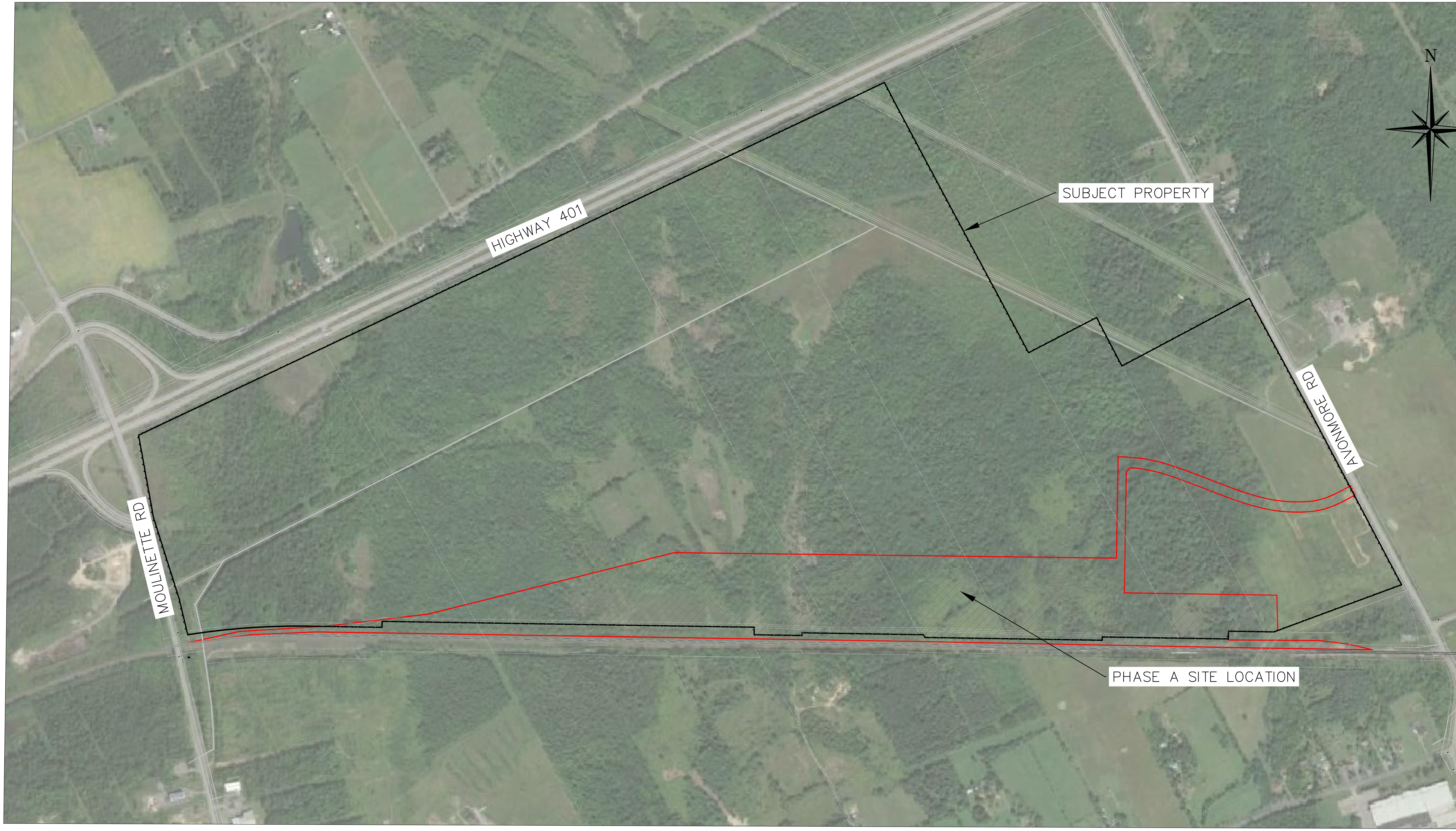


Figure 4: Railway Culvert #3 Capacity, Proposed Pipe Size

FIGURES



LEGEND

PHASE A SITE LIMITS

SUBJECT PROPERTY

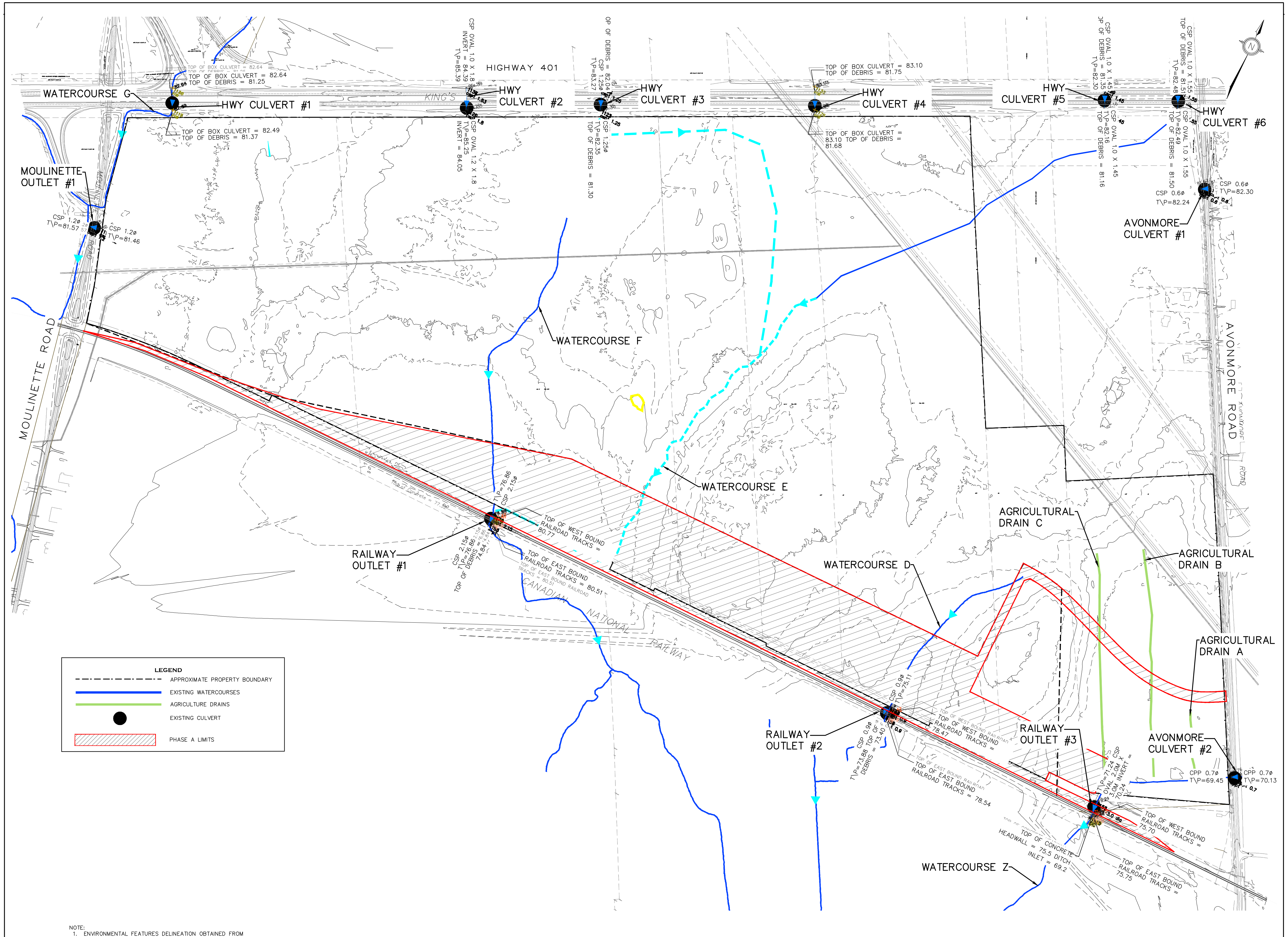
No.	ISSUE	DATE: MMM/DD/YYYY
0	ISSUED FOR SPA 1ST SUBMISSION	NOV/15/2021

Project
LONG SAULT BUSINESS PARK
TOWNSHIP OF SOUTH STORMONT

Drawing
SITE LOCATION

CROZIER & ASSOCIATES Consulting Engineers
15 Martin Street
Suite 202, Carriage Sq.
Milton, ON L9T 2R1
905.875.0026 T
905.875.4915 F
WWW.CFCROZIER.CA

Drawn By	S.A.	Design By	S.A./T.E.	Project	1909–5629
Scale	1:1000	Date	11/15/2021	Check By	T.E.
Drawing	FIG 1				



NOTE:
1. ENVIRONMENTAL FEATURES DELINEATION OBTAINED FROM BOWFIN ENVIRONMENTAL (NOVEMBER 16, 2020).
2. THIS FIGURE HAS BEEN PREPARED FOR DISCUSSION PURPOSES ONLY.

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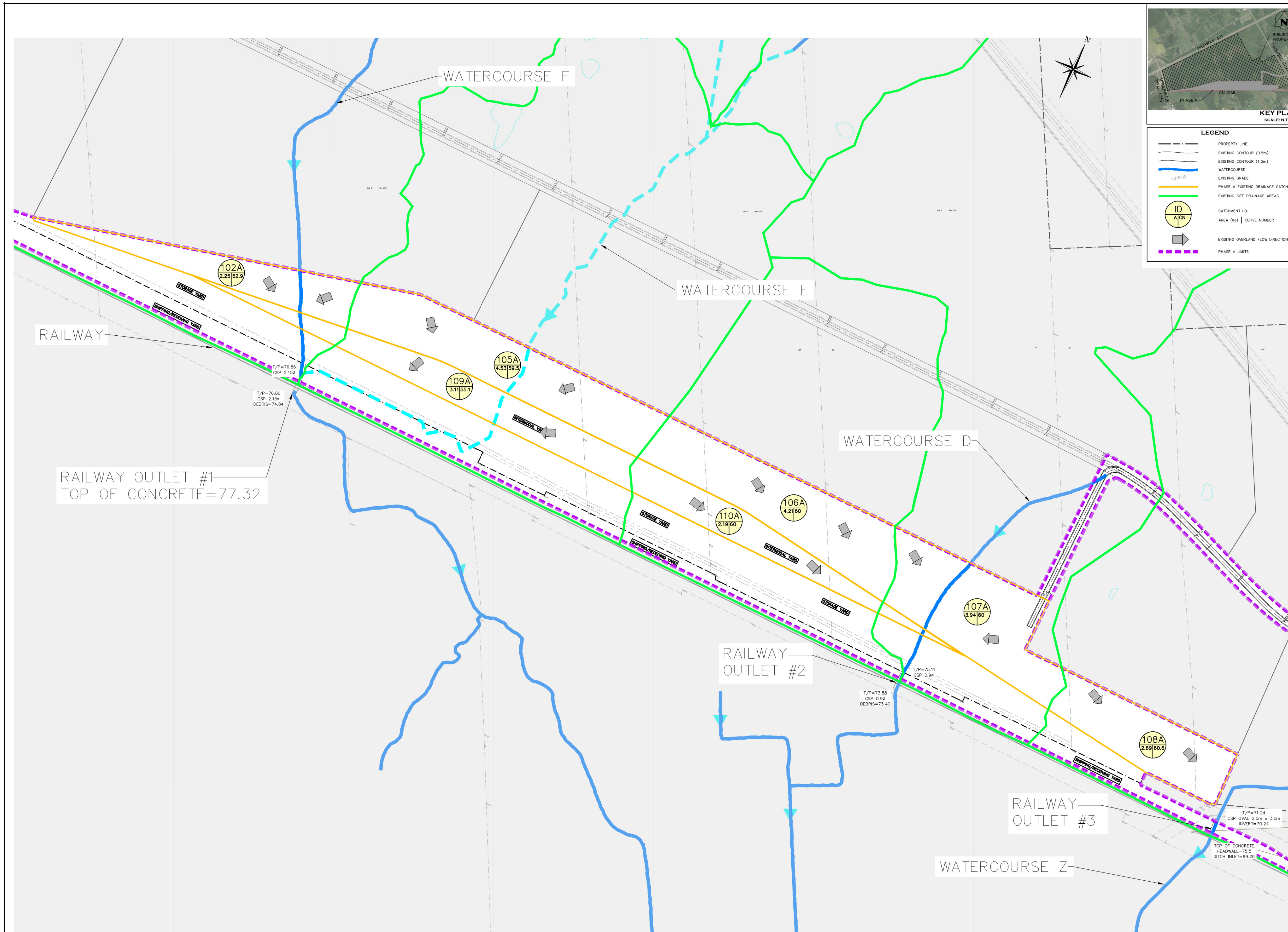
LONG SAULT BUSINESS PARK
TOWNSHIP OF SOUTH STORMONT

