Oil Mill Creek Drain Watershed Hydrology and Hydraulics Report

City of Port Colborne

April 5, 2023

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EARTH WATER AIR ENGINEERING

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1 Introduction

The City of Port Colborne retained Paul Marsh, P.Eng of EWA Engineers Inc. to prepare a Drainage Report under the Drainage Act R.S.O. 1990 for the Oil Mill Creek Drain. The Drain Engineer's Report is prepared as follows:

- Oil Mill Creek Drain Baseline Report; provides an assessment of current drainage problems and identifies the extent of the drainage area to be serviced by the municipal drain.

- Oil Mill Creek Watershed Report; provides a capacity assessment of existing capacity through the use of hydrologic and hydraulic modelling and assessing existing conditions and design for future conditions. The modelling will be used to identify the options for resolving problems and recommends the preferred options to improve drainage.

The final Engineer's Report is composed of the two previous reports along with supporting documentation and final drainage cost estimates and assessment schedules.

This report is the Oil Mill Creek Watershed Report and provides a summary assessment of the existing drainage capacity for the Municipal Drain.

The Baseline Drainage Report for the drain presents the current, as of 2021, baseline or reference conditions. In some cases, a drainage issue may be identified in the Baseline Report but deferred from implementation in the Drain Engineer's report. The Baseline Report identifies the total needs of the drain works but does not provide specific recommendations on implementation.

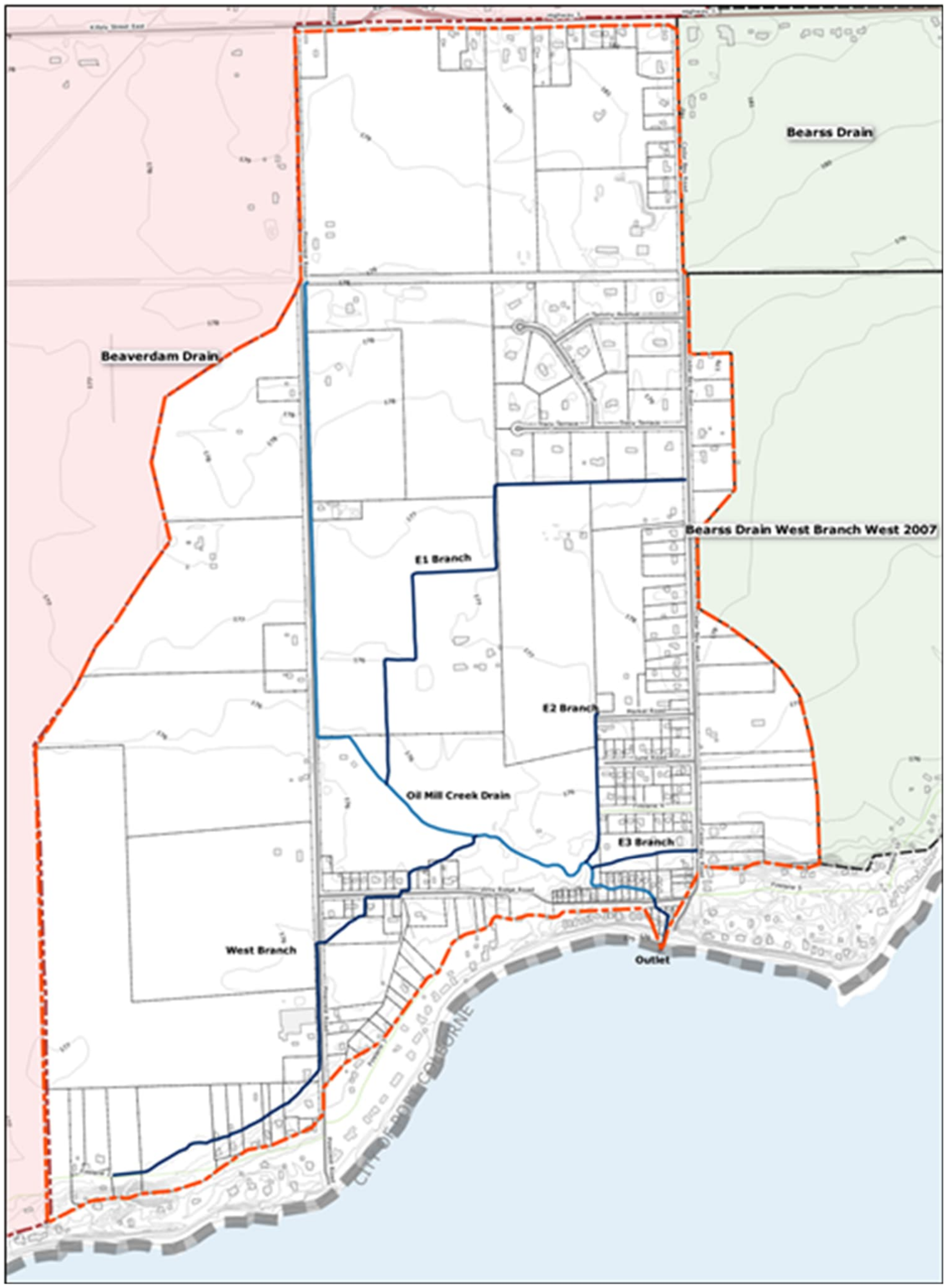


Figure 1 Oil Mill Creek Drain - Boundary

1.1 Oil Mill Creek Drain Watershed

The Oil Mill Creek Drain Watershed is composed of seven distinct channels or drainage flow paths:

- **Outlet** with Control & Pumping
  124m –@ Vimy Ridge Rd. to the Lake, formerly a partially open channel now as of 2000, a completely enclosed path to the lake.
- **Main Drain to Pinecrest Rd**; 800m to STA 0+900 lower reach with over dug sections and compromised grade to the outlet.

- **Upper Main Catchment**; to drain's end at Killaly St / Highway 3. 1000m to STA 1+936 to culvert crossing @ Killaly St
- **West Branch**; connects to drain at 0+475 The existing 1100m serves the area west of Pinecrest Rd
- **E1 Branch**; connects to drain at 0+475 existing 1278m channel to Cedar Bay Rd.
- **E2 Branch**; connects to drain at 0+198 existing 329m channel to the West end of Merkel Rd.
- **E3 Branch**; connects to drain at 0+180 existing 239m channel to Cedar Bay Rd.

The Oil Mill Creek Drain serves an area of 265.2 hectares based on the defined drain boundary, refer to Figure 1.

- Watershed average fall (slope) is given 0.26% or 2.6m per 1000m

- Drain average fall (slope) is given as 0.14% or 1.4m per 1000m

This slope characterizes the Oil Mill Creek as a low slope or slow watershed. In particular, the lower portion of the drain is highly influenced by the Lake water elevation with a littoral sand beach-influenced outlet.

The Oil Mill Creek Drain was last maintained spring of 2019. A pipe conveyance outlet was constructed by a report prepared by K. Smart Associates in 1999 with associated works.

The drain can be segregated into distinct geographic areas.

- **Outlet environment**; this area starts north side of Vimy Ridge Rd, 0+050 chainage marker and proceeds to the outlet. Predominately sand soil.

- **From 0+050 to 0+900**; this area is East of Pinecrest Rd and crosses Centennial Park to the outlet. Significant in that roughly half is identified as a wetland.

- **North of Friendship Trail area** south of Gasline to the start of the main branch drain. Serviced by road swales and swales along Friendship Trail.

- **West Branch** is Lake influenced with the channel progressing North and East to outlet into the main branch. Includes farm areas west of Pinecrest Rd.

- **E1 Branch** serves lands to the east of Pinecrest Rd. and north of the main channel. Specifically, the Bell Acres subdivision uses E1 Branch as a sufficient outlet.

- **E2 and E3 Branches** serve the area east of the main branch and north of Vimy Ridge Rd;

2 Study Approach

The analysis of the Oil Mill Creek Watershed is based on Hydrologic and Hydraulic Scientific analysis. Water monitoring, and gauge measurements, have not been practiced in the past and thus calibration or validation of the computer-based model results is limited to historical anecdotal comparisons.

2.1 Methodology

Two engineering analysis methods are key to the analysis of municipal drainage.

1. The prediction of runoff flow based on a hydrologic analysis.
2. The calculation of ditch and culvert capacity (ability to contain water flow) using hydraulic formulae.

2.1.1 Hydrologic Techniques

Figure 2 and Figure 3 illustrate the modelling and design process for sizing a ditch, channel or stream. The computer model predicts a peak flow (hydrograph) based on a mathematical model of runoff from a specific land use. The ditch is sized to convey the peak flow based on design parameters but is significantly influenced by the available grade, slope m/m, for the ditch, channel or stream.

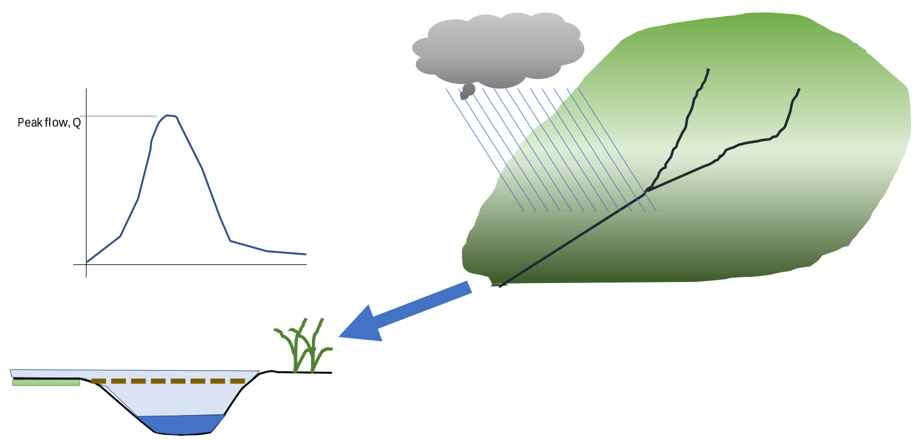


Figure 2 Watershed Predicted Runoff Peak Flow

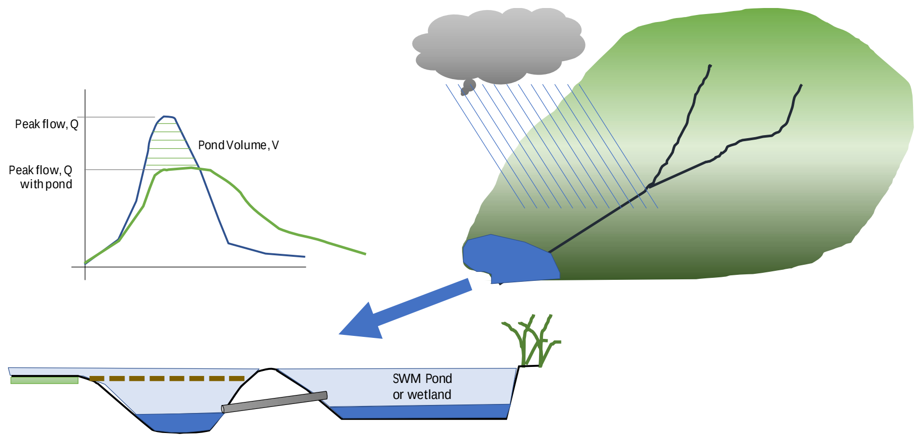


Figure 3 Watershed SWM Pond Runoff Peak Flow

The software selected for modelling is the US Environmental Protection Agency (EPA) Storm Water Management Model (SWMM) Version 5.1

www.epa.gov/swmm

The following is provided as a description of the software and its function.

> The EPA Storm Water Management Model (SWMM) is a dynamic rainfall-runoff-routing simulation model used for a single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. The runoff component of SWMM operates on a collection of sub-catchment areas that receive precipitation and generate runoff and pollutant loads. The routing portion of SWMM transports this runoff through a system of pipes, channels, storage/treatment devices, pumps, and regulators. SWMM tracks the quantity and quality of runoff generated within each sub-catchment, and the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period comprised of multiple time steps.

This software was selected as being freely available, accessible and for the variety of techniques that are implemented and available. Specifically, the two techniques of interest are:

- Historically, runoff methods used for watershed modelling often implement the SCS Curve Number Method. The SCS curve number (CN) method is a simple, widely used and efficient method for determining the approximant amount of runoff from a rainfall event in a particular area.

- EPA SWMM is also used for Low Impact Development (LID) assessments. This is relevant to the analysis of runoff function rather than the characterization available with the CN method.

2.1.2 Hydraulic Techniques

The EPA SWMM computer-based hydrology modelling implements dynamic routing in addition to the runoff methods, there is a characterization of the existing drainage system using simple hydraulic analysis. This is limited in assessing specific aspects of the existing system but provides a segment-by-segment and element-by-element comparison of the previous design and current function.

The predominant analytical technique used is Manning's Equation (developed by Gauckler in 1867 and Manning in 1890) for fluid flow in open channels.

$$V = \frac{k}{n} {R_h}^{2/3} \, S^{1/2}$$

From this equation, a prediction can be made of the existing capacity of the ditch or the maximum fluid flow for a culvert that is flowing fully.

For a culvert operating in inlet control, where the headwater is higher than the tailwater, a different formula is used and based on MTO requirements can predict the maximum design capacity for the culvert or bridge crossing.

These hydraulic analysis techniques provide a means to compare current capacities from the upstream limit of the drainage system to the downstream outlet for the existing conditions.

The use of the hydrologic model allows a more detailed examination of the range of drainage performance conditions including the analysis of storage within the system.

This second analytical technique is used to assess the existing and potential use of additional storage elements within the drainage area such as ponds, wetlands and other runoff detection features.

2.2 Design Storm

Three primary scenarios are proposed for investigation using EPA SWMM computer-based analysis of the Oil Mill Creek Watershed. They are as follows:

1. A 24-hour duration precipitation event with a range of frequency of occurrence from the likely (1:2 year) to the less probable events (1:50 year or 1:100 year). This event is characterized or described as a major precipitation event associated with a significant weather event.

2. A short duration highly intense summertime convective storm with a duration of 1 hour and a low frequency or probability of occurrence ranging to a higher probability of occurrence.

3. A wintertime precipitation event. This is related to the event described in #1 but specifically occurs during the winter when the ground is frozen and limited infiltration occurs. There may also be melting contributing to

the runoff but in this specific case, we are only considering the impact of rain on frozen ground as a worse-case consideration for drainage performance.

These three types of scenarios will be investigated using EPA SWMM for the full range of IDF predicted storms; 1:2, 1:5, 1:10, 1:25, 1:50 and 1:100. There is a recognized risk of a Hurricane Hazel type of storm (referred to often as the Regional flood event) occurring that is not considered in this analysis other than the similarity that occurs within the rain on frozen ground case.

The storm probability analysis for Port Colborne is provided by a recording gauge and is reported on the website:

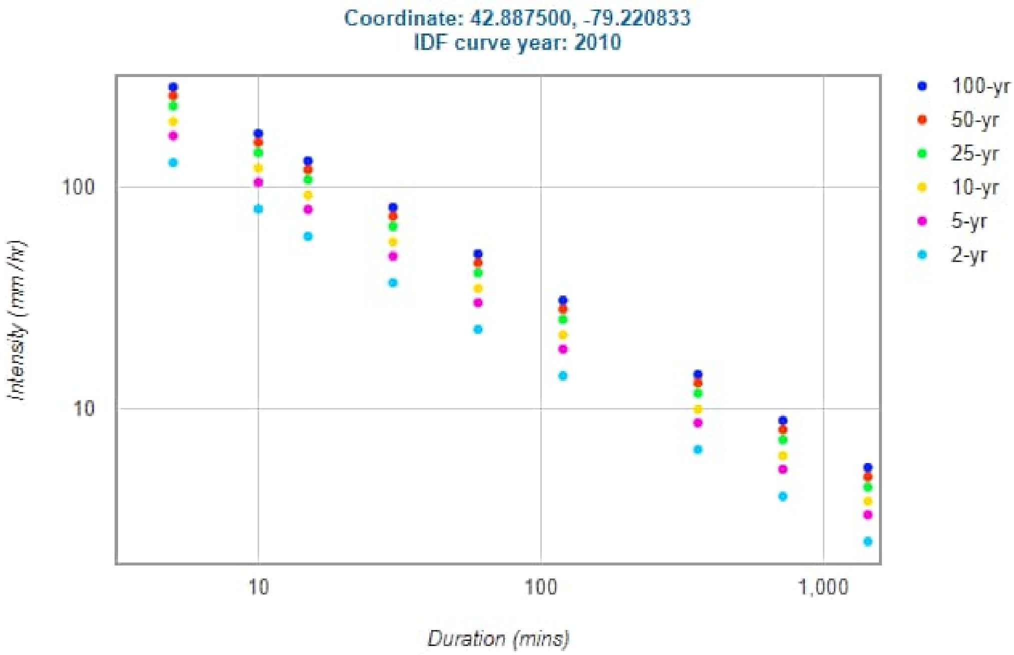


Figure 4 Port Colborne IDF Curve Chart
From: http://www.eng.uwaterloo.ca/~dprincz/mto_site/results_out.shtml?coords=42.890648,-79.223098

The tables of intensity and volume values are provided in Appendix A.

From these tables two design storms are prepared for use within the Hydrologic analysis;

- As described in the Canada Flood Guide a SCS type of storm is used for the longer duration event, 24-hour storms.
- The short duration intense storm is represented with the Chicago storm distribution to characterize the intense type of sudden storm.

The design storms are implemented and provided in Appendix A for reference.

The precipitation events used in the design storms for each probability occurrence are as follows in the Design Storm Table.

Table 1 Hydrologic Model Design Storm Events

Design Storm	Probability return period	Volume, mm
SCS Type – 24 hour	1:2	49.8
	1:5	68.9
	1:10	81.5
	1:25	97.5
	1:50	109.3
	1:100	121.1
Chicago – 1 hour	1:5	48.2

2.2.1 Historical Precipitation Events

There are storms indicated in the precipitation record; 1979 and 1991 that are more than the 100-year storm and would provide historical context for field verification of model results. This is not a gauged watershed verification but using historical anecdotal observations to confirm runoff values is a reasonable basis for validating model results.

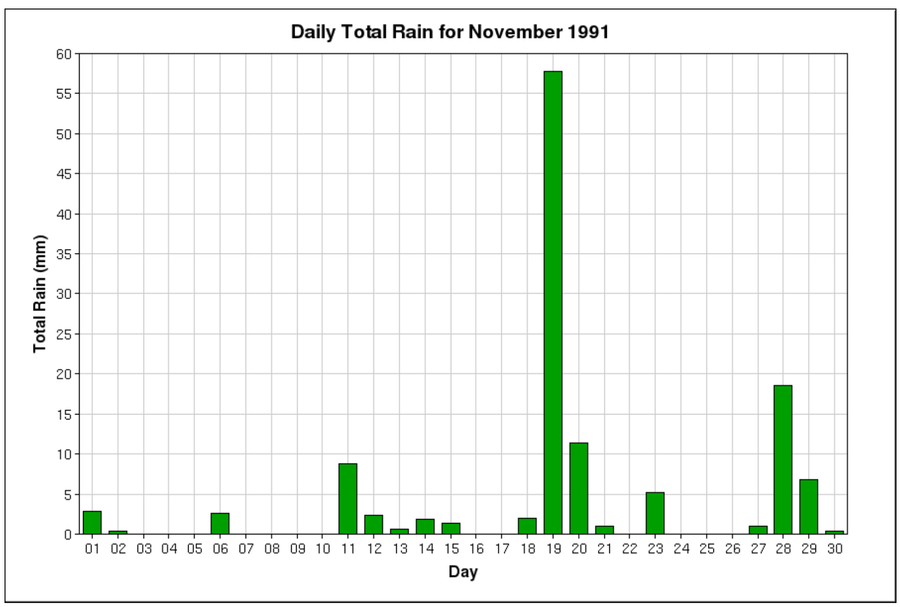


Figure 5 Precipitation data for Nov 1991

The year 1991 had a value greater than the 100-year storm. Data 64.2mm
100 year = 63.1 - 2 hour storm comparable event

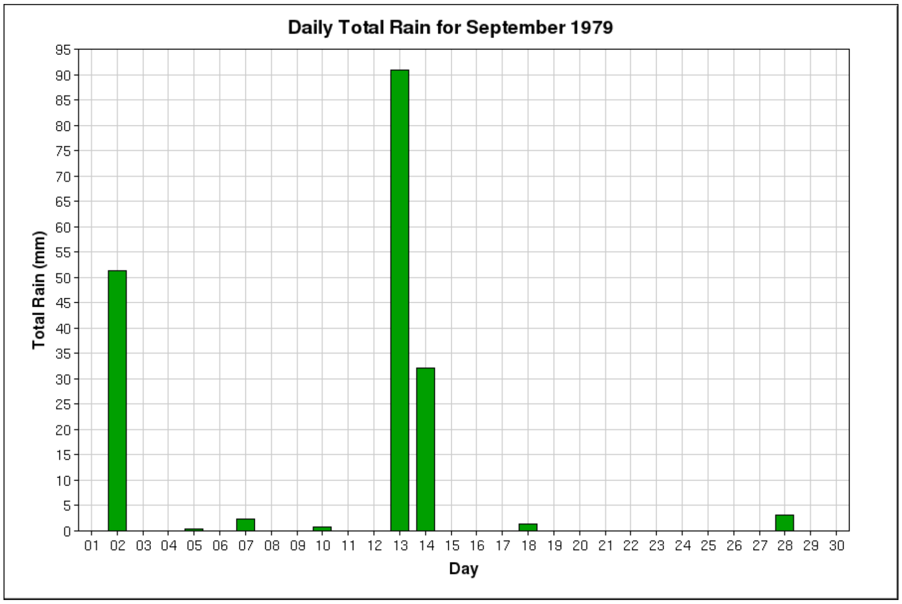


Figure 6 Precipitation data for Sept. 1979

The year 1979 had a value greater than the 100-year storm. Data 116.4mm
100 year = 105.9 - 12 hour storm comparable value.

2.2.2 August 2018 Storms

Environment Canada maintains a Metrological station in Port Colborne, which is located at or near the lighthouse along the waterfront. The 7 is the daily rainfall for that location.

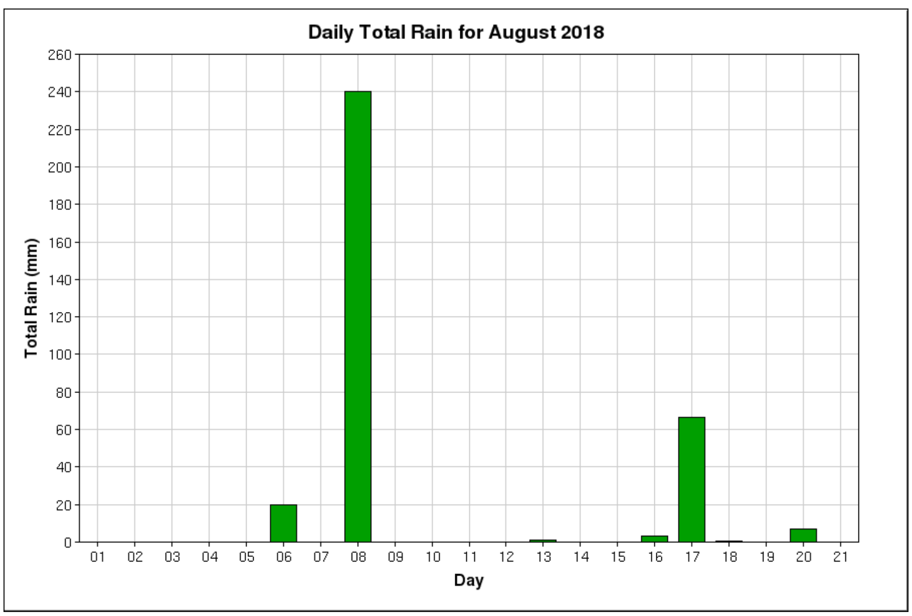


Figure 7 Env Canada Port Colborne Rain August 2018

The Regional Municipality of Niagara maintains a precipitation station on the Seaway WWTP grounds and provided data on precipitation measured at the station in 5-minute intervals for the period of August 2018. Figure 8 shows the rainstorm events for both the August 7th morning event and the August 8 morning event.

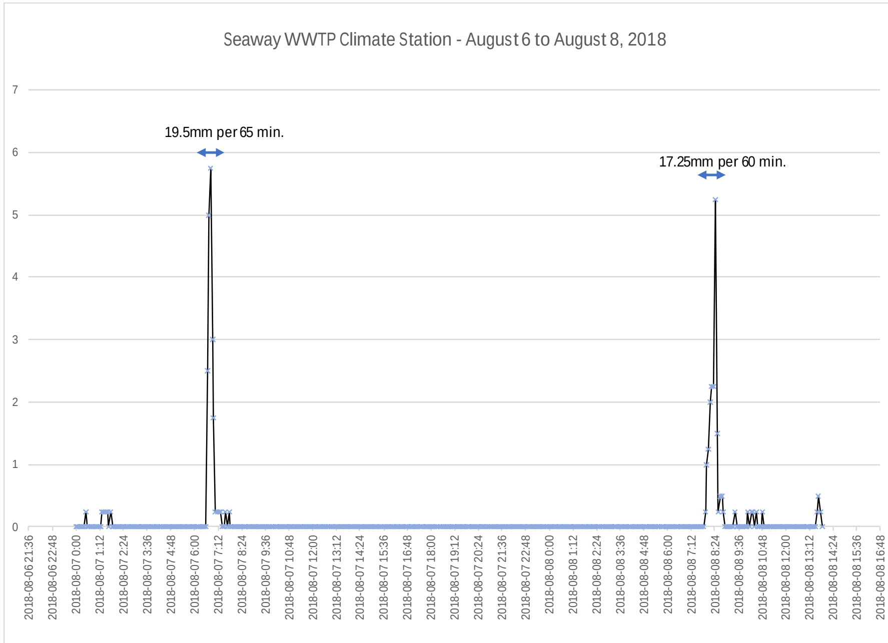


Figure 8 August 2018 Precipitation Events

Both events are characteristic of summer convective storms with short-duration intense events that are not widespread but very localized. There were significant reports of flooding in localized portions of Port Colborne but no documented reports of flooding within the drains. The distance between the two gauges is 2km. The one-day reported total of 240mm exceeds by a significant margin the IDF intensity for a 1:100 year event while the Seaway WWTP station reported storm is below a 1:2 year event.

From this historical event, we can conclude that sudden intense rainfall events are happening but are not widely distributed. The impacts are very localized.

2.2.3 July 17 2021 Storm

A storm occurred on July 17th, 2021 that had widespread impacts across Port Colborne including the Oil Mill Creek Watershed.

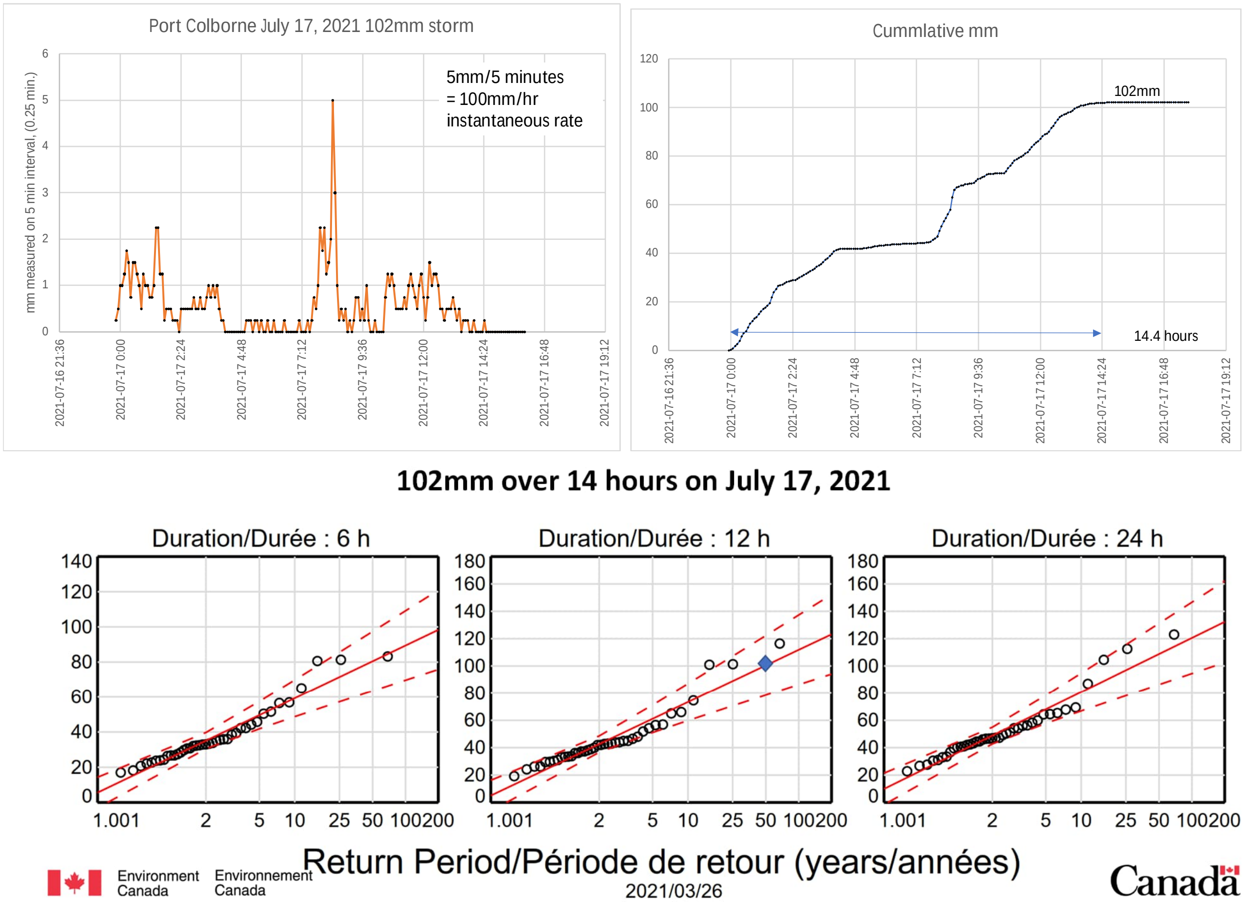


Figure 9 July 17 Storm Records

The size of the storm over 12 hours, actually closer to 14 hours, suggests that the storm was a 1:50-year return period storm. Reports indicate that flooding did occur in several areas of Port Colborne. No high-level marks were recorded on the Oil Mill Creek but a discussion with local property owners along Vimy Ridge Rd. indicated extensive flooding through the roadway and yards. Additional flooding was reported along the upper portion of the West Branch, west of Pinecrest Rd.

2.3 Historical Seiche Storms

This area is influenced by both upstream runoff that exceeds the available channel capacity, but also backwater effects from Lake Erie that inundate the nearshore area.

Seiche - A seiche (/ˈseɪʃ/ SAYSH) is a standing wave in an enclosed or partially enclosed body of water.

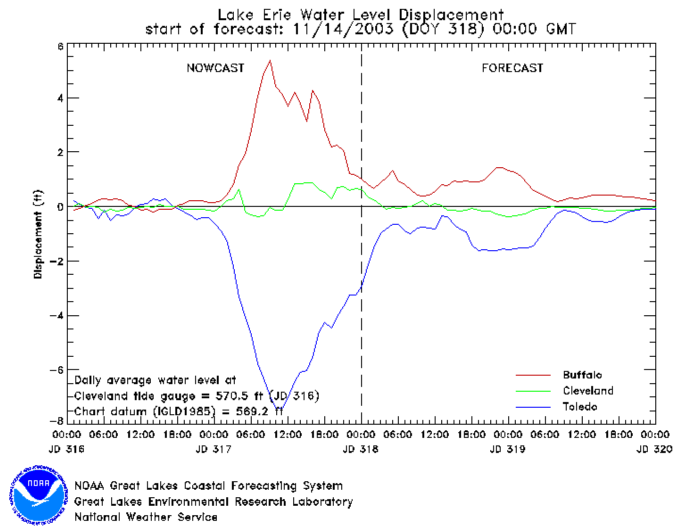


Figure 10 NOAA Seiche Chart

Differences in water level caused by a seiche on Lake Erie recorded between Buffalo, New York (red) and Toledo, Ohio (blue) on November 14, 2003:
Source: https://en.wikipedia.org/wiki/Seiche

Surge

A storm surge, storm flood, tidal surge or storm tide is a coastal flood or tsunami-like phenomenon of rising water commonly associated with low-pressure weather systems, such as tropical cyclones. It is measured as the rise in water level above the normal tidal level and does not include waves.

For our purposes in this report, we will use the terms seiche and surge together and reference the same phenomena, which is a rise in the Lake water surface level that causes water to back up from the lake into the local streams and drainage systems.

2.3.1 October 31, 2019 Storm

This sudden storm caused widespread flooding along the Lake Erie North Shore and was both an intense precipitation event and a high wind lake surge or seiche event. In addition to very high winds driving up lake levels, there was a recorded 29.4mm of precipitation, which is not a significant amount (5 days prior there was 36.6mm without flooding). Using Environment Canada reporting for Port Colborne station.

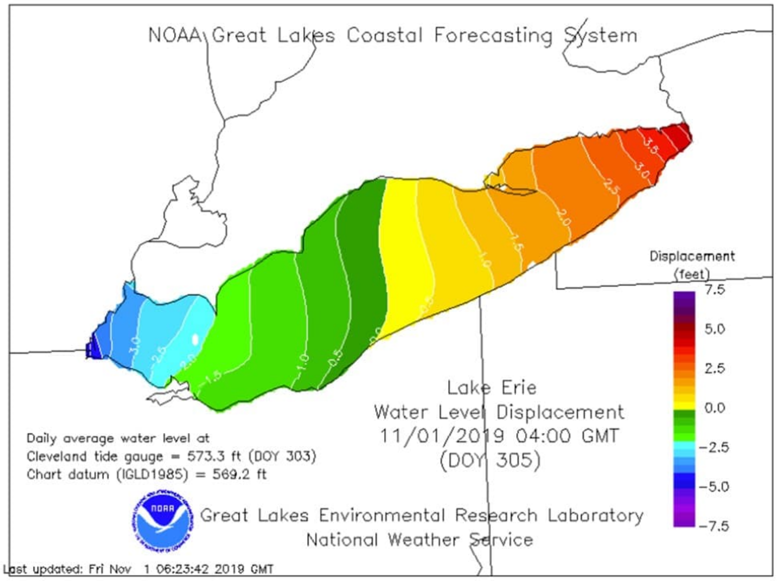


Figure 11 NOAA Lake Erie Seiche Conditions

The level that the water had risen was subsequently surveyed and reported to be 176.45m using UTM NAD 83 datum.

2.3.2 November 15, 2020 Storm

This storm surge caused a similar flood as the previous year's storm. Post-storm, the Town of Fort Erie surveyed the debris highwater mark left on the fence for #137 Shirley Rd.

Precipitation report from Environment Canada for the Port Colborne station showed that the total day recorded rainfall was 6.6mm of precipitation. This was confirmed by precipitation reports for two stations in Fort Erie operated by RMON.

- 500 Ridgeway Road, Crystal Beach precipitation station: 6.75mm
- 660 Industrial Drive, Industrial Park precipitation station: 7.75mm

(Data provided by email from Mr. Glenn Fulton dated January 8th, 2021.)

This confirms that the event was from Lake effect flooding and not from precipitation-induced stormwater runoff. This storm flood elevation was recorded as 176.46m, nearly the same as the previous year.

This sudden storm caused widespread flooding along the Lake Erie North Shore and was predominately a high wind lake surge or seiche event. The following chart shows the average hourly results for lake levels as recorded at Port Colborne, (note that these values are recorded as height above the International Great Lakes Datum (IGLD which is not the same datum as used by the survey).

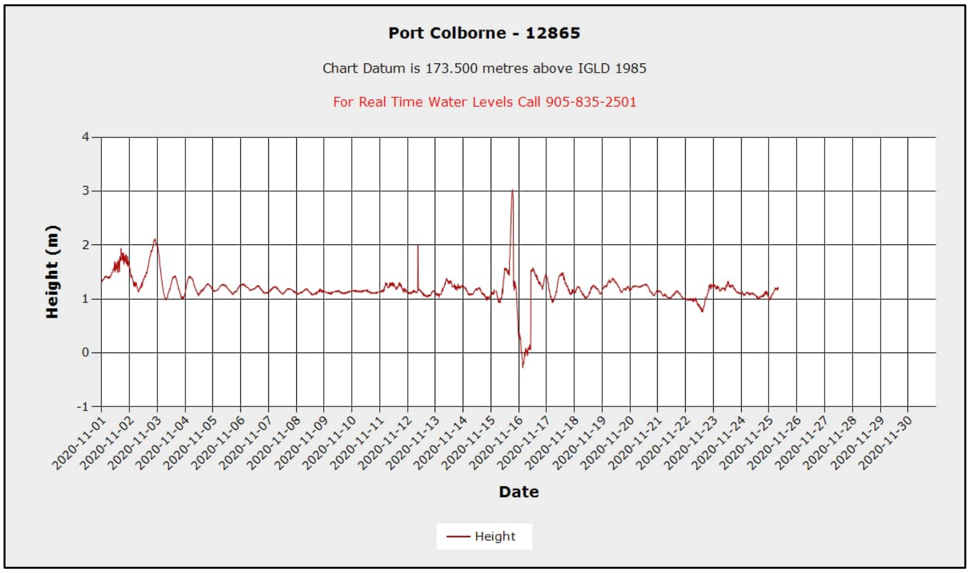


Figure 12 Great Lakes Water Level at Port Colborne

A recent presentation titled, “Vulnerability Assessment and Climate Change Adaptation Options for the Great Lakes Coastline – The Chatham-Kent Lake Erie Example” by Pete Zuzek and Linda Mortsch hosted by Climate Risk Institute identified that as winter temperatures change with climate change, we expect to have more winter storms with open water in Lake Erie. The prediction is for fewer winters with lake ice acting to dampen the effects of storm surge and seiche impacts.

The conclusion is that the risk of wintertime events on the lakes will be greater in the future than in the past. The risk of these events is a combination of high lake levels and storm surge/seiche. A storm event when the lake levels are low poses less risk.

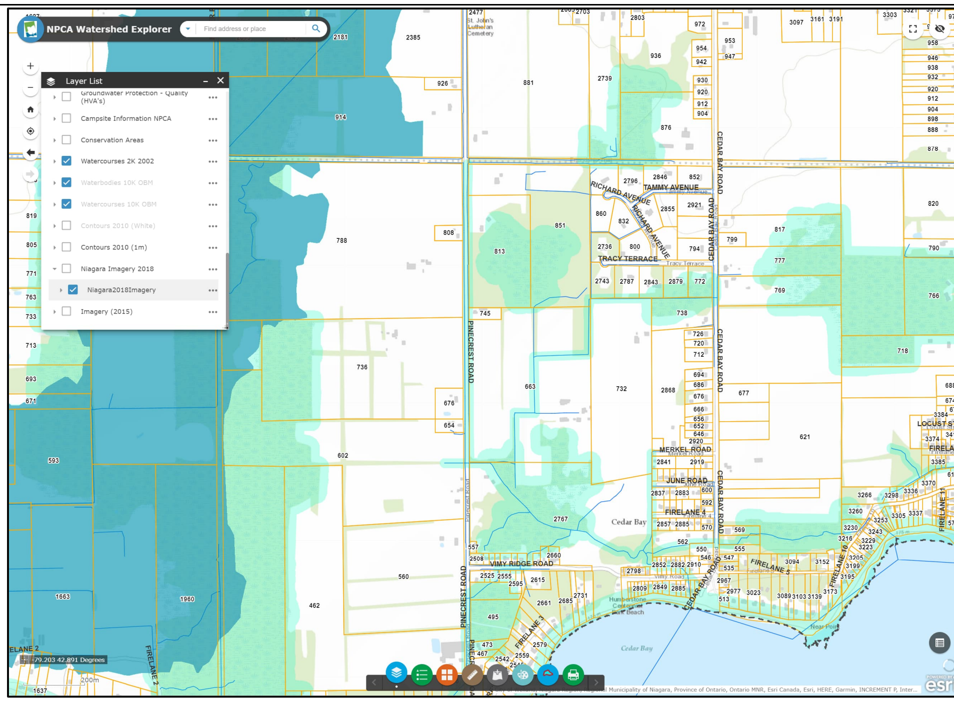
2.4 Previous Reports and Studies

The Oil Mill Creek watershed does not appear to have previous stormwater modelling prepared as part of a flood line study or water quality report.

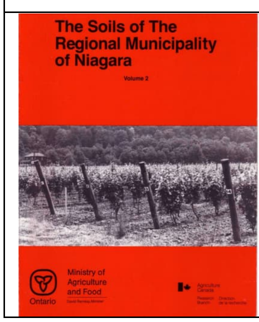
Wetlands are identified.

NPCA-regulated lands are shown based on the buffer.

Reference Documents:



NPCA Watershed Explorer does not show any previous stormwater flood studies completed for the Oil Mill Creek Drain.
Light green shading is indicative of approximate regulated limits.



THE SOILS OF THE REGIONAL MUNICIPALITY OF NIAGARA, Vol 2
OMAF
1989

3 Hydrology

The Oil Mill Creek Drainage system was composed into a computer-based model to analyze the hydrology and hydraulics of the existing drain. The model was created using PC-SWMM software to complete an EPA SWM v5.4 model. Considerations for the landform were given in the creation of the model.

The predominate soil through the Oil Mill Creek Watershed is clay with poorly drained conditions. Figure 13 is colour coded for the predominant soil types.

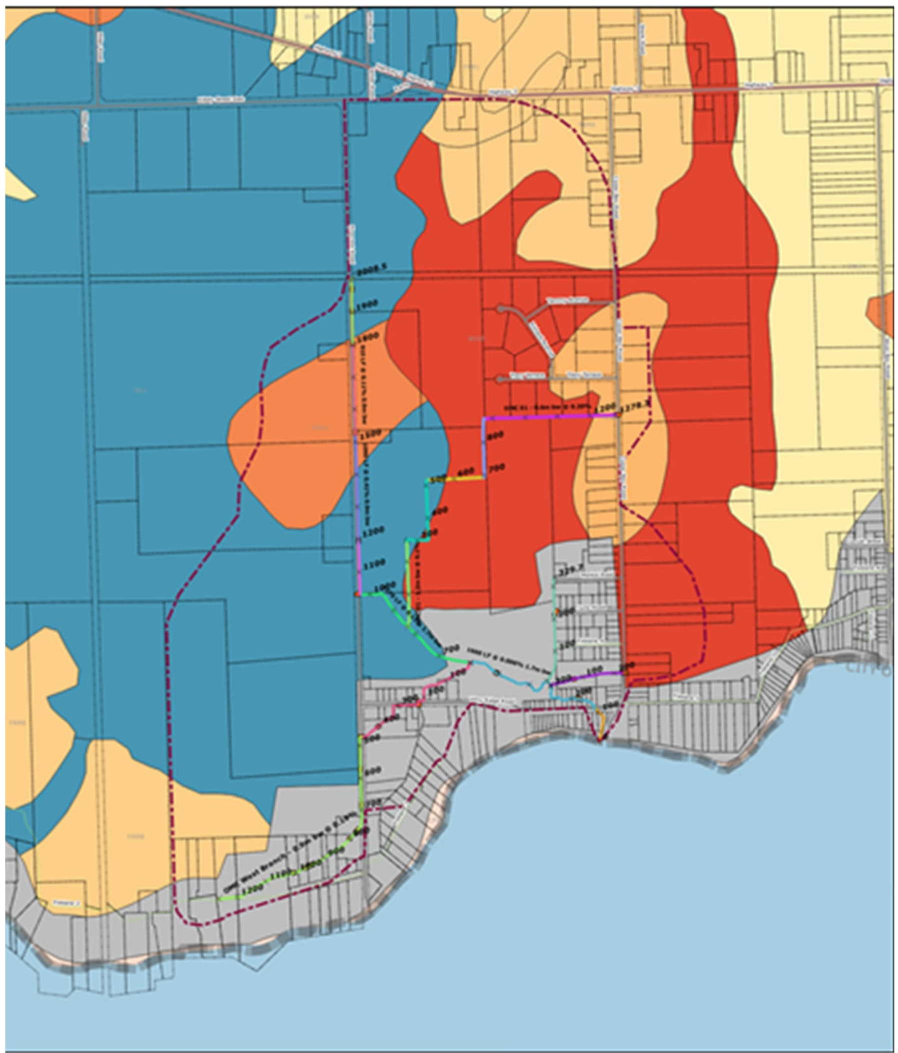


Figure 13 Oil Mill Creek Watershed Soil Classifications

The two predominate soils within the catchment are Welland Clay (blue) to the west and Bok (red) to the east with lobes of Chinguacousy, Farmington and Franktown (light shades). The grey is a series labelled 'not mapped' and is generally representative of the dunes Erie shoreline, which was deemed unsuitable for farming and thus not mapped.

Table 2 Oil Mill Creek Soils Table

BOK	Brooke Soil, 50 to 100 cm variable textures over mainly limestone and dolostone bedrock.

CHINGUACOUSY	Mainly clay loam till. Imperfectly drained.
FARMINGTON Loam	10 to 20cm variable textures over mainly limestone and dolostone bedrock. Drainage is rapid. Brunisolic Gray Brown Luvisol
FRANKTOWN	20 to 50 cm variable textures over mainly limestone and dolostone bedrock. Imperfectly drain. Gleyed Melanci Brunisol
WELLAND Clay	Mainly reddish-hued lacustrine heavy clay. Drainage is poor.
NM	Not Mapped, covers all of the urban area, dune along Firelane, the Chicken processing lands and the former golf course.

From The Soils of Regional Municipality of Niagara, volume 2, dated 1989, from which the GIS data is shown.

From The Soils of Regional Municipality of Niagara, volume 2, dated 1989, from which the GIS data is shown in Figure 13 as a map with the Oil Mill Creek Drain, boundary overlaid, we can see that the predominate feature is poor drainage above (North) of the Friendship Trail. Predominately land grades throughout the Watershed are low, with almost very low land slopes below the Friendship Trail.

From this information, we can choose our soil groups for CN values within the Watershed. Group D soils are those for the upper watershed, Brooke, Chinguacousy, Welland and Franktown. The lower areas consisting of land not mapped adjacent to the lake are considered Group C or B because of the presence of major sand deposits.

Table 3 CN Hydrologic Soil Groups

Land Use Description on Input Screen	Description and Curve Numbers from TR-55					
	Cover Description		Curve Number for Hydrologic Soil Group			
	Cover Type and Hydrologic Condition	% Impervious Areas	A	B	C	D
Agricultural	Row Crops - Straight Rows + Crop Residue Cover-Good Condition (1)		64	75	82	85
Commercial	Urban Districts: Commercial and Business	85	89	92	94	95
Forest	Woods(2) - Good Condition		30	55	70	77
Grass/Pasture	Pasture, Grassland, or Range(3) - Good Condition		39	61	74	80
High Density Residential	Residential districts by average lot size: 1/8 acre or less	65	77	85	90	92
Industrial	Urban district: Industrial	72	81	88	91	93
Low Density Residential	Residential districts by average lot size: 1/2 acre lot	25	54	70	80	85
Open Spaces	Open Space (lawns, parks, golf courses, cemeteries, etc.)(4) Fair Condition (grass cover 50% to 70%)		49	69	79	84

Parking and Paved Spaces	Impervious areas: Paved parking lots, roofs, driveways, etc. (excluding right-of-way)	100	98	98	98	98
Residential 1/8 acre	Residential districts by average lot size: 1/8 acre or less	65	77	85	90	92
Residential 1/4 acre	Residential districts by average lot size: 1/4 acre	38	61	75	83	87
Residential 1/3 acre	Residential districts by average lot size: 1/3 acre	30	57	72	81	86
Residential 1/2 acre	Residential districts by average lot size: 1/2 acre	25	54	70	80	85
Residential 1 acre	Residential districts by average lot size: 1 acre	20	51	68	79	84
Residential 2 acres	Residential districts by average lot size: 2 acre	12	46	65	77	82
Water/ Wetlands		0	0	0	0	0

Colour Key

CN #XX	Oil Mill Creek subject value	Model implemented

Notes
(1) Hydraulic condition is based on a combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue on the land surface (good>=20%), and (e) degree of surface roughness.
(2) Good: Woods are protected from grazing, and litter and brush adequately cover the soil.
(3) Good: >75% ground cover and lightly or only occasionally grazed.
(4) CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover types.

Information on soil permeability was found online for grape growers within Niagara Region and published in the following form.

WATER INFILTRATION INTO SOIL

		WATER INFILTRATION INTO SOIL		SOIL WATER HOLDING CAPACITY				DRAINAGE - WATER MOVEMENT THROUGH ENTIRE PROFILE			
SOIL SERIES	SURFACE SOIL TEXTURE	RATE OF WATER INFILTRATION (based on surface soil texture)	RATE OF WATER INFILTRATION (in/hr)	SOIL WATER HOLDING CAPACITY	AVERAGE INCHES OF WATER/ INCH OF SOIL AT FIELD CAPACITY	GRAPE ROOTING DEPTH (36 inches or max of A and B soil profile depth) inches	AVAILABLE WATER WITHIN ROOTING DEPTH (inches)	HYDRO-LOGIC SOIL GROUP	RATE OF WATER FLOW THROUGH THE SOIL PROFILE (in/hr)	LEACHING RISK	DRAINAGE CLASS
Morley	Silty Clay	Slow	0.08-0.2	Medium	0.13	27	3.60	D	0-0.04	Very Low	Poorly drained
Toldeo	Silty Clay	Slow	0.08-0.2	Medium	0.13	22	2.93	D	0-0.04	Very Low	Poorly drained
Jeddo	Clay Loam	Medium	0.15-0.3	High	0.17	19	3.17	D	0-0.04	Very Low	Poorly drained
Beverly	Silty Clay Loam	Medium	0.15-0.3	High	0.17	26	4.33	C	0.04-0.16	Low	Imperfectly drained
Chingua-cousy	Clay Loam	Medium	0.15-0.3	High	0.19	16	3.00	C	0.04-0.16	Low	Imperfectly drained
Tavistock	Loam	Fast	0.3-0.5	Medium	0.15	28	4.08	C	0.04-0.16	Low	Imperfectly drained
Vineland	Very Fine Sandy Loam	Fast	0.3-0.5	Low	0.10	33	3.44	B	0.16-0.32	Medium	Imperfectly drained
Grimsby	Very Fine Sandy Loam	Fast	0.3-0.5	Low	0.10	36	3.75	A	0.3-0.5	High	Well drained

Sarah Krick and Donna Speranzini AAFC 2013

Figure 14 Soil Drainage Permeability Factors

This shows a low rate of infiltration of 3.8 mm/hr to 7.62 mm/hr for both Chinguacousy Clay loam and Jeddo Clay Loam within the Oil Mill Creek Watershed. From this, a setting of Ia = 5mm was selected.

3.1 Existing Conditions Drain Model

An EPA SWMM v5.1 model was set up based on a sub-catchment discretization and channel segregation using GIS data as the base for model determinations. A GIS map of the data used for the model setup is included in Appendix B. The Catchment definitions are shown in Figure 15 and Table 4 with runoff parameters for the CN runoff model. Consideration was given in the catchment definitions to major roads and culvert crossings along with drainage junctions for branch drains.

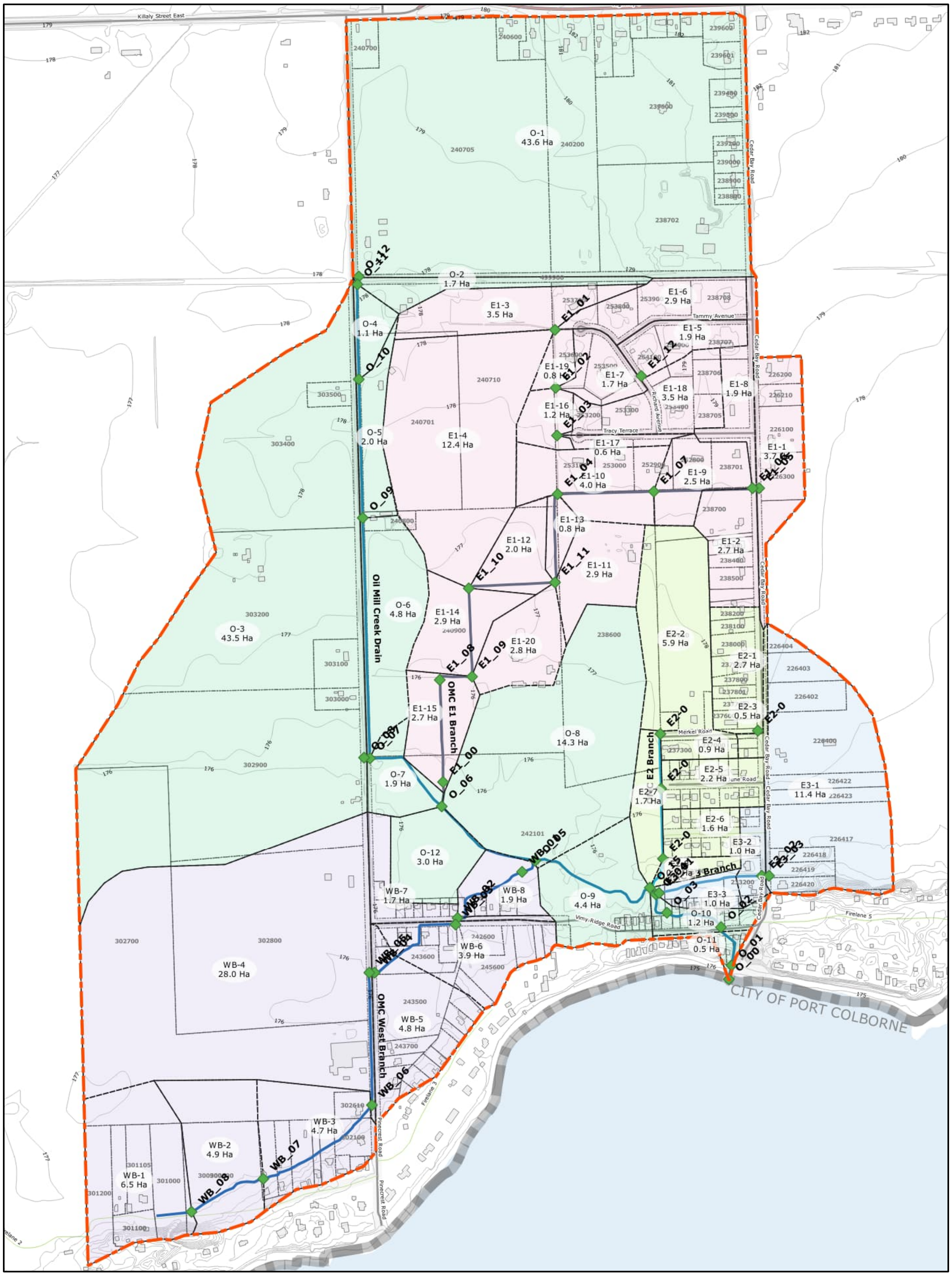


Figure 15 SWMM Model view

Catchment areas:
The Catchments were defined in GIS and specific areas were calculated and runoff characteristics were selected based on landforms, land use and other factors for each catchment, those variables are listed in the following table.

The percent impervious was calculated from GIS for area PC2 and found to be 4.3% based on paved surfaces with directed runoff paths. An average percent impervious was used for the other watersheds with variations made to account for specific catchment definitions. For example, PC10 and PC11 are defined by road allowances and are almost wholly road-based catchments and have higher % impervious values assigned.

Table 4 Oil Mill Creek Watershed Catchment Variables

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	Curve Number	Infiltration (mm)	Imperv Runoff (mm)	Perv Runoff (mm)	Runoff Depth (mm)	Runoff Volume (ML)	Peak Runoff (m^3/s)	Runoff Coefficient
E1-1	E1_05	3.7	100.0	367.1	0.5	16	88	21.07	0	0	43.95	1.61	0.22	0.638
E1-10	E1_04	4.0	199.5	199.5	0.28	10.5	86	25.41	0	0	39.99	1.59	0.21	0.58
E1-11	E1_11	2.9	170.2	170.2	0.3	2.5	80	36.29	0	0	30.35	0.88	0.08	0.441
E1-12	E1_10	2.0	143.0	143.0	0.3	2.5	80	36.29	0	0	30.51	0.62	0.07	0.443
E1-13	E1_11	0.8	57.0	137.7	0.3	2.5	80	36.29	0	0	30.54	0.24	0.03	0.443
E1-14	E1_09	2.9	169.1	169.1	0.3	2.5	80	36.29	0	0	30.36	0.87	0.08	0.441
E1-15	E1_00	2.7	163.2	163.2	0.3	2.5	78	38.84	0	0	28.32	0.75	0.07	0.411
E1-16	E1_03	1.2	111.2	111.2	0.28	2.5	80	36.29	0	0	30.68	0.38	0.05	0.445
E1-17	E1_03	0.6	25.0	229.5	0.28	12.5	80	32.57	0	0	33.98	0.19	0.03	0.493
E1-18	E1_03	3.5	186.4	186.4	0.28	12.5	86	24.84	0	0	40.68	1.41	0.21	0.59
E1-19	E1_02	0.8	87.0	86.9	0.28	2.5	86	27.68	0	0	38.02	0.29	0.05	0.552
E1-2	E1_06	2.7	102.0	259.9	0.25	7.5	85	27.73	0	0	37.47	0.99	0.1	0.544
E1-20	E1_09	2.8	166.9	166.9	0.3	2.5	80	36.29	0	0	30.37	0.85	0.08	0.441
E1-3	E1_01	3.5	187.2	187.2	0.3	2.5	80	36.29	0	0	30.26	1.06	0.09	0.439
E1-4	E1_10	12.4	352.7	352.7	0.34	2.5	80	36.29	0	0	29.57	3.68	0.23	0.429
E1-5	E1_12	1.9	136.6	136.6	0.28	12.5	86	24.84	0	0	40.88	0.76	0.13	0.593
E1-6	E1_01	2.9	170.8	170.8	0.28	12.5	86	24.84	0	0	40.74	1.19	0.18	0.591
E1-7	E1_02	1.7	129.6	129.6	0.28	12.5	86	24.84	0	0	40.91	0.69	0.12	0.594
E1-8	E1_06	1.9	137.1	137.1	0.28	12.5	88	21.95	0	0	43.4	0.82	0.14	0.63
E1-9	E1_07	2.5	157.1	157.1	0.28	10.5	86	25.41	0	0	40.16	0.99	0.15	0.583
E2-1	E2_3	2.7	104.0	259.9	0.2	7.5	85	27.73	0	0	37.35	1.01	0.1	0.542
E2-2	E2_1	5.9	152.0	387.4	0.2	7.5	80	34.43	0	0	31.05	1.83	0.15	0.451
E2-3	E2_3	0.5	15.0	338.9	0.5	22	86	22.15	0	0	43.47	0.22	0.04	0.631
E2-4	E2_1	0.9	60.0	153.3	0.2	7.5	85	27.73	0	0	37.85	0.35	0.04	0.549
E2-5	E2_2	2.2	146.7	146.6	0.2	7.5	85	27.73	0	0	37.89	0.81	0.1	0.55
E2-6	E2_0	1.6	126.1	126.1	0.2	7.5	85	27.73	0	0	38	0.6	0.08	0.551
E2-7	E2_0	1.7	65.0	258.7	0.2	2.5	78	38.84	0	0	27.53	0.46	0.03	0.4
E2-8	E2_0	0.7	84.3	84.3	0.2	7.5	76	38.77	0	0	28.9	0.21	0.03	0.419
E3-1	E3_03	11.4	338.1	338.1	0.4	4.5	84	30.09	0	0	35.16	4.02	0.34	0.51
E3-2	E3_02	1.0	51.0	205.0	0.2	7.5	86	26.26	0	0	38.87	0.41	0.04	0.564
E3-3	E3_01	1.0	101.6	101.6	0.2	7.5	76	38.88	0	0	28.77	0.3	0.04	0.418
O-1	O_12	43.6	600.0	727.4	0.59	4.5	84	30.09	0	0	34.36	14.99	0.93	0.499
O-10	O_02	1.2	111.1	111.1	0.035	7.5	77	38.01	0	0	28.68	0.35	0.03	0.416
O-11	O_01	0.5	68.3	68.3	0.2	7.5	77	37.74	0	0	29.92	0.14	0.02	0.434
O-12	O_06	3.0	172.1	172.1	0.035	2.5	78	38.84	0	0	26.73	0.79	0.04	0.388
O-2	O_11	1.7	27.0	629.5	0.2	22	90	16.81	0	0	47.25	0.8	0.09	0.686
O-3	O_08	43.5	400.0	1086.5	0.5	2.5	84	30.72	0	0	32.62	14.18	0.55	0.473
O-4	O_10	1.1	103.1	103.1	0.5	2.5	84	30.72	0	0	35.51	0.38	0.07	0.515
O-5	O_09	2.0	45.0	442.7	0.3	2.5	84	30.72	0	0	33.88	0.68	0.04	0.492
O-6	O_07	4.8	122.0	395.4	0.3	2.5	84	30.72	0	0	34.06	1.64	0.1	0.494
O-7	O_06	1.9	136.1	136.1	0.25	2.5	84	30.72	0	0	35.11	0.65	0.08	0.51
O-8	O_05	14.3	377.8	377.8	0.3	2.5	78	38.84	0	0	27.25	3.89	0.22	0.396
O-9	O_04	4.4	209.7	209.7	0.035	7.5	76	39.14	0	0	26.65	1.17	0.09	0.387
WB-1	WB_08	6.5	255.1	255.1	0.08	7.5	77	38.01	0	0	28	1.82	0.15	0.406
WB-2	WB_07	4.9	221.3	221.3	0.08	7.5	76	39.14	0	0	27.34	1.34	0.12	0.397
WB-3	WB_06	4.7	217.1	217.1	0.08	7.5	77	38.01	0	0	28.29	1.33	0.12	0.411
WB-4	WB_05	28.0	529.6	529.6	0.24	4.5	84	30.09	0	0	34.12	9.57	0.56	0.495
WB-5	WB_04	4.8	218.9	218.9	0.08	7.5	77	38.01	0	0	28.27	1.35	0.12	0.41
WB-6	WB_03	3.9	198.0	198.0	0.08	7.5	77	38.01	0	0	28.44	1.11	0.1	0.413
WB-7	WB_02	1.7	35.0	486.7	0.08	7.5	88	23.2	0	0	39.67	0.68	0.04	0.576
WB-8	WB_01	1.9	137.9	137.9	0.08	7.5	76	39.14	0	0	28.03	0.53	0.05	0.407

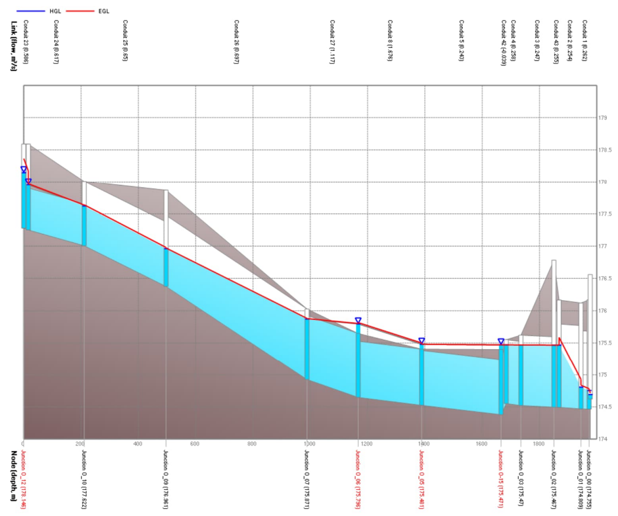
The total area of the Oil Mill Creek watershed modelled is given as 265.2 Ha.

