FINAL

Drainage and Stormwater Management Report – West Section CVC Area

Highway 413 Preliminary Design and Assessment of Environmental Impacts

March 2026

Ontario

WSP

AECOM

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Revision History

Revision	Revision Date	Details	Name	Position
0	July 2024	First submission	Emily Cameron	Sr. Water Resources Engineer
1	September 2025	Second submission – comments addressed	Emily Cameron	Sr. Water Resources Engineer
2	October 2025	Final submission – CVC comments addressed	Emily Cameron	Sr. Water Resources Engineer
3	December 2025	Final Submission - stamped	Emily Cameron	Sr. Water Resources Engineer
4	March 19, 2026	Formatted for AODA compliance. Section 1.1 Project Overview updated.	Emily Cameron	Sr. Water Resources Engineer

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Executive Summary

The Ontario Ministry of Transportation has retained WSP Canada Inc. and AECOM Canada ULC in collaboration with various sub-consultants and technical firms to undertake the Highway 413 Preliminary Design and Assessment of Environmental Impacts, hereinafter referred to as “the Project”.

The Project is following the requirements of the *Highway 413 Act*, 2024.

The proposed highway crosses three different Conservation Authorities: Toronto Region Conservation Authority (TRCA), Credit Valley Conservation (CVC) and Conservation Halton (CH). Separate drainage and stormwater management reports have been prepared for the proposed highway segments in each Conservation Authority area, and this report represents the highway segment in the CVC area.

Within the CVC jurisdiction, Highway 413 will traverse four different subwatersheds: Mullet Creek, Levi Creek, the Credit River and Huttonville Creek. This 12.4 km long portion of highway has three interchanges proposed, resulting in grade separations at these locations.

The highway will bisect several watercourses and drainage paths, and so several culverts and bridges are proposed to convey flows across the highway corridor. The CVC provided hydraulic models for Levi Creek and the Credit River, and so three of the proposed crossings will be modelled in HEC-RAS, based on flows from the model with an additional 10% to account for climate change in the future scenario at the end of the design service life of 75 years. The remaining, smaller crossings proposed are designed based on either the Rational Method (for areas less than 20 hectares), or the greater of the United Ontario Flow Method (UOFM) or a Visual OTTHYMO (VO) model. Culvert hydraulics were modelled using CulvertMaster software.

Culverts and bridges were designed to meet hydraulic design criteria set forth by MTO and CVC. Other disciplines were also involved in the design process, and so structural, environmental, and fluvial geomorphology criteria were also considered in sizing the crossings.

Since this is a new highway, there will be a considerable increase in impervious area. This could result in higher peak flows, increased erosion potential and lower water quality downstream. To mitigate these negative impacts, stormwater management measures are proposed along the highway corridor. Each watercourse crossing was analyzed to determine the area of highway that will drain to this location under proposed conditions. If the area is approximately 10 hectares or greater, a stormwater management wet pond is proposed to treat both stormwater quality and quantity. If the area is between 5 and 10 hectares, it may be treated with a linear dry pond. For drainage areas smaller than 5 hectares, runoff treatment is proposed with grassed swales and check dams.

Catchment areas were delineated for each of the pond locations, and existing and proposed drainage areas were modelled in VO to determine the amount of storage volume required to attenuate peak flows to the pre-development levels. Permanent pool and extended detention volumes were determined using the Ministry of Environment, Conservation and Parks' (MECP) Stormwater Management Planning and Design Manual (MOE, 2003), with proposed pond grading assumed to determine approximate footprints of each pond. These ponds were placed in locations adjacent to the receiving watercourse, ideally in areas that are relatively flat but at an elevation above the watercourse. Ponds were designed for an ultimate design scenario where the entire highway area is paved with no grassed swale in the middle. The impervious area of the proposed transitway was also included in the pond design.

The following report will describe the various criteria to be met, the agencies involved, hydrology and hydraulic assumptions made and the resulting pond, culverts and bridges within the CVC area.

1. Introduction

1.1 Project Overview

The Ontario Ministry of Transportation has retained WSP Canada Inc. and AECOM Canada ULC in collaboration with various sub-consultants and technical firms to undertake the Highway 413 Preliminary Design and Assessment of Environmental Impacts, hereinafter referred to as “the Project”.

The Project is following the requirements of the *Highway 413 Act, 2024*.

The Project includes the 52-kilometre Highway 413 Corridor, a 4 kilometre extension to Highway 410, and a 3 kilometre extension to Highway 427 (both facilitating connections to the Highway 413 Corridor), for a total of 59 kilometres of new infrastructure (**Figure** 1-1). The highway will have 11 interchanges at municipal roads. Features such as stormwater management ponds, carpool lots, Commercial Vehicle Inspection Facilities, maintenance facilities and the potential for electric vehicle charging stations have been explored as part of Preliminary Design.

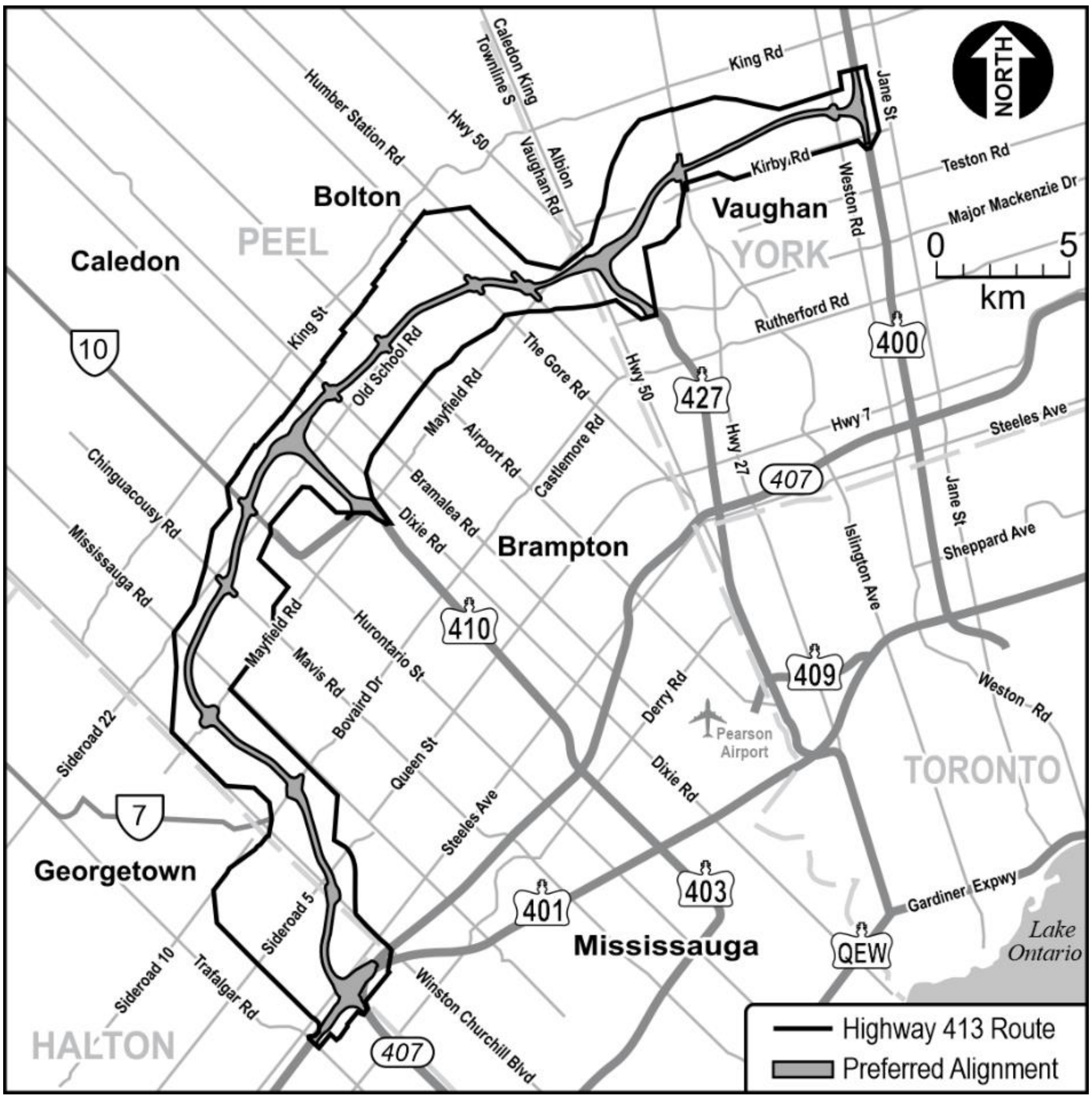
Highway 413 will connect Highway 401 and Highway 407 Express Toll Route in the Regional Municipality of Halton and the Regional Municipality of Peel with Highway 400 in the Regional Municipality of York.

The typical right-of-way will be 170 metres which includes 110 metres for the typical mainline highway and 60 metres for a proposed transitway. A multi-use trail parallel to Highway 413 may be accommodated within the proposed transitway right-of-way. The right-of-way is expanded at interchanges and high fill areas to accommodate ramps to and from the crossing roads, as well as in locations with ancillary highway facilities as mentioned above. The Preliminary Design consists of a typical six-lane cross section (three lanes in each direction) with a grassed median. The right-of-way has been designed to accommodate up to ten-lanes (five lanes in each direction) should future traffic conditions warrant additional capacity. These additional lanes would be provided by widening the highway towards the median.

The proposed transitway will be a separate corridor running alongside the highway, dedicated for public transit, including stations to facilitate passenger access at key locations. The proposed transitway and stations will be subject to a separate future assessment of environmental impacts.

Highway 413 is a 400-series highway, which is a network of controlled-access highways throughout the Province of Ontario. Their primary function is to accommodate through traffic and provide links between urban centres. 400-series highways feature full grade separations (such as bridges) at most intersecting roads and railway lines. Interchanges are provided along the 400-series highways to connect to other highways and municipal roads. These highways have design standards to accommodate high speeds and various collision avoidance and traffic management systems. Highway 413 is proposed to have a posted speed limit of 110 kilometres per hour.

Figure 1-1: Highway 413 Route



The future Highway 413 is expected to:

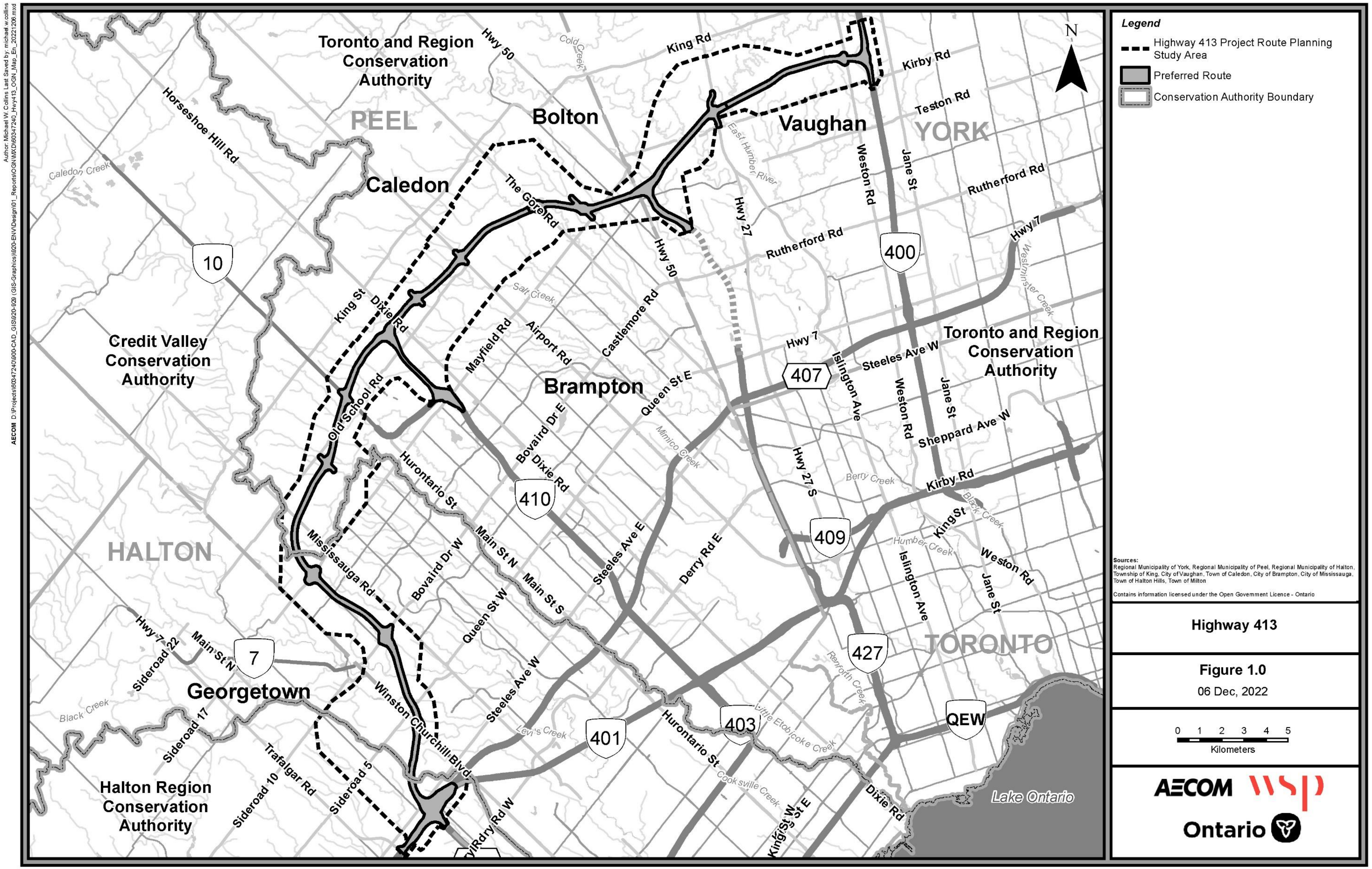
- Relieve traffic on local roads and parallel highways,
- Help accommodate travel demand,
- Reduce travel times for commuters and goods movement,
- Reduce the social, environmental, and economic costs of congestion,
- Provide greater connectivity between urban growth centres,
- Provide better connections to residential and employment lands, and
- Provide an alternate route in the event of an incident or road closure on local and regional roads.

For drainage and stormwater management assessment, the project is divided into three sections based on the proposed alignment located in the relevant jurisdiction of each Conservation Authority: Toronto and Region Conservation Authority (TRCA), Credit Valley Conservation Authority (CVC) and Conservation Halton (CH) Section as shown on **Figure 1.2** and described below:

- TRCA Section – an approximately 36.7 km long segment from north of Mayfield Road to Highway 400.
- CVC Section - an approximately 12.4 km long segment from west of Tenth Line to north of Mayfield Road
- CH Section - an approximately 1.3 km long segment containing the Highway 407 interchange.

This report documents the drainage and stormwater management for the proposed alignment located in the CVC's jurisdiction.

Figure 1.2: Study Area



1.2 Background Review

The overall study area is within the jurisdiction of Toronto Region Conservation Authority (TRCA), Credit Valley Conservation Authority (CVC) and Conservation Halton (CH). This report will cover the portion of the study area within the CVC's jurisdiction.

The CVC-regulated area is within the West Section of the project study area. It extends from 1.3 km north of Mayfield Road, where it abuts the Central Section and TRCA jurisdiction, to 620 m west of Tenth Line, where it meets the area within CH jurisdiction. There are 12.4 km of highway proposed within the CVC-regulated area of the West Section.

The foundation for the Drainage and Hydrology design will be based on a review of the existing documentation, including:

1. 1:10 000 Ontario Base Mapping
2. Topographic information and base maps as provided by MTO
3. MTO Contract Drawings
4. GTA West Corridor – Stage 1 study material
5. MTO contract documentation
6. Development reports and hydrologic reports within the study area.

The above information was used to determine existing drainage conditions and to prepare a drainage mosaic for the study area.

1.3 Regulatory Agencies Consultation

The following regulatory agencies were consulted throughout this study to address their concerns and requirements for the proposed alignment.

- TRCA – Three meetings were held with TRCA on October 6, 2020, March 4, 2021, and July 28, 2025;
- CVC – Two meetings were held with CVC on December 10, 2020, and December 12, 20022. Minutes of the meetings are included in **Appendix A**
- CH – Two meetings were held with CH on September 30, 2020, and December 15, 2022.

2. Policy Framework and Design Criteria

2.1 Policy Framework

The relevant guidelines and policies used in this report for the assessment of the Highway 413 drainage system include:

- MTO Drainage Management Manual (1997)
- MTO Highway Drainage Design Standards (2008)
- MOE (now MECP) Stormwater Management Planning and Design Manual (March 2003)
- DIR-PHM-B-014 Drainage Management Policy and Practice (Aug. 23, 2007, Rev. July 2007)
- DIR-PLNG-B-012 Drainage Act – Drainage Works and Municipal Drains (March 16, 2010)
- HSBM DCSO 2016-03 Implementing the New Unified Ontario Flood Method as the Method for Calculating the Design Flow Rates for Water Crossings (March 31, 2016)
- HSBM DCSO 2016-13 Implementation of the Ministry Update IDF Curves Online Application Version 3 (October 28, 2016)
- HSBM DCSO 2016-14 Implementation of the Ministry's Climate Change Consideration in the Design of Highway Drainage Infrastructure (October 28, 2016)
- HSBM DCSO 2020-02 Moratorium on Styrene Containing Cured-in-Place-Pipe (CIPP) Products Remains in Effect (April 2, 2020)
- HSBM DCSO 2020-03 Culvert Design Workbook Version 1.0 for MTO Culvert Design Assignments (May 12, 2020)

2.2 Design Criteria

2.2.1 Surface Drainage System

MTO’s Highway Drainage Design Standards prescribe standards for designing Surface Drainage Systems (SD). The standards that are relevant to this study are as follows:

- **SD-1 Design Flows for Surface Drainage Systems:** This standard identifies the minimum design flows that should be used for the highway surface drainage systems. The minor system of freeways shall be designed for the 10-year design flow, while the major system shall be designed for the 100-year design flow.
- **SD-2 Longitudinal Grade and Cross-fall:** This standard identifies the minimum longitudinal grade and cross-fall for highway surface drainage.
- **SD-3 Flow Spread onto Travel Lanes:** This standard identifies the maximum distance that flow can spread onto the travel lanes of a highway. It also defines the maximum depth of flow at the edge of the travel lanes.
- **SD-4, SD-5 and SD-6:** These standards identify the design of storm sewer systems, storm sewer inlets on a continuous grade and highway sags, respectively.
- **SD-9 Roadside Ditches (Conveyance Only):** This standard outlines the minimum design requirements of Roadside Ditches for the conveyance of flow. It does not address the design of roadside ditches for the enhancement of water quality.
- **SD-12 Freeboard above Adjacent Watercourse or Water Bodies:** This standard identifies the minimum required freeboard for roadways that are constructed adjacent to watercourses or water bodies.
- **SD-13 Design Flow and Freeboards for Culverts not on a Watercourse:** This standard identifies the design flows and the required freeboard for culverts associated with runoff from roadways and local external catchment areas. Culverts under highways, ramps, and adjacent roadways shall be designed to convey the minor and major systems design flow.

2.2.2 Hydraulic Criteria

MTO's Highway Drainage Design Standards prescribe standards for designing Water Crossings (WC). The standards that are relevant to this study are as follows:

- **WC-1 Design Flows (Bridges and Culverts):** This standard identifies the minimum design flows for the sizing of bridges and culverts for flow conveyance on regulated and non-regulated watercourses. The bridges and culverts of the highway will be designed to the design flow criteria provided in the following **Table 1**.

Table 1: Design Flows (Bridges and Culverts)

Functional Road Classification	Return Period of Design Flows (Years)		Check Flow for Scour
	Total Span ≤ 6.0 m	Total Span > 6.0 m	
Freeway, Urban Arterial	50	100	130% of 100 year
Rural Arterial, Collector Road	25	50	115% of 100 year
Local Road	10	25	100% of 100 year

For the design flow, Highway 413, Transitway and associated ramps are considered as a Freeway, and all culverts and bridges will be designed in accordance with the design flow stipulated in the above Table.

Regulatory flow will be calculated for all regulated watercourses where Floodline Mapping is available, where there is a potential risk to public safety, or where there is potential damage to adjacent properties. The existing and proposed upstream water surface elevations shall also be calculated for Regulated Watercourses where the Regulatory Flow estimate is required to assess the impacts of the proposed crossings.

- **WC-2 Freeboard and Clearance at Bridge Crossings:** This standard identifies the soffit clearance and freeboard for bridges.
- **WC-4 Bridge Deck Drainage:** This standard identifies the Maximum Allowable Spread Distance onto the travel lanes of highway bridges. It also defines the Maximum Depth of flow at the edge of the travel lanes.
- **WC-5 Bridge Deck Drains:** This standard identifies the requirements for drains in bridge decks.
- **WC-7 Culvert Crossings on a Watercourse:** This standard identifies the minimum freeboard, minimum clearance, and the maximum flood depth at culvert crossings.
- **WC-8 Minimum Culvert Size:** This standard identifies minimum culvert sizes for various road types. The minimum culvert size to be used under freeways

and urban arterials is 800 mm diameter for circular culverts and 900 mm rise for box culverts.

- **WC-12 Fish Passage through Culverts:** This standard identifies requirements to facilitate Fish Passage through Culverts on fish-bearing streams. The standard defines the width of the culvert, embedment depth, substrate materials to be used, and shape of the low-flow channel within the culvert.

2.2.3 Stormwater Management Criteria

The MTO's Highway Drainage Design Standards prescribe standards for the design of Stormwater Management (SW) Best Management Practices. The standards that are relevant to this study are as follows:

- **SW-1 Stormwater Management-Level of Control:** This standard identifies the level of control requirements for the design of stormwater management facilities for highways.
- **SW-2 Stormwater Management Ponds:** This standard identifies design standards for the design of stormwater quantity and quality pond components (wet, wetlands and dry).
- **SW-3 Roadside Ditches for Water Quality:** This standard provides the minimum design requirement for Roadside Ditches to achieve water quality control.
- **CVC Stormwater Management Criteria (CVC, July 2022):** This document provides guidance in the planning and design of stormwater management infrastructure and outlines the processes and infrastructure needed to address flooding, water quality, erosion, water balance and natural heritage.
- **Gateway West Subwatershed Study Update (2008):** This document outlines the quantity, erosion control and water balance requirements for areas draining to Mullet and Levi Creeks.
- **Stormwater Management Planning and Design Manual (MOE, now MECP, March 2003)**: This manual provides technical and procedural guidance for the planning, design, and review of stormwater management practices.

Based on the above, the stormwater management criteria for the proposed Highway 413 project are summarized below:

- **Quantity Control** – For Credit River and Huttonville Creek, control post-development peak flows to pre-development levels for all storms up to and including the 100-year storm.

For other subwatersheds, control post-development peak flows to the unit flow rates in **Table 2** below, depending on the location.

Table 2: Target Unit Flow Rates for Quantity Control

	Unit Flow Rates ($m^3/s/ha$)						
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Regional
Mullet Creek	0.017	0.027	0.030	0.041	0.048	0.054	0.077
Levi Creek (South Branch)	0.023	0.035	0.039	0.055	0.063	0.072	0.088
Levi Creek (Main Branch)	0.018	0.028	0.032	0.045	0.053	0.062	0.082

- **Water Quality** – Enhanced level of protection, i.e. 80% Total Suspended Solids (TSS) on a long-term basis.
- **Erosion Control** – For sites with SWM ponds, detain runoff generated from a 25 mm storm for 24 hours, unless otherwise stated in **Table 3** below.

Table 3: Erosion Control Storage and Release Rates

Subwatershed	Erosion Control Storage Volume (m^3/impervious ha)	Erosion Control Outflow (L/s/impervious ha)
Mullet Creek	250	1.6
Levi Creek (South Branch)	250	3.0
Levi Creek (Main Branch)	300	1.4

- **Water Balance** – Best efforts to maintain groundwater recharge and hydrologic regimes. A water balance analysis is required to compare the proposed infiltration rates to the existing ones. Except for Low Volume Groundwater Recharge Areas (as identified in CVC SWM Guideline), predevelopment infiltration/recharge must be maintained to address Water Balance. For this purpose, a detailed and site-specific water balance analysis in accordance with Section 7 and Appendix A of the CVC SWM Guideline is required at the detailed design stage to determine the pre-development infiltration. Also, for vulnerable groundwater systems, infiltration design must be based on "clean water" practices.

2.2.3.1 Site-Specific Erosion Control Storage and Target Release Rate Criteria

Refer to the "Fluvial Geomorphology Assessment" for the fluvial geomorphological assessment completed for the preliminary design of Highway 413. If required, an erosion threshold assessment will be completed in line with CVC's Fluvial Geomorphic Guidelines at the detailed design phase."

3. Methodology and Approach

3.1 Hydrology

The foundation for the Drainage and Hydrology design will be based on a review of the existing documentation, including, among others, the Highway 413 Transportation Corridor – Stage 1 study material, MTO contract documentation, development reports, and hydrologic reports within the study area. Where existing models exist, flows will be referenced and verified. Where existing models are not available, flows were calculated based on the Rational Method for areas less than 20 hectares, and the Unified Ontario Flow Method (UOFM) for areas greater than 20 hectares. A Visual OTTHYMO (VO) hydrologic model was also set up to simulate peak flows at culvert locations where a HEC-RAS model is not available. Model peak flows were compared to the Rational and UOFM flows, and the greatest was chosen for design purposes.

3.2 Hydraulics

Existing hydraulic models were obtained, where possible, from the CVC. These models were updated to represent existing and proposed conditions, and water levels were referenced from the output. Where hydraulic models were not available, CulvertMaster was used to assess the proposed culverts and determine the proposed headwater elevations.

Realistically, adding a large highway through an undeveloped area will have some impact on water levels. It’s not possible to have zero impact. For large crossings where hydraulic models were provided, a maximum 0.3 m increase in the water levels during the Regional storm upstream of proposed crossings was set as the goal. Within an interchange, water level increases may be higher, since the area will be regraded and redesigned for the project.

3.3 Stormwater Management

The overall objective of the drainage and stormwater management plan is to minimize impacts on existing drainage systems within the study area and on the natural environment due to the proposed highway works in terms of water quantity and quality.

It must be noted that stormwater management measures do not exist under existing drainage conditions. Runoff from the study area is mostly conveyed to the receiving water bodies without quality or quantity control. The Ministry of Transportation Ontario (MTO) Drainage Management Manual (1997) and the Ministry of Environment (now the Ministry of Environment, Conservation and Parks (MECP)) Stormwater Management Planning and Design Manual (March 2003) provided the guidelines and policies for the selection and design of the stormwater management measures required to mitigate the impacts of the proposed highway works.

Based on Credit Valley Conservation Stormwater Management Criteria, the post-development peak flow is required to be controlled to the pre-development level peak flows for Credit River and Huttonville Creek for all storms (2-year to 100-year). For Levi Creek and Mullet Creek, post-development flow rates are to be controlled to unit flows listed in Table 2, depending on location. Portions of the Credit River watershed do not require quantity control; however, our study area is north of Hwy 407, and therefore post-to-pre quantity control is required for 2-year to 100-year storms (CVC SWM Criteria, 2022).

The quality control criteria are Enhanced (80% TSS removal) for all subwatersheds within CVC.

In areas where the proposed highway drainage exceeds 10 hectares at a specific outlet, it is recommended to address both quality and quantity concerns through the use of stormwater management wet ponds located adjacent to the highway and watercourse. For drainage areas between 5 and 10 hectares, a linear dry pond will be constructed in the space between the highway and the proposed transitway. If the highway catchment area at a specific outlet is less than 5 hectares, engineered swales with check dams will be implemented to mitigate potential impacts.

3.4 Water Balance

At this stage, a qualitative assessment will be undertaken for water balance. Once the specifics of the proposed design are determined, a water balance table will be prepared to compare and analyze existing and proposed infiltration across the site at the next design phase.

4. Existing Conditions Drainage

The proposed Highway 413 Transportation Corridor spans through six (6) different watersheds within three (3) separate conservation authorities' jurisdictions. The West Segment falls within CVC and CH jurisdiction. The CVC covers the Credit River watershed, which contains Levi Creek, Mullet Creek and Huttonville Creek, which cross the study area. The surrounding area is predominantly farmland, rural residential and natural areas, with the overall drainage pattern from northwest to southeast. The existing conditions drainage mosaics are shown in **Figures 4.1** to **4.4**.

Figure 4.1: Existing Drainage Mosaic

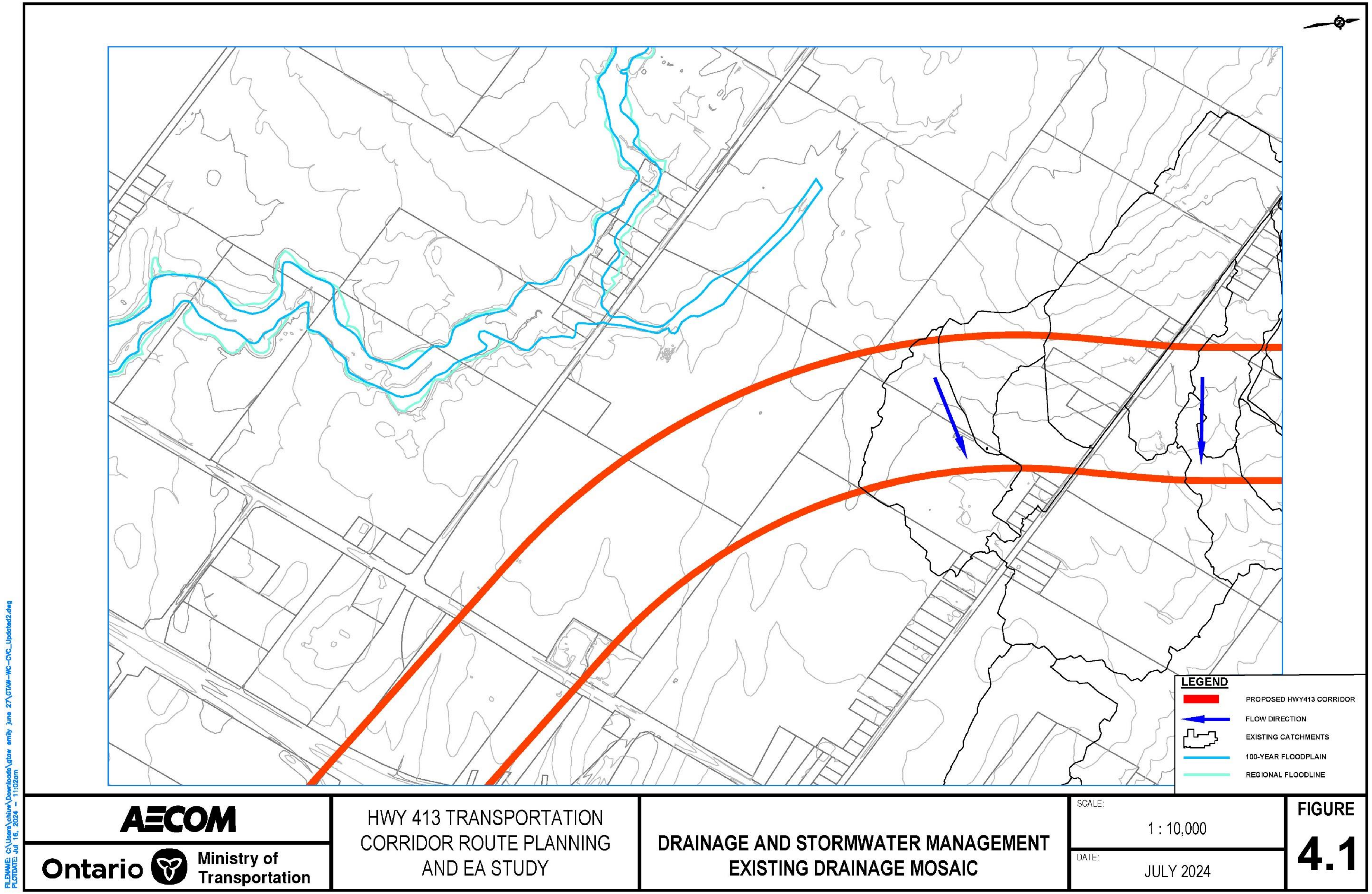
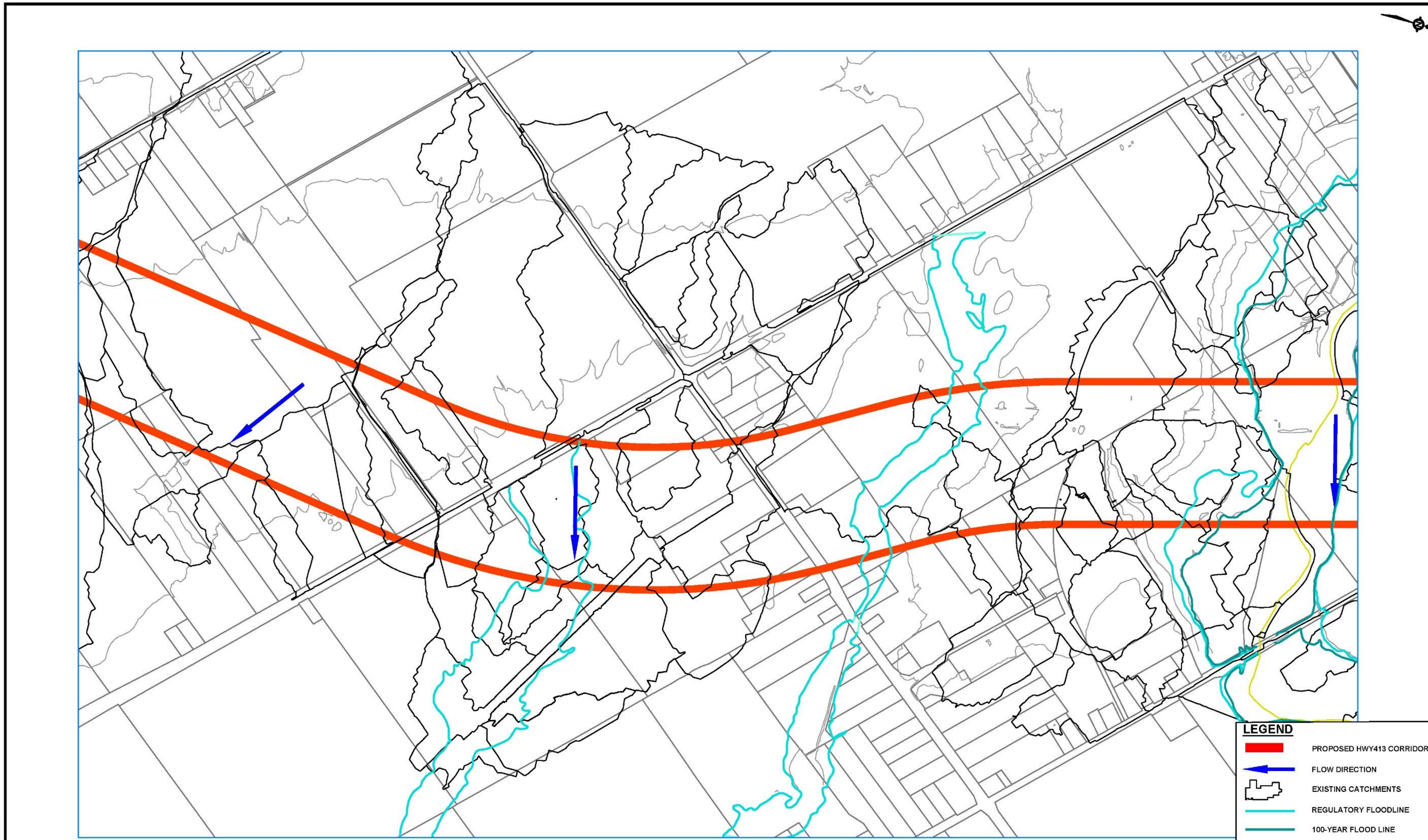


Figure 4.2: Existing Drainage Mosaic



AECOM / Ontario Ministry of Transportation	HWY 413 TRANSPORTATION CORRIDOR ROUTE PLANNING AND EA STUDY	DRAINAGE AND STORMWATER MANAGEMENT EXISTING DRAINAGE MOSAIC	SCALE: 1 : 10,000 / DATE: JULY 2024	FIGURE 4.2

Figure 4.3: Existing Drainage Mosaic

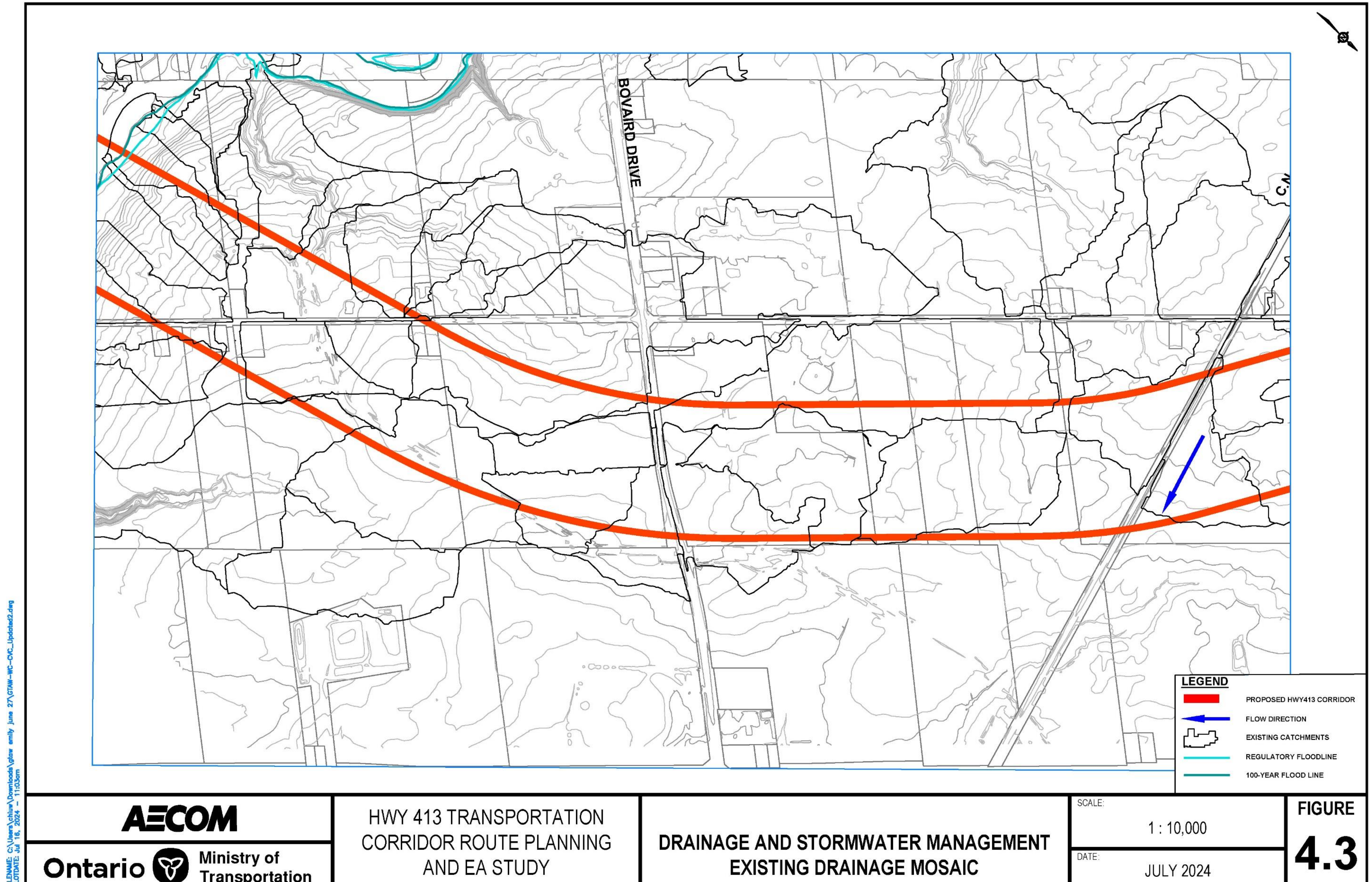
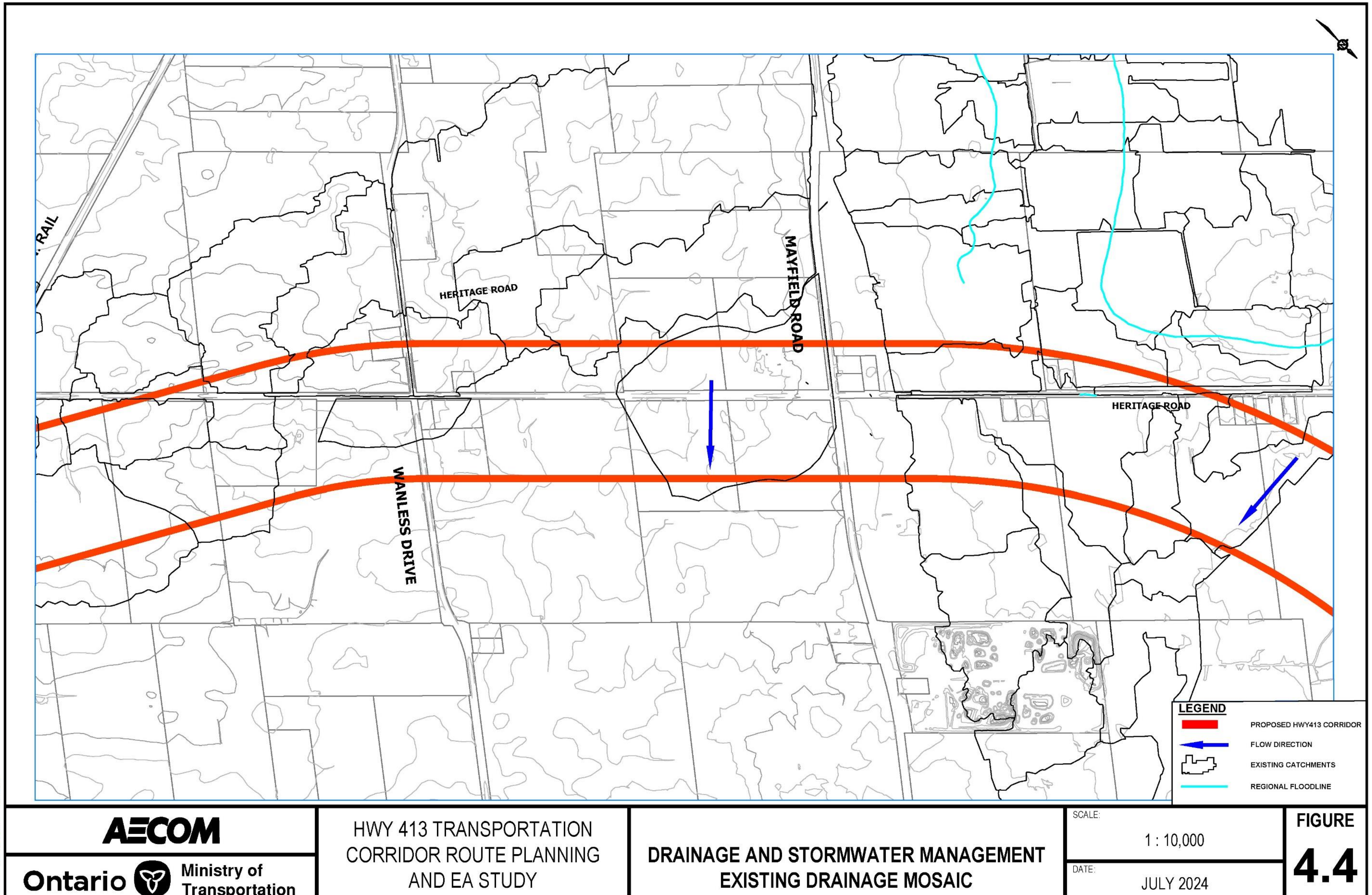


Figure 4.4: Existing Drainage Mosaic



5. Proposed Conditions Drainage

Under the proposed condition, the Highway 413 Transportation Corridor crosses 55 catchments within the Credit River Watershed. The typical highway cross-sections of the proposed highway are as shown in **Figure 5.1**.

Under the initial construction plan, the proposed highway will consist of 6 lanes (three lanes in each direction) with an open median in the middle and a two-lane transitway. The proposed highway will consist of a rural cross-section that conveys flows entirely through a series of roadside ditches and culverts. The highway runoff will be collected and conveyed through median and side ditches and ultimately discharged to the adjacent creeks. The proposed transitway will also have a rural cross-section and drain through a series of ditches and culverts. In future expansions or ultimate conditions, the highway will be widened to the middle and will consist of 8 lanes, 2 HOV lanes and a two-lane transitway. The open median ditch will be replaced with an underground storm sewer to collect and convey storm runoff to the proposed stormwater management ponds/ditches and ultimately to the nearby creeks. The proposed condition drainage mosaics for the ultimate construction plan are presented in **Figures 5.2 to 5.9,** provided at the end of this report.

Figure 5.1: Typical Highway Cross-sections

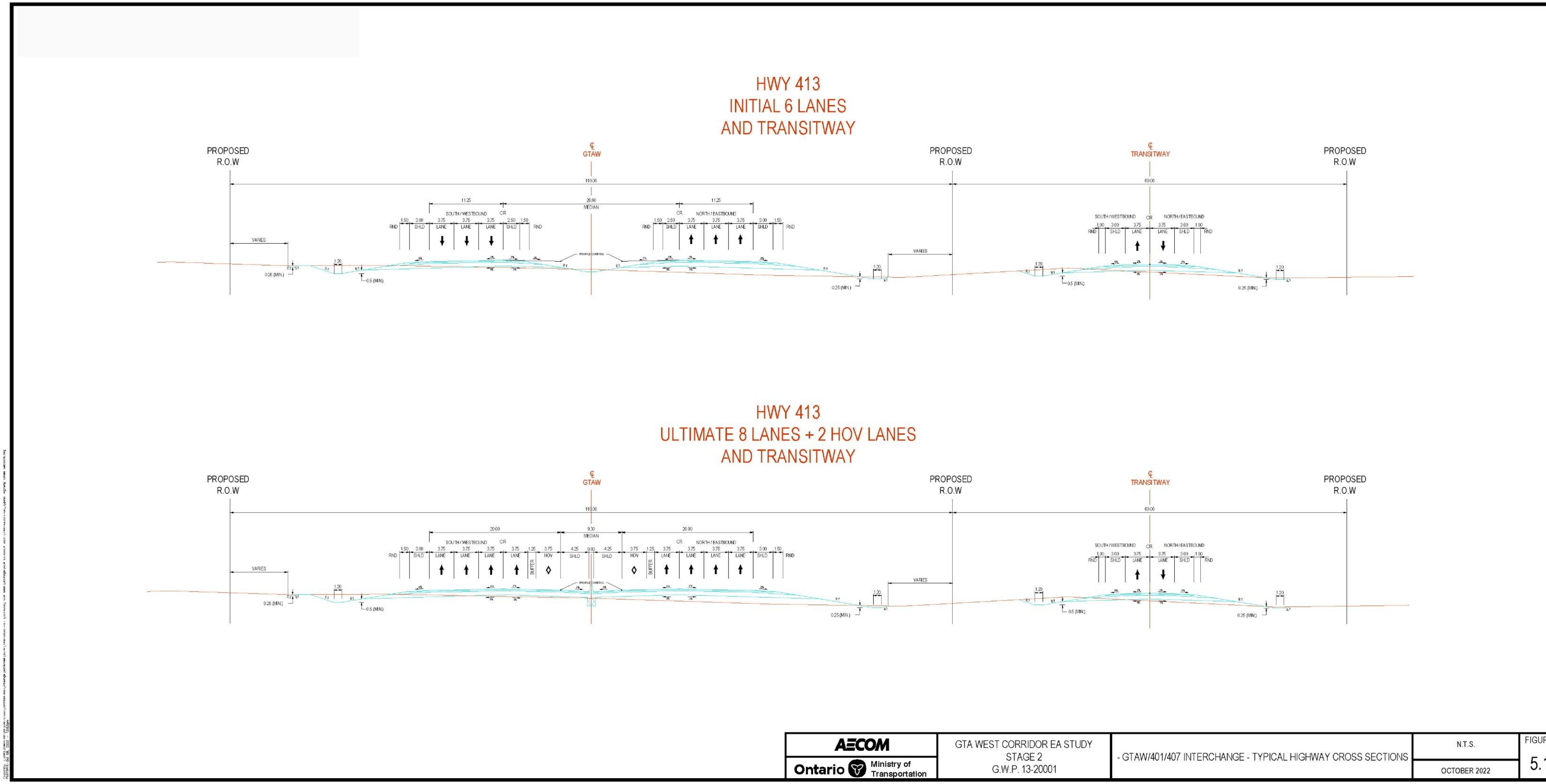


Figure 5.2: Proposed Drainage Mosaic

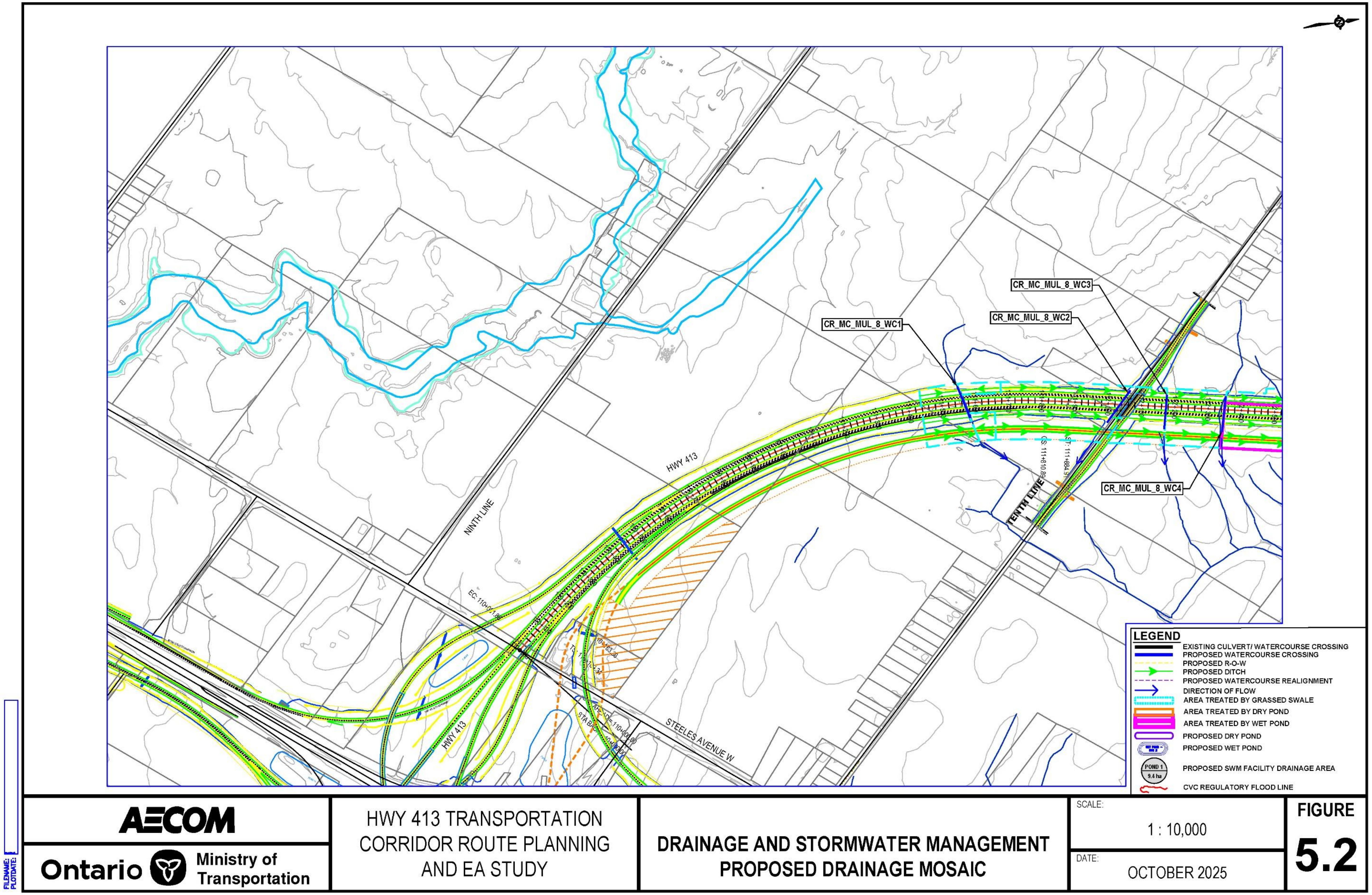
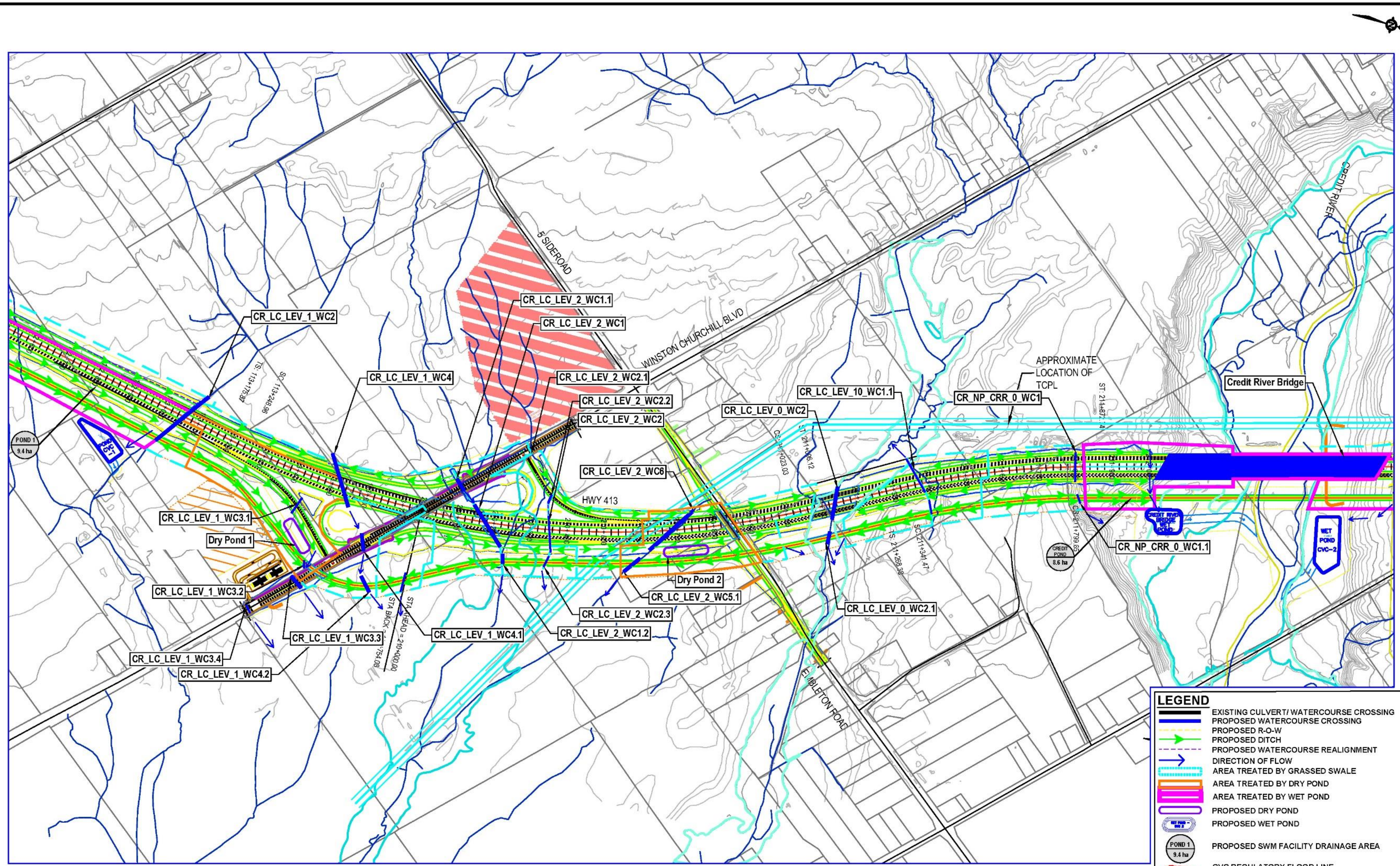


Figure 5.3: Proposed Drainage Mosaic



AECOM / Ontario Ministry of Transportation	HWY 413 TRANSPORTATION CORRIDOR ROUTE PLANNING AND EA STUDY	DRAINAGE AND STORMWATER MANAGEMENT PROPOSED DRAINAGE MOSAIC	SCALE: 1 : 10,000 DATE: OCTOBER 2025	FIGURE 5.3

Figure 5.4: Proposed Drainage Mosaic

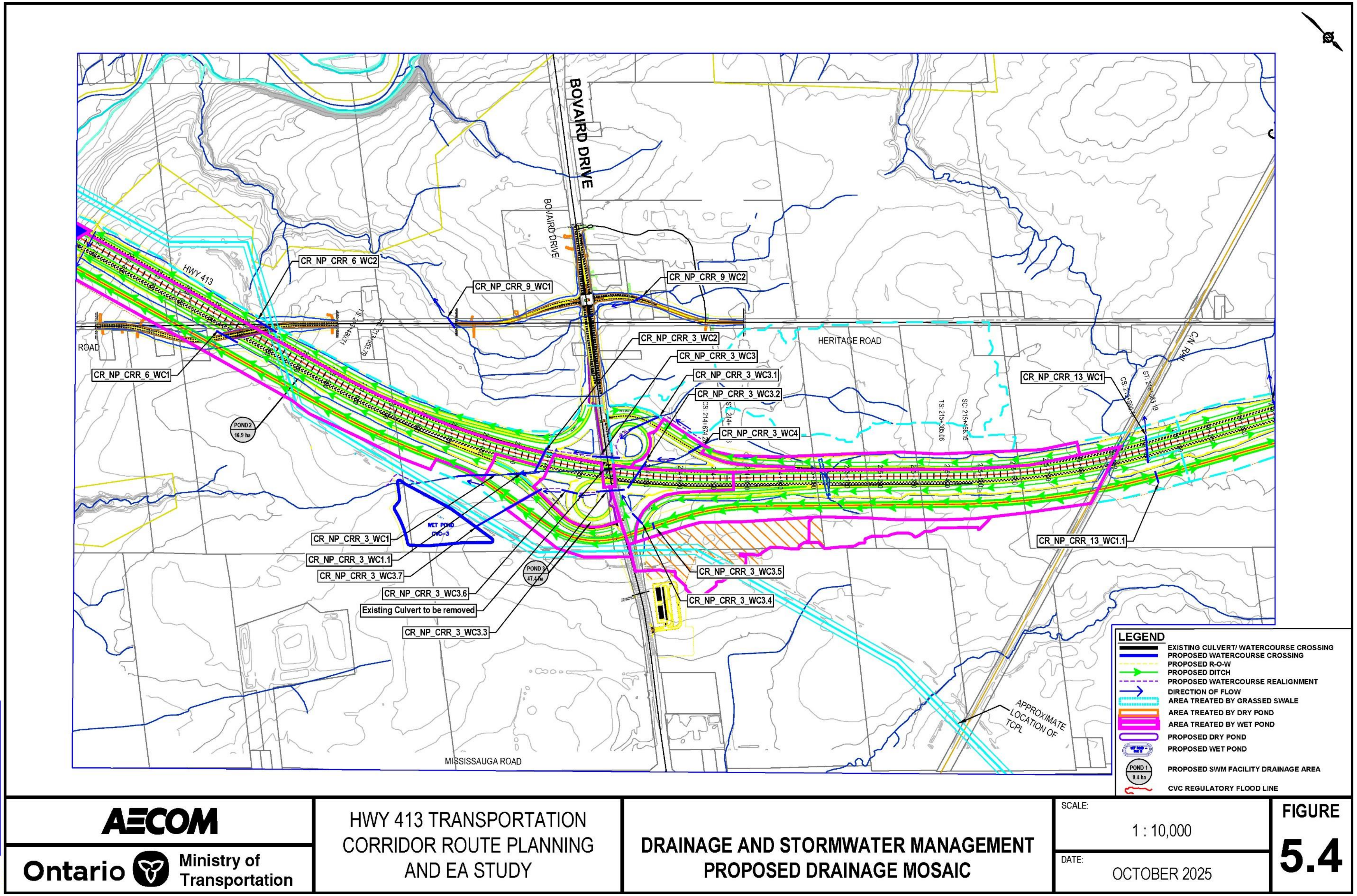


Figure 5.5: Proposed Drainage Mosaic

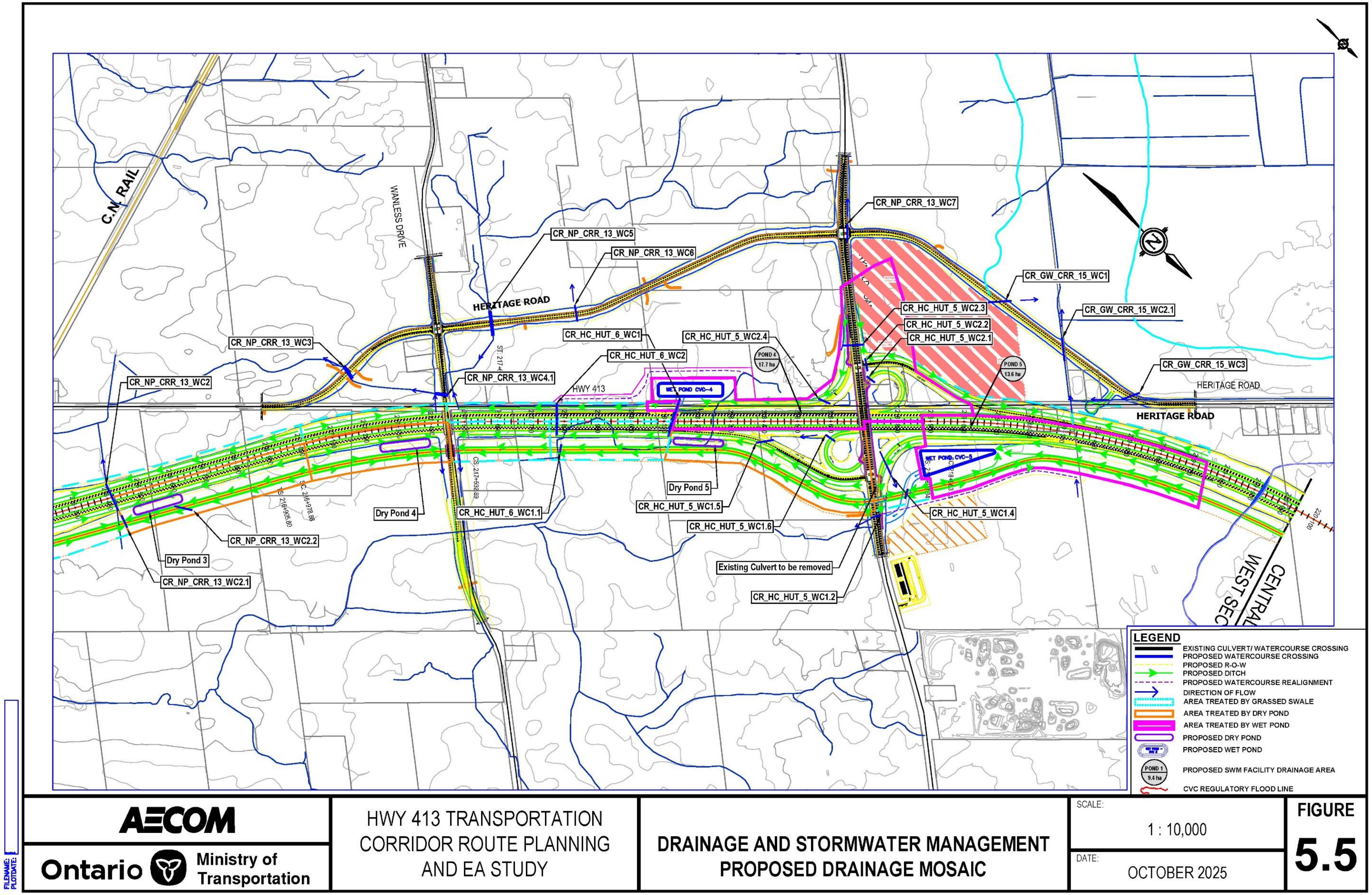


Figure 5.6: Proposed External Culvert Catchments

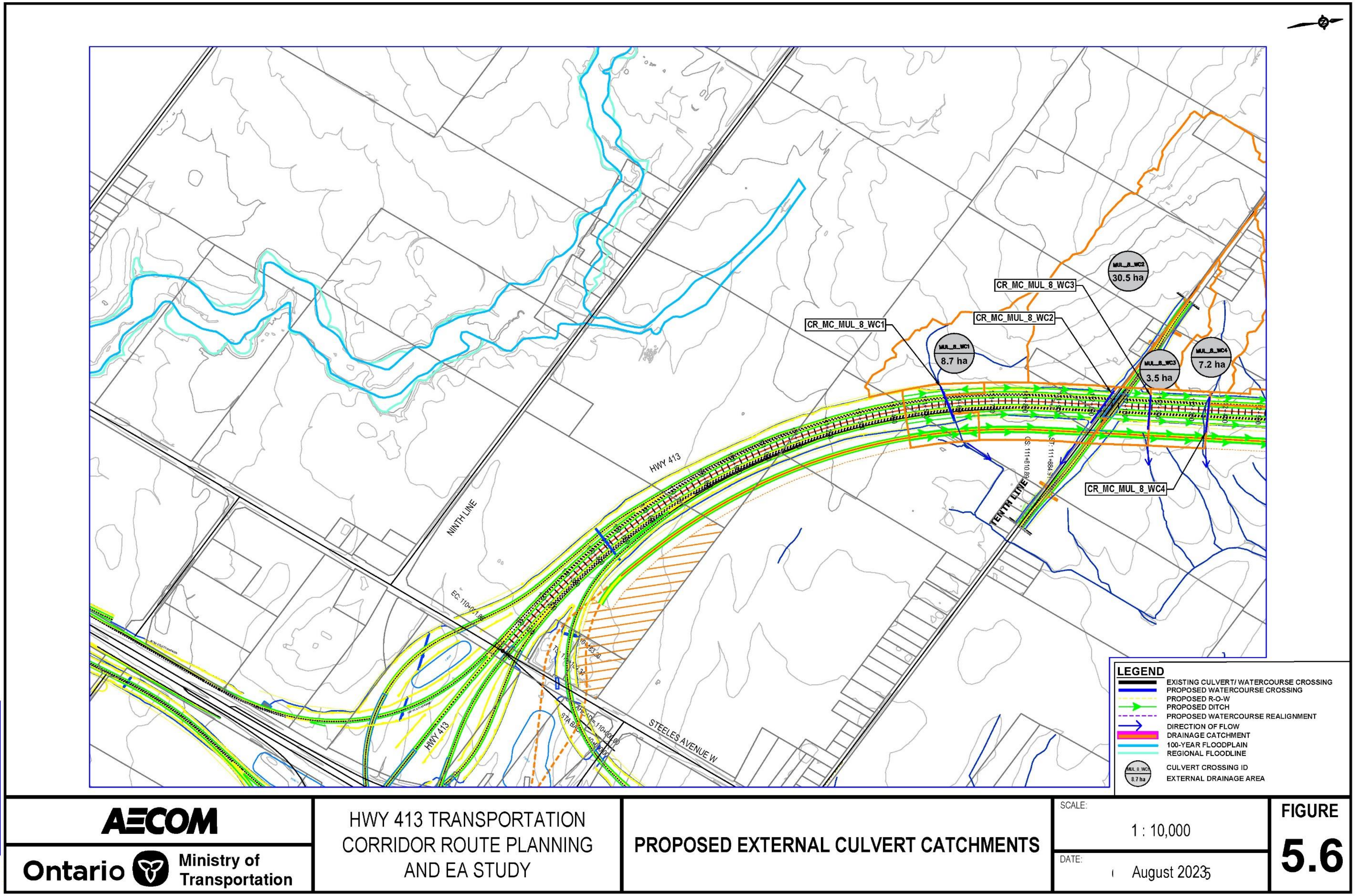


Figure 5.7: Proposed External Culvert Catchments

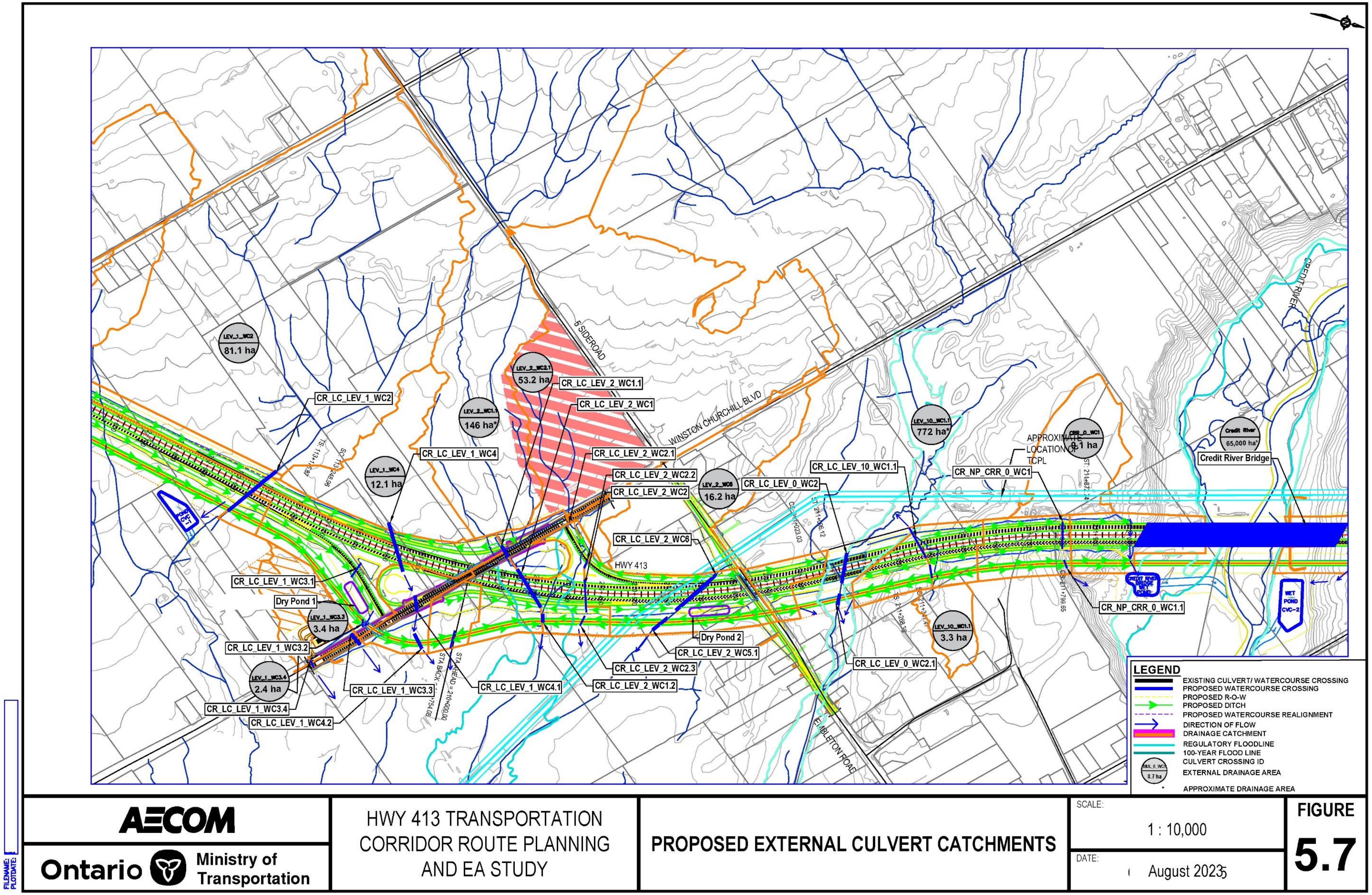


Figure 5.8: Proposed External Culvert Catchments

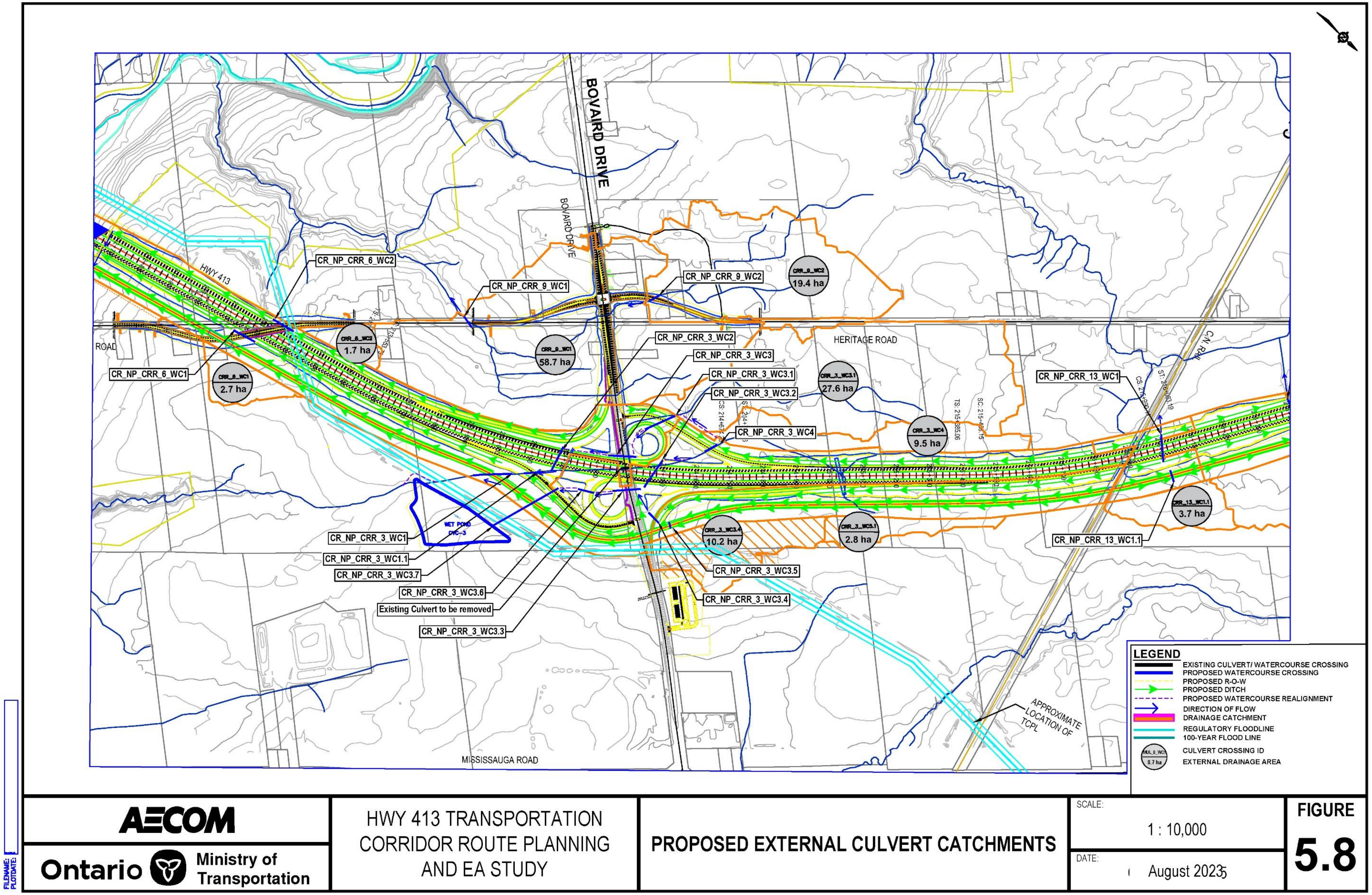
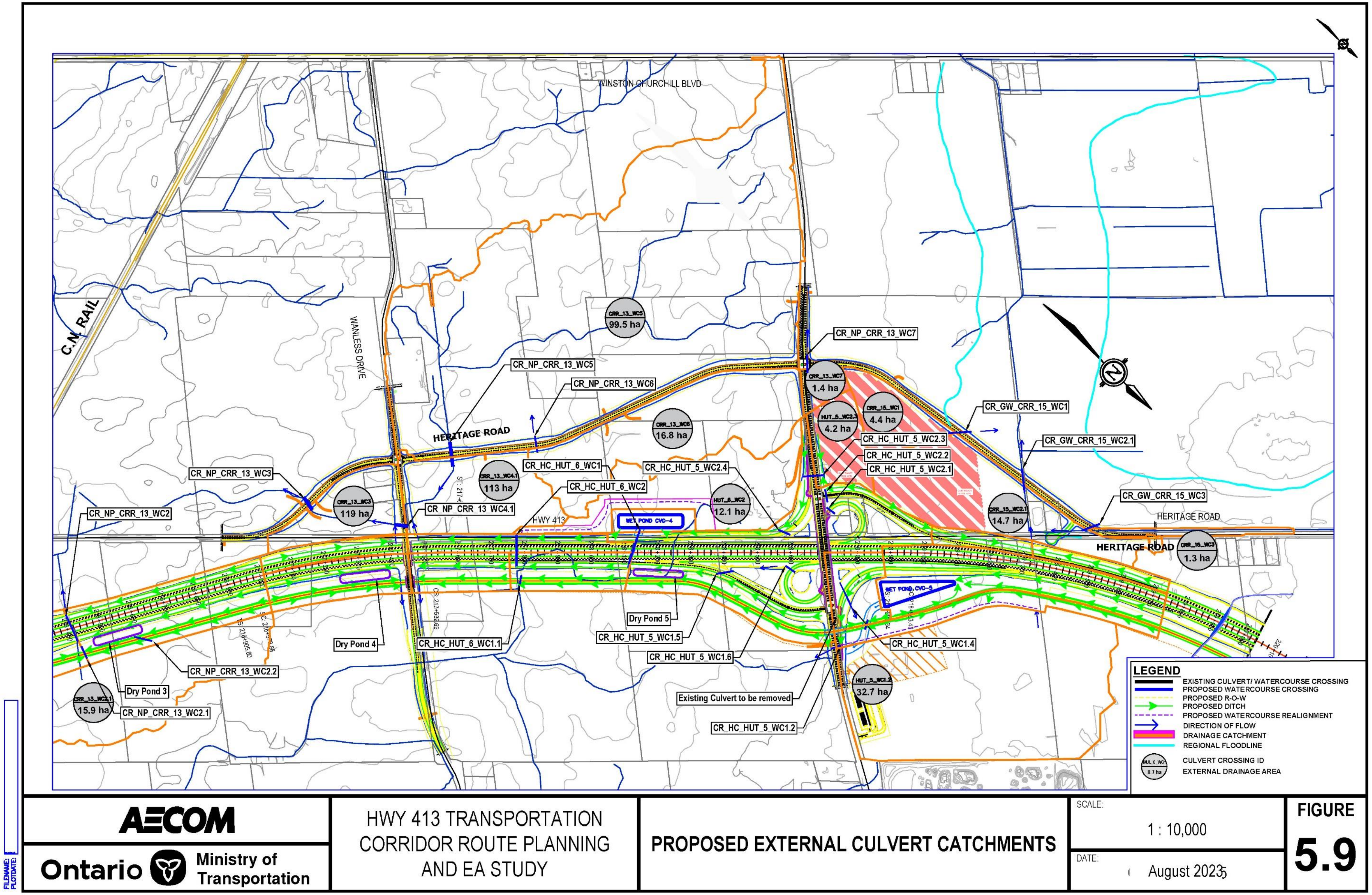


Figure 5.9: Proposed External Culvert Catchments



6. Geomorphic and Environmental Considerations

Geomorphic assessment was completed for the proposed watercourse crossings where property access was permitted along Highway 413 and will be complied in a separate report. Similarly, the ecology team completed field investigations for all watercourse crossings where property access was permitted, and their findings will be documented in a separate report. The geomorphic, fish habitat and wildlife requirements are summarized in **Table 4** below.