EXISTING SURFACE WATER FEATURES

CROZIER CONSULTING ENGINEERS

Project No. 1909-5629
FIG 2



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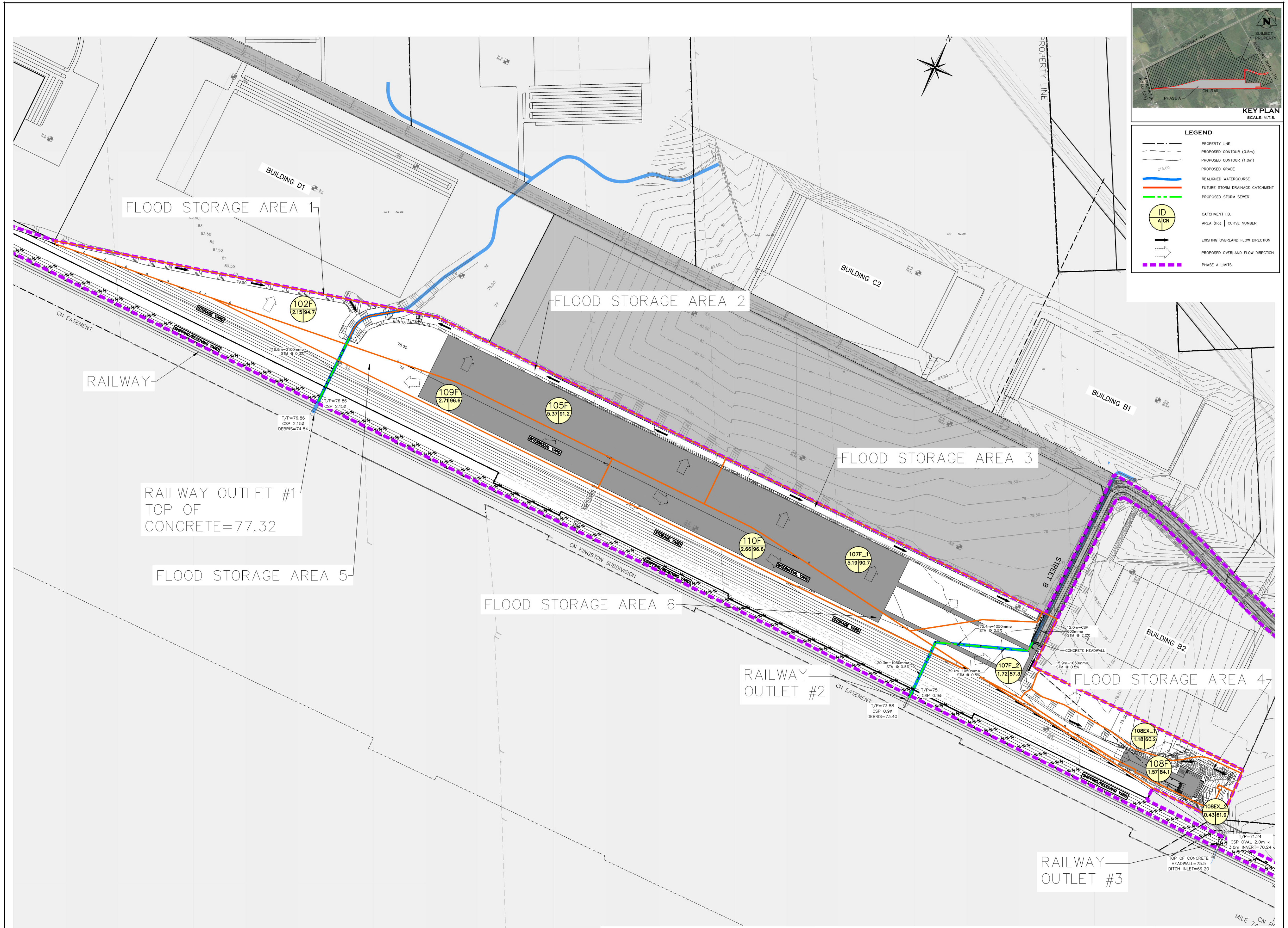
LONG SAULT BUSINESS PARK
TOWNSHIP OF SOUTH STORMONT

EXISTING STORM DRAINAGE AREA PLAN

CROZIER CONSULTING ENGINEERS
2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON, L9T 6P4
905-875-0026 T
905-875-4915 F
WWW.CFCROZIER.CA
INFO@CFCROZIER.CA

Drawn By R.L. | Design By J.W. | Project 1909-5629
Check By S.A./B.W. | Check By S.A./B.W. | Scale 1:2000 | Drawing FIG 3



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Engineer Engineer

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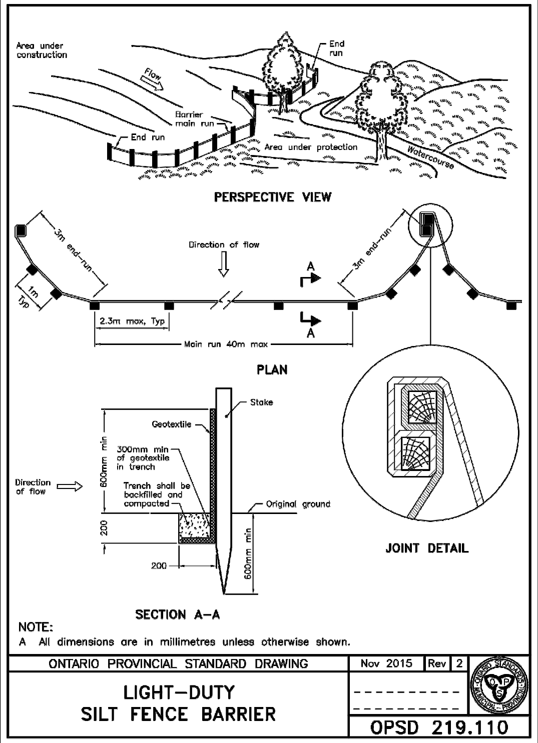
LONG SAULT BUSINESS PARK
TOWNSHIP OF SOUTH STORMONT

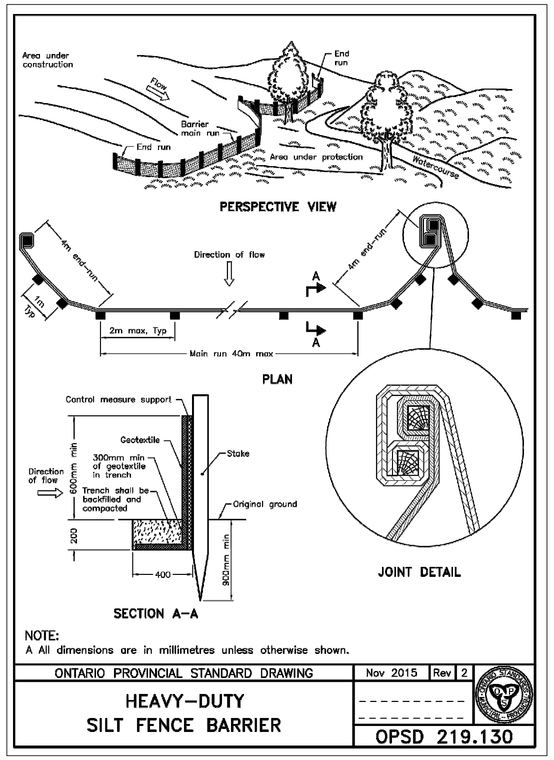
FUTURE STORM DRAINAGE AREA PLAN

CROZIER
CONSULTING ENGINEERS
2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON, L9T 6P4
905-875-0026 T
905-875-4915 F
WWW.CFCROZIER.CA
INFO@CFCROZIER.CA

Drawn By R.L.	Design By J.W.	Project 1909–5629	
Check By S.A./B.W.	Check By S.A/B.W.	Scale 1:2000	Drawing FIG 4

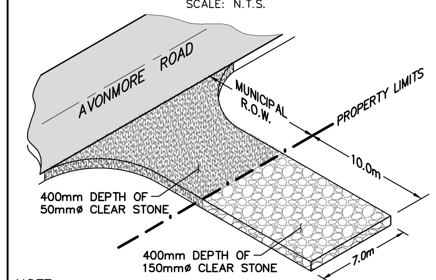
DRAWINGS





MUD–MAT DETAIL

SCALE: N.T.S.



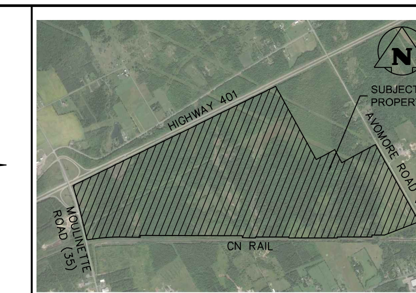
NOTE:
GEOTEXTILE (TERRAFIX 270R OR APPROVED EQUAL) TO BE PLACED AS SEPARATION BARRIER BETWEEN EXISTING GROUND AND CLEAR STONE.

EROSION & SEDIMENT CONTROL NOTES:

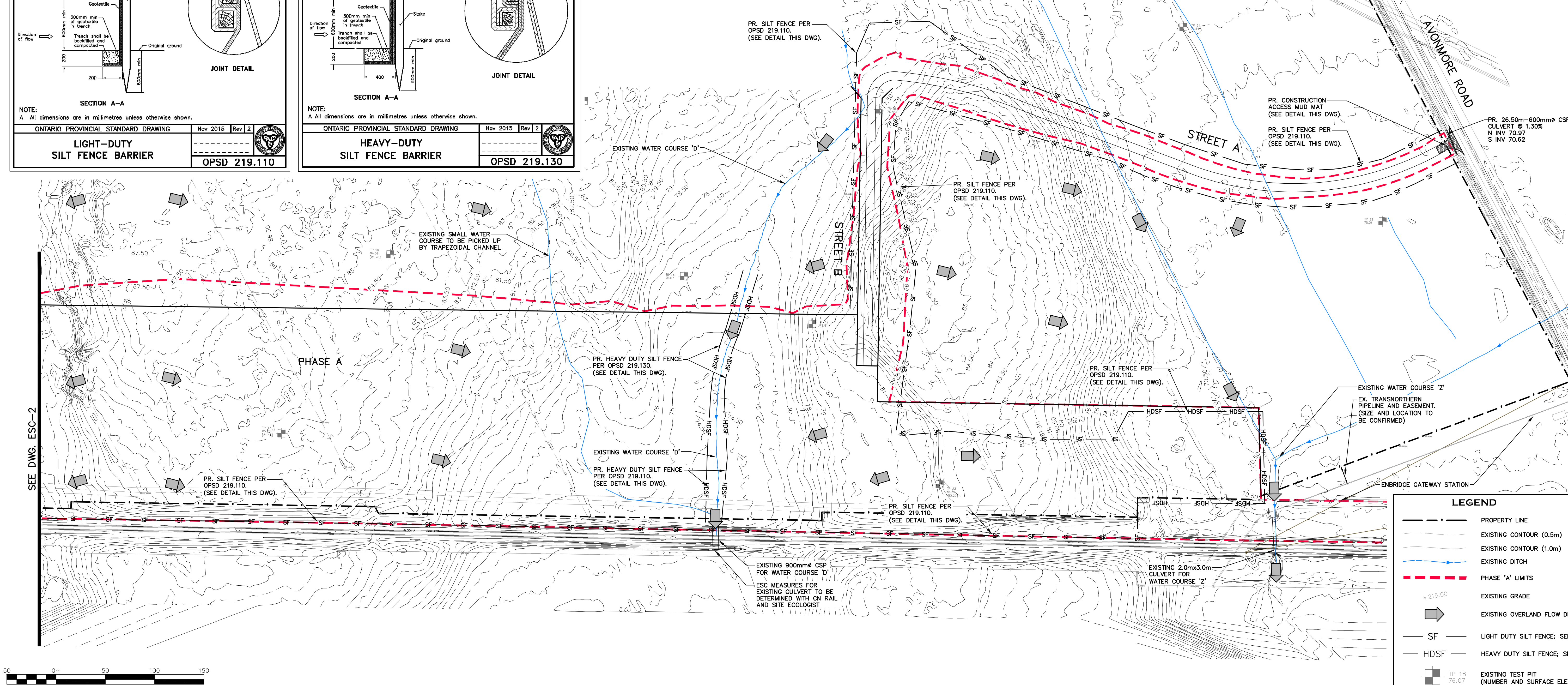
1. EROSION & SEDIMENT CONTROL MEASURES MUST BE INSTALLED PRIOR TO THE COMMENCEMENT OF SITE WORKS.
2. EROSION & SEDIMENT CONTROLS MUST BE INSPECTED ON A REGULAR BASIS AND AFTER EVERY RAIN FALL EVENT, AND MUST BE MAINTAINED AND REPAIRED IN A TIMELY MANNER TO PREVENT SEDIMENT FROM LEAVING THE SITE.
3. EXISTING AND PROPOSED CATCHBASINS ARE TO BE PROTECTED WITH FILTER CLOTH AND 150mm OF 50mm STONE COVER DURING CONSTRUCTION.
4. IT IS REQUIRED TO STABILIZE ALL AREAS THAT WILL REMAIN DISTURBED FOR MORE THAN 30 DAYS.
5. MUD MAT, SILT FENCE, AND CATCHBASIN PROTECTION ARE NOT TO BE REMOVED UNTIL COMPLETION OF CONSTRUCTION.

WATERCOURSE 'D' NOTES:

1. EXISTING WATERCOURSE 'D' TO REMAIN ON–LINE AND PROTECTED UNTIL RE–ALIGNMENT CONSTRUCTION IS COMPLETED AND SITE ECOLOGIST APPROVES RE–ALIGNMENT TIMING.



KEY PLAN
SCALE: N.T.S.



