UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

FUNCTIONAL SERVICING REPORT

RIVERFRONT (PHASE 2)

October 17, 2024

INTRODUCTION

The purpose of this report is to address the servicing needs for the residential subdivision known as Riverfront (Phase 2) in the City of Niagara Falls in support of the Submission for Draft Plan of Subdivision Approval. The subject lands comprise the second phase of the overall Riverfront Residential development, which is located north of Chippawa Parkway, south of CP Rail tracks, and west of Stanley Avenue.

The currently vacant Phase 2 lands comprise of approximately 175 single detached dwellings, 319 townhouse dwellings and several multiple family residencies. The lands with future Riverfront development (Phase 3) located west of Phase 2 lands, will be subject to separate Planning Act applications and to be submitted at a later date.

The objectives of this report are as follows:

1. Identify domestic and fire protection water servicing needs for Phase 2;
2. Identify sanitary servicing needs for Phase 2; and,
3. Identify stormwater management needs for Phase 2.

WATER SERVICING

There are presently no municipal watermains located on Chippawa Parkway, in front of the subject lands. Therefore, it is proposed to extend the existing 300mm diameter watermain located in front of the existing 8100 Dorchester road property, which is supplied by the existing 1050mm diameter Regional watermain on Old Field Road, Southerly on Dorchester Road / Chippawa Parkway to the eastern limit of the subject lands. The extension of this existing 300mm diameter watermain was proposed to service the subject lands as part of the Thundering Waters Secondary Plan; therefore, there is expected to be adequate domestic water supply and fire protection for the development. In the future, this proposed 300mm diameter watermain will be extended easterly to the existing 300mm diameter watermain on Stanley Avenue, providing a looped watermain system.

The private hydrants located within the development site are prepared to provide fire protection for the proposed dwellings. The spacing and location of the proposed private fire hydrants will be identified as part of the detailed engineering design.

SANITARY SERVICING

There are presently no municipal Sanitary Sewers on Chippawa Parkway, in front of the subject lands and it is not feasible to construct a gravity sanitary sewer to the nearest feasible Sanitary outlet (the existing 825mm diameter Regional Sanitary Sewer in front of the 8100 Dorchester Road property).Therefore, in accordance with the Thundering Waters Secondary Plan, it is proposed to extend a new 600mm diameter municipal Sanitary sewer southerly on Dorchester Road, and construct a new Sanitary Sewage Pumping Station on Chippawa Parkway.

A Sanitary Drainage Area Plan (2209-OVL SANDA), and associated sewer design sheet for the new Sanitary Sewage Pumping Station and existing 825mm diameter Regional sanitary sewer on Dorchester Road has been prepared by Upper Canada Consultants, and has been included in Appendix A for reference. This Drainage Area Plan includes the subject lands, the Riverfront Phase 1 and 3 lands to the east and west of subject lands which are also owned by the applicant and future development areas to the north and north east, which are owned by others.

As shown in the enclosed Drainage Area Plan, the proposed development has been allocated capacity within the design of the proposed Riverfront Sanitary Sewer Pumping Station. This Pumping Station has received Environmental Compliance Approval (ECA), enclosed in Appendix B, from the Ministry of the Environment, Conservation and Parks (MECP) based on the flows calculated from the drainage areas and populations shown on the enclosed Drainage Area Plan and associated design sheet. Therefore, the Riverfront Sanitary Sewage Pumping Station will have adequate capacity to receive the peak sanitary flows from the proposed Riverfront Phase 2 and 3 development.

The sanitary flows from Phase 3 development will be incorporated into the proposed sanitary sewer system within Phase 2 development. The sanitary drainage area for Riverfront Phase 2 and 3 development (Drainage Area A3) is 36.08 hectares with a total population of approximately 2451 people. The peak sanitary flows from the proposed Riverfront Phase 2 and 3 development is approximately 61.16 L/s. Full build-out within the areas shown in the enclosed Drainage Area Plan will utilize approximately 56.4% of the flow capacity of the proposed 600mm diameter sanitary sewer on Dorchester Road and 24.1% of the flow capacity of the existing 825mm diameter Regional sanitary sewer on Dorchester Road.

Therefore, there is expected to be adequate capacity for the subject lands in the existing and proposed sanitary sewer networks and the proposed sanitary Sewage Pumping Station.

STORMWATER MANAGEMENT

A separate Stormwater Management Plan has been prepared by Upper Canada Consultants (UCC) and has been enclosed in Appendix C for reference.

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

CONCLUSIONS AND RECOMMENDATIONS

Therefore, based on the above comments and design calculations provided for this site, the following summarizes the servicing for this site:

1. The existing 300mm diameter watermain on Dorchester Road is expected to have adequate capacity to provide both domestic and fire protection water supply for Phase 2 lands.

2. The receiving 825mm diameter sanitary sewer on Dorchester Road will have adequate capacity to service the Phase 2 lands.

3. The proposed 600mm diameter sanitary sewer extended Southerly on Dorchester Road will have adequate capacity to service the Phase 2 lands.

4. The proposed Pumping Station having received an Environment Compliance Approval from the Ministry of the Environment, Conservation and Parks (MECP) will have adequate capacity to service the Phase 2 lands.

5. Stormwater quantity controls are not considered necessary for the subject lands (See enclosed Stormwater Management Plan).

6. Stormwater quality protection is being provided by the wet pond facility up to Enhanced (80% TSS) Level Protection as per the recommendation of the Region of Niagara (See enclosed Stormwater Management Plan).

Based on the above and the accompanying calculations, there exists adequate municipal servicing for this development. We trust the above comments and enclosed calculations are satisfactory for approval. If you have any questions or require additional information, please do not hesitate to contact our office.

Yours very truly,
Prepared By:

Anu Jacob, E.I.T.

Reviewed By:

LICENSED PROFESSIONAL ENGINEER
A. S. KEANE
100109861
PROVINCE OF ONTARIO

Adam Keane, P.Eng.

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

APPENDICES

APPENDIX A

Overall Sanitary Drainage Area Plan
Overall Sanitary Sewer Calculation Sheet

UPPER CANADA CONSULTANTS
30 HANNOVER DRIVE, UNIT 3
ST.CATHARINES, ON, L2W 1A3

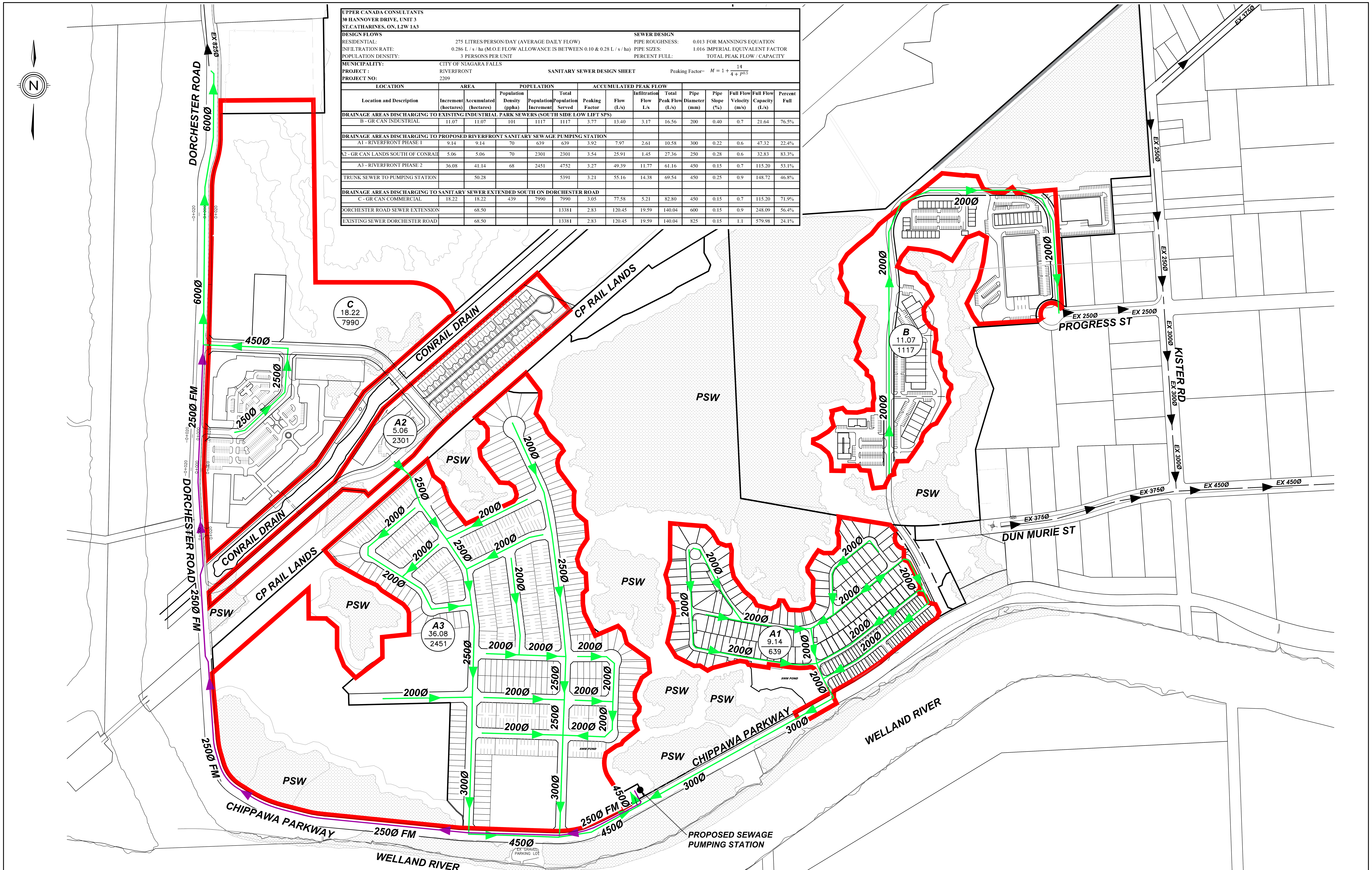
DESIGN FLOWS		**SEWER DESIGN**	
RESIDENTIAL:	275 LITRES/PERSON/DAY (AVERAGE DAILY FLOW)	PIPE ROUGHNESS:	0.013 FOR MANNING'S EQUATION
INFILTRATION RATE:	0.286 L / s / ha (M.O.E FLOW ALLOWANCE IS BETWEEN 0.10 & 0.28 L / s / ha)	PIPE SIZES:	1.016 IMPERIAL EQUIVALENT FACTOR
POPULATION DENSITY:	3 PERSONS PER UNIT	PERCENT FULL:	TOTAL PEAK FLOW / CAPACITY