The model was set up as a Junction (node) and conduit (link) model in EPA SWMM software as shown in the GIS depicted in Figure 15.

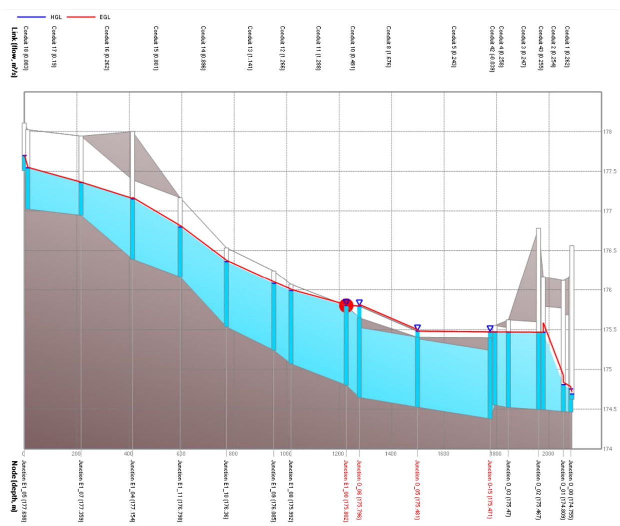
A Logical Model Diagram is included in the report Appendix B. The logical Diagram represents the organization of the specific nodes and links irrespective of the geographic representation shown in Figure 15.

Idealized Channels are used to represent flows without surcharging conditions. Channels are typically designed to a lower capacity than the 1:100-year design storm and thus an idealized version is required unless a 2D or dual drainage model is implemented.

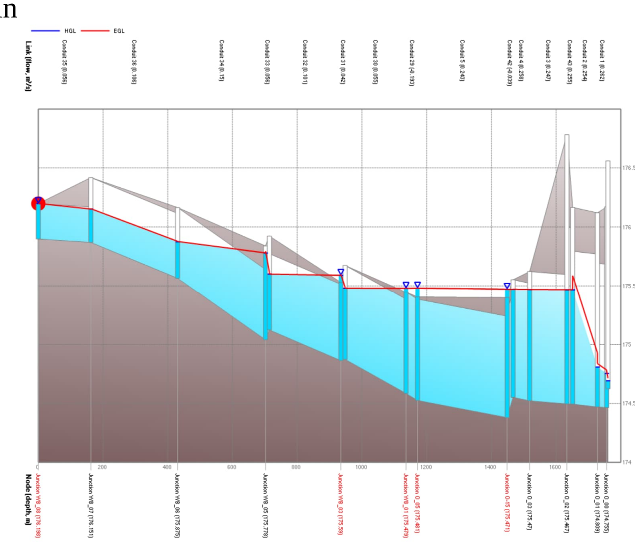
The model has surcharge points as shown in the following profile view of the 1:5 year model result, see.



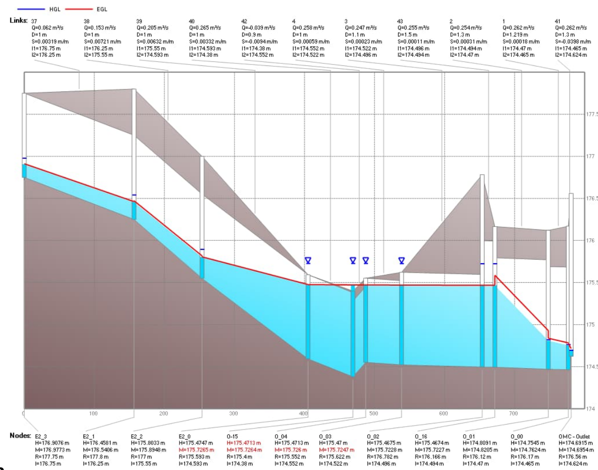
Oil Mill Creek Drain



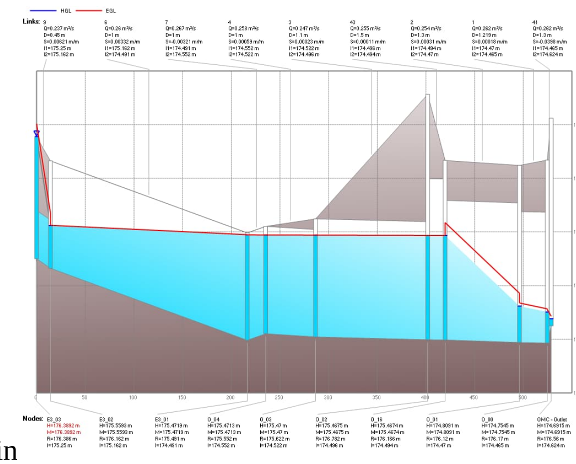
E1 Branch Drain



West Branch Drain



E2 Branch Drain



E3 Branch Drain

Figure 16 Design Runoff Event Profiles

All profiles are shown to the outlet at Lake Erie instead of ending at the confluence with OMC.

The right portion of Figure 16 shows the outlet of the Oil Mill Creek Drain to Lake Erie. The outlet is considered for the model to be a free-flowing outlet, which means that the elevation shown for the outlet invert does not have a Lake water surface elevation that is higher than the water's edge elevation.

What we can appreciate is that the outlet is impacted by the Lake's surface elevation. Most of the time the drain has a consistent and steady flow to Lake Erie but this is not the case during seiche storm events. Standing water upstream of the gate outlet is common as the lake levels vary and the outlet littoral sand drift occurs. The current outlet concrete 'lip' is designed to reduce sand incursion to the outlet but effectively alters the grade line in the outlet.

The current outlet compromises the flow to the lake from the portion of the drain north of Vimy Ridge Rd. The rate of flow is too low and thus we exceed the capacity of the drain within Centennial Park.

3.1.1 Hydrologic Model Results

The model was prepared using the best available information and configured with accepted input variables representative of the areas and land uses occurring in the watershed. The model was run based on input files and the output files were reviewed using the graphic interface provided by the software. Additional analysis was prepared using GIS to graphically display results. The 1D model results are shown in the following model output tables and discussed with recommended actions to support the Drainage design process.

Table 5 Oil Mill Creek Junction 1:2 Yr Flood Results

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days hr: min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
E2_0	14.87	0.028	0 19:44	0.209	0.039
E3_01	32.64	0.077	0 14:47	0.893	0.14
O_03	5.83	0.002	0 23:31	0.011	0.008
O_04	22.66	0.011	0 17:07	0.096	0.079
O_05	35.37	0.985	0 12:49	12.081	0.237
O-15	35.33	0.358	0 12:42	4.766	0.232
WB_01	34.72	0.204	0 13:22	1.905	0.197
WB_03	35.38	0.055	0 12:41	1.311	0.242
WB_04	6.05	0.016	1 00:25	0.161	0
WB_05	35.94	0.294	0 12:10	3.794	0.246
WB_08	0.06	0.021	0 12:10	0.003	0

Table 6 Oil Mill Creek Junction 1:5 Yr Flood Results

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days hr: min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
E1_00	4.95	0.966	0 12:47	5.353	0
E2_0	26.05	0.113	0 14:53	0.717	0.134
E3_01	34.79	0.188	0 13:16	1.496	0.235
E3_03	1.11	0.099	0 12:10	0.045	0.006
O_03	21.21	0.02	0 15:30	0.139	0.103
O_04	31.78	0.035	0 14:08	0.21	0.174
O_05	35.71	1.785	0 12:36	16.682	0.327
O_06	21.79	0.988	0 12:28	0.913	0.152
O_08	2.73	0.085	0 12:10	0.437	0
O_12	0.25	0.194	0 12:10	0.042	0.001
O-15	35.7	0.939	0 12:20	6.709	0.326
WB_01	35.34	0.359	0 12:44	2.707	0.28
WB_02	13.48	0.523	0 20:22	19.433	0
WB_03	35.83	0.144	0 12:14	1.331	0.244
WB_04	27.76	0.099	0 16:19	4.136	0
WB_05	36.04	0.641	0 12:10	7.747	0.501
WB_06	4.47	0.072	0 21:28	0.573	0
WB_08	1.57	0.112	0 12:10	0.108	0

The model results are shown as visual map-based results in the following figure.

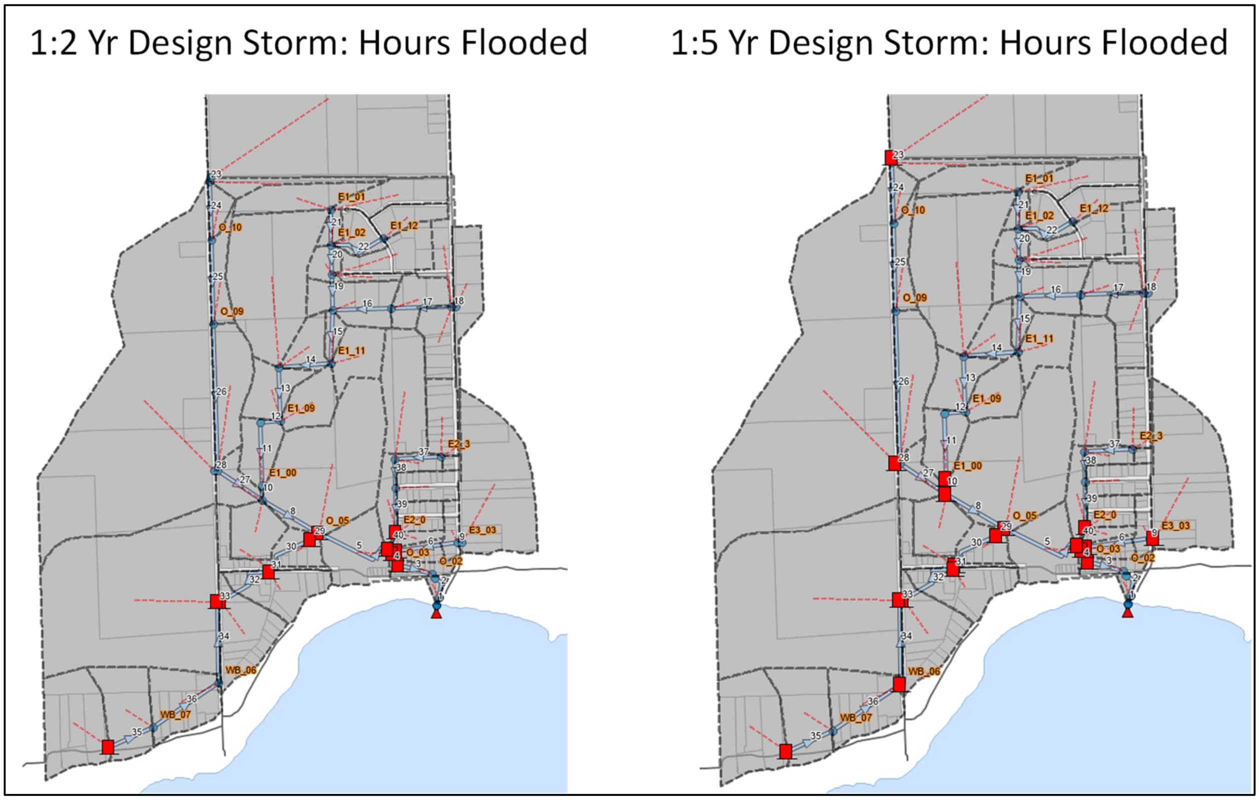
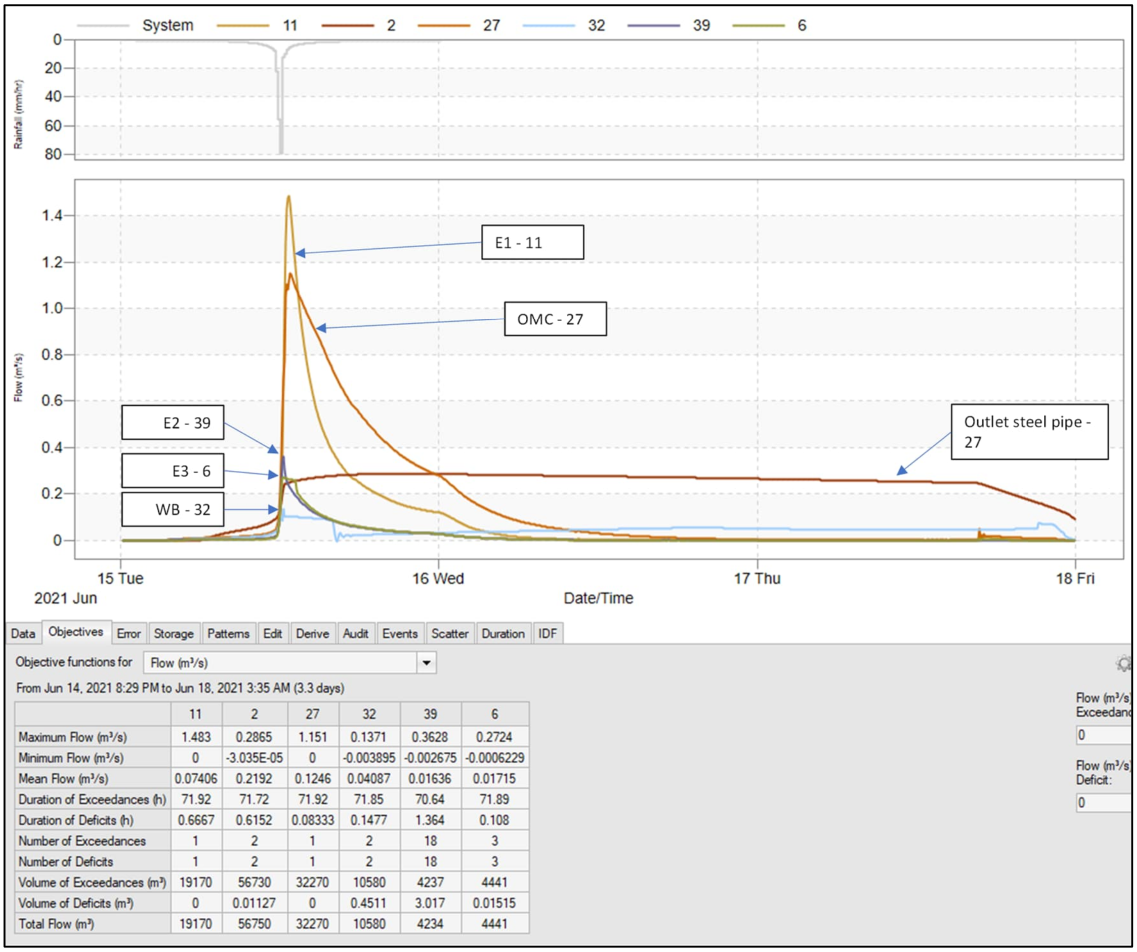


Figure 17 Design Storms and Hours Flooded

These model results indicate that the drain or portions thereof are not meeting the minimum standards for conveyance without flooding occurring.

The model provides runoff results for channels, which are represented in the model as links with pipe shapes and dimensions or trapezoidal channels with a depth consistent with survey results. The results are shown for the 5-year precipitation event indicating system challenges with the current arrangement.



	11	2	27	32	39	6
Maximum Flow (m³/s)	1.483	0.2865	1.151	0.1371	0.3628	0.2724
Minimum Flow (m³/s)	0	-3.035E-05	0	-0.003895	-0.002675	-0.0006229
Mean Flow (m³/s)	0.07406	0.2192	0.1246	0.04087	0.01636	0.01715
Duration of Exceedances (h)	71.92	71.72	71.92	71.85	70.64	71.89
Duration of Deficits (h)	0.6667	0.6152	0.08333	0.1477	1.364	0.108
Number of Exceedances	1	2	1	2	18	3
Number of Deficits	1	2	1	2	18	3
Volume of Exceedances (m³)	19170	56730	32270	10580	4237	4441
Volume of Deficits (m³)	0	0.01127	0	0.4511	3.017	0.01515
Total Flow (m³)	19170	56750	32270	10580	4234	4441

Figure 18 Model Hydrograph Results 1:5 year Design Storm

Base Model Observations

The following are observations about the existing system resulting from the modelling performed to date.

1. The existing outlet peak capacity is not large enough to meet the 1:2-year design standard. The model may underrepresent the peak capacity based on the reverse slope of the outlet and the outlet assumes a free-flowing state. The hydrograph shows the outlet quickly reaching capacity and then staying there for nearly 60 hours after the storm event.

2. The red boxes in Figure 17 Design Storms and Hours Flooded indicate that the existing system isn't able to meet a base 1:2 year design storm capacity requirement.

3. Predominate flow contributions are from the upper watershed from OMC Drain along Pleasant Beach Rd and the E1 branch. These higher slope sections commit runoff at a rate greater than the outlet capacity.

4. The West Branch has such a low slope that it may run backwards during certain events as the peak capacity of the outlet is reached while the

upper watersheds are contributing flows faster than the West Branch itself can flow.

5. Portions of the drain at major roadways, such as OMC @ Friendship Trail, E3 at Cedar Bay Rd. and West Branch at Pleasant Beach Rd. These culverts appear to be undersized for the flows that are predicted.

Notes:

This is for the existing surveyed conditions and not based on the original design. Flow monitoring has not been performed and the model is unverified.

3.2 Proposed Design Model

After the 50% design review to consider options for improvement and design profiles for 70% are composed then a final model to assess performance improvements and limitations will be performed and those results will be documented in the final report.

4 Drain Hydraulics

The following presents the existing grades based on the survey. These are the actual grades from the survey of inverts at road crossings, and along the drain, as the survey did collect ditch grades for a selected set of cross-sections. Those are represented in the Baseline Drawings included in Appendix B of the Baseline Report.

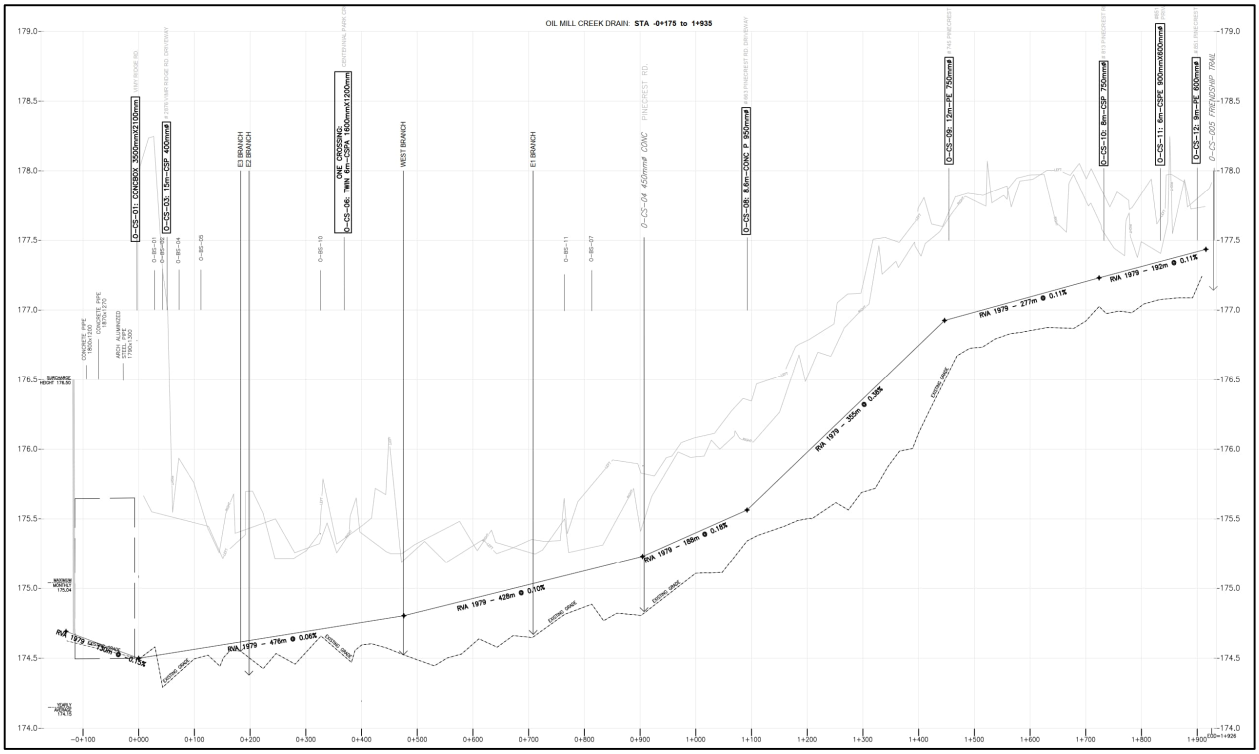


Figure 19 Oil Mill Creek Drain Profile

Detailed drawings are included in the Baseline report and show the existing static water level. The static water is undesirable but constricted by the outlet elevation and past over-excavation of the channel during maintenance.

4.1 Drain Channel Capacity Analysis

The cross-section of each drain channel, where drain channels are defined by the model set up with specific junctions as shown in the Model Map Diagrams in Appendix B was used to calculate a top-of-bank channel flow capacity.

Manning's n values were used from the US DOT reference, included in Appendix D. Where a top bank on either side of the channel has different heights then the lowest height, providing the least capacity, is used in the calculation.

For the runoff model, idealized channels are used to ensure that a predicted design flow is achieved and used to benchmark against actual drain performance.

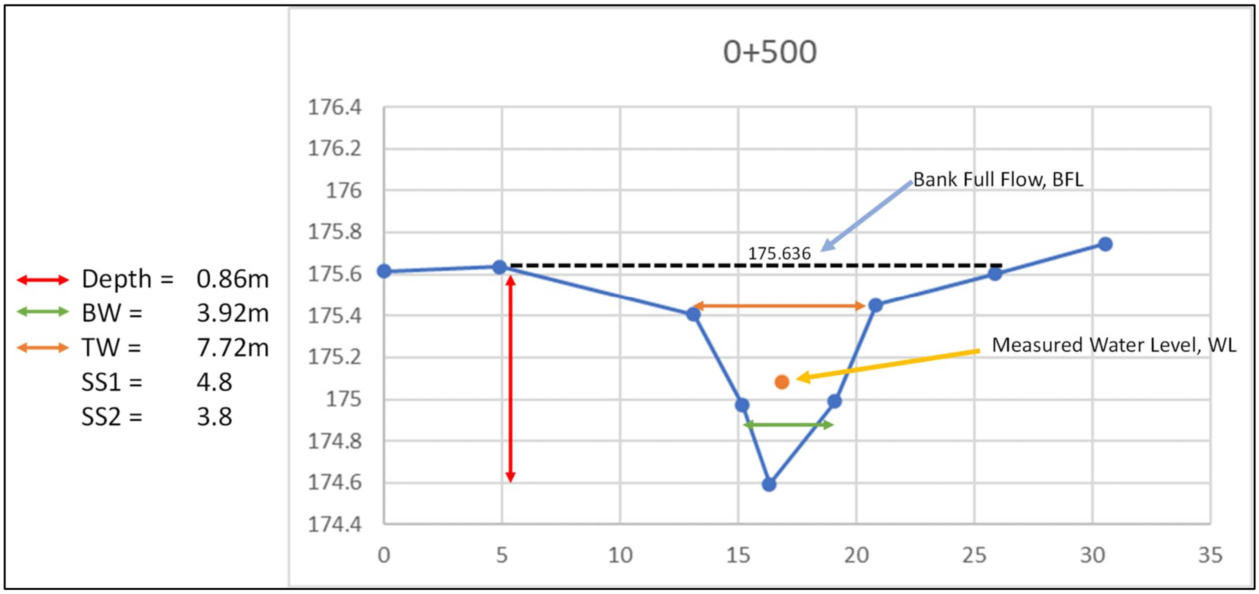


Figure 20 Channel Capacity Cross-Sectional Analysis

Table 7 Hydraulic Drain Channel Capacity Analysis

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The result of the analysis is as follows:

- Cross-sections are available for every segment of the Oil Mill Creek Drain.
- The Grade line or lack of a positive grade is the greatest influence on capacity.
- Branch E1's lower reach is lower capacity than upper reaches, which is a negative condition.

Table 8 Cross-Section Existing Capacities

Oil Mill Creek		
STA	Upstream Area	Capacity Q, cms
0+175	259.8	1.085
0+500	228.0	1.516
0+880	95.2	1.131
1+350	47.3	3.062
1+841	45.3	0.061

WB Branch Drain		
STA	Upstream Area	Capacity Q, cms
0+097	56.5	1.282
0+500	49.0	0.430
1+105	6.5	0.204

OMC E1 Branch		
STA	Upstream Area	Capacity Q, cms
0+050	57.1	0.746
0+460	48.8	0.941
0+795	30.7	0.830
1+050	10.8	0.771
1+224	8.3	0.204

OMC E2 Branch		
STA	Upstream Area	Capacity Q, cms
0+093	15	0.533
0+277	9.5	0.469

OMC E3 Branch		
STA	Upstream Area	Capacity Q, cms
0+104	12.4	0.599

4.2 Oil Mill Creek Bridge and Culvert Structures

There is a total of 36 identified road crossings that are part of the Oil Mill Creek Drain including the West and East Branches. There are additional culverts that connect to the drain as a road outlet or Right of Way (ROW) crossing. The ROW culverts use the drain as an outlet either directly or by ROW swales.

The culvert capacity analysis was conducted using HY-8 software for each culvert. Software Output reports are available in Appendix E. The design performance targets are 1:5 year for local roads, and 1:2 year for private crossings and if present then an MTO crossing is 1:25. Each culvert has a design flow based on the hydrologic model implemented for the design flows given for each node.

Crossings, bridges, gate structure and culverts are shown in Figure 21.

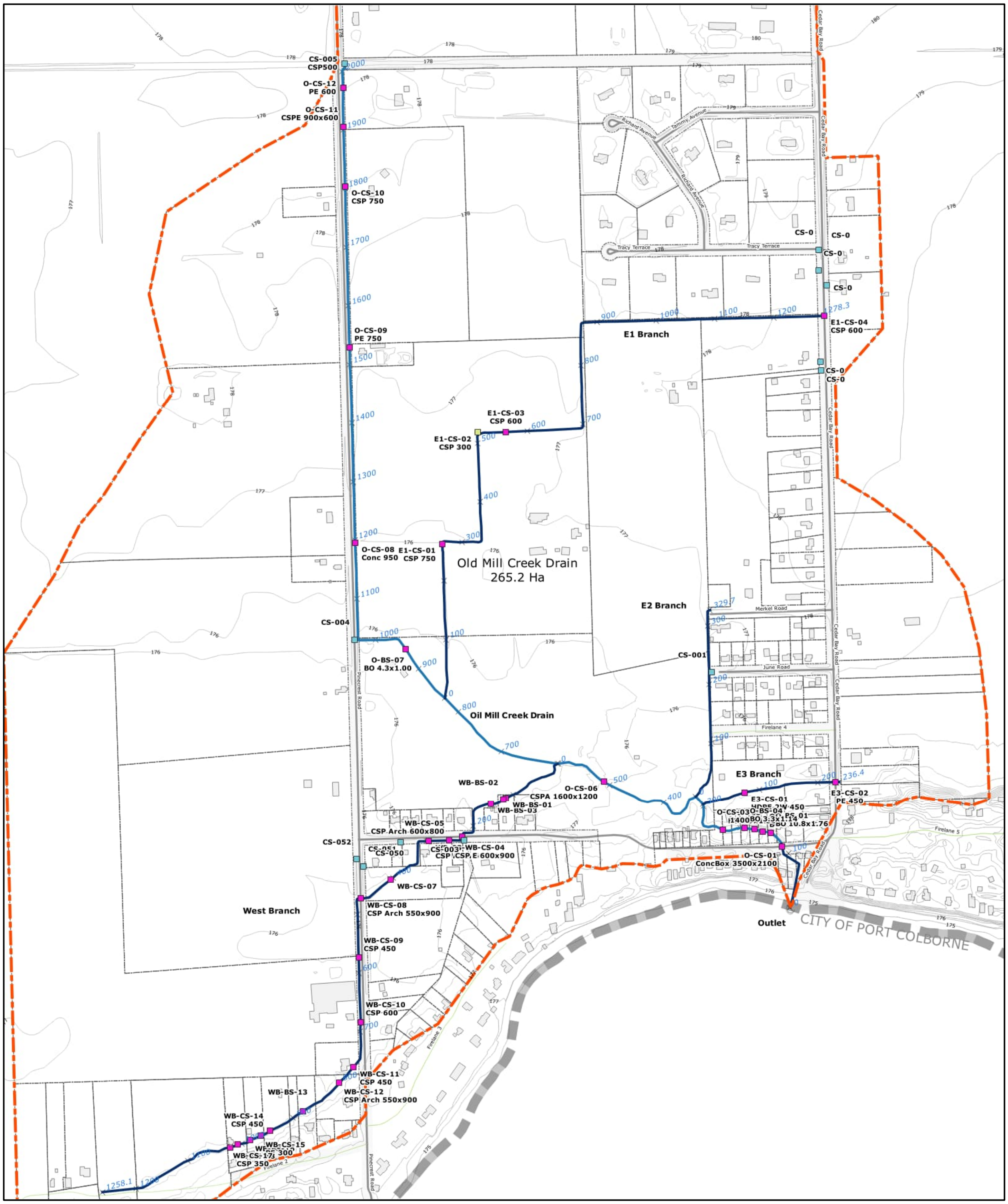


Figure 21 Oil Mill Creek Drain Crossings

A map with a plan view of the culverts is included in Appendix A. The existing culverts were assessed for capacity and integrity.

A few of the existing culverts were already identified for removal by site inspection performed by the City of Port Colborne drainage staff.

Table 9 Oil Mill Creek Drain Crossings

Name ID	Crossing	INSP Status	Drain	Diam	Material	Culvert desc	L, m	Q 5yr	P/Fail
Culverts									
E1-CS-01	#663 PINECREST RD. DRIVEWAY		E1 Branch	750	CSP	CSP 750	5	1.52/.73	Fail
E1-CS-03	Private Access		E1 Branch	600	CSP	Twin CSP 600	9	1.15/.69	Fail
E1-CS-04	CEDAR BAY RD		E1 Branch	600	CSP	CSP 600	9	.22/.22	P
E3-CS-01	Private Access		E3 Branch	450	HDPE 2W	HDPE 2W 450	6	.27/.22	Fail
E3-CS-03	CEDAR BAY RD.		E3 Branch	450	PE	PE 450	12	.27/.27	P
O-CS-03	#2876 VIMY RIDGE RD. DRIVEWAY		Oil Mill Creek Drain		CSP	1400		1.9/1.9	P
O-CS-05	FRIENDSHIP TRAIL		Oil Mill Creek Drain	500	CSP	CSP 500	11.6	.93/.58	Fail
O-CS-06	CENTENNIAL PARK CROSSING		Oil Mill Creek Drain		CSPA Poly-coated	Twin CSPA 1600x1200	6	1.9/1.9	P
O-CS-08	#663 PINECREST RD. DRIVEWAY	PIPE REPAIR REPLACE	Oil Mill Creek Drain	950	Concrete	Conc 950	8.6	.94/.63	Fail
O-CS-09	#745 PINECREST RD. DRIVEWAY		Oil Mill Creek Drain	750	PE	PE 750	12	(.94/.90)	Fail
O-CS-10	#813 PINECREST RD. DRIVEWAY	REPLACE	Oil Mill Creek Drain	750	CSP	CSP 750	8	.93/.58	Fail
O-CS-11	#815 PINECREST RD. DRIVEWAY		Oil Mill Creek Drain		CSPE	CSPE 900x600	6	.93/.58	Fail
O-CS-12	#815 PINECREST RD. DRIVEWAY		Oil Mill Creek Drain	600	PE	PE 600	9	.93/.58	P
WB-CS-04	VIMY RIDGE RD.		West Branch		CSPE	CSP E 600x900	12.2	.7/.69	P
WB-CS-05	#2595 VIMY RD. DRIVEWAY	REPLACE	West Branch		CSP Arch	CSP Arch 600x800	6	.7/.58	Fail
WB-CS-06	#2555 VIMY RD. DRIVEWAY		West Branch		CSP Arch	CSP Arch 600x900	6	.7/.7	P
WB-CS-07	PRIVATE DRIVEWAY		West Branch			CSPA 1400x800	12	.7/.7	
WB-CS-08	PINECREST RD.		West Branch		CSP Arch	CSP Arch 550x900	6	.7/.7	P
WB-CS-09	462 PINECREST RD. DRIVEWAY		West Branch			CSP 450	10	.7/.7	Fail
WB-CS-10	462 PINECREST RD. DRIVEWAY		West Branch			CSP 600	10	.24/.24	P
WB-CS-11	446 PINECREST RD. DRIVEWAY		West Branch			CSP 450	14.3	.16/.16	P
WB-CS-12	426 PINECREST RD. DRIVEWAY		West Branch		CSP Arch	CSP Arch 550x900		.16/.16	P
WB-CS-14	2366 FIRELANE 2		West Branch			CSP 450	4.4	.16/.11	Fail
WB-CS-15	2334 FIRELANE 2		West Branch	300	PE	PE 300	6	.16/.12	Fail
WB-CS-17	316 FIRELANE 2		West Branch	350	CSP	CSP 350	6	.13/.11	Fail
O-CS-01	Vimy Ridge Rd		Oil Mill Creek Drain	TIP		ConcBox 3500x2100	6.6	2/2	P
Bridges (Bridge conveyance not assessed)									
O-BS-01		176.339	Oil Mill Creek Drain			BO 10.8x1.76			
O-BS-02		175.862	Oil Mill Creek Drain			BO 9.00x1.57			
O-BS-04		175.748	Oil Mill Creek Drain			BO 3.3x1.14			
O-BS-05		175.872	Oil Mill Creek Drain			BO 5.9x1.38			
O-BS-07		175.88	Oil Mill Creek Drain			BO 4.3x1.00			
WB-BS-01	Private Lane		West Branch						
WB-BS-02			West Branch						
WB-BS-03			West Branch						

WB-BS-13	Firelane 2		West Branch				3.2		
WB-BS-16	Firelane 2		West Branch						
WB-BS-18	Firelane 2		West Branch						

4.2.1 Culvert Analysis

Culverts have two forms of analysis on their capacity.

- The first is the PC-SWMM Model of runoff and has two nodes, one node for the upstream side of the culvert and the second for the downstream side of the culvert. The result is a prediction of flow capacity through an existing culvert using the PC-SWMM dynamic analysis to solve higher-order flow equations through the node-link model. Smaller culverts, such as laneway crossings, are not modelled in this manner and only those large road crossing culverts are analyzed in this manner.

- The second is an analysis of the existing culverts using HY-8 to perform the traditional inlet condition vs. outlet condition analysis of predicted design flows.

This distinction between two differing measures for culvert performance is important when considering the actual design deployment of culverts.

The following culverts are identified as not meeting the capacity target, (highlighted in yellow with Status set to Fail).

Table 10 Culvert Capacity Assessment,

NameID	Crossing	Drain	Type	Culv_desc	Culvert Capacity, cms	Design Flow, cms	Status
E1-CS-01	#663 PINECREST RD. DRIVEWAY	E1 Branch	Culvert	CSP 750	.73	1.52/.73	Fail
E1-CS-03	Private Access	E1 Branch	Culvert	CSP 600	.69	1.15/.69	Fail
E1-CS-04	CEDAR BAY RD	E1 Branch	Culvert	CSP 600	.22	.22/.22	P
E3-CS-01	Private Access	E3 Branch	Culvert	HDPE 2W 450	.22	.27/.22	Fail
E3-CS-02	CEDAR BAY RD.	E3 Branch	Culvert	PE 450	.27	.27/.27	P
O-CS-03	#2876 VIMY RIDGE RD. DRIVEWAY	Oil Mill Creek Drain	Culvert	1400	1.9	1.9/1.9	P
O-CS-05	FRIENDSHIP TRAIL	Oil Mill Creek Drain	Culvert	500 CSP	.45	.93/.58	Fail
O-CS-06	CENTENNIAL PARK CROSSING	Oil Mill Creek Drain	Culvert	CSPA 1600x1200	1.9	1.9/1.9	P
O-CS-08	#663 PINECREST RD. DRIVEWAY	Oil Mill Creek Drain	Culvert	Conc 950	.63	.94/.63	Fail
O-CS-09	#745 PINECREST RD. DRIVEWAY	Oil Mill Creek Drain	Culvert	PE 750	.90	(.94/.90)	Fail
O-CS-10	#813 PINE CREST RD. DRIVEWAY	Oil Mill Creek Drain	Culvert	CSP 750	.58	.93/.58	Fail
O-CS-11	#815 PINECREST RD. DRIVEWAY	Oil Mill Creek Drain	Culvert	CSPE 900x600	.58	.93/.58	Fail
O-CS-12	#815 PINECREST RD. DRIVEWAY	Oil Mill Creek Drain	Culvert	PE 600	.58	.93/.58	P
WB-CS-04	VIMY RIDGE RD.	West Branch	Culvert	CSP E 600x900	.69	.7/.69	P
WB-CS-05	#2595 VIMY RD. DRIVEWAY	West Branch	Culvert	CSP Arch 600x800	.58	.7/.58	Fail
WB-CS-06	#2555 VIMY RD. DRIVEWAY	West Branch	Culvert	CSP Arch 600x900	.7	.7/.7	P
WB-CS-07	PRIVATE DRIVEWAY	West Branch	Culvert	0	.7	.7/.7	
WB-CS-08	PINECREST RD.	West Branch	Culvert	CSP Arch 550x900	.7	.7/.7	P
WB-CS-09	462 PINECREST RD. DRIVEWAY	West Branch	Culvert	CSP 450	.7	.7/.7	Fail
WB-CS-10	462 PINECREST RD. DRIVEWAY	West Branch	Culvert	CSP 600	.24	.24/.24	P
WB-CS-11	446 PINECREST RD. DRIVEWAY	West Branch	Culvert	CSP 450	.16	.16/.16	P
WB-CS-12	426 PINECREST RD. DRIVEWAY	West Branch	Culvert	CSP Arch 550x900	.16	.16/.16	P
WB-CS-14	2366 FIRELANE 2	West Branch	Culvert	CSP 450	.11	.16/.11	Fail
WB-CS-15	2334 FIRELANE 2	West Branch	Culvert	PE 300	.12	.16/.12	Fail
WB-CS-17	316 FIRELANE 2	West Branch	Culvert	CSP 350	.11	.13/.11	Fail
O-CS-01	Vimy Ridge Rd	Oil Mill Creek Drain	Conc Box	ConcBox 3500x2100	2	2/2	P

4.3 Outlet

The existing outlet is primarily composed of a trapezoidal outlet structure including a grate to prevent access, and a steel flap gate controlled by a winch located on top of the structure.

Figure 22 Oil Mill Creek Outlet Structure

This outlet has been in place since the 1961 Clarke Report. There has been minor maintenance since then except the 1999 Report to enclose the portion north of the beach to the culvert crossing Vimy Ridge Rd.

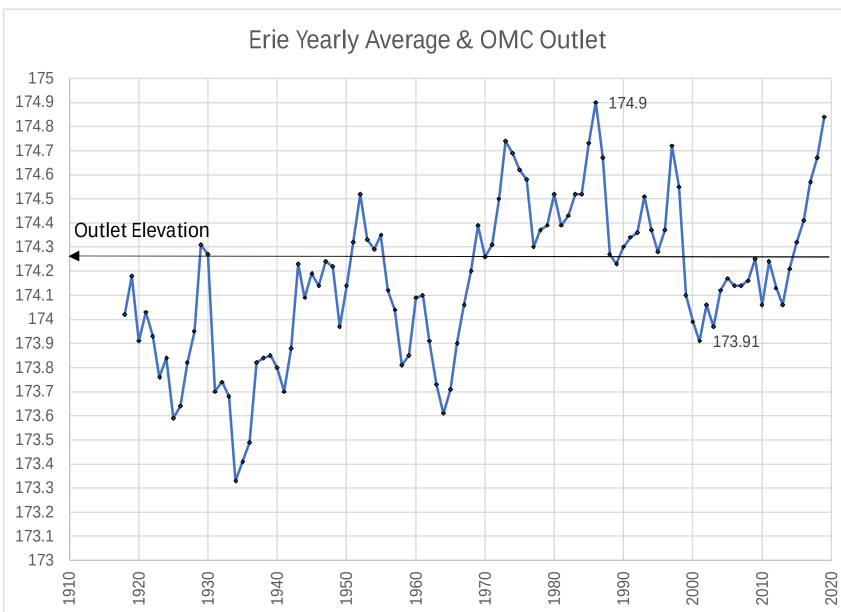


Figure 23 Lake Erie Annual Elevations compared to Oil Mill Creek Outlet

The outlet elevation shown is indicating that the existing outlet is positioned at an average height relative to the monthly average elevations of Lake Erie.

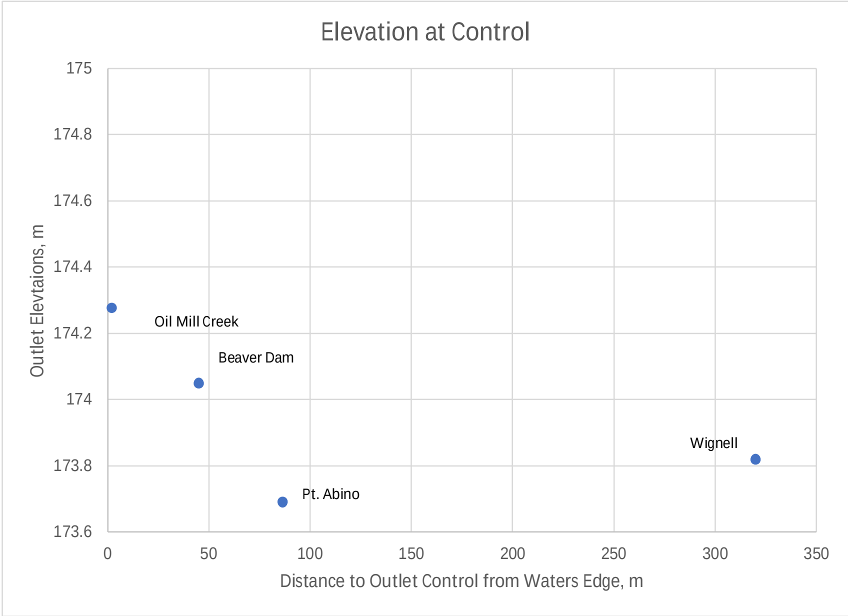


Figure 24 Port Colborne East Drain Outlet Elevations

Figure 24 Port Colborne East Drain Outlet Elevations shows that the Oil Mill Creek outlet invert with the control structure located at the water's edge is high when compared to other outlets of drains on the East side of Port Colborne.

Flow through the outlet is dependent on the flap gate. The role of the flap gate is not modelled in the base model. An assessment of the flap gate is planned as part of the drain design improvements.

Figure 25 Oil Mill Creek Flap Gate

From the site inspection conducted on July 20, 2021, the gate when down obstructs the flow to the lake and restricts exit flow to the area around the edge of the partially closed gate.

The gate when closed prevents surge/seiche events from travelling backwards through the drain outlet. However, this is dependent on an operator, the City of

Port Colborne staff person, to actively close the flap gate by using the winch connected to the wire shown in the photo. Once closed the gate does not allow flow to exit from the event until after the gate is re-opened by the operator. Open/closed positions are dependent on the operator's action.

The drain would operate more effectively if the gate position were determined from local site conditions and an automatic control that closed or opened the gate without the requirement of operator attendance.

There are a variety of mechanisms to achieve this objective. Assessing their environmental impact (potential need for grease) along with consideration for the cost to implement can be considered in the context of more passive solutions such as a flexible control gate that responds to local conditions without automatic control requirements.

4.3.1 Oil Mill Creek Pumping System

Oil Mill Creek Drain includes a pumping system that at present has been abandoned.

Figure 26 Oil Mill Creek Control Structure and Pump

The last work on the outlet was prepared by KSmart & Associates in 1999, the drawings are referenced in the Baseline Report.

There is no pumping infrastructure currently in use on the Oil Mill Creek Drain. The components remaining from the original system include:

- Discharge piping, 150mm steel
- Wetwell – manhole structure – diameter 2.2m
- CSP suction piping into an existing elliptical concrete pipe

- Discharge pipe exit within the outlet structure, see photo Figure 25 Oil Mill Creek Flap Gate

This pumping arrangement predates the work performed in 1999 to enclose the outlet using a 1791 x 1300 aluminized steel pipe. Figure 27 Oil Mill Creek Outlet PS before 1999 shows a view of how a submersible pump would have functioned given the arrangement that is present. The suction side of the pump draws water from the wetwell which is connected to the existing concrete pipe by the 300 CSP inlet pipe. This pumping would lower the water in the pipe by discharging pumped water through the discharge at the outlet (blue arrows). The culvert has a 300mm CSP as a suction line or draws from the existing concrete elliptical pipe into the pump wet well. The discharge pipe is a 150mm steel pipe with a flange connection shown above

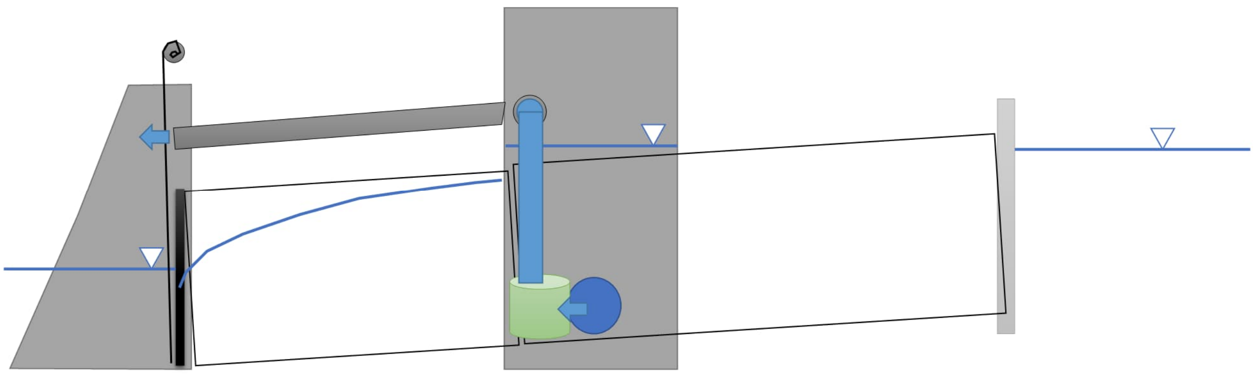


Figure 27 Oil Mill Creek Outlet PS before 1999

Before the addition of the aluminized pipe, the then-current pump operation would draw down drain water from the open channel immediately north of the beach edge. This open channel area provided a flat surface open to atmospheric pressure with the flow into it only controlled by the existing culvert located at Vimy Ridge Rd. The result was a benefit to the adjacent properties from the operation of the pump.

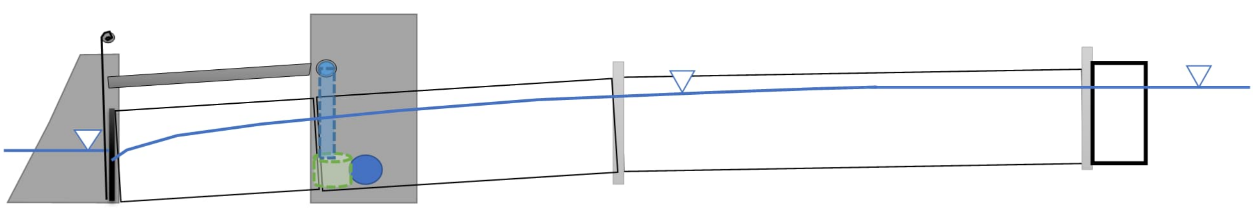


Figure 28 Oil Mill Creek Outlet - circa 2021

The enclosing of the upstream portion of the formerly open channel now moves the potential draw for the pumping station more than 80 metres to the north side of Vimy Ridge Rd. This affects the water surface profile through the closed conduit and thus affects the potential restoration of a submersible pump.

The existing placement of the wet well is made less effective by the enclosing pipe. This used to draw from an open channel but now that open channel is nearly 100m away. The existing wet well requires that runoff flows into the wet well from the closed conduit portion of the gravity pipe. This draw or flow into the wet well is limited by the available flow in the gravity portion of the pipe. The addition of a pump will increase the total capacity of the lake but by a limited amount controlled by the rate of draw into the wet well and the pumping rate out of the wet well. In the past, this may have provided minimal flow during times when the gate was closed.

If pumping is to be restored, then it is recommended that a new pumping station be implemented. The new station would draw water from the north side of Vimy Ridge Rd. and pump it to the outlet. This ensures that the available capacity of the existing gravity outlet is maintained. Based on standard accepted rates for pumping, a watershed the size of Oil Mill Creek should require a pump operating at 195 lps to 390 lps.

5 Design Analysis

The section provides details on using the model to affirm the design improvements for the Oil Mill Creek Drain Report. The existing model using surveyed inverts is adjusted to the design grade line inverts and adjustments are made to incorporate the design basis in the PC-SWMM which uses the US Environmental Protection Agency (EPA) Storm Water Management Model (SWMM) rainfall runoff simulator.

5.1 Design Goals

The purpose of the stormwater model analysis is to affirm and show success with the proposed improvements. This is performed for the design case, the 1:5-year storm having 68.9mm of precipitation over 24 hours.

The lower return period storms will be reported for the 10-year storm and the 100-year storm but no design changes are required based on the results. The results are analyzed for information only.

The following are some of the goals or principles for design improvements:

- Integrated Watershed Management – solving or improving one area but not at the expense of a detrimental or downstream negative impact.

- Room for the River – accept the limits for space within the geographic area and retain space for flooding.

- Design for bio-diversity – use green infrastructure solutions, leverage biomimicry where possible and recognize the diversity of species and habitats.

- Adaptive Control - Instrumental & Control in conjunction with mechanical improvements.

5.1.1 Bell Acres Stormwater Management

Bell Acres relies on E1 Branch for sufficient outlets. The proposed design makes design grade line improvements as shown in yellow.

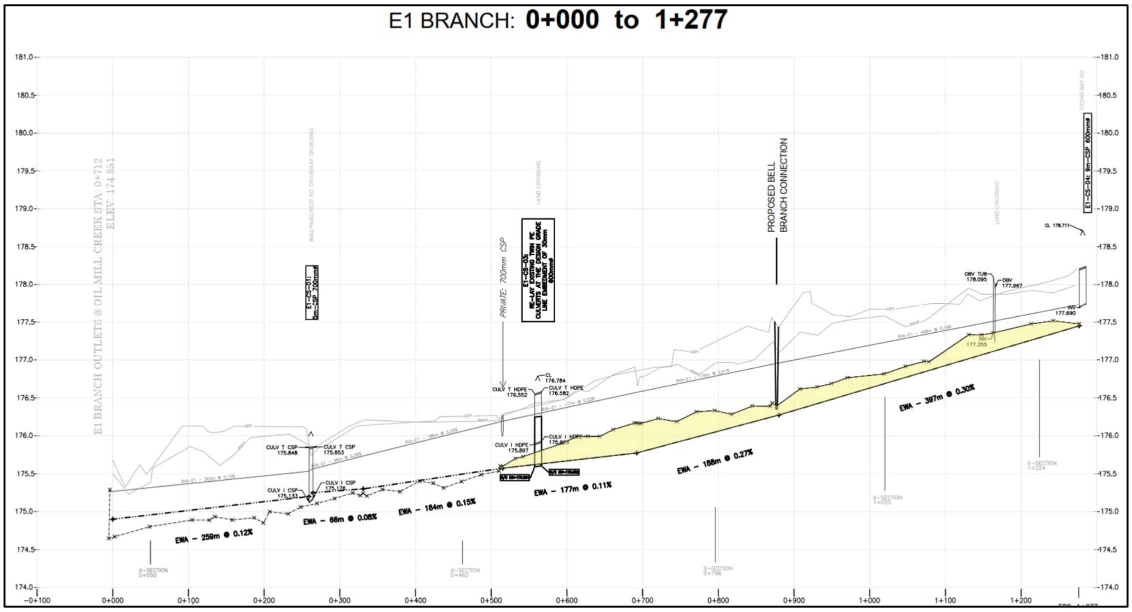


Figure 29 Proposed E1 Grade Line Improvements

Identified above are the Proposed Bell Branch Outlet and the proposed lower connection invert. This provides for a lower grade line in the proposed Bell Branch as shown in the following figure.

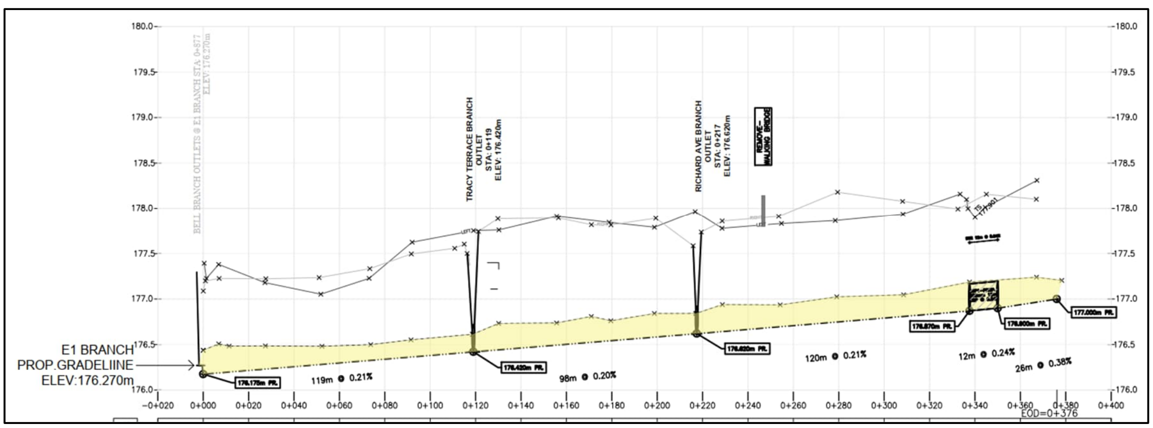


Figure 30 Proposed Bell Branch Improvements

5.1.2 Outlet Simulation

The existing outlet is fixed in grade line geometry and pipe sizes with limited to no options for making changes without incurring significant costs. The key observation to be made of the existing outlet arrangement is the low bank or channel depth from station 200 to 600m. The following figure uses the model profile of the outlet with an overlay of surveyed values to indicate the flood depth above the top of the bank for the pipes to the outlet to be full. This requires a total depth of over 1.5m

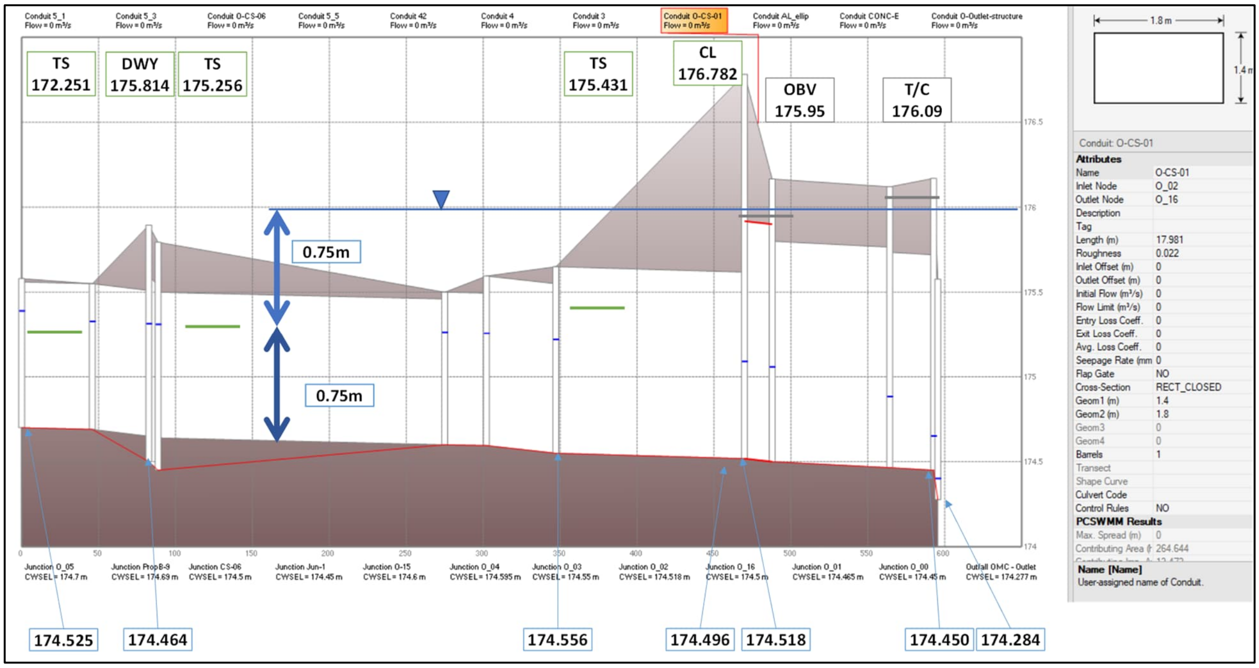


Figure 31 Outlet Parameters

5.1.3 Peak Runoff Management

The model goal is to demonstrate that the proposed drain improvements are ‘better’ for the watershed overall, that one area of the watershed is not improved at the expense of other areas but that the watershed as an integrated whole system is balanced for the design case.

The flood zone cases, where the precipitation exceeds the design case are simulated but the design is not adjusted based on the model results.

5.2 Design SWM Model

The following are the techniques used to model the Oil Mill Creek Municipal Drain improvements.

The specific improvements to be modelled are:

- Controlled Runoff from the Bell Acres Subdivision
- Culvert and channel improvements
- Outlet impacts and flow constraints
- Proposed Centennial Wetland for flood storage

5.2.1 Ponding Volumes

The existing watershed has areas that pond or flood regularly. These areas are connected to the drain through low top-of-bank elevations in the existing drain. These areas are also identified as conservation authority-regulated wetlands with restrictions regarding what we can or can't do for drainage. However, in the case of Oil Mill Creek, the wetlands offer a benefit to the watershed. The benefit is storage volume during flood events. When excess runoff can't get through the existing outlet to the lake, it is stored in the drainage system as low land flooding and leading to a wetland forming.

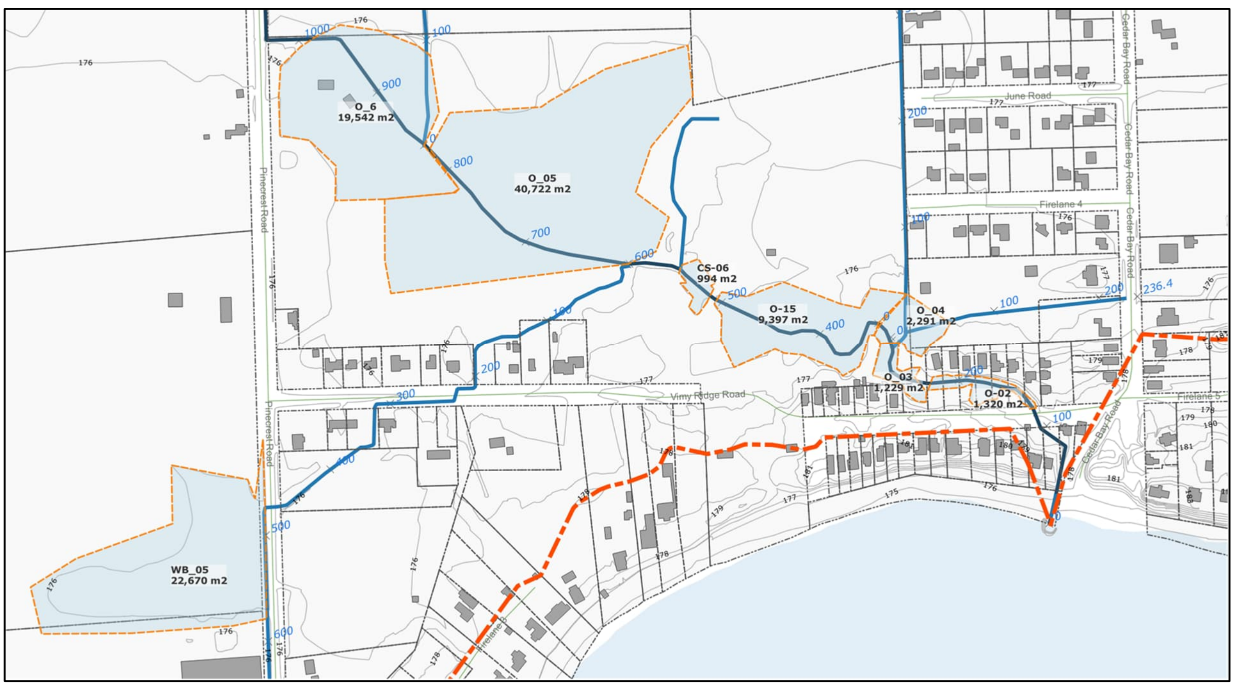


Figure 32 Ponding Volumes @ Junctions

5.2.2 Bell Acres Flow Control

As identified above, Bell Acres is to receive a lower grade line improvement through both E1 Branch and the proposed Bell Branch. As part of this improvement, the runoff from the subdivision branches, three connections, requires a flow control method to slow down the subdivision runoff and reduce the peak flow into the Bell Branch Drain.

