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Appendix Q - Part 1

Stormwater Management Assessment Report

BURNSIDE

Stormwater Management, Drainage, and Hydrology Assessment Report for Warden Avenue and Kennedy Road Environmental Assessment Studies between Major Mackenzie Drive East and Elgin Mills Road East

Regional Municipality of York
Markham ON

Stormwater Management, Drainage, and Hydrology Assessment Report for Warden Avenue and Kennedy Road Environmental Assessment Studies between Major Mackenzie Drive East and Elgin Mills Road East

Regional Municipality of York
Markham ON

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August 2023
300052314.0000

Distribution List

No. of Hard Copies	PDF	Email	Organization Name
0	Yes	Yes	The Regional Municipality of York

Record of Revisions

Revision	Date	Description
0	January 11, 2023	Draft Submission to Regional Municipality of York
1	April 11, 2023	Final Draft Submission to Regional Municipality of York
2	August 11, 2023	Final Submission to Regional Municipality of York

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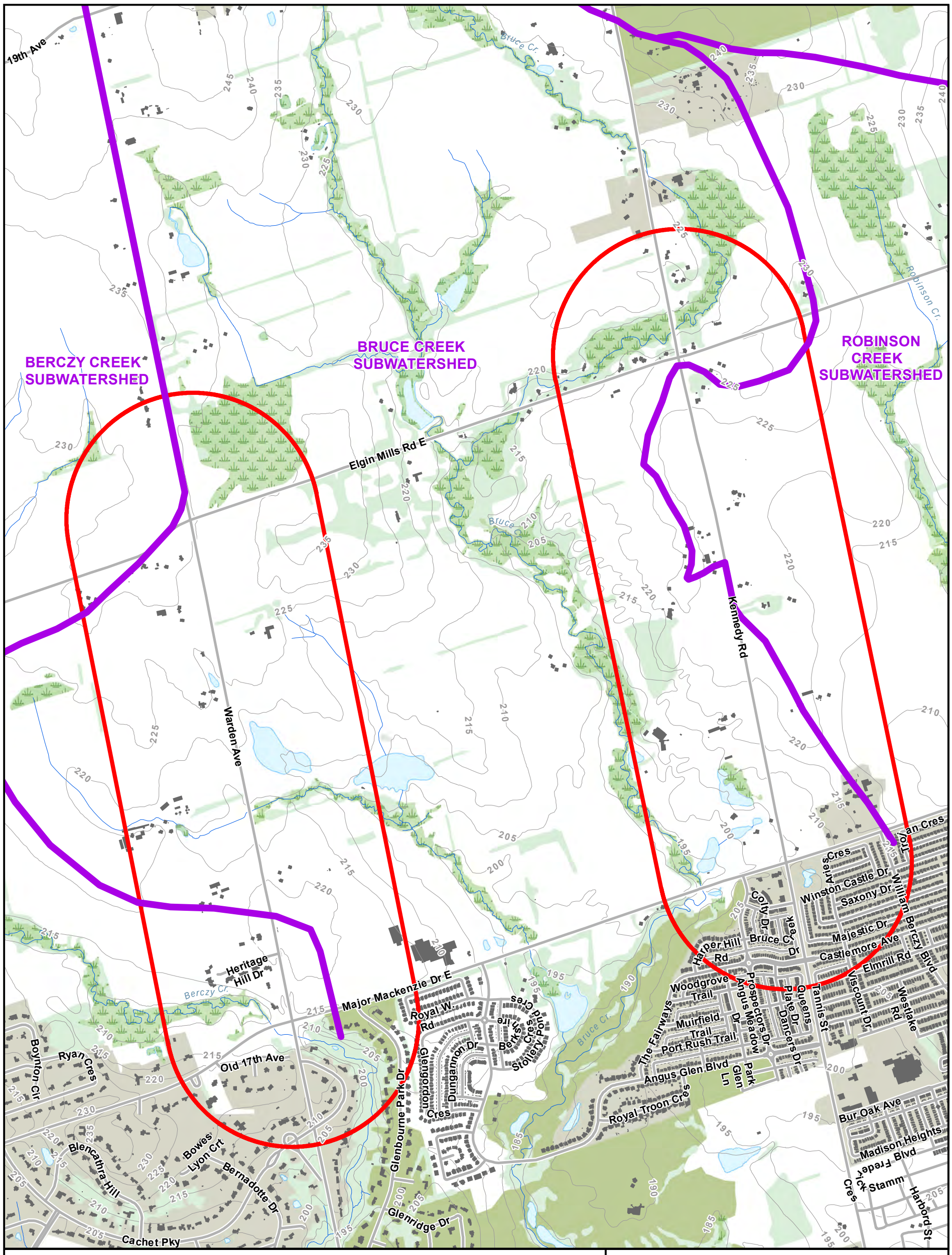
Disclaimer

1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) has been retained by the Regional Municipality of York to provide a Stormwater Management, Drainage and Hydrology Assessment in support of the Class Environmental Assessment (EA) Studies for the proposed improvements to Warden Avenue and Kennedy Road from Major Mackenzie Drive to Elgin Mills Road, in the City of Markham. The purpose of this Report is to develop a strategic approach to stormwater management (SWM) in the Study Areas that will identify and evaluate existing drainage patterns and transverse culvert and bridge locations, identify potential stormwater runoff quality and quantity impacts to the receiving watercourses from any potential increase in pavement area and propose an appropriate drainage system, transverse culvert and bridge upgrades, and a SWM system in conjunction with the proposed road widenings to mitigate any potential impacts.

1.1 Study Areas

The Study Areas for the Class EA Studies are illustrated on Figure 1 and include lands within 500 m of the subject roads of Warden Avenue and Kennedy Road between Major Mackenzie Drive East and Elgin Mills Road East in the City of Markham. The Warden Avenue Study Area includes 65 m south of Major Mackenzie Drive and the Kennedy Road Study Area also includes a segment of road 120 m north of Elgin Mills Road; however, the proposed road improvement areas for Warden Avenue and Kennedy Road are limited to the segments between Major Mackenzie Drive East and Elgin Mills Road East. The proposed road improvements will be limited to the proposed right of way (ROW) along the roads and will not extend into private properties, with the exception of grading within a future established grading easement. The width of the ROW in the areas to be improved is expected to be 41 m mid block and 43 m at intersections.



LEGEND

- STUDY AREAS
- SUBWATERSHED BOUNDARY
- BUILDING
- ROADWAY
- CONTOUR (5m intervals - masl)
- WATERCOURSE
- WETLAND
- OPEN WATER
- WOODED AREA
- BUILT-UP AREA: IMPERVIOUS
- BUILT-UP AREA: PERVIOUS

Sources:
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Client / Report

CITY OF MARKHAM
MARKHAM, ONTARIO

WARDEN AVENUE & KENNEDY ROAD EA STUDIES
STORMWATER MANAGEMENT, DRAINAGE & HYDROLOGY ASSESSMENT
HYDROGEOLOGICAL ASSESSMENT

Figure Title

STUDY AREAS

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1.2 Background Information

A Subwatershed Study (North Markham Future Urban Areas Subwatershed Study, City of Markham, Amec Foster Wheeler Environment and Infrastructure – FUA SWS) was completed in 2019 and forms the basis of the background information utilized for this Report. The relevant SWM Design criteria documents are listed below:

- York Region Road Design Guidelines, York Region Transportation Services, December 2020;
- TRCA Stormwater Management Criteria, Toronto and Region Conservation Authority, August 2012;
- Stormwater Management Planning and Design Manual, Ontario Ministry of Environment, March 2003; and
- Low Impact Development Stormwater Management Planning and Design Guide, Credit Valley Conservation and Toronto and Region Conservation Authority, 2010.

2.0 Existing Drainage Conditions

2.1 Watershed and Subwatersheds

The Study Areas are located in the Rouge River watershed within the jurisdiction of the Toronto and Region Conservation Authority (TRCA) and occupies portions of the Berczy Creek, Bruce Creek, and Robinson Creek subwatersheds. Warden Avenue is within the Bruce and Berczy Creek subwatersheds; Kennedy Road is within the Bruce and Robinson Creek subwatersheds.

2.2 Topography and Drainage Patterns

The Study Areas are characterized by gently sloped topography with slopes generally being southwards towards the watercourse valleys. Hydrologic modeling using PCSWMM software was included in the FUA SWS.

2.3 Hydrogeological Conditions

A Hydrogeological Assessment was completed in support of the Warden Avenue and Kennedy Road EA Studies by Burnside.

The shallow groundwater in the Study Areas has been observed in previous hydrogeological and geotechnical studies. Groundwater levels were also measured in wells along the road alignments by the Region in May 2021. A review of available groundwater data indicates that along Warden Avenue groundwater elevations range from 212 masl to 227 masl with depths ranging from <1 mbgs to 5 mbgs. Similarly, available groundwater data indicates that along Kennedy Road, groundwater elevations range from 202 masl to 221 masl with depths ranging from <1 mbgs to 9 mbgs. Most of

the land along Kennedy Road is shown as having groundwater levels between 2 m and greater than 4 mbgs.

2.4 Aquatic Resources

Along Warden Avenue, a tributary of Bruce Creek crosses approximately 825 m north of Major Mackenzie Drive flowing in the southeast direction. The main branch of Berczy Creek also flows across Warden Avenue, south of Major Mackenzie Drive. Along Kennedy Road, there are no watercourse crossings except for Bruce Creek, which crosses just north of Elgin Mills Road. Both roads include other road crossing culverts which are not associated with watercourses.

Bruce Creek provides habitat for 25 fish species within or in close proximity to the North Markham FUA. Most of the fish species located within Bruce Creek system are a mix of warmwater, coolwater, and coldwater species. The Bruce Creek tributary within the Study Area is designated as contributing habitat for Redside Dace (*Clinostomus elongatus*), a provincially Endangered Species. Berczy Creek provides habitat for 22 fish species within or close to the North Markham FUA (AMEC 2015) including Redside Dace. Both Berczy and Bruce Creek provide good quality habitat for all life stages (including spawning, rearing, feeding, refuge, and migration) for the several fish identified. The Berczy Creek and Bruce Creek Redside Dace population is considered one of the three most significant in Ecodistricts 7E4 and 7E.

In July 2015 and subsequently in May 2016, Beacon and the Berczy Glen Landowner's Consultants (along with Ministry of Northern Development and Mines, Natural Resources and Forestry (NDMNRF), TRCA, and City staff) conducted a fish community survey to confirm presence / absence of fish within the upstream portion of Bruce Creek Tributary on the west side of Warden Avenue. No fish were captured during the fish sampling activities. Fish community sampling was not conducted in Berczy Creek due to the presence of Redside Dace and abundance of background information.

2.5 Transverse Drainage Crossings (Warden Avenue)

One watercourse crossing exists within the Study Areas, where the Bruce Creek Tributary crosses Warden Avenue approximately 825 m north of Major Mackenzie Drive. This crossing consists of two 600 mm diameter CSP culverts and is regulated by the TRCA with an associated Regional floodplain. The HEC-RAS hydraulic modeling, and the Rouge River Floodplain Mapping Update – Phase 2, prepared by Wood (March 2020) were provided to Burnside by the TRCA. The Hydraulic Structure Inventory Sheet for this crossing (rou_529) as provided in the Rouge River Floodplain Mapping Update (FMU) is included in Appendix A.

The existing watercourse crossing of Warden Avenue, approximately 60 m south of Major Mackenzie Drive, is not included in this analysis, as it is outside of the scope of this EA.

2.5.1 Existing Condition Summary

Visual inspection of these culverts did not identify any condition concerns, or any signs of erosion or scouring. A formal inspection was not completed, and a structural assessment was not warranted for this size of culvert.

2.5.2 Assessment Criteria

Road crossing culvert criteria is identified in the 2023 York Region Design Guidelines. The minimum culvert size is stated as 750 mm diameter, with concrete or HDPE material. Culverts over 1500 mm diameter are to be concrete; however, floodline and fish passage requirements may restrict the use of HDPE culverts. Design storm frequency is to be based on the 2008 MTO Highway Drainage Design Standards.

MTO Drainage Design Standard WC-1 specifies design flows for bridges and culverts. The proposed classification for Warden Avenue would fall under “Urban Arterial”, which requires conveyance of the 50-year storm for spans less than or equal to 6.0 m, and the 100-year storm for spans greater than 6.0 m. The check flow for scour is 130% of the 100-year storm.

The minimum required freeboard, as measured from the energy gradeline elevation for the design flow to the edge of travelled lane is 1.0 m for an urban arterial road, per MTO Drainage Design Standard WC-2 (Freeboard and Clearance at Bridge Crossings) and WC-7 (Culvert Crossings on a Watercourse). Similarly, these standards also specify the minimum required clearance for open-footing culverts, as measured from the high water level for the design flow to the lowest point on the soffit is 0.3 m. Where the structure is required to convey the Regulatory Flow, clearance shall be based on the design flows noted in WC-1 above.

As the crossing is located within the TRCA regulated area, the hydraulic analysis must also demonstrate that there will be no increase in the Regional floodplain elevation upstream of the crossing. The objectives of the TRCA Crossings Guideline for Valley and Stream Corridors will also be achieved for natural hazards and natural heritage.

2.5.3 Hydraulic Assessment of Existing Transverse Drainage Crossings

The TRCA HEC-RAS model and Rouge River Floodplain Mapping Update Report (FMU) were obtained from the TRCA through a data request. This model forms the basis for the Hydraulic Assessment of the Warden Avenue crossing. The crossing in the model is located at Bruce Creek Tributary A / Reach A1, Station 2200.14. Appendix A includes

floodplain mapping from the FMU to show the station locations and estimated floodplain extents.

Peak flow rates established in the FMU were used in the analysis. Present peak flow rates are anticipated to be maintained. Table 1 below summarizes the hydraulic analysis results from the FMU.

Table 1: FMU Hydraulic Analysis Results

Storm	Total Flow (m^3/s)	W.S. Elevation (m)
2-Year	0.05	213.54
5-Year	0.08	213.58
10-Year	0.51	213.94
25-Year	1.04	214.41
50-Year	1.44	214.45
100-Year	3.41	214.51
Regional	15.39	214.66

*Total Flows and W.S. Elevations at Station 2209.84, upstream of the culvert.

The existing HEC-RAS model was updated with surveyed existing road centreline elevations and culvert inverts. The FMU model includes twin 600 mm diameter CSP culverts; however, survey data indicates these culverts are 700 mm diameter. As a conservative approach to establish the existing Regional floodplain, the larger size of existing culverts was used. Table 2 below summarizes the updated hydraulic analysis results.

Table 2: Updated Hydraulic Analysis Existing Results

Storm	Total Flow (m^3/s)	W.S. Elevation (m)
2-Year	0.05	213.46
5-Year	0.08	213.47
10-Year	0.51	213.69
25-Year	1.04	214.02
50-Year	1.44	214.29
100-Year	3.41	214.53
Regional	15.39	214.67

As part of the road improvement works, to accommodate servicing and an urban cross-section, Warden Avenue is expected to be raised from its existing profile. A preliminary proposed road profile has been established, with elevations approximately up to 1.0 m above existing. The existing low point elevation is 214.41 m; therefore, raising the centreline by more than 0.26 m would prevent any overflow below the existing Regional floodplain elevation of 214.67 m.

The preliminary proposed road profile is subject to further review and refinement at Detailed Design. As a conservative approach, we have assumed the proposed

centreline will be higher than the existing Regional flood elevation, and no road overtopping will occur. To maintain the existing Regional floodplain elevation, all flows including the Regional storm, will be conveyed below the road, through the proposed culvert opening.

The proposed model incorporates the raised road centreline and longer culvert to accommodate the proposed road improvements and widening. To fit the longer culvert and wider roadway into the model, the sections immediately upstream and downstream of the culvert (2209.84 and 2188.97) were removed from the proposed model (refer to Appendix A Figures). Adjacent upstream and downstream sections (2215.47 and 2182.64) were shifted 9 m away from the road to accommodate the proposed widening, resulting in new Sections 2224.47 and 2173.64.

Through iterations of available culvert sizes, a three-sided rigid frame precast concrete culvert with a 9.1 m span and 1.5 m rise was chosen to provide Regional conveyance without increasing the upstream floodplain elevation. This structure was modeled with a blocked depth of 0.45 m, providing a 1.05 m high opening, while allowing sufficient cover to the proposed road deck. A summary of the results, and comparison to the assessment criteria noted above, is provided in Table 3 below.

Table 3: Summary of Hydraulic Assessment Results

Criteria	Target WS (m)	Target Description	Modeled Storm WS (m)	Difference (m)
WC-1: Conveyance of 100-year storm without overtopping	215.18	Proposed road elevation	213.92	1.26
WC-2: Freeboard of 1.0 m between 100-year storm and travelled lane	214.06	1 m below travelled lane	213.92	0.14
WC-7 Clearance of 0.3 m between 100-year storm and culvert soffit	214.10	0.3 m below soffit	213.92	0.18
Proposed Regional flood elevation to be equal to or less than existing	214.67	Existing Regional elevation upstream of culvert	214.64	0.03

As shown in Table 3 above, the proposed 9.1 m span x 1.5 m rise open-bottom culvert has sufficient capacity to meet the applicable road-crossing criteria established by York Region and the TRCA. Detailed output from the HEC-RAS hydraulic modeling is included in Appendix A.

The wide span, three-sided, open-bottom culvert is well-suited for creating a naturalized watercourse within the culvert and can also allow for a range of wildlife passage if

necessary. Any requirements for these considerations will be reviewed and addressed during the Detailed Design phase of the project.

3.0 Proposed Drainage Conditions

3.1 Roadway Drainage System

Both Warden Avenue and Kennedy Road are currently rural cross-sections with roadside ditches on both sides. Some curbing exists at the intersections with Major Mackenzie Drive and Elgin Mills Road, and Kennedy Road has an urban cross-section from the existing Angus Glen Golf Club entrance to Major Mackenzie Drive.

The existing ROWs vary in width, but the proposed 41 m ROW is considered for comparison with the proposed condition. The existing paved roadway is approximately 9.75 m wide, with an additional 2 m of gravel shoulder on each side. Over the 41 m ROW, this results in a 30% imperviousness across a typical section; however, imperviousness increases at the existing intersections. The imperviousness for each catchment area was calculated based on measurements from aerial photography and survey data.

Major and minor runoff from Warden Avenue currently discharges to one of three locations: the existing 900 mm diameter culvert crossing 700 m south of Elgin Mills Road; the existing Bruce Creek Tributary 825 m north of Major Mackenzie Drive; and the existing storm system at Major Mackenzie Drive to the south. A summary of the existing Warden Avenue drainage system is provided in Table 4 below.

Table 4: Existing Warden Avenue Drainage

Outlet Location	Length of Road (m)	Catchment Area (ha)	Imperviousness	
			(%)	Area (ha)
Existing Culvert 700 m South of Elgin Mills Road	780	3.20	31	1.00
Bruce Creek Tributary	880	3.61	27	0.97
Major Mackenzie Drive Storm System	360	1.48	51	0.75

Major and minor runoff from Kennedy Road currently discharges to one of three locations: Elgin Mills Road ditch system to the north; an existing 900 mm diameter culvert at a low point in the road 290 m south of Elgin Mills Road; and the existing storm system at Major Mackenzie Drive to the south. A summary of the existing Kennedy Road drainage system is provided in Table 5 below.

Table 5: Existing Kennedy Road Drainage

Outlet Location	Length of Road (m)	Catchment Area (ha)	Imperviousness	
			(%)	Area (ha)
Elgin Mills Road	125	0.51	54	0.28
Existing Culvert 290 m South of Elgin Mills Road	350	1.44	32	0.46
Major Mackenzie Drive Storm System	1,605	6.59	36	2.37

The Preferred Road Design concept proposes the following cross-section:

- Widen existing two lanes to four lanes with a 1 m centre median;
- Add 1.5 m sidewalk to each side; and
- Add 1.8 m cycle track to each side.

Across the 41 m ROW, this results in a 53% imperviousness, across a typical section; however, imperviousness increases at the existing and proposed intersections. The imperviousness for each catchment area was calculated based on measurements from the preliminary design plans.

The existing roadside ditches are to be replaced with curb and gutter drainage, including a minor storm sewer system. The outlet locations and associated catchment areas are generally maintained with the exception of the 900 mm diameter culvert crossing Kennedy Road 290 m south of Elgin Mills Road.

The drainage areas and associated outlet locations for Warden Avenue are expected to be maintained. A summary of the Proposed Drainage System for Warden Avenue is provided in Table 6 below.

Table 6: Proposed Warden Avenue Drainage

Outlet Location	Length of Road (m)	Catchment Area (ha)	Imperviousness	
			(%)	Area (ha)
Existing Culvert 700 m South of Elgin Mills Road	760	3.12	66	2.06
Bruce Creek Tributary	900	3.69	66	2.44
Major Mackenzie Drive Storm System	360	1.48	64	0.95

Due to the anticipated development of the Angus Glen and Robinson Glen properties, the existing Kennedy Road low point 290 m south of Elgin Mills is to be raised and the culvert eliminated (Refer to Kennedy Road – North Drainage Review Memo prepared by Burnside November 1, 2022 included in Appendix B). By eliminating this low point, an

additional 0.54 ha will be directed to the Elgin Mills Road outlet, and an additional 0.89 ha to the Major Mackenzie Road outlet. SWM quantity controls will be implemented in the ROW to retain runoff such that existing flow rates are not exceeded. A summary of the Proposed Drainage System for Kennedy Road is provided in Table 7 below.

Table 7: Proposed Kennedy Road Drainage

Outlet Location	Length of Road (m)	Catchment Area (ha)	Imperviousness	
			(%)	Area (ha)
Elgin Mills Road	255	1.05	59	0.62
Major Mackenzie Drive Storm System	1,825	7.48	63	4.71

The proposed increases in impervious area and redirection of flows will result in increased runoff from the ROW. Mitigation strategies are described in Section 4.0.

4.0 Stormwater Management Strategy

4.1 Stormwater Management Criteria

The Stormwater Management Design is to conform to the standards of the Region of York, City of Markham, TRCA, and MECP. These standards include:

- Control post-development peak flow rates to the existing rates or lower;
- Provide an enhanced level (80% TSS removal) of quality control for ROW runoff; and
- Provide erosion control for the first flush storm.

The North Markham Future Urban Areas Subwatershed Study provides criteria for quantity and erosion control volumes; however, through discussion with the TRCA, it was determined these volumes apply to the surrounding lands where SWM ponds are implemented. For the purposes of this Report, the majority of the of the ROW drainage is considered to be generally self-contained and controlled as described above.

A 2.44 ha portion of Warden Avenue is proposed to drain to stormwater management ponds in the Berczy Warden subdivision for quantity and quality control. A stormwater management design for this subdivision is currently being prepared by SCS Consulting Group Ltd.

4.1.1 Erosion Control and Water Balance

The typical TRCA requirement for water balance and erosion control is to retain the initial 5 mm runoff volume. As part of the hydrologic modeling for the ROW SWM Assessment, the 4-hour 25 mm Chicago storm was run, which provided the anticipated 25 mm storm runoff volume. Table 8 below provides a summary of the available infiltration volume for each outlet segment of road.

Table 8: Infiltration Volume Summary

Road	Outlet Location	Drainage Area (ha)	25 mm Runoff Volume (m^3)	Available Infiltration Storage Volume (m^3)
Warden Avenue	Culvert Outlet	3.12	498	779
Warden Avenue	Bruce Creek Tributary	3.69	601	272*
Warden Avenue	Major Mackenzie	1.48	241	238
Kennedy Road	Elgin Mills	1.05	162	254
Kennedy Road	Major Mackenzie	7.48	1,135	1,819

*2.44 ha of this drainage area receives quality control from the Berczy Warden Subdivision stormwater management ponds.

Available infiltration volumes exceed the 25 mm storm runoff volume, with the exception of the Bruce Creek Tributary outlet for Warden Avenue. The majority of this drainage area (2.44 / 3.69 ha) will drain to the Berczy Warden stormwater management ponds for treatment. Therefore, the provided infiltration storage volume greatly exceeds the minimum 5 mm runoff for erosion control and water balance. Infiltration calculations are included in Appendix C.

4.1.2 Water Quality Control

Water quality control is to be provided to an enhanced level, as defined by the MECP, which requires a minimum 80% total suspended solids (TSS) removal rate. This level of treatment will be designed for the proposed ROW, utilizing the established imperviousness. A treatment train approach including infiltration measures and oil / grit separators is proposed to achieve the enhanced quality control for the ROW.

As noted above, approximately 2.44 ha of Warden Avenue will drain to the Berczy Warden subdivision for quality control, per the subdivision SWM design. Additional treatment for this ROW area will be provided by oil/grit separators proposed upstream of SWM Ponds 7 & 8.

The draft Minor Storm Drainage Plans provided by the Region indicate the areas and runoff coefficients of the areas draining to Ponds 7 and 8 in the Berczy Warden subdivision. A comparison of the design catchment areas and the catchment areas proposed in preliminary design prepared for this EA is provided in Table 9 below.

Table 9: Berczy Warden SWM Ponds Catchments Comparison

SWM Pond	Berczy Warden Subdivision Design			EA Proposed		
	Area (ha)	Imperviousness* (%)	A x I	Area (ha)	Imperviousness (%)	A x I
Pond 7	1.45	65	0.94	1.15	68	0.78
Pond 8	1.43	65	0.93	1.29	69	0.89

*65% imperviousness for the Berczy Warden Subdivision Design refers to the Percent Impervious Calculations Summary included in Appendix B of the SCS Stormwater Management Report.

As demonstrated in Table 9, the proposed area and imperviousness of Warden Avenue draining to the Berczy Warden stormwater management ponds are within the design parameters of the ponds.

Through the evaluation process, boulevard box trench features are the preferred low impact development (LID) measure to be utilized with the preferred ROW cross-section. Box trenches are linear infiltration trenches which are open to the surface and planted with wet tolerant plant material. They consist of a below-ground perforated pipe system to allow infiltration, and a small hickenbottom or riser pipe to allow for controlled discharge. By providing below-ground storage, box trenches will also achieve temperature mitigation, by allowing runoff to cool in the underground storage medium. Pavement runoff can be directed to the box trench through road catchbasins or overland through curb outlets. Where full box trenches are not feasible due to groundwater conditions, vegetated swale surface features are preferred. At detailed design, filtration LIDs (non-infiltrating LID measures, such as stone trenches wrapped with an impermeable lining with subdrains) may also be considered, where high groundwater conditions do not allow for infiltration. The Design considerations for the infiltration LID features are discussed further in Section 4.1.3.

In addition to the infiltration features described in Section 4.1.1, oil / grit separators are proposed at each outlet. Table 10 provides a summary of the preliminary design parameters for the oil / grit separators. A minimum 80% TSS removal will be required, utilizing products verified through ETV Canada to provide quality control. We note that the TRCA considers 50% TSS removal, while the remainder of the required 80% can be achieved when used in conjunction with the proposed LID measures.

Table 10: Preliminary Drainage Design Parameters

Road	Outlet Location	Drainage Area (ha)	Imperviousness (%)
Warden Avenue	Culvert Outlet	3.12	66
Warden Avenue	Bruce Creek Tributary (North)	0.49	53
Warden Avenue	Bruce Creek Tributary (South)	0.76	60
Warden Avenue	Major Mackenzie	1.48	64
Kennedy Road	Elgin Mills	1.05	59
Kennedy Road	Major Mackenzie	7.48	63

As an additional quality / erosion control measure, outlets proposing to discharge to watercourses will include enhanced swales upstream of the watercourse. These outlets include the Berczy Creek Tributary outlet on Warden Avenue, and the Elgin Mills outlet on Kennedy Road. The specifics of these mitigation measures will be determined at Detailed Design, through consultation and co-ordination with the TRCA.

4.1.3 Water Quantity Control

The Preferred Design Concept results in increased hardened surface within the ROW, approximately doubling the imperviousness of the ROW. Without implementing SWM controls, the increased impervious area will result in increased peak flow runoff. A hydrologic model was prepared to determine the increase in runoff and potential mitigation measures for the ROWs.

Visual OTTHYMO 3.0 (VO3) software was used to create the models for the existing and proposed conditions for both Warden Avenue and Kennedy Road. The 4-hour Chicago and 24-hour SCS II storm distributions were included in the model. The 6-hour AES distribution was considered in the early stages of the preliminary design per the Rouge River Hydrology Update but was omitted in this reporting as the Chicago and SCS distributions were found to be more conservative. The 6-hour AES storm distribution should be included as part of the detailed design analysis, in consultation with TRCA during the detailed design phase of the project. The York Region Road Design Guidelines (December 2023) provide intensity-duration-frequency (IDF) data for the 5, 10, 25, 50, and 100-year return periods. The 2-year IDF data was determined using the City of Markham Engineering Design Criteria.

The catchment areas for existing and proposed scenarios consider the ultimate 41 m ROW width for comparison. Delineation of the ROW catchment areas is based on the outlet locations and road slope, which are anticipated to be generally maintained. In the proposed scenario, flow-splitting dual hydrograph (DUHYD) commands are used to represent the capture of the 10-year storm in the Regional storm sewer system. This minor runoff will be overcontrolled, to allow the major runoff to bypass the SWM controls

without exceeding existing peak flow rates. Model information and results are provided in Appendix D, and summarized in Table 11 and Table 12 for Warden Avenue and Table 13 and Table 14 for Kennedy Road.