MUNICIPALITY: CITY OF NIAGARA FALLS
PROJECT : RIVERFRONT
PROJECT NO: 2209

SANITARY SEWER DESIGN SHEET

Peaking Factor= $M = 1 + \frac{14}{4 + P^{0.5}}$

LOCATION	AREA		POPULATION			ACCUMULATED PEAK FLOW								
Location and Description	Increment (hectares)	Accumulated (hectares)	Population Density (ppha)	Population Increment	Total Population Served	Peaking Factor	Flow (L/s)	Infiltration Flow L/s	Total Peak Flow (L/s)	Pipe Diameter (mm)	Pipe Slope (%)	Full Flow Velocity (m/s)	Full Flow Capacity (L/s)	Percent Full
DRAINAGE AREAS DISCHARGING TO EXISTING INDUSTRIAL PARK SEWERS (SOUTH SIDE LOW LIFT SPS)														
B - GR CAN INDUSTRIAL	11.07	11.07	101	1117	1117	3.77	13.40	3.17	16.56	200	0.40	0.7	21.64	76.5%
DRAINAGE AREAS DISCHARGING TO PROPOSED RIVERFRONT SANITARY SEWAGE PUMPING STATION														
A1 - RIVERFRONT PHASE 1	9.14	9.14	70	639	639	3.92	7.97	2.61	10.58	300	0.22	0.6	47.32	22.4%
A2 - GR CAN LANDS SOUTH OF CONRAIL	5.06	5.06	70	2301	2301	3.54	25.91	1.45	27.36	250	0.28	0.6	32.83	83.3%
A3 - RIVERFRONT PHASE 2	36.08	41.14	68	2451	4752	3.27	49.39	11.77	61.16	450	0.15	0.7	115.20	53.1%
TRUNK SEWER TO PUMPING STATION		50.28			5391	3.21	55.16	14.38	69.54	450	0.25	0.9	148.72	46.8%
DRAINAGE AREAS DISCHARGING TO SANITARY SEWER EXTENDED SOUTH ON DORCHESTER ROAD														
C - GR CAN COMMERCIAL	18.22	18.22	439	7990	7990	3.05	77.58	5.21	82.80	450	0.15	0.7	115.20	71.9%
DORCHESTER ROAD SEWER EXTENSION		68.50			13381	2.83	120.45	19.59	140.04	600	0.15	0.9	248.09	56.4%
EXISTING SEWER DORCHESTER ROAD		68.50			13381	2.83	120.45	19.59	140.04	825	0.15	1.1	579.98	24.1%



NOTES:

1. THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER, AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
2. PROPERTY LINES WERE PLOTTED USING REGISTERED PLANS AND BARS LOCATED IN THE FIELD. TO VERIFY THE ACCURACY OF THESE PROPERTY LINES, A LEGAL SURVEY SHOULD BE PERFORMED PRIOR TO CONSTRUCTION.
3. ALL CONSTRUCTION MUST COMPLY WITH THE NIAGARA PENINSULA STANDARD CONTRACT DOCUMENT.

#	REVISION	DATE	INIT

DRAFTING AJ/BV
DESIGN MH
CHECKED BY AK
APPROVED BY AK

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS
30 Hannover Drive Unit 3
St. Catharines, Ontario
L2W 1A3
Phone: (905)688-9400
Fax: (905)688-5274

OWNER
CENTENNIAL HOMES (NIAGARA) INC.
353 TOWNLINE ROAD
NIAGARA-ON-THE-LAKE, ON
LOS 1JO

RIVERFRONT
SANITARY SERVICING MASTERPLAN
CITY OF NIAGARA FALLS

CONSULTANT FILE No.
DATE 2024-10-17
PRINTED 2024-10-17
SCALE 1:3000 m
REF No.
DWG No. 2209-OVLSAN
REV 0

DRAWING FILE: F:\2209\Engineering\2209-PH1-BASE.dwg PLOTTED: Oct 17, 2024 - 2:33pm PLOTTED BY: BVanderValk

UPPER CANADA CONSULTANTS
30 HANNOVER DRIVE, UNIT 3
ST.CATHARINES, ON, L2W 1A3

DESIGN FLOWS

RESIDENTIAL: 275 LITRES/PERSON/DAY (AVERAGE DAILY FLOW)
INFILTRATION RATE: 0.286 L / s / ha (M.O.E FLOW ALLOWANCE IS BETWEEN 0.10 & 0.28 L / s / ha)
POPULATION DENSITY: 3 PERSONS PER UNIT

SEWER DESIGN

PIPE ROUGHNESS: 0.013 FOR MANNING'S EQUATION
PIPE SIZES: 1.016 IMPERIAL EQUIVALENT FACTOR
PERCENT FULL: TOTAL PEAK FLOW / CAPACITY

MUNICIPALITY: CITY OF NIAGARA FALLS
PROJECT : RIVERFRONT
PROJECT NO: 2209

SANITARY SEWER DESIGN SHEET

Peaking Factor= $M = 1 + \frac{14}{4 + P^{0.5}}$

LOCATION	AREA		POPULATION			ACCUMULATED PEAK FLOW								
Location and Description	Increment (hectares)	Accumulated (hectares)	Population Density (ppha)	Population Increment	Total Population Served	Peaking Factor	Flow (L/s)	Infiltration Flow L/s	Total Peak Flow (L/s)	Pipe Diameter (mm)	Pipe Slope (%)	Full Flow Velocity (m/s)	Full Flow Capacity (L/s)	Percent Full
DRAINAGE AREAS DISCHARGING TO EXISTING INDUSTRIAL PARK SEWERS (SOUTH SIDE LOW LIFT SPS)														
B - GR CAN INDUSTRIAL	11.07	11.07	101	1117	1117	3.77	13.40	3.17	16.56	200	0.40	0.7	21.64	76.5%
DRAINAGE AREAS DISCHARGING TO PROPOSED RIVERFRONT SANITARY SEWAGE PUMPING STATION														
A1 - RIVERFRONT PHASE 1	9.14	9.14	70	639	639	3.92	7.97	2.61	10.58	300	0.22	0.6	47.32	22.4%
A2 - GR CAN LANDS SOUTH OF CONRAIL	5.06	5.06	70	2301	2301	3.54	25.91	1.45	27.36	250	0.28	0.6	32.83	83.3%
A3 - RIVERFRONT PHASE 2	36.08	41.14	68	2451	4752	3.27	49.39	11.77	61.16	450	0.15	0.7	115.20	53.1%
TRUNK SEWER TO PUMPING STATION		50.28			5391	3.21	55.16	14.38	69.54	450	0.25	0.9	148.72	46.8%
DRAINAGE AREAS DISCHARGING TO SANITARY SEWER EXTENDED SOUTH ON DORCHESTER ROAD														
C - GR CAN COMMERCIAL	18.22	18.22	439	7990	7990	3.05	77.58	5.21	82.80	450	0.15	0.7	115.20	71.9%
DORCHESTER ROAD SEWER EXTENSION		68.50			13381	2.83	120.45	19.59	140.04	600	0.15	0.9	248.09	56.4%
EXISTING SEWER DORCHESTER ROAD		68.50			13381	2.83	120.45	19.59	140.04	825	0.15	1.1	579.98	24.1%

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

APPENDIX B

Pumping Station - Environment Compliance Approval

Schedule C: Notice of Amendment to ECA 007-W603

System Owner	**Regional Municipality of Niagara**
ECA Number	**007-W603**
Sewage System Name	**Niagara Falls Wastewater Catchment System**
Schedule C Issue Number	**1**

Pursuant to the Environmental Protection Act, R.S.O 1990, c. E. 19 (EPA), and the regulations made thereunder and subject to the limitations thereof, this approval is issued under section 20.3 of Part II.1 of the EPA as Schedule C, issue 1 to ECA 007-W603.

1.0 Description of New or Altered Sewage Works

1.1 Schedule B is amended to add the following:

Riverfront Sanitary Sewage Pumping Station

Asset ID and Name	Riverfront Sanitary Pumping Station
Site Location	6610 Chippawa Parkway, Niagara Falls, ON
Watershed/Subwatershed	Welland River
Latitude and Longitude	43.046010, -79.108730
Coordinates (optional)	
Description	A sewage pumping station, located along Chippawa Parkway between Stanley Avenue and Dorchester Road, for the collection and transmission of separated sewage, serving a catchment area of approximately 59 hectares in the City of Niagara Falls, discharging to an existing gravity sewer located on Dorchester Road north-west of the proposed development.
Pumping Station Capacity	47 L/s in Phases 1 and 2, 82 L/s in Phase 3
Equipment	Two (2) submersible pumps (1 duty, 1 standby) rated at 47.0 L/s at a TDH of 20 m in Phases 1 and 2 and two (2) submersible pumps (1 duty, 1 standby) each rated at 82 L/s at a TDH of 37 m in Phase 3, and one (1) wet well, 3.0 m by 3.0 m. The station is connected to one (1) 250 mm diameter forcemain discharging to an existing gravity sewer located on Dorchester Road north-west of the proposed development. The pumps are currently operating at 47.0 L/s for Phase 1 and 2.
Emergency Storage	A total emergency storage volume of 51 m^3 is provided by the SPS sewers and SPS. Approximately 18 minutes of retention time is provided based on peak flow design flow of 47 L/s. There is an additional 87 m^3 of emergency storage in the sewer system upstream of the SPS.
Equipment: Associated controls and Appurtenances	Equipped with: • A forcemain bypass connection including all other mechanical system, electrical system, instrumentation and control system, standby power system, piping, pumps, valves, and appurtenances essential for the proper, safe, and reliable operation of the Works.