5.2.3 Proposed Centennial Wetland

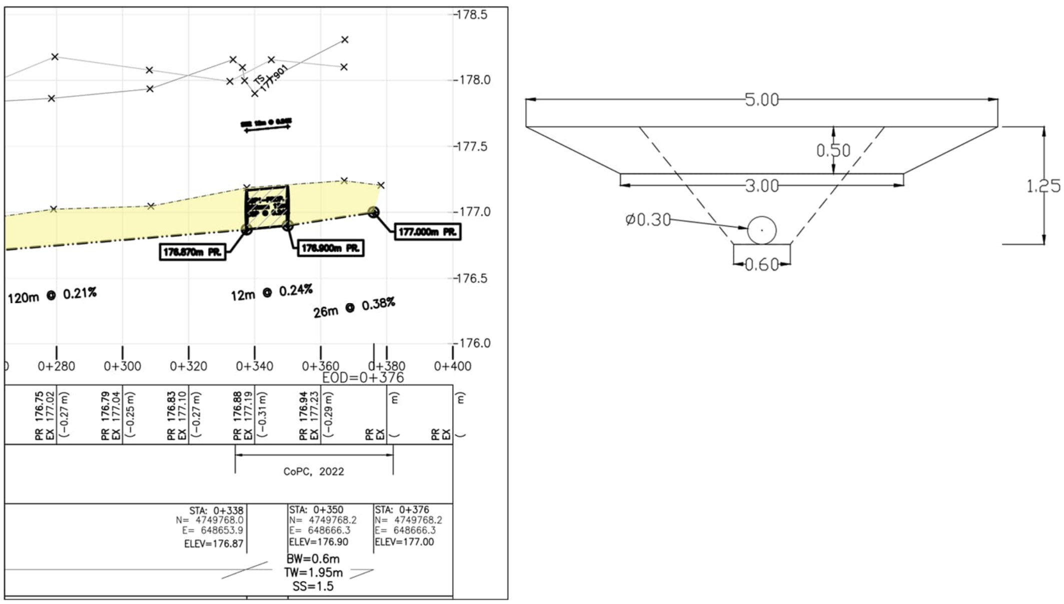


Figure 33 Flow Control Method

The flow control is composed of two elements;

- The first part is a low-flow pipe, constructed on the proposed grade line but sized to cause a restriction in flow from the subdivision.
- The second part is an overflow channel consisting of a wide bottom trapezoidal channel allowing runoff to reach the Bell Branch as an outlet.

5.3 Design Analysis

For the outlet pipe to be flowing fully requires a depth of 175.75m, which exceeds the existing bank full flow by 0.5m at Station 0+600.

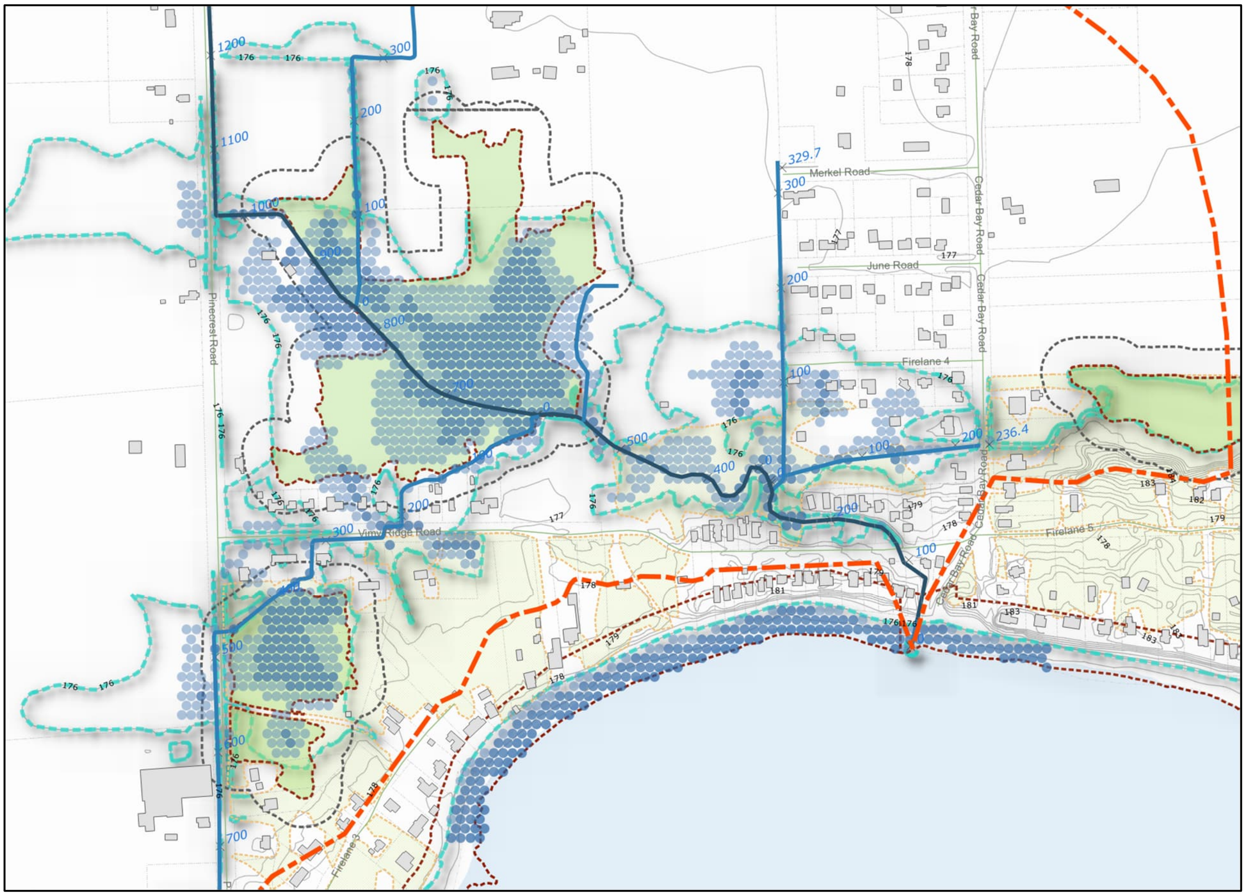


Figure 34 Flooding extends from 175.50 to 175.75 and 176.0

This figure is composed using data from GIS. The building outlines are from Niagara open data (orange). The Oil Mill Creek Drain is the proposed pathway. The 176.0 light blue dashed line is from the 2012 NPCA contour series and the light blue shaded areas are based on the NPCA 2012 DEM 10m grid with only those ground surface elevation or points lower than (below) 175.75m highlighted. This reveals areas with some amount of water above. These are existing conditions unaffected by the modelling or any other performance aspect of the watershed. This is the existing and future condition of the geography of the area which is a constraint in the design of the municipal drain.

5.4 Stormwater Management

The model is implemented with all of the recommended grade line elevations from the proposed drawings. The SWM model is configured for the following design elements:

- Flow control elements consisting of a low flow pipe and overflow broad crested weir on the three outlet channels for the Bell Acres Subdivision

- Centennial Wetland with two distinct water storage areas; a west pond with a direct hydraulic connection and a weir-controlled entrance east pond with a permanent pool.

- Improved culverts to address structural and hydraulic issues.

- Controlled closed conduit outlet consisting of ellipse concrete and Aluminized steel pipe as per drawings. The flow restriction from the existing and future flap gates is not modelled.

The runoff flow control for the Bell Acres subdivision is successful as demonstrated in the following figure.

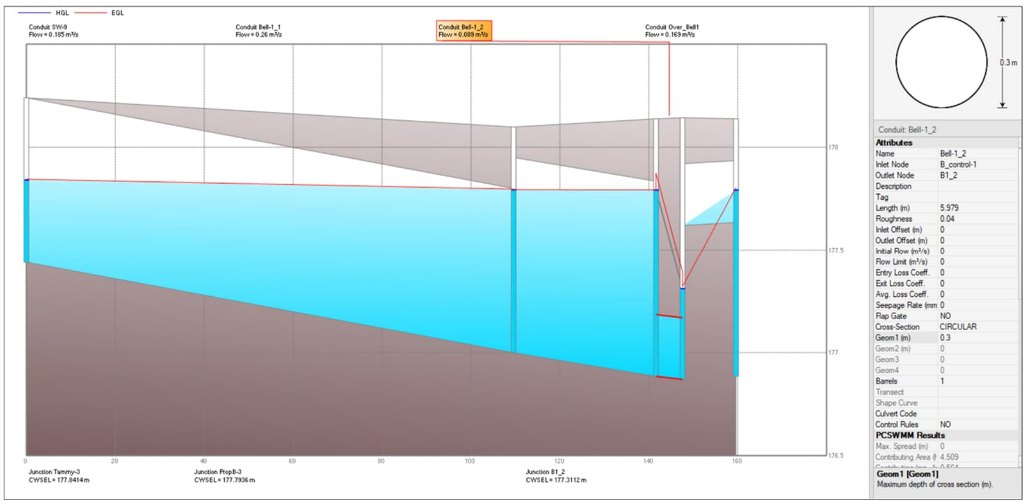


Figure 35 Flow Control - Bell 1,2,3

This shows that the controlled flow pipe is backing up water, restricting or limiting flow with a small depth of flow running over the overflow channel into the Bell 1 Branch outlet. The use of the 300mm pipe is determined or controlled by the receiving channel elevation as this affects the head upstream of the pipe determining the flow through the pipe.

The peak runoff is recorded in the model as 260 lps and the 300mm pipe controls the peak to 96 lps with an additional peak flow coming from the overflow swale of 169 lps. The higher the inverts on the overflow swale the better the low-flow pipe performs.

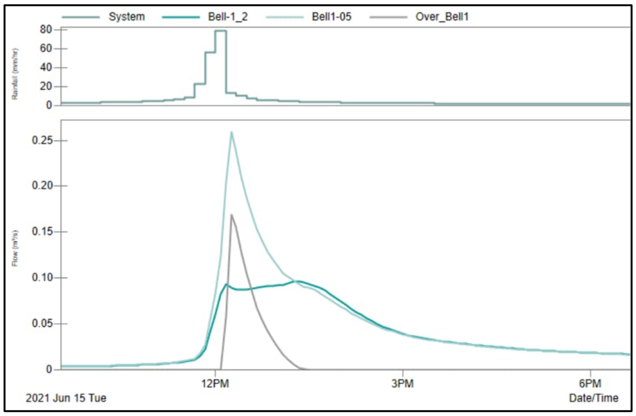
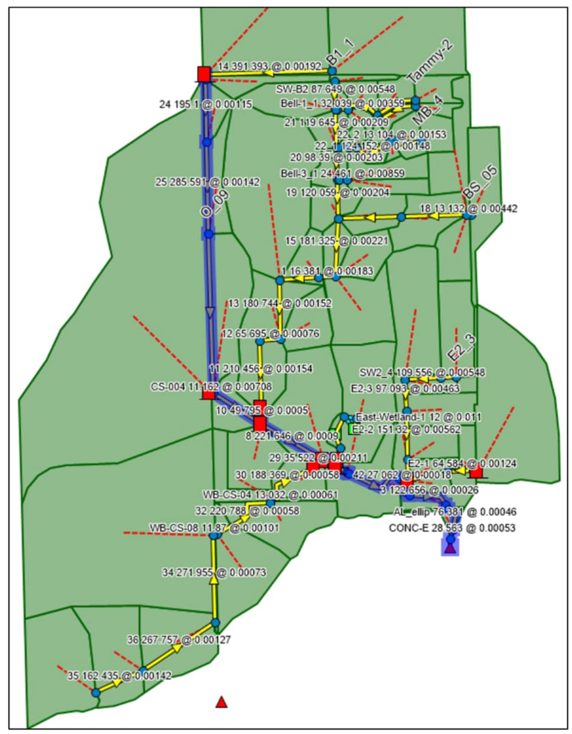


Figure 36 Bell Acres Control Flow Hydrographs

While this proposed measure is effective it does not provide a comparison of post development to pre-development flow. This was not used as a criterion for selection or evaluation of alternatives.

The following are two windows of the Oil Mill Creek Drain model.



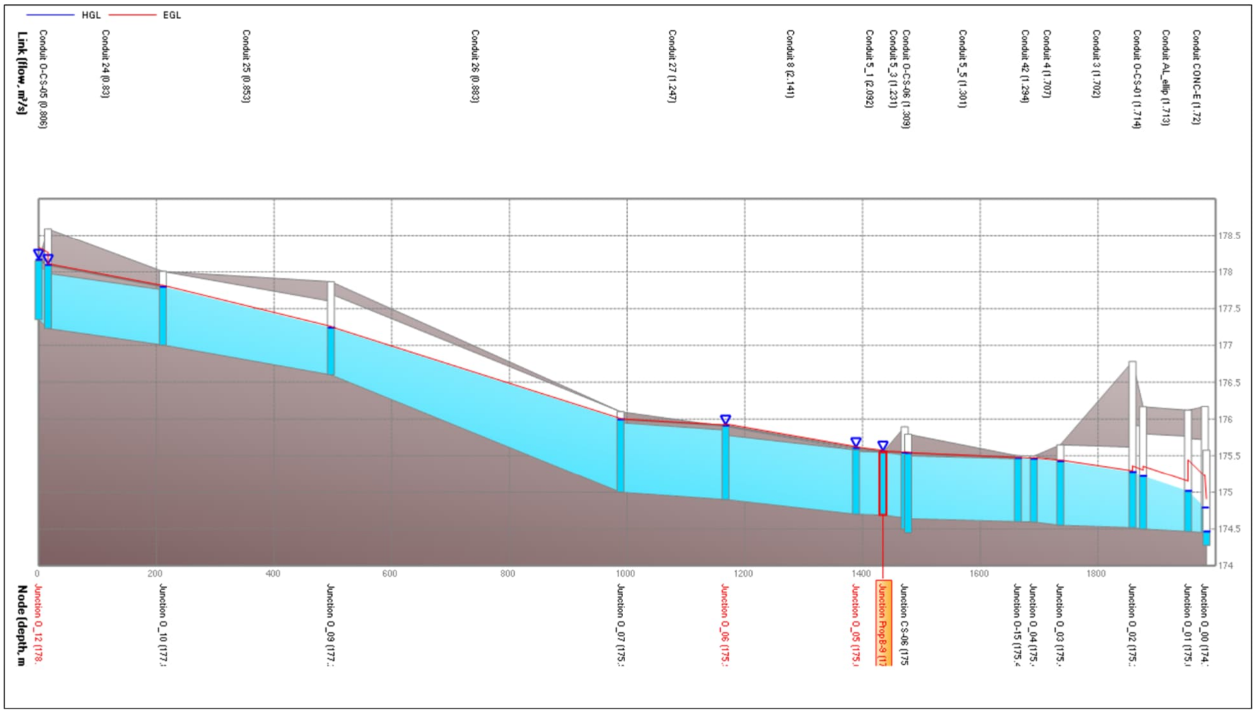


Figure 37 PC-SWMM Model views

Each window shows the model result when using controlled runoff. The flooding that would have been made worse is not avoided but it is less through the use of the outflow control pipes to slow the peak runoff from the three subdivision stormwater runoff connections.

5.4.1 Centennial Wetland Performance

The addition of a storage system within Centennial Park was evaluated for cost and benefit. The benefit of having storage is to reduce the extent of the peak flow attempting to flow out through the outlet and inducing more flooding. The wetland adds storage space to the already existing wetland that exists within the west side of Centennial Park.

The wetland is proposed to have two halves segregated by an access path for future maintenance if required.

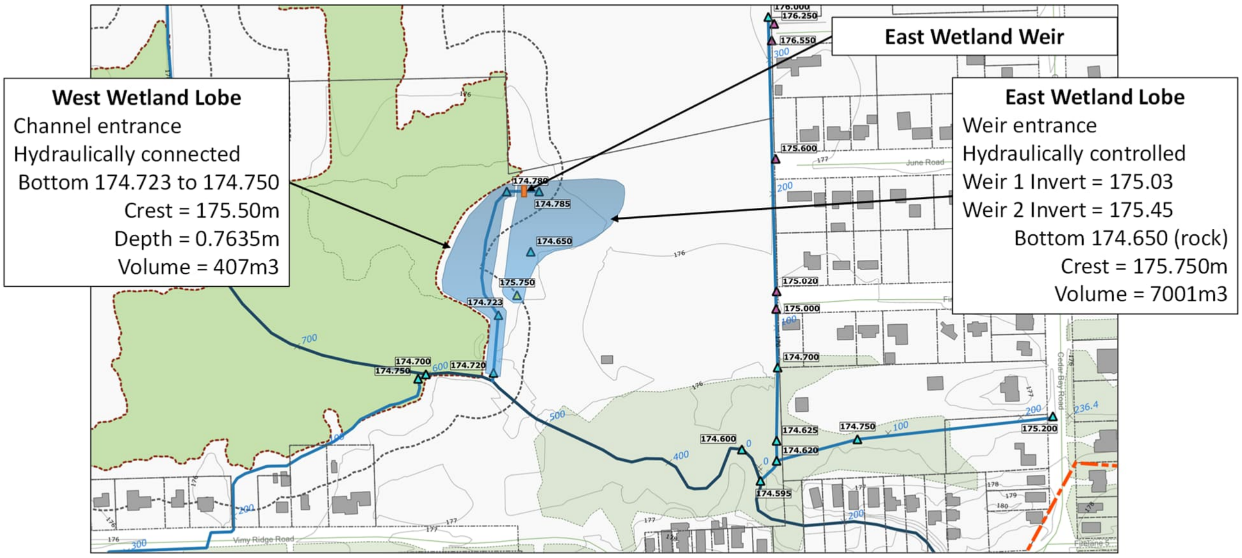


Figure 38 Centennial Wetland

The following at the key components of the proposed wetland.

- West wetland is connected to Oil Mill Creek Drain through a trapezoidal channel with a positive slope to the outlet. This is the bottom of the west lobe of the wetland. U/S invert = 174.80 to D/S invert 174.723. 150m @ 0.04%
- West wetland volume is estimated at 407m^3.
- East wetland is connected to the West wetland lobe through a trapezoidal channel and a weir.
- The weir has two notches. Notch 1 is low (175.03) and controls low flows into the East wetland. Notch 2 is higher (175.45) and allows a higher rate of flow into and out of the East wetland.
- The bottom of the East wetland is proposed as 174.65 which is survey tested as rock within the area of the East wetland. This is proposed as a permanent pool at a depth of 0.38m controlled by the low weir notch elevation. The volume reported for the East Wetland is 8073 with a permanent pool volume of 1072 for a total detained volume of 7001m^3.
- The East wetland also has an overflow weir, which is more of a relief area than an effective spill zone.

The function of the wetland was modelled and the result is shown in the following figure of runoff hydrographs. There are 5 hydrographs shown along with the design storm as a precipitation event.

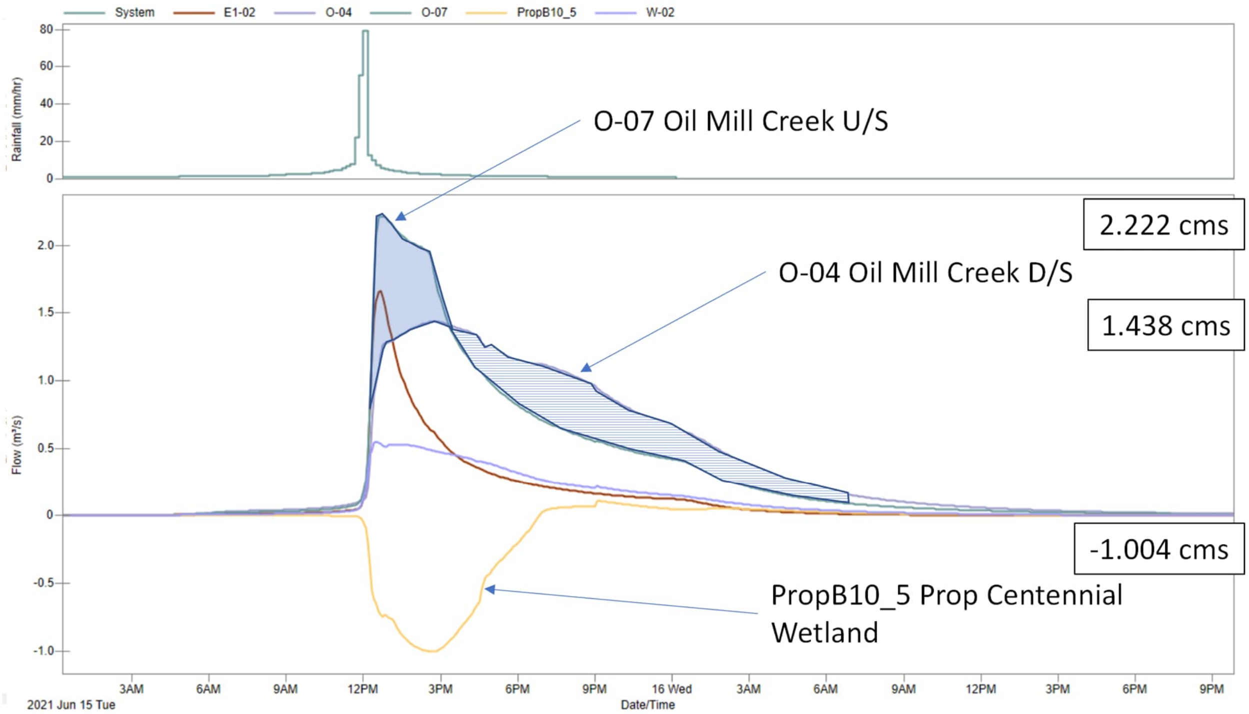


Figure 39 OMC Runoff & Centennial Wetland Hydrographs

Hydrograph O-07 is upstream of the wetland entrance and is considered the input hydrograph as part of the Oil Mill Creek main drain.

Hydrograph O-04 is downstream of the wetland entrance and is considered the wetland-modified hydrograph. This hydrograph is the result of the installation of the wetland.

Hydrograph W-02 is the runoff hydrograph from the West Branch of Oil Mill Creek and is added to the input hydrograph before connecting to the wetland.

Hydrograph E1-02 is upstream of the wetland and is the runoff from the E1 Branch of Oil Mill Creek with the new grade line and flow-controlled outlets.

Hydrograph PropB10_5 is the flow into the west channel of the wetland. It is negative because the channel is a positive grade to the outlet and this indicates that it runs backwards for the wetland to function as per design.

The interpretation of these model results is as follows:

1. The two shaded areas are a comparison between the input hydrograph and output hydrograph with the implication being the volume between the peak hydrograph and the output hydrograph is stored within the wetland and/or system.

2. The outlet and configuration of the model can also have an impact on the runoff hydrograph.

3. The indication from the reverse hydrograph is the flow entering the wetland both east and west.

4. The peaky flow indicated from E1 is modified into a slower longer duration peak flow as shown in O-04.

5. This analysis shows a reduction in peak flow from 2.2 cms to 1.4 cms and confirms that the wetland is providing a benefit to the system overall. The reduction is probably not solely a result of the wetland and related to the overall function of the outlet.

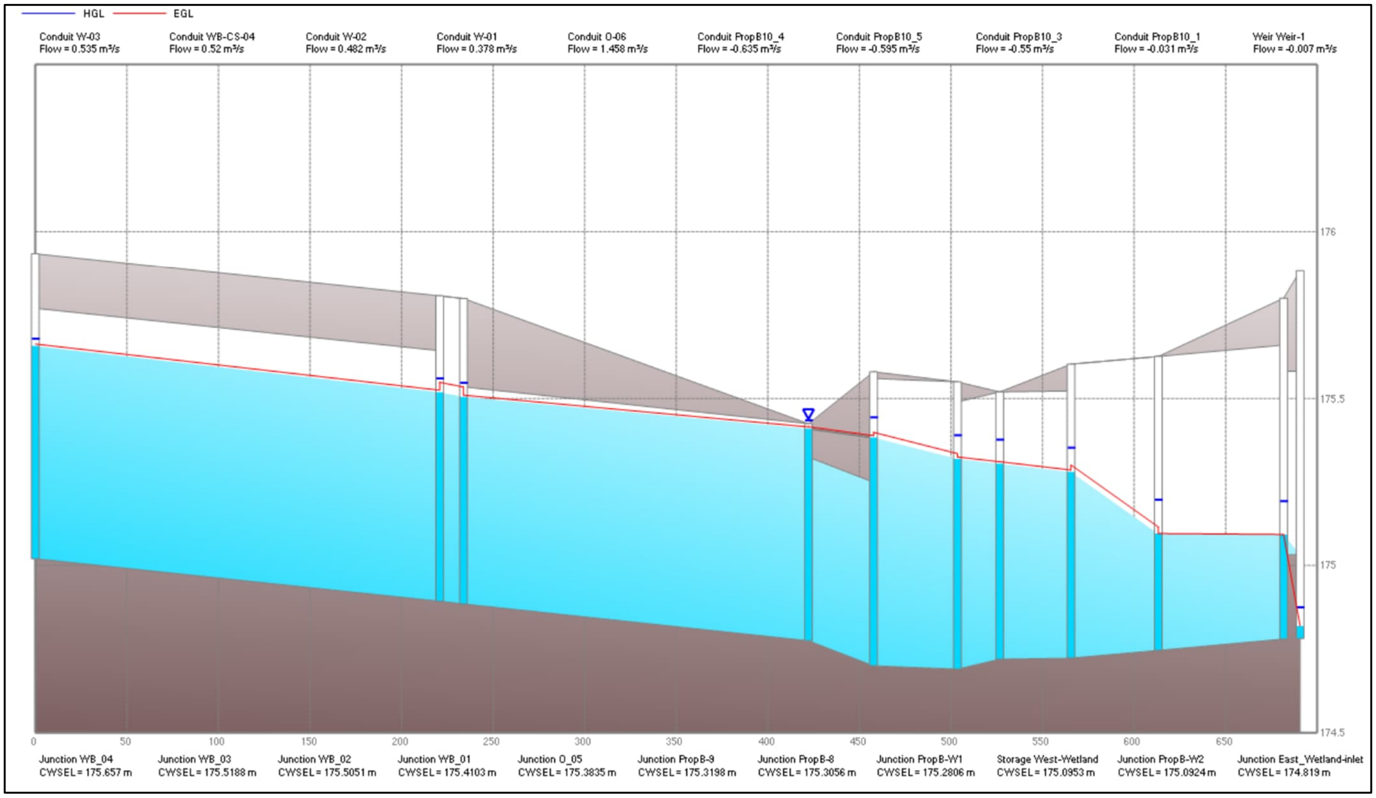


Figure 40 West Branch Elevations & Centennial Wetland

This profile from the model shows that the Centennial wetland is still filling when the West Branch is running full. The objective of the inverts selected for the West wetland channel is to preferentially accept flows from the OMC Drain before the West Branch is running full.

The West Branch invert at Pinecrest Rd is 175.657.

The Centennial Wetland invert at the path (bridge) is 175.28 which is 0.377m lower than the invert at Pinecrest Rd.

5.4.2 PMP Storm Results

The Probable Maximum Precipitation (PMP) storm is a model result to identify the extent and severity of flooding that would likely occur within the Oil Mill Creek Watershed. For this case, we are using the same type of storm shape, SCS 24-hour storm with the Intensity Duration Frequency (IDF) forecast volume of

121mm, which is the 1:100 year event prediction based on the existing precipitation record.

Environment Canada provides a variety of climate-adjusted data for consideration as Engineering data. There are a variety of model results and prediction scenarios to consider and for comparison with the historical values used in the model here are the predicted 100-year value impacts.

- The historical average rain rate for IDF 1:100 is given as 5mm (5x24 = **120mm**)
- CMIP 5 – RCP 4.5 forecasted rate 1:100 2051 – 2080 is 6.6mm (**158.4mm**)
- CMIP 5 – RCP 8.5 forecasted rate 1:100 2051- 2080 is 7.3mm (**175.2mm**)

For our assessment of the PMP, we're using the historical 1:100-year design storm as the use of the future forecast climate storms is not yet recommended for design considerations. There are some model limitations that we recognize with this type of stormwater event modelling. Those are:

- Runoff characteristics vary for extreme events from the antecedent conditions used in the model.
- Existing modelled channels are likely to be exceeded and the conveyance outside of the bank-to-bank modelled flow is not included in the model.
- For some nodes, the model 'leaks' excess flows.

The model result is flooding shown at most node locations.

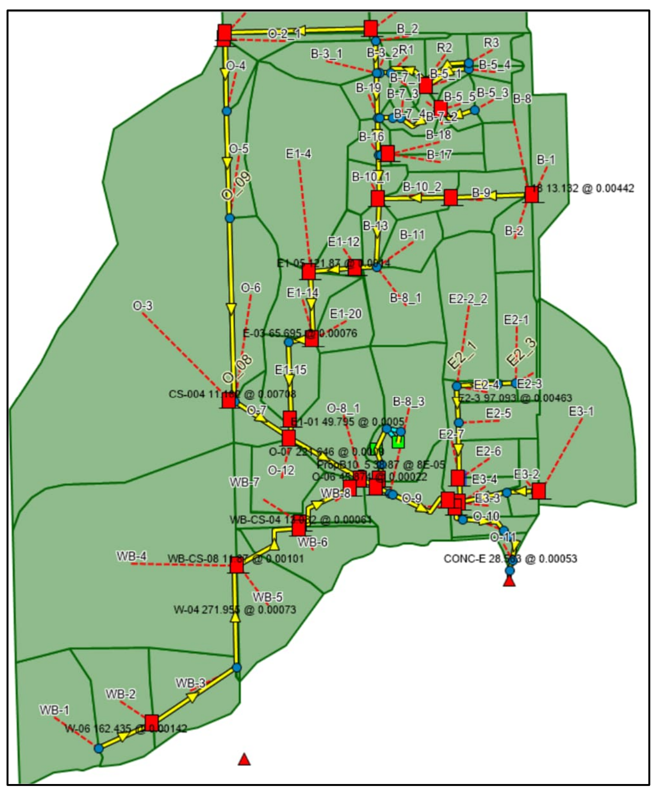


Figure 41 1:100 yr PMP flood prediction

In conclusion, the model prediction is for significant flooding within this watershed for the extreme rainfall scenario.

5.5 SWM Model Summary of Results

The following is a summary of the modelling results.

1. The Bell Acres Subdivision is composed of the proposed Bell Branch Drain, Richard Av Branch Drain and Tracey Branch Drain. E1 and Bell Branch Drain have an improved grade line thereby improving drainage for all of the Bell Subdivision properties.

2. The proposed flow controls, 300mm PE pipe, to limit the peak runoff from the Bell Acres Subdivision was shown to be effective.

3. The proposed culvert replacement at the Friendship Trail is identified as a 900mm dia. culvert which is nearly twice the existing pipe, (500mm CSP). The recommended replacement is a 750mm CSP or double wall PE culvert to improve flow through the culvert but to limit peak flow without flooding downstream OMC sections.
   Note: historical culvert pierced by cabling, Niagara Regional Broadband Network, NRBN.

4. The proposed Centennial wetland with two sides; the West side directly connected to Oil Mill Creek and the East side connected through a flow-controlling weir is effective at reducing the peak flow through the outlet.

5. For the design case, 69mm over 24 hours, there are several flood-identified junctions from the model. Those are:

   a. E3 Culvert crossing Cedar Bay Rd – E3-CS-02 450 PE

   b. The proposed confluence of E2 and E3 indicates some flooding from the low slope outlet to the main OMC channel.

   c. Culvert crossing Friendship Trail east side of Pinecrest Rd – O-CS-05 CSP500

   d. Culvert crossing Richard Ave, CS – 16 CSP 375 showing flooding in the model for the corrected grade line above.

   e. E1 confluence has flooding at the main channel within the existing identified wetland.

   f. West Branch confluence with the main channel and through the park upstream of the existing twin culverts crossing.

6. The model does show improvements in watershed performance with the proposed grade line improvements with the stormwater management features; Bell Acres controlled flow outlets and the Centennial Park Wetland.

6 Oil Mill Creek Watershed Summary

The following summarizes the results of the hydrology and hydraulic analysis.

1. Overall Oil Mill Creek has some flooding points for the design storm, with 68.9mm of precipitation in 24 hours.
    a. The model indicates that the grade line to the lake is compromised. Runoff is delivered at a peak flow rate greater than the capacity of the existing pipe to the lake can convey. The pipe to the lake appears to be deficient in total capacity of conveyance without flooding north of Vimy Ridge Rd.

2. The portion of the drain compromised for capacity is the Oil Mill Creek drains through the existing park where the positive slope to the Vimy Ridge Rd crossing has been lost from channel deepening. The proposed riffle, run and plunge pool upstream and downstream of the twin culverts is to recover this grade over the next 30 years.

3. The upper portions of the drain are functioning and have a positive slope such that a sufficient working drain is achieved.

4. The West Branch is compromised but has a positive slope but with a very low grade to the outlet at the Oil Mill Creek main drain within the defined NPCA wetland boundaries. The past maintenance that has been done in patchwork areas appears to have resulted in unimproved sections that impede and degrade the overall performance of the drain when the drain's conveyance capacity was already minimally achieving the design target. The historical presence of rock outcrops within the drain channel complicates past cleaning efforts.

    a. The west branch could be improved through a targeted controlled excavation to design a grade line with associated culvert improvements.

    b. West Branch improvement is limited by the available slope to a sufficient outlet.

5. The E1 proposed grade line improves the outlet for the proposed Bell Branch. The existing channel can then be improved through a deeper grade line. This improvement is balanced with flow control on existing outlets using culverts and overflow channels. A program to implement green infrastructure solutions upstream to reduce the peak runoff from the subdivision is recommended for consideration by landowners.

6. Most existing culverts can convey to a minimum standard. However, culvert improvements/replacements are needed to address deficiencies in the following two categories:

    a. Structural condition of the culvert is compromised,

    b. Existing design capacity and/or upstream/downstream capacity are compromised.

See the list of deficient culverts Table 9 Oil Mill Creek Drain Crossings

7. Restoration of the existing pump infrastructure can be achieved but is assessed as limited functional value.
    a. Existing discharge piping will require physical assessment for integrity. Assessment will include all physical mounting infrastructure as well as pipe wall integrity.

    b. Pump placement should be reviewed in the context of the existing wet well with regards to performance and capacity where the target flow is 250 lps at 3m TDH.

    c. A cost versus benefit analysis for pumping options should be assessed in the Preliminary Design Report (PDR):

        i. Cost vs Benefit to re-implement the existing pump arrangement, and

        ii. Cost vs Benefit of complete replacement in a new location.

8. The existing Oil Mill Creek outlet control structure is functional but is compromised from a conveyance capacity and existing elevation assessment.
    a. Options to improve the flow capacity through the outlet including improved maintenance capabilities should be considered in the pumping/outlet improvements.

    b. Flap gate operation is an ongoing difficulty that could be addressed through automation.

    c. The Existing 'J' hook break wall to protect the outlet is damaged and requires repair and/or physical improvements.

9. The following deficiencies of the existing Oil Mill Creek Drain are noted for inclusion in the Final Report.

    a. Outlet Breakwall damages,

    b. Flap Gate operation,

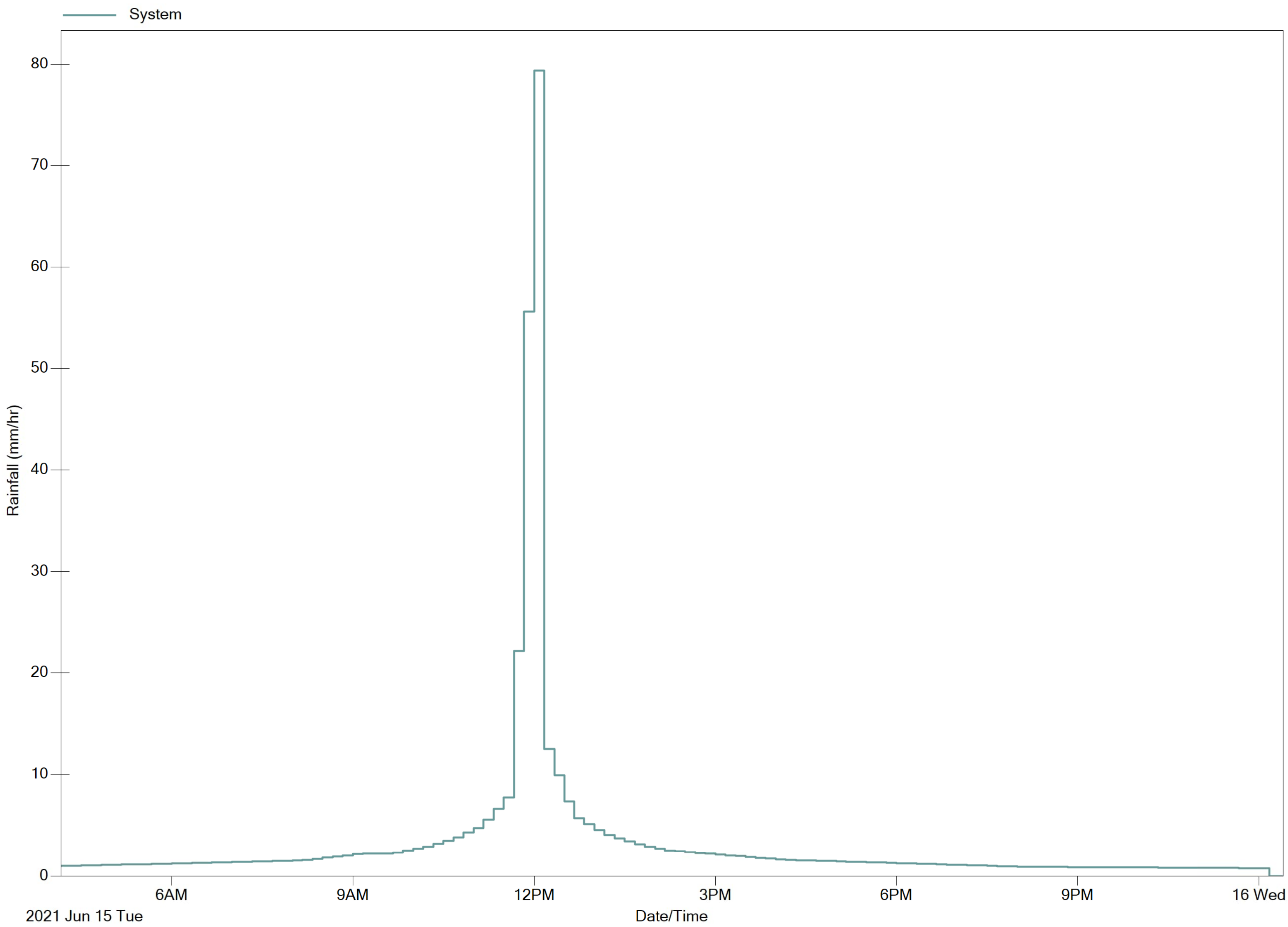
    c. West Branch Grade line,

    d. Culverts with structural deficiencies

    e. Culverts with capacity deficiencies

10. The proposed Wetland with a flow flood storage capability within Centennial Park provides a benefit for peak reduction in the Oil Mill Creek Drain.

Appendix A:
Design Storm Data


System
Rainfall (mm/hr)
80
70
60
50
40
30
20
10
0
6AM
9AM
12PM
3PM
6PM
9PM
16 Wed
2021 Jun 15 Tue
Date/Time

;5-year cumulative storm with a total rainfall amount of 68.90 mm using a SCS Type II 24-hr storm distribution.

24hr-SCS-5yr	0:00	0.00000
24hr-SCS-5yr	0:10	0.11580
24hr-SCS-5yr	0:20	0.23350
24hr-SCS-5yr	0:30	0.35311
24hr-SCS-5yr	0:40	0.47465
24hr-SCS-5yr	0:50	0.59810
24hr-SCS-5yr	1:00	0.72345
24hr-SCS-5yr	1:10	0.85073
24hr-SCS-5yr	1:20	0.97992
24hr-SCS-5yr	1:30	1.11101
24hr-SCS-5yr	1:40	1.24404
24hr-SCS-5yr	1:50	1.37896
24hr-SCS-5yr	2:00	1.51580
24hr-SCS-5yr	2:10	1.65456
24hr-SCS-5yr	2:20	1.79524
24hr-SCS-5yr	2:30	1.93781
24hr-SCS-5yr	2:40	2.08232
24hr-SCS-5yr	2:50	2.22873
24hr-SCS-5yr	3:00	2.37705
24hr-SCS-5yr	3:10	2.52730
24hr-SCS-5yr	3:20	2.67945
24hr-SCS-5yr	3:30	2.83351
24hr-SCS-5yr	3:40	2.98950
24hr-SCS-5yr	3:50	3.14740
24hr-SCS-5yr	4:00	3.30720
24hr-SCS-5yr	4:10	3.46994
24hr-SCS-5yr	4:20	3.63645
24hr-SCS-5yr	4:30	3.80673
24hr-SCS-5yr	4:40	3.98095
24hr-SCS-5yr	4:50	4.15894
24hr-SCS-5yr	5:00	4.34070
24hr-SCS-5yr	5:10	4.52636
24hr-SCS-5yr	5:20	4.71588
24hr-SCS-5yr	5:30	4.90912
24hr-SCS-5yr	5:40	5.10627
24hr-SCS-5yr	5:50	5.30728
24hr-SCS-5yr	6:00	5.51200
24hr-SCS-5yr	6:10	5.72068
24hr-SCS-5yr	6:20	5.93307
24hr-SCS-5yr	6:30	6.14933
24hr-SCS-5yr	6:40	6.36944
24hr-SCS-5yr	6:50	6.59336
24hr-SCS-5yr	7:00	6.82110
24hr-SCS-5yr	7:10	7.05274
24hr-SCS-5yr	7:20	7.28815
24hr-SCS-5yr	7:30	7.52733
24hr-SCS-5yr	7:40	7.77045
24hr-SCS-5yr	7:50	8.01734
24hr-SCS-5yr	8:00	8.26800
24hr-SCS-5yr	8:10	8.53037

24hr-SCS-5yr	8:20	8.81171
24hr-SCS-5yr	8:30	9.11203
24hr-SCS-5yr	8:40	9.43181
24hr-SCS-5yr	8:50	9.77057
24hr-SCS-5yr	9:00	10.12830
24hr-SCS-5yr	9:10	10.49577
24hr-SCS-5yr	9:20	10.86323
24hr-SCS-5yr	9:30	11.23070
24hr-SCS-5yr	9:40	11.61378
24hr-SCS-5yr	9:50	12.02718
24hr-SCS-5yr	10:00	12.47090
24hr-SCS-5yr	10:10	12.95366
24hr-SCS-5yr	10:20	13.48189
24hr-SCS-5yr	10:30	14.05560
24hr-SCS-5yr	10:40	14.69178
24hr-SCS-5yr	10:50	15.40374
24hr-SCS-5yr	11:00	16.19150
24hr-SCS-5yr	11:10	17.11200
24hr-SCS-5yr	11:20	18.21440
24hr-SCS-5yr	11:30	19.49870
24hr-SCS-5yr	11:40	23.18807
24hr-SCS-5yr	11:50	32.45142
24hr-SCS-5yr	12:00	45.68070
24hr-SCS-5yr	12:10	47.76630
24hr-SCS-5yr	12:20	49.41990
24hr-SCS-5yr	12:30	50.64150
24hr-SCS-5yr	12:40	51.58979
24hr-SCS-5yr	12:50	52.43956
24hr-SCS-5yr	13:00	53.19080
24hr-SCS-5yr	13:10	53.86395
24hr-SCS-5yr	13:20	54.48405
24hr-SCS-5yr	13:30	55.05110
24hr-SCS-5yr	13:40	55.57130
24hr-SCS-5yr	13:50	56.05360
24hr-SCS-5yr	14:00	56.49800
24hr-SCS-5yr	14:10	56.91604
24hr-SCS-5yr	14:20	57.32083
24hr-SCS-5yr	14:30	57.71236
24hr-SCS-5yr	14:40	58.09021
24hr-SCS-5yr	14:50	58.45481
24hr-SCS-5yr	15:00	58.80615
24hr-SCS-5yr	15:10	59.14381
24hr-SCS-5yr	15:20	59.46821
24hr-SCS-5yr	15:30	59.77936
24hr-SCS-5yr	15:40	60.07683
24hr-SCS-5yr	15:50	60.36104
24hr-SCS-5yr	16:00	60.63200
24hr-SCS-5yr	16:10	60.89368
24hr-SCS-5yr	16:20	61.15061
24hr-SCS-5yr	16:30	61.40285
24hr-SCS-5yr	16:40	61.65014
24hr-SCS-5yr	16:50	61.89273

24hr-SCS-5yr	17:00	62.13058
24hr-SCS-5yr	17:10	62.36355
24hr-SCS-5yr	17:20	62.59177
24hr-SCS-5yr	17:30	62.81523
24hr-SCS-5yr	17:40	63.03390
24hr-SCS-5yr	17:50	63.24777
24hr-SCS-5yr	18:00	63.45690
24hr-SCS-5yr	18:10	63.66117
24hr-SCS-5yr	18:20	63.86070
24hr-SCS-5yr	18:30	64.05550
24hr-SCS-5yr	18:40	64.24537
24hr-SCS-5yr	18:50	64.43055
24hr-SCS-5yr	19:00	64.61098
24hr-SCS-5yr	19:10	64.78653
24hr-SCS-5yr	19:20	64.95736
24hr-SCS-5yr	19:30	65.12338
24hr-SCS-5yr	19:40	65.28461
24hr-SCS-5yr	19:50	65.44108
24hr-SCS-5yr	20:00	65.59280
24hr-SCS-5yr	20:10	65.74158
24hr-SCS-5yr	20:20	65.88941
24hr-SCS-5yr	20:30	66.03631
24hr-SCS-5yr	20:40	66.18224
24hr-SCS-5yr	20:50	66.32723
24hr-SCS-5yr	21:00	66.47128
24hr-SCS-5yr	21:10	66.61431
24hr-SCS-5yr	21:20	66.75641
24hr-SCS-5yr	21:30	66.89763
24hr-SCS-5yr	21:40	67.03777
24hr-SCS-5yr	21:50	67.17699
24hr-SCS-5yr	22:00	67.31530
24hr-SCS-5yr	22:10	67.45259
24hr-SCS-5yr	22:20	67.58895
24hr-SCS-5yr	22:30	67.72436
24hr-SCS-5yr	22:40	67.85881
24hr-SCS-5yr	22:50	67.99231
24hr-SCS-5yr	23:00	68.12488
24hr-SCS-5yr	23:10	68.25643
24hr-SCS-5yr	23:20	68.38704
24hr-SCS-5yr	23:30	68.51671
24hr-SCS-5yr	23:40	68.64541
24hr-SCS-5yr	23:50	68.77318
24hr-SCS-5yr	24:00	68.90000

Environment Canada/Environnement Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2014/12/21

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PORT COLBORNE ON 6136606

Latitude: 42 53'N Longitude: 79 15'W Elevation/Altitude: 175 m

Years/Années : 1964 - 2007 # Years/Années : 37

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****

Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

****

Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1964	8.6	13.2	14.7	28.4	34.3	45.5	56.9	56.9	64.3
1965	5.8	6.3	8.9	13.7	19.8	26.4	33.0	33.0	42.4
1966	6.9	10.7	10.7	10.7	14.0	15.0	22.1	26.2	26.7
1967	7.6	12.2	17.0	26.2	26.7	26.7	26.7	36.1	59.9
1968	8.1	14.5	16.8	19.8	26.9	42.4	81.3	101.3	112.5
1969	6.9	10.2	12.4	12.7	19.8	22.6	32.0	37.3	43.2
1970	8.4	10.9	12.2	16.0	19.3	20.3	26.4	33.3	39.6
1971	8.1	12.4	15.0	21.8	24.6	25.7	26.7	29.5	30.5
1972	5.8	9.4	13.7	17.3	23.4	23.4	27.4	33.8	36.8
1973	7.6	12.7	17.3	25.4	36.6	37.6	39.4	39.9	40.4
1974	6.9	7.9	8.6	11.7	15.2	25.7	29.7	29.7	33.0
1975	12.7	20.3	24.6	31.7	32.0	32.0	32.5	33.5	33.5
1976	4.8	7.9	9.1	11.4	19.0	23.9	23.9	38.1	47.2
1977	12.2	14.5	16.6	33.3	37.6	37.6	42.2	48.0	51.3
1978	6.9	8.8	11.1	15.5	25.7	31.6	35.5	42.0	42.0
1979	8.0	11.4	16.2	26.0	34.2	47.6	80.6	116.4	123.0
1980	11.1	14.8	15.3	17.0	25.5	32.8	33.8	41.9	44.4
1981	8.2	9.6	9.6	11.6	14.4	25.7	32.9	37.2	44.6
1983	8.0	10.5	15.2	27.4	29.3	32.0	44.2	46.5	56.3
1984	9.8	15.0	18.0	26.9	28.9	30.7	30.8	51.8	54.2
1985	7.6	9.5	10.5	12.5	16.2	17.2	23.7	38.9	54.2
1986	12.4	18.4	21.2	24.7	26.5	30.6	35.1	43.0	46.6
1987	8.1	13.0	15.3	21.9	34.8	46.4	56.5	56.5	69.4
1988	8.0	11.3	12.9	14.7	17.0	20.0	22.7	42.7	47.2

1989	8.7	9.9	10.5	10.8	17.9	20.5	20.7	24.2	27.6
1990	7.2	9.0	13.1	21.8	28.0	32.8	35.9	44.9	50.4
1991	14.2	20.0	29.0	34.0	60.0	64.2	65.0	65.0	65.3
1992	6.0	10.4	13.5	20.4	28.4	30.3	32.3	42.9	46.0
1993	6.7	7.5	8.3	12.1	17.6	24.6	42.3	43.8	46.9
1994	7.2	8.5	11.5	14.3	18.3	24.4	50.4	74.6	86.9
1996	7.6	11.1	14.1	25.7	30.8	34.6	36.0	36.0	40.6
1997	7.6	9.6	12.3	15.5	17.6	23.2	45.8	54.2	58.2
1998	3.6	3.9	4.4	5.5	7.1	10.5	18.2	26.2	46.5
1999	9.4	14.1	16.6	20.7	22.2	29.7	38.5	45.0	49.2
2000	6.8	7.4	7.4	8.3	8.5	13.5	24.3	30.3	41.0
2005	7.0	9.6	11.6	18.9	30.9	41.8	83.2	100.9	104.5
2006	8.4	10.8	13.7	22.2	29.6	31.2	33.4	44.0	64.5
2007	10.4	16.8	18.8	25.5	28.2	28.2	28.4	-99.9	56.0
# Yrs. Années	38	38	38	38	38	38	38	37	38
Mean Moyenne	8.1	11.4	13.9	19.3	24.9	29.7	38.2	46.6	53.3
Std. Dev. Écart-type	2.2	3.6	4.7	7.3	9.6	10.5	16.6	20.9	21.6
Skew. Dissymétrie	0.91	0.70	0.96	0.22	1.10	0.97	1.53	2.03	1.81
Kurtosis	4.46	3.83	5.32	2.40	6.69	5.12	5.02	7.16	6.52

*-99.9 Indicates Missing Data/Données manquantes

Warning: annual maximum amount greater than 100-yr return period amount
Avertissement : la quantité maximale annuelle excède la quantité
pour une période de retour de 100 ans

Year/Année	Duration/Durée	Data/Données	100-yr/ans
1979	12 h	116.4	112.3
1979	24 h	123.0	121.1
1991	15 min	29.0	28.6
1991	1 h	60.0	55.0
1991	2 h	64.2	62.7

****

Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	7.8	9.7	11.0	12.6	13.7	14.9	38
10 min	10.8	14.0	16.1	18.7	20.7	22.7	38
15 min	13.1	17.3	20.0	23.5	26.0	28.6	38
30 min	18.1	24.5	28.8	34.1	38.1	42.1	38
1 h	23.3	31.8	37.4	44.5	49.8	55.0	38
2 h	28.0	37.3	43.4	51.2	57.0	62.7	38

6 h	35.4	50.1	59.8	72.0	81.1	90.1	38
12 h	43.2	61.7	73.9	89.4	100.9	112.3	37
24 h	49.8	68.9	81.5	97.5	109.3	121.1	38

****

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	93.4	116.3	131.5	150.7	164.9	179.0	38
	+/- 7.6	+/- 12.8	+/- 17.2	+/- 23.2	+/- 27.8	+/- 32.4	38
10 min	65.0	84.0	96.6	112.4	124.2	135.9	38
	+/- 6.3	+/- 10.6	+/- 14.3	+/- 19.2	+/- 23.0	+/- 26.8	38
15 min	52.5	69.0	80.0	93.9	104.2	114.4	38
	+/- 5.5	+/- 9.2	+/- 12.5	+/- 16.8	+/- 20.1	+/- 23.4	38
30 min	36.2	49.1	57.6	68.3	76.2	84.1	38
	+/- 4.2	+/- 7.1	+/- 9.6	+/- 13.0	+/- 15.5	+/- 18.1	38
1 h	23.3	31.8	37.4	44.5	49.8	55.0	38
	+/- 2.8	+/- 4.7	+/- 6.4	+/- 8.6	+/- 10.3	+/- 12.0	38
2 h	14.0	18.6	21.7	25.6	28.5	31.4	38
	+/- 1.5	+/- 2.6	+/- 3.5	+/- 4.7	+/- 5.6	+/- 6.6	38
6 h	5.9	8.3	10.0	12.0	13.5	15.0	38
	+/- 0.8	+/- 1.4	+/- 1.8	+/- 2.5	+/- 3.0	+/- 3.4	38
12 h	3.6	5.1	6.2	7.5	8.4	9.4	37
	+/- 0.5	+/- 0.9	+/- 1.2	+/- 1.6	+/- 1.9	+/- 2.2	37
24 h	2.1	2.9	3.4	4.1	4.6	5.0	38
	+/- 0.3	+/- 0.4	+/- 0.6	+/- 0.8	+/- 1.0	+/- 1.1	38

****

Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)
RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)
T = Rainfall duration (h) / Durée de la pluie (h)

****

Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	32.9	42.8	49.4	57.7	63.8	69.9
Std. Dev. /Écart-type (RR)	31.8	39.9	45.3	52.2	57.2	62.3
Std. Error/Erreur-type	6.6	9.6	11.7	14.3	16.3	18.2
Coefficient (A)	20.2	27.1	31.7	37.4	41.6	45.9
Exponent/Exposant (B)	-0.680	-0.661	-0.653	-0.645	-0.641	-0.638
Mean % Error/% erreur moyenne	8.3	9.1	9.5	10.0	10.3	10.5

Ontario IDF CURVE LOOKUP

Active coordinate

42° 52' 45" N, 79° 15' 14" W (42.879167,-79.254167)

Retrieved: Mon, 10 Apr 2023 12:54:20 GMT

Location summary

These are the locations in the selection.

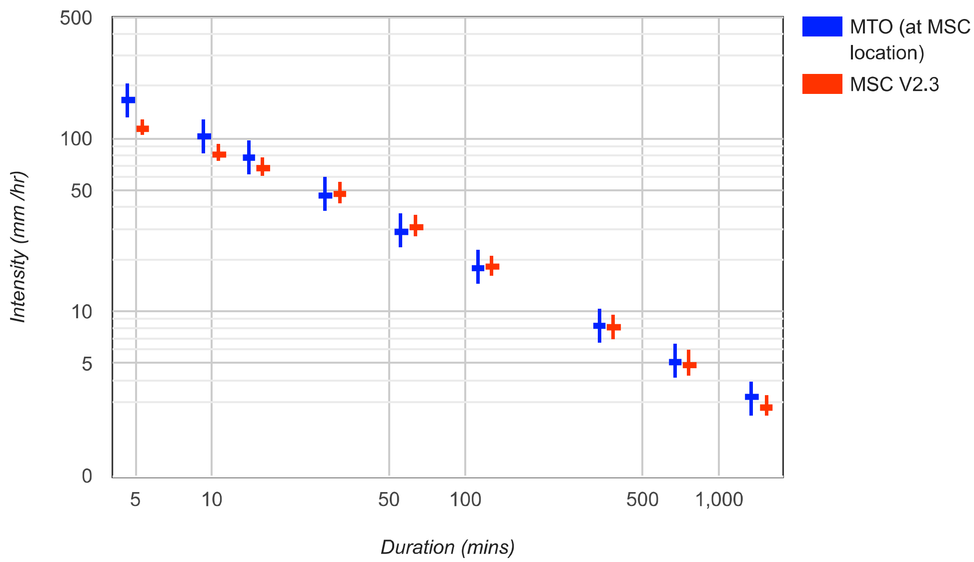
IDF Curve: 42° 52' 45" N, 79° 15' 14" W (42.879167,-79.254167)

Results

An IDF curve was found.