Table 4: Proposed Bridges and Culverts – Geomorphic and Environmental Requirements Summary

Culvert ID	Station	Drainage Area (ha)	Geomorphic Requirement		Environmental (Fish/Wildlife) Recommendations					
			Span (m)	Notes	Height	Width	Terr. Passage Width	Length	Openness Ratio	Fish Passage Consideration
CR-MC-MUL-8-WC1	111+570	12.23	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (no defined channel, small upstream drainage area 10.3 ha)	Min. 1 m	Min. 1 m	1 m, min. 0.5 m	<25 m	>0.4, min. 0.1	Y
CR-MC-MUL-8-WC2	112+029	37.41	N/A	N/A	>1 m, min. 0.5 m	>1 m, min. 0.5 m	1 m, min. 0.5 m	<25 m	N/A	N
CR-MC-MUL-8-WC3	112+175	6.3	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (no defined channel, small upstream drainage area 4.3 ha)	>1 m, min. 0.5 m	>1 m, min. 0.5 m	1 m, min. 0.5 m	<25 m	N/A	N
CR-MC-MUL-8-WC4	112+349	10.43	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (no defined channel, small upstream drainage area 4.9 ha)	N/A	N/A	N/A	N/A	N/A	N
CR_LC_LEV_1_WC2	113+071	104.38	3.7 m	For the watercourses that are less than 4 m wide, the crossing opening of three times the bankfull channel can be adopted. Based on field assessment the bankfull width is approximately 1.3 m wide resulting in a span approximately 4.5 m wide (1.5 x 3 m).	>1 m, min. 0.5 m	>1 m, min. 0.5 m	1 m, min. 0.5 m	<25 m	min 0.1	Y
CR_LC_LEV_1_WC3.1	10+170	8.85	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_LC_LEV_1_WC3.3	10+400	13.44	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_LC_LEV_1_WC3.4	10+554	2.43	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_LC_LEV_1_WC4	113+510	11.65	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_LC_LEV_1_WC4.1	10+195	15.66	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_LC_LEV_2_WC1	210+170	131.49	9 m	For the watercourses that are less than 4 m wide, the crossing opening of three times the bankfull channel can be adopted. Based on field assessment the bankfull width is approximately 2.9 m wide resulting in a span approximately 9 m wide (2.9 x 3 m).	Min. 1 m	Min. 1 m.	1 m, min. 0.5 m	<25 m	>0.4, min. 0.1	Y
CR_LC_LEV_2_WC1.1	9+883	131.49	9 m	For the watercourses that are less than 4 m wide, the crossing opening of three times the bankfull channel can be adopted. Based on field assessment the bankfull width is approximately 2.9 m wide resulting in a span approximately 9 m wide (2.9 x 3 m).	Min. 1 m	Min. 1 m	1 m, min. 0.5 m	<25 m	>0.4, min. 0.1	Y
CR_LC_LEV_2_WC2.1	9+674	53.2	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (not defined at ROW, small upstream drainage area 53.4 ha)	Min. 0.3	Min. 0.3	N/A	N/A	N/A	Y
CR_LC_LEV_2_WC2.2	10+166	62.5	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (not defined at ROW, small upstream drainage area 53.4 ha)	N/A	N/A	N/A	N/A	N/A	Y
CR_LC_LEV_2_WC2	210+343	62.5	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (not defined at ROW, small upstream drainage area 53.4 ha)	N/A	N/A	N/A	N/A	N/A	Y
CR_LC_LEV_2_WC6	210+675	25.05	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (no defined channel, small upstream drainage area 17.1 ha).	Min. 1 m	Min. 1 m	N/A	N/A	N/A	N
CR_LC_LEV_0_WC2	211+140	733.35	94 m or 12 m	Proposed bridge piers should be 10 m away from top of bank on either side (100-year erosion rate). The span of crossings should be selected based on detailed fluvial geomorphic analyses. Abutments, piers and other bridge components should be located outside of the 100-year local erosion hazard. Due to width, it is likely that the piers will be placed within the meander belt. If piers are necessary within the meander belt of the watercourse, their foundations should be designed assuming they will be in contact with the watercourse channel in future, taking into consideration the base elevation of the channel and an allowance for channel downcutting over time. Redside Dace recovery habitat - Crossing must span meander belt + 30 m buffer on either side due to Regulatory requirements for species at risk Final MBW Including Riparian Buffer 94 m If we are not considering regulatory requirements for species at risk, fluvial recommendation is 3 times bankfull width as per CVC guidance (3 x 4 = 12) - 12 m	Min. 1 m	Min. 1 m	1 m, min. 0.5 m	< 25 m	>0.4, min 0.1	Y
CR_LC_LEV_10_1.1	211+375	5.19	N/A	N/A						N
CR_NP_CRR_0_WC1	211+800	13.76	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
Credit River Bridge	212+300		67 m	Proposed bridge piers should be 20 m away from top of bank on either side (100-year erosion rate). The span of crossings should be selected based on detailed fluvial geomorphic analyses. Abutments, piers and other bridge components should be located outside of the 100-year local erosion hazard. Due to width, it is likely that the piers will be placed within the meander belt. If piers are necessary within the meander belt of the watercourse, their foundations should be designed assuming they will be in contact with the watercourse channel in future, taking into consideration the base elevation of the channel and an allowance for channel downcutting over time. 67 m: 100-year erosion rate is 20 +/- 3 m beyond top of bank. Bankfull width is 27 m. Width should be 27+ (2 x 20) = 67 m. Piers should remain outside of erosion rate	> 3 m, min. 2 m	> 3 m	3 m, min. 1 m on both sides	< 25 m, max. 90 m without open median	0.6 – 1.0	

Culvert ID	Station	Drainage Area (ha)	Geomorphic Requirement		Environmental (Fish/Wildlife) Recommendations					
			Span (m)	Notes	Height	Width	Terr. Passage Width	Length	Openness Ratio	Fish Passage Consideration
CR_NP_CRR_6_WC1	9+932	2.68	N/A	N/A	0.3 – 1 m	0.3 – 1 m	1 m, min. 0.5 m	N/A		N
CR_NP_CRR_6_WC2	10+065	1.73	N/A	N/A	0.3 – 1 m	0.3 – 1 m	1 m, min. 0.5 m	N/A		N
CR_NP_CRR_3_WC1.1	10+090	40.52	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (from ROW appears undefined, small upstream drainage area 78.83 ha).	N/A	N/A	N/A	N/A	min 0.05	N
CR_NP_CRR_3_WC2	214+180	39.76	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (from ROW appears undefined, small upstream drainage area 78.83 ha).	>1 m, min. 0.5 m	>1 m, min. 0.5 m	1 m, min. 0.5 m	<25 m	>0.25, min. 0.05	N
CR_NP_CRR_9_WC1	9+585*	58.74	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (no defined channel, small upstream drainage area 58.74 ha)	>1 m, min. 0.5 m	>1 m, min. 0.5 m	1 m, min. 0.5 m	<25 m	>0.25, min. 0.1	N
CR_NP_CRR_9_WC2	10+153	19.42	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (no defined channel, small upstream drainage area 19.4 ha)	>1 m, min. 0.5 m	>1 m, min. 0.5 m	1 m, min. 0.5 m	<25 m	N/A	N
CR_NP_CRR_3_WC3	9+958	37.15	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (from ROW appears undefined, small upstream drainage area 65.99 ha).	N/A	N/A	N/A	N/A	0.05	N
CR_NP_CRR_3_WC3.1	10+316	35.03	N/A	No PTE - initial assessment defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (small upstream drainage area 27.66 ha).	0.5	0.5	N/A	N/A	N/A	N
CR_NP_CRR_3_WC3.2	214+470	7.45	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (upstream no defined channel, small upstream drainage area 22.83 ha).	N/A	N/A	N/A	N/A	N/A	N
CR_NP_CRR_3_WC3.3	214+400	37.82	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_NP_CRR_3_WC3.4	9+542	28.19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_NP_CRR_3_WC3.6	9+900	41.39	N/A	N/A	0.5	0.5	N/A	N/A	N/A	N
CR_NP_CRR_3_WC4	10+150	4.75	N/A	Defer to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria (upstream no defined channel, small upstream drainage area 25.27 ha).	N/A	N/A	N/A	N/A	Min. 0.05	N
CR_NP_CRR_3_WC3.7	10+200	41.39								
CR_NP_CRR_13_WC1	216+005	8.03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_NP_CRR_13_WC2	216+415	32.41	N/A	Initial Fluvial Geomorphic Assessment - Due to size of upstream drainage area and lack of definition seen in aerial image, crossing sizing requirements for this reach will likely be deferred to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria.	N/A	N/A	N/A	N/A	N/A	N
CR_NP_CRR_13_WC3	5+328	125.09	N/A	Due to the lack of channel definition, sizing would be deferred to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria.	N/A	N/A	N/A	N/A	min. 0.05	N
CR_NP_CRR_13_WC4.1	9+919	112.52	N/A	Due to the lack of channel definition, sizing would be deferred to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria.	N/A	N/A	N/A	N/A	min. 0.05	N
CR_NP_CRR_13_WC5	5+800	99.47	N/A	Due to the lack of channel definition, sizing would be deferred to hydraulic flow requirements as well as any fisheries/ terrestrial limiting criteria.	N/A	N/A	N/A	N/A	min 0.05	N
CR_NP_CRR_13_WC6	6+056	16.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_NP_CRR_13_WC7	6+918	1.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_HC_HUT_6_WC1	218+125	27.32	N/A	N/A	>1 m, min. 0.5	>1 m, min. 0.5	1 m, min. 0.5	<25 m	>0.25, min. 0.05	N
CR_HC_HUT_6_WC2	217+776	12.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_HC_HUT_5_WC1.2	10+280	48.72	N/A	N/A	>1 m, min. 0.5 m	>1 m, min. 0.5 m	1 m, min. 0.5 m	<25 m	N/A	N
CR_HC_HUT_5_WC1.4					>1 m, min. 0.5 m	>1 m, min. 0.5 m	1 m, min. 0.5 m	<25 m	N/A	N
CR_HC_HUT_5_WC1.5	10+150	1.04	N/A	N/A	>1 m, min. 0.5 m	>1 m, min. 0.5 m	1 m, min. 0.5 m	<25 m	N/A	N
CR_HC_HUT_5_WC1.6					>1 m, min. 0.5 m	>1 m, min. 0.5 m	1 m, min. 0.5 m	<25 m	N/A	N
CR_HC_HUT_5_WC2.1	9+760	1.11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_HC_HUT_5_WC2.2	9+820	4.42	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_HC_HUT_5_WC2.3	9+770	4.31	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_HC_HUT_5_WC2.4	9+550	1.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_GW_CRR_15_WC1	7+439	4.46	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_GW_CRR_15_WC2.1	7+675	15.14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N
CR_GW_CRR_15_WC3	7+922	1.32	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N

Note: Refer for Highway 413 Transportation Corridor Route Planning, Preliminary Design and Environmental Assessment Study – Stage 2 Fluvial Geomorphological Assessment Draft, AECOM, 2023 for further assessment recommendations.

Also, where fish passage is considered, culverts will have to be embedded. The depth of embedment is yet to be determined, and so these culverts may have to be upsized at a later date when the fish passage requirements are confirmed.

7. Hydrologic Assessment

7.1 Watersheds

A portion of the West Segment of the proposed Highway 413 Transportation Corridor is within the Credit River Watershed, which is under the Credit Valley Conservation (CVC) jurisdiction. The Credit River Watershed drainage area is approximately 950 km^2 from the headwaters in Orangeville, Erin and Mono to Lake Ontario, according to the CVC. The watershed includes 21 subwatersheds, four of which are within the project study area, i.e., Mullet Creek, Levi Creek, Huttonville Creek and Credit River – Norval to Port Credit subwatersheds.

The topography within the Highway 413 Transportation Corridor study area is generally flat and low-lying. The land use throughout the study area within the Credit River watershed is predominantly composed of agricultural properties, natural forested areas, and lesser densities of residential properties.

7.2 Rainfall Data

MTO's IDF lookup data was referenced to determine the rainfall predicted for 75 years in the future (2096) versus the design year (2021, when the stormwater analyses began). It was found that the increase is approximately 6% for the 100-year storm event. The 24- hour rainfall volumes for the design year (2021) and end of design service life year (2096) are provided in **Table 5** below and IDF data is included in **Appendix B**.

Table 5: Rainfall Runoff Volumes

Return Perion (Years)	Rainfall Volume (mm) 2021	Rainfall Volume (mm) 2096
2-Year	57.6	69.6
5-Year	76.8	86.4
10-Year	88.8	98.4
25-Year	103.2	115.2
50-Year	115.2	124.8
100-Year	127.2	136.8

7.3 Hydrologic Modeling

The CVC provided catchment areas across the watershed. The catchments that cross the proposed highway corridor were cut off at the proposed highway ROW to estimate the drainage area draining towards the project site, where a crossing culvert was proposed. Land use and runoff coefficients were based on aerial photographs (Google Earth), and catchment flow length and slopes were calculated based on contour mapping. The following hydrologic techniques were used to determine peak flow rates at the proposed watercourse crossings and points of interests:

- For the Credit River and Levi's Creek Watercourses, peak flow rates for the 2- through 100-year and Regional Storms were obtained from the hydraulic models provided by the CVC. The latest Levi Creek model contains 'Existing' and 'Future' flows. The future flows appear to be based on future changes to land use and not climate change, as some are the same as existing. Therefore, the peak flow rates for the 2 through 100-year future events were increased by 10% to account for the climatic change scenario in the Levi Creek model. The 2-year to 100-year flows in the Credit River model were increased by 10%.
- For drainage areas less than 20 ha, the Rational method was used to calculate peak flow rates for the 2 through 100-year storm events. Rainfall intensities were based on MTO IDF values for the year 2096 accounting for climate change.
- For drainage areas larger than 20 ha, the Unified Ontario Flow Method (UOFM) was used to calculate peak flow rates for the 2 through 100-year storm events. The UOFM calculations come up with three flow values for each storm event; the flow estimate, the upper limit flow and the lower limit flow. To account for climate change in the future, the upper limit was used for culvert sizing.
- A Visual OTTHYMO model was also set up to simulate flows. The 2096 IDF values were used in a 24-hour SCS Type II distribution to account for climate change. Depending on the drainage area, the UOFM and VO model flows or the Rational Method and VO flows were compared with the larger of the two used for design.
- Where CVC provided hydrologic models, flows were prorated based on the relevant drainage area at the watercourse crossing or point of interest.

- At the Bovaird Drive interchange, some watercourse realignment was necessary to keep external flow separate from ROW flow. Ideally, only ROW runoff is treated by a SWM pond, but some external flow may also be treated if it is not possible to separate. Proposed drainage areas and flows were determined based on proposed culvert placements and drainage divides.

Catchment areas were determined for upstream of the ROW (External), the proposed ROW, and the combined area. Culverts were sized based on the combined area to be conservative, since it’s not yet known how much of the ROW will drain to the upstream side in the ultimate design scenario.

7.4 Modeling Results

Peak flow rates for the 2 through 100-year and Regional Storm events were calculated for the larger watercourses modelled in HEC-RAS that cross the ROW. For the smaller crossings, the 2 through 100-year flows were determined using the various methods discussed above. The results of the hydrologic assessment are presented in **Table 6.**

A review was completed on the flows obtained from the CVC HEC-RAS models to confirm their accuracy. Flows seemed inaccurate for Levi Creek, and after a discussion with CVC on January 12, 2023, updated Levi Creek models and flows were provided to AECOM on January 19, 2023. These updated flows were increased by 10% to account for climate change and then used for the bridge/culvert analyses.

Table 6: Hydrologic Modeling Results Summary

Culvert ID	Station	Drainage Area (ha)	Hydrology Methodology	Peak Flow Rates (m^3/s)						
				2-year	5-year	10-year	25-year	50-year	100-year	Regional Storm
CR-MC-MUL-8-WC1	111+570	12.2	VO	0.37	0.58	0.75	0.95	1.14	1.32	1.39
CR-MC-MUL-8-WC2	112+029	37.4	VO	0.67	1.06	1.36	1.75	2.09	2.45	
CR-MC-MUL-8-WC3	112+175	6.3	VO	0.12	0.19	0.24	0.31	0.37	0.43	
CR-MC-MUL-8-WC4	112+349	10.4	VO	0.26	0.40	0.51	0.66	0.78	0.91	1.10
CR_LC_LEV_1_WC2	113+071	104.4	VO	1.44	2.26	2.92	3.76	4.50	5.27	9.04
CR_LC_LEV_1_WC3.1	10+170	8.9	VO	0.18	0.24	0.28	0.35	0.40	0.45	
CR_LC_LEV_1_WC3.3	10+400	13.4	VO	0.16	0.25	0.32	0.41	0.49	0.57	
CR_LC_LEV_1_WC3.4	10+554	2.4	VO	0.07	0.10	0.13	0.17	0.20	0.23	
CR_LC_LEV_1_WC4	113+510	11.7	VO	0.22	0.35	0.44	0.57	0.68	0.79	
CR_LC_LEV_1_WC4.1	10+195	15.7	VO	0.25	0.39	0.50	0.64	0.75	0.88	
CR_LC_LEV_2_WC1	210+170	131.49	HEC-RAS	2.42	4.07	5.50	7.26	8.80	10.45	14.90
CR_LC_LEV_2_WC1.1	9+883	131.49	HEC-RAS	2.42	4.07	5.50	7.26	8.80	10.45	14.90
CR_LC_LEV_2_WC2.1	9+674	53.2	VO	0.79	1.24	1.59	2.05	2.46	2.88	
CR_LC_LEV_2_WC2.2	10+166	62.5	VO	0.92	1.44	1.85	2.39	2.85	3.34	
CR_LC_LEV_2_WC2	210+343	62.5	VO	0.91	1.42	1.82	2.35	2.81	3.29	
CR_LC_LEV_2_WC6	210+675	25.1	VO	0.51	0.79	1.01	1.28	1.53	1.78	2.46
CR_LC_LEV_0_WC2	211+140	733.35	HEC-RAS	7.92	15.18	21.34	30.03	37.18	44.55	73.30
CR_LC_LEV_10_1.1	211+375	5.2	VO	0.15	0.23	0.30	0.38	0.49	0.52	
CR_NP_CRR_0_WC1	211+800	13.8	VO	0.32	0.50	0.65	0.82	0.98	1.14	
Credit River Bridge	212+300		HEC-RAS	66.0	158.5	207.5	279.5	342.2	411.1	675.6
CR_NP_CRR_6_WC1	9+932	2.7	VO	0.08	0.13	0.17	0.21	0.25	0.30	
CR_NP_CRR_6_WC2	10+065	1.7	VO	0.07	0.10	0.13	0.17	0.20	0.23	
CR_NP_CRR_3_WC1.1	10+090	40.52	VO	0.66	1.02	1.31	1.67	1.99	2.30	3.71
CR_NP_CRR_3_WC2	214+180	39.76	VO	0.65	1.01	1.30	1.65	1.96	2.27	3.64
CR_NP_CRR_9_WC1	9+585	58.7	VO	0.85	1.34	1.73	2.23	2.67	3.13	
CR_NP_CRR_9_WC2	10+153	19.4	VO	0.40	0.63	0.80	1.03	1.22	1.42	1.93
CR_NP_CRR_3_WC3	9+958	37.15	VO	0.57	0.90	1.16	1.50	1.80	2.01	3.37
CR_NP_CRR_3_WC3.1	10+316	35.03	VO	0.54	0.85	1.10	1.41	1.69	1.98	3.17
CR_NP_CRR_3_WC3.2	9+960	7.45	VO	0.16	0.24	0.31	0.40	0.47	0.55	0.74
CR_NP_CRR_3_WC3.3	214+400	37.82	VO	0.66	1.06	1.36	1.80	2.11	2.50	3.61
CR_NP_CRR_3_WC3.4	9+542	28.19	VO	0.55	0.87	1.11	1.44	1.69	1.98	2.67
CR_NP_CRR_3_WC3.6	9+900	41.39	VO	0.70	1.13	1.45	1.92	2.26	2.68	3.95
CR_NP_CRR_3_WC4	10+150	4.75	VO	0.09	0.14	0.18	0.23	0.28	0.33	
CR_NP_CRR_3_WC3.7	10+200	41.39	VO	0.70	1.13	1.45	1.92	2.26	2.68	3.95

Culvert ID	Station	Drainage Area (ha)	Hydrology Methodology	Peak Flow Rates (m^3/s)						
				2-year	5-year	10-year	25-year	50-year	100-year	Regional Storm
CR_NP_CRR_13_WC1	216+005	8.0	VO	0.20	0.31	0.40	0.51	0.61	0.71	
CR_NP_CRR_13_WC2	216+415	32.4	VO	0.59	0.92	1.18	1.51	1.80	2.09	
CR_NP_CRR_13_WC3	5+328	125.1	UOFM	1.14	1.93	2.52	3.32	3.96	4.68	
CR_NP_CRR_13_WC4.1	9+919	112.5	UOFM	1.05	1.76	2.30	3.04	3.63	4.28	
CR_NP_CRR_13_WC5	5+800	99.5	VO	1.11	1.75	2.26	2.91	3.48	4.08	
CR_NP_CRR_13_WC6	6+056	16.8	VO	0.30	0.46	0.59	0.76	0.90	1.05	
CR_NP_CRR_13_WC7	6+918	1.4	VO	0.07	0.09	0.11	0.14	0.17	0.20	
CR_HC_HUT_6_WC1	218+125	27.3	VO	0.54	0.84	1.07	1.37	1.63	1.90	
CR_HC_HUT_6_WC2	217+776	12.1	VO	0.19	0.29	0.38	0.48	0.57	0.66	
CR_HC_HUT_5_WC1.2	10+280	48.7	VO	0.66	1.03	1.32	1.69	2.01	2.34	
CR_HC_HUT_5_WC1.4	9+940	1.4	VO	0.11	0.15	0.18	0.22	0.26	0.29	
CR_HC_HUT_5_WC1.5	10+150	1.0	VO	0.08	0.11	0.14	0.17	0.21	0.25	
CR_HC_HUT_5_WC1.6	9+950	4.4	VO	0.12	0.18	0.23	0.30	0.35	0.41	
CR_HC_HUT_5_WC2.1	9+760	1.1	VO	0.05	0.07	0.09	0.12	0.14	0.17	
CR_HC_HUT_5_WC2.2	9+820	4.4	VO	0.31	0.44	0.57	0.69	0.80	1.02	
CR_HC_HUT_5_WC2.3	9+770	4.3	VO	0.11	0.16	0.21	0.27	0.32	0.37	
CR_HC_HUT_5_WC2.4	9+550	1.4	VO	0.10	0.13	0.16	0.20	0.24	0.28	
CR_GW_CRR_15_WC1	7+439	4.5	VO	0.11	0.17	0.22	0.28	0.33	0.39	
CR_GW_CRR_15_WC2.1	7+675	17.8	VO	0.25	0.39	0.50	0.65	0.77	0.91	
CR_GW_CRR_15_WC3	7+922	1.3	VO	0.03	0.04	0.05	0.07	0.08	0.09	

Hydrologic modeling output files can be found in **Appendix C**, and a digital copy of the modelling files is provided separately.

8. Hydraulic Assessment

8.1 Hydraulic Modeling

Two hydraulic models were obtained from the CVC, one for the Credit River and one for Levi Creek. These models were updated to include the proposed highway and associated culvert crossings. The Credit River model was updated to include a 605 m long bridge over the Credit River to determine hydraulic impacts. The modelling showed that a 120 m span bridge would be adequate to convey flow and meet hydraulic design criteria, limiting the Regional water level increase to 0.30 m, however, the Credit River valley is quite deep, and for many environmental and construction-related reasons, it makes more sense to construct a bridge to span the valley.

The Levi Creek model was updated to include two additional crossings, one along the south tributary downstream of Winston Churchill Blvd, and one on the north tributary north of Embleton Road. The remaining, smaller crossings were modelled in CulvertMaster. The Manning's roughness of the proposed culverts was chosen conservatively, as the proposed material won't be confirmed until the detailed design. For culverts modelled in CulvertMaster, circular culverts were modelled with a Manning's n of 0.024 (corrugated metal pipe), and box culverts with an n of 0.035 (open bottom substrate). If different/smoother material options are chosen later on, the recommended spans will still meet the criteria.

8.2 Modeling Results

The results of the HEC-RAS and CulvertMaster hydraulic modelling of the proposed culverts and bridge structures are summarized in **Table 7**, where they are compared to the spans required by other disciplines.

Table 8 summarizes the minimum span for each culvert based on hydraulic criteria. This is also considering that culverts should not decrease in span as flow travels downstream. Also, existing culverts that require replacement would not be replaced with a smaller span than the existing, even if hydraulics permitted. In locations where there are cover limitations, two culverts side by side may be required to convey the proposed flows.

After considering hydraulic, fisheries/wildlife and fluvial geomorphologic input, the recommended culvert/bridge spans are listed in **Table 9** below.

Table 7: Proposed Bridges and Culverts – Recommended Size

Culvert ID	Station	Design Storm	Hydraulic Size			Fluvial Geomorphology Recommendation	Fisheries Recommendation		Openness Ratio Size	Overall Recommended Size
			Shape	Span (m)	Rise (m)	Span (m)	Span (m)	Rise (m)		
CR-MC-MUL-8-WC1	111+570	50-year	Circular	1.05			1.0	1.0	3.0 x 3.6 m box	3.6 m span box
CR-MC-MUL-8-WC2	112+029	50-year	Box	2.1	1.2		0.5	0.5		2.1 m span box
CR-MC-MUL-8-WC3	112+175	50-year	Circular	0.9			0.5	0.5		900 mm diameter
CR-MC-MUL-8-WC4	112+349	50-year	Circular	1.05						105 0 mm diameter
CR_LC_LEV_1_WC2	113+071	50-year	Circular	2.1		3.7	0.5	0.5	6.0 x 2.1 m box	6.0 m span box
CR_LC_LEV_1_WC3.1	10+170	50-year	Circular	0.9						900 mm diameter
CR_LC_LEV_1_WC3.3	10+400	50-year	Circular	0.9						900 mm diameter
CR_LC_LEV_1_WC3.4	10+554	50-year	Circular	0.9						900 mm diameter
CR_LC_LEV_1_WC4	113+510	50-year	Circular	1.05 x 2						1050 mm diameter x 2
CR_LC_LEV_1_WC4.1	10+195	50-year	Circular	0.9						900 mm diameter
CR_LC_LEV_2_WC1	210+170	100-year	Box	12.2	2.2	9	1.0	1.0		14.1 m span culvert
CR_LC_LEV_2_WC1.1	9+883	100-year	Box	11.0	3.0	9	1.0	1.0		two 5.5 m span box
CR_LC_LEV_2_WC2.1	9+674	50-year	Circular	1.65			0.3	0.3		1650 mm diameter
CR_LC_LEV_2_WC2.2	10+166	50-year	Circular	1.65						1650 mm diameter
CR_LC_LEV_2_WC2	210+343	50-year	Circular	1.65						1650 mm diameter
CR_LC_LEV_2_WC6	210+675	50-year	Circular	1.35			1.0	1.0		1350 mm diameter
CR_LC_LEV_0_WC2	211+140	100-year	Bridge	40.0	3.2	94 or 12	1.0	1.0		93.2 m span
CR_LC_LEV_10_1.1	211+375	50-year	Circular	0.9						900 mm diameter
CR_NP_CRR_0_WC1	211+800	50-year	Circular	1.05						1050 mm diameter
Credit River Bridge	212+300	100-year	Bridge	120	19.0	67	3.0	2.0		605 m bridge*
CR_NP_CRR_6_WC1	9+932	50-year	Circular	0.9			0.3	0.3		900 mm diameter
CR_NP_CRR_6_WC2	10+065	50-year	Circular	0.9			0.3	0.3		900 mm diameter
CR_NP_CRR_3_WC1.1	10+090	50-year	Box	3.0	1.8				3.0 x 1.8 m box	3.0 m span box
CR_NP_CRR_3_WC2	214+180	50-year	Box	3.0	1.8		0.5	0.5	3.0 x 1.8 m box	3.0 m span box
CR_NP_CRR_9_WC1	9+585	50-year	Box	2.4 x 1.5			0.5	0.5	3.6 x 1.5 m box	3.6 m span box
CR_NP_CRR_9_WC2	10+153	50-year	Box	0.9 x 3			0.5	0.5		900 mm diameter x 3
CR_NP_CRR_3_WC3	9+958	50-year	Box	2.4	1.5				2.4 x 1.5 m box	2.4 m span box
CR_NP_CRR_3_WC3.1	10+316	50-year	Circular	1.5			0.5	0.5	1500 mm diameter	1500 mm diameter
CR_NP_CRR_3_WC3.2	9+960	50-year	Circular	1.2					1200 mm diameter	1200 mm diameter
CR_NP_CRR_3_WC3.3	214+400	50-year	Box	2.1	1.2				2.1 x 1.2 m box	2.1 m span box
CR_NP_CRR_3_WC3.4	9+542	50-year	Circular	1.05					1050 mm	1050 mm diameter
CR_NP_CRR_3_WC3.6	9+900	50-year	Box	2.4	1.5		0.5	0.5	2.4 x 1.5 m box	2.4 m span box
CR_NP_CRR_3_WC4	10+150	50-year	Circular	0.9					1.8 x 1.5 m box	1.8 m span box
CP_NP_CRR_3_WC3.7	10+200	50-year	Box	2.4	1.5				2.4 x 1.5 m box	2.4 m span box
CR_NP_CRR_13_WC1	216+005	50-year	Circular	0.9						900 mm diameter
CR_NP_CRR_13_WC2	216+415	50-year	Circular	1.2						1.2 m span box
CR_NP_CRR_13_WC3	5+328	50-year	Box	3.6	1.2					3.6 m span box
CR_NP_CRR_13_WC4.1	9+919	50-year	Circular	2.4	1.5					2.4 m span box
CR_NP_CRR_13_WC5	5+800	50-year	Box	2.4	1.5					2.4 m span box
CR_NP_CRR_13_WC6	6+056	50-year	Circular	1.2						1200 mm diameter
CR_NP_CRR_13_WC7	6+918	50-year	Circular	0.9 x 2						900 mm diameter x 2
CR_HC_HUT_6_WC1	218+125	50-year	Circular	1.35			0.5	0.5	3.3 x 1.5 m box	3.3 m span box
CR_HC_HUT_6_WC2	217+776	50-year	Circular	0.9						900 mm diameter
CR_HC_HUT_5_WC1.2	10+280	50-year	Circular	1.2			0.5	0.5		1200 mm diameter
CR_HC_HUT_5_WC1.4	9+940	50-year	Circular	0.9			0.5	0.5		900 mm diameter
CR_HC_HUT_5_WC1.5	10+150	50-year	Circular	0.9			0.5	0.5		900 mm diameter
CR_HC_HUT_5_WC1.6	9+950	50-year	Circular	0.9			0.5	0.5		900 mm diameter
CR_HC_HUT_5_WC2.1	9+760	50-year	Circular	0.9						900 mm diameter
CR_HC_HUT_5_WC2.2	9+820	50-year	Circular	0.9						900 mm diameter

Culvert ID	Station	Design Storm	Hydraulic Size			Fluvial Geomorphology Recommendation	Fisheries Recommendation		Openness Ratio Size	Overall Recommended Size
			Shape	Span (m)	Rise (m)	Span (m)	Span (m)	Rise (m)		
CR_HC_HUT_5_WC2.3	9+770	50-year	Circular	0.9						900 mm diameter
CR_HC_HUT_5_WC2.4	9+550	50-year	Circular	0.9						900 mm diameter
CR_GW_CRR_15_WC1	7+439	50-year	Circular	0.9						900 mm diameter
CR_GW_CRR_15_WC2.1	7+675	50-year	Circular	0.9						900 mm diameter
CR_GW_CRR_15_WC3	7+922	50-year	Circular	0.9						900 mm diameter

Note: *The spans of these Bridges are still under discussion / design with the structural team. Final spans and details will be confirmed at a later stage, at which time hydraulic modelling will be finalized.

As previously mentioned in Section 6.0, where fish passage is considered, culvert sizes may later be increased once embedment depth is finalized, at which point hydraulics will be finalized.

Table 8: Proposed Bridges and Culverts – Hydraulic Minimum Sizes

Culvert ID	Station	Design Storm	Prop. Culvert				Prop. Edge of Pavement (m)	Water Level (m)			Design Storm		Span Required to Meet FB	Regional Flood Level Increase (m)
			Shape	Span (m)	Height (m)	U/S Inv (m)		50-year	100-year	Check Flow	HW/D (<1.5)	FB (>1 m)		
CR-MC-MUL-8-WC1	111+570	50-year	Circular	1.05		219.68	223.50	220.87	221.15	221.91	1.13	2.63		0.00
CR-MC-MUL-8-WC2	112+029	50-year	Box	2.1	1.2	219.21	221.39	220.28	220.38	220.68	0.88	1.11		
CR-MC-MUL-8-WC3	112+175	50-year	Circular	0.9		218.86	220.99	219.47	219.53	219.65	0.68	1.52		
CR-MC-MUL-8-WC4	112+349	50-year	Circular	1.05		218.33	220.48	219.21	219.31	219.58	0.84	1.27		0.03
CR_LC_LEV_1_WC2	113+071	50-year	Circular	2.1		211.80	214.73	213.47	213.63	213.93	0.80	1.26		Watercourse Realignment
CR_LC_LEV_1_WC3.1	10+170	50-year	Circular	0.9		209.93	212.79	210.53	210.57	210.67	0.67	2.26		
CR_LC_LEV_1_WC3.3	10+400	50-year	Circular	0.9		207.20	209.63	207.90	207.96	208.07	0.78	1.73		
CR_LC_LEV_1_WC3.4	10+554	50-year	Circular	0.9		205.70	207.26	206.17	206.19	206.24	0.52	1.09		
CR_LC_LEV_1_WC4	113+510	50-year	Circular	1.05 x 2		210.50	212.00	210.99	211.12	211.12	0.47	1.01		
CR_LC_LEV_1_WC4.1	10+195	50-year	Circular	0.9		207.93	215.63	208.80	208.88	209.07	0.97	6.83		
CR_LC_LEV_2_WC1	210+170	100-year	Box	12.2	2.0	208.85	208.85	206.69	206.76	206.93	0.19	2.16		0.55
CR_LC_LEV_2_WC1.1	9+883	100-year	Box	11.0	2.2	206.72	209.48	207.39	207.44	207.53	0.24	2.09		0.00
CR_LC_LEV_2_WC2.1	9+674	50-year	Circular	1.65		206.70	209.90	208.06	208.19	208.43	0.82	1.84		
CR_LC_LEV_2_WC2.2	10+166	50-year	Circular	1.65		205.10	207.90	206.55	206.69	206.70	0.88	1.35		
CR_LC_LEV_2_WC2	210+343	50-year	Circular	1.65		204.70	207.56	206.13	206.28	206.61	0.87	1.43		
CR_LC_LEV_2_WC6	210+675	50-year	Circular	1.35		204.37	206.68	205.51	205.66	206.17	0.84	1.17		*Existing culvert upstream – more information required to determine increase
CR_LC_LEV_0_WC2	211+140	100-year	Bridge	40.0	3.5	203.35	208.93	204.54	204.64	204.80	0.37	4.39		0.29
CR_NP_CRR_0_WC1	211+800	50-year	Circular	1.05		210.29	212.29	211.27	211.36	211.55	0.93	1.02		
Credit River Bridge	212+300	50-year	Bridge	605	19.0	210.00		189.99	190.22			19.78		0.03
CR_NP_CRR_6_WC1	9+932	50-year	Circular	0.9		227.60	237.32	228.07	228.11	228.19	0.52	9.25		
CR_NP_CRR_6_WC2	10+065	50-year	Circular	0.9		228.20	237.04	228.63	228.66	228.73	0.48	8.41		
CR_NP_CRR_3_WC1.1	10+090	50-year	Box	3.0	1.8	234.30	236.80	235.32	235.35	235.42	0.57	1.48		Within Bovaird IC – Watercourse realignment
CR_NP_CRR_3_WC2	214+180	50-year	Box	3.0	1.8	234.55	237.31	235.52	235.46	235.650	0.51	1.85		Within Bovaird IC – Watercourse realignment
CR_NP_CRR_9_WC1	9+585	50-year	Box	2.4	1.5	224.35	226.30	225.29	225.40	225.60	0.63	1.01		Just outside the study area
CR_NP_CRR_9_WC2	10+153	50-year	Circular	0.9 x 3		237.10	237.82	237.63	237.68	237.77	0.59	0.19	N/A*	*Existing culvert upstream – more information required to determine increase
CR_NP_CRR_3_WC3	9+958	50-year	Box	2.4	1.5	235.30	245.30	236.29	236.35	236.51	0.55	10.51		Within Bovaird IC – Watercourse realignment
CR_NP_CRR_3_WC3.1	10+316	50-year	Circular	1.05		237.33	241.37	238.43	238.53	239.73	0.73	2.94		Within Bovaird IC – Watercourse realignment
CR_NP_CRR_3_WC3.2	9+960	50-year	Circular	1.2		236.06	238.38	236.78	236.93	237.47	0.60	1.60		Within Bovaird IC – Watercourse realignment
CR_NP_CRR_3_WC3.3	214+400	50-year	Box	2.1	1.2	235.66	246.80	236.69	236.83	237.33	0.86	9.91		
CR_NP_CRR_3_WC3.4	9+542	50-year	Circular	1.05		236.50	241.94	237.86	238.23	239.38	1.30	4.08		
CR_NP_CRR_3_WC3.6	9+900	50-year	Box	2.4	1.5	235.30	241.38	236.26	236.39	236.62	0.64	5.12		
CR_NP_CRR_3_WC4	10+150	50-year	Circular	0.9		237.80	239.94	238.29	238.34	238.42	0.54	1.65		Within Bovaird IC – Watercourse realignment
CR_NP_CRR_3_WC3.7	10+200	50-year	Box	2.4	1.5	235.00	239.00	236.00	236.12	236.34	0.67	3.00		Within Bovaird IC – Watercourse realignment
CR_NP_CRR_13_WC1	216+005	50-year	Circular	0.9		249.01	260.20	249.79	249.88	250.20	0.87	10.41		
CR_NP_CRR_13_WC2	216+415	50-year	Circular	1.2		247.90	251.60	249.57	249.93	250.61	1.39	2.03		
CR_NP_CRR_13_WC3	5+328	50-year	Box	3.6	1.2	249.51	251.37	250.50	250.60	250.79	0.83	0.87	N/A**	
CR_NP_CRR_13_WC4.1	9+919	50-year	Box	2.4	1.5	250.52	258.30	251.61	251.74	251.97	0.73	6.69		
CR_NP_CRR_13_WC5	5+800	50-year	Box	2.4	1.5	251.17	253.40	252.29	252.42	252.65	0.75	1.11		
CR_NP_CRR_13_WC6	6+056	50-year	Circular	1.2		252.98	255.66	253.86	253.93	254.08	0.73	1.80		
CR_NP_CRR_13_WC7	6+918	50-year	Circular	0.9 x 2		262.91	264.21	263.25	263.27	263.30	0.38	0.96	N/A***	
CR_HC_HUT_6_WC1	218+125	50-year	Circular	1.35		255.27	257.47	256.41	256.53	256.81	0.84	1.06		
CR_HC_HUT_6_WC2	217+776	50-year	Circular	0.9		253.00	255.02	253.92	254.06	254.45	1.02	1.10		
CR_HC_HUT_5_WC1.2	10+280	50-year	Circular	1.2		261.20	263.62	262.61	263.08	263.08	1.18	1.01		

Culvert ID	Station	Design Storm	Prop. Culvert				Prop. Edge of Pavement (m)	Water Level (m)			Design Storm		Span Required to Meet FB	Regional Flood Level Increase (m)
			Shape	Span (m)	Height (m)	U/S Inv (m)		50-year	100-year	Check Flow	HW/D (<1.5)	FB (>1 m)		
CR_HC_HUT_5_WC1.4	9+940	50-year	Circular	0.9		261.17	266.14	261.65	261.68	261.76	0.53	4.49		
CR_HC_HUT_5_WC1.5	10+150	50-year	Circular	0.9		257.03	258.73	257.46	257.50	257.56	0.48	1.27		
CR_HC_HUT_5_WC1.6	9+950	50-year	Circular	0.9		258.30	261.12	258.86	258.91	259.00	0.62	2.26		
CR_HC_HUT_5_WC2.1	9+760	50-year	Circular	0.9		262.50	269.50	262.84	262.88	262.92	0.38	6.66		
CR_HC_HUT_5_WC2.2	9+820	50-year	Circular	0.9		262.08	267.70	262.62	262.64	262.73	0.60	5.08		
CR_HC_HUT_5_WC2.3	9+770	50-year	Circular	0.9		261.54	266.20	262.07	262.11	262.21	0.59	4.13		
CR_HC_HUT_5_WC2.4	9+550	50-year	Circular	0.9		259.90	262.37	260.37	260.41	260.49	0.52	2.00		
CR_GW_CRR_15_WC1	7+439	50-year	Circular	0.9		261.40	263.57	262.00	262.00	262.17	0.67	1.57		
CR_GW_CRR_15_WC2.1	7+675	50-year	Circular	0.9		260.46	262.89	261.71	261.96	262.48	1.39	1.18		
CR_GW_CRR_15_WC3	7+922	50-year	Circular	0.9		261.74	263.16	262.00	262.02	262.07	0.29	1.16		

Note: * The elevation difference between the road and invert is less than 1 m, the road elevation must increase to meet this criterion. A custom culvert may be required here
** There are cover issues here. A box culvert may be better than three 900 mm diameter culverts, but it would have to be custom made
*** Hydraulics for this culvert are governed by the tailwater level. To meet this criterion the road will have to be increased

As previously discussed, a final recommended culvert size was determined based on criteria from all disciplines, and culverts were re-modelled with these spans to determine hydraulic impacts. The hydraulic modelling results of this analysis is summarized in **Table 9**. At six locations where culverts were upsized to meet openness ratio criteria, culvert hydraulics were updated to reflect the larger sizes. Some general arrangement drawings of structural crossings can be found in **Appendix F**. Some crossings are still under review, and all general arrangement drawings will be provided once final.

Table 9: Proposed Bridges and Culverts – Hydraulic Assessment Summary based on Final Recommendations

Culvert ID	Station	Design Storm	Discipline Size Recommendations					Hydraulic Design Criteria		
			Fluvial Span (m)	Fisheries (Span x Rise) (m)	Hydraulics (Diam or Span x Rise)	Ecology (Openness)	Overall	Design Storm HW/D (< 1.5)	Design Storm Freeboard (m) (> 1.0 m)	Regional Storm Freeboard (m) (> 0 m)
CR-MC-MUL-8-WC1	111+570	50-year		1.0 x 1.0	1050 mm	3.6 x 3.0 m box	3.6 m span box	0.13	3.43	3.37
CR-MC-MUL-8-WC2	112+029	50-year		0.5 x 0.5	2.1 x 1.2 m		2.1 m span box	0.88	1.11	
CR-MC-MUL-8-WC3	112+175	50-year		0.5 x 0.5	900 mm		900 mm diameter	0.68	1.52	
CR-MC-MUL-8-WC4	112+349	50-year			1050 mm		1050 mm diameter	0.84	1.27	1.00
CR_LC_LEV_1_WC2	113+071	50-year	3.7	0.5 x 0.5	2.1 x 2.1	6.0 x 1.2 m box	6.0 m x 1.2 m box	0.34	2.22	1.81
CR_LC_LEV_1_WC3.1	10+170	50-year			900 mm		900 mm diameter	0.67	2.26	
CR_LC_LEV_1_WC3.3	10+400	50-year			900 mm		900 mm diameter	0.78	1.73	
CR_LC_LEV_1_WC3.4	10+554	50-year			900 mm		900 mm diameter	0.52	1.09	
CR_LC_LEV_1_WC4	113+510	50-year			1050 mm x 2		1050 mm diameter x 2	0.47	1.01	
CR_LC_LEV_1_WC4.1	10+195	50-year			900 mm		900 mm diameter	0.97	6.83	
CR_LC_LEV_2_WC1	210+170	100-year	9.0	1.0 x 1.0	12.2 m span		14.1 m span culvert	0.21	2.08	1.92
CR_LC_LEV_2_WC1.1	9+883	100-year	9.0	1.0 x 1.0	11 m span		two 5.5 m span box	0.27	2.04	1.76
CR_LC_LEV_2_WC2.1	9+674	50-year		0.3 x 0.3	1650 mm		1650 mm diameter	0.82	1.84	
CR_LC_LEV_2_WC2.2	10+166	50-year			1650 mm		1650 mm diameter	0.88	1.35	
CR_LC_LEV_2_WC2	210+343	50-year			1650 mm		1650 mm diameter	0.87	1.43	
CR_LC_LEV_2_WC6	210+675	50-year		1.0 x 1.0	1350 mm		1350 mm diameter	0.84	1.17	0.34
CR_LC_LEV_0_WC2	211+140	100-year	94 or 12	1.0 x 1.0	40 m span		93.2 m span	0.32	4.39	3.97
CR_LC_LEV_10_1.1	211+375	50-year			900 mm		900 mm diameter	0.58	2.46	
CR_NP_CRR_0_WC1	211+800	50-year			1050 mm		1050 mm diameter	0.93	1.02	
Credit River Bridge	212+300	100-year	67	3.0 x 2.0			605 m bridge*		19.78	18.40
CR_NP_CRR_6_WC1	9+932	50-year		0.3 x 0.3	900 mm		900 mm diameter	0.52	9.25	
CR_NP_CRR_6_WC2	10+065	50-year		0.3 x 0.3	900 mm		900 mm diameter	0.48	8.41	
CR_NP_CRR_3_WC1.1	10+090	50-year			3.0 x 1.8 m		3.0 m span box	0.57	1.48	1.29
CR_NP_CRR_3_WC2	214+180	50-year		0.5 x 0.5	3.0 x 1.8 m		3.0 m span box	0.51	1.85	1.52
CR_NP_CRR_9_WC1	9+585	50-year		0.5 x 0.5	2.4 x 1.5	3.6 m x 1.5 box	3.6 x 1.5 m box	0.63	1.01	Just outside the study area
CR_NP_CRR_9_WC2	10+153	50-year		0.5 x 0.5	900 mm x 3		900 mm diameter x 3	0.59	**0.19**	0.03
CR_NP_CRR_3_WC3	9+958	50-year			2.4 x 1.5 m		2.4 m span box	0.55	10.51	10.10
CR_NP_CRR_3_WC3.1	10+316	50-year		0.5 x 0.5	1500 mm		1500 mm diameter	0.73	2.94	2.45
CR_NP_CRR_3_WC3.2	9+960	50-year			1200 mm		1200 mm diameter	0.60	1.60	0.60
CR_NP_CRR_3_WC3.3	214+400	50-year			2.1 x 1.2 m		2.1 m span box	0.86	9.91	8.97

Culvert ID	Station	Design Storm	Discipline Size Recommendations					Hydraulic Design Criteria		
			Fluvial Span (m)	Fisheries (Span x Rise) (m)	Hydraulics (Diam or Span x Rise)	Ecology (Openness)	Overall	Design Storm HW/D (< 1.5)	Design Storm Freeboard (m) (> 1.0 m)	Regional Storm Freeboard (m) (> 0 m)
CR_NP_CRR_3_WC3.4	9+542	50-year			1050 mm		1050 mm diameter	1.30	4.08	
CR_NP_CRR_3_WC3.6	9+900	50-year		0.5 x 0.5	2.4 x 1.5 m		2.4 m span box	0.64	5.12	4.63
CR_NP_CRR_3_WC4	10+150	50-year			900 mm	1.8 x 1.5 m box	1.8 m span box	0.17	1.89	1.80
CR_NP_CRR_3_WC3.7	10+200	50-year			2.4 x 1.5 m		2.4 m span box	0.67	3.00	2.53
CR_NP_CRR_13_WC1	216+005	50-year			900 mm		900 mm diameter	0.87	10.41	
CR_NP_CRR_13_WC2	216+415	50-year			1200 mm		1.2 m span box	1.23	2.59	
CR_NP_CRR_13_WC3	5+328	50-year			3.6 x 1.2 m		3.6 m span box	0.83	**0.87**	
CR_NP_CRR_13_WC4.1	9+919	50-year			2.4 x 1.5 m		2.4 m span box	0.73	6.69	
CR_NP_CRR_13_WC5	5+800	50-year			2.4 x 1.5 m		2.4 m span box	0.75	1.11	
CR_NP_CRR_13_WC6	6+056	50-year			1200 mm		1200 mm diameter	0.73	1.80	
CR_NP_CRR_13_WC7	6+918	50-year			900 mm x 2		900 mm diameter x 2	0.38	**0.96**	
CR_HC_HUT_6_WC1	218+125	50-year		0.5 x 0.5	1350 mm	3.3 x 1.5 m box	3.3 m span box	0.38	1.63	
CR_HC_HUT_6_WC2	217+776	50-year			900 mm		900 mm diameter	1.02	1.10	
CR_HC_HUT_5_WC1.2	10+280	50-year		0.5 x 0.5	1200 mm		1200 mm diameter	1.18	1.01	
CR_HC_HUT_5_WC1.4	9+940	50-year		0.5 x 0.5	900 mm		900 mm diameter	0.53	4.49	
CR_HC_HUT_5_WC1.5	10+150	50-year		0.5 x 0.5	900 mm		900 mm diameter	0.48	1.27	
CR_HC_HUT_5_WC1.6	9+950	50-year		0.5 x 0.5	900 mm		900 mm diameter	0.62	2.26	
CR_HC_HUT_5_WC2.1	9+760	50-year			900 mm		900 mm diameter	0.38	6.66	
CR_HC_HUT_5_WC2.2	9+820	50-year			900 mm		900 mm diameter	0.60	5.08	
CR_HC_HUT_5_WC2.3	9+770	50-year			900 mm		900 mm diameter	0.59	4.13	
CR_HC_HUT_5_WC2.4	9+550	50-year			900 mm		900 mm diameter	0.52	2.00	
CR_GW_CRR_15_WC1	7+439	50-year			900 mm		900 mm diameter	0.67	1.57	
CR_GW_CRR_15_WC2.1	7+675	50-year			900 mm		900 mm diameter	1.39	1.18	
CR_GW_CRR_15_WC3	7+922	50-year			900 mm		900 mm diameter	0.29	1.16	

Note: * The elevation difference between the road and invert is less than 1 m, the road elevation must increase to meet this criterion. A custom culvert may be required here
** There are cover issues here. A box culvert may be better than three 900 mm diameter culverts, but it would have to be custom made
*** Hydraulics for this culvert are governed by the tailwater level. To meet this criterion the road will have to be increased

There is less than 0.6 m cover in a few locations, and so this will have to be reviewed at detailed design to determine if grading changes should be made or custom culverts. With the proposed culverts and bridges in the table above, no roadways are overtopped.

At the Levi Creek crossing east of Winston Churchill Blvd, an increase of 0.55 m was noted on the upstream side water levels during the Regional Storm event. This crossing will be within the ROW, and so the proposed grading will consider this increase and prevent any impacts beyond the ROW. This should be reviewed in the detailed design to ensure that the proposed water levels do not impact property outside of the ROW. Best efforts were made to meet all the design criteria, but in three cases, the freeboard is less than 1 m due to grading/hydraulic constraints. Hydraulic model output files can be found in **Appendix D**, and a digital copy of the modelling files is provided separately.

Culvert spans will be finalized once the fluvial team has completed their fieldwork and recommendations, and the structural and environmental teams have completed their assessments for the large bridge crossings.

9. Stormwater Management

The proposed Highway 413 Transportation Corridor will result in an increase in impervious area. Increased pavement areas are proposed to be addressed by stormwater quality treatment and quantity control measures.

A list of stormwater best management practices (BMPs) was screened, with consideration of the general advantages and disadvantages, experience, and practical feasibility for the site-specific conditions, such as:

- Integration with the standard type of drainage (storm sewers and outside ditches);
- Space availability and practical outlet points;
- Functionality of using small orifice sizes to control discharge rates; and
- Future integration/replacement with future SWM plans for the developed lands.

It was determined at the start of the study that the “do nothing” alternative is not an acceptable course of action. The proposed increase in pavement area and the associated potential increase in pollutant loading to the receiving watercourses would result in negative effects such as reduced stream water quality, degraded aquatic habitat, flooding, and in-stream erosion, which necessitate the provision of appropriate mitigation measures. To reduce the potential impacts of the proposed works, a treatment train approach is recommended that utilizes a combination of source, conveyance, and end-of-pipe practices.

The MECP has identified a broad range of SWMPs that may be considered for the proposed Highway 413 Transportation Corridor. The recommended practices that can be implemented as part of this project are:

- Dry linear facilities providing quantity control;
- Vegetated grassed swale providing quality treatment and quantity control;
- Special SWMPs, such as oil and grit separators, to provide quality treatment;

Storage SWMPs, such as wet ponds, dry ponds, and linear SWM facilities, can be effective in providing combined quality treatment and/or quantity control where drainage areas are sufficient and space is available.

Within the study area, runoff from the proposed highway will ultimately discharge to the existing watercourses via ditches/storm sewers. The paved areas will result in a significant increase in impervious area, which will eventually lead to a larger potential for erosion, flood risk, and water quality degradation along the receiving watercourses. Therefore, road runoff needs to be treated before discharging into the receiving watercourses.

9.1 Quantity Control

The design criteria for quantity control differ by subwatershed. Attenuation of post-development peak flows is required to the pre-development levels for all storms up to and including the 100-year storm in some areas, where other areas have target release rates.

This criterion will be met by implementing wet pond stormwater management (SWM) facilities for drainage areas larger than 10 hectares, linear dry ponds for areas between 5 and 10 hectares, and grassed swales with check dams for smaller drainage areas. According to the Ministry of Transportation Ontario (MTO) recommendations, the design of these SWM facilities is based on current rainfall data, and future climate change scenarios were not taken into account.

9.2 Quality Control

An enhanced level of stormwater treatment was identified for the study area. This is the highest level of treatment (80% removal of total suspended solids on a long-term basis) identified in the MECP SWM Planning and Design Manual (2003).

This criterion will be achieved by SWM facilities for drainage areas greater than 10 ha, and enhanced swales with check dams for smaller drainage areas.

9.3 Erosion and Sediment Control

Flat-bottom ditches offer water quality control and space to incorporate check dams to reduce velocities where required. Additionally, flat-bottom grassed swales are designed to reduce flow velocities and to promote sedimentation. Both measures are particularly applicable for highway applications due to their linear nature. However, specific design criteria must be achieved as discussed in **Section 2.2**.

Flat-bottom swales are proposed along the east and west side ditches of the proposed highway. The bottom width is selected based on the available land and grading constraints to maintain the swale within the MTO Right-of-Way. In addition, in areas where swales are in the proximity of wetlands, they were designed as shallow as possible to minimize adverse impacts to ground water levels in the wetlands.

9.4 Proposed Drainage and SWM Facilities

Table 10 summarizes the proposed drainage and stormwater management practices (SWMPs) proposed along the proposed highway.

Table 10 some outlets show an area greater than 10 hectares with swales as the treatment method instead of a pond. In these cases, there are multiple swales treating different portions of the roadway upstream of the outlet, which would not be able to drain to a single pond for treatment. Multiple ponds would be required, rendering each drainage area to be less than 10 hectares.

The ditches/enhanced swales are anticipated to provide 50% TSS removal, while the wet ponds are designed to provide 80% TSS removal on a long-term basis. Best efforts were made to direct areas larger than 10 hectares to SWM ponds; however, in some cases, the upstream side of the highway converges with external flows, rendering it too much flow to direct to the SWM pond. Where small external areas combine with ROW flows, SWM ponds are used for quantity and quality treatment.

9.4.1 Stormwater Management Ponds

Within the CVC's jurisdiction, six wet ponds and five dry ponds are proposed along the Highway 413 Corridor. Of the six wet ponds, two ponds (Pond 1 and Credit River Pond) are designed for quality and erosion control, but not quantity control. The remaining four wet ponds (Ponds 2, 3, 4, and 5) are designed to provide both water quality and quantity control, as well as erosion control. Wet ponds that offer both quality and quantity controls are proposed for drainage areas that are approximately 10 hectares or greater. Dry ponds are proposed for drainage areas ranging from 5 to 10 hectares.

The proposed wet ponds will provide the required quality, quantity, and erosion controls. These wet ponds are designed for the ultimate design scenario and will include:

- A permanent pool of water;
- Extended detention volume, where water will be stored and gradually released through a controlled outlet;

Table 10: Proposed Impervious Area and Treatment Approach

Outlet / Culvert ID	Station	Highway Drainage Area (ha)	Impervious Area (ha)	% Impervious	New Pavement Area (ha) to SWM Measures / TSS Removal Rates			Equivalent Protection Level for New Pavement
					Grassed Swales 50%	Proposed Wet Ponds 80%	Weighted Treatment (%)	
CR-MC-MUL-8-WC1	111+570	3.38	1.06	31%	1.06	-	50%	Basic
CR-MC-MUL-8-WC2	112+029	6.84	3.19	47%	3.19	-	50%	Basic
CR-MC-MUL-8-WC3	112+175	2.43	1.05	43%	1.05	-	50%	Basic
CR-MC-MUL-8-WC4	112+349	2.97	1.30	44%	1.30	-	50%	Basic
CR_LC_LEV_1_WC2	113+071	14.11	5.29	37%	1.09	4.20	70%	Normal
CR_LC_LEV_1_WC3.1	10+170	8.38	3.13	37%	3.13	-	50%	Basic
CR_LC_LEV_1_WC4.1	10+195	5.94	1.92	32%	1.92	-	50%	Basic
CR_LC_LEV_2_DR3 - transitway		2.49	0.32	13%	0.32	-	50%	Basic
CR_LC_LEV_2_WC1	210+170	9.22	3.74	41%	3.74	-	50%	Basic
CR_LC_LEV_2_WC2	210+343	4.38	1.70	39%	1.70	-	50%	Basic
CR_LC_LEV_2_WC6	210+675	9.06	3.84	42%	3.84	-	50%	Basic
CR_LC_LEV_0_WC2	211+140	9.32	4.02	43%	4.02	-	50%	Basic
CR_LC_LEV_10_WC1.1		3.15	1.26	40%	1.26	-	50%	Basic
CR_NP_CRR_0_WC1	211+800	4.82	1.95	40%	1.95	-	50%	Basic
Credit River Bridge	212+300	8.60	5.55	65%		5.55	80%	Enhanced
CR_NP_CRR_3_WC1	10+090	35.00*	0.35	1%	0.35		50%	Basic
		5.52	2.55	46%	2.55		50%	Basic
CR_NP_CRR_3_WC3.7	214+200	9.60	0.10	1%	-	0.10	80%	Enhanced
		37.83	15.56	41%		15.56	80%	Enhanced
CR_NP_CRR_13_WC1	213+780	4.38	1.00	23%	1.00	-	50%	Basic
CR_NP_CRR_13_WC2	214+180	16.57	6.75	41%	6.75	-	50%	Basic
LP South of Wanless	217+350	14.83	6.52	44%	6.52	-	50%	Basic
CR_HC_HUT_6_WC1	218+125	16.51*	0.68	4%	-	0.68	80%	Enhanced
		10.81	4.10	38%	-	4.10	80%	Enhanced
		18.35	6.15	34%	6.15	-	50%	Basic
Hwy LP North of Mayfield	219+380	13.56	7.08	52%	-	7.08	80%	Enhanced
		3.89	1.11	29%	1.11	-	50%	Basic

Note: * Wet Ponds 3 and 4 are designed for a larger area that includes external area and may be revisited during the detailed design stage.

- Flood storage volume to store water during larger storm events, to attenuate peak flow rates to the pre-development levels;
- An overflow spillway to safely pass the Regional storm event;
- Landscaped areas around the pond to promote evapotranspiration;
- Provision of pond liners can be considered during the detailed design stage to prevent leaching of contaminated water into the groundwater system.

The Proposed Pond 1 within the Levi Creek watershed is only designed to treat water quality and erosion, as the target outflow is already reached without the pond, and so no quantity storage is required. A wet pond is designed on the west side of the highway, south of the Credit River Bridge, to treat runoff from the proposed Credit River bridge. The area draining to these water quality ponds is much less than 10 ha, and so they would not be feasible for quantity control. These wet ponds are designed for the ultimate design scenario.

For the Wet Pond design, a The Visual OTTHYMO model was set up to simulate flows from the existing area and the proposed area, which drain to the same outlet locations along the ROW. NASHYD commands were used for existing catchments, and STANDHYD were used for the more impervious proposed areas. Route Reservoir commands were iterated until proposed flows matched existing for each storm event, creating a pond rating curve of flow vs. storage volume. The maximum volume determined for a 100-year event was considered the maximum quantity control volume required to attenuate flows to the pre-development levels. Approximate footprint areas of these ponds are summarized in **Table 11** and shown on the Proposed Drainage Mosaic in **Figures 5.2** to **5.5.** Stormwater management modelling output files and calculations can be found in **Appendix E**. Digital models will also be made available.

Table 11: SWM Ponds Features

Pond ID	Watershed	Drainage Area (ha)	Imper. (%)	Permanent Pool Volume (m^3)	Extended Detention Volume (m^3)	Total Active Volume (incl. Extended Detention) (m^3)	Approximate Pond Size(ha)
Pond 1	Levi Creek	9.4	44	1,127	1,097	1,097	0.3
Pond 2	Credit	16.9	45	6,161	2,086	7,393	1.0
Pond 3	Credit	47.4	33	11,552	5,362	17,920	2.3
Pond 4	Huttonville	17.7	80	5,988	2,411	11,131	1.1
Pond 5	Huttonville	13.6	52	6,547	1,909	8,127	1.1
Credit Bridge Pond	Credit	8.6	65	1,500	830	830	0.3

The Credit River "Bridge Pond" is located on the south end of the Credit River bridge to treat runoff from the bridge itself. Due to the steep slopes and proximity to the Credit River, the pond could not be designed outside of the Regional floodplain. However, it is outside of the 100-year floodplain and designed to provide quality control only, as quantity control is not required here. Due to the steep slopes along the edge of the Credit River Valley, the pond may require a drop-down structure. A spillway or diversion channel may also be required; the details of which are to be determined at the next design phase.

Five linear dry ponds are proposed between the highway and transitway that will provide water quantity control. These ponds will receive runoff from a drainage area of between 10 and 5 hectares. The design calculations/modeling, and ultimate footprint for these dry ponds will be determined at the detailed design stage.

During the detailed design phase, the stormwater management will be reassessed, and if additional quality and quantity treatment is required, additional linear dry ponds can be placed between the Highway ROW and transitway.

9.4.2 Grass Swales

Grass swales are proposed on both sides of the highway and in the middle of the open median under the initial construction plan. In the CVC's jurisdiction, approximately 33 km (11+11+11) long swales are proposed along the proposed highway. These ditches/swales will be designed as flat-bottom ditches with check dams and will collect, treat, attenuate, and convey storm runoff generated at highway surfaces. The hydraulic design of these swales will be carried out in the next design phase, but typically these swales will have a bottom width of 1 m and a 2:1 (H:V) side slope.

9.4.3 Enhanced Grass Swales

For larger contributing drainage areas with no downstream SWM controls, these swales can be converted into enhanced grass swales or bioswales to provide additional quality controls. Bio Swales or Enhanced grass swales or vegetated swales are vegetated open channels designed to convey, treat, attenuate and convey stormwater runoff to respective outlets. Check dams and vegetation in the swale reduce the flow velocity to allow sedimentation, filtration, evapotranspiration and infiltration into the underlying native soil (CVC, TRCA, 2010).

9.4.4 Water Balance

Precipitation that falls on the ground is distributed through the hydrological cycle via various pathways. Some of the water is retained in the soil and returns to the atmosphere through evapotranspiration. Another portion infiltrates the soil and can recharge groundwater. The remaining portion of the precipitation becomes overland flow or direct runoff, which discharges into lakes and rivers.

The addition of impervious surfaces affects the balance of infiltration, evapotranspiration, and runoff from the pre-development conditions. Within the project limits of the CVC area, approximately 60 ha of impervious area will be added during the initial six-lane configuration. This will increase the runoff and reduce infiltration and evapotranspiration.

The primary goal of the water balance criteria is to effectively capture and manage the annual rainfall within the highway corridor. This helps maintain the natural water systems, such as infiltration, evapotranspiration, and runoff, as they were before any development occurred. Under the proposed stormwater management plan for the highway, the runoff from the road surface will be directed to grassed swales on both sides of the highway. The expected infiltration capacity of the grassed swales won't be enough to compensate for the additional highway runoff completely; however, check dams at regular intervals along the ditches will provide additional infiltration potential by retaining small volumes of water back during every rainfall event. These pockets of water at regular intervals along the swales will increase infiltration and evapotranspiration and significantly reduce runoff potential during small rainfall events of 5 mm or less. In Toronto, storms with 24-hour volumes of 5 mm or less contribute about 50% of the total average annual rainfall volume.