Sewage Pumping Station – Collection System Overflow	Overflow will connect into the subdivision's storm pond overflow maintenance hole located immediately west of the proposed SPS and will outlet south to Welland River
Receiving Stations (if applicable)	An existing gravity sewer located on Dorchester Road located north-west of the proposed development.
Odour Control Units	Odour control units are located on vent lines
Standby Power	A 50 kW natural gas outdoor emergency generator proposed
Notes	The development is currently being planned in three phases. Phase 1 is expected to contribute flows to the SPS in late 2024. Phase 2 will follow and is expected to contribute flows to the station in 2025. Phase 3 is currently under review for draft plan approval, and the timeframe is unknown. However, it is assumed that wastewater flows from this phase could contribute to the Sewage Pump Station as early as 2027. When Phase 3 is implemented, a Director Notification to update the description will be required.

2.0 Conditions Added to ECA 007-W603

2.1 Schedule E Condition 3.2.1(h) will be amended as:

h) Emergency Response, Spill Reporting and Contingency Plans and Procedures for dealing with Equipment breakdowns, potential Spills, and any other abnormal situations, including notification to the SAC, the Medical Officer of Health, and the District Manager, as applicable, including:

i. In the event of a spill or overflow to the stormwater management system, the Owner is responsible to use best efforts to immediately inspect the area and when necessary, start cleanup measures for the spill or overflow and the portion of the stormwater management system impacted by the spill or overflow. The Owner shall notify the District Manager of the spill or overflow and any cleanup efforts being undertaken.

ii. The Owner shall prepare a spill prevention/contingency plan, that clearly outlines the procedures/response plan for a sanitary spill or overflow event into a stormwater management system including notification procedures, contingency measures to prevent a spill or overflow, sampling plan for the spill or overflow, and clean up procedures that will be carried out for the spill, backflow, or overflow, which will include cleaning the portion of the stormwater management system impacted by the spill or overflow.

2.2 Table B5: Identified Sanitary Sewer Overflow Points including Pumping Stations will be amended to add the following rows:

Column 1 Asset ID	Column 2 Asset Name	Column 3 Overflow Location (Latitude and Longitude)	Column 4 Point of Entry to Receiver (Latitude and Longitude)
54000524/54000525	Riverfront Sanitary Pumping	43.04671,	43.04586,

	Station	-79.10556	-79.10514

3.0 Director Notification

3.1 In accordance with condition 3.5 in Schedule D of ECA 007-W603 you are required to notify the Director within thirty (30) days of the earlier of the placing into service or Completion of the altered Sewage Works and Equipment described in condition 1 (Description of New or Altered Sewage Works).

Applications, Plans and Supporting Documentation

Table 1	
Application dated July 11, 2023	Application for Environmental Compliance Approval, dated July 11, 2023, submitted by Associated Engineering Ltd. on behalf of the Regional Municipality of Niagara.
	Riverfront Community Sewage Pumping Station and Forcemain Design Report, dated April 2023, prepared by Associated Engineering Ltd.
	Engineering Drawings, signed, stamped, and dated on June 27, 2023, prepared by Associated Engineering Ltd.
	Engineering Drawing titled 2209-PS OUTLET Rev 0, signed, stamped, and dated on May 8, 2023, prepared by Upper Canada Consultants
	Pipe Data Form, dated May 19, 2023, prepared by Associated Engineering Ltd.
Notes	

Except as otherwise provided by ECA 007-W603, the alterations described in this schedule shall be designed, developed, built, operated and maintained in accordance with this schedule and the documentation listed in Table 1.

In accordance with Section 139 of the Environmental Protection Act, you may by written notice served upon me, the Ontario Land Tribunal and in accordance with Section 47 of the Environmental Bill of Rights, 1993, the Minister of the Environment, Conservation and Parks, within 15 days after receipt of this notice, require a hearing by the Tribunal. The Minister of the Environment, Conservation and Parks will place notice of your appeal on the Environmental Registry. Section 142 of the Environmental Protection Act provides that the notice requiring the hearing ("the Notice") shall state:

a) The portions of the environmental compliance approval or each term or condition in the environmental compliance approval in respect of which the hearing is required, and;
b) The grounds on which you intend to rely at the hearing in relation to each portion appealed. Pursuant to subsection 139(3) of the Environmental Protection Act, a hearing may not be required with respect to any terms and conditions in this environmental compliance approval, if the terms and conditions are substantially the same as those contained in an approval that is amended or revoked by this environmental compliance approval.

The Notice should also include:

1. The name of the appellant;
2. The address of the appellant;
3. The environmental compliance approval number;
4. The date of the environmental compliance approval;
5. The name of the Director, and;
6. The municipality or municipalities within which the project is to be engaged in.

And the Notice should be signed and dated by the appellant.

This Notice must be served upon:

Registrar*
Ontario Land Tribunal
655 Bay Street, Suite 1500
Toronto, Ontario
M5G 1E5
OLT.Registrar@ontario.ca

and

The Minister of the Environment,
Conservation and Parks
777 Bay Street, 5th Floor
Toronto, Ontario
M7A 2J3

and

The Director appointed for the purposes of
Part II.1 of the Environmental Protection Act
Ministry of the Environment,
Conservation and Parks
135 St. Clair Avenue West, 1st Floor
Toronto, Ontario
M4V 1P5

* Further information on the Ontario Land Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 212-6349 or 1 (866) 448-2248, or www.olt.gov.on.ca

DATED at TORONTO this 16th day of February, 2024

Signature

Aziz Ahmed, P.Eng.
Director
Part V, *Safe Drinking Water Act*, 2002

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

APPENDIX C

Riverfront (Phase 2) - Stormwater Management Plan

STORMWATER MANAGEMENT PLAN

RIVERFRONT (PHASE 2)

CITY OF NIAGARA FALLS

Prepared by:

Upper Canada Consultants
3-30 Hannover Drive
St. Catharines, Ontario
L2W 1A3

October 17, 2024

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

REFERENCES

1. Stormwater Management Planning and Design Manual
   Ontario Ministry of Environment (March 2003)

STORMWATER MANAGEMENT PLAN

RIVERFRONT (PHASE 2)

CITY OF NIAGARA FALLS

1.0 INTRODUCTION

1.1 Study Area

The proposed residential development of Riverfront is located at the City of Niagara Falls, within the Thundering Waters Secondary Plan area. As shown on the enclosed Site Location Plan (Figure 1), the subject lands are bound to the south and west by the Chippawa Parkway, situated south of the existing CP Rail tracks and west of Stanley Avenue.

The Stormwater Management Plan has been prepared to assess existing and future stormwater conditions to establish the property requirements for the proposed Stormwater Management Facility in support of the Submission for Draft Plan of Subdivision Approval.

1.2 Objectives

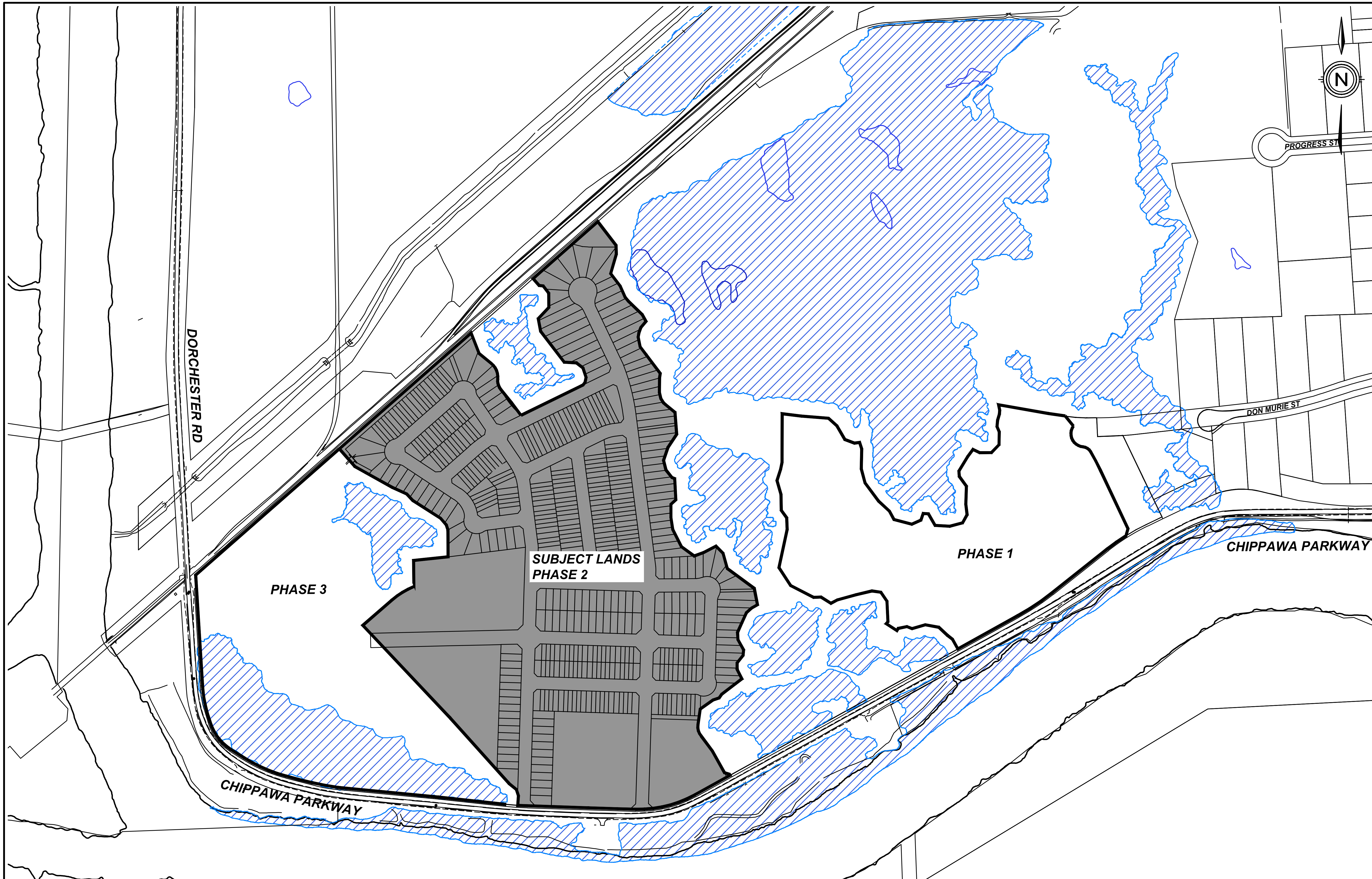
The objectives of this study are as follows:

1. Establish specific criteria for the management of stormwater from Phase 2;

2. Determine the impact of development on the stormwater peak flow & volume of flows from Phase 2 and external drainage areas;

3. Investigate alternatives for controlling the quality of stormwater discharging from Phase 2; and,

4. Recommend a comprehensive plan for the management of stormwater during and after construction.



UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

RIVERFRONT
CITY OF NIAGARA FALLS

STUDY AREA PLAN

DATE:	2024-10-17
SCALE:	1:5000
REF No.	2209
DWG No.	FIGURE 1

1.3 Existing & Proposed Conditions

a) Existing Conditions

The subject lands and external drainage areas are currently vacant, comprising of predominantly open space separated by areas of dense vegetation. The existing stormwater flows are conveyed overland through existing ditches, ultimately outletting to the Welland River.

The subject lands presently convey stormwater overland to three separate outlets. Figure 2 shows the existing catchment areas and drainage paths within the overall Riverfront Submission Area. As shown in this Figure, the Phase 2 lands convey existing stormwater flows to the Welland River through three separate catchments:

A. Catchment C1 which flows easterly to the adjacent Provincially Significant Wetlands, outletting to the Welland River through an existing culvert crossing on Chippawa Parkway;

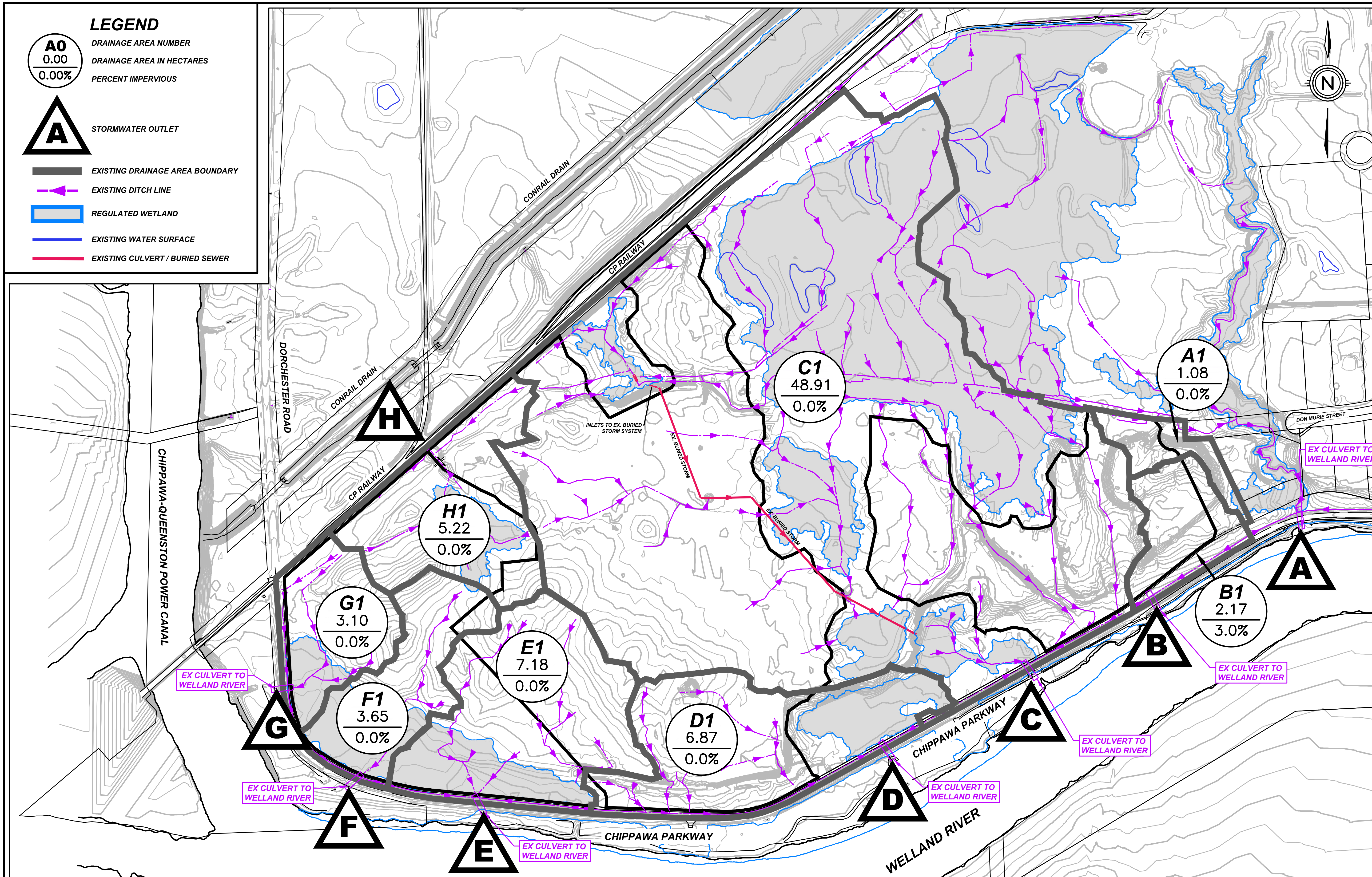
B. Catchment Area D1 which flows Southerly to the existing ditch present along the north side of Chippawa Parkway, outletting to the Welland River through a separate existing culvert crossing, and;

C. Catchment Area E1 which flows westerly and southerly to the existing wetland present on the north side of Chippawa Parkway, outletting to the Welland River through a third existing culvert crossing.

The soil in the subject lands consist mainly of silty clay/clayey silt fill and is classified in the Soil Conservation Service (SCS) classification method as belonging to hydrologic soil group C.

b) Proposed Conditions

The subject lands are approximately 27.83 hectares and comprises of approximately 191 single detached and 289 townhouse dwellings. The subject lands will be developed with full urban services including sanitary and storm sewers, watermains, private asphalt roads with concrete curb and gutters.



UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

RIVERFRONT
CITY OF NIAGARA FALLS

EXISTING STORM DRAINAGE AREA PLAN

DATE:	2023-09-25
SCALE:	1:5000
REF No.	2209
DWG No.	FIGURE 2

2.0 STORMWATER MANAGEMENT CRITERIA

New developments are required to provide stormwater management in accordance with provincial and municipal policies including:

- Stormwater Quality Guidelines for New Development (MECP/MNRF, May 1991)
- Stormwater Management Planning and Design Manual (MECP, March 2003)

The development area outlets to the Welland River. This drainage system has been identified as Type 2 fish habitat. Based on this classification, the corresponding MECP level of Protection for stormwater management quality practices necessary is Normal (70% TSS Removal). However, as per the comments received by the Niagara Region, Enhanced Protection (80% TSS Removal) is required prior to discharging to the Welland River.

Based on the above policies and site specific considerations, the following stormwater management criteria have been established for the site.

a. Stormwater **quality** controls are to be provided for the more frequent storm events to provide Enhanced Protection (80% TSS Removal) in accordance with MECP guidelines.

b. Erosion control is not required for the Welland River or Chippawa-Queenston Power Canal, as the outlet discharges to concrete storm sewers and ultimately to the Welland River. An extended detention volume for 24 hours is to be provided in accordance with MECP.

c. Quantity controls are not required as the subject lands will outlet to the Welland River, where water levels are controlled by the Niagara River and Chippawa-Queenston Power Canal.

3.0 STORMWATER ANALYSIS

Since stormwater quantity controls are not required for the subject lands. future stormwater flows are modelled using the MIDUSS computer modelling program for the purposes of sizing sediment forebays and determining stormwater quality volumes **only**.

This program was selected because it is applicable to an urban drainage area like the study area, it is relatively easy to use and modify for the proposed drainage conditions and control facilities, and it readily allows for the use of design storm hyetographs for the various return periods being investigated.

3.1 Design Storms

The 5-year design storm hyetograph was developed using a 4 hour Chicago distribution based on the City of Niagara Falls Intensity-Duration-Frequency (IDF) curves. The 25mm design storm IDF curve parameters were derived using a 4-hour Chicago distribution. Table 1 summarizes the rainfall data used in this study.

Table 1. Rainfall Data			
Design Storm (Return Period)	**Chicago Distribution Parameters**		
	a	**b**	**c**
25mm	512.000	6.00	0.800
5 Year	719.500	6.34	0.7687

$$\text{Intensity } (mm/hr) = \frac{a}{(t_d + b)^c}$$

3.2 Future Conditions

It is proposed to convey future stormwater flows from the subject lands to Welland River through a proposed 1050mm diameter concrete culvert. The proposed SWM pond has been designed to include the stormwater flows from Riverfront Development Phases 2 and 3.