LEGEND

	PROPERTY LINE
	EXISTING CONTOUR (0.5m)
	EXISTING CONTOUR (1.0m)
	EXISTING DITCH
	PHASE 'A' LIMITS
+215.00	EXISTING GRADE
	EXISTING OVERLAND FLOW DIRECTION
— SF —	LIGHT DUTY SILT FENCE; SEE DETAIL
— HDSF —	HEAVY DUTY SILT FENCE; SEE DETAIL
TP 18 76.07	EXISTING TEST PIT (NUMBER AND SURFACE ELEVATION)

2. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS, LEVELS, AND DATUMS ON SITE AND REPORT ANY DISCREPANCIES OR OMISSIONS TO THIS OFFICE PRIOR TO CONSTRUCTION.
3. THIS DRAWING IS TO BE READ AND UNDERSTOOD IN CONJUNCTION WITH ALL OTHER PLANS AND DOCUMENTS APPLICABLE TO THIS PROJECT.
4. DO NOT SCALE THE DRAWINGS.
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Town

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FOR REVIEW
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Project
LONG SAULT INDUSTRIAL PARK
TOWN OF LONG SAULT

Drawing
EROSION AND SEDIMENT CONTROL

CROZIER CONSULTING ENGINEERS
2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
905-875-0026 T
905-875-4915 F
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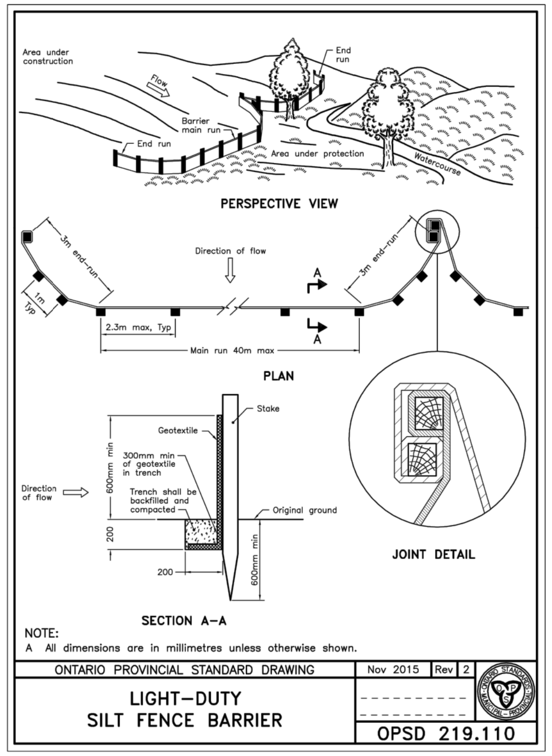
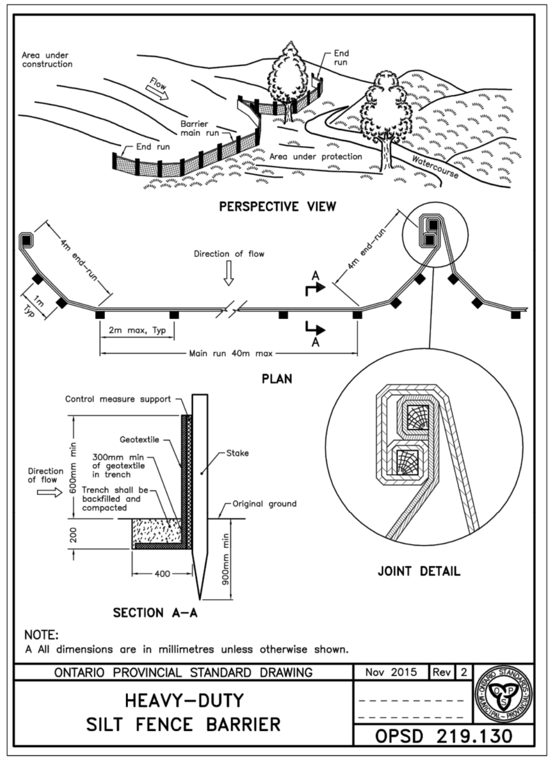
Drawn By	Design By	Project
D.G./M.M.	D.G./M.M.	1909–5629

Check By	Check By	Scale	Drawing
T.E./B.W.	T.E./B.W.	1:2000	ESC–1





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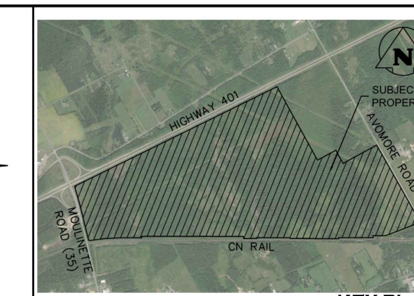
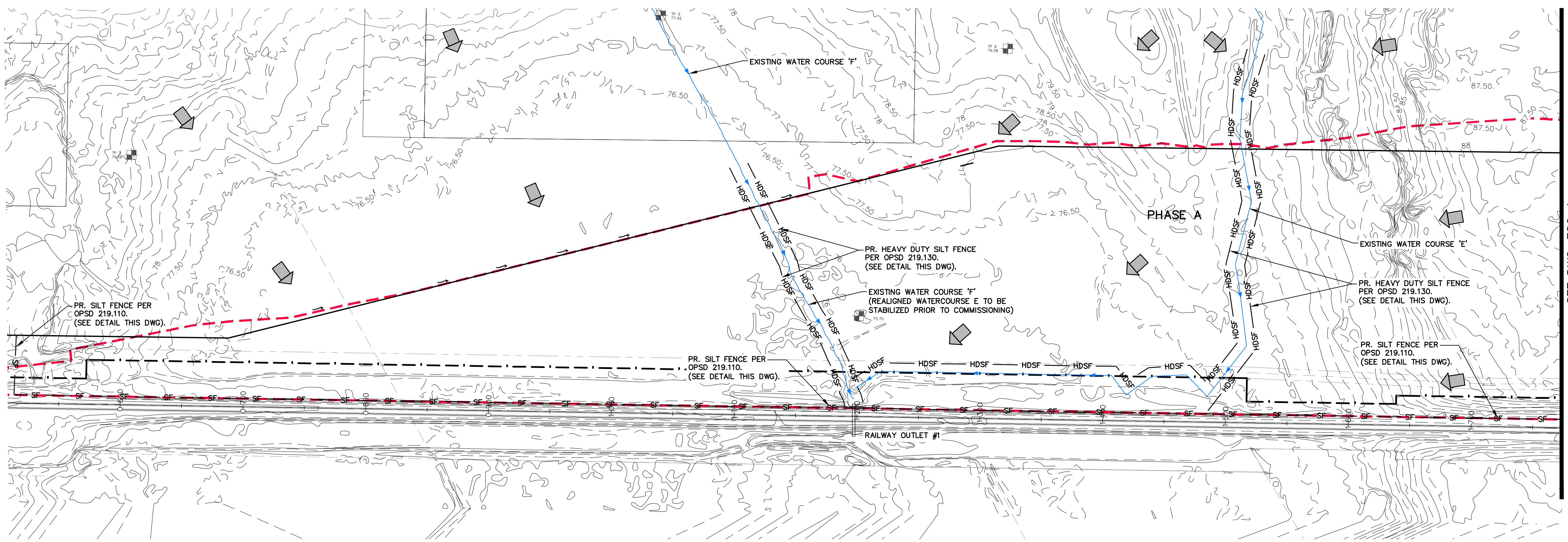
N



KEY PLAN
SCALE: N.T.S.

LEGEND

	PROPERTY LINE
	EXISTING CONTOUR (0.5m)
	EXISTING CONTOUR (1.0m)
	EXISTING DITCH
	PHASE 'A' LIMITS
x 215.00	EXISTING GRADE
	EXISTING OVERLAND FLOW DIRECTION
SF	LIGHT DUTY SILT FENCE; SEE DETAIL
HDSF	HEAVY DUTY SILT FENCE; SEE DETAIL
TP 18 76.07	EXISTING TEST PIT (NUMBER AND SURFACE ELEVATION)



50 0m 50 100 150
SCALE: 1:2000

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TOWN OF LONG SAULT

Drawing
EROSION AND SEDIMENT CONTROL

CROZIER CONSULTING ENGINEERS
2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
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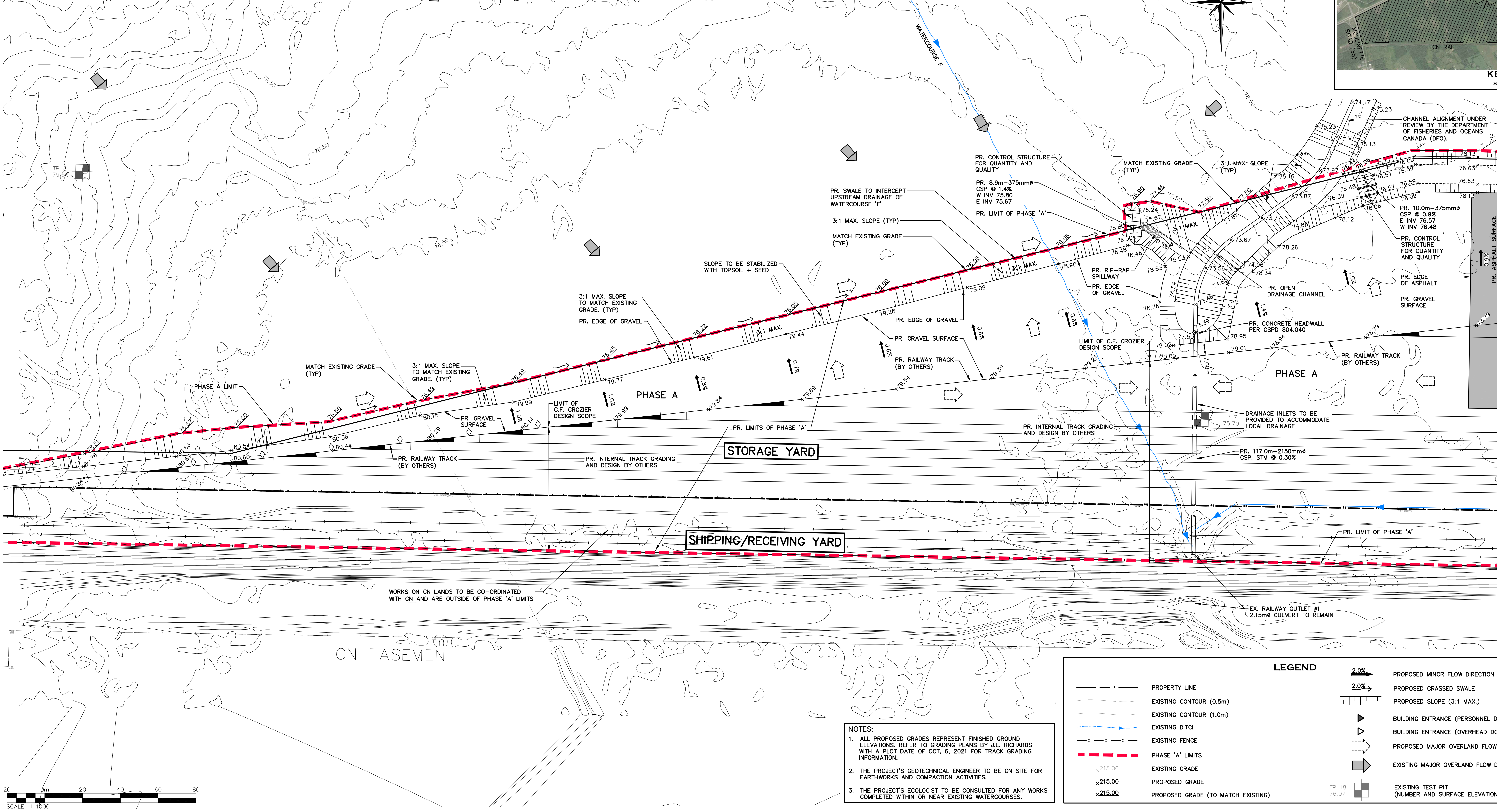
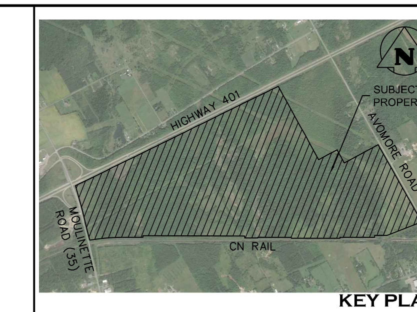
Drawn By	Design By	Project
D.G./M.M.	D.G./M.M.	1909-5629
Check By T.E./B.W.	Check By T.E./B.W.	Scale 1:2000
		Drawing ESC-2





KEY PLAN
SCALE: N.T.S.

NOTES:

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3. THE PROJECT'S ECOLOGIST TO BE CONSULTED FOR ANY WORKS COMPLETED WITHIN OR NEAR EXISTING WATERCOURSES.