Warden Avenue

Table 11: Warden Avenue Existing Peak Flow Rates

Outlet	Catchment(s)	Dist.	Peak Flow Rates (m^3/s)					
			2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Culvert Outlet	101 – 103 (3.20 ha)	CHI	0.24	0.39	0.53	0.63	0.73	0.83
		SCS	0.22	0.31	0.40	0.50	0.57	0.67
Bruce Creek Tributary	110 – 113 (3.61 ha)	CHI	0.27	0.45	0.60	0.73	0.84	0.96
		SCS	0.25	0.37	0.47	0.58	0.69	0.78
Major Mackenzie	120 (1.48 ha)	CHI	0.18	0.26	0.34	0.41	0.47	0.53
		SCS	0.14	0.19	0.24	0.29	0.33	0.37

Table 12: Warden Avenue Unmitigated Proposed Peak Flow Rates and Required Storage Volumes

Outlet	Catchment(s)	Dist.	Peak Flow Rates (m^3/s)					
			2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Culvert Outlet	201-203 (3.12 ha)	CHI	0.35	0.56	0.72	0.87	0.99	1.15
		SCS	0.29	0.41	0.51	0.63	0.72	0.80
		Required Volumes (m^3)						
		CHI	149	211	297	352	391	420
Bruce Creek Tributary	210 – 213 (3.69 ha)	CHI	0.47	0.72	0.94	1.11	1.28	1.44
		SCS	0.37	0.52	0.64	0.79	0.89	0.99
		Required Volumes (m^3)						
		Quantity control accommodated in Berczy Warden SWM Ponds 7 and 8						
Major Mackenzie	220 (1.48 ha)	CHI	0.18	0.29	0.37	0.44	0.5	0.57
		SCS	0.15	0.21	0.25	0.31	0.36	0.40
		Required Volumes (m^3)						
		SCS	41	57	72	83	87	89

In the proposed condition, the tributary drainage areas are to be generally maintained. The calculated required volumes reflect the storage required so as not to increase runoff to these outlets resulting from the increased impervious area.

As a Preliminary Design, oversized underground pipes are considered to provide the required quantity control storage. The Culvert outlet requires a 146 m length of 2.4 m x 1.2 m concrete box culvert to provide the required quantity control. Similarly, the Major Mackenzie outlet requires a 31 m length of 2.4 m x 1.2 m concrete box culvert to

provide the required quantity control storage. A portion of the area draining to the Bruce Creek Tributary outlet will be diverted to the Berczy Warden subdivision stormwater management ponds. Modeling confirms this diversion will reduce ROW flows to the Bruce Creek Tributary to existing flow rates without the need for additional ROW storage.

At the Detailed Design phase of the project, other storage options or configurations will be considered, such as underground storage tanks, and additional surface storage within the proposed box trench LID features may be utilized for quantity control. A cost-benefit analysis should be undertaken to determine the most effective quantity control methods.

The "Culvert Outlet" will also need to accommodate existing external drainage conveyance from a manmade pond on the west side of Warden Avenue. This is a temporary condition, as a new stormwater management pond for the external lands is anticipated in this area. Ultimate drainage from this area will be determined at Detailed Design through co-ordination with the adjacent land developers.

Kennedy Road

Table 13: Kennedy Road Existing Peak Flow Rates

Outlet	Catchment(s)	Dist.	Peak Flow Rates (m^3/s)					
			2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Elgin Mills	101 (0.51 ha)	CHI	0.06	0.10	0.13	0.15	0.17	0.19
		SCS	0.05	0.07	0.09	0.10	0.12	0.13
Ex. 900 mm Dia. Culvert	110 + 111 (1.44 ha)	CHI	0.11	0.18	0.24	0.28	0.34	0.38
		SCS	0.10	0.14	0.18	0.22	0.26	0.30
Major Mackenzie	120 – 125 (6.59 ha)	CHI	0.55	0.88	1.16	1.42	1.63	1.87
		SCS	0.48	0.69	0.87	1.09	1.26	1.42

Table 14: Kennedy Road Unmitigated Proposed Peak Flow Rates and Required Storage Volumes

Outlet	Catchment(s)	Dist.	Peak Flow Rates (m^3/s)					
			2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Elgin Mills	201 (1.05 ha)	CHI	0.11	0.17	0.22	0.27	0.32	0.36
		SCS	0.09	0.13	0.16	0.20	0.23	0.26
			Required Volumes (m^3)					
		SCS	139	190	234	271	294	315
Major Mackenzie	220 – 224 (7.48 ha)	CHI	0.73	1.16	1.53	1.88	2.15	2.43
		SCS	0.62	0.88	1.11	1.38	1.57	1.79
			Required Volumes (m^3)					

Outlet	Catchment(s)	Dist.	Peak Flow Rates (m^3/s)					
			2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
		SCS	300	412	557	675	736	788

In the proposed condition, the existing outlet at the existing 900 mm diameter road-crossing culvert approximately 290 m south of Elgin Mills Road is to be eliminated, with 0.74 ha redirected to Elgin Mills Road, and 0.65 ha redirected to the Major Mackenzie Drive outlet. The calculated required volumes reflect the storage required so as not to increase runoff to these two outlets resulting from the increased impervious area and redirection of flow. As a temporary measure, external runoff draining to the low point associated with the existing 900 mm diameter culvert will be conveyed north through a temporary swale constructed on the west side of Kennedy Road. The swale will discharge to the existing culvert crossing Elgin Mills Road.

As a Preliminary Design, oversized underground pipes are considered to provide the required quantity control storage. The Elgin Mills Road outlet requires a 109 m length of 2.4 m x 1.2 m concrete box culvert to provide the required quantity control. Similarly, the Major Mackenzie outlet requires a 274 m length of 2.4 m x 1.2 m concrete box culvert to provide the required quantity control storage.

At the Detailed Design phase of the project, other storage options or configurations will be considered, such as underground storage tanks, and additional surface storage within the proposed Box Trench Design LID features may be utilized for quantity control. A cost-benefit analysis should be undertaken to determine the most effective quantity control methods.

4.2 Low Impact Development Features

4.2.1 Low Impact Development Options Evaluation for Study Area

As part of the Assessment of Alternative Design concepts for Warden Avenue and Kennedy Road, the study team identified several LID technologies (options) that could potentially be implemented for the two roadways. LID options considered included:

- Box Trench Design;
- Vegetated / Bioswale Design;
- Bioretention Rain Garden Design;
- Infiltration Trenches; and
- Underground Storage Tanks.

The evaluation process for the LID options is described in more detail in the Environmental Study Reports (ESRs). The preferred LID option is the Box Trench Design; however, in areas of high groundwater table, the Vegetated / Bioswale Design is a feasible alternative to the Box Trench Design.

4.2.2 Characterization of Preferred Low Impact Development Option

The box trench is intended to be constructed on both sides of Warden Avenue and Kennedy Road, between the boulevard and cycle track. The trench width will be 2.5 m to 3 m wide, with a depth of 1.0 m. The trench is filled with layers of soil / granular material to filter the runoff and provide storage prior to infiltration. The location and geometry of the box trench is affected by the road cross-section and the seasonally high groundwater levels. The MECP recommends a minimum 1.0 m vertical separation between the bottom of the infiltration surface and the high groundwater table (GWT).

York County Soils Mapping (Agriculture Canada, 1954) identifies the subject site soils as Peel clay and Cashel clay, which are classified as hydrologic soils Group D. This Assessment is also supported by Geotechnical Investigations provided by Golder Associates Ltd. (August 2021), which indicate sandy, silty clay soils. These soils are not ideal for infiltration; however, infiltration may still be feasible. Soils information is provided in Appendix C.

Groundwater depths were established in the Hydrogeological Assessment Report for Warden Avenue and Kennedy Road, prepared by Burnside (December 2022). Depths varied from <1 mbgs to 5 mbgs for Warden Avenue and <1 mbgs to 9 mbgs for Kennedy Road. These depths are shown in the Figures in Appendix C. Box trenches are proposed where the GWT is equal to or greater than 2 mbgs, and vegetated swales are proposed where the GWT is equal to or greater than 1 mbgs. LID features are not proposed where the high GWT is expected to be less than 1 mbgs. The locations of these features are shown on the SWM Plans provided in Appendix F.

The MECP Stormwater Management Planning and Design Manual provides design criteria for infiltration facilities. Maximum depth is calculated as a function of percolation rate, drawdown time, and storage medium void ratio. The percolation rate of the existing soils was not established in the Geotechnical Investigations completed thus far for this project; therefore, an estimated rate of 10 mm/hr was assumed and will be verified at the Detailed Design phase of the project, with appropriate safety correction factors applied. A drawdown time of 48 hours is recommended, and a void ratio of 40% is generally specified for clear stone infiltration trench material. Through these parameters, a maximum depth of 1.2 m was determined. The maximum proposed box trench depth is 1.0 m, which may be increased to 1.2 m at the Detailed Design phase of the project, if feasible.

Considering a provided infiltration surface area, based on the feature width and length, an estimated drawdown time was calculated through the SWM Manual formula:

$$A = (1000V) / (PnT)$$

$$T = (1000V) / (APn)$$

Table 15 and Table 16 below summarize the LID Design by outlet for Warden Avenue and Kennedy Road respectively. Infiltration calculations are provided in Appendix C.

Table 15: Warden Avenue LID Summary

Outlet	LID Type	Width (m)	Depth (m)	Length		Void Ratio	Volume (m^3)
				West (m)	East (m)		
Culvert Outlet	Box Trench	2.7	1	410	311	0.4	779
						Total	**779**
25 mm Runoff Volume = 498 m^3 Drawdown Time = 64 hours							
Bruce Creek Tributary	Box Trench	2.7	1.0	126	126	0.4	272
						Total	**272**
25 mm Runoff Volume = 272 m^3 Drawdown Time = 100 hours							
Major Mackenzie Drive	Box Trench	2.7	1.0		220	0.4	238
						Total	**238**
25 mm Runoff Volume = 241 m^3 Drawdown Time = 100 hours							

Table 16: Kennedy Road LID Summary

Outlet	LID Type	Width (m)	Depth (m)	Length		Void Ratio	Volume (m^3)
				West (m)	East (m)		
Elgin Mills Road	Box Trench	2.7	1.0	125	100	0.4	254
						Total	**254**
25 mm Runoff Volume = 162 m^3 Drawdown Time = 64 hours							
Major Mackenzie Drive	Box Trench	2.7	1.0	885	762	0.4	1,779
	Vegetated Swale	1.0	0.5		200	0.4	40
						Total	**1,819**
25 mm Runoff Volume = 1,135 m^3 Drawdown Time = 61 hours							

As demonstrated, the proposed infiltration LID features will provide storage volume for the 25 mm storm runoff and drawdown times meet or exceed 48 hours. The infiltration parameters will be confirmed and updated at the Detailed Design phase of the project.

4.2.3 Cost-Benefit Analysis of Low Impact Development Options and Preferred Plan

4.2.3.1 LID Option Costs

The Sustainable Technologies Evaluation Program (STEP) LID Lifecycle Costing Tool, Version 3, December 2021 was used to estimate the capital (construction) costs, operation and maintenance costs and overall lifecycle costs associated with the implementation of each of the five LID options evaluated. Table 17 provides a summary of the tool profiles used for each LID options and the associated costs. For each option, a sample drainage area size of 100 m^2 was used and for options that included an infiltration component, the maximum desired drainage period was set at 48 hours and the native soil infiltration rate at 25 mm/hr. Screen captures from the STEP LID Lifecycle Costing Tool profiles are provided in Appendix E.

Table 17: STEP LID Lifecycle Costing Tool Inputs

LID Option	STEP Tool Profile	Construction Costs (per 100 m^2)	Operations and Maintenance Costs (per 100 m^2)	Lifecycle Costs
Box Trench Design	Bioretention	$25,000*	$140	$27,000
Vegetated / Bioswale Design	Enhanced Swale	$11,000	$90	$14,000
Bioretention Rain Garden Design	Bioretention	$23,000	$140	$27,000
Infiltration Trenches	Infiltration Trench	$24,000	$1,600	$75,000
Underground Storage Tanks	Infiltration Chamber	$14,000	$33	$14,000

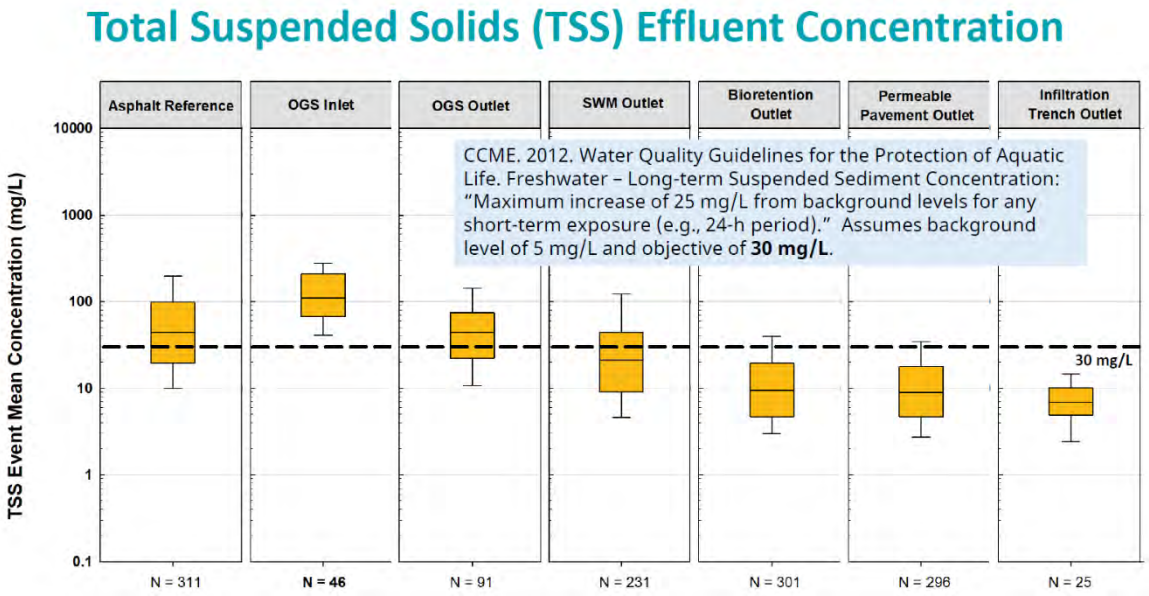
*The Box Trench Design Option Construction Cost includes the output cost from the STEP LID Lifecycle Cost Tool for the Bioretention LID with additional capital costs for the retaining walls of the box trench unit.

4.2.3.2 LID Option Benefits

Reduction of Total Suspended Solids

As shown in Figure 2, Bioretention, permeable pavement, and infiltration trench LID measures show similar capacity for reduction of Total Suspended Solids (TSS) in effluent concentration. Infiltration trenches demonstrate greater effectiveness in TSS reduction out of these three LID measures. Infiltration trenches are shown to reduce TSS concentration below the CCME guideline (30 mg/L).

Figure 2: STEP Webinar (December 8, 2022) Data Comparison of TSS Effluent Concentration



Cost Comparisons

Figure 3 shows that permeable pavers and porous asphalt have a greater construction cost than measures such as infiltration chambers, infiltration trenches, and bioretention which can; therefore, offer a greater cost to benefit ratio for projects. Figure 4 further shows that lifecycle costs follow this same trend – infiltration chambers have the lowest lifecycle cost of the LID treatments followed by infiltration trenches.

Figure 3: Cost Comparison and Breakdown of Various LID Options

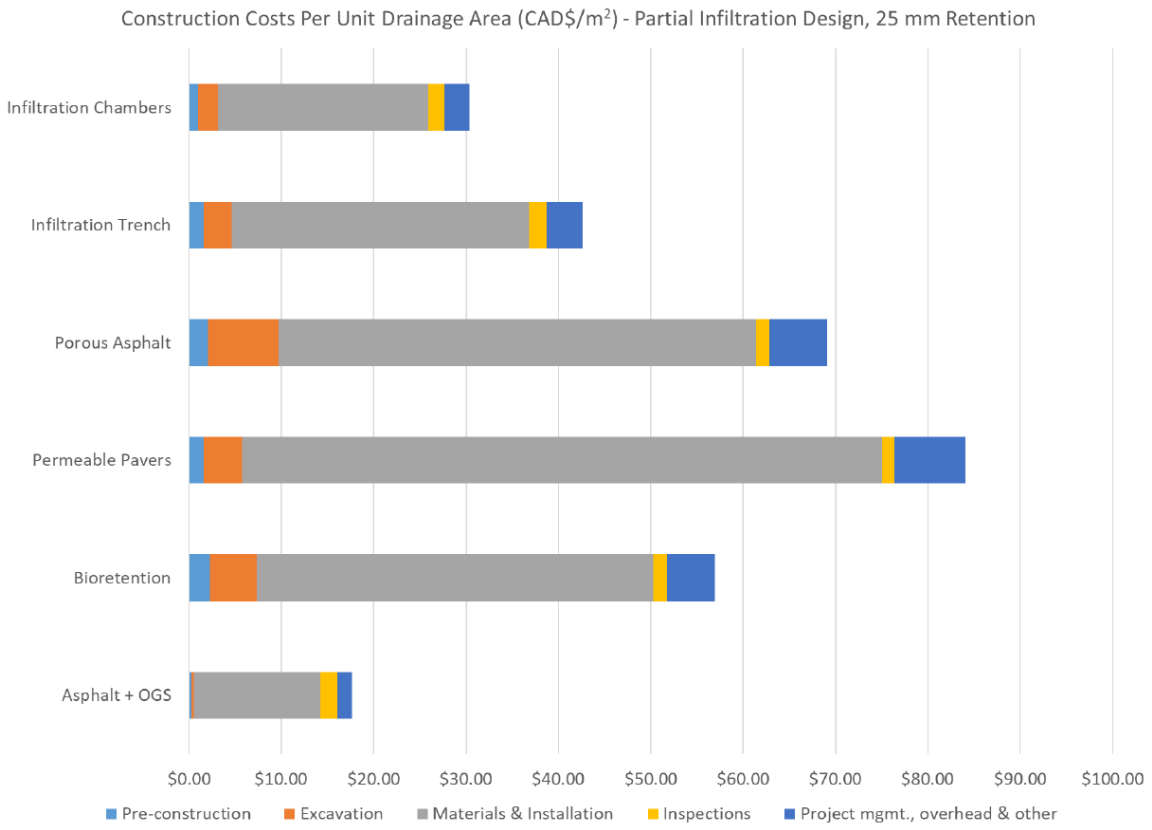
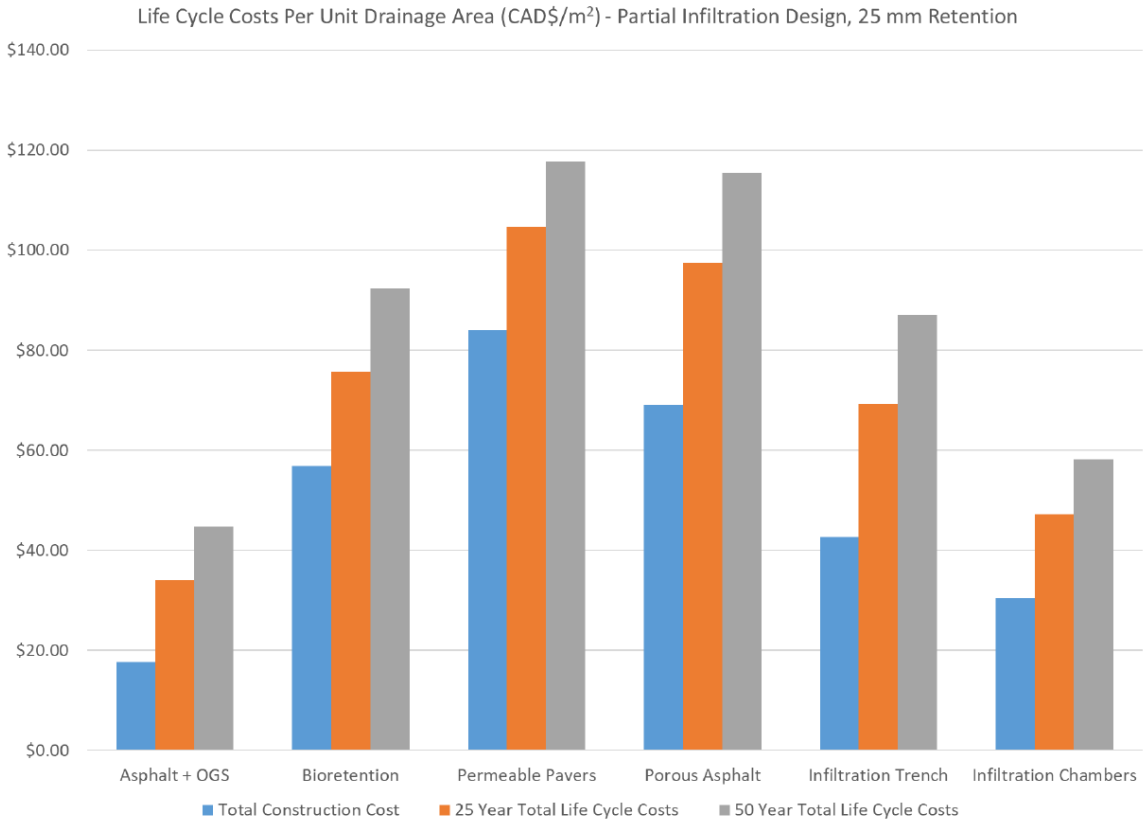


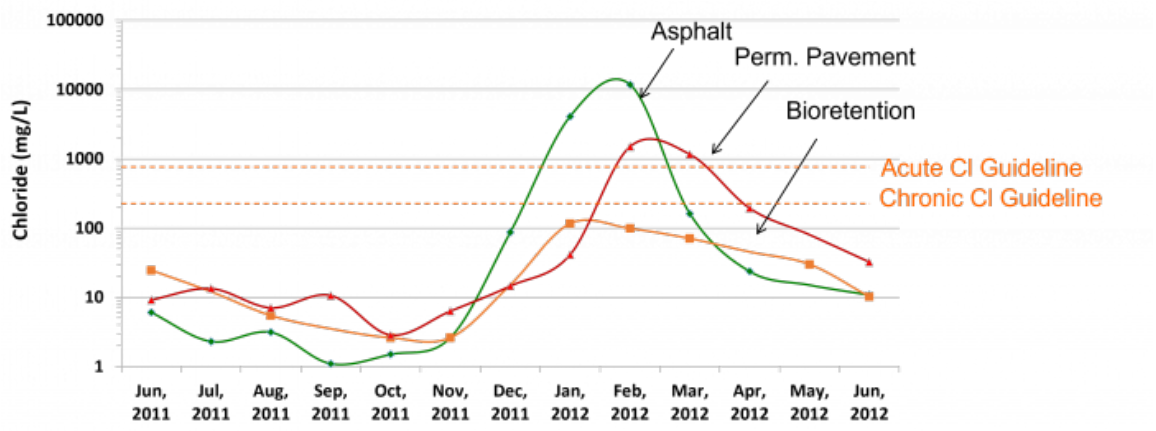
Figure 4: Lifecycle Cost Comparison between Various LID Options



Reduction of Chloride Discharge

Figure 5 shows research conducted by STEP comparing level of chloride discharge between asphalt and two commonly used LID practices (Permeable Pavement and Bioretention). The results show that asphalt permits salt to release into the surrounding environment in concentrated bursts during winter. In comparison, the LIDs analyzed release salt more gradually throughout the entire year. Bioretention has a more gradual release of salt than permeable pavement. These LIDs accomplish this reduced chloride discharge by temporary retention of salt and slow release over the year. LIDs thereby reduce the peak concentrations of salt and delay discharge until streams have greater dilution capacity. The capacity for LIDs to reduce the impact of salt along with salt reduction best management practices with property owners and management creates a means to manage the impact of salt on the environment.

Figure 5: Annual Chloride Discharge Concentrations for Asphalt, Permeable Pavement, and Bioretention



4.3 Erosion and Sediment Control Measures

Erosion and Sediment Control Plans will be required as part of the Detailed Design and will include all necessary controls in accordance with the current Region and Conservation Authority Guidelines.

Below is a list of recommended erosion and sediment control measures that may be installed and maintained during road construction:

- Temporary filter sock fiber rolls, and a tree protection fence, if required, will be installed prior to grading or any earth work;
- Filter sock fiber rolls as check dams, where necessary, to reduce velocity;
- Controlled access during construction to reduce mud trafficking;
- Use of Mud Mats and nightly clean-up of roads to prevent migration of sediment into Regional roads;

- Employ on-site Sediment and Erosion Control Inspectors to ensure that erosion control practices are adhered to, and any breaches are repaired immediately; and
- Complete monthly Inspection Reports.

5.0 Conclusions

This Stormwater Management, Drainage, and Hydrology Assessment Report has been prepared in support of the Class Environmental Assessment (EA) Studies for the proposed improvements to Warden Avenue and Kennedy Road from Major Mackenzie Drive to Elgin Mills Road, in the City of Markham. The hydrologic and hydraulic assessments included in this Report demonstrate the required improvements to accommodate the Preferred Design concept.

Enhanced quality control is provided for the impervious surfaces through a combination of oil / grit separators and infiltrating LIDs, and the Berczy Warden Stormwater Management Ponds 7 and 8, which also provide temperature mitigation, erosion control, and water balance. Quantity control is provided to reduce proposed peak flows to existing flow rates through underground pipe storage and the Berczy Warden Stormwater Management Ponds 7 and 8.

Hydraulic assessment of the existing culvert crossing Warden Avenue provides a Preliminary Culvert Design to confirm hydraulic capacity and demonstrates the anticipated floodplain impacts.

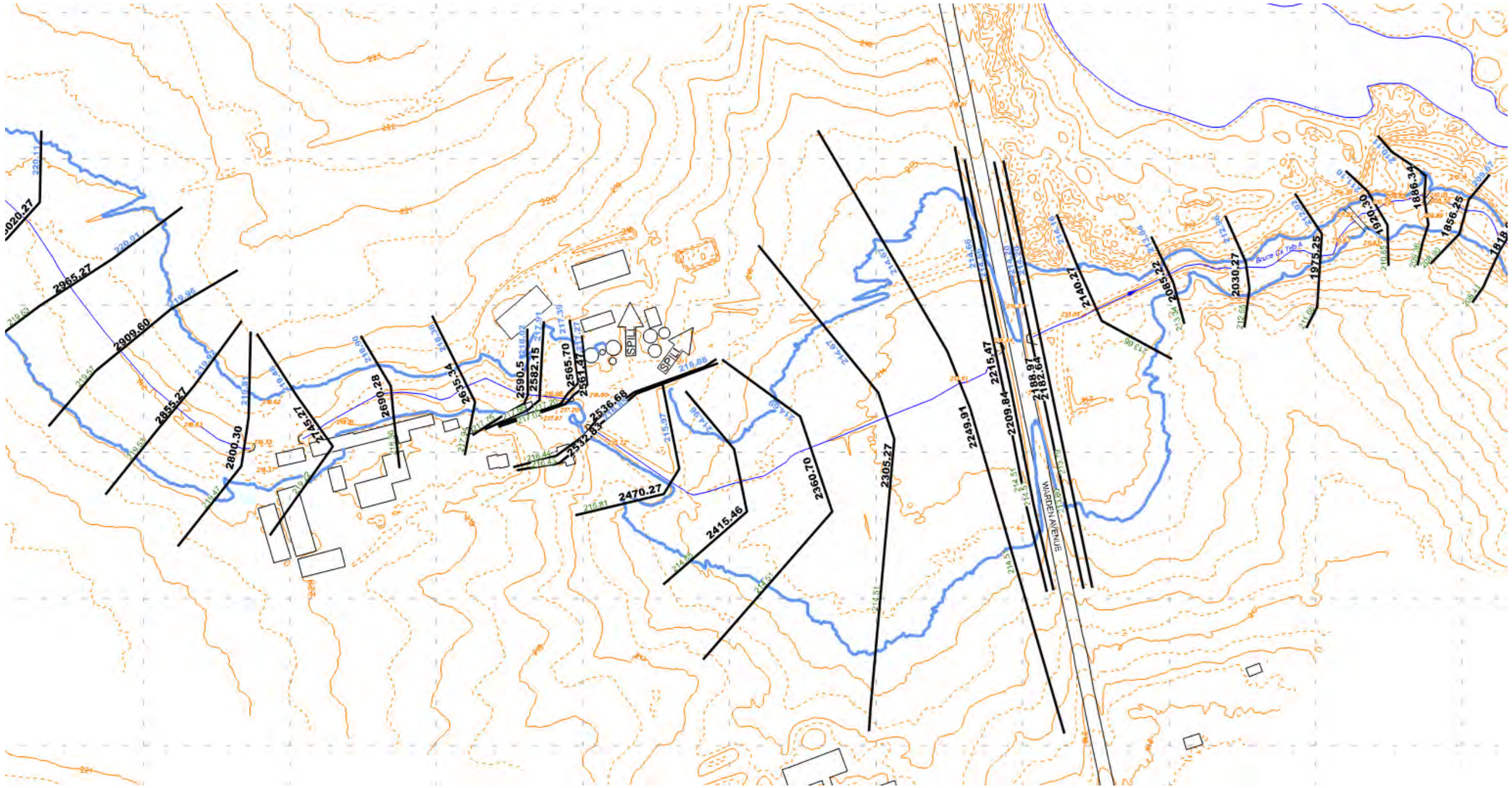
The preliminary SWM measures described in this Report are designed to mitigate the impacts of the Preferred Design. As the project proceeds, the Design is expected to be refined with the development of additional data and finalized road layout.