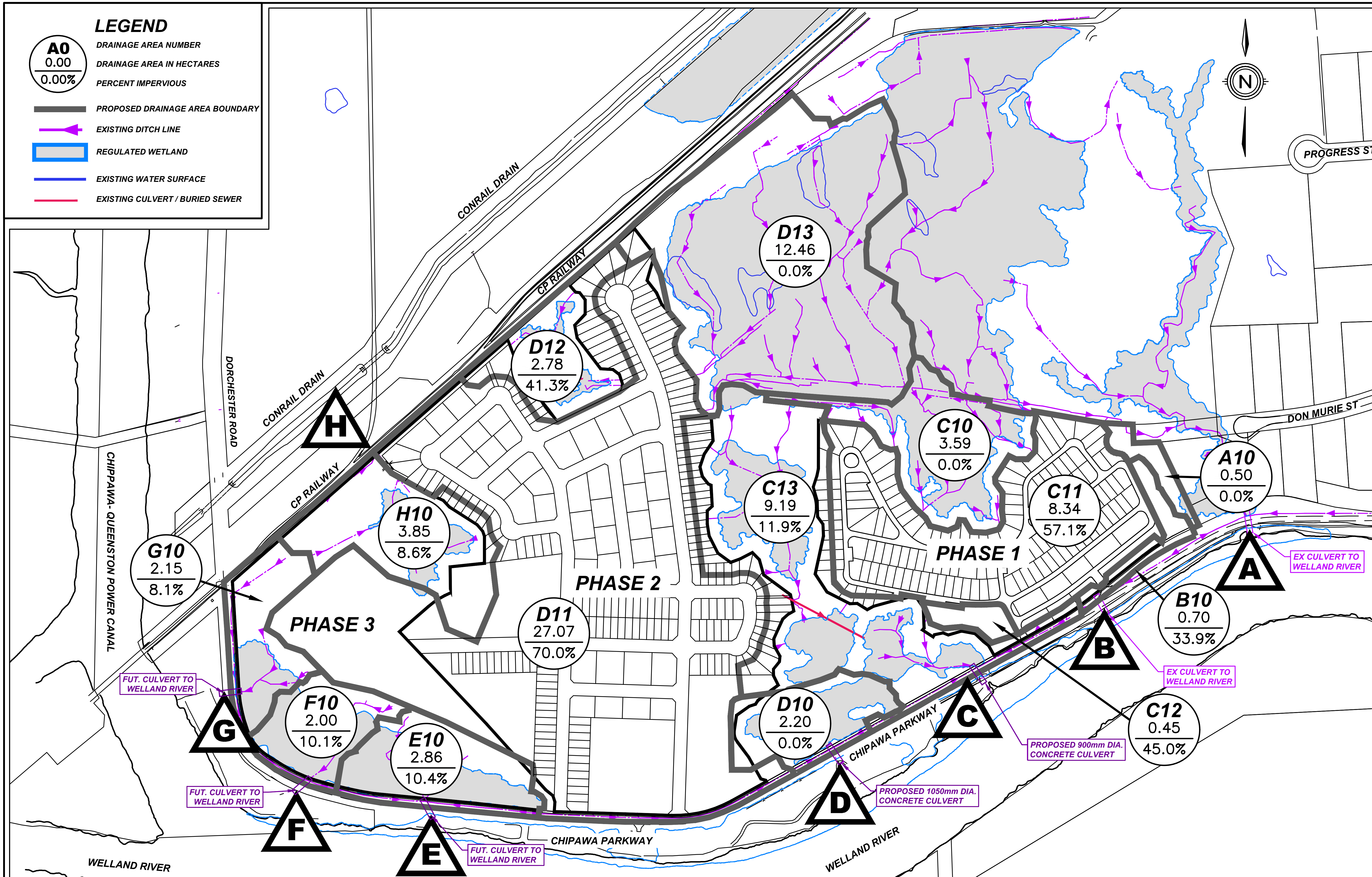
An overall imperviousness value of 70% has been assumed for the site and 0% for the external drainage areas.

Figure 3 shows the proposed drainage areas for subject lands. Input parameters for the computer model for proposed development conditions are shown in Table 2.

Table 2. Hydrologic Parameters for Future Conditions – SWM Pond					
Area No.	**Area (ha)**	**Length (m)**	**Slope (%)**	**SCS CN**	**Percent Impervious**
D13	12.46	288	0.6	80	0.0%
D12	2.78	136	7.0	80	0.0%
D11	27.07	428	1.0	74	70.0%
	42.31	**Total Area**			

As shown in Figure 3, the rear yard areas from the limits of subject lands will contribute future stormwater flows to the adjacent Provincially Significant Wetlands through Catchment Areas C13, D12 and H10.

The detailed MIDUSS modelling output files have been enclosed in Appendix B for reference.



UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

RIVERFRONT
CITY OF NIAGARA FALLS

PROPOSED STORM DRAINAGE AREA PLAN

DATE:	2024-03-13
SCALE:	1:5000
REF No.	2209
DWG No.	FIGURE 3

4.0 STORMWATER MANAGEMENT ALTERNATIVES

4.1 Screening of Stormwater Management Alternatives

A variety of stormwater management alternatives are available to control the quality of stormwater, most of which are described in the Stormwater Management Planning and Design Manual (MECP, March 2003). Alternatives for the proposed and ultimate developments were considered in the following broad categories: lot level, vegetative, infiltration, and end-of-pipe controls. General comments on each category are provided below. Individual alternatives for the proposed development are listed in Table 3 with comments on their effectiveness and applicability to the proposed outlet.

a) Lot Level Controls

Lot level controls are not generally suitable as the primary control facility for quality control. They are generally used to enhance stormwater quality in conjunction with other types of control facilities.

b) Vegetative Alternatives

Vegetative stormwater management practices are not generally suitable as the primary control facility for quality control. They are generally used to enhance stormwater quality in conjunction with other types of control facilities.

c) Infiltration Alternatives

Where soils are suitable, infiltration techniques can be very effective in providing quantity and quality control. However, the very small amount of surface area on this site dedicated to permeable surfaces such as greenspace and landscaping make this an impractical option. Therefore, infiltration techniques will not be considered for this development.

d) End-of-Pipe Alternatives

Surface storage techniques can be very effective in providing quality and quantity control. Wet facilities are effective practices for stormwater quality control for large drainage areas (>5ha).

Table 3. Evaluation of Stormwater Management Practices

Riverfront (Phase 2)	Criteria for Implementation of Stormwater Management Practices (SWMP)					Technical Effectiveness (10 high)	Recommend Implementation Yes / No	Comments
	Topography	**Soils**	**Bedrock**	**Groundwater**	**Area**			
Site Conditions	***Variable 1 to 3%***	***Clayey Silt ±15mm/hr***	***At Considerable Depth***	***At Considerable Depth***	***± 12.83ha***			
Lot Level Controls								
Lot Grading	<5%	nlc	nlc	nlc	nlc	2	Yes	Quality/quantity benefits
Roof Leaders to Surface	nlc	nlc	nlc	nlc	nlc	2	Yes	Quality/quantity benefits
Roof Ldrs.to Soakaway Pits	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 0.5 ha	6	No	Unsuitable site conditions
Sump Pump Fdtn. Drains	nlc	nlc	nlc	nlc	nlc	2	Yes	Suitable site conditions
Vegetative								
Grassed Swales	< 5 %	nlc	nlc	nlc	nlc	7	Yes	Quality/quantity benefits
Filter Strips(Veg. Buffer)	< 10 %	nlc	nlc	>.5m Below Bottom	< 2 ha	5	No	Unsuitable site conditions
Infiltration								
Infiltration Basins	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 5 ha	2	No	Unsuitable site conditions
Infiltration Trench	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 2 ha	4	No	Unsuitable site conditions
Rear Yard Infiltration	< 2.0 %	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 0.5 ha	7	No	Unsuitable site conditions
Perforated Pipes	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	nlc	4	No	Unsuitable site conditions
Pervious Catch basins	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	nlc	3	No	Unsuitable site conditions
Sand Filters	nlc	nlc	nlc	>.5m Below Bottom	< 5 ha	5	No	High maintenance/poor aesthetics
Surface Storage								
Dry Ponds	nlc	nlc	nlc	nlc	> 5 ha	7	No	No quality control
Wet Ponds	nlc	nlc	nlc	nlc	> 5 ha	9	Yes	Very effective quality control
Wetlands	nlc	nlc	nlc	nlc	> 5 ha	6	No	Very effective quality control
Other								
Oil/Grit Separator	nlc	nlc	nlc	nlc	<5 ha	3	No	Limited benefit/area too large

Reference: Stormwater Management Planning and Design Manual - 2003
nlc - No Limiting Criteria

4.2 Selection of Stormwater Management Alternatives

Stormwater management alternatives were screened based on technical effectiveness, physical suitability for this site, and their ability to meet the stormwater management criteria established for proposed and future development areas. The following stormwater management alternatives are recommended for implementation on the proposed development:

- **Lot grading** to be kept as flat as practical in order to slow down stormwater and encourage infiltration.
- **Roof leaders to be discharged to the ground surface** in order to slow down stormwater and encourage infiltration.
- **Grassed swales** to be used to collect rear lot drainage. Grassed swales tend to filter sediments and slow down the rate of stormwater.
- A **wet pond facility** to be constructed to provide stormwater quality enhancement.

5.0 STORMWATER MANAGEMENT PLAN

5.1 Proposed Stormwater Management Facility - Phase 2

5.1.1 Stormwater Quality

Based on Table 3.2 of SWMP & Design Manual, the water quality storage requirement is approximately 255 m^3/ha for *Enhanced* protection for developments with 70% impervious areas. The proposed stormwater management facility will be required to provide stormwater quality improvements for a future drainage area of 27.07 hectares. The storage volumes required for this proposed facility are shown in Table 4.