Return period: 5-yr Modify selection

Coordinate: 42.879167, -79.254167 (RT: 5-yr)
IDF curve year: 2010



Coefficient summary

IDF Curve: 42° 52' 45" N, 79° 15' 14" W (42.879167,-79.254167)

Retrieved: Mon, 10 Apr 2023 12:54:20 GMT

Data year: 2010
IDF curve year: 2010

A: 30 (+6.8, -6.8)

B: -0.699

Statistics

Rainfall intensity (mm hr^{-1})

	Data Set	5-min		10-min		15-min		30-min		1-hr		2-hr		6-hr		12-hr		24-hr	
	MTO (at MSC location)	170.4	+38.7	105.0	+23.8	79.1	+17.9	48.7	+11.1	30.0	+6.8	18.5	+4.2	8.6	+1.9	5.3	+1.2	3.3	+0.7
			-38.7		-23.9		-18.0		-11.1		-6.8		-4.2		-2.0		-1.2		-0.8
	MSC V2.3	116.3	+12.8	84.0	+10.6	69.0	+9.2	49.1	+7.1	31.8	+4.7	18.6	+2.6	8.3	+1.4	5.1	+0.9	2.9	+0.4
			-12.8		-10.6		-9.2		-7.1		-4.7		-2.6		-1.4		-0.9		-0.4

Rainfall depth (mm)

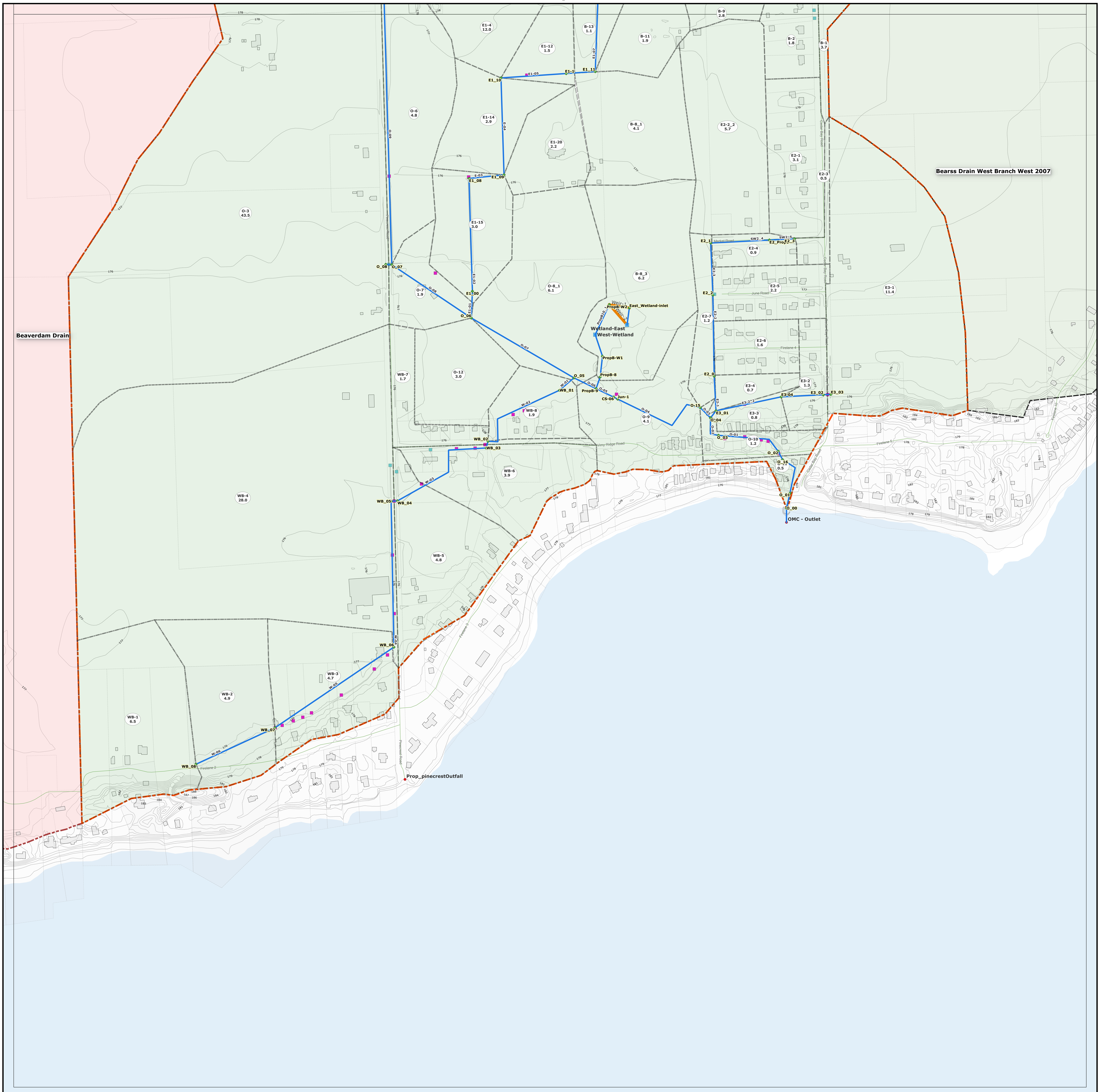
	Data Set	5-min		10-min		15-min		30-min		1-hr		2-hr		6-hr		12-hr		24-hr	
	MTO (at MSC location)	14.2	+3.2	17.5	+4.0	19.8	+4.5	24.4	+5.5	30.0	+6.8	37.0	+8.4	51.4	+11.6	63.4	+14.6	78.1	+17.9
			-3.2		-4.0		-4.5		-5.6		-6.8		-8.4		-11.8		-14.2		-18.1
	MSC V2.3	9.7	+1.1	14.0	+1.8	17.3	+2.3	24.6	+3.5	31.8	+4.7	37.2	+5.2	49.8	+8.4	61.2	+10.8	69.6	+9.6
			-1.1		-1.8		-2.4		-3.6		-4.7		-5.2		-8.4		-10.8		-9.6

Terms of Use

Appendix B:

Oil Mill Creek Watershed Model & Figures

Oil Mill Creek Municipal Drain



200 0 200 400 m

Map Scale: 1:2,400

Figure : Oil Mill Creek Municipal Drain

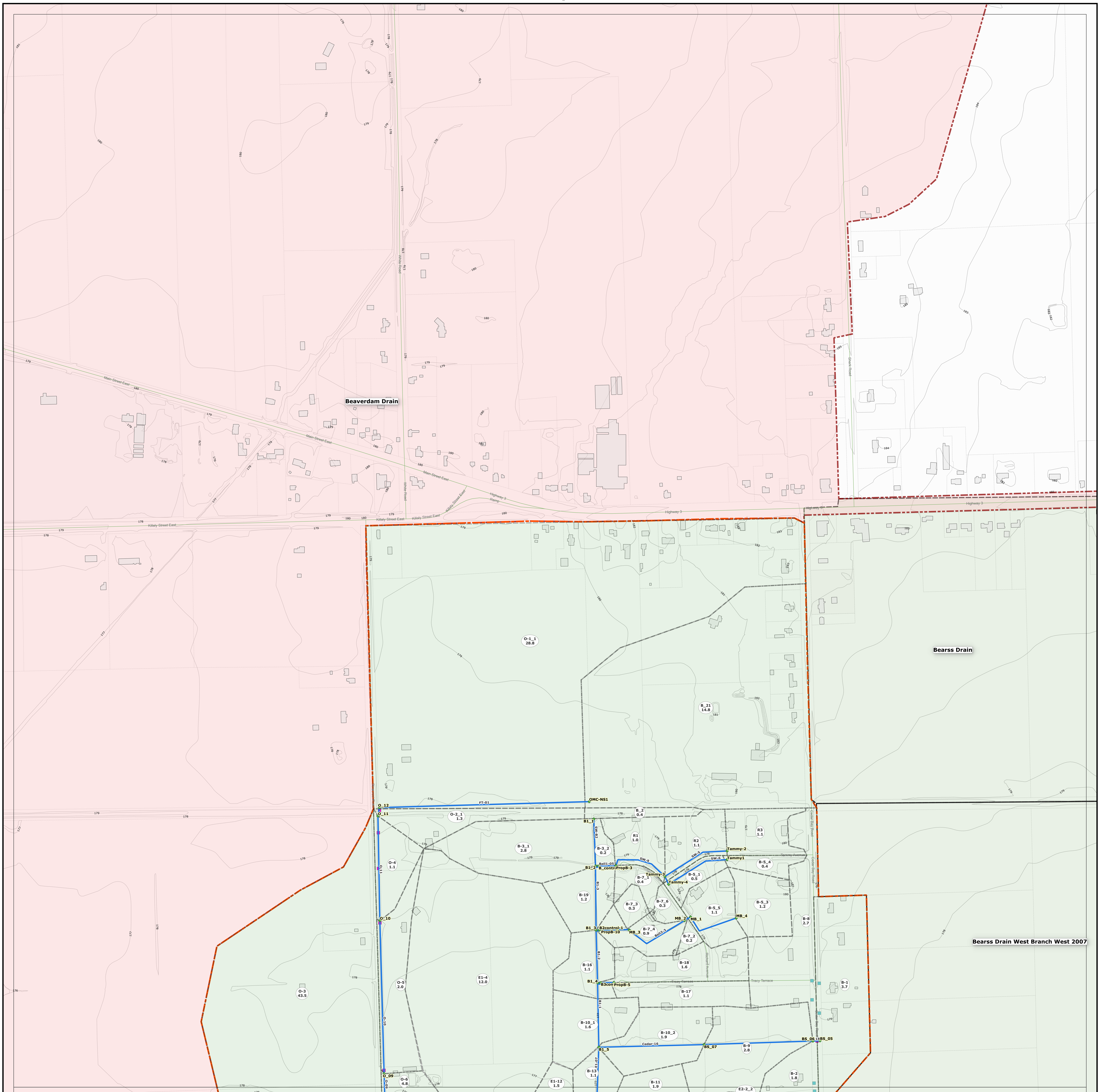
Stormwater Management Model

OMC_SWM_101_Post Control
Junctions
Conduits
Outfalls
Storages
Subcatchments
Weirs
OMC_MapBook
crossings
OMC
ROW
OldMill_catchment
BuildingFootprints
Roads
CofPC Drains
Beaverdam_Drain_Boundary
Bearss_WBW
Current Parcel data - 202211
Ownership_Parcels
Contours
Lake_&_Canal

EARTH WATER AIR ENGINEERING

Printed on: 2023-04-10

Oil Mill Creek Municipal Drain



200 0 200 400 m

Map Scale: 1:2,400

OMC_SWM_101_Post Control
Junctions
Conduits
Subcatchments
OMC_MapBook
crossings
OMC
ROW
OldMill_catchment
BuildingFootprints
Roads
CofPC Drains
Beaverdam_Drain_Boundary
Bearss_WBW
Current Parcel data - 202211
Ownership_Parcels
Contours

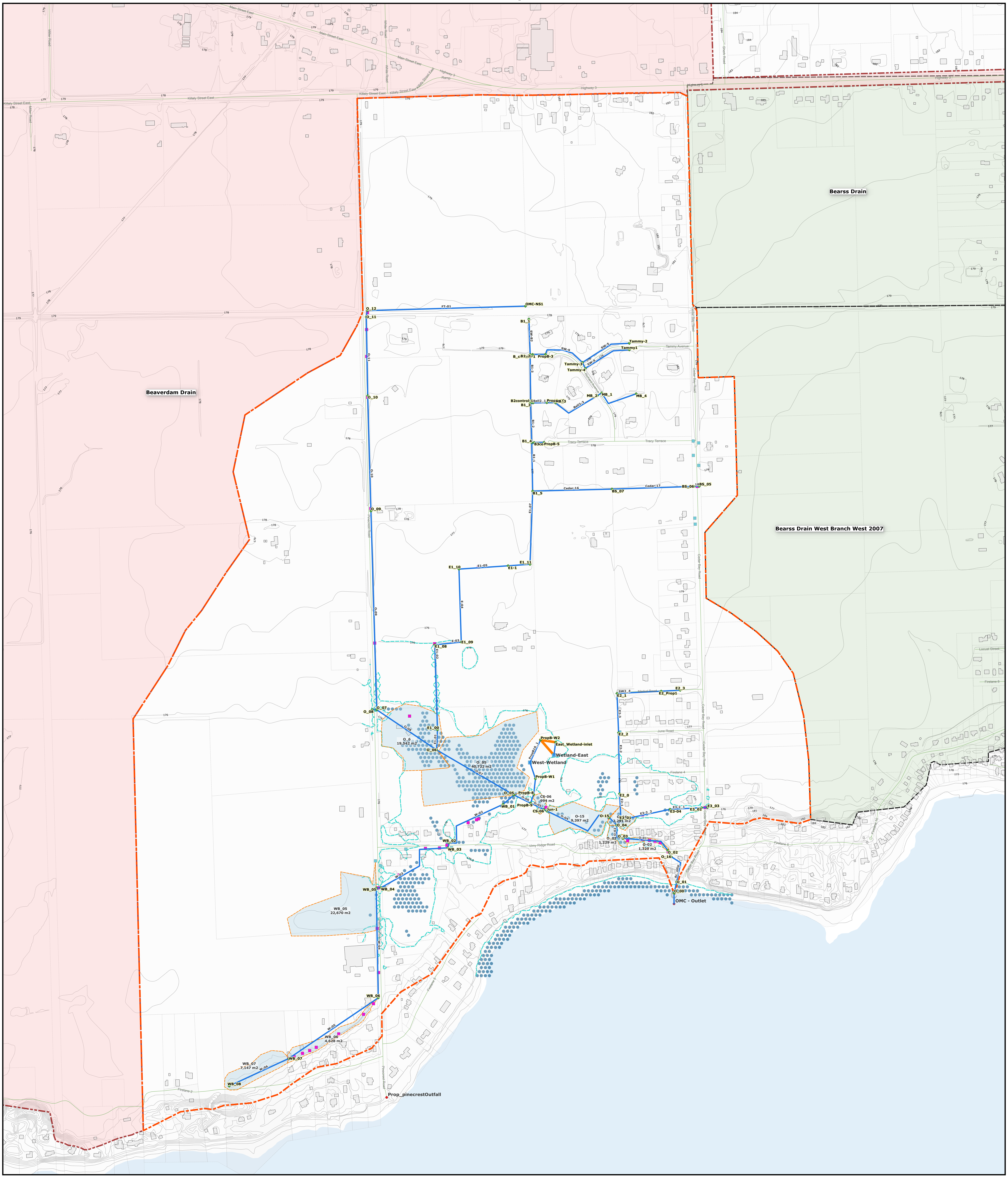
Figure : Oil Mill Creek Municipal Drain

Stormwater Management Model

EARTH WATER AIR ENGINEERING

Printed on: 2023-04-10

Oil Mill Creek Municipal Drain



200 0 200 400 m

Map Scale: 1:3,000

Figure : Oil Mill Creek Municipal Drain

Stormwater Management - Existing Flood Zones

OMC_SWM_101_Post Control
- Junctions
- Conduits
- Outfalls
- Storages
- Weirs

crossings
- OMC
- ROW

- OldMill_catchment
- Flood zones
- BuildingFootprints
- Roads

CofPC Drains
- Beaverdam_Drain_Boundary

- Bearss_WBW

Current Parcel data - 202211
- Ownership_Parcels

ortho_pts_Elevation_b
- 176.0
- ortho_pts >= 175.5
- Contours
- Lake_&_Canal

EARTH WATER AIR ENGINEERING

Printed on: 2023-04-10

Oil Mill Creek Municipal Drain

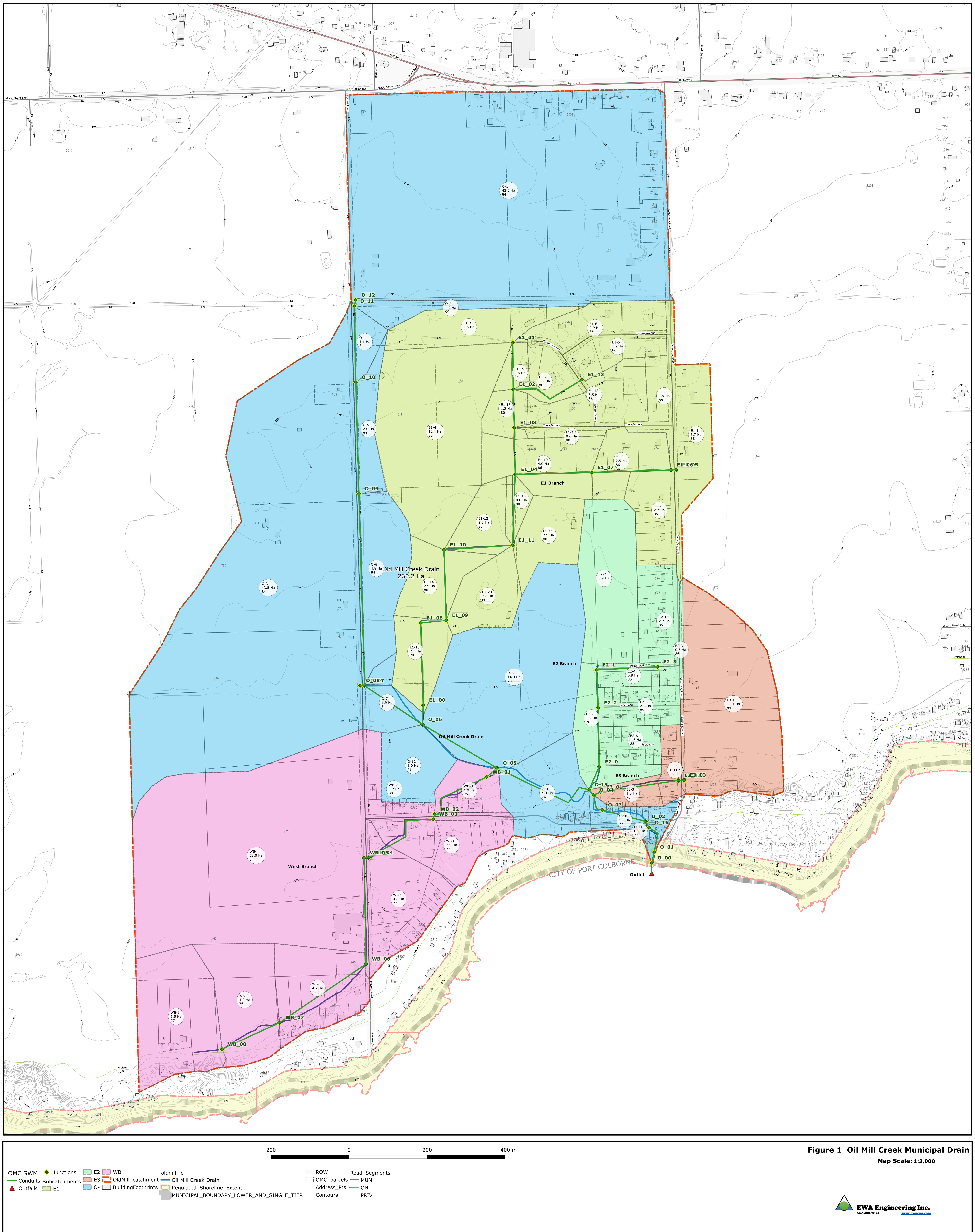


Figure 1 Oil Mill Creek Municipal Drain

Appendix C:

Model Output Files

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.3)
------------------------------------------------------------

WARNING 02: maximum depth increased for Node BS_05
WARNING 02: maximum depth increased for Node BS_06
WARNING 02: maximum depth increased for Node E1_00
WARNING 02: maximum depth increased for Node E1_08
WARNING 02: maximum depth increased for Node E1_09
WARNING 02: maximum depth increased for Node E1_10
WARNING 02: maximum depth increased for Node E2_0
WARNING 02: maximum depth increased for Node E3_01
WARNING 02: maximum depth increased for Node E3-04
WARNING 02: maximum depth increased for Node East_Wetland-inlet
WARNING 02: maximum depth increased for Node MB_2
WARNING 02: maximum depth increased for Node O_03
WARNING 02: maximum depth increased for Node O_04
WARNING 02: maximum depth increased for Node O_05
WARNING 02: maximum depth increased for Node O_06
WARNING 02: maximum depth increased for Node O_07
WARNING 02: maximum depth increased for Node O_10
WARNING 02: maximum depth increased for Node O_12
WARNING 02: maximum depth increased for Node O-15
WARNING 02: maximum depth increased for Node OMC-NS1
WARNING 02: maximum depth increased for Node PropB-5
WARNING 02: maximum depth increased for Node PropB-8
WARNING 02: maximum depth increased for Node PropB-9
WARNING 02: maximum depth increased for Node PropB-W1
WARNING 02: maximum depth increased for Node Tammy1
WARNING 02: maximum depth increased for Node Tammy-2
WARNING 02: maximum depth increased for Node Tammy-3
WARNING 02: maximum depth increased for Node WB_01
WARNING 02: maximum depth increased for Node WB_02
WARNING 02: maximum depth increased for Node WB_03
WARNING 02: maximum depth increased for Node WB_04
WARNING 02: maximum depth increased for Node WB_07
WARNING 02: maximum depth increased for Node WB_08

*************
Element Count
*************
Number of rain gages ...... 2
Number of subcatchments ... 66
Number of nodes ........... 72
Number of links ........... 74
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                              Data       Recording
Name                 Data Source                              Type       Interval
------------------------------------------------------------------------
Chicago_1h           Chicago_1h                               INTENSITY    5 min.
Rain Gage-01         24hr-SCS-5yr                             CUMULATIVE  10 min.
```

```
  ********************
  Subcatchment Summary
  ********************
  Name                       Area     Width   %Imperv    %Slope Rain Gage
Outlet
  --------------------------------------------------------------------------------
--------------------------
  B_2                        0.38     27.00     22.00    0.2000 Rain Gage-01
B1_1
  B_21                      14.83    600.00      4.50    0.5900 Rain Gage-01
OMC-NS1
  B-1                        3.67    100.00     12.50    0.2800 Rain Gage-01
BS_05
  B-10_1                     1.57    199.52     10.50    0.2800 Rain Gage-01
B1_5
  B-10_2                     1.85    199.52     10.50    0.2800 Rain Gage-01
B1_5
  B-11                       1.85    170.25      2.50    0.3000 Rain Gage-01
E1_11
  B-13                       1.14     57.00      2.50    0.3000 Rain Gage-01
E1_11
  B-16                       1.10    111.16     10.50    0.2800 Rain Gage-01
B1_4
  B-17                       1.13     25.00     12.50    0.2800 Rain Gage-01
PropB-5
  B-18                       1.56    186.38     12.50    0.2800 Rain Gage-01
PropB-5
  B-19                       1.16     86.95     10.50    0.2800 Rain Gage-01
B1_3
  B-2                        1.84    102.00      7.50    0.2500 Rain Gage-01
BS_06
  B-3_1                      2.76    187.20      2.50    0.3000 Rain Gage-01
B1_2
  B-3_2                      0.24     40.00     12.50    0.2000 Rain Gage-01
B1_2
  B-5_1                      0.46    136.60     12.50    0.2800 Rain Gage-01
Tammy-4
  B-5_3                      1.18    136.60     12.50    0.2800 Rain Gage-01
MB_4
  B-5_4                      0.44    136.60     12.50    0.2800 Rain Gage-01
Tammy1
  B-5_5                      1.10    136.60     12.50    0.2800 Rain Gage-01
MB_1
  B-7_1                      0.45    129.64     12.50    0.2800 Rain Gage-01
PropB-3
  B-7_2                      0.15    129.64     12.50    0.2800 Rain Gage-01
MB_2
  B-7_3                      0.32    129.64     12.50    0.2800 Rain Gage-01
MB_3
  B-7_4                      0.89    129.64     12.50    0.2800 Rain Gage-01
MB_3
  B-7_6                      0.28    129.64     12.50    0.2800 Rain Gage-01
MB_2
  B-8                        2.75    100.00     12.50    0.2800 Rain Gage-01
BS_06
  B-8_1                      4.14    377.84      2.50    0.3000 Rain Gage-01
E1_11
  B-8_3                      6.19    377.84      2.50    0.3000 Rain Gage-01
```

B-9	2.84	157.15	10.50	0.2800	Rain Gage-01	BS_07
E1-12	1.51	142.96	2.50	0.3000	Rain Gage-01	E1-1
E1-14	2.86	169.06	2.50	0.3000	Rain Gage-01	E1_09
E1-15	3.05	163.16	2.50	0.3000	Rain Gage-01	E1_00
E1-20	2.17	166.87	2.50	0.3000	Rain Gage-01	E1_09
E1-4	12.04	352.69	2.50	0.3400	Rain Gage-01	E1_10
E2-1	3.09	104.00	7.50	0.2000	Rain Gage-01	E2_3
E2-2_2	5.74	152.00	2.50	0.2000	Rain Gage-01	E2_1
E2-3	0.51	15.00	22.00	0.2800	Rain Gage-01	E2_3
E2-4	0.92	60.00	7.50	0.2000	Rain Gage-01	E2_1
E2-5	2.15	146.65	7.50	0.2000	Rain Gage-01	E2_2
E2-6	1.59	126.13	7.50	0.2000	Rain Gage-01	E2_0
E2-7	1.20	65.00	2.50	0.2000	Rain Gage-01	E2_0
E3-1	11.44	338.06	4.50	0.2800	Rain Gage-01	E3_03
E3-2	1.27	51.00	7.50	0.2000	Rain Gage-01	E3_02
E3-3	0.76	101.63	7.50	0.2000	Rain Gage-01	E3_01
E3-4	0.74	84.26	7.50	0.2000	Rain Gage-01	E3_01
O-1_1	28.82	600.00	4.50	0.5900	Rain Gage-01	O_12
O-10	1.19	111.05	7.50	0.0350	Rain Gage-01	O_02
O-11	0.47	68.27	7.50	0.2000	Rain Gage-01	O_01
O-12	2.96	172.08	2.50	0.0350	Rain Gage-01	O_06
O-2_1	1.32	27.00	22.00	0.2000	Rain Gage-01	O_11
O-3	43.46	400.00	2.50	0.2400	Rain Gage-01	O_08
O-4	1.06	103.09	2.50	0.2400	Rain Gage-01	O_10
O-5	1.99	45.00	2.50	0.3000	Rain Gage-01	O_09
O-6	4.82	122.00	2.50	0.3000	Rain Gage-01	O_07
O-7	1.85	136.13	2.50	0.2500	Rain Gage-01	O_06
O-8_1	6.11	377.84	2.50	0.3000	Rain Gage-01	O_05
O-9	4.07	209.67	7.50	0.0350	Rain Gage-01	O_04
R1	0.98	80.00	12.50	0.2000	Rain Gage-01	PropB-3

R2	1.09	70.00	12.50	0.2000	Rain Gage-01	Tammy-3
R3	1.09	90.00	12.50	0.2000	Rain Gage-01	Tammy-2
WB-1	6.51	255.13	7.50	0.0800	Rain Gage-01	WB_08
WB-2	4.90	221.26	7.50	0.0800	Rain Gage-01	WB_07
WB-3	4.71	217.08	7.50	0.0800	Rain Gage-01	WB_06
WB-4	28.05	529.59	4.50	0.2400	Rain Gage-01	WB_05
WB-5	4.79	218.91	7.50	0.0800	Rain Gage-01	WB_04
WB-6	3.92	197.99	7.50	0.0800	Rain Gage-01	WB_03
WB-7	1.70	35.00	7.50	0.0800	Rain Gage-01	WB_02
WB-8	1.90	137.88	7.50	0.0800	Rain Gage-01	WB_01

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
B_control-1	JUNCTION	176.88	1.25	200.0	
B1_1	JUNCTION	177.35	1.04	0.0	
B1_2	JUNCTION	176.87	1.27	0.0	
B1_3	JUNCTION	176.62	1.34	0.0	
B1_4	JUNCTION	176.42	1.33	0.0	
B1_5	JUNCTION	176.18	1.24	0.0	
B2control-1	JUNCTION	176.69	1.27	200.0	
B3control	JUNCTION	176.47	1.23	200.0	
BS_05	JUNCTION	177.51	0.60	0.0	
BS_06	JUNCTION	177.45	0.80	0.0	
BS_07	JUNCTION	176.80	0.84	0.0	
CS-06	JUNCTION	174.50	1.39	0.0	
E1_00	JUNCTION	174.93	1.00	0.0	
E1_08	JUNCTION	175.25	1.00	0.0	
E1_09	JUNCTION	175.30	1.00	0.0	
E1_10	JUNCTION	175.57	1.00	0.0	
E1_11	JUNCTION	175.78	1.17	0.0	
E1-1	JUNCTION	175.75	1.05	0.0	
E2_0	JUNCTION	174.70	1.00	5000.0	
E2_1	JUNCTION	176.00	1.80	0.0	
E2_2	JUNCTION	175.55	1.45	0.0	
E2_3	JUNCTION	176.75	1.00	0.0	
E2_Prop1	JUNCTION	176.60	1.17	0.0	
E3_01	JUNCTION	174.62	0.80	6000.0	
E3_02	JUNCTION	175.16	0.81	0.0	
E3_03	JUNCTION	175.25	1.14	7500.0	
E3-04	JUNCTION	174.90	0.75	0.0	
East_Wetland-inlet	JUNCTION	174.78	1.10	0.0	
Jun-1	JUNCTION	174.45	1.34	0.0	
MB_1	JUNCTION	177.25	0.75	0.0	

MB_2	JUNCTION	177.23	0.80	0.0
MB_3	JUNCTION	177.05	0.88	0.0
MB_4	JUNCTION	177.80	0.55	0.0
O_00	JUNCTION	174.45	1.72	0.0
O_01	JUNCTION	174.47	1.66	0.0
O_02	JUNCTION	174.52	2.26	1000.0
O_03	JUNCTION	174.55	1.10	1229.0
O_04	JUNCTION	174.59	0.90	1000.0
O_05	JUNCTION	174.70	0.88	20386.0
O_06	JUNCTION	174.90	1.00	9271.0
O_07	JUNCTION	175.00	1.10	0.0
O_08	JUNCTION	175.08	1.28	0.0
O_09	JUNCTION	176.60	1.27	0.0
O_10	JUNCTION	177.01	1.00	0.0
O_11	JUNCTION	177.23	1.36	2250.0
O_12	JUNCTION	177.35	0.80	31500.0
O_16	JUNCTION	174.50	1.67	0.0
O-15	JUNCTION	174.60	0.90	9397.0
OMC-NS1	JUNCTION	178.10	0.80	0.0
PropB-10	JUNCTION	177.01	0.91	0.0
PropB-3	JUNCTION	177.00	1.10	0.0
PropB-5	JUNCTION	176.68	0.80	0.0
PropB-8	JUNCTION	174.72	0.80	3500.0
PropB-9	JUNCTION	174.69	0.86	994.0
PropB-W1	JUNCTION	174.72	0.88	50000.0
PropB-W2	JUNCTION	174.78	1.02	0.0
Tammy1	JUNCTION	177.90	0.45	0.0
Tammy-2	JUNCTION	177.90	0.45	0.0
Tammy-3	JUNCTION	177.44	0.80	0.0
Tammy-4	JUNCTION	177.45	0.55	0.0
WB_01	JUNCTION	174.78	0.65	9285.0
WB_02	JUNCTION	174.89	0.91	0.0
WB_03	JUNCTION	174.89	0.91	500.0
WB_04	JUNCTION	175.02	0.91	0.0
WB_05	JUNCTION	175.03	1.34	1000.0
WB_06	JUNCTION	175.23	1.30	500.0
WB_07	JUNCTION	175.57	0.65	500.0
WB_08	JUNCTION	175.80	0.60	0.0
OMC - Outlet	OUTFALL	174.28	1.30	0.0
Prop_pinecrestOutfall	OUTFALL	174.50	0.00	0.0
West-Wetland	STORAGE	174.75	0.75	0.0
Wetland-East	STORAGE	174.65	0.80	0.0

****
Link Summary
****

Name	From Node	To Node	Type	Length	% Slope	Roughness
18	BS_05	BS_06	CONDUIT	13.1	0.4417	0.0400
AL_ellip	O_16	O_01	CONDUIT	76.4	0.0458	0.0150
B1-1	B1_4	B1_5	CONDUIT	120.1	0.2041	0.0400

B1-2	B1_3	B1_4	CONDUIT	98.4		0.2033	0.0400
B1-3	B1_2	B1_3	CONDUIT	119.6		0.2090	0.0400
Bell-1_2	B_control-1	B1_2	CONDUIT	6.0		0.2509	0.0400
Bell1-05	PropB-3	B_control-1	CONDUIT	32.0		0.3589	0.0400
Bell2_1	PropB-10	B2control-1	CONDUIT	34.0		0.9528	0.0400
Bell-2_2	B2control-1	B1_3	CONDUIT	6.1		1.1316	0.0400
Bell2-2	MB_3	PropB-10	CONDUIT	21.9		0.1507	0.0400
Bell2-3	MB_2	MB_3	CONDUIT	124.2		0.1482	0.0400
Bell2-CS-01	MB_1	MB_2	CONDUIT	13.1		0.1526	0.0400
Bell-3_1	PropB-5	B3control	CONDUIT	24.5		0.8585	0.0400
Bell-3_2	B3control	B1_4	CONDUIT	6.1		0.7399	0.0400
Bell-Over1	B_control-1	B1_2	CONDUIT	12.0	-	0.0417	0.0400
Bell-over2	B3control	B1_4	CONDUIT	12.0		0.2083	0.0400
Cedar-16	BS_07	B1_5	CONDUIT	196.3		0.3184	0.0400
Cedar-17	BS_06	BS_07	CONDUIT	203.1		0.3200	0.0400
CONC-E	O_01	O_00	CONDUIT	28.6		0.0525	0.0180
CS-004	O_08	O_07	CONDUIT	11.2		0.7078	0.0230
E-03	E1_09	E1_08	CONDUIT	65.7		0.0761	0.0400
E-04	E1_10	E1_09	CONDUIT	180.7		0.1516	0.0400
E1-01	E1_00	O_06	CONDUIT	49.8		0.0502	0.0400
E1-02	E1_08	E1_00	CONDUIT	210.5		0.1544	0.0400
E1-05	E1-1	E1_10	CONDUIT	121.9		0.1403	0.0400
E1-06	E1_11	E1-1	CONDUIT	16.4		0.1831	0.0400
E1-07	B1_5	E1_11	CONDUIT	181.3		0.2206	0.0400
E2-1	E2_0	E3_01	CONDUIT	64.6		0.1239	0.0400
E2-2	E2_2	E2_0	CONDUIT	151.3		0.5617	0.0400
E2-3	E2_1	E2_2	CONDUIT	97.1		0.4635	0.0400
E3-1	E3_01	O_04	CONDUIT	16.7		0.1495	0.0400
E3-2_1	E3_02	E3-04	CONDUIT	78.5		0.3285	0.0400
E3-2_2	E3-04	E3_01	CONDUIT	124.3		0.2284	0.0400

E3-CS-03	E3_03	E3_02	CONDUIT	14.2	0.6210	0.0400
East-Wetland-1	East_Wetland-inlet	Wetland-East	CONDUIT	12.0	1.1001	0.0400
FT-01	OMC-NS1	O_12	CONDUIT	391.4	0.1916	0.0400
O-01	O_03	O_02	CONDUIT	122.7	0.0261	0.0400
O-02	O_04	O_03	CONDUIT	45.1	0.0997	0.0400
O-03	O-15	O_04	CONDUIT	27.1	0.0185	0.0400
O-04	Jun-1	O-15	CONDUIT	186.3	0.0215	0.0400
O-05	PropB-9	CS-06	CONDUIT	36.7	0.1089	0.0400
O-06	O_05	PropB-9	CONDUIT	45.9	0.0218	0.0400
O-07	O_06	O_05	CONDUIT	221.6	0.0902	0.0400
O-08	O_07	O_06	CONDUIT	178.4	0.0560	0.0400
O-09	O_09	O_07	CONDUIT	492.2	0.3251	0.0400
O-10	O_10	O_09	CONDUIT	285.6	0.1422	0.0400
O-11	O_11	O_10	CONDUIT	195.1	0.1148	0.0400
O-CS-01	O_02	O_16	CONDUIT	18.0	0.1001	0.0220
O-CS-05	O_12	O_11	CONDUIT	15.9	0.7549	0.0120
O-CS-06	CS-06	Jun-1	CONDUIT	6.0	0.8334	0.0400
O-Outlet-structure	O_00	OMC - Outlet	CONDUIT	2.7	6.4206	0.0180
Over-Bell2	B2control-1	B1_3	CONDUIT	12.0	0.4083	0.0400
PropB10_1	PropB-W2	West-Wetland	CONDUIT	68.4	0.0497	0.0400
PropB10_3	West-Wetland	PropB-W1	CONDUIT	47.7	0.0482	0.0400
PropB10_4	PropB-8	PropB-9	CONDUIT	23.1	0.1301	0.0400
PropB10_5	PropB-W1	PropB-8	CONDUIT	38.9	0.0077	0.0400
SW-2	MB_4	MB_1	CONDUIT	103.8	0.5298	0.0360
SW2_4	E2_Prop1	E2_1	CONDUIT	109.6	0.5477	0.0400
SW2_5	E2_3	E2_Prop1	CONDUIT	47.1	0.3188	0.0400
SW-5	Tammy-2	Tammy-3	CONDUIT	129.4	0.3556	0.0400
SW-6	Tammy1	Tammy-4	CONDUIT	121.7	0.3699	0.0400
SW-7	Tammy-4	Tammy-3	CONDUIT	16.3	0.0615	0.0400
SW-9	Tammy-3	PropB-3	CONDUIT	109.6	0.4015	0.0400

SW-B2	B1_1	B1_2	CONDUIT	87.6	0.5476	0.0400
W-01	WB_01	O_05	CONDUIT	35.5	0.2111	0.0400
W-02	WB_02	WB_01	CONDUIT	188.4	0.0584	0.0400
W-03	WB_04	WB_03	CONDUIT	220.8	0.0575	0.0400
W-04	WB_06	WB_05	CONDUIT	272.0	0.0728	0.0400
W-05	WB_07	WB_06	CONDUIT	267.8	0.1270	0.0400
W-06	WB_08	WB_07	CONDUIT	162.4	0.1416	0.0400
WB-CS-04	WB_03	WB_02	CONDUIT	13.0	0.0614	0.0180
WB-CS-08	WB_05	WB_04	CONDUIT	11.9	0.1011	0.0180
Weir-1	East_Wetland-inlet	PropB-W2	WEIR			
Weir-2	Wetland-East	PropB-W2	WEIR			

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Cross Section Summary
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Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
18	CIRCULAR	0.60	0.28	0.15	0.60	1	0.13
AL_ellip	HORIZ_ELLIPSE	1.30	2.14	0.40	1.79	1	1.66
B1-1	TRAPEZOIDAL	1.00	2.50	0.54	4.00	1	1.88
B1-2	TRAPEZOIDAL	1.00	2.50	0.54	4.00	1	1.88
B1-3	TRAPEZOIDAL	1.00	2.50	0.54	4.00	1	1.90
Bell-1_2	CIRCULAR	0.30	0.07	0.07	0.30	1	0.02
Bell1-05	TRAPEZOIDAL	0.95	5.15	0.69	6.85	1	6.05
Bell2_1	TRAPEZOIDAL	0.90	3.92	0.63	5.70	1	7.00
Bell-2_2	CIRCULAR	0.30	0.07	0.07	0.30	1	0.03
Bell2-2	TRAPEZOIDAL	0.80	1.44	0.41	3.00	1	0.78
Bell2-3	TRAPEZOIDAL	0.80	1.44	0.41	3.00	1	0.77
Bell2-CS-01	CIRCULAR	0.38	0.11	0.09	0.38	1	0.02
Bell-3_1	TRAPEZOIDAL	0.80	2.16	0.49	3.90	1	3.12
Bell-3_2	CIRCULAR	0.30	0.07	0.07	0.30	1	0.03

Bell-Over1	TRAPEZOIDAL	0.20	0.68	0.17	3.80	1	0.11
Bell-over2	TRAPEZOIDAL	0.20	0.68	0.17	3.80	1	0.24
Cedar-16	TRAPEZOIDAL	0.80	1.44	0.41	3.00	1	1.13
Cedar-17	TRAPEZOIDAL	0.80	1.44	0.41	3.00	1	1.13
CONC-E	HORIZ_ELLIPSE	1.27	2.05	0.39	1.87	1	1.39
CS-004	CIRCULAR	0.45	0.16	0.11	0.45	1	0.14
E-03	TRAPEZOIDAL	1.00	3.00	0.59	4.50	1	1.45
E-04	TRAPEZOIDAL	1.00	2.55	0.55	4.05	1	1.66
E1-01	TRAPEZOIDAL	1.00	3.00	0.59	4.50	1	1.18
E1-02	TRAPEZOIDAL	1.00	3.00	0.59	4.50	1	2.07
E1-05	TRAPEZOIDAL	1.00	2.40	0.53	3.90	1	1.48
E1-06	TRAPEZOIDAL	1.00	2.70	0.56	4.20	1	1.97
E1-07	TRAPEZOIDAL	0.90	2.03	0.49	3.60	1	1.48
E2-1	TRAPEZOIDAL	0.80	1.68	0.44	3.30	1	0.86
E2-2	TRAPEZOIDAL	1.00	2.40	0.53	3.90	1	2.96
E2-3	TRAPEZOIDAL	0.80	1.68	0.44	3.30	1	1.66
E3-1	TRAPEZOIDAL	0.80	1.92	0.47	3.60	1	1.12
E3-2_1	TRAPEZOIDAL	0.75	1.29	0.39	2.85	1	0.99
E3-2_2	TRAPEZOIDAL	0.75	1.29	0.39	2.85	1	0.83
E3-CS-03	CIRCULAR	0.45	0.16	0.11	0.45	1	0.07
East-Wetland-1	TRAPEZOIDAL	1.10	2.48	0.54	3.90	1	4.32
FT-01	TRAPEZOIDAL	0.80	1.60	0.43	3.20	1	1.00
O-01	TRAPEZOIDAL	1.10	4.46	0.70	5.70	1	1.42
O-02	TRAPEZOIDAL	0.90	3.56	0.61	5.30	1	2.01
O-03	TRAPEZOIDAL	0.90	3.92	0.63	5.70	1	0.97
O-04	TRAPEZOIDAL	0.86	3.86	0.61	5.78	1	1.02
O-05	TRAPEZOIDAL	0.86	3.86	0.61	5.78	1	2.30
O-06	TRAPEZOIDAL	0.86	3.69	0.60	5.58	1	0.97
O-07	TRAPEZOIDAL	0.88	3.27	0.59	5.04	1	1.72
O-08	TRAPEZOIDAL	0.95	3.25	0.60	4.85	1	1.37

O-09	TRAPEZOIDAL	1.10	2.81	0.58	4.20	1	2.77
O-10	TRAPEZOIDAL	1.00	2.40	0.53	3.90	1	1.49
O-11	TRAPEZOIDAL	0.75	1.52	0.42	3.15	1	0.72
O-CS-01	RECT_CLOSED	1.40	2.52	0.39	1.80	1	1.95
O-CS-05	CIRCULAR	0.75	0.44	0.19	0.75	1	1.05
O-CS-06	ARCH	1.09	1.37	0.33	1.63	2	1.48
O-Outlet-structure	RECT_OPEN	1.30	2.86	0.60	2.20	1	28.51
Over-Bell2	TRAPEZOIDAL	0.20	0.68	0.17	3.80	1	0.34
PropB10_1	TRAPEZOIDAL	0.88	2.22	0.51	3.84	1	0.79
PropB10_3	TRAPEZOIDAL	0.88	2.22	0.51	3.84	1	0.77
PropB10_4	TRAPEZOIDAL	0.80	2.72	0.53	4.60	1	1.62
PropB10_5	TRAPEZOIDAL	0.80	2.72	0.53	4.60	1	0.39
SW-2	TRAPEZOIDAL	0.45	0.57	0.26	1.95	1	0.47
SW2_4	TRAPEZOIDAL	0.80	1.44	0.41	3.00	1	1.48
SW2_5	TRAPEZOIDAL	0.60	1.08	0.35	2.70	1	0.76
SW-5	TRAPEZOIDAL	0.45	0.43	0.24	1.40	1	0.25
SW-6	TRAPEZOIDAL	0.45	0.43	0.24	1.40	1	0.25
SW-7	HORIZ_ELLIPSE	0.48	0.31	0.15	0.76	1	0.05
SW-9	TRAPEZOIDAL	0.80	1.12	0.39	2.20	1	0.95
SW-B2	TRAPEZOIDAL	0.80	1.68	0.44	3.30	1	1.81
W-01	TRAPEZOIDAL	0.55	1.11	0.35	2.85	1	0.64
W-02	TRAPEZOIDAL	0.65	1.61	0.42	3.45	1	0.54
W-03	TRAPEZOIDAL	0.75	1.97	0.47	3.75	1	0.71
W-04	TRAPEZOIDAL	0.90	2.74	0.56	4.40	1	1.25
W-05	TRAPEZOIDAL	0.65	1.41	0.40	3.15	1	0.68
W-06	TRAPEZOIDAL	0.60	1.26	0.37	3.00	1	0.62
WB-CS-04	ARCH	0.91	0.87	0.24	1.17	1	0.46
WB-CS-08	ARCH	0.91	0.87	0.24	1.17	1	0.59

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Analysis Options

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****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 06/15/2021 00:00:00
Ending Date .............. 06/18/2021 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:10:00
Routing Time Step ........ 30.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 4
Head Tolerance ........... 0.001500 m


*********************
Control Actions Taken
*********************


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......        18.266        68.900
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         9.116        34.385
Surface Runoff ...........         8.695        32.798
Final Storage ............         0.461         1.740
Continuity Error (%) .....        -0.034


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         8.695        86.950
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         7.136        71.362
Flooding Loss ............         1.504        15.043
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.001         0.011
Final Stored Volume ......         0.056         0.565
Continuity Error (%) .....        -0.011
```

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

Link O-Outlet-structure (93.35%)
Link O-CS-06 (5.81%)

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

Link Weir-2 (1)
Link Weir-1 (1)
Link O-CS-06 (1)

****
Most Frequent Nonconverging Nodes
****

Convergence obtained at all time steps.