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix A

Hydraulic Analysis of Warden Avenue Culvert



HIGHLIGHTED SEGMENT FROM TRCA ROUGE RIVER FLOODPLAIN MAPPING UPDATE

FLOODPLAIN MAPPING SHEET 07

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : rou_529 — Location: Warden Avenue

Watershed and Location Information

Date (dd/mm/yyyy):	29/08/2019
Field Crew:	Wood
Watershed Name:	Rouge
River Name:	Bruce Ck Trib A
Reach ID:	Reach A1
Municipality:	Markham
Easting:	632894.1441
Northing:	4862073.185

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):		Culvert	
Number of Openings:	2	Open Footing (Yes/No):	No
Opening Shape:	Round	Material (Conc/Steel):	Steel
Opening Height (m)	0.6	Opening / Span (m):	0.6
Length in Direction of Flow (m):			15
Inlet Type (Projecting/Mitered/Headwall):			Projecting
Skew Angle of Crossing (Degrees):			-
Height from Obvert to Top of Road (m):			0.7
Railing Height (m):	-	Depth of Siltation (mm):	-

Current Flow Information

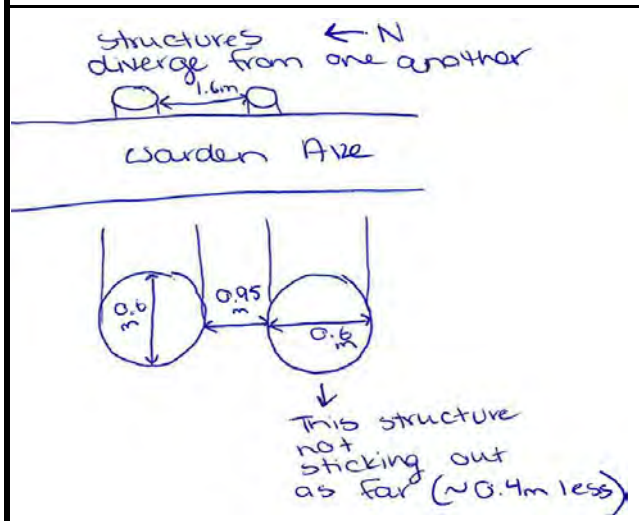
Flow Present (Y/N):	No
Approx. Depth (mm):	-
Approx. Velocity (m/s):	-
Upstream Erosion (Y/N):	No
Downstream Erosion (Y/N):	No

Additional Flow Information / Field Notes:

No water present US or DS

Site Photograph and Additional Field Notes

Site Sketch:



Upstream Structure Face

Downstream Structure Face

Watercourse Looking Upstream

Watercourse Looking Downstream

BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING
EXISTING OUTPUT SUMMARY

HEC-RAS Plan: Plan 05 River: Bruce Ck Trib A Reach: Reach A1

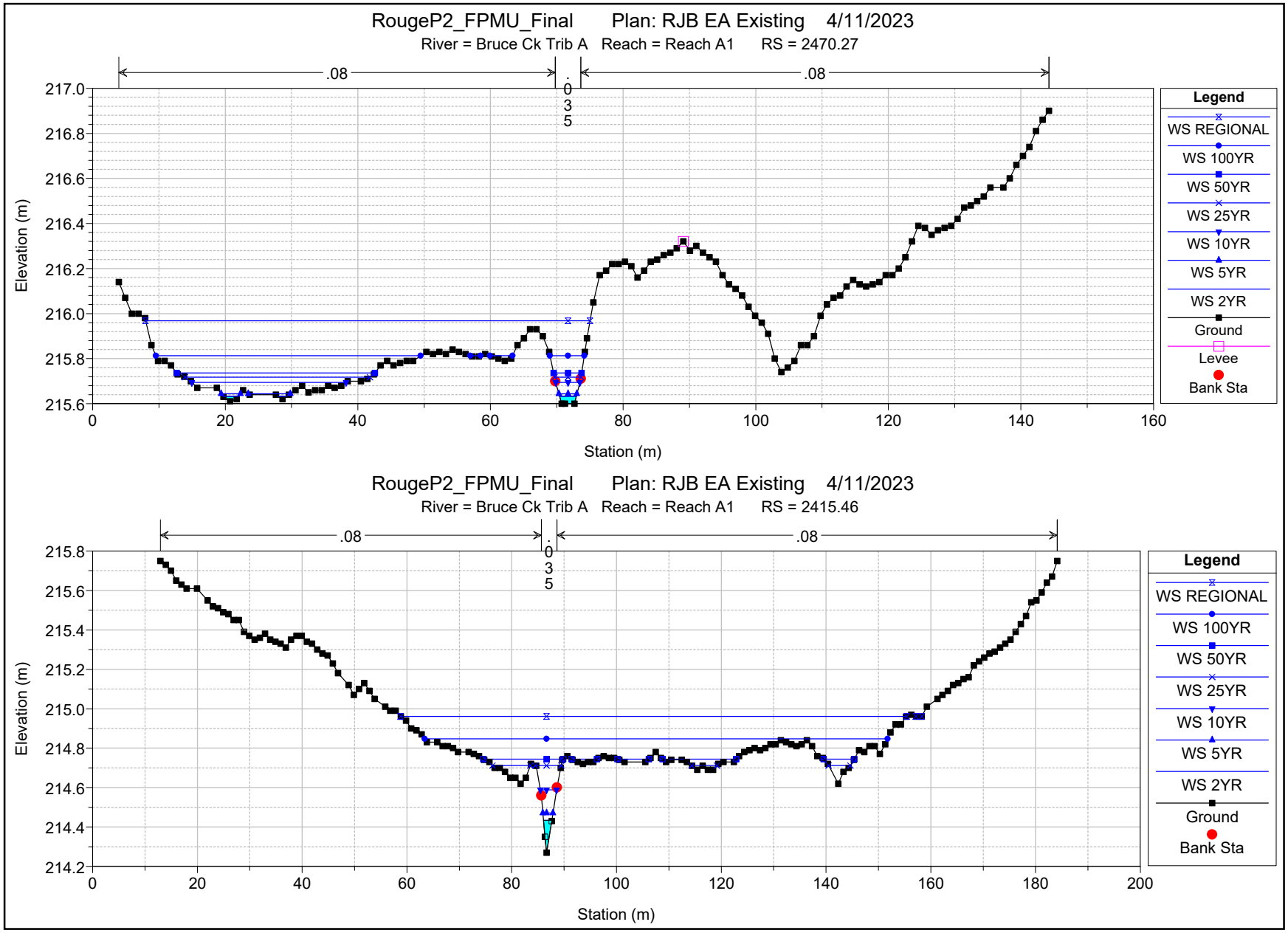
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach A1	2470.27	2YR	0.04	215.60	215.633	215.63	215.64	0.032652	0.49	0.11	6.13	0.91
Reach A1	2470.27	5YR	0.07	215.60	215.644	215.64	215.66	0.029196	0.55	0.21	11.98	0.90
Reach A1	2470.27	10YR	0.46	215.60	215.695	215.69	215.71	0.028352	0.83	1.22	26.88	0.99
Reach A1	2470.27	25YR	0.93	215.60	215.718	215.72	215.75	0.036533	1.10	1.91	31.88	1.17
Reach A1	2470.27	50YR	1.29	215.60	215.736	215.74	215.77	0.032282	1.17	2.52	34.11	1.13
Reach A1	2470.27	100YR	3.69	215.60	215.813	215.81	215.87	0.030894	1.64	5.55	50.11	1.21
Reach A1	2470.27	REGIONAL	13.66	215.60	215.969	215.96	216.05	0.027612	2.32	15.28	67.04	1.27
Reach A1	2415.46	2YR	0.04	214.27	214.434	214.38	214.44	0.003256	0.30	0.13	1.59	0.34
Reach A1	2415.46	5YR	0.07	214.27	214.471	214.40	214.48	0.003371	0.36	0.20	1.93	0.36
Reach A1	2415.46	10YR	0.46	214.27	214.588	214.55	214.63	0.012550	0.95	0.49	3.10	0.75
Reach A1	2415.46	25YR	0.93	214.27	214.712	214.66	214.76	0.006609	0.99	1.53	21.11	0.59
Reach A1	2415.46	50YR	1.29	214.27	214.744	214.74	214.80	0.007414	1.13	2.52	45.97	0.64
Reach A1	2415.46	100YR	3.69	214.27	214.847	214.85	214.89	0.007557	1.37	9.70	88.36	0.68
Reach A1	2415.46	REGIONAL	13.66	214.27	214.962	214.96	215.05	0.015750	2.33	20.22	97.84	1.02
Reach A1	2360.70	2YR	0.04	213.87	213.990	213.99	214.02	0.033223	0.77	0.05	0.88	1.01
Reach A1	2360.70	5YR	0.07	213.87	214.019	214.02	214.06	0.030842	0.86	0.08	1.10	1.01
Reach A1	2360.70	10YR	0.46	213.87	214.256	214.22	214.27	0.003856	0.59	2.10	39.37	0.42
Reach A1	2360.70	25YR	0.93	213.87	214.269	214.27	214.30	0.010223	0.99	2.61	42.69	0.69
Reach A1	2360.70	50YR	1.29	213.87	214.295	214.28	214.32	0.009413	1.03	3.90	56.72	0.68
Reach A1	2360.70	100YR	3.69	213.87	214.515	214.36	214.52	0.000757	0.45	27.39	133.10	0.21
Reach A1	2360.70	REGIONAL	13.66	213.87	214.693	214.47	214.70	0.001563	0.81	52.96	157.95	0.33
Reach A1	2305.27	2YR	0.04	213.56	213.751	213.67	213.75	0.001284	0.21	0.19	1.97	0.22
Reach A1	2305.27	5YR	0.07	213.56	213.789	213.69	213.79	0.001499	0.26	0.27	2.34	0.24
Reach A1	2305.27	10YR	0.46	213.56	213.874	213.84	213.92	0.012448	0.90	0.51	3.88	0.74
Reach A1	2305.27	25YR	0.93	213.56	214.036	213.95	214.04	0.000826	0.34	8.22	93.60	0.21
Reach A1	2305.27	50YR	1.29	213.56	214.310	213.97	214.31	0.000022	0.09	47.04	184.36	0.04
Reach A1	2305.27	100YR	3.69	213.56	214.511	214.03	214.51	0.000032	0.13	86.71	211.48	0.05
Reach A1	2305.27	REGIONAL	13.66	213.56	214.677	214.15	214.68	0.000162	0.34	124.12	239.21	0.11
Reach A1	2249.91	2YR	0.04	213.51	213.607	213.58	213.61	0.007429	0.36	0.11	2.00	0.48
Reach A1	2249.91	5YR	0.07	213.51	213.638	213.60	213.65	0.006087	0.39	0.18	2.45	0.46
Reach A1	2249.91	10YR	0.46	213.51	213.778	213.72	213.78	0.000889	0.26	5.18	77.92	0.20
Reach A1	2249.91	25YR	0.93	213.51	214.034	213.75	214.03	0.000025	0.08	33.40	131.64	0.04
Reach A1	2249.91	50YR	1.29	213.51	214.309	213.76	214.31	0.000005	0.05	74.12	163.48	0.02
Reach A1	2249.91	100YR	3.69	213.51	214.510	213.81	214.51	0.000012	0.09	108.74	181.03	0.03
Reach A1	2249.91	REGIONAL	13.66	213.51	214.670	213.91	214.67	0.000096	0.29	141.05	229.52	0.09
Reach A1	2224.47	2YR	0.05	213.39	213.542	213.47	213.54	0.001553	0.21	0.23	2.77	0.24
Reach A1	2224.47	5YR	0.08	213.39	213.569	213.49	213.57	0.001758	0.26	0.31	3.14	0.26
Reach A1	2224.47	10YR	0.51	213.39	213.733	213.61	213.75	0.002205	0.53	1.42	22.33	0.34
Reach A1	2224.47	25YR	1.04	213.39	214.033	213.70	214.03	0.000053	0.14	25.99	131.43	0.06
Reach A1	2224.47	50YR	1.44	213.39	214.309	213.78	214.31	0.000007	0.07	69.75	171.61	0.02
Reach A1	2224.47	100YR	3.41	213.39	214.510	213.85	214.51	0.000012	0.10	106.09	198.77	0.03
Reach A1	2224.47	REGIONAL	15.39	213.39	214.667	214.02	214.67	0.000129	0.36	140.64	235.58	0.11
Reach A1	2209.84	2YR	0.05	213.38	213.456	213.46	213.48	0.036413	0.64	0.08	1.97	1.02
Reach A1	2209.84	5YR	0.08	213.38	213.472	213.47	213.50	0.033281	0.70	0.11	2.33	1.01
Reach A1	2209.84	10YR	0.51	213.38	213.691	213.59	213.71	0.002922	0.63	1.17	48.75	0.39
Reach A1	2209.84	25YR	1.04	213.38	214.020	213.67	214.03	0.000571	0.48	3.31	149.16	0.20
Reach A1	2209.84	50YR	1.44	213.38	214.300	213.72	214.31	0.000273	0.43	5.13	168.37	0.15
Reach A1	2209.84	100YR	3.41	213.38	214.510	213.88	214.51	0.000008	0.09	119.88	178.86	0.03
Reach A1	2209.84	REGIONAL	15.39	213.38	214.666	214.37	214.67	0.000091	0.31	153.60	214.80	0.09
Reach A1	2200.14		Culvert									
Reach A1	2188.97	2YR	0.05	213.24	213.300	213.28	213.31	0.011320	0.39	0.13	2.84	0.58
Reach A1	2188.97	5YR	0.08	213.24	213.319	213.30	213.33	0.009786	0.43	0.19	3.18	0.56
Reach A1	2188.97	10YR	0.51	213.24	213.468	213.40	213.49	0.004880	0.67	0.80	4.84	0.48
Reach A1	2188.97	25YR	1.04	213.24	213.581	213.47	213.61	0.004014	0.82	1.41	5.82	0.47
Reach A1	2188.97	50YR	1.44	213.24	213.648	213.52	213.69	0.003768	0.91	1.82	6.48	0.47
Reach A1	2188.97	100YR	3.41	213.24	213.816	213.70	213.90	0.005271	1.38	3.01	73.80	0.60
Reach A1	2188.97	REGIONAL	15.39	213.24	214.201	214.11	214.21	0.000825	0.78	59.31	182.92	0.26
Reach A1	2173.64	2YR	0.05	213.08	213.194	213.16	213.20	0.004913	0.33	0.15	2.25	0.41
Reach A1	2173.64	5YR	0.08	213.08	213.217	213.18	213.23	0.004920	0.39	0.21	2.42	0.42
Reach A1	2173.64	10YR	0.51	213.08	213.383	213.30	213.41	0.005105	0.74	0.71	3.62	0.50
Reach A1	2173.64	25YR	1.04	213.08	213.486	213.39	213.54	0.005621	1.00	1.12	4.50	0.56
Reach A1	2173.64	50YR	1.44	213.08	213.537	213.44	213.60	0.006394	1.18	1.36	4.98	0.61
Reach A1	2173.64	100YR	3.41	213.08	213.758	213.76	213.82	0.004019	1.27	6.74	83.48	0.53
Reach A1	2173.64	REGIONAL	15.39	213.08	214.192	213.90	214.20	0.000511	0.65	68.16	170.97	0.21
Reach A1	2140.27	2YR	0.05	212.97	213.062	213.02	213.07	0.003409	0.28	0.18	2.68	0.34
Reach A1	2140.27	5YR	0.08	212.97	213.087	213.04	213.09	0.003332	0.32	0.25	2.95	0.35
Reach A1	2140.27	10YR	0.51	212.97	213.271	213.15	213.29	0.002727	0.53	0.96	4.67	0.37
Reach A1	2140.27	25YR	1.04	212.97	213.387	213.23	213.41	0.002443	0.67	1.83	10.61	0.37
Reach A1	2140.27	50YR	1.44	212.97	213.449	213.28	213.47	0.002213	0.72	2.81	18.74	0.36

BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING
EXISTING OUTPUT SUMMARY

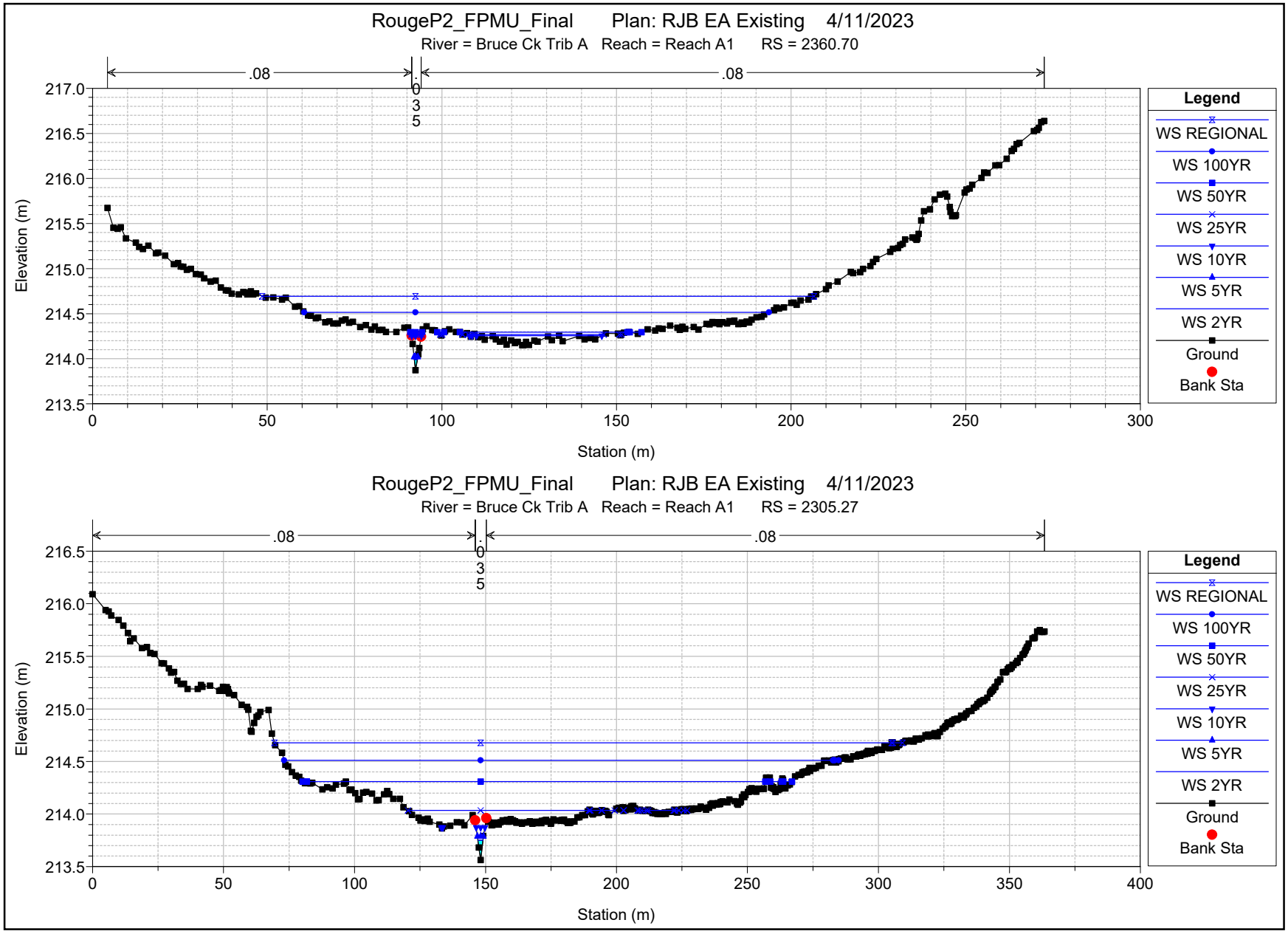
HEC-RAS Plan: Plan 05 River: Bruce Ck Trib A Reach: Reach A1 (Continued)

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)	
Reach A1	2140.27	100YR	3.41	212.97	213.659	213.49	213.68	0.001262	0.72	8.87	40.04	0.30
Reach A1	2140.27	REGIONAL	15.39	212.97	214.162	213.77	214.17	0.000689	0.80	42.00	81.50	0.24
Reach A1	2085.22	2YR	0.05	212.75	212.855	212.82	212.86	0.004078	0.31	0.16	2.26	0.37
Reach A1	2085.22	5YR	0.08	212.75	212.880	212.83	212.89	0.004178	0.37	0.22	2.41	0.39
Reach A1	2085.22	10YR	0.51	212.75	213.035	212.96	213.06	0.006467	0.77	0.66	3.33	0.55
Reach A1	2085.22	25YR	1.04	212.75	213.136	213.05	213.19	0.007478	1.01	1.03	3.95	0.62
Reach A1	2085.22	50YR	1.44	212.75	213.186	213.11	213.26	0.008355	1.18	1.23	4.31	0.67
Reach A1	2085.22	100YR	3.41	212.75	213.336	213.32	213.50	0.011956	1.83	2.05	7.46	0.86
Reach A1	2085.22	REGIONAL	15.39	212.75	213.836	213.84	214.06	0.008770	2.56	10.08	22.86	0.83
Reach A1	2030.27	2YR	0.05	212.32	212.352	212.35	212.36	0.036356	0.46	0.14	5.18	0.94
Reach A1	2030.27	5YR	0.08	212.32	212.361	212.36	212.37	0.037313	0.55	0.19	5.54	0.99
Reach A1	2030.27	10YR	0.51	212.32	212.446	212.44	212.48	0.021259	0.89	0.84	10.59	0.90
Reach A1	2030.27	25YR	1.04	212.32	212.498	212.47	212.55	0.020952	1.11	1.50	14.66	0.95
Reach A1	2030.27	50YR	1.44	212.32	212.528	212.52	212.58	0.019756	1.19	1.96	15.34	0.94
Reach A1	2030.27	100YR	3.41	212.32	212.646	212.60	212.72	0.016154	1.46	3.98	20.08	0.92
Reach A1	2030.27	REGIONAL	15.39	212.32	212.965	212.93	213.15	0.015676	2.46	11.33	24.18	1.04
Reach A1	1975.25	2YR	0.05	211.28	211.358	211.34	211.37	0.010798	0.43	0.14	3.21	0.58
Reach A1	1975.25	5YR	0.08	211.28	211.377	211.36	211.39	0.010490	0.48	0.21	3.86	0.59
Reach A1	1975.25	10YR	0.51	211.28	211.473	211.45	211.51	0.014889	0.88	0.85	9.06	0.78
Reach A1	1975.25	25YR	1.04	211.28	211.535	211.51	211.58	0.014785	1.10	1.47	10.81	0.83
Reach A1	1975.25	50YR	1.44	211.28	211.568	211.55	211.63	0.015373	1.23	1.84	11.54	0.86
Reach A1	1975.25	100YR	3.41	211.28	211.679	211.67	211.79	0.017611	1.76	3.48	19.51	0.99
Reach A1	1975.25	REGIONAL	15.39	211.28	212.025	212.02	212.24	0.017069	2.82	11.33	24.66	1.11
Reach A1	1920.30	2YR	0.07	210.28	210.337	210.34	210.35	0.031056	0.58	0.16	5.71	0.93
Reach A1	1920.30	5YR	0.10	210.28	210.343	210.34	210.36	0.035826	0.67	0.20	6.09	1.03
Reach A1	1920.30	10YR	0.64	210.28	210.432	210.43	210.48	0.023796	1.14	0.94	10.10	1.00
Reach A1	1920.30	25YR	1.23	210.28	210.485	210.48	210.56	0.024335	1.44	1.49	10.91	1.07
Reach A1	1920.30	50YR	1.65	210.28	210.518	210.52	210.60	0.023328	1.57	1.87	11.52	1.08
Reach A1	1920.30	100YR	3.84	210.28	210.653	210.65	210.78	0.020180	2.02	3.63	14.20	1.09
Reach A1	1920.30	REGIONAL	17.60	210.28	211.103	211.10	211.30	0.014202	2.94	14.84	32.70	1.05

BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING
EXISTING CROSS SECTIONS



BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING
EXISTING CROSS SECTIONS



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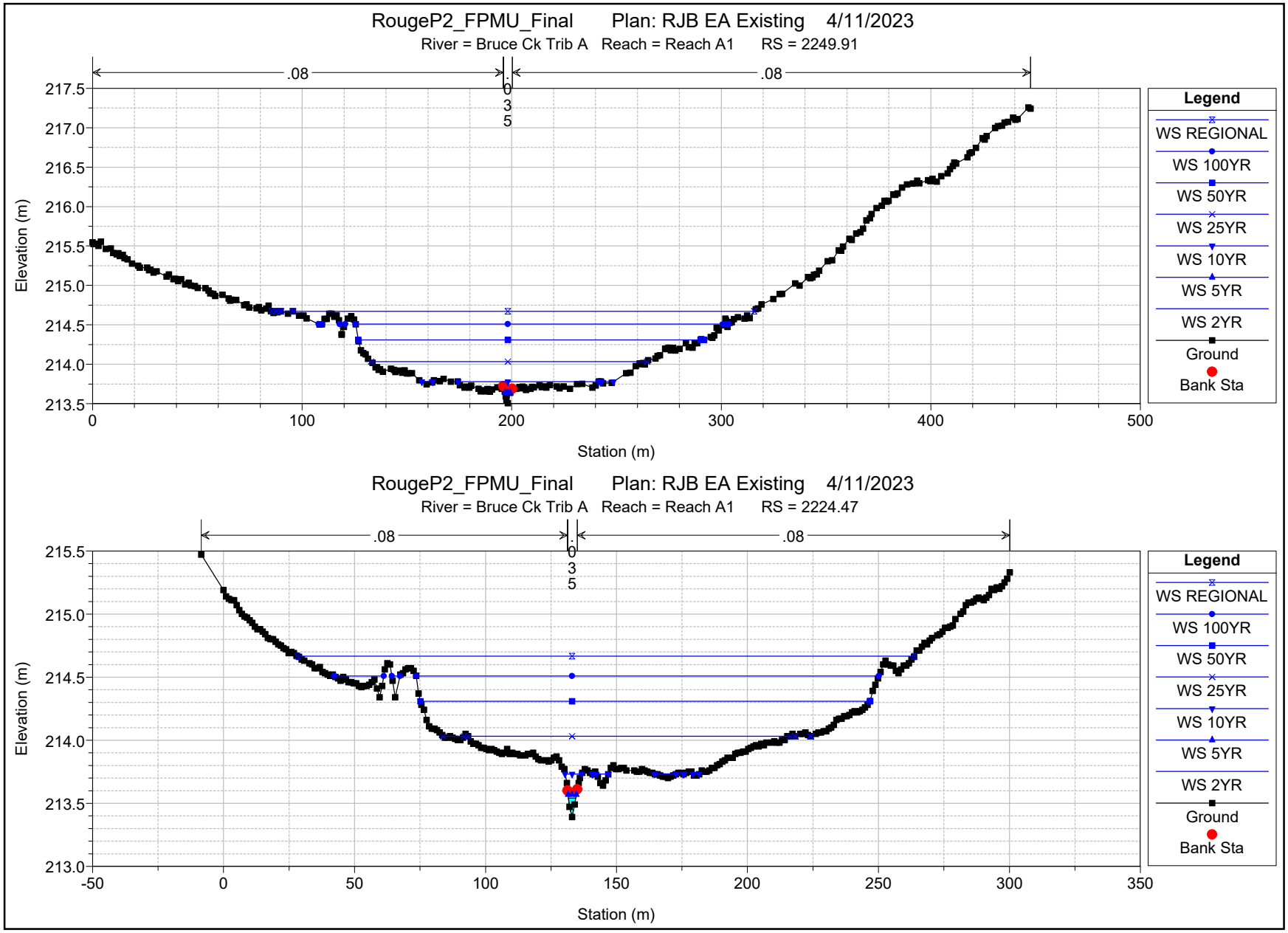

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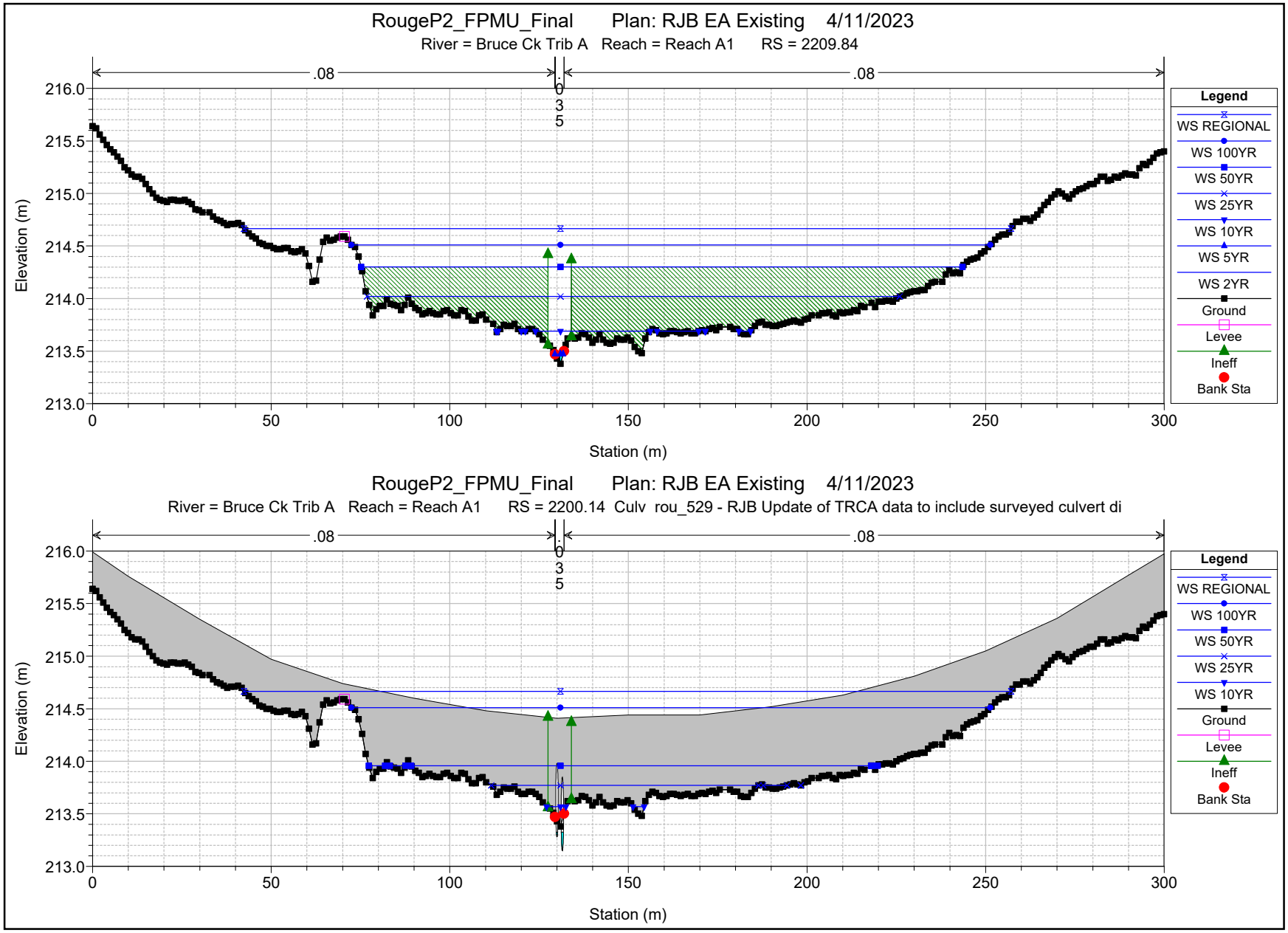