If linear dry ponds are included in the detailed design phase, they could provide additional opportunities for water balance along the study area.

A detailed site-specific water balance will be provided in the detailed design stage.

10. Conclusions and Recommendations

This Preliminary Drainage and Stormwater Management Report is prepared in support of the proposed Highway 413 within the CVC's jurisdiction from Mayfield Road in the east to Tenth Line in the west, covering a distance of approximately 12 km. Field investigations and desktop assessments were completed to assess the existing and proposed drainage conditions of the proposed Highway 413 corridor. The potential impacts were evaluated, and a conceptual drainage plan was prepared as part of the proposed works. Based on the preceding analysis, the following conclusions and recommendations are made.

- Under the current plan, the proposed Highway 413 corridor consists of a 6-lane divided highway with an open median and a two-lane transitway. In the ultimate conditions, the proposed highway will consist of an 8 lane + 2 HOV lanes highway and a two-lane transitway.
- The proposed highway corridor will add approximately 95 ha of impervious cover for the ultimate conditions (60 ha under the current plan) within the CVC's 12 km long section from Mayfield Road in the east to Tenth Line in the west.
- The proposed highway corridor will cross various watercourses and requires:
  - A 605 m span Credit River Bridge crossing
  - A 94 m span Levi's Creek Bridge crossing
  - A 12.2 m span Levi's Creek South Tributary Bridge crossing
  - 6 structural culverts
  - 45 non-structural culverts
- Hydrologic and hydraulic assessment of the proposed bridges and culverts was conducted as summarized in **Tables 6 and 8**. The proposed bridges and culverts meet the required freeboard, clearance, and overtopping criteria in most cases. There are a few locations where it is not possible to meet the freeboard criterion.

The hydraulic analysis of the proposed bridges indicates that the increase in the upstream flood elevations will be limited to less than 0.3 m except at the at the Levi Creek crossing east of Winston Churchill where the increase in the upstream is 0.55 m, this crossing will be within the ROW and so the proposed grading will consider this increase and prevent any impacts beyond the ROW.

A

Agency Meeting Minutes

Minutes

Meeting name
Drainage consultation meeting with Credit Valley Conservation, CVC, Consultants and MTO

Meeting date
Dec 10, 2020

Attendees
Jakub Kilis, CVC
Rizwan Haq, CVC
Lukasz Grobel, MTO
Shahbaz Asif, MTO
Felipe Sapaterio, AECOM
Brian Richert, AECOM
Rhonneke Van Riezen,AECOM
Jenny Dai, AECOM

Time
9:00am

Location
MS Teams

Project name
GTA West
GWP 13 20001
Assignment Number
2013-E-0008

AECOM project number
60347240

Prepared by
B. Richert/J.Dai

1) Brian Richert introduced project team and gave an overview of the project history, status and schedule, including:

    a) Stage 2 of GTAWest Study started in 2014 and was suspended in December 2015. On June 19, 2019, the government announced that the GTA West Study will resume from its point of suspension in 2015.
    b) Assessing and evaluating the shortlist of route alternatives have been completed and the preferred route and interchange locations were selected. Currently the design team is developing the preferred plan to a preliminary design level.
    c) The new corridor is anticipated to be a 4 to 6-lane highway with a separate adjacent transitway. The highway corridor has a capacity for widening to 10 lanes ultimately.

2) Brian Richert gave an overview of study area and drainage features within limits of CVC and drainage scope, including
    a) GTAWest corridor crosses three conservation authorities – Conservation Halton (CH), Credit Valley Conservation (CVC) and Toronto Region Conservation Authority (TRCA).
    b) The preferred GTAW route intersects four sub-watersheds in CVC's jurisdiction – Mullet Creek, Levi Creek, Credit River, and Huttonville Creek.
    c) Within CVC's jurisdiction, the preferred GTAW route extends approximately 12 km and new three interchanges are proposed – Winston Churchill Boulevard Interchange, Bovaird Drive Interchange, Mayfield Road Interchange.
    d) Primary tasks of drainage work include but not limited to watercourse crossing design, stormwater management, and possible creek realignment. A major bridge crossing over Credit River will be designed.
    e) Interchange drainage is an important feature. Channel realignment might be required at interchanges. Creek realignment has been considered as one of evaluation factors during the route section exercise.

3) Specific issues and design criteria discussion:
    a) Mullet Creek Subwatershed: The study area crosses headwater of Mullet Creek. A numbers of minor watercourse crossings are required to remain existing drainage pattern.
    b) Levi Creek Subwatershed: Minor creek realignment might be required for the tributaries of Levi Creek at/adject to the new Winston Churchill Boulevard Interchange.
    c) Credit River Bridge Crossing:
        i. Rhonneke indicates that 100-year erosion rate is determined based historical air photo review. The calculated 100-year erosion rate is approximately 20 m. The proposed piers will be located outside of 100-year erosion limits.
        ii. Generally, CVC is looking for technical supporting documents for review. CVC indicated that Design team should follow relevant technical guidelines including CVC Technical Guidelines for

Watercourse Crossings and TRCA's Meander Belt Delineation. Meander belt width is recommended to be provided as part of the technical supporting document.

iii. AECOM will provide a Technical Memo of Fluvial Geomorphology Assessment of Credit River to CVC for a review. Any drainage / fluvial submissions could be sent to Jakub Kilis (CVC) upon approval from MTO.

iv. Design Team noted that preliminary assessment based on CVC's HEC-RAS model (Stantec 2008) shows the proposed crossing will cause a minor increase on upstream Regulatory Flood Level (<5 cm) due to piers within floodplain. Design Team will provide technical document of hydraulics assessment for CVC review.

v. CVC indicated that there are no significant hydrology/hydraulics updates on Credit River recently. However, CVC will provide the up-to-date hydraulic model to the Design Team through data request.

d) Tributaries of Credit River and Hutonville Creek Subwatershed (GTAWest corridor from Bovaird Drive Interchange to Mayfield Road Interchange).

i. At many locations, the creek alignments overlap with GTAWest roadway platform and the footprint of new interchanges, certain level of creek realignments of Credit Creek tributaries and tributaries of Hutonville Creek might not be avoided. Design Team will further evaluate the potential impact and mitigation measures.

ii. Jakub Kilis pointed out that the City of Brampton is working on the Secondary Plan for Heritage Heights Community (stretching from Mayfield Road to the Credit River valley, and from Winston Churchill Boulevard to Mississauga Road). The development of Heritage Heights will change drainage nature of this area. Felipe Sapaterio indicated that Design Team had a meeting with the City and will continue to work with the City to integrate GTAWest design with Secondary Plan of Heritage Heights.

e) CVC is not expecting a lot of efforts on water balance for the roadway expansion work. However, erosion control is more critical for CVC. The erosion threshold should be determined by fluvial geomorphologic investigation at a reach by reach basis. Heritage Heights Sub-watershed Study has already characterized the natural heritages and established water balance and erosion control criteria which could be referred by Design Team.

f) Design Team will review source water protection documents which are published in CTC's website. For specific questions regarding source water protection, Design Team could contact Janet Ivey directly in CVC.

4) Data availability and request:

a) The project team will proceed the data request process.
b) Sub-watershed Characterization for Heritage Heights by Wood has been completed. The information available at the City's website could be used for GTAWest EA and Preliminary Study.
c) CVC could provide the latest hydrologic / hydraulic models and floodplain maps. However, CVC doesn't own soil maps.
d) Regarding applicable fluvial geomorphology reports, CVC could search up in their records if Design Team could highlight locations of interest.

5) Schedule and Consultation Protocol with CVC

a) Draft drainage deliverables will be completed in summer/fall next year.
b) The project team will set consultation meeting(s) shortly to establish design criteria and review key issues. Then another meeting might be required for conceptual design review.

Meeting Reference Attachments

Presentation Slides

Minutes

Meeting name
Hwy 413 - Consultation meeting with CVC

Meeting date
December 12, 2022

Location
Teams

Project number
60315006

Subject
Discussing the preliminary design with CVC

Time
11:00

Project name
GTA West

Prepared by
E. Cameron

Attendees
Brian Richert, AECOM
Javeed Khan, AECOM
Emily Cameron, AECOM
Felipe Sapateiro, AECOM
Tim Sorochinsky, AECOM
Rhonneke Van Riezen, AECOM
Gary Epp, AECOM
Jakub Kilis, CVC
Rizwan Haq, CVC
Christine Wilson, CVC
Hossein Hosseini, MTO
Shahbaz Asif, MTO
Curtis Beyer, MTO
Jonathan McGarry, MTO
Aamir Munir, WSP
Jenny Enoae, WSP
Josh Tong, WSP

Regrets
Dragan Ilic, AECOM
Jay Goldberg, WSP
Mark Gimpoli, WSP
Saif Ahmad, WSP
Christa Beard, WSP

Ref	Discussion / Action	Responsible	Due by
01	Introductions	INFO	
02	Safety moment – snow shovelling	INFO	
03	Agenda Overview	INFO	
04	Background Review	INFO	
05	Fish habitat summary – maps show where all direct or indirect fish habitat exists across the study area	INFO	
06	Channel realignment summary – there are a few watercourse realignments across the site, the most significant of which is at the Bovaird Dr. intersection	INFO	
07	The Heritage heights future development will be completed independent from the Highway design, but AECOM has been in communication with City of Brampton about it.	INFO	
08	Culvert sizing methodology & design criteria – Meet MTO design criteria (1m freeboard, no flooding impacts upstream, No overtopping), CVC Criteria (No increase in Regulatory flood upstream of ROW for regulated watercourses, or a maximum of 0.3m where increase is unavoidable). Regulated watercourse flows are based on HEC-RAS models plus additional for climate change, whereas flows at smaller crossings are determined based on Rational method or United Ontario Flow Method (UOFM) with OFAT flows as a reference.	INFO	
09	Other sizing considerations – Fluvial geomorphology and environment	INFO	
10	There are three main crossings within CVC jurisdiction – Credit River bridge (605m), Levi Creek north of Embleton (65m – 140m), south tributary of Levi Creek downstream of Winston Churchill (12m).	INFO	
11	Credit River Crossing – pier placement & 100yr erosion limit. Piers near watercourse – what are the chances of the watercourse shifting towards piers? How many years before that could occur? CVC is looking for pier locations designed so that if the watercourse comes in contact, the infrastructure is not threatened. The foundation may need to be deeper in these locations	CVC & Structural AECOM	

Ref	Discussion / Action	Responsible	Due by
	(deeper than scour depth). CVC will get back to us. Can we increase span of one set of piers at watercourse? Yes, that's a possible alternative, but more expensive. Should have a separate meeting about this with structural (Dragan). MECP has expectations for the project where environmental aspects may be a higher priority than cost – discussed in TRCA meeting last week. We need to think long term and have a thorough evaluation of alternatives. CVC will ask their geomorphologist to review the design and will complete a risk assessment and provide comments. More discussions will need to occur.		
12	Levi Crossing north of Embleton with redside dace criteria (30m offset + meander belt = 140m span). Different alternatives could minimize span. Could realign small section upstream to reduce span. Different pier configurations could minimize impacts. CVC can't comment on MECP regulations, however, it is CVC's preference not to alter the channel and to span the 100yr erosion rate of the watercourse. There is a private online pond connected upstream of proposed structure which impacts water levels, and realignment could include the removal of that connection – will need to discuss more in the future with all parties. Along Levi Creek we are more than spanning the wetlands, but more pier placement assessments could to minimize impacts.	All parties to discuss later	
13	Wetland impacts at Credit River crossing – constructability and short- and long-term impacts. The final pier configuration will account for this. We will mitigate impacts as much as possible and find optimal design and look for opportunities for enhancement if possible. MTO understands that criteria must be met and all factors be considered.	INFO	
14	AECOM will provide proposed drainage mosaic to CVC for review, showing culvert locations, ditch locations, ponds, watercourse realignments.	AECOM	
15	Next steps – what does CVC want to see? 30% design now, 60% next summer. What deliverables will AECOM have and in what format? TRCA wants all models, spreadsheets, all background files loaded on Sharepoint. CVC wants technical information, similar to TRCA. AECOM to provide folder template used for TRCA for CVC to review. Site-specific decision-making rationale should be included.	AECOM	ASAP
16	Ecology impacts – has this been reviewed? Environmental has input on potential impacts affected by span requirements. Ecological assessment of crossings will be part of impact assessment and will be submitted with the deliverables package.	INFO	
17	Check Levi Creek HEC-RAS flows – separate discussion between AECOM and CVC to confirm flows.	AECOM & CVC	ASAP
18	CVC recommends a 15% increase to flows to consider climate change. AECOM has assumed a 10% increase– AECOM and CVC will discuss.	AECOM & CVC	
19	If AECOM has any other questions / clarifications for CVC pass them along and meetings can be set up to discuss.	INFO	

Cameron, Emily

From:	Kilis, Jakub <Jakub.Kilis@cvc.ca>
Sent:	Friday, April 19, 2024 9:59 AM
To:	Cameron, Emily
Cc:	Khan, Javeed
Subject:	RE: RE: RE: RE: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hi Emily,

I'm looking into the Gateway West request for you.

On a separate note, I now have the follow-up to the previous discussion/comment in relation to the Heritage Heights Subwatershed Study. In absence of an approved subwatershed study, the design must follow the CVC SWM Guidelines. CVC updated comments are below:

For Credit River, Credit River Tributaries, and West Huttonville Creek, please update flood control, erosion control, and water balance calculations based on design criteria as identified in CVC Stormwater Management Guideline (July 2022):

Quantity Control:

1. For Credit River and Credit River Tributaries:
    a. Provide post to pre control for 2, 5, 10, 25, 50 & 100-year storm events.
    b. Requirement for post to pre control for Regional storm event must be determined by assessing the impact of development downstream to the point where the developed property is 10% of the total drainage area.
2. For West Huttonville Creek, provide post to pre control for 2, 5, 10, 25, 50 & 100-year, and Regional storm events.

Erosion Control:

1. For Credit River Tributaries and West Huttonville Creek, provide a geomorphic assessment by a fluvial geomorphologist and in accordance with Section 5 of the CVC SWM Guideline to determine a site-specific erosion control storage and target release rate.

Water Balance:

1. For Low Volume Groundwater Recharge Areas as identified in CVC SWM Guideline, best effort to maintain predevelopment infiltration/recharge is expected.
2. For all other areas, predevelopment infiltration/recharge must be maintained and for this purpose, a detailed and site-specific water balance analysis in accordance with Section 7 and Appendix A of the CVC SWM Guideline is required to determine the pre-development infiltration.
3. For vulnerable groundwater systems, infiltration design must be based on "clean water" practices.

Please let me know if you have any questions or concerns,
Jakub

From: Cameron, Emily <Emily.Cameron@aecom.com>
Sent: Thursday, April 18, 2024 2:29 PM
To: Kilis, Jakub <Jakub.Kilis@cvc.ca>
Cc: Khan, Javeed <Javeed.Khan@aecom.com>
Subject: [External] RE: RE: RE: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hello again Jakub,

I've gone through the 2008 Gateway West Subwatershed Study Update per your comments, and the PDF report I have does not contain any figures or appendices. The old 1999 report does, but some are outdated. It is difficult to know where the unit flow rates are applied without the Nodes shown in a figure. If you have a version of this report with the figures and appendices please provide.

Thanks so much,

Emily Cameron, P.Eng
She/her
Water Resources Engineer, Water
emily.cameron@aecom.com

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aecom.com

From: Kilis, Jakub <Jakub.Kilis@cvc.ca>
Sent: Wednesday, April 17, 2024 11:23 AM
To: Cameron, Emily <Emily.Cameron@aecom.com>
Cc: Khan, Javeed <Javeed.Khan@aecom.com>
Subject: RE: RE: RE: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hi Emily,

In light of the city not being in a position to share the document CVC will provide a revised comment shortly. I'll provide this in writing in the next few days, just giving our engineers a chance to discuss.

Thanks,
Jakub

From: Cameron, Emily <Emily.Cameron@aecom.com>
Sent: Monday, April 15, 2024 3:10 PM
To: Kilis, Jakub <Jakub.Kilis@cvc.ca>
Cc: Khan, Javeed <Javeed.Khan@aecom.com>
Subject: [External] RE: RE: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hi Jakub,

I contacted the City to obtain the Heritage heights report and they didn't want to provide it as it has not been approved and may need changes (see email below). Pam suggested reaching out to Wood directly, but since it's a City document Wood would not be in a position to share.

Please advise on how we should proceed with the following CVC comment:

Please update the flood control and erosion control calculations based on the target flows and storage requirements as identified in the following documents:

a. For Credit River, Credit River Tributaries, and West Huttonville Creek, please refer to the design criteria as identified in Heritage Heights Subwatershed Study (Phase 2, Subwatershed Impact Assessment, WOOD, March 2022).

Thanks,

Emily Cameron, P.Eng
She/her
Water Resources Engineer, Water
emily.cameron@aecom.com

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aecom.com

From: Cooper, Pam Pam.Cooper@brampton.ca
Sent: Friday, April 12, 2024 10:38 AM
To: Cameron, Emily Emily.Cameron@aecom.com
Cc: Singer, Geoffrey Geoffrey.Singer@brampton.ca
Subject: RE: RE: Report request

Hi Emily,

I spoke with Geoffrey and as the report has not been approved by Brampton or posted publicly the thought was that it is best to direct AECOM to make a direct request from Wood as the best option. We also feel we should flag that the secondary plan is still under appeal and any work done by Wood would have been based on the Council-adopted plan that does not make provision for a highway corridor.

Regards,

Pam Cooper, MCIP, RPP
Manager, Environmental Planning
Environment & Development Engineering Division
Planning, Building & Growth Management Department
pam.cooper@brampton.ca T: 905.874.2265

BRAMPTON

From: Kilis, Jakub <Jakub.Kilis@cvc.ca>
Sent: Thursday, March 21, 2024 4:35 PM
To: Cameron, Emily <Emily.Cameron@aecom.com>
Subject: RE: RE: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hi Emily,

This is a City of Brampton document and you need to reach out to the City to acquire a copy. The good contact person at the city is Pamela Cooper-Hood, Manager of Environmental Planning.

Regards,
Jakub

From: Cameron, Emily <Emily.Cameron@aecom.com>
Sent: Wednesday, March 6, 2024 2:55 PM
To: Kilis, Jakub <Jakub.Kilis@cvc.ca>
Cc: Khan, Javeed <Javeed.Khan@aecom.com>
Subject: [External] RE: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hi Jakub,

Thank you for your comments on the Hwy 413 Drainage and Stormwater Report. Can you please send us the Heritage Heights Subwatershed Study Impact Assessment (WOOD, March 2022). I seem to have part of the report, but not all of it.

Thanks so much,

Emily Cameron, P.Eng
Water Resources Engineer, Water
D +647-616-3665
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From: Kilis, Jakub <Jakub.Kilis@cvc.ca>
Sent: Monday, March 4, 2024 10:56 PM
To: Khan, Javeed <Javeed.Khan@aecom.com>
Cc: Richert, Brian <Brian.Richert@aecom.com>
Subject: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hi Javeed,

Please find below CVC comments on the draft Drainage and Stormwater Report.

General

1. Considering the existing land cover/land use within Heritage Heights, the proposed highway corridor will cross some regulated watercourses, however, the proposed development in Heritage Heights may change the drainage area of some of these crossings as shown in the table below:

Location	Culvert ID
Bovaird Drive	CR_NP_CRR_3_WC1 CR_NP_CRR_3_WC1.1 CR_NP_CRR_3_WC2 CR_NP_CRR_3_WC3 CR_NP_CRR_3_WC3.1 CR_NP_CRR_3_WC3.2 CR_NP_CRR_3_WC4 CR_NP_CRR_3_WC5 CR_NP_CRR_3_WC5.1
Bovaird Drive	CR_NP_CRR_9_WC1 CR_NP_CRR_9_WC2
Wanless Drive	CR_NP_CRR_13_WC3 CR_NP_CRR_13_WC4.1 CR_NP_CRR_13_WC5

   Also, according to the latest version of Heritage Heights Subwatershed Study Impact Assessment (WOOD, March 2022), the proposed highway corridor seems to have one crossing at a proposed realigned reach of Credit River Tributary south of Bovaird Drive that is not considered in the submitted report. The proposed channel realignments within Heritage Heights study area may also limit the locations where the outflow from the proposed highway SWM facilities can be released. Coordination with Heritage Heights development is recommended.

2. The City of Brampton IDF curves have been considered in previous comprehensive subwatershed studies within the study area which predicted larger existing rainfall volumes 24-hr, 50-yr and 100-yr

storm events. Consideration of IDF curves and hydrologic parameters that provide more conservative results is recommended.

3. CVC Stormwater Management Criteria, August 2012 has been cited in the report while the latest version is July 2022. Please update the report.

4. Please provide digital copies of all hydrologic and hydraulic models.

Crossings

5. Please confirm that the proposed crossings will be flood free under regulatory storm and add a column to Table 6 to indicate the freeboard under Regulatory storm.

6. Please demonstrate through modeling and calculations that there will be no offsite increase in flood hazard as result of the proposed crossings during a Regulatory storm event.

7. The report indicates that geomorphic assessment has been completed for the proposed watercourse crossings along Highway 413 and will be complied in a separate report. The geomorphic assessment will be reviewed upon submission and comments will be provided separately.

8. For confined valley systems, geotechnical assessment is required to identify the impacts of the proposed works on the stability of the valley slopes when designing the crossing. Please provide a discussion in the report.

Stormwater Management

9. Please note that comprehensive studies (e.g., subwatershed studies, secondary plans, etc.) supersede the minimum requirements as identified in CVC SWM Guideline (July 2022). Please update the flood control and erosion control calculations based on the target flows and storage requirements as identified in the following documents:
   a. For Credit River, Credit River Tributaries, and West Huttonville Creek, please refer to the design criteria as identified in Heritage Heights Subwatershed Study (Phase 2, Subwatershed Impact Assessment, WOOD, March 2022).
   b. For Mullet and Levi creeks, please refer to the design criteria as identified in Gateway West Subwatershed Study Update (2008).

10. For sites with no SWM pond, the CVC's minimum erosion control requirement is retention of the first 5mm of every rainfall event. Please update the calculations and the report accordingly.

Please note additional comments will be provided upon review of the response and the revised report and let us know if you have any questions about the above,
Jakub

I'm working remotely and in the office. The best way to reach me is by email, mobile phone or Microsoft Teams.

Jakub Kilis | RPP
Senior Manager, Infrastructure and Regulations | Credit Valley Conservation
905-670-1615 ext 287 | M: 647-212-6554
jakub.kilis@cvc.ca | cvc.ca

Cameron, Emily

From:	Kilis, Jakub <Jakub.Kilis@cvc.ca>
Sent:	Wednesday, April 24, 2024 9:15 AM
To:	Cameron, Emily
Cc:	Khan, Javeed
Subject:	RE: RE: RE: RE: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hi Emily,

To expedite the process, our engineering staff summarized the quantity and erosion control and water balance requirements for drainage to Mullet and Levi Creeks based on the Gateway West Subwatershed Study below. The applicant should refer to subwatershed study reports for additional details and background information.

Quantity and Erosion Control:

1. Mullet Creek
   - Erosion Control: Based on Table 5.4 of Gateway West Subwatershed Study Update (2008), for Mullet Creek, the erosion control storage volume and release rate requirements are 250 m^3/impervious ha storage, and outflow of 1.6 L/s/impervious ha.
   - Quantity Control: The following target unit flows must be used to estimate storage requirement for quantity control for drainage to Mullet Creek upstream of Heritage Road:

Mullet Creek Upstream of Heritage Rd, unit flows based on Node 729 (Drainage Area 486 ha)- Gateway West Subwatershed Study, Gartner Lee, Cosburn Patterson Mather, March 1999, Table 3 Summary of Existing Peak Flows							
Storm Event	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Regional
Flow at Node 729 (m^3/s)	8.48	13.1	14.5	19.7	23.4	26.3	37.4
Unit Flow (m^3/s/ha)	0.017	0.027	0.030	0.041	0.048	0.054	0.077

2. Levi Creek Southern Branch
   - Erosion Control: Based on Table 5.4 of Gateway West Subwatershed Study Update (2008), for Levi Creek Southern Branch, the erosion control storage volume and release rate requirements are 250 m^3/impervious ha storage, and outflow of 3.0 L/s/impervious ha.
   - Quantity Control: The following target unit flows must be used to estimate storage requirement for quantity control for drainage to Levi Creek Southern Branch upstream of Heritage Road:

Levi Creek Southern Branch Upstream of Heritage Rd, unit flows based on Node 620 (Drainage Area 642 ha)- Gateway West Subwatershed Study, Gartner Lee, Cosburn Patterson Mather, March 1999, Table 3 Summary of Existing Peak Flows							
Storm Event	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Regional
Flow at Node 620 (m^3/s)	14.8	22.6	25.1	35.3	40.5	46.3	56.4
Unit Flow ($m^3/s/ha$)	0.023	0.035	0.039	0.055	0.063	0.072	0.088

3. Levi Creek Main Branch
    - Erosion Control: Based on Table 5.4 of Gateway West Subwatershed Study Update (2008), for Levi Creek Main Branch, the erosion control storage volume and release rate requirements are 300 m^3/impervious ha storage, and outflow of 1.4 L/s/impervious ha.
    - Quantity Control: The following target unit flows must be used to estimate storage requirement for quantity control for drainage to Levi Creek Main Branch upstream of Embleton Road:

Levi Creek Main Branch Upstream of Embleton Rd, unit flows based on Node 612 (Drainage Area 780 ha)- Gateway West Subwatershed Study, Gartner Lee, Cosburn Patterson Mather, March 1999, Table 3 Summary of Existing Peak Flows							
Storm Event	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Regional
Flow at Node 612 (m^3/s)	13.7	21.8	25.3	35.4	41.7	48.5	63.8
Unit Flow ($m^3/s/ha$)	0.018	0.028	0.032	0.045	0.053	0.062	0.082

Water Balance:

1. For Low Volume Groundwater Recharge Areas as identified in CVC SWM Guideline, best effort to maintain predevelopment infiltration/recharge is expected.
2. For all other areas, pre-development infiltration/recharge must be maintained and for this purpose, a detailed and site-specific water balance analysis in accordance with Section 7 and Appendix A of the CVC SWM Guideline is required to determine the pre-development infiltration.
3. For vulnerable groundwater systems, infiltration design must be based on "clean water" practices.

Please let me know if you have any questions or concerns,
Jakub

I'm working remotely and in the office. The best way to reach me is by email, mobile phone or Microsoft Teams.

Jakub Kilis | RPP
Senior Manager, Infrastructure and Regulations | Credit Valley Conservation
905-670-1615 ext 2870 | M: 647-212-6554
jakub.kilis@cvc.ca | cvc.ca

Name of Document Reviewed: Drainage & Stormwater Management Report – West Section CVC Area
Reviewer(s): Jakub Kilis, CVC

<table>
<tr><th>Comment #</th><th>Document Reference (Table, page, paragraph number, etc.)</th><th>CVC Comments (March 4, 2024)</th><th>AECOM’s Response (July15, 2024)</th></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">SWM Report</td></tr>
<tr><td>1</td><td>General</td><td>
Considering the existing land cover/land use within Heritage Heights, the proposed highway corridor will cross some regulated watercourses, however, the proposed development in Heritage Heights may change the drainage area of some of these crossings as shown in the table below:
<table>
<tr><th>Location</th><th>Culvert ID</th></tr>
<tr><td>Bovaird Drive</td><td>CR_NP_CRR_3_WC1
CR_NP_CRR_3_WC1.1
CR_NP_CRR_3_WC2
CR_NP_CRR_3_WC3
CR_NP_CRR_3_WC3.1
CR_NP_CRR_3_WC3.2
CR_NP_CRR_3_WC4
CR_NP_CRR_3_WC5
CR_NP_CRR_3_WC5.1</td></tr>
<tr><td>Bovaird Drive</td><td>CR_NP_CRR_9_WC1
CR_NP_CRR_9_WC2</td></tr>
<tr><td>Wanless Drive</td><td>CR_NP_CRR_13_WC3
CR_NP_CRR_13_WC4.1
CR_NP_CRR_13_WC5</td></tr>
</table>
Also, according to the latest version of Heritage Heights Subwatershed Study Impact Assessment (WOOD, March 2022), the proposed highway corridor seems to have one crossing at a proposed realigned reach of Credit River Tributary south of Bovaird Drive that is not considered in the submitted report. The proposed channel realignments within Heritage Heights study area may also limit the locations where the outflow from the proposed highway SWM facilities can be released. Coordination with Heritage Heights development is recommended.

Updated comment from April 19, 2024:
In absence of an approved subwatershed study, the design must follow the CVC SWM Guidelines. CVC updated comments are below:

For Credit River, Credit River Tributaries, and West Huttonville Creek, please update flood control, erosion control, and water balance calculations based on design criteria as identified in CVC Stormwater Management Guideline (July 2022):

<u>Quantity Control</u>:
For Credit River and Credit River Tributaries:
<ol type="a">
Provide post to pre control for 2, 5, 10, 25, 50 & 100-year storm events.
</td><td>
Quantity Control:

As there is no subwatershed study for the Credit River, quantity control criteria is based on the CVC guidelines (post to pre-development quantity controls). The original pond designs were based on those criteria so no updates are required to the ponds in the Credit River subwatershed.

Erosion Control:

For erosion control criteria, where SWM ponds are proposed, the 25mm storm will be retained for 24 hours per MECP SWMPP criteria. An erosion threshold assessment can be completed by fluvial geomorphology at detailed design stage.

Water Balance:

A detailed site-specific water balance will be provided in the detailed design stage. The proposed highway has a rural cross-section, and runoff generated at the highway surface will be conveyed to the highway swales on both sides and an open median. These swales will have check dams to hold back runoff, promoting infiltration and evapotranspiration. The spacing of check dams and the expected volume to be infiltrated will be determined at the detailed design stage.

Note:

Once the Heritage Heights Subwatershed Study Impact Assessment becomes available, coordination will have to take place between the Heritage Heights and the Highway design teams to ensure there are no conflicts.
</td></tr>
</table>

Comment #	Document Reference (Table, page, paragraph number, etc.)	CVC Comments (March 4, 2024)	AECOM's Response (July15, 2024)
		b. Requirement for post to pre control for Regional storm event must be determined by assessing the impact of development downstream to the point where the developed property is 10% of the total drainage area. 2. For West Huttonville Creek, provide post to pre control for 2, 5, 10, 25, 50 & 100-year, and Regional storm events. Erosion Control: 1. For Credit River Tributaries and West Huttonville Creek, provide a geomorphic assessment by a fluvial geomorphologist and in accordance with Section 5 of the CVC SWM Guideline to determine a site-specific erosion control storage and target release rate. Water Balance: 1. For Low Volume Groundwater Recharge Areas as identified in CVC SWM Guideline, best effort to maintain predevelopment infiltration/recharge is expected. 2. For all other areas, predevelopment infiltration/recharge must be maintained and for this purpose, a detailed and site-specific water balance analysis in accordance with Section 7 and Appendix A of the CVC SWM Guideline is required to determine the pre-development infiltration. 3. For vulnerable groundwater systems, infiltration design must be based on "clean water" practices.	
2	General	The City of Brampton IDF curves have been considered in previous comprehensive subwatershed studies within the study area which predicted larger existing rainfall volumes 24-hr, 50-yr and 100-yr storm events. Consideration of IDF curves and hydrologic parameters that provide more conservative results is recommended.	The proposed project traverses various municipalities (Vaughan, Brampton, Mississauga, Milton) and three conservation authorities (TRCA, CVC, and CH). The MTO IDF curves are used to ensure consistency across the project for small drainage courses. CVC flows were used for all regulated watercourses.
3	General	CVC Stormwater Management Criteria, August 2012 has been cited in the report while the latest version is July 2022. Please update the report.	Noted
4	General	Please provide digital copies of all hydrologic and hydraulic models.	Noted
5	Crossings	Please confirm that the proposed crossings will be flood free under regulatory storm and add a column to Table 6 to indicate the freeboard under Regulatory storm.	The regulated watercourses have been modeled and confirmed that they will not be overtopped during a regulatory event, Table 6 (now renamed Table 8) has been updated for regulated watercourses only.
6	Crossings	Please demonstrate through modeling and calculations that there will be no offsite increase in flood hazard as result of the proposed crossings during a Regulatory storm event.	The regulated watercourses have been modeled and confirmed that there will be minimal water level increases upstream, with no impacts to adjacent lands
7	Crossings	The report indicates that geomorphic assessment has been completed for the proposed watercourse crossings along Highway 413 and will be complied in a separate report. The geomorphic assessment will be reviewed upon submission and comments will be provided separately.	Noted

<table>
<tr><th>Comment #</th><th>Document Reference (Table, page, paragraph number, etc.)</th><th>CVC Comments (March 4, 2024)</th><th>AECOM's Response (July15, 2024)</th></tr>
<tr><td>8</td><td>Crossings</td><td>For confined valley systems, geotechnical assessment is required to identify the impacts of the proposed works on the stability of the valley slopes when designing the crossing. Please provide a discussion in the report.</td><td>This will be addressed in detailed design</td></tr>
<tr><td>9</td><td>SWM</td><td>Please note that comprehensive studies (e.g., subwatershed studies, secondary plans, etc.) supersede the minimum requirements as identified in CVC SWM Guideline (July 2022). Please update the flood control and erosion control calculations based on the target flows and storage requirements as identified in the following documents:
a. For Credit River, Credit River Tributaries, and West Huttonville Creek, please refer to the design criteria as identified in Heritage Heights Subwatershed Study (Phase 2, Subwatershed Impact Assessment, WOOD, March 2022).
b. For Mullet and Levi creeks, please refer to the design criteria as identified in Gateway West Subwatershed Study Update (2008).

Updated comment from April 24, 2024:
To expedite the process, our engineering staff summarized the quantity and erosion control and water balance requirements for drainage to Mullet and Levi Creeks based on the Gateway West Subwatershed Study below. The applicant should refer to subwatershed study reports for additional details and background information.

<u>Quantity and Erosion Control:</u>
1. Mullet Creek
• <u>Erosion Control:</u> Based on Table 5.4 of Gateway West Subwatershed Study Update (2008), for Mullet Creek, the erosion control storage volume and release rate requirements are 250 m^3/impervious ha storage, and outflow of 1.6 L/s/impervious ha.
• <u>Quantity Control:</u> The following target unit flows must be used to estimate storage requirement for quantity control for drainage to Mullet Creek upstream of Heritage Road:

<table>
<tr><th colspan="8">Mullet Creek Upstream of Heritage Rd, unit flows based on Node 729 (Drainage Area 486 ha)- Gateway West Subwatershed Study, Gartner Lee, Cosburn Patterson Mather, March 1999, Table 3 Summary of Existing Peak Flows</th></tr>
<tr><td>Storm Event</td><td>2-yr</td><td>5-yr</td><td>10-yr</td><td>25-yr</td><td>50-yr</td><td>100-yr</td><td>Regional</td></tr>
<tr><td>Flow at Node 729 (m^3/s)</td><td>8.48</td><td>13.1</td><td>14.5</td><td>19.7</td><td>23.4</td><td>26.3</td><td>37.4</td></tr>
<tr><td>Unit Flow ($m^3/s/ha$)</td><td>0.017</td><td>0.027</td><td>0.030</td><td>0.041</td><td>0.048</td><td>0.054</td><td>0.077</td></tr>
</table>

2. Levi Creek Southern Branch
• <u>Erosion Control:</u> Based on Table 5.4 of Gateway West Subwatershed Study Update (2008), for Levi Creek Southern Branch, the erosion control storage volume and release rate requirements are 250 m^3/impervious ha storage, and outflow of 3.0 L/s/impervious ha.
• <u>Quantity Control:</u> The following target unit flows must be used to estimate storage requirement for quantity control for drainage to Levi Creek Southern Branch upstream of Heritage Road:</td><td>The quantity control and erosion control criteria provided by the CVC in April 2024 are different than what the original design was based on. Stormwater management has been reassessed within the Mullet Creek and Levi Creek subwatersheds, and pond designs have been updated accordingly. See response to comment No. 1 regarding water balance.</td></tr>
</table>

<table>
<tr><th>Comment #</th><th>Document Reference (Table, page, paragraph number, etc.)</th><th>CVC Comments (March 4, 2024)</th><th>AECOM's Response (July15, 2024)</th></tr>
<tr><td></td><td></td><td>

<table>
<tr><th colspan="8">Levi Creek Southern Branch Upstream of Heritage Rd, unit flows based on Node 620 (Drainage Area 642 ha)- Gateway West Subwatershed Study, Gartner Lee, Cosburn Patterson Mather, March 1999, Table 3 Summary of Existing Peak Flows</th></tr>
<tr><td>Storm Event</td><td>2-yr</td><td>5-yr</td><td>10-yr</td><td>25-yr</td><td>50-yr</td><td>100-yr</td><td>Regional</td></tr>
<tr><td>Flow at Node 620 (m^3/s)</td><td>14.8</td><td>22.6</td><td>25.1</td><td>35.3</td><td>40.5</td><td>46.3</td><td>56.4</td></tr>
<tr><td>Unit Flow ($m^3/s/ha$)</td><td>0.023</td><td>0.035</td><td>0.039</td><td>0.055</td><td>0.063</td><td>0.072</td><td>0.088</td></tr>
</table>

3. Levi Creek Main Branch
   - Erosion Control: Based on Table 5.4 of Gateway West Subwatershed Study Update (2008), for Levi Creek Main Branch, the erosion control storage volume and release rate requirements are 300 m^3/impervious ha storage, and outflow of 1.4 L/s/impervious ha.
   - Quantity Control: The following target unit flows must be used to estimate storage requirement for quantity control for drainage to Levi Creek Main Branch upstream of Embleton Road:

<table>
<tr><th colspan="8">Levi Creek Main Branch Upstream of Embleton Rd, unit flows based on Node 612 (Drainage Area 780 ha)- Gateway West Subwatershed Study, Gartner Lee, Cosburn Patterson Mather, March 1999, Table 3 Summary of Existing Peak Flows</th></tr>
<tr><td>Storm Event</td><td>2-yr</td><td>5-yr</td><td>10-yr</td><td>25-yr</td><td>50-yr</td><td>100-yr</td><td>Regional</td></tr>
<tr><td>Flow at Node 612 (m^3/s)</td><td>13.7</td><td>21.8</td><td>25.3</td><td>35.4</td><td>41.7</td><td>48.5</td><td>63.8</td></tr>
<tr><td>Unit Flow ($m^3/s/ha$)</td><td>0.018</td><td>0.028</td><td>0.032</td><td>0.045</td><td>0.053</td><td>0.062</td><td>0.082</td></tr>
</table>

Water Balance:

1. For Low Volume Groundwater Recharge Areas as identified in CVC SWM Guideline, best effort to maintain predevelopment infiltration/recharge is expected.
2. For all other areas, pre-development infiltration/recharge must be maintained and for this purpose, a detailed and site-specific water balance analysis in accordance with Section 7 and Appendix A of the CVC SWM Guideline is required to determine the pre-development infiltration.
3. For vulnerable groundwater systems, infiltration design must be based on "clean water" practices.
</td><td></td></tr>
<tr><td>10</td><td>SWM</td><td>For sites with no SWM pond, the CVC's minimum erosion control requirement is retention of the first 5mm of every rainfall event. Please update the calculations and the report accordingly.</td><td>MTO does not use infiltration facilities on the main line of the highway as the highway is a long, thin strip of impervious surface and doesn't significantly impact groundwater balance. The proposed roadside swales with check dams will provide an opportunity for infiltration and evapotranspiration for water balance and water quality treatment.</td></tr>
</table>

Name of Document Reviewed: GTA West SWM Report – CVC Section	
Reviewer(s): CVC	

Comment #	Document Reference (Table, page, paragraph number, etc.)	Reviewer's Comments	Lead's Disposition
Electronic Message from Jakub Kilis, Metrolinx, dated April 25, 2025			
1.	SWM Report - General	Digital copies of the hydrologic and hydraulic models, geomorphic assessment for the proposed crossings, and site-specific erosion control storage and target release rate for Credit River Tributaries and West Huttonville Creek (in absence of HHSWS Impact Assessment) have not been provided despite our request for these in previous comments. These supporting data are required to finalize the review at this stage. Other studies such as geotechnical assessment for confined valley systems and site-specific water balance analysis for significant groundwater recharge areas can be deferred to detailed design stage.	Models and geomorphic assessment are attached. The site-specific erosion control designs will be completed at the detailed design stage for the entire study area (CVC, TRCA, CH)
2.	SWM Report - Crossings	Except for Credit River and Levi Creek main branch crossings, confirmation that the proposed crossings will be flood free under Regulatory storm is not provided for several other regulated watercourses. Please extend the modeling exercise to all regulated watercourses along Highway 413 corridor and demonstrate that the proposed crossings will be flood free under Regulatory storm event.	The report examined the Regulatory storm impacts on the Credit River and Levi Creek downstream of Winston Churchill Blvd., utilizing HEC-RAS models. According to the mapping available on Regulation Mapping - Credit Valley Conservation, there are 11 additional culverts that are on regulated watercourses – see table below and Table 9 in the report.

Culvert	Description
CR_MC_MUL_8_WC1	Larger culvert proposed for ecology purposes (1050mm diameter circular culvert required for hydraulics, and a 3.6m x 3.0m box proposed)
CR_MC_MUL_8_WC4	A HEC-RAS model was created to simulate this crossing and compare the proposed conditions to the existing. Model results indicate that there is no significant impact on Regional water levels.
CR_LC_LEV_1_WC2	Larger culvert proposed for ecology purposes (2.1m span required for hydraulics, and 6mx1.2 m box proposed)
CR_LC_LEV_2_WC6	The existing culvert crossing at Embleton, approximately 70 m upstream of the proposed culvert, has not been investigated. There is insufficient information on existing conditions and hydraulics to make a proper comparison with the proposed design, so this will need to be analyzed at the detailed design stage.
CR_NP_CRR_3_WC1.1	These culverts are situated within the proposed Bovaird interchange. Some watercourses will be realigned, and additional culverts are planned to direct external areas across the highway. Rainwater runoff from the highway surface will be managed by the proposed stormwater management (SWM) pond. Comparing the existing flood elevation to the proposed elevation is challenging at this
CR_NP_CRR_3_WC2	
CR_NP_CRR_3_WC3	
CR_NP_CRR_3_WC3.1	

<table>
<tr><th>Comment #</th><th>Document Reference (Table, page, paragraph number, etc.)</th><th>Reviewer's Comments</th><th>Lead's Disposition</th></tr>
<tr><td></td><td></td><td></td><td><table>
<tr><td>CR_NP_CRR_3_WC3.2</td><td rowspan="2">stage and cannot be completed now; this comparison will need to be confirmed during the detailed design phase.</td></tr>
<tr><td>CR_NP_CRR_3_WC4</td></tr>
<tr><td>CR_NP_CRR_9_WC2</td><td>There appears to be a driveway culvert in the approximate location of the new Heritage realignment culvert crossing. There is not enough information on the existing conditions to properly compare to the proposed, so this will need to be analyzed at detailed design.</td></tr>
</table></td></tr>
<tr><td>3.</td><td>SWM Report - Crossings</td><td>As mentioned above, please extend the modeling exercise to all regulated watercourses along Highway 413 and demonstrate that the proposed crossings will cause no offsite impact to private property under Reguatory storm event.</td><td>This was completed for culvert CR_MC_MUL_8_WC4. No significant impacts to Regional water levels or adjacent properties during a Regional event (A 3 cm Regional increase was determined). CR_LC_LEV_2_WC6 and CRR_3_WC3.1, as well as all of the culverts within the Bovaird Drive interchange, will have to be analyzed at detailed design when more information is known about the existing hydraulics and proposed design.</td></tr>
<tr><td>4.</td><td>SWM Report - Crossings</td><td>As acknowledged, please provide geomorphic assessment for the proposed watercourse crossings along Highway 413 corridor. The geomorphic assessment will be reviewed upon submission and comments will be provided separately.</td><td>The geomorphic assessment is attached.</td></tr>
<tr><td>5.</td><td>SWM Report – Erosion control</td><td>For Credit River Tributaries and West Huttonville Creek, provide a geomorphic assessment by a fluvial geomorphologist and in accordance with Section 5 of the CVC SWM Guideline to determine a site-specific erosion control storage and target release rate. Please update Section 2.2.3 Stormwater Management Criteria and revise the preliminary design and supporting calculations accordingly. As acknowledged in responses to previous CVC comments, coordination with Heritage Heights development is recommended once the Heritage Heights Subwatershed Study Impact Assessment becomes available.</td><td>The geomorphic assessment is attached.</td></tr>
<tr><td>6.</td><td>SWM Report – Water Balance</td><td>Except for Low Volume Groundwater Recharge Areas (as identified in CVC SWM Guideline), predevelopment infiltration/recharge must be maintained to address Water Balance. For this purpose, a detailed and site-specific water balance analysis in accordance with Section 7 and Appendix A of the CVC SWM Guideline is required at detailed design stage to determine the pre-development infiltration. Also, for vulnerable groundwater systems, infiltration design must be based on "clean water" practices. Please update Section 2.2.3 Stormwater Management Criteria accordingly.</td><td>Section 2.2.3 is updated. A detailed and site-specific water balance analysis in accordance with Section 7 and Appendix A of the CVC SWM Guideline will be conducted at the detailed design stage.</td></tr>
</table>

Cameron, Emily

From:	Kilis, Jakub <Jakub.Kilis@cvc.ca>
Sent:	April 25, 2025 9:57 AM
To:	Cameron, Emily
Subject:	RE: RE: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hi Emily,

My understanding was that the comments below on the review of the updated draft Drainage and Stormwater Report were previously shared. It does not appear to be the case. Please see below:

General

1. Digital copies of the hydrologic and hydraulic models, geomorphic assessment for the proposed crossings, and site-specific erosion control storage and target release rate for Credit River Tributaries and West Huttonville Creek (in absence of HHSWS Impact Assessment) have not been provided despite our request for these in previous comments. These supporting data are required to finalize the review at this stage. Other studies such as geotechnical assessment for confined valley systems and site-specific water balance analysis for significant groundwater recharge areas can be deferred to detailed design stage.

Crossings

2. Except for Credit River and Levi Creek main branch crossings, confirmation that the proposed crossings will be flood free under Regulatory storm is not provided for several other regulated watercourses. Please extend the modeling exercise to all regulated watercourses along Highway 413 corridor and demonstrate that the proposed crossings will be flood free under Regulatory storm event.
3. As mentioned above, please extend the modeling exercise to all regulated watercourses along Highway 413 and demonstrate that the proposed crossings will cause no offsite impact to private property under Regulatory storm event.
4. As acknowledged, please provide geomorphic assessment for the proposed watercourse crossings along Highway 413 corridor. The geomorphic assessment will be reviewed upon submission and comments will be provided separately.

Erosion Control:

5. For Credit River Tributaries and West Huttonville Creek, provide a geomorphic assessment by a fluvial geomorphologist and in accordance with Section 5 of the CVC SWM Guideline to determine a site-specific erosion control storage and target release rate. Please update Section 2.2.3 Stormwater Management Criteria and revise the preliminary design and supporting calculations accordingly. As acknowledged in responses to previous CVC comments, coordination with Heritage Heights development is recommended once the Heritage Heights Subwatershed Study Impact Assessment becomes available.

Water Balance:

6. Except for Low Volume Groundwater Recharge Areas (as identified in CVC SWM Guideline), predevelopment infiltration/recharge must be maintained to address Water Balance. For this purpose, a detailed and site-specific water balance analysis in accordance with Section 7 and

Appendix A of the CVC SWM Guideline is required at detailed design stage to determine the pre-development infiltration. Also, for vulnerable groundwater systems, infiltration design must be based on “clean water” practices. Please update Section 2.2.3 Stormwater Management Criteria accordingly.

Please let us know if you have any questions about the above,
Jakub

Jakub Kilis | RPP
Senior Manager, Infrastructure and Regulations | Credit Valley Conservation
905-670-1615 ext 2870 | M: 647-212-6554
jakub.kilis@cvc.ca | cvc.ca

Our working hours may be different. Please do not feel obligated to reply outside of your scheduled working hours. Let’s work together to help foster healthy work-life boundaries.

View our privacy statement

From: Cameron, Emily <Emily.Cameron@aecom.com>
Sent: Tuesday, April 1, 2025 2:01 PM
To: Kilis, Jakub <Jakub.Kilis@cvc.ca>; Khan, Javeed <Javeed.Khan@aecom.com>
Subject: [External] RE: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hi Jakub,

I hope you are well. Please provide an update on the status of your review for Hwy 413 – CVC Section.

Thanks so much,

Emily Cameron, P.Eng
She/her
Water Resources Engineer, Water
emily.cameron@aecom.com

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From: Kilis, Jakub <Jakub.Kilis@cvc.ca>
Sent: August 13, 2024 10:28 AM
To: Khan, Javeed <Javeed.Khan@aecom.com>
Cc: Richert, Brian <Brian.Richert@aecom.com>; Cameron, Emily <Emily.Cameron@aecom.com>; Sapateiro, Felipe <felipe.sapateiro@aecom.com>; Gimpoli, Mark <mark.gimpoli@wsp.com>; Beyer, Curtis (MTO) <curtis.beyer@ontario.ca>; McGarry, Jonathan (MTO) <jonathan.mcgarry@ontario.ca>; Brown, Chris (MTO) <Chris.Brown2@ontario.ca>; Asif, Shahbaz (MTO) <Shahbaz.Asif@ontario.ca>
Subject: RE: RE: RE: RE: RE: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hi Javeed,

We have successfully downloaded the report and started our review. I will be in touch once we've had a chance to finish the review.

Regards,
Jakub

From: Khan, Javeed <Javeed.Khan@aecom.com>
Sent: Monday, August 12, 2024 4:12 PM
To: Kilis, Jakub <Jakub.Kilis@cvc.ca>
Cc: Richert, Brian <Brian.Richert@aecom.com>; Cameron, Emily <Emily.Cameron@aecom.com>; Sapateiro, Felipe <felipe.sapateiro@aecom.com>; Gimpoli, Mark <mark.gimpoli@wsp.com>; Beyer, Curtis (MTO) <curtis.beyer@ontario.ca>; McGarry, Jonathan (MTO) <jonathan.mcgarry@ontario.ca>; Brown, Chris (MTO) <Chris.Brown2@ontario.ca>; Asif, Shahbaz (MTO) <Shahbaz.Asif@ontario.ca>
Subject: [External] RE: RE: RE: RE: CVC Comments - MTO Hwy 413 - draft Drainage and Stormwater Report

Hi Jakub,

The final drainage report for the Highway 413 CVC area is now available for download at the following link. We have addressed the CVC's comments, and our response is included in the report. Please take a moment to review it and let us know if you have any additional comments.

August 12, 2024 Submission

Thank you,

Javeed Khan, M.Eng., P.Eng., PMP
Manager Water Resources (Transportation) - Ontario
M +1-226-752-8261
javeed.khan@aecom.com

Cameron, Emily

From:	Kilis, Jakub <Jakub.Kilis@cvc.ca>
Sent:	October 9, 2025 10:26 AM
To:	Cameron, Emily
Cc:	Khan, Javeed; Sapateiro, Felipe; Goldberg, Jay; Gimpoli, Mark; McGarry, Jonathan (MTO); Asif, Shahbaz (MTO); Beyer, Curtis (MTO)
Subject:	CVC Comments - MTO Hwy 413 -CVC Section - Stormwater Management Report and Fluvial Geomorphology Report

Hi Emily,

CVC staff has now had an opportunity to review the Final Drainage and Stormwater Management Report – West Section CVC Area, Highway 413 Transportation Corridor Route Planning, Preliminary Design and Environmental Assessment, AECOM & WSP, September 2025
Draft Highway 413 Transportation Corridor Route Planning, Preliminary Design and Environmental Assessment Study – Phase 2, Fluvial Geomorphological Assessment, AECOM & WSP, November 2024, and the Comment Response Matrix, AECOM, September 9, 2025 and offer the following comments for your consideration:

General

1. The peak flow rates provided in Table 6 (Hydrologic Modelling Results Summary) for Levi Creek crossings CR_LC_LEV_0_WC2 are not consistent with the information that CVC provided to AECOM on January 19, 2023. Also, the regional peak flow at CR_LC_LEV_2_WC2, WC2.1 and WC2.2 are not provided. Please clarify. Using the CVC's hydrology and hydraulic models for Levi and Mullet is recommended.

2. Please provide general arrangement drawings for major crossings within CVC watershed as part of preliminary design submission.

Stormwater Management

3. For Credit River Tributaries and West Huttonville Creek, provide a geomorphic assessment by a fluvial geomorphologist and in accordance with Section 5 of the CVC SWM Guideline to determine a site-specific erosion control storage and target release rate. Please update Section 2.2.3 Stormwater Management Criteria and revise the preliminary design and supporting calculations accordingly. As acknowledged in responses to previous CVC comments, coordination with Heritage Heights development is recommended once the Heritage Heights Subwatershed Study Impact Assessment becomes available.

4. For Levi Creek and Mullet Creek, the erosion control target storage and release rates are provided in Table 4 of the SWM Report, and the response to previous CVC comment acknowledged that "*Stormwater management has been reassessed within the Mullet Creek and Levi Creek subwatersheds, and pond designs have been updated accordingly*". However, according to Table 11, Pond 1 that is proposed to discharge to Levi Creek is designed as a water quality pond and does not providing erosion control. Please clarify

Please let me know if you have any question about the above,
Jakub

Jakub Kilis | RPP
Senior Manager, Infrastructure and Regulations | Credit Valley Conservation
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jakub.kilis@cvc.ca | cvc.ca

From: Cameron, Emily <Emily.Cameron@aecom.com>
Sent: Tuesday, September 9, 2025 3:40 PM
To: Kilis, Jakub <Jakub.Kilis@cvc.ca>
Cc: Khan, Javeed <Javeed.Khan@aecom.com>; Sapateiro, Felipe <felipe.sapateiro@aecom.com>; Goldberg, Jay <jay.goldberg@wsp.com>; Gimpoli, Mark <mark.gimpoli@wsp.com>; McGarry, Jonathan (MTO) <jonathan.mcgarry@ontario.ca>; Asif, Shahbaz (MTO) <shahbaz.asif@ontario.ca>; Beyer, Curtis (MTO) <curtis.beyer@ontario.ca>
Subject: [External] MTO Hwy 413 -CVC Section - Stormwater Management Report

Hello Jakub,

Please find the updated Stormwater Management Report for MTO's Highway 413, which has addressed the previous comments provided by CVC. We trust that this report will satisfy CVC's concerns, however, if you have any further comments please provide.

The updated report and all digital models can be found in the following link, as well as the comment responses (which are also included in Appendix A).

Submission to CVC - Sept. 9, 2025

The geomorphic report will be submitted separately.

If you require anything else, please let me know.

Take care,

Emily Cameron, P.Eng
She/her
Water Resources Engineer, Water
emily.cameron@aecom.com

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AECOM	External Review Comment & Disposition Sheet	Project: Hwy 413 Transportation Corridor Route Planning, Preliminary Design and Environmental Assessment Drainage and SWM Report Date Issued: October 17, 2025. Page __1__ of __2__

Name of Document Reviewed: Drainage & Stormwater Management Report – West Section CVC Area

Reviewer(s): Jakub Kilis, CVC

Comment #	Document Reference (Table, page, paragraph number, etc.)	CVC Comments (October 9, 2025)	AECOM's Response (October 17, 2025)
SWM Report			
1	General	The peak flow rates provided in Table 6 (Hydrologic Modelling Results Summary) for Levi Creek crossings CR_LC_LEV_0_WC2 are not consistent with the information that CVC provided to AECOM on January 19, 2023. Also, the regional peak flow at CR_LC_LEV_2_WC2, WC2.1 and WC2.2 are not provided. Please clarify. Using the CVC's hydrology and hydraulic models for Levi and Mullet is recommended.	The flows used at Levi Creek crossing CR_LC_LEV_0_WC2 are 10% higher than those provided by the CVC in January 2023, to account for climate change. The report was updated to clarify. Crossings CR_LC_LEV_2_WC2, WC2.1 and WC2.2 are not within the Regulated area and so the Regional water surface was not determined here. See image below (Hwy 413 in red). 

AECOM	External Review Comment & Disposition Sheet	Project: Hwy 413 Transportation Corridor Route Planning, Preliminary Design and Environmental Assessment Drainage and SWM Report Date Issued: October 17, 2025. Page __2__ of __2__

Comment #	Document Reference (Table, page, paragraph number, etc.)	CVC Comments (October 9, 2025)	AECOM's Response (October 17, 2025)
2	General	Please provide general arrangement drawings for major crossings within CVC watershed as part of preliminary design submission.	Available general arrangement drawings were included in the report in Appendix F.
3	Stormwater Management	For Credit River Tributaries and West Huttonville Creek, provide a geomorphic assessment by a fluvial geomorphologist and in accordance with Section 5 of the CVC SWM Guideline to determine a site-specific erosion control storage and target release rate. Please update Section 2.2.3 Stormwater Management Criteria and revise the preliminary design and supporting calculations accordingly. As acknowledged in responses to previous CVC comments, coordination with Heritage Heights development is recommended once the Heritage Heights Subwatershed Study Impact Assessment becomes available.	Section 2.2.3 was updated in the report, however, design and supporting calculations for the erosion threshold assessment will be completed at the detailed design stage. Heritage Heights report will be referenced in detailed design when received.
4	Stormwater Management	For Levi Creek and Mullet Creek, the erosion control target storage and release rates are provided in Table 4 of the SWM Report, and the response to previous CVC comment acknowledged that "Stormwater management has been reassessed within the Mullet Creek and Levi Creek subwatersheds, and pond designs have been updated accordingly". However, according to Table 11, Pond 1 that is proposed to discharge to Levi Creek is designed as a water quality pond and does not providing erosion control. Please clarify	Pond 1 was designed to provide quality and erosion control, but not quantity control, as outflow rates are already met. The report was updated to clarify this.

B

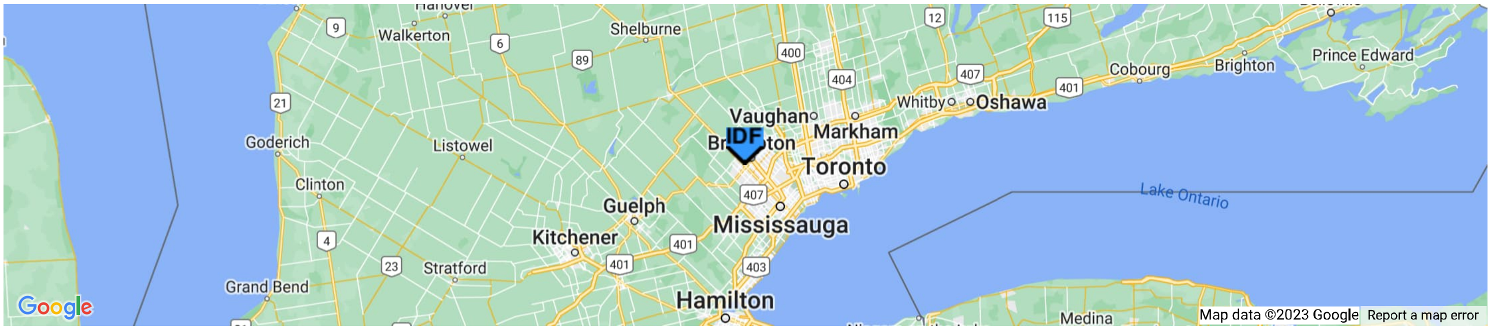
IDF Data

IDF CURVE LOOKUP

Active coordinate

43° 42' 45" N, 79° 47' 14" W (43.712500,-79.787500)

Retrieved: Mon, 30 Jan 2023 20:06:30 GMT



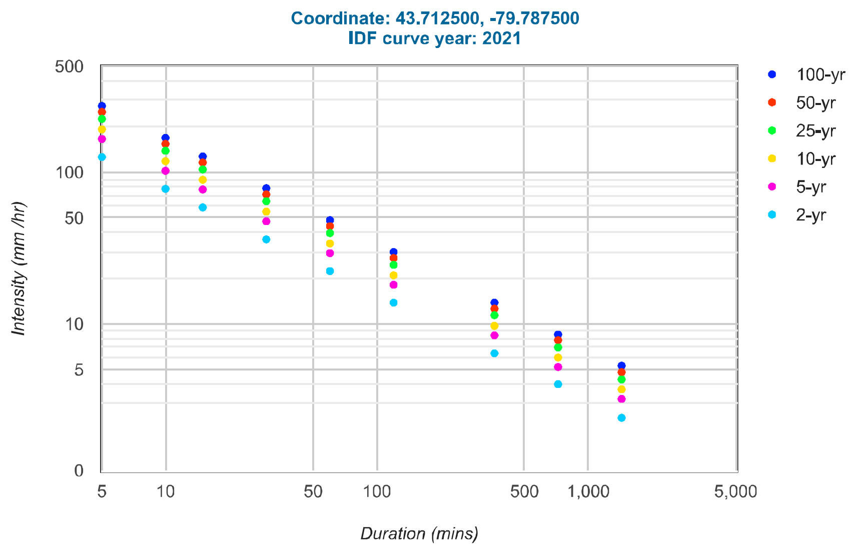
Location summary

These are the locations in the selection.

IDF Curve: 43° 42' 45" N, 79° 47' 14" W (43.712500,-79.787500)

Results

An IDF curve was found.



Coefficient summary

IDF Curve: 43° 42' 45" N, 79° 47' 14" W (43.712500,-79.787500)

Retrieved: Mon, 30 Jan 2023 20:06:30 GMT

Data year: 2010
IDF curve year: 2021

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	126.0	77.7	58.6	36.1	22.3	13.8	6.4	4.0	2.4
5-yr	165.8	102.2	77.0	47.5	29.3	18.1	8.4	5.2	3.2
10-yr	191.9	118.3	89.2	55.0	33.9	20.9	9.7	6.0	3.7
25-yr	224.8	138.6	104.4	64.4	39.7	24.5	11.4	7.0	4.3
50-yr	249.8	154.0	116.0	71.5	44.1	27.2	12.6	7.8	4.8
100-yr	273.7	168.7	127.1	78.4	48.3	29.8	13.8	8.5	5.3

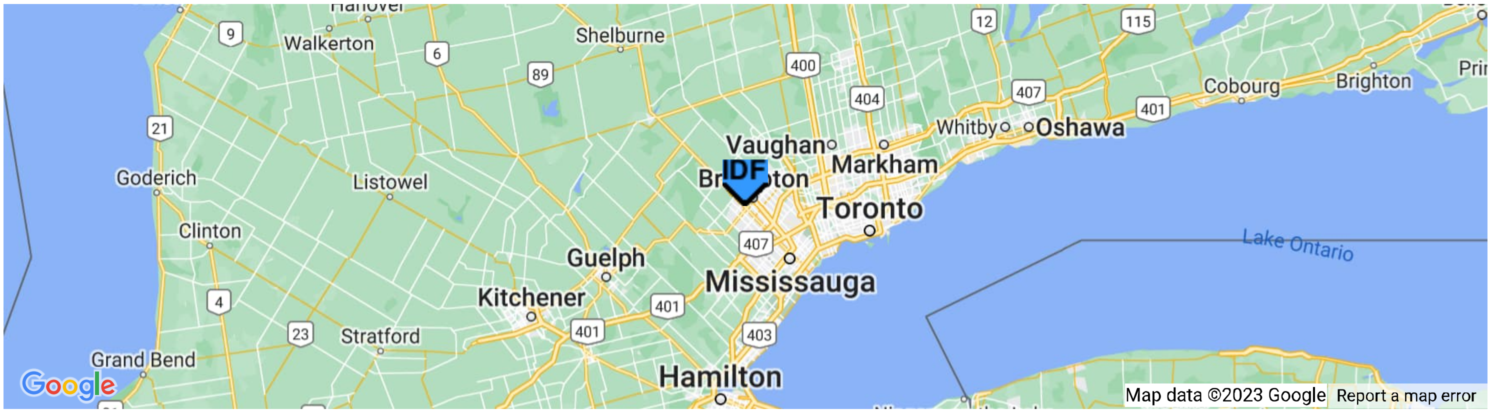
Rainfall depth (mm)

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	10.5	13.0	14.7	18.1	22.3	27.6	38.4	48.0	57.6
5-yr	13.8	17.0	19.3	23.8	29.3	36.2	50.4	62.4	76.8
10-yr	16.0	19.7	22.3	27.5	33.9	41.8	58.2	72.0	88.8
25-yr	18.7	23.1	26.1	32.2	39.7	49.0	68.4	84.0	103.2
50-yr	20.8	25.7	29.0	35.8	44.1	54.4	75.6	93.6	115.2
100-yr	22.8	28.1	31.8	39.2	48.3	59.6	82.8	102.0	127.2

Active coordinate

43° 42' 45" N, 79° 47' 14" W (43.712500,-79.787500)

Retrieved: Mon, 30 Jan 2023 20:08:32 GMT



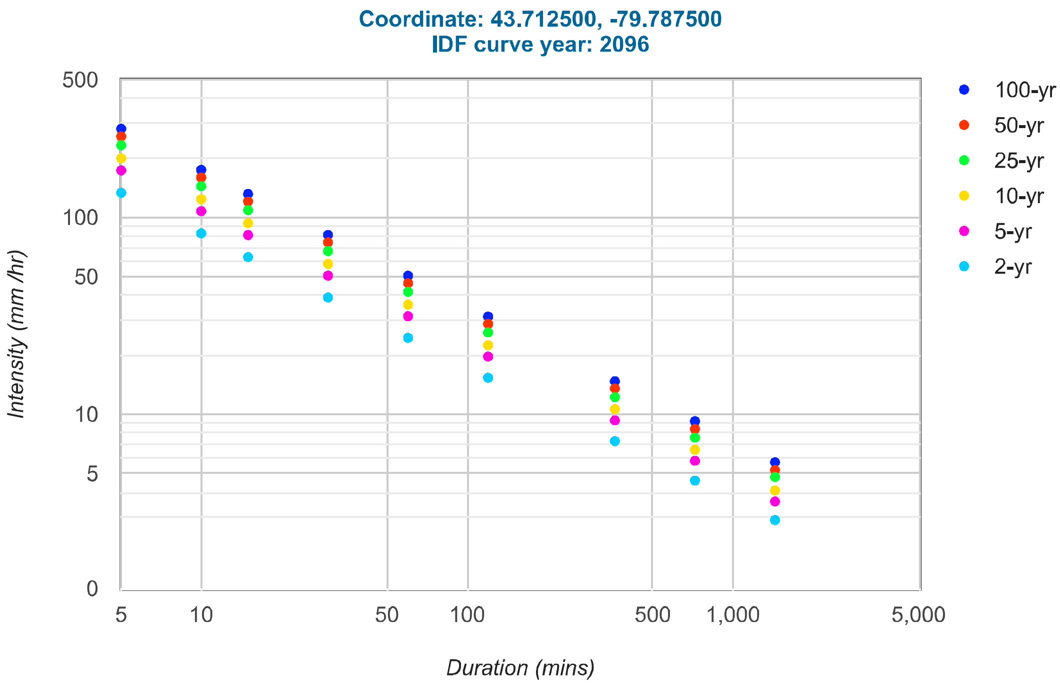
Location summary

These are the locations in the selection.

IDF Curve: 43° 42' 45" N, 79° 47' 14" W (43.712500,-79.787500)

Results

An IDF curve was found.