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

```
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.28 sec
Maximum Time Step           :    30.00 sec
% of Time in Steady State   :     0.00
Average Iterations per Step :     2.00
% of Steps Not Converging   :     0.00
Time Step Frequencies       :
   30.000 - 13.228 sec      :     0.18 %
   13.228 -  5.833 sec      :     2.51 %
    5.833 -  2.572 sec      :     7.93 %
    2.572 -  1.134 sec      :    22.18 %
    1.134 -  0.500 sec      :    67.19 %
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Subcatchment Runoff Summary
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Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
B_2	68.90	0.00	0.00	18.02	14.88	33.56	48.44	0.19	0.04	0.703
B_21	68.90	0.00	0.00	32.00	3.04	32.62	35.66	5.29	0.60	0.518

B-1	68.90	0.00	0.00	23.73	8.45	34.22	42.67	1.57	0.18	0.619
B-10_1	68.90	0.00	0.00	33.72	7.10	26.86	33.96	0.53	0.10	0.493
B-10_2	68.90	0.00	0.00	27.21	7.10	33.36	40.46	0.75	0.15	0.587
B-11	68.90	0.00	0.00	36.94	1.69	29.03	30.72	0.57	0.07	0.446
B-13	68.90	0.00	0.00	37.45	1.69	28.50	30.19	0.35	0.03	0.438
B-16	68.90	0.00	0.00	33.83	7.10	26.74	33.83	0.37	0.06	0.491
B-17	68.90	0.00	0.00	27.09	8.45	31.38	39.83	0.45	0.05	0.578
B-18	68.90	0.00	0.00	26.55	8.45	32.67	41.12	0.64	0.14	0.597
B-19	68.90	0.00	0.00	34.02	7.10	26.54	33.64	0.39	0.06	0.488
B-2	68.90	0.00	0.00	29.84	5.07	32.74	37.81	0.69	0.08	0.549
B-3_1	68.90	0.00	0.00	37.17	1.69	28.80	30.48	0.84	0.09	0.442
B-3_2	68.90	0.00	0.00	26.48	8.45	32.74	41.19	0.10	0.02	0.598
B-5_1	68.90	0.00	0.00	26.27	8.44	32.99	41.43	0.19	0.06	0.601
B-5_3	68.90	0.00	0.00	26.56	8.45	32.66	41.11	0.49	0.10	0.597
B-5_4	68.90	0.00	0.00	26.25	8.44	33.00	41.44	0.18	0.06	0.601
B-5_5	68.90	0.00	0.00	26.53	8.45	32.69	41.14	0.45	0.10	0.597
B-7_1	68.90	0.00	0.00	26.27	8.44	32.99	41.42	0.19	0.06	0.601
B-7_2	68.90	0.00	0.00	26.08	8.43	33.22	41.65	0.06	0.02	0.604
B-7_3	68.90	0.00	0.00	26.20	8.43	33.07	41.51	0.13	0.04	0.602
B-7_4	68.90	0.00	0.00	26.47	8.45	32.76	41.20	0.37	0.08	0.598
B-7_6	68.90	0.00	0.00	26.17	8.43	33.10	41.53	0.12	0.04	0.603
B-8	68.90	0.00	0.00	23.73	8.45	34.48	42.93	1.18	0.15	0.623
B-8_1	68.90	0.00	0.00	36.96	1.69	29.02	30.71	1.27	0.16	0.446
B-8_3	68.90	0.00	0.00	43.07	1.69	22.89	24.58	1.52	0.13	0.357
B-9	68.90	0.00	0.00	27.58	7.10	32.97	40.07	1.14	0.16	0.582
E1-12	68.90	0.00	0.00	36.93	1.69	29.05	30.73	0.47	0.06	0.446
E1-14	68.90	0.00	0.00	37.30	1.69	28.67	30.36	0.87	0.08	0.441
E1-15	68.90	0.00	0.00	39.47	1.69	26.50	28.18	0.86	0.07	0.409
E1-20	68.90	0.00	0.00	37.07	1.69	28.90	30.59	0.66	0.08	0.444
E1-4	68.90	0.00	0.00	38.02	1.69	27.93	29.62	3.57	0.23	0.430

E2-1	68.90	0.00	0.00	30.35	5.07	32.12	37.20	1.15	0.10	0.540
E2-2_2	68.90	0.00	0.00	38.62	1.69	27.34	29.03	1.67	0.09	0.421
E2-3	68.90	0.00	0.00	21.16	14.87	30.67	45.53	0.23	0.03	0.661
E2-4	68.90	0.00	0.00	29.81	5.07	32.78	37.85	0.35	0.04	0.549
E2-5	68.90	0.00	0.00	29.77	5.07	32.82	37.89	0.81	0.10	0.550
E2-6	68.90	0.00	0.00	29.66	5.07	32.93	38.00	0.60	0.08	0.551
E2-7	68.90	0.00	0.00	39.68	1.69	26.29	27.97	0.34	0.03	0.406
E3-1	68.90	0.00	0.00	32.71	3.04	31.90	34.94	4.00	0.30	0.507
E3-2	68.90	0.00	0.00	35.94	5.07	26.63	31.70	0.40	0.04	0.460
E3-3	68.90	0.00	0.00	41.98	5.07	20.62	25.68	0.19	0.03	0.373
E3-4	68.90	0.00	0.00	42.09	5.07	20.50	25.57	0.19	0.03	0.371
O-1_1	68.90	0.00	0.00	32.68	3.04	31.93	34.97	10.08	0.77	0.508
O-10	68.90	0.00	0.00	37.98	5.07	24.60	29.67	0.35	0.03	0.431
O-11	68.90	0.00	0.00	37.74	5.07	24.86	29.92	0.14	0.02	0.434
O-12	68.90	0.00	0.00	44.74	1.69	21.21	22.90	0.68	0.03	0.332
O-2_1	68.90	0.00	0.00	18.02	14.86	32.74	47.59	0.63	0.08	0.691
O-3	68.90	0.00	0.00	33.75	1.69	30.01	31.70	13.78	0.46	0.460
O-4	68.90	0.00	0.00	32.38	1.69	33.60	35.29	0.38	0.05	0.512
O-5	68.90	0.00	0.00	33.75	1.69	32.19	33.88	0.68	0.04	0.492
O-6	68.90	0.00	0.00	33.59	1.69	32.37	34.06	1.64	0.10	0.494
O-7	68.90	0.00	0.00	32.55	1.69	33.42	35.11	0.65	0.08	0.510
O-8_1	68.90	0.00	0.00	43.07	1.69	22.90	24.59	1.50	0.13	0.357
O-9	68.90	0.00	0.00	40.84	5.07	21.74	26.81	1.09	0.09	0.389
R1	68.90	0.00	0.00	26.82	8.45	32.39	40.84	0.40	0.07	0.593
R2	68.90	0.00	0.00	26.97	8.45	32.23	40.69	0.44	0.07	0.591
R3	68.90	0.00	0.00	26.81	8.45	32.40	40.85	0.45	0.07	0.593
WB-1	68.90	0.00	0.00	39.64	5.07	22.93	28.00	1.82	0.15	0.406
WB-2	68.90	0.00	0.00	40.31	5.07	22.27	27.34	1.34	0.12	0.397
WB-3	68.90	0.00	0.00	39.36	5.07	23.22	28.29	1.33	0.12	0.411
WB-4	68.90	0.00	0.00	33.06	3.04	31.08	34.12	9.57	0.56	0.495

WB-5	68.90	0.00	0.00	39.36	5.07	23.20	28.27	1.35	0.12	0.410
WB-6	68.90	0.00	0.00	39.20	5.07	23.36	28.44	1.11	0.10	0.413
WB-7	68.90	0.00	0.00	28.64	5.07	31.89	36.95	0.63	0.04	0.536
WB-8	68.90	0.00	0.00	39.62	5.07	22.96	28.03	0.53	0.05	0.407

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Node Depth Summary
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Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days	Time of Max Occurrence hr:min	Reported Max Depth Meters
B_control-1	JUNCTION	0.17	1.01	177.89	0	12:30	1.01
B1_1	JUNCTION	0.01	0.09	177.44	0	12:10	0.09
B1_2	JUNCTION	0.07	0.39	177.26	0	12:31	0.39
B1_3	JUNCTION	0.10	0.53	177.15	0	12:32	0.53
B1_4	JUNCTION	0.12	0.63	177.05	0	12:31	0.62
B1_5	JUNCTION	0.17	0.78	176.95	0	12:30	0.78
B2control-1	JUNCTION	0.13	0.99	177.68	0	12:28	0.99
B3control	JUNCTION	0.13	0.98	177.45	0	12:13	0.98
BS_05	JUNCTION	0.10	0.52	178.03	0	12:10	0.52
BS_06	JUNCTION	0.10	0.48	177.93	0	12:11	0.48
BS_07	JUNCTION	0.11	0.53	177.33	0	12:13	0.53
CS-06	JUNCTION	0.60	1.08	175.58	0	14:41	1.08
E1_00	JUNCTION	0.36	1.00	175.93	0	12:33	1.00
E1_08	JUNCTION	0.23	0.89	176.14	0	12:39	0.89
E1_09	JUNCTION	0.24	0.93	176.23	0	12:39	0.93
E1_10	JUNCTION	0.23	0.93	176.51	0	12:34	0.93
E1_11	JUNCTION	0.20	0.92	176.69	0	12:31	0.92
E1-1	JUNCTION	0.22	0.93	176.68	0	12:31	0.93
E2_0	JUNCTION	0.35	0.78	175.48	0	13:59	0.78
E2_1	JUNCTION	0.07	0.30	176.30	0	12:12	0.29
E2_2	JUNCTION	0.08	0.33	175.88	0	12:13	0.33
E2_3	JUNCTION	0.05	0.24	176.99	0	12:10	0.24
E2_Prop1	JUNCTION	0.05	0.24	176.84	0	12:11	0.24
E3_01	JUNCTION	0.41	0.86	175.48	0	14:07	0.86
E3_02	JUNCTION	0.13	0.41	175.57	0	12:10	0.41
E3_03	JUNCTION	0.20	1.14	176.39	0	12:14	1.14
E3-04	JUNCTION	0.23	0.59	175.50	0	13:40	0.59
East_Wetland-inlet	JUNCTION	0.41	0.67	175.45	0	13:20	0.67
Jun-1	JUNCTION	0.65	1.12	175.57	0	14:40	1.12
MB_1	JUNCTION	0.11	0.75	178.00	0	12:02	0.75
MB_2	JUNCTION	0.06	0.47	177.70	0	12:28	0.47
MB_3	JUNCTION	0.09	0.63	177.68	0	12:28	0.63
MB_4	JUNCTION	0.02	0.26	178.06	0	12:10	0.26
O_00	JUNCTION	0.14	0.35	174.80	0	14:09	0.35
O_01	JUNCTION	0.30	0.56	175.03	0	14:09	0.56
O_02	JUNCTION	0.40	0.77	175.29	0	14:10	0.77
O_03	JUNCTION	0.45	0.89	175.44	0	14:11	0.89
O_04	JUNCTION	0.44	0.88	175.48	0	14:11	0.88

O_05	JUNCTION	0.44	0.96	175.66	0	14:41	0.96
O_06	JUNCTION	0.38	1.02	175.92	0	14:11	1.02
O_07	JUNCTION	0.37	1.00	176.00	0	13:22	1.00
O_08	JUNCTION	0.44	1.28	176.36	0	12:09	1.28
O_09	JUNCTION	0.20	0.64	177.24	0	12:55	0.64
O_10	JUNCTION	0.25	0.82	177.83	0	12:19	0.82
O_11	JUNCTION	0.25	0.87	178.10	0	12:58	0.87
O_12	JUNCTION	0.18	0.82	178.17	0	13:03	0.82
O_16	JUNCTION	0.39	0.73	175.23	0	14:10	0.73
O-15	JUNCTION	0.44	0.89	175.49	0	14:17	0.89
OMC-NS1	JUNCTION	0.12	0.57	178.67	0	12:14	0.57
PropB-10	JUNCTION	0.05	0.66	177.68	0	12:28	0.66
PropB-3	JUNCTION	0.09	0.89	177.89	0	12:29	0.89
PropB-5	JUNCTION	0.05	0.77	177.45	0	12:13	0.77
PropB-8	JUNCTION	0.40	0.86	175.58	0	14:43	0.86
PropB-9	JUNCTION	0.43	0.90	175.59	0	14:42	0.90
PropB-W1	JUNCTION	0.39	0.84	175.56	0	14:43	0.84
PropB-W2	JUNCTION	0.33	0.69	175.47	0	13:20	0.69
Tammy1	JUNCTION	0.02	0.19	178.09	0	12:10	0.19
Tammy-2	JUNCTION	0.03	0.23	178.13	0	12:11	0.22
Tammy-3	JUNCTION	0.07	0.47	177.91	0	12:29	0.47
Tammy-4	JUNCTION	0.06	0.46	177.91	0	12:28	0.46
WB_01	JUNCTION	0.39	0.92	175.70	0	14:53	0.92
WB_02	JUNCTION	0.35	0.90	175.78	0	14:31	0.90
WB_03	JUNCTION	0.35	0.90	175.79	0	14:28	0.90
WB_04	JUNCTION	0.31	0.82	175.84	0	14:14	0.82
WB_05	JUNCTION	0.30	0.82	175.85	0	14:13	0.82
WB_06	JUNCTION	0.19	0.62	175.85	0	14:13	0.62
WB_07	JUNCTION	0.10	0.33	175.90	0	12:14	0.33
WB_08	JUNCTION	0.06	0.27	176.07	0	12:11	0.26
OMC - Outlet	OUTFALL	0.09	0.19	174.47	0	14:09	0.19
Prop_pinecrestOutfall	OUTFALL	0.00	0.00	174.50	0	00:00	0.00
West-Wetland	STORAGE	0.37	0.75	175.50	0	13:04	0.75
Wetland-East	STORAGE	0.53	0.80	175.45	0	13:20	0.80

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Node Inflow Summary
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Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
B_control-1	JUNCTION	0.000	0.171	0	12:27	0	1.85	0.015
B1_1	JUNCTION	0.036	0.036	0	12:10	0.186	0.186	-0.203
B1_2	JUNCTION	0.111	0.266	0	12:27	0.94	[illegible]	[illegible]

B1_3	JUNCTION	0.059	0.449	0	12:30	0.391	4.92	0.008
B1_4	JUNCTION	0.064	0.569	0	12:30	0.373	6.38	-0.003
B1_5	JUNCTION	0.249	1.089	0	12:14	1.28	12.2	0.011
B2control-1	JUNCTION	0.000	0.156	0	12:24	0	1.55	0.013
B3control	JUNCTION	0.000	0.161	0	12:09	0	1.09	0.006
BS_05	JUNCTION	0.175	0.175	0	12:10	1.57	1.57	-0.001
BS_06	JUNCTION	0.233	0.408	0	12:10	1.87	3.44	-0.060
BS_07	JUNCTION	0.160	0.530	0	12:10	1.14	4.58	-0.043
CS-06	JUNCTION	0.129	1.441	0	14:46	1.52	59.8	0.002
E1_00	JUNCTION	0.073	1.598	0	12:40	0.859	20.9	0.065
E1_08	JUNCTION	0.000	1.545	0	12:37	0	20	-0.061
E1_09	JUNCTION	0.159	1.566	0	12:31	1.53	20	0.023
E1_10	JUNCTION	0.225	1.454	0	12:30	3.57	18.5	-0.020
E1_11	JUNCTION	0.267	1.249	0	12:21	2.19	14.4	0.020
E1-1	JUNCTION	0.061	1.275	0	12:27	0.465	14.9	-0.015
E2_0	JUNCTION	0.109	0.411	0	12:12	0.94	5.16	0.102
E2_1	JUNCTION	0.129	0.252	0	12:10	2.02	3.4	0.005
E2_2	JUNCTION	0.105	0.335	0	12:11	0.815	4.21	-0.141
E2_3	JUNCTION	0.139	0.139	0	12:10	1.38	1.38	-0.007
E2_Prop1	JUNCTION	0.000	0.136	0	12:10	0	1.38	-0.014
E3_01	JUNCTION	0.055	0.670	0	12:13	0.384	9.94	0.057
E3_02	JUNCTION	0.038	0.275	0	12:10	0.403	4.4	-0.053
E3_03	JUNCTION	0.303	0.303	0	12:10	4	4	-0.005
E3-04	JUNCTION	0.000	0.273	0	12:10	0	4.4	-0.050
East_Wetland-inlet	JUNCTION	0.000	0.107	0	12:41	0	2.1	0.075
Jun-1	JUNCTION	0.000	1.441	0	14:46	0	59.8	0.005
MB_1	JUNCTION	0.097	0.193	0	12:10	0.451	0.937	0.025
MB_2	JUNCTION	0.064	0.162	0	12:05	0.18	1.05	-0.126
MB_3	JUNCTION	0.128	0.279	0	12:10	0.499	1.55	0.058
MB_4	JUNCTION	0.101	0.101	0	12:10	0.486	0.486	-0.081

O_00	JUNCTION	0.000	1.785	0	14:09	0	71.4	-0.011
O_01	JUNCTION	0.023	1.785	0	14:09	0.139	71.4	0.000
O_02	JUNCTION	0.033	1.781	0	14:09	0.353	71.2	0.002
O_03	JUNCTION	0.000	1.770	0	14:11	0	70.9	0.003
O_04	JUNCTION	0.089	1.770	0	14:10	1.09	70.9	0.001
O_05	JUNCTION	0.128	2.515	0	13:02	1.5	72.3	0.011
O_06	JUNCTION	0.107	2.416	0	12:33	1.33	52.5	-0.006
O_07	JUNCTION	0.098	1.256	0	12:49	1.64	32.4	0.040
O_08	JUNCTION	0.457	0.457	0	12:10	13.8	13.8	0.000
O_09	JUNCTION	0.038	0.895	0	12:29	0.675	17.1	-0.006
O_10	JUNCTION	0.052	0.920	0	12:12	0.375	16.4	-0.045
O_11	JUNCTION	0.077	0.874	0	12:12	0.626	16	-0.034
O_12	JUNCTION	0.772	1.194	0	12:10	10.1	15.4	0.039
O_16	JUNCTION	0.000	1.781	0	14:10	0	71.2	0.000
O-15	JUNCTION	0.000	1.441	0	14:47	0	59.8	0.003
OMC-NS1	JUNCTION	0.599	0.599	0	12:10	5.29	5.29	-0.169
PropB-10	JUNCTION	0.000	0.226	0	12:06	0	1.55	0.021
PropB-3	JUNCTION	0.122	0.315	0	12:11	0.587	1.85	0.140
PropB-5	JUNCTION	0.182	0.182	0	12:10	1.09	1.09	-0.006
PropB-8	JUNCTION	0.000	1.011	0	14:36	0	17.5	0.001
PropB-9	JUNCTION	0.000	2.405	0	14:41	0	73.8	0.004
PropB-W1	JUNCTION	0.000	1.009	0	14:43	0	17.4	0.002
PropB-W2	JUNCTION	0.000	0.723	0	13:02	0	12	0.007
Tammy1	JUNCTION	0.056	0.056	0	12:10	0.182	0.182	-0.454
Tammy-2	JUNCTION	0.073	0.073	0	12:10	0.445	0.445	-0.144
Tammy-3	JUNCTION	0.065	0.225	0	12:10	0.443	1.26	-0.153
Tammy-4	JUNCTION	0.058	0.109	0	12:10	0.191	0.374	0.223
WB_01	JUNCTION	0.053	1.017	0	12:35	0.533	18.3	0.024
WB_02	JUNCTION	0.040	0.578	0	12:28	0.63	17.2	-0.024
WB_03	JUNCTION	0.099	0.595	0	12:29	1.11	16.5	0.035

WB_04	JUNCTION	0.117	0.567	0	12:21	1.35	15.4	-0.034
WB_05	JUNCTION	0.560	0.589	0	12:10	9.57	14.1	0.002
WB_06	JUNCTION	0.115	0.277	0	12:10	1.33	4.51	0.118
WB_07	JUNCTION	0.116	0.248	0	12:10	1.34	3.16	-0.138
WB_08	JUNCTION	0.151	0.151	0	12:10	1.82	1.82	-0.053
OMC - Outlet	OUTFALL	0.000	1.785	0	14:09	0	71.4	0.000
Prop_pinecrestOutfall	OUTFALL	0.000	0.000	0	00:00	0	0	0.000 ltr
West-Wetland	STORAGE	0.000	1.009	0	14:43	0	17	0.002
Wetland-East	STORAGE	0.000	0.717	0	13:01	0	10.3	0.029

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Node Surcharge Summary
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Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
E1_00	JUNCTION	1.79	0.000	0.000
E3_01	JUNCTION	4.32	0.061	0.000
E3_03	JUNCTION	2.99	0.688	0.000
Jun-1	JUNCTION	2.58	0.026	0.226
MB_1	JUNCTION	1.15	0.300	0.000
O_05	JUNCTION	3.73	0.076	0.000
O_06	JUNCTION	2.10	0.015	0.000
O_08	JUNCTION	11.29	0.835	0.000
O_11	JUNCTION	2.05	0.116	0.493
O_12	JUNCTION	1.89	0.016	0.000
PropB-8	JUNCTION	4.02	0.063	0.000
PropB-9	JUNCTION	3.24	0.045	0.000
WB_01	JUNCTION	8.62	0.272	0.000

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Node Flooding Summary
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Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
E1_00	1.78	0.606	0 12:49	2.014	0.000
E3_01	4.32	0.205	0 12:40	0.382	0.061

E3_03	0.41	0.066	0	12:10	0.017	0.002
MB_1	0.48	0.095	0	12:10	0.064	0.000
O_05	3.73	0.498	0	12:54	1.596	0.076
O_06	2.10	0.181	0	12:38	0.157	0.015
O_08	1.86	0.020	0	13:30	0.095	0.000
O_12	1.88	0.356	0	12:12	0.515	0.016
PropB-8	4.02	0.114	0	12:47	0.229	0.063
PropB-9	3.24	0.030	0	13:01	0.057	0.045
WB_01	8.62	1.017	0	12:35	2.630	0.272
West-Wetland	3.62	0.504	0	14:43	4.777	0.000
Wetland-East	5.48	0.513	0	13:20	8.092	0.000

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Storage Volume Summary
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Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
West-Wetland	0.063	34.5	0.0	0.0	0.184	100.0	0 13:04	0.723
Wetland-East	1.150	52.8	0.0	0.0	2.179	100.0	0 13:20	0.078

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Outfall Loading Summary
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Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OMC - Outlet	99.57	0.651	1.785	71.362
Prop_pinecrestOutfall	0.00	0.000	0.000	0.000
System	49.78	0.651	1.785	71.362

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Link Flow Summary
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Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
18	CONDUIT	0.175	0 12:10	0.70	1.32	0.83

AL_ellip	CONDUIT	1.781	0	14:11	1.67	1.08	0.50
B1-1	CONDUIT	0.569	0	12:32	0.40	0.30	0.70
B1-2	CONDUIT	0.447	0	12:32	0.41	0.24	0.58
B1-3	CONDUIT	0.263	0	12:31	0.36	0.14	0.46
Bell-1_2	CONDUIT	0.107	0	13:21	1.52	6.81	1.00
Bell1-05	CONDUIT	0.171	0	12:27	0.07	0.03	0.97
Bell2_1	CONDUIT	0.156	0	12:24	0.15	0.02	0.87
Bell-2_2	CONDUIT	0.095	0	13:10	1.35	2.85	1.00
Bell2-2	CONDUIT	0.226	0	12:06	0.72	0.29	0.81
Bell2-3	CONDUIT	0.154	0	12:08	0.34	0.20	0.69
Bell2-CS-01	CONDUIT	0.109	0	12:03	1.05	4.91	1.00
Bell-3_1	CONDUIT	0.161	0	12:09	0.17	0.05	0.98
Bell-3_2	CONDUIT	0.091	0	12:11	1.28	3.35	1.00
Bell-Over1	CONDUIT	0.066	0	12:30	0.29	0.61	0.36
Bell-over2	CONDUIT	0.049	0	12:13	0.28	0.20	0.29
Cedar-16	CONDUIT	0.470	0	12:13	0.50	0.42	0.79
Cedar-17	CONDUIT	0.378	0	12:11	0.57	0.33	0.63
CONC-E	CONDUIT	1.785	0	14:09	2.92	1.29	0.36
CS-004	CONDUIT	0.453	0	12:09	2.85	3.34	1.00
E-03	CONDUIT	1.545	0	12:37	0.63	1.06	0.91
E-04	CONDUIT	1.444	0	12:32	0.66	0.87	0.93
E1-01	CONDUIT	1.429	0	12:33	0.53	1.21	1.00
E1-02	CONDUIT	1.542	0	12:40	0.59	0.75	0.95
E1-05	CONDUIT	1.271	0	12:29	0.61	0.86	0.93
E1-06	CONDUIT	1.230	0	12:28	0.53	0.63	0.92
E1-07	CONDUIT	1.035	0	12:21	0.59	0.70	0.93
E2-1	CONDUIT	0.364	0	12:14	0.39	0.42	0.99