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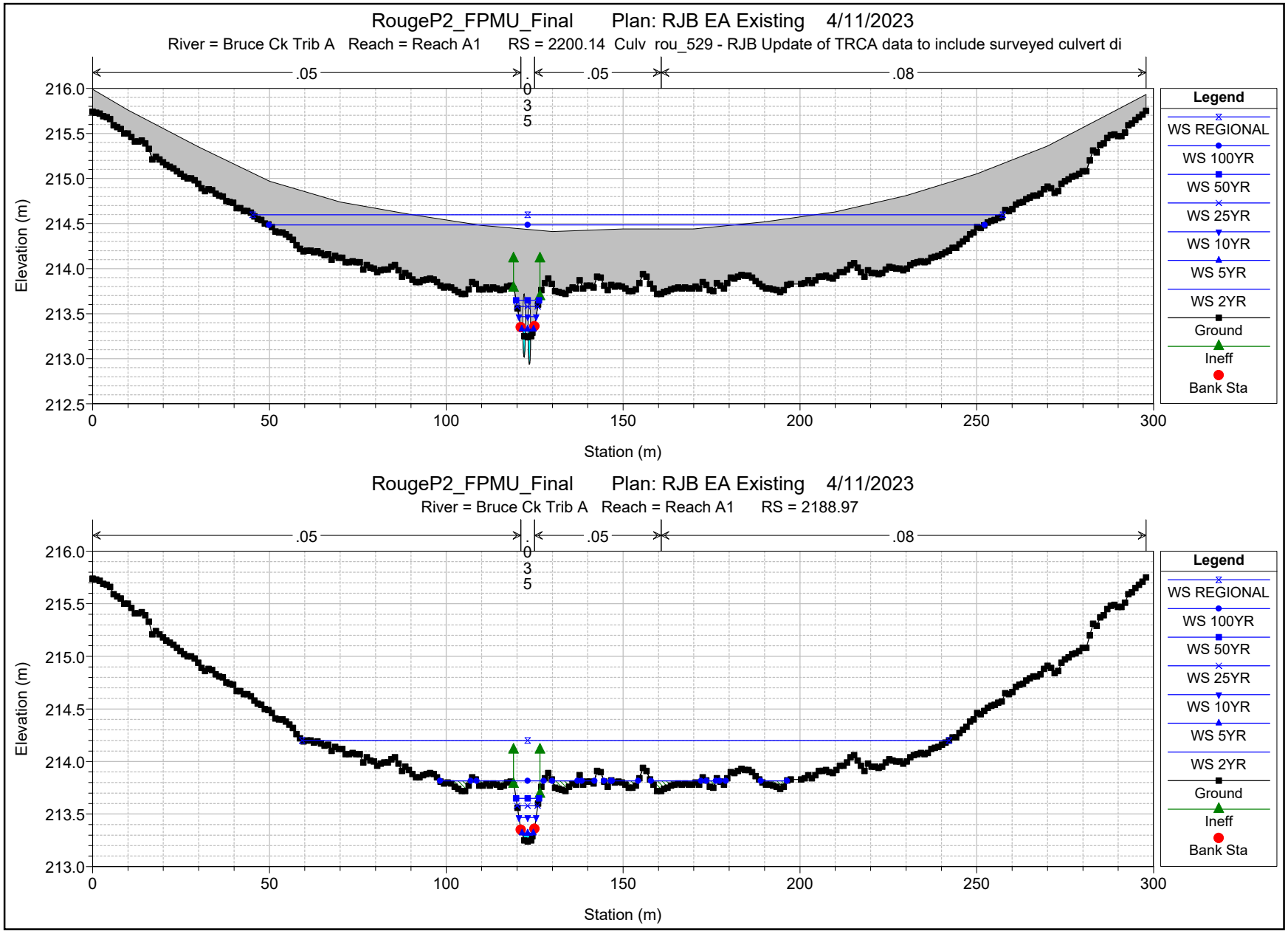

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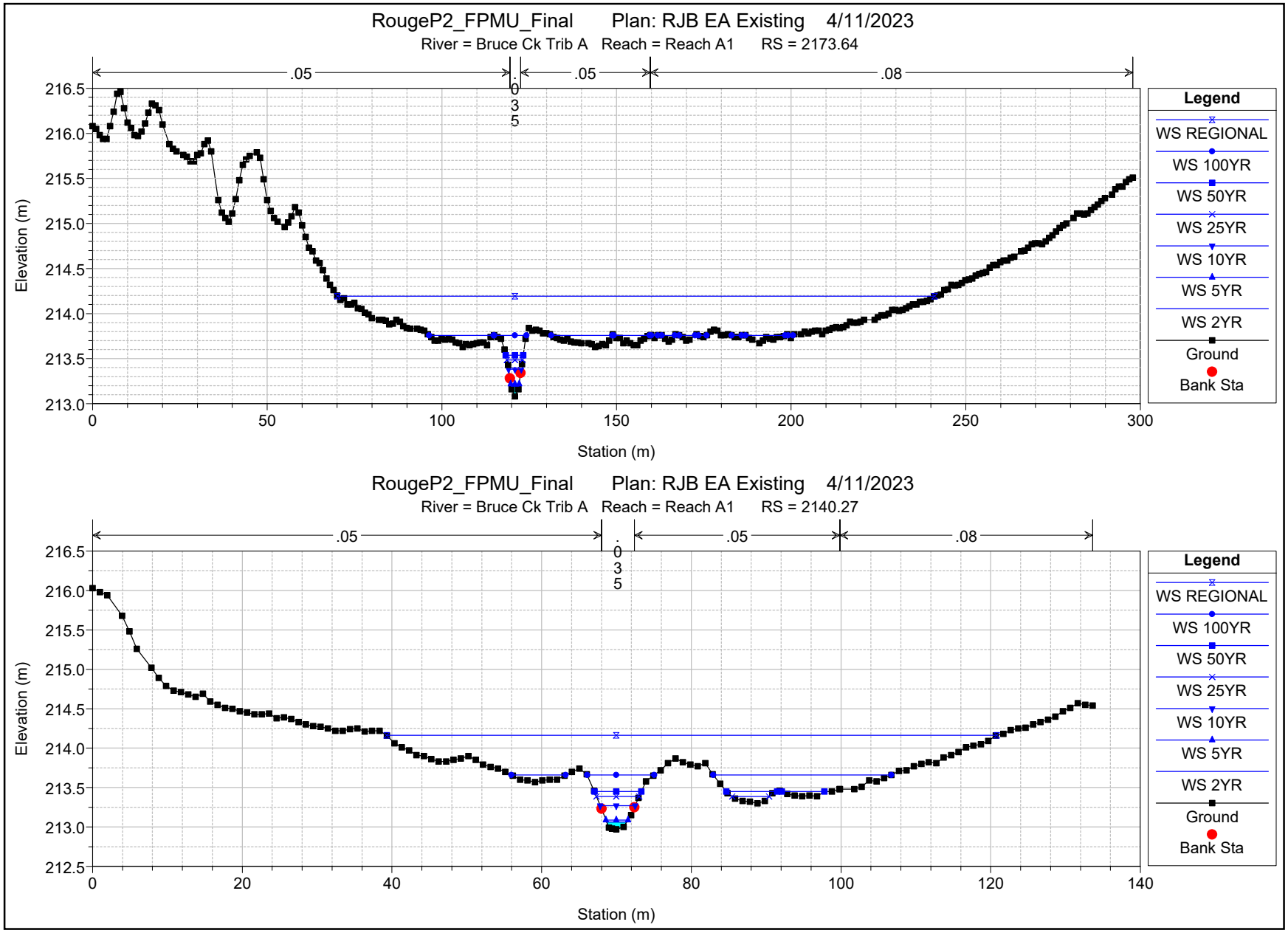

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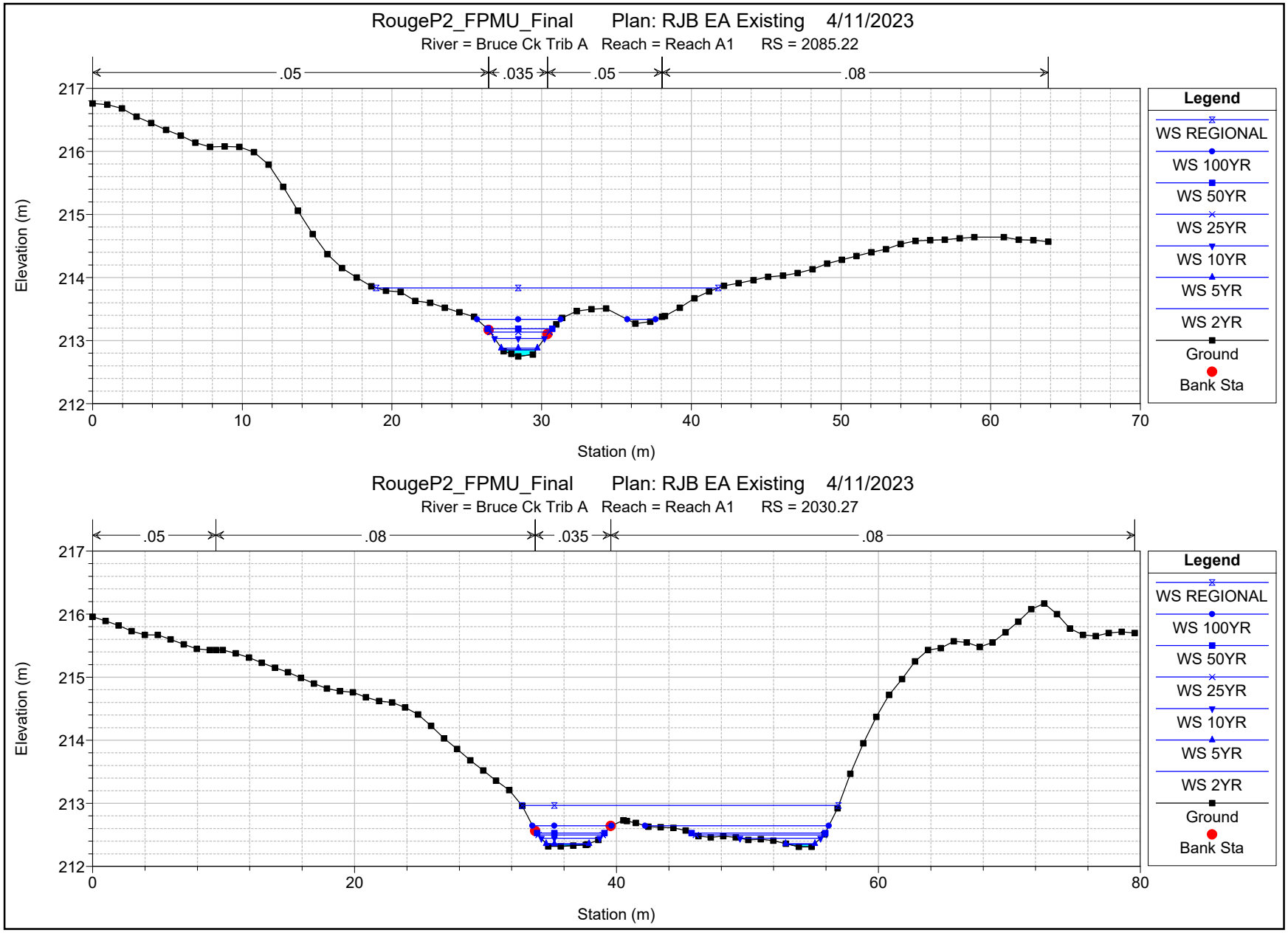
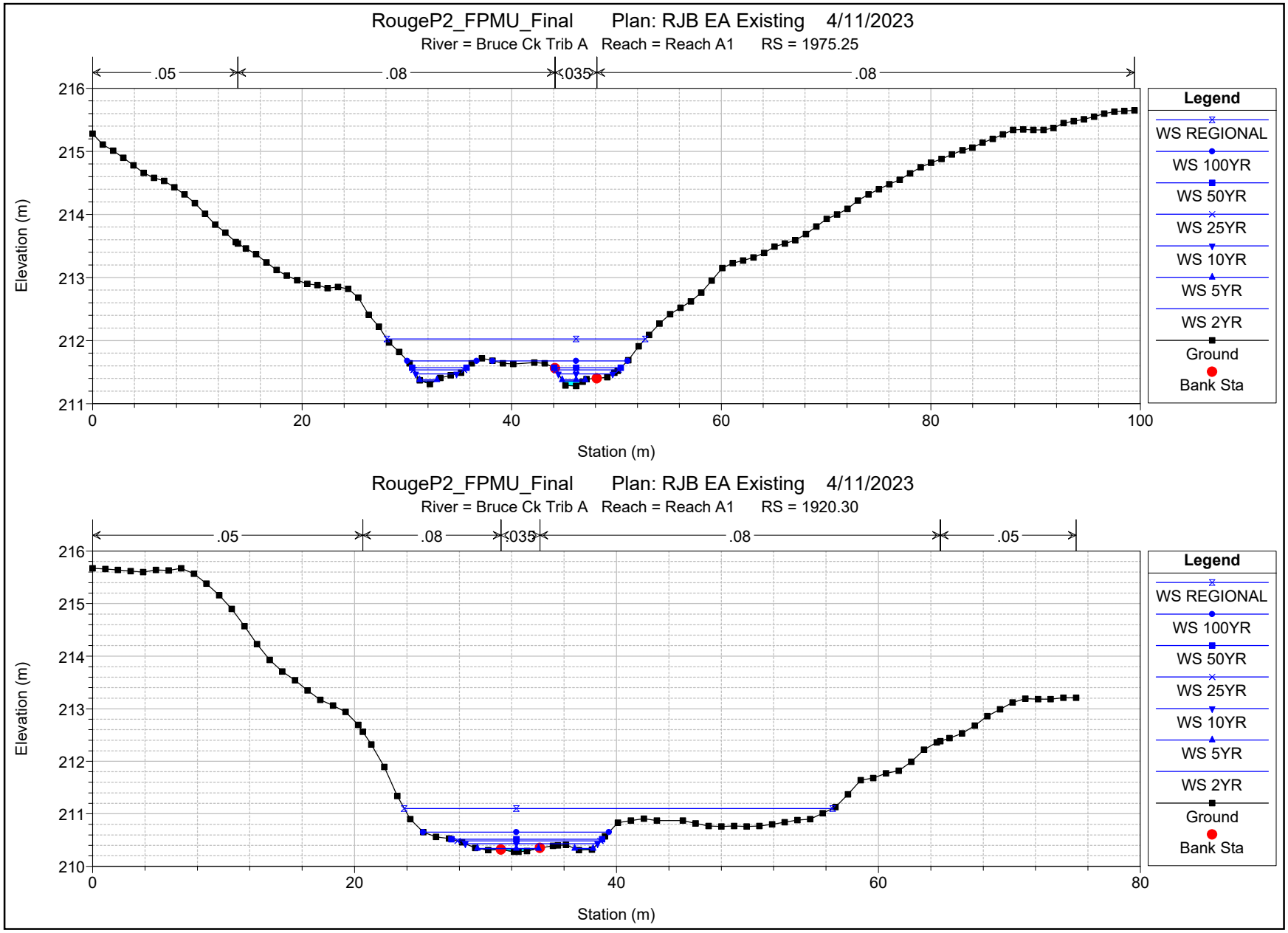
EXISTING CROSS SECTIONS



BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING
EXISTING CROSS SECTIONS



BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING
PROPOSED OUTPUT SUMMARY

HEC-RAS Plan: Plan 06 River: Bruce Ck Trib A Reach: Reach A1

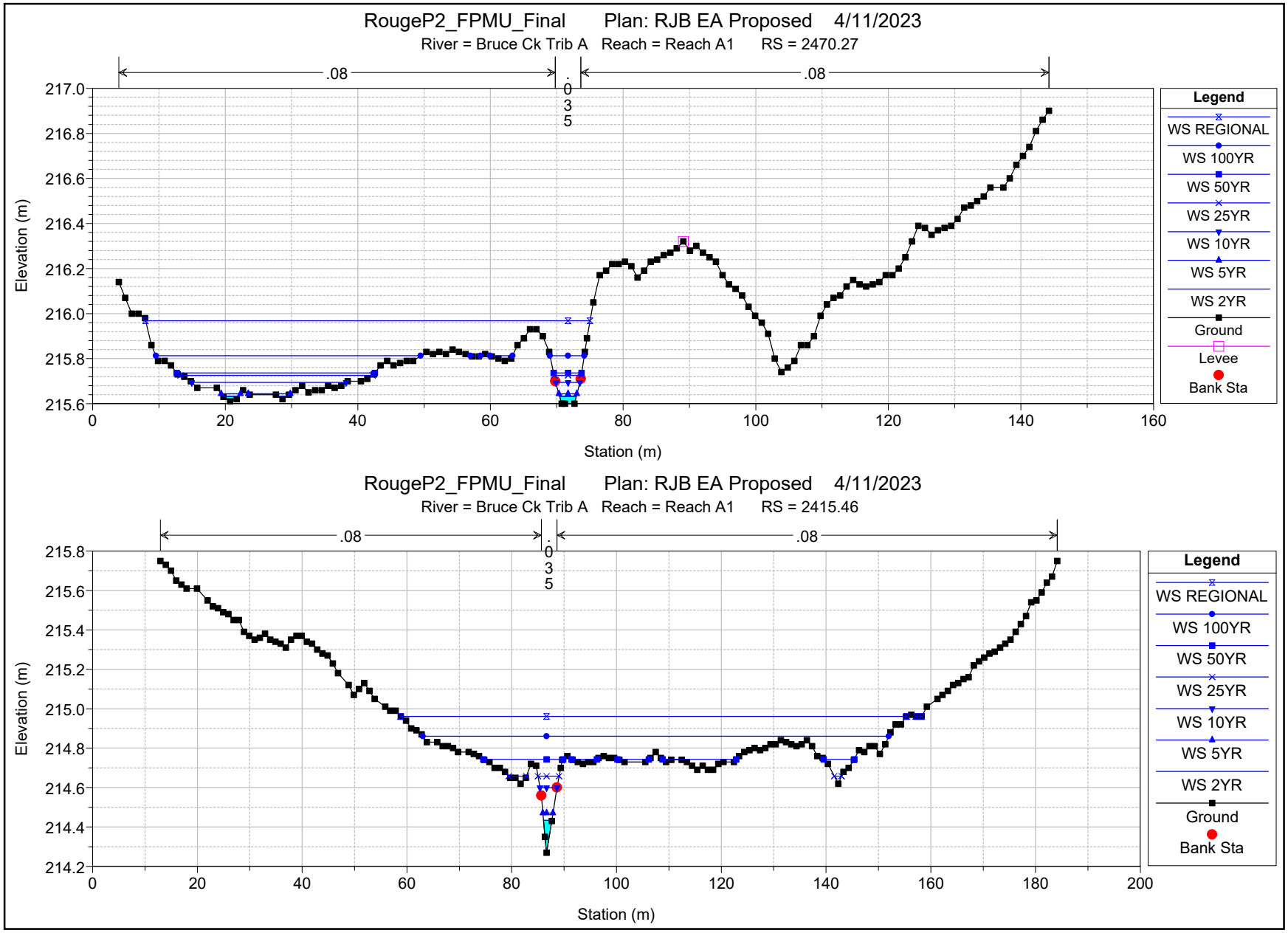
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach A1	2470.27	2YR	0.04	215.60	215.633	215.63	215.64	0.032652	0.49	0.11	6.13	0.91
Reach A1	2470.27	5YR	0.07	215.60	215.644	215.64	215.66	0.029196	0.55	0.21	11.98	0.90
Reach A1	2470.27	10YR	0.46	215.60	215.695	215.69	215.71	0.028352	0.83	1.22	26.88	0.99
Reach A1	2470.27	25YR	0.93	215.60	215.726	215.72	215.75	0.025471	0.98	2.17	33.06	0.99
Reach A1	2470.27	50YR	1.29	215.60	215.736	215.74	215.77	0.032282	1.17	2.52	34.11	1.13
Reach A1	2470.27	100YR	3.69	215.60	215.813	215.81	215.87	0.030894	1.64	5.55	50.11	1.21
Reach A1	2470.27	REGIONAL	13.66	215.60	215.969	215.96	216.05	0.027612	2.32	15.28	67.04	1.27
Reach A1	2415.46	2YR	0.04	214.27	214.434	214.38	214.44	0.003256	0.30	0.13	1.59	0.34
Reach A1	2415.46	5YR	0.07	214.27	214.471	214.40	214.48	0.003371	0.36	0.20	1.93	0.36
Reach A1	2415.46	10YR	0.46	214.27	214.600	214.55	214.64	0.010295	0.89	0.52	3.24	0.68
Reach A1	2415.46	25YR	0.93	214.27	214.658	214.66	214.75	0.015565	1.32	0.81	8.75	0.88
Reach A1	2415.46	50YR	1.29	214.27	214.744	214.74	214.80	0.007433	1.13	2.51	45.91	0.64
Reach A1	2415.46	100YR	3.69	214.27	214.861	214.85	214.89	0.005748	1.22	10.87	88.91	0.59
Reach A1	2415.46	REGIONAL	13.66	214.27	214.962	214.96	215.05	0.015750	2.33	20.22	97.84	1.02
Reach A1	2360.70	2YR	0.04	213.87	213.990	213.99	214.02	0.033223	0.77	0.05	0.88	1.01
Reach A1	2360.70	5YR	0.07	213.87	214.019	214.02	214.06	0.030842	0.86	0.08	1.10	1.01
Reach A1	2360.70	10YR	0.46	213.87	214.249	214.22	214.26	0.004626	0.63	1.83	37.45	0.46
Reach A1	2360.70	25YR	0.93	213.87	214.301	214.27	214.31	0.004176	0.70	4.30	62.96	0.45
Reach A1	2360.70	50YR	1.29	213.87	214.323	214.28	214.34	0.004196	0.74	5.77	73.75	0.46
Reach A1	2360.70	100YR	3.69	213.87	214.357	214.36	214.40	0.014699	1.50	8.60	94.50	0.88
Reach A1	2360.70	REGIONAL	13.66	213.87	214.673	214.47	214.68	0.001827	0.86	49.73	152.51	0.35
Reach A1	2305.27	2YR	0.04	213.56	213.740	213.67	213.74	0.001786	0.24	0.17	1.86	0.26
Reach A1	2305.27	5YR	0.07	213.56	213.781	213.69	213.78	0.001803	0.28	0.25	2.26	0.27
Reach A1	2305.27	10YR	0.46	213.56	213.897	213.84	213.93	0.008306	0.77	0.65	9.05	0.61
Reach A1	2305.27	25YR	0.93	213.56	213.952	213.95	213.99	0.009263	0.91	2.40	57.22	0.66
Reach A1	2305.27	50YR	1.29	213.56	213.972	213.97	214.00	0.009419	0.97	3.57	61.18	0.68
Reach A1	2305.27	100YR	3.69	213.56	214.118	214.03	214.13	0.002379	0.69	17.69	126.52	0.37
Reach A1	2305.27	REGIONAL	13.66	213.56	214.654	214.15	214.65	0.000187	0.36	118.53	236.47	0.12
Reach A1	2249.91	2YR	0.04	213.51	213.640	213.58	213.64	0.001865	0.22	0.19	2.51	0.25
Reach A1	2249.91	5YR	0.07	213.51	213.671	213.60	213.67	0.002245	0.25	0.31	7.64	0.28
Reach A1	2249.91	10YR	0.46	213.51	213.768	213.72	213.77	0.001300	0.30	4.44	75.43	0.24
Reach A1	2249.91	25YR	0.93	213.51	213.839	213.75	213.84	0.000602	0.26	10.81	97.63	0.17
Reach A1	2249.91	50YR	1.29	213.51	213.892	213.76	213.89	0.000374	0.24	16.13	106.05	0.14
Reach A1	2249.91	100YR	3.69	213.51	214.095	213.81	214.10	0.000206	0.25	41.74	138.41	0.12
Reach A1	2249.91	REGIONAL	13.66	213.51	214.646	213.91	214.65	0.000108	0.30	135.60	218.87	0.10
Reach A1	2224.47	2YR	0.05	213.39	213.475	213.47	213.50	0.034762	0.64	0.08	1.84	1.00
Reach A1	2224.47	5YR	0.08	213.39	213.493	213.49	213.52	0.030176	0.71	0.11	2.11	0.97
Reach A1	2224.47	10YR	0.51	213.39	213.612	213.61	213.67	0.024129	1.11	0.46	3.72	1.00
Reach A1	2224.47	25YR	1.04	213.39	213.691	213.69	213.79	0.019122	1.37	0.81	7.90	0.96
Reach A1	2224.47	50YR	1.44	213.39	213.742	213.74	213.85	0.017084	1.50	1.10	30.14	0.95
Reach A1	2224.47	100YR	3.41	213.39	213.921	213.92	214.07	0.012531	1.83	2.71	95.90	0.88
Reach A1	2224.47	REGIONAL	15.39	213.39	214.643	214.41	214.64	0.000145	0.38	134.84	232.99	0.11
Reach A1	2200.14		Culvert									
Reach A1	2173.64	2YR	0.05	213.08	213.194	213.16	213.20	0.004913	0.33	0.15	2.25	0.41
Reach A1	2173.64	5YR	0.08	213.08	213.217	213.18	213.23	0.004920	0.39	0.21	2.42	0.42
Reach A1	2173.64	10YR	0.51	213.08	213.383	213.30	213.41	0.005105	0.74	0.71	3.62	0.50
Reach A1	2173.64	25YR	1.04	213.08	213.486	213.39	213.54	0.005621	1.00	1.12	4.50	0.56
Reach A1	2173.64	50YR	1.44	213.08	213.537	213.45	213.60	0.006394	1.18	1.36	4.98	0.61
Reach A1	2173.64	100YR	3.41	213.08	213.661	213.66	213.85	0.012529	1.99	2.06	16.72	0.90
Reach A1	2173.64	REGIONAL	15.39	213.08	214.192	214.15	214.20	0.000511	0.65	68.16	170.97	0.21
Reach A1	2140.27	2YR	0.05	212.97	213.062	213.02	213.07	0.003409	0.28	0.18	2.68	0.34
Reach A1	2140.27	5YR	0.08	212.97	213.087	213.04	213.09	0.003332	0.32	0.25	2.95	0.35
Reach A1	2140.27	10YR	0.51	212.97	213.271	213.15	213.29	0.002727	0.53	0.96	4.67	0.37
Reach A1	2140.27	25YR	1.04	212.97	213.387	213.23	213.41	0.002443	0.67	1.83	10.61	0.37
Reach A1	2140.27	50YR	1.44	212.97	213.449	213.28	213.47	0.002213	0.72	2.81	18.74	0.36
Reach A1	2140.27	100YR	3.41	212.97	213.659	213.49	213.68	0.001262	0.72	8.87	40.04	0.30
Reach A1	2140.27	REGIONAL	15.39	212.97	214.162	213.77	214.17	0.000689	0.80	42.00	81.50	0.24
Reach A1	2085.22	2YR	0.05	212.75	212.855	212.82	212.86	0.004078	0.31	0.16	2.26	0.37
Reach A1	2085.22	5YR	0.08	212.75	212.880	212.83	212.89	0.004178	0.37	0.22	2.41	0.39
Reach A1	2085.22	10YR	0.51	212.75	213.035	212.96	213.06	0.006467	0.77	0.66	3.33	0.55
Reach A1	2085.22	25YR	1.04	212.75	213.136	213.05	213.19	0.007478	1.01	1.03	3.95	0.62
Reach A1	2085.22	50YR	1.44	212.75	213.186	213.11	213.26	0.008355	1.18	1.23	4.31	0.67
Reach A1	2085.22	100YR	3.41	212.75	213.336	213.32	213.50	0.011956	1.83	2.05	7.46	0.86
Reach A1	2085.22	REGIONAL	15.39	212.75	213.836	213.84	214.06	0.008770	2.56	10.08	22.86	0.83
Reach A1	2030.27	2YR	0.05	212.32	212.352	212.35	212.36	0.036356	0.46	0.14	5.18	0.94
Reach A1	2030.27	5YR	0.08	212.32	212.361	212.36	212.37	0.037313	0.55	0.19	5.54	0.99
Reach A1	2030.27	10YR	0.51	212.32	212.446	212.44	212.48	0.021259	0.89	0.84	10.59	0.90
Reach A1	2030.27	25YR	1.04	212.32	212.498	212.47	212.55	0.020952	1.11	1.50	14.66	0.95
Reach A1	2030.27	50YR	1.44	212.32	212.528	212.52	212.58	0.019756	1.19	1.96	15.34	0.94

BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING
PROPOSED OUTPUT SUMMARY