LEGEND

PROPERTY LINE	
EXISTING CONTOUR (0.5m)	
EXISTING CONTOUR (1.0m)	
EXISTING DITCH	
EXISTING FENCE	
PHASE 'A' LIMITS	
x215.00	EXISTING GRADE
x215.00	PROPOSED GRADE
x215.00	PROPOSED GRADE (TO MATCH EXISTING)
2.0%	PROPOSED MINOR FLOW DIRECTION
2.0%	PROPOSED GRASSED SWALE
	PROPOSED SLOPE (3:1 MAX.)
	BUILDING ENTRANCE (PERSONNEL DOOR)
	BUILDING ENTRANCE (OVERHEAD DOOR)
	PROPOSED MAJOR OVERLAND FLOW DIRECTION
	EXISTING MAJOR OVERLAND FLOW DIRECTION
TP 18 76.07	EXISTING TEST PIT (NUMBER AND SURFACE ELEVATION)

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Engineer

Engineer

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Project

LONG SAULT INDUSTRIAL PARK
TOWN OF LONG SAULT

Drawing

GRADING AND SERVICING PLAN

CROZIER
CONSULTING ENGINEERS

2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
905-875-0026 T
905-875-4915 F
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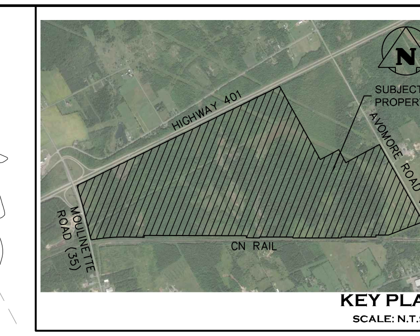
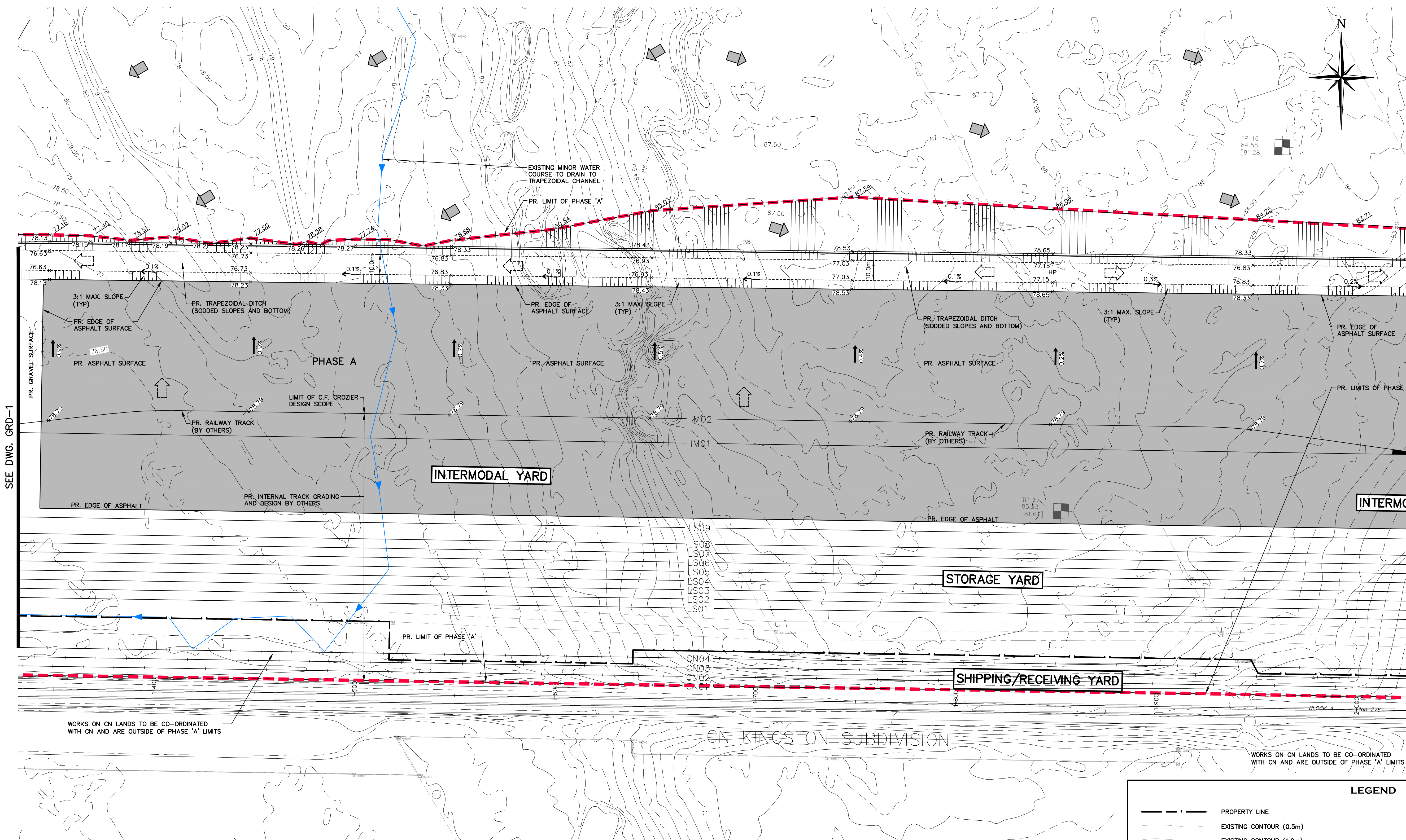
Drawn By	D.G./M.M.	Design By	D.G./M.M.	Project	1909–5629
Check By	T.E./B.W.	Check By	T.E./B.W.	Scale 1:1000	Drawing GRD–1





NOTES:

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2. THE PROJECT'S GEOTECHNICAL ENGINEER TO BE ON SITE FOR EARTHWORKS AND COMPACTION ACTIVITIES.
3. THE PROJECT'S ECOLOGIST TO BE CONSULTED FOR ANY WORKS COMPLETED WITHIN OR NEAR EXISTING WATERCOURSES.

LEGEND

Symbol	Description
	PROPERTY LINE
	EXISTING CONTOUR (0.5m)
	EXISTING CONTOUR (1.0m)
	EXISTING DITCH
	EXISTING FENCE
	PHASE 'A' LIMITS
×215.00	EXISTING GRADE
×215.00	PROPOSED GRADE
×215.00	PROPOSED GRADE (TO MATCH EXISTING)
2.0%	PROPOSED MINOR FLOW DIRECTION
2.0%	PROPOSED GRASSED SWALE
	PROPOSED SLOPE (3:1 MAX.)
	BUILDING ENTRANCE (PERSONNEL DOOR)
	BUILDING ENTRANCE (OVERHEAD DOOR)
	PROPOSED MAJOR OVERLAND FLOW DIRECTION
	EXISTING MAJOR OVERLAND FLOW DIRECTION
TP 18 76.07	EXISTING TEST PIT (NUMBER AND SURFACE ELEVATION)

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Engineer

Engineer

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Project
LONG SAULT INDUSTRIAL PARK
TOWN OF LONG SAULT

Drawing
GRADING AND SERVICING PLAN

CROZIER
CONSULTING ENGINEERS

2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
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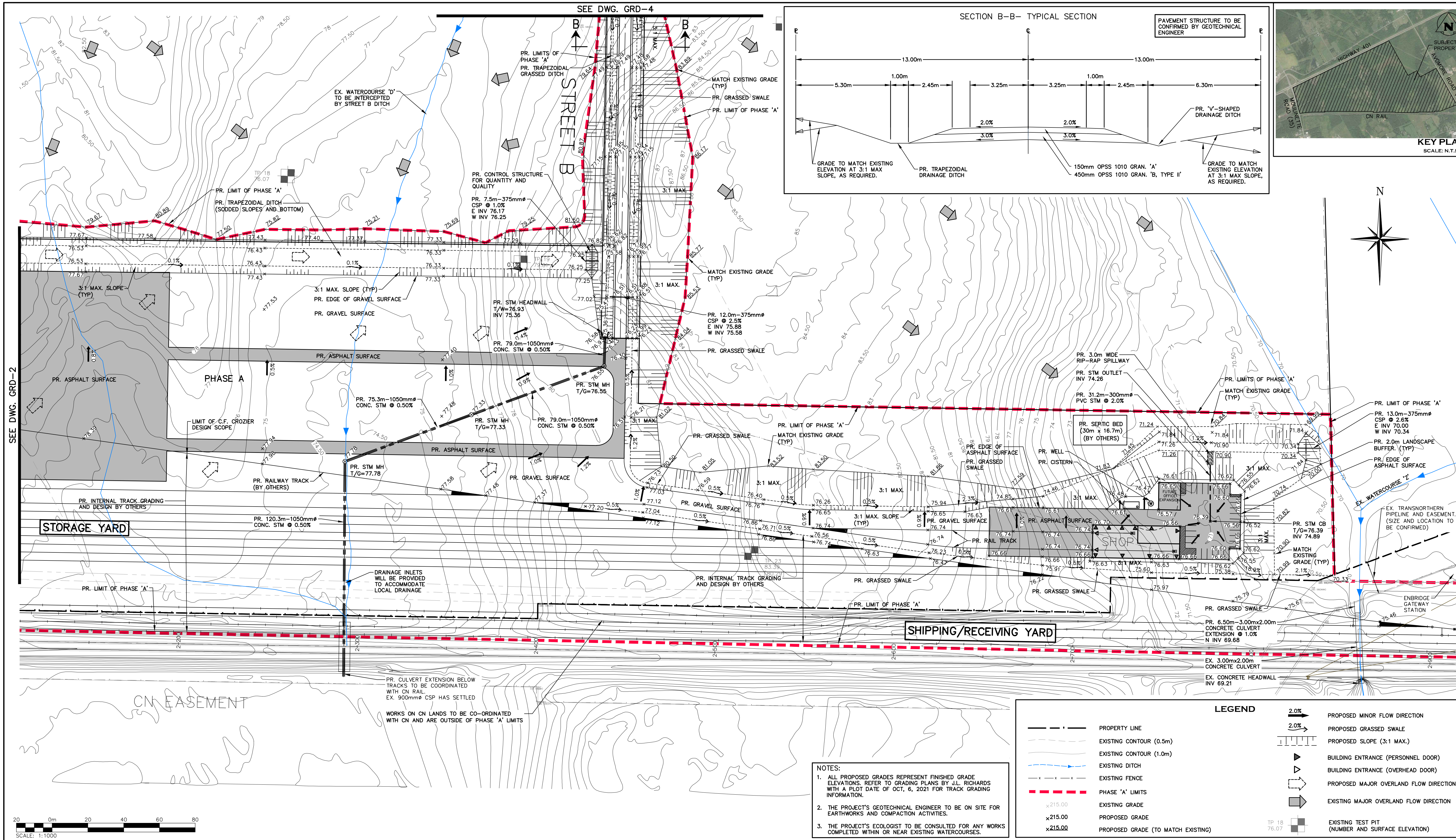
Drawn By	D.G./M.M.	Design By	D.G./M.M.	Project	1909–5629
Check By	T.E./B.W.	Check By	T.E./B.W.	Scale 1:1000	Drawing GRD–2



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LEGEND

- PROPERTY LINE
- EXISTING CONTOUR (0.5m)
- EXISTING CONTOUR (1.0m)
- EXISTING DITCH
- EXISTING FENCE
- PHASE 'A' LIMITS
- 215.00 EXISTING GRADE
- 215.00 PROPOSED GRADE
- 215.00 PROPOSED GRADE (TO MATCH EXISTING)
- 2.0% PROPOSED MINOR FLOW DIRECTION
- 2.0% PROPOSED GRASSED SWALE
- 3:1 PROPOSED SLOPE (3:1 MAX.)
- BUILDING ENTRANCE (PERSONNEL DOOR)
- BUILDING ENTRANCE (OVERHEAD DOOR)
- PROPOSED MAJOR OVERLAND FLOW DIRECTION
- EXISTING MAJOR OVERLAND FLOW DIRECTION
- TP 18 76.07 EXISTING TEST PIT (NUMBER AND SURFACE ELEVATION)

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Engineer

Engineer

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Project
LONG SAULT INDUSTRIAL PARK
TOWN OF LONG SAULT