E2-2	CONDUIT	0.320	0	12:13	0.47	0.11	0.51
E2-3	CONDUIT	0.241	0	12:12	0.56	0.14	0.40
E3-1	CONDUIT	0.604	0	12:13	0.57	0.54	1.00
E3-2_1	CONDUIT	0.273	0	12:10	0.55	0.28	0.65
E3-2_2	CONDUIT	0.266	0	12:13	0.43	0.32	0.90
E3-CS-03	CONDUIT	0.237	0	12:16	1.52	3.24	0.95
East-Wetland-1	CONDUIT	0.105	0	12:41	0.69	0.02	0.67
FT-01	CONDUIT	0.488	0	12:14	0.40	0.49	0.85
O-01	CONDUIT	1.770	0	14:13	0.58	1.25	0.76
O-02	CONDUIT	1.770	0	14:11	0.51	0.88	0.99
O-03	CONDUIT	1.442	0	14:48	0.38	1.48	0.98
O-04	CONDUIT	1.441	0	14:47	0.37	1.41	1.00
O-05	CONDUIT	1.397	0	14:48	0.36	0.61	1.00
O-06	CONDUIT	2.405	0	14:41	0.65	2.47	1.00
O-07	CONDUIT	2.214	0	12:43	0.70	1.28	1.00
O-08	CONDUIT	1.251	0	12:56	0.38	0.91	1.00
O-09	CONDUIT	0.885	0	12:55	0.55	0.32	0.74
O-10	CONDUIT	0.864	0	12:28	0.65	0.58	0.72
O-11	CONDUIT	0.872	0	12:12	0.57	1.21	1.00
O-CS-01	CONDUIT	1.781	0	14:10	1.31	0.91	0.54
O-CS-05	CONDUIT	0.807	0	13:25	1.83	0.77	1.00
O-CS-06	CONDUIT	1.441	0	14:46	0.53	0.49	0.99
O-Outlet-structure	CONDUIT	1.785	0	14:09	2.98	0.06	0.21
Over-Bell2	CONDUIT	0.063	0	12:28	0.33	0.18	0.31
PropB10_1	CONDUIT	0.723	0	13:02	0.47	0.92	0.82
PropB10_3	CONDUIT	1.009	0	14:43	0.53	1.30	0.91
PropB10_4	CONDUIT	1.011	0	14:36	0.37	0.63	1.00
PropB10_5	CONDUIT	1.009	0	14:43	0.37	2.56	1.00
SW-2	CONDUIT	0.098	0	12:10	0.24	0.21	0.79
SW2_4	CONDUIT	0.129	0	12:11	0.47	0.09	0.34

SW2_5	CONDUIT	0.136	0	12:10	0.44	0.18	0.41
SW-5	CONDUIT	0.068	0	12:11	0.29	0.28	0.70
SW-6	CONDUIT	0.052	0	12:10	0.23	0.21	0.65
SW-7	CONDUIT	0.096	0	12:11	0.36	1.79	0.97
SW-9	CONDUIT	0.210	0	12:12	0.44	0.22	0.79
SW-B2	CONDUIT	0.034	0	12:10	0.13	0.02	0.28
W-01	CONDUIT	0.611	0	16:32	0.55	0.96	1.00
W-02	CONDUIT	0.546	0	12:29	0.36	1.00	1.00
W-03	CONDUIT	0.547	0	12:29	0.37	0.77	1.00
W-04	CONDUIT	0.180	0	12:20	0.13	0.14	0.80
W-05	CONDUIT	0.188	0	12:14	0.29	0.28	0.71
W-06	CONDUIT	0.136	0	12:11	0.29	0.22	0.49
WB-CS-04	CONDUIT	0.558	0	12:29	0.79	1.22	0.98
WB-CS-08	CONDUIT	0.510	0	12:28	0.73	0.87	0.90
Weir-1	WEIR	0.107	0	12:41			0.79
Weir-2	WEIR	0.636	0	13:04			0.44

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Flow Classification Summary
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Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
18	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.26	0.00
AL_ellip	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.34	0.00
B1-1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.96	0.00
B1-2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.97	0.00
B1-3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.97	0.00
Bell-1_2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.01	0.00
Bell1-05	1.00	0.00	0.03	0.00	0.97	0.00	0.00	0.00	0.80	0.00
Bell2_1	1.00	0.00	0.01	0.00	0.99	0.00	0.00	0.00	0.96	0.00
Bell-2_2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.16	0.00
Bell2-2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
Bell2-3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.97	0.00
Bell2-CS-01	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
Bell-3_1	1.00	0.00	0.14	0.00	0.86	0.00	0.00	0.00	0.95	0.00
Bell-3_2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.36	0.

Bell-Over1	1.00	0.98	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Bell-over2	1.00	0.99	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Cedar-16	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.97	0.00
Cedar-17	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.96	0.00
CONC-E	1.00	0.00	0.00	0.00	0.46	0.53	0.00	0.00	0.00	0.00
CS-004	1.00	0.00	0.00	0.00	0.96	0.04	0.00	0.00	0.27	0.00
E-03	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
E-04	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.85	0.00
E1-01	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.35	0.00
E1-02	1.00	0.00	0.01	0.00	0.99	0.00	0.00	0.00	0.82	0.00
E1-05	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.44	0.00
E1-06	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.60	0.00
E1-07	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.32	0.00
E2-1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.60	0.00
E2-2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00
E2-3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.89	0.00
E3-1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.28	0.00
E3-2_1	1.00	0.00	0.03	0.00	0.97	0.00	0.00	0.00	0.84	0.00
E3-2_2	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.75	0.00
E3-CS-03	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.10	0.00
East-Wetland-1	1.00	0.00	0.17	0.00	0.83	0.00	0.00	0.00	0.00	0.00
FT-01	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.80	0.00
O-01	1.00	0.00	0.01	0.00	0.99	0.00	0.00	0.00	0.01	0.00
O-02	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.40	0.00
O-03	1.00	0.00	0.02	0.00	0.98	0.00	0.00	0.00	0.00	0.00
O-04	1.00	0.02	0.03	0.00	0.95	0.00	0.00	0.00	0.25	0.00
O-05	1.00	0.02	0.00	0.00	0.81	0.00	0.00	0.18	0.18	0.00
O-06	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.15	0.00
O-07	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.77	0.00
O-08	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.27	0.00

O-09	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.99	0.00
O-10	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.45	0.00
O-11	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.86	0.00
O-CS-01	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.17	0.00
O-CS-05	1.00	0.00	0.01	0.00	0.97	0.02	0.00	0.00	0.80	0.00
O-CS-06	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.01	0.00
O-Outlet-structure	1.00	0.02	0.01	0.00	0.02	0.94	0.00	0.00	0.00	0.00
Over-Bell2	1.00	0.99	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PropB10_1	1.00	0.09	0.03	0.00	0.89	0.00	0.00	0.00	0.48	0.00
PropB10_3	1.00	0.07	0.01	0.00	0.92	0.00	0.00	0.00	0.43	0.00
PropB10_4	1.00	0.02	0.05	0.00	0.93	0.00	0.00	0.00	0.36	0.00
PropB10_5	1.00	0.07	0.00	0.00	0.93	0.00	0.00	0.00	0.00	0.00
SW-2	1.00	0.00	0.26	0.00	0.73	0.00	0.00	0.00	0.99	0.00
SW2_4	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.99	0.00
SW2_5	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.96	0.00
SW-5	1.00	0.00	0.11	0.00	0.88	0.00	0.00	0.00	0.98	0.00
SW-6	1.00	0.13	0.24	0.00	0.63	0.00	0.00	0.00	0.85	0.00
SW-7	1.00	0.00	0.13	0.00	0.87	0.00	0.00	0.00	0.58	0.00
SW-9	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.07	0.00
SW-B2	1.00	0.00	0.17	0.00	0.83	0.00	0.00	0.00	1.00	0.00
W-01	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.56	0.00
W-02	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.10	0.00
W-03	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.74	0.00
W-04	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.81	0.00
W-05	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.87	0.00
W-06	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.96	0.00
WB-CS-04	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
WB-CS-08	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.15	0.00

****
Conduit Surcharge Summary

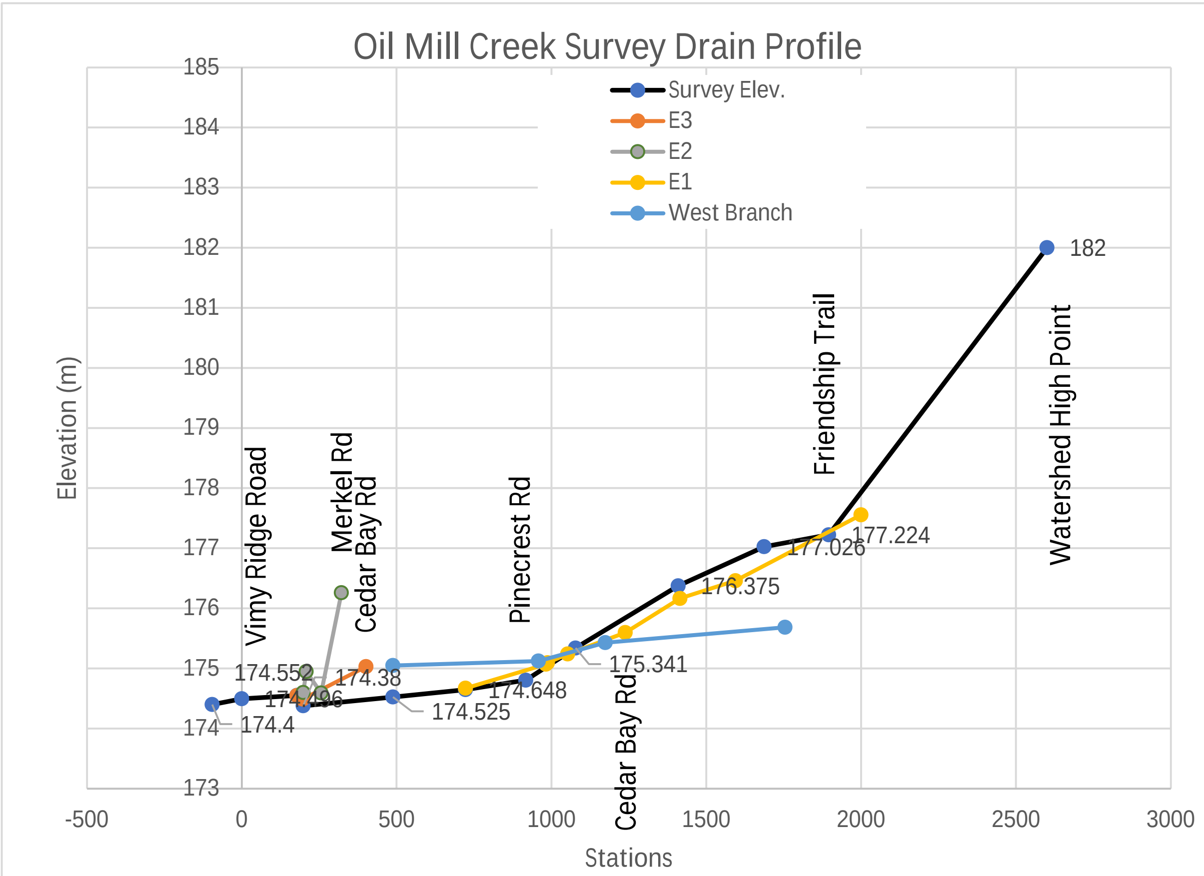
****

Conduit	--------- Hours Full -------- Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
18	0.01	0.01	0.01	0.16	0.01
AL_ellip	0.01	0.01	0.01	3.25	0.01
Bell-1_2	1.04	3.30	1.04	7.17	1.04
Bell1-05	0.01	0.01	0.79	0.01	0.01
Bell2_1	0.01	0.01	1.03	0.01	0.01
Bell-2_2	2.49	2.74	2.49	2.89	2.49
Bell2-CS-01	1.09	1.48	1.09	2.46	1.09
Bell-3_1	0.01	0.01	0.84	0.01	0.01
Bell-3_2	2.81	2.92	2.85	2.77	2.61
CONC-E	0.01	0.01	0.01	5.03	0.01
CS-004	10.82	11.29	10.82	12.35	10.82
E-03	0.01	0.01	0.01	0.46	0.01
E1-01	1.76	1.78	2.10	0.22	0.01
E1-02	0.01	0.01	1.78	0.01	0.01
E1-07	0.01	0.01	0.38	0.01	0.01
E2-1	0.01	0.01	4.32	0.01	0.01
E3-1	4.32	4.32	4.63	0.01	0.01
E3-2_2	0.01	0.01	5.34	0.01	0.01
E3-CS-03	0.01	2.99	0.01	4.82	0.01
FT-01	0.01	0.01	1.89	0.01	0.01
O-01	0.01	0.01	0.01	4.76	0.01
O-03	0.01	0.01	0.01	8.33	0.01
O-04	3.23	4.09	3.23	7.76	3.23
O-05	3.24	3.24	4.05	0.01	0.01
O-06	3.24	3.96	3.24	7.67	3.24
O-07	2.51	2.85	3.73	2.45	2.08
O-08	2.11	2.11	2.37	0.01	0.01
O-11	2.00	2.05	2.03	2.04	1.97
O-CS-05	1.94	1.94	2.05	0.01	0.01
O-CS-06	0.01	0.01	2.57	0.01	0.01
PropB10_3	0.01	0.01	0.01	2.93	0.01
PropB10_4	4.02	4.02	4.70	0.01	0.01
PropB10_5	3.69	3.69	4.02	4.75	0.01
SW-2	0.01	0.01	1.15	0.01	0.01
SW-5	0.01	0.01	0.36	0.01	0.01
SW-6	0.01	0.01	0.28	0.01	0.01
SW-7	0.01	0.01	0.01	0.24	0.01
SW-9	0.01	0.01	1.07	0.01	0.01
W-01	10.42	10.42	12.46	0.01	0.01
W-02	6.18	6.18	8.62	0.10	0.10
W-03	3.10	3.10	4.52	0.01	0.01
WB-CS-04	0.01	0.01	0.01	2.65	0.01

Analysis begun on: Tue Aug 8 14:20:46 2023
Analysis ended on: Tue Aug 8 14:20:51 2023
Total elapsed time: 00:00:05

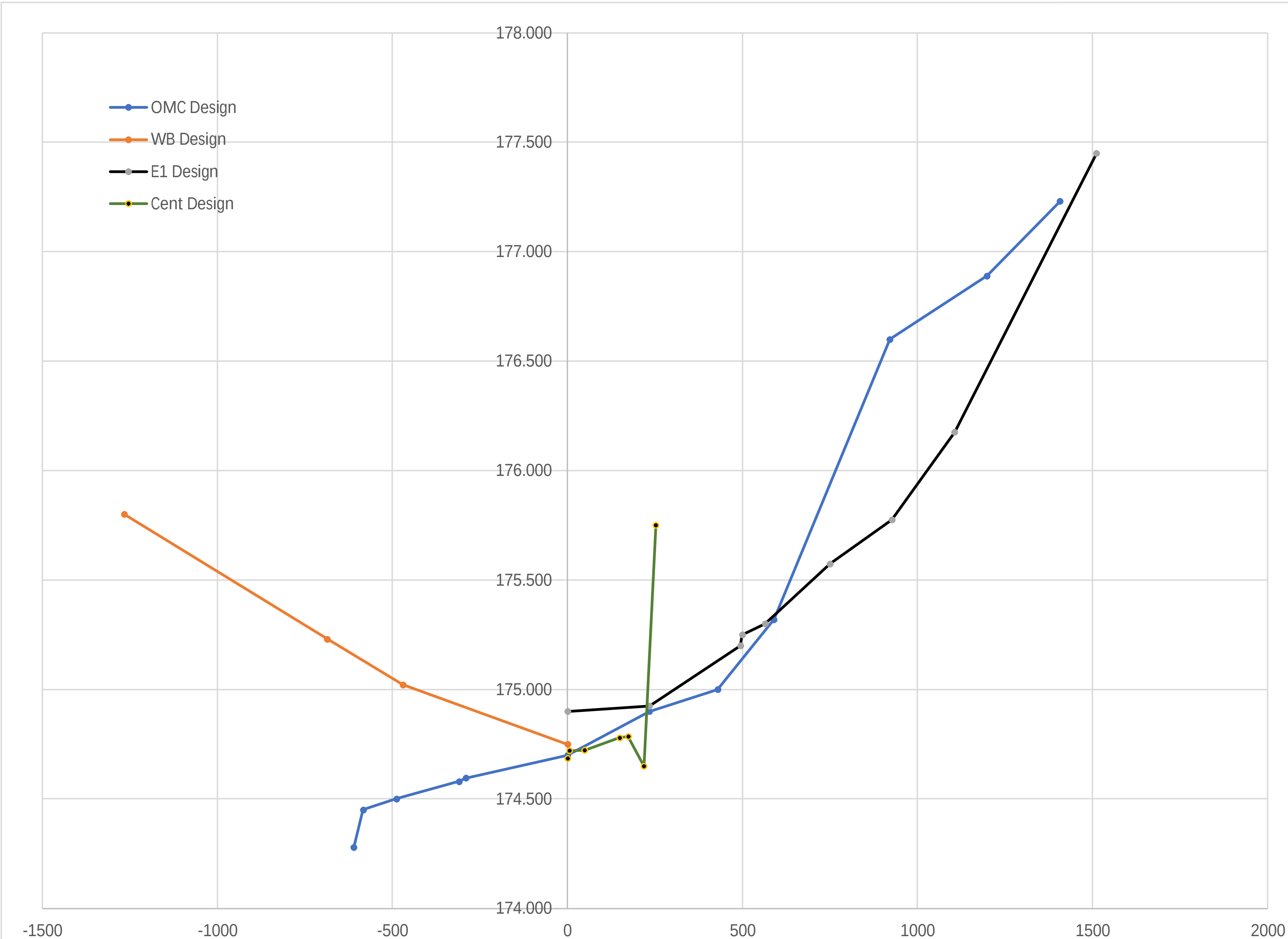
Appendix D:

Channel Analysis



Oil Mill Creek Survey Drain Profile
Survey Elev.
E3
E2
E1
West Branch
Elevation (m)
Stations
Vimy Ridge Road
Merkel Rd
Cedar Bay Rd
Pinecrest Rd
Cedar Bay Rd
Friendship Trail
Watershed High Point
182
177.224
177.026
176.375
175.341
174.648
174.525
174.38
174.552
174.4

West Branch Confluence Grade Comparison with Centennial Wetland

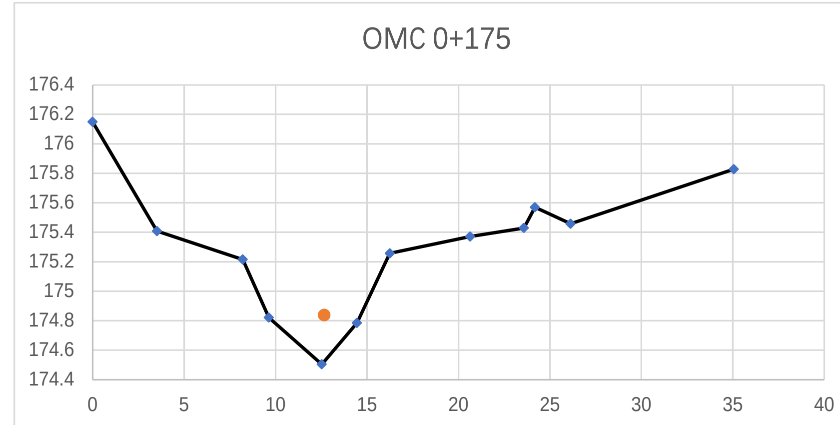


Oil Mill Creek

Capacity analysis using Mannings formula

0+175

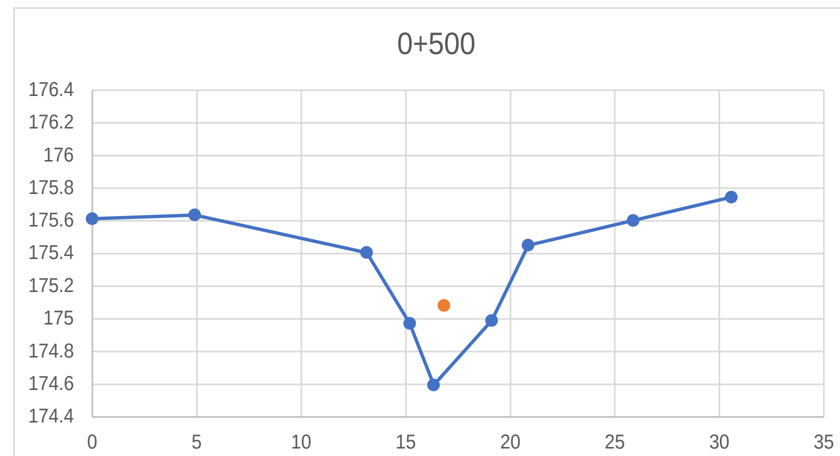
			field_1	E	N	E	txt	Distance	Length
Slope	0.0003	1	3701	4748568	648853.1	176.149	OG	0	0
Depth	0.75	2	3700	4748571	648854.6	175.408	OG	3.518	3.518
BW	4.81	3	3699	4748574	648858.5	175.215	TS	4.694	8.211
TW	8.03	4	3698	4748575	648859.6	174.821	BS	1.424	9.635
SS1	3.6	5	3696	4748577	648861.9	174.504	D	2.891	12.526
SS2	3.8	7	3695	4748577	648863.7	174.785	BS	1.921	14.447
		8	3694	4748578	648865.4	175.257	TS	1.799	16.246
		9	3693	4748578	648869.7	175.371	OG	4.394	20.640
		10	3709	4748578	648872.7	175.429	01-Dec	2.939	23.579
		11	3710	4748578	648873.3	175.57	10-Dec	0.598	24.177
		12	3711	4748578	648875.2	175.458	05-Dec	1.948	26.126
		13	3712	4748581	648883.6	175.828	03-Dec	8.929	35.055
		6	3697	4748577	648862	174.838	WL	0.137	12.663



Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
175.429	0.00					
175.429	3.52					
175.429	4.70	0.55				
175.429	1.55	0.59				
175.429	3.04	2.22				
175.429	2.03	1.51				
175.429	1.81	0.73				
175.429	4.39	0.51				
175.429	2.94	0.09				
175.429	0.00					
	23.97	6.18	0.26	0.04	0.175	1.085

0+500

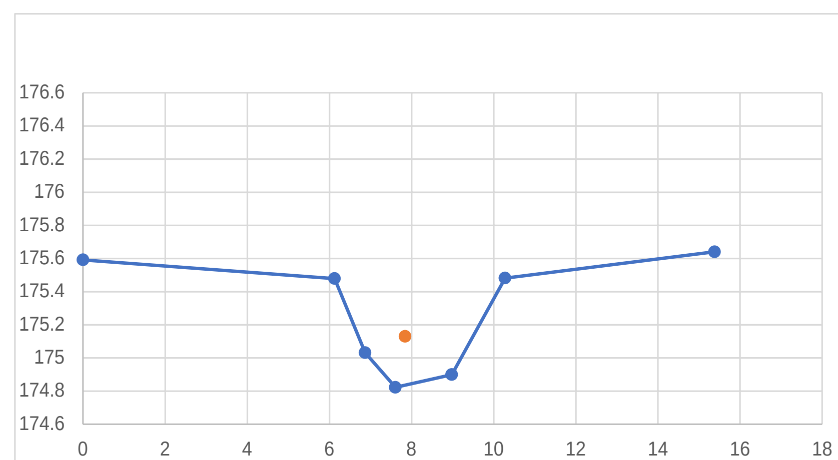
		field_1	field_2	field_3	field_4	field_5	Distance	Length
Slope	0.0003	3457	4748660	648686.8	175.613	OG	0	0
Depth	0.86	3458	4748665	648688.4	175.636	OG	4.901	4.901
BW	3.92	3459	4748657	648684.7	175.406	TS	8.224	13.125
TW	7.72	3460	4748656	648683.3	174.972	BS	2.062	15.187
SS1	4.8	3461	4748655	648682.7	174.595	D	1.147	16.334
SS2	3.8	3463	4748653	648680.5	174.99	BS	2.773	19.106
		3464	4748652	648679	175.451	TS	1.742	20.848
		3465	4748649	648675.4	175.602	OG	5.029	25.877
		3466	4748646	648671.8	175.745	OG	4.693	30.570
		3462	4748655	648683	175.082	WL	0.496	16.830



Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
175.636	0.00					
175.636	0.00	0.06				
175.636	8.23	0.95				
175.636	2.17	0.92				
175.636	1.55	0.98				
175.636	2.85	2.34				
175.636	1.75	0.72				
175.636	0.00	0.55				
175.636	0.00					
	16.54	6.51	0.39	0.04	0.233	1.516

0+880

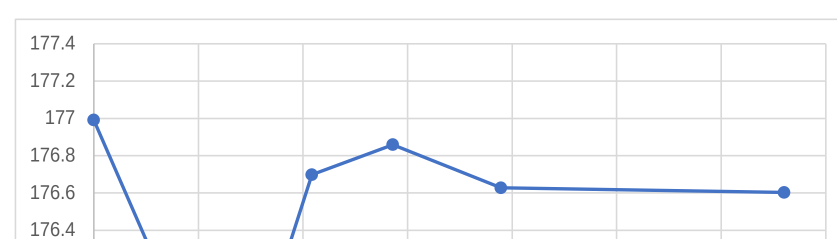
		field_1	field_2	field_3	field_4	field_5	Distance	Length
Slope	0.0022							
Depth	0.66	3252	4748880	648321.3	175.592	OG	0	0
BW	2.11	3253	4748886	648321.9	175.479	TS	6.124	6.124
TW	4.15	3254	4748887	648321.9	175.031	BS	0.745	6.870
SS1	1.7	3255	4748888	648321.9	174.822	D	0.737	7.607
SS2	2.2	3257	4748889	648321.7	174.899	BS	1.372	8.979
		3258	4748891	648321.7	175.482	TS	1.298	10.277
		3259	4748896	648320.6	175.64	OG	5.106	15.383
		3256	4748888	648322	175.13	WL	0.238	7.846



Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
175.482	0.00					
175.482	0.00	0.00				
175.482	0.87	0.17				
175.482	0.99	0.41				
175.482	1.49	0.85				
175.482	1.30	0.38				
175.482	0.00	0.00				
	4.65	1.81	0.39	0.04	0.625	1.131

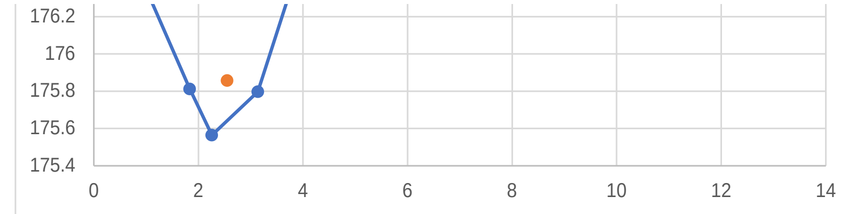
1+350

		field_1	field_2	field_3	field_4	field_5	Distance	Length
Slope	0.0041							
Depth	1.13	1156	4749207	648264.7	176.991	TS	0	0
BW	1.30	1157	4749207	648266.5	175.812	BS	1.836	1.836
TW	4.17	1158	4749207	648266.9	175.564	D	0.421	2.257
SS1	1.6	1160	4749207	648267.8	175.797	BS	0.880	3.137
SS2	1.1	1161	4749207	648268.8	176.698	TS	1.033	4.170



Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
176.859	0.00					
176.859	2.11	0.84				
176.859	1.36	0.49				
176.859	1.38	1.04				
176.859	1.05	0.63				

	field_1	field_2	field_3	field_4	field_5	Distance	Length
	1162	4749208	648270.2	176.859	OG	1.549	5.719
	1163	4749208	648272.3	176.628	EF	2.066	7.785
	1164	4749208	648277.7	176.603	OG	5.416	13.202
	1159	4749208	648266.7	175.857	WL	0.294	2.551

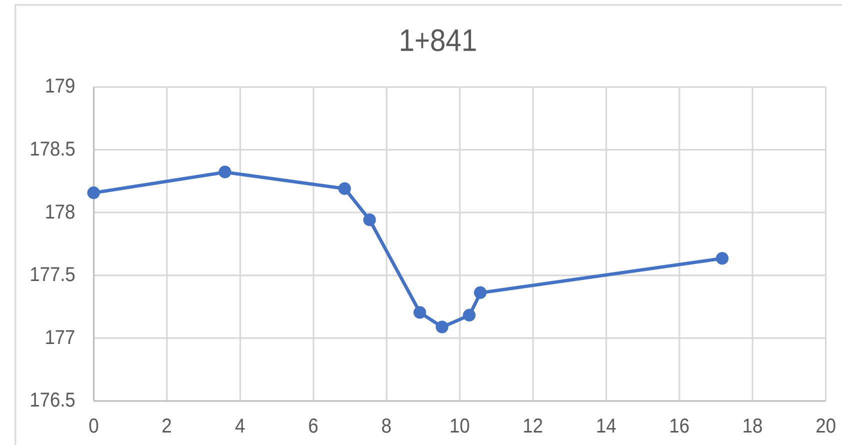


Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
176.859						
176.859						
176.859						
	5.90	3.00	0.51	0.04	1.020	3.062

1+841

Slope	0.001
Depth	0.27
BW	1.35
TW	3.03
SS1	1.9
SS2	1.7

field_1	field_2	field_3	field_4	field_5	Distance	Length
2072	4749799	648240.8	178.157	EP	0	0
2073	4749799	648244.4	178.322	CL	3.590	3.590
2074	4749799	648247.6	178.19	EP	3.269	6.859
2075	4749799	648248.3	177.941	TS	0.679	7.538
2076	4749798	648249.7	177.203	BS	1.376	8.913
2077	4749799	648250.3	177.088	D	0.607	9.520
2078	4749798	648251	177.182	BS	0.741	10.261
2079	4749799	648251.3	177.361	TS	0.304	10.565
2080	4749799	648257.9	177.634	OG	6.607	17.172



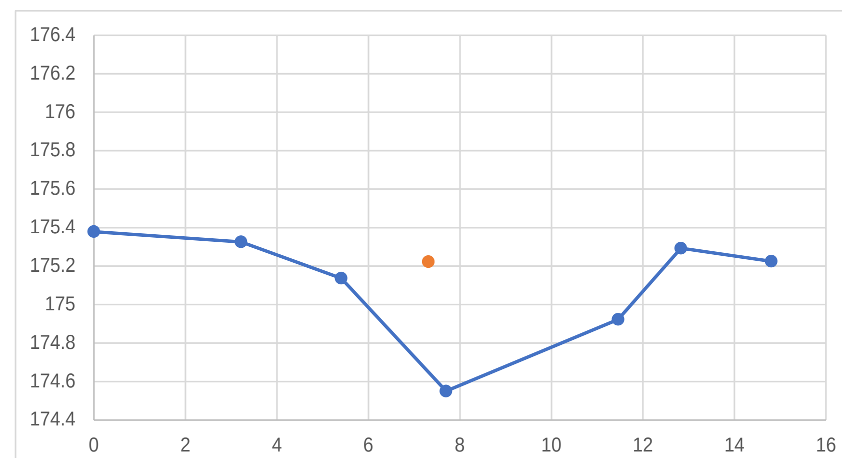
Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
177.361	0.00					
177.361	0.00					
177.361	0.00					
177.361	0.00					
177.361	1.38					
177.361	0.67	0.13				
177.361	0.76	0.17				
177.361	0.00	0.03				
177.361	0.00					
	2.81	0.33	0.12	0.04	0.188	0.061

WB Branch Drain

0+097

Slope	0.001
Depth	0.74
BW	6.05
TW	9.61
SS1	11.6
SS2	3.7

	field_1	field_2	field_3	field_4	field_5	Distance	Length
1	3203	4748634	648568.9	175.379	OG	0	0
2	3199	4748635	648565.9	175.326	TS	3.217	3.217
3	3238	4748637	648564.2	175.137	BS	2.188	5.405
5	3268	4748637	648562	174.55	D	2.291	7.696
6	3485	4748641	648562.3	174.923	BS	3.761	11.457
7	3484	4748642	648561.1	175.293	TS	1.374	12.831
8	3468	4748643	648559.4	175.225	OG	1.975	14.806
4	3310	4748637	648562.3	175.223	WL	1.907	7.311

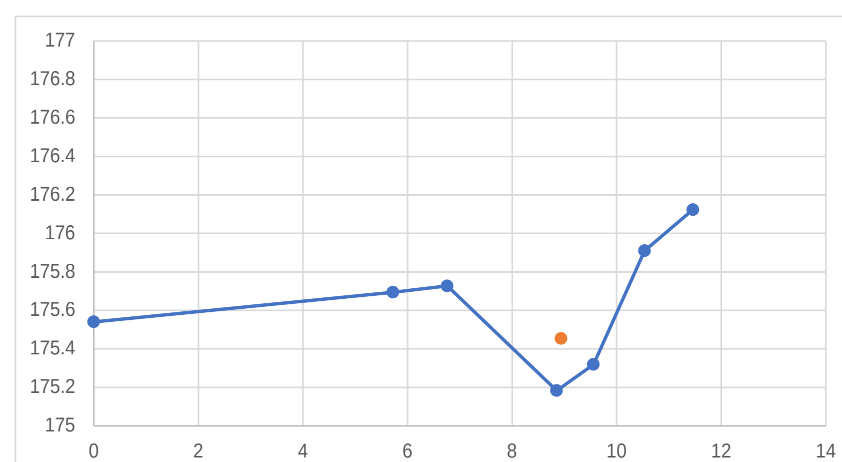


Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
175.293	0.00					
175.293	0.00					
175.293	2.19	0.13				
175.293	2.41	1.03				
175.293	3.78	2.09				
175.293	1.37	0.25				
175.293	1.98	0.07				
175.293						
	11.73	3.58	0.31	0.04	0.358	1.282

0+500

Slope	0.0017
Depth	0.73
BW	0.70
TW	3.78
SS1	3.8
SS2	1.7

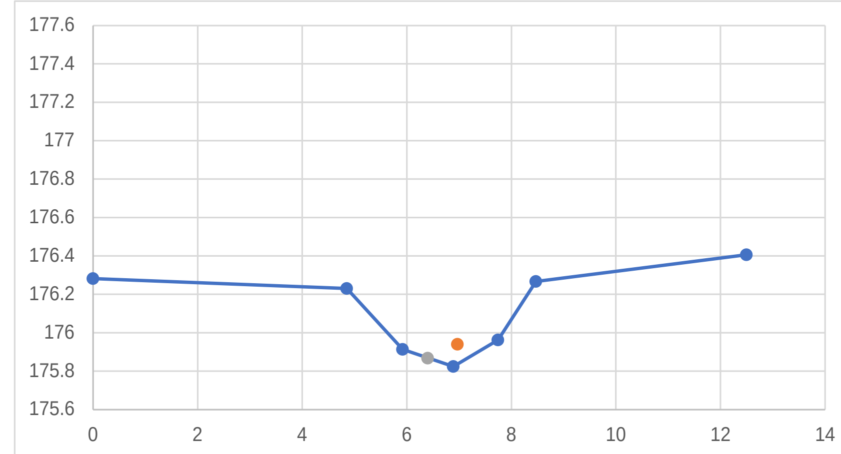
	field_1	field_2	field_3	field_4	field_5	Distance	Length
1	1482	4748393	648267.4	175.54	OG	0	0
2	1481	4748393	648273.1	175.694	HGUY	5.720	5.720
3	1480	4748394	648274	175.727	TS	1.038	6.759
4	1478	4748394	648276	175.183	D	2.094	8.853
6	1477	4748394	648276.7	175.319	BS	0.703	9.555
7	1476	4748394	648277.7	175.91	TS	0.980	10.535
8	1475	4748394	648278.6	176.123	EP	0.922	11.458
5	1479	4748394	648276.1	175.454	WL	0.086	8.938



Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
175.727						
175.727						
175.727	1.04	0.02				
175.727	2.16	0.57				
175.727	0.81	0.33				
175.727	0.00	0.11				
175.727	0.00					

1+105

Slope	0.0008		field_1	field_2	field_3	field_4	field_5	Distance	Length
Depth	0.44	1	4816	4747993	647982.6	176.282	OG	0	0
BW	1.83	2	4815	4747998	647981.1	176.23	TS	4.852	4.852
TW	3.62	3	4814	4747999	647980.6	175.913	BS	1.067	5.919
SS1	3.4	5	4811	4748000	647980.4	175.824	D	0.491	6.890
SS2	2.4	7	4810	4748000	647979.5	175.962	BS	0.775	7.745
		8	4809	4748000	647979.2	176.267	TS	0.724	8.469