Coefficient summary

IDF Curve: 43° 42' 45" N, 79° 47' 14" W (43.712500,-79.787500)

Retrieved: Mon, 30 Jan 2023 20:08:32 GMT

Data year: 2010
IDF curve year: 2096

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	133.1	82.8	62.7	39.1	24.4	15.3	7.3	4.6	2.9
5-yr	172.9	107.3	81.2	50.5	31.4	19.6	9.3	5.8	3.6
10-yr	199.0	123.4	93.3	57.9	36.0	22.4	10.6	6.6	4.1
25-yr	232.0	143.7	108.6	67.3	41.8	26.0	12.2	7.6	4.8
50-yr	257.0	159.1	120.2	74.5	46.2	28.7	13.5	8.4	5.2
100-yr	280.8	173.8	131.3	81.3	50.4	31.3	14.7	9.2	5.7

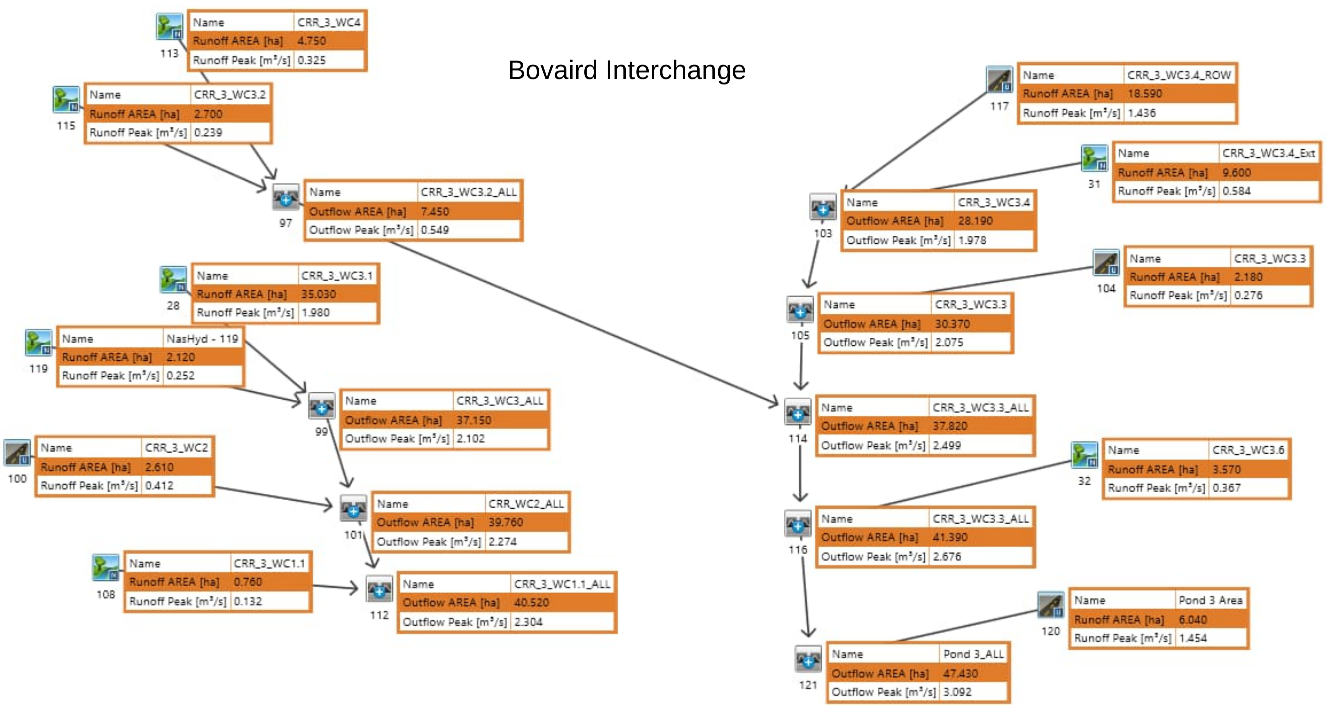
Rainfall depth (mm)

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	11.1	13.8	15.7	19.6	24.4	30.6	43.8	55.2	69.6
5-yr	14.4	17.9	20.3	25.3	31.4	39.2	55.8	69.6	86.4
10-yr	16.6	20.6	23.3	28.9	36.0	44.8	63.6	79.2	98.4
25-yr	19.3	24.0	27.1	33.6	41.8	52.0	73.2	91.2	115.2
50-yr	21.4	26.5	30.1	37.3	46.2	57.4	81.0	100.8	124.8
100-yr	23.4	29.0	32.8	40.6	50.4	62.6	88.2	110.4	136.8

C

Hydrology

VO2 Schematic - Culverts



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====================

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

      OOO    TTTTT  TTTTT  H    H  Y    Y  M    M   OOO     TM
     O    O    T        T     H    H   Y Y    MM MM  O    O
     O    O    T        T     H    H     Y     M    M  O    O
      OOO      T        T     H    H     Y     M    M   OOO
```

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***** S U M M A R Y   O U T P U T *****

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DATE: 10-27-2025   TIME: 12:52:59

USER:

COMMENTS: ____

****
** SIMULATION : 100yr 24hr SCS II   **
****

W/E COMMAND   HYD ID   DT   AREA ' Qpeak Tpeak   R.V. R.C.   Qbase
                        min   ha   ' cms   hrs   mm   cms

START @ 0.00 hrs

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remark: 100yr 24hr 15min SCS
*

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remark: 100yr 24hr 15min SCS
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remark: 100yr 24hr 15min SCS
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** CALIB NASHYD 0010 1 5.0 15.66 0.88 13.25 72.19 0.57 0.000
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*

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40cd-9420-fe
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*
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40cd-9420-fe
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 ** CALIB NASHYD        0035  1  5.0    8.03    0.71 12.67  69.08 0.54   0.000
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40cd-9420-fe
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 *  CALIB NASHYD        0435  1  5.0    1.11    0.17 12.33  69.04 0.54   0.000
   [CN=73.0        ]
   [ N = 3.0:Tp 0.26]
*
   READ STORM              15.0
   [ Ptot=127.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-
40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*
 *  CALIB STANDHYD      0402  1  5.0    1.40    0.20 12.25  81.26 0.64   0.000
   [I%=21.0:S%= 1.00]
*
   READ STORM              15.0
   [ Ptot=127.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-
40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*
 *  CALIB STANDHYD      0432  1  5.0    1.39    0.29 12.25  98.41 0.77   0.000
   [I%=35.0:S%= 1.50]
*
   READ STORM              15.0
   [ Ptot=127.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-
40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*
 *  CALIB STANDHYD      0433  1  5.0    1.04    0.25 12.25  88.76 0.70   0.000
   [I%=29.0:S%= 1.50]
*
   READ STORM              15.0
   [ Ptot=127.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-
40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*
 *  CALIB STANDHYD      0436  1  5.0    4.42    1.02 12.25  88.76 0.70   0.000
   [I%=29.0:S%= 1.50]
*
   READ STORM              15.0
   [ Ptot=127.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-
40cd-9420-fe
   remark: 100yr 24hr 15min SCS
```

*
 * CALIB NASHYD   0437 1 5.0   4.31   0.37 12.67 69.08 0.54   0.000
   [CN=73.0   ]
   [N = 3.0:Tp 0.56]
*
   READ STORM   15.0
   [Ptot=127.20 mm]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*
 * CALIB STANDHYD   0438 1 5.0   1.39   0.28 12.25 88.76 0.70   0.000
   [I%=29.0:S%= 1.50]
*
   READ STORM   15.0
   [Ptot=127.20 mm]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*
 * CALIB NASHYD   0093 1 5.0   11.77   0.84 12.92 69.09 0.54   0.000
   [CN=73.0   ]
   [N = 3.0:Tp 0.73]
*
   READ STORM   15.0
   [Ptot=127.20 mm]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*
 * CALIB NASHYD   0028 1 5.0   35.03   1.98 13.08 63.19 0.50   0.000
   [CN=69.0   ]
   [N = 3.0:Tp 0.87]
*
   READ STORM   15.0
   [Ptot=127.20 mm]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*
 * CALIB NASHYD   0119 1 5.0   2.12   0.25 12.50 69.07 0.54   0.000
   [CN=73.0   ]
   [N = 3.0:Tp 0.36]
*
   ADD [0119+ 0028] 0099 3 5.0   37.15   2.10 13.00 63.53 n/a   0.000
*
   READ STORM   15.0
   [Ptot=127.20 mm]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*

* CALIB STANDHYD 0100 1 5.0 2.61 0.41 12.42 92.15 0.72 0.000
[I%=10.0:S%= 0.60]
*
ADD [0100+ 0099] 0101 3 5.0 39.76 2.27 12.92 65.40 n/a 0.000
*
READ STORM 15.0
[Ptot=127.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
remark: 100yr 24hr 15min SCS
*
* CALIB NASHYD 0108 1 5.0 0.76 0.13 12.33 68.98 0.54 0.000
[CN=73.0]
[N = 3.0:Tp 0.21]
*
ADD [0101+ 0108] 0112 3 5.0 40.52 2.30 12.92 65.47 n/a 0.000
*
READ STORM 15.0
[Ptot=127.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
remark: 100yr 24hr 15min SCS
*
* CALIB NASHYD 0031 1 5.0 9.60 0.58 13.08 69.09 0.54 0.000
[CN=73.0]
[N = 3.0:Tp 0.90]
*
READ STORM 15.0
[Ptot=127.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
remark: 100yr 24hr 15min SCS
*
* CALIB STANDHYD 0117 1 5.0 18.59 1.44 13.42 106.43 0.84 0.000
[I%= 1.0:S%= 1.00]
*
ADD [0117+ 0031] 0103 3 5.0 28.19 1.98 13.42 93.71 n/a 0.000
*
READ STORM 15.0
[Ptot=127.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
remark: 100yr 24hr 15min SCS
*
* CALIB STANDHYD 0104 1 5.0 2.18 0.28 12.58 89.84 0.71 0.000
[I%=10.0:S%= 1.50]
*
ADD [0103+ 0104] 0105 3 5.0 30.37 2.07 13.33 93.43 n/a 0.000
*
READ STORM 15.0
[Ptot=127.20 mm]

fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
remark: 100yr 24hr 15min SCS
*
* CALIB NASHYD 0113 1 5.0 4.75 0.32 12.92 69.09 0.54 0.000
[CN=73.0]
[N = 3.0:Tp 0.77]
*
READ STORM 15.0
[Ptot=127.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
remark: 100yr 24hr 15min SCS
*
* CALIB NASHYD 0115 1 5.0 2.70 0.24 12.67 69.08 0.54 0.000
[CN=73.0]
[N = 3.0:Tp 0.54]
*
ADD [0113+ 0115] 0097 3 5.0 7.45 0.55 12.83 69.09 n/a 0.000
*
ADD [0105+ 0097] 0114 3 5.0 37.82 2.50 13.33 88.64 n/a 0.000
*
READ STORM 15.0
[Ptot=127.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
remark: 100yr 24hr 15min SCS
*
* CALIB NASHYD 0032 1 5.0 3.57 0.37 12.58 69.08 0.54 0.000
[CN=73.0]
[N = 3.0:Tp 0.44]
*
ADD [0114+ 0032] 0116 3 5.0 41.39 2.68 13.17 86.95 n/a 0.000
*
READ STORM 15.0
[Ptot=127.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
remark: 100yr 24hr 15min SCS
*
* CALIB STANDHYD 0120 1 5.0 6.04 1.45 12.25 108.09 0.85 0.000
[I%=46.0:S%= 1.00]
*
ADD [0116+ 0120] 0121 3 5.0 47.43 3.09 12.75 89.64 n/a 0.000
*
READ STORM 15.0
[Ptot=127.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-40cd-9420-fe
remark: 100yr 24hr 15min SCS
*
* CALIB NASHYD 0122 1 5.0 6.68 0.72 12.50 69.08 0.54 0.000

```
   [CN=73.0        ]
   [ N = 3.0:Tp 0.41]
*
   READ STORM               15.0
   [ Ptot=127.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-
40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*
 *  CALIB NASHYD        0123  1  5.0    7.50    0.66 12.67  69.08 0.54   0.000
   [CN=73.0        ]
   [ N = 3.0:Tp 0.54]
*
   READ STORM               15.0
   [ Ptot=127.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-
40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*
 *  CALIB NASHYD        0124  1  5.0   67.00    3.38 13.25  63.19 0.50   0.000
   [CN=69.0        ]
   [ N = 3.0:Tp 1.01]
*
   READ STORM               15.0
   [ Ptot=127.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\7e1678bf-1cb7-
40cd-9420-fe
   remark: 100yr 24hr 15min SCS
*
 *  CALIB NASHYD        0094  1  5.0   12.10    0.66 13.25  69.09 0.54   0.000
   [CN=73.0        ]
   [ N = 3.0:Tp 1.03]
*
================================================================================
====================


     V   V  I   SSSSS  U   U   A    L           (v 6.2.2019)
     V   V  I   SS     U   U   A A  L
      V V   I    SS    U   U  AAAAA  L
      V V   I     SS   U   U  A   A  L
       VV   I   SSSSS  UUUUU  A   A  LLLLL

      OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
     O   O    T      T    H   H   Y Y   MM MM  O   O
     O   O    T      T    H   H    Y    M   M  O   O
      OOO     T      T    H   H    Y    M   M   OOO
Developed and Distributed by Smart City Water Inc
```

***** S U M M A R Y   O U T P U T *****

Input   filename: C:\Temp\Visual OTTHYMO 6.2\VO2\voin.dat
Output filename: C:\Users\Camerone\AppData\Local\Civica\VH5\d70c904b-d540-495f-bf7e-db70299bd929\c5710895-1963-42dd-b44c-c4b211055d7c\sce
Summary filename: C:\Users\Camerone\AppData\Local\Civica\VH5\d70c904b-d540-495f-bf7e-db70299bd929\c5710895-1963-42dd-b44c-c4b211055d7c\sce

DATE: 10-27-2025   TIME: 12:53:00

USER:

COMMENTS: ____

```
 **************************************************
 ** SIMULATION : 50yr 24hr SCS II             **
 **************************************************

 W/E COMMAND            HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.   Qbase
                                 min     ha   '  cms   hrs     mm         cms

     START @  0.00 hrs
     --------------------
   READ STORM                15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 ** CALIB NASHYD         0002  1  5.0   37.41    2.09 12.92  55.44 0.48   0.000
   [CN=70.0         ]
   [ N = 3.0:Tp 0.74]
*
   READ STORM                15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 ** CALIB NASHYD         0005  1  5.0  104.38    4.50 13.25  54.14 0.47   0.000
   [CN=69.0         ]
   [ N = 3.0:Tp 1.01]
*
   READ STORM                15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
   remark: 50yr 24hr 15min SCS
```

*
** CALIB NASHYD 0016 1 5.0 25.05 1.53 12.92 59.49 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.73]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0015 1 5.0 62.50 2.81 13.17 55.44 0.48 0.000
[CN=70.0]
[N = 3.0:Tp 0.99]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0014 1 5.0 62.50 2.85 13.17 55.44 0.48 0.000
[CN=70.0]
[N = 3.0:Tp 0.97]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0013 1 5.0 53.20 2.46 13.08 54.14 0.47 0.000
[CN=69.0]
[N = 3.0:Tp 0.92]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0025 1 5.0 58.74 2.67 13.17 54.14 0.47 0.000
[CN=69.0]
[N = 3.0:Tp 0.94]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0039 1 5.0 99.47 3.48 13.58 54.14 0.47 0.000

[CN=69.0]
[N = 3.0:Tp 1.33]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0043 1 5.0 48.72 2.01 13.50 59.49 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 1.23]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0036 1 5.0 32.41 1.80 13.00 59.49 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.83]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0037 1 5.0 125.09 3.74 13.92 54.14 0.47 0.000
[CN=69.0]
[N = 3.0:Tp 1.63]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0041 1 5.0 27.32 1.63 12.92 59.49 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.75]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0038 1 5.0 112.52 3.59 13.83 54.14 0.47 0.000
[CN=69.0]
[N = 3.0:Tp 1.50]

*
   READ STORM   15.0
   [Ptot=115.20 mm]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 ** CALIB NASHYD   0046 1 5.0   17.83   0.77 13.25 54.14 0.47   0.000
   [CN=69.0   ]
   [N = 3.0:Tp 1.00]
*
   READ STORM   15.0
   [Ptot=115.20 mm]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 ** CALIB NASHYD   0026 1 5.0   19.42   1.22 12.83 59.49 0.52   0.000
   [CN=73.0   ]
   [N = 3.0:Tp 0.70]
*
   READ STORM   15.0
   [Ptot=115.20 mm]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 ** CALIB NASHYD   0034 1 5.0   17.75   1.24 12.75 59.49 0.52   0.000
   [CN=73.0   ]
   [N = 3.0:Tp 0.61]
*
   READ STORM   15.0
   [Ptot=115.20 mm]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 ** CALIB NASHYD   0040 1 5.0   16.80   0.90 13.08 59.49 0.52   0.000
   [CN=73.0   ]
   [N = 3.0:Tp 0.87]
*
   READ STORM   15.0
   [Ptot=115.20 mm]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 ** CALIB NASHYD   0044 1 5.0   4.46   0.33 12.67 59.48 0.52   0.000
   [CN=73.0   ]
   [N = 3.0:Tp 0.55]
*
   READ STORM   15.0

[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0047 1 5.0 1.32 0.08 12.92 59.49 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.77]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0001 1 5.0 12.23 1.13 12.50 59.48 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.41]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0003 1 5.0 6.30 0.37 12.92 59.49 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.77]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0004 1 5.0 10.43 0.78 12.67 59.48 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.55]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0007 1 5.0 6.21 0.49 12.67 59.48 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.52]
*
READ STORM 15.0
[Ptot=115.20 mm]

fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0008 1 5.0 2.43 0.20 12.58 59.48 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.49]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0009 1 5.0 11.65 0.68 12.92 59.49 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.78]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0010 1 5.0 15.66 0.75 13.25 62.32 0.54 0.000
[CN=75.0]
[N = 3.0:Tp 1.07]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0019 1 5.0 13.76 0.98 12.75 59.49 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.59]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0021 1 5.0 2.68 0.25 12.50 59.48 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.40]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0

remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0022 1 5.0 1.73 0.20 12.42 59.47 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.31]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
** CALIB NASHYD 0035 1 5.0 8.03 0.61 12.67 59.48 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.54]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB STANDHYD 0006 1 5.0 1.62 0.40 12.25 92.04 0.80 0.000
[I%=49.0:S%= 1.50]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB NASHYD 0434 1 5.0 4.38 0.35 12.67 59.48 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.50]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB NASHYD 0435 1 5.0 1.11 0.14 12.33 59.45 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.26]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB STANDHYD 0402 1 5.0 1.40 0.17 12.25 71.20 0.62 0.000

[I%=21.0:S%= 1.00]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB STANDHYD 0432 1 5.0 1.39 0.26 12.25 87.26 0.76 0.000
[I%=35.0:S%= 1.50]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB STANDHYD 0433 1 5.0 1.04 0.21 12.25 78.22 0.68 0.000
[I%=29.0:S%= 1.50]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB STANDHYD 0436 1 5.0 4.42 0.80 12.25 78.23 0.68 0.000
[I%=29.0:S%= 1.50]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB NASHYD 0437 1 5.0 4.31 0.32 12.67 59.48 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.56]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB STANDHYD 0438 1 5.0 1.39 0.24 12.25 78.22 0.68 0.000
[I%=29.0:S%= 1.50]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0

```
   remark: 50yr 24hr 15min SCS
*
 *  CALIB NASHYD         0093  1  5.0   11.77    0.72 12.92  59.49 0.52   0.000
   [CN=73.0         ]
   [ N = 3.0:Tp 0.73]
*
   READ STORM                15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-
44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 *  CALIB NASHYD         0028  1  5.0   35.03    1.69 13.08  54.14 0.47   0.000
   [CN=69.0         ]
   [ N = 3.0:Tp 0.87]
*
   READ STORM                15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-
44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 *  CALIB NASHYD         0119  1  5.0    2.12    0.22 12.50  59.48 0.52   0.000
   [CN=73.0         ]
   [ N = 3.0:Tp 0.36]
*
   ADD [  0119+  0028]  0099  3  5.0   37.15    1.79 13.00  54.44  n/a   0.000
*
   READ STORM                15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-
44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 *  CALIB STANDHYD       0100  1  5.0    2.61    0.34 12.50  81.19 0.70   0.000
   [I%=10.0:S%= 0.60]
*
   ADD [  0100+  0099]  0101  3  5.0   39.76    1.96 12.92  56.20  n/a   0.000
*
   READ STORM                15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-
44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 *  CALIB NASHYD         0108  1  5.0    0.76    0.11 12.33  59.39 0.52   0.000
   [CN=73.0         ]
   [ N = 3.0:Tp 0.21]
*
   ADD [  0101+  0108]  0112  3  5.0   40.52    1.99 12.92  56.26  n/a   0.000
*
   READ STORM                15.0
```

[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB NASHYD 0031 1 5.0 9.60 0.50 13.08 59.49 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.90]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB STANDHYD 0117 1 5.0 18.59 1.24 13.50 94.76 0.82 0.000
[I%= 1.0:S%= 1.00]
*
ADD [0117+ 0031] 0103 3 5.0 28.19 1.69 13.50 82.74 n/a 0.000
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB STANDHYD 0104 1 5.0 2.18 0.23 12.58 79.03 0.69 0.000
[I%=10.0:S%= 1.50]
*
ADD [0103+ 0104] 0105 3 5.0 30.37 1.77 13.42 82.48 n/a 0.000
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB NASHYD 0113 1 5.0 4.75 0.28 12.92 59.49 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.77]
*
READ STORM 15.0
[Ptot=115.20 mm]
fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-44b1-9622-e0
remark: 50yr 24hr 15min SCS
*
* CALIB NASHYD 0115 1 5.0 2.70 0.21 12.67 59.48 0.52 0.000
[CN=73.0]
[N = 3.0:Tp 0.54]
*
ADD [0113+ 0115] 0097 3 5.0 7.45 0.47 12.83 59.49 n/a 0.000

```
*
   ADD [  0105+  0097]  0114  3  5.0   37.82    2.11 13.33  77.95  n/a   0.000
*
   READ STORM                 15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-
44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 *  CALIB NASHYD         0032  1  5.0    3.57    0.31 12.58  59.48 0.52   0.000
   [CN=73.0          ]
   [ N = 3.0:Tp 0.44]
*
   ADD [  0114+  0032]  0116  3  5.0   41.39    2.26 13.17  76.36  n/a   0.000
*
   READ STORM                 15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-
44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 *  CALIB STANDHYD       0120  1  5.0    6.04    1.30 12.25  96.57 0.84   0.000
   [I%=46.0:S%= 1.00]
*
   ADD [  0116+  0120]  0121  3  5.0   47.43    2.62 12.75  78.93  n/a   0.000
*
   READ STORM                 15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-
44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 *  CALIB NASHYD         0122  1  5.0    6.68    0.62 12.50  59.48 0.52   0.000
   [CN=73.0          ]
   [ N = 3.0:Tp 0.41]
*
   READ STORM                 15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-
44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 *  CALIB NASHYD         0123  1  5.0    7.50    0.57 12.67  59.48 0.52   0.000
   [CN=73.0          ]
   [ N = 3.0:Tp 0.54]
*
   READ STORM                 15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-
44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
```

```
 *  CALIB NASHYD          0124  1  5.0   67.00    2.89 13.25  54.14 0.47   0.000
   [CN=69.0         ]
   [ N = 3.0:Tp 1.01]
*
   READ STORM                 15.0
   [ Ptot=115.20 mm ]
   fname : C:\Users\Camerone\AppData\Local\Temp\5160d121-487b-455c-b4cd-56e2fe91f359\2d8baf69-3ff0-
44b1-9622-e0
   remark: 50yr 24hr 15min SCS
*
 *  CALIB NASHYD          0094  1  5.0   12.10    0.57 13.25  59.49 0.52   0.000
   [CN=73.0         ]
   [ N = 3.0:Tp 1.03]
*
 FINISH

=====================================================================================
====================
```

United Ontario Flow Method Calculations

Unified Ontario Flood Method

								UOFM Flow Estimate					UOFM Lower Limit Flow					UOFM Upper Limit Flow				
TWP	Culvert ID	Culvert Name	Area (ha)	Lake Area (ha)	Lake Attenuation Index	Average Annual Precipitation (mm)	Ecosystem	Q2 (m^3/s)	Q10 (m^3/s)	Q25 (m^3/s)	Q50 (m^3/s)	Q100 (m^3/s)	Q2 (m^3/s)	Q10 (m^3/s)	Q25 (m^3/s)	Q50	Q100 (m^3/s)	Q2 (m^3/s)	Q10 (m^3/s)	Q25 (m^3/s)	Q50 (m^3/s)	Q100 (m^3/s)
	28	CR_NP_CRR_3_WC3.1	27.7	0.5	1.02	825	Mixed Wood Plains	0.27	0.59	0.76	0.90	1.04	0.19	0.40	0.51	0.58	0.66	0.37	0.86	1.14	1.37	1.63
	37	CR_NP_CRR_13_WC3	125.1	3.4	1.03	825	Mixed Wood Plains	0.82	1.73	2.22	2.59	2.98	0.58	1.17	1.48	1.68	1.91	1.14	2.52	3.32	3.96	4.68
	38	CR_NP_CRR_13_WC4.1	112.5	3.4	1.03	825	Mixed Wood Plains	0.75	1.58	2.03	2.37	2.72	0.53	1.07	1.36	1.54	1.74	1.05	2.30	3.04	3.63	4.28

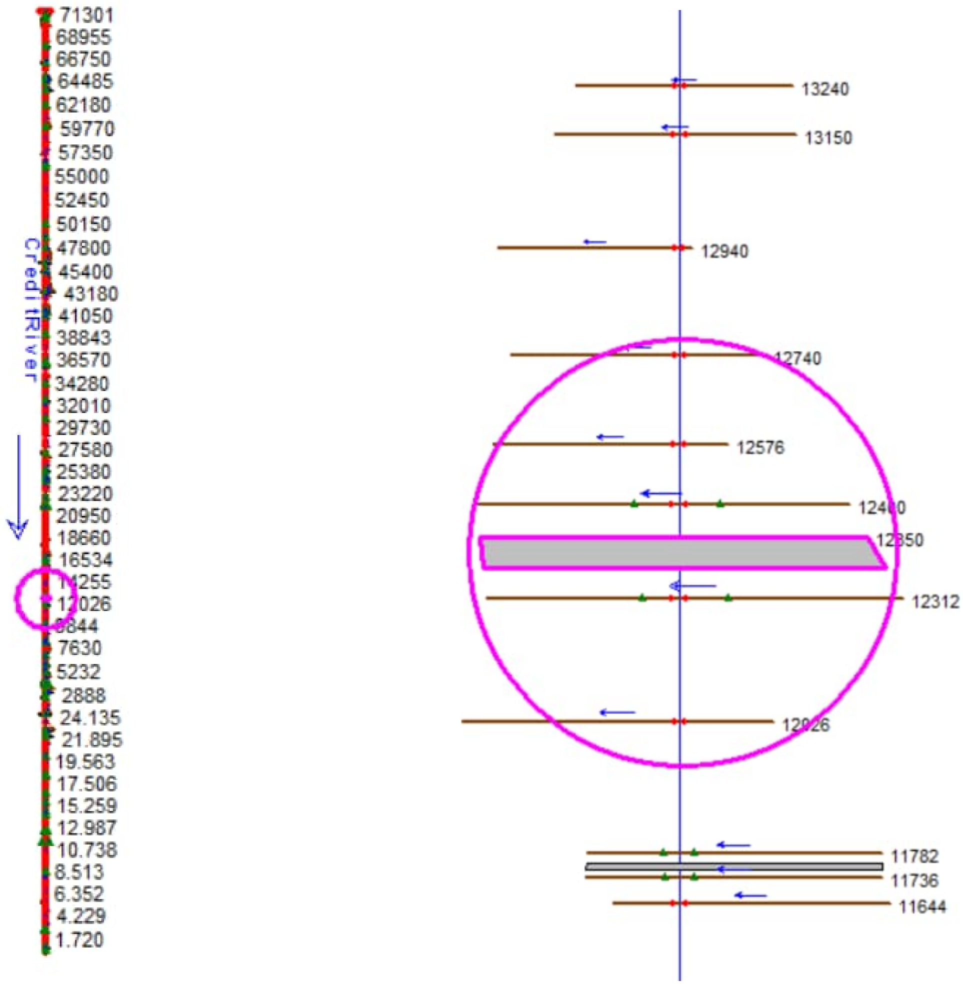
D

Hydraulics

HEC-RAS Files

Credit River

Schematic:



Flows:

XS16730	Regional	100-year	50-year	25-year	10-year	5-year	2-year
	675.6	373.7	311.1	254.1	188.6	144.1	60.0

Add 10% to 2-year through 100-year for climate change

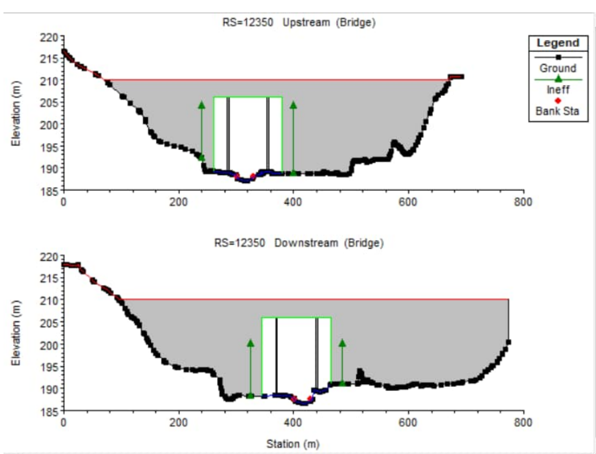
XS16730	Regional	100-year	50-year	25-year	10-year	5-year	2-year
	675.6	411.1	342.2	279.5	207.5	158.5	66.0

Existing Water Levels:

HEC-RAS Plan: Ex. Rev Locations

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
CreditRiver	1	13150	Regional	675.60	189.70	193.22		193.79	0.005002	4.45	354.44	220.09	0.78
CreditRiver	1	13150	100 year	373.70	189.70	192.65		193.04	0.003819	3.43	237.57	186.86	0.66
CreditRiver	1	13150	50 year	311.10	189.70	192.47		192.82	0.003667	3.21	204.78	172.61	0.64
CreditRiver	1	13150	25 year	254.10	189.70	192.28		192.60	0.003552	3.00	172.53	157.32	0.62
CreditRiver	1	13150	10 year	188.60	189.70	192.01		192.29	0.003425	2.71	132.96	136.25	0.60
CreditRiver	1	13150	5 year	144.10	189.70	191.79		192.04	0.003258	2.46	105.35	122.86	0.57
CreditRiver	1	13150	2 year	60.00	189.70	191.23		191.38	0.002690	1.76	46.11	87.78	0.49
CreditRiver	1	12940	Regional	675.60	188.82	192.56		192.84	0.003567	3.89	524.10	326.22	0.66
CreditRiver	1	12940	100 year	373.70	188.82	191.99	191.61	192.26	0.003420	3.39	342.97	313.99	0.63
CreditRiver	1	12940	50 year	311.10	188.82	191.83	191.47	192.07	0.003305	3.20	292.37	282.08	0.61
CreditRiver	1	12940	25 year	254.10	188.82	191.63	191.31	191.87	0.003232	3.02	242.04	246.27	0.60
CreditRiver	1	12940	10 year	188.60	188.82	191.38		191.60	0.003050	2.74	185.88	206.26	0.57
CreditRiver	1	12940	5 year	144.10	188.82	191.13		191.35	0.003275	2.64	138.06	174.28	0.58
CreditRiver	1	12940	2 year	60.00	188.82	190.42	190.26	190.66	0.004439	2.33	45.21	88.66	0.63
CreditRiver	1	12740	Regional	675.60	188.21	191.66		192.05	0.004527	4.16	452.41	365.20	0.74
CreditRiver	1	12740	100 year	373.70	188.21	190.88	190.88	191.36	0.006240	4.06	212.07	243.43	0.83
CreditRiver	1	12740	50 year	311.10	188.21	190.71	190.71	191.18	0.006324	3.90	174.92	215.76	0.82
CreditRiver	1	12740	25 year	254.10	188.21	190.56	190.56	191.00	0.006149	3.67	144.09	189.74	0.80
CreditRiver	1	12740	10 year	188.60	188.21	190.33	190.33	190.75	0.006238	3.43	104.84	150.26	0.79
CreditRiver	1	12740	5 year	144.10	188.21	190.20	190.13	190.54	0.005243	3.00	86.76	128.03	0.72
CreditRiver	1	12740	2 year	60.00	188.21	189.88	189.49	190.01	0.002324	1.75	53.86	83.97	0.46
CreditRiver	1	12576	Regional	675.60	187.60	191.64		191.70	0.000609	1.71	761.38	317.40	0.28
CreditRiver	1	12576	100 year	373.70	187.60	190.34		190.43	0.001678	2.15	368.94	290.77	0.43
CreditRiver	1	12576	50 year	311.10	187.60	190.09		190.20	0.002202	2.29	297.04	287.94	0.49
CreditRiver	1	12576	25 year	254.10	187.60	189.87		190.00	0.002818	2.42	233.73	275.71	0.54
CreditRiver	1	12576	10 year	188.60	187.60	189.60		189.78	0.003766	2.56	164.72	253.99	0.61
CreditRiver	1	12576	5 year	144.10	187.60	189.42	189.42	189.64	0.004632	2.64	119.86	238.81	0.67
CreditRiver	1	12576	2 year	60.00	187.60	188.81	188.81	189.26	0.011145	2.97	21.04	26.39	0.95
CreditRiver	1	12400	Regional	675.60	187.03	191.57		191.65	0.000657	1.93	764.04	271.28	0.30
CreditRiver	1	12400	100 year	373.70	187.03	190.21		190.32	0.001264	2.08	410.25	256.81	0.39
CreditRiver	1	12400	50 year	311.10	187.03	189.94		190.06	0.001449	2.09	342.25	255.90	0.41
CreditRiver	1	12400	25 year	254.10	187.03	189.70		189.83	0.001641	2.09	280.18	255.08	0.43
CreditRiver	1	12400	10 year	188.60	187.03	189.40		189.55	0.001908	2.07	204.68	251.05	0.45
CreditRiver	1	12400	5 year	144.10	187.03	189.17		189.33	0.002157	2.04	147.26	241.95	0.47
CreditRiver	1	12400	2 year	60.00	187.03	188.52		188.65	0.002483	1.66	39.82	54.27	0.47

Proposed Bridge (120m span – required to meet hydraulic design criteria):

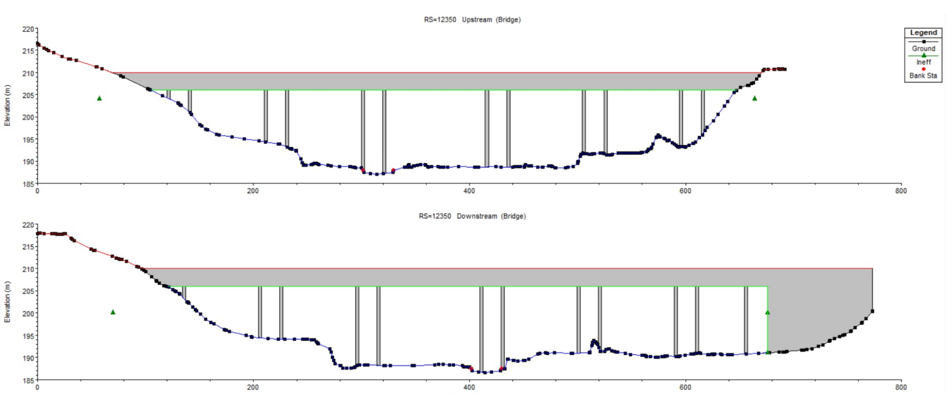


Proposed Water Levels (120m span):

HEC-RAS Plan: Reg Locations:

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
CreditRiver	1	13150	Regional	675.60	189.70	193.22		193.79	0.005004	4.45	354.39	220.08	0.78
CreditRiver	1	13150	100 year	411.10	189.70	192.73		193.15	0.004044	3.60	252.37	192.95	0.68
CreditRiver	1	13150	50 year	342.20	189.70	192.57		192.93	0.003740	3.32	221.39	179.97	0.65
CreditRiver	1	13150	25 year	279.50	189.70	192.37		192.70	0.003597	3.09	187.27	164.48	0.63
CreditRiver	1	13150	10 year	207.50	189.70	192.09		192.38	0.003482	2.81	144.28	142.60	0.61
CreditRiver	1	13150	5 year	158.50	189.70	191.86		192.12	0.003336	2.55	114.16	127.25	0.58
CreditRiver	1	13150	2 year	66.00	189.70	191.29		191.45	0.002713	1.82	51.31	91.40	0.50
CreditRiver	1	12940	Regional	675.60	188.82	192.56		192.84	0.003556	3.89	524.64	326.25	0.66
CreditRiver	1	12940	100 year	411.10	188.82	192.09	191.70	192.35	0.003311	3.41	374.01	316.82	0.62
CreditRiver	1	12940	50 year	342.20	188.82	191.91	191.51	192.17	0.003372	3.30	317.46	298.33	0.62
CreditRiver	1	12940	25 year	279.50	188.82	191.72	191.39	191.97	0.003292	3.12	263.73	262.30	0.61
CreditRiver	1	12940	10 year	207.50	188.82	191.46	191.15	191.68	0.003083	2.82	202.49	216.27	0.58
CreditRiver	1	12940	5 year	158.50	188.82	191.25	190.95	191.45	0.002994	2.61	158.54	188.64	0.56
CreditRiver	1	12940	2 year	66.00	188.82	190.49	190.33	190.73	0.004383	2.39	50.99	96.12	0.63
CreditRiver	1	12740	Regional	675.60	188.21	192.10		192.28	0.002121	3.10	625.25	417.86	0.52
CreditRiver	1	12740	100 year	411.10	188.21	190.95	190.95	191.45	0.006431	4.20	229.82	255.60	0.84
CreditRiver	1	12740	50 year	342.20	188.21	190.80	190.80	191.27	0.006261	3.98	193.71	230.17	0.82
CreditRiver	1	12740	25 year	279.50	188.21	190.64	190.64	191.09	0.006157	3.76	158.88	202.64	0.81
CreditRiver	1	12740	10 year	207.50	188.21	190.40	190.40	190.83	0.006232	3.51	115.89	162.34	0.80
CreditRiver	1	12740	5 year	158.50	188.21	190.21	190.21	190.61	0.006267	3.28	87.31	128.76	0.79
CreditRiver	1	12740	2 year	66.00	188.21	189.93	189.56	190.07	0.002420	1.82	58.07	87.92	0.48
CreditRiver	1	12576	Regional	675.60	187.60	192.06		192.10	0.000373	1.43	896.29	329.63	0.22
CreditRiver	1	12576	100 year	411.10	187.60	190.92		190.96	0.000642	1.52	538.96	297.34	0.28
CreditRiver	1	12576	50 year	342.20	187.60	190.63		190.67	0.000752	1.54	454.03	294.07	0.29
CreditRiver	1	12576	25 year	279.50	187.60	190.35		190.40	0.000906	1.58	373.36	290.94	0.32
CreditRiver	1	12576	10 year	207.50	187.60	190.01		190.07	0.001242	1.68	273.56	287.02	0.36
CreditRiver	1	12576	5 year	158.50	187.60	189.74		189.81	0.001668	1.78	198.55	264.86	0.41
CreditRiver	1	12576	2 year	66.00	187.60	188.94	188.88	189.35	0.008812	2.87	24.59	28.75	0.86
CreditRiver	1	12400	Regional	675.60	187.03	191.85	190.24	192.02	0.000936	2.41	519.00	299.65	0.36
CreditRiver	1	12400	100 year	411.10	187.03	190.69	189.77	190.85	0.001263	2.30	335.59	258.51	0.40
CreditRiver	1	12400	50 year	342.20	187.03	190.41	189.62	190.56	0.001313	2.22	290.90	257.50	0.40
CreditRiver	1	12400	25 year	279.50	187.03	190.13	189.42	190.28	0.001357	2.12	248.18	256.57	0.40
CreditRiver	1	12400	10 year	207.50	187.03	189.79	189.13	189.93	0.001399	1.98	195.19	255.38	0.40
CreditRiver	1	12400	5 year	158.50	187.03	189.52	188.81	189.66	0.001452	1.87	153.41	254.57	0.40
CreditRiver	1	12400	2 year	66.00	187.03	188.70	188.08	188.82	0.001872	1.57	48.34	131.78	0.42
CreditRiver	1	12350		Bridge									

Proposed Bridge (605m span – recommended to span the valley):



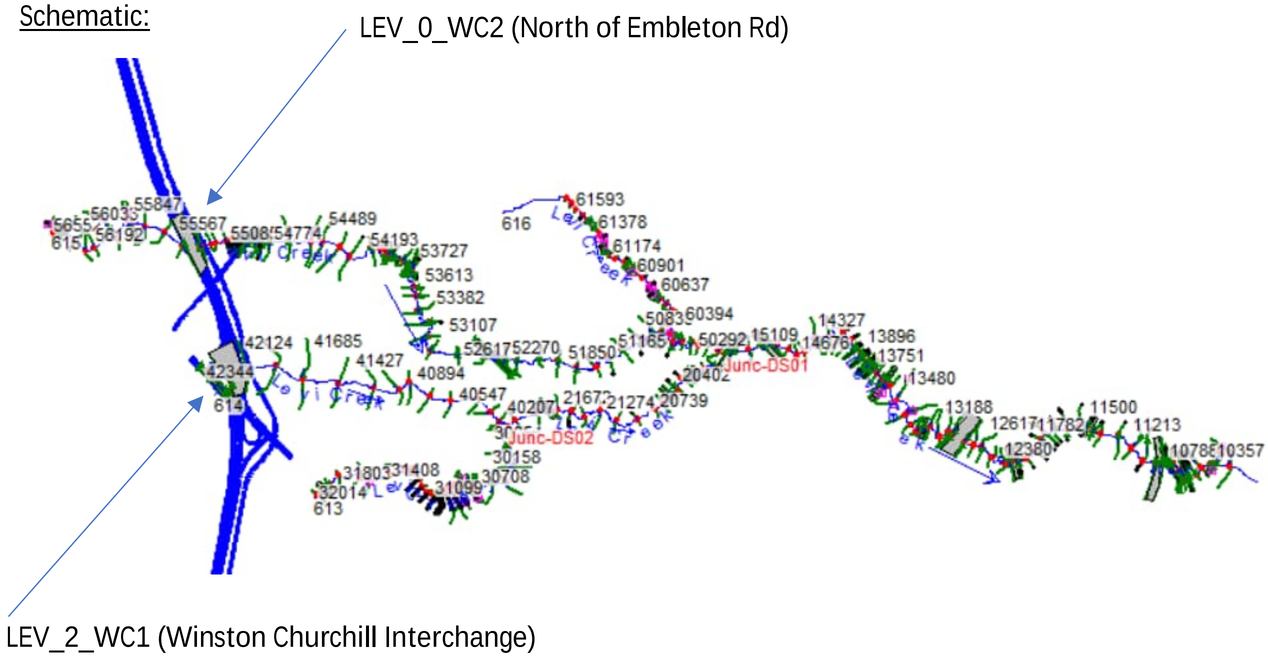
Proposed Water Levels (605m span):

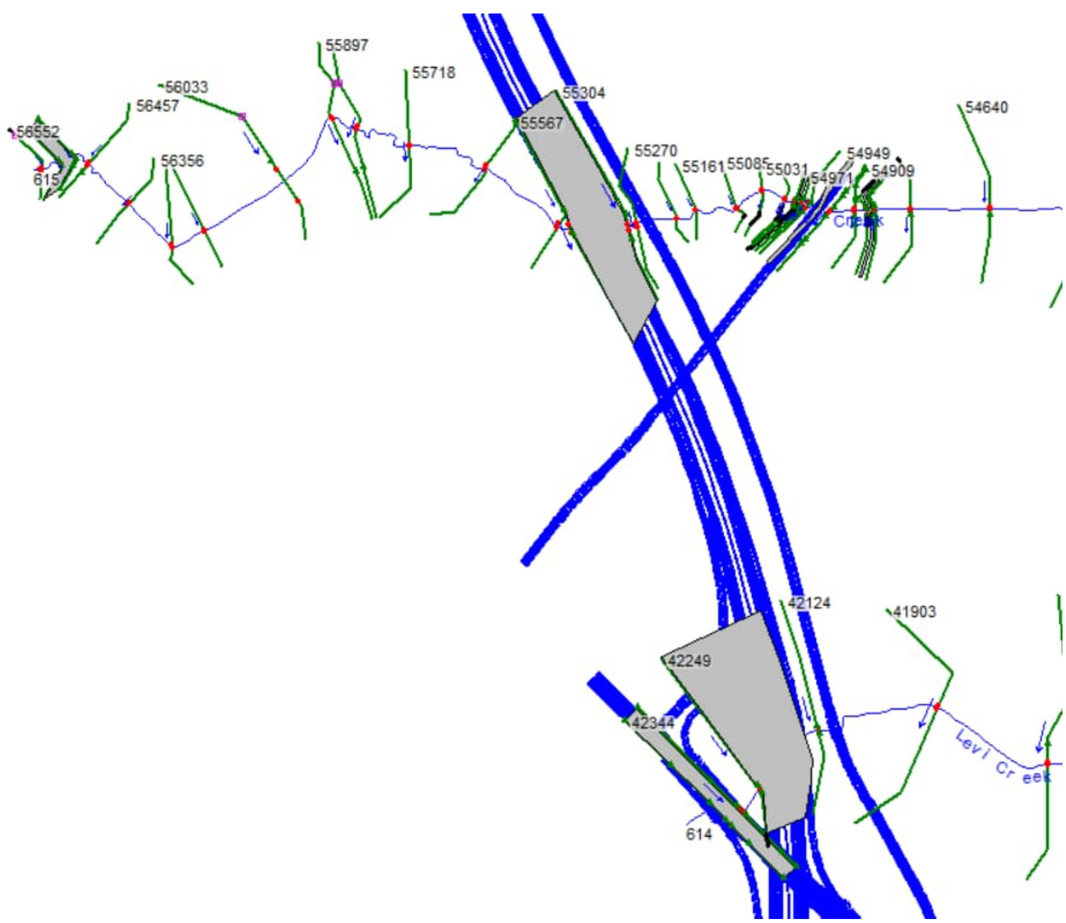
HEC-RAS Plan: Prop Locations:

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
CreditRiver	1	13150	Regional	675.60	189.70	193.22		193.79	0.004991	4.45	354.75	220.13	0.78
CreditRiver	1	13150	100 year	411.10	189.70	192.73		193.15	0.004044	3.60	252.37	192.95	0.68
CreditRiver	1	13150	50 year	342.20	189.70	192.57		192.93	0.003740	3.32	221.39	179.97	0.65
CreditRiver	1	13150	25 year	279.50	189.70	192.37		192.70	0.003597	3.09	187.26	164.48	0.63
CreditRiver	1	13150	10 year	207.50	189.70	192.09		192.38	0.003482	2.81	144.28	142.60	0.61
CreditRiver	1	13150	5 year	158.50	189.70	191.86		192.12	0.003336	2.55	114.16	127.25	0.58
CreditRiver	1	13150	2 year	66.00	189.70	191.29		191.45	0.002717	1.82	51.28	91.38	0.50
CreditRiver	1	12940	Regional	675.60	188.82	192.55		192.83	0.003633	3.92	520.65	326.00	0.67
CreditRiver	1	12940	100 year	411.10	188.82	192.09	191.70	192.35	0.003311	3.41	374.01	316.82	0.62
CreditRiver	1	12940	50 year	342.20	188.82	191.91	191.51	192.17	0.003372	3.30	317.46	298.33	0.62
CreditRiver	1	12940	25 year	279.50	188.82	191.72	191.39	191.97	0.003288	3.12	263.87	262.40	0.61
CreditRiver	1	12940	10 year	207.50	188.82	191.46	191.15	191.68	0.003083	2.82	202.47	216.25	0.58
CreditRiver	1	12940	5 year	158.50	188.82	191.25	190.95	191.45	0.002994	2.61	158.54	188.64	0.56
CreditRiver	1	12940	2 year	66.00	188.82	190.49	190.33	190.73	0.004369	2.38	51.08	96.23	0.63
CreditRiver	1	12740	Regional	675.60	188.21	191.70		192.06	0.004224	4.05	467.00	371.21	0.72
CreditRiver	1	12740	100 year	411.10	188.21	190.95	190.95	191.45	0.006431	4.20	229.82	255.60	0.84
CreditRiver	1	12740	50 year	342.20	188.21	190.80	190.80	191.27	0.006261	3.98	193.71	230.17	0.82
CreditRiver	1	12740	25 year	279.50	188.21	190.64	190.64	191.09	0.006157	3.76	158.88	202.64	0.81
CreditRiver	1	12740	10 year	207.50	188.21	190.40	190.40	190.83	0.006232	3.51	115.89	162.34	0.80
CreditRiver	1	12740	5 year	158.50	188.21	190.21	190.21	190.61	0.006267	3.28	87.31	128.76	0.79
CreditRiver	1	12740	2 year	66.00	188.21	189.93	189.56	190.06	0.002448	1.83	57.73	87.61	0.48
CreditRiver	1	12576	Regional	675.60	187.60	191.68		191.73	0.000582	1.68	772.98	318.49	0.27
CreditRiver	1	12576	100 year	411.10	187.60	190.52		190.60	0.001344	2.01	423.13	292.88	0.39
CreditRiver	1	12576	50 year	342.20	187.60	190.26		190.36	0.001679	2.10	347.68	289.94	0.43
CreditRiver	1	12576	25 year	279.50	187.60	190.03		190.14	0.002094	2.20	280.64	287.30	0.47
CreditRiver	1	12576	10 year	207.50	187.60	189.78		189.90	0.002487	2.21	209.71	268.35	0.50
CreditRiver	1	12576	5 year	158.50	187.60	189.59		189.72	0.002789	2.19	161.55	252.95	0.53
CreditRiver	1	12576	2 year	66.00	187.60	188.95	188.88	189.35	0.008520	2.84	24.90	28.94	0.85
CreditRiver	1	12400	Regional	675.60	187.03	191.60	189.95	191.68	0.000634	1.91	773.15	274.16	0.29
CreditRiver	1	12400	100 year	411.10	187.03	190.40	189.60	190.51	0.001094	2.02	461.17	257.48	0.36
CreditRiver	1	12400	50 year	342.20	187.03	190.14	189.46	190.24	0.001198	2.00	392.83	256.58	0.37
CreditRiver	1	12400	25 year	279.50	187.03	189.91	189.34	190.01	0.001255	1.93	333.51	255.78	0.38
CreditRiver	1	12400	10 year	207.50	187.03	189.65	189.12	189.75	0.001231	1.79	267.52	254.93	0.37
CreditRiver	1	12400	5 year	158.50	187.03	189.47	188.96	189.56	0.001118	1.62	222.32	253.09	0.35
CreditRiver	1	12400	2 year	66.00	187.03	188.81	188.08	188.90	0.001296	1.38	73.03	178.20	0.35
CreditRiver	1	12350		Bridge									

Levi Creek

Schematic:





Flows:

Crossing: LEV_2_WC1 (Winston Churchill interchange)

	Existing Flows							*Future Flows*						
XS	2-year	5-year	10-year	25-year	50-year	100-year	Regional	2-year	5-year	10-year	25-year	50-year	100-year	Regional
42344	2.2	3.7	5	6.6	8	9.5	14.9	2.2	3.7	5	6.6	8	9.5	14.9
41903	3	5.2	7	9.4	11.5	13.6	22.2	3.1	5	6.7	8.9	10.8	12.8	22.2
41427	3.7	6.5	8.8	11.9	14.6	17.3	31	7.6	13.6	16.9	21.1	24.3	27.6	31.1
40707	3.1	6	8.3	11.4	14.1	16.8	33.9	6.7	9.9	12.2	15.2	17.6	20.1	34.7

It is assumed that the "future flows" in the model represent future changes in land use, and do not account for climate change (as some flows are the same as existing). And so the future flows will have a 10% increase applied to account for climate change assuming future land use conditions.

	Future w 10% Climate Change Increase								
XS	2-year	5-year	10-year	25-year	50-year	100-year	Check Q	Regional	
42344	2.42	4.07	5.50	7.26	8.80	10.45	13.59	14.90	<- these are the flows through our culvert
41903	3.4	5.5	7.4	9.8	11.9	14.1		22.2	
41427	8.4	15.0	18.6	23.2	26.7	30.4		31.1	
40707	7.4	10.9	13.4	16.7	19.4	22.1		34.7	

Crossing: LEV_0_WC2 (North of Embleton Rd)

	Existing Flows							*Future Flows*						
XS	2-year	5-year	10-year	25-year	50-year	100-year	Regional	2-year	5-year	10-year	25-year	50-year	100-year	Regional
56552	6.7	13.3	18.8	26.8	33.3	40	73.3	7.2	13.8	19.4	27.3	33.8	40.5	73.3
55270	5.9	11.7	16.7	23.7	30.1	36.3	75	6.4	12.4	17.6	24.8	31.2	37.5	75.8
54989	5.9	11.8	16.9	24.1	30.5	36.9	79.3	6.5	12.6	17.9	25.3	31.7	38.2	80.2
53856	5.1	10	14.7	21.2	27.1	33.1	80.5	5.8	11.2	16	22.8	28.9	35	81.7

Future w 10% Climate Change Increase

XS	2-year	5-year	10-year	25-year	50-year	100-year	Check Q	Regional	
56552	7.92	15.18	21.34	30.03	37.18	44.55	57.92	73.30	<- these are the flows through our culvert
55270	7.0	13.6	19.4	27.3	34.3	41.3		75.8	
54989	7.2	13.9	19.7	27.8	34.9	42.0		80.2	
53856	6.4	12.3	17.6	25.1	31.8	38.5		81.7	

Existing Water Levels:

HEC-RAS Plan: Levi_FHM Locations: User Defined

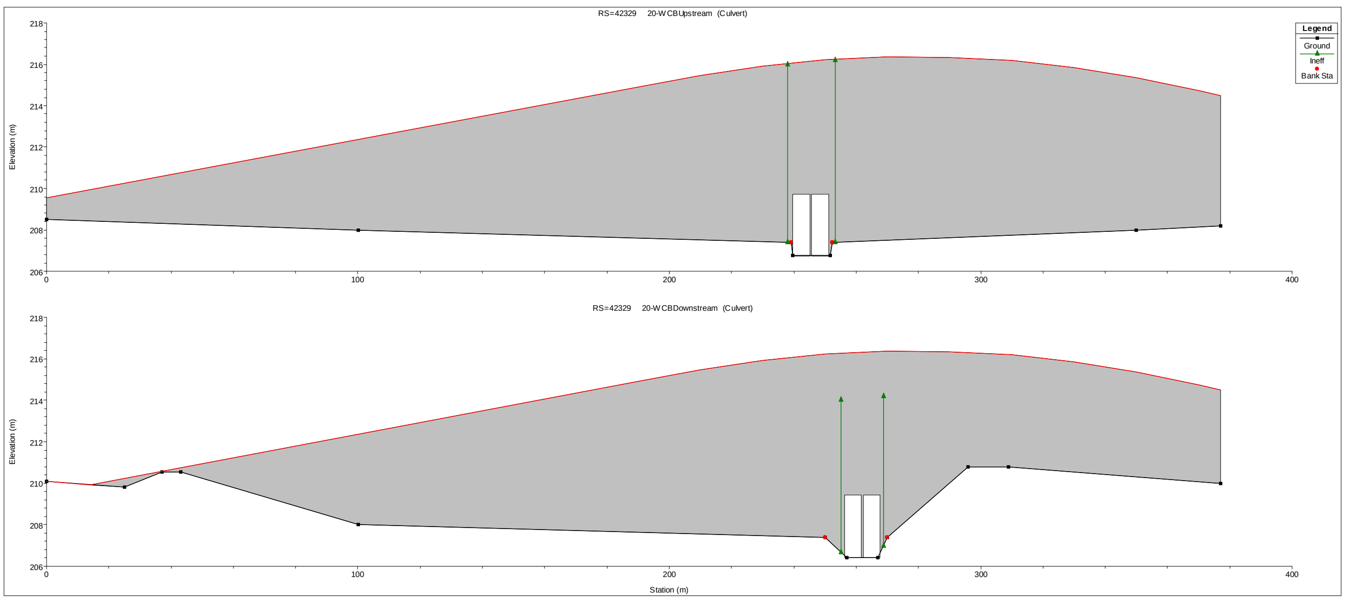
River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Levi Creek	614	42344	2yr_Ex	2.20	206.72	207.08	207.03	207.13	0.009984	1.00	2.21	73.91	0.70
Levi Creek	614	42344	5yr_Ex	3.70	206.72	207.17	207.11	207.24	0.008936	1.16	3.18	103.09	0.70
Levi Creek	614	42344	10yr_Ex	5.00	206.72	207.22	207.16	207.31	0.009881	1.34	3.73	107.69	0.75
Levi Creek	614	42344	25yr_Ex	6.60	206.72	207.29	207.22	207.40	0.009274	1.47	4.49	124.99	0.75
Levi Creek	614	42344	50yr_Ex	8.00	206.72	207.34	207.26	207.46	0.008841	1.56	5.12	154.42	0.75
Levi Creek	614	42344	100yr_Ex	9.50	206.72	207.40	207.31	207.53	0.008386	1.65	5.78	163.90	0.74
Levi Creek	614	42344	Reg_Ex	14.90	206.72	207.60	207.45	207.77	0.006738	1.85	8.11	196.96	0.70
Levi Creek	614	42344	2yr_Fut	2.20	206.72	207.08	207.03	207.13	0.009984	1.00	2.21	73.91	0.70
Levi Creek	614	42344	5yr_Fut	3.70	206.72	207.17	207.11	207.24	0.008936	1.16	3.18	103.09	0.70
Levi Creek	614	42344	10yr_Fut	5.00	206.72	207.22	207.16	207.31	0.009881	1.34	3.73	107.69	0.75
Levi Creek	614	42344	25yr_Fut	6.60	206.72	207.29	207.22	207.40	0.009274	1.47	4.49	124.99	0.75
Levi Creek	614	42344	50yr_Fut	8.00	206.72	207.34	207.26	207.46	0.008841	1.56	5.12	154.42	0.75
Levi Creek	614	42344	100yr_Fut	9.50	206.72	207.40	207.31	207.53	0.008386	1.65	5.78	163.90	0.74
Levi Creek	614	42344	Reg_Fut	14.90	206.72	207.60	207.45	207.77	0.006738	1.85	8.11	196.96	0.70
Levi Creek	614	42329 20-WCB		Culvert									
Levi Creek	614	42314	2yr_Ex	2.20	206.42	207.04	207.02	207.09	0.010423	1.03	2.49	101.79	0.71
Levi Creek	614	42314	5yr_Ex	3.70	206.42	207.12	207.08	207.18	0.009645	1.16	3.87	118.54	0.71
Levi Creek	614	42314	10yr_Ex	5.00	206.42	207.13	207.13	207.23	0.015971	1.52	4.01	119.81	0.92
Levi Creek	614	42314	25yr_Ex	6.60	206.42	207.17	207.17	207.29	0.015742	1.67	4.92	132.88	0.93
Levi Creek	614	42314	50yr_Ex	8.00	206.42	207.21	207.21	207.34	0.015886	1.79	5.60	151.25	0.95
Levi Creek	614	42314	100yr_Ex	9.50	206.42	207.24	207.24	207.39	0.015932	1.90	6.28	173.33	0.97
Levi Creek	614	42314	Reg_Ex	14.90	206.42	207.35	207.35	207.55	0.015646	2.22	8.47	218.60	1.00
Levi Creek	614	42314	2yr_Fut	2.20	206.42	207.04	207.02	207.09	0.010423	1.03	2.49	101.79	0.71
Levi Creek	614	42314	5yr_Fut	3.70	206.42	207.12	207.08	207.18	0.009645	1.16	3.87	118.54	0.71
Levi Creek	614	42314	10yr_Fut	5.00	206.42	207.13	207.13	207.23	0.015971	1.52	4.01	119.81	0.92
Levi Creek	614	42314	25yr_Fut	6.60	206.42	207.17	207.17	207.29	0.015742	1.67	4.92	132.88	0.93
Levi Creek	614	42314	50yr_Fut	8.00	206.42	207.21	207.21	207.34	0.015886	1.79	5.60	151.25	0.95
Levi Creek	614	42314	100yr_Fut	9.50	206.42	207.24	207.24	207.39	0.015932	1.90	6.28	173.33	0.97
Levi Creek	614	42314	Reg_Fut	14.90	206.42	207.35	207.35	207.55	0.015646	2.22	8.47	218.60	1.00
Levi Creek	614	42249	2yr_Ex	2.20	205.55	206.03	206.03	206.16	0.019498	1.58	1.39	152.16	1.00
Levi Creek	614	42249	5yr_Ex	3.70	205.55	206.16	206.16	206.31	0.018423	1.69	2.19	177.17	1.00
Levi Creek	614	42249	10yr_Ex	5.00	205.55	206.27	206.29	206.39	0.010562	1.54	4.11	217.83	0.79
Levi Creek	614	42249	25yr_Ex	6.60	205.55	206.32	206.36	206.45	0.010816	1.68	6.09	252.30	0.82
Levi Creek	614	42249	50yr_Ex	8.00	205.55	206.35	206.40	206.48	0.011061	1.78	7.74	262.97	0.83
Levi Creek	614	42249	100yr_Ex	9.50	205.55	206.37	206.42	206.51	0.011481	1.87	9.28	269.02	0.86
Levi Creek	614	42249	Reg_Ex	14.90	205.55	206.43	206.48	206.59	0.013352	2.18	13.75	281.15	0.94
Levi Creek	614	42249	2yr_Fut	2.20	205.55	206.03	206.03	206.16	0.019498	1.58	1.39	152.16	1.00
Levi Creek	614	42249	5yr_Fut	3.70	205.55	206.16	206.16	206.31	0.018423	1.69	2.19	177.17	1.00
Levi Creek	614	42249	10yr_Fut	5.00	205.55	206.27	206.29	206.39	0.010562	1.54	4.11	217.83	0.79
Levi Creek	614	42249	25yr_Fut	6.60	205.55	206.32	206.36	206.45	0.010816	1.68	6.09	252.30	0.82
Levi Creek	614	42249	50yr_Fut	8.00	205.55	206.35	206.40	206.48	0.011061	1.78	7.74	262.97	0.83
Levi Creek	614	42249	100yr_Fut	9.50	205.55	206.37	206.42	206.51	0.011481	1.87	9.28	269.02	0.86
Levi Creek	614	42249	Reg_Fut	14.90	205.55	206.43	206.48	206.59	0.013352	2.18	13.75	281.15	0.94
Levi Creek	615	55718	2yr_Ex	6.70	204.94	205.93	205.90	206.00	0.003951	1.51	13.70	58.42	0.53
Levi Creek	615	55718	5yr_Ex	13.30	204.94	206.10	206.01	206.16	0.004142	1.75	23.71	64.58	0.56
Levi Creek	615	55718	10yr_Ex	18.80	204.94	206.19	206.08	206.26	0.004549	1.95	30.43	76.51	0.60
Levi Creek	615	55718	25yr_Ex	26.80	204.94	206.30	206.18	206.37	0.004810	2.13	38.81	82.21	0.63
Levi Creek	615	55718	50yr_Ex	33.30	204.94	206.37	206.24	206.45	0.004943	2.25	45.11	84.35	0.64
Levi Creek	615	55718	100yr_Ex	40.00	204.94	206.45	206.29	206.53	0.005012	2.35	51.24	87.26	0.65
Levi Creek	615	55718	Reg_Ex	73.30	204.94	206.74	206.48	206.84	0.005053	2.70	77.79	92.96	0.68
Levi Creek	615	55718	2yr_Fut	7.20	204.94	205.96	205.91	206.01	0.003630	1.47	15.16	59.08	0.51
Levi Creek	615	55718	5yr_Fut	13.80	204.94	206.11	206.01	206.17	0.004166	1.76	24.34	65.29	0.57
Levi Creek	615	55718	10yr_Fut	19.40	204.94	206.20	206.09	206.27	0.004530	1.95	31.23	76.86	0.60
Levi Creek	615	55718	25yr_Fut	27.30	204.94	206.31	206.19	206.38	0.004800	2.14	39.49	82.49	0.63
Levi Creek	615	55718	50yr_Fut	33.80	204.94	206.38	206.25	206.46	0.004924	2.26	45.67	84.72	0.64
Levi Creek	615	55718	100yr_Fut	40.50	204.94	206.45	206.29	206.53	0.004997	2.36	51.75	87.41	0.65
Levi Creek	615	55718	Reg_Fut	73.30	204.94	206.74	206.48	206.84	0.005049	2.70	77.81	92.97	0.68
Levi Creek	615	55567	2yr_Ex	6.70	204.30	205.09	205.09	205.16	0.008267	1.91	12.18	69.49	0.74
Levi Creek	615	55567	5yr_Ex	13.30	204.30	205.21		205.29	0.008470	2.17	21.69	75.81	0.78
Levi Creek	615	55567	10yr_Ex	18.80	204.30	205.30		205.37	0.008008	2.26	28.12	76.91	0.77
Levi Creek	615	55567	25yr_Ex	26.80	204.30	205.41		205.48	0.007485	2.35	36.47	78.08	0.76
Levi Creek	615	55567	50yr_Ex	33.30	204.30	205.48		205.55	0.007240	2.43	42.53	78.91	0.75
Levi Creek	615	55567	100yr_Ex	40.00	204.30	205.56		205.63	0.007058	2.52	48.67	81.17	0.75
Levi Creek	615	55567	Reg_Ex	73.30	204.30	205.88		205.97	0.006594	2.87	76.33	92.89	0.76
Levi Creek	615	55567	2yr_Fut	7.20	204.30	205.10	205.09	205.19	0.009154	2.03	12.97	71.16	0.79
Levi Creek	615	55567	5yr_Fut	13.80	204.30	205.22		205.30	0.008508	2.19	22.23	75.90	0.78
Levi Creek	615	55567	10yr_Fut	19.40	204.30	205.31		205.38	0.008050	2.27	28.67	77.00	0.77
Levi Creek	615	55567	25yr_Fut	27.30	204.30	205.41		205.48	0.007578	2.38	36.77	78.12	0.76
Levi Creek	615	55567	50yr_Fut	33.80	204.30	205.49		205.56	0.007304	2.45	42.83	78.95	0.76
Levi Creek	615	55567	100yr_Fut	40.50	204.30	205.56		205.64	0.007112	2.53	48.95	81.23	0.76
Levi Creek	615	55567	Reg_Fut	73.30	204.30	205.88		205.97	0.006606	2.88	76.28	92.88	0.76
Levi Creek	615	55408	2yr_Ex	6.70	203.61	204.36	204.23	204.38	0.003152	1.24	20.97	82.70	0.47
Levi Creek	615	55408	5yr_Ex	13.30	203.61	204.50	204.34	204.52	0.003082	1.39	32.98	83.62	0.48
Levi Creek	615	55408	10yr_Ex	18.80	203.61	204.60		204.62	0.003069	1.49	41.10	84.12	0.49
Levi Creek	615	55408	25yr_Ex	26.80	203.61	204.72		204.74	0.003105	1.62	51.14	84.63	0.50
Levi Creek	615	55408	50yr_Ex	33.30	203.61	204.81		204.83	0.003087	1.71	58.65	85.02	0.51
Levi Creek	615	55408	100yr_Ex	40.00	203.61	204.89		204.92	0.003102	1.79	65.64	85.35	0.51
Levi Creek	615	55408	Reg_Ex	73.30	203.61	205.27		205.30	0.002873	2.05	97.91	86.96	0.52
Levi Creek	615	55408	2yr_Fut	7.20	203.61	204.37		204.39	0.003085	1.24	22.15	82.79	0.47
Levi Creek	615	55408	5yr_Fut	13.80	203.61	204.52	204.33	204.53	0.003046	1.39	33.89	83.69	0.48
Levi Creek	615	55408	10yr_Fut	19.40	203.61	204.61		204.63	0.003011	1.49	42.18	84.17	0.49

HEC-RAS Plan: Levi_FHM Locations: User Defined (Continued)

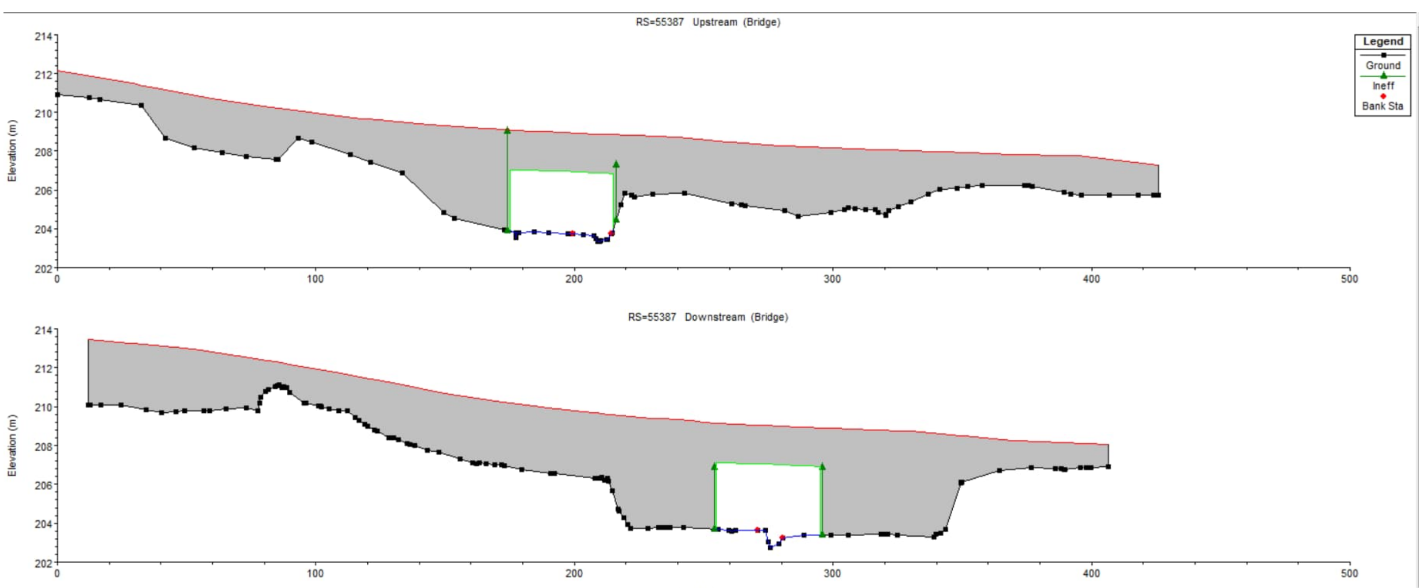
River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Levi Creek	615	55408	25yr_Fut	27.30	203.61	204.73		204.75	0.003033	1.61	52.11	84.68	0.50
Levi Creek	615	55408	50yr_Fut	33.80	203.61	204.82		204.85	0.003024	1.70	59.58	85.07	0.50
Levi Creek	615	55408	100yr_Fut	40.50	203.61	204.90		204.93	0.003040	1.78	66.56	85.40	0.51
Levi Creek	615	55408	Reg_Fut	73.30	203.61	205.27		205.31	0.002832	2.04	98.35	86.98	0.51
Levi Creek	615	55270	2yr_Ex	5.90	203.44	203.85		203.86	0.005315	0.98	15.24	59.87	0.54
Levi Creek	615	55270	5yr_Ex	11.70	203.44	203.97		203.98	0.006217	1.29	22.22	61.39	0.61
Levi Creek	615	55270	10yr_Ex	16.70	203.44	204.05		204.07	0.006574	1.48	27.33	62.98	0.64
Levi Creek	615	55270	25yr_Ex	23.70	203.44	204.14		204.17	0.007197	1.72	33.13	64.24	0.69
Levi Creek	615	55270	50yr_Ex	30.10	203.44	204.23		204.27	0.007094	1.86	38.87	67.41	0.70
Levi Creek	615	55270	100yr_Ex	36.30	203.44	204.30		204.34	0.007366	2.02	43.72	70.92	0.73
Levi Creek	615	55270	Reg_Ex	75.00	203.44	204.71		204.77	0.006206	2.45	74.34	77.20	0.71
Levi Creek	615	55270	2yr_Fut	6.40	203.44	203.86		203.87	0.005579	1.02	15.79	59.98	0.55
Levi Creek	615	55270	5yr_Fut	12.40	203.44	203.98		204.00	0.006188	1.31	23.08	61.72	0.61
Levi Creek	615	55270	10yr_Fut	17.60	203.44	204.06		204.09	0.006658	1.51	28.14	63.16	0.65
Levi Creek	615	55270	25yr_Fut	24.80	203.44	204.15		204.19	0.007161	1.74	34.16	64.59	0.69
Levi Creek	615	55270	50yr_Fut	31.20	203.44	204.24		204.28	0.007132	1.89	39.74	68.54	0.71
Levi Creek	615	55270	100yr_Fut	37.50	203.44	204.31		204.35	0.007404	2.04	44.59	71.15	0.73
Levi Creek	615	55270	Reg_Fut	75.80	203.44	204.72		204.78	0.006134	2.45	75.15	77.34	0.71

Proposed Bridges:

LEV_2_WC1 (Winston Churchill Interchange) – Final Culvert Configuration



LEV_0_WC2 (North of Embleton Rd) – Minimum Hydraulic Opening



Proposed Water Levels:

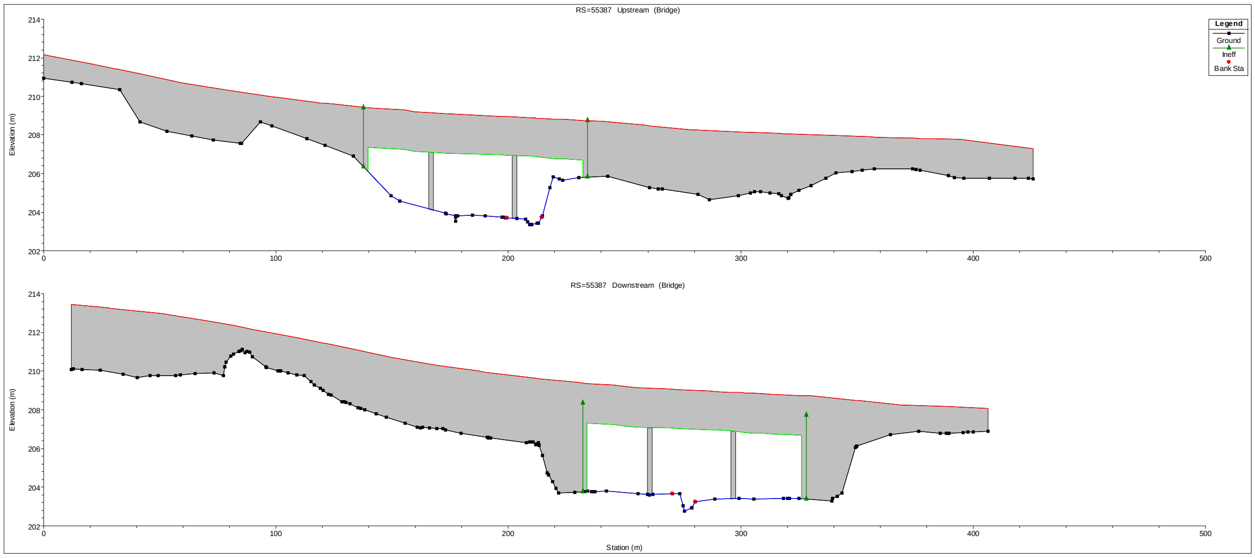
HEC-RAS Plan: Plan 02 Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Levi Creek	614	42344	2yr_Ex	2.20	206.72	207.07	207.03	207.13	0.011410	1.04	2.11	72.46	0.74
Levi Creek	614	42344	5yr_Ex	3.70	206.72	207.16	207.11	207.23	0.010232	1.22	3.04	92.27	0.74
Levi Creek	614	42344	10yr_Ex	5.00	206.72	207.22	207.16	207.31	0.009881	1.34	3.73	107.69	0.75
Levi Creek	614	42344	25yr_Ex	6.60	206.72	207.29	207.22	207.40	0.009274	1.47	4.49	124.99	0.75
Levi Creek	614	42344	50yr_Ex	8.00	206.72	207.34	207.26	207.46	0.008841	1.56	5.12	154.42	0.75
Levi Creek	614	42344	100yr_Ex	9.50	206.72	207.40	207.31	207.53	0.008386	1.65	5.78	163.90	0.74
Levi Creek	614	42344	Reg_Ex	14.90	206.72	207.60	207.45	207.77	0.006738	1.85	8.11	196.96	0.70
Levi Creek	614	42344	2yr_Fut	2.20	206.72	207.07	207.03	207.13	0.011410	1.04	2.11	72.46	0.74
Levi Creek	614	42344	5yr_Fut	3.70	206.72	207.16	207.11	207.23	0.010232	1.22	3.04	92.27	0.74
Levi Creek	614	42344	10yr_Fut	5.00	206.72	207.22	207.16	207.31	0.009881	1.34	3.73	107.69	0.75
Levi Creek	614	42344	25yr_Fut	6.60	206.72	207.29	207.22	207.40	0.009274	1.47	4.49	124.99	0.75
Levi Creek	614	42344	50yr_Fut	8.00	206.72	207.34	207.26	207.46	0.008841	1.56	5.12	154.42	0.75
Levi Creek	614	42344	100yr_Fut	9.50	206.72	207.40	207.31	207.53	0.008386	1.65	5.78	163.90	0.74
Levi Creek	614	42344	Reg_Fut	14.90	206.72	207.60	207.45	207.77	0.006738	1.85	8.11	196.96	0.70
Levi Creek	614	42344	2yr_Fut +CC	2.40	206.72	207.09	207.05	207.14	0.011087	1.06	2.26	74.66	0.74
Levi Creek	614	42344	5yr_Fut +CC	4.10	206.72	207.18	207.12	207.26	0.010099	1.26	3.26	104.00	0.74
Levi Creek	614	42344	10yr_Fut +CC	5.50	206.72	207.24	207.18	207.34	0.009732	1.39	3.97	109.80	0.75
Levi Creek	614	42344	25yr_Fut +CC	7.30	206.72	207.31	207.24	207.43	0.009042	1.52	4.81	145.97	0.75
Levi Creek	614	42344	50yr_Fut +CC	8.80	206.72	207.37	207.29	207.50	0.008591	1.61	5.47	159.69	0.75
Levi Creek	614	42344	100yr_Fut +CC	10.50	206.72	207.43	207.33	207.58	0.008125	1.70	6.20	170.07	0.74
Levi Creek	614	42344	Check Flow Fut +	13.59	206.72	207.54	207.42	207.71	0.007210	1.82	7.51	190.34	0.72
Levi Creek	614	42329 20-WCB		Culvert									
Levi Creek	614	42314	2yr_Ex	2.20	206.42	207.02	207.02	207.09	0.016577	1.22	2.04	89.66	0.88
Levi Creek	614	42314	5yr_Ex	3.70	206.42	207.08	207.08	207.17	0.017023	1.41	3.10	108.61	0.92
Levi Creek	614	42314	10yr_Ex	5.00	206.42	207.13	207.13	207.23	0.015971	1.52	4.01	119.81	0.92
Levi Creek	614	42314	25yr_Ex	6.60	206.42	207.17	207.17	207.29	0.015742	1.67	4.92	132.88	0.93
Levi Creek	614	42314	50yr_Ex	8.00	206.42	207.21	207.21	207.34	0.015886	1.79	5.60	151.25	0.95
Levi Creek	614	42314	100yr_Ex	9.50	206.42	207.24	207.24	207.39	0.015932	1.90	6.28	173.33	0.97
Levi Creek	614	42314	Reg_Ex	14.90	206.42	207.35	207.35	207.55	0.015646	2.22	8.47	218.60	1.00
Levi Creek	614	42314	2yr_Fut	2.20	206.42	207.02	207.02	207.09	0.016577	1.22	2.04	89.66	0.88
Levi Creek	614	42314	5yr_Fut	3.70	206.42	207.08	207.08	207.17	0.017023	1.41	3.10	108.61	0.92
Levi Creek	614	42314	10yr_Fut	5.00	206.42	207.13	207.13	207.23	0.015971	1.52	4.01	119.81	0.92
Levi Creek	614	42314	25yr_Fut	6.60	206.42	207.17	207.17	207.29	0.015742	1.67	4.92	132.88	0.93
Levi Creek	614	42314	50yr_Fut	8.00	206.42	207.21	207.21	207.34	0.015886	1.79	5.60	151.25	0.95
Levi Creek	614	42314	100yr_Fut	9.50	206.42	207.24	207.24	207.39	0.015932	1.90	6.28	173.33	0.97
Levi Creek	614	42314	Reg_Fut	14.90	206.42	207.35	207.35	207.55	0.015646	2.22	8.47	218.60	1.00
Levi Creek	614	42314	2yr_Fut +CC	2.40	206.42	207.03	207.03	207.10	0.016726	1.26	2.20	91.57	0.89
Levi Creek	614	42314	5yr_Fut +CC	4.10	206.42	207.10	207.10	207.19	0.016590	1.44	3.40	114.35	0.92
Levi Creek	614	42314	10yr_Fut +CC	5.50	206.42	207.14	207.14	207.25	0.015807	1.57	4.32	122.54	0.92
Levi Creek	614	42314	25yr_Fut +CC	7.30	206.42	207.19	207.19	207.32	0.015712	1.73	5.28	141.09	0.94
Levi Creek	614	42314	50yr_Fut +CC	8.80	206.42	207.23	207.23	207.37	0.015543	1.84	6.01	164.80	0.95
Levi Creek	614	42314	100yr_Fut +CC	10.50	206.42	207.26	207.26	207.42	0.015735	1.96	6.73	185.93	0.97
Levi Creek	614	42314	Check Flow Fut +	13.59	206.42	207.32	207.32	207.51	0.015619	2.14	7.99	211.90	0.99
Levi Creek	614	42249	2yr_Ex	2.20	205.98	206.38	206.30	206.41	0.005095	0.88	3.42	255.91	0.53
Levi Creek	614	42249	5yr_Ex	3.70	205.98	206.48	206.36	206.51	0.005029	1.05	4.74	262.94	0.55
Levi Creek	614	42249	10yr_Ex	5.00	205.98	206.55	206.40	206.60	0.004859	1.17	5.77	270.36	0.55
Levi Creek	614	42249	25yr_Ex	6.60	205.98	206.63	206.45	206.68	0.004728	1.28	6.90	286.50	0.56
Levi Creek	614	42249	50yr_Ex	8.00	205.98	206.69	206.49	206.76	0.004577	1.36	7.83	304.56	0.56
Levi Creek	614	42249	100yr_Ex	9.50	205.98	206.76	206.53	206.83	0.004436	1.44	8.78	320.89	0.57
Levi Creek	614	42249	Reg_Ex	14.90	205.98	206.98	206.66	207.07	0.004066	1.66	11.85	340.30	0.57
Levi Creek	614	42249	2yr_Fut	2.20	205.98	206.38	206.30	206.41	0.005095	0.88	3.42	255.91	0.53
Levi Creek	614	42249	5yr_Fut	3.70	205.98	206.48	206.36	206.51	0.005029	1.05	4.74	262.94	0.55
Levi Creek	614	42249	10yr_Fut	5.00	205.98	206.55	206.40	206.60	0.004859	1.17	5.77	270.36	0.55
Levi Creek	614	42249	25yr_Fut	6.60	205.98	206.63	206.45	206.68	0.004728	1.28	6.90	286.50	0.56
Levi Creek	614	42249	50yr_Fut	8.00	205.98	206.69	206.49	206.76	0.004577	1.36	7.83	304.56	0.56
Levi Creek	614	42249	100yr_Fut	9.50	205.98	206.76	206.53	206.83	0.004436	1.44	8.78	320.89	0.57
Levi Creek	614	42249	Reg_Fut	14.90	205.98	206.98	206.66	207.07	0.004066	1.66	11.85	340.30	0.57
Levi Creek	614	42249	2yr_Fut +CC	2.40	205.98	206.40	206.30	206.42	0.005122	0.91	3.60	256.69	0.53
Levi Creek	614	42249	5yr_Fut +CC	4.10	205.98	206.50	206.37	206.54	0.004971	1.09	5.07	264.84	0.55
Levi Creek	614	42249	10yr_Fut +CC	5.50	205.98	206.57	206.42	206.62	0.004848	1.21	6.12	273.89	0.56
Levi Creek	614	42249	25yr_Fut +CC	7.30	205.98	206.66	206.47	206.72	0.004679	1.33	7.36	295.24	0.57
Levi Creek	614	42249	50yr_Fut +CC	8.80	205.98	206.73	206.51	206.80	0.004512	1.41	8.34	313.53	0.57
Levi Creek	614	42249	100yr_Fut +CC	10.50	205.98	206.80	206.56	206.88	0.004397	1.49	9.36	327.55	0.57
Levi Creek	614	42249	Check Flow Fut +	13.59	205.98	206.93	206.63	207.02	0.004153	1.62	11.13	335.18	0.57
Levi Creek	614	42248		Bridge									
Levi Creek	615	55718	2yr_Ex	6.70	204.94	205.90	205.90	205.99	0.005536	1.73	11.71	57.50	0.63
Levi Creek	615	55718	5yr_Ex	13.30	204.94	206.02	206.01	206.13	0.007211	2.19	19.06	61.63	0.73
Levi Creek	615	55718	10yr_Ex	18.80	204.94	206.14	206.08	206.23	0.006405	2.23	26.28	67.64	0.71
Levi Creek	615	55718	25yr_Ex	26.80	204.94	206.25	206.18	206.35	0.006333	2.38	35.09	77.91	0.71
Levi Creek	615	55718	50yr_Ex	33.30	204.94	206.32	206.24	206.42	0.006726	2.55	40.36	82.76	0.74
Levi Creek	615	55718	100yr_Ex	40.00	204.94	206.37	206.29	206.49	0.007179	2.71	45.01	84.27	0.77
Levi Creek	615	55718	Reg_Ex	73.30	204.94	206.60	206.48	206.75	0.008362	3.28	65.38	90.18	0.86
Levi Creek	615	55718	2yr_Fut	7.20	204.94	205.91	205.91	206.00	0.005758	1.78	12.31	57.78	0.64
Levi Creek	615	55718	5yr_Fut	13.80	204.94	206.03	206.01	206.14	0.007120	2.19	19.74	61.96	0.73
Levi Creek	615	55718	10yr_Fut	19.40	204.94	206.15	206.09	206.25	0.006283	2.23	27.28	71.90	0.70
Levi Creek	615	55718	25yr_Fut	27.30	204.94	206.26	206.19	206.35	0.006386	2.40	35.46	77.99	0.72
Levi Creek	615	55718	50yr_Fut	33.80	204.94	206.32	206.25	206.43	0.006767	2.56	40.71	82.87	0.75
Levi Creek	615	55718	100yr_Fut	40.50	204.94	206.38	206.29	206.49	0.007238	2.73	45.28	84.46	0.78
Levi Creek	615	55718	Reg_Fut	73.30	204.94	206.60	206.48	206.75	0.008368	3.28	65.37	90.18	0.86
Levi Creek	615	55718	2yr_Fut +CC	7.92	204.94	205.93	205.93	206.02	0.005918	1.84	13.28	58.22	0.65
Levi Creek	615	55718	5yr_Fut +CC	15.18	204.94	206.06	206.04	206.17	0.006863	2.20	21.59	62.87	0.72
Levi Creek	615	55718	10yr_Fut +CC	21.34	204.94	206.18	206.11	206.28	0.006352	2.28	29.49	76.08	0.71
Levi Creek	615	55718	25yr_Fut +CC	30.03	204.94	206.29	206.21	206.39	0.006522	2.46	37.72	81.05	0.73
Levi Creek	615	55718	50yr_Fut +CC	37.18	204.94	206.35	206.27	206.46	0.007017	2.65	43.05	83.58	0.76
Levi Creek	615	55718	100yr_Fut +CC	44.55	204.94	206.41	206.30	206.53	0.007442	2.82	48.05	86.28	0.79
Levi Creek	615	55718	Check Flow Fut +	57.92	204.94	206.51	206.40	206.64	0.007957	3.05	56.52	88.65	0.83
Levi Creek	615	55567	2yr_Ex	6.70	204.11	204.74	204.77	204.89	0.009919	1.82	7.25	54.86	0.81
Levi Creek	615	55567	5yr_Ex	13.30	204.11	204.91	204.91	205.02	0.007504	1.90	18.01	69.63	0.73

HEC-RAS Plan: Plan 02 Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Levi Creek	615	55567	10yr_Ex	18.80	204.11	204.97	204.97	205.10	0.008719	2.18	22.49	70.51	0.80
Levi Creek	615	55567	25yr_Ex	26.80	204.11	205.07		205.21	0.009068	2.40	29.14	72.80	0.84
Levi Creek	615	55567	50yr_Ex	33.30	204.11	205.15		205.29	0.008339	2.46	35.55	75.14	0.81
Levi Creek	615	55567	100yr_Ex	40.00	204.11	205.23		205.37	0.007601	2.48	41.79	75.67	0.79
Levi Creek	615	55567	Reg_Ex	73.30	204.11	205.60		205.73	0.005512	2.60	70.24	78.34	0.71
Levi Creek	615	55567	2yr_Fut	7.20	204.11	204.76	204.78	204.90	0.009455	1.82	8.24	56.20	0.79
Levi Creek	615	55567	5yr_Fut	13.80	204.11	204.91	204.91	205.03	0.007616	1.93	18.47	69.69	0.74
Levi Creek	615	55567	10yr_Fut	19.40	204.11	204.98	204.98	205.11	0.008989	2.22	22.78	71.14	0.82
Levi Creek	615	55567	25yr_Fut	27.30	204.11	205.07		205.22	0.008963	2.40	29.69	73.05	0.83
Levi Creek	615	55567	50yr_Fut	33.80	204.11	205.16		205.30	0.008262	2.46	36.05	75.18	0.81
Levi Creek	615	55567	100yr_Fut	40.50	204.11	205.24		205.37	0.007547	2.48	42.25	75.70	0.79
Levi Creek	615	55567	Reg_Fut	73.30	204.11	205.60		205.73	0.005504	2.60	70.27	78.35	0.71
Levi Creek	615	55567	2yr_Fut +CC	7.92	204.11	204.78	204.81	204.92	0.009138	1.84	9.50	59.63	0.78
Levi Creek	615	55567	5yr_Fut +CC	15.18	204.11	204.93	204.93	205.05	0.007933	2.00	19.66	69.84	0.76
Levi Creek	615	55567	10yr_Fut +CC	21.34	204.11	205.00	205.00	205.14	0.008954	2.26	24.59	71.52	0.82
Levi Creek	615	55567	25yr_Fut +CC	30.03	204.11	205.11		205.25	0.008705	2.43	32.30	74.25	0.83
Levi Creek	615	55567	50yr_Fut +CC	37.18	204.11	205.20		205.34	0.007876	2.47	39.22	75.45	0.80
Levi Creek	615	55567	100yr_Fut +CC	44.55	204.11	205.29		205.42	0.007195	2.50	45.88	76.01	0.77
Levi Creek	615	55567	Check Flow Fut +	57.92	204.11	205.44		205.57	0.006310	2.56	57.40	77.32	0.74
Levi Creek	615	55408	2yr_Ex	6.70	203.35	204.04	203.95	204.07	0.002971	0.98	15.28	62.99	0.44
Levi Creek	615	55408	5yr_Ex	13.30	203.35	204.22	204.05	204.25	0.002541	1.11	27.05	65.73	0.43
Levi Creek	615	55408	10yr_Ex	18.80	203.35	204.34	204.11	204.38	0.002435	1.21	34.92	66.96	0.43
Levi Creek	615	55408	25yr_Ex	26.80	203.35	204.49		204.53	0.002343	1.33	45.03	68.50	0.44
Levi Creek	615	55408	50yr_Ex	33.30	203.35	204.60		204.64	0.002286	1.41	52.54	69.62	0.44
Levi Creek	615	55408	100yr_Ex	40.00	203.35	204.70		204.75	0.002242	1.49	59.77	70.68	0.44
Levi Creek	615	55408	Reg_Ex	73.30	203.35	205.17		205.23	0.001956	1.74	93.68	75.47	0.44
Levi Creek	615	55408	2yr_Fut	7.20	203.35	204.05	203.96	204.09	0.002934	0.99	16.26	63.22	0.44
Levi Creek	615	55408	5yr_Fut	13.80	203.35	204.23	204.05	204.27	0.002539	1.12	27.77	65.84	0.43
Levi Creek	615	55408	10yr_Fut	19.40	203.35	204.35	204.12	204.39	0.002439	1.22	35.66	67.07	0.43
Levi Creek	615	55408	25yr_Fut	27.30	203.35	204.50		204.54	0.002352	1.34	45.53	68.57	0.44
Levi Creek	615	55408	50yr_Fut	33.80	203.35	204.61		204.65	0.002289	1.42	53.04	69.69	0.44
Levi Creek	615	55408	100yr_Fut	40.50	203.35	204.71		204.76	0.002244	1.50	60.25	70.75	0.44
Levi Creek	615	55408	Reg_Fut	73.30	203.35	205.17		205.23	0.001942	1.74	93.91	75.50	0.43
Levi Creek	615	55408	2yr_Fut +CC	7.92	203.35	204.08	203.97	204.11	0.002868	1.01	17.67	63.55	0.44
Levi Creek	615	55408	5yr_Fut +CC	15.18	203.35	204.26	204.07	204.30	0.002508	1.15	29.82	66.16	0.43
Levi Creek	615	55408	10yr_Fut +CC	21.34	203.35	204.39	204.14	204.43	0.002415	1.25	38.20	67.46	0.43
Levi Creek	615	55408	25yr_Fut +CC	30.03	203.35	204.54		204.59	0.002314	1.37	48.82	69.07	0.44
Levi Creek	615	55408	50yr_Fut +CC	37.18	203.35	204.66		204.71	0.002266	1.46	56.73	70.24	0.44
Levi Creek	615	55408	100yr_Fut +CC	44.55	203.35	204.77		204.82	0.002217	1.54	64.47	71.37	0.44
Levi Creek	615	55408	Check Flow Fut +	57.92	203.35	204.95		205.01	0.002140	1.66	77.70	73.26	0.45
Levi Creek	615	55388	2yr_Ex	6.70	203.35	203.96	203.86	204.00	0.004308	0.99	9.93	42.81	0.51
Levi Creek	615	55388	5yr_Ex	13.30	203.35	204.15	203.98	204.20	0.003588	1.17	17.55	49.02	0.50
Levi Creek	615	55388	10yr_Ex	18.80	203.35	204.25	204.06	204.32	0.003679	1.33	22.04	52.65	0.52
Levi Creek	615	55388	25yr_Ex	26.80	203.35	204.39	204.15	204.48	0.003777	1.53	27.67	57.17	0.54
Levi Creek	615	55388	50yr_Ex	33.30	203.35	204.49	204.22	204.59	0.003816	1.65	31.79	60.46	0.55
Levi Creek	615	55388	100yr_Ex	40.00	203.35	204.58	204.29	204.69	0.003854	1.77	35.67	63.23	0.57
Levi Creek	615	55388	Reg_Ex	73.30	203.35	205.01	204.56	205.17	0.003574	2.16	53.65	109.25	0.58
Levi Creek	615	55388	2yr_Fut	7.20	203.35	203.98	203.88	204.02	0.004190	1.00	10.62	43.37	0.51
Levi Creek	615	55388	5yr_Fut	13.80	203.35	204.16	203.99	204.21	0.003625	1.19	17.94	49.33	0.50
Levi Creek	615	55388	10yr_Fut	19.40	203.35	204.26	204.07	204.33	0.003723	1.35	22.42	52.96	0.52
Levi Creek	615	55388	25yr_Fut	27.30	203.35	204.39	204.16	204.48	0.003817	1.54	27.91	57.37	0.54
Levi Creek	615	55388	50yr_Fut	33.80	203.35	204.49	204.23	204.59	0.003838	1.67	32.04	60.66	0.56
Levi Creek	615	55388	100yr_Fut	40.50	203.35	204.59	204.29	204.70	0.003870	1.78	35.91	63.32	0.57
Levi Creek	615	55388	Reg_Fut	73.30	203.35	205.01	204.56	205.17	0.003536	2.16	53.83	109.91	0.57
Levi Creek	615	55388	2yr_Fut +CC	7.92	203.35	204.00	203.90	204.05	0.004032	1.02	11.59	44.16	0.50
Levi Creek	615	55388	5yr_Fut +CC	15.18	203.35	204.18	204.01	204.24	0.003647	1.23	19.12	50.29	0.51
Levi Creek	615	55388	10yr_Fut +CC	21.34	203.35	204.30	204.09	204.37	0.003752	1.40	23.84	54.10	0.53
Levi Creek	615	55388	25yr_Fut +CC	30.03	203.35	204.44	204.19	204.53	0.003801	1.59	29.76	58.84	0.55
Levi Creek	615	55388	50yr_Fut +CC	37.18	203.35	204.54	204.26	204.65	0.003856	1.73	34.02	62.25	0.56
Levi Creek	615	55388	100yr_Fut +CC	44.55	203.35	204.64	204.33	204.76	0.003878	1.85	38.15	64.12	0.57
Levi Creek	615	55388	Check Flow Fut +	57.92	203.35	204.80	204.44	204.95	0.003888	2.04	45.04	81.39	0.59
Levi Creek	615	55387		Bridge									

LEV_0_WC2 (North of Embleton Rd) – Recommended Span



Proposed Water Levels based on Recommended Span:

HEC-RAS Plan: Final Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Levi Creek	615	55718	2yr_Ex	6.70	204.94	205.90	205.90	205.99	0.005536	1.73	11.71	57.50	0.63
Levi Creek	615	55718	5yr_Ex	13.30	204.94	206.02	206.01	206.13	0.007211	2.19	19.06	61.63	0.73
Levi Creek	615	55718	10yr_Ex	18.80	204.94	206.13	206.08	206.23	0.006542	2.25	26.05	67.02	0.71
Levi Creek	615	55718	25yr_Ex	26.80	204.94	206.23	206.18	206.34	0.007317	2.53	33.29	77.48	0.77
Levi Creek	615	55718	50yr_Ex	33.30	204.94	206.29	206.24	206.41	0.007651	2.68	38.38	81.76	0.79
Levi Creek	615	55718	100yr_Ex	40.00	204.94	206.35	206.29	206.48	0.007927	2.82	43.43	83.70	0.81
Levi Creek	615	55718	Reg_Ex	73.30	204.94	206.61	206.48	206.75	0.008318	3.27	65.50	90.20	0.86
Levi Creek	615	55718	2yr_Fut	7.20	204.94	205.91	205.91	206.00	0.005758	1.78	12.31	57.78	0.64
Levi Creek	615	55718	5yr_Fut	13.80	204.94	206.03	206.01	206.14	0.007120	2.19	19.74	61.96	0.73
Levi Creek	615	55718	10yr_Fut	19.40	204.94	206.14	206.09	206.24	0.006637	2.27	26.58	68.46	0.72
Levi Creek	615	55718	25yr_Fut	27.30	204.94	206.23	206.19	206.35	0.007359	2.54	33.67	77.57	0.77
Levi Creek	615	55718	50yr_Fut	33.80	204.94	206.30	206.25	206.42	0.007661	2.69	38.79	82.19	0.79
Levi Creek	615	55718	100yr_Fut	40.50	204.94	206.36	206.29	206.48	0.007974	2.84	43.73	83.79	0.81
Levi Creek	615	55718	Reg_Fut	73.30	204.94	206.61	206.48	206.75	0.008313	3.27	65.51	90.20	0.86
Levi Creek	615	55718	2yr_Fut +CC	7.92	204.94	205.93	205.93	206.02	0.005918	1.84	13.28	58.22	0.65
Levi Creek	615	55718	5yr_Fut +CC	15.18	204.94	206.06	206.04	206.17	0.006863	2.20	21.59	62.87	0.72
Levi Creek	615	55718	10yr_Fut +CC	21.34	204.94	206.17	206.11	206.27	0.006840	2.35	28.50	74.85	0.73
Levi Creek	615	55718	25yr_Fut +CC	30.03	204.94	206.26	206.21	206.38	0.007494	2.61	35.85	78.39	0.78
Levi Creek	615	55718	50yr_Fut +CC	37.18	204.94	206.33	206.27	206.45	0.007851	2.77	41.34	83.06	0.80
Levi Creek	615	55718	100yr_Fut +CC	44.55	204.94	206.39	206.30	206.52	0.008117	2.91	46.55	85.30	0.83
Levi Creek	615	55718	Check Flow Fut +	57.92	204.94	206.50	206.40	206.63	0.008290	3.10	55.72	88.51	0.84
Levi Creek	615	55567	2yr_Ex	6.70	204.11	204.77	204.77	204.88	0.007114	1.60	8.99	57.15	0.69
Levi Creek	615	55567	5yr_Ex	13.30	204.11	204.91	204.91	205.02	0.007504	1.90	18.01	69.63	0.73
Levi Creek	615	55567	10yr_Ex	18.80	204.11	204.98	204.97	205.10	0.008510	2.16	22.71	71.12	0.79
Levi Creek	615	55567	25yr_Ex	26.80	204.11	205.09		205.22	0.007556	2.24	31.26	73.78	0.77
Levi Creek	615	55567	50yr_Ex	33.30	204.11	205.18		205.30	0.007057	2.31	37.72	75.32	0.75
Levi Creek	615	55567	100yr_Ex	40.00	204.11	205.26		205.38	0.006636	2.36	43.80	75.83	0.74
Levi Creek	615	55567	Reg_Ex	73.30	204.11	205.60		205.73	0.005626	2.62	69.76	78.31	0.71
Levi Creek	615	55567	2yr_Fut	7.20	204.11	204.78	204.78	204.89	0.007619	1.67	9.45	59.37	0.72
Levi Creek	615	55567	5yr_Fut	13.80	204.11	204.91	204.91	205.03	0.007616	1.93	18.47	69.69	0.74
Levi Creek	615	55567	10yr_Fut	19.40	204.11	204.99	204.98	205.11	0.008409	2.16	23.39	71.27	0.79
Levi Creek	615	55567	25yr_Fut	27.30	204.11	205.10		205.22	0.007507	2.25	31.78	74.01	0.77
Levi Creek	615	55567	50yr_Fut	33.80	204.11	205.19		205.31	0.007042	2.31	38.15	75.36	0.75
Levi Creek	615	55567	100yr_Fut	40.50	204.11	205.27		205.39	0.006610	2.36	44.24	75.87	0.74
Levi Creek	615	55567	Reg_Fut	73.30	204.11	205.60		205.73	0.005632	2.62	69.74	78.31	0.71
Levi Creek	615	55567	2yr_Fut +CC	7.92	204.11	204.81	204.81	204.92	0.007315	1.69	10.98	66.26	0.71
Levi Creek	615	55567	5yr_Fut +CC	15.18	204.11	204.93	204.93	205.05	0.007933	2.00	19.66	69.84	0.76
Levi Creek	615	55567	10yr_Fut +CC	21.34	204.11	205.01	205.00	205.14	0.008152	2.18	25.50	71.71	0.78
Levi Creek	615	55567	25yr_Fut +CC	30.03	204.11	205.14		205.26	0.007287	2.28	34.64	75.06	0.76
Levi Creek	615	55567	50yr_Fut +CC	37.18	204.11	205.23		205.35	0.006803	2.34	41.28	75.62	0.75
Levi Creek	615	55567	100yr_Fut +CC	44.55	204.11	205.31		205.43	0.006411	2.40	47.72	76.16	0.73
Levi Creek	615	55567	Check Flow Fut +	57.92	204.11	205.45		205.58	0.005929	2.50	58.61	77.42	0.72
Levi Creek	615	55408	2yr_Ex	6.70	203.35	204.04		204.07	0.002901	0.97	15.43	63.02	0.44
Levi Creek	615	55408	5yr_Ex	13.30	203.35	204.21		204.24	0.002802	1.15	26.12	65.52	0.45
Levi Creek	615	55408	10yr_Ex	18.80	203.35	204.31		204.35	0.002881	1.29	32.96	66.65	0.47
Levi Creek	615	55408	25yr_Ex	26.80	203.35	204.44		204.49	0.002979	1.45	41.52	67.97	0.49
Levi Creek	615	55408	50yr_Ex	33.30	203.35	204.53		204.58	0.003048	1.56	47.70	68.90	0.50
Levi Creek	615	55408	100yr_Ex	40.00	203.35	204.61		204.68	0.003124	1.67	53.50	69.76	0.51
Levi Creek	615	55408	Reg_Ex	73.30	203.35	204.99		205.08	0.003074	2.02	80.57	73.66	0.54
Levi Creek	615	55408	2yr_Fut	7.20	203.35	204.06		204.09	0.002886	0.98	16.37	63.24	0.44
Levi Creek	615	55408	5yr_Fut	13.80	203.35	204.22		204.25	0.002835	1.17	26.70	65.67	0.45
Levi Creek	615	55408	10yr_Fut	19.40	203.35	204.32		204.36	0.002894	1.30	33.63	66.76	0.47
Levi Creek	615	55408	25yr_Fut	27.30	203.35	204.44		204.50	0.002987	1.46	42.00	68.04	0.49
Levi Creek	615	55408	50yr_Fut	33.80	203.35	204.53		204.59	0.003053	1.57	48.15	68.97	0.50
Levi Creek	615	55408	100yr_Fut	40.50	203.35	204.62		204.68	0.003126	1.67	53.93	69.83	0.52
Levi Creek	615	55408	Reg_Fut	73.30	203.35	204.99		205.08	0.003038	2.01	80.89	73.70	0.53
Levi Creek	615	55408	2yr_Fut +CC	7.92	203.35	204.08		204.11	0.002869	1.01	17.66	63.55	0.44
Levi Creek	615	55408	5yr_Fut +CC	15.18	203.35	204.24		204.28	0.002839	1.20	28.55	65.97	0.46
Levi Creek	615	55408	10yr_Fut +CC	21.34	203.35	204.35		204.40	0.002919	1.34	35.80	67.09	0.47
Levi Creek	615	55408	25yr_Fut +CC	30.03	203.35	204.48		204.54	0.003015	1.51	44.66	68.44	0.49
Levi Creek	615	55408	50yr_Fut +CC	37.18	203.35	204.58		204.64	0.003096	1.62	51.10	69.41	0.51
Levi Creek	615	55408	100yr_Fut +CC	44.55	203.35	204.67		204.73	0.003161	1.73	57.27	70.32	0.52
Levi Creek	615	55408	Check Flow Fut +	57.92	203.35	204.81		204.89	0.003273	1.91	67.44	71.79	0.54
Levi Creek	615	55388	2yr_Ex	6.70	203.35	203.97	203.86	204.01	0.004114	0.98	10.21	42.98	0.50
Levi Creek	615	55388	5yr_Ex	13.30	203.35	204.12	203.99	204.18	0.004422	1.26	17.07	48.04	0.55
Levi Creek	615	55388	10yr_Ex	18.80	203.35	204.20	204.06	204.28	0.005056	1.48	21.15	50.81	0.60
Levi Creek	615	55388	25yr_Ex	26.80	203.35	204.30	204.16	204.41	0.005705	1.74	26.45	54.20	0.65
Levi Creek	615	55388	50yr_Ex	33.30	203.35	204.37	204.23	204.50	0.006079	1.91	30.46	56.63	0.68
Levi Creek	615	55388	100yr_Ex	40.00	203.35	204.44	204.29	204.59	0.006457	2.07	34.21	58.81	0.71
Levi Creek	615	55388	Reg_Ex	73.30	203.35	204.83	204.58	205.00	0.004914	2.32	59.03	84.54	0.66
Levi Creek	615	55388	2yr_Fut	7.20	203.35	203.98	203.88	204.02	0.004140	1.00	10.80	43.44	0.50
Levi Creek	615	55388	5yr_Fut	13.80	203.35	204.12	203.99	204.19	0.004581	1.29	17.32	48.22	0.56
Levi Creek	615	55388	10yr_Fut	19.40	203.35	204.21	204.07	204.29	0.005138	1.50	21.53	51.06	0.60
Levi Creek	615	55388	25yr_Fut	27.30	203.35	204.31	204.17	204.42	0.005752	1.75	26.74	54.38	0.65
Levi Creek	615	55388	50yr_Fut	33.80	203.35	204.38	204.23	204.51	0.006101	1.92	30.76	56.81	0.69
Levi Creek	615	55388	100yr_Fut	40.50	203.35	204.44	204.30	204.60	0.006461	2.08	34.53	58.99	0.71
Levi Creek	615	55388	Reg_Fut	73.30	203.35	204.84	204.58	205.01	0.004786	2.30	59.59	85.59	0.65
Levi Creek	615	55388	2yr_Fut +CC	7.92	203.35	204.00	203.90	204.04	0.004181	1.04	11.61	44.06	0.51
Levi Creek	615	55388	5yr_Fut +CC	15.18	203.35	204.15	204.02	204.22	0.004691	1.34	18.47	49.01	0.57
Levi Creek	615	55388	10yr_Fut +CC	21.34	203.35	204.23	204.10	204.33	0.005315	1.57	22.85	51.92	0.62
Levi Creek	615	55388	25yr_Fut +CC	30.03	203.35	204.34	204.20	204.46	0.005910	1.83	28.46	55.43	0.67

HEC-RAS Plan: Final Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Levi Creek	615	55388	50yr_Fut +CC	37.18	203.35	204.41	204.27	204.55	0.006327	2.01	32.62	57.89	0.70
Levi Creek	615	55388	100yr_Fut +CC	44.55	203.35	204.48	204.34	204.65	0.006594	2.17	36.84	60.29	0.73
Levi Creek	615	55388	Check Flow Fut +	57.92	203.35	204.61	204.44	204.80	0.006708	2.38	44.56	63.63	0.75
Levi Creek	615	55387		Bridge									
Levi Creek	615	55304	2yr_Ex	6.70	202.76	203.52	203.49	203.58	0.004253	1.22	10.01	67.68	0.53
Levi Creek	615	55304	5yr_Ex	13.30	202.76	203.72	203.59	203.75	0.003068	0.99	22.19	94.48	0.44
Levi Creek	615	55304	10yr_Ex	18.80	202.76	203.84	203.69	203.87	0.002301	0.99	33.04	122.79	0.40
Levi Creek	615	55304	25yr_Ex	26.80	202.76	203.99	203.69	204.01	0.001832	1.01	46.94	123.84	0.37
Levi Creek	615	55304	50yr_Ex	33.30	202.76	204.09	203.73	204.12	0.001613	1.04	57.13	124.85	0.35
Levi Creek	615	55304	100yr_Ex	40.00	202.76	204.19	203.78	204.22	0.001492	1.07	66.43	125.39	0.35
Levi Creek	615	55304	Reg_Ex	73.30	202.76	204.73	203.95	204.75	0.000850	1.08	118.10	129.25	0.28
Levi Creek	615	55304	2yr_Fut	7.20	202.76	203.54	203.50	203.59	0.003926	1.20	11.09	67.92	0.51
Levi Creek	615	55304	5yr_Fut	13.80	202.76	203.74	203.59	203.76	0.002809	0.97	23.65	100.32	0.43
Levi Creek	615	55304	10yr_Fut	19.40	202.76	203.86	203.68	203.89	0.002118	0.97	34.99	122.94	0.38
Levi Creek	615	55304	25yr_Fut	27.30	202.76	204.01	203.69	204.03	0.001705	0.99	48.80	123.99	0.36
Levi Creek	615	55304	50yr_Fut	33.80	202.76	204.11	203.74	204.14	0.001526	1.02	58.83	124.79	0.34
Levi Creek	615	55304	100yr_Fut	40.50	202.76	204.21	203.78	204.23	0.001417	1.05	68.14	125.53	0.34
Levi Creek	615	55304	Reg_Fut	73.30	202.76	204.74	203.95	204.76	0.000825	1.07	119.25	129.32	0.28
Levi Creek	615	55304	2yr_Fut +CC	7.92	202.76	203.57	203.51	203.61	0.003687	1.19	12.37	68.21	0.50
Levi Creek	615	55304	5yr_Fut +CC	15.18	202.76	203.77	203.61	203.79	0.002618	0.97	26.21	110.22	0.42
Levi Creek	615	55304	10yr_Fut +CC	21.34	202.76	203.90	203.66	203.92	0.001973	0.97	38.67	123.21	0.37
Levi Creek	615	55304	25yr_Fut +CC	30.03	202.76	204.05	203.71	204.07	0.001652	1.01	52.76	124.30	0.35
Levi Creek	615	55304	50yr_Fut +CC	37.18	202.76	204.16	203.76	204.19	0.001471	1.04	63.54	125.16	0.34
Levi Creek	615	55304	100yr_Fut +CC	44.55	202.76	204.26	203.82	204.29	0.001370	1.07	73.42	125.95	0.34
Levi Creek	615	55304	Check Flow Fut +	57.92	202.76	204.43	203.89	204.46	0.001257	1.14	89.65	127.13	0.33

Culvert Analysis Report
01-MUL-8-WC1_PROP

Analysis Component			
Storm Event	Design	Discharge	1.1400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.1400 m³/s	Check Discharge	1.3200 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	220.00 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1050 mm Circular	1.1398 m³/s	220.87 m	1.96 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	220.87 m	N/A
Total	----------------	1.1398 m³/s	220.87 m	N/A

Culvert Analysis Report
01-MUL-8-WC1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	220.87 m	Discharge	1.1398 m³/s
Inlet Control HW Elev.	220.65 m	Tailwater Elevation	220.00 m
Outlet Control HW Elev.	220.87 m	Control Type	Outlet Control
Headwater Depth/Height	1.11		

Grades			
Upstream Invert	219.68 m	Downstream Invert	219.34 m
Length	107.00 m	Constructed Slope	0.003178 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.66 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.60 m
Velocity Downstream	1.96 m/s	Critical Slope	0.014682 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.07 m
Section Size	1050 mm	Rise	1.07 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	220.87 m	Upstream Velocity Head	0.08 m
Ke	0.90	Entrance Loss	0.08 m

Inlet Control Properties			
Inlet Control HW Elev.	220.65 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.9 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
01-MUL-8-WC1_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	220.87 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	222.85 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	222.85
200.00	222.85

Culvert Analysis Report
01-MUL-8-WC1_PROP-Check

Analysis Component			
Storm Event	Check	Discharge	1.3900 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.7200 m³/s	Check Discharge	1.3900 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	219.90 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1050 mm Circular	1.3899 m³/s	221.27 m	2.36 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	221.27 m	N/A
Total	----------------	1.3899 m³/s	221.27 m	N/A

Culvert Analysis Report
01-MUL-8-WC1_PROP-Check

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	221.27 m	Discharge	1.3899 m³/s
Inlet Control HW Elev.	220.79 m	Tailwater Elevation	219.90 m
Outlet Control HW Elev.	221.27 m	Control Type	Outlet Control
Headwater Depth/Height	1.49		

Grades			
Upstream Invert	219.68 m	Downstream Invert	219.34 m
Length	107.00 m	Constructed Slope	0.003178 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.67 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.67 m
Velocity Downstream	2.36 m/s	Critical Slope	0.015862 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.07 m
Section Size	1050 mm	Rise	1.07 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	221.27 m	Upstream Velocity Head	0.12 m
Ke	0.90	Entrance Loss	0.11 m

Inlet Control Properties			
Inlet Control HW Elev.	220.79 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.9 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
01-MUL-8-WC1_PROP-Check

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	221.27 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	222.85 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	222.85
200.00	222.85

Culvert Analysis Report
01-MUL-8-WC1_PROP-Check-Recommended

Analysis Component			
Storm Event	Check	Discharge	1.3900 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.7200 m³/s	Check Discharge	1.3900 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	219.90 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-3660 x 3050 mm Box	1.3911 m³/s	220.13 m	0.68 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	220.13 m	N/A
Total	----------------	1.3911 m³/s	220.13 m	N/A

Culvert Analysis Report
01-MUL-8-WC1_PROP-Check-Recommended

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	220.13 m	Discharge	1.3911 m³/s
Inlet Control HW Elev.	220.08 m	Tailwater Elevation	219.90 m
Outlet Control HW Elev.	220.13 m	Control Type	Entrance Control
Headwater Depth/Height	0.15		

Grades			
Upstream Invert	219.68 m	Downstream Invert	219.34 m
Length	107.00 m	Constructed Slope	0.003178 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.56 m
Slope Type	Steep	Normal Depth	0.24 m
Flow Regime	N/A	Critical Depth	0.25 m
Velocity Downstream	0.68 m/s	Critical Slope	0.003131 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.66 m
Section Size	3660 x 3050 mm	Rise	3.05 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	220.13 m	Upstream Velocity Head	0.12 m
Ke	0.70	Entrance Loss	0.09 m

Inlet Control Properties			
Inlet Control HW Elev.	220.08 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	11.1 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
01-MUL-8-WC1_PROP-Check-Recommended

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	220.13 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	222.85 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	222.85
200.00	222.85

Culvert Analysis Report
02-MUL-8-WC2_PROP

Analysis Component			
Storm Event	Check	Discharge	2.4500 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.0900 m³/s	Check Discharge	2.4500 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	219.80 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2130 x 1220 mm Box	2.4496 m³/s	220.38 m	1.21 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	220.38 m	N/A
Total	----------------	2.4496 m³/s	220.38 m	N/A

Culvert Analysis Report
02-MUL-8-WC2_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	220.38 m	Discharge	2.4496 m³/s
Inlet Control HW Elev.	220.08 m	Tailwater Elevation	219.80 m
Outlet Control HW Elev.	220.38 m	Control Type	Outlet Control
Headwater Depth/Height	0.96		

Grades			
Upstream Invert	219.21 m	Downstream Invert	218.85 m
Length	125.00 m	Constructed Slope	0.002880 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.95 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.51 m
Velocity Downstream	1.21 m/s	Critical Slope	0.025327 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	220.38 m	Upstream Velocity Head	0.06 m
Ke	0.70	Entrance Loss	0.04 m

Inlet Control Properties			
Inlet Control HW Elev.	220.08 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	2.6 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
02-MUL-8-WC2_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	220.38 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	221.59 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	221.59
200.00	221.59

Culvert Analysis Report
02-MUL-8-WC2_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	3.1800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	3.1800 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	219.70 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2130 x 1220 mm Box	3.1798 m³/s	220.68 m	1.75 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	220.68 m	N/A
Total	----------------	3.1798 m³/s	220.68 m	N/A

Culvert Analysis Report
02-MUL-8-WC2_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	220.68 m	Discharge	3.1798 m³/s
Inlet Control HW Elev.	220.25 m	Tailwater Elevation	219.70 m
Outlet Control HW Elev.	220.68 m	Control Type	Outlet Control
Headwater Depth/Height	1.20		

Grades			
Upstream Invert	219.21 m	Downstream Invert	218.85 m
Length	125.00 m	Constructed Slope	0.002880 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.85 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.61 m
Velocity Downstream	1.75 m/s	Critical Slope	0.025884 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	220.68 m	Upstream Velocity Head	0.08 m
Ke	0.70	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	220.25 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	2.6 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
02-MUL-8-WC2_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	220.68 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	221.59 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	221.59
200.00	221.59

Culvert Analysis Report
03-MUL-8-WC3_PROP

Analysis Component			
Storm Event	Check	Discharge	0.4300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.3700 m³/s	Check Discharge	0.4300 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	219.00 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.4301 m³/s	219.53 m	1.14 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	219.53 m	N/A
Total	----------------	0.4301 m³/s	219.53 m	N/A

Culvert Analysis Report
03-MUL-8-WC3_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	219.53 m	Discharge	0.4301 m³/s
Inlet Control HW Elev.	219.42 m	Tailwater Elevation	219.00 m
Outlet Control HW Elev.	219.53 m	Control Type	Outlet Control
Headwater Depth/Height	0.73		

Grades			
Upstream Invert	218.86 m	Downstream Invert	218.49 m
Length	110.00 m	Constructed Slope	0.003364 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.51 m
Slope Type	Mild	Normal Depth	0.58 m
Flow Regime	Subcritical	Critical Depth	0.38 m
Velocity Downstream	1.14 m/s	Critical Slope	0.013689 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	219.53 m	Upstream Velocity Head	0.05 m
Ke	0.90	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	219.42 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
03-MUL-8-WC3_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	219.53 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	221.03 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	221.03
200.00	221.03

Culvert Analysis Report
03-MUL-8-WC3_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.5600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.5600 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	219.00 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.5602 m³/s	219.65 m	1.49 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	219.65 m	N/A
Total	----------------	0.5602 m³/s	219.65 m	N/A

Culvert Analysis Report
03-MUL-8-WC3_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	219.65 m	Discharge	0.5602 m³/s
Inlet Control HW Elev.	219.53 m	Tailwater Elevation	219.00 m
Outlet Control HW Elev.	219.65 m	Control Type	Outlet Control
Headwater Depth/Height	0.87		

Grades			
Upstream Invert	218.86 m	Downstream Invert	218.49 m
Length	110.00 m	Constructed Slope	0.003364 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.51 m
Slope Type	Mild	Normal Depth	0.71 m
Flow Regime	Subcritical	Critical Depth	0.43 m
Velocity Downstream	1.49 m/s	Critical Slope	0.014230 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	219.65 m	Upstream Velocity Head	0.06 m
Ke	0.90	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	219.53 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
03-MUL-8-WC3_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	219.65 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	221.03 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	221.03
200.00	221.03

Culvert Analysis Report
04-MUL-8-WC4_PROP

Analysis Component			
Storm Event	Check	Discharge	0.9100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.7800 m³/s	Check Discharge	0.9100 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	218.50 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1050 mm Circular	0.9102 m³/s	219.31 m	2.03 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	219.31 m	N/A
Total	----------------	0.9102 m³/s	219.31 m	N/A

Culvert Analysis Report
04-MUL-8-WC4_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	219.31 m	Discharge	0.9102 m³/s
Inlet Control HW Elev.	219.16 m	Tailwater Elevation	218.50 m
Outlet Control HW Elev.	219.31 m	Control Type	Outlet Control
Headwater Depth/Height	0.92		

Grades			
Upstream Invert	218.33 m	Downstream Invert	217.97 m
Length	110.00 m	Constructed Slope	0.003273 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.53 m
Slope Type	Mild	Normal Depth	0.91 m
Flow Regime	Subcritical	Critical Depth	0.53 m
Velocity Downstream	2.03 m/s	Critical Slope	0.013799 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.07 m
Section Size	1050 mm	Rise	1.07 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	219.31 m	Upstream Velocity Head	0.07 m
Ke	0.90	Entrance Loss	0.07 m

Inlet Control Properties			
Inlet Control HW Elev.	219.16 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.9 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
04-MUL-8-WC4_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	219.31 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	220.50 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	220.50
200.00	220.50

Culvert Analysis Report
04-MUL-8-WC4_PROP-Ck

Analysis Component			
Storm Event	Check	Discharge	1.1000 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.1800 m³/s	Check Discharge	1.1000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	218.50 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1050 mm Circular	1.0999 m³/s	219.48 m	2.17 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	219.48 m	N/A
Total	----------------	1.0999 m³/s	219.48 m	N/A

Culvert Analysis Report
04-MUL-8-WC4_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	219.48 m	Discharge	1.0999 m³/s
Inlet Control HW Elev.	219.27 m	Tailwater Elevation	218.50 m
Outlet Control HW Elev.	219.48 m	Control Type	Outlet Control
Headwater Depth/Height	1.07		

Grades			
Upstream Invert	218.33 m	Downstream Invert	217.97 m
Length	110.00 m	Constructed Slope	0.003273 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.59 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.59 m
Velocity Downstream	2.17 m/s	Critical Slope	0.014514 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.07 m
Section Size	1050 mm	Rise	1.07 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	219.48 m	Upstream Velocity Head	0.08 m
Ke	0.90	Entrance Loss	0.07 m

Inlet Control Properties			
Inlet Control HW Elev.	219.27 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.9 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
04-MUL-8-WC4_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	219.48 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	220.50 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	220.50
200.00	220.50

Culvert Analysis Report
05-LEV-1-WC2_PROP

Analysis Component			
Storm Event	Check	Discharge	5.2700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	4.5000 m³/s	Check Discharge	5.2700 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	212.03 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2100 mm Circular	5.2700 m³/s	213.63 m	2.40 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	213.63 m	N/A
Total	----------------	5.2700 m³/s	213.63 m	N/A

Culvert Analysis Report
05-LEV-1-WC2_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	213.63 m	Discharge	5.2700 m³/s
Inlet Control HW Elev.	213.48 m	Tailwater Elevation	212.03 m
Outlet Control HW Elev.	213.63 m	Control Type	Outlet Control
Headwater Depth/Height	0.86		

Grades			
Upstream Invert	211.80 m	Downstream Invert	210.77 m
Length	130.00 m	Constructed Slope	0.007923 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	1.26 m
Slope Type	Mild	Normal Depth	1.20 m
Flow Regime	Subcritical	Critical Depth	1.08 m
Velocity Downstream	2.40 m/s	Critical Slope	0.011011 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.13 m
Section Size	2100 mm	Rise	2.13 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	213.63 m	Upstream Velocity Head	0.33 m
Ke	0.90	Entrance Loss	0.30 m

Inlet Control Properties			
Inlet Control HW Elev.	213.48 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.6 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
05-LEV-1-WC2_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	213.63 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	215.29 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	215.29
200.00	215.29

Culvert Analysis Report
05-LEV-1-WC2_PROP-Ck

Analysis Component			
Storm Event	Check	Discharge	9.0400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	6.8500 m³/s	Check Discharge	9.0400 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	212.03 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2100 mm Circular	9.0389 m³/s	214.36 m	3.54 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	214.36 m	N/A
Total	----------------	9.0389 m³/s	214.36 m	N/A

Culvert Analysis Report
05-LEV-1-WC2_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	214.36 m	Discharge	9.0389 m³/s
Inlet Control HW Elev.	214.27 m	Tailwater Elevation	212.03 m
Outlet Control HW Elev.	214.36 m	Control Type	Outlet Control
Headwater Depth/Height	1.20		

Grades			
Upstream Invert	211.80 m	Downstream Invert	210.77 m
Length	130.00 m	Constructed Slope	0.007923 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.43 m
Slope Type	Mild	Normal Depth	1.83 m
Flow Regime	Subcritical	Critical Depth	1.43 m
Velocity Downstream	3.54 m/s	Critical Slope	0.013540 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.13 m
Section Size	2100 mm	Rise	2.13 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	214.36 m	Upstream Velocity Head	0.40 m
Ke	0.90	Entrance Loss	0.36 m

Inlet Control Properties			
Inlet Control HW Elev.	214.27 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.6 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
05-LEV-1-WC2_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	214.36 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	215.29 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	215.29
200.00	215.29

Culvert Analysis Report
05-LEV-1-WC2_PROP-Ck-Recommended

Analysis Component			
Storm Event	Check	Discharge	9.0400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	6.8500 m³/s	Check Discharge	9.0400 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	212.03 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-3050 x 2130 mm Box	9.0382 m³/s	212.92 m	1.18 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	212.92 m	N/A
Total	----------------	9.0382 m³/s	212.92 m	N/A

Culvert Analysis Report
05-LEV-1-WC2_PROP-Ck-Recommended

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	212.92 m	Discharge	9.0382 m³/s
Inlet Control HW Elev.	212.82 m	Tailwater Elevation	212.03 m
Outlet Control HW Elev.	212.92 m	Control Type	Entrance Control
Headwater Depth/Height	0.53		

Grades			
Upstream Invert	211.80 m	Downstream Invert	210.77 m
Length	130.00 m	Constructed Slope	0.007923 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	1.26 m
Slope Type	Steep	Normal Depth	0.44 m
Flow Regime	N/A	Critical Depth	0.61 m
Velocity Downstream	1.18 m/s	Critical Slope	0.003061 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.05 m
Section Size	3050 x 2130 mm	Rise	2.13 m
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	212.92 m	Upstream Velocity Head	0.30 m
Ke	0.70	Entrance Loss	0.21 m

Inlet Control Properties			
Inlet Control HW Elev.	212.82 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	13.0 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
05-LEV-1-WC2_PROP-Ck-Recommended

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	212.92 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	215.29 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	215.29
200.00	215.29

Culvert Analysis Report
06-LEV-1-WC3.1_PROP

Analysis Component			
Storm Event	Check	Discharge	0.4500 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.4000 m³/s	Check Discharge	0.4500 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	210.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.4502 m³/s	210.57 m	1.12 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	210.57 m	N/A
Total	----------------	0.4502 m³/s	210.57 m	N/A

Culvert Analysis Report
06-LEV-1-WC3.1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	210.57 m	Discharge	0.4502 m³/s
Inlet Control HW Elev.	210.51 m	Tailwater Elevation	210.10 m
Outlet Control HW Elev.	210.57 m	Control Type	Outlet Control
Headwater Depth/Height	0.70		

Grades			
Upstream Invert	209.93 m	Downstream Invert	209.56 m
Length	38.00 m	Constructed Slope	0.009737 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.54 m
Slope Type	Mild	Normal Depth	0.43 m
Flow Regime	Subcritical	Critical Depth	0.39 m
Velocity Downstream	1.12 m/s	Critical Slope	0.013762 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	210.57 m	Upstream Velocity Head	0.11 m
Ke	0.90	Entrance Loss	0.10 m

Inlet Control Properties			
Inlet Control HW Elev.	210.51 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
06-LEV-1-WC3.1_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)				
Discharge	0.0000 m³/s		Allowable HW Elevation	210.57 m
Roadway Width	60.00 m		Overtopping Coefficient	1.60 SI
Length	200.00 m		Crest Elevation	215.29 m
Headwater Elevation	N/A m		Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00			

Sta (m)	Elev. (m)
0.00	215.29
200.00	215.29

Culvert Analysis Report
06-LEV-1-WC3.1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.5800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.5800 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	210.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.5801 m³/s	210.67 m	1.44 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	210.67 m	N/A
Total	----------------	0.5801 m³/s	210.67 m	N/A

Culvert Analysis Report
06-LEV-1-WC3.1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	210.67 m	Discharge	0.5801 m³/s
Inlet Control HW Elev.	210.61 m	Tailwater Elevation	210.10 m
Outlet Control HW Elev.	210.67 m	Control Type	Outlet Control
Headwater Depth/Height	0.81		

Grades			
Upstream Invert	209.93 m	Downstream Invert	209.56 m
Length	38.00 m	Constructed Slope	0.009737 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.54 m
Slope Type	Mild	Normal Depth	0.50 m
Flow Regime	Subcritical	Critical Depth	0.44 m
Velocity Downstream	1.44 m/s	Critical Slope	0.014328 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	210.67 m	Upstream Velocity Head	0.13 m
Ke	0.90	Entrance Loss	0.12 m

Inlet Control Properties			
Inlet Control HW Elev.	210.61 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
06-LEV-1-WC3.1_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	210.67 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	215.29 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	215.29
200.00	215.29

Culvert Analysis Report
07-LEV-1-WC3.3_PROP

Analysis Component			
Storm Event	Design	Discharge	0.4900 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.4900 m³/s	Check Discharge	0.5700 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	207.00 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.4902 m³/s	207.90 m	1.33 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	207.90 m	N/A
Total	----------------	0.4902 m³/s	207.90 m	N/A

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	207.90 m	Discharge	0.4902 m³/s
Inlet Control HW Elev.	207.81 m	Tailwater Elevation	207.00 m
Outlet Control HW Elev.	207.90 m	Control Type	Outlet Control
Headwater Depth/Height	0.76		

Grades			
Upstream Invert	207.20 m	Downstream Invert	206.50 m
Length	52.00 m	Constructed Slope	0.013462 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.50 m
Slope Type	Mild	Normal Depth	0.41 m
Flow Regime	Subcritical	Critical Depth	0.41 m
Velocity Downstream	1.33 m/s	Critical Slope	0.013924 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	207.90 m	Upstream Velocity Head	0.15 m
Ke	0.90	Entrance Loss	0.14 m

Inlet Control Properties			
Inlet Control HW Elev.	207.81 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
07-LEV-1-WC3.3_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	207.90 m
Roadway Width	15.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	209.83 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	209.83
200.00	209.83

Culvert Analysis Report
07-LEV-1-WC3.3_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.7300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.7300 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	207.00 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.7302 m³/s	208.07 m	1.99 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	208.07 m	N/A
Total	----------------	0.7302 m³/s	208.07 m	N/A

Culvert Analysis Report
07-LEV-1-WC3.3_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	208.07 m	Discharge	0.7302 m³/s
Inlet Control HW Elev.	207.99 m	Tailwater Elevation	207.00 m
Outlet Control HW Elev.	208.07 m	Control Type	Outlet Control
Headwater Depth/Height	0.95		

Grades			
Upstream Invert	207.20 m	Downstream Invert	206.50 m
Length	52.00 m	Constructed Slope	0.013462 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.50 m
Slope Type	Mild	Normal Depth	0.52 m
Flow Regime	Subcritical	Critical Depth	0.50 m
Velocity Downstream	1.99 m/s	Critical Slope	0.015166 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	208.07 m	Upstream Velocity Head	0.18 m
Ke	0.90	Entrance Loss	0.17 m

Inlet Control Properties			
Inlet Control HW Elev.	207.99 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
07-LEV-1-WC3.3_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	208.07 m
Roadway Width	15.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	209.83 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	209.83
200.00	209.83

Culvert Analysis Report
08-LEV-1-WC3.4_PROP

Analysis Component			
Storm Event	Check	Discharge	0.2300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2000 m³/s	Check Discharge	0.2300 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	206.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.2296 m³/s	206.19 m	0.62 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	206.19 m	N/A
Total	----------------	0.2296 m³/s	206.19 m	N/A

Culvert Analysis Report
08-LEV-1-WC3.4_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	206.19 m	Discharge	0.2296 m³/s
Inlet Control HW Elev.	206.10 m	Tailwater Elevation	206.10 m
Outlet Control HW Elev.	206.19 m	Control Type	Outlet Control
Headwater Depth/Height	0.54		

Grades			
Upstream Invert	205.70 m	Downstream Invert	205.60 m
Length	25.00 m	Constructed Slope	0.004000 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.50 m
Slope Type	Mild	Normal Depth	0.38 m
Flow Regime	Subcritical	Critical Depth	0.27 m
Velocity Downstream	0.62 m/s	Critical Slope	0.013268 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	206.19 m	Upstream Velocity Head	0.03 m
Ke	0.90	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	206.10 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
08-LEV-1-WC3.4_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	206.19 m
Roadway Width	10.00 m	Overtopping Coefficient	1.60 SI
Length	50.00 m	Crest Elevation	207.46 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	207.46
50.00	207.46

Culvert Analysis Report
08-LEV-1-WC3.4_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.3000 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.3000 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	206.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.2997 m³/s	206.24 m	0.82 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	206.24 m	N/A
Total	----------------	0.2997 m³/s	206.24 m	N/A

Culvert Analysis Report
08-LEV-1-WC3.4_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	206.24 m	Discharge	0.2997 m³/s
Inlet Control HW Elev.	206.15 m	Tailwater Elevation	206.10 m
Outlet Control HW Elev.	206.24 m	Control Type	Outlet Control
Headwater Depth/Height	0.59		

Grades			
Upstream Invert	205.70 m	Downstream Invert	205.60 m
Length	25.00 m	Constructed Slope	0.004000 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.50 m
Slope Type	Mild	Normal Depth	0.44 m
Flow Regime	Subcritical	Critical Depth	0.31 m
Velocity Downstream	0.82 m/s	Critical Slope	0.013335 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	206.24 m	Upstream Velocity Head	0.04 m
Ke	0.90	Entrance Loss	0.04 m

Inlet Control Properties			
Inlet Control HW Elev.	206.15 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
08-LEV-1-WC3.4_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	206.24 m
Roadway Width	10.00 m	Overtopping Coefficient	1.60 SI
Length	50.00 m	Crest Elevation	207.46 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	207.46
50.00	207.46

Culvert Analysis Report
09-LEV-1-WC4_PROP

Analysis Component			
Storm Event	Design	Discharge	0.6800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.6800 m³/s	Check Discharge	1.0200 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	208.80 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-1050 mm Circular	0.6803 m³/s	210.99 m	1.51 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	210.99 m	N/A
Total	----------------	0.6803 m³/s	210.99 m	N/A

Culvert Analysis Report
09-LEV-1-WC4_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	210.99 m	Discharge	0.6803 m³/s
Inlet Control HW Elev.	210.93 m	Tailwater Elevation	208.80 m
Outlet Control HW Elev.	210.99 m	Control Type	Outlet Control
Headwater Depth/Height	0.46		

Grades			
Upstream Invert	210.50 m	Downstream Invert	209.88 m
Length	153.00 m	Constructed Slope	0.004052 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.32 m
Slope Type	Mild	Normal Depth	0.43 m
Flow Regime	Subcritical	Critical Depth	0.32 m
Velocity Downstream	1.51 m/s	Critical Slope	0.012602 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.07 m
Section Size	1050 mm	Rise	1.07 m
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	210.99 m	Upstream Velocity Head	0.05 m
Ke	0.20	Entrance Loss	0.01 m

Inlet Control Properties			
Inlet Control HW Elev.	210.93 m	Flow Control	N/A
Inlet Type	Beveled ring, 45° (1:1) bevels	Area Full	1.8 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	A
C	0.03000	Equation Form	1
Y	0.74000		

Culvert Analysis Report
09-LEV-1-WC4_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	210.99 m
Roadway Width	80.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	212.84 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	212.84
200.00	212.84

Culvert Analysis Report
09-LEV-1-WC4_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	1.0200 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.0200 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	208.90 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-1050 mm Circular	1.0204 m³/s	211.12 m	1.69 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	211.12 m	N/A
Total	----------------	1.0204 m³/s	211.12 m	N/A

Culvert Analysis Report
09-LEV-1-WC4_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	211.12 m	Discharge	1.0204 m³/s
Inlet Control HW Elev.	211.04 m	Tailwater Elevation	208.90 m
Outlet Control HW Elev.	211.12 m	Control Type	Outlet Control
Headwater Depth/Height	0.58		

Grades			
Upstream Invert	210.50 m	Downstream Invert	209.88 m
Length	153.00 m	Constructed Slope	0.004052 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.40 m
Slope Type	Mild	Normal Depth	0.55 m
Flow Regime	Subcritical	Critical Depth	0.40 m
Velocity Downstream	1.69 m/s	Critical Slope	0.012760 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.07 m
Section Size	1050 mm	Rise	1.07 m
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	211.12 m	Upstream Velocity Head	0.06 m
Ke	0.20	Entrance Loss	0.01 m

Inlet Control Properties			
Inlet Control HW Elev.	211.04 m	Flow Control	N/A
Inlet Type	Beveled ring, 45° (1:1) bevels	Area Full	1.8 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	A
C	0.03000	Equation Form	1
Y	0.74000		

Culvert Analysis Report
09-LEV-1-WC4_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	211.12 m
Roadway Width	80.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	212.84 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	212.84
200.00	212.84

Culvert Analysis Report
10-LEV-1-WC4.1_PROP

Analysis Component			
Storm Event	Check	Discharge	0.8800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.7500 m³/s	Check Discharge	0.8800 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	207.40 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.8802 m³/s	208.88 m	2.13 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	208.88 m	N/A
Total	----------------	0.8802 m³/s	208.88 m	N/A

Culvert Analysis Report
10-LEV-1-WC4.1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	208.88 m	Discharge	0.8802 m³/s
Inlet Control HW Elev.	208.83 m	Tailwater Elevation	207.40 m
Outlet Control HW Elev.	208.88 m	Control Type	Outlet Control
Headwater Depth/Height	1.04		

Grades			
Upstream Invert	207.93 m	Downstream Invert	206.90 m
Length	90.00 m	Constructed Slope	0.011444 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.55 m
Slope Type	Mild	Normal Depth	0.62 m
Flow Regime	Subcritical	Critical Depth	0.55 m
Velocity Downstream	2.13 m/s	Critical Slope	0.016185 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	208.88 m	Upstream Velocity Head	0.18 m
Ke	0.90	Entrance Loss	0.16 m

Inlet Control Properties			
Inlet Control HW Elev.	208.83 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
10-LEV-1-WC4.1_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	208.88 m
Roadway Width	15.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	215.80 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	215.80
200.00	215.80

Culvert Analysis Report
10-LEV-1-WC4.1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	1.1400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.1400 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	207.40 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.1400 m³/s	209.07 m	2.36 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	209.07 m	N/A
Total	----------------	1.1400 m³/s	209.07 m	N/A

Culvert Analysis Report
10-LEV-1-WC4.1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	209.07 m	Discharge	1.1400 m³/s
Inlet Control HW Elev.	209.02 m	Tailwater Elevation	207.40 m
Outlet Control HW Elev.	209.07 m	Control Type	Outlet Control
Headwater Depth/Height	1.24		

Grades			
Upstream Invert	207.93 m	Downstream Invert	206.90 m
Length	90.00 m	Constructed Slope	0.011444 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.63 m
Slope Type	Mild	Normal Depth	0.79 m
Flow Regime	Subcritical	Critical Depth	0.63 m
Velocity Downstream	2.36 m/s	Critical Slope	0.018492 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	209.07 m	Upstream Velocity Head	0.18 m
Ke	0.90	Entrance Loss	0.16 m

Inlet Control Properties			
Inlet Control HW Elev.	209.02 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
10-LEV-1-WC4.1_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	209.07 m
Roadway Width	15.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	215.80 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	215.80
200.00	215.80

Culvert Analysis Report
12-LEV-2-WC1.1_EX-STRUCTURAL CV

Analysis Component			
Storm Event	Check	Discharge	21.1000 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	18.7000 m³/s	Check Discharge	21.1000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	1.46 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	3-3660 x 1220 mm Box	21.0966 m³/s	208.64 m	4.74 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	208.64 m	N/A
Total	----------------	21.0966 m³/s	208.64 m	N/A

Culvert Analysis Report
12-LEV-2-WC1.1_EX-STRUCTURAL CV

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	208.64 m	Discharge	21.0966 m³/s
Inlet Control HW Elev.	208.52 m	Tailwater Elevation	1.46 m
Outlet Control HW Elev.	208.64 m	Control Type	Entrance Control
Headwater Depth/Height	1.10		

Grades			
Upstream Invert	207.30 m	Downstream Invert	206.50 m
Length	30.00 m	Constructed Slope	0.026667 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.41 m
Slope Type	Steep	Normal Depth	0.35 m
Flow Regime	Supercritical	Critical Depth	0.72 m
Velocity Downstream	4.74 m/s	Critical Slope	0.002879 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.66 m
Section Size	3660 x 1220 mm	Rise	1.22 m
Number Sections	3		

Outlet Control Properties			
Outlet Control HW Elev.	208.64 m	Upstream Velocity Head	0.36 m
Ke	0.70	Entrance Loss	0.25 m

Inlet Control Properties			
Inlet Control HW Elev.	208.52 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	13.4 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
12-LEV-2-WC1.1_EX-STRUCTURAL CV

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	208.64 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	217.35 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	217.35
200.00	217.35

Culvert Analysis Report
13-LEV-2-WC2.1_PROP

Analysis Component			
Storm Event	Check	Discharge	2.8800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.4600 m³/s	Check Discharge	2.8800 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	206.55 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1650 mm Circular	2.8803 m³/s	208.19 m	2.61 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	208.19 m	N/A
Total	----------------	2.8803 m³/s	208.19 m	N/A

Culvert Analysis Report
13-LEV-2-WC2.1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	208.19 m	Discharge	2.8803 m³/s
Inlet Control HW Elev.	208.02 m	Tailwater Elevation	206.55 m
Outlet Control HW Elev.	208.19 m	Control Type	Entrance Control
Headwater Depth/Height	0.89		

Grades			
Upstream Invert	206.70 m	Downstream Invert	206.20 m
Length	40.00 m	Constructed Slope	0.012500 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.84 m
Slope Type	Steep	Normal Depth	0.84 m
Flow Regime	Supercritical	Critical Depth	0.85 m
Velocity Downstream	2.61 m/s	Critical Slope	0.011929 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.68 m
Section Size	1650 mm	Rise	1.68 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	208.19 m	Upstream Velocity Head	0.34 m
Ke	0.90	Entrance Loss	0.30 m

Inlet Control Properties			
Inlet Control HW Elev.	208.02 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	2.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
13-LEV-2-WC2.1_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	208.19 m
Roadway Width	15.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	211.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	211.00
200.00	211.00

Culvert Analysis Report
13-LEV-2-WC2.1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	3.7500 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	3.7500 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	206.69 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1650 mm Circular	3.7505 m³/s	208.43 m	2.81 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	208.43 m	N/A
Total	----------------	3.7505 m³/s	208.43 m	N/A

Culvert Analysis Report
13-LEV-2-WC2.1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	208.43 m	Discharge	3.7505 m³/s
Inlet Control HW Elev.	208.28 m	Tailwater Elevation	206.69 m
Outlet Control HW Elev.	208.43 m	Control Type	Outlet Control
Headwater Depth/Height	1.03		

Grades			
Upstream Invert	206.70 m	Downstream Invert	206.20 m
Length	40.00 m	Constructed Slope	0.012500 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.98 m
Slope Type	Mild	Normal Depth	0.99 m
Flow Regime	Subcritical	Critical Depth	0.98 m
Velocity Downstream	2.81 m/s	Critical Slope	0.012894 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.68 m
Section Size	1650 mm	Rise	1.68 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	208.43 m	Upstream Velocity Head	0.39 m
Ke	0.90	Entrance Loss	0.35 m

Inlet Control Properties			
Inlet Control HW Elev.	208.28 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	2.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
13-LEV-2-WC2.1_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	208.43 m
Roadway Width	15.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	211.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	211.00
200.00	211.00

Culvert Analysis Report
14-LEV-2-WC2.2_PROP

Analysis Component			
Storm Event	Check	Discharge	3.3400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.8500 m³/s	Check Discharge	3.3400 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	206.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1650 mm Circular	3.3394 m³/s	206.69 m	1.82 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	206.69 m	N/A
Total	----------------	3.3394 m³/s	206.69 m	N/A

Culvert Analysis Report
14-LEV-2-WC2.2_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	206.68 m	Discharge	3.3394 m³/s
Inlet Control HW Elev.	206.56 m	Tailwater Elevation	206.10 m
Outlet Control HW Elev.	206.68 m	Control Type	Outlet Control
Headwater Depth/Height	0.95		

Grades			
Upstream Invert	205.10 m	Downstream Invert	204.80 m
Length	48.00 m	Constructed Slope	0.006250 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	1.30 m
Slope Type	Mild	Normal Depth	1.16 m
Flow Regime	Subcritical	Critical Depth	0.92 m
Velocity Downstream	1.82 m/s	Critical Slope	0.012403 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.68 m
Section Size	1650 mm	Rise	1.68 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	206.68 m	Upstream Velocity Head	0.19 m
Ke	0.90	Entrance Loss	0.17 m

Inlet Control Properties			
Inlet Control HW Elev.	206.56 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	2.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
14-LEV-2-WC2.2_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	206.69 m
Roadway Width	15.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	208.10 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	208.10
200.00	208.10

Culvert Analysis Report
14-LEV-2-WC2.2_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	4.3400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	4.3400 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	206.30 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1650 mm Circular	4.3392 m³/s	206.70 m	2.08 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	206.70 m	N/A
Total	----------------	4.3392 m³/s	206.70 m	N/A

Culvert Analysis Report
14-LEV-2-WC2.2_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	206.70 m	Discharge	4.3392 m³/s
Inlet Control HW Elev.	206.64 m	Tailwater Elevation	206.30 m
Outlet Control HW Elev.	206.70 m	Control Type	Outlet Control
Headwater Depth/Height	0.95		

Grades			
Upstream Invert	205.10 m	Downstream Invert	204.80 m
Length	48.00 m	Constructed Slope	0.006250 m/m

Hydraulic Profile			
Profile	S1	Depth, Downstream	1.50 m
Slope Type	Steep	Normal Depth	0.91 m
Flow Regime	Subcritical	Critical Depth	1.05 m
Velocity Downstream	2.08 m/s	Critical Slope	0.004019 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.68 m
Section Size	1650 mm	Rise	1.68 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	206.70 m	Upstream Velocity Head	0.35 m
Ke	0.20	Entrance Loss	0.07 m

Inlet Control Properties			
Inlet Control HW Elev.	206.64 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	2.2 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
14-LEV-2-WC2.2_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	206.70 m
Roadway Width	15.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	208.10 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	208.10
200.00	208.10

Culvert Analysis Report
15-LEV-2-WC2_PROP

Analysis Component			
Storm Event	Check	Discharge	3.2900 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.8100 m³/s	Check Discharge	3.2900 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	205.20 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1650 mm Circular	3.2897 m³/s	206.28 m	2.40 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	206.28 m	N/A
Total	----------------	3.2897 m³/s	206.28 m	N/A

Culvert Analysis Report
15-LEV-2-WC2_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	206.28 m	Discharge	3.2897 m³/s
Inlet Control HW Elev.	206.15 m	Tailwater Elevation	205.20 m
Outlet Control HW Elev.	206.28 m	Control Type	Outlet Control
Headwater Depth/Height	0.94		

Grades			
Upstream Invert	204.70 m	Downstream Invert	204.20 m
Length	103.00 m	Constructed Slope	0.004854 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.00 m
Slope Type	Mild	Normal Depth	1.26 m
Flow Regime	Subcritical	Critical Depth	0.91 m
Velocity Downstream	2.40 m/s	Critical Slope	0.012355 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.68 m
Section Size	1650 mm	Rise	1.68 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	206.28 m	Upstream Velocity Head	0.18 m
Ke	0.90	Entrance Loss	0.17 m

Inlet Control Properties			
Inlet Control HW Elev.	206.15 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	2.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
15-LEV-2-WC2_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	206.28 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	207.76 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	207.76
200.00	207.76