Table 4. Stormwater Quality Volume Calculations

Total Water Quality Volume = 27.07 ha x 225 m^3/ha = 6,091 m^3	Reference: Table 3.2, SWMP & Design Manual (MECP 2003)
Permanent Pool Volume = 27.07 ha x 185 m^3/ha = 5,008 m^3	**Extended Detention Volume** = 27.07 ha x 40 m^3/ha = 1,083 m^3

Erosion control measures are not considered necessary for the stormwater management facility as the outlet discharges to concrete storm sewers that are not subject to erosion, and ultimately to the Welland River which contains a permanent water volume and therefore not exposed soils present to contribute sedimentation to the natural environment.

5.1.2 Stormwater Management Facility Configuration

It is proposed to construct a stormwater management wet pond facility with a controlled outlet. The outlet consists of a reverse slope pipe acting as a tubular control orifice providing the required quality control connected to a ditch inlet, another second ditch inlet; each provided with 450mm diameter orifice plates connected to outlet pipes and an emergency spillway which will provide an outlet for greater storm events.

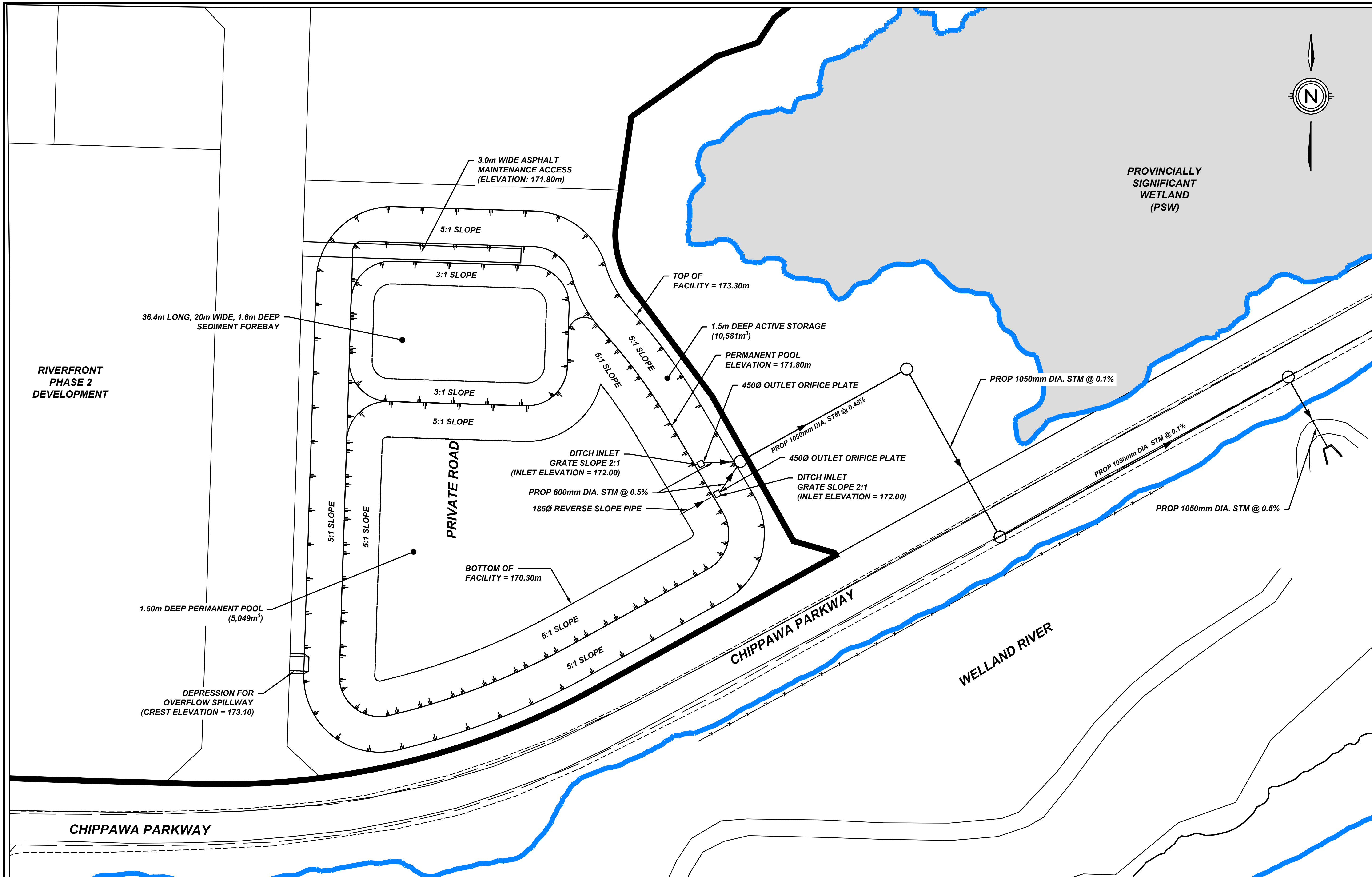
The proposed bottom elevation of the facility is 170.30 m, and the permanent pool water level is 171.80 m for a permanent pool depth of 1.50 m. The configuration of the facility provides 5,049 m^3 of permanent pool volume, which is more than the required 5,008 m^3. The proposed top of pond is at an elevation of 173.30m, providing a total active storage volume of 10,581 m^3.

Based on the proposed configuration of the proposed facility it was determined that a 185mm diameter reverse slope pipe with an invert of 171.80 m can provide 24 hours of detention with the emergency spillway being constructed at an elevation of 173.10m; which is equal to the minimum drawdown time of 24 hours. This configuration will provide an extended detention volume of 1,206 m^3, which is greater than the volume of 1,083 m^3 specified in Table 4.

Stage-storage-discharge calculations have been prepared for this facility and are included in Appendix A for reference.

Major overland flows from Riverfront Phase 2 and 3 will be directed to the SWM facility, which will ultimately outlet to the Welland River.

A sediment forebay was designed to minimize the transport of heavy sediment through the facility to the Welland River and to localize future maintenance activities. Calculations for the forebay sizing follow MECP Guidelines and are shown in Appendix A.



UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

RIVERFRONT
CITY OF NIAGARA FALLS

STORMWATER MANAGEMENT POND

DATE:	2024-05-29
SCALE:	1:750
REF No.	2209
DWG No.	FIGURE 4

Table 5. SWM Facility - MECP Quality and Erosion Requirements Comparison		
SWM Facility Characteristic	**MECP Requirement**	**Provided by SWM Facility**
Permanent Pool Volume (m^3) - *minimum*	5,008	5,049
Extended Detention Volume (m^3) - *minimum*	1,083	1,206
Total Quality + Detention Storage (m^3) - *minimum*	6,091	6,255
Facility Drawdown Time (hours) - *minimum*	24	24
Forebay Length (m) - *minimum*	35.95	36.4
Forebay Width (m) - *minimum*	4.49	20
Average Forebay Velocity (m/s) - *maximum*	0.15	0.03
Cleanout Frequency (years) - *minimum*	10	17.6

As shown in Table 5, the configuration of the proposed stormwater management facility satisfies the quality control requirements outlined by the MECP for the subject lands.

Table 6. Stormwater Management Wet Pond Facility Characteristics				
Design Storm (Return Period)	**Peak Flows (m^3/s)**		**Maximum Elevation (m)**	**Maximum Volume (m^3)**
	Inflow	**Outflow**		
25 mm	1.272	0.213	172.18	2422
5 Year	3.290	0.602	172.56	4,921

As shown in Table 6, the proposed stormwater management facility has adequate storage capacity to detain future 25mm and 5year design storm flows to provide the required quality controls.

6.0 SEDIMENT AND EROSION CONTROL

Sediment and erosion controls are required during all construction phases of this development to limit the transport of sediment into Welland River.

The following additional erosion and sediment controls will also be implemented during construction:

- Install silt control fencing along the limits of construction where overland flows will flow beyond the limits of the development or into downstream watercourse.

- Re-vegetate disturbed areas as soon as possible after grading works have been completed.

- Lot grading and siltation controls plans will be provided with sediment and erosion control measures to the appropriate agencies for approval during the final design stage.

- The stormwater management facility be cleaned after construction prior to assumption by municipality.

7.0 STORMWATER MANAGEMENT FACILITY MAINTENANCE

7.1 Wet Pond Facility

Maintenance is a necessary and important aspect of urban stormwater quality and quantity measures such as constructed wetlands. Many pollutants (i.e. nutrients, metals, bacteria, etc.) bind to sediment and therefore removal of sediment on a scheduled basis is required.

The wet pond for this development is subject to frequent wetting and deposition of sediments as a result of frequent low intensity storm events. The purpose of the wet pond is to improve post development sediment and contaminant loadings by detaining the 'first flush' flow for a 24-hour period. For the initial operation period of the stormwater management facility, the required frequency of maintenance is not definitively known and many of the maintenance tasks will be performed on an 'as required' basis. For example, during the home construction phase of the development there will be a greater potential for increased maintenance frequency, which depends on the effectiveness of sediment and erosion control techniques employed.

Inspections of the wet pond will indicate whether or not maintenance is required. Inspections should be made after every significant storm during the first two years of operation or until all development is completed to ensure the wet pond is functioning properly. This may translate into an average of six inspections per year. Once all building activity is finalized, inspections shall be performed annually. The following points should be addressed during inspections of the facility:

a) Standing water above the inlet storm sewer invert a day or more after a storm may indicate a blockage in the reverse slope pipe or orifice. The blockage may be caused by trash or sediment and a visual inspection would be required to determine the cause.

b) The vegetation around the wet pond should be inspected to ensure its function and aesthetics. Visual inspections will indicate whether replacement of plantings are required. A decline in vegetation habitat may indicate that other aspects of the constructed wet pond are operating improperly, such as the detention times may be inadequate or excessive.

c) The accumulation of sediment and debris at the wet pond inlet sediment forebay or around the high-water line of the wet pond should be inspected. This will indicate the need for sediment removal or debris clean up.

d) The wet pond has been created by excavating a detention area. The integrity of the embankments should be periodically checked to ensure that it remains watertight and the side slopes have not sloughed.