		9	4808	4748004	647976.6	176.406	OG	4.026	12.495
		4	4813	4747999	647980.3	175.867	BEDROCK	0.480	6.399
		6	4812	4748000	647980.3	175.94	WL	0.079	6.969



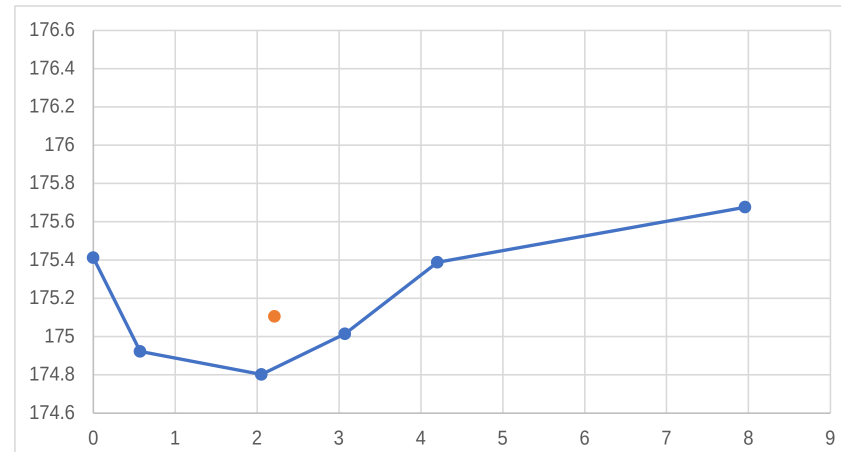
4.01	1.03	0.26	0.04	0.417	0.430

Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
176.23	0.00					
176.23	0.00					
176.23	1.11	0.17				
176.23	0.64	0.18				
176.23	0.82	0.26				
176.23	0.00	0.08				
176.23	0.00					

OMC E1 Branch

0+050

Slope	0.001		field_1	field_2	field_3	field_4	field_5	Distance	Length
Depth	0.59	1	3350	4748838	648424.3	175.412	TS	0	0
BW	2.50	2	3349	4748838	648424.9	174.922	BS	0.572	0.572
TW	4.20	3	3347	4748839	648426.4	174.802	D	1.481	2.053
SS1	1.2	5	3346	4748839	648427.4	175.014	BS	0.859	3.073
SS2	3.0	6	3345	4748839	648428.5	175.388	TS	1.130	4.203
		7	3344	4748839	648432.2	175.676	OG	3.756	7.959
		4	3348	4748839	648426.5	175.105	WL	0.160	2.214

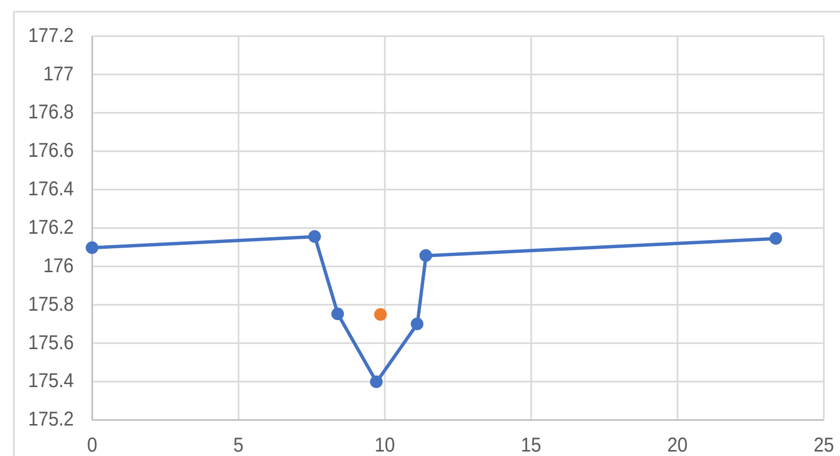


2.57	0.69	0.27	0.04	0.295	0.204

Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
175.412	0.00					
175.412	0.00	0.14				
175.412	1.60	0.81				
175.412	0.95	0.43				
175.412	1.13	0.24				
	0.00					
	0.00					

0+460

Slope	0.0025	field_1	field_2	field_3	field_4	field_5	Distance	Length
Depth	0.66	2229	4749185	648471.6	176.097	OG	0	0
BW	2.72	2230	4749185	648479.2	176.155	TS	7.605	7.605
TW	3.80	2231	4749185	648480	175.752	BS	0.787	8.392
SS1	2.0	2232	4749185	648481.3	175.398	D	1.320	9.712
SS2	0.8	2234	4749185	648482.7	175.7	BS	1.397	11.109
		2235	4749185	648483	176.056	TS	0.296	11.404
		2679	4749185	648495	176.145	OG	11.958	23.362
		2233	4749185	648481.5	175.749	WL	0.146	9.858

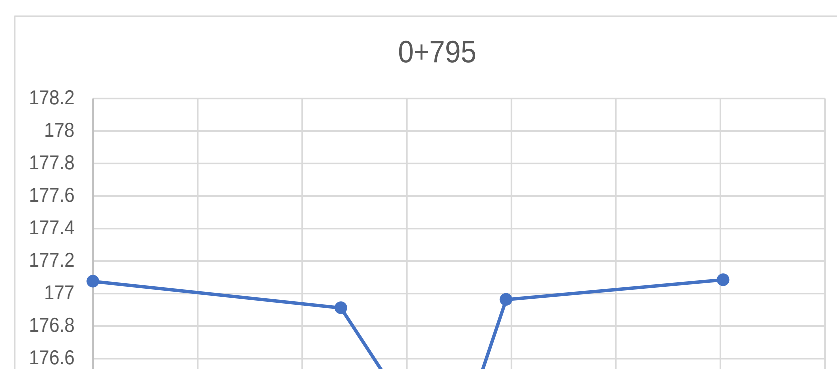


3.68	1.63	0.44	0.04	0.459	0.746

Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
176.056	0.00					
176.056	0.00					
176.056	0.84	0.08				
176.056	1.48	0.64				
176.056	1.44	0.71				
176.056	0.30	0.05				
176.056	0.00					

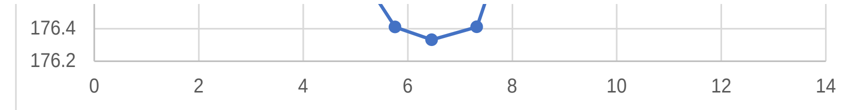
0+795

Slope	0.0021	field_1	field_2	field_3	field_4	field_5	Distance	Length
Depth	0.63	3063	4749351	648648.9	177.075	OG	0	0
BW	1.56	3064	4749352	648653.7	176.912	TS	4.741	4.741
TW	3.16	3065	4749352	648654.7	176.41	BS	1.019	5.759
SS1	2.0	3066	4749352	648655.3	176.331	D	0.699	6.458
SS2	1.0	3067	4749352	648656.2	176.411	BS	0.862	7.321
		3068	4749352	648656.8	176.963	TS	0.578	7.899
		3069	4749353	648660.9	177.084	OG	4.152	12.051



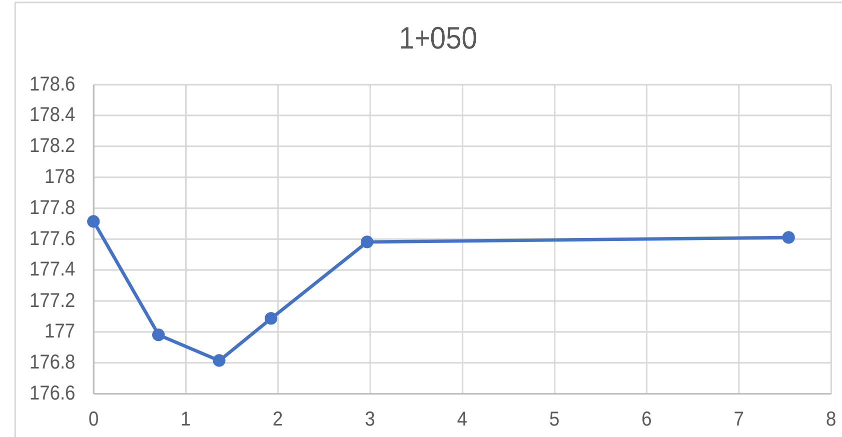
4.06	1.48	0.36	0.04	0.637	0.941

Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
176.963	0.00					
176.963	0.00					
176.963	1.16	0.31				
176.963	0.94	0.41				
176.963	1.02	0.51				
176.963	0.58	0.16				
176.963	0.00					

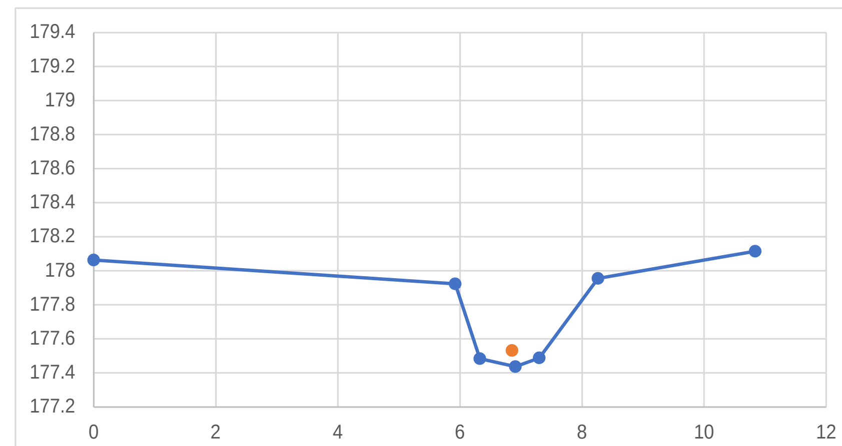


1+050

			field_1	field_2	field_3	field_4	field_5	Distance	Length
Slope	0.0019								
Depth	0.77	1	2661	4749434	648803.8	177.714	TS	0	0
BW	1.22	2	2660	4749434	648804.1	176.98	BS	0.705	0.705
TW	2.97	3	2659	4749433	648803.9	176.814	D	0.659	1.363
SS1	1.0	4	2658	4749433	648804.2	177.087	BS	0.562	1.926
SS2	2.1	5	2657	4749432	648804.1	177.581	TS	1.042	2.967
		6	2656	4749427	648804.9	177.61	OG	4.571	7.539



Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
	3.70	1.39	0.38	0.04	0.597	0.830
177.581	0.00					
177.581	0.00	0.16				
177.581	1.01	0.45				
177.581	0.75	0.35				
177.581	1.04	0.26				
177.581	0.00					



1+224

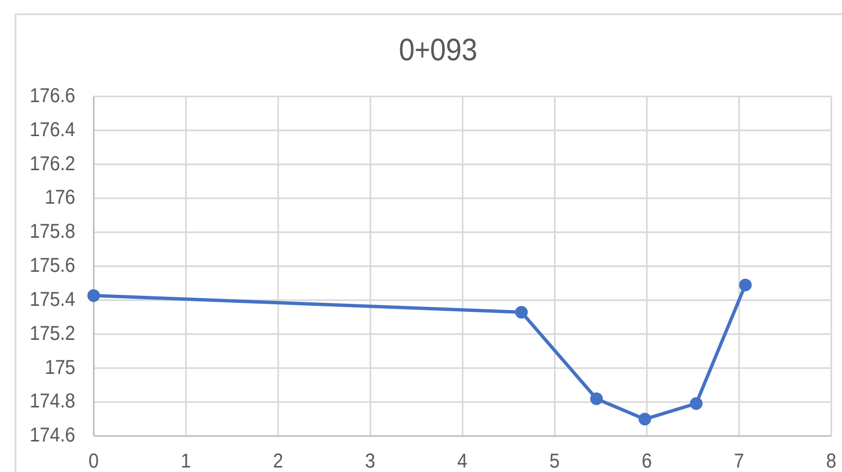
			field_1	field_2	field_3	field_4	field_5	Distance	Length
Slope	0.0019								
Depth	0.52	1	4773	4749445	649007.4	178.063	OG	0	0
BW	0.97	2	4772	4749439	649007.6	177.923	TS	5.920	5.920
TW	2.34	3	4771	4749439	649007.6	177.484	BS	0.405	6.325
SS1	0.9	5	4769	4749438	649007.6	177.437	D	0.055	6.907
SS2	2.1	6	4768	4749438	649007.6	177.488	BS	0.390	7.297
		7	4767	4749437	649008.1	177.955	TS	0.962	8.260
		8	4766	4749435	649008	178.115	OG	2.577	10.836
		4	4770	4749439	649007.6	177.532	WL	0.527	6.852

Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
	2.80	1.23	0.44	0.04	0.629	0.771
177.955						
177.955	0.00					
177.955	0.62	0.10				
177.955	0.52	0.03				
177.955	0.61	0.19				
177.955	0.96	0.22				
177.955	0.00					

OMC E2 Branch

0+093

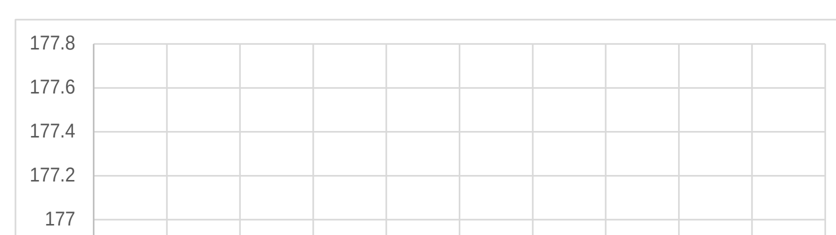
		field_1	field_2	field_3	field_4	field_5	Distance	Length
Slope	0.002							
Depth	0.79	2400	4748704	648870.7	175.427	OG	0	0
BW	1.08	2401	4748705	648875.3	175.329	TS	4.639	4.639
TW	2.43	2402	4748705	648876.1	174.819	BS	0.814	5.453
SS1	1.6	2403	4748705	648876.6	174.699	D	0.525	5.978
SS2	0.8	2404	4748705	648877.2	174.791	BS	0.556	6.535
		2405	4748705	648877.7	175.489	TS	0.533	7.068



Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
	2.71	0.55	0.20	0.04	0.374	0.204
175.329	0.00					
175.329	0.96	0.21				
175.329	0.82	0.30				
175.329	0.77	0.32				
175.329	0.00	0.10				

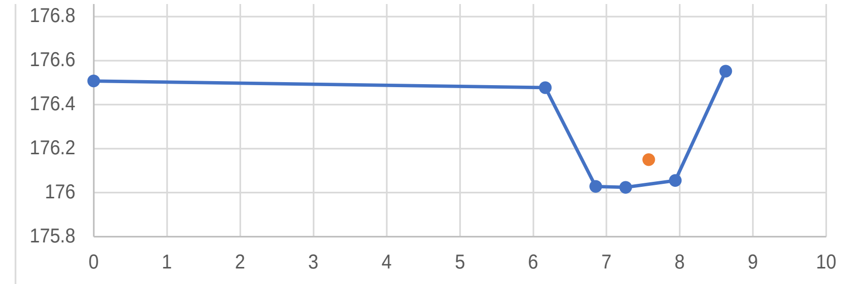
0+277

		field_1	field_2	field_3	field_4	field_5	Distance	Length
Slope	0.0044							
Depth	0.53	2496	4748889	648864.3	176.507	OG	0	0
BW	1.09	2497	4748889	648870.4	176.477	TS	6.165	6.165
TW	2.46	2498	4748889	648871.1	176.028	BS	0.689	6.854
SS1	1.5	2499	4748889	648871.5	176.024	D	0.407	7.261
SS2	1.4	2501	4748890	648872	176.055	BS	0.364	7.940



Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
	2.55	0.93	0.37	0.04	0.571	0.533
176.477	0.00					
176.477	0.82	0.15				
176.477	0.61	0.18				
176.477	0.56	0.16				

field_1	field_2	field_3	field_4	field_5	Distance	Length	Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
2502	4748890	648872.6	176.552	TS	0.689	8.629	176.477	0.00	0.12				
2500	4748890	648871.6	176.15	WL	0.314	7.575							
								1.99	0.62	0.31	0.04	0.760	0.469

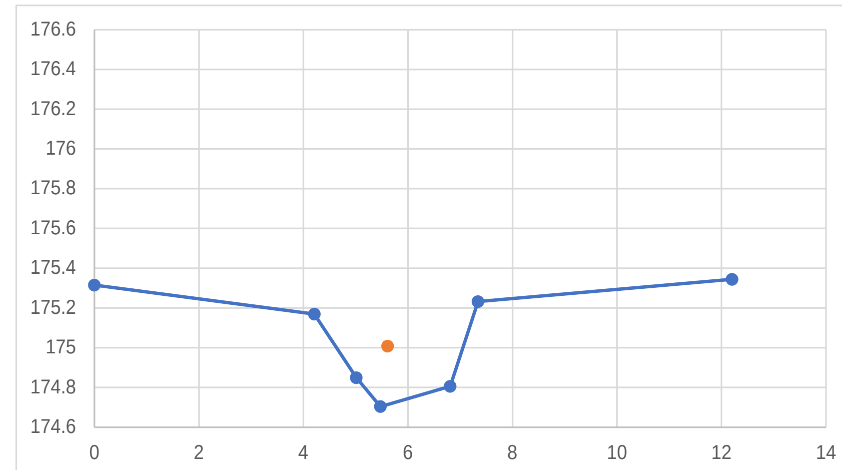


OMC E3 Branch

0+104

Slope	0.002
Depth	0.53
BW	1.79
TW	3.13
SS1	2.5
SS2	1.3

field_1	field_2	field_3	field_4	field_5	Distance	Length	Full height	Perimeter	Area	Rh	n	Velocity	Flow, Q
4648	4748639	648964.7	175.315	OG	0	0							
4649	4748635	648965.6	175.169	TS	4.208	4.208	175.232	0.00					
4650	4748635	648965.5	174.849	BS	0.804	5.012	175.232	0.89	0.18				
4651	4748634	648965.5	174.704	D	0.460	5.472	175.232	0.70	0.21				
4653	4748633	648966	174.806	BS	1.334	6.806	175.232	1.40	0.64				
4654	4748632	648966.1	175.232	TS	0.533	7.339	175.232	0.53	0.11				
4655	4748628	648967.1	175.344	OG	4.860	12.200	175.232	0.00					
4652	4748634	648965.5	175.008	WL	0.139	5.611							



Appendix E:

HY-8 Analysis

Table 1 - Summary of Culvert Flows at Crossing: E1_09

Headwater Elevation (m)	Total Discharge (cms)	E1-CS-01 #663 Pinecrest Rd Private Access Discharge (cms)	Roadway Discharge (cms)	Iterations
176.10	1.00	0.69	0.30	10
176.12	1.25	0.71	0.54	5
176.14	1.50	0.72	0.77	4
176.14	1.52	0.73	0.79	3
176.17	2.00	0.75	1.25	4
176.18	2.25	0.76	1.49	3
176.19	2.50	0.77	1.73	3
176.21	2.75	0.78	1.97	3
176.22	3.00	0.79	2.21	3
176.23	3.25	0.79	2.45	3
176.25	3.50	0.81	2.70	4
176.06	0.64	0.64	0.00	Overtopping

Rating Curve Plot for Crossing: E1_09

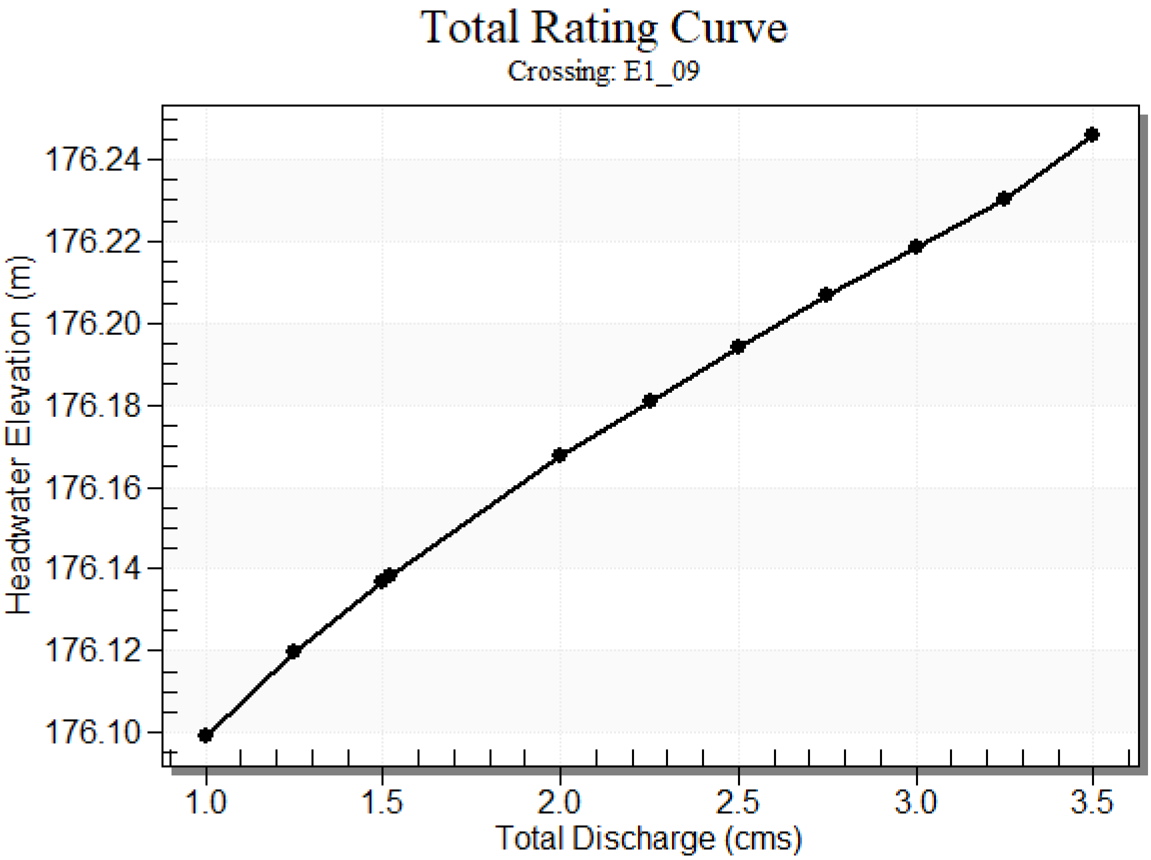


Table 2 - Summary of Culvert Flows at Crossing: E3-3

Headwater Elevation (m)	Total Discharge (cms)	E3-CS-01 - Private Lane 6m-450PE Discharge (cms)	Roadway Discharge (cms)	Iterations
175.21	0.20	0.20	0.00	1
175.27	0.23	0.22	0.01	28
175.28	0.26	0.22	0.04	5
175.28	0.27	0.22	0.05	4
175.29	0.32	0.22	0.10	4
175.29	0.35	0.22	0.12	3
175.30	0.38	0.23	0.15	3
175.30	0.41	0.23	0.18	3
175.30	0.44	0.23	0.21	3
175.30	0.47	0.23	0.24	3
175.31	0.50	0.23	0.27	3
175.27	0.22	0.22	0.00	Overtopping

Rating Curve Plot for Crossing: E3-3

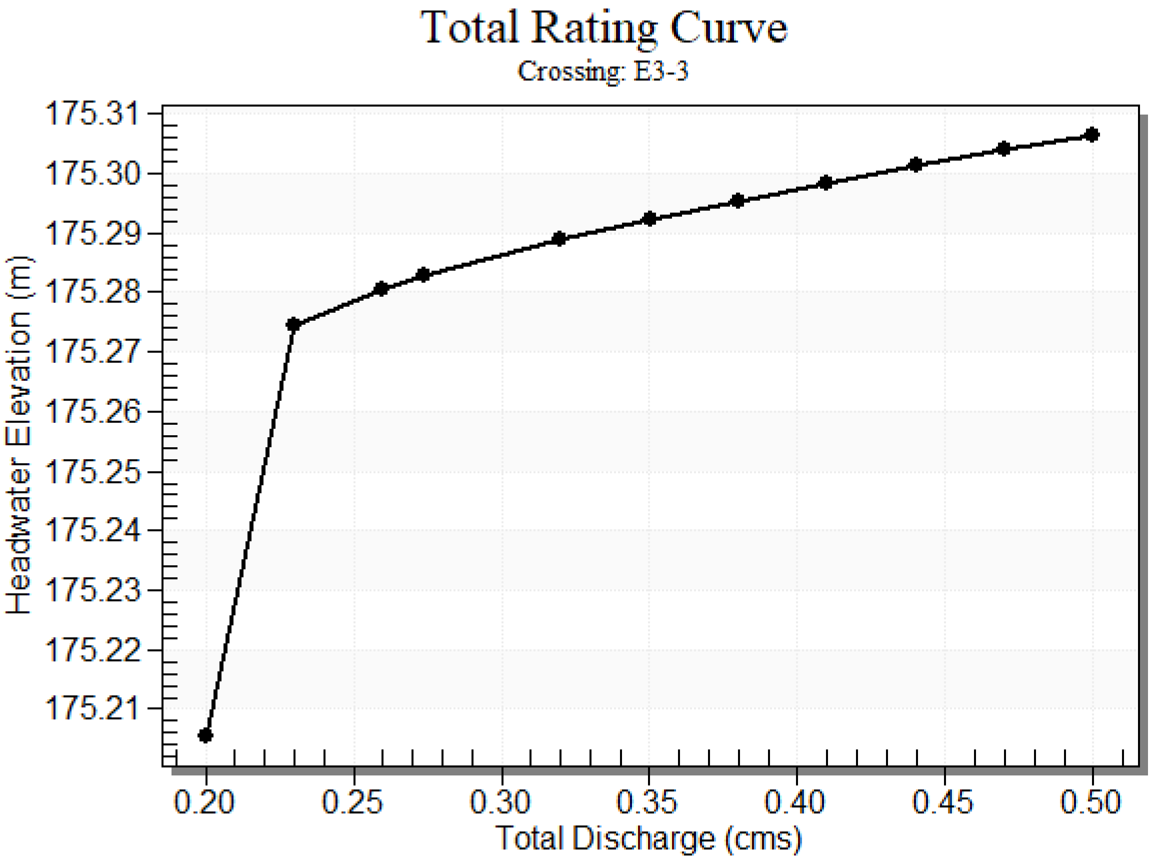


Table 3 - Summary of Culvert Flows at Crossing: E3-2 Cedar Bay Rd

Headwater Elevation (m)	Total Discharge (cms)	E3-CS-03 12m-450PE Discharge (cms)	Roadway Discharge (cms)	Iterations
175.80	0.18	0.18	0.00	1
175.87	0.21	0.21	0.00	1
175.97	0.24	0.24	0.00	1
176.08	0.27	0.27	0.00	1
176.21	0.31	0.31	0.00	1
176.36	0.34	0.34	0.00	1
176.39	0.37	0.35	0.02	13
176.40	0.40	0.35	0.05	4
176.40	0.44	0.35	0.08	3
176.40	0.47	0.35	0.12	3
176.41	0.50	0.35	0.15	3
176.39	0.35	0.35	0.00	Overtopping

Rating Curve Plot for Crossing: E3-2 Cedar Bay Rd

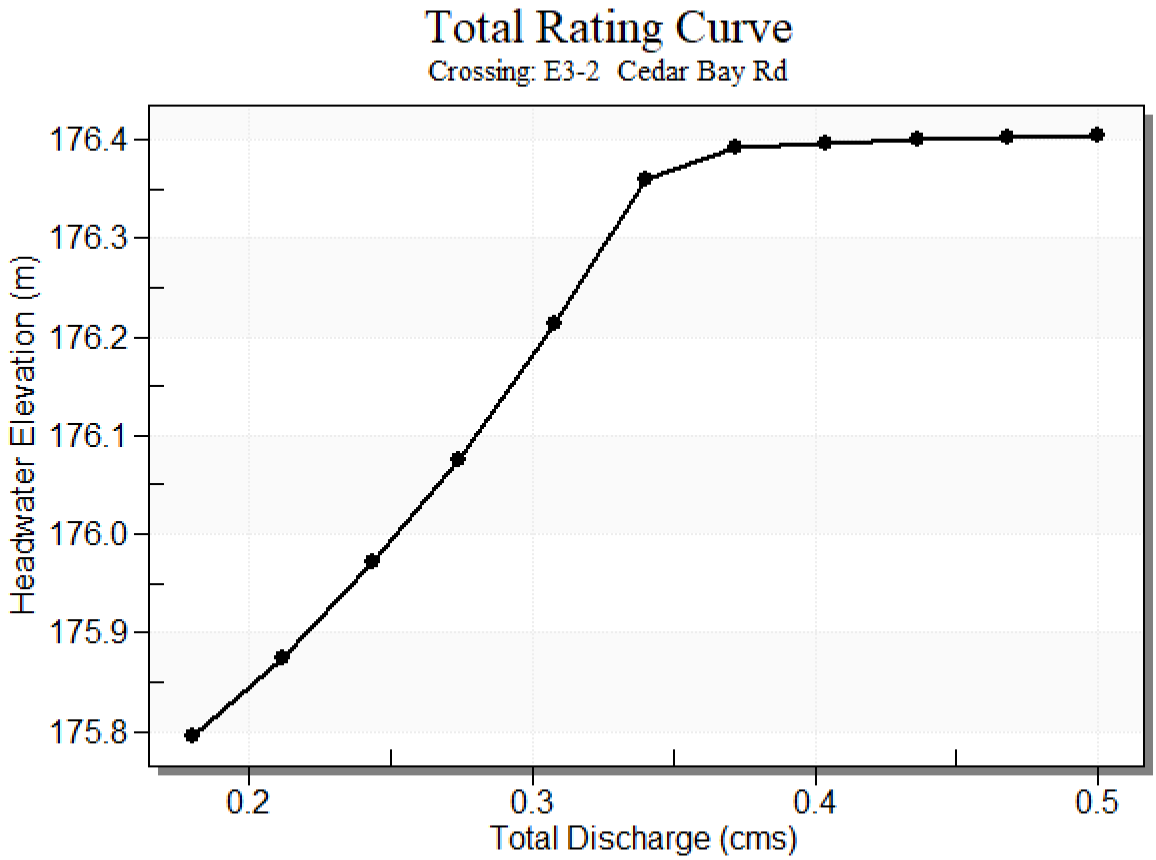


Table 4 - Summary of Culvert Flows at Crossing: WB_07 - West Branch

Headwater Elevation (m)	Total Discharge (cms)	WB-CS-17 - #2316 Firelane 2 Discharge (cms)	Roadway Discharge (cms)	Iterations
176.32	0.10	0.10	0.00	1
176.35	0.12	0.11	0.00	30
176.36	0.13	0.11	0.02	5
176.36	0.15	0.11	0.03	4
176.36	0.16	0.11	0.05	4
176.37	0.17	0.11	0.06	3
176.37	0.19	0.11	0.07	3
176.37	0.20	0.11	0.09	3
176.37	0.22	0.12	0.10	2
176.37	0.24	0.12	0.12	3
176.37	0.25	0.12	0.13	2
176.35	0.11	0.11	0.00	Overtopping

Rating Curve Plot for Crossing: WB_07 - West Branch

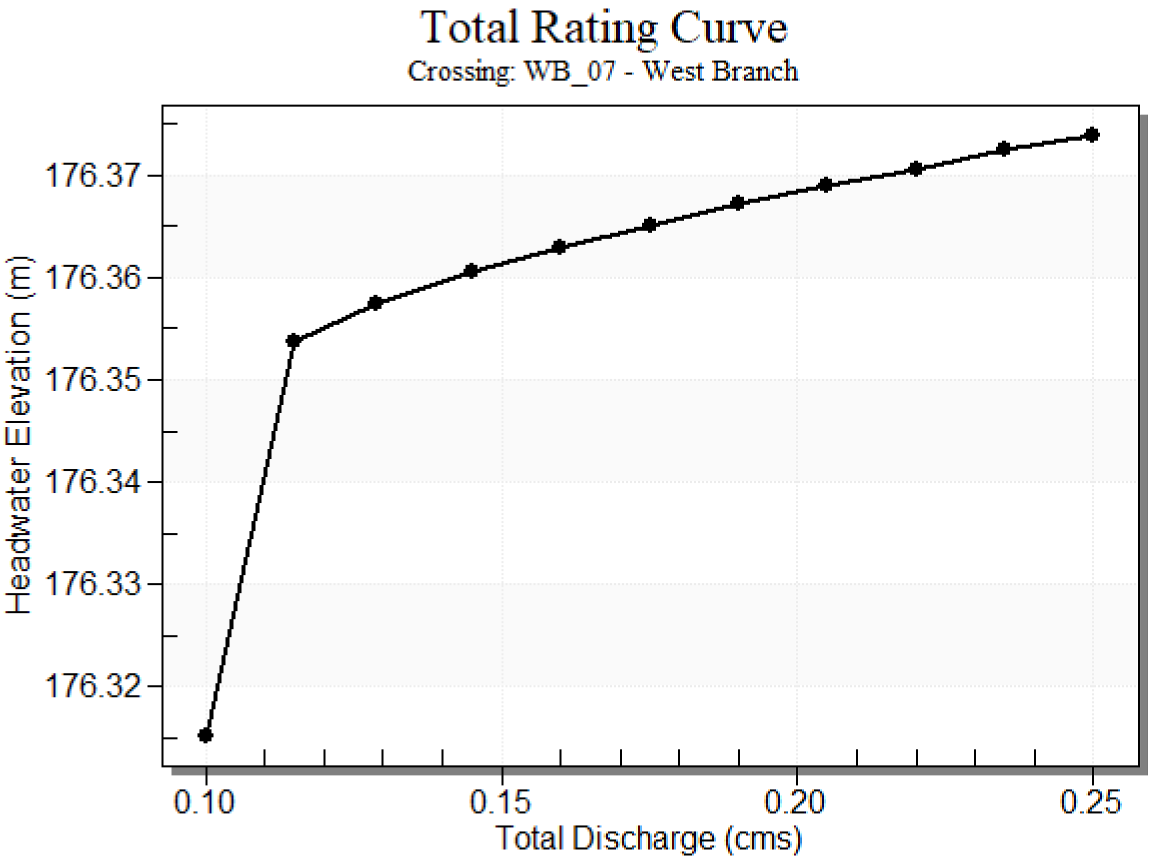


Table 5 - Summary of Culvert Flows at Crossing: WB_07 - West Branch

Headwater Elevation (m)	Total Discharge (cms)	WB-CS-15 #2334 Firelane 2 Discharge (cms)	Roadway Discharge (cms)	Iterations
176.43	0.10	0.10	0.00	1
176.54	0.12	0.12	0.00	1
176.58	0.13	0.12	0.01	20
176.59	0.15	0.12	0.02	4
176.59	0.16	0.12	0.04	4
176.59	0.17	0.12	0.05	3
176.59	0.19	0.12	0.07	3
176.59	0.20	0.12	0.08	3
176.60	0.22	0.12	0.10	3
176.60	0.24	0.12	0.11	3
176.60	0.25	0.12	0.13	2
176.58	0.12	0.12	0.00	Overtopping

Rating Curve Plot for Crossing: WB_07 - West Branch

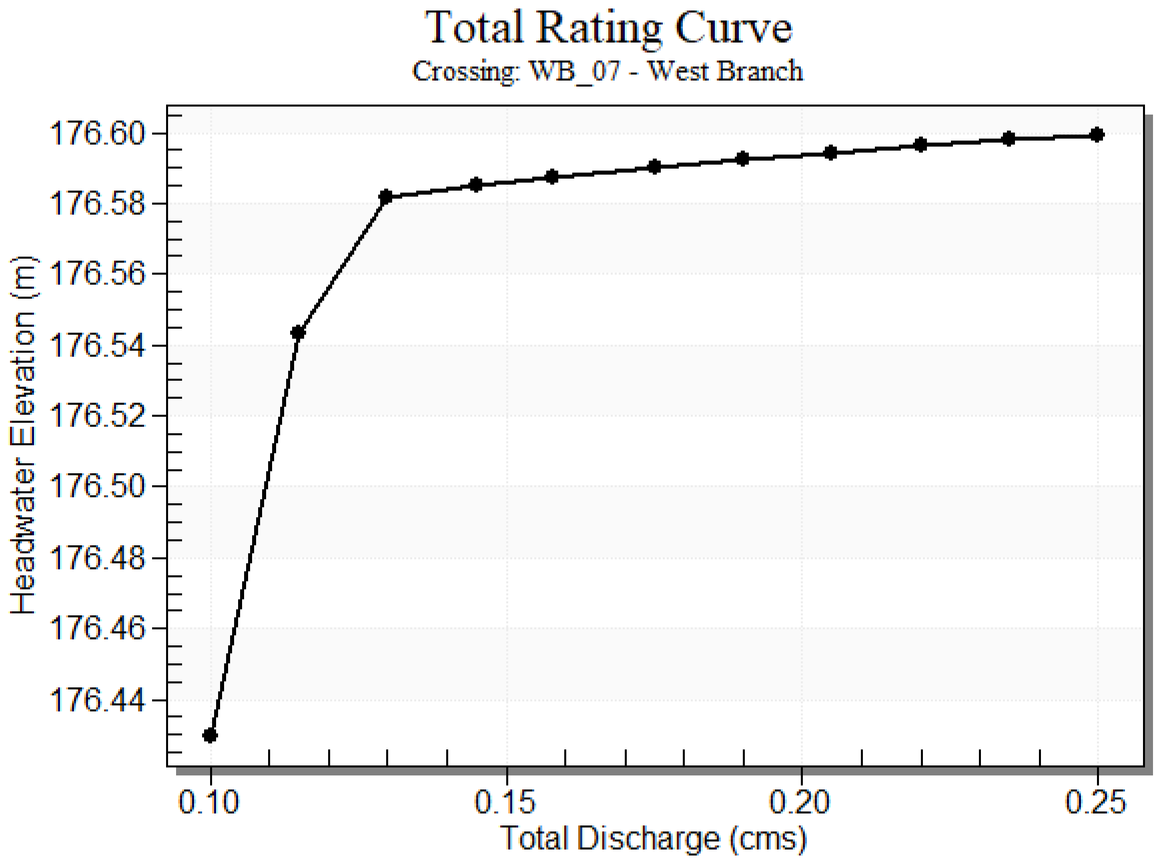


Table 6 - Summary of Culvert Flows at Crossing: WB_07 - West Branch

Headwater Elevation (m)	Total Discharge (cms)	WB-CS-14 - #2366 Firelane 2 Discharge (cms)	Roadway Discharge (cms)	Iterations
176.33	0.10	0.10	0.00	1
176.35	0.12	0.11	0.00	19
176.36	0.13	0.11	0.02	5
176.36	0.15	0.11	0.03	4
176.36	0.16	0.11	0.04	4
176.36	0.17	0.11	0.06	3
176.37	0.19	0.12	0.07	3
176.37	0.20	0.12	0.09	3
176.37	0.22	0.12	0.10	3
176.37	0.24	0.12	0.11	2
176.37	0.25	0.12	0.13	3
176.35	0.11	0.11	0.00	Overtopping

Rating Curve Plot for Crossing: WB_07 - West Branch

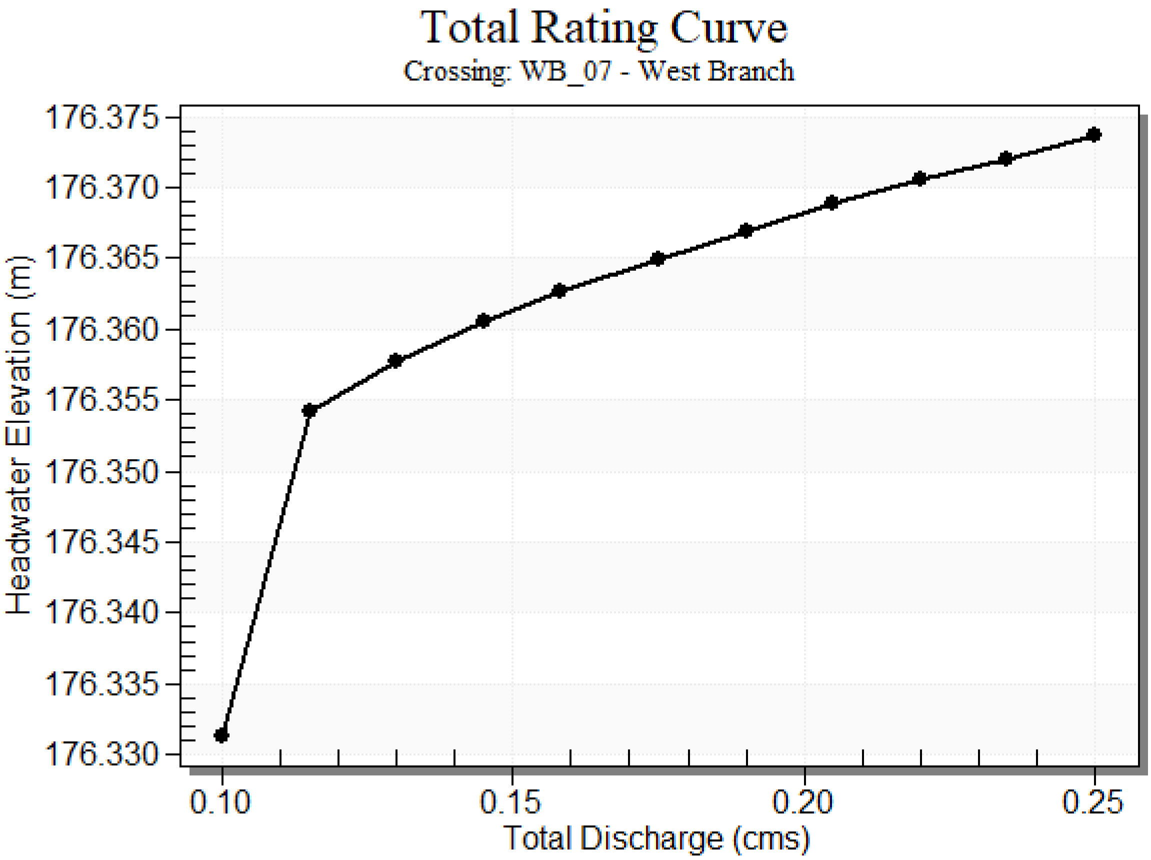


Table 7 - Summary of Culvert Flows at Crossing: WB_07 - West Branch

Headwater Elevation (m)	Total Discharge (cms)	WB-CS-12 #426 Pinecrest Rd Discharge (cms)	Roadway Discharge (cms)	Iterations
176.04	0.10	0.10	0.00	1
176.06	0.12	0.12	0.00	1
176.08	0.13	0.13	0.00	1
176.10	0.15	0.15	0.00	1
176.12	0.16	0.16	0.00	1
176.14	0.17	0.17	0.00	1
176.16	0.19	0.19	0.00	1
176.18	0.20	0.20	0.00	1
176.20	0.22	0.22	0.00	1
176.21	0.24	0.24	0.00	1
176.23	0.25	0.25	0.00	1
176.64	0.60	0.60	0.00	Overtopping

Rating Curve Plot for Crossing: WB_07 - West Branch

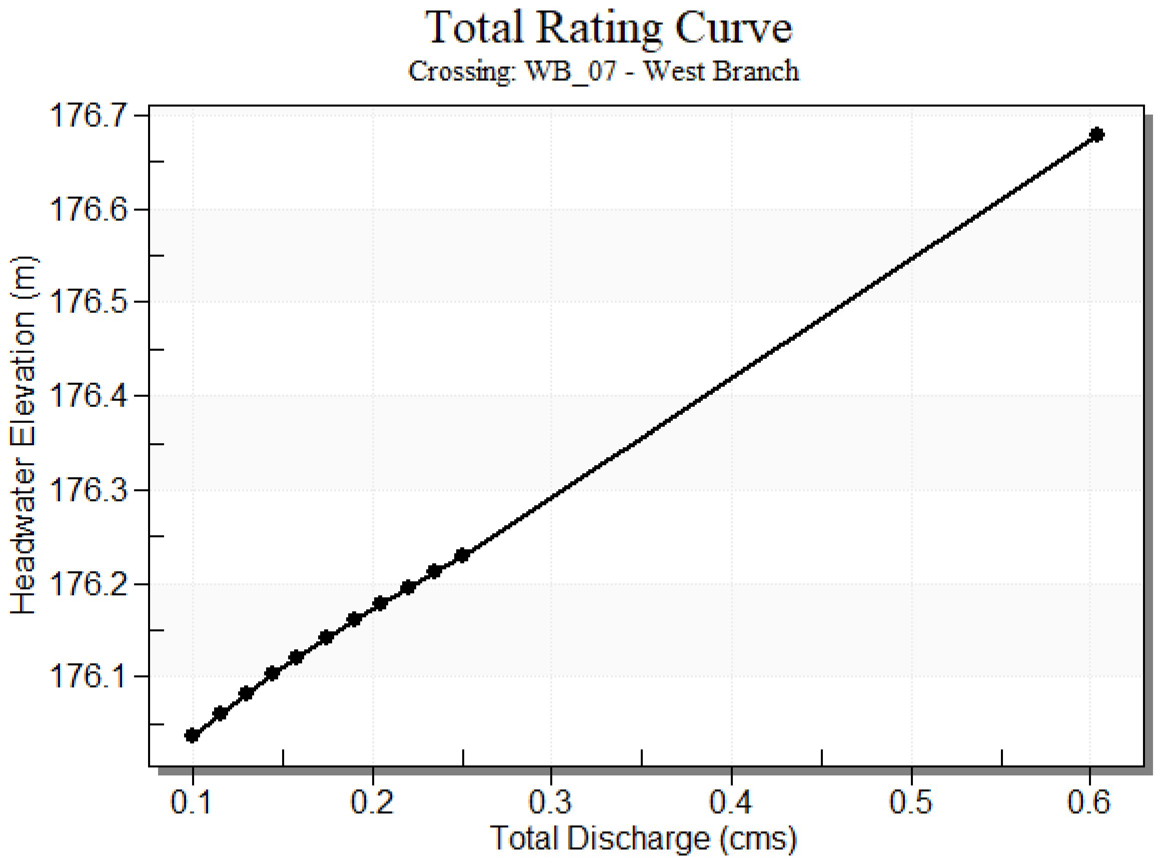


Table 8 - Summary of Culvert Flows at Crossing: WB_07 - West Branch

Headwater Elevation (m)	Total Discharge (cms)	WB-CS-11 #446 Pinecrest Rd Discharge (cms)	Roadway Discharge (cms)	Iterations
176.10	0.10	0.10	0.00	1
176.14	0.12	0.12	0.00	1
176.17	0.13	0.13	0.00	1
176.21	0.15	0.15	0.00	1
176.24	0.16	0.16	0.00	1
176.28	0.17	0.17	0.00	1
176.34	0.19	0.19	0.00	1
176.41	0.20	0.20	0.00	1
176.48	0.22	0.22	0.00	1
176.55	0.24	0.24	0.00	1
176.64	0.25	0.25	0.00	1
176.64	0.25	0.25	0.00	Overtopping

Rating Curve Plot for Crossing: WB_07 - West Branch

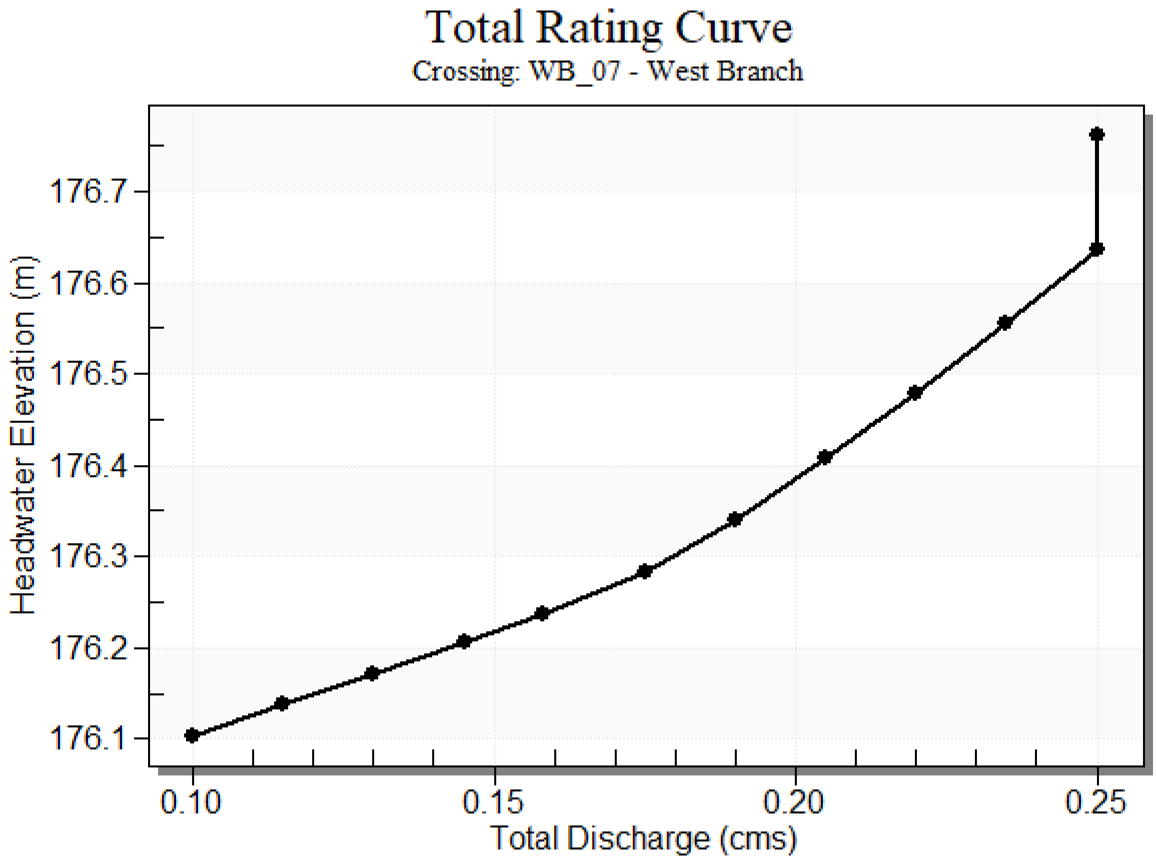


Table 9 - Summary of Culvert Flows at Crossing: WB_06 - West Branch

Headwater Elevation (m)	Total Discharge (cms)	WB-CS-10 #462 Pinecrest Rd Discharge (cms)	Roadway Discharge (cms)	Iterations
175.66	0.10	0.10	0.00	1
175.73	0.14	0.14	0.00	1
175.79	0.18	0.18	0.00	1
175.85	0.22	0.22	0.00	1
175.87	0.24	0.24	0.00	1
175.97	0.30	0.30	0.00	1
176.00	0.34	0.34	0.00	1
176.03	0.38	0.38	0.00	1
176.07	0.42	0.42	0.00	1
176.11	0.46	0.46	0.00	1
176.20	0.50	0.50	0.00	1
176.45	0.61	0.61	0.00	Overtopping

Rating Curve Plot for Crossing: WB_06 - West Branch

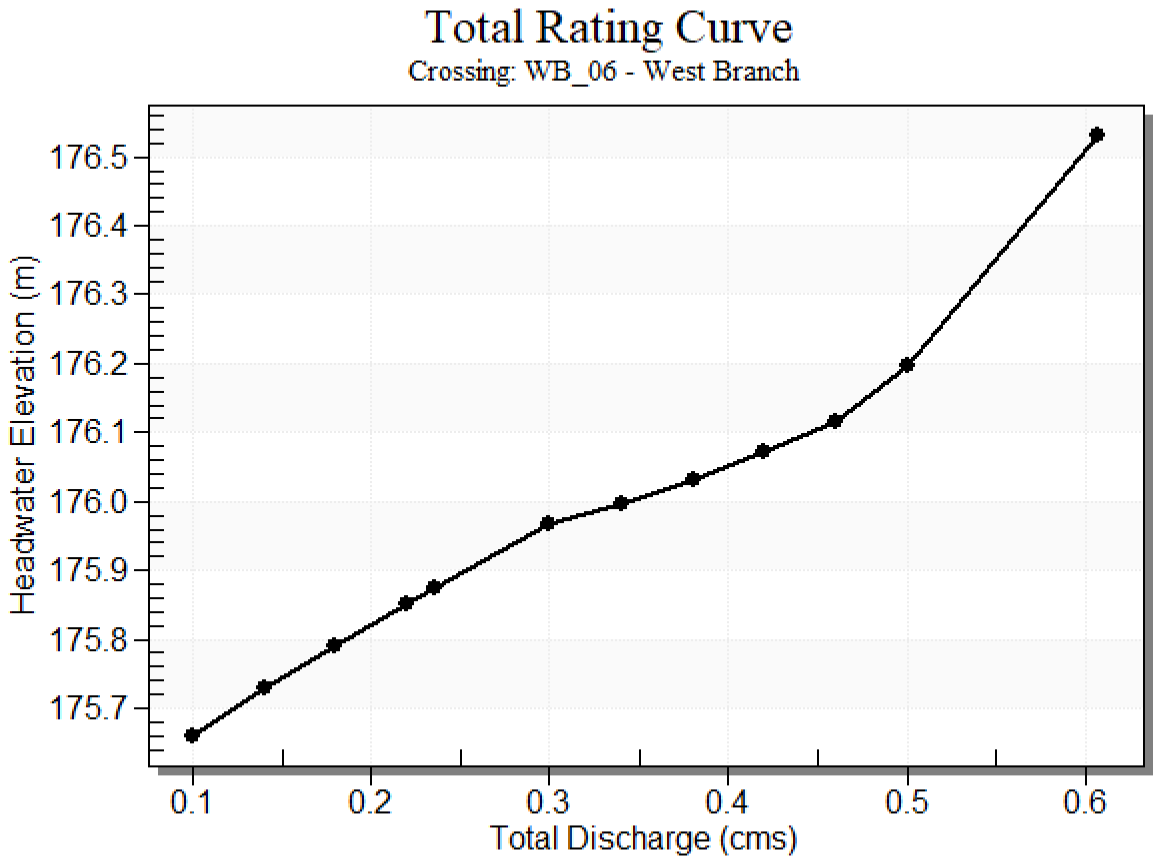


Table 10 - Summary of Culvert Flows at Crossing: WB_04 - West Branch

Headwater Elevation (m)	Total Discharge (cms)	WB-CS-08 Pinecrest Rd Discharge (cms)	Roadway Discharge (cms)	Iterations
175.31	0.10	0.10	0.00	1
175.43	0.19	0.19	0.00	1
175.53	0.28	0.28	0.00	1
175.63	0.37	0.37	0.00	1
175.73	0.46	0.46	0.00	1
175.84	0.55	0.55	0.00	1
175.98	0.64	0.64	0.00	1
176.07	0.70	0.70	0.00	1
176.28	0.82	0.82	0.00	1
176.38	0.91	0.87	0.04	18
176.39	1.00	0.88	0.12	5
176.37	0.87	0.87	0.00	Overtopping

Rating Curve Plot for Crossing: WB_04 - West Branch

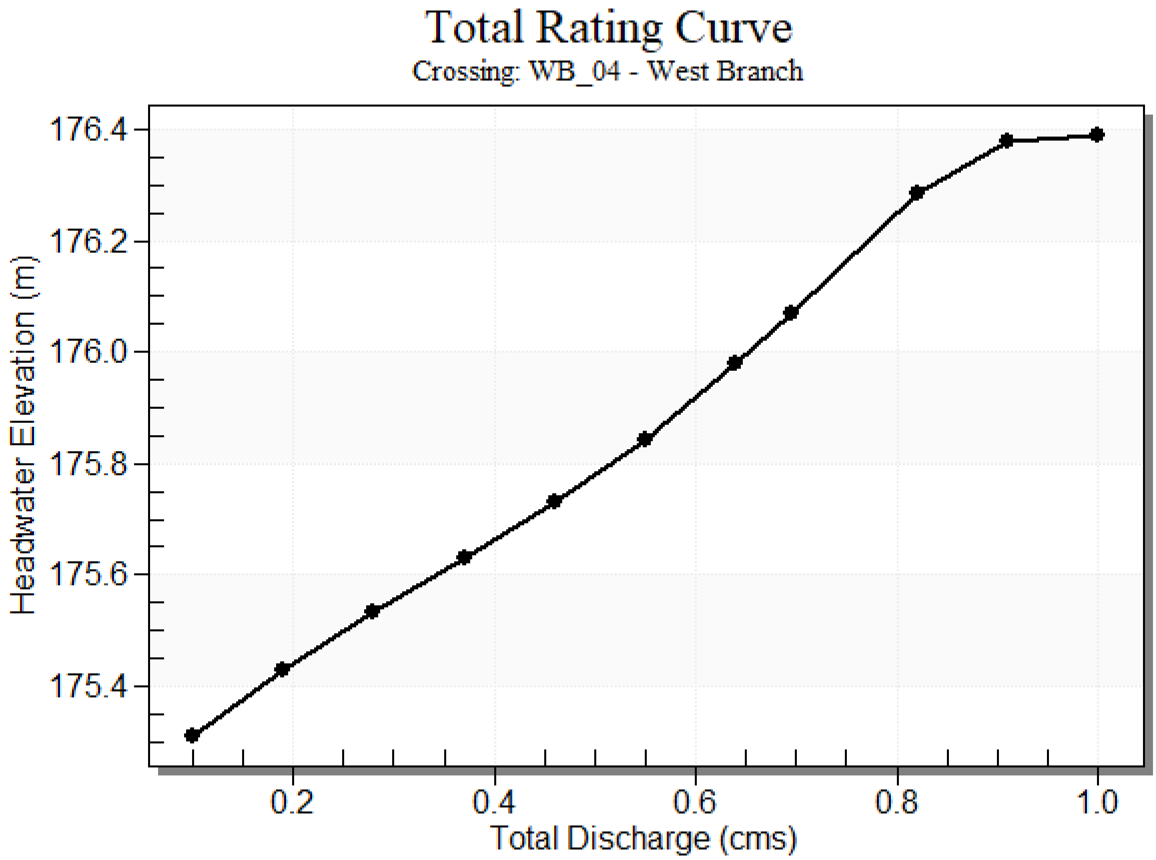


Table 11 - Summary of Culvert Flows at Crossing: WB_04 - West Branch (Copy)

Headwater Elevation (m)	Total Discharge (cms)	WB-CS-07 Private Driveway Discharge (cms)	Roadway Discharge (cms)	Iterations
175.25	0.10	0.10	0.00	1
175.36	0.19	0.19	0.00	1
175.45	0.28	0.28	0.00	1
175.53	0.37	0.37	0.00	1
175.60	0.46	0.46	0.00	1
175.67	0.55	0.55	0.00	1
175.74	0.64	0.64	0.00	1
175.78	0.70	0.70	0.00	1
175.87	0.82	0.82	0.00	1
175.94	0.91	0.91	0.00	1
176.02	1.00	1.00	0.00	1
176.37	1.41	1.41	0.00	Overtopping

Rating Curve Plot for Crossing: WB_04 - West Branch (Copy)

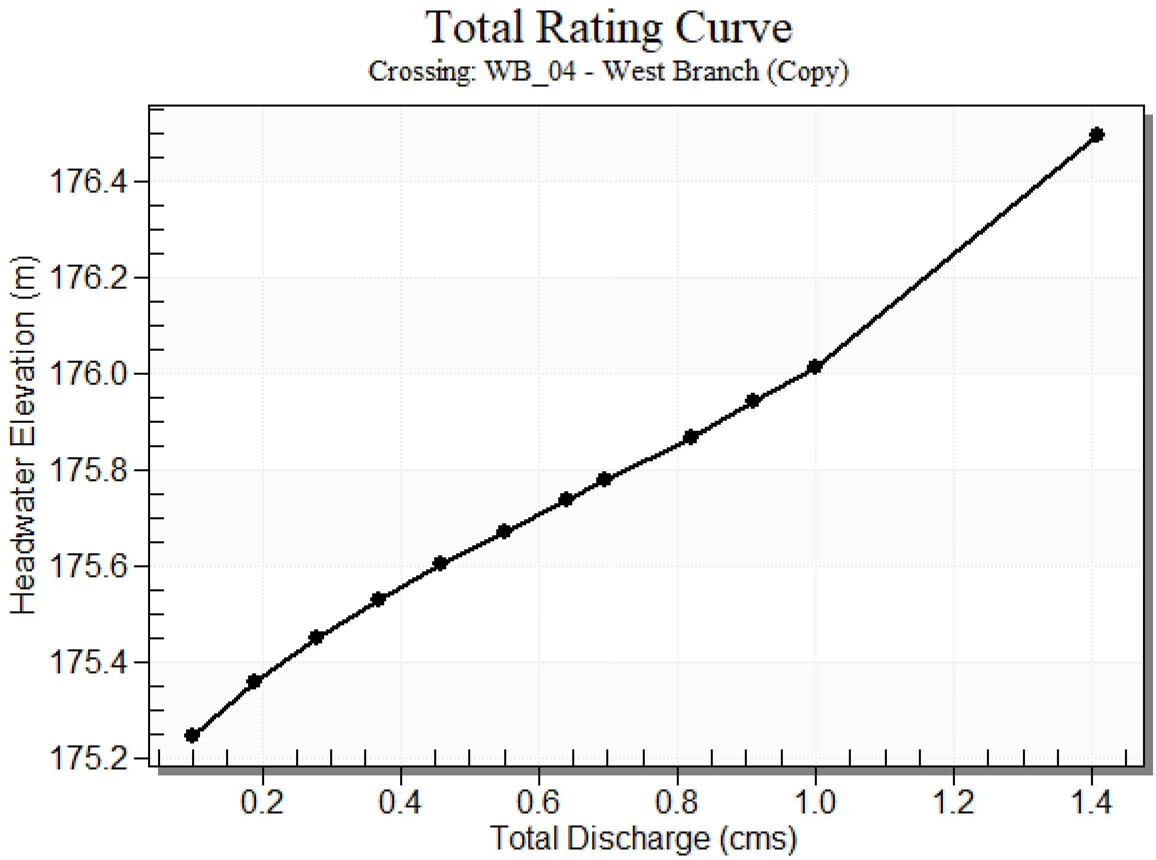


Table 12 - Summary of Culvert Flows at Crossing: WB_04 - West Branch

Headwater Elevation (m)	Total Discharge (cms)	WB-CS-06 #2555 Vimy Ridge Rd Discharge (cms)	Roadway Discharge (cms)	Iterations
175.25	0.10	0.10	0.00	1
175.37	0.19	0.19	0.00	1
175.48	0.28	0.28	0.00	1
175.58	0.37	0.37	0.00	1
175.69	0.46	0.46	0.00	1
175.80	0.55	0.55	0.00	1
175.93	0.64	0.64	0.00	1
176.01	0.70	0.70	0.00	1
176.18	0.82	0.81	0.01	31
176.19	0.91	0.81	0.09	5
176.20	1.00	0.82	0.18	4
176.18	0.80	0.80	0.00	Overtopping

Rating Curve Plot for Crossing: WB_04 - West Branch

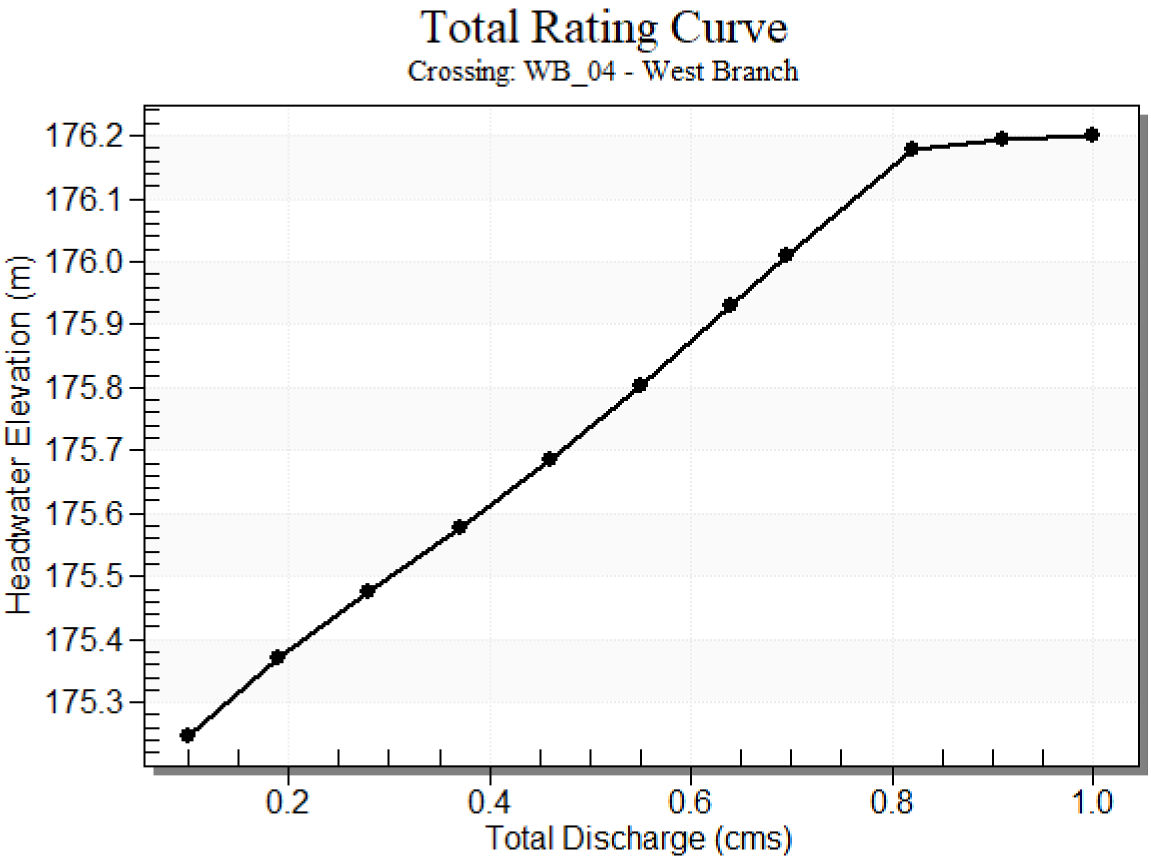


Table 13 - Summary of Culvert Flows at Crossing: WB_04 - West Branch

Headwater Elevation (m)	Total Discharge (cms)	WB-CS-05 #2595 Vimy Ridge Rd Discharge (cms)	Roadway Discharge (cms)	Iterations
175.58	0.30	0.30	0.00	1
175.72	0.37	0.37	0.00	1
175.86	0.44	0.44	0.00	1
176.02	0.51	0.51	0.00	1
176.18	0.58	0.57	0.00	50
176.19	0.65	0.58	0.07	6
176.19	0.70	0.58	0.11	4
176.20	0.79	0.59	0.20	4
176.21	0.86	0.59	0.27	4
176.22	0.93	0.59	0.34	3
176.22	1.00	0.59	0.41	3
176.18	0.57	0.57	0.00	Overtopping

Rating Curve Plot for Crossing: WB_04 - West Branch

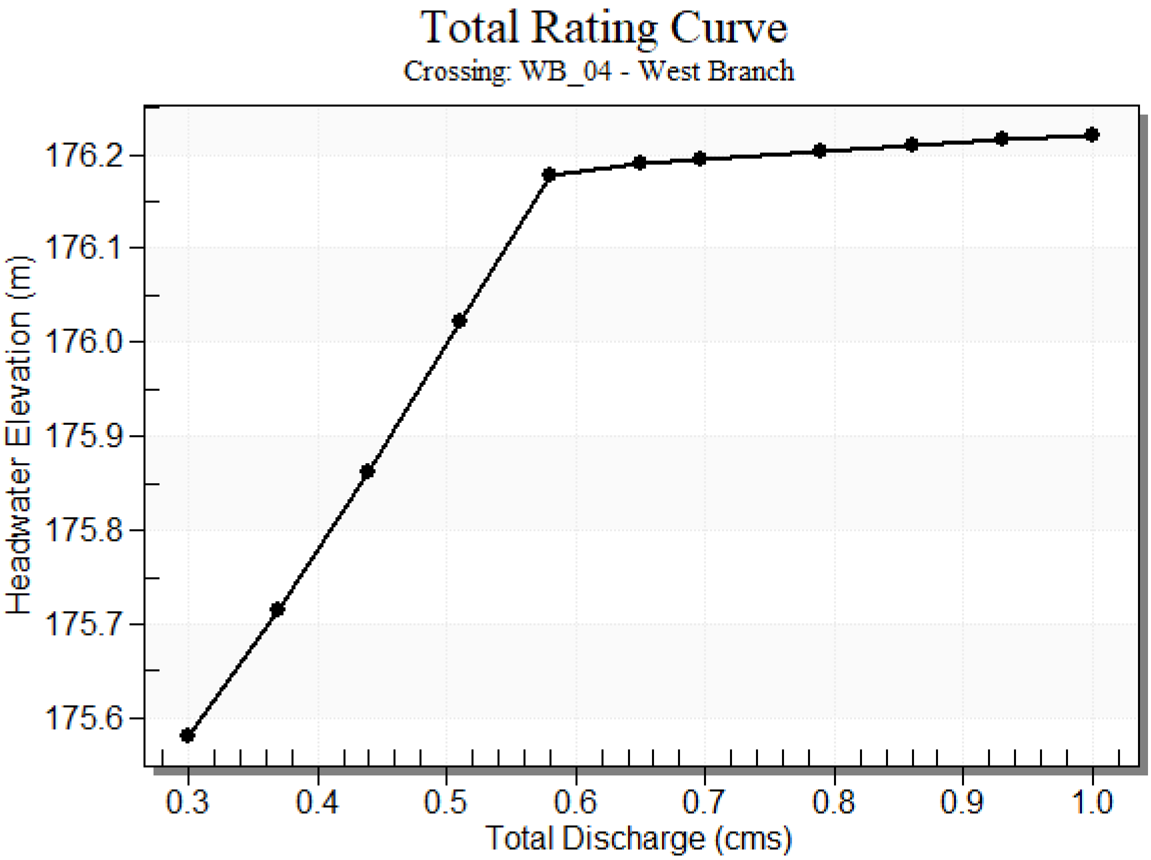


Table 14 - Summary of Culvert Flows at Crossing: WB_03 - West Branch

Headwater Elevation (m)	Total Discharge (cms)	WB-CS-04 Vimy Ridge Rd Discharge (cms)	Roadway Discharge (cms)	Iterations
175.06	0.10	0.10	0.00	1
175.16	0.17	0.17	0.00	1
175.24	0.24	0.24	0.00	1
175.33	0.31	0.31	0.00	1
175.41	0.38	0.38	0.00	1
175.49	0.45	0.45	0.00	1
175.52	0.52	0.52	0.00	1
175.71	0.59	0.59	0.00	1
175.82	0.66	0.66	0.00	1
175.87	0.70	0.69	0.01	25
175.88	0.80	0.70	0.10	5
175.86	0.69	0.69	0.00	Overtopping

Rating Curve Plot for Crossing: WB_03 - West Branch

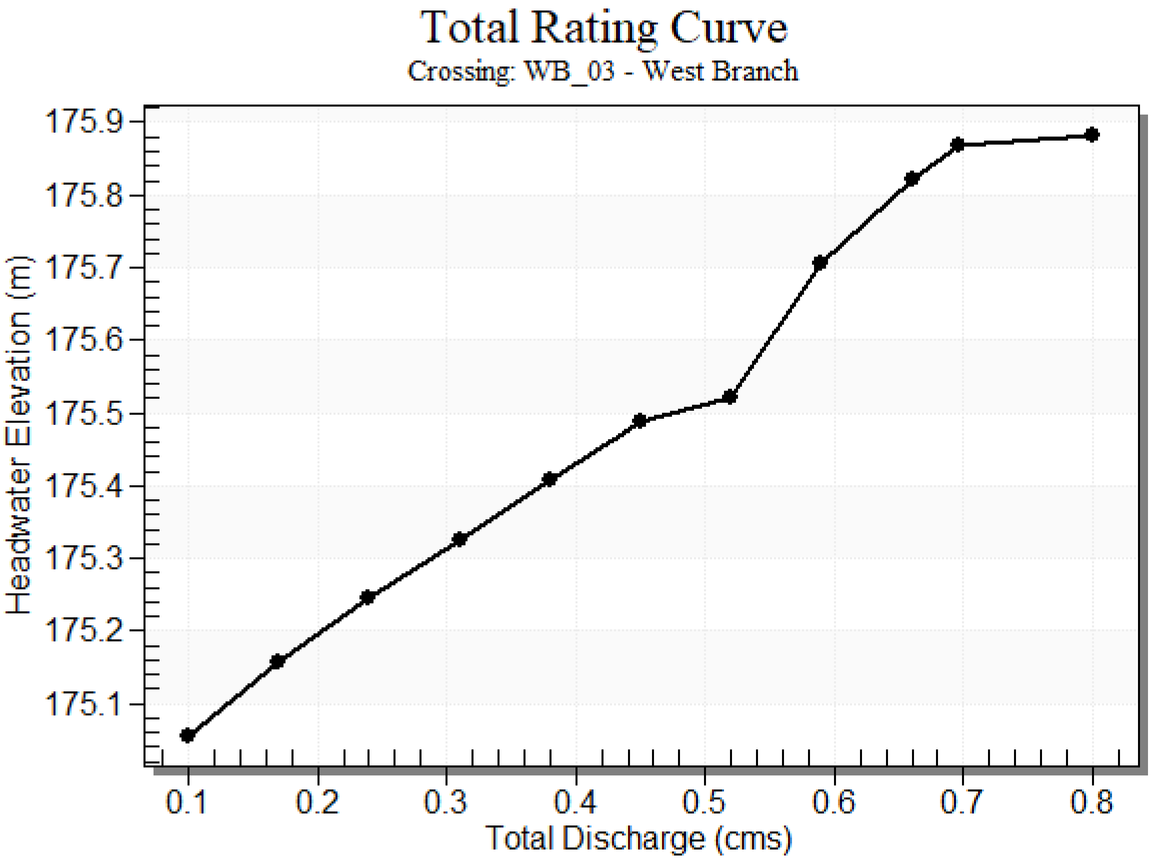


Table 15 - Summary of Culvert Flows at Crossing: O-12 Michener RD

Headwater Elevation (m)	Total Discharge (cms)	O-CS-12 #851 Pinecrest Rd private access Discharge (cms)	CS-005 Discharge (cms)	Roadway Discharge (cms)	Iterations
178.04	0.80	0.50	0.30	0.00	6
178.18	0.90	0.56	0.34	0.00	4
178.23	0.93	0.58	0.35	0.00	3
178.52	1.10	0.68	0.42	0.00	3
178.61	1.20	0.71	0.43	0.05	19
178.63	1.30	0.72	0.43	0.14	5
178.63	1.40	0.72	0.44	0.24	5
178.64	1.50	0.72	0.44	0.34	4
178.65	1.60	0.72	0.44	0.43	4
178.66	1.70	0.73	0.44	0.53	3
178.66	1.80	0.73	0.44	0.63	3
178.60	1.14	0.71	0.43	0.00	Overtopping

Rating Curve Plot for Crossing: O-12 Michener RD

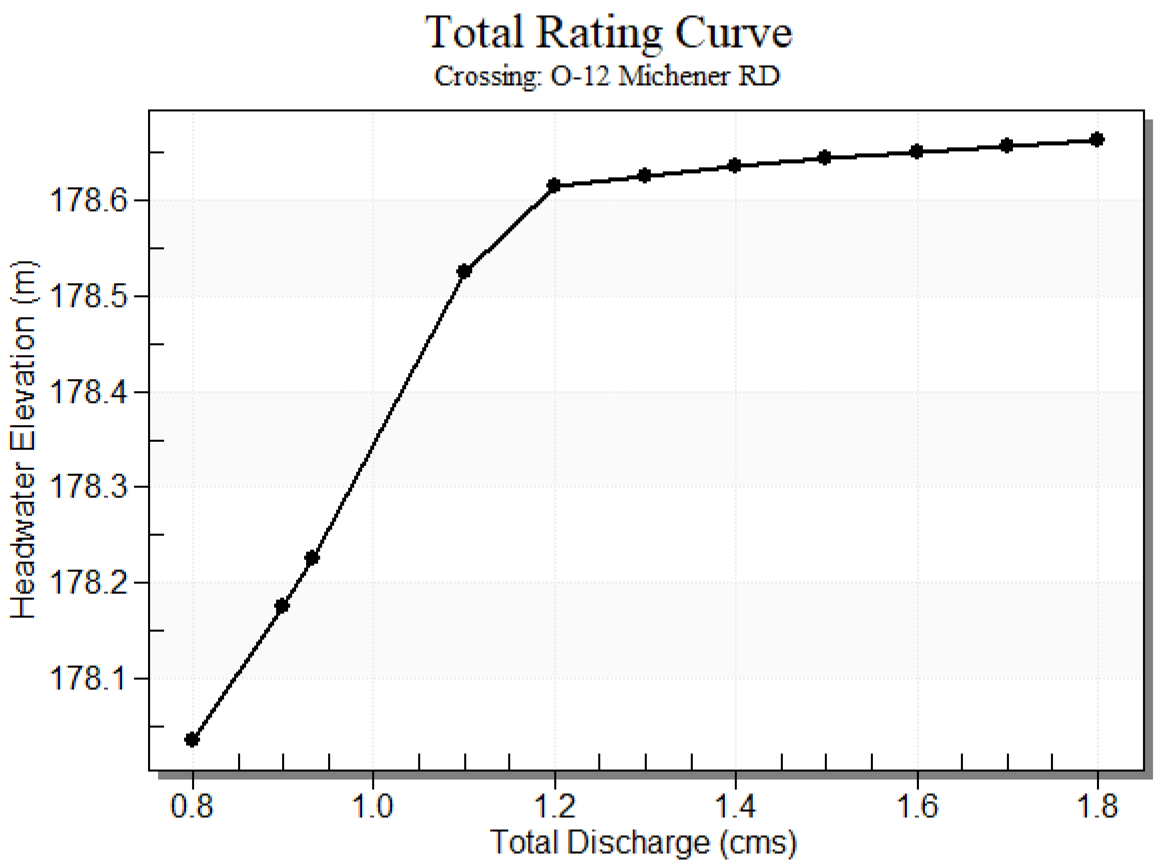


Table 16 - Summary of Culvert Flows at Crossing: O-11

Headwater Elevation (m)	Total Discharge (cms)	O-CS-11 #851 Pinecrest Rd Private Access Discharge (cms)	Roadway Discharge (cms)	Iterations
178.11	0.80	0.58	0.22	10
178.12	0.90	0.58	0.32	4
178.12	0.93	0.58	0.35	3