Culvert Analysis Report
15-LEV-2-WC2_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	4.2700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	4.2700 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	205.20 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1650 mm Circular	4.2704 m³/s	206.61 m	2.95 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	206.61 m	N/A
Total	----------------	4.2704 m³/s	206.61 m	N/A

Culvert Analysis Report
15-LEV-2-WC2_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	206.61 m	Discharge	4.2704 m³/s
Inlet Control HW Elev.	206.44 m	Tailwater Elevation	205.20 m
Outlet Control HW Elev.	206.61 m	Control Type	Outlet Control
Headwater Depth/Height	1.14		

Grades			
Upstream Invert	204.70 m	Downstream Invert	204.20 m
Length	103.00 m	Constructed Slope	0.004854 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.04 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	1.04 m
Velocity Downstream	2.95 m/s	Critical Slope	0.013598 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.68 m
Section Size	1650 mm	Rise	1.68 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	206.61 m	Upstream Velocity Head	0.21 m
Ke	0.90	Entrance Loss	0.19 m

Inlet Control Properties			
Inlet Control HW Elev.	206.44 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	2.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
15-LEV-2-WC2_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)				
Discharge	0.0000 m³/s	Allowable HW Elevation	206.61 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	207.76 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	207.76
200.00	207.76

Culvert Analysis Report
16-LEV-2-WC6_PROP

Analysis Component			
Storm Event	Check	Discharge	1.7800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.5300 m³/s	Check Discharge	1.7800 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	204.90 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1350 mm Circular	1.7803 m³/s	205.66 m	1.20 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	205.66 m	N/A
Total	----------------	1.7803 m³/s	205.66 m	N/A

Culvert Analysis Report
16-LEV-2-WC6_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	205.66 m	Discharge	1.7803 m³/s
Inlet Control HW Elev.	205.47 m	Tailwater Elevation	204.90 m
Outlet Control HW Elev.	205.66 m	Control Type	Outlet Control
Headwater Depth/Height	0.94		

Grades			
Upstream Invert	204.37 m	Downstream Invert	203.22 m
Length	176.00 m	Constructed Slope	0.006534 m/m

Hydraulic Profile			
Profile	CompositePressureProfileM1	Depth, Downstream	1.68 m
Slope Type	N/A	Normal Depth	0.87 m
Flow Regime	Subcritical	Critical Depth	0.70 m
Velocity Downstream	1.20 m/s	Critical Slope	0.012817 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.37 m
Section Size	1350 mm	Rise	1.37 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	205.66 m	Upstream Velocity Head	0.10 m
Ke	0.90	Entrance Loss	0.09 m

Inlet Control Properties			
Inlet Control HW Elev.	205.47 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.5 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
16-LEV-2-WC6_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	205.66 m
Roadway Width	70.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	207.20 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	207.20
200.00	207.20

Culvert Analysis Report
16-LEV-2-WC6_PROP-Ck

Analysis Component			
Storm Event	Check	Discharge	2.4600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.3100 m³/s	Check Discharge	2.4600 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	204.90 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1350 mm Circular	2.4599 m³/s	206.34 m	1.66 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	206.34 m	N/A
Total	----------------	2.4599 m³/s	206.34 m	N/A

Culvert Analysis Report
16-LEV-2-WC6_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	206.34 m	Discharge	2.4599 m³/s
Inlet Control HW Elev.	205.74 m	Tailwater Elevation	204.90 m
Outlet Control HW Elev.	206.34 m	Control Type	Outlet Control
Headwater Depth/Height	1.44		

Grades			
Upstream Invert	204.37 m	Downstream Invert	203.22 m
Length	176.00 m	Constructed Slope	0.006534 m/m

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	1.68 m
Slope Type	N/A	Normal Depth	1.14 m
Flow Regime	N/A	Critical Depth	0.83 m
Velocity Downstream	1.66 m/s	Critical Slope	0.014225 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.37 m
Section Size	1350 mm	Rise	1.37 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	206.34 m	Upstream Velocity Head	0.14 m
Ke	0.90	Entrance Loss	0.13 m

Inlet Control Properties			
Inlet Control HW Elev.	205.74 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.5 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
16-LEV-2-WC6_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	206.34 m
Roadway Width	70.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	207.20 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	207.20
200.00	207.20

Culvert Analysis Report
18-LEV-10-WC1.1_PROP

Analysis Component			
Storm Event	Check	Discharge	0.2900 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2700 m³/s	Check Discharge	0.2900 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	205.40 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.2902 m³/s	208.72 m	0.79 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	208.72 m	N/A
Total	----------------	0.2902 m³/s	208.72 m	N/A

Culvert Analysis Report
18-LEV-10-WC1.1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	208.72 m	Discharge	0.2902 m³/s
Inlet Control HW Elev.	208.63 m	Tailwater Elevation	205.40 m
Outlet Control HW Elev.	208.72 m	Control Type	Entrance Control
Headwater Depth/Height	0.57		

Grades			
Upstream Invert	208.20 m	Downstream Invert	204.90 m
Length	115.00 m	Constructed Slope	0.028696 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.50 m
Slope Type	Steep	Normal Depth	0.25 m
Flow Regime	N/A	Critical Depth	0.31 m
Velocity Downstream	0.79 m/s	Critical Slope	0.013320 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	208.72 m	Upstream Velocity Head	0.11 m
Ke	0.90	Entrance Loss	0.10 m

Inlet Control Properties			
Inlet Control HW Elev.	208.63 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
18-LEV-10-WC1.1_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	208.72 m
Roadway Width	100.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	211.16 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	211.16
100.00	211.16

Culvert Analysis Report
18-LEV-10-WC1.1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.3800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.3800 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	205.40 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.3800 m³/s	208.81 m	1.03 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	208.81 m	N/A
Total	----------------	0.3800 m³/s	208.81 m	N/A

Culvert Analysis Report
18-LEV-10-WC1.1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	208.81 m	Discharge	0.3800 m³/s
Inlet Control HW Elev.	208.71 m	Tailwater Elevation	205.40 m
Outlet Control HW Elev.	208.81 m	Control Type	Entrance Control
Headwater Depth/Height	0.66		

Grades			
Upstream Invert	208.20 m	Downstream Invert	204.90 m
Length	115.00 m	Constructed Slope	0.028696 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.50 m
Slope Type	Steep	Normal Depth	0.29 m
Flow Regime	N/A	Critical Depth	0.36 m
Velocity Downstream	1.03 m/s	Critical Slope	0.013527 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	208.81 m	Upstream Velocity Head	0.13 m
Ke	0.90	Entrance Loss	0.12 m

Inlet Control Properties			
Inlet Control HW Elev.	208.71 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
18-LEV-10-WC1.1_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	208.81 m
Roadway Width	100.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	211.16 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	211.16
100.00	211.16

Culvert Analysis Report
19-CRR-0-WC1_PROP

Analysis Component			
Storm Event	Check	Discharge	1.1400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.9800 m³/s	Check Discharge	1.1400 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	207.00 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1050 mm Circular	1.1402 m³/s	211.36 m	3.09 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	211.36 m	N/A
Total	----------------	1.1402 m³/s	211.36 m	N/A

Culvert Analysis Report
19-CRR-0-WC1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	211.36 m	Discharge	1.1402 m³/s
Inlet Control HW Elev.	211.24 m	Tailwater Elevation	207.00 m
Outlet Control HW Elev.	211.36 m	Control Type	Entrance Control
Headwater Depth/Height	1.00		

Grades			
Upstream Invert	210.29 m	Downstream Invert	206.40 m
Length	106.00 m	Constructed Slope	0.036698 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.46 m
Slope Type	Steep	Normal Depth	0.46 m
Flow Regime	Supercritical	Critical Depth	0.60 m
Velocity Downstream	3.09 m/s	Critical Slope	0.014683 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.07 m
Section Size	1050 mm	Rise	1.07 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	211.36 m	Upstream Velocity Head	0.25 m
Ke	0.90	Entrance Loss	0.22 m

Inlet Control Properties			
Inlet Control HW Elev.	211.24 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.9 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
19-CRR-0-WC1_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	211.36 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	212.20 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	212.20
200.00	212.20

Culvert Analysis Report
19-CRR-0-WC1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	1.4900 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.4900 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	207.00 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1050 mm Circular	1.4903 m³/s	211.55 m	3.31 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	211.55 m	N/A
Total	----------------	1.4903 m³/s	211.55 m	N/A

Culvert Analysis Report
19-CRR-0-WC1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	211.55 m	Discharge	1.4903 m³/s
Inlet Control HW Elev.	211.44 m	Tailwater Elevation	207.00 m
Outlet Control HW Elev.	211.55 m	Control Type	Entrance Control
Headwater Depth/Height	1.18		

Grades			
Upstream Invert	210.29 m	Downstream Invert	206.40 m
Length	106.00 m	Constructed Slope	0.036698 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.54 m
Slope Type	Steep	Normal Depth	0.54 m
Flow Regime	Supercritical	Critical Depth	0.69 m
Velocity Downstream	3.31 m/s	Critical Slope	0.016414 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.07 m
Section Size	1050 mm	Rise	1.07 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	211.55 m	Upstream Velocity Head	0.30 m
Ke	0.90	Entrance Loss	0.27 m

Inlet Control Properties			
Inlet Control HW Elev.	211.44 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.9 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
19-CRR-0-WC1_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	211.55 m
Roadway Width	60.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	212.20 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	212.20
200.00	212.20

Culvert Analysis Report
21-CRR-6-WC1_PROP

Analysis Component			
Storm Event	Check	Discharge	0.3000 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2500 m³/s	Check Discharge	0.3000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	227.40 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.2998 m³/s	228.11 m	0.82 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	228.11 m	N/A
Total	----------------	0.2998 m³/s	228.11 m	N/A

Culvert Analysis Report
21-CRR-6-WC1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	228.11 m	Discharge	0.2998 m³/s
Inlet Control HW Elev.	228.05 m	Tailwater Elevation	227.40 m
Outlet Control HW Elev.	228.11 m	Control Type	Outlet Control
Headwater Depth/Height	0.56		

Grades			
Upstream Invert	227.60 m	Downstream Invert	226.90 m
Length	74.00 m	Constructed Slope	0.009459 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.50 m
Slope Type	Mild	Normal Depth	0.34 m
Flow Regime	Subcritical	Critical Depth	0.31 m
Velocity Downstream	0.82 m/s	Critical Slope	0.013335 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	228.11 m	Upstream Velocity Head	0.09 m
Ke	0.90	Entrance Loss	0.08 m

Inlet Control Properties			
Inlet Control HW Elev.	228.05 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
21-CRR-6-WC1_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	228.11 m
Roadway Width	50.00 m	Overtopping Coefficient	1.60 SI
Length	50.00 m	Crest Elevation	237.52 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	237.52
50.00	237.52

Culvert Analysis Report
21-CRR-6-WC1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.3800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.3800 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	227.40 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.3798 m³/s	228.19 m	1.03 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	228.19 m	N/A
Total	----------------	0.3798 m³/s	228.19 m	N/A

Culvert Analysis Report
21-CRR-6-WC1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	228.19 m	Discharge	0.3798 m³/s
Inlet Control HW Elev.	228.12 m	Tailwater Elevation	227.40 m
Outlet Control HW Elev.	228.19 m	Control Type	Outlet Control
Headwater Depth/Height	0.64		

Grades			
Upstream Invert	227.60 m	Downstream Invert	226.90 m
Length	74.00 m	Constructed Slope	0.009459 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.50 m
Slope Type	Mild	Normal Depth	0.39 m
Flow Regime	Subcritical	Critical Depth	0.36 m
Velocity Downstream	1.03 m/s	Critical Slope	0.013526 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	228.19 m	Upstream Velocity Head	0.10 m
Ke	0.90	Entrance Loss	0.09 m

Inlet Control Properties			
Inlet Control HW Elev.	228.12 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
21-CRR-6-WC1_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	228.19 m
Roadway Width	50.00 m	Overtopping Coefficient	1.60 SI
Length	50.00 m	Crest Elevation	237.52 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	237.52
50.00	237.52

Culvert Analysis Report
22-CRR-6-WC2_PROP

Analysis Component			
Storm Event	Check	Discharge	0.2300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2000 m³/s	Check Discharge	0.2300 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	227.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.2301 m³/s	228.66 m	0.63 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	228.66 m	N/A
Total	----------------	0.2301 m³/s	228.66 m	N/A

Culvert Analysis Report
22-CRR-6-WC2_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	228.66 m	Discharge	0.2301 m³/s
Inlet Control HW Elev.	228.58 m	Tailwater Elevation	227.10 m
Outlet Control HW Elev.	228.66 m	Control Type	Entrance Control
Headwater Depth/Height	0.50		

Grades			
Upstream Invert	228.20 m	Downstream Invert	226.60 m
Length	80.00 m	Constructed Slope	0.020000 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.50 m
Slope Type	Steep	Normal Depth	0.25 m
Flow Regime	N/A	Critical Depth	0.27 m
Velocity Downstream	0.63 m/s	Critical Slope	0.013268 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	228.66 m	Upstream Velocity Head	0.10 m
Ke	0.90	Entrance Loss	0.09 m

Inlet Control Properties			
Inlet Control HW Elev.	228.58 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
22-CRR-6-WC2_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	228.66 m
Roadway Width	50.00 m	Overtopping Coefficient	1.60 SI
Length	50.00 m	Crest Elevation	237.24 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	237.24
50.00	237.24

Culvert Analysis Report
22-CRR-6-WC2_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.3000 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.3000 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	227.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.3000 m³/s	228.73 m	0.82 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	228.73 m	N/A
Total	----------------	0.3000 m³/s	228.73 m	N/A

Culvert Analysis Report
22-CRR-6-WC2_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	228.73 m	Discharge	0.3000 m³/s
Inlet Control HW Elev.	228.65 m	Tailwater Elevation	227.10 m
Outlet Control HW Elev.	228.73 m	Control Type	Entrance Control
Headwater Depth/Height	0.58		

Grades			
Upstream Invert	228.20 m	Downstream Invert	226.60 m
Length	80.00 m	Constructed Slope	0.020000 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.50 m
Slope Type	Steep	Normal Depth	0.28 m
Flow Regime	N/A	Critical Depth	0.31 m
Velocity Downstream	0.82 m/s	Critical Slope	0.013336 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	228.73 m	Upstream Velocity Head	0.12 m
Ke	0.90	Entrance Loss	0.10 m

Inlet Control Properties			
Inlet Control HW Elev.	228.65 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
22-CRR-6-WC2_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	228.73 m
Roadway Width	50.00 m	Overtopping Coefficient	1.60 SI
Length	50.00 m	Crest Elevation	237.24 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	237.24
50.00	237.24

Culvert Analysis Report
23-CRR-3-WC1.1_PROP-Ck_Update

Analysis Component			
Storm Event	Check	Discharge	3.7100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	3.0000 m³/s	Check Discharge	3.7100 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	235.23 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-3050 x 1830 mm Box	3.7100 m³/s	235.51 m	1.13 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	235.51 m	N/A
Total	----------------	3.7100 m³/s	235.51 m	N/A

Culvert Analysis Report
23-CRR-3-WC1.1_PROP-Ck_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	235.51 m	Discharge	3.7100 m³/s
Inlet Control HW Elev.	235.23 m	Tailwater Elevation	235.23 m
Outlet Control HW Elev.	235.51 m	Control Type	Outlet Control
Headwater Depth/Height	0.66		

Grades			
Upstream Invert	234.30 m	Downstream Invert	234.15 m
Length	60.00 m	Constructed Slope	0.002500 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.08 m
Slope Type	Mild	Normal Depth	1.13 m
Flow Regime	Subcritical	Critical Depth	0.53 m
Velocity Downstream	1.13 m/s	Critical Slope	0.022101 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	3.05 m
Section Size	3050 x 1830 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	235.51 m	Upstream Velocity Head	0.06 m
Ke	0.70	Entrance Loss	0.04 m

Inlet Control Properties			
Inlet Control HW Elev.	235.23 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	5.6 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
23-CRR-3-WC1.1_PROP-Ck_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	235.51 m
Roadway Width	32.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	237.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	237.00
100.00	237.00

Culvert Analysis Report
23-CRR-3-WC1.1_PROP_Update

Analysis Component			
Storm Event	Check	Discharge	2.3000 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.9900 m³/s	Check Discharge	2.3000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	235.23 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-3050 x 1830 mm Box	2.2989 m³/s	235.35 m	0.70 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	235.35 m	N/A
Total	----------------	2.2989 m³/s	235.35 m	N/A

Culvert Analysis Report
23-CRR-3-WC1.1_PROP_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	235.35 m	Discharge	2.2989 m³/s
Inlet Control HW Elev.	235.23 m	Tailwater Elevation	235.23 m
Outlet Control HW Elev.	235.35 m	Control Type	Outlet Control
Headwater Depth/Height	0.57		

Grades			
Upstream Invert	234.30 m	Downstream Invert	234.15 m
Length	60.00 m	Constructed Slope	0.002500 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	1.08 m
Slope Type	Mild	Normal Depth	0.81 m
Flow Regime	Subcritical	Critical Depth	0.39 m
Velocity Downstream	0.70 m/s	Critical Slope	0.022290 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	3.05 m
Section Size	3050 x 1830 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	235.35 m	Upstream Velocity Head	0.03 m
Ke	0.70	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	235.23 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	5.6 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
23-CRR-3-WC1.1_PROP_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.0000	m³/s	Allowable HW Elevation	235.35	m
Roadway Width	32.00	m	Overtopping Coefficient	1.60	SI
Length	100.00	m	Crest Elevation	237.00	m
Headwater Elevation	N/A	m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (m)	Elev. (m)
0.00	237.00
100.00	237.00

Culvert Analysis Report
24-CRR-3-WC2_PROP-Ck_Update

Analysis Component			
Storm Event	Check	Discharge	3.6400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.9500 m³/s	Check Discharge	3.6400 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	235.51 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-3050 x 1830 mm Box	3.6393 m³/s	235.79 m	1.03 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	235.79 m	N/A
Total	----------------	3.6393 m³/s	235.79 m	N/A

Culvert Analysis Report
24-CRR-3-WC2_PROP-Ck_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	235.79 m	Discharge	3.6393 m³/s
Inlet Control HW Elev.	235.51 m	Tailwater Elevation	235.51 m
Outlet Control HW Elev.	235.79 m	Control Type	Outlet Control
Headwater Depth/Height	0.68		

Grades			
Upstream Invert	234.55 m	Downstream Invert	234.35 m
Length	80.00 m	Constructed Slope	0.002500 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	1.16 m
Slope Type	Mild	Normal Depth	1.12 m
Flow Regime	Subcritical	Critical Depth	0.53 m
Velocity Downstream	1.03 m/s	Critical Slope	0.022098 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	3.05 m
Section Size	3050 x 1830 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	235.79 m	Upstream Velocity Head	0.06 m
Ke	0.70	Entrance Loss	0.04 m

Inlet Control Properties			
Inlet Control HW Elev.	235.51 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	5.6 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
24-CRR-3-WC2_PROP-Ck_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	235.79 m
Roadway Width	32.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	237.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	237.00
100.00	237.00

Culvert Analysis Report
24-CRR-3-WC2_PROP_Update

Analysis Component			
Storm Event	Check	Discharge	2.2700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.9600 m³/s	Check Discharge	2.2700 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	235.35 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-3050 x 1830 mm Box	2.2691 m³/s	235.52 m	0.74 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	235.52 m	N/A
Total	----------------	2.2691 m³/s	235.52 m	N/A

Culvert Analysis Report
24-CRR-3-WC2_PROP_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	235.52 m	Discharge	2.2691 m³/s
Inlet Control HW Elev.	235.35 m	Tailwater Elevation	235.35 m
Outlet Control HW Elev.	235.52 m	Control Type	Outlet Control
Headwater Depth/Height	0.53		

Grades			
Upstream Invert	234.55 m	Downstream Invert	234.35 m
Length	80.00 m	Constructed Slope	0.002500 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	1.00 m
Slope Type	Mild	Normal Depth	0.80 m
Flow Regime	Subcritical	Critical Depth	0.38 m
Velocity Downstream	0.74 m/s	Critical Slope	0.022303 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	3.05 m
Section Size	3050 x 1830 mm	Rise	1.83 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	235.52 m	Upstream Velocity Head	0.03 m
Ke	0.70	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	235.35 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	5.6 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
24-CRR-3-WC2_PROP_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	235.52 m
Roadway Width	32.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	237.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	237.00
100.00	237.00

Culvert Analysis Report
25-CRR-9-WC1_PROP

Analysis Component			
Storm Event	Check	Discharge	3.1300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.6700 m³/s	Check Discharge	3.1300 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	224.60 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440 x 1520 mm Box	3.1303 m³/s	225.40 m	2.33 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	225.40 m	N/A
Total	----------------	3.1303 m³/s	225.40 m	N/A

Culvert Analysis Report
25-CRR-9-WC1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	225.40 m	Discharge	3.1303 m³/s
Inlet Control HW Elev.	225.20 m	Tailwater Elevation	224.60 m
Outlet Control HW Elev.	225.40 m	Control Type	Outlet Control
Headwater Depth/Height	0.69		

Grades			
Upstream Invert	224.35 m	Downstream Invert	224.10 m
Length	55.00 m	Constructed Slope	0.005455 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.55 m
Slope Type	Mild	Normal Depth	0.93 m
Flow Regime	Subcritical	Critical Depth	0.55 m
Velocity Downstream	2.33 m/s	Critical Slope	0.024095 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	225.40 m	Upstream Velocity Head	0.11 m
Ke	0.50	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	225.20 m	Flow Control	N/A
Inlet Type	18 to 33.7° wingwall flare, d=0.0830	Area Full	3.7 m²
K	0.48600	HDS 5 Chart	9
M	0.66700	HDS 5 Scale	2
C	0.02490	Equation Form	2
Y	0.83000		

Culvert Analysis Report
25-CRR-9-WC1_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	225.40 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	226.50 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	226.50
100.00	226.50

Culvert Analysis Report
25-CRR-9-WC1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	4.0700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	4.0700 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	224.60 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-1200 mm Circular	4.0697 m³/s	225.79 m	2.57 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	225.60 m	N/A
Total	----------------	4.0707 m³/s	225.60 m	N/A

Culvert Analysis Report
25-CRR-9-WC1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	225.79 m	Discharge	4.0697 m³/s
Inlet Control HW Elev.	225.67 m	Tailwater Elevation	224.60 m
Outlet Control HW Elev.	225.79 m	Control Type	Outlet Control
Headwater Depth/Height	1.18		

Grades			
Upstream Invert	224.35 m	Downstream Invert	224.10 m
Length	55.00 m	Constructed Slope	0.005455 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.78 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.78 m
Velocity Downstream	2.57 m/s	Critical Slope	0.015522 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	225.79 m	Upstream Velocity Head	0.17 m
Ke	0.90	Entrance Loss	0.15 m

Inlet Control Properties			
Inlet Control HW Elev.	225.67 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	2.3 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
25-CRR-9-WC1_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)				
Discharge	0.0000 m³/s	Allowable HW Elevation	225.60	m
Roadway Width	12.00 m	Overtopping Coefficient	1.60	SI
Length	100.00 m	Crest Elevation	226.50	m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00			

Sta (m)	Elev. (m)
0.00	226.50
100.00	226.50

Culvert Analysis Report
26-CRR-9-WC2_PROP

Analysis Component			
Storm Event	Design	Discharge	1.2200 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.2200 m³/s	Check Discharge	1.4200 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	236.50 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	3-900 mm Circular	1.2206 m³/s	237.63 m	1.11 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	237.63 m	N/A
Total	----------------	1.2206 m³/s	237.63 m	N/A

Culvert Analysis Report
26-CRR-9-WC2_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	237.63 m	Discharge	1.2206 m³/s
Inlet Control HW Elev.	237.60 m	Tailwater Elevation	236.50 m
Outlet Control HW Elev.	237.63 m	Control Type	Entrance Control
Headwater Depth/Height	0.58		

Grades			
Upstream Invert	237.10 m	Downstream Invert	236.00 m
Length	38.00 m	Constructed Slope	0.028947 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.50 m
Slope Type	Steep	Normal Depth	0.22 m
Flow Regime	N/A	Critical Depth	0.37 m
Velocity Downstream	1.11 m/s	Critical Slope	0.003991 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	3		

Outlet Control Properties			
Outlet Control HW Elev.	237.63 m	Upstream Velocity Head	0.14 m
Ke	0.20	Entrance Loss	0.03 m

Inlet Control Properties			
Inlet Control HW Elev.	237.60 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	2.0 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
26-CRR-9-WC2_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	237.63 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	239.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	239.00
100.00	239.00

Culvert Analysis Report
26-CRR-9-WC2_PROP-Ck

Analysis Component			
Storm Event	Check	Discharge	1.9300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.8500 m³/s	Check Discharge	1.9300 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	236.50 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	3-900 mm Circular	1.9303 m³/s	237.79 m	1.75 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	237.79 m	N/A
Total	----------------	1.9303 m³/s	237.79 m	N/A

Culvert Analysis Report
26-CRR-9-WC2_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	237.79 m	Discharge	1.9303 m³/s
Inlet Control HW Elev.	237.75 m	Tailwater Elevation	236.50 m
Outlet Control HW Elev.	237.79 m	Control Type	Entrance Control
Headwater Depth/Height	0.75		

Grades			
Upstream Invert	237.10 m	Downstream Invert	236.00 m
Length	38.00 m	Constructed Slope	0.028947 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.50 m
Slope Type	Steep	Normal Depth	0.28 m
Flow Regime	N/A	Critical Depth	0.47 m
Velocity Downstream	1.75 m/s	Critical Slope	0.004300 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	3		

Outlet Control Properties			
Outlet Control HW Elev.	237.79 m	Upstream Velocity Head	0.18 m
Ke	0.20	Entrance Loss	0.04 m

Inlet Control Properties			
Inlet Control HW Elev.	237.75 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	2.0 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
26-CRR-9-WC2_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	237.79 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	239.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	239.00
100.00	239.00

Culvert Analysis Report
27-CRR-3-WC3_PROP-Ck_Update

Analysis Component			
Storm Event	Check	Discharge	3.3700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.6200 m³/s	Check Discharge	3.3700 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	235.79 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440 x 1520 mm Box	3.3699 m³/s	236.70 m	2.38 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	236.70 m	N/A
Total	----------------	3.3699 m³/s	236.70 m	N/A

Culvert Analysis Report
27-CRR-3-WC3_PROP-Ck_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	236.70 m	Discharge	3.3699 m³/s
Inlet Control HW Elev.	236.45 m	Tailwater Elevation	235.79 m
Outlet Control HW Elev.	236.70 m	Control Type	Outlet Control
Headwater Depth/Height	0.81		

Grades			
Upstream Invert	235.47 m	Downstream Invert	235.22 m
Length	84.70 m	Constructed Slope	0.002952 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.58 m
Slope Type	Mild	Normal Depth	1.23 m
Flow Regime	Subcritical	Critical Depth	0.58 m
Velocity Downstream	2.38 m/s	Critical Slope	0.024201 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	236.70 m	Upstream Velocity Head	0.08 m
Ke	0.70	Entrance Loss	0.06 m

Inlet Control Properties			
Inlet Control HW Elev.	236.45 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	3.7 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
27-CRR-3-WC3_PROP-Ck_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	236.70 m
Roadway Width	20.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	245.50 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	245.50
100.00	245.50

Culvert Analysis Report
27-CRR-3-WC3_PROP_Update

Analysis Component			
Storm Event	Check	Discharge	2.0100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.8000 m³/s	Check Discharge	2.0100 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	235.52 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440 x 1520 mm Box	2.0105 m³/s	236.35 m	2.01 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	236.35 m	N/A
Total	----------------	2.0105 m³/s	236.35 m	N/A

Culvert Analysis Report
27-CRR-3-WC3_PROP_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	236.35 m	Discharge	2.0105 m³/s
Inlet Control HW Elev.	236.16 m	Tailwater Elevation	235.52 m
Outlet Control HW Elev.	236.35 m	Control Type	Outlet Control
Headwater Depth/Height	0.58		

Grades			
Upstream Invert	235.47 m	Downstream Invert	235.22 m
Length	84.70 m	Constructed Slope	0.002952 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.41 m
Slope Type	Mild	Normal Depth	0.84 m
Flow Regime	Subcritical	Critical Depth	0.41 m
Velocity Downstream	2.01 m/s	Critical Slope	0.023801 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	236.35 m	Upstream Velocity Head	0.06 m
Ke	0.70	Entrance Loss	0.04 m

Inlet Control Properties			
Inlet Control HW Elev.	236.16 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	3.7 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
27-CRR-3-WC3_PROP_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	236.35 m
Roadway Width	20.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	245.50 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	245.50
100.00	245.50

Culvert Analysis Report
28-CRR-3_WC3.1_PROP-Ck_Update

Analysis Component			
Storm Event	Check	Discharge	3.1700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.5700 m³/s	Check Discharge	3.1700 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	236.70 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1500 mm Circular	3.1695 m³/s	238.92 m	2.75 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	238.92 m	N/A
Total	----------------	3.1695 m³/s	238.92 m	N/A

Culvert Analysis Report
28-CRR-3_WC3.1_PROP-Ck_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	238.92 m	Discharge	3.1695 m³/s
Inlet Control HW Elev.	238.84 m	Tailwater Elevation	236.70 m
Outlet Control HW Elev.	238.92 m	Control Type	Outlet Control
Headwater Depth/Height	1.04		

Grades			
Upstream Invert	237.33 m	Downstream Invert	236.50 m
Length	100.00 m	Constructed Slope	0.008300 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.92 m
Slope Type	Mild	Normal Depth	1.10 m
Flow Regime	Subcritical	Critical Depth	0.92 m
Velocity Downstream	2.75 m/s	Critical Slope	0.013677 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.52 m
Section Size	1500 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	238.92 m	Upstream Velocity Head	0.26 m
Ke	0.90	Entrance Loss	0.23 m

Inlet Control Properties			
Inlet Control HW Elev.	238.84 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
28-CRR-3_WC3.1_PROP-Ck_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	238.92 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	243.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	243.00
80.00	243.00

Culvert Analysis Report
28-CRR-3_WC3.1_PROP_Update

Analysis Component			
Storm Event	Check	Discharge	1.9800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.6900 m³/s	Check Discharge	1.9800 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	236.35 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1500 mm Circular	1.9804 m³/s	238.53 m	2.34 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	238.53 m	N/A
Total	----------------	1.9804 m³/s	238.53 m	N/A

Culvert Analysis Report
28-CRR-3_WC3.1_PROP_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	238.53 m	Discharge	1.9804 m³/s
Inlet Control HW Elev.	238.43 m	Tailwater Elevation	236.35 m
Outlet Control HW Elev.	238.53 m	Control Type	Outlet Control
Headwater Depth/Height	0.79		

Grades			
Upstream Invert	237.33 m	Downstream Invert	236.50 m
Length	100.00 m	Constructed Slope	0.008300 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.72 m
Slope Type	Mild	Normal Depth	0.80 m
Flow Regime	Subcritical	Critical Depth	0.72 m
Velocity Downstream	2.34 m/s	Critical Slope	0.011970 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.52 m
Section Size	1500 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	238.53 m	Upstream Velocity Head	0.21 m
Ke	0.90	Entrance Loss	0.19 m

Inlet Control Properties			
Inlet Control HW Elev.	238.43 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
28-CRR-3_WC3.1_PROP_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.0000	m³/s	Allowable HW Elevation	238.53	m
Roadway Width	12.00	m	Overtopping Coefficient	1.60	SI
Length	80.00	m	Crest Elevation	243.00	m
Headwater Elevation	N/A	m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (m)	Elev. (m)
0.00	243.00
80.00	243.00

Culvert Analysis Report
29-CRR-3-WC3.2_PROP-Ck_Update

Analysis Component			
Storm Event	Check	Discharge	0.7400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.7100 m³/s	Check Discharge	0.7400 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	237.63 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1200 mm Circular	0.7403 m³/s	237.78 m	0.63 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	237.78 m	N/A
Total	----------------	0.7403 m³/s	237.78 m	N/A

Culvert Analysis Report
29-CRR-3-WC3.2_PROP-Ck_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	237.78 m	Discharge	0.7403 m³/s
Inlet Control HW Elev.	237.63 m	Tailwater Elevation	237.63 m
Outlet Control HW Elev.	237.78 m	Control Type	Outlet Control
Headwater Depth/Height	1.41		

Grades			
Upstream Invert	236.06 m	Downstream Invert	235.46 m
Length	100.00 m	Constructed Slope	0.006000 m/m

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	2.17 m
Slope Type	N/A	Normal Depth	0.56 m
Flow Regime	N/A	Critical Depth	0.46 m
Velocity Downstream	0.63 m/s	Critical Slope	0.012240 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	237.78 m	Upstream Velocity Head	0.02 m
Ke	0.90	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	237.63 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
29-CRR-3-WC3.2_PROP-Ck_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	237.78 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	238.38 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	238.38
80.00	238.38

Culvert Analysis Report
29-CRR-3-WC3.2_PROP_Update

Analysis Component			
Storm Event	Check	Discharge	0.5500 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.4700 m³/s	Check Discharge	0.5500 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	236.83 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1200 mm Circular	0.5493 m³/s	236.93 m	0.47 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	236.93 m	N/A
Total	----------------	0.5493 m³/s	236.93 m	N/A

Culvert Analysis Report
29-CRR-3-WC3.2_PROP_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	236.93 m	Discharge	0.5493 m³/s
Inlet Control HW Elev.	236.83 m	Tailwater Elevation	236.83 m
Outlet Control HW Elev.	236.93 m	Control Type	Outlet Control
Headwater Depth/Height	0.71		

Grades			
Upstream Invert	236.06 m	Downstream Invert	235.46 m
Length	100.00 m	Constructed Slope	0.006000 m/m

Hydraulic Profile			
Profile	CompositePressureProfileM1	Depth, Downstream	1.37 m
Slope Type	N/A	Normal Depth	0.48 m
Flow Regime	Subcritical	Critical Depth	0.39 m
Velocity Downstream	0.47 m/s	Critical Slope	0.012075 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	Aluminum	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	236.93 m	Upstream Velocity Head	0.02 m
Ke	0.90	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	236.83 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
29-CRR-3-WC3.2_PROP_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.0000	m³/s	Allowable HW Elevation	236.93	m
Roadway Width	12.00	m	Overtopping Coefficient	1.60	SI
Length	80.00	m	Crest Elevation	238.00	m
Headwater Elevation	N/A	m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (m)	Elev. (m)
0.00	238.00
80.00	238.00

Culvert Analysis Report
30-CRR-3-WC3.3_PROP-Ck_Update

Analysis Component			
Storm Event	Check	Discharge	3.6100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	3.2500 m³/s	Check Discharge	3.6100 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	236.75 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2130 x 1220 mm Box	3.6097 m³/s	237.63 m	1.39 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	237.63 m	N/A
Total	----------------	3.6097 m³/s	237.63 m	N/A

Culvert Analysis Report
30-CRR-3-WC3.3_PROP-Ck_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	237.63 m	Discharge	3.6097 m³/s
Inlet Control HW Elev.	236.79 m	Tailwater Elevation	236.75 m
Outlet Control HW Elev.	237.63 m	Control Type	Outlet Control
Headwater Depth/Height	1.61		

Grades			
Upstream Invert	235.66 m	Downstream Invert	235.40 m
Length	85.20 m	Constructed Slope	0.003052 m/m

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	1.35 m
Slope Type	N/A	Normal Depth	N/A m
Flow Regime	N/A	Critical Depth	0.66 m
Velocity Downstream	1.39 m/s	Critical Slope	0.026247 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	237.63 m	Upstream Velocity Head	0.10 m
Ke	0.70	Entrance Loss	0.07 m

Inlet Control Properties			
Inlet Control HW Elev.	236.79 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	2.6 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
30-CRR-3-WC3.3_PROP-Ck_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	237.63 m
Roadway Width	80.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	239.70 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	239.70
80.00	239.70

Culvert Analysis Report
30-CRR-3-WC3.3_PROP_Update

Analysis Component			
Storm Event	Check	Discharge	2.5000 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.1100 m³/s	Check Discharge	2.5000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	236.39 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2130 x 1220 mm Box	2.5005 m³/s	236.83 m	1.18 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	236.83 m	N/A
Total	----------------	2.5005 m³/s	236.83 m	N/A

Culvert Analysis Report
30-CRR-3-WC3.3_PROP_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	236.83 m	Discharge	2.5005 m³/s
Inlet Control HW Elev.	236.54 m	Tailwater Elevation	236.39 m
Outlet Control HW Elev.	236.83 m	Control Type	Outlet Control
Headwater Depth/Height	0.96		

Grades			
Upstream Invert	235.66 m	Downstream Invert	235.40 m
Length	85.20 m	Constructed Slope	0.003052 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.99 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.52 m
Velocity Downstream	1.18 m/s	Critical Slope	0.025362 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.13 m
Section Size	2130 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	236.83 m	Upstream Velocity Head	0.06 m
Ke	0.70	Entrance Loss	0.04 m

Inlet Control Properties			
Inlet Control HW Elev.	236.54 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	2.6 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
30-CRR-3-WC3.3_PROP_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.0000	m³/s	Allowable HW Elevation	236.83	m
Roadway Width	80.00	m	Overtopping Coefficient	1.60	SI
Length	80.00	m	Crest Elevation	239.70	m
Headwater Elevation	N/A	m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (m)	Elev. (m)
0.00	239.70
80.00	239.70

Culvert Analysis Report
31-CRR-3-WC3.4_PROP-Ck_Update

Analysis Component			
Storm Event	Check	Discharge	2.6700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.5700 m³/s	Check Discharge	2.6700 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	237.63 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1050 mm Circular	2.6699 m³/s	239.84 m	2.99 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	239.84 m	N/A
Total	----------------	2.6699 m³/s	239.84 m	N/A

Culvert Analysis Report
31-CRR-3-WC3.4_PROP-Ck_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	239.84 m	Discharge	2.6699 m³/s
Inlet Control HW Elev.	238.69 m	Tailwater Elevation	237.63 m
Outlet Control HW Elev.	239.84 m	Control Type	Outlet Control
Headwater Depth/Height	3.13		

Grades			
Upstream Invert	236.50 m	Downstream Invert	236.10 m
Length	45.00 m	Constructed Slope	0.008889 m/m

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	1.53 m
Slope Type	N/A	Normal Depth	N/A m
Flow Regime	N/A	Critical Depth	0.91 m
Velocity Downstream	2.99 m/s	Critical Slope	0.027848 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.07 m
Section Size	1050 mm	Rise	1.07 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	239.84 m	Upstream Velocity Head	0.45 m
Ke	0.90	Entrance Loss	0.41 m

Inlet Control Properties			
Inlet Control HW Elev.	238.69 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.9 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
31-CRR-3-WC3.4_PROP-Ck_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	239.84 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	242.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	242.00
80.00	242.00

Culvert Analysis Report
31-CRR-3-WC3.4_PROP_Update

Analysis Component			
Storm Event	Check	Discharge	1.9800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.6900 m³/s	Check Discharge	1.9800 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	236.83 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1050 mm Circular	1.9799 m³/s	238.23 m	2.76 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	238.23 m	N/A
Total	----------------	1.9799 m³/s	238.23 m	N/A

Culvert Analysis Report
31-CRR-3-WC3.4_PROP_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	238.23 m	Discharge	1.9799 m³/s
Inlet Control HW Elev.	237.98 m	Tailwater Elevation	236.83 m
Outlet Control HW Elev.	238.23 m	Control Type	Outlet Control
Headwater Depth/Height	1.62		

Grades			
Upstream Invert	236.50 m	Downstream Invert	236.10 m
Length	45.00 m	Constructed Slope	0.008889 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.80 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.80 m
Velocity Downstream	2.76 m/s	Critical Slope	0.019879 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.07 m
Section Size	1050 mm	Rise	1.07 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	238.23 m	Upstream Velocity Head	0.25 m
Ke	0.90	Entrance Loss	0.23 m

Inlet Control Properties			
Inlet Control HW Elev.	237.98 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.9 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
31-CRR-3-WC3.4_PROP_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	238.23 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	242.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	242.00
80.00	242.00

Culvert Analysis Report
32-CRR-3-WC3.6_PROP-Ck_Update

Analysis Component			
Storm Event	Check	Discharge	3.9500 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	3.4800 m³/s	Check Discharge	3.9500 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	236.47 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440 x 1520 mm Box	3.9498 m³/s	236.75 m	1.23 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	236.75 m	N/A
Total	----------------	3.9498 m³/s	236.75 m	N/A

Culvert Analysis Report
32-CRR-3-WC3.6_PROP-Ck_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	236.75 m	Discharge	3.9498 m³/s
Inlet Control HW Elev.	236.47 m	Tailwater Elevation	236.47 m
Outlet Control HW Elev.	236.75 m	Control Type	Outlet Control
Headwater Depth/Height	0.95		

Grades			
Upstream Invert	235.30 m	Downstream Invert	235.15 m
Length	45.00 m	Constructed Slope	0.003333 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.32 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.64 m
Velocity Downstream	1.23 m/s	Critical Slope	0.024489 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	236.75 m	Upstream Velocity Head	0.08 m
Ke	0.70	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	236.47 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	3.7 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
32-CRR-3-WC3.6_PROP-Ck_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	236.75 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	241.58 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	241.58
80.00	241.58

Culvert Analysis Report
32-CRR-3-WC3.6_PROP_Update

Analysis Component			
Storm Event	Check	Discharge	2.6800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.2600 m³/s	Check Discharge	2.6800 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	236.12 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440 x 1520 mm Box	2.6783 m³/s	236.39 m	1.13 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	236.39 m	N/A
Total	----------------	2.6783 m³/s	236.39 m	N/A

Culvert Analysis Report
32-CRR-3-WC3.6_PROP_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	236.39 m	Discharge	2.6783 m³/s
Inlet Control HW Elev.	236.14 m	Tailwater Elevation	236.12 m
Outlet Control HW Elev.	236.39 m	Control Type	Outlet Control
Headwater Depth/Height	0.71		

Grades			
Upstream Invert	235.30 m	Downstream Invert	235.15 m
Length	45.00 m	Constructed Slope	0.003333 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.97 m
Slope Type	Mild	Normal Depth	0.99 m
Flow Regime	Subcritical	Critical Depth	0.50 m
Velocity Downstream	1.13 m/s	Critical Slope	0.023926 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	236.39 m	Upstream Velocity Head	0.06 m
Ke	0.70	Entrance Loss	0.04 m

Inlet Control Properties			
Inlet Control HW Elev.	236.14 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	3.7 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
32-CRR-3-WC3.6_PROP_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.0000	m³/s	Allowable HW Elevation	236.39	m
Roadway Width	12.00	m	Overtopping Coefficient	1.60	SI
Length	80.00	m	Crest Elevation	241.58	m
Headwater Elevation	N/A	m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (m)	Elev. (m)
0.00	241.58
80.00	241.58

Culvert Analysis Report
33-CRR-3-WC4_PROP-Ck_Recommended

Analysis Component			
Storm Event	Check	Discharge	0.4600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.4200 m³/s	Check Discharge	0.4600 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	237.40 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1830 x 1520 mm Box	0.4603 m³/s	238.14 m	1.35 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	238.14 m	N/A
Total	----------------	0.4603 m³/s	238.14 m	N/A

Culvert Analysis Report
33-CRR-3-WC4_PROP-Ck_Recommended

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	238.14 m	Discharge	0.4603 m³/s
Inlet Control HW Elev.	238.10 m	Tailwater Elevation	237.40 m
Outlet Control HW Elev.	238.14 m	Control Type	Outlet Control
Headwater Depth/Height	0.23		

Grades			
Upstream Invert	237.80 m	Downstream Invert	237.40 m
Length	45.00 m	Constructed Slope	0.008889 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.19 m
Slope Type	Mild	Normal Depth	0.27 m
Flow Regime	Subcritical	Critical Depth	0.19 m
Velocity Downstream	1.35 m/s	Critical Slope	0.026935 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	1.83 m
Section Size	1830 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	238.14 m	Upstream Velocity Head	0.05 m
Ke	0.70	Entrance Loss	0.03 m

Inlet Control Properties			
Inlet Control HW Elev.	238.10 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	2.8 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
33-CRR-3-WC4_PROP-Ck_Recommended

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	238.14 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	241.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	241.00
80.00	241.00

Culvert Analysis Report
33-CRR-3-WC4_PROP-Ck_Update

Analysis Component			
Storm Event	Check	Discharge	0.4600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.4200 m³/s	Check Discharge	0.4600 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	237.78 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.4601 m³/s	238.45 m	1.71 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	238.45 m	N/A
Total	----------------	0.4601 m³/s	238.45 m	N/A

Culvert Analysis Report
33-CRR-3-WC4_PROP-Ck_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	238.45 m	Discharge	0.4601 m³/s
Inlet Control HW Elev.	238.38 m	Tailwater Elevation	237.78 m
Outlet Control HW Elev.	238.45 m	Control Type	Outlet Control
Headwater Depth/Height	0.71		

Grades			
Upstream Invert	237.80 m	Downstream Invert	237.40 m
Length	45.00 m	Constructed Slope	0.008889 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.39 m
Slope Type	Mild	Normal Depth	0.44 m
Flow Regime	Subcritical	Critical Depth	0.39 m
Velocity Downstream	1.71 m/s	Critical Slope	0.013800 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	238.45 m	Upstream Velocity Head	0.11 m
Ke	0.90	Entrance Loss	0.10 m

Inlet Control Properties			
Inlet Control HW Elev.	238.38 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
33-CRR-3-WC4_PROP-Ck_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	238.45 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	241.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	241.00
80.00	241.00

Culvert Analysis Report
33-CRR-3-WC4_PROP_Recommended

Analysis Component			
Storm Event	Check	Discharge	0.4300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2800 m³/s	Check Discharge	0.4300 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	237.40 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1830 x 1520 mm Box	0.4303 m³/s	238.13 m	1.32 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	238.13 m	N/A
Total	----------------	0.4303 m³/s	238.13 m	N/A

Culvert Analysis Report
33-CRR-3-WC4_PROP_Recommended

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	238.13 m	Discharge	0.4303 m³/s
Inlet Control HW Elev.	238.09 m	Tailwater Elevation	237.40 m
Outlet Control HW Elev.	238.13 m	Control Type	Outlet Control
Headwater Depth/Height	0.22		

Grades			
Upstream Invert	237.80 m	Downstream Invert	237.40 m
Length	45.00 m	Constructed Slope	0.008889 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.18 m
Slope Type	Mild	Normal Depth	0.26 m
Flow Regime	Subcritical	Critical Depth	0.18 m
Velocity Downstream	1.32 m/s	Critical Slope	0.027070 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	1.83 m
Section Size	1830 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	238.13 m	Upstream Velocity Head	0.04 m
Ke	0.70	Entrance Loss	0.03 m

Inlet Control Properties			
Inlet Control HW Elev.	238.09 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	2.8 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
33-CRR-3-WC4_PROP_Recommended

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	238.13 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	241.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	241.00
80.00	241.00

Culvert Analysis Report
33-CRR-3-WC4_PROP_Update

Analysis Component			
Storm Event	Check	Discharge	0.3300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2800 m³/s	Check Discharge	0.3300 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	236.93 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.3301 m³/s	238.34 m	1.54 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	238.34 m	N/A
Total	----------------	0.3301 m³/s	238.34 m	N/A

Culvert Analysis Report
33-CRR-3-WC4_PROP_Update

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	238.34 m	Discharge	0.3301 m³/s
Inlet Control HW Elev.	238.28 m	Tailwater Elevation	236.93 m
Outlet Control HW Elev.	238.34 m	Control Type	Outlet Control
Headwater Depth/Height	0.59		

Grades			
Upstream Invert	237.80 m	Downstream Invert	237.40 m
Length	45.00 m	Constructed Slope	0.008889 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.33 m
Slope Type	Mild	Normal Depth	0.37 m
Flow Regime	Subcritical	Critical Depth	0.33 m
Velocity Downstream	1.54 m/s	Critical Slope	0.013396 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	238.34 m	Upstream Velocity Head	0.09 m
Ke	0.90	Entrance Loss	0.08 m

Inlet Control Properties			
Inlet Control HW Elev.	238.28 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
33-CRR-3-WC4_PROP_Update

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	238.34 m
Roadway Width	12.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	241.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	241.00
80.00	241.00

Culvert Analysis Report
34-CRR-3-WC5_PROP

Analysis Component			
Storm Event	Check	Discharge	1.4400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.2400 m³/s	Check Discharge	1.4400 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	241.00 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1200 mm Circular	1.4397 m³/s	242.19 m	2.08 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	242.19 m	N/A
Total	----------------	1.4397 m³/s	242.19 m	N/A

Culvert Analysis Report
34-CRR-3-WC5_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	242.19 m	Discharge	1.4397 m³/s
Inlet Control HW Elev.	242.11 m	Tailwater Elevation	241.00 m
Outlet Control HW Elev.	242.19 m	Control Type	Outlet Control
Headwater Depth/Height	0.91		

Grades			
Upstream Invert	241.08 m	Downstream Invert	240.30 m
Length	112.00 m	Constructed Slope	0.006964 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.70 m
Slope Type	Mild	Normal Depth	0.81 m
Flow Regime	Subcritical	Critical Depth	0.65 m
Velocity Downstream	2.08 m/s	Critical Slope	0.013619 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.19 m	Upstream Velocity Head	0.15 m
Ke	0.90	Entrance Loss	0.14 m

Inlet Control Properties			
Inlet Control HW Elev.	242.11 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
34-CRR-3-WC5_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	242.19 m
Roadway Width	80.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	244.53 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	244.53
80.00	244.53

Culvert Analysis Report
34-CRR-3-WC5_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	1.8700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.8700 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	241.00 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1200 mm Circular	1.8697 m³/s	242.41 m	2.49 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	242.41 m	N/A
Total	----------------	1.8697 m³/s	242.41 m	N/A

Culvert Analysis Report
34-CRR-3-WC5_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	242.41 m	Discharge	1.8697 m³/s
Inlet Control HW Elev.	242.32 m	Tailwater Elevation	241.00 m
Outlet Control HW Elev.	242.41 m	Control Type	Outlet Control
Headwater Depth/Height	1.09		

Grades			
Upstream Invert	241.08 m	Downstream Invert	240.30 m
Length	112.00 m	Constructed Slope	0.006964 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.75 m
Slope Type	Mild	Normal Depth	1.02 m
Flow Regime	Subcritical	Critical Depth	0.75 m
Velocity Downstream	2.49 m/s	Critical Slope	0.014922 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	242.41 m	Upstream Velocity Head	0.17 m
Ke	0.90	Entrance Loss	0.15 m

Inlet Control Properties			
Inlet Control HW Elev.	242.32 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
34-CRR-3-WC5_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.0000	m³/s	Allowable HW Elevation	242.41	m
Roadway Width	80.00	m	Overtopping Coefficient	1.60	SI
Length	80.00	m	Crest Elevation	244.53	m
Headwater Elevation	N/A	m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (m)	Elev. (m)
0.00	244.53
80.00	244.53

Culvert Analysis Report
35-CRR-13-WC1_PROP

Analysis Component			
Storm Event	Check	Discharge	0.7100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.6100 m³/s	Check Discharge	0.7100 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	248.90 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.7099 m³/s	249.88 m	1.68 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	249.88 m	N/A
Total	----------------	0.7099 m³/s	249.88 m	N/A

Culvert Analysis Report
35-CRR-13-WC1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	249.88 m	Discharge	0.7099 m³/s
Inlet Control HW Elev.	249.79 m	Tailwater Elevation	248.90 m
Outlet Control HW Elev.	249.88 m	Control Type	Outlet Control
Headwater Depth/Height	0.95		

Grades			
Upstream Invert	249.01 m	Downstream Invert	248.34 m
Length	120.76 m	Constructed Slope	0.005548 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.56 m
Slope Type	Mild	Normal Depth	0.70 m
Flow Regime	Subcritical	Critical Depth	0.49 m
Velocity Downstream	1.68 m/s	Critical Slope	0.015041 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	249.88 m	Upstream Velocity Head	0.09 m
Ke	0.90	Entrance Loss	0.08 m

Inlet Control Properties			
Inlet Control HW Elev.	249.79 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
35-CRR-13-WC1_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	249.88 m
Roadway Width	70.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	260.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	260.00
80.00	260.00

Culvert Analysis Report
35-CRR-13-WC1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.9200 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.9200 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	248.90 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.9199 m³/s	250.20 m	2.16 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	250.20 m	N/A
Total	----------------	0.9199 m³/s	250.20 m	N/A

Culvert Analysis Report
35-CRR-13-WC1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	250.20 m	Discharge	0.9199 m³/s
Inlet Control HW Elev.	249.94 m	Tailwater Elevation	248.90 m
Outlet Control HW Elev.	250.20 m	Control Type	Outlet Control
Headwater Depth/Height	1.30		

Grades			
Upstream Invert	249.01 m	Downstream Invert	248.34 m
Length	120.76 m	Constructed Slope	0.005548 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.56 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.56 m
Velocity Downstream	2.16 m/s	Critical Slope	0.016492 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	250.20 m	Upstream Velocity Head	0.10 m
Ke	0.90	Entrance Loss	0.09 m

Inlet Control Properties			
Inlet Control HW Elev.	249.94 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
35-CRR-13-WC1_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.0000	m³/s	Allowable HW Elevation	250.20	m
Roadway Width	70.00	m	Overtopping Coefficient	1.60	SI
Length	80.00	m	Crest Elevation	260.00	m
Headwater Elevation	N/A	m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (m)	Elev. (m)
0.00	260.00
80.00	260.00

Culvert Analysis Report
36-CRR-13-WC2_PROP

Analysis Component			
Storm Event	Check	Discharge	2.0900 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.8000 m³/s	Check Discharge	2.0900 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	248.40 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1200 mm Circular	2.0901 m³/s	249.93 m	2.60 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	249.93 m	N/A
Total	----------------	2.0901 m³/s	249.93 m	N/A

Culvert Analysis Report
36-CRR-13-WC2_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	249.93 m	Discharge	2.0901 m³/s
Inlet Control HW Elev.	249.25 m	Tailwater Elevation	248.40 m
Outlet Control HW Elev.	249.93 m	Control Type	Outlet Control
Headwater Depth/Height	1.66		

Grades			
Upstream Invert	247.90 m	Downstream Invert	247.71 m
Length	104.00 m	Constructed Slope	0.001827 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.79 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.79 m
Velocity Downstream	2.60 m/s	Critical Slope	0.015736 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	249.93 m	Upstream Velocity Head	0.16 m
Ke	0.90	Entrance Loss	0.15 m

Inlet Control Properties			
Inlet Control HW Elev.	249.25 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
36-CRR-13-WC2_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	249.93 m
Roadway Width	70.00 m	Overtopping Coefficient	1.60 SI
Length	80.00 m	Crest Elevation	250.60 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	250.60
80.00	250.60

Culvert Analysis Report
36-CRR-13-WC2_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	2.7200 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.7200 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	248.40 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1200 mm Circular	2.5593 m³/s	250.61 m	2.84 m/s
Weir	Roadway (Constant Elevation)	0.1630 m³/s	250.61 m	N/A
Total	----------------	2.7223 m³/s	250.61 m	N/A

Culvert Analysis Report
36-CRR-13-WC2_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	250.61 m	Discharge	2.5593 m³/s
Inlet Control HW Elev.	249.48 m	Tailwater Elevation	248.40 m
Outlet Control HW Elev.	250.61 m	Control Type	Outlet Control
Headwater Depth/Height	2.22		

Grades			
Upstream Invert	247.90 m	Downstream Invert	247.71 m
Length	104.00 m	Constructed Slope	0.001827 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.88 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.88 m
Velocity Downstream	2.84 m/s	Critical Slope	0.017872 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	250.61 m	Upstream Velocity Head	0.25 m
Ke	0.90	Entrance Loss	0.22 m

Inlet Control Properties			
Inlet Control HW Elev.	249.48 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
36-CRR-13-WC2_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.1630 m³/s	Allowable HW Elevation	250.61 m
Roadway Width	70.00 m	Overtopping Coefficient	1.61 SI
Length	80.00 m	Crest Elevation	250.60 m
Headwater Elevation	250.61 m	Discharge Coefficient (Cr)	2.92
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	250.60
80.00	250.60

Culvert Analysis Report
37-CRR-13-WC3_PROP

Analysis Component			
Storm Event	Check	Discharge	4.6800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	3.9600 m³/s	Check Discharge	4.6800 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	250.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-3660 x 1220 mm Box	4.6794 m³/s	250.60 m	1.85 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	250.60 m	N/A
Total	----------------	4.6794 m³/s	250.60 m	N/A

Culvert Analysis Report
37-CRR-13-WC3_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	250.60 m	Discharge	4.6794 m³/s
Inlet Control HW Elev.	250.45 m	Tailwater Elevation	250.10 m
Outlet Control HW Elev.	250.60 m	Control Type	Outlet Control
Headwater Depth/Height	0.89		

Grades			
Upstream Invert	249.51 m	Downstream Invert	249.41 m
Length	40.00 m	Constructed Slope	0.002500 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.69 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.55 m
Velocity Downstream	1.85 m/s	Critical Slope	0.020818 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	3.66 m
Section Size	3660 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	250.60 m	Upstream Velocity Head	0.10 m
Ke	0.70	Entrance Loss	0.07 m

Inlet Control Properties			
Inlet Control HW Elev.	250.45 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	4.5 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
37-CRR-13-WC3_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	250.60 m
Roadway Width	20.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	251.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	251.00
100.00	251.00

Culvert Analysis Report
37-CRR-13-WC3_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	6.0800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	6.0800 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	250.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-3660 x 1220 mm Box	6.0811 m³/s	250.79 m	2.41 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	250.79 m	N/A
Total	----------------	6.0811 m³/s	250.79 m	N/A

Culvert Analysis Report
37-CRR-13-WC3_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	250.79 m	Discharge	6.0811 m³/s
Inlet Control HW Elev.	250.63 m	Tailwater Elevation	250.10 m
Outlet Control HW Elev.	250.79 m	Control Type	Outlet Control
Headwater Depth/Height	1.05		

Grades			
Upstream Invert	249.51 m	Downstream Invert	249.41 m
Length	40.00 m	Constructed Slope	0.002500 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.69 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.66 m
Velocity Downstream	2.41 m/s	Critical Slope	0.020806 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	3.66 m
Section Size	3660 x 1220 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	250.79 m	Upstream Velocity Head	0.12 m
Ke	0.70	Entrance Loss	0.09 m

Inlet Control Properties			
Inlet Control HW Elev.	250.63 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	4.5 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
37-CRR-13-WC3_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.0000	m³/s	Allowable HW Elevation	250.79	m
Roadway Width	20.00	m	Overtopping Coefficient	1.60	SI
Length	100.00	m	Crest Elevation	251.00	m
Headwater Elevation	N/A	m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (m)	Elev. (m)
0.00	251.00
100.00	251.00

Culvert Analysis Report
38-CRR-13-WC4.1_PROP

Analysis Component			
Storm Event	Check	Discharge	4.2800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	3.6300 m³/s	Check Discharge	4.2800 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	250.80 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440 x 1520 mm Box	4.2804 m³/s	251.74 m	1.87 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	251.74 m	N/A
Total	----------------	4.2804 m³/s	251.74 m	N/A

Culvert Analysis Report
38-CRR-13-WC4.1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	251.74 m	Discharge	4.2804 m³/s
Inlet Control HW Elev.	251.67 m	Tailwater Elevation	250.80 m
Outlet Control HW Elev.	251.74 m	Control Type	Outlet Control
Headwater Depth/Height	0.80		

Grades			
Upstream Invert	250.52 m	Downstream Invert	249.86 m
Length	60.00 m	Constructed Slope	0.013200 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.94 m
Slope Type	Mild	Normal Depth	0.85 m
Flow Regime	Subcritical	Critical Depth	0.68 m
Velocity Downstream	1.87 m/s	Critical Slope	0.024668 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	251.74 m	Upstream Velocity Head	0.22 m
Ke	0.70	Entrance Loss	0.15 m

Inlet Control Properties			
Inlet Control HW Elev.	251.67 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	3.7 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
38-CRR-13-WC4.1_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	251.74 m
Roadway Width	20.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	258.50 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	258.50
100.00	258.50

Culvert Analysis Report
38-CRR-13-WC4.1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	5.5600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	5.5600 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	250.80 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440 x 1520 mm Box	5.5593 m³/s	251.97 m	2.43 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	251.97 m	N/A
Total	----------------	5.5593 m³/s	251.97 m	N/A

Culvert Analysis Report
38-CRR-13-WC4.1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	251.97 m	Discharge	5.5593 m³/s
Inlet Control HW Elev.	251.89 m	Tailwater Elevation	250.80 m
Outlet Control HW Elev.	251.97 m	Control Type	Outlet Control
Headwater Depth/Height	0.95		

Grades			
Upstream Invert	250.52 m	Downstream Invert	249.86 m
Length	60.00 m	Constructed Slope	0.013200 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.94 m
Slope Type	Mild	Normal Depth	1.03 m
Flow Regime	Subcritical	Critical Depth	0.81 m
Velocity Downstream	2.43 m/s	Critical Slope	0.025415 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	251.97 m	Upstream Velocity Head	0.25 m
Ke	0.70	Entrance Loss	0.18 m

Inlet Control Properties			
Inlet Control HW Elev.	251.89 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	3.7 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
38-CRR-13-WC4.1_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.0000	m³/s	Allowable HW Elevation	251.97	m
Roadway Width	20.00	m	Overtopping Coefficient	1.60	SI
Length	100.00	m	Crest Elevation	258.50	m
Headwater Elevation	N/A	m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (m)	Elev. (m)
0.00	258.50
100.00	258.50

Culvert Analysis Report
39-CRR-13-WC5_PROP

Analysis Component			
Storm Event	Check	Discharge	4.0800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	3.4800 m³/s	Check Discharge	4.0800 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	251.60 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440 x 1520 mm Box	4.0807 m³/s	252.42 m	2.32 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	252.42 m	N/A
Total	----------------	4.0807 m³/s	252.42 m	N/A

Culvert Analysis Report
39-CRR-13-WC5_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	252.42 m	Discharge	4.0807 m³/s
Inlet Control HW Elev.	252.29 m	Tailwater Elevation	251.60 m
Outlet Control HW Elev.	252.42 m	Control Type	Outlet Control
Headwater Depth/Height	0.82		

Grades			
Upstream Invert	251.17 m	Downstream Invert	250.88 m
Length	45.00 m	Constructed Slope	0.006444 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.72 m
Slope Type	Mild	Normal Depth	1.06 m
Flow Regime	Subcritical	Critical Depth	0.66 m
Velocity Downstream	2.32 m/s	Critical Slope	0.024559 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	252.42 m	Upstream Velocity Head	0.14 m
Ke	0.70	Entrance Loss	0.10 m

Inlet Control Properties			
Inlet Control HW Elev.	252.29 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	3.7 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
39-CRR-13-WC5_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	252.42 m
Roadway Width	20.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	253.60 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	253.60
100.00	253.60

Culvert Analysis Report
39-CRR-13-WC5_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	5.3000 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	5.3000 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	251.70 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440 x 1520 mm Box	5.3000 m³/s	252.65 m	2.65 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	252.65 m	N/A
Total	----------------	5.3000 m³/s	252.65 m	N/A

Culvert Analysis Report
39-CRR-13-WC5_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	252.65 m	Discharge	5.3000 m³/s
Inlet Control HW Elev.	252.50 m	Tailwater Elevation	251.70 m
Outlet Control HW Elev.	252.65 m	Control Type	Outlet Control
Headwater Depth/Height	0.97		

Grades			
Upstream Invert	251.17 m	Downstream Invert	250.88 m
Length	45.00 m	Constructed Slope	0.006444 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.82 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.78 m
Velocity Downstream	2.65 m/s	Critical Slope	0.025259 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	252.65 m	Upstream Velocity Head	0.17 m
Ke	0.70	Entrance Loss	0.12 m

Inlet Control Properties			
Inlet Control HW Elev.	252.50 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	3.7 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
39-CRR-13-WC5_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	252.65 m
Roadway Width	20.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	253.60 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	253.60
100.00	253.60

Culvert Analysis Report
40-CRR-13-WC6_PROP

Analysis Component			
Storm Event	Check	Discharge	1.0500 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.9000 m³/s	Check Discharge	1.0500 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	253.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1200 mm Circular	1.0498 m³/s	253.93 m	1.57 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	253.93 m	N/A
Total	----------------	1.0498 m³/s	253.93 m	N/A

Culvert Analysis Report
40-CRR-13-WC6_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	253.93 m	Discharge	1.0498 m³/s
Inlet Control HW Elev.	253.81 m	Tailwater Elevation	253.10 m
Outlet Control HW Elev.	253.93 m	Control Type	Outlet Control
Headwater Depth/Height	0.78		

Grades			
Upstream Invert	252.98 m	Downstream Invert	252.42 m
Length	45.00 m	Constructed Slope	0.012444 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.68 m
Slope Type	Mild	Normal Depth	0.56 m
Flow Regime	Subcritical	Critical Depth	0.55 m
Velocity Downstream	1.57 m/s	Critical Slope	0.012733 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	253.93 m	Upstream Velocity Head	0.21 m
Ke	0.90	Entrance Loss	0.19 m

Inlet Control Properties			
Inlet Control HW Elev.	253.81 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
40-CRR-13-WC6_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	253.93 m
Roadway Width	15.00 m	Overtopping Coefficient	1.60 SI
Length	60.00 m	Crest Elevation	255.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	255.00
60.00	255.00

Culvert Analysis Report
40-CRR-13-WC6_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	1.3600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.3600 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	253.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1200 mm Circular	1.3603 m³/s	254.08 m	2.03 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	254.08 m	N/A
Total	----------------	1.3603 m³/s	254.08 m	N/A

Culvert Analysis Report
40-CRR-13-WC6_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	254.08 m	Discharge	1.3603 m³/s
Inlet Control HW Elev.	253.97 m	Tailwater Elevation	253.10 m
Outlet Control HW Elev.	254.08 m	Control Type	Outlet Control
Headwater Depth/Height	0.90		

Grades			
Upstream Invert	252.98 m	Downstream Invert	252.42 m
Length	45.00 m	Constructed Slope	0.012444 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.68 m
Slope Type	Mild	Normal Depth	0.65 m
Flow Regime	Subcritical	Critical Depth	0.63 m
Velocity Downstream	2.03 m/s	Critical Slope	0.013415 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.08 m	Upstream Velocity Head	0.24 m
Ke	0.90	Entrance Loss	0.21 m

Inlet Control Properties			
Inlet Control HW Elev.	253.97 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
40-CRR-13-WC6_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	254.08 m
Roadway Width	15.00 m	Overtopping Coefficient	1.60 SI
Length	60.00 m	Crest Elevation	255.00 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	255.00
60.00	255.00

Culvert Analysis Report
402-CRR-13-WC7_PROP

Analysis Component			
Storm Event	Check	Discharge	0.2000 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.1700 m³/s	Check Discharge	0.2000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	263.20 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-900 mm Circular	0.2000 m³/s	263.27 m	0.45 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
402-CRR-13-WC7_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	263.27 m	Discharge	0.2000 m³/s
Inlet Control HW Elev.	263.20 m	Tailwater Elevation	263.20 m
Outlet Control HW Elev.	263.27 m	Control Type	Outlet Control
Headwater Depth/Height	0.39		

Grades			
Upstream Invert	262.91 m	Downstream Invert	262.86 m
Length	55.00 m	Constructed Slope	0.000909 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.34 m
Slope Type	Mild	Normal Depth	0.36 m
Flow Regime	Subcritical	Critical Depth	0.18 m
Velocity Downstream	0.45 m/s	Critical Slope	0.013720 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	263.27 m	Upstream Velocity Head	0.01 m
Ke	0.20	Entrance Loss	0.00 m

Inlet Control Properties			
Inlet Control HW Elev.	263.20 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° (1.5:1) bevels	Area Full	1.3 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
402-CRR-13-WC7_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.2600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2600 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	263.20 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-900 mm Circular	0.2600 m³/s	263.30 m	0.58 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
402-CRR-13-WC7_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	263.30 m	Discharge	0.2600 m³/s
Inlet Control HW Elev.	263.20 m	Tailwater Elevation	263.20 m
Outlet Control HW Elev.	263.30 m	Control Type	Outlet Control
Headwater Depth/Height	0.43		

Grades			
Upstream Invert	262.91 m	Downstream Invert	262.86 m
Length	55.00 m	Constructed Slope	0.000909 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.34 m
Slope Type	Mild	Normal Depth	0.41 m
Flow Regime	Subcritical	Critical Depth	0.20 m
Velocity Downstream	0.58 m/s	Critical Slope	0.013467 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	263.30 m	Upstream Velocity Head	0.01 m
Ke	0.20	Entrance Loss	0.00 m

Inlet Control Properties			
Inlet Control HW Elev.	263.20 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° (1.5:1) bevels	Area Full	1.3 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
41-HUT-6-WC1_PROP

Analysis Component			
Storm Event	Design	Discharge	1.6300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.6300 m³/s	Check Discharge	1.9000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	255.30 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1200 mm Circular	1.6304 m³/s	256.31 m	2.52 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	256.31 m	N/A
Total	----------------	1.6304 m³/s	256.31 m	N/A

Culvert Analysis Report
41-HUT-6-WC1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	256.31 m	Discharge	1.6304 m³/s
Inlet Control HW Elev.	256.27 m	Tailwater Elevation	255.30 m
Outlet Control HW Elev.	256.31 m	Control Type	Entrance Control
Headwater Depth/Height	0.85		

Grades			
Upstream Invert	255.27 m	Downstream Invert	254.79 m
Length	98.00 m	Constructed Slope	0.004898 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.66 m
Slope Type	Steep	Normal Depth	0.66 m
Flow Regime	Supercritical	Critical Depth	0.70 m
Velocity Downstream	2.52 m/s	Critical Slope	0.004151 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	256.31 m	Upstream Velocity Head	0.29 m
Ke	0.20	Entrance Loss	0.06 m

Inlet Control Properties			
Inlet Control HW Elev.	256.27 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	1.2 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
41-HUT-6-WC1_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	256.31 m
Roadway Width	20.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	257.67 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	257.67
200.00	257.67

Culvert Analysis Report
41-HUT-6-WC1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	2.4800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.4800 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	255.30 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1220 x 910 mm Box	2.4798 m³/s	256.74 m	2.68 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	256.74 m	N/A
Total	----------------	2.4798 m³/s	256.74 m	N/A

Culvert Analysis Report
41-HUT-6-WC1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	256.74 m	Discharge	2.4798 m³/s
Inlet Control HW Elev.	256.74 m	Tailwater Elevation	255.30 m
Outlet Control HW Elev.	256.72 m	Control Type	Inlet Control
Headwater Depth/Height	1.60		

Grades			
Upstream Invert	255.27 m	Downstream Invert	254.79 m
Length	98.00 m	Constructed Slope	0.004898 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.76 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.75 m
Velocity Downstream	2.68 m/s	Critical Slope	0.005315 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.22 m
Section Size	1220 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	256.72 m	Upstream Velocity Head	0.27 m
Ke	0.70	Entrance Loss	0.19 m

Inlet Control Properties			
Inlet Control HW Elev.	256.74 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	1.1 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
41-HUT-6-WC1_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	256.74 m
Roadway Width	20.00 m	Overtopping Coefficient	1.60 SI
Length	200.00 m	Crest Elevation	257.67 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	257.67
200.00	257.67

Culvert Analysis Report
43-HUT-5-WC1.2_PROP

Analysis Component			
Storm Event	Design	Discharge	2.0100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.0100 m³/s	Check Discharge	3.0400 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	260.70 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1200 mm Circular	2.0104 m³/s	262.38 m	4.02 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	262.38 m	N/A
Total	----------------	2.0104 m³/s	262.38 m	N/A

Culvert Analysis Report
43-HUT-5-WC1.2_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	262.38 m	Discharge	2.0104 m³/s
Inlet Control HW Elev.	262.33 m	Tailwater Elevation	260.70 m
Outlet Control HW Elev.	262.38 m	Control Type	Entrance Control
Headwater Depth/Height	0.97		

Grades			
Upstream Invert	261.20 m	Downstream Invert	260.20 m
Length	64.00 m	Constructed Slope	0.015625 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.54 m
Slope Type	Steep	Normal Depth	0.53 m
Flow Regime	Supercritical	Critical Depth	0.78 m
Velocity Downstream	4.02 m/s	Critical Slope	0.004527 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.38 m	Upstream Velocity Head	0.33 m
Ke	0.20	Entrance Loss	0.07 m