Drawing
GRADING AND SERVICING PLAN

CROZIER CONSULTING ENGINEERS
2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
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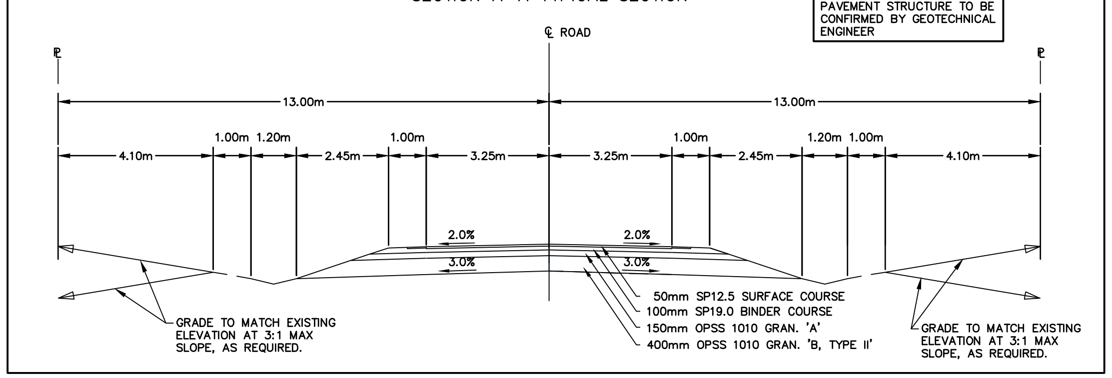
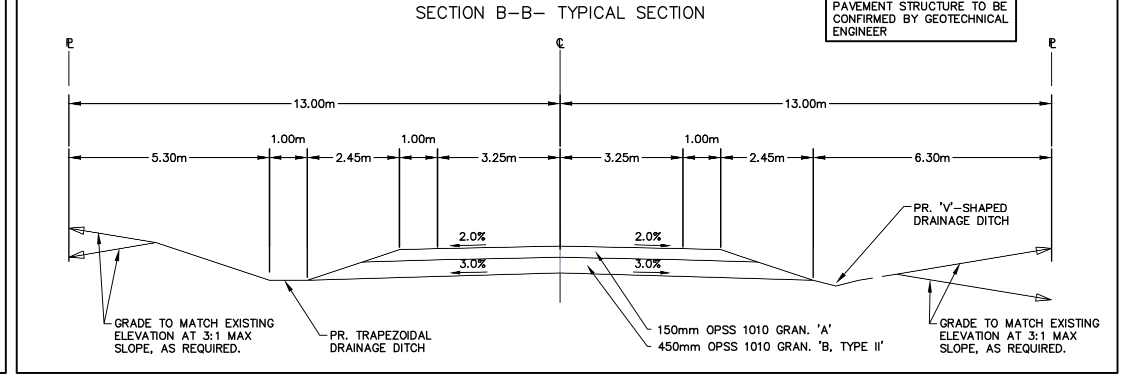
Drawn By	D.G./M.M.	Design By	D.G./M.M.	Project	1909-5629
Check By	T.E./B.W.	Check By	T.E./B.W.	Scale 1:1000	Drawing GRD-3

SECTION A–A TYPICAL SECTION

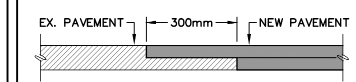


SECTION B–B– TYPICAL SECTION

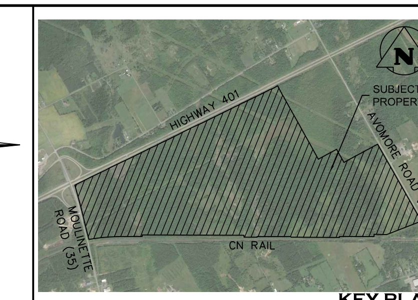


ASPHALT LAP JOINT DETAIL

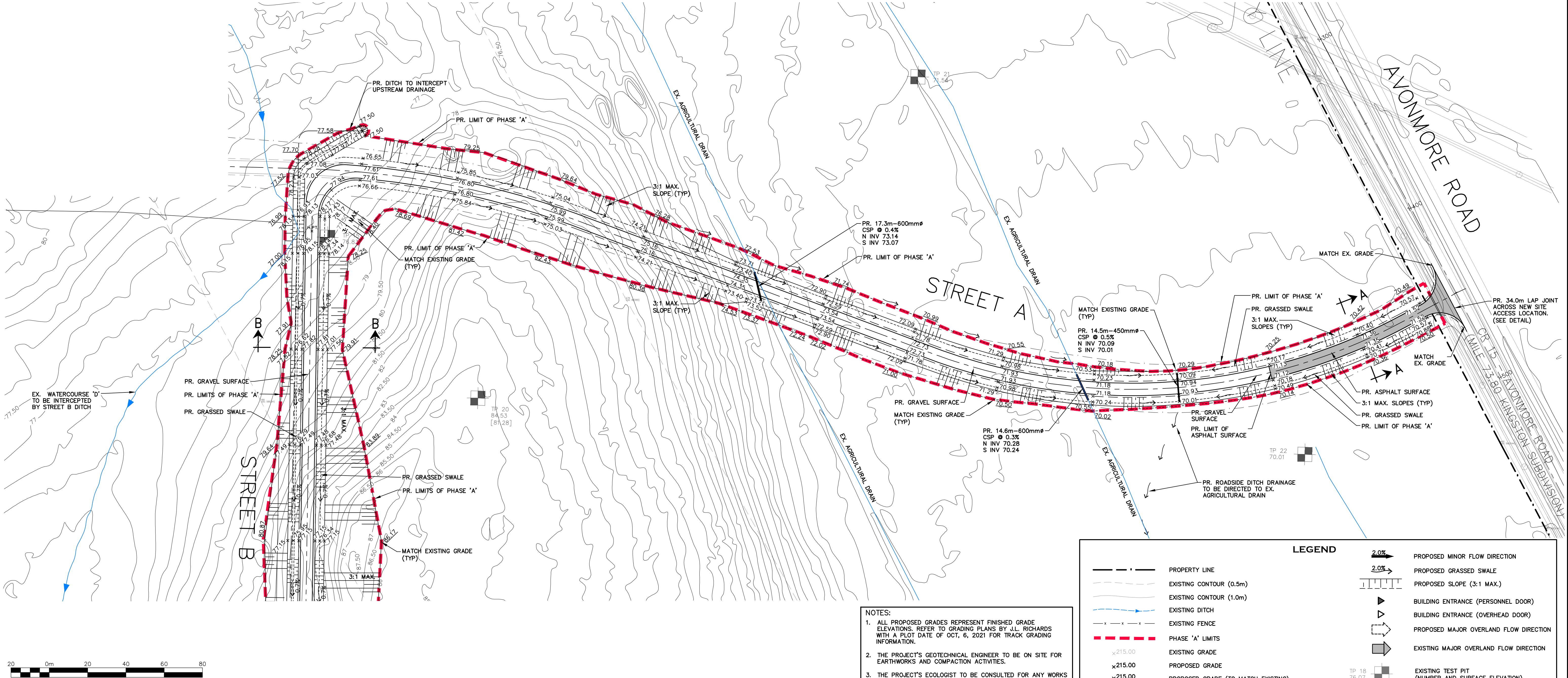
SCALE: N.T.S.



NOTE:
SAWCUT & COLD PLANE 300mm WIDE & 40mm DEEP WHERE NEW PAVEMENT MEETS EXISTING PAVEMENT. GROUT & SEAL WITH HOT RUBBERIZED ASPHALT.



KEY PLAN
SCALE: N.T.S.



NOTES:

1. ALL PROPOSED GRADES REPRESENT FINISHED GRADE ELEVATIONS. REFER TO GRADING PLANS BY J.L. RICHARDS WITH A PLOT DATE OF OCT, 6, 2021 FOR TRACK GRADING INFORMATION.
2. THE PROJECT'S GEOTECHNICAL ENGINEER TO BE ON SITE FOR EARTHWORKS AND COMPACTION ACTIVITIES.
3. THE PROJECT'S ECOLOGIST TO BE CONSULTED FOR ANY WORKS COMPLETED WITHIN OR NEAR EXISTING WATERCOURSES.

LEGEND

PROPERTY LINE	PROPOSED MINOR FLOW DIRECTION
EXISTING CONTOUR (0.5m)	PROPOSED GRASSED SWALE
EXISTING CONTOUR (1.0m)	PROPOSED SLOPE (3:1 MAX.)
EXISTING DITCH	BUILDING ENTRANCE (PERSONNEL DOOR)
EXISTING FENCE	BUILDING ENTRANCE (OVERHEAD DOOR)
PHASE 'A' LIMITS	PROPOSED MAJOR OVERLAND FLOW DIRECTION
×215.00 EXISTING GRADE	EXISTING MAJOR OVERLAND FLOW DIRECTION
×215.00 PROPOSED GRADE	TP 18 76.07 EXISTING TEST PIT (NUMBER AND SURFACE ELEVATION)
×215.00 PROPOSED GRADE (TO MATCH EXISTING)	

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Town

No.	ISSUE	DATE: MMM/DD/YYYY
0	ISSUED FOR SPA 1ST SUBMISSION	NOV/15/2021

Engineer

Engineer

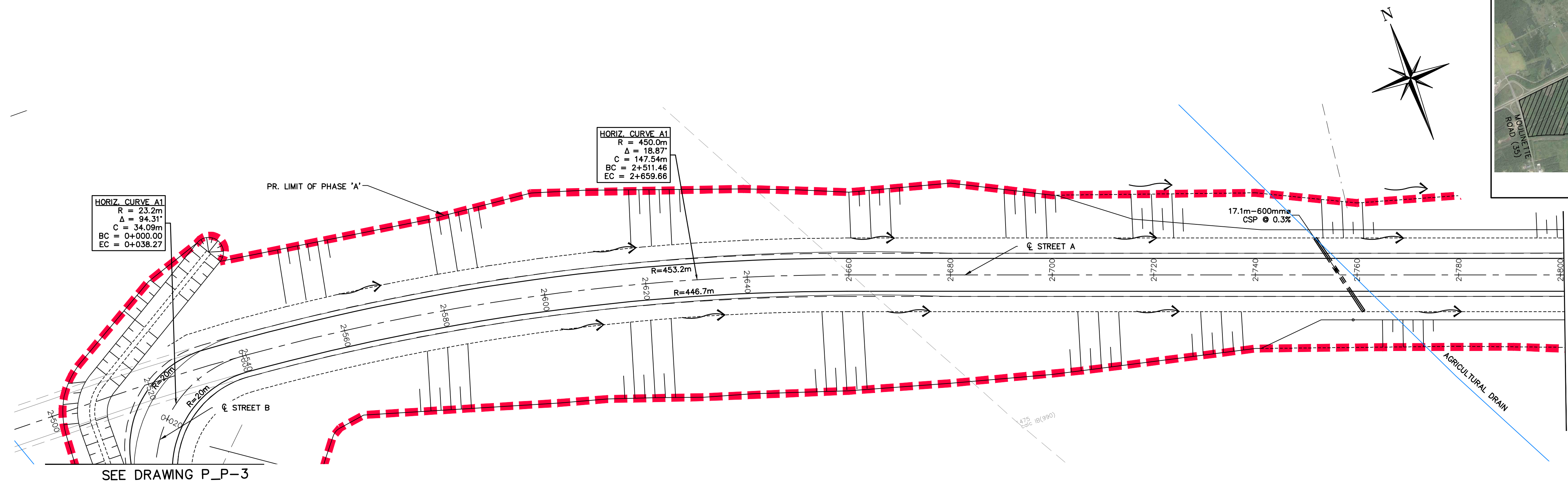
FOR REVIEW
NOT TO BE USED FOR CONSTRUCTION

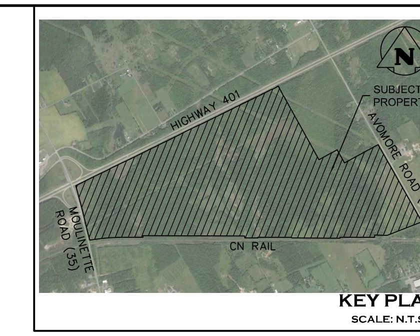
Project
LONG SAULT INDUSTRIAL PARK
TOWN OF LONG SAULT

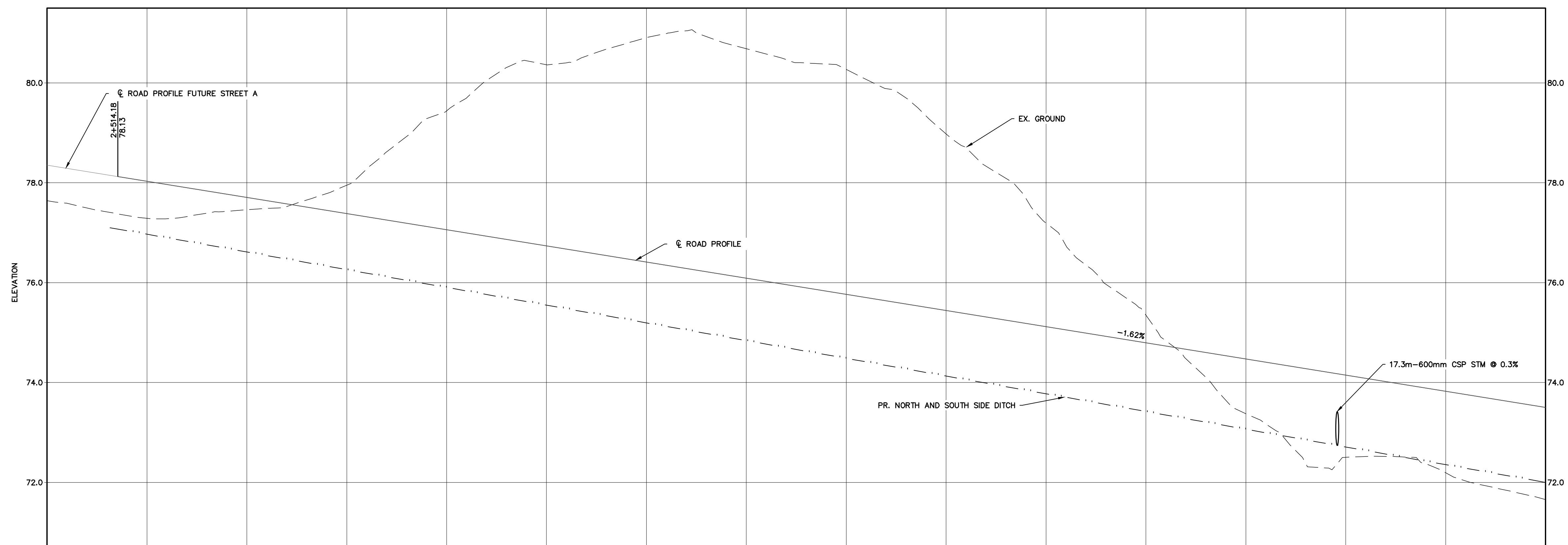
Drawing
GRADING AND SERVICING PLAN

CROZIER CONSULTING ENGINEERS
2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
905-875-0026 T
905-875-4915 F
WWW.CFCROZIER.CA