178.13	1.10	0.58	0.51	4
178.14	1.20	0.59	0.61	3
178.15	1.30	0.59	0.71	3
178.15	1.40	0.59	0.81	3
178.16	1.50	0.59	0.91	3
178.16	1.60	0.59	1.01	3
178.17	1.70	0.59	1.11	3
178.17	1.80	0.59	1.21	3
178.08	0.56	0.56	0.00	Overtopping

Rating Curve Plot for Crossing: O-11

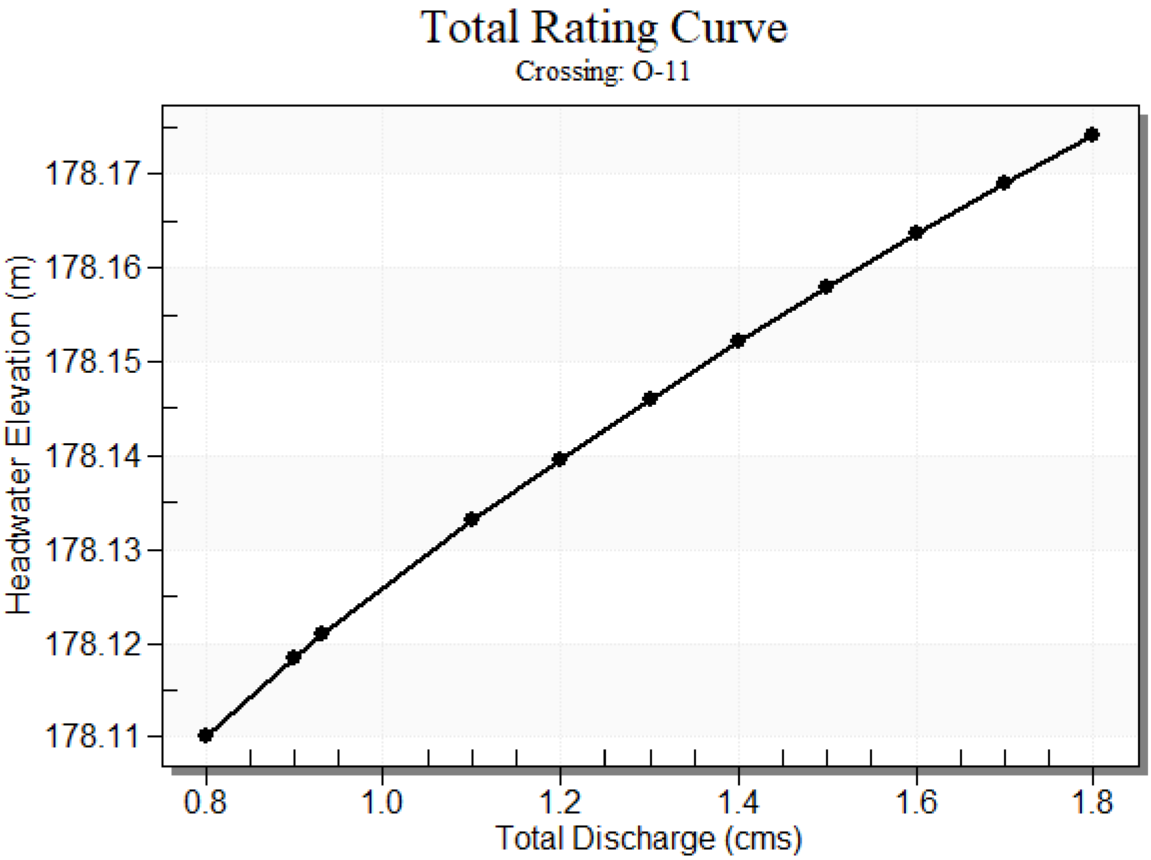


Table 17 - Summary of Culvert Flows at Crossing: O-10

Headwater Elevation (m)	Total Discharge (cms)	O-CS-10 #813 Pinecrest Rd Private Access - Structural Replace Discharge (cms)	Roadway Discharge (cms)	Iterations
177.97	0.80	0.80	0.00	1
178.08	0.90	0.88	0.02	32
178.09	0.92	0.88	0.03	5
178.11	1.10	0.90	0.20	6
178.12	1.20	0.91	0.29	4
178.12	1.30	0.91	0.39	4
178.13	1.40	0.91	0.49	4
178.14	1.50	0.92	0.58	3
178.14	1.60	0.92	0.67	3
178.15	1.70	0.93	0.77	3
178.16	1.80	0.93	0.87	3
178.08	0.88	0.88	0.00	Overtopping

Rating Curve Plot for Crossing: O-10

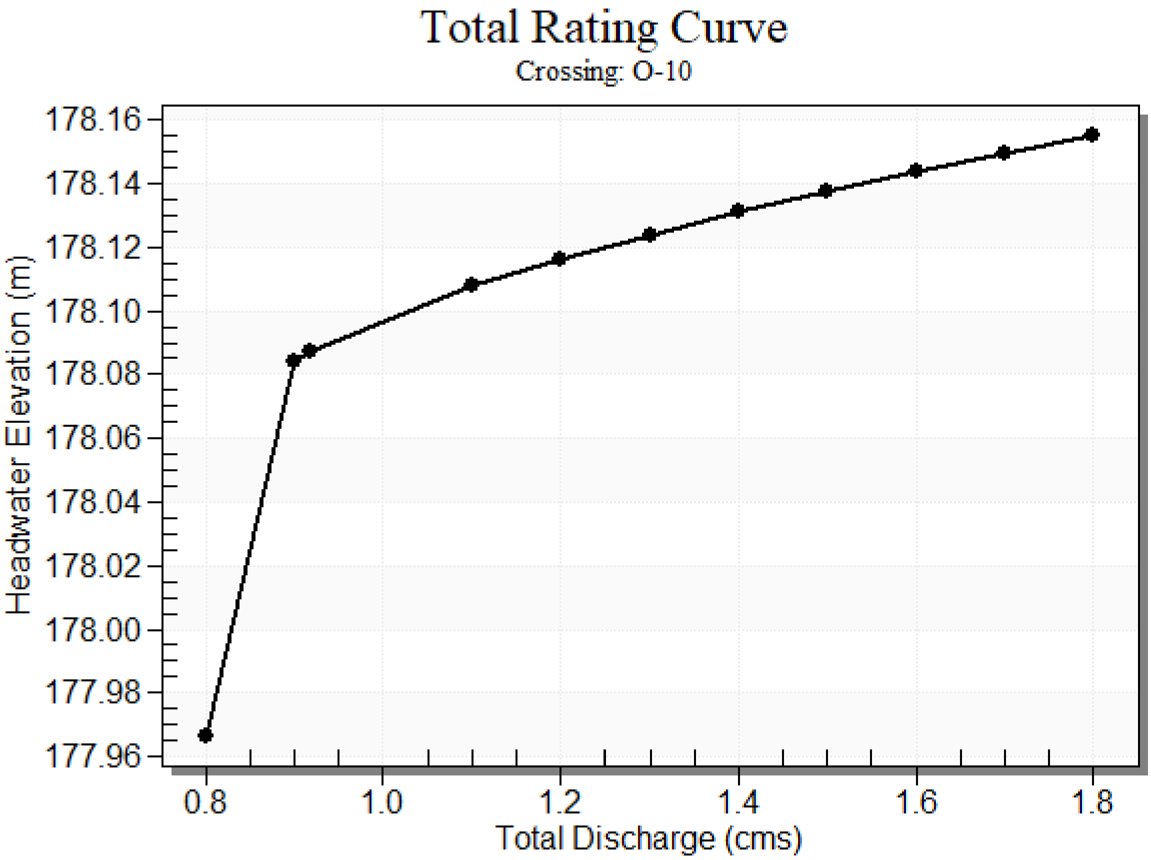


Table 18 - Summary of Culvert Flows at Crossing: O-9

Headwater Elevation (m)	Total Discharge (cms)	O-CS-09 #745 Pinecrest Rd Private access Discharge (cms)	Roadway Discharge (cms)	Iterations
177.78	0.80	0.80	0.00	1
177.92	0.90	0.90	0.00	55
177.93	0.94	0.90	0.04	7
177.95	1.10	0.91	0.19	6
177.96	1.20	0.92	0.28	4
177.96	1.30	0.92	0.38	4
177.97	1.40	0.93	0.47	4
177.98	1.50	0.93	0.56	3
177.98	1.60	0.93	0.66	3
177.99	1.70	0.94	0.76	3
178.00	1.80	0.94	0.86	3
177.92	0.89	0.89	0.00	Overtopping

Rating Curve Plot for Crossing: O-9

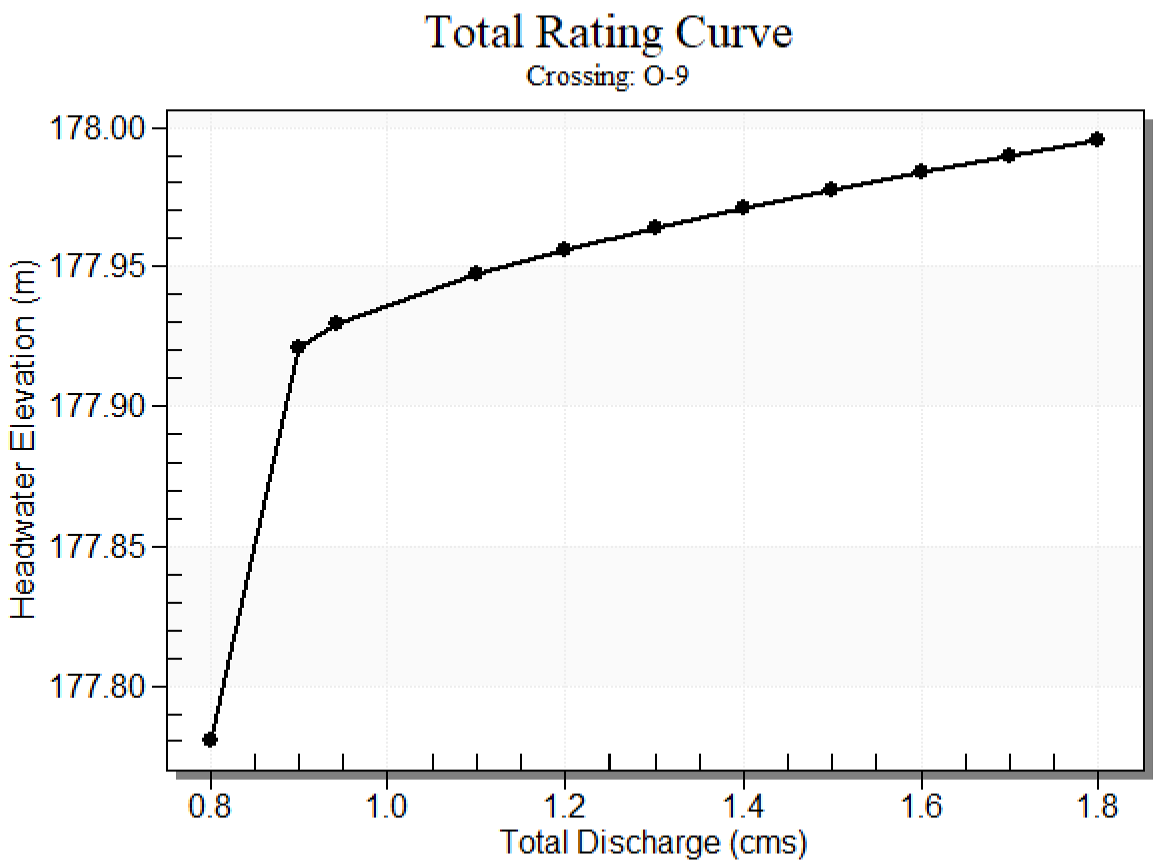


Table 19 - Summary of Culvert Flows at Crossing: O-9 (Copy)

Headwater Elevation (m)	Total Discharge (cms)	O-CS-08 #663 Pinecrest Rd Private access - Struct replace Discharge (cms)	Roadway Discharge (cms)	Iterations
176.32	0.80	0.62	0.18	12
176.32	0.90	0.62	0.27	4
176.33	0.94	0.63	0.31	3
176.34	1.10	0.64	0.46	4
176.35	1.20	0.64	0.55	3
176.35	1.30	0.65	0.65	3
176.36	1.40	0.65	0.74	3
176.36	1.50	0.66	0.84	3
176.37	1.60	0.66	0.94	3
176.37	1.70	0.67	1.03	3
176.38	1.80	0.67	1.13	3
176.29	0.59	0.59	0.00	Overtopping

Rating Curve Plot for Crossing: O-9 (Copy)

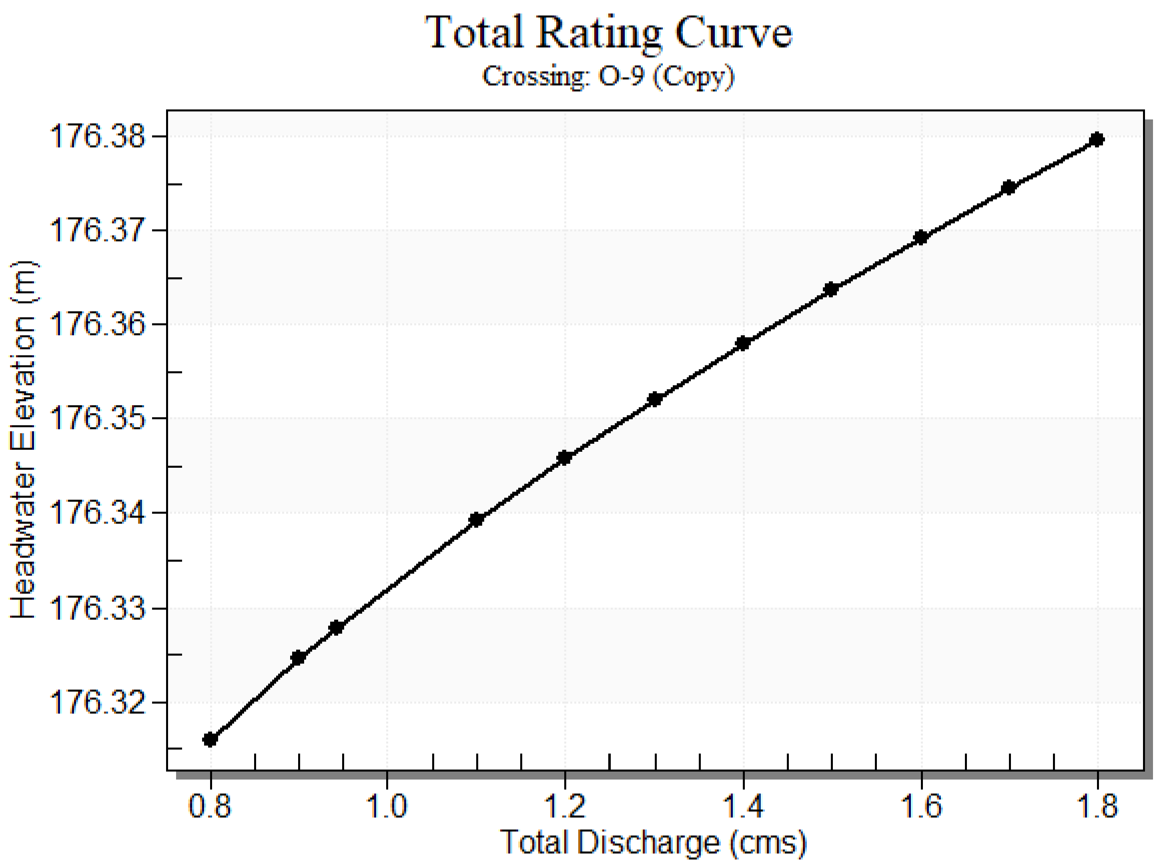


Table 20 - Summary of Culvert Flows at Crossing: O-5

Headwater Elevation (m)	Total Discharge (cms)	O-CS-06 Centennial Park Discharge (cms)	Roadway Discharge (cms)	Iterations
175.41	1.75	1.75	0.00	1
175.48	1.99	1.99	0.00	1
175.59	2.40	2.40	0.00	1
175.67	2.73	2.73	0.00	1
175.74	3.05	3.05	0.00	1
175.82	3.38	3.38	0.00	1
175.88	3.70	3.59	0.10	14
175.89	4.02	3.65	0.37	6
175.91	4.35	3.69	0.65	5
175.92	4.67	3.76	0.91	4
175.93	5.00	3.78	1.21	4
175.87	3.55	3.55	0.00	Overtopping

Rating Curve Plot for Crossing: O-5

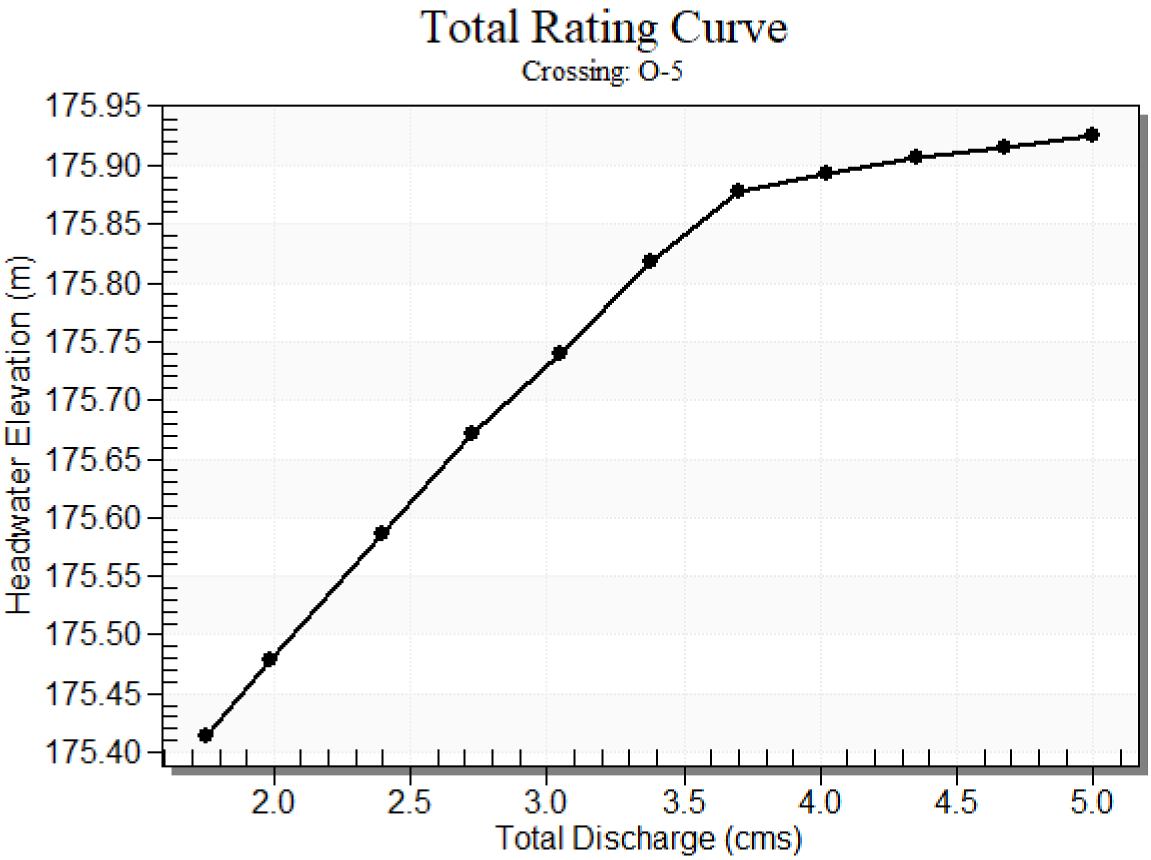


Table 21 - Summary of Culvert Flows at Crossing: O-3

Headwater Elevation (m)	Total Discharge (cms)	O-CS-03 #2876 Vimy Ridge Rd Private Access Discharge (cms)	Roadway Discharge (cms)	Iterations
175.39	0.80	0.80	0.00	1
175.58	1.22	1.22	0.00	1
175.76	1.64	1.64	0.00	1
175.87	1.90	1.90	0.00	1
176.10	2.48	2.48	0.00	1
176.28	2.90	2.90	0.00	1
176.42	3.32	3.32	0.00	1
176.54	3.74	3.74	0.00	1
176.76	4.16	4.16	0.00	1
177.01	4.58	4.56	0.01	14
177.06	5.00	4.63	0.37	7
177.01	4.56	4.56	0.00	Overtopping

Rating Curve Plot for Crossing: O-3

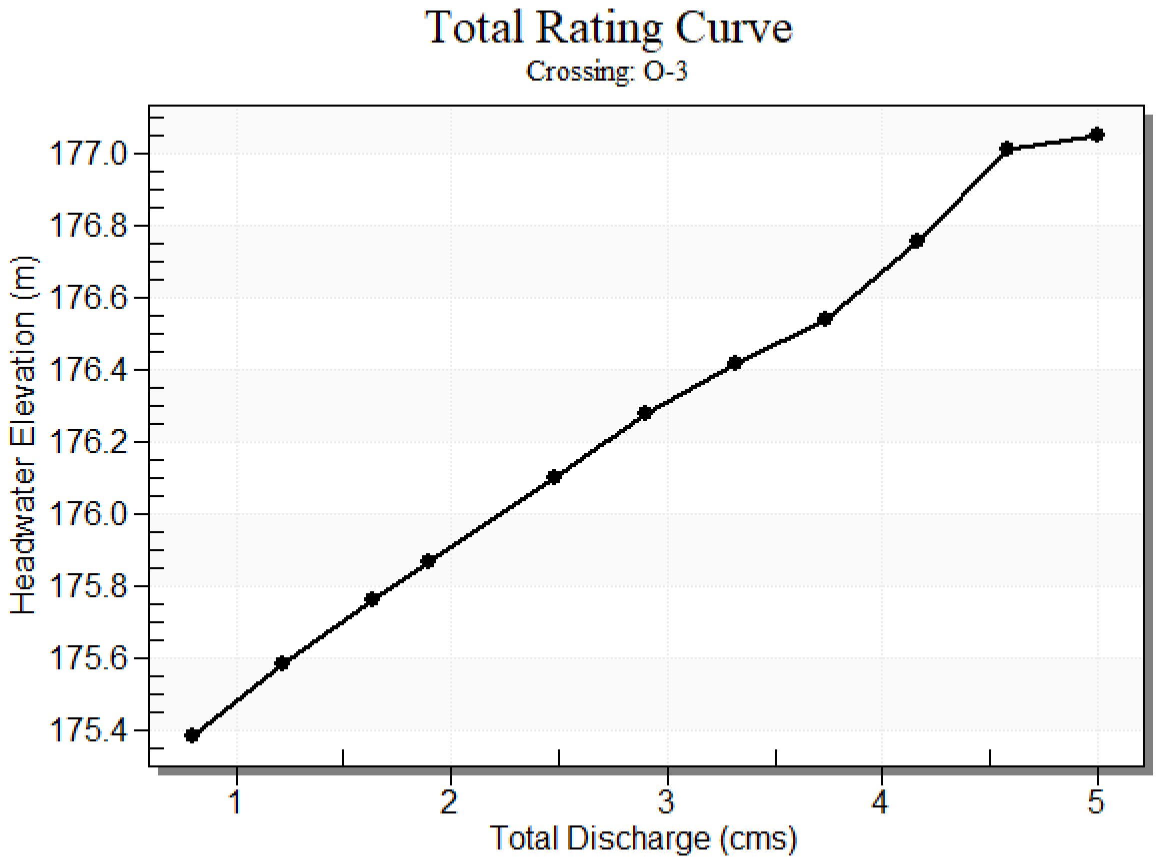


Table 22 - Summary of Culvert Flows at Crossing: O-2

Headwater Elevation (m)	Total Discharge (cms)	O-CS-01 Conc Box Outlet Discharge (cms)	Roadway Discharge (cms)	Iterations
175.65	1.75	1.75	0.00	1
175.76	1.99	1.99	0.00	1
175.97	2.40	2.40	0.00	1
176.00	2.73	2.73	0.00	1
176.03	3.05	3.05	0.00	1
176.08	3.38	3.38	0.00	1
176.15	3.70	3.70	0.00	1
176.23	4.02	4.02	0.00	1
176.32	4.35	4.35	0.00	1
176.41	4.67	4.67	0.00	1
176.50	5.00	4.94	0.05	19
176.49	4.92	4.92	0.00	Overtopping

Rating Curve Plot for Crossing: O-2

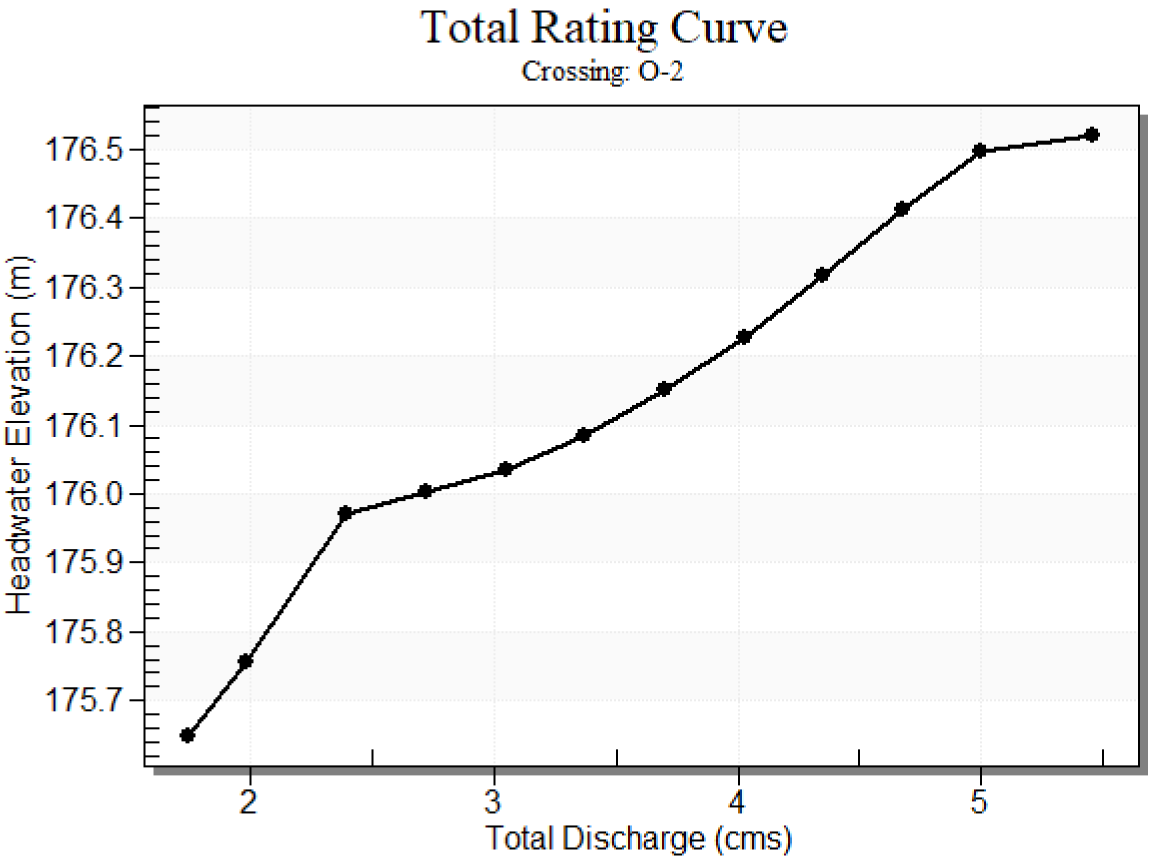


Table 23 - Summary of Culvert Flows at Crossing: E1_05

Headwater Elevation (m)	Total Discharge (cms)	E1-CS-04 Cedar Bay Rd Discharge (cms)	Roadway Discharge (cms)	Iterations
177.98	0.15	0.15	0.00	1
178.03	0.19	0.19	0.00	1
178.08	0.22	0.22	0.00	1
178.09	0.22	0.22	0.00	1
178.19	0.29	0.29	0.00	1
178.24	0.33	0.33	0.00	1
178.27	0.36	0.36	0.00	1
178.30	0.40	0.40	0.00	1
178.33	0.43	0.43	0.00	1
178.38	0.46	0.46	0.00	1
178.45	0.50	0.50	0.00	1
178.71	0.61	0.61	0.00	Overtopping

Rating Curve Plot for Crossing: E1_05

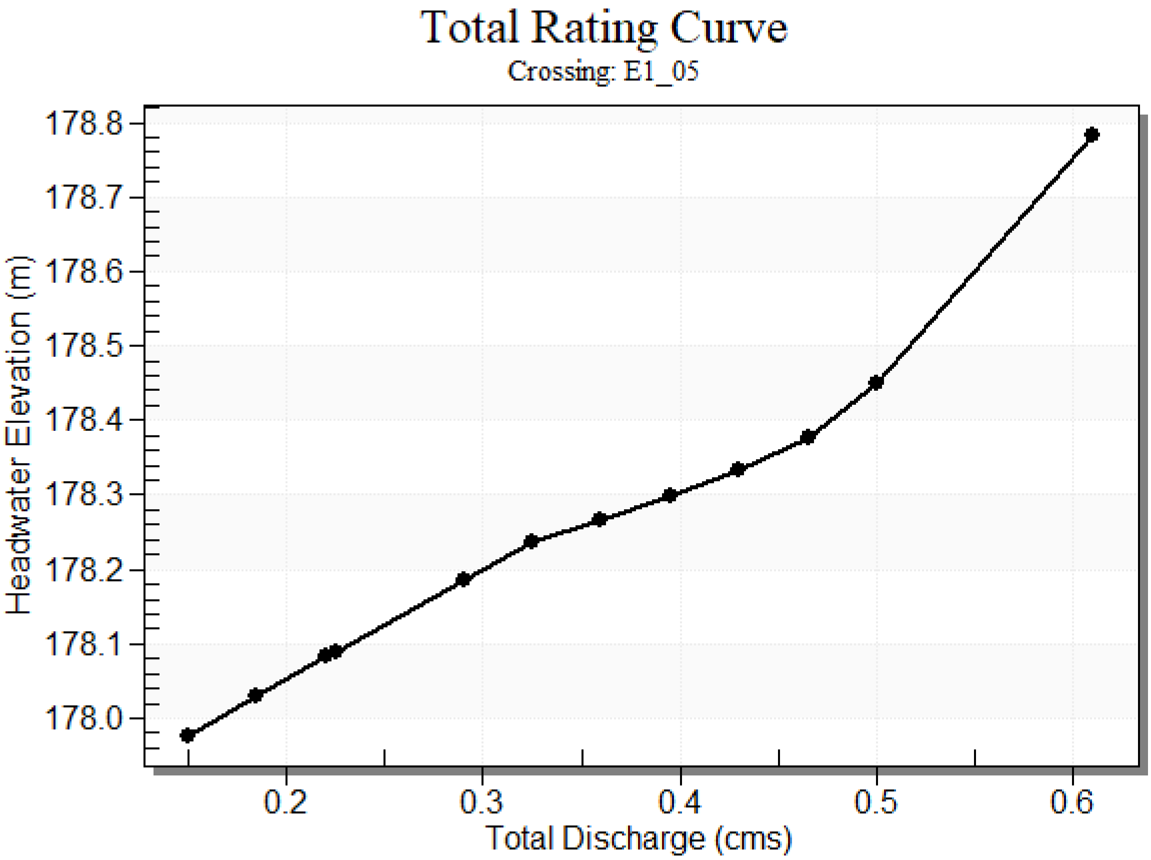
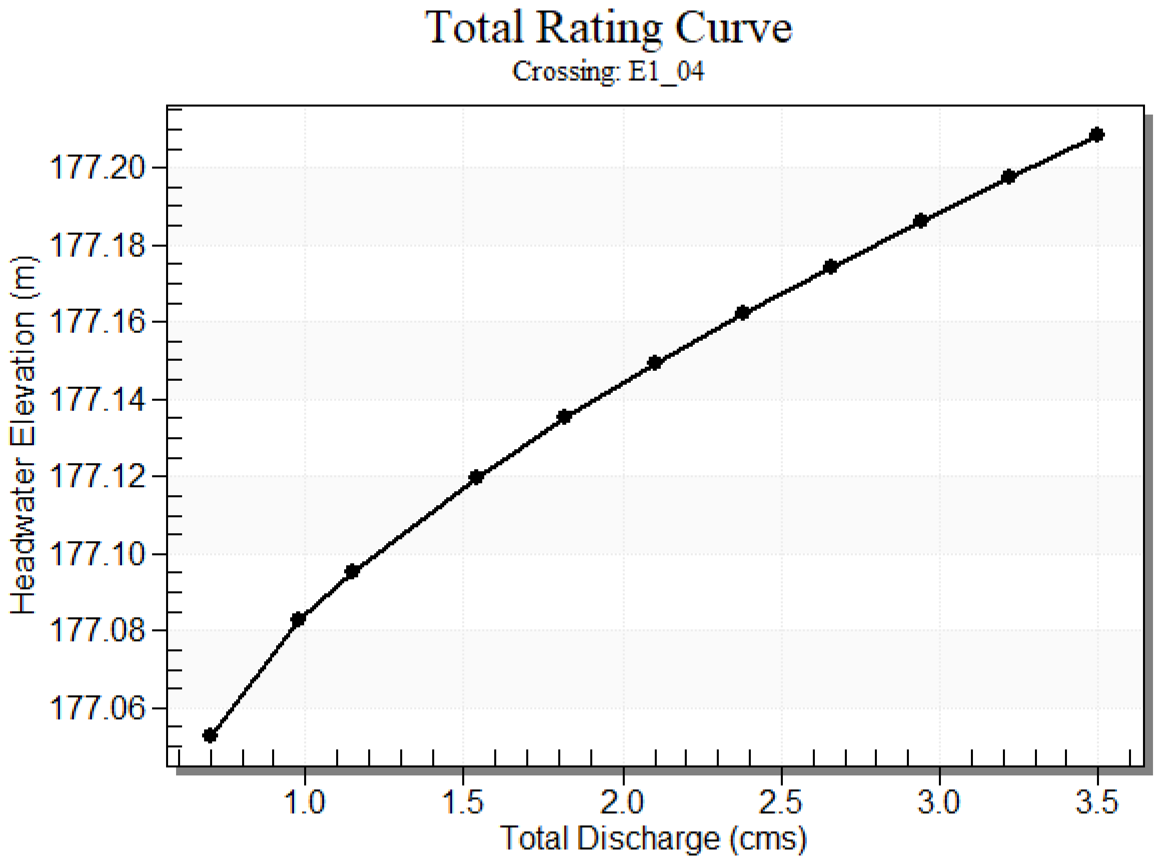


Table 24 - Summary of Culvert Flows at Crossing: E1_04

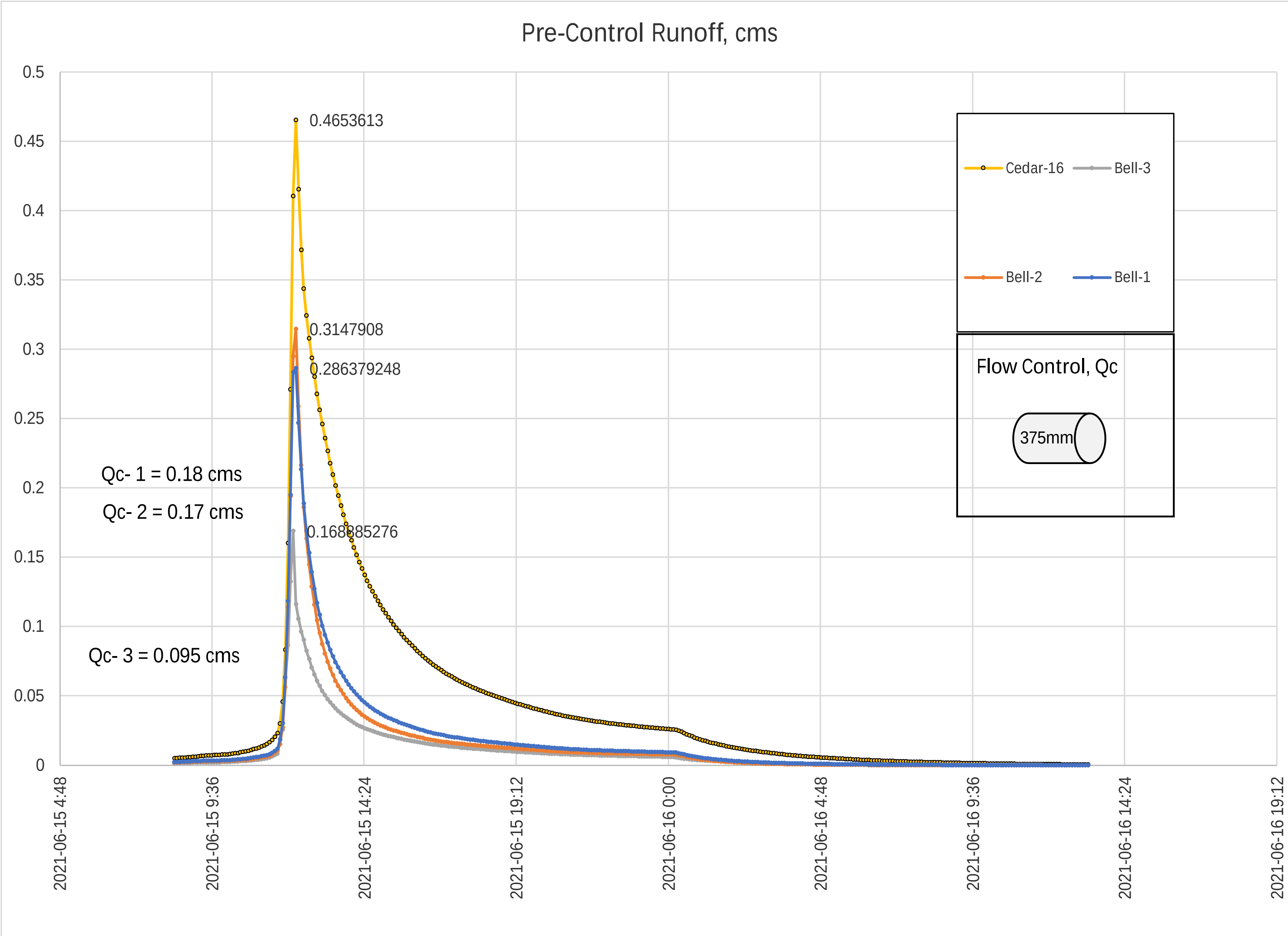
Headwater Elevation (m)	Total Discharge (cms)	E1-CS-03 Private Access Discharge (cms)	Roadway Discharge (cms)	Iterations
177.05	0.70	0.67	0.03	34
177.08	0.98	0.68	0.30	7
177.10	1.15	0.69	0.46	5
177.12	1.54	0.70	0.84	5
177.14	1.82	0.70	1.11	4
177.15	2.10	0.71	1.39	4
177.16	2.38	0.72	1.66	3
177.17	2.66	0.72	1.94	3
177.19	2.94	0.73	2.21	3
177.20	3.22	0.73	2.49	3
177.21	3.50	0.74	2.76	3
177.04	0.66	0.66	0.00	Overtopping

Rating Curve Plot for Crossing: E1_04



Appendix F:

Calculations and Supporting Documents



Pre-Control Runoff, cms
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.4653613
0.3147908
0.286379248
0.168885276
Qc- 1 = 0.18 cms
Qc- 2 = 0.17 cms
Qc- 3 = 0.095 cms
Cedar-16
Bell-3
Bell-2
Bell-1
Flow Control, Qc
375mm
2021-06-15 4:48
2021-06-15 9:36
2021-06-15 14:24
2021-06-15 19:12
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2021-06-16 4:48
2021-06-16 9:36
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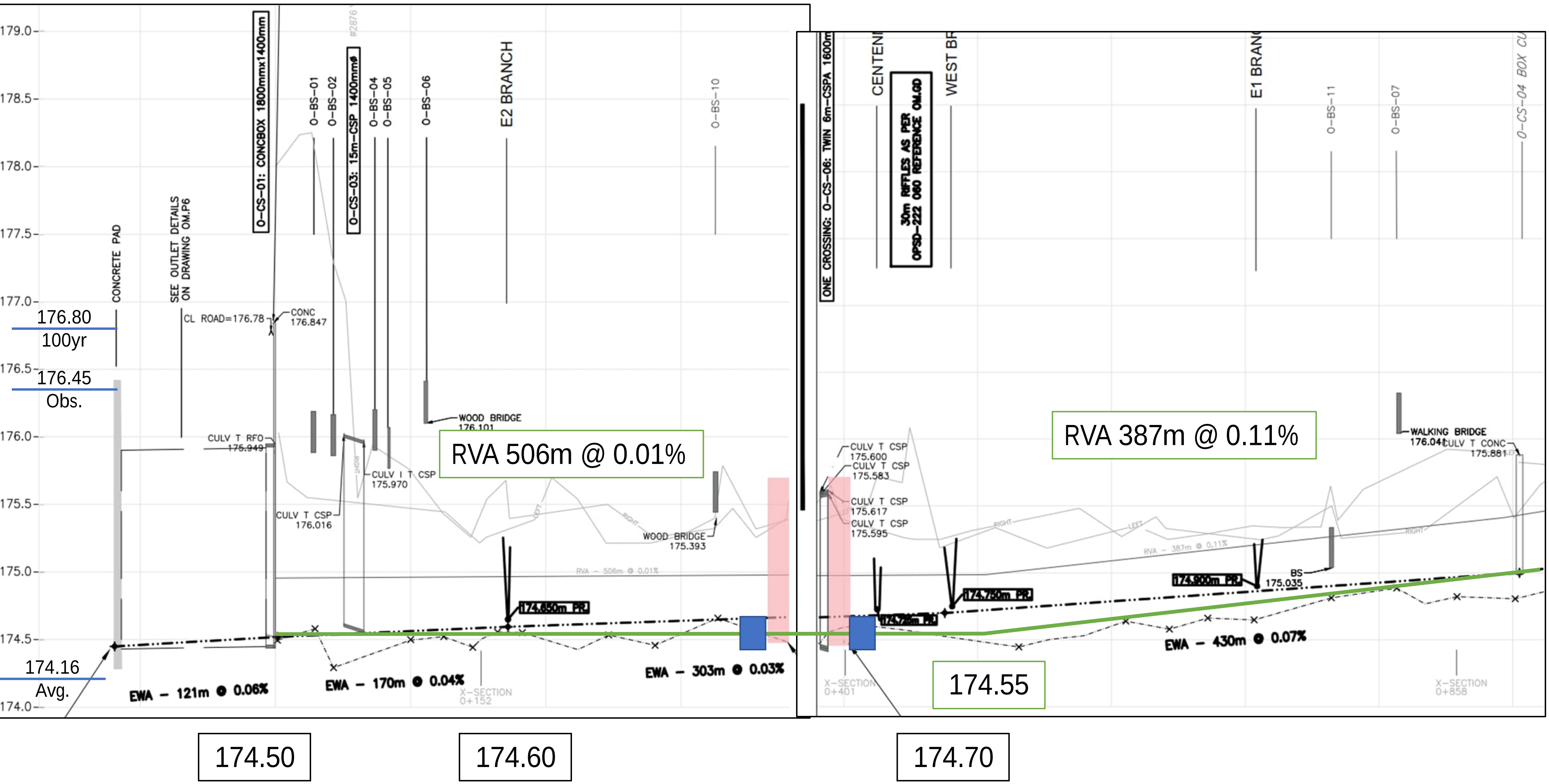
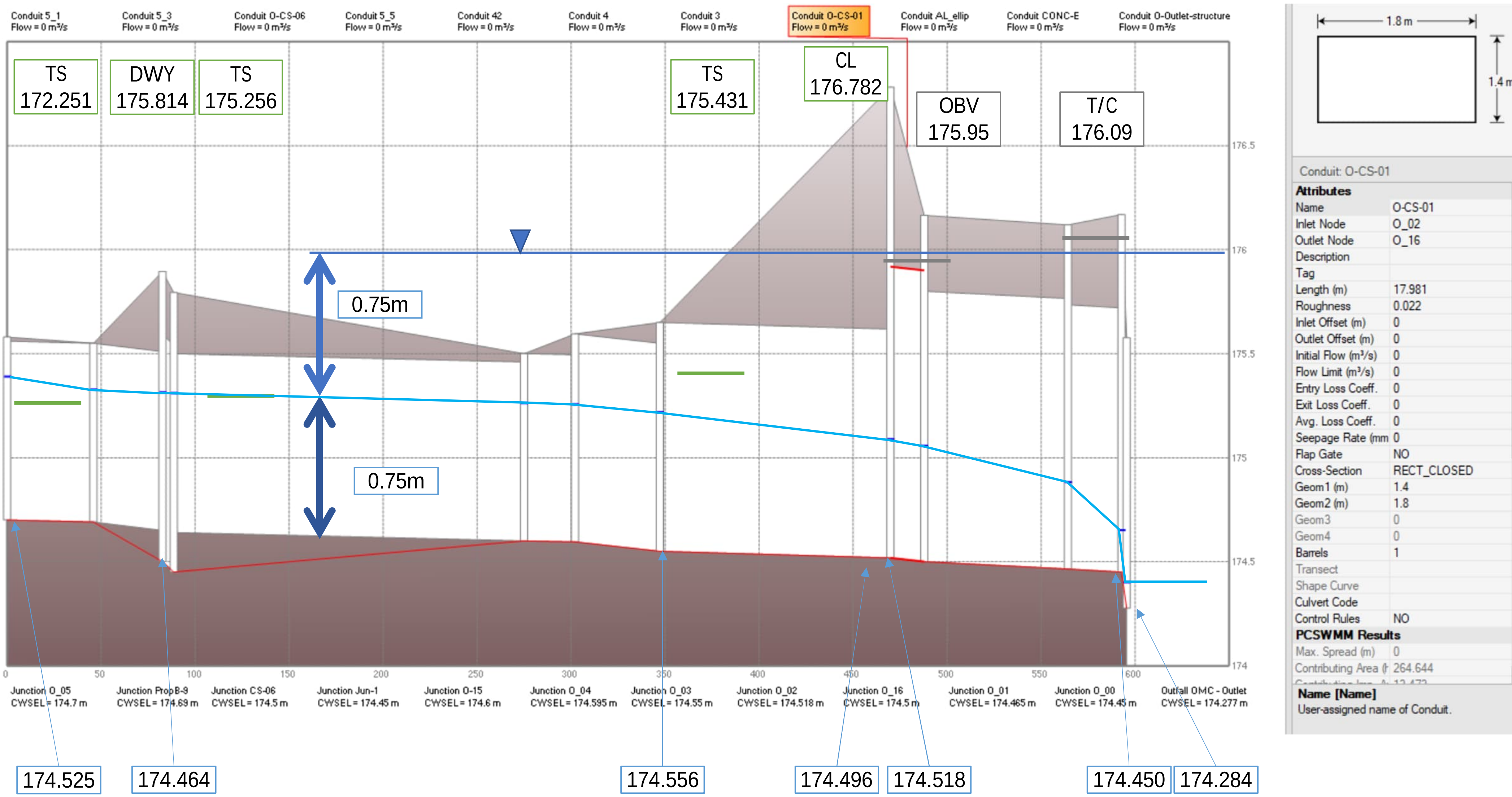
2021-06-16 19:12



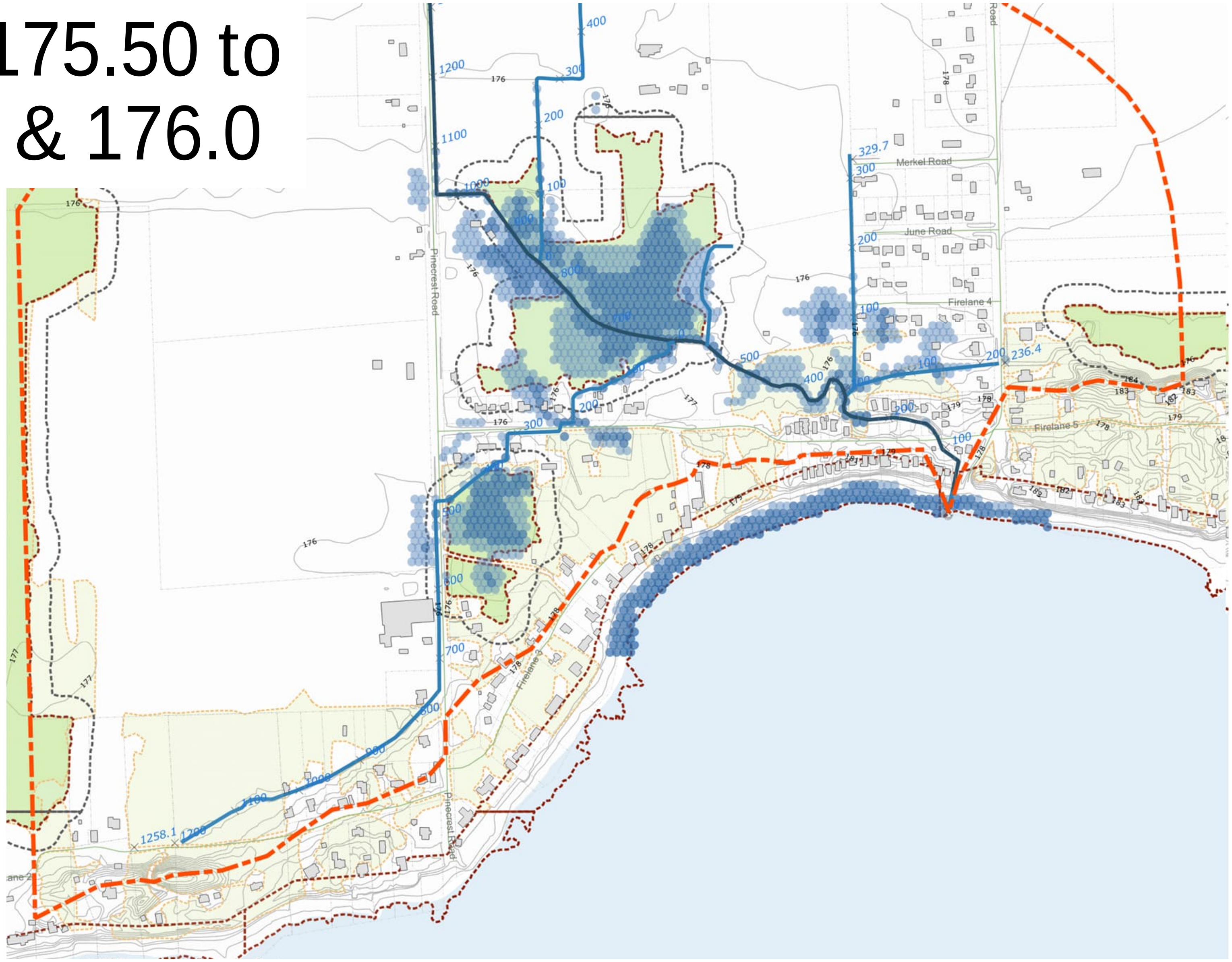
179.0
178.5
178.0
177.5
177.0
176.5
176.0
175.5
175.0
174.5
174.0
CONCRETE PAD
SEE OUTLET DETAILS ON DRAWING OM.P6
0-CS-01: CONCBOX 1800mmx1400mm
0-BS-01
0-BS-02
0-CS-03: 15m-CSP 1400mmø
0-BS-04
0-BS-05
0-BS-06
E2 BRANCH
0-BS-10
176.80
100yr
176.45
Obs.
174.16
Avg.
CL ROAD=176.78
CONC 176.847
CULV T RFO 175.949
CULV T CSP 176.016
CULV I T CSP 175.970
WOOD BRIDGE 176.101
WOOD BRIDGE 175.393
RVA 506m @ 0.01%
174.650m PRJ
EWA - 121m @ 0.06%
EWA - 170m @ 0.04%
EWA - 303m @ 0.03%
X-SECTION 0+152
174.50
174.60
ONE CROSSING: 0-CS-06: TWIN 6m-CSPA 1600m
CENTENI
30m RIFFLES AS PER OPSD-222 060 REFERENCE OM.OD
WEST BR
E1 BRANC
0-BS-11
0-BS-07
0-CS-04 BOX CU
CULV T CSP 175.600
CULV T CSP 175.583
CULV T CSP 175.617
CULV T CSP 175.595
RVA 387m @ 0.11%
WALKING BRIDGE 176.041
CULV T CONC 175.881
BS 175.035
174.900m PRJ
174.750m PRJ
174.725m PRJ
EWA - 430m @ 0.07%
X-SECTION 0+401
X-SECTION 0+858
174.55
174.70



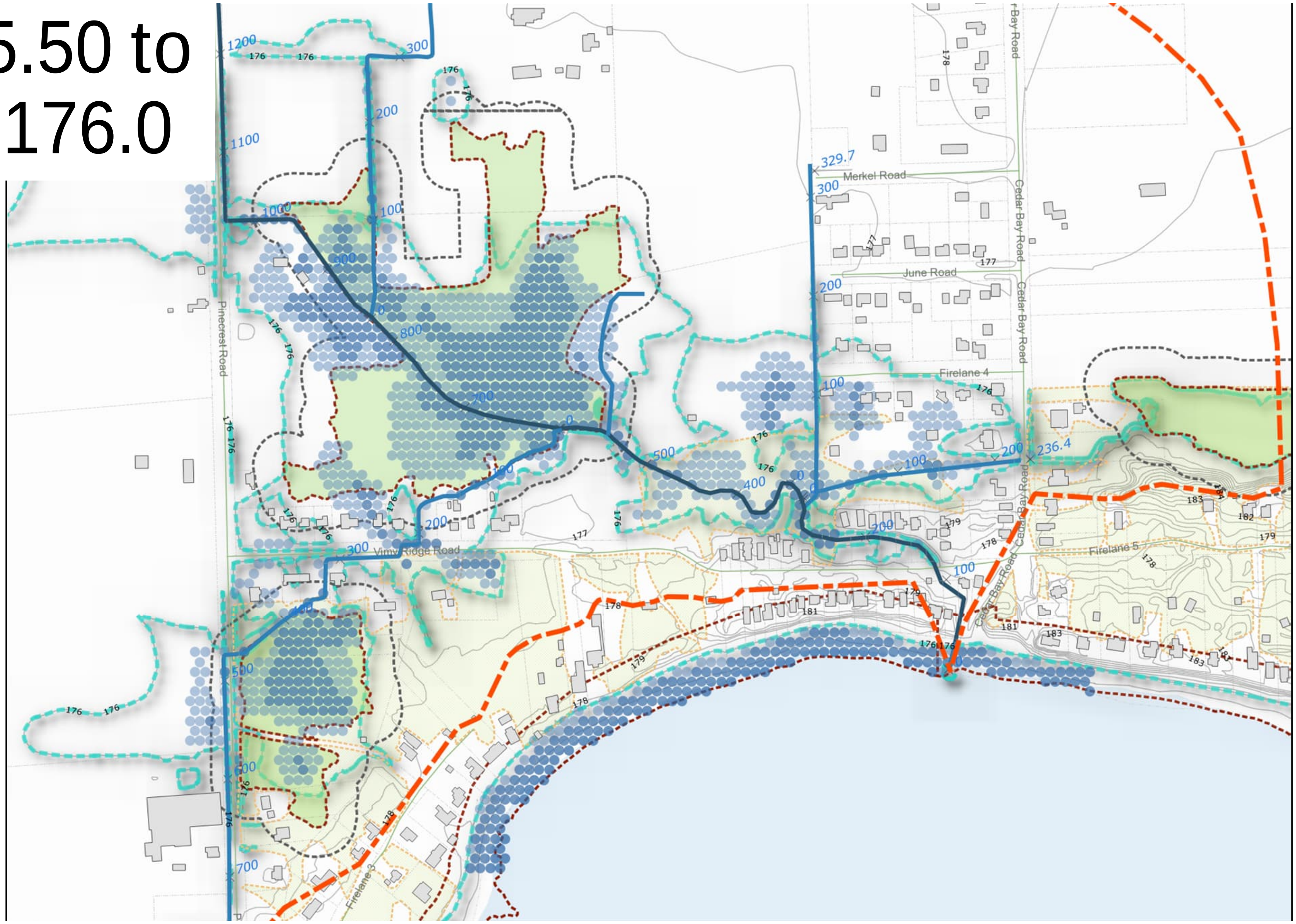
Conduit 5_1 Flow = 0 m³/s
Conduit 5_3 Flow = 0 m³/s
Conduit O-CS-06 Flow = 0 m³/s
Conduit 5_5 Flow = 0 m³/s
Conduit 42 Flow = 0 m³/s
Conduit 4 Flow = 0 m³/s
Conduit 3 Flow = 0 m³/s
Conduit O-CS-01 Flow = 0 m³/s
Conduit AL_ellip Flow = 0 m³/s
Conduit CONC-E Flow = 0 m³/s
Conduit O-Outlet-structure Flow = 0 m³/s
TS 172.251
DWY 175.814
TS 175.256
TS 175.431
CL 176.782
OBV 175.95
T/C 176.09
0.75m
0.75m
176.5
176
175.5
175
174.5
174
0 50 100 150 200 250 300 350 400 450 500 550 600
Junction O_05 CWSEL = 174.7 m
Junction PropB-9 CWSEL = 174.69 m
Junction CS-06 CWSEL = 174.5 m
Junction Jun-1 CWSEL = 174.45 m
Junction O-15 CWSEL = 174.6 m
Junction O_04 CWSEL = 174.595 m
Junction O_03 CWSEL = 174.55 m
Junction O_02 CWSEL = 174.518 m
Junction O_16 CWSEL = 174.5 m
Junction O_01 CWSEL = 174.465 m
Junction O_00 CWSEL = 174.45 m
Outfall OMC - Outlet CWSEL = 174.277 m
174.525
174.464
174.556
174.496
174.518
174.450
174.284
1.8 m
1.4 m
Conduit: O-CS-01
Attributes
Name O-CS-01
Inlet Node O_02
Outlet Node O_16
Description
Tag
Length (m) 17.981
Roughness 0.022
Inlet Offset (m) 0
Outlet Offset (m) 0
Initial Flow (m³/s) 0
Flow Limit (m³/s) 0
Entry Loss Coeff. 0
Exit Loss Coeff. 0
Avg. Loss Coeff. 0
Seepage Rate (mm 0
Flap Gate NO
Cross-Section RECT_CLOSED
Geom1 (m) 1.4
Geom2 (m) 1.8
Geom3 0
Geom4 0
Barrels 1
Transect
Shape Curve
Culvert Code
Control Rules NO
PCSWMM Results
Max. Spread (m) 0
Contributing Area (l 264.644
Name [Name]
User-assigned name of Conduit.

Outlet flow – Feb 28, 2022

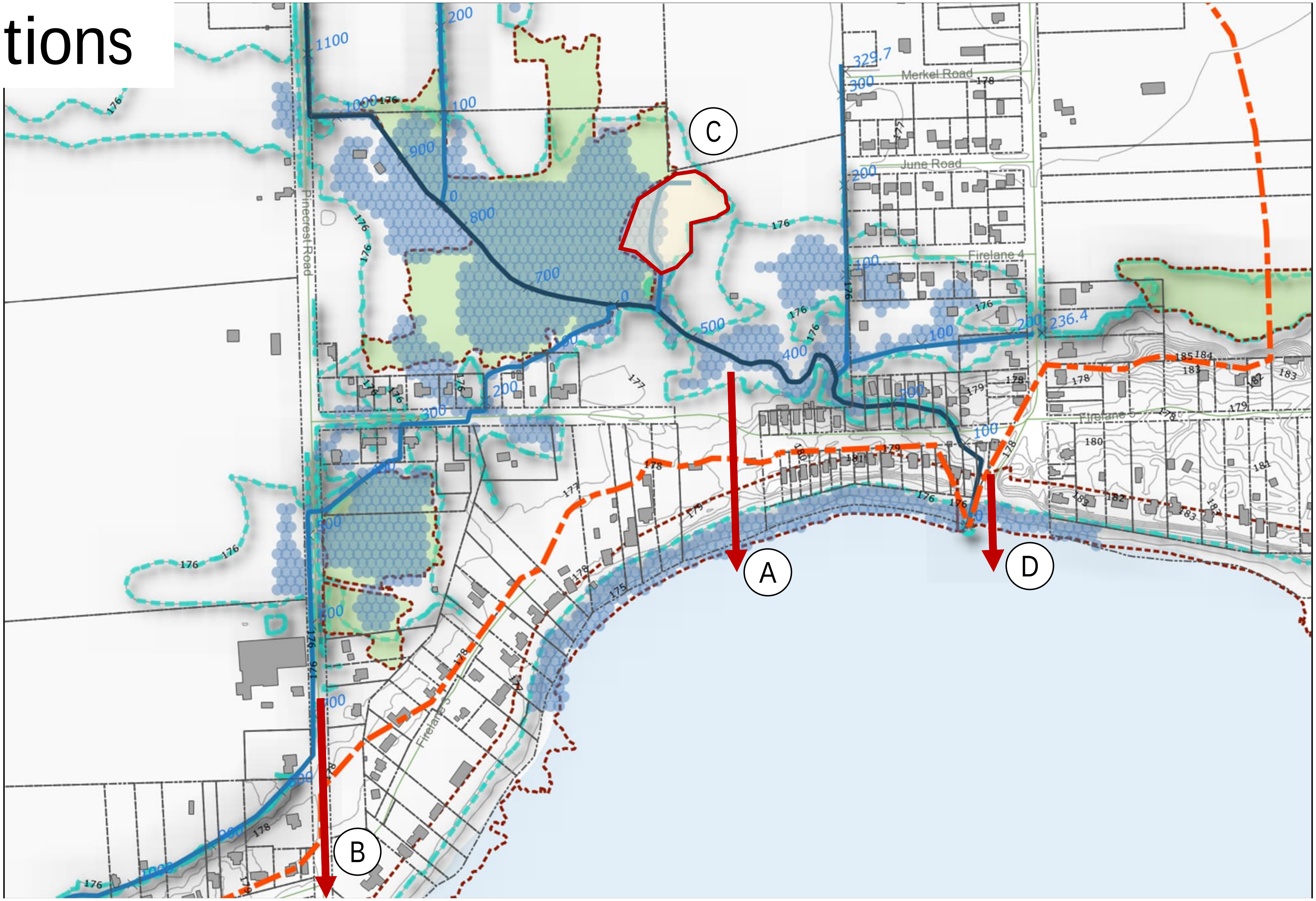
Elev = 175.50 to 175.75 & 176.0



Elev = 175.50 to 175.75 & 176.0

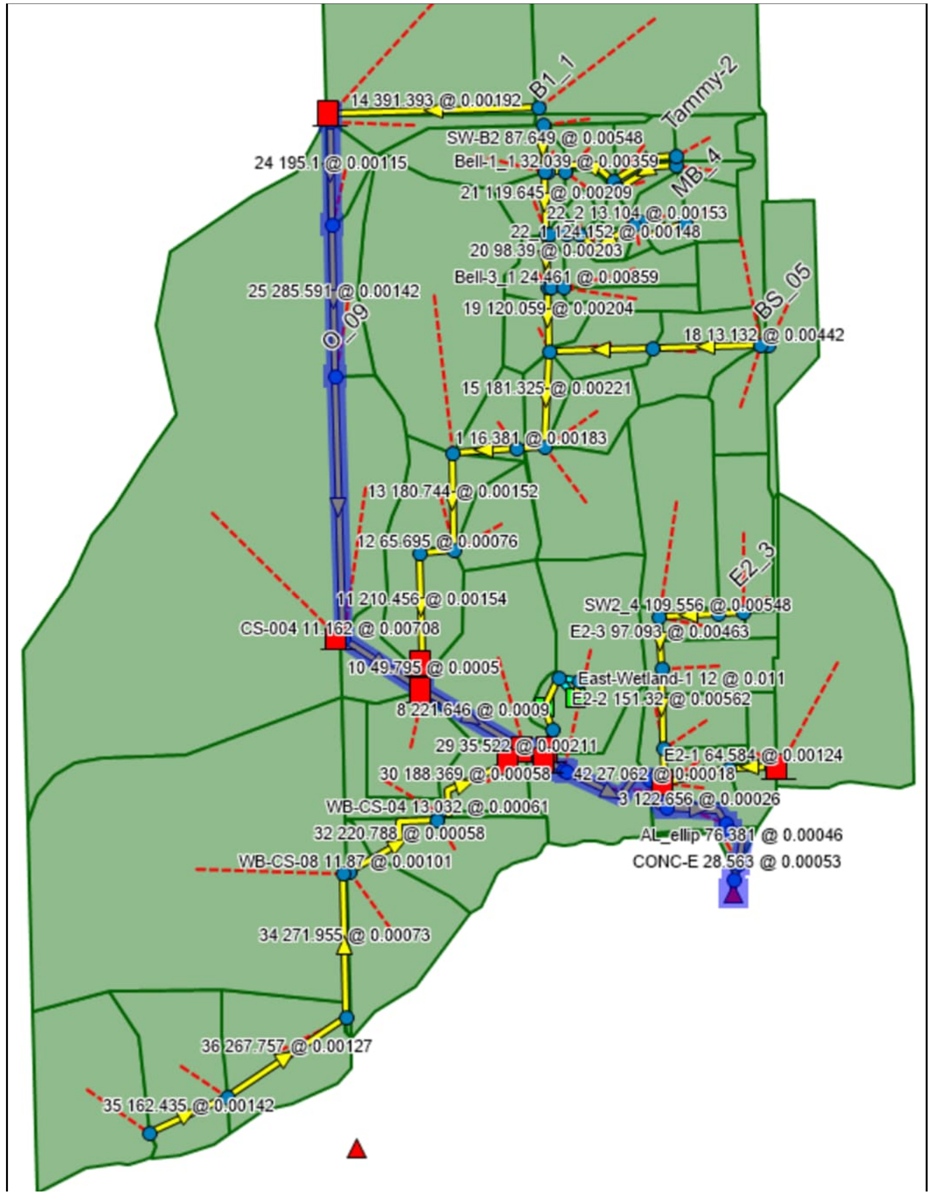


Options

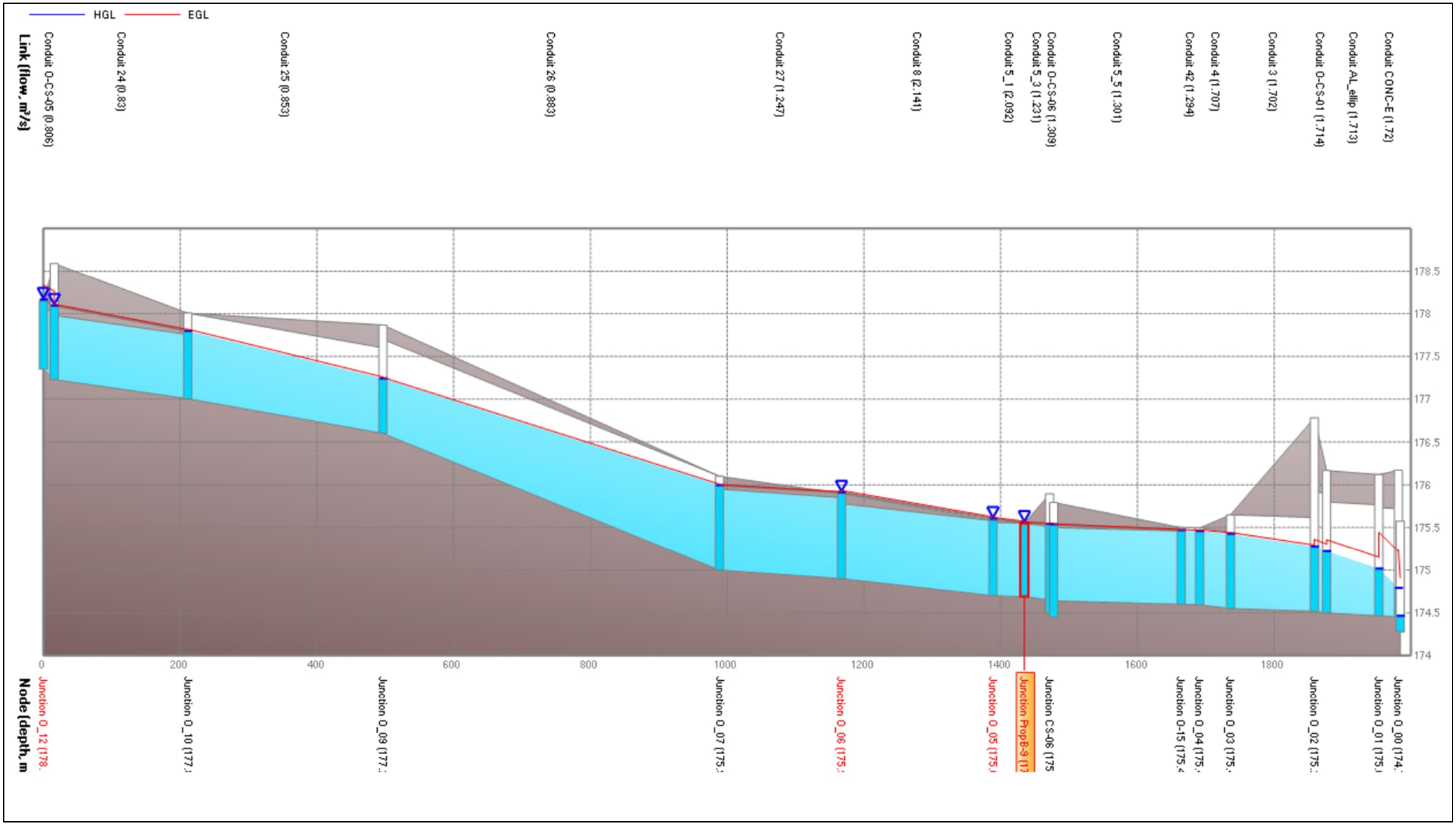


A
B
C
D
Merkel Road
June Road
Firelane 4
Firelane 5
Pinecrest Road

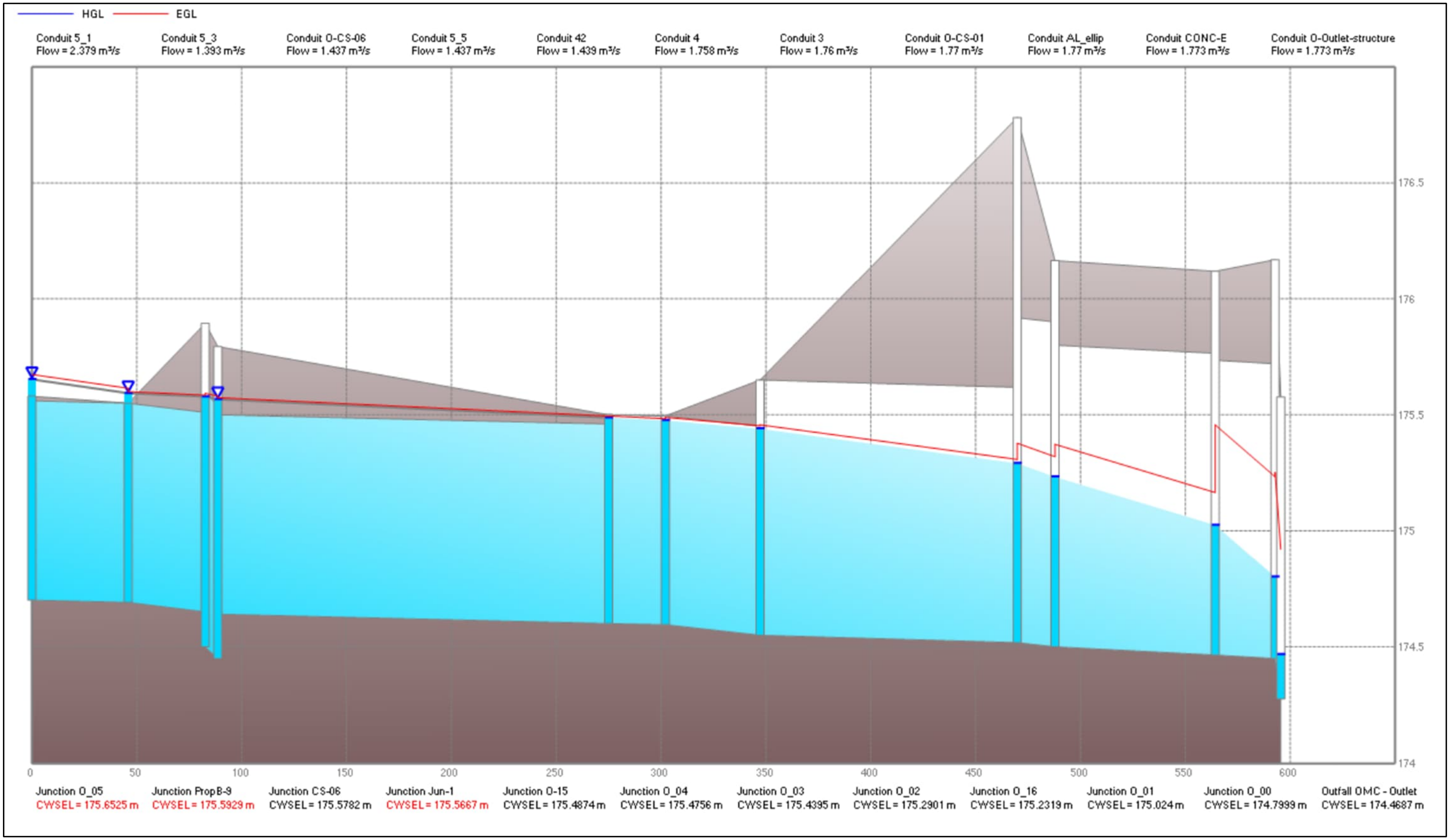
Ponding Volumes



14 391.393 @ 0.00192
B1_1
Tammy-2
SW-B2 87.649 @ 0.00548
Bell-1_1 32.039 @ 0.00359
MB_4
24 195.1 @ 0.00115
21 119.645 @ 0.00209
22_2 13.104 @ 0.00153
22_1 124.152 @ 0.00148
20 98.39 @ 0.00203
Bell-3_1 24.461 @ 0.00859
25 285.591 @ 0.00142
O_09
19 120.059 @ 0.00204
BS_05
18 13.132 @ 0.00442
15 181.325 @ 0.00221
1 16.381 @ 0.00183
13 180.744 @ 0.00152
12 65.695 @ 0.00076
E2_3
11 210.456 @ 0.00154
SW2_4 109.556 @ 0.00548
CS-004 11.162 @ 0.00708
E2-3 97.093 @ 0.00463
10 49.795 @ 0.0005
East-Wetland-1 12 @ 0.011
E2-2 151.32 @ 0.00562
8 221.646 @ 0.0009
29 35.522 @ 0.00211
E2-1 64.584 @ 0.00124
30 188.369 @ 0.00058
42 27.062 @ 0.00018
3 122.656 @ 0.00026
WB-CS-04 13.032 @ 0.00061
32 220.788 @ 0.00058
AL_ellip 76.381 @ 0.00046
WB-CS-08 11.87 @ 0.00101
CONC-E 28.563 @ 0.00053
34 271.955 @ 0.00073
36 267.757 @ 0.00127
35 162.435 @ 0.00142

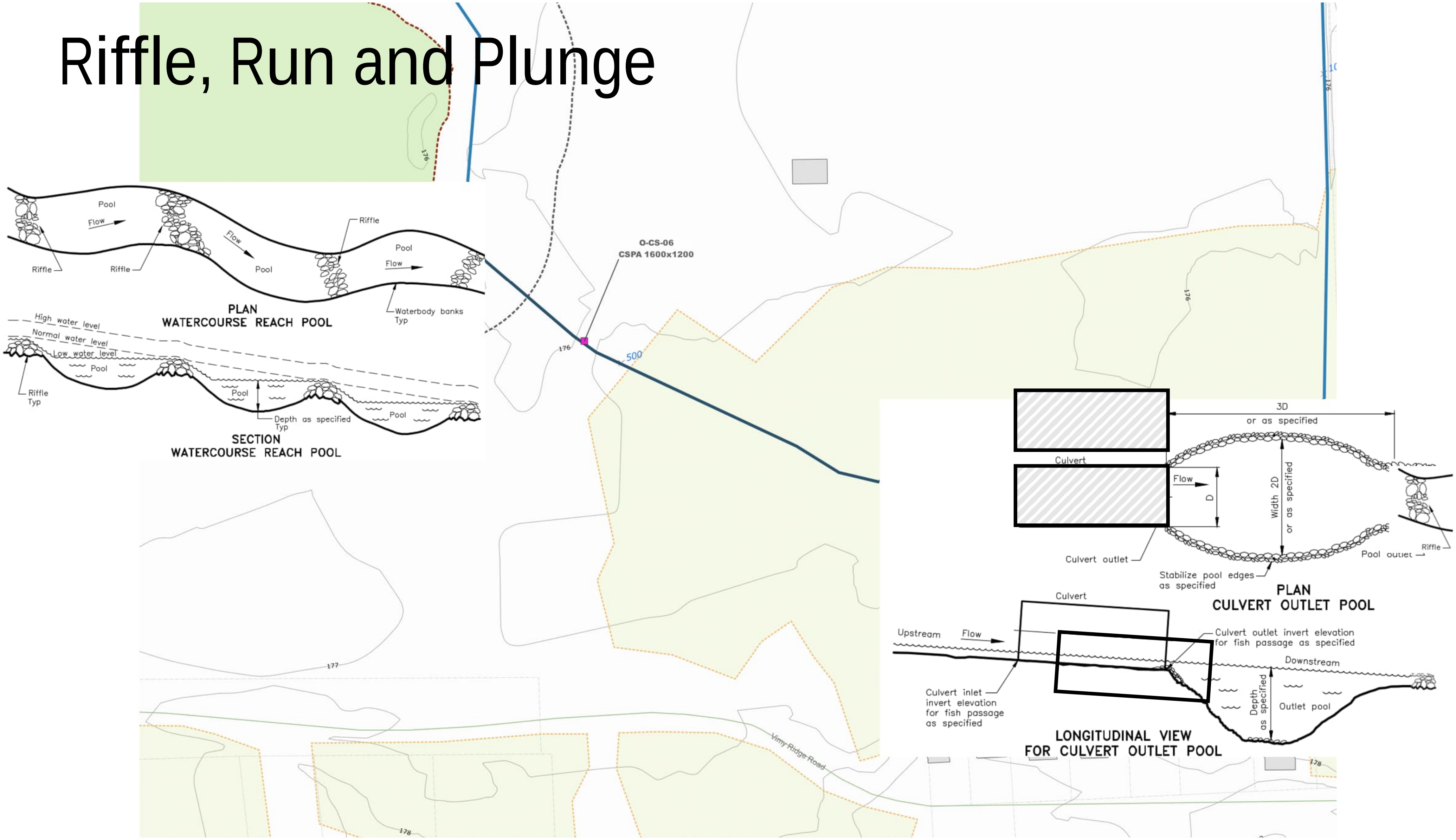


HGL
EGL
Link (flow, m³/s)
Conduit O-CS-05 (0.806)
Conduit 24 (0.83)
Conduit 25 (0.853)
Conduit 26 (0.883)
Conduit 27 (1.247)
Conduit 8 (2.141)
Conduit 5_1 (2.092)
Conduit 5_3 (1.231)
Conduit O-CS-06 (1.309)
Conduit 5_5 (1.301)
Conduit 42 (1.294)
Conduit 4 (1.707)
Conduit 3 (1.702)
Conduit O-CS-01 (1.714)
Conduit AL_ellip (1.713)
Conduit CONC-E (1.72)
178.5
178
177.5
177
176.5
176
175.5
175
174.5
174
0
200
400
600
800
1000
1200
1400
1600
1800
Node (depth, m
Junction O_12 (178.
Junction O_10 (177.
Junction O_09 (177.
Junction O_07 (175.
Junction O_06 (175.
Junction O_05 (175.
Junction PropB-9 (17
Junction CS-06 (175
Junction O-15 (175.4
Junction O_04 (175.
Junction O_03 (175.
Junction O_02 (175.
Junction O_01 (175.
Junction O_00 (174.



HGL
EGL
Conduit 5_1
Flow = 2.379 m³/s
Conduit 5_3
Flow = 1.393 m³/s
Conduit O-CS-06
Flow = 1.437 m³/s
Conduit 5_5
Flow = 1.437 m³/s
Conduit 42
Flow = 1.439 m³/s
Conduit 4
Flow = 1.758 m³/s
Conduit 3
Flow = 1.76 m³/s
Conduit O-CS-01
Flow = 1.77 m³/s
Conduit AL_ellip
Flow = 1.77 m³/s
Conduit CONC-E
Flow = 1.773 m³/s
Conduit O-Outlet-structure
Flow = 1.773 m³/s
176.5
176
175.5
175
174.5
174
0
50
100
150
200
250
300
350
400
450
500
550
600
Junction O_05
CWSEL = 175.6525 m
Junction PropB-9
CWSEL = 175.5929 m
Junction CS-06
CWSEL = 175.5782 m
Junction Jun-1
CWSEL = 175.5667 m
Junction O-15
CWSEL = 175.4874 m
Junction O_04
CWSEL = 175.4756 m
Junction O_03
CWSEL = 175.4395 m
Junction O_02
CWSEL = 175.2901 m
Junction O_16
CWSEL = 175.2319 m
Junction O_01
CWSEL = 175.024 m
Junction O_00
CWSEL = 174.7999 m
Outfall OMC - Outlet
CWSEL = 174.4687 m

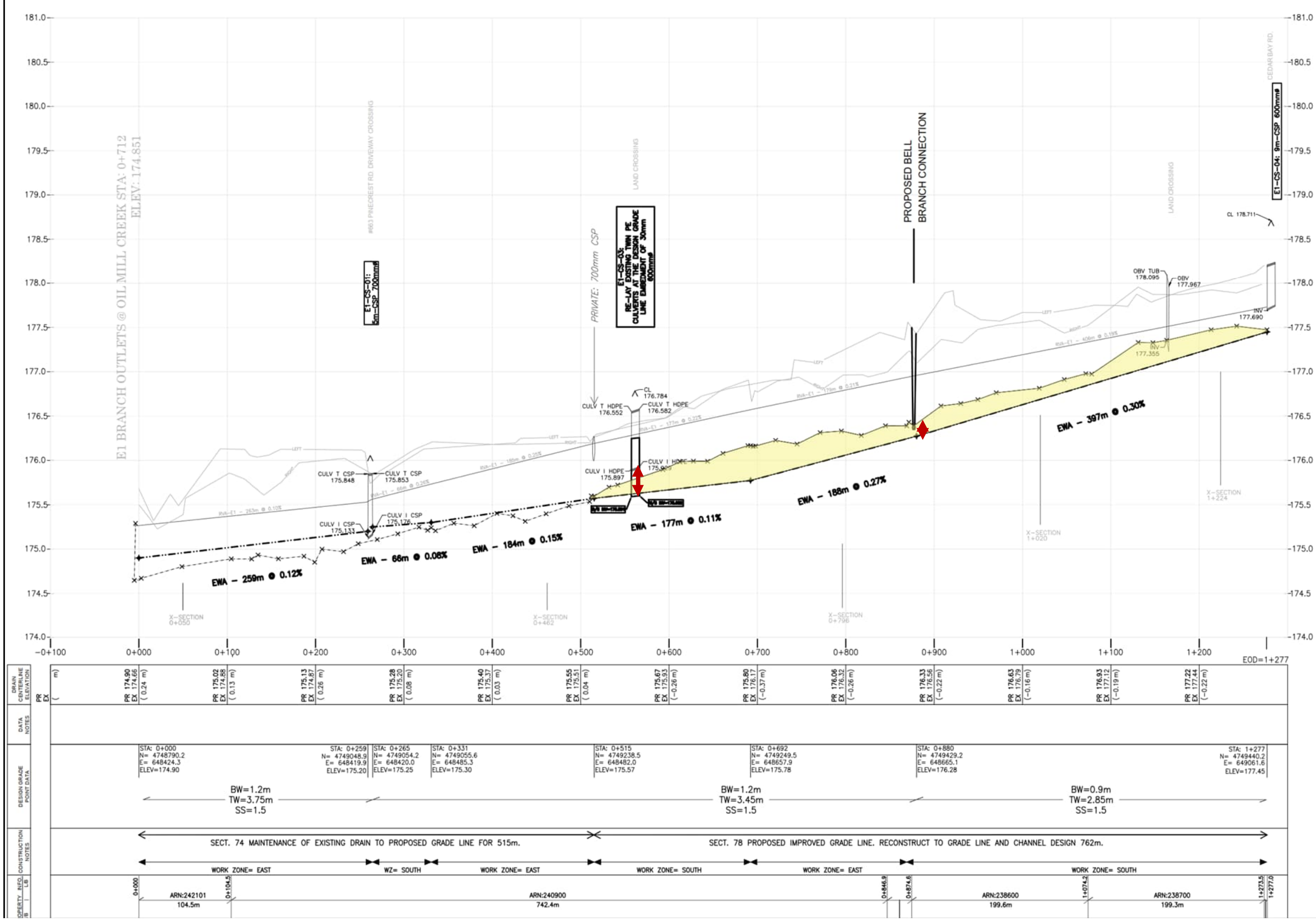
Riffle, Run and Plunge



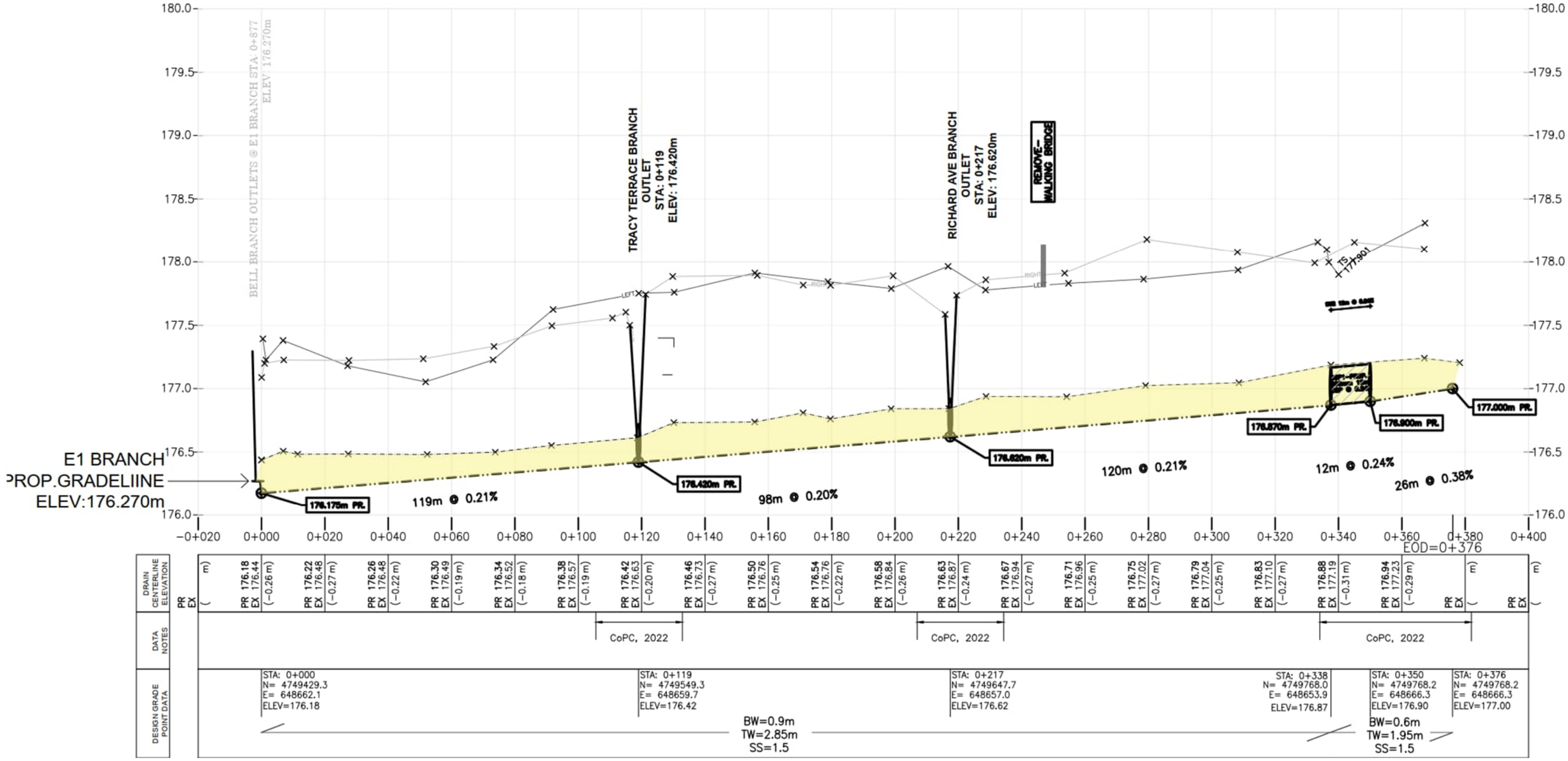

Prop. Wetland
Outlet
West Branch
Outlet

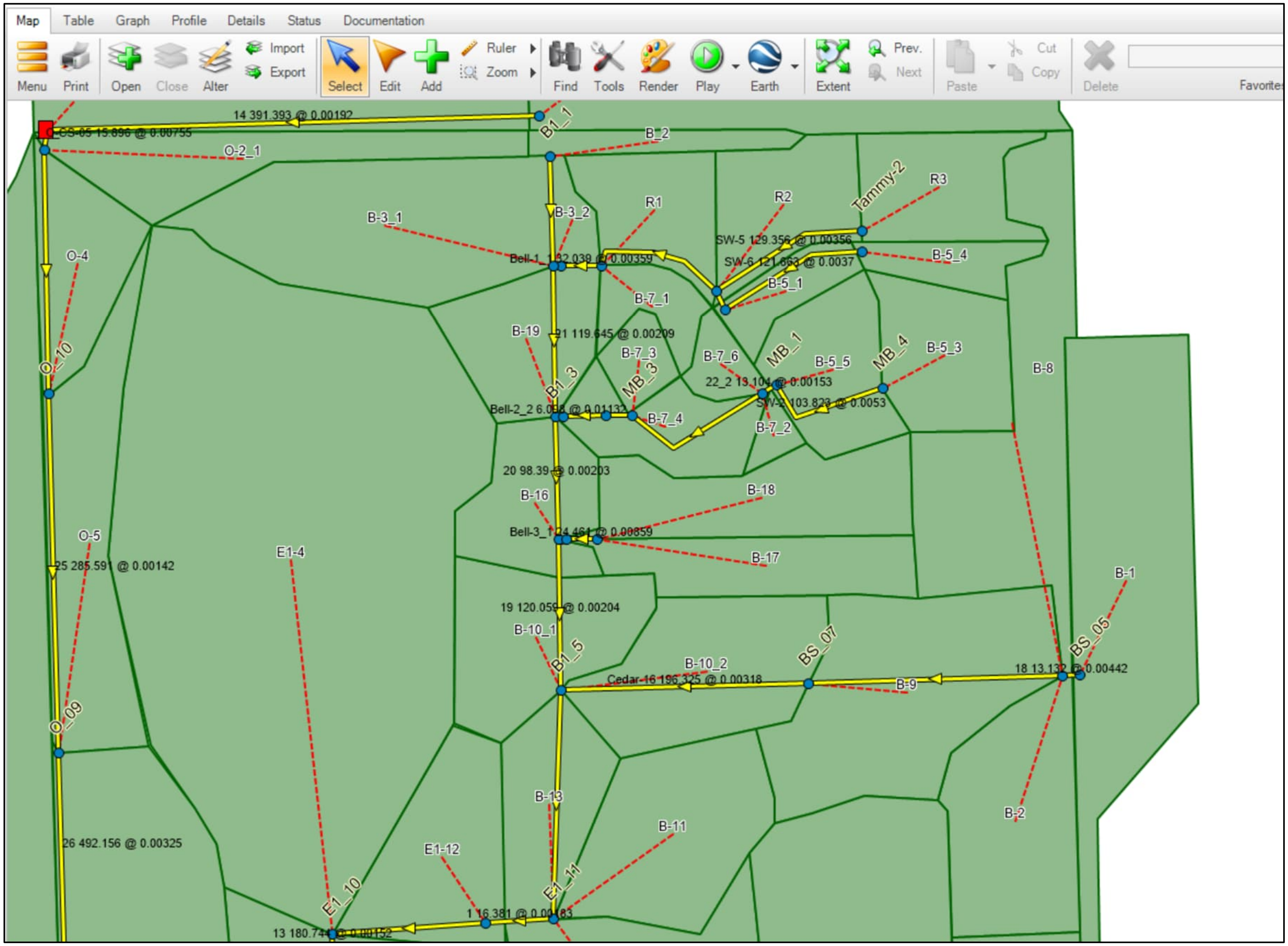
Bell Acres Improvements

E1 BRANCH: 0+000 to 1+277



Proposed Bell Branch Profile





Map
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Select
Edit
Add
Ruler
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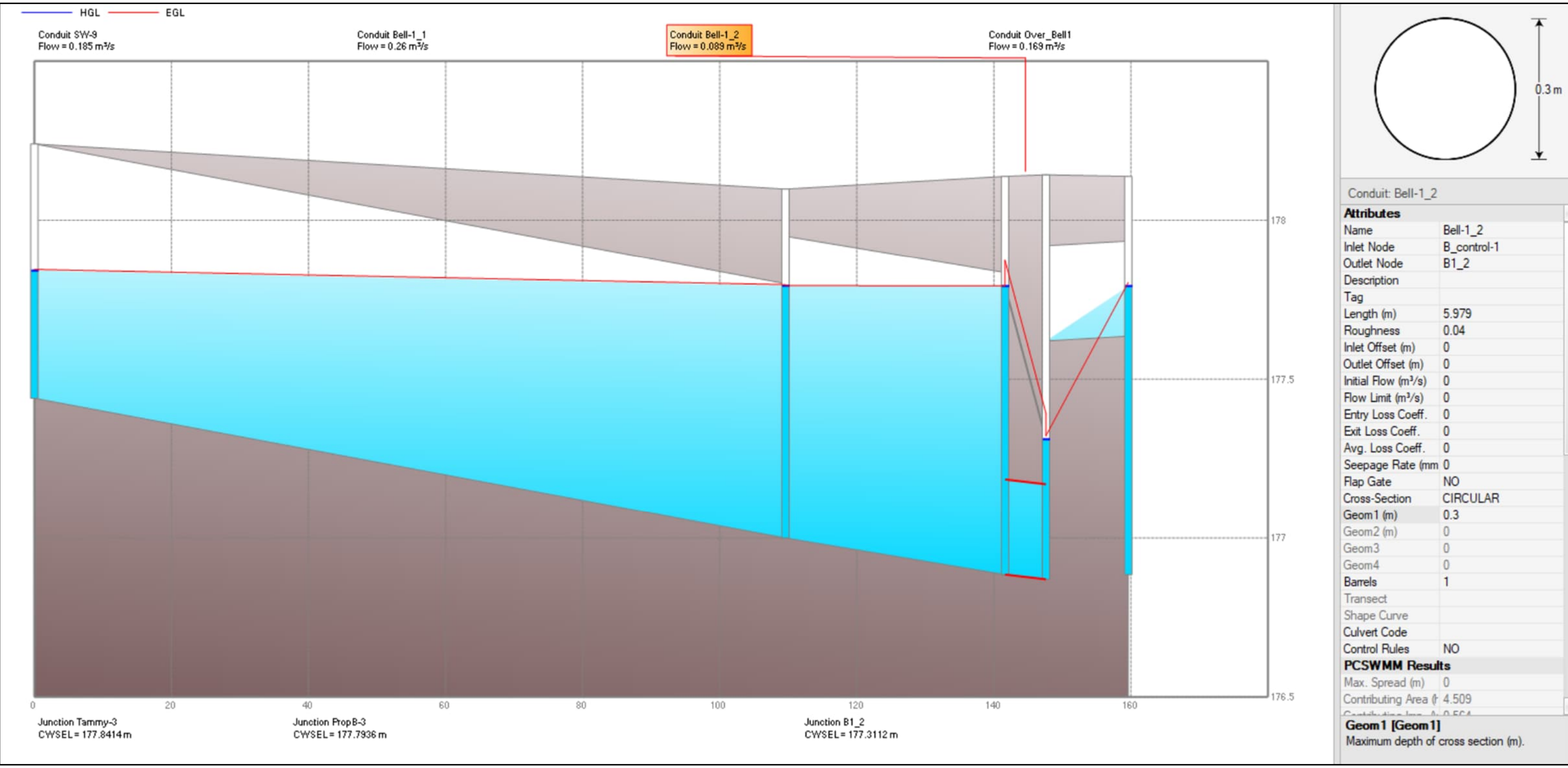
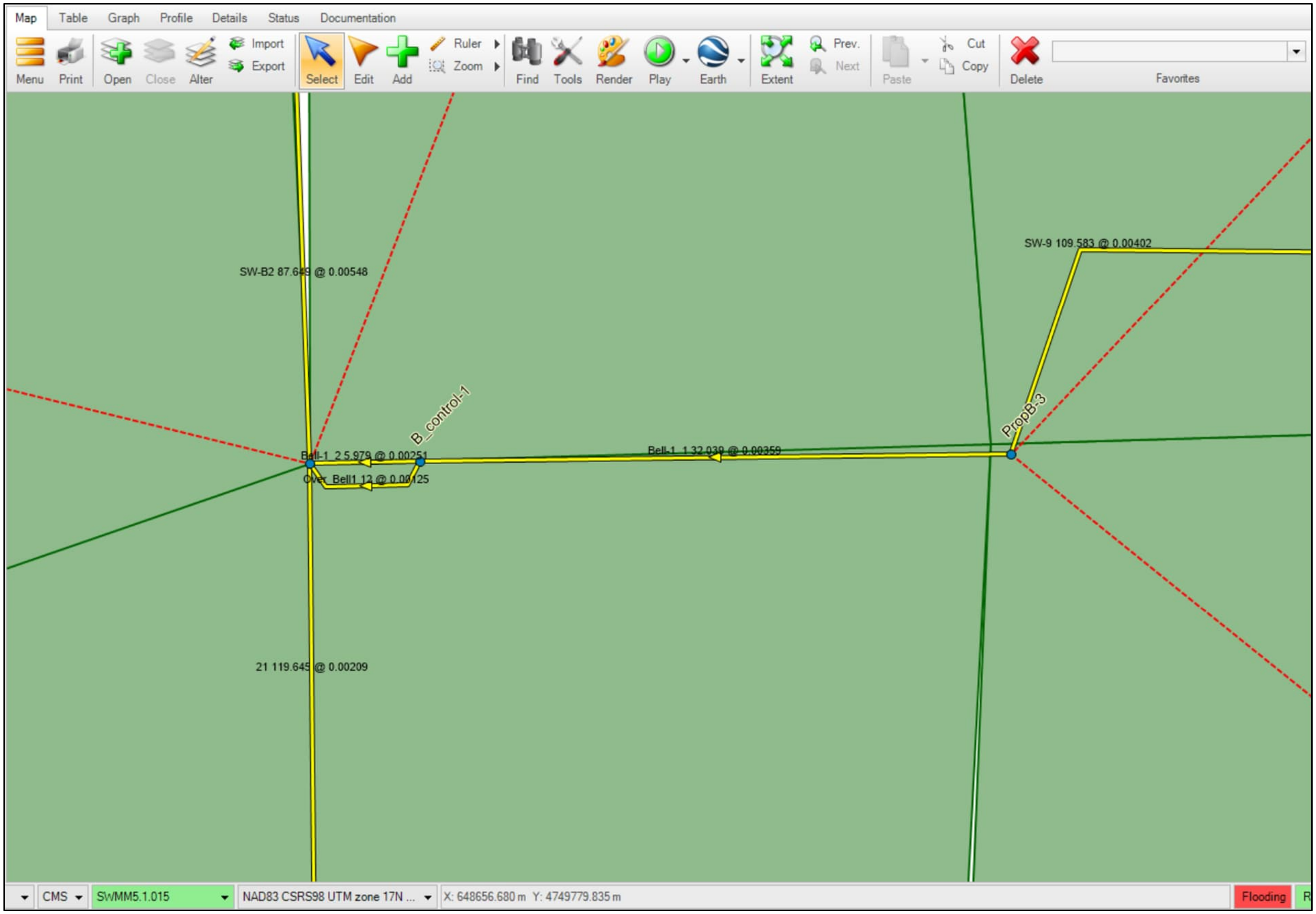
Find
Tools
Render
Play
Earth
Extent
Prev.
Next
Paste
Cut
Copy
Delete
Favorites
14 391.393 @ 0.00192
B1_1
B_2
O-2_1
B-3_1
B-3_2
R1
R2
Tammy-2
R3
SW-5 129.356 @ 0.00356
SW-6 121.663 @ 0.0037
B-5_4
B-5_1
Bell-1 132.039 @ 0.00359
B-7_1
O-4
B-19
21 119.645 @ 0.00209
B-7_3
B-7_6
MB_1
B-5_5
MB_4
B-5_3
B-8
O_10
B1_3
MB_3
22_2 13.104 @ 0.00153
SW-2 103.823 @ 0.0053
Bell-2_2 6.098 @ 0.01132
B-7_4
B-7_2
20 98.39 @ 0.00203
B-18
B-16
Bell-3_1 24.461 @ 0.00859
O-5
E1-4
B-17
25 285.591 @ 0.00142
B-1
19 120.059 @ 0.00204
B-10_1
BS_05
B1_5
B-10_2
BS_07
18 13.132 @ 0.00442
Cedar-16 196.325 @ 0.00318
B-9
O_09
B-13
B-2
B-11
26 492.156 @ 0.00325
E1-12
E1_10
E1_11
1 16.381 @ 0.00183
13 180.744 @ 0.00152



HGL
EGL
Conduit SW-9
Flow = 0.185 m³/s
Conduit Bell-1_1
Flow = 0.26 m³/s
Conduit Bell-1_2
Flow = 0.089 m³/s
Conduit Over_Bell1
Flow = 0.169 m³/s
178
177.5
177
176.5
0
20
40
60
80
100
120
140
160
Junction Tammy-3
CWSEL = 177.8414 m
Junction PropB-3
CWSEL = 177.7936 m
Junction B1_2
CWSEL = 177.3112 m
0.3 m
Conduit: Bell-1_2
Attributes
Name Bell-1_2
Inlet Node B_control-1
Outlet Node B1_2
Description
Tag
Length (m) 5.979
Roughness 0.04
Inlet Offset (m) 0
Outlet Offset (m) 0
Initial Flow (m³/s) 0
Flow Limit (m³/s) 0
Entry Loss Coeff. 0
Exit Loss Coeff. 0
Avg. Loss Coeff. 0
Seepage Rate (mm 0
Flap Gate NO
Cross-Section CIRCULAR
Geom1 (m) 0.3
Geom2 (m) 0
Geom3 0
Geom4 0
Barrels 1
Transect
Shape Curve
Culvert Code
Control Rules NO
PCSWMM Results
Max. Spread (m) 0
Contributing Area (ł 4.509
Geom1 [Geom1]
Maximum depth of cross section (m).



Map
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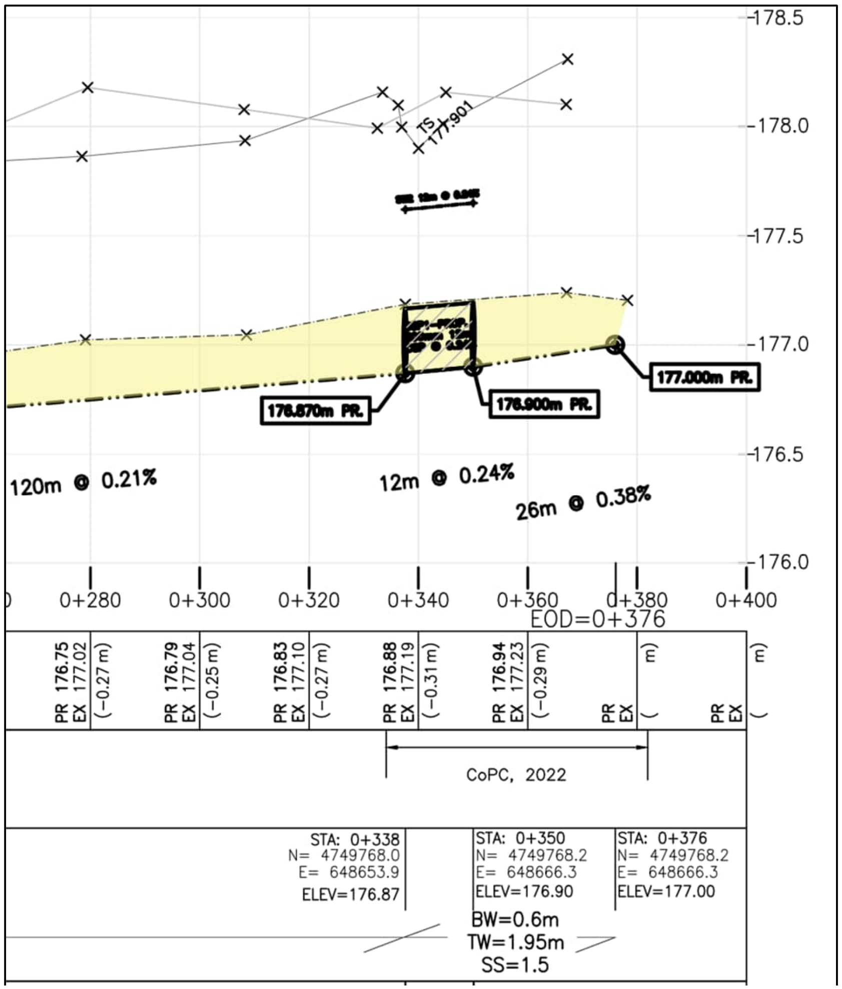
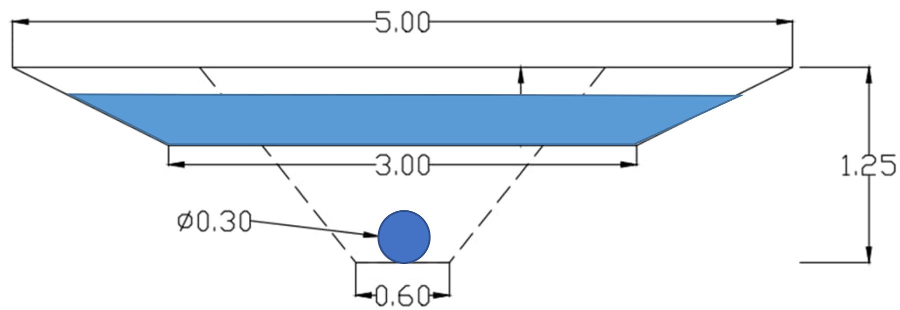
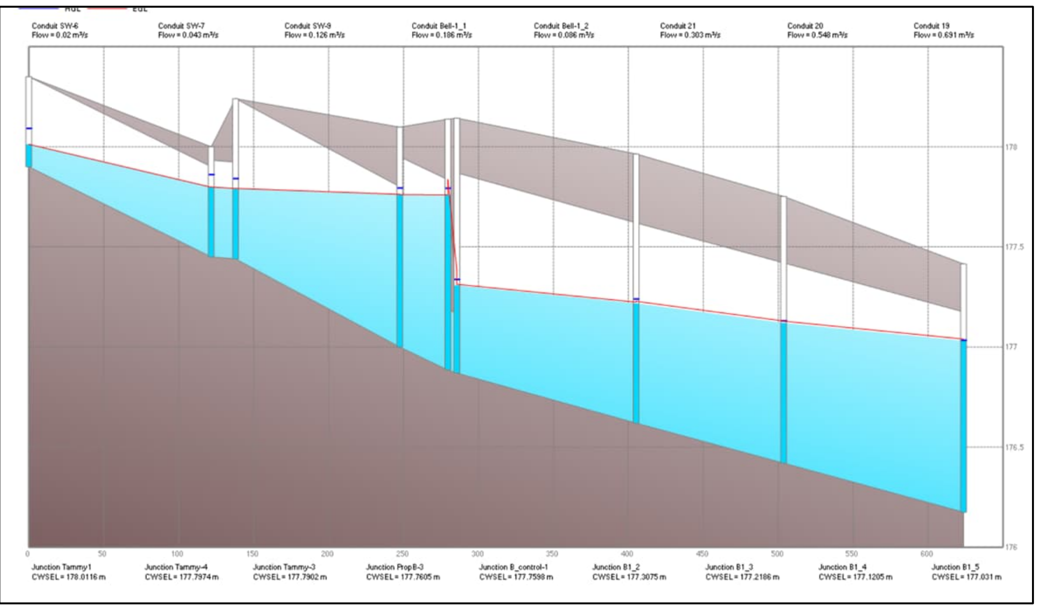
Close
Alter
Import
Export
Select
Edit
Add
Ruler
Zoom
Find
Tools
Render
Play
Earth
Extent
Prev.
Next
Paste
Cut
Copy
Delete
Favorites
SW-B2 87.649 @ 0.00548
SW-9 109.583 @ 0.00402
B_control-1
PropB-3
Bell-1_2 5.979 @ 0.00251
Bell-1_1 32.039 @ 0.00359
Over_Bell1 12 @ 0.00125
21 119.645 @ 0.00209
CMS
SWMM5.1.015
NAD83 CSRS98 UTM zone 17N ...
X: 648656.680 m Y: 4749779.835 m
Flooding

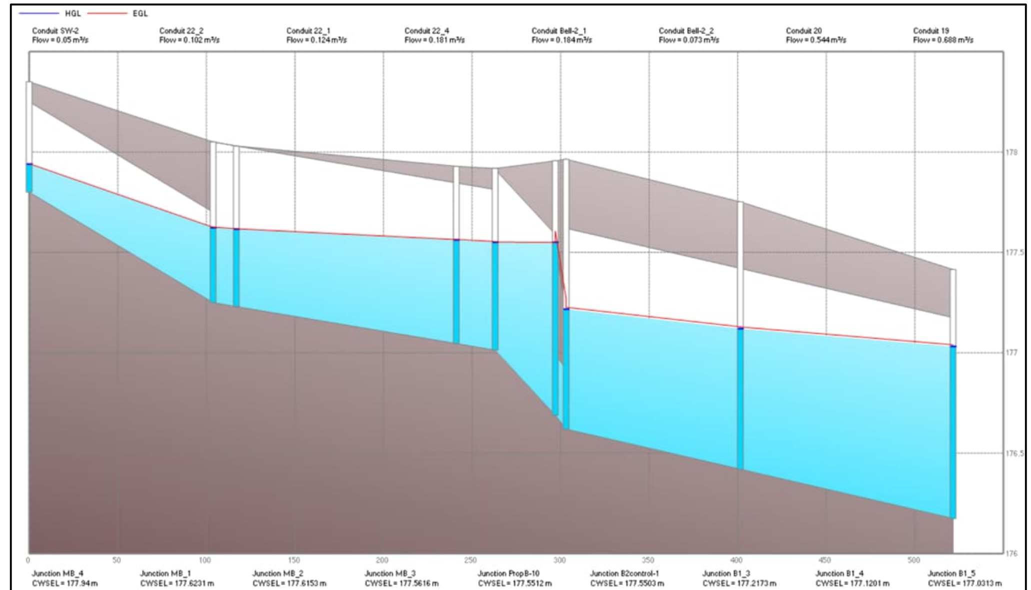
Flow Controlled Outlet

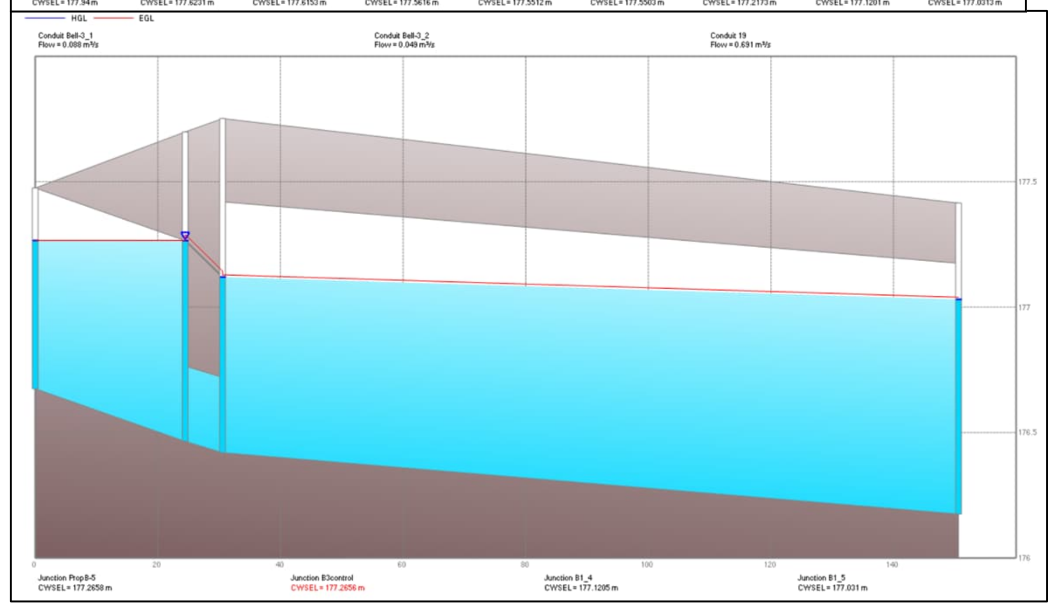




Bell1, Bell2 and Bell3

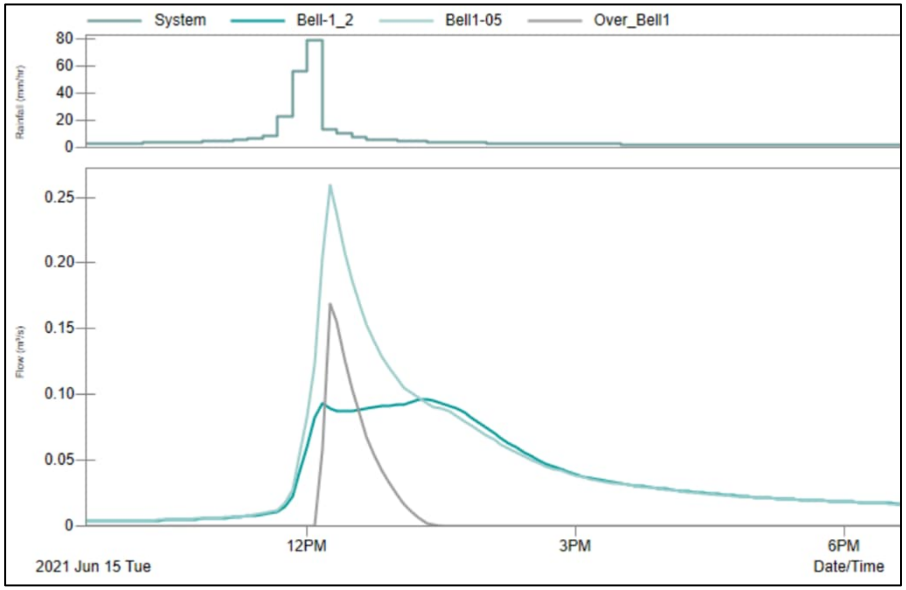






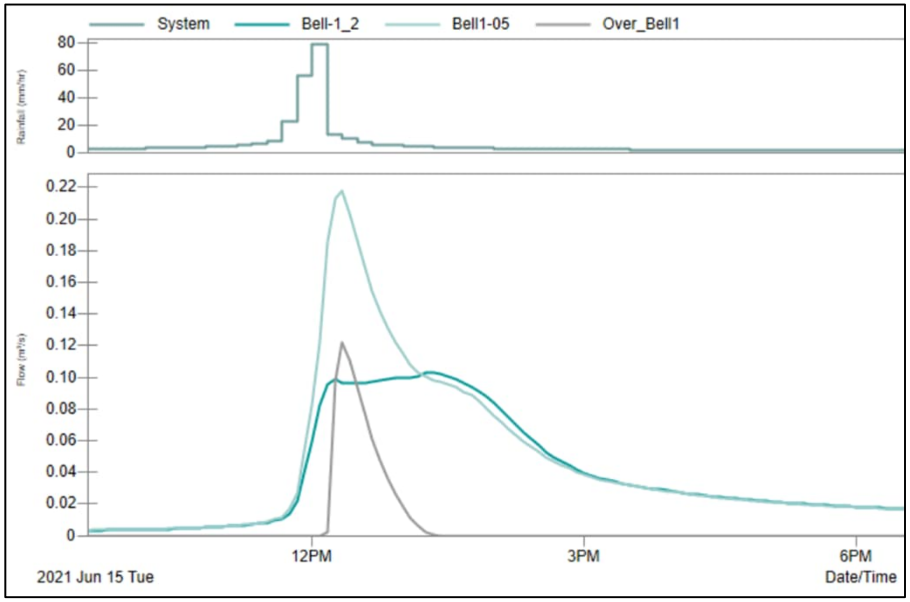
300mm d & 0.75m offset & h=0.3m

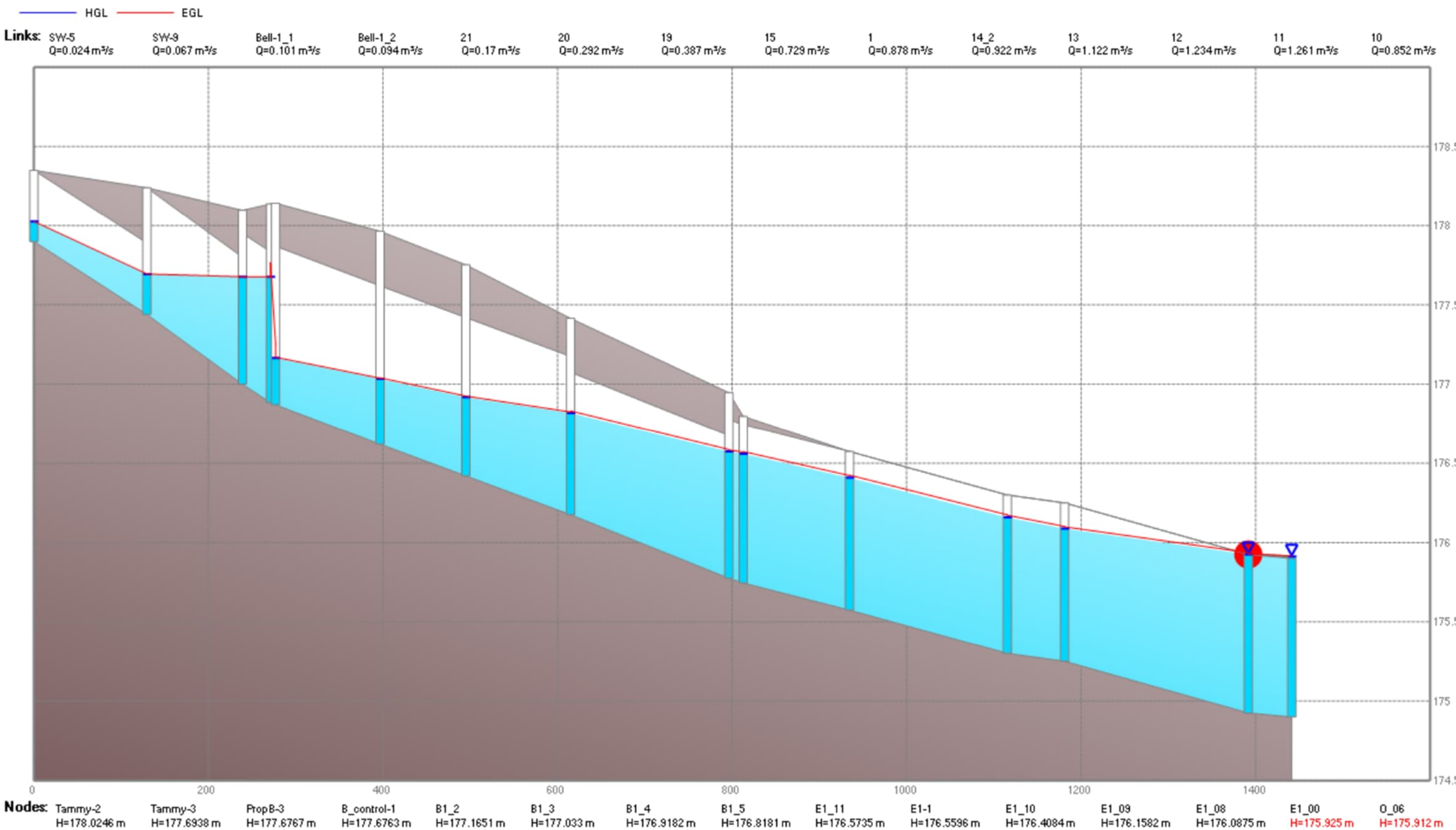
260 lps; 96 lps & 169 lps



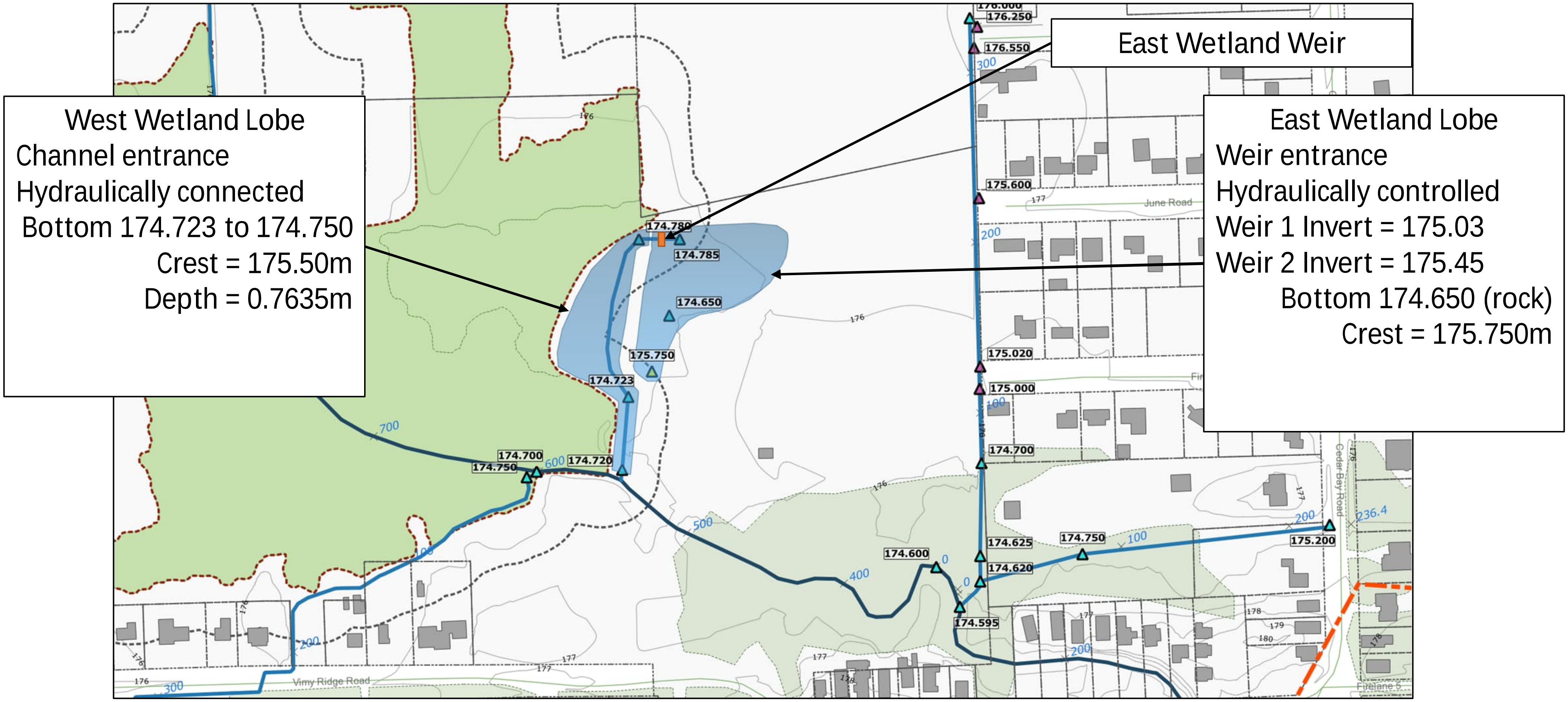
300mm d & 0.85m offset & h=0.2m

218 lps; 103 lps & 122 lps

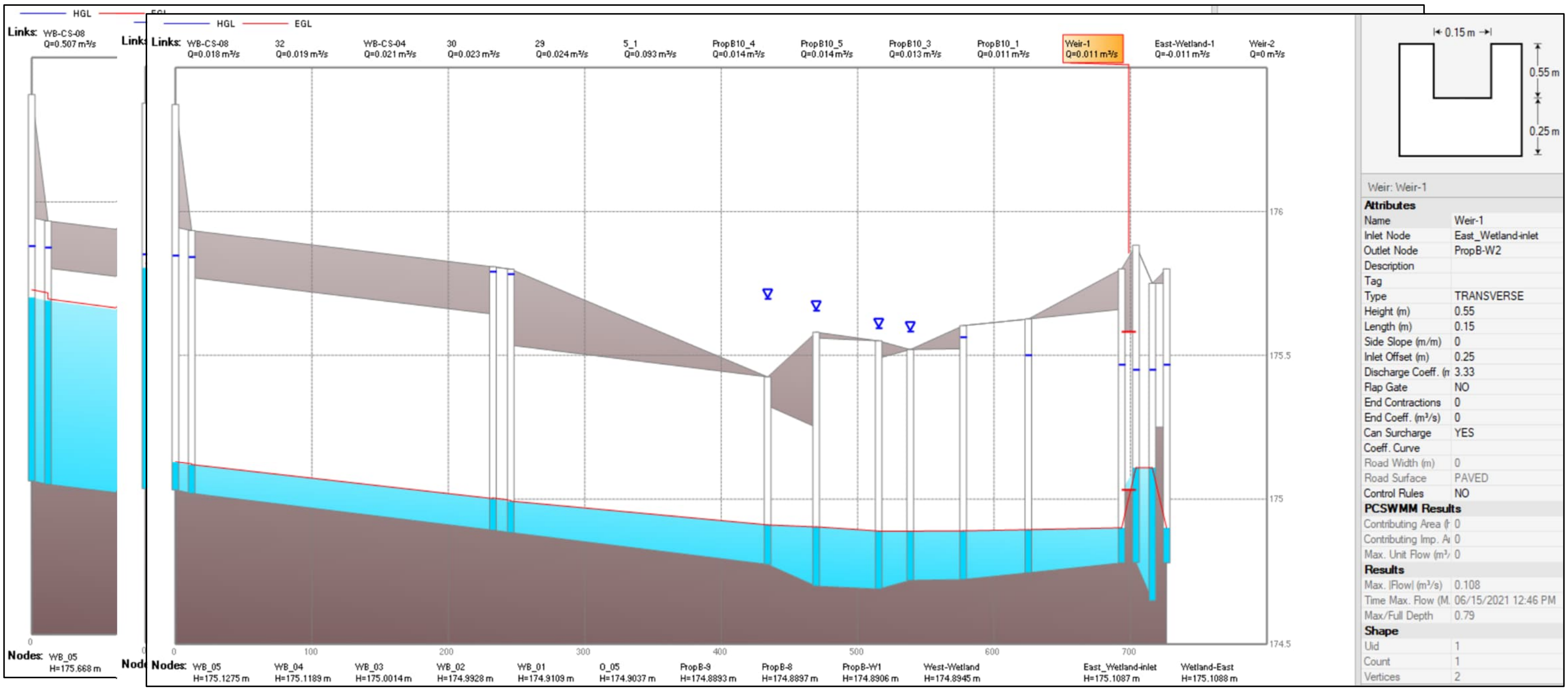


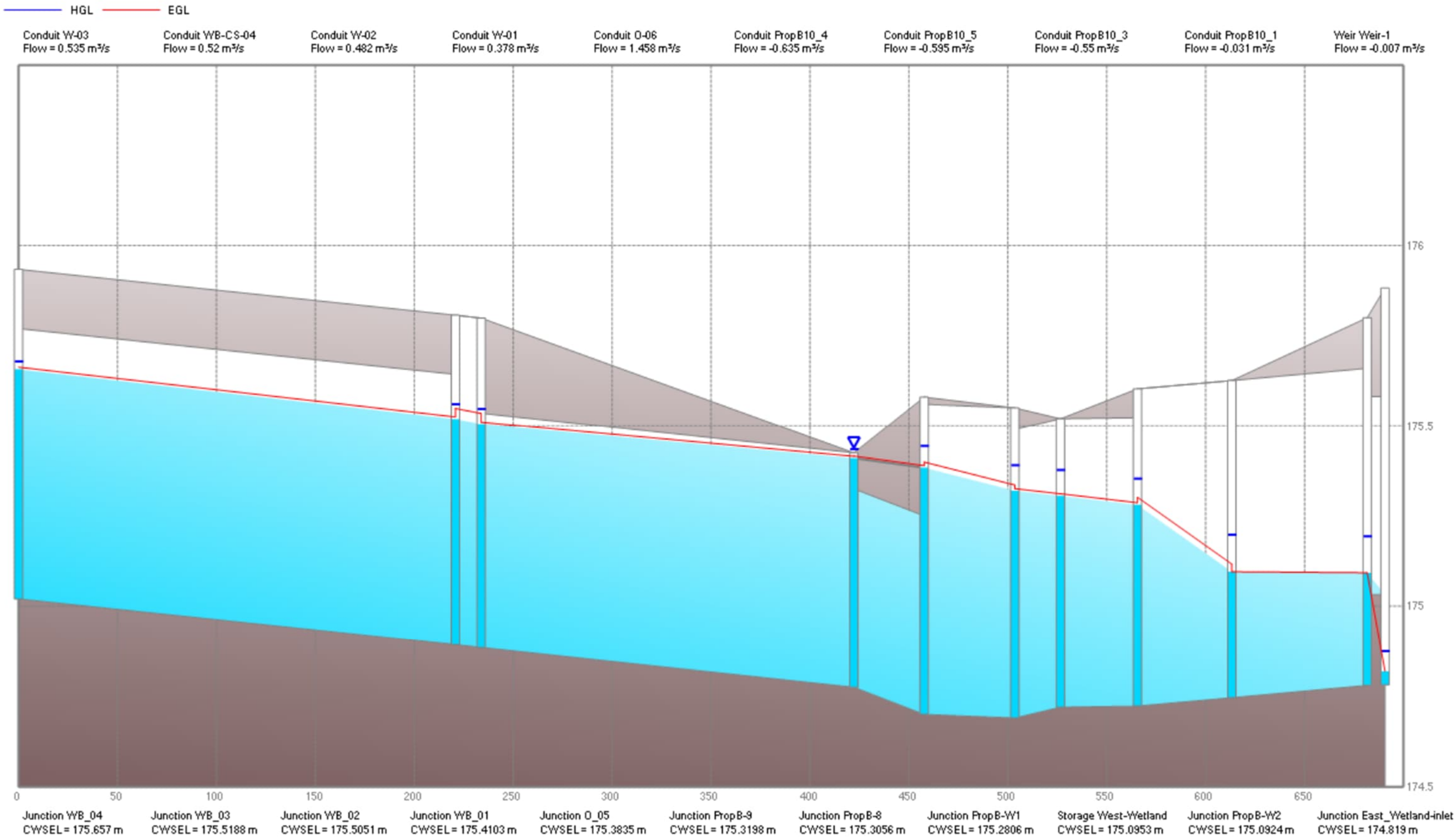

HGL
EGL
Links:
SW-5 Q=0.024 m³/s
SW-9 Q=0.067 m³/s
Bell-1_1 Q=0.101 m³/s
Bell-1_2 Q=0.094 m³/s
21 Q=0.17 m³/s
20 Q=0.292 m³/s
19 Q=0.387 m³/s
15 Q=0.729 m³/s
1 Q=0.878 m³/s
14_2 Q=0.922 m³/s
13 Q=1.122 m³/s
12 Q=1.234 m³/s
11 Q=1.261 m³/s
10 Q=0.852 m³/s
178.5
178
177.5
177
176.5
176
175.5
175
174.5
0
200
400
600
800
1000
1200
1400
Nodes:
Tammy-2 H=178.0246 m
Tammy-3 H=177.6938 m
PropB-3 H=177.6767 m
B_control-1 H=177.6763 m
B1_2 H=177.1651 m
B1_3 H=177.033 m
B1_4 H=176.9182 m
B1_5 H=176.8181 m
E1_11 H=176.5735 m
E1-1 H=176.5596 m
E1_10 H=176.4084 m
E1_09 H=176.1582 m
E1_08 H=176.0875 m
E1_00 H=175.925 m
O_06 H=175.912 m

Centennial Wetland



West Branch and Centennial Wetland




HGL
EGL
Conduit W-03
Flow = 0.535 m³/s
Conduit WB-CS-04
Flow = 0.52 m³/s
Conduit W-02
Flow = 0.482 m³/s
Conduit W-01
Flow = 0.378 m³/s
Conduit O-06
Flow = 1.458 m³/s
Conduit PropB10_4
Flow = -0.635 m³/s
Conduit PropB10_5
Flow = -0.595 m³/s
Conduit PropB10_3
Flow = -0.55 m³/s
Conduit PropB10_1
Flow = -0.031 m³/s
Weir Weir-1
Flow = -0.007 m³/s
176
175.5
175
174.5
0
50
100
150
200
250
300
350
400
450
500
550
600
650
Junction WB_04
CWSEL = 175.657 m
Junction WB_03
CWSEL = 175.5188 m
Junction WB_02
CWSEL = 175.5051 m
Junction WB_01
CWSEL = 175.4103 m
Junction O_05
CWSEL = 175.3835 m
Junction PropB-9
CWSEL = 175.3198 m
Junction PropB-8
CWSEL = 175.3056 m
Junction PropB-W1
CWSEL = 175.2806 m
Storage West-Wetland
CWSEL = 175.0953 m
Junction PropB-W2
CWSEL = 175.0924 m
Junction East_Wetland-inlet
CWSEL = 174.819 m

Runoff Performance