Inlet Control Properties			
Inlet Control HW Elev.	262.33 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	1.2 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
43-HUT-5-WC1.2_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	262.38 m
Roadway Width	20.00 m	Overtopping Coefficient	1.60 SI
Length	50.00 m	Crest Elevation	263.80 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	263.80
50.00	263.80

Culvert Analysis Report
43-HUT-5-WC1.2_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	3.0400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	3.0400 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	260.70 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1200 mm Circular	3.0404 m³/s	262.74 m	4.41 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	262.74 m	N/A
Total	----------------	3.0404 m³/s	262.74 m	N/A

Culvert Analysis Report
43-HUT-5-WC1.2_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	262.74 m	Discharge	3.0404 m³/s
Inlet Control HW Elev.	262.74 m	Tailwater Elevation	260.70 m
Outlet Control HW Elev.	262.74 m	Control Type	Inlet Control
Headwater Depth/Height	1.27		

Grades			
Upstream Invert	261.20 m	Downstream Invert	260.20 m
Length	64.00 m	Constructed Slope	0.015625 m/m

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.70 m
Slope Type	Steep	Normal Depth	0.68 m
Flow Regime	Supercritical	Critical Depth	0.96 m
Velocity Downstream	4.41 m/s	Critical Slope	0.006095 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.22 m
Section Size	1200 mm	Rise	1.22 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.74 m	Upstream Velocity Head	0.49 m
Ke	0.20	Entrance Loss	0.10 m

Inlet Control Properties			
Inlet Control HW Elev.	262.74 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	1.2 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
43-HUT-5-WC1.2_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	262.74 m
Roadway Width	20.00 m	Overtopping Coefficient	1.60 SI
Length	50.00 m	Crest Elevation	263.80 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	263.80
50.00	263.80

Culvert Analysis Report
432-HUT-5-WC1.4_PROP

Analysis Component			
Storm Event	Check	Discharge	0.2900 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2600 m³/s	Check Discharge	0.2900 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	261.30 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.2900 m³/s	261.61 m	0.67 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
432-HUT-5-WC1.4_PROP

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	261.61 m	Discharge	0.2900 m³/s
Inlet Control HW Elev.	261.59 m	Tailwater Elevation	261.30 m
Outlet Control HW Elev.	261.61 m	Control Type	Entrance Control
Headwater Depth/Height	0.49		

Grades

Upstream Invert	261.17 m	Downstream Invert	260.73 m
Length	45.00 m	Constructed Slope	0.009778 m/m

Hydraulic Profile

Profile	CompositeS1S2	Depth, Downstream	0.57 m
Slope Type	Steep	Normal Depth	0.24 m
Flow Regime	N/A	Critical Depth	0.31 m
Velocity Downstream	0.67 m/s	Critical Slope	0.003908 m/m

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	261.61 m	Upstream Velocity Head	0.11 m
Ke	0.20	Entrance Loss	0.02 m

Inlet Control Properties

Inlet Control HW Elev.	261.59 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
432-HUT-5-WC1.4_PROP-Ck

Analysis Component

Storm Event	Design	Discharge	0.3800 m³/s

Peak Discharge Method: User-Specified

Design Discharge	0.3800 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	261.30 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.3800 m³/s	261.68 m	0.88 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
432-HUT-5-WC1.4_PROP-Ck

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	261.68 m	Discharge	0.3800 m³/s
Inlet Control HW Elev.	261.66 m	Tailwater Elevation	261.30 m
Outlet Control HW Elev.	261.68 m	Control Type	Entrance Control
Headwater Depth/Height	0.56		

Grades

Upstream Invert	261.17 m	Downstream Invert	260.73 m
Length	45.00 m	Constructed Slope	0.009778 m/m

Hydraulic Profile

Profile	CompositeS1S2	Depth, Downstream	0.57 m
Slope Type	Steep	Normal Depth	0.28 m
Flow Regime	N/A	Critical Depth	0.36 m
Velocity Downstream	0.88 m/s	Critical Slope	0.003969 m/m

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	261.68 m	Upstream Velocity Head	0.13 m
Ke	0.20	Entrance Loss	0.03 m

Inlet Control Properties

Inlet Control HW Elev.	261.66 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
433-HUT-5-WC1.5_PROP

Analysis Component

Storm Event	Check	Discharge	0.2500 m³/s

Peak Discharge Method: User-Specified

Design Discharge	0.2100 m³/s	Check Discharge	0.2500 m³/s

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	257.00 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.2500 m³/s	257.44 m	0.66 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
433-HUT-5-WC1.5_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	257.44 m	Discharge	0.2500 m³/s
Inlet Control HW Elev.	257.42 m	Tailwater Elevation	257.00 m
Outlet Control HW Elev.	257.44 m	Control Type	Entrance Control
Headwater Depth/Height	0.45		

Grades			
Upstream Invert	257.03 m	Downstream Invert	256.49 m
Length	55.00 m	Constructed Slope	0.009818 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.51 m
Slope Type	Steep	Normal Depth	0.23 m
Flow Regime	N/A	Critical Depth	0.29 m
Velocity Downstream	0.66 m/s	Critical Slope	0.003895 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	257.44 m	Upstream Velocity Head	0.10 m
Ke	0.20	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	257.42 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
433-HUT-5-WC1.5_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.3200 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.3200 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	257.00 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.3200 m³/s	257.50 m	0.85 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
433-HUT-5-WC1.5_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	257.50 m	Discharge	0.3200 m³/s
Inlet Control HW Elev.	257.47 m	Tailwater Elevation	257.00 m
Outlet Control HW Elev.	257.50 m	Control Type	Entrance Control
Headwater Depth/Height	0.51		

Grades			
Upstream Invert	257.03 m	Downstream Invert	256.49 m
Length	55.00 m	Constructed Slope	0.009818 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.51 m
Slope Type	Steep	Normal Depth	0.26 m
Flow Regime	N/A	Critical Depth	0.32 m
Velocity Downstream	0.85 m/s	Critical Slope	0.003924 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	257.50 m	Upstream Velocity Head	0.12 m
Ke	0.20	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	257.47 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
434-HUT-5-WC1.6_PROP

Analysis Component			
Storm Event	Check	Discharge	0.4100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.3500 m³/s	Check Discharge	0.4100 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	258.60 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.4100 m³/s	258.84 m	0.95 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
434-HUT-5-WC1.6_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	258.84 m	Discharge	0.4100 m³/s
Inlet Control HW Elev.	258.81 m	Tailwater Elevation	258.60 m
Outlet Control HW Elev.	258.84 m	Control Type	Entrance Control
Headwater Depth/Height	0.59		

Grades			
Upstream Invert	258.30 m	Downstream Invert	258.03 m
Length	35.00 m	Constructed Slope	0.007714 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.57 m
Slope Type	Steep	Normal Depth	0.31 m
Flow Regime	N/A	Critical Depth	0.37 m
Velocity Downstream	0.95 m/s	Critical Slope	0.003996 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	258.84 m	Upstream Velocity Head	0.14 m
Ke	0.20	Entrance Loss	0.03 m

Inlet Control Properties			
Inlet Control HW Elev.	258.81 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
434-HUT-5-WC1.6_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.5300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.5300 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	258.60 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.5300 m³/s	258.92 m	1.23 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
434-HUT-5-WC1.6_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	258.92 m	Discharge	0.5300 m³/s
Inlet Control HW Elev.	258.89 m	Tailwater Elevation	258.60 m
Outlet Control HW Elev.	258.92 m	Control Type	Entrance Control
Headwater Depth/Height	0.68		

Grades			
Upstream Invert	258.30 m	Downstream Invert	258.03 m
Length	35.00 m	Constructed Slope	0.007714 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.57 m
Slope Type	Steep	Normal Depth	0.36 m
Flow Regime	N/A	Critical Depth	0.42 m
Velocity Downstream	1.23 m/s	Critical Slope	0.004133 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	258.92 m	Upstream Velocity Head	0.16 m
Ke	0.20	Entrance Loss	0.03 m

Inlet Control Properties			
Inlet Control HW Elev.	258.89 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
435-HUT-5-WC2.1_PROP

Analysis Component			
Storm Event	Check	Discharge	0.1700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.1400 m³/s	Check Discharge	0.1700 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	262.60 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.1700 m³/s	262.83 m	0.44 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
435-HUT-5-WC2.1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	262.83 m	Discharge	0.1700 m³/s
Inlet Control HW Elev.	262.81 m	Tailwater Elevation	262.60 m
Outlet Control HW Elev.	262.83 m	Control Type	Entrance Control
Headwater Depth/Height	0.37		

Grades			
Upstream Invert	262.50 m	Downstream Invert	262.08 m
Length	53.00 m	Constructed Slope	0.007925 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.52 m
Slope Type	Steep	Normal Depth	0.20 m
Flow Regime	N/A	Critical Depth	0.23 m
Velocity Downstream	0.44 m/s	Critical Slope	0.003912 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.83 m	Upstream Velocity Head	0.08 m
Ke	0.20	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	262.81 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
435-HUT-5-WC2.1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.2100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2100 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	262.60 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.2100 m³/s	262.87 m	0.54 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
435-HUT-5-WC2.1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	262.87 m	Discharge	0.2100 m³/s
Inlet Control HW Elev.	262.85 m	Tailwater Elevation	262.60 m
Outlet Control HW Elev.	262.87 m	Control Type	Entrance Control
Headwater Depth/Height	0.41		

Grades			
Upstream Invert	262.50 m	Downstream Invert	262.08 m
Length	53.00 m	Constructed Slope	0.007925 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.52 m
Slope Type	Steep	Normal Depth	0.22 m
Flow Regime	N/A	Critical Depth	0.26 m
Velocity Downstream	0.54 m/s	Critical Slope	0.003895 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.87 m	Upstream Velocity Head	0.09 m
Ke	0.20	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	262.85 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
436-HUT-5-WC2.2_PROP

Analysis Component			
Storm Event	Check	Discharge	0.3600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.3300 m³/s	Check Discharge	0.3600 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	262.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.3600 m³/s	262.58 m	1.00 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
436-HUT-5-WC2.2_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	262.58 m	Discharge	0.3600 m³/s
Inlet Control HW Elev.	262.55 m	Tailwater Elevation	262.10 m
Outlet Control HW Elev.	262.58 m	Control Type	Entrance Control
Headwater Depth/Height	0.55		

Grades			
Upstream Invert	262.08 m	Downstream Invert	261.61 m
Length	62.00 m	Constructed Slope	0.007581 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.49 m
Slope Type	Steep	Normal Depth	0.29 m
Flow Regime	N/A	Critical Depth	0.35 m
Velocity Downstream	1.00 m/s	Critical Slope	0.003952 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.58 m	Upstream Velocity Head	0.13 m
Ke	0.20	Entrance Loss	0.03 m

Inlet Control Properties			
Inlet Control HW Elev.	262.55 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
436-HUT-5-WC2.2_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.4600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.4600 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	262.10 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.4600 m³/s	262.65 m	1.28 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
436-HUT-5-WC2.2_PROP-Ck

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	262.65 m	Discharge	0.4600 m³/s
Inlet Control HW Elev.	262.62 m	Tailwater Elevation	262.10 m
Outlet Control HW Elev.	262.65 m	Control Type	Entrance Control
Headwater Depth/Height	0.62		

Grades

Upstream Invert	262.08 m	Downstream Invert	261.61 m
Length	62.00 m	Constructed Slope	0.007581 m/m

Hydraulic Profile

Profile	CompositeS1S2	Depth, Downstream	0.49 m
Slope Type	Steep	Normal Depth	0.33 m
Flow Regime	N/A	Critical Depth	0.39 m
Velocity Downstream	1.28 m/s	Critical Slope	0.004049 m/m

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	262.65 m	Upstream Velocity Head	0.15 m
Ke	0.20	Entrance Loss	0.03 m

Inlet Control Properties

Inlet Control HW Elev.	262.62 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
437-HUT-5-WC2.3_PROP

Analysis Component

Storm Event	Check	Discharge	0.3700 m³/s

Peak Discharge Method: User-Specified

Design Discharge	0.3200 m³/s	Check Discharge	0.3700 m³/s

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	261.60 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.3700 m³/s	262.05 m	1.01 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
437-HUT-5-WC2.3_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	262.05 m	Discharge	0.3700 m³/s
Inlet Control HW Elev.	262.02 m	Tailwater Elevation	261.60 m
Outlet Control HW Elev.	262.05 m	Control Type	Entrance Control
Headwater Depth/Height	0.55		

Grades			
Upstream Invert	261.54 m	Downstream Invert	261.10 m
Length	67.00 m	Constructed Slope	0.006567 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.50 m
Slope Type	Steep	Normal Depth	0.31 m
Flow Regime	N/A	Critical Depth	0.35 m
Velocity Downstream	1.01 m/s	Critical Slope	0.003960 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.05 m	Upstream Velocity Head	0.13 m
Ke	0.20	Entrance Loss	0.03 m

Inlet Control Properties			
Inlet Control HW Elev.	262.02 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
437-HUT-5-WC2.3_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.4800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.4800 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	261.60 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.4800 m³/s	262.12 m	1.31 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
437-HUT-5-WC2.3_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	262.12 m	Discharge	0.4800 m³/s
Inlet Control HW Elev.	262.09 m	Tailwater Elevation	261.60 m
Outlet Control HW Elev.	262.12 m	Control Type	Entrance Control
Headwater Depth/Height	0.64		

Grades			
Upstream Invert	261.54 m	Downstream Invert	261.10 m
Length	67.00 m	Constructed Slope	0.006567 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.50 m
Slope Type	Steep	Normal Depth	0.35 m
Flow Regime	N/A	Critical Depth	0.40 m
Velocity Downstream	1.31 m/s	Critical Slope	0.004072 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.12 m	Upstream Velocity Head	0.15 m
Ke	0.20	Entrance Loss	0.03 m

Inlet Control Properties			
Inlet Control HW Elev.	262.09 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
438-HUT-5-WC2.4_PROP

Analysis Component			
Storm Event	Design	Discharge	0.2400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2400 m³/s	Check Discharge	0.2800 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	258.70 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.2400 m³/s	260.30 m	0.62 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
438-HUT-5-WC2.4_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	260.30 m	Discharge	0.2400 m³/s
Inlet Control HW Elev.	260.27 m	Tailwater Elevation	258.70 m
Outlet Control HW Elev.	260.30 m	Control Type	Entrance Control
Headwater Depth/Height	0.44		

Grades			
Upstream Invert	259.90 m	Downstream Invert	258.18 m
Length	49.00 m	Constructed Slope	0.035102 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.52 m
Slope Type	Steep	Normal Depth	0.16 m
Flow Regime	N/A	Critical Depth	0.28 m
Velocity Downstream	0.62 m/s	Critical Slope	0.003894 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	260.30 m	Upstream Velocity Head	0.10 m
Ke	0.20	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	260.27 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
438-HUT-5-WC2.4_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.3600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.3600 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	258.70 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.3600 m³/s	260.40 m	0.93 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
438-HUT-5-WC2.4_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	260.40 m	Discharge	0.3600 m³/s
Inlet Control HW Elev.	260.36 m	Tailwater Elevation	258.70 m
Outlet Control HW Elev.	260.40 m	Control Type	Entrance Control
Headwater Depth/Height	0.55		

Grades			
Upstream Invert	259.90 m	Downstream Invert	258.18 m
Length	49.00 m	Constructed Slope	0.035102 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.52 m
Slope Type	Steep	Normal Depth	0.20 m
Flow Regime	N/A	Critical Depth	0.35 m
Velocity Downstream	0.93 m/s	Critical Slope	0.003952 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	260.40 m	Upstream Velocity Head	0.13 m
Ke	0.20	Entrance Loss	0.03 m

Inlet Control Properties			
Inlet Control HW Elev.	260.36 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
44-CR-GW-CRR15-WC1_PROP

Analysis Component			
Storm Event	Check	Discharge	0.3900 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.3300 m³/s	Check Discharge	0.3900 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	261.70 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.3900 m³/s	261.95 m	1.06 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
44-CR-GW-CRR15-WC1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	261.95 m	Discharge	0.3900 m³/s
Inlet Control HW Elev.	261.90 m	Tailwater Elevation	261.70 m
Outlet Control HW Elev.	261.95 m	Control Type	Outlet Control
Headwater Depth/Height	0.61		

Grades			
Upstream Invert	261.40 m	Downstream Invert	261.20 m
Length	80.00 m	Constructed Slope	0.002500 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.50 m
Slope Type	Mild	Normal Depth	0.41 m
Flow Regime	Subcritical	Critical Depth	0.36 m
Velocity Downstream	1.06 m/s	Critical Slope	0.003978 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	261.95 m	Upstream Velocity Head	0.09 m
Ke	0.50	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	261.90 m	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	0.7 m²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Analysis Report
44-CR-GW-CRR15-WC1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.5100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.5100 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	261.70 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.5100 m³/s	262.04 m	1.39 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
44-CR-GW-CRR15-WC1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	262.04 m	Discharge	0.5100 m³/s
Inlet Control HW Elev.	261.99 m	Tailwater Elevation	261.70 m
Outlet Control HW Elev.	262.04 m	Control Type	Outlet Control
Headwater Depth/Height	0.70		

Grades			
Upstream Invert	261.40 m	Downstream Invert	261.20 m
Length	80.00 m	Constructed Slope	0.002500 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.50 m
Slope Type	Mild	Normal Depth	0.48 m
Flow Regime	Subcritical	Critical Depth	0.41 m
Velocity Downstream	1.39 m/s	Critical Slope	0.004111 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.04 m	Upstream Velocity Head	0.11 m
Ke	0.50	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	261.99 m	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	0.7 m²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Analysis Report
46-CR-GW-CRR15-WC2.1_PROP

Analysis Component			
Storm Event	Check	Discharge	0.9500 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.8100 m³/s	Check Discharge	0.9500 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	261.20 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.9500 m³/s	261.55 m	1.63 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
46-CR-GW-CRR15-WC2.1_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	261.55 m	Discharge	0.9500 m³/s
Inlet Control HW Elev.	261.35 m	Tailwater Elevation	261.20 m
Outlet Control HW Elev.	261.55 m	Control Type	Outlet Control
Headwater Depth/Height	1.19		

Grades			
Upstream Invert	260.46 m	Downstream Invert	260.44 m
Length	70.00 m	Constructed Slope	0.000286 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.76 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.57 m
Velocity Downstream	1.63 m/s	Critical Slope	0.004910 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	261.55 m	Upstream Velocity Head	0.11 m
Ke	0.50	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	261.35 m	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	0.7 m²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Analysis Report
46-CR-GW-CRR15-WC2.1_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	1.1800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.1800 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	261.20 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	1.1800 m³/s	262.48 m	2.02 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
46-CR-GW-CRR15-WC2.1_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	262.48 m	Discharge	1.1800 m³/s
Inlet Control HW Elev.	261.59 m	Tailwater Elevation	261.20 m
Outlet Control HW Elev.	262.48 m	Control Type	Outlet Control
Headwater Depth/Height	2.20		

Grades			
Upstream Invert	260.46 m	Downstream Invert	260.44 m
Length	70.00 m	Constructed Slope	0.000286 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.76 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.64 m
Velocity Downstream	2.02 m/s	Critical Slope	0.018916 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.48 m	Upstream Velocity Head	0.16 m
Ke	0.90	Entrance Loss	0.15 m

Inlet Control Properties			
Inlet Control HW Elev.	261.59 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
47-CR-GW-CRR15-WC3_PROP

Analysis Component			
Storm Event	Design	Discharge	0.0800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.0800 m³/s	Check Discharge	0.0900 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	261.30 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.0801 m³/s	261.97 m	0.22 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	261.97 m	N/A
Total	----------------	0.0801 m³/s	261.97 m	N/A

Culvert Analysis Report
47-CR-GW-CRR15-WC3_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	261.97 m	Discharge	0.0801 m³/s
Inlet Control HW Elev.	261.95 m	Tailwater Elevation	261.30 m
Outlet Control HW Elev.	261.97 m	Control Type	Entrance Control
Headwater Depth/Height	0.25		

Grades			
Upstream Invert	261.74 m	Downstream Invert	260.80 m
Length	57.00 m	Constructed Slope	0.016491 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.50 m
Slope Type	Steep	Normal Depth	0.11 m
Flow Regime	N/A	Critical Depth	0.16 m
Velocity Downstream	0.22 m/s	Critical Slope	0.004096 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	261.97 m	Upstream Velocity Head	0.06 m
Ke	0.20	Entrance Loss	0.01 m

Inlet Control Properties			
Inlet Control HW Elev.	261.95 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
47-CR-GW-CRR15-WC3_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	261.97 m
Roadway Width	20.00 m	Overtopping Coefficient	1.60 SI
Length	50.00 m	Crest Elevation	263.80 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	263.80
50.00	263.80

Culvert Analysis Report
47-CR-GW-CRR15-WC3_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.1200 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.1200 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	261.50 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.1201 m³/s	262.02 m	0.22 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	262.02 m	N/A
Total	----------------	0.1201 m³/s	262.02 m	N/A

Culvert Analysis Report
47-CR-GW-CRR15-WC3_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	262.02 m	Discharge	0.1201 m³/s
Inlet Control HW Elev.	262.00 m	Tailwater Elevation	261.50 m
Outlet Control HW Elev.	262.02 m	Control Type	Entrance Control
Headwater Depth/Height	0.30		

Grades			
Upstream Invert	261.74 m	Downstream Invert	260.80 m
Length	57.00 m	Constructed Slope	0.016491 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.70 m
Slope Type	Steep	Normal Depth	0.14 m
Flow Regime	N/A	Critical Depth	0.20 m
Velocity Downstream	0.22 m/s	Critical Slope	0.003969 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.02 m	Upstream Velocity Head	0.07 m
Ke	0.20	Entrance Loss	0.01 m

Inlet Control Properties			
Inlet Control HW Elev.	262.00 m	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.7 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Analysis Report
47-CR-GW-CRR15-WC3_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.0000	m^3/s	Allowable HW Elevation	262.02	m
Roadway Width	20.00	m	Overtopping Coefficient	1.60	SI
Length	50.00	m	Crest Elevation	263.80	m
Headwater Elevation	N/A	m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (m)	Elev. (m)
0.00	263.80
50.00	263.80

Culvert Analysis Report
48-CRR-3-WC3.7_PROP-Ck_NEW

Analysis Component			
Storm Event	Check	Discharge	3.9500 m^3/s

Peak Discharge Method: User-Specified			
Design Discharge	3.4800 m^3/s	Check Discharge	3.9500 m^3/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	234.30 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440 x 1520 mm Box	3.9495 m^3/s	236.47 m	2.51 m/s
Weir	Roadway (Constant Elevation)	0.0000 m^3/s	236.47 m	N/A
Total	----------------	3.9495 m^3/s	236.47 m	N/A

Culvert Analysis Report
48-CRR-3-WC3.7_PROP-Ck_NEW

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	236.47 m	Discharge	3.9495 m³/s
Inlet Control HW Elev.	236.09 m	Tailwater Elevation	234.30 m
Outlet Control HW Elev.	236.47 m	Control Type	Outlet Control
Headwater Depth/Height	0.96		

Grades			
Upstream Invert	235.00 m	Downstream Invert	234.30 m
Length	230.00 m	Constructed Slope	0.003043 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.64 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.64 m
Velocity Downstream	2.51 m/s	Critical Slope	0.024489 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	236.47 m	Upstream Velocity Head	0.07 m
Ke	0.70	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	236.09 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	3.7 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
48-CRR-3-WC3.7_PROP-Ck_NEW

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	236.47 m
Roadway Width	8.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	239.20 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	239.20
100.00	239.20

Culvert Analysis Report
48-CRR-3-WC3.7_PROP_NEW

Analysis Component			
Storm Event	Check	Discharge	2.6800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	2.2600 m³/s	Check Discharge	2.6800 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	234.30 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440 x 1520 mm Box	2.6805 m³/s	236.12 m	2.21 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	236.12 m	N/A
Total	----------------	2.6805 m³/s	236.12 m	N/A

Culvert Analysis Report
48-CRR-3-WC3.7_PROP_NEW

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	236.12 m	Discharge	2.6805 m³/s
Inlet Control HW Elev.	235.84 m	Tailwater Elevation	234.30 m
Outlet Control HW Elev.	236.12 m	Control Type	Outlet Control
Headwater Depth/Height	0.74		

Grades			
Upstream Invert	235.00 m	Downstream Invert	234.30 m
Length	230.00 m	Constructed Slope	0.003043 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.50 m
Slope Type	Mild	Normal Depth	1.03 m
Flow Regime	Subcritical	Critical Depth	0.50 m
Velocity Downstream	2.21 m/s	Critical Slope	0.023927 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.035
Section Material	Concrete	Span	2.44 m
Section Size	2440 x 1520 mm	Rise	1.52 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	236.12 m	Upstream Velocity Head	0.06 m
Ke	0.70	Entrance Loss	0.04 m

Inlet Control Properties			
Inlet Control HW Elev.	235.84 m	Flow Control	N/A
Inlet Type	0° wingwall flares	Area Full	3.7 m²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

Culvert Analysis Report
48-CRR-3-WC3.7_PROP_NEW

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.0000	m^3/s	Allowable HW Elevation	236.12	m
Roadway Width	8.00	m	Overtopping Coefficient	1.60	SI
Length	100.00	m	Crest Elevation	239.20	m
Headwater Elevation	N/A	m	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (m)	Elev. (m)
0.00	239.20
100.00	239.20

Culvert Analysis Report
42-HUT-6-WC2_PROP

Analysis Component			
Storm Event	Check	Discharge	0.6600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.5700 m³/s	Check Discharge	0.6600 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	252.90 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.6600 m³/s	254.06 m	1.92 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	254.06 m	N/A
Total	----------------	0.6600 m³/s	254.06 m	N/A

Culvert Analysis Report
42-HUT-6-WC2_PROP

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	254.06 m	Discharge	0.6600 m³/s
Inlet Control HW Elev.	253.74 m	Tailwater Elevation	252.90 m
Outlet Control HW Elev.	254.06 m	Control Type	Outlet Control
Headwater Depth/Height	1.16		

Grades			
Upstream Invert	253.00 m	Downstream Invert	252.90 m
Length	98.00 m	Constructed Slope	0.001020 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.47 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.47 m
Velocity Downstream	1.92 m/s	Critical Slope	0.014750 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.06 m	Upstream Velocity Head	0.05 m
Ke	0.90	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	253.74 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
42-HUT-6-WC2_PROP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	254.06 m
Roadway Width	80.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	255.22 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	255.22
100.00	255.22

Culvert Analysis Report
42-HUT-6-WC2_PROP-Ck

Analysis Component			
Storm Event	Design	Discharge	0.8600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.8600 m³/s	Check Discharge	0.0000 m³/s

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	252.90 m

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-900 mm Circular	0.8600 m³/s	254.45 m	2.11 m/s
Weir	Roadway (Constant Elevation)	0.0000 m³/s	254.45 m	N/A
Total	----------------	0.8600 m³/s	254.45 m	N/A

Culvert Analysis Report
42-HUT-6-WC2_PROP-Ck

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	254.45 m	Discharge	0.8600 m³/s
Inlet Control HW Elev.	253.89 m	Tailwater Elevation	252.90 m
Outlet Control HW Elev.	254.45 m	Control Type	Outlet Control
Headwater Depth/Height	1.59		

Grades			
Upstream Invert	253.00 m	Downstream Invert	252.90 m
Length	98.00 m	Constructed Slope	0.001020 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.54 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.54 m
Velocity Downstream	2.11 m/s	Critical Slope	0.016034 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.91 m
Section Size	900 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.45 m	Upstream Velocity Head	0.09 m
Ke	0.90	Entrance Loss	0.08 m

Inlet Control Properties			
Inlet Control HW Elev.	253.89 m	Flow Control	Unsubmerged
Inlet Type	Projecting	Area Full	0.7 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
42-HUT-6-WC2_PROP-Ck

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)			
Discharge	0.0000 m³/s	Allowable HW Elevation	254.45 m
Roadway Width	80.00 m	Overtopping Coefficient	1.60 SI
Length	100.00 m	Crest Elevation	255.22 m
Headwater Elevation	N/A m	Discharge Coefficient (Cr)	2.90
Submergence Factor (Kt)	1.00		

Sta (m)	Elev. (m)
0.00	255.22
100.00	255.22

E

Stormwater Management

Existing Condition (Pond 2,3,4 and 5)-100yr Storm

5

NHYD	5
Name	Pond 5_Dr. Area
Runoff AREA [ha]	13.560
Runoff Peak [m³/s]	0.361

4

NHYD	4
Name	Pond 4_Dr. Area
Runoff AREA [ha]	27.320
Runoff Peak [m³/s]	1.167

3

NHYD	3
Name	Pond 3_Dr. Area
Runoff AREA [ha]	47.400
Runoff Peak [m³/s]	2.411

2

NHYD	2
Name	Pond 2_Dr. Area
Runoff AREA [ha]	16.940
Runoff Peak [m³/s]	1.081

Proposed Condition (Pond 2,3,4 and 5) -100yr Storm

5

NHYD	5
Name	Pond 5_Dr. Area
Runoff AREA [ha]	13.560
Runoff Peak [m³/s]	3.936

500

NHYD	500
Name	Pond 5
Outflow Peak [m³/s]	0.324
Outflow Max. Used Vol [ha.m]	0.776

4

NHYD	4
Name	Pond 4_Dr. Area
Runoff AREA [ha]	17.800
Runoff Peak [m³/s]	6.717

400

NHYD	400
Name	Pond 4
Outflow Peak [m³/s]	1.126
Outflow Max. Used Vol [ha.m]	1.056

3

NHYD	3
Name	Pond 3_Dr. Area
Runoff AREA [ha]	47.400
Runoff Peak [m³/s]	10.620

300

NHYD	300
Name	Pond 3
Outflow Peak [m³/s]	2.344
Outflow Max. Used Vol [ha.m]	1.977

2

NHYD	2
Name	Pond 2_Dr. Area
Runoff AREA [ha]	16.940
Runoff Peak [m³/s]	4.553

200

NHYD	200
Name	Pond 2
Outflow Peak [m³/s]	1.068
Outflow Max. Used Vol [ha.m]	0.739

Pond 1 and Bridge Pond (Water Quality Control-25mm storm)

1

NHYD	1
Name	Pond 1_Dr. Area
Runoff AREA [ha]	9.440
Runoff Peak [m³/s]	0.422

100

NHYD	100
Name	Pond 1
Outflow Peak [m³/s]	0.012
Outflow Max. Used Vol [ha.m]	0.091

6

NHYD	6
Name	Bridge Pond _Dr. Area
Runoff AREA [ha]	8.600
Runoff Peak [m³/s]	0.567

600

NHYD	600
Name	Bridge Pond
Outflow Peak [m³/s]	0.019
Outflow Max. Used Vol [ha.m]	0.104

```
==========================================================================================================

       V    V   I    SSSSS  U   U    A    L              (v 6.2.2021)
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
```

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```
                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voin.dat

  Output  filename:
C:\Users\AbirA\AppData\Local\Civica\VH5\d70c904b-d540-495f-bf7e-db70299bd929\686892b3-484b-482b-b894-25525829e92c\s
cenar
  Summary filename:
C:\Users\AbirA\AppData\Local\Civica\VH5\d70c904b-d540-495f-bf7e-db70299bd929\686892b3-484b-482b-b894-25525829e92c\s
cenar


DATE: 09-05-2025                          TIME: 10:11:32

USER:



COMMENTS: ____________________________________________________________


----------------------------------------------------------------------------------------------------------
  ***********************************************
  ** SIMULATION : 7_100yr 24hr -SCS II          **
  ***********************************************


--------------------
|    READ STORM    |    Filename: C:\Users\AbirA\AppD
|                  |              ata\Local\Temp\
|                  |              3ad99fdd-abe8-4b04-ad16-dd80d008c335\9f38d89e
| Ptotal=127.20 mm |    Comments: 100yr 24hr 15min SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.00    0.00 |  6.25    2.29 | 12.50   18.32 | 18.75    2.29
                 0.25    1.40 |  6.50    2.29 | 12.75    9.41 | 19.00    2.29
                 0.50    1.40 |  6.75    2.29 | 13.00    9.41 | 19.25    2.29
                 0.75    1.40 |  7.00    2.29 | 13.25    6.87 | 19.50    2.29
                 1.00    1.40 |  7.25    2.80 | 13.50    6.87 | 19.75    2.29
                 1.25    1.40 |  7.50    2.80 | 13.75    5.34 | 20.00    2.29
                 1.50    1.40 |  7.75    2.80 | 14.00    5.34 | 20.25    1.53
                 1.75    1.40 |  8.00    2.80 | 14.25    3.82 | 20.50    1.53
                 2.00    1.40 |  8.25    3.31 | 14.50    3.82 | 20.75    1.53
                 2.25    1.65 |  8.50    3.31 | 14.75    3.82 | 21.00    1.53
                 2.50    1.65 |  8.75    3.56 | 15.00    3.82 | 21.25    1.53
                 2.75    1.65 |  9.00    3.56 | 15.25    3.82 | 21.50    1.53
                 3.00    1.65 |  9.25    4.07 | 15.50    3.82 | 21.75    1.53
                 3.25    1.65 |  9.50    4.07 | 15.75    3.82 | 22.00    1.53
                 3.50    1.65 |  9.75    4.58 | 16.00    3.82 | 22.25    1.53
```

Existing 100-year storm

```
                 3.75    1.65 | 10.00    4.58 | 16.25    2.29 | 22.50    1.53
                 4.00    1.65 | 10.25    5.85 | 16.50    2.29 | 22.75    1.53
                 4.25    2.04 | 10.50    5.85 | 16.75    2.29 | 23.00    1.53
                 4.50    2.04 | 10.75    7.89 | 17.00    2.29 | 23.25    1.53
                 4.75    2.04 | 11.00    7.89 | 17.25    2.29 | 23.50    1.53
                 5.00    2.04 | 11.25   12.21 | 17.50    2.29 | 23.75    1.53
                 5.25    2.04 | 11.50   12.21 | 17.75    2.29 | 24.00    1.53
                 5.50    2.04 | 11.75   37.65 | 18.00    2.29 |
                 5.75    2.04 | 12.00  155.69 | 18.25    2.29 |
                 6.00    2.04 | 12.25   18.32 | 18.50    2.29 |

-------------------------------------------------------------------------------


--------------------
| CALIB            |
| NASHYD   (  0003)|   Area    (ha)=  47.40   Curve Number   (CN)= 69.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   1.00

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


                            ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 6.167    2.04 |12.250  155.69 | 18.33    2.29
                0.167    0.00 | 6.250    2.04 |12.333   18.33 | 18.42    2.29
                0.250    0.00 | 6.333    2.29 |12.417   18.32 | 18.50    2.29
                0.333    1.40 | 6.417    2.29 |12.500   18.32 | 18.58    2.29
                0.417    1.40 | 6.500    2.29 |12.583   18.32 | 18.67    2.29
                0.500    1.40 | 6.583    2.29 |12.667   18.32 | 18.75    2.29
                0.583    1.40 | 6.667    2.29 |12.750   18.32 | 18.83    2.29
                0.667    1.40 | 6.750    2.29 |12.833    9.41 | 18.92    2.29
                0.750    1.40 | 6.833    2.29 |12.917    9.41 | 19.00    2.29
                0.833    1.40 | 6.917    2.29 |13.000    9.41 | 19.08    2.29
                0.917    1.40 | 7.000    2.29 |13.083    9.41 | 19.17    2.29
                1.000    1.40 | 7.083    2.29 |13.167    9.41 | 19.25    2.29
                1.083    1.40 | 7.167    2.29 |13.250    9.41 | 19.33    2.29
                1.167    1.40 | 7.250    2.29 |13.333    6.87 | 19.42    2.29
                1.250    1.40 | 7.333    2.80 |13.417    6.87 | 19.50    2.29
                1.333    1.40 | 7.417    2.80 |13.500    6.87 | 19.58    2.29
                1.417    1.40 | 7.500    2.80 |13.583    6.87 | 19.67    2.29
                1.500    1.40 | 7.583    2.80 |13.667    6.87 | 19.75    2.29
                1.583    1.40 | 7.667    2.80 |13.750    6.87 | 19.83    2.29
                1.667    1.40 | 7.750    2.80 |13.833    5.34 | 19.92    2.29
                1.750    1.40 | 7.833    2.80 |13.917    5.34 | 20.00    2.29
                1.833    1.40 | 7.917    2.80 |14.000    5.34 | 20.08    2.29
                1.917    1.40 | 8.000    2.80 |14.083    5.34 | 20.17    2.29
                2.000    1.40 | 8.083    2.80 |14.167    5.34 | 20.25    2.29
                2.083    1.40 | 8.167    2.80 |14.250    5.34 | 20.33    1.53
                2.167    1.40 | 8.250    2.80 |14.333    3.82 | 20.42    1.53
                2.250    1.40 | 8.333    3.31 |14.417    3.82 | 20.50    1.53
                2.333    1.65 | 8.417    3.31 |14.500    3.82 | 20.58    1.53
                2.417    1.65 | 8.500    3.31 |14.583    3.82 | 20.67    1.53
                2.500    1.65 | 8.583    3.31 |14.667    3.82 | 20.75    1.53
                2.583    1.65 | 8.667    3.31 |14.750    3.82 | 20.83    1.53
                2.667    1.65 | 8.750    3.31 |14.833    3.82 | 20.92    1.53
                2.750    1.65 | 8.833    3.56 |14.917    3.82 | 21.00    1.53
                2.833    1.65 | 8.917    3.56 |15.000    3.82 | 21.08    1.53
                2.917    1.65 | 9.000    3.56 |15.083    3.82 | 21.17    1.53
                3.000    1.65 | 9.083    3.56 |15.167    3.82 | 21.25    1.53
                3.083    1.65 | 9.167    3.56 |15.250    3.82 | 21.33    1.53
                3.167    1.65 | 9.250    3.56 |15.333    3.82 | 21.42    1.53
                3.250    1.65 | 9.333    4.07 |15.417    3.82 | 21.50    1.53
                3.333    1.65 | 9.417    4.07 |15.500    3.82 | 21.58    1.53
                3.417    1.65 | 9.500    4.07 |15.583    3.82 | 21.67    1.53
                3.500    1.65 | 9.583    4.07 |15.667    3.82 | 21.75    1.53
                3.583    1.65 | 9.667    4.07 |15.750    3.82 | 21.83    1.53
```

Existing 100-year storm

3.667	1.65	9.750	4.07	15.833	3.82	21.92	1.53
3.750	1.65	9.833	4.58	15.917	3.82	22.00	1.53
3.833	1.65	9.917	4.58	16.000	3.82	22.08	1.53
3.917	1.65	10.000	4.58	16.083	3.82	22.17	1.53
4.000	1.65	10.083	4.58	16.167	3.82	22.25	1.53
4.083	1.65	10.167	4.58	16.250	3.82	22.33	1.53
4.167	1.65	10.250	4.58	16.333	2.29	22.42	1.53
4.250	1.65	10.333	5.85	16.417	2.29	22.50	1.53
4.333	2.04	10.417	5.85	16.500	2.29	22.58	1.53
4.417	2.04	10.500	5.85	16.583	2.29	22.67	1.53
4.500	2.04	10.583	5.85	16.667	2.29	22.75	1.53
4.583	2.04	10.667	5.85	16.750	2.29	22.83	1.53
4.667	2.04	10.750	5.85	16.833	2.29	22.92	1.53
4.750	2.04	10.833	7.89	16.917	2.29	23.00	1.53
4.833	2.04	10.917	7.89	17.000	2.29	23.08	1.53
4.917	2.04	11.000	7.89	17.083	2.29	23.17	1.53
5.000	2.04	11.083	7.89	17.167	2.29	23.25	1.53
5.083	2.04	11.167	7.89	17.250	2.29	23.33	1.53
5.167	2.04	11.250	7.89	17.333	2.29	23.42	1.53
5.250	2.04	11.333	12.21	17.417	2.29	23.50	1.53
5.333	2.04	11.417	12.21	17.500	2.29	23.58	1.53
5.417	2.04	11.500	12.21	17.583	2.29	23.67	1.53
5.500	2.04	11.583	12.21	17.667	2.29	23.75	1.53
5.583	2.04	11.667	12.21	17.750	2.29	23.83	1.53
5.667	2.04	11.750	12.21	17.833	2.29	23.92	1.53
5.750	2.04	11.833	37.65	17.917	2.29	24.00	1.53
5.833	2.04	11.917	37.65	18.000	2.29	24.08	1.53
5.917	2.04	12.000	37.65	18.083	2.29	24.17	1.53
6.000	2.04	12.083	155.68	18.167	2.29	24.25	1.53
6.083	2.04	12.167	155.69	18.250	2.29		

Unit Hyd Qpeak (cms)= 1.810

PEAK FLOW (cms)= 2.411 (i)
TIME TO PEAK (hrs)= 13.167
RUNOFF VOLUME (mm)= 63.190
TOTAL RAINFALL (mm)= 127.200
RUNOFF COEFFICIENT = 0.497

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


```
| CALIB            |
| NASHYD   (  0002)|   Area    (ha)=  16.94   Curve Number   (CN)= 69.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.74
```

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

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	6.167	2.04	12.250	155.69	18.33	2.29
0.167	0.00	6.250	2.04	12.333	18.33	18.42	2.29
0.250	0.00	6.333	2.29	12.417	18.32	18.50	2.29
0.333	1.40	6.417	2.29	12.500	18.32	18.58	2.29
0.417	1.40	6.500	2.29	12.583	18.32	18.67	2.29
0.500	1.40	6.583	2.29	12.667	18.32	18.75	2.29
0.583	1.40	6.667	2.29	12.750	18.32	18.83	2.29
0.667	1.40	6.750	2.29	12.833	9.41	18.92	2.29
0.750	1.40	6.833	2.29	12.917	9.41	19.00	2.29
0.833	1.40	6.917	2.29	13.000	9.41	19.08	2.29
0.917	1.40	7.000	2.29	13.083	9.41	19.17	2.29
1.000	1.40	7.083	2.29	13.167	9.41	19.25	2.29
1.083	1.40	7.167	2.29	13.250	9.41	19.33	2.29
1.167	1.40	7.250	2.29	13.333	6.87	19.42	2.29

Existing 100-year storm

1.250	1.40	7.333	2.80	13.417	6.87	19.50	2.29
1.333	1.40	7.417	2.80	13.500	6.87	19.58	2.29
1.417	1.40	7.500	2.80	13.583	6.87	19.67	2.29
1.500	1.40	7.583	2.80	13.667	6.87	19.75	2.29
1.583	1.40	7.667	2.80	13.750	6.87	19.83	2.29
1.667	1.40	7.750	2.80	13.833	5.34	19.92	2.29
1.750	1.40	7.833	2.80	13.917	5.34	20.00	2.29
1.833	1.40	7.917	2.80	14.000	5.34	20.08	2.29
1.917	1.40	8.000	2.80	14.083	5.34	20.17	2.29
2.000	1.40	8.083	2.80	14.167	5.34	20.25	2.29
2.083	1.40	8.167	2.80	14.250	5.34	20.33	1.53
2.167	1.40	8.250	2.80	14.333	3.82	20.42	1.53
2.250	1.40	8.333	3.31	14.417	3.82	20.50	1.53
2.333	1.65	8.417	3.31	14.500	3.82	20.58	1.53
2.417	1.65	8.500	3.31	14.583	3.82	20.67	1.53
2.500	1.65	8.583	3.31	14.667	3.82	20.75	1.53
2.583	1.65	8.667	3.31	14.750	3.82	20.83	1.53
2.667	1.65	8.750	3.31	14.833	3.82	20.92	1.53
2.750	1.65	8.833	3.56	14.917	3.82	21.00	1.53
2.833	1.65	8.917	3.56	15.000	3.82	21.08	1.53
2.917	1.65	9.000	3.56	15.083	3.82	21.17	1.53
3.000	1.65	9.083	3.56	15.167	3.82	21.25	1.53
3.083	1.65	9.167	3.56	15.250	3.82	21.33	1.53
3.167	1.65	9.250	3.56	15.333	3.82	21.42	1.53
3.250	1.65	9.333	4.07	15.417	3.82	21.50	1.53
3.333	1.65	9.417	4.07	15.500	3.82	21.58	1.53
3.417	1.65	9.500	4.07	15.583	3.82	21.67	1.53
3.500	1.65	9.583	4.07	15.667	3.82	21.75	1.53
3.583	1.65	9.667	4.07	15.750	3.82	21.83	1.53
3.667	1.65	9.750	4.07	15.833	3.82	21.92	1.53
3.750	1.65	9.833	4.58	15.917	3.82	22.00	1.53
3.833	1.65	9.917	4.58	16.000	3.82	22.08	1.53
3.917	1.65	10.000	4.58	16.083	3.82	22.17	1.53
4.000	1.65	10.083	4.58	16.167	3.82	22.25	1.53
4.083	1.65	10.167	4.58	16.250	3.82	22.33	1.53
4.167	1.65	10.250	4.58	16.333	2.29	22.42	1.53
4.250	1.65	10.333	5.85	16.417	2.29	22.50	1.53
4.333	2.04	10.417	5.85	16.500	2.29	22.58	1.53
4.417	2.04	10.500	5.85	16.583	2.29	22.67	1.53
4.500	2.04	10.583	5.85	16.667	2.29	22.75	1.53
4.583	2.04	10.667	5.85	16.750	2.29	22.83	1.53
4.667	2.04	10.750	5.85	16.833	2.29	22.92	1.53
4.750	2.04	10.833	7.89	16.917	2.29	23.00	1.53
4.833	2.04	10.917	7.89	17.000	2.29	23.08	1.53
4.917	2.04	11.000	7.89	17.083	2.29	23.17	1.53
5.000	2.04	11.083	7.89	17.167	2.29	23.25	1.53
5.083	2.04	11.167	7.89	17.250	2.29	23.33	1.53
5.167	2.04	11.250	7.89	17.333	2.29	23.42	1.53
5.250	2.04	11.333	12.21	17.417	2.29	23.50	1.53
5.333	2.04	11.417	12.21	17.500	2.29	23.58	1.53
5.417	2.04	11.500	12.21	17.583	2.29	23.67	1.53
5.500	2.04	11.583	12.21	17.667	2.29	23.75	1.53
5.583	2.04	11.667	12.21	17.750	2.29	23.83	1.53
5.667	2.04	11.750	12.21	17.833	2.29	23.92	1.53
5.750	2.04	11.833	37.65	17.917	2.29	24.00	1.53
5.833	2.04	11.917	37.65	18.000	2.29	24.08	1.53
5.917	2.04	12.000	37.65	18.083	2.29	24.17	1.53
6.000	2.04	12.083	155.68	18.167	2.29	24.25	1.53
6.083	2.04	12.167	155.69	18.250	2.29		

Unit Hyd Qpeak (cms)= 0.874

PEAK FLOW (cms)= 1.081 (i)
TIME TO PEAK (hrs)= 12.917
RUNOFF VOLUME (mm)= 63.189
TOTAL RAINFALL (mm)= 127.200
RUNOFF COEFFICIENT = 0.497

Existing 100-year storm

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

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--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0005)|   Area    (ha)=  13.56   Curve Number   (CN)= 69.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   2.33
```

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

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	' TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	6.167	2.04	12.250	155.69	18.33	2.29
0.167	0.00	6.250	2.04	12.333	18.33	18.42	2.29
0.250	0.00	6.333	2.29	12.417	18.32	18.50	2.29
0.333	1.40	6.417	2.29	12.500	18.32	18.58	2.29
0.417	1.40	6.500	2.29	12.583	18.32	18.67	2.29
0.500	1.40	6.583	2.29	12.667	18.32	18.75	2.29
0.583	1.40	6.667	2.29	12.750	18.32	18.83	2.29
0.667	1.40	6.750	2.29	12.833	9.41	18.92	2.29
0.750	1.40	6.833	2.29	12.917	9.41	19.00	2.29
0.833	1.40	6.917	2.29	13.000	9.41	19.08	2.29
0.917	1.40	7.000	2.29	13.083	9.41	19.17	2.29
1.000	1.40	7.083	2.29	13.167	9.41	19.25	2.29
1.083	1.40	7.167	2.29	13.250	9.41	19.33	2.29
1.167	1.40	7.250	2.29	13.333	6.87	19.42	2.29
1.250	1.40	7.333	2.80	13.417	6.87	19.50	2.29
1.333	1.40	7.417	2.80	13.500	6.87	19.58	2.29
1.417	1.40	7.500	2.80	13.583	6.87	19.67	2.29
1.500	1.40	7.583	2.80	13.667	6.87	19.75	2.29
1.583	1.40	7.667	2.80	13.750	6.87	19.83	2.29
1.667	1.40	7.750	2.80	13.833	5.34	19.92	2.29
1.750	1.40	7.833	2.80	13.917	5.34	20.00	2.29
1.833	1.40	7.917	2.80	14.000	5.34	20.08	2.29
1.917	1.40	8.000	2.80	14.083	5.34	20.17	2.29
2.000	1.40	8.083	2.80	14.167	5.34	20.25	2.29
2.083	1.40	8.167	2.80	14.250	5.34	20.33	1.53
2.167	1.40	8.250	2.80	14.333	3.82	20.42	1.53
2.250	1.40	8.333	3.31	14.417	3.82	20.50	1.53
2.333	1.65	8.417	3.31	14.500	3.82	20.58	1.53
2.417	1.65	8.500	3.31	14.583	3.82	20.67	1.53
2.500	1.65	8.583	3.31	14.667	3.82	20.75	1.53
2.583	1.65	8.667	3.31	14.750	3.82	20.83	1.53
2.667	1.65	8.750	3.31	14.833	3.82	20.92	1.53
2.750	1.65	8.833	3.56	14.917	3.82	21.00	1.53
2.833	1.65	8.917	3.56	15.000	3.82	21.08	1.53
2.917	1.65	9.000	3.56	15.083	3.82	21.17	1.53
3.000	1.65	9.083	3.56	15.167	3.82	21.25	1.53
3.083	1.65	9.167	3.56	15.250	3.82	21.33	1.53
3.167	1.65	9.250	3.56	15.333	3.82	21.42	1.53
3.250	1.65	9.333	4.07	15.417	3.82	21.50	1.53
3.333	1.65	9.417	4.07	15.500	3.82	21.58	1.53
3.417	1.65	9.500	4.07	15.583	3.82	21.67	1.53
3.500	1.65	9.583	4.07	15.667	3.82	21.75	1.53
3.583	1.65	9.667	4.07	15.750	3.82	21.83	1.53
3.667	1.65	9.750	4.07	15.833	3.82	21.92	1.53
3.750	1.65	9.833	4.58	15.917	3.82	22.00	1.53
3.833	1.65	9.917	4.58	16.000	3.82	22.08	1.53
3.917	1.65	10.000	4.58	16.083	3.82	22.17	1.53
4.000	1.65	10.083	4.58	16.167	3.82	22.25	1.53
4.083	1.65	10.167	4.58	16.250	3.82	22.33	1.53
4.167	1.65	10.250	4.58	16.333	2.29	22.42	1.53
4.250	1.65	10.333	5.85	16.417	2.29	22.50	1.53
4.333	2.04	10.417	5.85	16.500	2.29	22.58	1.53
4.417	2.04	10.500	5.85	16.583	2.29	22.67	1.53
4.500	2.04	10.583	5.85	16.667	2.29	22.75	1.53
4.583	2.04	10.667	5.85	16.750	2.29	22.83	1.53
4.667	2.04	10.750	5.85	16.833	2.29	22.92	1.53
4.750	2.04	10.833	7.89	16.917	2.29	23.00	1.53
4.833	2.04	10.917	7.89	17.000	2.29	23.08	1.53
4.917	2.04	11.000	7.89	17.083	2.29	23.17	1.53
5.000	2.04	11.083	7.89	17.167	2.29	23.25	1.53
5.083	2.04	11.167	7.89	17.250	2.29	23.33	1.53
5.167	2.04	11.250	7.89	17.333	2.29	23.42	1.53
5.250	2.04	11.333	12.21	17.417	2.29	23.50	1.53
5.333	2.04	11.417	12.21	17.500	2.29	23.58	1.53
5.417	2.04	11.500	12.21	17.583	2.29	23.67	1.53
5.500	2.04	11.583	12.21	17.667	2.29	23.75	1.53
5.583	2.04	11.667	12.21	17.750	2.29	23.83	1.53
5.667	2.04	11.750	12.21	17.833	2.29	23.92	1.53
5.750	2.04	11.833	37.65	17.917	2.29	24.00	1.53
5.833	2.04	11.917	37.65	18.000	2.29	24.08	1.53
5.917	2.04	12.000	37.65	18.083	2.29	24.17	1.53
6.000	2.04	12.083	155.68	18.167	2.29	24.25	1.53
6.083	2.04	12.167	155.69	18.250	2.29		

```
Unit Hyd Qpeak  (cms)=   0.222

PEAK FLOW       (cms)=   0.361 (i)
TIME TO PEAK    (hrs)=  14.750
RUNOFF VOLUME    (mm)=  63.190
TOTAL RAINFALL   (mm)= 127.200
RUNOFF COEFFICIENT   =   0.497
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(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| NASHYD   (  0004)|   Area    (ha)=  27.32   Curve Number   (CN)= 69.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   1.26
```

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

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	' TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	6.167	2.04	12.250	155.69	18.33	2.29
0.167	0.00	6.250	2.04	12.333	18.33	18.42	2.29
0.250	0.00	6.333	2.29	12.417	18.32	18.50	2.29
0.333	1.40	6.417	2.29	12.500	18.32	18.58	2.29
0.417	1.40	6.500	2.29	12.583	18.32	18.67	2.29
0.500	1.40	6.583	2.29	12.667	18.32	18.75	2.29
0.583	1.40	6.667	2.29	12.750	18.32	18.83	2.29
0.667	1.40	6.750	2.29	12.833	9.41	18.92	2.29
0.750	1.40	6.833	2.29	12.917	9.41	19.00	2.29
0.833	1.40	6.917	2.29	13.000	9.41	19.08	2.29
0.917	1.40	7.000	2.29	13.083	9.41	19.17	2.29
1.000	1.40	7.083	2.29	13.167	9.41	19.25	2.29
1.083	1.40	7.167	2.29	13.250	9.41	19.33	2.29
1.167	1.40	7.250	2.29	13.333	6.87	19.42	2.29
1.250	1.40	7.333	2.80	13.417	6.87	19.50	2.29
1.333	1.40	7.417	2.80	13.500	6.87	19.58	2.29
1.417	1.40	7.500	2.80	13.583	6.87	19.67	2.29
1.500	1.40	7.583	2.80	13.667	6.87	19.75	2.29
1.583	1.40	7.667	2.80	13.750	6.87	19.83	2.29
1.667	1.40	7.750	2.80	13.833	5.34	19.92	2.29
1.750	1.40	7.833	2.80	13.917	5.34	20.00	2.29
1.833	1.40	7.917	2.80	14.000	5.34	20.08	2.29
1.917	1.40	8.000	2.80	14.083	5.34	20.17	2.29
2.000	1.40	8.083	2.80	14.167	5.34	20.25	2.29

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                                        Existing 100-year storm
               2.083     1.40 | 8.167    2.80 |14.250    5.34 | 20.33    1.53
               2.167     1.40 | 8.250    2.80 |14.333    3.82 | 20.42    1.53
               2.250     1.40 | 8.333    3.31 |14.417    3.82 | 20.50    1.53
               2.333     1.65 | 8.417    3.31 |14.500    3.82 | 20.58    1.53
               2.417     1.65 | 8.500    3.31 |14.583    3.82 | 20.67    1.53
               2.500     1.65 | 8.583    3.31 |14.667    3.82 | 20.75    1.53
               2.583     1.65 | 8.667    3.31 |14.750    3.82 | 20.83    1.53
               2.667     1.65 | 8.750    3.31 |14.833    3.82 | 20.92    1.53
               2.750     1.65 | 8.833    3.56 |14.917    3.82 | 21.00    1.53
               2.833     1.65 | 8.917    3.56 |15.000    3.82 | 21.08    1.53
               2.917     1.65 | 9.000    3.56 |15.083    3.82 | 21.17    1.53
               3.000     1.65 | 9.083    3.56 |15.167    3.82 | 21.25    1.53
               3.083     1.65 | 9.167    3.56 |15.250    3.82 | 21.33    1.53
               3.167     1.65 | 9.250    3.56 |15.333    3.82 | 21.42    1.53
               3.250     1.65 | 9.333    4.07 |15.417    3.82 | 21.50    1.53
               3.333     1.65 | 9.417    4.07 |15.500    3.82 | 21.58    1.53
               3.417     1.65 | 9.500    4.07 |15.583    3.82 | 21.67    1.53
               3.500     1.65 | 9.583    4.07 |15.667    3.82 | 21.75    1.53
               3.583     1.65 | 9.667    4.07 |15.750    3.82 | 21.83    1.53
               3.667     1.65 | 9.750    4.07 |15.833    3.82 | 21.92    1.53
               3.750     1.65 | 9.833    4.07 |15.917    3.82 | 22.00    1.53
               3.833     1.65 | 9.917    4.58 |16.000    3.82 | 22.08    1.53
               3.917     1.65 |10.000    4.58 |16.083    3.82 | 22.17    1.53
               4.000     1.65 |10.083    4.58 |16.167    3.82 | 22.25    1.53
               4.083     1.65 |10.167    4.58 |16.250    3.82 | 22.33    1.53
               4.167     1.65 |10.250    4.58 |16.333    2.29 | 22.42    1.53
               4.250     1.65 |10.333    5.85 |16.417    2.29 | 22.50    1.53
               4.333     2.04 |10.417    5.85 |16.500    2.29 | 22.58    1.53
               4.417     2.04 |10.500    5.85 |16.583    2.29 | 22.67    1.53
               4.500     2.04 |10.583    5.85 |16.667    2.29 | 22.75    1.53
               4.583     2.04 |10.667    5.85 |16.750    2.29 | 22.83    1.53
               4.667     2.04 |10.750    5.85 |16.833    2.29 | 22.92    1.53
               4.750     2.04 |10.833    7.89 |16.917    2.29 | 23.00    1.53
               4.833     2.04 |10.917    7.89 |17.000    2.29 | 23.08    1.53
               4.917     2.04 |11.000    7.89 |17.083    2.29 | 23.17    1.53
               5.000     2.04 |11.083    7.89 |17.167    2.29 | 23.25    1.53
               5.083     2.04 |11.167    7.89 |17.250    2.29 | 23.33    1.53
               5.167     2.04 |11.250    7.89 |17.333    2.29 | 23.42    1.53
               5.250     2.04 |11.333   12.21 |17.417    2.29 | 23.50    1.53
               5.333     2.04 |11.417   12.21 |17.500    2.29 | 23.58    1.53
               5.417     2.04 |11.500   12.21 |17.583    2.29 | 23.67    1.53
               5.500     2.04 |11.583   12.21 |17.667    2.29 | 23.75    1.53
               5.583     2.04 |11.667   12.21 |17.750    2.29 | 23.83    1.53
               5.667     2.04 |11.750   12.21 |17.833    2.29 | 23.92    1.53
               5.750     2.04 |11.833   37.65 |17.917    2.29 | 24.00    1.53
               5.833     2.04 |11.917   37.65 |18.000    2.29 | 24.08    1.53
               5.917     2.04 |12.000   37.65 |18.083    2.29 | 24.17    1.53
               6.000     2.04 |12.083  155.68 |18.167    2.29 | 24.25    1.53
               6.083     2.04 |12.167  155.69 |18.250    2.29 |

     Unit Hyd Qpeak  (cms)=   0.828

     PEAK FLOW       (cms)=   1.167 (i)
     TIME TO PEAK    (hrs)=  13.500
     RUNOFF VOLUME    (mm)=  63.190
     TOTAL RAINFALL   (mm)= 127.200
     RUNOFF COEFFICIENT   =   0.497

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

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 FINISH
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       V    V   I    SSSSS  U   U    A    L             (v 6.2.2021)
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
```

Developed and Distributed by Smart City Water Inc

***** D E T A I L E D   O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voin.dat

Output filename:
C:\Users\AbirA\AppData\Local\Civica\VH5\d70c904b-d540-495f-bf7e-db70299bd929\e1d44246-9db6-46e5-9935-6d07965fd413\s
cenar
Summary filename:
C:\Users\AbirA\AppData\Local\Civica\VH5\d70c904b-d540-495f-bf7e-db70299bd929\e1d44246-9db6-46e5-9935-6d07965fd413\s
cenar

DATE: 10-27-2025   TIME: 03:50:44

USER:

COMMENTS: ____

```
************************************************
** SIMULATION : 7_100yr 24hr -SCS II          **
************************************************
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```
--------------------
|    READ STORM    |    Filename: C:\Users\AbirA\AppD
|                  |              ata\Local\Temp\
|                  |              384b5844-7d56-4c1f-bc3d-a71a6fee97ba\9f38d89e
| Ptotal=127.20 mm |    Comments: 100yr 24hr 15min SCS
--------------------
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.00	0.00	6.25	2.29	12.50	18.32	18.75	2.29
0.25	1.40	6.50	2.29	12.75	9.41	19.00	2.29
0.50	1.40	6.75	2.29	13.00	9.41	19.25	2.29
0.75	1.40	7.00	2.29	13.25	6.87	19.50	2.29
1.00	1.40	7.25	2.80	13.50	6.87	19.75	2.29
1.25	1.40	7.50	2.80	13.75	5.34	20.00	2.29
1.50	1.40	7.75	2.80	14.00	5.34	20.25	1.53
1.75	1.40	8.00	2.80	14.25	3.82	20.50	1.53
2.00	1.40	8.25	3.31	14.50	3.82	20.75	1.53
2.25	1.65	8.50	3.31	14.75	3.82	21.00	1.53
2.50	1.65	8.75	3.56	15.00	3.82	21.25	1.53
2.75	1.65	9.00	3.56	15.25	3.82	21.50	1.53
3.00	1.65	9.25	4.07	15.50	3.82	21.75	1.53
3.25	1.65	9.50	4.07	15.75	3.82	22.00	1.53
3.50	1.65	9.75	4.58	16.00	3.82	22.25	1.53
3.75	1.65	10.00	4.58	16.25	2.29	22.50	1.53
4.00	1.65	10.25	5.85	16.50	2.29	22.75	1.53
4.25	2.04	10.50	5.85	16.75	2.29	23.00	1.53
4.50	2.04	10.75	7.89	17.00	2.29	23.25	1.53
4.75	2.04	11.00	7.89	17.25	2.29	23.50	1.53
5.00	2.04	11.25	12.21	17.50	2.29	23.75	1.53
5.25	2.04	11.50	12.21	17.75	2.29	24.00	1.53
5.50	2.04	11.75	37.65	18.00	2.29		
5.75	2.04	12.00	155.69	18.25	2.29		
6.00	2.04	12.25	18.32	18.50	2.29		

Proposed Condition

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--------------------
| CALIB            |
| STANDHYD (  0002)|   Area    (ha)=  16.94
|ID= 1 DT= 5.0 min |   Total Imp(%)=  45.00   Dir. Conn.(%)=  45.00
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```

		IMPERVIOUS	PERVIOUS (i)
Surface Area	(ha)=	7.62	9.32
Dep. Storage	(mm)=	5.00	1.50
Average Slope	(%)=	1.00	2.00
Length	(m)=	336.06	40.00
Mannings n	=	0.013	0.250

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

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	6.167	2.04	12.250	155.69	18.33	2.29
0.167	0.00	6.250	2.04	12.333	18.33	18.42	2.29
0.250	0.00	6.333	2.29	12.417	18.32	18.50	2.29
0.333	1.40	6.417	2.29	12.500	18.32	18.58	2.29
0.417	1.40	6.500	2.29	12.583	18.32	18.67	2.29
0.500	1.40	6.583	2.29	12.667	18.32	18.75	2.29
0.583	1.40	6.667	2.29	12.750	18.32	18.83	2.29
0.667	1.40	6.750	2.29	12.833	9.41	18.92	2.29
0.750	1.40	6.833	2.29	12.917	9.41	19.00	2.29
0.833	1.40	6.917	2.29	13.000	9.41	19.08	2.29
0.917	1.40	7.000	2.29	13.083	9.41	19.17	2.29
1.000	1.40	7.083	2.29	13.167	9.41	19.25	2.29
1.083	1.40	7.167	2.29	13.250	9.41	19.33	2.29
1.167	1.40	7.250	2.29	13.333	6.87	19.42	2.29
1.250	1.40	7.333	2.80	13.417	6.87	19.50	2.29
1.333	1.40	7.417	2.80	13.500	6.87	19.58	2.29
1.417	1.40	7.500	2.80	13.583	6.87	19.67	2.29
1.500	1.40	7.583	2.80	13.667	6.87	19.75	2.29
1.583	1.40	7.667	2.80	13.750	6.87	19.83	2.29
1.667	1.40	7.750	2.80	13.833	5.34	19.92	2.29
1.750	1.40	7.833	2.80	13.917	5.34	20.00	2.29
1.833	1.40	7.917	2.80	14.000	5.34	20.08	2.29
1.917	1.40	8.000	2.80	14.083	5.34	20.17	2.29
2.000	1.40	8.083	2.80	14.167	5.34	20.25	2.29
2.083	1.40	8.167	2.80	14.250	5.34	20.33	1.53
2.167	1.40	8.250	2.80	14.333	3.82	20.42	1.53
2.250	1.40	8.333	3.31	14.417	3.82	20.50	1.53
2.333	1.65	8.417	3.31	14.500	3.82	20.58	1.53
2.417	1.65	8.500	3.31	14.583	3.82	20.67	1.53
2.500	1.65	8.583	3.31	14.667	3.82	20.75	1.53
2.583	1.65	8.667	3.31	14.750	3.82	20.83	1.53
2.667	1.65	8.750	3.31	14.833	3.82	20.92	1.53
2.750	1.65	8.833	3.56	14.917	3.82	21.00	1.53
2.833	1.65	8.917	3.56	15.000	3.82	21.08	1.53
2.917	1.65	9.000	3.56	15.083	3.82	21.17	1.53
3.000	1.65	9.083	3.56	15.167	3.82	21.25	1.53
3.083	1.65	9.167	3.56	15.250	3.82	21.33	1.53

3.167	1.65	9.250	3.56	15.333	3.82	21.42	1.53
3.250	1.65	9.333	4.07	15.417	3.82	21.50	1.53
3.333	1.65	9.417	4.07	15.500	3.82	21.58	1.53
3.417	1.65	9.500	4.07	15.583	3.82	21.67	1.53
3.500	1.65	9.583	4.07	15.667	3.82	21.75	1.53
3.583	1.65	9.667	4.07	15.750	3.82	21.83	1.53
3.667	1.65	9.750	4.07	15.833	3.82	21.92	1.53
3.750	1.65	9.833	4.58	15.917	3.82	22.00	1.53
3.833	1.65	9.917	4.58	16.000	3.82	22.08	1.53
3.917	1.65	10.000	4.58	16.083	3.82	22.17	1.53
4.000	1.65	10.083	4.58	16.167	3.82	22.25	1.53
4.083	1.65	10.167	4.58	16.250	3.82	22.33	1.53
4.167	1.65	10.250	4.58	16.333	2.29	22.42	1.53
4.250	1.65	10.333	5.85	16.417	2.29	22.50	1.53
4.333	2.04	10.417	5.85	16.500	2.29	22.58	1.53
4.417	2.04	10.500	5.85	16.583	2.29	22.67	1.53
4.500	2.04	10.583	5.85	16.667	2.29	22.75	1.53
4.583	2.04	10.667	5.85	16.750	2.29	22.83	1.53
4.667	2.04	10.750	5.85	16.833	2.29	22.92	1.53
4.750	2.04	10.833	7.89	16.917	2.29	23.00	1.53
4.833	2.04	10.917	7.89	17.000	2.29	23.08	1.53
4.917	2.04	11.000	7.89	17.083	2.29	23.17	1.53
5.000	2.04	11.083	7.89	17.167	2.29	23.25	1.53
5.083	2.04	11.167	7.89	17.250	2.29	23.33	1.53
5.167	2.04	11.250	7.89	17.333	2.29	23.42	1.53
5.250	2.04	11.333	12.21	17.417	2.29	23.50	1.53
5.333	2.04	11.417	12.21	17.500	2.29	23.58	1.53
5.417	2.04	11.500	12.21	17.583	2.29	23.67	1.53
5.500	2.04	11.583	12.21	17.667	2.29	23.75	1.53
5.583	2.04	11.667	12.21	17.750	2.29	23.83	1.53
5.667	2.04	11.750	12.21	17.833	2.29	23.92	1.53
5.750	2.04	11.833	37.65	17.917	2.29	24.00	1.53
5.833	2.04	11.917	37.65	18.000	2.29	24.08	1.53
5.917	2.04	12.000	37.65	18.083	2.29	24.17	1.53
6.000	2.04	12.083	155.68	18.167	2.29	24.25	1.53
6.083	2.04	12.167	155.69	18.250	2.29		

```
    Max.Eff.Inten.(mm/hr)=     155.69        95.49
               over (min)        5.00        15.00
    Storage Coeff.  (min)=       4.43 (ii)   11.62 (ii)
    Unit Hyd. Tpeak (min)=       5.00        15.00
    Unit Hyd. peak  (cms)=       0.23         0.09
                                                         *TOTALS*
    PEAK FLOW       (cms)=       3.21         1.55          4.553 (iii)
    TIME TO PEAK    (hrs)=      12.25        12.33         12.25
    RUNOFF VOLUME    (mm)=     122.20        65.89         91.23
    TOTAL RAINFALL   (mm)=     127.20       127.20        127.20
    RUNOFF COEFFICIENT   =       0.96         0.52          0.72

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  69.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0200)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
```

OUTFLOW (cms)	STORAGE (ha.m.)	OUTFLOW (cms)	STORAGE (ha.m.)
0.0000	0.0000	0.4080	0.4540
0.0080	0.0490	0.5530	0.5220
0.0210	0.1000	0.7120	0.5920
0.0290	0.1530	0.8850	0.6640
0.0360	0.2090	1.0700	0.7390

0.0850	0.2660	1.2670	0.8170
0.1710	0.3270	1.4750	0.8970
0.2800	0.3890	1.6930	0.9810

```
                              AREA     QPEAK     TPEAK       R.V.
                              (ha)     (cms)     (hrs)       (mm)
  INFLOW : ID= 2 (  0002)    16.940     4.553     12.25      91.23
  OUTFLOW: ID= 1 (  0200)    16.940     1.068     12.67      91.14

            PEAK   FLOW   REDUCTION [Qout/Qin](%)= 23.46
            TIME SHIFT OF PEAK FLOW        (min)= 25.00
            MAXIMUM  STORAGE   USED      (ha.m.)=  0.7388

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--------------------
| CALIB            |
| STANDHYD (  0004)|   Area    (ha)=  17.80
|ID= 1 DT= 5.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  80.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      14.24         3.56
     Dep. Storage     (mm)=       5.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     344.48        40.00
     Mannings n          =      0.013        0.250

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

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	6.167	2.04	12.250	155.69	18.33	2.29
0.167	0.00	6.250	2.04	12.333	18.33	18.42	2.29
0.250	0.00	6.333	2.29	12.417	18.32	18.50	2.29
0.333	1.40	6.417	2.29	12.500	18.32	18.58	2.29
0.417	1.40	6.500	2.29	12.583	18.32	18.67	2.29
0.500	1.40	6.583	2.29	12.667	18.32	18.75	2.29
0.583	1.40	6.667	2.29	12.750	18.32	18.83	2.29
0.667	1.40	6.750	2.29	12.833	9.41	18.92	2.29
0.750	1.40	6.833	2.29	12.917	9.41	19.00	2.29
0.833	1.40	6.917	2.29	13.000	9.41	19.08	2.29
0.917	1.40	7.000	2.29	13.083	9.41	19.17	2.29
1.000	1.40	7.083	2.29	13.167	9.41	19.25	2.29
1.083	1.40	7.167	2.29	13.250	9.41	19.33	2.29
1.167	1.40	7.250	2.29	13.333	6.87	19.42	2.29
1.250	1.40	7.333	2.80	13.417	6.87	19.50	2.29
1.333	1.40	7.417	2.80	13.500	6.87	19.58	2.29
1.417	1.40	7.500	2.80	13.583	6.87	19.67	2.29
1.500	1.40	7.583	2.80	13.667	6.87	19.75	2.29
1.583	1.40	7.667	2.80	13.750	6.87	19.83	2.29
1.667	1.40	7.750	2.80	13.833	5.34	19.92	2.29
1.750	1.40	7.833	2.80	13.917	5.34	20.00	2.29
1.833	1.40	7.917	2.80	14.000	5.34	20.08	2.29
1.917	1.40	8.000	2.80	14.083	5.34	20.17	2.29
2.000	1.40	8.083	2.80	14.167	5.34	20.25	2.29
2.083	1.40	8.167	2.80	14.250	5.34	20.33	1.53
2.167	1.40	8.250	2.80	14.333	3.82	20.42	1.53
2.250	1.40	8.333	3.31	14.417	3.82	20.50	1.53
2.333	1.65	8.417	3.31	14.500	3.82	20.58	1.53
2.417	1.65	8.500	3.31	14.583	3.82	20.67	1.53
2.500	1.65	8.583	3.31	14.667	3.82	20.75	1.53
2.583	1.65	8.667	3.31	14.750	3.82	20.83	1.53
2.667	1.65	8.750	3.31	14.833	3.82	20.92	1.53
2.750	1.65	8.833	3.56	14.917	3.82	21.00	1.53
2.833	1.65	8.917	3.56	15.000	3.82	21.08	1.53
2.917	1.65	9.000	3.56	15.083	3.82	21.17	1.53
3.000	1.65	9.083	3.56	15.167	3.82	21.25	1.53