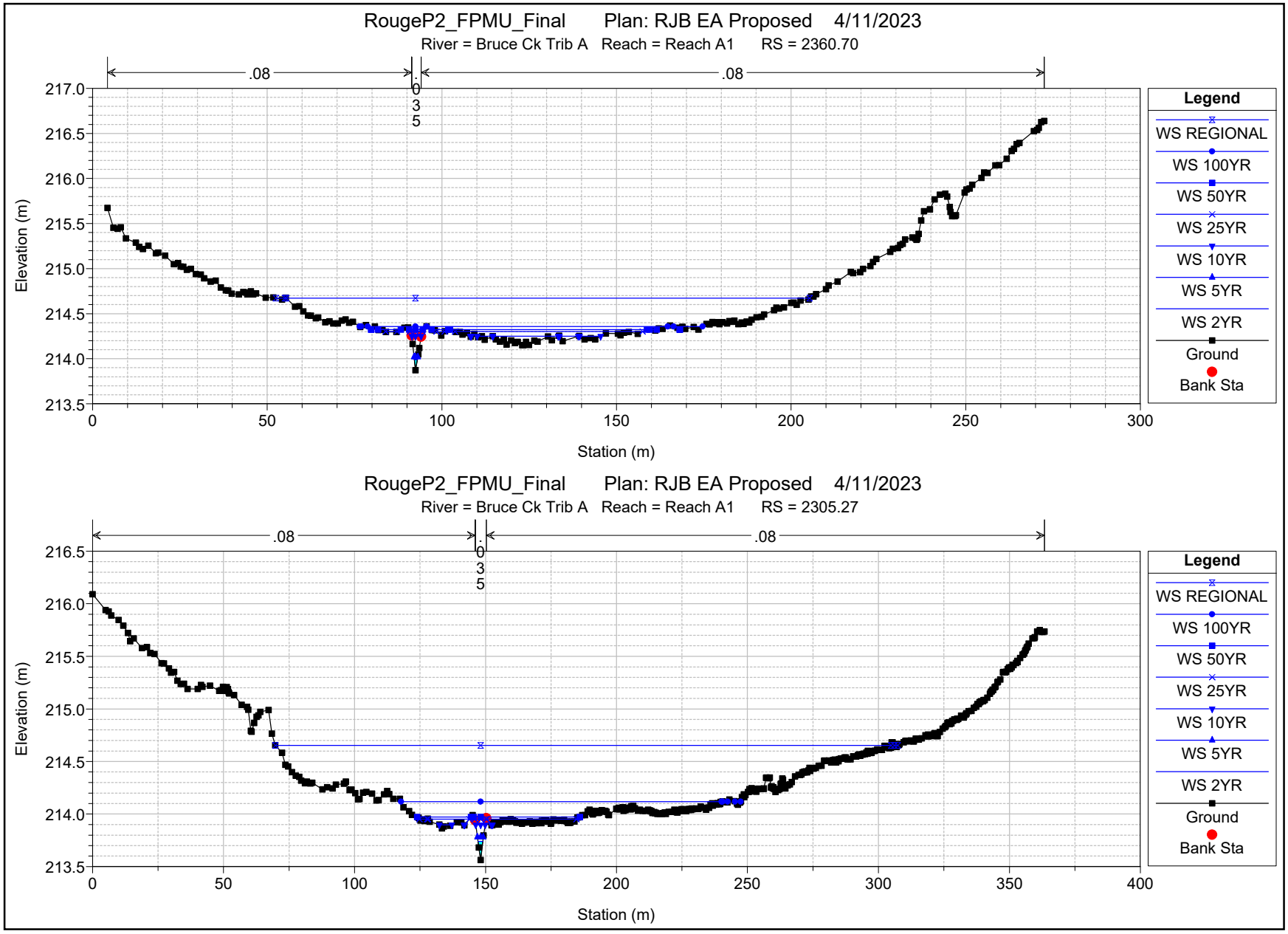
HEC-RAS Plan: Plan 06 River: Bruce Ck Trib A Reach: Reach A1 (Continued)

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)	
Reach A1	2030.27	100YR	3.41	212.32	212.646	212.60	212.72	0.016154	1.46	3.98	20.08	0.92
Reach A1	2030.27	REGIONAL	15.39	212.32	212.965	212.93	213.15	0.015676	2.46	11.33	24.18	1.04
Reach A1	1975.25	2YR	0.05	211.28	211.358	211.34	211.37	0.010798	0.43	0.14	3.21	0.58
Reach A1	1975.25	5YR	0.08	211.28	211.377	211.36	211.39	0.010490	0.48	0.21	3.86	0.59
Reach A1	1975.25	10YR	0.51	211.28	211.473	211.45	211.51	0.014889	0.88	0.85	9.06	0.78
Reach A1	1975.25	25YR	1.04	211.28	211.535	211.51	211.58	0.014785	1.10	1.47	10.81	0.83
Reach A1	1975.25	50YR	1.44	211.28	211.568	211.55	211.63	0.015373	1.23	1.84	11.54	0.86
Reach A1	1975.25	100YR	3.41	211.28	211.679	211.67	211.79	0.017611	1.76	3.48	19.51	0.99
Reach A1	1975.25	REGIONAL	15.39	211.28	212.025	212.02	212.24	0.017069	2.82	11.33	24.66	1.11
Reach A1	1920.30	2YR	0.07	210.28	210.337	210.34	210.35	0.031056	0.58	0.16	5.71	0.93
Reach A1	1920.30	5YR	0.10	210.28	210.343	210.34	210.36	0.035826	0.67	0.20	6.09	1.03
Reach A1	1920.30	10YR	0.64	210.28	210.432	210.43	210.48	0.023796	1.14	0.94	10.10	1.00
Reach A1	1920.30	25YR	1.23	210.28	210.485	210.48	210.56	0.024335	1.44	1.49	10.91	1.07
Reach A1	1920.30	50YR	1.65	210.28	210.518	210.52	210.60	0.023328	1.57	1.87	11.52	1.08
Reach A1	1920.30	100YR	3.84	210.28	210.653	210.65	210.78	0.020180	2.02	3.63	14.20	1.09
Reach A1	1920.30	REGIONAL	17.60	210.28	211.103	211.10	211.30	0.014202	2.94	14.84	32.70	1.05

BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING
PROPOSED CROSS SECTIONS



BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING
PROPOSED CROSS SECTIONS



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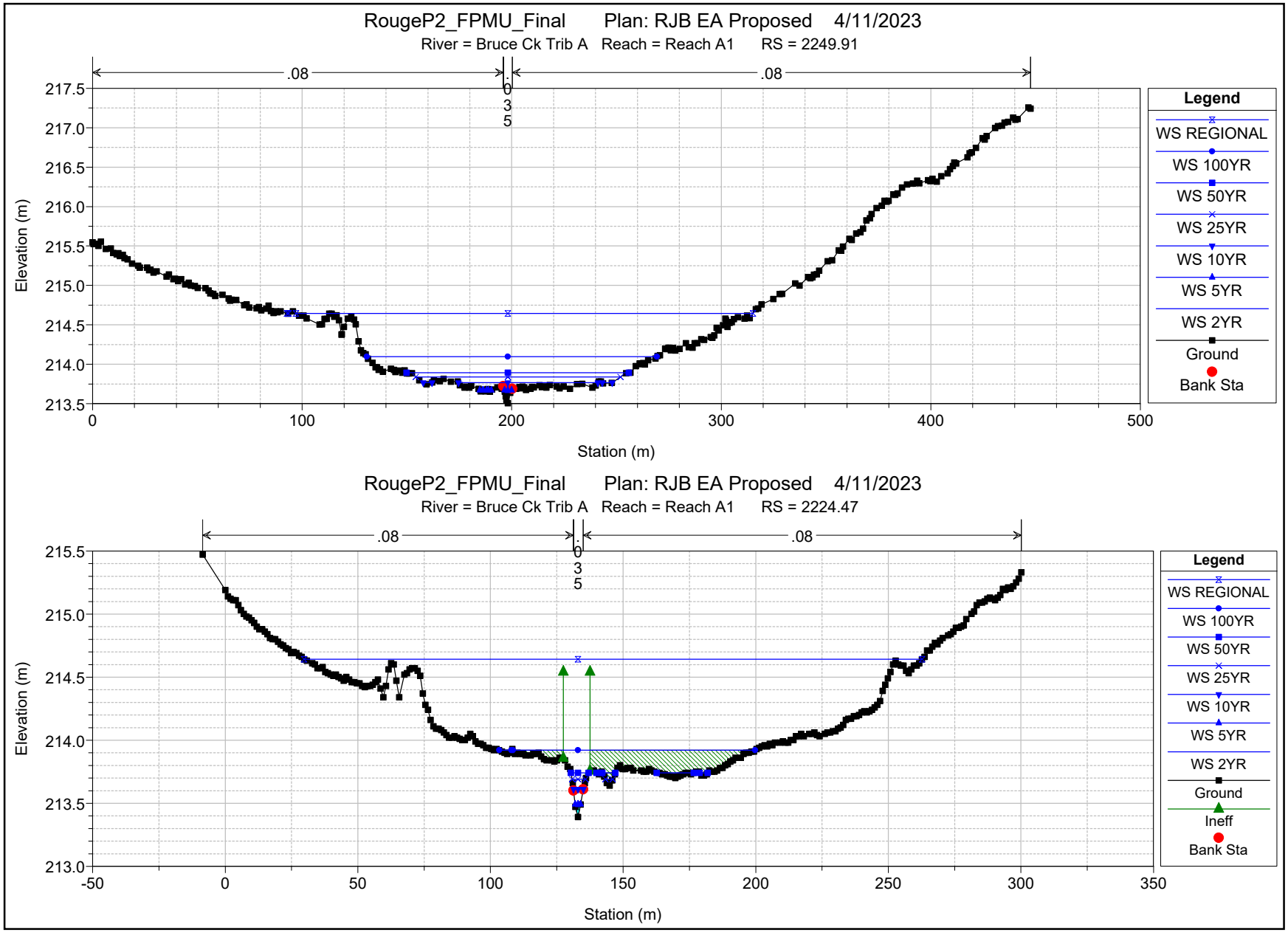

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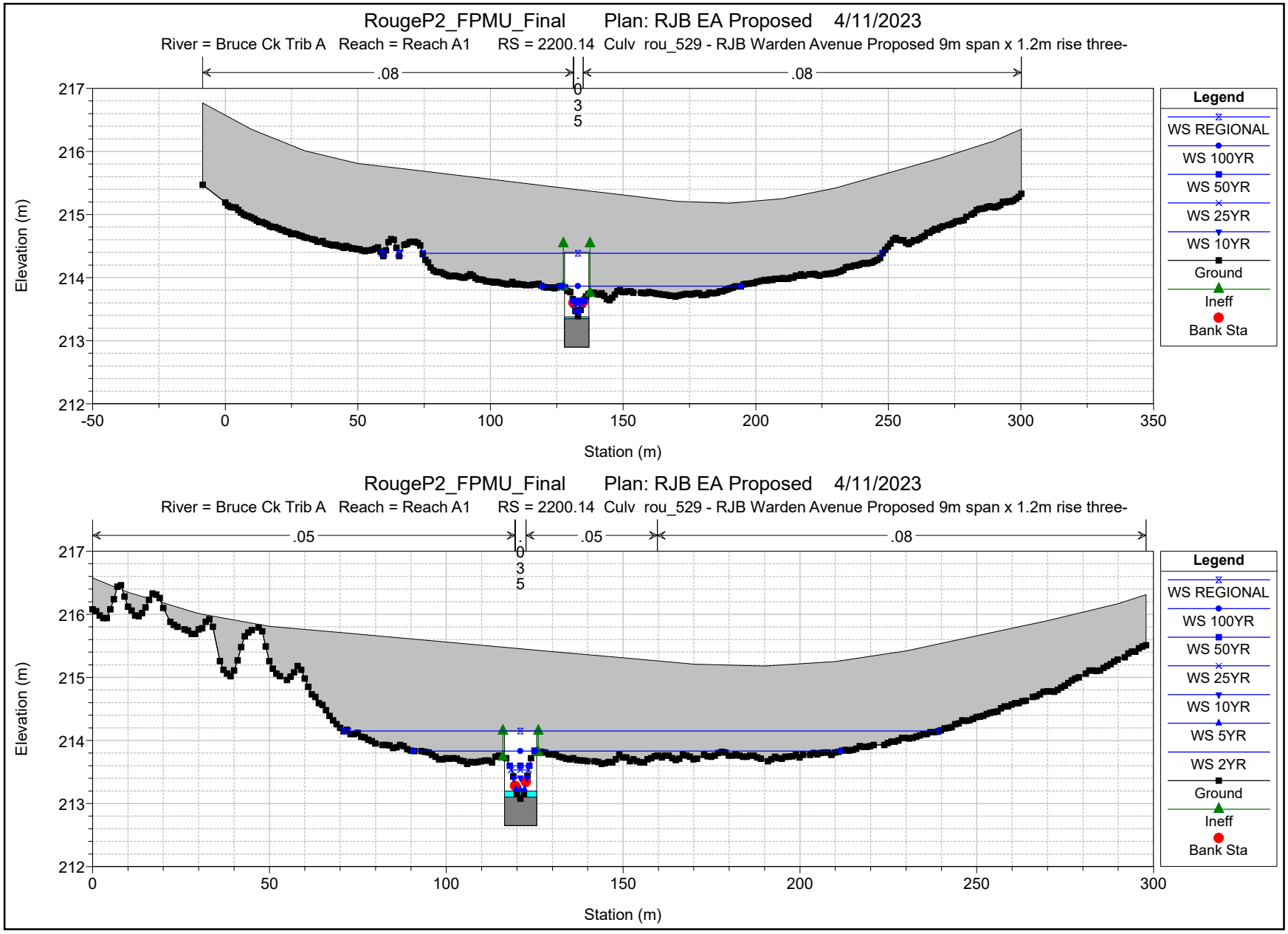

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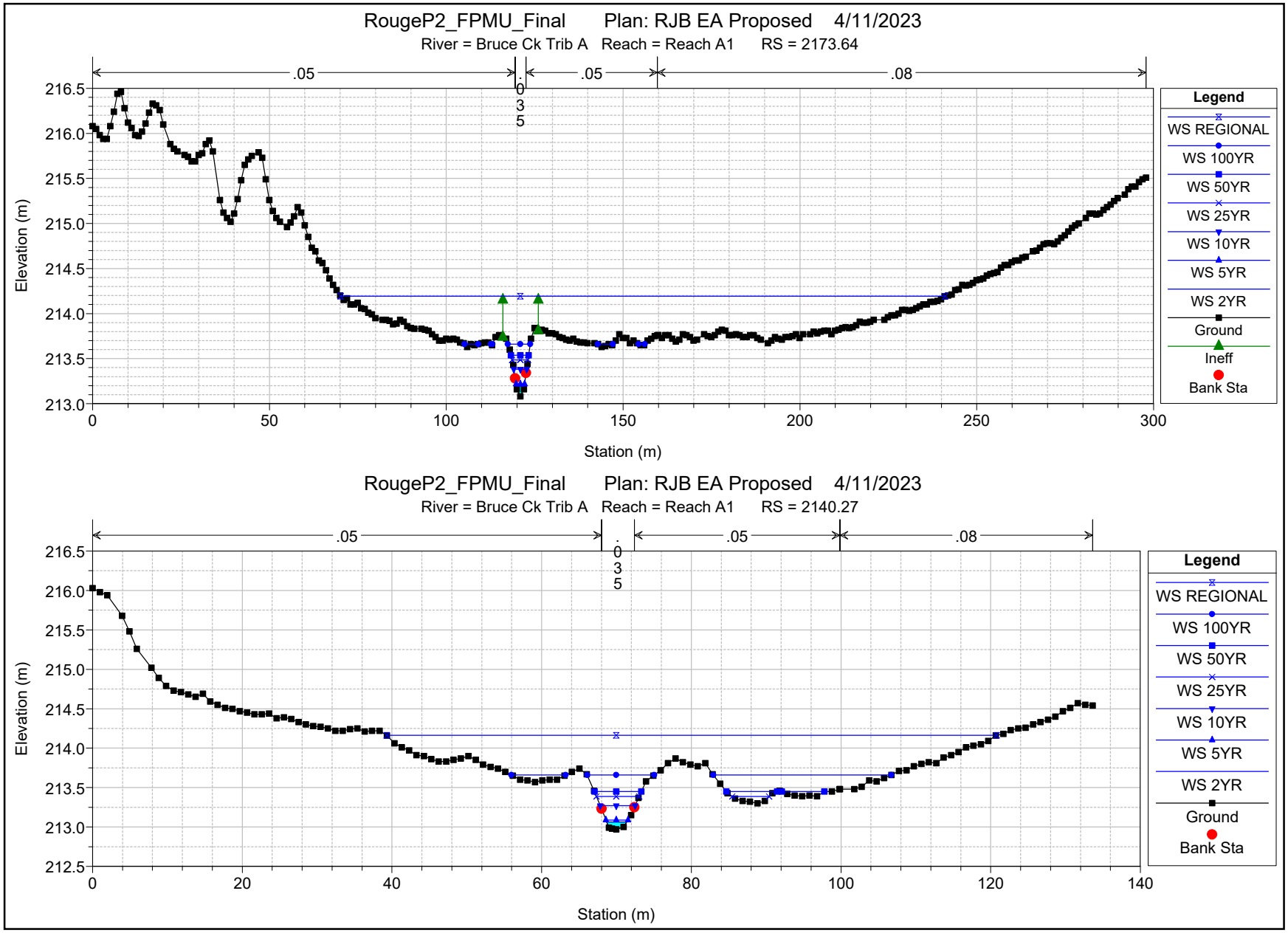
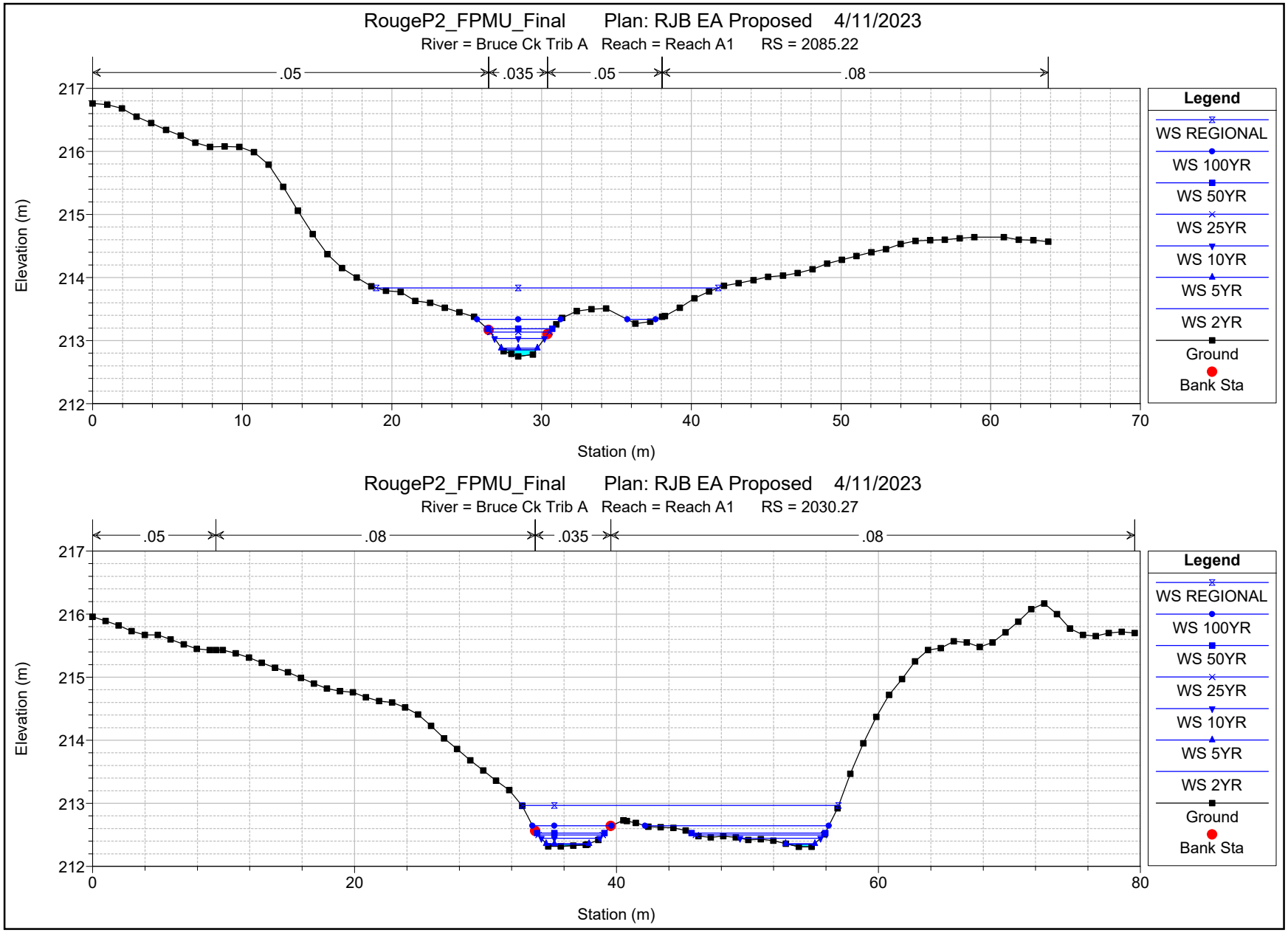
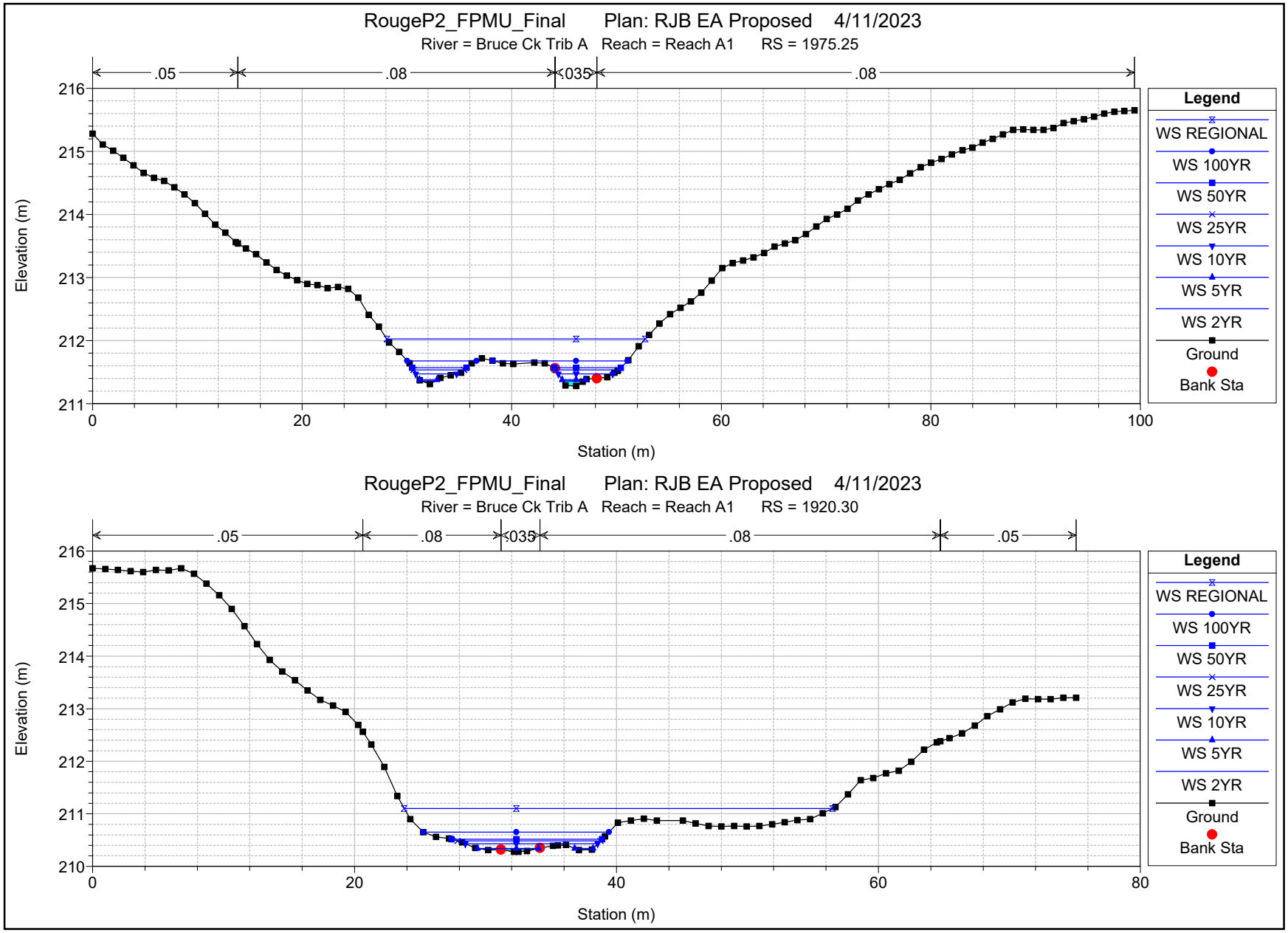


BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING
PROPOSED CROSS SECTIONS



BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING
PROPOSED CROSS SECTIONS



BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING REGIONAL SUMMARY

EXISTING CONDITION

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
Reach A1	3380	REGIONAL	13.66	221.82	222.322	222.16	222.35	0.009508	1.72	23.42	87.35	0.79
Reach A1	3350.27	REGIONAL	13.66	221.51	222.042	221.93	222.08	0.008826	1.73	24.71	95.5	0.77
Reach A1	3295.27	REGIONAL	13.66	221.19	221.698	221.54	221.72	0.00502	1.25	33.01	125.57	0.57
Reach A1	3240.27	REGIONAL	13.66	220.78	221.286	221.2	221.32	0.01101	1.82	25.78	123.19	0.84
Reach A1	3185.27	REGIONAL	13.66	220.39	220.94	220.79	220.96	0.00431	1.25	35.78	131.38	0.54
Reach A1	3130.27	REGIONAL	13.66	220.1	220.667	220.56	220.69	0.005228	1.37	31.43	119.6	0.59
Reach A1	3075.27	REGIONAL	13.66	219.86	220.407	220.23	220.43	0.004317	1.22	31.1	110.27	0.54
Reach A1	3020.27	REGIONAL	13.66	219.54	220.111	220	220.14	0.006333	1.49	28.75	112.52	0.65
Reach A1	2965.27	REGIONAL	13.66	219.17	220.014	219.67	220.02	0.001037	0.81	54.8	132.14	0.28
Reach A1	2909.6	REGIONAL	13.66	218.96	219.963	219.51	219.97	0.000743	0.77	52.59	99.35	0.25
Reach A1	2855.27	REGIONAL	13.66	218.89	219.916	219.42	219.92	0.001039	0.91	46.7	85.42	0.29
Reach A1	2800.3	REGIONAL	13.66	218.84	219.81	219.5	219.84	0.002242	1.27	31.03	75.23	0.42
Reach A1	2745.27	REGIONAL	13.66	218.74	219.485	219.42	219.6	0.010984	2.37	18.29	65.41	0.9
Reach A1	2690.28	REGIONAL	13.66	217.76	218.898	218.9	219.1	0.007286	2.55	14.09	36.9	0.79
Reach A1	2635.34	REGIONAL	13.66	217.49	218.384	218.24	218.51	0.005557	1.94	14.86	32.94	0.66
Reach A1	2590.5	REGIONAL	13.66	217	218.017	218.02	218.21	0.00779	2.27	13.03	42.54	0.78
Reach A1	2582.15	REGIONAL	13.66	217.02	217.906	217.91	218.01	0.007574	2.08	18.65	72.42	0.75
Reach A1	2565.7	REGIONAL	13.66	216.73	217.394	217.39	217.52	0.015957	2.56	15.48	54.26	1.05
Reach A1	2561.47	REGIONAL	13.66	216.08	217.266	217.27	217.43	0.012562	2.59	13.78	41.47	0.92
Reach A1	2555.07		Culvert									
Reach A1	2536.68	REGIONAL	13.66	215.72	216.878	216.88	217.3	0.012079	3	6.59	15.21	0.97
Reach A1	2532.83	REGIONAL	13.66	215.7	216.85	216.85	216.86	0.00047	0.61	61.43	103.56	0.2
Reach A1	2470.27	REGIONAL	13.66	215.6	215.969	215.96	216.05	0.027612	2.32	15.28	67.04	1.27
Reach A1	2415.46	REGIONAL	13.66	214.27	214.962	214.96	215.05	0.01575	2.33	20.22	97.84	1.02
Reach A1	2360.7	REGIONAL	13.66	213.87	214.693	214.47	214.7	0.001563	0.81	52.96	157.95	0.33
Reach A1	2305.27	REGIONAL	13.66	213.56	214.677	214.15	214.68	0.000162	0.34	124.12	239.21	0.11
Reach A1	2249.91	REGIONAL	13.66	213.51	214.67	213.91	214.67	0.000096	0.29	141.05	229.52	0.09
Reach A1	2224.47	REGIONAL	15.39	213.39	214.667	214.02	214.67	0.000129	0.36	140.64	235.58	0.11
Reach A1	2209.84	REGIONAL	15.39	213.38	214.666	214.37	214.67	0.000091	0.31	153.6	214.8	0.09
Reach A1	2200.14		Culvert									
Reach A1	2188.97	REGIONAL	15.39	213.24	214.201	214.11	214.21	0.000825	0.78	59.31	182.92	0.26
Reach A1	2173.64	REGIONAL	15.39	213.08	214.192	213.9	214.2	0.000511	0.65	68.16	170.97	0.21
Reach A1	2140.27	REGIONAL	15.39	212.97	214.162	213.77	214.17	0.000689	0.8	42	81.5	0.24
Reach A1	2085.22	REGIONAL	15.39	212.75	213.836	213.84	214.06	0.00877	2.56	10.08	22.86	0.83
Reach A1	2030.27	REGIONAL	15.39	212.32	212.965	212.93	213.15	0.015676	2.46	11.33	24.18	1.04
Reach A1	1975.25	REGIONAL	15.39	211.28	212.025	212.02	212.24	0.017069	2.82	11.33	24.66	1.11
Reach A1	1920.3	REGIONAL	17.6	210.28	211.103	211.1	211.3	0.014202	2.94	14.84	32.7	1.05
Reach A1	1886.34	REGIONAL	17.6	208.9	210.114	209.96	210.22	0.003356	1.81	17.97	41.79	0.54
Reach A1	1856.25	REGIONAL	29.18	208.37	209.666	209.67	210	0.010751	3.34	17.73	27.48	0.97
Reach A1	1818.61	REGIONAL	29.18	207.91	209.149	209.15	209.53	0.011672	3.34	13.16	18.47	1
Reach A1	1787.62	REGIONAL	29.18	207.64	208.777	208.5	208.89	0.005853	2.29	28.03	33.46	0.71
Reach A1	1756.22	REGIONAL	29.18	207.19	208.158	208.16	208.57	0.019634	3.81	14.33	18.59	1.26
Reach A1	1715.22	REGIONAL	29.18	206.1	207.53	207.53	207.87	0.010607	3.45	19.79	31.09	0.97
Reach A1	1673.34	REGIONAL	29.18	205.68	207.027	207.03	207.28	0.009291	3.09	23.36	38.8	0.89
Reach A1	1635.84	REGIONAL	29.18	205	206.271	206.27	206.52	0.012551	3.59	23.78	42.14	1.05
Reach A1	1606.19	REGIONAL	29.18	204.89	205.863	205.83	206.06	0.010508	2.71	25.1	48.61	0.91
Reach A1	1556.22	REGIONAL	29.24	204.68	205.427	205.26	205.55	0.013129	2.57	25.24	44.19	0.98
Reach A1	1498.47	REGIONAL	29.24	203.64	204.534	204.43	204.68	0.017145	3.26	23.55	42.23	1.15
Reach A1	1447.13	REGIONAL	29.24	203.09	203.605	203.55	203.73	0.023973	2.6	24.23	63.3	1.24
Reach A1	1394.43	REGIONAL	34.32	202.22	202.951	202.86	203.04	0.009526	2.21	40.04	93.01	0.84
Reach A1	1390.03	REGIONAL	34.32	202.15	202.906	202.78	203	0.008653	2.15	40.32	88.95	0.81
Reach A1	1372.01	REGIONAL	34.32	202.09	202.709	202.53	202.8	0.012217	2.25	35.88	78.81	0.93
Reach A1	1363.97	REGIONAL	34.32	201.97	202.606	202.41	202.69	0.014845	2.48	34.59	78.46	1.02
Reach A1	1329.1	REGIONAL	34.32	201.53	202.48	202.03	202.51	0.002426	1.34	60.83	83.47	0.44
Reach A1	1291.48	REGIONAL	34.32	200.93	201.988	201.99	202.31	0.012433	3.12	21.52	35.1	1.01
Reach A1	1215.83	REGIONAL	34.32	200.3	201.011	200.87	201.16	0.014614	2.72	27.02	47.68	1.04
Reach A1	1163.79	REGIONAL	34.32	199.42	200.313	200.27	200.52	0.015372	3.11	24.63	44.88	1.09
Reach A1	1125.44	REGIONAL	34.32	199.04	200.077	199.81	200.17	0.006689	2.28	33.13	47.38	0.74
Reach A1	1070.64	REGIONAL	34.32	198.73	199.586	199.4	199.72	0.010346	2.55	28.25	40.53	0.9
Reach A1	1024.38	REGIONAL	34.32	198.31	199.113	198.96	199.25	0.011057	2.55	29.03	46.82	0.92
Reach A1	993.4	REGIONAL	34.32	198.05	198.761	198.59	198.89	0.01774	2.92	26.31	44.43	1.14
Reach A1	919.87	REGIONAL	34.32	197.43	198.372	198	198.42	0.004051	1.7	46.61	62.2	0.57
Reach A1	858.75	REGIONAL	34.32	197.04	198.052	197.77	198.14	0.006249	2.21	37.96	56.02	0.72
Reach A1	797.72	REGIONAL	38.99	196.33	197.263	197.26	197.54	0.02024	3.64	23.56	38.76	1.26
Reach A1	728.08	REGIONAL	38.99	195.83	196.522	196.26	196.58	0.008355	1.9	44.62	78.62	0.77
Reach A1	634.45	REGIONAL	38.99	195.09	196.11	195.86	196.2	0.007323	2.43	39.74	61.36	0.78
Reach A1	600.7	REGIONAL	38.99	194.67	196.009	195.65	196.06	0.002677	1.74	55.92	67.39	0.49
Reach A1	573.19	REGIONAL	38.99	194.29	196.014	195.03	196.03	0.000519	0.92	105.14	82.62	0.23
Reach A1	565.18	REGIONAL	38.99	193.12	195.409	195.41	195.88	0.010445	3.59	18.74	63.1	0.88
Reach A1	545.05		Culvert									
Reach A1	520.84	REGIONAL	38.99	193	195.005	195	195.62	0.008633	3.75	15.61	14.64	0.9
Reach A1	514.56	REGIONAL	38.99	192.94	194.923	194.92	195.24	0.005744	3.13	31.14	47.07	0.74
Reach A1	491.21	REGIONAL	42.71	192.53	194.498	194.5	194.83	0.005949	3.17	32.24	45.74	0.75
Reach A1	454.44	REGIONAL	42.71	191.81	193.696	192.84	193.72	0.000705	1.08	67.78	57.06	0.26
Reach A1	409.42	REGIONAL	42.71	191.29	193.69	192.37	193.71	0.000257	0.8	86.83	50.86	0.17
Reach A1	354.85	REGIONAL	42.71	191.07	193.691	191.83	193.7	0.000082	0.48	138.86	66.54	0.1
Reach A1	310.91	REGIONAL	42.71	190.52	193.691	191.46	193.69	0.000028	0.32	202.17	89.94	0.06
Reach A1	259.79	REGIONAL	42.71	190.21	193.69	191.36	193.69	0.000033	0.37	200.9	98.56	0.06
Reach A1	210.41	REGIONAL	42.71	189.64	193.69	190.98	193.69	0.000014	0.27	278.36	174.83	0.04
Reach A1	154.86	REGIONAL	42.71	189.42	193.69	190.34	193.69	0.000008	0.2	368.09	228.21	0.03
Reach A1	146.02	REGIONAL	42.71	189.38	193.69	190.89	193.69	0.000004	0.15	376.06	245.12	0.02
Reach A1	122.02		Culvert									
Reach A1	99.28	REGIONAL	42.71	188.5	189.969	189.97	190.48	0.009667	3.41	15.12	106.49	0.94
Reach A1	84.41	REGIONAL	42.71	188.13	188.87	188.78	188.91	0.004506	1.42	51.62	114.92	0.57

BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING REGIONAL SUMMARY

PROPOSED CONDITION

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
Reach A1	3380	REGIONAL	13.66	221.82	222.322	222.16	222.35	0.009508	1.72	23.42	87.35	0.79
Reach A1	3350.27	REGIONAL	13.66	221.51	222.042	221.93	222.08	0.008826	1.73	24.71	95.5	0.77
Reach A1	3295.27	REGIONAL	13.66	221.19	221.698	221.54	221.72	0.00502	1.25	33.01	125.57	0.57
Reach A1	3240.27	REGIONAL	13.66	220.78	221.286	221.2	221.32	0.01101	1.82	25.78	123.19	0.84
Reach A1	3185.27	REGIONAL	13.66	220.39	220.94	220.79	220.96	0.00431	1.25	35.78	131.38	0.54
Reach A1	3130.27	REGIONAL	13.66	220.1	220.667	220.56	220.69	0.005228	1.37	31.43	119.6	0.59
Reach A1	3075.27	REGIONAL	13.66	219.86	220.407	220.23	220.43	0.004317	1.22	31.1	110.27	0.54
Reach A1	3020.27	REGIONAL	13.66	219.54	220.111	220	220.14	0.006333	1.49	28.75	112.52	0.65
Reach A1	2965.27	REGIONAL	13.66	219.17	220.014	219.67	220.02	0.001037	0.81	54.8	132.14	0.28
Reach A1	2909.6	REGIONAL	13.66	218.96	219.963	219.51	219.97	0.000743	0.77	52.59	99.35	0.25
Reach A1	2855.27	REGIONAL	13.66	218.89	219.916	219.42	219.92	0.001039	0.91	46.7	85.42	0.29
Reach A1	2800.3	REGIONAL	13.66	218.84	219.81	219.5	219.84	0.002242	1.27	31.03	75.23	0.42
Reach A1	2745.27	REGIONAL	13.66	218.74	219.485	219.42	219.6	0.010984	2.37	18.29	65.41	0.9
Reach A1	2690.28	REGIONAL	13.66	217.76	218.898	218.9	219.1	0.007286	2.55	14.09	36.9	0.79
Reach A1	2635.34	REGIONAL	13.66	217.49	218.384	218.24	218.51	0.005557	1.94	14.86	32.94	0.66
Reach A1	2590.5	REGIONAL	13.66	217	218.017	218.02	218.21	0.00779	2.27	13.03	42.54	0.78
Reach A1	2582.15	REGIONAL	13.66	217.02	217.906	217.91	218.01	0.007574	2.08	18.65	72.42	0.75
Reach A1	2565.7	REGIONAL	13.66	216.73	217.394	217.39	217.52	0.015957	2.56	15.48	54.26	1.05
Reach A1	2561.47	REGIONAL	13.66	216.08	217.266	217.27	217.43	0.012562	2.59	13.78	41.47	0.92
Reach A1	2555.07		Culvert									
Reach A1	2536.68	REGIONAL	13.66	215.72	216.878	216.88	217.3	0.012079	3	6.59	15.21	0.97
Reach A1	2532.83	REGIONAL	13.66	215.7	216.85	216.85	216.86	0.00047	0.61	61.43	103.56	0.2
Reach A1	2470.27	REGIONAL	13.66	215.6	215.969	215.96	216.05	0.027612	2.32	15.28	67.04	1.27
Reach A1	2415.46	REGIONAL	13.66	214.27	214.962	214.96	215.05	0.01575	2.33	20.22	97.84	1.02
Reach A1	2360.7	REGIONAL	13.66	213.87	214.673	214.47	214.68	0.001827	0.86	49.73	152.51	0.35
Reach A1	2305.27	REGIONAL	13.66	213.56	214.654	214.15	214.65	0.000187	0.36	118.53	236.47	0.12
Reach A1	2249.91	REGIONAL	13.66	213.51	214.646	213.91	214.65	0.000108	0.3	135.6	218.87	0.1
Reach A1	2224.47	REGIONAL	15.39	213.39	214.643	214.41	214.64	0.000145	0.38	134.84	232.99	0.11
Reach A1	2200.14		Culvert									
Reach A1	2173.64	REGIONAL	15.39	213.08	214.192	214.15	214.2	0.000511	0.65	68.16	170.97	0.21
Reach A1	2140.27	REGIONAL	15.39	212.97	214.162	213.77	214.17	0.000689	0.8	42	81.5	0.24
Reach A1	2085.22	REGIONAL	15.39	212.75	213.836	213.84	214.06	0.00877	2.56	10.08	22.86	0.83
Reach A1	2030.27	REGIONAL	15.39	212.32	212.965	212.93	213.15	0.015676	2.46	11.33	24.18	1.04
Reach A1	1975.25	REGIONAL	15.39	211.28	212.025	212.02	212.24	0.017069	2.82	11.33	24.66	1.11
Reach A1	1920.3	REGIONAL	17.6	210.28	211.103	211.1	211.3	0.014202	2.94	14.84	32.7	1.05
Reach A1	1886.34	REGIONAL	17.6	208.9	210.114	209.96	210.22	0.003356	1.81	17.97	41.79	0.54
Reach A1	1856.25	REGIONAL	29.18	208.37	209.666	209.67	210	0.010751	3.34	17.73	27.48	0.97
Reach A1	1818.61	REGIONAL	29.18	207.91	209.149	209.15	209.53	0.011672	3.34	13.16	18.47	1
Reach A1	1787.62	REGIONAL	29.18	207.64	208.777	208.5	208.89	0.005853	2.29	28.03	33.46	0.71
Reach A1	1756.22	REGIONAL	29.18	207.19	208.158	208.16	208.57	0.019634	3.81	14.33	18.59	1.26
Reach A1	1715.22	REGIONAL	29.18	206.1	207.53	207.53	207.87	0.010607	3.45	19.79	31.09	0.97
Reach A1	1673.34	REGIONAL	29.18	205.68	207.027	207.03	207.28	0.009291	3.09	23.36	38.8	0.89
Reach A1	1635.84	REGIONAL	29.18	205	206.271	206.27	206.52	0.012551	3.59	23.78	42.14	1.05
Reach A1	1606.19	REGIONAL	29.18	204.89	205.863	205.83	206.06	0.010508	2.71	25.1	48.61	0.91
Reach A1	1556.22	REGIONAL	29.24	204.68	205.427	205.26	205.55	0.013129	2.57	25.24	44.19	0.98
Reach A1	1498.47	REGIONAL	29.24	203.64	204.534	204.43	204.68	0.017145	3.26	23.55	42.23	1.15
Reach A1	1447.13	REGIONAL	29.24	203.09	203.605	203.55	203.73	0.023973	2.6	24.23	63.3	1.24
Reach A1	1394.43	REGIONAL	34.32	202.22	202.951	202.86	203.04	0.009526	2.21	40.04	93.01	0.84
Reach A1	1390.03	REGIONAL	34.32	202.15	202.906	202.78	203	0.008653	2.15	40.32	88.95	0.81
Reach A1	1372.01	REGIONAL	34.32	202.09	202.709	202.53	202.8	0.012217	2.25	35.88	78.81	0.93
Reach A1	1363.97	REGIONAL	34.32	201.97	202.606	202.41	202.69	0.014845	2.48	34.59	78.46	1.02
Reach A1	1329.1	REGIONAL	34.32	201.53	202.48	202.03	202.51	0.002426	1.34	60.83	83.47	0.44
Reach A1	1291.48	REGIONAL	34.32	200.93	201.988	201.99	202.31	0.012433	3.12	21.52	35.1	1.01
Reach A1	1215.83	REGIONAL	34.32	200.3	201.011	200.87	201.16	0.014614	2.72	27.02	47.68	1.04
Reach A1	1163.79	REGIONAL	34.32	199.42	200.313	200.27	200.52	0.015372	3.11	24.63	44.88	1.09
Reach A1	1125.44	REGIONAL	34.32	199.04	200.077	199.81	200.17	0.006689	2.28	33.13	47.38	0.74
Reach A1	1070.64	REGIONAL	34.32	198.73	199.586	199.4	199.72	0.010346	2.55	28.25	40.53	0.9
Reach A1	1024.38	REGIONAL	34.32	198.31	199.113	198.96	199.25	0.011057	2.55	29.03	46.82	0.92
Reach A1	993.4	REGIONAL	34.32	198.05	198.761	198.59	198.89	0.01774	2.92	26.31	44.43	1.14
Reach A1	919.87	REGIONAL	34.32	197.43	198.372	198	198.42	0.004051	1.7	46.61	62.2	0.57
Reach A1	858.75	REGIONAL	34.32	197.04	198.052	197.77	198.14	0.006249	2.21	37.96	56.02	0.72
Reach A1	797.72	REGIONAL	38.99	196.33	197.263	197.26	197.54	0.02024	3.64	23.56	38.76	1.26
Reach A1	728.08	REGIONAL	38.99	195.83	196.522	196.26	196.58	0.008355	1.9	44.62	78.62	0.77
Reach A1	634.45	REGIONAL	38.99	195.09	196.11	195.86	196.2	0.007323	2.43	39.74	61.36	0.78
Reach A1	600.7	REGIONAL	38.99	194.67	196.009	195.65	196.06	0.002677	1.74	55.92	67.39	0.49
Reach A1	573.19	REGIONAL	38.99	194.29	196.014	195.03	196.03	0.000519	0.92	105.14	82.62	0.23
Reach A1	565.18	REGIONAL	38.99	193.12	195.409	195.41	195.88	0.010445	3.59	18.74	63.1	0.88
Reach A1	545.05		Culvert									
Reach A1	520.84	REGIONAL	38.99	193	195.005	195	195.62	0.008633	3.75	15.61	14.64	0.9
Reach A1	514.56	REGIONAL	38.99	192.94	194.923	194.92	195.24	0.005744	3.13	31.14	47.07	0.74
Reach A1	491.21	REGIONAL	42.71	192.53	194.498	194.5	194.83	0.005949	3.17	32.24	45.74	0.75
Reach A1	454.44	REGIONAL	42.71	191.81	193.696	192.84	193.72	0.000705	1.08	67.78	57.06	0.26
Reach A1	409.42	REGIONAL	42.71	191.29	193.69	192.37	193.71	0.000257	0.8	86.83	50.86	0.17
Reach A1	354.85	REGIONAL	42.71	191.07	193.691	191.83	193.7	0.000082	0.48	138.86	66.54	0.1
Reach A1	310.91	REGIONAL	42.71	190.52	193.691	191.46	193.69	0.000028	0.32	202.17	89.94	0.06
Reach A1	259.79	REGIONAL	42.71	190.21	193.69	191.36	193.69	0.000033	0.37	200.9	98.56	0.06
Reach A1	210.41	REGIONAL	42.71	189.64	193.69	190.98	193.69	0.000014	0.27	278.36	174.83	0.04
Reach A1	154.86	REGIONAL	42.71	189.42	193.69	190.34	193.69	0.000008	0.2	368.09	228.21	0.03
Reach A1	146.02	REGIONAL	42.71	189.38	193.69	190.89	193.69	0.000004	0.15	376.06	245.12	0.02
Reach A1	122.02		Culvert									
Reach A1	99.28	REGIONAL	42.71	188.5	189.969	189.97	190.48	0.009667	3.41	15.12	106.49	0.94
Reach A1	84.41	REGIONAL	42.71	188.13	188.87	188.78	188.91	0.004506	1.42	51.62	114.92	0.57

BRUCE CREEK TRIBUTARY WARDEN AVENUE CROSSING REGIONAL SUMMARY

FLOODPLAIN AND VELOCITY COMPARISON

	EXISTING					PROPOSED					DIFFERENCE	
Reach	**River Sta**	**Profile**	**#REF!**	**Min Ch El**	**Vel Chnl**	**River Sta**	**Profile**	**Q Total**	**W.S. Elev**	**Vel Chnl**	**W.S. Elev**	**Vel Chnl**
			#REF!	**(m)**	**(m/s)**			**(m3/s)**	**(m)**	**(m/s)**	**(m)**	**(m/s)**
Reach A1	3380	REGIONAL	13.66	222.322	1.72	3380	REGIONAL	13.66	222.322	1.72	0	0
Reach A1	3350.27	REGIONAL	13.66	222.042	1.73	3350.27	REGIONAL	13.66	222.042	1.73	0	0
Reach A1	3295.27	REGIONAL	13.66	221.698	1.25	3295.27	REGIONAL	13.66	221.698	1.25	0	0
Reach A1	3240.27	REGIONAL	13.66	221.286	1.82	3240.27	REGIONAL	13.66	221.286	1.82	0	0
Reach A1	3185.27	REGIONAL	13.66	220.94	1.25	3185.27	REGIONAL	13.66	220.94	1.25	0	0
Reach A1	3130.27	REGIONAL	13.66	220.667	1.37	3130.27	REGIONAL	13.66	220.667	1.37	0	0
Reach A1	3075.27	REGIONAL	13.66	220.407	1.22	3075.27	REGIONAL	13.66	220.407	1.22	0	0
Reach A1	3020.27	REGIONAL	13.66	220.111	1.49	3020.27	REGIONAL	13.66	220.111	1.49	0	0
Reach A1	2965.27	REGIONAL	13.66	220.014	0.81	2965.27	REGIONAL	13.66	220.014	0.81	0	0
Reach A1	2909.6	REGIONAL	13.66	219.963	0.77	2909.6	REGIONAL	13.66	219.963	0.77	0	0
Reach A1	2855.27	REGIONAL	13.66	219.916	0.91	2855.27	REGIONAL	13.66	219.916	0.91	0	0
Reach A1	2800.3	REGIONAL	13.66	219.81	1.27	2800.3	REGIONAL	13.66	219.81	1.27	0	0
Reach A1	2745.27	REGIONAL	13.66	219.485	2.37	2745.27	REGIONAL	13.66	219.485	2.37	0	0
Reach A1	2690.28	REGIONAL	13.66	218.898	2.55	2690.28	REGIONAL	13.66	218.898	2.55	0	0
Reach A1	2635.34	REGIONAL	13.66	218.384	1.94	2635.34	REGIONAL	13.66	218.384	1.94	0	0
Reach A1	2590.5	REGIONAL	13.66	218.017	2.27	2590.5	REGIONAL	13.66	218.017	2.27	0	0
Reach A1	2582.15	REGIONAL	13.66	217.906	2.08	2582.15	REGIONAL	13.66	217.906	2.08	0	0
Reach A1	2565.7	REGIONAL	13.66	217.394	2.56	2565.7	REGIONAL	13.66	217.394	2.56	0	0
Reach A1	2561.47	REGIONAL	13.66	217.266	2.59	2561.47	REGIONAL	13.66	217.266	2.59	0	0
Reach A1	2555.07		Culvert			2555.07		Culvert				
Reach A1	2536.68	REGIONAL	13.66	216.878	3	2536.68	REGIONAL	13.66	216.878	3	0	0
Reach A1	2532.83	REGIONAL	13.66	216.85	0.61	2532.83	REGIONAL	13.66	216.85	0.61	0	0
Reach A1	2470.27	REGIONAL	13.66	215.969	2.32	2470.27	REGIONAL	13.66	215.969	2.32	0	0
Reach A1	2415.46	REGIONAL	13.66	214.962	2.33	2415.46	REGIONAL	13.66	214.962	2.33	0	0
Reach A1	2360.7	REGIONAL	13.66	214.693	0.81	2360.7	REGIONAL	13.66	214.673	0.86	-0.02	0.05
Reach A1	2305.27	REGIONAL	13.66	214.677	0.34	2305.27	REGIONAL	13.66	214.654	0.36	-0.023	0.02
Reach A1	2249.91	REGIONAL	13.66	214.67	0.29	2249.91	REGIONAL	13.66	214.646	0.3	-0.024	0.01
Reach A1	2224.47	REGIONAL	15.39	214.667	0.36	2224.47	REGIONAL	15.39	214.643	0.38	-0.024	0.02
Reach A1	2209.84	REGIONAL	15.39	214.666	0.31							
Reach A1	2200.14		Culvert			2200.14		Culvert				
Reach A1	2188.97	REGIONAL	15.39	214.201	0.78							
Reach A1	2173.64	REGIONAL	15.39	214.192	0.65	2173.64	REGIONAL	15.39	214.192	0.65	0	0
Reach A1	2140.27	REGIONAL	15.39	214.162	0.8	2140.27	REGIONAL	15.39	214.162	0.8	0	0
Reach A1	2085.22	REGIONAL	15.39	213.836	2.56	2085.22	REGIONAL	15.39	213.836	2.56	0	0
Reach A1	2030.27	REGIONAL	15.39	212.965	2.46	2030.27	REGIONAL	15.39	212.965	2.46	0	0
Reach A1	1975.25	REGIONAL	15.39	212.025	2.82	1975.25	REGIONAL	15.39	212.025	2.82	0	0
Reach A1	1920.3	REGIONAL	17.6	211.103	2.94	1920.3	REGIONAL	17.6	211.103	2.94	0	0
Reach A1	1886.34	REGIONAL	17.6	210.114	1.81	1886.34	REGIONAL	17.6	210.114	1.81	0	0
Reach A1	1856.25	REGIONAL	29.18	209.666	3.34	1856.25	REGIONAL	29.18	209.666	3.34	0	0
Reach A1	1818.61	REGIONAL	29.18	209.149	3.34	1818.61	REGIONAL	29.18	209.149	3.34	0	0
Reach A1	1787.62	REGIONAL	29.18	208.777	2.29	1787.62	REGIONAL	29.18	208.777	2.29	0	0
Reach A1	1756.22	REGIONAL	29.18	208.158	3.81	1756.22	REGIONAL	29.18	208.158	3.81	0	0
Reach A1	1715.22	REGIONAL	29.18	207.53	3.45	1715.22	REGIONAL	29.18	207.53	3.45	0	0
Reach A1	1673.34	REGIONAL	29.18	207.027	3.09	1673.34	REGIONAL	29.18	207.027	3.09	0	0
Reach A1	1635.84	REGIONAL	29.18	206.271	3.59	1635.84	REGIONAL	29.18	206.271	3.59	0	0
Reach A1	1606.19	REGIONAL	29.18	205.863	2.71	1606.19	REGIONAL	29.18	205.863	2.71	0	0
Reach A1	1556.22	REGIONAL	29.24	205.427	2.57	1556.22	REGIONAL	29.24	205.427	2.57	0	0
Reach A1	1498.47	REGIONAL	29.24	204.534	3.26	1498.47	REGIONAL	29.24	204.534	3.26	0	0
Reach A1	1447.13	REGIONAL	29.24	203.605	2.6	1447.13	REGIONAL	29.24	203.605	2.6	0	0
Reach A1	1394.43	REGIONAL	34.32	202.951	2.21	1394.43	REGIONAL	34.32	202.951	2.21	0	0
Reach A1	1390.03	REGIONAL	34.32	202.906	2.15	1390.03	REGIONAL	34.32	202.906	2.15	0	0
Reach A1	1372.01	REGIONAL	34.32	202.709	2.25	1372.01	REGIONAL	34.32	202.709	2.25	0	0
Reach A1	1363.97	REGIONAL	34.32	202.606	2.48	1363.97	REGIONAL	34.32	202.606	2.48	0	0
Reach A1	1329.1	REGIONAL	34.32	202.48	1.34	1329.1	REGIONAL	34.32	202.48	1.34	0	0
Reach A1	1291.48	REGIONAL	34.32	201.988	3.12	1291.48	REGIONAL	34.32	201.988	3.12	0	0
Reach A1	1215.83	REGIONAL	34.32	201.011	2.72	1215.83	REGIONAL	34.32	201.011	2.72	0	0
Reach A1	1163.79	REGIONAL	34.32	200.313	3.11	1163.79	REGIONAL	34.32	200.313	3.11	0	0
Reach A1	1125.44	REGIONAL	34.32	200.077	2.28	1125.44	REGIONAL	34.32	200.077	2.28	0	0
Reach A1	1070.64	REGIONAL	34.32	199.586	2.55	1070.64	REGIONAL	34.32	199.586	2.55	0	0
Reach A1	1024.38	REGIONAL	34.32	199.113	2.55	1024.38	REGIONAL	34.32	199.113	2.55	0	0
Reach A1	993.4	REGIONAL	34.32	198.761	2.92	993.4	REGIONAL	34.32	198.761	2.92	0	0
Reach A1	919.87	REGIONAL	34.32	198.372	1.7	919.87	REGIONAL	34.32	198.372	1.7	0	0
Reach A1	858.75	REGIONAL	34.32	198.052	2.21	858.75	REGIONAL	34.32	198.052	2.21	0	0
Reach A1	797.72	REGIONAL	38.99	197.263	3.64	797.72	REGIONAL	38.99	197.263	3.64	0	0
Reach A1	728.08	REGIONAL	38.99	196.522	1.9	728.08	REGIONAL	38.99	196.522	1.9	0	0
Reach A1	634.45	REGIONAL	38.99	196.11	2.43	634.45	REGIONAL	38.99	196.11	2.43	0	0
Reach A1	600.7	REGIONAL	38.99	196.009	1.74	600.7	REGIONAL	38.99	196.009	1.74	0	0
Reach A1	573.19	REGIONAL	38.99	196.014	0.92	573.19	REGIONAL	38.99	196.014	0.92	0	0
Reach A1	565.18	REGIONAL	38.99	195.409	3.59	565.18	REGIONAL	38.99	195.409	3.59	0	0
Reach A1	545.05		Culvert			545.05		Culvert				
Reach A1	520.84	REGIONAL	38.99	195.005	3.75	520.84	REGIONAL	38.99	195.005	3.75	0	0
Reach A1	514.56	REGIONAL	38.99	194.923	3.13	514.56	REGIONAL	38.99	194.923	3.13	0	0
Reach A1	491.21	REGIONAL	42.71	194.498	3.17	491.21	REGIONAL	42.71	194.498	3.17	0	0
Reach A1	454.44	REGIONAL	42.71	193.696	1.08	454.44	REGIONAL	42.71	193.696	1.08	0	0
Reach A1	409.42	REGIONAL	42.71	193.69	0.8	409.42	REGIONAL	42.71	193.69	0.8	0	0
Reach A1	354.85	REGIONAL	42.71	193.691	0.48	354.85	REGIONAL	42.71	193.691	0.48	0	0
Reach A1	310.91	REGIONAL	42.71	193.691	0.32	310.91	REGIONAL	42.71	193.691	0.32	0	0
Reach A1	259.79	REGIONAL	42.71	193.69	0.37	259.79	REGIONAL	42.71	193.69	0.37	0	0
Reach A1	210.41	REGIONAL	42.71	193.69	0.27	210.41	REGIONAL	42.71	193.69	0.27	0	0
Reach A1	154.86	REGIONAL	42.71	193.69	0.2	154.86	REGIONAL	42.71	193.69	0.2	0	0
Reach A1	146.02	REGIONAL	42.71	193.69	0.15	146.02	REGIONAL	42.71	193.69	0.15	0	0
Reach A1	122.02		Culvert			122.02		Culvert				
Reach A1	99.28	REGIONAL	42.71	189.969	3.41	99.28	REGIONAL	42.71	189.969	3.41	0	0
Reach A1	84.41	REGIONAL	42.71	188.87	1.42	84.41	REGIONAL	42.71	188.87	1.42	0	0

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix B

Kennedy Road North Drainage Review Memo

R.J. Burnside & Associates Limited 292 Speedvale Avenue West Unit 20 Guelph ON N1H 1C4 CANADA
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BURNSIDE
[THE DIFFERENCE IS OUR PEOPLE]

Technical Memorandum

Kennedy Road – North Drainage Review

Date:	October 03, 2022	**Project No.:**	300052314.0000
Project Name:	Warden Avenue and Kennedy Road Environmental Assessment Studies Between Major Mackenzie Drive and Elgin Mills Road		
Client Name:	Regional Municipality of York		
Submitted To:	Jennifer Vandermeer, P.Eng.		
Submitted By:	Harold Faulkner, P.Eng.		
Reviewed By:	Jennifer Vandermeer, P.Eng.		