Drawn By	Design By	Project
D.G./M.M.	D.G./M.M.	1909–5629
Check By	**Check By**	**Scale** / **Drawing**
T.E./B.W.	T.E./B.W.	1:1000 / GRD–4







STATION	EXISTING CENTERLINE	PROPOSED CENTERLINE
2+500	77.64	
2+520	77.29	78.03
2+540	77.46	77.71
2+560	77.95	77.38
2+580	79.44	77.06
2+600	80.36	76.74
2+620	80.91	76.41
2+640	80.68	76.09
2+660	80.27	75.77
2+680	78.98	75.44
2+700	77.20	75.12
2+720	75.35	74.80
2+740	73.38	74.47
2+760	72.50	74.15
2+780	72.19	73.82
2+800	71.65	73.50

20 0m 20 40 60 80
SCALE: 1:1000

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Town

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0	ISSUED FOR SPA 1ST SUBMISSION	NOV/15/2021

Engineer

Engineer

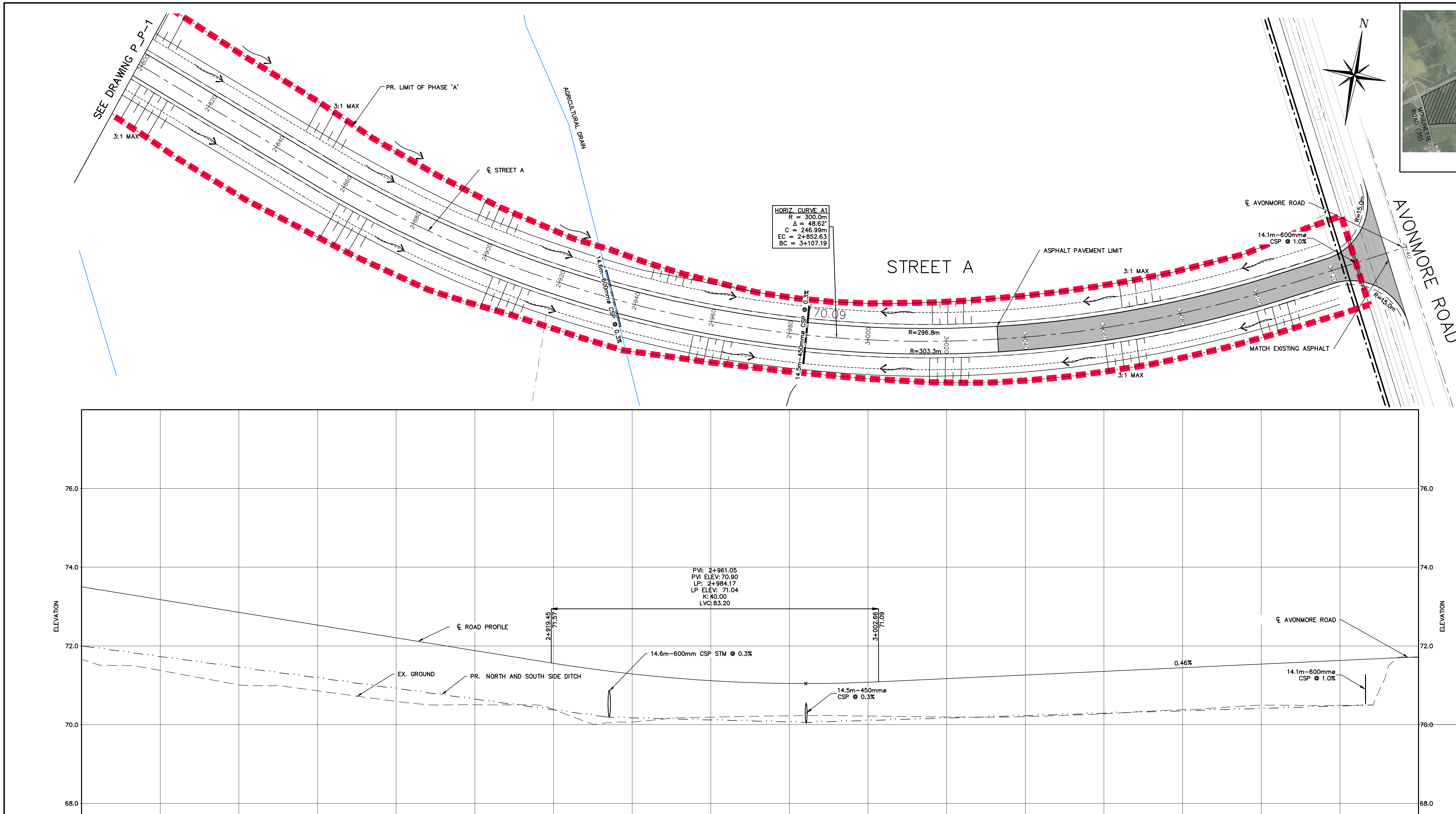
FOR REVIEW
NOT TO BE USED FOR CONSTRUCTION

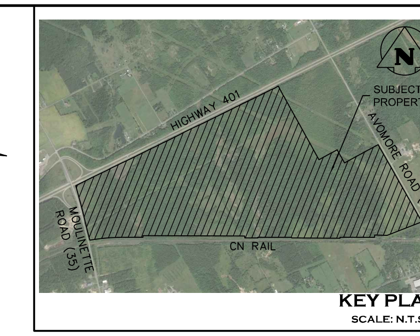
Project
LONG SAULT INDUSTRIAL PARK
TOWN OF LONG SAULT

Drawing
STREET A (STA 2+514 TO 2+800)
PLAN AND PROFILES

CROZIER
CONSULTING ENGINEERS
2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
905-875-0026 T
905-875-4915 F
WWW.CFCROZIER.CA

Drawn By D.G./M.M. | Design By D.G./M.M. | Project 1909–5629
Check By T.E./B.W. | Check By T.E./B.W. | Scale 1:500 | Drawing P_P-1





STATION	EXISTING CENTERLINE	PROPOSED CENTERLINE
2+800	71.65	73.50
2+820	71.38	73.18
2+840	71.01	72.85
2+860	70.86	72.53
2+880	70.59	72.21
2+900	70.51	71.88
2+920	70.39	71.56
2+940	70.07	71.29
2+960	70.19	71.12
2+980	70.22	71.05
3+000	70.22	71.08
3+020	70.19	71.17
3+040	70.20	71.26
3+060	70.27	71.35
3+080	70.38	71.45
3+100	70.50	71.54
3+120	70.49	71.63
3+140	71.70	71.72

10 0m 10 20 30 40
SCALE: 1:500

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Engineer

Engineer

FOR REVIEW
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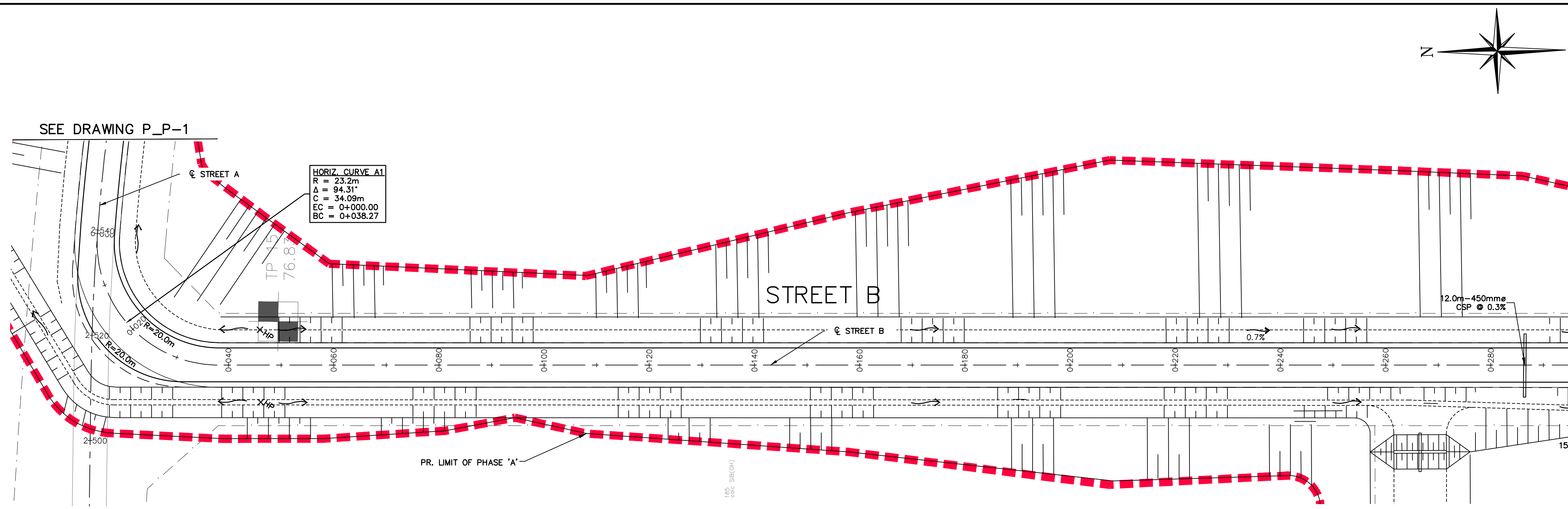
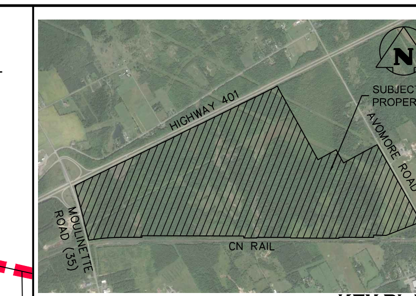
Project
LONG SAULT INDUSTRIAL PARK
TOWN OF LONG SAULT

Drawing
STREET A (STA 2+280 TO STA 3+140)
PLAN AND PROFILES

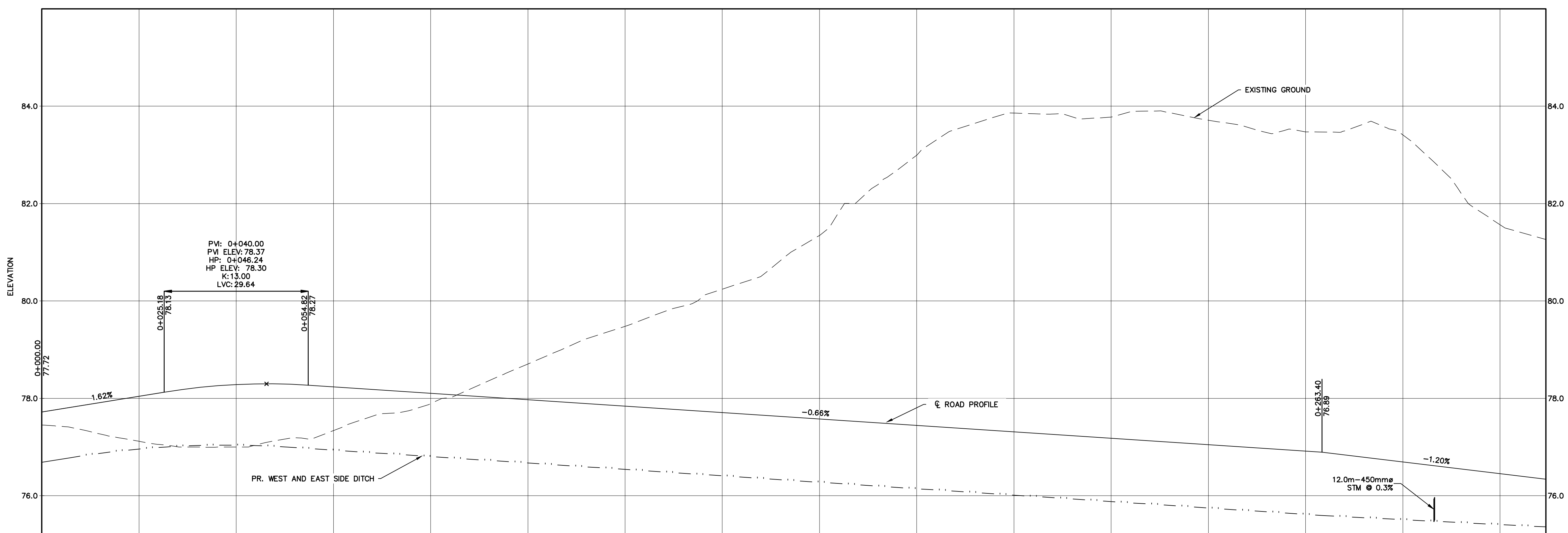
CROZIER
CONSULTING ENGINEERS
2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
905-875-0026 T
905-875-4915 F
WWW.CFCROZIER.CA

Drawn By	D.G./M.M.	Design By	D.G./M.M.	Project	1909–5629
Check By	T.E./B.W.	Check By	T.E./B.W.	Scale 1:500	Drawing P_P-2





KEY PLAN
SCALE: N.T.S.