Grass cutting is a maintenance activity that is done solely for aesthetic purposes. It is recommended that grass cutting be eliminated. It should be noted that municipal by-laws may require regular grass maintenance for weed control.

Trash removal is an integral part of maintenance and an annual clean-up, usually in the spring, is a minimum requirement. After this, trash removal is performed as required basis on observation of trash build-up during inspections.

To ensure long term effectiveness, the sediment that accumulates in the forebay area should be removed periodically to ensure that sediment in not deposited throughout the facility. For sediment removal operations, typical grading/excavating equipment should be used to remove sediment from the inlet forebay and detention areas. Care should be taken to ensure that limited damage occurs to existing vegetation and habitat.

Generally, the sediment which is removed from the detention pond will not be contaminated to the point that it would be classified as hazardous waste. However, the sediment should be tested to determine the disposal options.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, the following conclusions are offered:

- Infiltration techniques are not suitable for this site as the primary control facility due to the low soil infiltration rates and the large drainage area for this development.
- Roof water leaders shall discharge to grade.
- The proposed stormwater management wet pond facility will provide the required stormwater quality control to the proposed development.
- Various lot level vegetative stormwater management practices can be implemented to enhance stormwater quality.
- This report was prepared in accordance with the provincial guidelines contained in "Stormwater Management Planning and Design Manual, March 2003".

The above conclusions lead to the following recommendations:

- That the stormwater management criteria established in this report be accepted.
- That a stormwater management wet pond facility be constructed to provide stormwater quality protection to MECP *Enhanced* Protection levels.
- That additional lot level controls and vegetative stormwater management practices as described previously in this report be implemented.
- That sediment and erosion controls be implemented during construction as described in this report.

Yours very truly,
Prepared By:

Anu Jacob, E.I.T.

Reviewed By:

Adam Keane, P.Eng.

LICENSED PROFESSIONAL ENGINEER
A. S. KEANE
100109861
PROVINCE OF ONTARIO

APPENDICES

APPENDIX A

Stormwater Management Facility Calculations

Upper Canada Consultants
3-30 Hannover Drive
St. Catharines, ON, L2W 1A3
PROJECT NAME: **RIVERFRONT-PHASE 2, CITY OF NIAGARA FALLS**
PROJECT NO.: **2209**

PRELIMINARY WET POND CALCULATIONS

Quality Requirements	Quality Orifice	Outlet Weir (2 Single Ditch Inlet)	Two Outflow Pipe Orifices	Overflow Spillway
Drainage Area (ha) = 27.07	Diameter (m) = 0.185	Perimeter Length (m) = 1.20	Diameter (m) = 0.450 (each)	Length (m) = 1.50
Enhanced (m^3/ha) = 225	Cd = 0.62	Inlet Elevation (m) = 172.00	Cd = 0.63	Slopes (X:1) = 3.00
Perm Pool (m^3/ha) = 185	Invert (m) = 171.80		Invert (m) = 171.80	Invert (m) = 173.10
Perm Pool Vol (m^3) = 5,008			Obvert (m) = 172.25	
Required Vol (m^3) = 6,091				
Min Ext Deten Vol (m^3) = 1,083		MOE Equation 4.11 Drawdown Coefficient 'C2' = 1,526		
Water Level Elev. = 171.80 m		MOE Equation 4.11 Drawdown Coefficient 'C3' = 5,877		
		MOE Equation 4.11 Drawdown Time (h) = **24**		

Elevation	Increment Depth (m)	Active Depth (m)	Surface Area (m^2)	Average Surface Area (m^2)	Increment Volume (m^3)	Permanent Volume (m^3)	Active Volume (m^3)	Quality Orifice (m^3/s)	Ditch Inlet (m^3/s)	Max Pipe Orifice (m^3/s)	Overflow Spillway (m^3/s)	Total Outflow (m^3/s)	Average Discharge (m^3/s)
170.30		1.50	**2,480**			0							
5:1	0.50			2,761	1,381								
170.80		1.00	3,043			1,381							
5:1	0.50			3,349	1,674								
171.30		0.50	3,655			3,055							
5:1	0.50			3,988	1,994								
171.80		0.00	**4,321**			5,049	100.82% Of Required Size						
	0.00												
171.80	Water	0.00	**5,877**				0	0.000	0.000	0.000	0.000	0.000	
5:1	0.20			6,030	1,206								0.010
172.00	Ditch Inlet	0.20	6,182				**1,206**	0.020	0.000	0.041	0.000	0.020	
5:1	0.55			6,607	3,634								0.308
172.55		0.75	7,031				4,840	0.058	0.835	0.596	0.000	0.596	
5:1	0.55			7,488	4,118								0.742
173.10	Spillway	1.30	7,944				8,958	0.080	2.361	0.888	0.000	0.888	
5:1	0.20			8,116	1,623								1.078
173.30		1.50	**8,288**				10,581	0.087	3.033	0.973	0.296	1.269	

Notes

1. Quality Orifice flow is the orifice controlling for the 24 hour detention period and uses an orifice formula.
2. Pipe Orifice flow is calcuated using an orifice formula on the pipe from the ditch inlet to the outlet and uses the total head on the orifice.
3. Overflow Weir flow is calculated using a trapezondial weir to convey outflow for less frequent storms through the embankment with an emergency spillway.
4. Total Outflow is calculated by adding the Overflow Spillway with the lowest of Quality Orifice plus Ditch Inlet or Max Pipe Orifice.

Ultimate Stormwater Management Facility Forebay Sizing

a) Forebay Settling Length (MOE SWMP&D, Equation 4.5)

$$Settling\ Length = \sqrt{\left(\frac{r \times Q}{V_s}\right)}$$

$r =$	1.8	:1	(Length:Width Ratio)
$Q_p =$	0.213	m^3/s	(25mm Storm Pond Discharge)
$V_s =$	0.0003	m/s	(Settling Velocity)

Settling Length = **35.95** **m**

b) Dispersion Length (MOE SWMP&D, Equation 4.6)

$$Dispersion\ Length = \frac{8 \times Q}{D \times V_f}$$

$Q =$	3.29	m^3/s	(5 Yr Stm Sew Design Inflow)
$D =$	1.60	m	(Depth of Perm. Pool in the Forebay)
$V_f =$	0.5	m/s	(Desired Velocity)

Dispersion Length = **32.90** **m**

c) Minimum Forebay Deep Zone Bottom Width (MOE SWMP&D), Equation 4.7)

$$Width = \frac{Min.\ Forebay\ Length}{8}$$

35.95	m	(minimum required length)

Width = **4.49** **m** (minimum required width)

d) Average Velocity of Flow

$$Average\ Velocity = \frac{Q}{A}$$

$Q =$	1.272	m^3/s	(25mm Storm Design Inflow)
$A =$	39.68	m^2	(Cross Sectional Area)
$D =$	1.60	m	(Depth of Forebay)
$W =$	20.00	m	(Proposed Bottom Width)
$SS =$	3	:1	(Side Slopes - Minimum)

Average Velocity = **0.03** **m/s**

Is this Acceptable? **Yes** (Maximum velocity of flow = 0.15 m/s)

e) Cleanout Frequency

Is this Acceptable? **Yes**

$L =$	36.4	m	(Proposed Bottom Length)
$ASL =$	2.8	m^3/ha	(Annual Sediment Loading)
$A =$	27.07	ha	(Drainage Area)
$FRC =$	80	%	(Facility Removal Efficiency)
$FV =$	1671.7	m^3	(Forebay Volume)

Cleanout Frequency = **17.6** **Years**

Is this Acceptable? **Yes** (10 Year Minimum Cleanout Frequency)