1.0 Introduction and Background

R.J. Burnside & Associates Limited (Burnside) has been retained by the Regional Municipality of York (Region) to provide storm drainage and Low Impact Development (LID) design services in support of the Class Environmental Assessment (EA) Studies for the proposed improvements to Warden Avenue from Major Mackenzie Drive to Elgin Mills Road and Kennedy Road from Major Mackenzie Drive to Elgin Mills Road. During the preliminary design stage of this process, Burnside and the Region have identified a potential drainage issue at the north end of Kennedy Road, south of Elgin Mills Road. The purpose of this memorandum is to describe the existing condition and provide an outline for the future and interim drainage conditions.

1.1 Background

The North Markham Future Urban Area (FUA) Subwatershed Study (SWS) was prepared by Amec Foster Wheeler for the City of Markham in December 2019. This study includes analysis of existing drainage areas, and preliminary design for future development. A PCSWMM hydrologic model is included in the study, and the drainage areas from that model are used in this Drainage Review Memo. The catchment area figures are also based on the PCSWMM model maps.

2.0 Drainage Conditions

2.1 Existing Condition

Currently, approximately 9.5 ha of mostly agricultural drainage area on the west side of Kennedy Road flows east to the Robinson Creek subwatershed. Drainage passes under Kennedy Road through an existing 900 mm diameter culvert (6 ha), and two existing 600 mm diameter culverts further south (3.5 ha). There are no evident watercourses associated with these crossings. The 900 mm diameter culvert coincides with an existing low point in the Kennedy Road right-of-way (ROW). Refer to Figure 1 – Existing Drainage Condition.

There is an existing high point in the Kennedy Road ROW, approximately 120 m south of Elgin Mills Road. From this high point, approximately 0.50 ha of ROW area drains north to two existing culverts crossing Elgin Mills Road and discharging to the Bruce Creek. Runoff from the southeast corner of the intersection (9.3 ha) drains through the eastern culvert to Bruce Creek, and runoff from the southwest corner (14.8 ha) also drains to the Bruce Creek, conveyed mostly through the existing south roadside ditch of Elgin Mills Road.

2.2 Future Condition

The existing drainage boundaries are expected to change, following the recommendations of the FUA SWS, and the preliminary development plans of the Angus Glen and Robinson Glen properties. The area east of Kennedy Road and south of Elgin Mills will drain southeast to Robinson Creek. The area west of Kennedy Road and south of Elgin Mills will drain southwest to Bruce Creek. Refer to Figure 2 – Future Drainage Condition.

To accommodate this drainage condition, the existing 900 mm and 600 mm diameter culverts crossing Kennedy Road are to be eliminated. The Kennedy Road ROW will be raised to convert the existing low point to a high point. As the high point will be shifted 170 m south from the existing location, an additional 0.70 ha of ROW area will drain north to the Elgin Mills Road crossing and Bruce Creek. Stormwater management controls are anticipated to be implemented in the ROW to retain runoff such that existing flow rates are not exceeded.

2.3 Interim Condition

Due to differences in construction timing, an interim condition is anticipated where the proposed Kennedy Road improvements will be completed prior to the development of the Angus Glen property. As a result, a temporary drainage system will be required for the period of time between the Kennedy Road reconstruction and the development of the Angus Glen property.

The 6 ha area that currently drains to the existing Kennedy Road low point and 900 mm diameter culvert will be conveyed north through the existing culvert crossing Elgin Mills Road, discharging to Bruce Creek. This alteration will require grading on the Angus Glen property for

conveyance, and a temporary stormwater facility may be required so as not to exceed capacity of the Elgin Mills Road culvert. There may also be an opportunity to direct some of the runoff from this area to Bruce Creek through the existing southern roadside ditch on Elgin Mills Road. As an interim condition, the additional drainage to the Bruce Creek subwatershed is not expected to have a significant impact, as the 6 ha drainage area is insignificant compared to the total 1,956 ha drainage area to the Bruce Creek upstream of the Elgin Mills Crossing.

There are several options to consider for the 3.5 ha area that currently drains to the existing 600 mm diameter culverts crossing Kennedy Road:

1. Regrade the area to allow runoff to be conveyed southwest to Bruce Creek.

2. Convey runoff from this area through the proposed Region storm sewer on Kennedy Road.

3. Allow runoff from this area to continue to drain through the existing Kennedy Road culverts through the Robinson Glen property to Robinson Creek. The TRCA has indicated the Robinson property is required to accept this drainage.

As the drainage design progresses, the most suitable option, or combination of options will be selected to accommodate the drainage from this area. Refer to Figure 3 – Interim Drainage Condition.

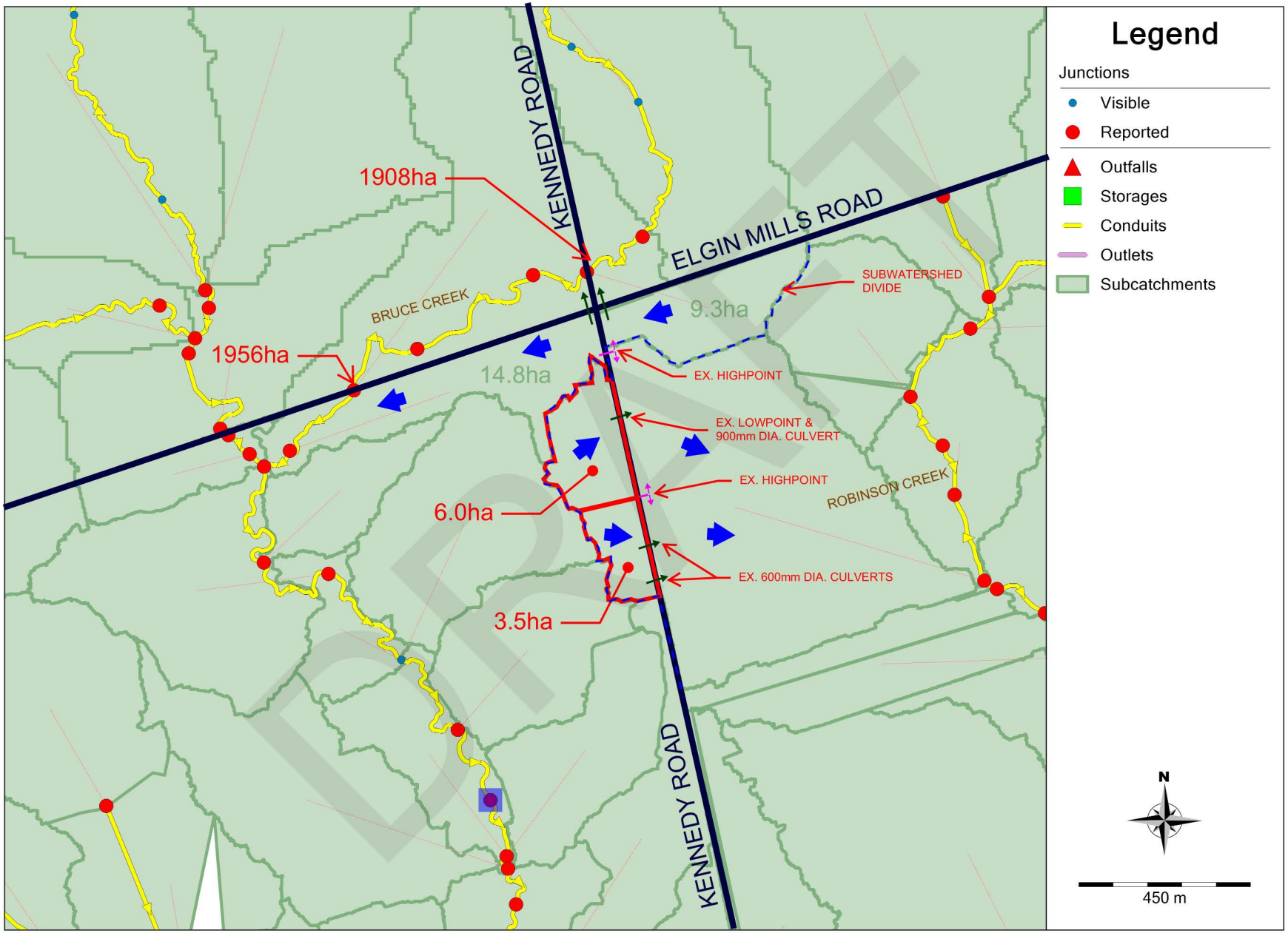
3.0 Conclusions

The drainage conditions described in this memo demonstrate the future and interim development stages can be accommodated without significant impact to the overall drainage of the study area. The drainage design will be further outlined and supported with design calculations at the detailed design stage.

R.J. Burnside & Associates Limited

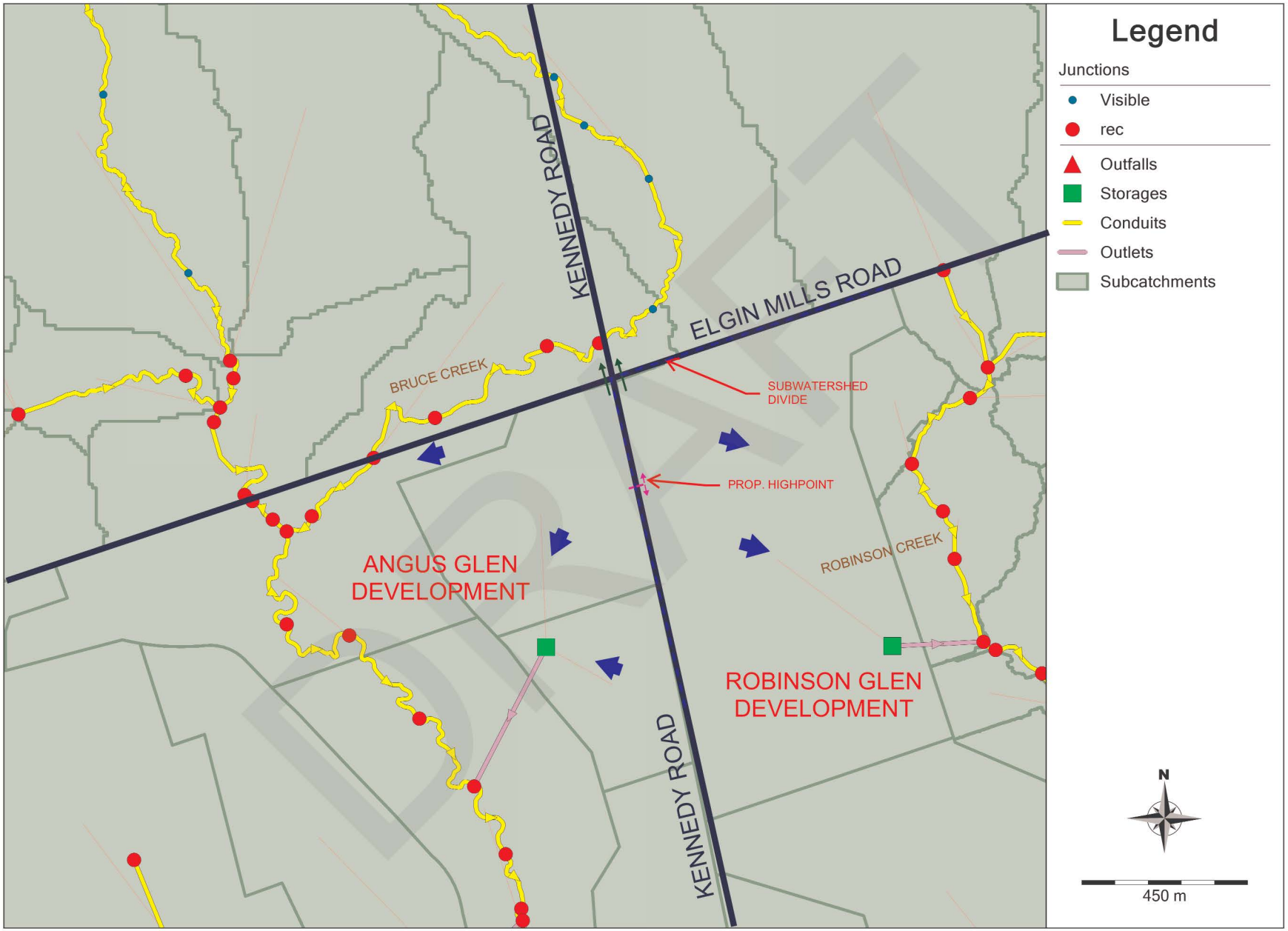
Harold Faulkner, P.Eng.
Water Resources Engineer
HF:tm

FIGURE 1 - EXISTING CONDITION



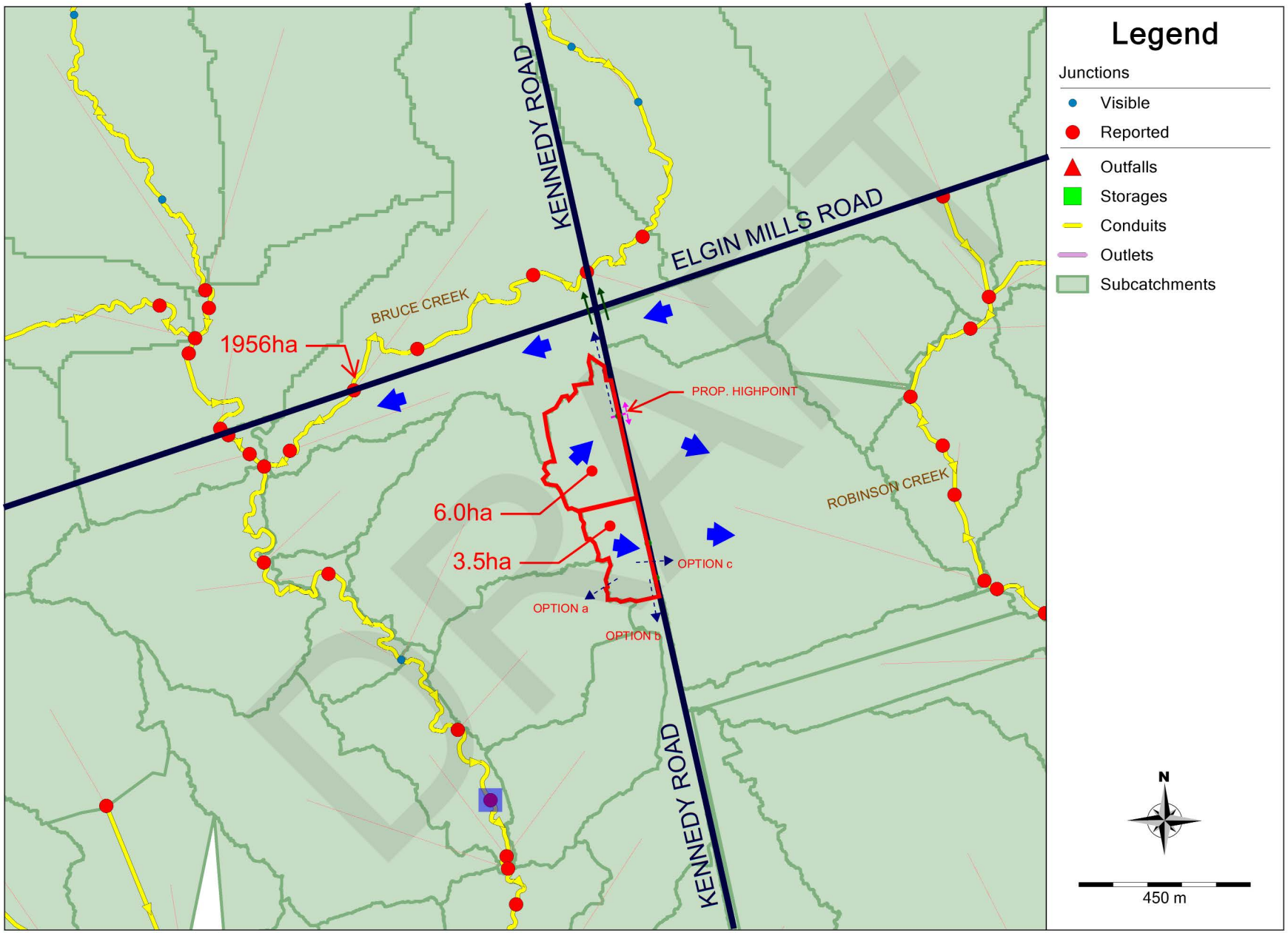
Catchment areas and watercourse information from PCSWMM Model included in the North Markham Future Urban Area Subwatershed Study prepared by Amec Foster Wheeler Environmental & Infrastructure, December 2019.

FIGURE 2 - FUTURE CONDITION



Catchment areas and watercourse information from PCSWMM Model included in the North Markham Future Urban Area Subwatershed Study prepared by Amec Foster Wheeler Environmental & Infrastructure, December 2019.

FIGURE 3 - INTERIM CONDITION



Catchment areas and watercourse information from PCSWMM Model included in the North Markham Future Urban Area Subwatershed Study prepared by Amec Foster Wheeler Environmental & Infrastructure, December 2019.

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Appendix C

Low Impact Development Infiltration Design

Project Name:	Warden & Kennedy EA
Project No:	300052314
Location:	Markham
Designer:	H. Faulkner
Date:	6-Dec-2022
Date Modified:	10-Mar-2023

LID Volumes

Warden LID

900mm Dia. Culvert Outlet

LID Type	2.7	m wide Box Trench			
LID Depth	1	m			
LID Void Ratio	40	%	A = (1000V) / (PnT)		
Total West Side Length	410	m	T = (1000V) / (APn)		
Total East Side Length	311	m	Area	1,947	sq.m
			V	498	cu.m
Infiltration Volume Provided	779	m^3	P	10	mm/hr
			n	0.4	
25mm Storm Runoff Volume			T	63.9	hours
Modeled Volume	15.96	mm			
Drainage Area	3.12	ha			
Total 25mm Storm Runoff Volume	498	m^3 <	779	m^3	

Bruce Tributary Outlet

LID Type	2.7	m wide Box Trench			
LID Depth	1	m			
LID Void Ratio	40	%	A = (1000V) / (PnT)		
Total West Side Length	126	m	T = (1000V) / (APn)		
Total East Side Length	126	m	Area	680	sq.m
			V	272	cu.m
Infiltration Volume Provided	272	m^3	P	10	mm/hr
			n	0.4	
25mm Storm Runoff Volume			T	100.0	hours
Modeled Volume	16.3	mm			
Drainage Area	3.69	ha			
Total 25mm Storm Runoff Volume	601	m^3 <	272	m^3	

Major Mackenzie Outlet

LID Type	2.7	m wide Box Trench			
LID Depth	1	m			
LID Void Ratio	40	%	A = (1000V) / (PnT)		
Total West Side Length	0	m	T = (1000V) / (APn)		
Total East Side Length	220	m	Area	594	sq.m
			V	238	cu.m
Infiltration Volume Provided	238	m^3	P	10	mm/hr
			n	0.4	
25mm Storm Runoff Volume			T	100.0	hours
Modeled Volume	16.28	mm			
Drainage Area	1.48	ha			
Total 25mm Storm Runoff Volume	241	m^3 =	238	m^3	

Project Name:	Warden & Kennedy EA
Project No:	300052314
Location:	Markham
Designer:	H. Faulkner
Date:	6-Dec-2022
Date Modified:	10-Mar-2023

LID Volumes

Kennedy LID

Elgin Mills Outlet

LID Type	2.7	m wide Box Trench			
LID Depth	1	m			
LID Void Ratio	40	%	A = (1000V) / (PnT)		
Total West Side Length	125	m	T = (1000V) / (APn)		
Total East Side Length	110	m	Area	635	sq.m
			V	162	cu.m
Infiltration Volume Provided	254	m^3	P	10	mm/hr
			n	0.4	
25mm Storm Runoff Volume			T	63.7	hours
Modeled Volume	15.4	mm			
Drainage Area	1.05	ha			
Total 25mm Storm Runoff Volume	162	m^3 <	254	m^3	

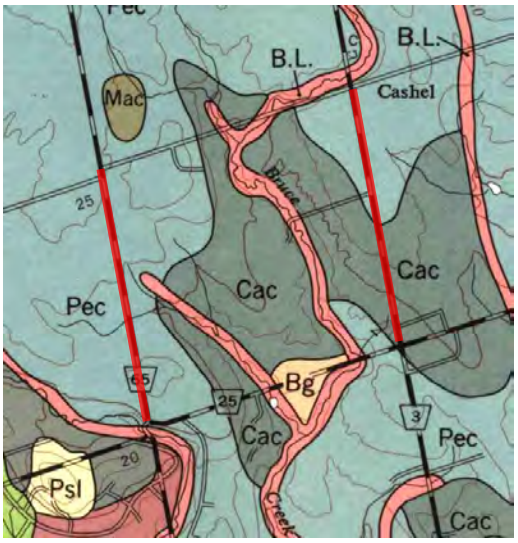
Major Mackenzie Outlet

LID Type	2.7	m wide Box Trench			
LID Depth	1	m			
LID Void Ratio	40	%			
Total West Side Length	885	m			
Total East Side Length	762	m			
LID Type	1	m wide Vegetated Swale			
LID Depth	0.5	m			
LID Void Ratio	40	%	A = (1000V) / (PnT)		
Total West Side Length	0	m	T = (1000V) / (APn)		
Total East Side Length	200	m	Area	4,647	sq.m
			V	1,135	cu.m
Infiltration Volume Provided	1,819	m^3	P	10	mm/hr
			n	0.4	
25mm Storm Runoff Volume			T	61.1	hours
Modeled Volume	15.18	mm			
Drainage Area	7.48	ha			
Total 25mm Storm Runoff Volume	1,135	m^3 <	1,819	m^3	

SOIL MAP
OF
YORK COUNTY
(REGIONAL MUNICIPALITY OF YORK)
ONTARIO

SOIL SURVEY REPORT No. 19

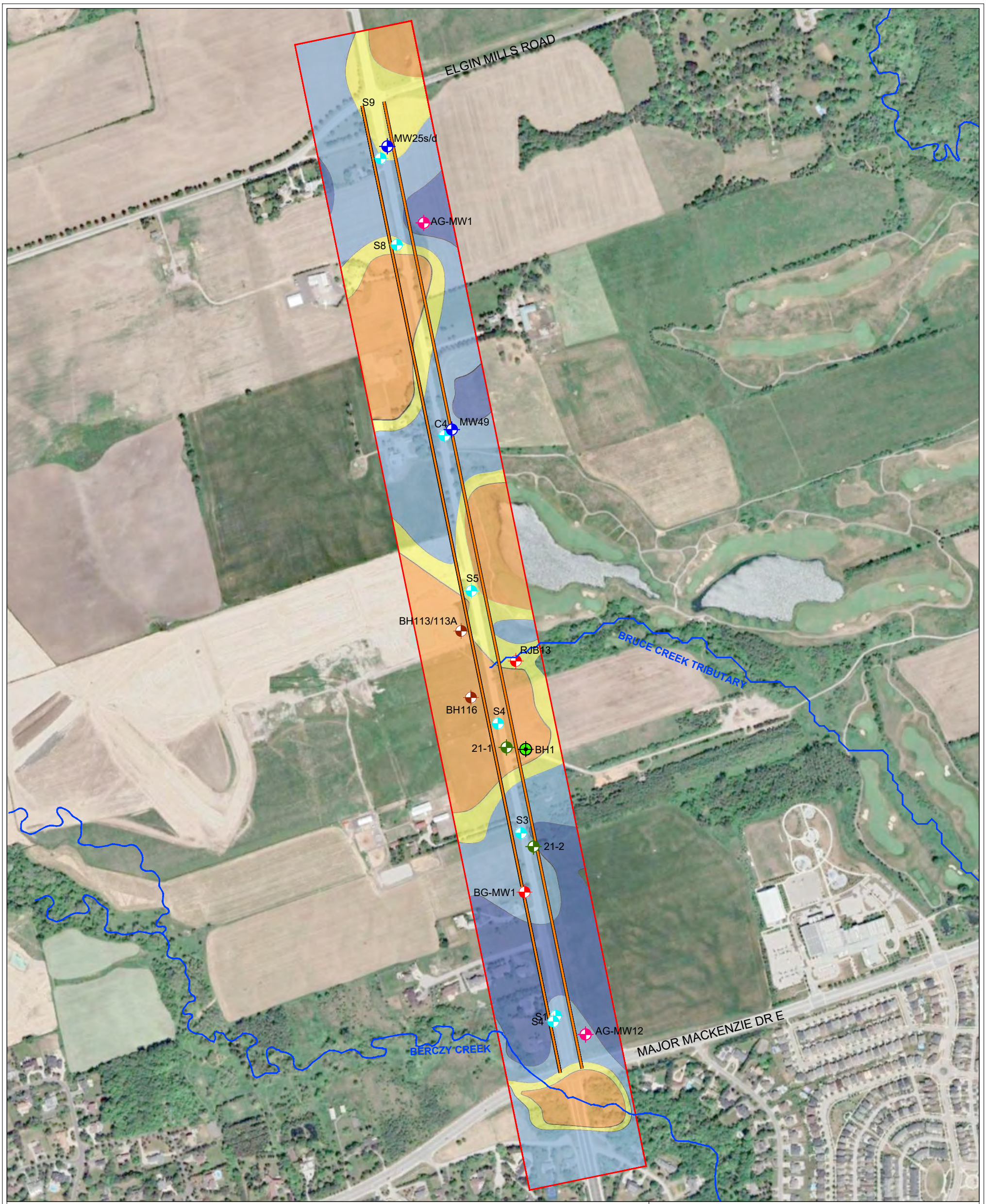
Soil Survey by the Department of Soils, Ontario Agricultural College, Guelph, in co-operation with the Soil Research Institute, Agriculture Canada, Ottawa, 1954.