STATION	0+000	0+020	0+040	0+060	0+080	0+100	0+120	0+140	0+160	0+180	0+200	0+220	0+240	0+260	0+280	0+300	0+309
EXISTING CENTERLINE	77.45	77.12	77.00	77.34	77.89	78.71	79.48	80.24	81.34	83.00	83.86	83.78	83.71	83.47	83.41	81.57	81.26
PROPOSED CENTERLINE	77.72	78.04	78.28	78.24	78.10	77.97	77.84	77.71	77.58	77.44	77.31	77.18	77.05	76.92	76.69	76.45	76.34

20 0m 20 40 60 80
SCALE: 1:1000

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Town

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Engineer | Engineer

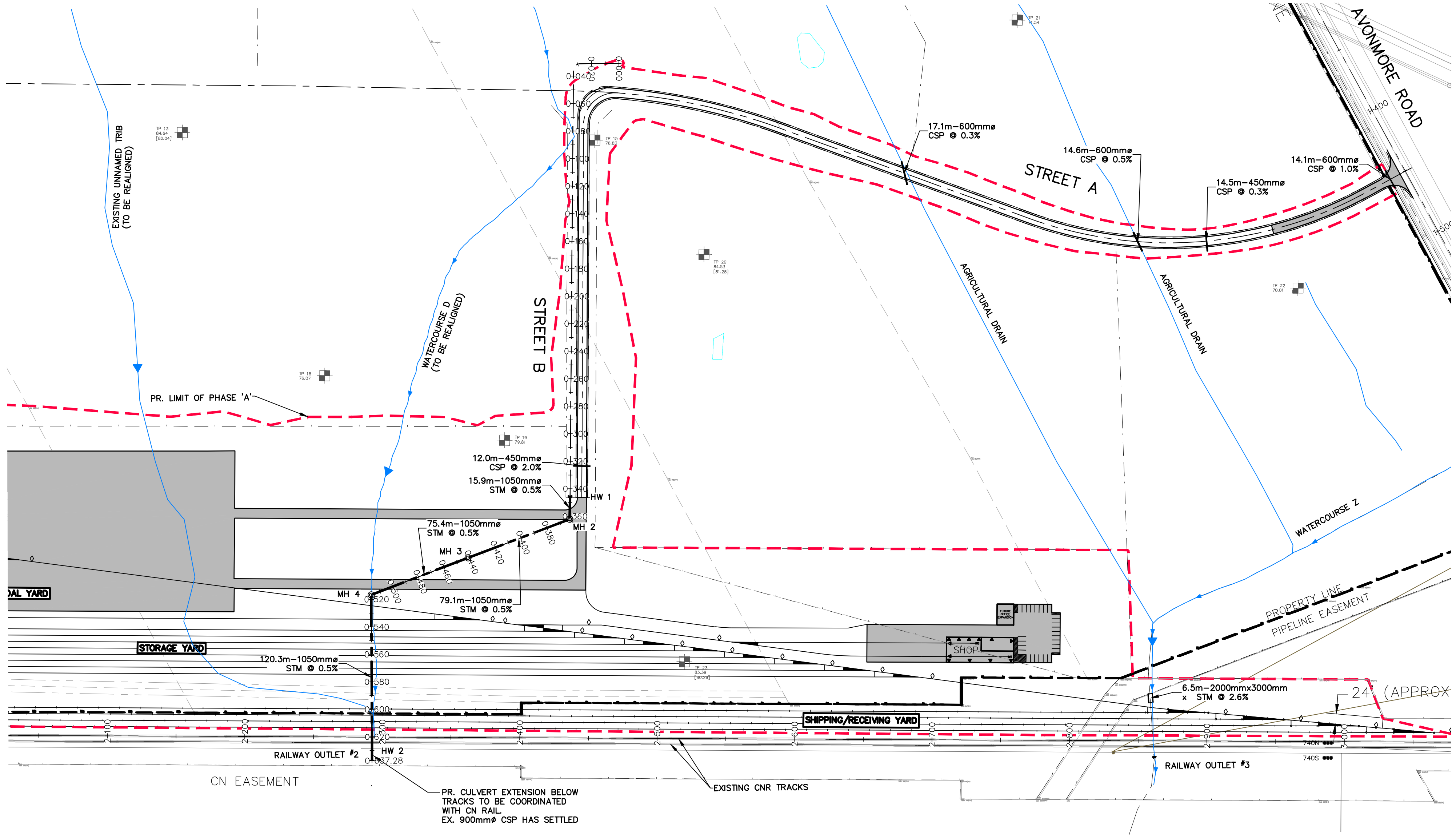
FOR REVIEW
NOT TO BE USED FOR CONSTRUCTION

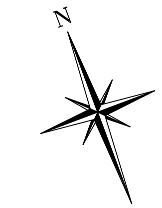
Project
LONG SAULT INDUSTRIAL PARK
TOWN OF LONG SAULT

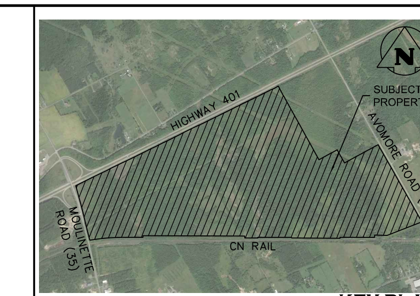
Drawing
STREET B (STA 0+000 TO 0+308)
PLAN AND PROFILES

CROZIER
CONSULTING ENGINEERS
2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
905-875-0026 T
905-875-4915 F
WWW.CFCROZIER.CA

Drawn By	D.G./M.M.	Design By	D.G./M.M.	Project	1909-5629
Check By	T.E./B.W.	Check By	T.E./B.W.	Scale 1:500	Drawing P_P-3



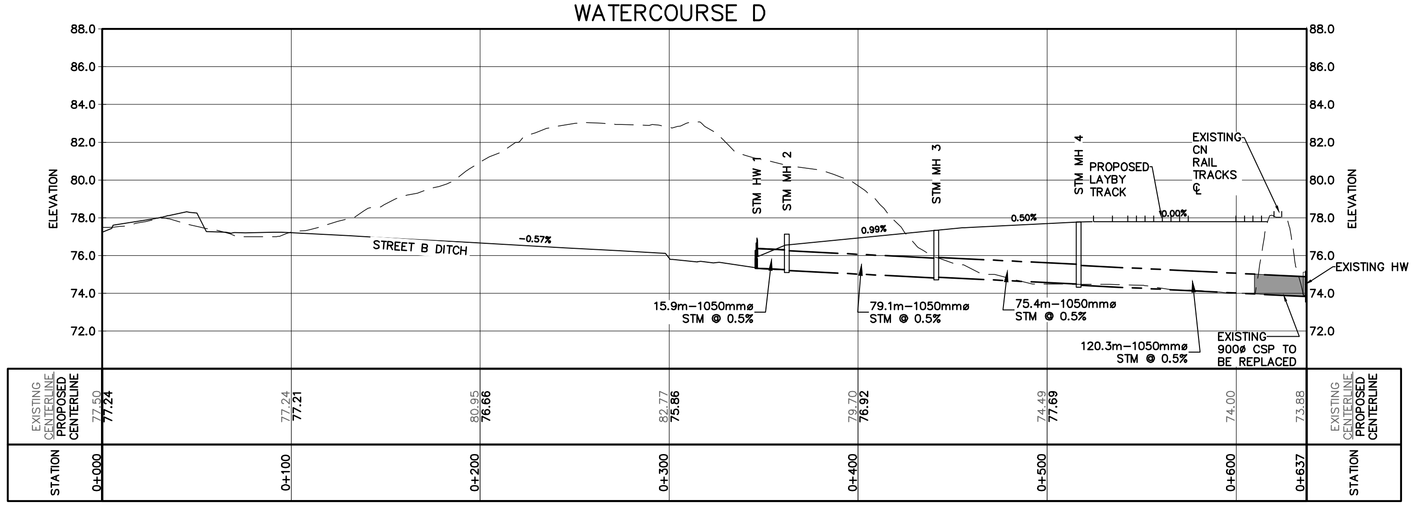




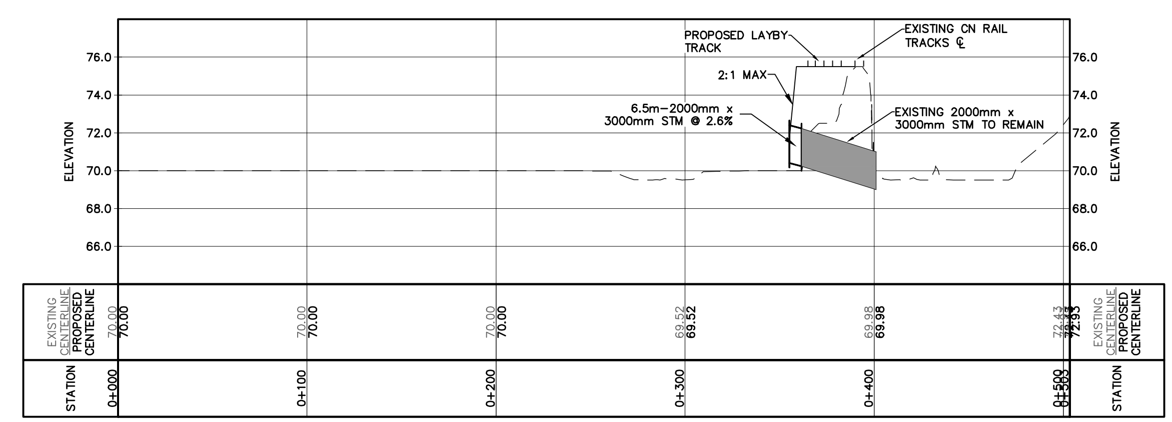
KEY PLAN
SCALE: N.T.S.

NOTE:
1. ENVIRONMENTAL FEATURES DELINEATION OBTAINED FROM BOWFIN ENVIRONMENTAL (NOVEMBER 16, 2020).

WATERCOURSE D



WATERCOURSE Z



SCALE: 1:2000

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Engineer

Engineer

FOR REVIEW
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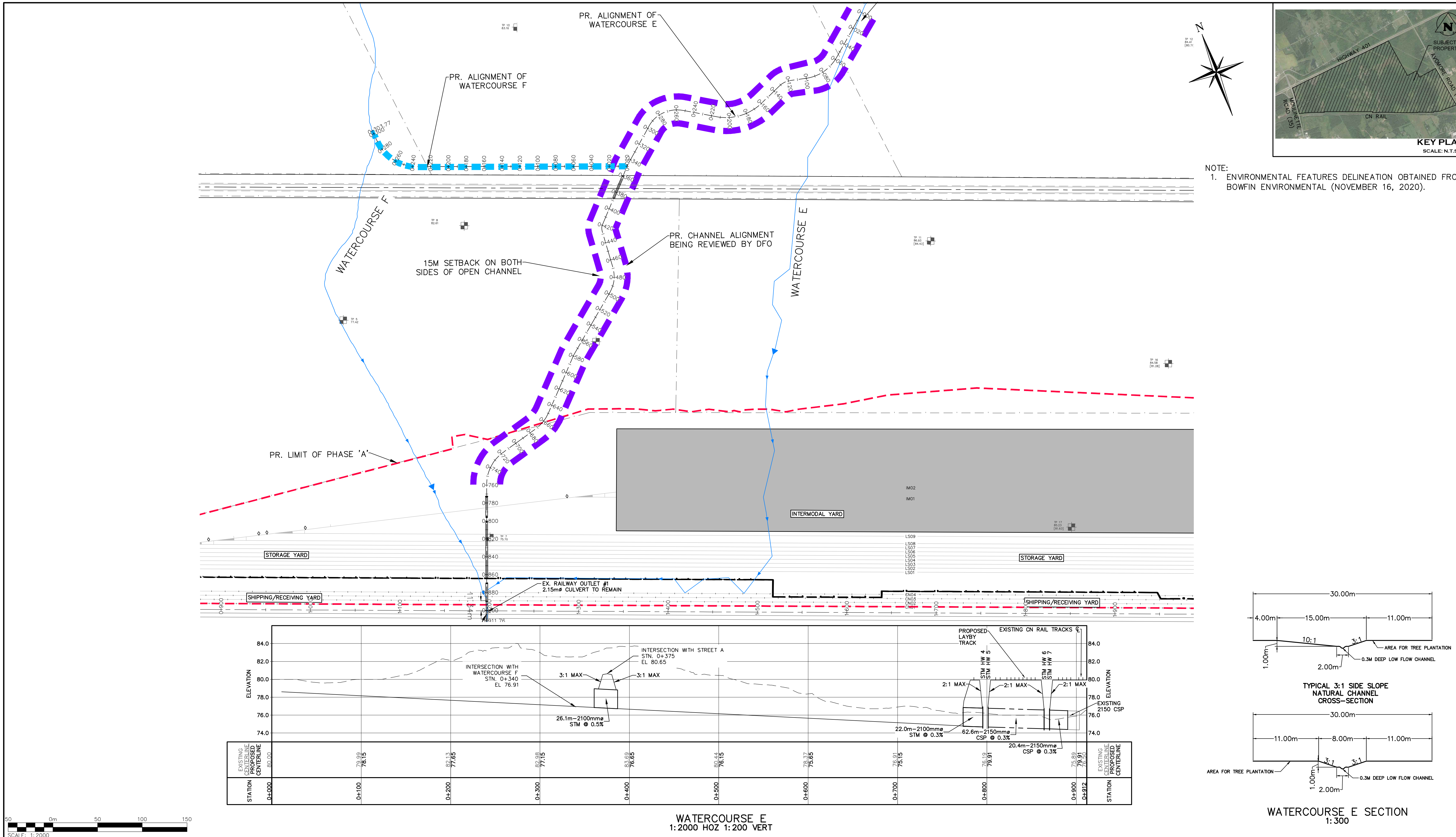
Project
LONG SAULT INDUSTRIAL PARK
TOWN OF LONG SAULT