APPENDIX B

MIDUSS Model Output Files

```
       Output File (4.7) SWM.OUT      opened 2024-03-14  13:33
       Units used are defined by G =    9.810
           24   144    10.000        are MAXDT MAXHYD & DTMIN values
       Licensee: UPPER CANADA CONSULTANTS
35     COMMENT
      1     line(s) of comment
       RIVERFRONT- PHASE 2, CITY OF NIAGARA FALLS
35     COMMENT
      3     line(s) of comment
       *********************
       25mm STORM EVENT
       *********************
 2     STORM
           1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
     512.000     Coefficient  a
       6.000     Constant  b    (min)
        .800     Exponent  c
        .350     Fraction to peak  r PL

     240.000     Duration ó  240 min
              25.037 mm     Total depth
 3     IMPERVIOUS
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .015     Manning "n"
      98.000     SCS Curve No or C
        .100     Ia/S Coefficient
        .518     Initial Abstraction
35     COMMENT
      3     line(s) of comment
       ***********************
       * PHASE 2 POND DESIGN *
       ***********************
 4     CATCHMENT
      13.000     ID No.ó 99999
      12.460     Area in hectares
     288.212     Length (PERV) metres
        .600     Gradient (%)
        .000     Per cent Impervious
     288.212     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .350     Manning "n"
      80.000     SCS Curve No or C
        .100     Ia/S Coefficient
       8.467     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .016       .000       .000       .000 c.m/s
              .137       .000       .137     C perv/imperv/total
15     ADD RUNOFF
              .016       .016       .000       .000 c.m/s
27     HYDROGRAPH DISPLAY
      4     is # of Hyeto/Hydrograph chosen
       Volume  =  .4272541E+03 c.m
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
              .016       .016       .016       .000 c.m/s
17     COMBINE
      5     Junction Node No.
              .016       .016       .016       .016 c.m/s
14     START
      1     1=Zero; 2=Define
 4     CATCHMENT
      12.000     ID No.ó 99999
       2.780     Area in hectares
     136.137     Length (PERV) metres
       7.000     Gradient (%)
        .000     Per cent Impervious
     136.137     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .350     Manning "n"
      80.000     SCS Curve No or C
        .100     Ia/S Coefficient
       8.467     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .009       .000       .016       .016 c.m/s
              .137       .000       .137     C perv/imperv/total
15     ADD RUNOFF
              .009       .009       .016       .016 c.m/s
27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .9527954E+02 c.m
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
              .009       .009       .009       .016 c.m/s
17     COMBINE
      5     Junction Node No.
              .009       .009       .009       .020 c.m/s
18     CONFLUENCE
      5     Junction Node No.
              .009       .020       .009       .000 c.m/s
 4     CATCHMENT
       5.000     ID No.ó 99999
      27.070     Area in hectares
     427.810     Length (PERV) metres
       1.000     Gradient (%)
      70.000     Per cent Impervious
     427.810     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .350     Manning "n"
      75.000     SCS Curve No or C
        .100     Ia/S Coefficient
       8.467     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             1.271       .020       .009       .000 c.m/s
              .108       .807       .597     C perv/imperv/total
15     ADD RUNOFF
             1.271      1.272       .009       .000 c.m/s
```

```
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
          1.271      1.272      1.272       .000 c.m/s
17     COMBINE
      7     Junction Node No.
          1.271      1.272      1.272      1.272 c.m/s
18     CONFLUENCE
      7     Junction Node No.
          1.271      1.272      1.272       .000 c.m/s
10     POND
      5 Depth - Discharge - Volume sets
       171.800        .000          .0
       172.000       .0200      1206.0
       172.550        .596      4840.0
       173.100        .888      8958.0
       173.300       1.269     10581.0
       Peak Outflow    =      .213 c.m/s
       Maximum Depth   =   172.184 metres
       Maximum Storage =     2422. c.m
          1.271      1.272       .213       .000 c.m/s
27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .4565400E+04 c.m
14     START
      1     1=Zero; 2=Define
35     COMMENT
      3     line(s) of comment
       *********************
       5YEAR - STORM EVENT
       *********************
 2     STORM
           1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
     830.000     Coefficient  a
       7.300     Constant  b    (min)
        .777     Exponent  c
        .450     Fraction to peak  r
     240.000     Duration ó  240 min
              45.874 mm     Total depth
 3     IMPERVIOUS
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .015     Manning "n"
      98.000     SCS Curve No or C
        .100     Ia/S Coefficient
        .518     Initial Abstraction
35     COMMENT
      3     line(s) of comment
       ***********************
       * PHASE 2 POND DESIGN *
       ***********************
 4     CATCHMENT
      13.000     ID No.ó 99999
      12.460     Area in hectares
     288.212     Length (PERV) metres
        .600     Gradient (%)
        .000     Per cent Impervious
     288.212     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .350     Manning "n"
      80.000     SCS Curve No or C
        .100     Ia/S Coefficient
       8.467     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
           .118       .000       .213       .000 c.m/s
           .302       .000       .302     C perv/imperv/total
15     ADD RUNOFF
           .118       .118       .213       .000 c.m/s
27     HYDROGRAPH DISPLAY
      4     is # of Hyeto/Hydrograph chosen
       Volume  =  .1727200E+04 c.m
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
           .118       .118       .118       .000 c.m/s
17     COMBINE
      5     Junction Node No.
           .118       .118       .118       .118 c.m/s
14     START
      1     1=Zero; 2=Define
 4     CATCHMENT
      12.000     ID No.ó 99999
       2.780     Area in hectares
     136.137     Length (PERV) metres
       7.000     Gradient (%)
        .000     Per cent Impervious
     136.137     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .350     Manning "n"
      80.000     SCS Curve No or C
        .100     Ia/S Coefficient
       8.467     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
           .066       .000       .118       .118 c.m/s
           .302       .000       .302     C perv/imperv/total
15     ADD RUNOFF
           .066       .066       .118       .118 c.m/s
27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .3853571E+03 c.m
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
           .066       .066       .066       .118 c.m/s
17     COMBINE
      5     Junction Node No.
```

```
               .066       .066       .066       .146 c.m/s
18     CONFLUENCE
      5     Junction Node No.
               .066       .146       .066       .000 c.m/s
 4     CATCHMENT
       5.000     ID No.ó 99999
      27.070     Area in hectares
     427.810     Length (PERV) metres
       1.000     Gradient (%)
      70.000     Per cent Impervious
     427.810     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .350     Manning "n"
      75.000     SCS Curve No or C
        .100     Ia/S Coefficient
       8.467     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             3.246       .146       .066       .000 c.m/s
              .250       .880       .691     C perv/imperv/total
15     ADD RUNOFF
             3.246      3.290       .066       .000 c.m/s
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
             3.246      3.290      3.290       .000 c.m/s
17     COMBINE
      7     Junction Node No.
             3.246      3.290      3.290      3.290 c.m/s
18     CONFLUENCE
      7     Junction Node No.
             3.246      3.290      3.290       .000 c.m/s
10     POND
      5 Depth - Discharge - Volume sets
       171.800        .000          .0
       172.000       .0200      1206.0
       172.550        .596      4840.0
       173.100        .888      8958.0
       173.300       1.269     10581.0
       Peak Outflow    =      .602 c.m/s
       Maximum Depth   =   172.561 metres
       Maximum Storage =     4921. c.m
             3.246      3.290       .602       .000 c.m/s
27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .1069500E+05 c.m
14     START
      1     1=Zero; 2=Define
35     COMMENT
      3     line(s) of comment
       *********************
       100 YEAR - STORM EVENT
       *********************
 2     STORM
           1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
    1264.600     Coefficient  a
       7.720     Constant  b    (min)
        .781     Exponent  c
        .450     Fraction to peak  r
     240.000     Duration ó  240 min
              68.280 mm     Total depth
 3     IMPERVIOUS
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .015     Manning "n"
      98.000     SCS Curve No or C
        .100     Ia/S Coefficient
        .518     Initial Abstraction
35     COMMENT
      3     line(s) of comment
       ***********************
       * PHASE 2 POND DESIGN *
       ***********************
 4     CATCHMENT
      13.000     ID No.ó 99999
      12.460     Area in hectares
     288.212     Length (PERV) metres
        .600     Gradient (%)
        .000     Per cent Impervious
     288.212     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .350     Manning "n"
      80.000     SCS Curve No or C
        .100     Ia/S Coefficient
       8.467     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .332       .000       .602       .000 c.m/s
              .425       .000       .425     C perv/imperv/total
15     ADD RUNOFF
              .332       .332       .602       .000 c.m/s
27     HYDROGRAPH DISPLAY
      4     is # of Hyeto/Hydrograph chosen
       Volume  =  .3613708E+04 c.m
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
              .332       .332       .332       .000 c.m/s
17     COMBINE
      5     Junction Node No.
              .332       .332       .332       .332 c.m/s
14     START
      1     1=Zero; 2=Define
 4     CATCHMENT
      12.000     ID No.ó 99999
       2.780     Area in hectares
     136.137     Length (PERV) metres
       7.000     Gradient (%)
        .000     Per cent Impervious
     136.137     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
```

```
       .350     Manning "n"
     80.000     SCS Curve No or C
       .100     Ia/S Coefficient
      8.467     Initial Abstraction
          1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             .185       .000       .332       .332 c.m/s
             .425       .000       .425     C perv/imperv/total
15     ADD RUNOFF
             .185       .185       .332       .332 c.m/s
27     HYDROGRAPH DISPLAY
     5     is # of Hyeto/Hydrograph chosen
      Volume  =  .8057946E+03 c.m
 9     ROUTE
       .000     Conduit Length
       .000     No Conduit defined
       .000     Zero lag
       .000     Beta weighting factor
       .000     Routing timestep
          0     No. of sub-reaches
             .185       .185       .185       .332 c.m/s
17     COMBINE
     5     Junction Node No.
             .185       .185       .185       .409 c.m/s
18     CONFLUENCE
     5     Junction Node No.
             .185       .409       .185       .000 c.m/s
 4     CATCHMENT
      5.000     ID No.ó 99999
     27.070     Area in hectares
    427.810     Length (PERV) metres
      1.000     Gradient (%)
     70.000     Per cent Impervious
    427.810     Length (IMPERV)
       .000     %Imp. with Zero Dpth
          1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .350     Manning "n"
     75.000     SCS Curve No or C
       .100     Ia/S Coefficient
      8.467     Initial Abstraction
          1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
            5.081       .409       .185       .000 c.m/s
             .363       .915       .749     C perv/imperv/total
15     ADD RUNOFF
            5.081      5.254       .185       .000 c.m/s
 9     ROUTE
       .000     Conduit Length
       .000     No Conduit defined
       .000     Zero lag
       .000     Beta weighting factor
       .000     Routing timestep
          0     No. of sub-reaches
            5.081      5.254      5.254       .000 c.m/s
17     COMBINE
     7     Junction Node No.
            5.081      5.254      5.254      5.254 c.m/s
18     CONFLUENCE
     7     Junction Node No.
            5.081      5.254      5.254       .000 c.m/s
12     DIVERT
        100     U/S Node No.ó 99999
      3.290     Threshold Discharge
      3.781     Max. Outflow reqd.
           Qmax & Vol.Diverted =     1.473 c.m/s       984.6 c.m
           No flow diverted
            5.081      5.254      3.781       .000 c.m/s
16     NEXT LINK
            5.081      3.781      3.781       .000 c.m/s
10     POND
     5 Depth - Discharge - Volume sets
      171.800        .000          .0
      172.000       .0200      1206.0
      172.550        .596      4840.0
      173.100        .888      8958.0
      173.300       1.269     10581.0
      Peak Outflow    =      .825 c.m/s
      Maximum Depth   =   172.981 metres
      Maximum Storage =     8069. c.m
            5.081      3.781       .825       .000 c.m/s
27     HYDROGRAPH DISPLAY
     5     is # of Hyeto/Hydrograph chosen
      Volume  =  .1727879E+05 c.m
14     START
     1     1=Zero; 2=Define
```