```
       3.083    1.65 | 9.167    3.56 |15.250    3.82 | 21.33    1.53
       3.167    1.65 | 9.250    3.56 |15.333    3.82 | 21.42    1.53
       3.250    1.65 | 9.333    4.07 |15.417    3.82 | 21.50    1.53
       3.333    1.65 | 9.417    4.07 |15.500    3.82 | 21.58    1.53
       3.417    1.65 | 9.500    4.07 |15.583    3.82 | 21.67    1.53
       3.500    1.65 | 9.583    4.07 |15.667    3.82 | 21.75    1.53
       3.583    1.65 | 9.667    4.07 |15.750    3.82 | 21.83    1.53
       3.667    1.65 | 9.750    4.07 |15.833    3.82 | 21.92    1.53
       3.750    1.65 | 9.833    4.58 |15.917    3.82 | 22.00    1.53
       3.833    1.65 | 9.917    4.58 |16.000    3.82 | 22.08    1.53
       3.917    1.65 |10.000    4.58 |16.083    3.82 | 22.17    1.53
       4.000    1.65 |10.083    4.58 |16.167    3.82 | 22.25    1.53
       4.083    1.65 |10.167    4.58 |16.250    3.82 | 22.33    1.53
       4.167    1.65 |10.250    4.58 |16.333    2.29 | 22.42    1.53
       4.250    1.65 |10.333    5.85 |16.417    2.29 | 22.50    1.53
       4.333    2.04 |10.417    5.85 |16.500    2.29 | 22.58    1.53
       4.417    2.04 |10.500    5.85 |16.583    2.29 | 22.67    1.53
       4.500    2.04 |10.583    5.85 |16.667    2.29 | 22.75    1.53
       4.583    2.04 |10.667    5.85 |16.750    2.29 | 22.83    1.53
       4.667    2.04 |10.750    5.85 |16.833    2.29 | 22.92    1.53
       4.750    2.04 |10.833    7.89 |16.917    2.29 | 23.00    1.53
       4.833    2.04 |10.917    7.89 |17.000    2.29 | 23.08    1.53
       4.917    2.04 |11.000    7.89 |17.083    2.29 | 23.17    1.53
       5.000    2.04 |11.083    7.89 |17.167    2.29 | 23.25    1.53
       5.083    2.04 |11.167    7.89 |17.250    2.29 | 23.33    1.53
       5.167    2.04 |11.250    7.89 |17.333    2.29 | 23.42    1.53
       5.250    2.04 |11.333   12.21 |17.417    2.29 | 23.50    1.53
       5.333    2.04 |11.417   12.21 |17.500    2.29 | 23.58    1.53
       5.417    2.04 |11.500   12.21 |17.583    2.29 | 23.67    1.53
       5.500    2.04 |11.583   12.21 |17.667    2.29 | 23.75    1.53
       5.583    2.04 |11.667   12.21 |17.750    2.29 | 23.83    1.53
       5.667    2.04 |11.750   12.21 |17.833    2.29 | 23.92    1.53
       5.750    2.04 |11.833   37.65 |17.917    2.29 | 24.00    1.53
       5.833    2.04 |11.917   37.65 |18.000    2.29 | 24.08    1.53
       5.917    2.04 |12.000   37.65 |18.083    2.29 | 24.17    1.53
       6.000    2.04 |12.083  155.68 |18.167    2.29 | 24.25    1.53
       6.083    2.04 |12.167  155.69 |18.250    2.29 |

     Max.Eff.Inten.(mm/hr)=     155.69        95.49
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.50 (ii)    7.89 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.23         0.13
                                                          *TOTALS*
     PEAK FLOW      (cms)=        5.99         0.73          6.717 (iii)
     TIME TO PEAK    (hrs)=      12.25        12.25          12.25
     RUNOFF VOLUME    (mm)=     122.20        65.89         110.94
     TOTAL RAINFALL   (mm)=     127.20       127.20         127.20
     RUNOFF COEFFICIENT  =        0.96         0.52           0.87

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  69.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR( 0400)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
     **** WARNING : FIRST OUTFLOW IS NOT ZERO.
                           0.0080      0.0570   |    0.5240      0.6770
                           0.0230      0.1160   |    0.6470      0.7580
                           0.0310      0.1770   |    0.7790      0.8430
```

Proposed Condition

```
                           0.0380      0.2410   |    0.9190      0.9300
                           0.0740      0.3070   |    1.0670      1.0200
                           0.1370      0.3760   |    1.2220      1.1130
                           0.2150      0.4470   |    1.3840      1.2090
                           0.3070      0.5210   |    1.5530      1.3070
                           0.4110      0.5980   |    0.0000      0.0000

                               AREA     QPEAK     TPEAK       R.V.
                               (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)     17.800      6.717     12.25     110.94
   OUTFLOW: ID= 1 (  0400)     17.800      1.126     12.50     110.84

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 16.76
                   TIME SHIFT OF PEAK FLOW         (min)= 15.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  1.0563

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--------------------
| CALIB            |
| STANDHYD (  0005)|   Area    (ha)=  13.56
|ID= 1 DT= 5.0 min |   Total Imp(%)=  52.00   Dir. Conn.(%)=  52.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       7.05         6.51
     Dep. Storage     (mm)=       5.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     300.67        40.00
     Mannings n           =      0.013        0.250

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


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 6.167    2.04 |12.250  155.69 | 18.33    2.29
                0.167    0.00 | 6.250    2.04 |12.333   18.33 | 18.42    2.29
                0.250    0.00 | 6.333    2.29 |12.417   18.32 | 18.50    2.29
                0.333    1.40 | 6.417    2.29 |12.500   18.32 | 18.58    2.29
                0.417    1.40 | 6.500    2.29 |12.583   18.32 | 18.67    2.29
                0.500    1.40 | 6.583    2.29 |12.667   18.32 | 18.75    2.29
                0.583    1.40 | 6.667    2.29 |12.750   18.32 | 18.83    2.29
                0.667    1.40 | 6.750    2.29 |12.833    9.41 | 18.92    2.29
                0.750    1.40 | 6.833    2.29 |12.917    9.41 | 19.00    2.29
                0.833    1.40 | 6.917    2.29 |13.000    9.41 | 19.08    2.29
                0.917    1.40 | 7.000    2.29 |13.083    9.41 | 19.17    2.29
                1.000    1.40 | 7.083    2.29 |13.167    9.41 | 19.25    2.29
                1.083    1.40 | 7.167    2.29 |13.250    9.41 | 19.33    2.29
                1.167    1.40 | 7.250    2.29 |13.333    6.87 | 19.42    2.29
                1.250    1.40 | 7.333    2.80 |13.417    6.87 | 19.50    2.29
                1.333    1.40 | 7.417    2.80 |13.500    6.87 | 19.58    2.29
                1.417    1.40 | 7.500    2.80 |13.583    6.87 | 19.67    2.29
                1.500    1.40 | 7.583    2.80 |13.667    6.87 | 19.75    2.29
                1.583    1.40 | 7.667    2.80 |13.750    6.87 | 19.83    2.29
                1.667    1.40 | 7.750    2.80 |13.833    5.34 | 19.92    2.29
                1.750    1.40 | 7.833    2.80 |13.917    5.34 | 20.00    2.29
                1.833    1.40 | 7.917    2.80 |14.000    5.34 | 20.08    2.29
                1.917    1.40 | 8.000    2.80 |14.083    5.34 | 20.17    2.29
                2.000    1.40 | 8.083    2.80 |14.167    5.34 | 20.25    2.29
                2.083    1.40 | 8.167    2.80 |14.250    5.34 | 20.33    1.53
                2.167    1.40 | 8.250    2.80 |14.333    3.82 | 20.42    1.53
                2.250    1.40 | 8.333    3.31 |14.417    3.82 | 20.50    1.53
                2.333    1.65 | 8.417    3.31 |14.500    3.82 | 20.58    1.53
                2.417    1.65 | 8.500    3.31 |14.583    3.82 | 20.67    1.53
                2.500    1.65 | 8.583    3.31 |14.667    3.82 | 20.75    1.53
                2.583    1.65 | 8.667    3.31 |14.750    3.82 | 20.83    1.53
                2.667    1.65 | 8.750    3.31 |14.833    3.82 | 20.92    1.53
                2.750    1.65 | 8.833    3.56 |14.917    3.82 | 21.00    1.53
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           2.833    1.65 | 8.917    3.56 |15.000    3.82 | 21.08    1.53
           2.917    1.65 | 9.000    3.56 |15.083    3.82 | 21.17    1.53
           3.000    1.65 | 9.083    3.56 |15.167    3.82 | 21.25    1.53
           3.083    1.65 | 9.167    3.56 |15.250    3.82 | 21.33    1.53
           3.167    1.65 | 9.250    3.56 |15.333    3.82 | 21.42    1.53
           3.250    1.65 | 9.333    4.07 |15.417    3.82 | 21.50    1.53
           3.333    1.65 | 9.417    4.07 |15.500    3.82 | 21.58    1.53
           3.417    1.65 | 9.500    4.07 |15.583    3.82 | 21.67    1.53
           3.500    1.65 | 9.583    4.07 |15.667    3.82 | 21.75    1.53
           3.583    1.65 | 9.667    4.07 |15.750    3.82 | 21.83    1.53
           3.667    1.65 | 9.750    4.07 |15.833    3.82 | 21.92    1.53
           3.750    1.65 | 9.833    4.58 |15.917    3.82 | 22.00    1.53
           3.833    1.65 | 9.917    4.58 |16.000    3.82 | 22.08    1.53
           3.917    1.65 |10.000    4.58 |16.083    3.82 | 22.17    1.53
           4.000    1.65 |10.083    4.58 |16.167    3.82 | 22.25    1.53
           4.083    1.65 |10.167    4.58 |16.250    3.82 | 22.33    1.53
           4.167    1.65 |10.250    4.58 |16.333    2.29 | 22.42    1.53
           4.250    1.65 |10.333    5.85 |16.417    2.29 | 22.50    1.53
           4.333    2.04 |10.417    5.85 |16.500    2.29 | 22.58    1.53
           4.417    2.04 |10.500    5.85 |16.583    2.29 | 22.67    1.53
           4.500    2.04 |10.583    5.85 |16.667    2.29 | 22.75    1.53
           4.583    2.04 |10.667    5.85 |16.750    2.29 | 22.83    1.53
           4.667    2.04 |10.750    5.85 |16.833    2.29 | 22.92    1.53
           4.750    2.04 |10.833    7.89 |16.917    2.29 | 23.00    1.53
           4.833    2.04 |10.917    7.89 |17.000    2.29 | 23.08    1.53
           4.917    2.04 |11.000    7.89 |17.083    2.29 | 23.17    1.53
           5.000    2.04 |11.083    7.89 |17.167    2.29 | 23.25    1.53
           5.083    2.04 |11.167    7.89 |17.250    2.29 | 23.33    1.53
           5.167    2.04 |11.250    7.89 |17.333    2.29 | 23.42    1.53
           5.250    2.04 |11.333   12.21 |17.417    2.29 | 23.50    1.53
           5.333    2.04 |11.417   12.21 |17.500    2.29 | 23.58    1.53
           5.417    2.04 |11.500   12.21 |17.583    2.29 | 23.67    1.53
           5.500    2.04 |11.583   12.21 |17.667    2.29 | 23.75    1.53
           5.583    2.04 |11.667   12.21 |17.750    2.29 | 23.83    1.53
           5.667    2.04 |11.750   12.21 |17.833    2.29 | 23.92    1.53
           5.750    2.04 |11.833   37.65 |17.917    2.29 | 24.00    1.53
           5.833    2.04 |11.917   37.65 |18.000    2.29 | 24.08    1.53
           5.917    2.04 |12.000   37.65 |18.083    2.29 | 24.17    1.53
           6.000    2.04 |12.083  155.68 |18.167    2.29 | 24.25    1.53
           6.083    2.04 |12.167  155.69 |18.250    2.29 |

     Max.Eff.Inten.(mm/hr)=     155.69        95.49
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       4.14 (ii)   11.33 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.24         0.09
                                                           *TOTALS*
     PEAK FLOW       (cms)=       2.99         1.09          3.936 (iii)
     TIME TO PEAK    (hrs)=      12.25        12.33         12.25
     RUNOFF VOLUME    (mm)=     122.20        65.89         95.17
     TOTAL RAINFALL   (mm)=     127.20       127.20        127.20
     RUNOFF COEFFICIENT   =       0.96         0.52          0.75

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  69.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0500)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000      0.0000   |    0.1940      0.5600
```

Proposed Condition

```
                          0.0080      0.0610   |    0.2410      0.6410
                          0.0210      0.1250   |    0.2930      0.7260
                          0.0290      0.1910   |    0.3470      0.8130
                          0.0360      0.2590   |    0.4050      0.9030
                          0.0760      0.3310   |    0.4660      0.9960
                          0.1110      0.4040   |    0.5290      1.0910
                          0.1500      0.4810   |    0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0005)     13.560      3.936     12.25      95.17
   OUTFLOW: ID= 1 (  0500)     13.560      0.324     13.25      95.03

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=  8.23
                  TIME SHIFT OF PEAK FLOW         (min)= 60.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.7759

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0003)|   Area    (ha)=  47.40
|ID= 1 DT= 5.0 min |   Total Imp(%)=  33.00   Dir. Conn.(%)=  33.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      15.64        31.76
     Dep. Storage     (mm)=       5.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     562.14        40.00
     Mannings n           =      0.013        0.250

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


                                ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 6.167    2.04 |12.250  155.69 | 18.33    2.29
                0.167    0.00 | 6.250    2.04 |12.333   18.33 | 18.42    2.29
                0.250    0.00 | 6.333    2.29 |12.417   18.32 | 18.50    2.29
                0.333    1.40 | 6.417    2.29 |12.500   18.32 | 18.58    2.29
                0.417    1.40 | 6.500    2.29 |12.583   18.32 | 18.67    2.29
                0.500    1.40 | 6.583    2.29 |12.667   18.32 | 18.75    2.29
                0.583    1.40 | 6.667    2.29 |12.750   18.32 | 18.83    2.29
                0.667    1.40 | 6.750    2.29 |12.833    9.41 | 18.92    2.29
                0.750    1.40 | 6.833    2.29 |12.917    9.41 | 19.00    2.29
                0.833    1.40 | 6.917    2.29 |13.000    9.41 | 19.08    2.29
                0.917    1.40 | 7.000    2.29 |13.083    9.41 | 19.17    2.29
                1.000    1.40 | 7.083    2.29 |13.167    9.41 | 19.25    2.29
                1.083    1.40 | 7.167    2.29 |13.250    9.41 | 19.33    2.29
                1.167    1.40 | 7.250    2.29 |13.333    6.87 | 19.42    2.29
                1.250    1.40 | 7.333    2.80 |13.417    6.87 | 19.50    2.29
                1.333    1.40 | 7.417    2.80 |13.500    6.87 | 19.58    2.29
                1.417    1.40 | 7.500    2.80 |13.583    6.87 | 19.67    2.29
                1.500    1.40 | 7.583    2.80 |13.667    6.87 | 19.75    2.29
                1.583    1.40 | 7.667    2.80 |13.750    6.87 | 19.83    2.29
                1.667    1.40 | 7.750    2.80 |13.833    5.34 | 19.92    2.29
                1.750    1.40 | 7.833    2.80 |13.917    5.34 | 20.00    2.29
                1.833    1.40 | 7.917    2.80 |14.000    5.34 | 20.08    2.29
                1.917    1.40 | 8.000    2.80 |14.083    5.34 | 20.17    2.29
                2.000    1.40 | 8.083    2.80 |14.167    5.34 | 20.25    2.29
                2.083    1.40 | 8.167    2.80 |14.250    5.34 | 20.33    1.53
                2.167    1.40 | 8.250    2.80 |14.333    3.82 | 20.42    1.53
                2.250    1.40 | 8.333    3.31 |14.417    3.82 | 20.50    1.53
                2.333    1.65 | 8.417    3.31 |14.500    3.82 | 20.58    1.53
                2.417    1.65 | 8.500    3.31 |14.583    3.82 | 20.67    1.53
                2.500    1.65 | 8.583    3.31 |14.667    3.82 | 20.75    1.53
                2.583    1.65 | 8.667    3.31 |14.750    3.82 | 20.83    1.53
                2.667    1.65 | 8.750    3.31 |14.833    3.82 | 20.92    1.53
```

```
                                       Proposed Condition
          2.750    1.65 | 8.833    3.56 |14.917    3.82 | 21.00    1.53
          2.833    1.65 | 8.917    3.56 |15.000    3.82 | 21.08    1.53
          2.917    1.65 | 9.000    3.56 |15.083    3.82 | 21.17    1.53
          3.000    1.65 | 9.083    3.56 |15.167    3.82 | 21.25    1.53
          3.083    1.65 | 9.167    3.56 |15.250    3.82 | 21.33    1.53
          3.167    1.65 | 9.250    3.56 |15.333    3.82 | 21.42    1.53
          3.250    1.65 | 9.333    4.07 |15.417    3.82 | 21.50    1.53
          3.333    1.65 | 9.417    4.07 |15.500    3.82 | 21.58    1.53
          3.417    1.65 | 9.500    4.07 |15.583    3.82 | 21.67    1.53
          3.500    1.65 | 9.583    4.07 |15.667    3.82 | 21.75    1.53
          3.583    1.65 | 9.667    4.07 |15.750    3.82 | 21.83    1.53
          3.667    1.65 | 9.750    4.07 |15.833    3.82 | 21.92    1.53
          3.750    1.65 | 9.833    4.58 |15.917    3.82 | 22.00    1.53
          3.833    1.65 | 9.917    4.58 |16.000    3.82 | 22.08    1.53
          3.917    1.65 |10.000    4.58 |16.083    3.82 | 22.17    1.53
          4.000    1.65 |10.083    4.58 |16.167    3.82 | 22.25    1.53
          4.083    1.65 |10.167    4.58 |16.250    3.82 | 22.33    1.53
          4.167    1.65 |10.250    4.58 |16.333    2.29 | 22.42    1.53
          4.250    1.65 |10.333    5.85 |16.417    2.29 | 22.50    1.53
          4.333    2.04 |10.417    5.85 |16.500    2.29 | 22.58    1.53
          4.417    2.04 |10.500    5.85 |16.583    2.29 | 22.67    1.53
          4.500    2.04 |10.583    5.85 |16.667    2.29 | 22.75    1.53
          4.583    2.04 |10.667    5.85 |16.750    2.29 | 22.83    1.53
          4.667    2.04 |10.750    5.85 |16.833    2.29 | 22.92    1.53
          4.750    2.04 |10.833    7.89 |16.917    2.29 | 23.00    1.53
          4.833    2.04 |10.917    7.89 |17.000    2.29 | 23.08    1.53
          4.917    2.04 |11.000    7.89 |17.083    2.29 | 23.17    1.53
          5.000    2.04 |11.083    7.89 |17.167    2.29 | 23.25    1.53
          5.083    2.04 |11.167    7.89 |17.250    2.29 | 23.33    1.53
          5.167    2.04 |11.250    7.89 |17.333    2.29 | 23.42    1.53
          5.250    2.04 |11.333   12.21 |17.417    2.29 | 23.50    1.53
          5.333    2.04 |11.417   12.21 |17.500    2.29 | 23.58    1.53
          5.417    2.04 |11.500   12.21 |17.583    2.29 | 23.67    1.53
          5.500    2.04 |11.583   12.21 |17.667    2.29 | 23.75    1.53
          5.583    2.04 |11.667   12.21 |17.750    2.29 | 23.83    1.53
          5.667    2.04 |11.750   12.21 |17.833    2.29 | 23.92    1.53
          5.750    2.04 |11.833   37.65 |17.917    2.29 | 24.00    1.53
          5.833    2.04 |11.917   37.65 |18.000    2.29 | 24.08    1.53
          5.917    2.04 |12.000   37.65 |18.083    2.29 | 24.17    1.53
          6.000    2.04 |12.083  155.68 |18.167    2.29 | 24.25    1.53
          6.083    2.04 |12.167  155.69 |18.250    2.29 |

     Max.Eff.Inten.(mm/hr)=     155.69        95.49
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       6.03 (ii)   13.22 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.19         0.08
                                                         *TOTALS*
     PEAK FLOW       (cms)=       6.33         5.00        10.620 (iii)
     TIME TO PEAK    (hrs)=      12.25        12.33         12.25
     RUNOFF VOLUME    (mm)=     122.20        65.89         84.47
     TOTAL RAINFALL   (mm)=     127.20       127.20        127.20
     RUNOFF COEFFICIENT   =       0.96         0.52          0.66


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  69.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0300)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000      0.1220   |    1.2220      1.3860
```

```
                                       Proposed Condition
                           0.0410      0.2480   |    1.5100      1.5450
                           0.0650      0.3770   |    1.8180      1.7080
                           0.0820      0.5100   |    2.1450      1.8760
                           0.0970      0.6460   |    2.4900      2.0470
                           0.3160      0.7870   |    2.8520      2.2220
                           0.5000      0.9310   |    3.2300      2.4020
                           0.7150      1.0780   |    3.6240      2.5860
                           0.9560      1.2300   |    0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0003)     47.400     10.620     12.25      84.47
   OUTFLOW: ID= 1 (  0300)     47.400      2.344     12.83      81.88

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 22.07
                   TIME SHIFT OF PEAK FLOW         (min)= 35.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  1.9767

------------------------------------------------------------------------------

 FINISH
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       V    V   I    SSSSS  U   U    A    L             (v 6.2.2021)
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

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


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voin.dat

  Output  filename:
C:\Users\AbirA\AppData\Local\Civica\VH5\d70c904b-d540-495f-bf7e-db70299bd929\79d287b5-e8f3-445a-85eb-13f73faaaba7\s
cenar
  Summary filename:
C:\Users\AbirA\AppData\Local\Civica\VH5\d70c904b-d540-495f-bf7e-db70299bd929\79d287b5-e8f3-445a-85eb-13f73faaaba7\s
cenar


DATE: 09-05-2025                          TIME: 10:19:43

USER:


COMMENTS: ____________________________________________________________


---------------------------------------------------------------------------------------------------------
  ***********************************************
  ** SIMULATION : Run 01                       **
  ***********************************************


--------------------
|    READ STORM    |    Filename: C:\Users\AbirA\AppD
|                  |              ata\Local\Temp\
|                  |              3baeb0f7-3671-4450-966d-98d677fa5f1e\7134677a
| Ptotal= 25.00 mm |    Comments: 25mm4Hr
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.00    1.79 |  1.00   40.34 |  2.00    3.38 |  3.00    1.68
                 0.25    2.46 |  1.25   13.68 |  2.25    2.69 |  3.25    1.50
                 0.50    3.97 |  1.50    6.92 |  2.50    2.24 |  3.50    1.35
                 0.75   10.29 |  1.75    4.56 |  2.75    1.91 |  3.75    1.23

-------------------------------------------------------------------------------

--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   9.44
|ID= 1 DT= 5.0 min |   Total Imp(%)=  44.00   Dir. Conn.(%)=  44.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       4.15         5.29
     Dep. Storage     (mm)=       5.00         1.50
```



```
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     250.87        40.00
     Mannings n          =      0.013        0.250

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


                              ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.083    1.79 | 1.083   40.34 | 2.083    3.38 |  3.08    1.68
                 0.167    1.79 | 1.167   40.34 | 2.167    3.38 |  3.17    1.68
                 0.250    1.79 | 1.250   40.34 | 2.250    3.38 |  3.25    1.68
                 0.333    2.46 | 1.333   13.68 | 2.333    2.69 |  3.33    1.50
                 0.417    2.46 | 1.417   13.68 | 2.417    2.69 |  3.42    1.50
                 0.500    2.46 | 1.500   13.68 | 2.500    2.69 |  3.50    1.50
                 0.583    3.97 | 1.583    6.92 | 2.583    2.24 |  3.58    1.35
                 0.667    3.97 | 1.667    6.92 | 2.667    2.24 |  3.67    1.35
                 0.750    3.97 | 1.750    6.92 | 2.750    2.24 |  3.75    1.35
                 0.833   10.29 | 1.833    4.56 | 2.833    1.91 |  3.83    1.23
                 0.917   10.29 | 1.917    4.56 | 2.917    1.91 |  3.92    1.23
                 1.000   10.29 | 2.000    4.56 | 3.000    1.91 |  4.00    1.23

     Max.Eff.Inten.(mm/hr)=      40.34         4.24
                over (min)        5.00        35.00
     Storage Coeff.  (min)=       6.38 (ii)   31.36 (ii)
     Unit Hyd. Tpeak (min)=       5.00        35.00
     Unit Hyd. peak  (cms)=       0.18         0.03
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.42         0.03          0.422 (iii)
     TIME TO PEAK    (hrs)=       1.25         1.83           1.25
     RUNOFF VOLUME    (mm)=      20.00         4.01          11.04
     TOTAL RAINFALL   (mm)=      25.00        25.00          25.00
     RUNOFF COEFFICIENT   =       0.80         0.16           0.44


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  69.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0100)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
     **** WARNING : FIRST OUTFLOW IS NOT ZERO.
                          0.0040      0.0150   |    0.0130      0.1100
                          0.0070      0.0320   |    0.1080      0.1330
                          0.0090      0.0490   |    0.2810      0.1570
                          0.0110      0.0680   |    0.5040      0.1830
                          0.0120      0.0880   |    0.0000      0.0000

                               AREA     QPEAK     TPEAK       R.V.
                               (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      9.440      0.422      1.25      11.04
   OUTFLOW: ID= 1 (  0100)      9.440      0.012      4.17      10.94

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=  2.87
                  TIME SHIFT OF PEAK FLOW        (min)=175.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0906

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0006)|   Area    (ha)=   8.60
```

```
|ID= 1 DT= 5.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  65.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.59         3.01
     Dep. Storage     (mm)=       5.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     239.44        40.00
     Mannings n          =      0.013        0.250

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


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    1.79 | 1.083   40.34 | 2.083    3.38 |  3.08    1.68
                0.167    1.79 | 1.167   40.34 | 2.167    3.38 |  3.17    1.68
                0.250    1.79 | 1.250   40.34 | 2.250    3.38 |  3.25    1.68
                0.333    2.46 | 1.333   13.68 | 2.333    2.69 |  3.33    1.50
                0.417    2.46 | 1.417   13.68 | 2.417    2.69 |  3.42    1.50
                0.500    2.46 | 1.500   13.68 | 2.500    2.69 |  3.50    1.50
                0.583    3.97 | 1.583    6.92 | 2.583    2.24 |  3.58    1.35
                0.667    3.97 | 1.667    6.92 | 2.667    2.24 |  3.67    1.35
                0.750    3.97 | 1.750    6.92 | 2.750    2.24 |  3.75    1.35
                0.833   10.29 | 1.833    4.56 | 2.833    1.91 |  3.83    1.23
                0.917   10.29 | 1.917    4.56 | 2.917    1.91 |  3.92    1.23
                1.000   10.29 | 2.000    4.56 | 3.000    1.91 |  4.00    1.23

     Max.Eff.Inten.(mm/hr)=      40.34         4.24
                over (min)        5.00        35.00
     Storage Coeff.  (min)=       6.20 (ii)   31.18 (ii)
     Unit Hyd. Tpeak (min)=       5.00        35.00
     Unit Hyd. peak  (cms)=       0.19         0.03
                                                         *TOTALS*
     PEAK FLOW      (cms)=       0.56         0.02          0.567 (iii)
     TIME TO PEAK    (hrs)=       1.25         1.83           1.25
     RUNOFF VOLUME    (mm)=      20.00         4.01          14.40
     TOTAL RAINFALL   (mm)=      25.00        25.00          25.00
     RUNOFF COEFFICIENT   =       0.80         0.16           0.58


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  69.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0600)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
     **** WARNING : FIRST OUTFLOW IS NOT ZERO.
                           0.0060      0.0170   |    0.0190      0.1080
                           0.0110      0.0350   |    0.1150      0.1360
                           0.0140      0.0560   |    0.2890      0.1660
                           0.0170      0.0810   |    0.5130      0.1980

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0006)      8.600      0.567      1.25      14.40
   OUTFLOW: ID= 1 (  0600)      8.600      0.019      4.00      14.32

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  3.30
                   TIME SHIFT OF PEAK FLOW         (min)=165.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1043
```

Pond 1 and Bridge Pond_25mm storm

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

 FINISH
=========================================================================================================
```

F

General Arrangements of Structures

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN
DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

Ontario Ministry of Transportation

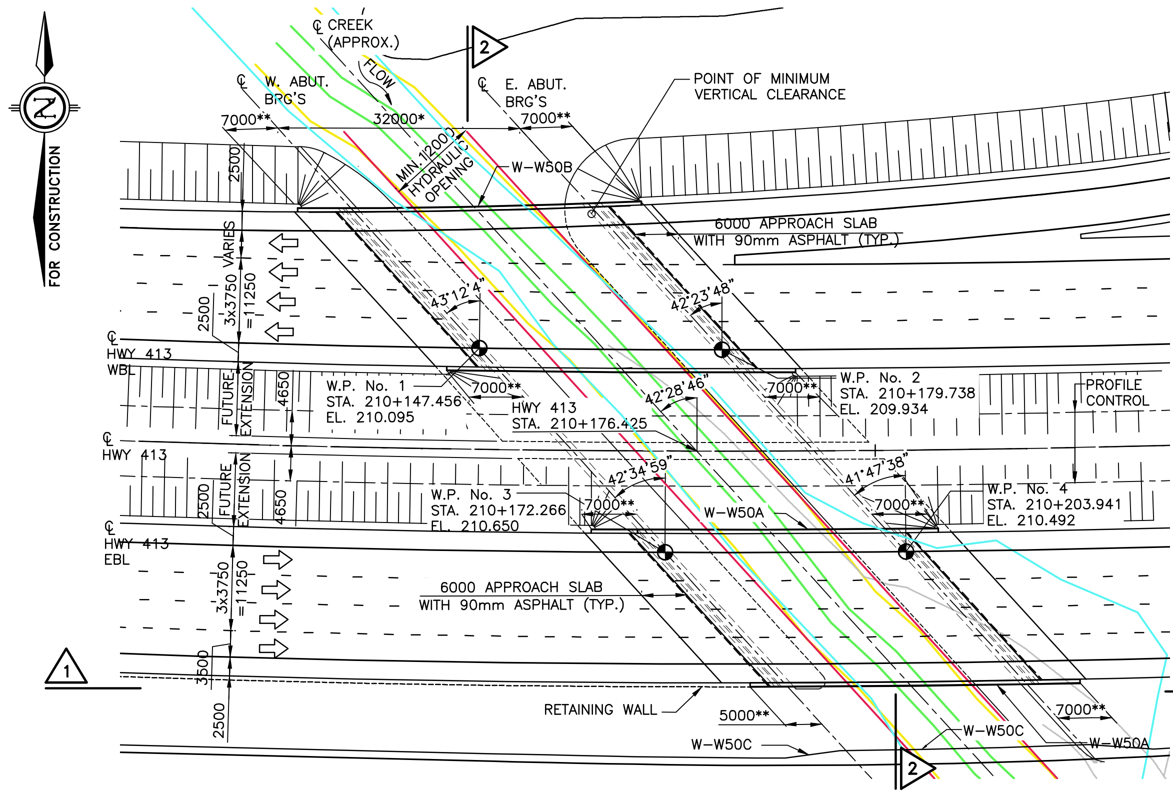
CONT
WP

HWY 413 PRELIMINARY DESIGN
W-W50A & B WATER CROSSING
(CR_LC_LEV_2_WC1)
GENERAL ARRANGEMENT

AECOM

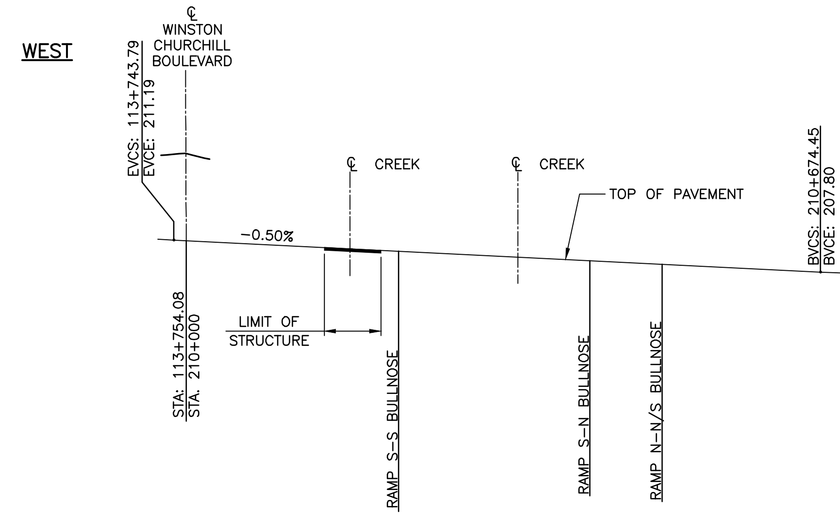
SHEET

FOR CONSTRUCTION

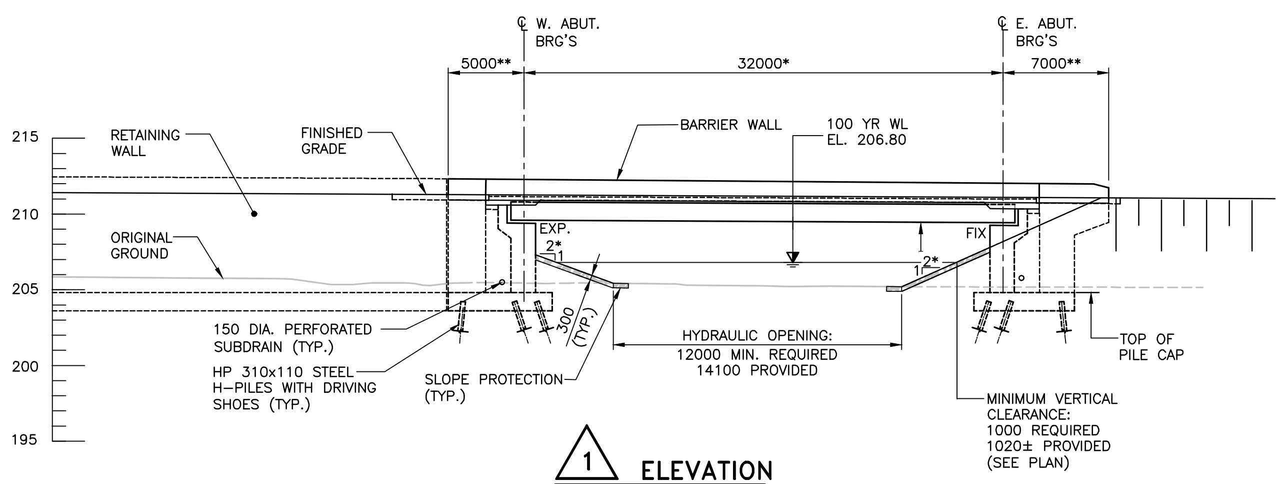


PLAN
1:500

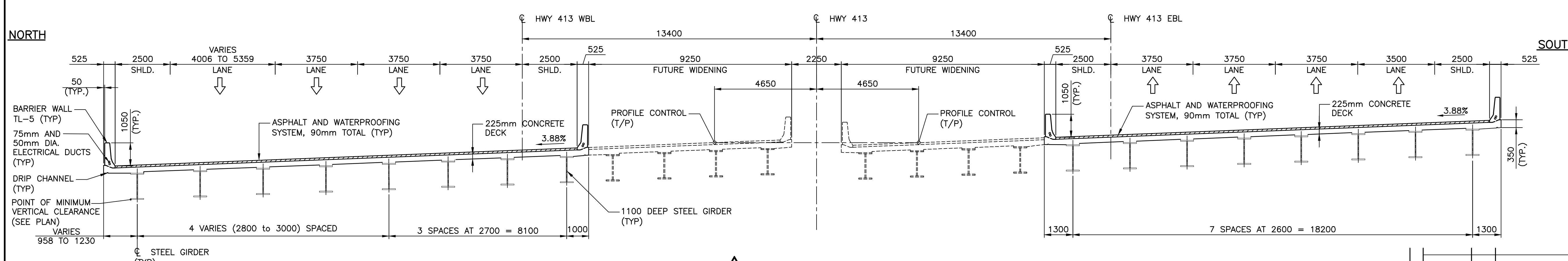
NOTE:
* DENOTES DIMENSIONS MEASURED ALONG ℄ HWY 413
** DENOTES DIMENSIONS MEASURED ALONG WINGWALL



PROFILE OF HWY 413
NTS



1 ELEVATION
1:250



2 SECTION
1:100

GENERAL NOTES:

CONCRETE:

SPECIFIED 28-DAY COMPRESSIVE STRENGTH 30 MPa

CLEAR COVER:

FOOTINGS	100 ± 25
DECK TOP	70 ± 20
BOTTOM	40 ± 10
REMAINDER (UNLESS OTHERWISE NOTED)	70 ± 20

REINFORCING STEEL

1. REINFORCING STEEL SHALL BE GRADE 500W.
2. STAINLESS REINFORCING STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500MPa, UNLESS OTHERWISE SPECIFIED.

STRUCTURAL STEEL

1. ALL STRUCTURAL STEEL SHALL CONFORM TO CSA G40.20/G40.21 GRADE 350AT.

CONSTRUCTION NOTES

1. BACKFILL SHALL NOT BE PLACED BEHIND THE ABUTMENTS UNTIL THE DECK SLAB IS IN PLACE AND HAS REACHED 70% PF ITS DESIGN STRENGTH.
2. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
3. CONSTRUCT ABUTMENTS AND WINGWALLS TO THE BEARING SEAT ELEVATIONS. THE CONTRACTOR SHALL SUPPLY TEMPORARY LATERAL BRACING FOR THE ABUTMENTS. FORMWORK AND LATERAL BRACING SHALL NOT BE REMOVED UNTIL THE CONCRETE IN DECK HAS REACHED 70% OF ITS SPECIFIED 28-DAY STRENGTH.

APPLICABLE STANDARD DRAWINGS:

OPSD 3101.150	WALLS-ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENTS
OPSD 3370.100	DECK, WATERPROOFING SYSTEM HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD
OPSD 3370.101	DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE AT ACTIVE CRACKS GREATER THAN 2mm WIDE AND CONSTRUCTION JOINTS

LEGEND:

- BANK - FLUVIAL
- EROSION RATE - FLUVIAL
- MEANDER BELT
- HYDRAULIC OPENING

LIST OF ABBREVIATIONS:

ABUT.	ABUTMENT
BRGS.	BEARINGS
E.	EAST
EBL.	EASTBOUND LANE
EL.	ELEVATION
HWY	HIGHWAY
MIN.	MINIMUM
SHLD.	SHOULDER
STA.	STATION
T/P	TOP OF PAVEMENT
TYP.	TYPICAL
U.N.O.	UNLESS NOTED OTHERWISE
YR.	YEAR
W.	WEST
WBL.	WESTBOUND LANE
WL	WATER LEVEL
WP	WORKING POINT

REVISIONS	DATE	BY	DESCRIPTION		
DESIGN H.K.	CHK J.V.	CODE CAN/CSA S6-19	LOAD CL-625-ONT	DATE APR., 2024	
DRAWN V.K.	CHK H.K.	SITE -		DWG -	

FILE NAME: Z:\RichmondHill-CARCH1\DCS\Projects\1-33017543_GTA_West_Stage_2\33017547_Bridges\900-CAD\Water Crossings\CR_LC_LEV_2_WC1 (W-W50)\W-W50A-B.dwg
MODIFIED: 2025-07-24 10:14

MINISTRY OF TRANSPORTATION, ONTARIO ANSI-D 2017-08

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN
DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

Ontario Ministry of Transportation

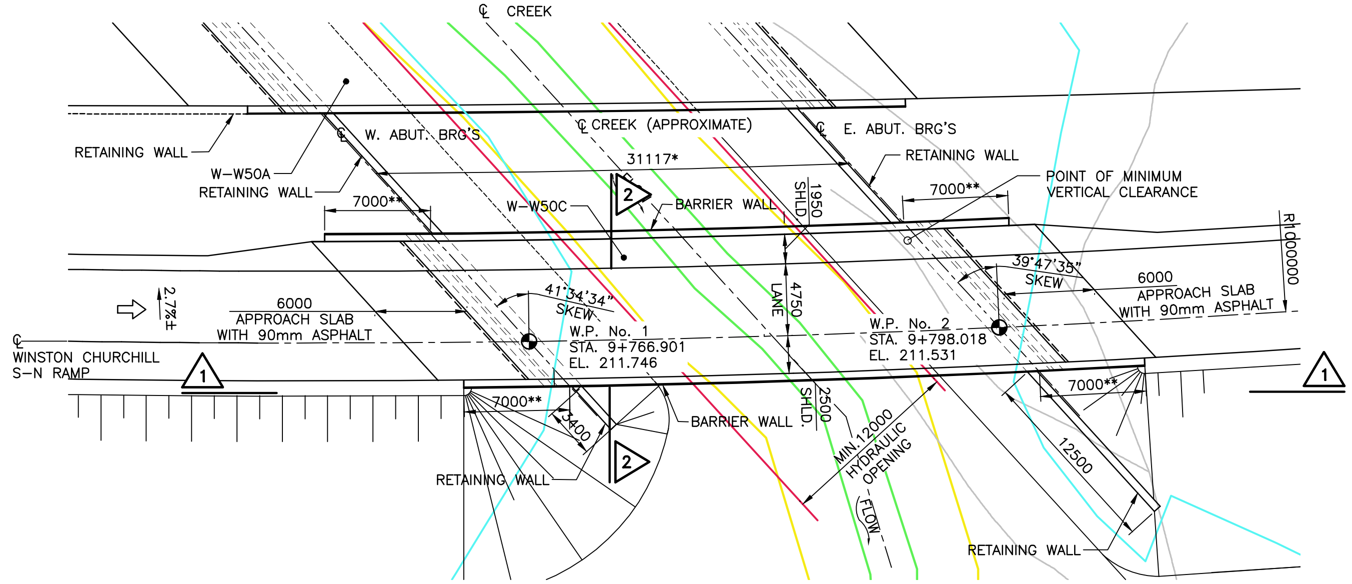
CONT
WP

HWY 413 PRELIMINARY DESIGN
W-W50C WATER CROSSING
(CR_LC_LEV_2_WC1)
GENERAL ARRANGEMENT

AECOM

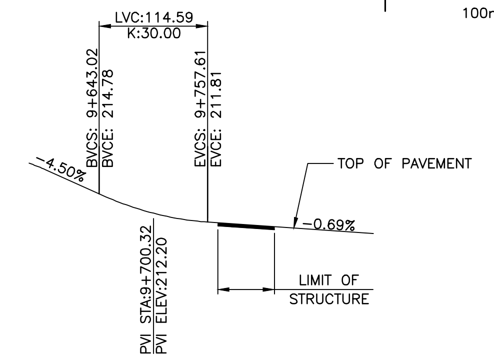
SHEET

FOR CONSTRUCTION

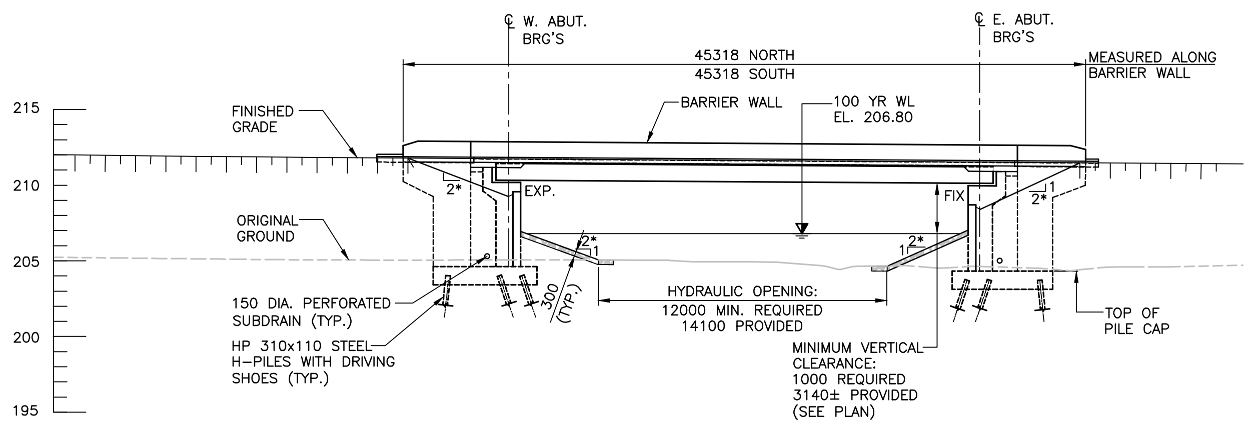


PLAN
1:250

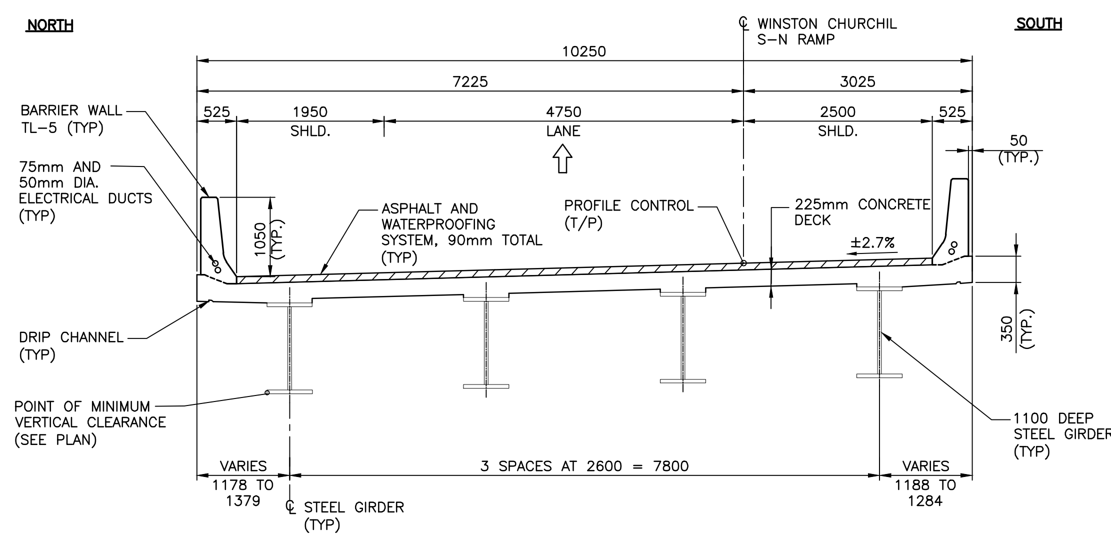
NOTE:
* DENOTES DIMENSIONS MEASURED ALONG ℄ WINSTON CHURCHILL S-N RAMP
** DENOTES DIMENSIONS MEASURED ALONG WINGWALL



PROFILE OF WINSTON CHURCHILL S-N RAMP
NTS



1 ELEVATION
1:250



2 SECTION
1:50

GENERAL NOTES:

CONCRETE:

SPECIFIED 28-DAY COMPRESSIVE STRENGTH 30 MPa

CLEAR COVER:

FOOTINGS	100 ± 25
DECK TOP	70 ± 20
BOTTOM	40 ± 10
REMAINDER (UNLESS OTHERWISE NOTED)	70 ± 20

REINFORCING STEEL

1. REINFORCING STEEL SHALL BE GRADE 500W.
2. STAINLESS REINFORCING STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500MPa, UNLESS OTHERWISE SPECIFIED.

STRUCTURAL STEEL

1. ALL STRUCTURAL STEEL SHALL CONFORM TO CSA G40.20/G40.21 GRADE 350AT.

CONSTRUCTION NOTES

1. BACKFILL SHALL NOT BE PLACED BEHIND THE ABUTMENTS UNTIL THE DECK SLAB IS IN PLACE AND HAS REACHED 70% PF ITS DESIGN STRENGTH.
2. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
3. CONSTRUCT ABUTMENTS AND WINGWALLS TO THE BEARING SEAT ELEVATIONS. THE CONTRACTOR SHALL SUPPLY TEMPORARY LATERAL BRACING FOR THE ABUTMENTS. FORMWORK AND LATERAL BRACING SHALL NOT BE REMOVED UNTIL THE CONCRETE IN DECK HAS REACHED 70% OF ITS SPECIFIED 28-DAY STRENGTH.

APPLICABLE STANDARD DRAWINGS:

OPSD 3101.150	WALLS-ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENTS
OPSD 3370.100	DECK, WATERPROOFING SYSTEM HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD
OPSD 3370.101	DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE AT ACTIVE CRACKS GREATER THAN 2mm WIDE AND CONSTRUCTION JOINTS

LEGEND:

- BANK - FLUVIAL
- EROSION RATE - FLUVIAL
- MEANDER BELT
- HYDRAULIC OPENING

LIST OF ABBREVIATIONS:

ABUT.	ABUTMENT
BRGS.	BEARINGS
E.	EAST
EBL.	EASTBOUND LANE
EL.	ELEVATION
HWY	HIGHWAY
MIN.	MINIMUM
SHLD.	SHOULDER
STA.	STATION
T/P	TOP OF PAVEMENT
TYP.	TYPICAL
U.N.O.	UNLESS NOTED OTHERWISE
YR.	YEAR
W.	WEST
WBL.	WESTBOUND LANE
WL	WATER LEVEL
WP	WORKING POINT

REVISIONS

DATE	BY	DESCRIPTION

DESIGN	H.K.	CHK	J.V.	CODE CAN/CSA S6-19	LOAD CL-625-ONT	DATE	APR.2024
DRAWN	V.K.	CHK	H.K.	SITE	-	DWG	-

FILE NAME: Z:\RichmondHill-CARCH1\DCS\Projects\1-33017543_GTA_West_Stage_2\33017547_Bridges\900-CAD\Water Crossings\CR_LC_LEV_2_WC1 (W-W50)\W-W50C.dwg
MODIFIED: 2025-07-24 10:19

MINISTRY OF TRANSPORTATION, ONTARIO ANSI-D 2017-08

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN
DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

Ontario

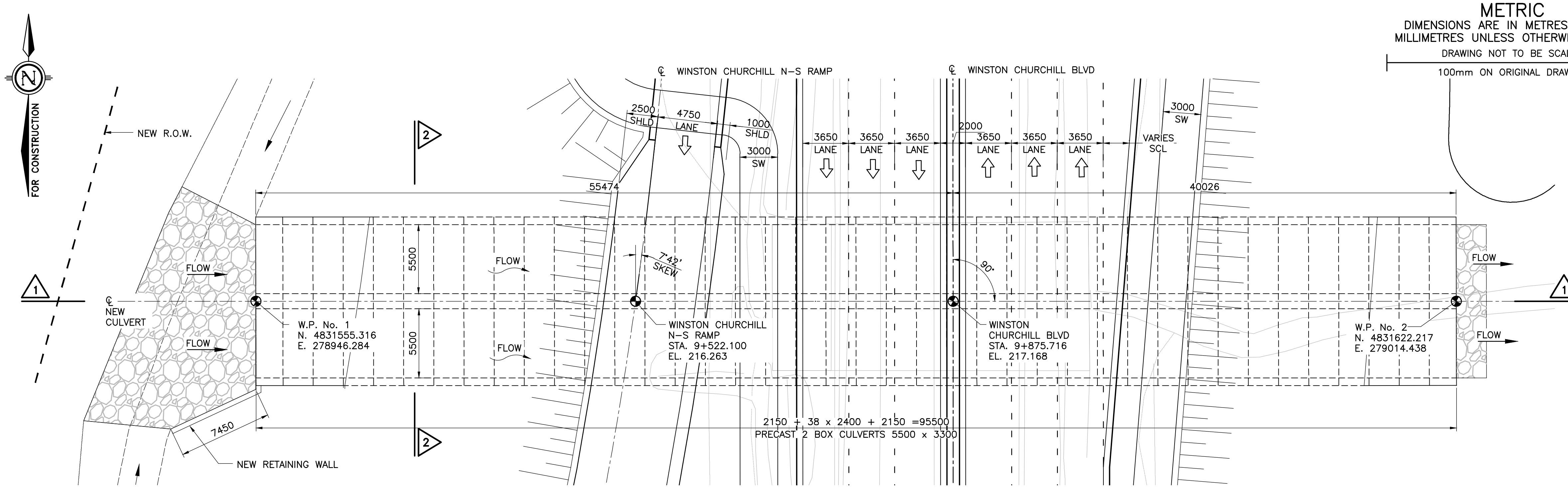
CONT
WP

HWY 413 PRELIMINARY DESIGN
W-W51 CULVERT
(CR_LC_LEV_2_WC1.1)
GENERAL ARRANGEMENT

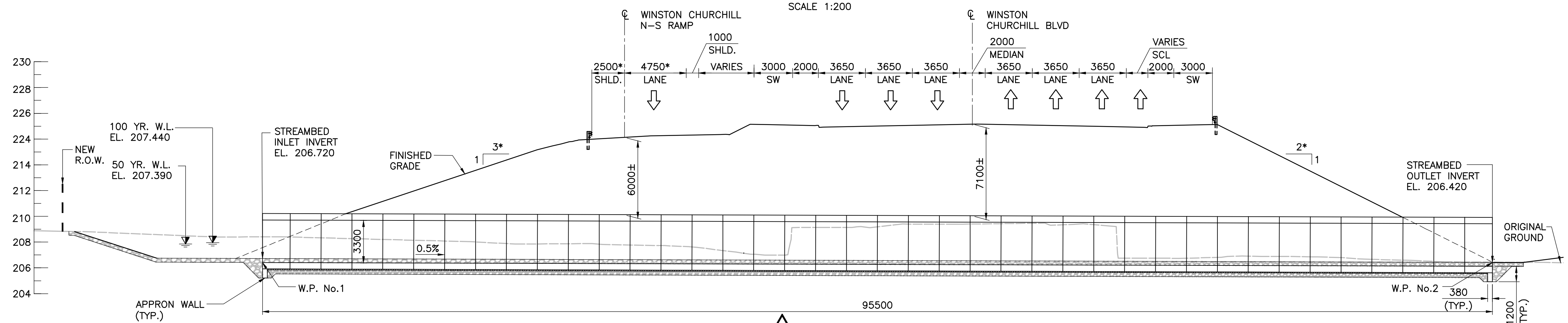
SHEET

AECOM

FOR CONSTRUCTION

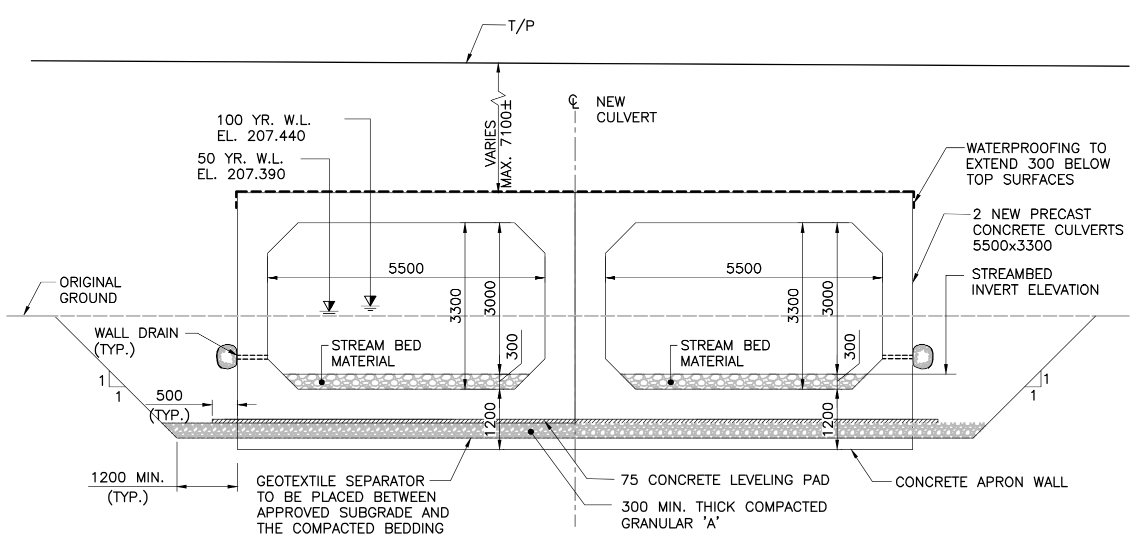


PLAN
SCALE 1:200

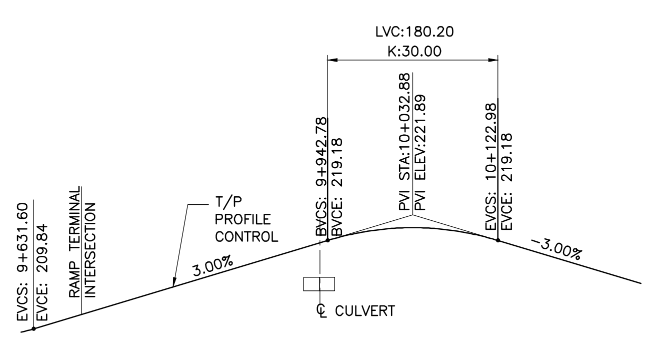


1 ELEVATION
1:200

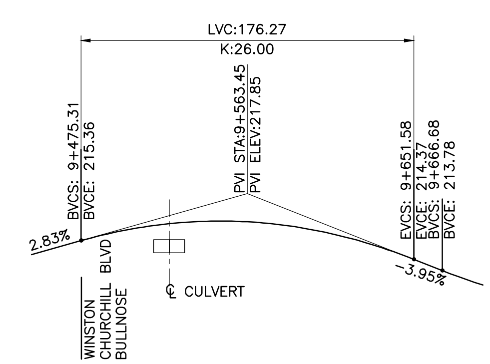
NOTE:
* DENOTES DIMENSIONS MEASURED PERPENDICULAR TO ℄ OF WINSTON CHURCHILL N-S RAMP.



2 SECTION
1:75



PROFILE OF WINSTON CHURCHILL BLVD
NTS



PROFILE OF WINSTON CHURCHILL RAMP N-S
NTS

GENERAL NOTES:

CONCRETE:

SPECIFIED 28-DAY COMPRESSIVE STRENGTH:

PRECAST CONCRETE	45 MPa
REMAINDER	30 MPa

CLEAR COVER:

BOTTOM OF TOP SLAB	40 ± 10 FOR SLABS <300 THICK 50 ± 10 FOR SLABS >300 THICK
BOTTOM OF BOTTOM SLAB	100 ± 25
REMAINDER	60 ± 20 UNLESS OTHERWISE NOTED

REINFORCING STEEL

1. REINFORCING STEEL SHALL BE GRADE 500W UNLESS OTHERWISE SPECIFIED.

CONSTRUCTION NOTES

1. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH SIDES OF CULVERT KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
2. SUPPORTS FOR REINFORCING STEEL SHALL BE AS PER OPSD-3329.101 AND OPSD-3329.100 ON FORMED SURFACES. ON NON-FORMED SURFACES, CONCRETE BLOCKS (MIN. 20MPa) SHALL BE USED.

APPLICABLE STANDARD DRAWINGS:

OPSD 803.010	BACKFILL AND COVER FOR CONCRETE CULVERTS
OPSD 3941.200	FIGURES IN CONCRETE SITE NUMBER AND DATE LAYOUT

LIST OF ABBREVIATIONS:

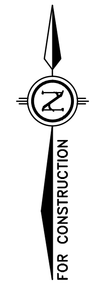
EL.	ELEVATION
HWY	HIGHWAY
MIN.	MINIMUM
SHLD.	SHOULDER
STA.	STATION
T/P	TOP OF PAVEMENT
TYP.	TYPICAL
U.N.O.	UNLESS NOTED OTHERWISE
W.L.	WATER LEVEL
W.P.	WORKING POINT
YR.	YEAR

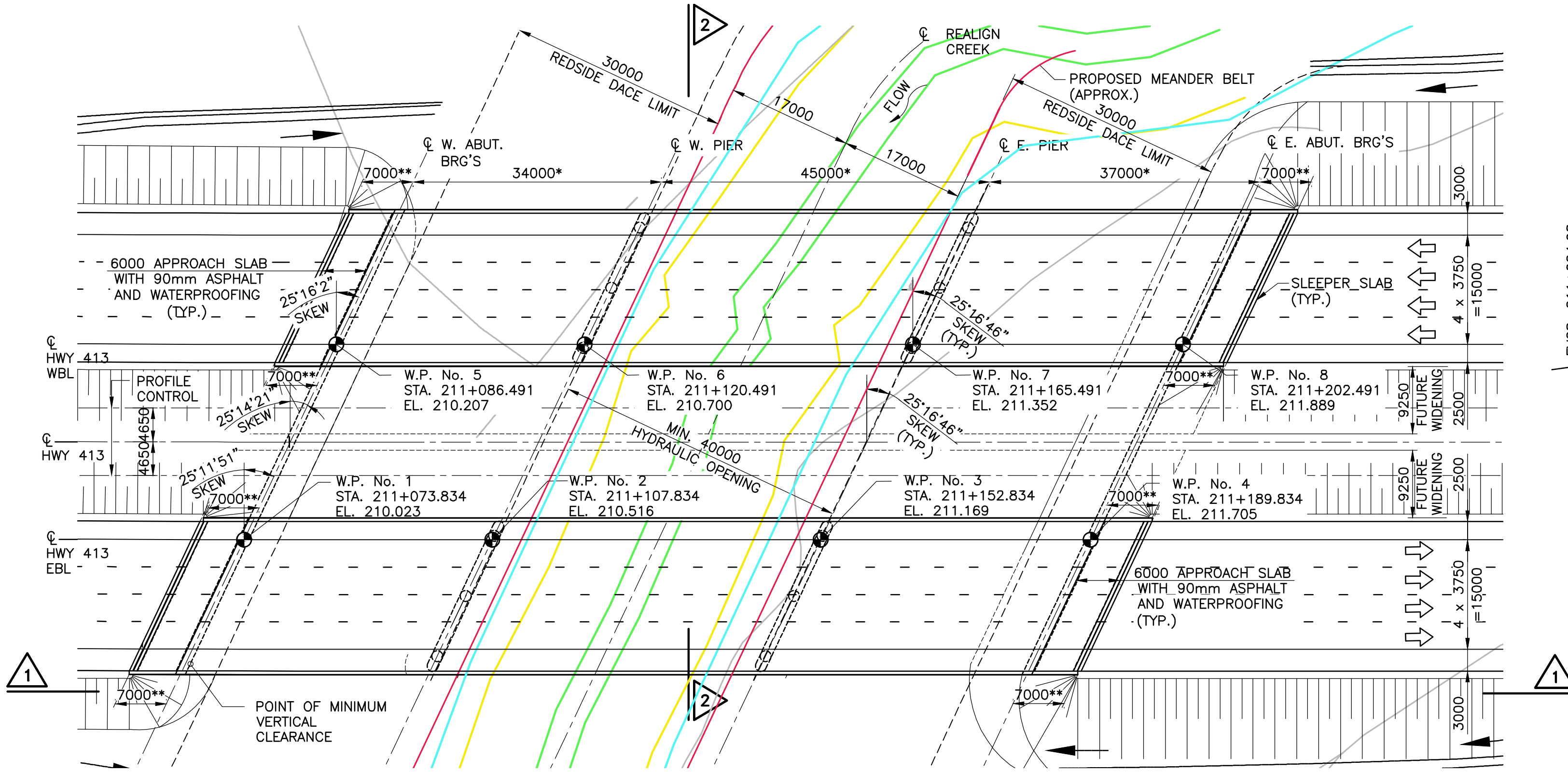
REVISIONS	DATE	BY	DESCRIPTION

DESIGN H.K.	CHK J.V.	CODE CAN/CSA S6-19	LOAD CL-625-ONT	DATE DEC. 2024
DRAWN V.K.	CHK H.K.	SITE -		DWG -

FILE NAME: C:\Users\Kromoric\OneDrive - AECOM_01 60315006-MTO HWY 413-WHITBY\Sheets\G3 CULVERTS\W-W51 (LEV_2_WC1.1).DWG
MODIFIED: 2025-04-22 10:29

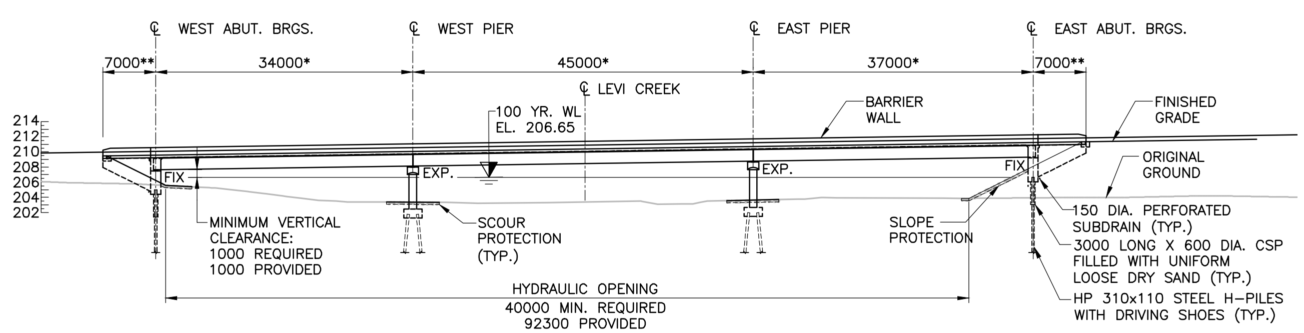
MINISTRY OF TRANSPORTATION, ONTARIO
ANS-D
2017-08



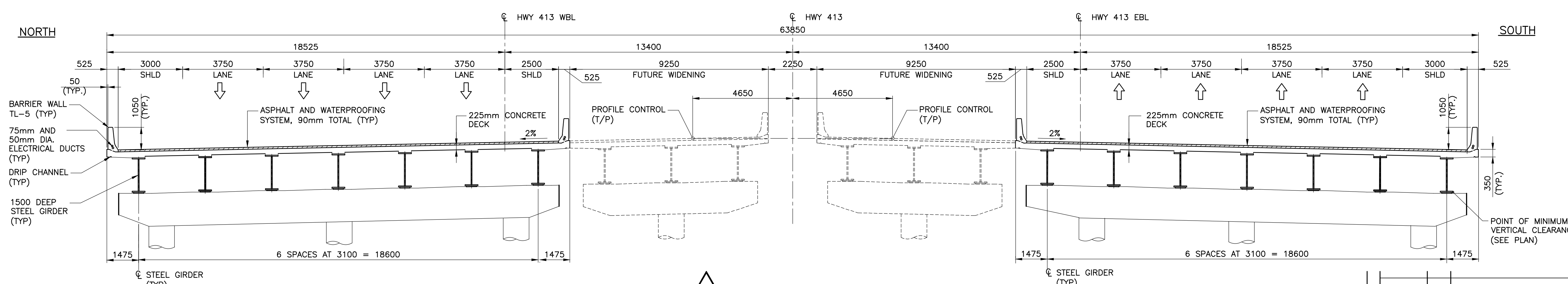


PLAN
1:500

NOTE:
* DENOTES DIMENSIONS MEASURED ALONG ℄ HWY 413
** DENOTES DIMENSIONS MEASURED ALONG WINGWALL

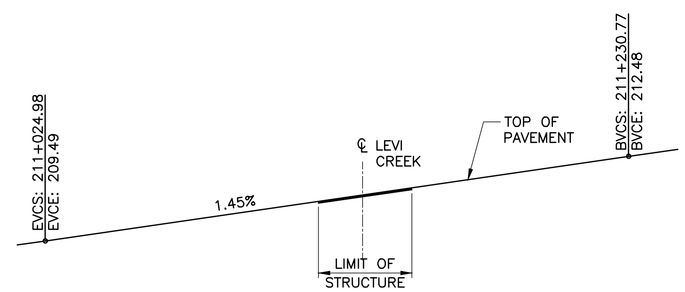


1 ELEVATION
1:500



2 SECTION
1:100

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN
DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING



PROFILE OF HWY 413
NTS

LEGEND:

BANK – FLUVIAL	green line
EROSION RATE – FLUVIAL	yellow line
MEANDER BELT	cyan line
HYDRAULIC OPENING	red line

LIST OF ABBREVIATIONS:

ABUT.	ABUTMENT
BRGS.	BEARINGS
EBL.	EASTBOUND LANE
EL.	ELEVATION
HWY	HIGHWAY
MIN.	MINIMUM
SHLD.	SHOULDER
STA.	STATION
T/P	TOP OF PAVEMENT
TYP.	TYPICAL
U.N.O.	UNLESS NOTED OTHERWISE
YR.	YEAR
W.	WEST
WBL.	WESTBOUND LANE
WL	WATER LEVEL
WP	WORKING POINT

Ontario Ministry of Transportation

CONT
WP

HWY 413 PRELIMINARY DESIGN
W-W56A & B WATER CROSSING
(CR_LC_LEV_0_WC2)
GENERAL ARRANGEMENT

SHEET

AECOM

GENERAL NOTES:

CONCRETE:

SPECIFIED 28-DAY COMPRESSIVE STRENGTH 30 MPa

CLEAR COVER:

FOOTINGS	100 ± 25
DECK TOP	70 ± 20
BOTTOM	40 ± 10
PIER COLUMNS	70 ± 10
REMAINDER (UNLESS OTHERWISE NOTED)	70 ± 20

REINFORCING STEEL

1. REINFORCING STEEL SHALL BE GRADE 500W.
2. STAINLESS REINFORCING STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500MPa, UNLESS OTHERWISE SPECIFIED.

STRUCTURAL STEEL

1. ALL STRUCTURAL STEEL SHALL CONFORM TO CSA G40.20/G40.21 GRADE 350AT.

CONSTRUCTION NOTES

1. BACKFILL SHALL NOT BE PLACED BEHIND THE ABUTMENTS UNTIL THE DECK SLAB IS IN PLACE AND HAS REACHED 70% PF ITS DESIGN STRENGTH.
2. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
3. CONSTRUCT ABUTMENTS AND WINGWALLS TO THE BEARING SEAT ELEVATIONS. THE CONTRACTOR SHALL SUPPLY TEMPORARY LATERAL BRACING FOR THE ABUTMENTS. FORMWORK AND LATERAL BRACING SHALL NOT BE REMOVED UNTIL THE CONCRETE IN DECK HAS REACHED 70% OF ITS SPECIFIED 28-DAY STRENGTH.

APPLICABLE STANDARD DRAWINGS:

OPSD 3101.150	WALLS–ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENTS
OPSD 3370.100	DECK, WATERPROOFING SYSTEM HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD
OPSD 3370.101	DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE AT ACTIVE CRACKS GREATER THAN 2mm WIDE AND CONSTRUCTION JOINTS
OPSD 3390.100	DECK DRIP CHANNEL

REVISIONS	DATE	BY	DESCRIPTION

DESIGN H.K.	CHK J.V.	CODE CAN/CSA S6-19	LOAD CL-625-ONT	DATE APR., 2024
DRAWN V.K.	CHK H.K.	SITE –		DWG –

FILE NAME: Z:\RichmondHill-CARCH1\DCS\Projects\1-33017543_GTA_West_Stage_2\33017547_Bridges\900-CAD\Water Crossings\CR_LC_LEV_0_WC2 (W-W56)\W-W56A_B.dwg
MODIFIED: 2025-07-24 09:58

MINISTRY OF TRANSPORTATION, ONTARIO ANG–D 2017–08