Drawing
WATERCOURSE D & Z
PLAN AND PROFILES

CROZIER
CONSULTING ENGINEERS

2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
905-875-0026 T
905-875-4915 F
WWW.CFCROZIER.CA

Drawn By	D.G./M.M.	Design By	D.G./M.M.	Project	1909–5629
Check By	T.E./B.W.	Check By	T.E./B.W.	Scale 1:2000	Drawing P_P–4



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FOR REVIEW
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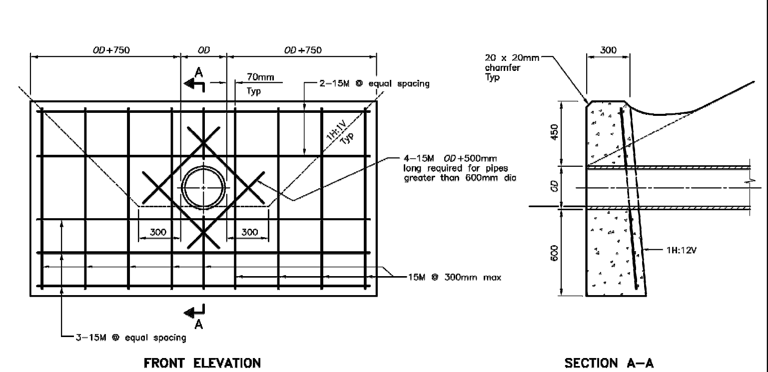
LONG SAULT INDUSTRIAL PARK
TOWN OF LONG SAULT

WATERCOURSE E
PLAN AND PROFILES

CROZIER CONSULTING ENGINEERS
2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
905-875-0026 T
905-875-4915 F
WWW.CFCROZIER.CA

Drawn By	Design By	Project
D.G./M.M.	D.G./M.M.	1909-5629
Check By	Check By	Scale	Drawing
T.E./B.W.	T.E./B.W.	AS SHOWN	P_P-5



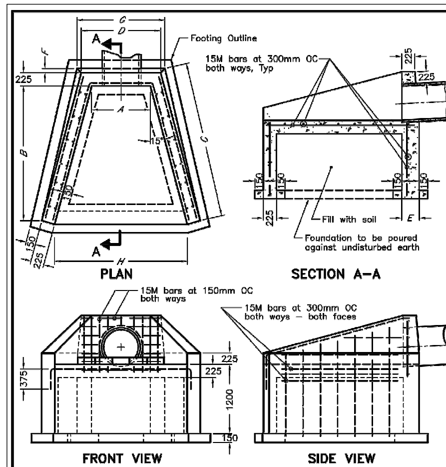
LEGEND:
OD – Outside diameter of pipe

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

ONTARIO PROVINCIAL STANDARD DRAWING | Nov 2017 | Rev 2

CONCRETE HEADWALL
FOR PIPE LESS THAN 900mm DIAMETER

OPSD 804.030



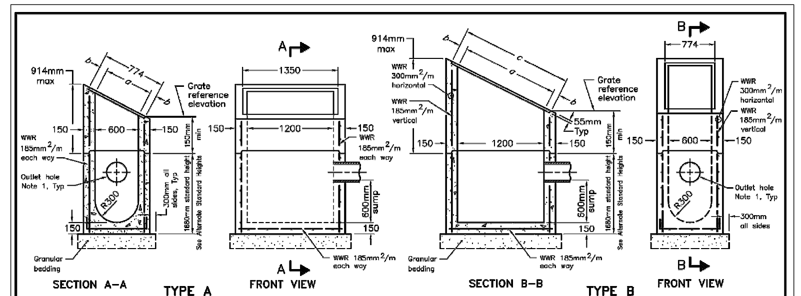
PIPE DIA	ENDWALL DIMENSIONS							
	A	B	C	D	E	F	G	H
600	1050	2400	2725	1400	300	75	1525	2350
675	1125	2400	2725	1475	300	75	1600	2425
750	1200	2400	2725	1550	300	75	1675	2500
825	1275	2400	2725	1625	300	75	1755	2575
900	1350	2400	2725	1700	300	75	1825	2650
975	1425	2400	2725	1775	375	150	1975	2725
1050	1500	3000	3400	1850	375	150	2050	3100
1200	1650	3000	3400	2000	375	150	2200	3250
1350	1800	3000	3400	2150	375	150	2350	3400
1500	1950	3000	3400	2300	375	150	2500	3550
1650	2100	3000	3400	2450	375	150	2650	3700
1800	2250	3000	3400	2600	375	150	2800	3850
2400	3000	3000	3400	3350	375	150	3550	4600

NOTES:
A This OPSD to be read in conjunction with OPSD 3940.150.
B Class of concrete: 30MPa.
C Cover to reinforcing bars: 75mm ±20mm.
D Granular backfill to be placed to 300mm min thickness on all sides.
E All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING | Nov 2017 | Rev 1

CONCRETE HEADWALL
FOR SEWER OR CULVERT PIPE OUTLET

OPSD 804.040



TYPE A

Opening Dimensions			
Grate Type	Grate Slope	a	b
B	2H:1V	670	52
	3H:1V	632	71
	4H:1V	618	78
	HOR	600	87

Alternate Standard Heights	
Alternate	Dimension
A	1980
B	1520
C	1380

TYPE B

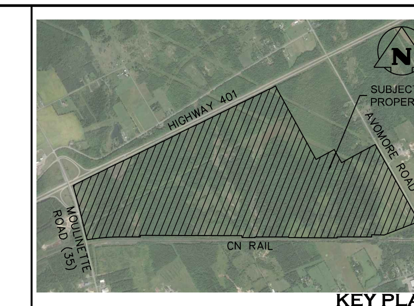
Opening Dimensions				
Grate Type	Grate Slope	a	b	c
C	2H:1V	1341	66	1473
	3H:1V	1265	104	1473
	4H:1V	1237	118	1473
B	6H:1V	1216	65	1346
	HOR	1200	73	1346

NOTES:
1 Outlet hole size 525mm max diameter.
A Where inlet is placed across ditch and is accessible to vehicular traffic, grating slope shall be 6H:1V or flatter.
B Center reinforcing in wall and base slab ±25mm.
C Lap riser horizontal wires 300mm. Laps shall be placed at corners.
D Granular backfill shall be placed to a minimum thickness of 300mm all around the ditch inlet.
E Grating shall be according to OPSD 403.010.
F Pipe support shall be according to OPSD 708.020.
G All dimensions are nominal.
H All dimensions are in millimetres unless otherwise shown.

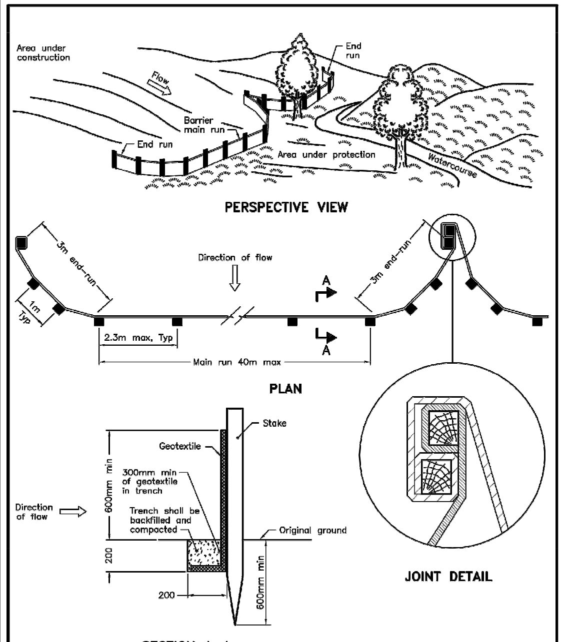
ONTARIO PROVINCIAL STANDARD DRAWING | Nov 2019 | Rev 4

PRECAST CONCRETE DITCH INLETS
600 x 1200mm

OPSD 705.040



KEY PLAN
SCALE: N.T.S.

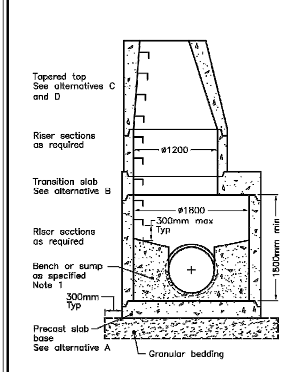


NOTE:
A All dimensions are in millimetres unless otherwise shown.

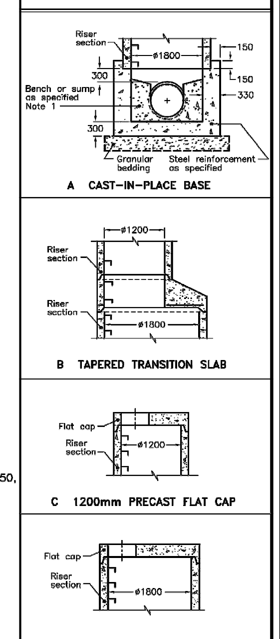
ONTARIO PROVINCIAL STANDARD DRAWING | Nov 2015 | Rev 2

LIGHT–DUTY
SILT FENCE BARRIER

OPSD 219.110



ALTERNATIVES



NOTES:
1 For sump detail, see OPSD 701.010.
A Granular backfill shall be placed to a minimum thickness of 300mm all around the maintenance hole.
B Precast concrete components shall be according to OPSD 701.030, 701.031, 701.050, 701.051, 703.012, 703.022, and 706.020.
C Structures exceeding 5.0m in depth shall include safety platform according to OPSD 404.020 or 404.022.
D Pipe support shall be according to OPSD 708.020.
E For benching and pipe opening details, see OPSD 701.021.
F For adjustment unit and frame installation, see OPSD 704.010.
G All dimensions are nominal.
H All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING | Nov 2014 | Rev 5

PRECAST CONCRETE MAINTENANCE HOLE
1800mm DIAMETER

OPSD 701.012

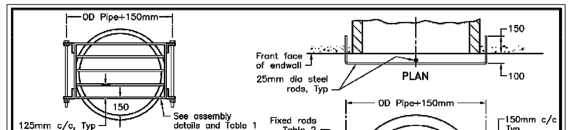
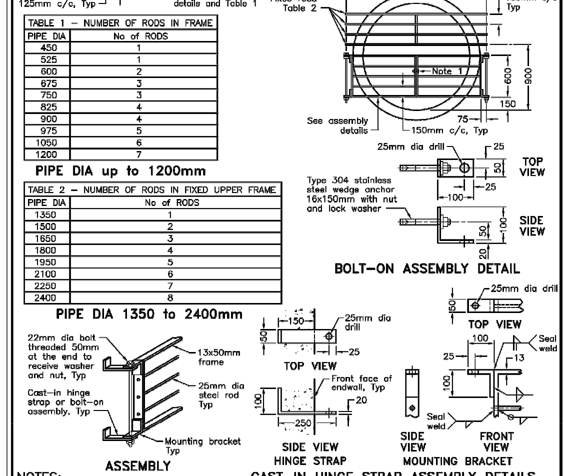


TABLE 1 – NUMBER OF RODS IN FRAME	
PIPE DIA	No of RODS
450	1
525	1
600	2
675	3
750	3
825	4
900	4
975	5
1050	6
1200	7

PIPE DIA up to 1200mm

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

PIPE DIA 1350 to 2400mm



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

ONTARIO PROVINCIAL STANDARD DRAWING | Nov 2018 | Rev 2

GRATING
FOR CONCRETE ENDWALL

OPSD 804.050

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Town

No.	ISSUE	DATE: MMM/DD/YYYY
0	ISSUED FOR SPA 1ST SUBMISSION	NOV/15/2021

Engineer | Engineer

FOR REVIEW
NOT TO BE USED FOR CONSTRUCTION

Project
LONG SAULT INDUSTRIAL PARK
TOWN OF LONG SAULT

Drawing
ONTARIO PROVINCIAL STANARD DETAILS

CROZIER CONSULTING ENGINEERS

2800 HIGH POINT DRIVE
SUITE 100
MILTON, ON L9T 6P4
905-875-0026 T
905-875-4915 F
WWW.CFCROZIER.CA

Drawn By	D.G./M.M.	Design By	D.G./M.M.	Project	1909–5629
Check By	T.E./B.W.	Check By	T.E./B.W.	Scale N/A	Drawing DET–1