Pec	PEEL	clay	Grey-Brown Podzolic	Imperfect	Smooth gently sloping. Stonefree	Neutral to slightly alkaline	Stonefree lacustrine clay over gritty clay till at depth of 3' or less
Cac	CASHEL	clay	Grey-Brown Podzolic	Good	Smooth moderately sloping. Stonefree	Neutral	Stonefree lacustrine clay over gritty clay till at depth of 3' or less

CHART H2-6A - HYDROLOGIC SOIL GROUPS FOR PRINCIPAL SOIL TEXTURES IDENTIFIED ON AGRICULTURAL SOILS MAPS (6)

Peel	C	D
Cashel	C	D



LEGEND

- 100m BUFFER AROUND ROW
- ROAD EXPANSION (ROW)
- WATERCOURSE
- MONITORING WELL (RJB, 2015)
- MONITORING WELL (YORK REGION)
- MONITORING WELL (SOIL ENG., 2013)
- MONITORING WELL (GOLDER, 2021)

DEPTH TO GROUNDWATER:

- 0 TO 1m BELOW GRADE
- 1 TO 2m BELOW GRADE
- 2 TO 4m BELOW GRADE
- >4m BELOW GRADE

0 100 200 400 600
Metres

N

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Client / Report

REGIONAL MUNICIPALITY OF YORK

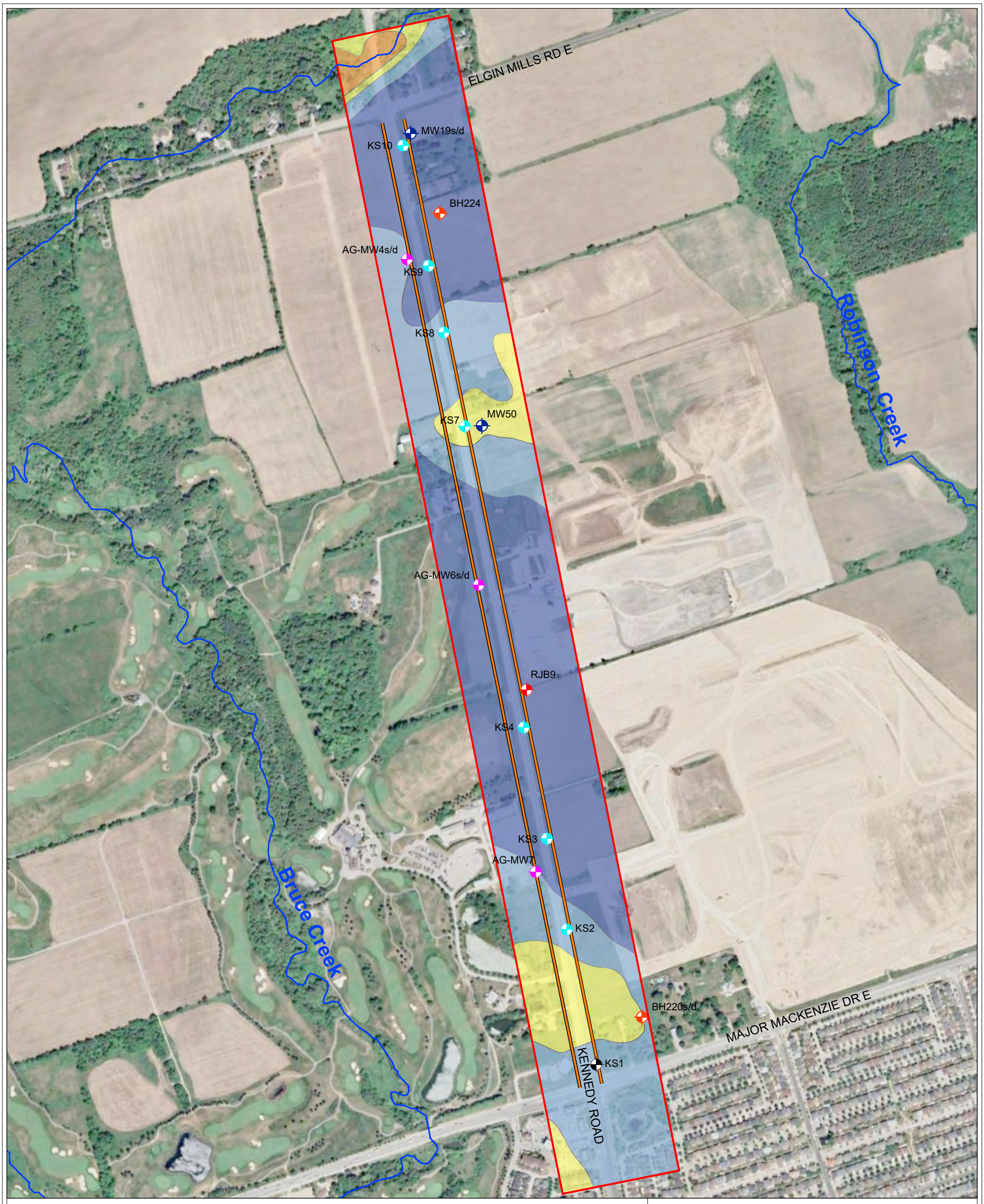
WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

INTERPRETED DEPTH TO GROUNDWATER (WARDEN AVENUE)

Drawn	Checked	Date	Figure No.
SK	SC	SEPTEMBER 2022	9
Scale		Project No.	
1:7,500		300052314	

File Name:Nigel/Shared Work Areas/035564 Highmark/02_Production/ 052314 Warden Kennedy EA.dwg Date Plotted: September 9, 2022 - 9:01 AM



LEGEND

- 100m BUFFER AROUND ROW
- ROAD EXPANSION (ROW)
- WATERCOURSE
- MONITORING WELL (RJB, 2015)
- MONITORING WELL (YORK REGION)
- MONITORING WELL (SOIL ENG., 2013)
- MONITORING WELL (GOLDER, 2021)
- MONITORING WELL (NO LOG)

DEPTH TO GROUNDWATER:

- 0 TO 1m BELOW GRADE
- 1 TO 2m BELOW GRADE
- 2 TO 4m BELOW GRADE
- >4m BELOW GRADE

0 100 200 400 600
Metres

N

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

INTERPRETED DEPTH TO GROUNDWATER (KENNEDY ROAD)

Drawn	Checked	Date	Figure No.
SK	SC	SEPTEMBER 2022	10
Scale		Project No.	
1:7,500		300052314	

File Name:Nigel/Shared Work Areas/035564 Highmark/02_Production/ 052314 Warden Kennedy EA.dwg Date Plotted: September 9, 2022 - 9:02 AM

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Appendix D

Hydrologic Analysis and Quantity Control

Project Name: Warden & Kennedy EA
Project No: 300052314
Location: Markham
Designer: H. Faulkner
Date: 6-Dec-2022
Date Modified: 10-Mar-2023

Drainage Areas — Warden Ex. ROW

SWMHYMO STANHYD Modelling Parameters

	C	TIMP (%)	XIMP (%)
Existing Pavement	0.90	100	100
Existing Gravel	0.70	65	65
Existing Grassed	0.25	0	0

Catchment	Length (m)	Width (m)	Area (ha)	Paved (ha)	Gravel (ha)	Grassed (ha)	C	TIMP (%)	XIMP (%)	Slope (%)	Tc* (min.)	Outlet
101	260	41	1.07	0.37	0.07	0.63	0.50	39	39	1.0	14.73	900mm Culvert
102	280	41	1.15	0.27	0.07	0.81	0.43	27	27	0.5	18.08	900mm Culvert
103	240	41	0.98	0.23	0.06	0.69	0.43	27	27	1.3	13.00	900mm Culvert
110	260	41	1.07	0.25	0.07	0.75	0.43	28	28	2.7	12.07	Bruce Tributary
111	180	41	0.74	0.17	0.04	0.53	0.42	27	27	1.4	9.89	Bruce Tributary
112	240	41	0.98	0.23	0.06	0.69	0.43	27	27	2.5	11.41	Bruce Tributary
113	200	41	0.82	0.19	0.05	0.58	0.43	27	27	1.0	11.63	Bruce Tributary
120	360	41	1.48	0.66	0.14	0.68	0.58	51	51	3.0	15.84	Major Mackenzie
	2,020		8.28									

*Bransby Williams Formula used, as runoff coefficient C is greater than 0.40

Project Name: Warden & Kennedy EA
Project No: 300052314
Location: Markham
Designer: H. Faulkner
Date: 6-Dec-2022
Date Modified: 10-Mar-2023

Drainage Areas — Kennedy Ex. ROW

SWMHYMO STANHYD Modelling Parameters

	C	TIMP (%)	XIMP (%)
Existing Pavement	0.90	100	100
Existing Gravel	0.70	65	65
Existing Grassed	0.25	0	0

Catchment	Length (m)	Width (m)	Area (ha)	Paved (ha)	Gravel (ha)	Grassed (ha)	C	TIMP (%)	XIMP (%)	Slope (%)	Tc* (min.)	Outlet
101	125	41	0.51	0.25	0.04	0.22	0.60	54	54	1.0	7.62	Elgin Mills
110	150	41	0.62	0.17	0.05	0.40	0.47	33	33	0.4	10.78	900mm Culvert
111	200	41	0.82	0.20	0.08	0.54	0.45	31	31	0.3	14.79	900mm Culvert
120	265	41	1.09	0.25	0.12	0.72	0.45	30	30	0.3	19.06	Major Mackenzie
121	370	41	1.52	0.35	0.18	0.99	0.45	31	31	0.5	23.24	Major Mackenzie
122	345	41	1.41	0.33	0.16	0.92	0.45	31	31	1.2	18.31	Major Mackenzie
123	165	41	0.68	0.15	0.08	0.45	0.45	30	30	2.5	8.14	Major Mackenzie
124	250	41	1.03	0.38	0.09	0.55	0.53	43	43	2.7	11.65	Major Mackenzie
125	210	41	0.86	0.53	0.00	0.33	0.65	62	62	1.5	11.20	Major Mackenzie
	2,080		8.53									

*Bransby Williams Formula used, as runoff coefficient C is greater than 0.40

Project Name: Warden & Kennedy EA
Project No: 300052314
Location: Markham
Designer: H. Faulkner
Date: 6-Dec-2022
Date Modified: 10-Mar-2023

Drainage Areas — Warden Prop. ROW

SWMHYMO STANHYD Modelling Parameters

	C	TIMP (%)	XIMP (%)
Proposed Pavement	0.90	100	100
Proposed Sidewalk	0.90	100	0
Proposed Cycle Track	0.90	100	0
Proposed Grassed	0.25	0	0

Catchment	Length (m)	Width (m)	Area (ha)	Paved (ha)	Sidewalk (ha)	Cycle Track (ha)	Grassed (ha)	C	TIMP (%)	XIMP (%)	Slope (%)	Tc* (min.)	Outlet
201	160	41	0.66	0.34	0.05	0.06	0.21	0.69	68	52	1.0	9.51	900mm Culvert
202	380	41	1.56	0.70	0.11	0.14	0.61	0.65	61	45	1.0	20.72	900mm Culvert
203	220	41	0.90	0.40	0.07	0.08	0.36	0.64	60	44	1.5	11.68	900mm Culvert
210	280	41	1.15	0.57	0.08	0.10	0.39	0.68	66	50	2.5	13.11	Bruce Tributary
211	120	41	0.49	0.18	0.04	0.04	0.23	0.60	53	37	1.2	7.08	Bruce Tributary
212	185	41	0.76	0.33	0.06	0.07	0.31	0.64	60	44	0.5	12.45	Bruce Tributary
213	315	41	1.29	0.68	0.09	0.11	0.40	0.70	69	53	2.3	14.82	Bruce Tributary
220	360	41	1.48	0.71	0.11	0.13	0.53	0.67	64	48	2.8	16.06	Major Mackenzie
	2,020		8.28										

*Bransby Williams Formula used, as runoff coefficient C is greater than 0.40

Project Name: Warden & Kennedy EA
Project No: 300052314
Location: Markham
Designer: H. Faulkner
Date: 6-Dec-2022
Date Modified: 10-Mar-2023

Drainage Areas — Kennedy Prop. ROW

SWMHYMO STANHYD Modelling Parameters

	C	TIMP (%)	XIMP (%)
Proposed Pavement	0.90	100	100
Proposed Sidewalk	0.90	100	0
Proposed Cycle Track	0.90	100	0
Proposed Grassed	0.25	0	0

Catchment	Length (m)	Width (m)	Area (ha)	Paved (ha)	Sidewalk (ha)	Cycle Track (ha)	Grassed (ha)	C	TIMP (%)	XIMP (%)	Slope (%)	Tc* (min.)	Outlet
201	255	41	1.05	0.45	0.08	0.09	0.43	0.63	59	43	0.55	16.31	Elgin Mills
220	420	41	1.72	0.73	0.13	0.15	0.71	0.63	58	42	0.5	26.05	Major Mackenzie
221	405	41	1.66	0.63	0.12	0.15	0.76	0.60	54	38	0.5	25.21	Major Mackenzie
222	350	41	1.44	0.66	0.11	0.13	0.54	0.65	62	46	1.2	18.55	Major Mackenzie
223	310	41	1.27	0.59	0.09	0.11	0.48	0.66	63	46	2.8	14.04	Major Mackenzie
224	340	41	1.39	0.52	0.10	0.12	0.65	0.60	53	37	2.5	15.61	Major Mackenzie
	2,080		8.53										

*Bransby Williams Formula used, as runoff coefficient C is greater than 0.40

Project Name: Warden & Kennedy EA
Project No: 300052314
Location: Markham
Designer: H. Faulkner
Date: 6-Dec-2022
Date Modified: 10-Mar-2023

Peak Flow Summary — Warden Flows

Existing Peak Flows (m^3/s)

		2	5	10	25	50	100
900mm Dia. Culvert Outlet							
Catchments 101-103	4hr CHI	0.24	0.39	0.53	0.63	0.73	0.83
3.20 ha	24hr SCS	0.22	0.31	0.40	0.50	0.57	0.67
Bruce Tributary							
Catchments 110-113	4hr CHI	0.27	0.45	0.60	0.73	0.84	0.96
3.61 ha	24hr SCS	0.25	0.37	0.47	0.58	0.69	0.78
Major Mackenzie Outlet							
Catchment 120	4hr CHI	0.18	0.26	0.34	0.41	0.47	0.53
1.48 ha	24hr SCS	0.14	0.19	0.24	0.29	0.33	0.37

Proposed Unattenuated Peak Flows (m^3/s)

		2	5	10	25	50	100
900mm Dia. Culvert Outlet							
Catchments 201-203	4hr CHI	0.35	0.56	0.72	0.87	0.99	1.15
3.12 ha	24hr SCS	0.29	0.41	0.51	0.63	0.72	0.80
Increase	4hr CHI	0.11	0.17	0.19	0.24	0.26	0.32
	24hr SCS	0.07	0.10	0.11	0.13	0.15	0.13
Bruce Tributary Outlet							
Catchments 210-213	4hr CHI	0.47	0.72	0.94	1.11	1.28	1.44
3.69 ha	24hr SCS	0.37	0.52	0.64	0.79	0.89	0.99
Increase	4hr CHI	0.20	0.27	0.34	0.38	0.44	0.48
	24hr SCS	0.12	0.15	0.17	0.21	0.20	0.21
Major Mackenzie Outlet							
Catchment 220	4hr CHI	0.18	0.29	0.37	0.44	0.5	0.57
1.48 ha	24hr SCS	0.15	0.21	0.25	0.31	0.36	0.40
Increase	4hr CHI	0.00	0.03	0.03	0.03	0.03	0.04
	24hr SCS	0.01	0.02	0.01	0.02	0.03	0.03

Proposed Attenuated Peak Flows (m^3/s)

		2	5	10	25	50	100
900mm Dia. Culvert Outlet							
Catchments 201-203	4hr CHI	0.23	0.39	0.40	0.54	0.67	0.83
3.12 ha	24hr SCS	0.22	0.30	0.35	0.47	0.57	0.67
Required Storage Volume	4hr CHI	**149**	**211**	**297**	**352**	**391**	**420**
(m^3)	24hr SCS	141	196	247	288	304	319
Pipe Length (m)	2.4x1.2	**52**	**73**	**103**	**122**	**136**	**146**
Bruce Tributary Outlet							
Catchments 210-213	4hr CHI	0.14	0.22	0.30	0.47	0.64	0.80
3.69 ha	24hr SCS	0.12	0.17	0.21	0.35	0.45	0.55

Diversion of 10-Year minor storm for catchments 204 and 207 to SWM Ponds 7 & 8 reduces peak flows to the outlet to below existing rates. No in-ROW storage required.

		2	5	10	25	50	100
Major Mackenzie Outlet							
Catchment 220	4hr CHI	0.16	0.25	0.32	0.39	0.49	0.53
1.48 ha	24hr SCS	0.13	0.18	0.21	0.27	0.32	0.37
					114		
Required Storage Volume	4hr CHI	32	50	65	70	73	73
(m^3)	24hr SCS	**41**	**57**	**72**	**83**	**87**	**89**
Pipe Length (m)	2.4x1.2	**14**	**20**	**25**	**29**	**30**	**31**

Project Name: Warden & Kennedy EA
Project No: 300052314
Location: Markham
Designer: H. Faulkner
Date: 6-Dec-2022
Date Modified: 10-Mar-2023

Peak Flow Summary — Kennedy Flows

Existing Peak Flows (m^3/s)

		2	5	10	25	50	100
Elgin Mills Outlet							
Catchment 101	4hr CHI	0.06	0.10	0.13	0.15	0.17	0.19
0.51 ha	24hr SCS	0.05	0.07	0.09	0.10	0.12	0.13
900mm Dia. Culvert Outlet							
Catchments 110+111	4hr CHI	0.11	0.18	0.24	0.28	0.34	0.38
1.44 ha	24hr SCS	0.10	0.14	0.18	0.22	0.26	0.30
Major Mackenzie Outlet							
Catchments 120-125	4hr CHI	0.55	0.88	1.16	1.42	1.63	1.87
6.59 ha	24hr SCS	0.48	0.69	0.87	1.09	1.26	1.42

Proposed Unattenuated Peak Flows (m^3/s)

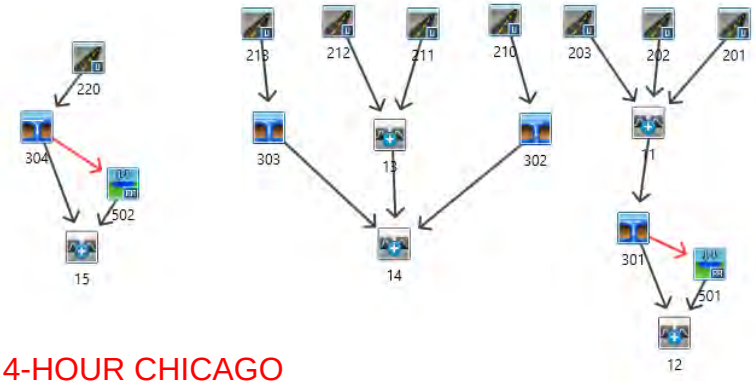
		2	5	10	25	50	100
Elgin Mills Outlet							
Catchment 201	4hr CHI	0.11	0.17	0.22	0.27	0.32	0.36
1.05 ha	24hr SCS	0.09	0.13	0.16	0.20	0.23	0.26
Increase	4hr CHI	0.05	0.07	0.09	0.12	0.15	0.17
	24hr SCS	0.04	0.06	0.07	0.10	0.11	0.13
Major Mackenzie Outlet							
Catchments 220-224	4hr CHI	0.73	1.16	1.53	1.88	2.15	2.43
7.48 ha	24hr SCS	0.62	0.88	1.11	1.38	1.57	1.79
Increase	4hr CHI	0.18	0.28	0.37	0.46	0.52	0.56
	24hr SCS	0.14	0.19	0.24	0.29	0.31	0.37

Proposed Attenuated Peak Flows (m^3/s)

		2	5	10	25	50	100
Elgin Mills Outlet							
Catchment 201	4hr CHI	0.04	0.05	0.05	0.09	0.14	0.19
1.05 ha	24hr SCS	0.02	0.03	0.04	0.07	0.10	0.13
Required Storage Volume	4hr CHI	93	149	197	228	246	264
(m^3)	24hr SCS	**139**	**190**	**234**	**271**	**294**	**315**
Pipe Length (m)	2.4x1.2	**48**	**66**	**81**	**94**	**102**	**109**
Major MacKenzie Outlet							
Catchments 220-224	4hr CHI	0.55	0.87	0.97	1.28	1.57	1.86
7.48 ha	24hr SCS	0.48	0.69	0.73	0.99	1.2	1.42
Required Storage Volume	4hr CHI	252	395	565	668	735	787
(m^3)	24hr SCS	**300**	**412**	**557**	**675**	**736**	**788**
Pipe Length (m)	2.4x1.2	**104**	**143**	**193**	**234**	**256**	**274**

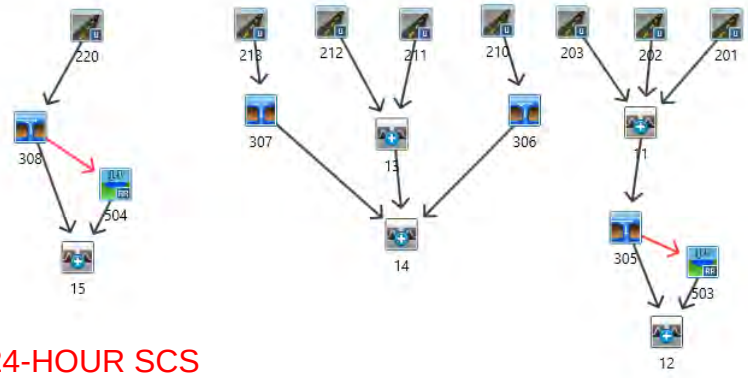
WARDEN AVENUE OTTHYMO SCHEMATIC

EXISTING 4-HOUR CHICAGO



PROPOSED 4-HOUR CHICAGO

EXISTING 24-HOUR SCS



PROPOSED 24-HOUR SCS

WARDEN AVENUE OTTHYMO SUMMARY OUTPUT: 4-HOUR CHICAGO

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

      V    V   I    SSSSS  U   U    A    L
      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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                  *****  S U M M A R Y   O U T P U T  *****

  Input   filename: C:\Program Files (x86)\VO Suite 3.0\VO2\voin.dat
  Output  filename: C:\Users\hfaulkner\AppData\Local\Temp\d007c77e-675f-4e2d-9e3f-
d43d4718d785\Scenario.out
  Summary filename: C:\Users\hfaulkner\AppData\Local\Temp\d007c77e-675f-4e2d-9e3f-
d43d4718d785\Scenario.sum

DATE: 04/06/2023                          TIME: 10:27:22

USER:

COMMENTS: _____

  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      CHIC STORM              10.0
      [ Ptot= 32.09 mm ]
*
  **  CALIB STANDHYD     0120  1  2.0    1.48    0.18  1.33  21.16 0.66   0.000
      [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD     0101  1  2.0    1.07    0.10  1.33  18.73 0.58   0.000
      [I%=39.0:S%= 2.00]
*
  **  CALIB STANDHYD     0103  1  2.0    0.98    0.07  1.37  16.30 0.51   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0102  1  2.0    1.15    0.07  1.40  16.30 0.51   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0101 + 0102]  0001  3  2.0    2.22    0.17  1.37  17.47  n/a   0.000
*
      ADD [0001 + 0103]  0001  1  2.0    3.20    0.24  1.37  17.11  n/a   0.000
*
  **  CALIB STANDHYD     0112  1  2.0    0.98    0.07  1.33  16.30 0.51   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0111  1  2.0    0.74    0.06  1.33  16.30 0.51   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    1.07    0.08  1.33  16.50 0.51   0.000
      [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD     0113  1  2.0    0.82    0.06  1.37  16.30 0.51   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0110 + 0111]  0002  3  2.0    1.81    0.14  1.33  16.42  n/a   0.000
*
      ADD [0002 + 0112]  0002  1  2.0    2.79    0.21  1.33  16.38  n/a   0.000
*
      ADD [0002 + 0113]  0002  3  2.0    3.61    0.27  1.33  16.36  n/a   0.000
*
  **  CALIB STANDHYD     0213  1  2.0    1.29    0.17  1.33  23.17 0.72   0.000
      [I%=53.0:S%= 2.00]
*
      DUHYD              0303  1  2.0    1.29    0.17  1.33  23.17  n/a   0.000
         MAJOR SYSTEM:   0303  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0303  3  2.0    1.29    0.17  1.33  23.17  n/a   0.000
*
  **  CALIB STANDHYD     0212  1  2.0    0.76    0.09  1.33  21.28 0.66   0.000
      [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD     0211  1  2.0    0.49    0.06  1.33  19.82 0.62   0.000
      [I%=37.0:S%= 2.00]
*
      ADD [0211 + 0212]  0013  3  2.0    1.25    0.14  1.33  20.71  n/a   0.000
*
  **  CALIB STANDHYD     0210  1  2.0    1.15    0.15  1.33  22.54 0.70   0.000
      [I%=50.0:S%= 2.00]
*
      DUHYD              0302  1  2.0    1.15    0.15  1.33  22.54  n/a   0.000
         MAJOR SYSTEM:   0302  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0302  3  2.0    1.15    0.15  1.33  22.54  n/a   0.000
*
      ADD [0013 + 0302]  0014  3  2.0    1.25    0.14  1.33  20.71  n/a   0.000
*
      ADD [0014 + 0303]  0014  1  2.0    1.25    0.14  1.33  20.71  n/a   0.000
*
  **  CALIB STANDHYD     0202  1  2.0    1.56    0.16  1.37  21.49 0.67   0.000
      [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    0.66    0.09  1.33  22.96 0.72   0.000
      [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD     0203  1  2.0    0.90    0.11  1.33  21.28 0.66   0.000
      [I%=44.0:S%= 2.00]
*
      ADD [0201 + 0202]  0011  3  2.0    2.22    0.25  1.37  21.93  n/a   0.000
*
      ADD [0011 + 0203]  0011  1  2.0    3.12    0.35  1.37  21.74  n/a   0.000
*
      DUHYD              0301  1  2.0    3.12    0.35  1.37  21.74  n/a   0.000
         MAJOR SYSTEM:   0301  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0301  3  2.0    3.12    0.35  1.37  21.74  n/a   0.000
*
      RESRVR [ 2 : 0301] 0501  1  2.0    3.12    0.23  1.47  21.74  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0301 + 0501]  0012  3  2.0    3.12    0.23  1.47  21.74  n/a   0.000
*
  **  CALIB STANDHYD     0220  1  2.0    1.48    0.18  1.33  22.12 0.69   0.000
      [I%=48.0:S%= 2.00]
*
      DUHYD              0304  1  2.0    1.48    0.18  1.33  22.12  n/a   0.000
         MAJOR SYSTEM:   0304  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0304  3  2.0    1.48    0.18  1.33  22.12  n/a   0.000
*
      RESRVR [ 2 : 0304] 0502  1  2.0    1.48    0.16  1.40  22.12  n/a   0.000
      {ST=  0.00 ha.m }
*
      ADD [0304 + 0502]  0015  3  2.0    1.48    0.16  1.40  22.12  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   2 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      CHIC STORM              10.0
      [ Ptot= 43.49 mm ]
*
  **  CALIB STANDHYD     0120  1  2.0    1.48    0.26  1.33  30.50 0.70   0.000
      [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD     0101  1  2.0    1.07    0.16  1.33  27.57 0.63   0.000
      [I%=39.0:S%= 2.00]
*
  **  CALIB STANDHYD     0103  1  2.0    0.98    0.11  1.37  24.63 0.57   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0102  1  2.0    1.15    0.13  1.40  24.63 0.57   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0101 + 0102]  0001  3  2.0    2.22    0.28  1.37  26.05  n/a   0.000
*
      ADD [0001 + 0103]  0001  1  2.0    3.20    0.39  1.37  25.61  n/a   0.000
*
  **  CALIB STANDHYD     0112  1  2.0    0.98    0.12  1.33  24.63 0.57   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0111  1  2.0    0.74    0.09  1.33  24.63 0.57   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    1.07    0.14  1.33  24.88 0.57   0.000
      [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD     0113  1  2.0    0.82    0.10  1.37  24.63 0.57   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0110 + 0111]  0002  3  2.0    1.81    0.23  1.33  24.78  n/a   0.000
*
      ADD [0002 + 0112]  0002  1  2.0    2.79    0.36  1.33  24.73  n/a   0.000
*
      ADD [0002 + 0113]  0002  3  2.0    3.61    0.45  1.37  24.71  n/a   0.000
*
  **  CALIB STANDHYD     0213  1  2.0    1.29    0.27  1.33  33.22 0.76   0.000
      [I%=53.0:S%= 2.00]
*
      DUHYD              0303  1  2.0    1.29    0.27  1.33  33.22  n/a   0.000
         MAJOR SYSTEM:   0303  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0303  3  2.0    1.29    0.27  1.33  33.22  n/a   0.000
*
  **  CALIB STANDHYD     0212  1  2.0    0.76    0.13  1.33  30.94 0.71   0.000
      [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD     0211  1  2.0    0.49    0.09  1.33  29.18 0.67   0.000
      [I%=37.0:S%= 2.00]
*
      ADD [0211 + 0212]  0013  3  2.0    1.25    0.22  1.33  30.25  n/a   0.000
*
  **  CALIB STANDHYD     0210  1  2.0    1.15    0.23  1.33  32.46 0.75   0.000
      [I%=50.0:S%= 2.00]
*
      DUHYD              0302  1  2.0    1.15    0.23  1.33  32.46  n/a   0.000
         MAJOR SYSTEM:   0302  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0302  3  2.0    1.15    0.23  1.33  32.46  n/a   0.000
*
      ADD [0013 + 0302]  0014  3  2.0    1.25    0.22  1.33  30.25  n/a   0.000
*
      ADD [0014 + 0303]  0014  1  2.0    1.25    0.22  1.33  30.25  n/a   0.000
*
  **  CALIB STANDHYD     0202  1  2.0    1.56    0.26  1.37  31.19 0.72   0.000
      [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    0.66    0.14  1.33  32.97 0.76   0.000
      [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD     0203  1  2.0    0.90    0.17  1.33  30.94 0.71   0.000
      [I%=44.0:S%= 2.00]
*
      ADD [0201 + 0202]  0011  3  2.0    2.22    0.39  1.37  31.72  n/a   0.000
*
      ADD [0011 + 0203]  0011  1  2.0    3.12    0.56  1.33  31.50  n/a   0.000
*
      DUHYD              0301  1  2.0    3.12    0.56  1.33  31.50  n/a   0.000
         MAJOR SYSTEM:   0301  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0301  3  2.0    3.12    0.56  1.33  31.50  n/a   0.000
*
      RESRVR [ 2 : 0301] 0501  1  2.0    3.12    0.39  1.43  31.49  n/a   0.000
      {ST=  0.02 ha.m }
*
      ADD [0301 + 0501]  0012  3  2.0    3.12    0.39  1.43  31.49  n/a   0.000
*
  **  CALIB STANDHYD     0220  1  2.0    1.48    0.29  1.33  31.95 0.73   0.000
      [I%=48.0:S%= 2.00]
*
      DUHYD              0304  1  2.0    1.48    0.29  1.33  31.95  n/a   0.000
         MAJOR SYSTEM:   0304  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0304  3  2.0    1.48    0.29  1.33  31.95  n/a   0.000
*
      RESRVR [ 2 : 0304] 0502  1  2.0    1.48    0.25  1.37  31.95  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0304 + 0502]  0015  3  2.0    1.48    0.25  1.37  31.95  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   3 **
  ****************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.   Qbase
```

RUN 1 = 2-YEAR
RUN 2 = 5-YEAR
RUN 3 = 10-YEAR
RUN 4 = 25-YEAR
RUN 5 = 50-YEAR
RUN 6 = 100-YEAR
RUN 7 = 25mm

```
                                  min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
      CHIC STORM                 10.0
      [ Ptot= 52.36 mm ]
*
  **  CALIB STANDHYD     0120  1  2.0    1.48    0.34  1.33  38.08 0.73   0.000
      [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD     0101  1  2.0    1.07    0.20  1.33  34.82 0.67   0.000
      [I%=39.0:S%= 2.00]
*
  **  CALIB STANDHYD     0103  1  2.0    0.98    0.16  1.37  31.57 0.60   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0102  1  2.0    1.15    0.17  1.40  31.57 0.60   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0101 + 0102]  0001  3  2.0    2.22    0.37  1.37  33.14  n/a   0.000
*
      ADD [0001 + 0103]  0001  1  2.0    3.20    0.53  1.37  32.66  n/a   0.000
*
  **  CALIB STANDHYD     0112  1  2.0    0.98    0.16  1.37  31.57 0.60   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0111  1  2.0    0.74    0.12  1.37  31.57 0.60   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    1.07    0.18  1.33  31.84 0.61   0.000
      [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD     0113  1  2.0    0.82    0.13  1.37  31.57 0.60   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0110 + 0111]  0002  3  2.0    1.81    0.30  1.33  31.73  n/a   0.000
*
      ADD [0002 + 0112]  0002  1  2.0    2.79    0.47  1.33  31.67  n/a   0.000
*
      ADD [0002 + 0113]  0002  3  2.0    3.61    0.60  1.37  31.65  n/a   0.000
*
  **  CALIB STANDHYD     0213  1  2.0    1.29    0.34  1.33  41.29 0.79   0.000
      [I%=53.0:S%= 2.00]
*
      DUHYD              0303  1  2.0    1.29    0.34  1.33  41.29  n/a   0.000
         MAJOR SYSTEM:   0303  2  2.0    0.00    0.00  1.33  41.29  n/a   0.000
         MINOR SYSTEM:   0303  3  2.0    1.29    0.34  1.33  41.29  n/a   0.000
*
  **  CALIB STANDHYD     0212  1  2.0    0.76    0.18  1.33  38.76 0.74   0.000
      [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD     0211  1  2.0    0.49    0.12  1.33  36.81 0.70   0.000
      [I%=37.0:S%= 2.00]
*
      ADD [0211 + 0212]  0013  3  2.0    1.25    0.29  1.33  37.99  n/a   0.000
*
  **  CALIB STANDHYD     0210  1  2.0    1.15    0.30  1.33  40.44 0.77   0.000
      [I%=50.0:S%= 2.00]
*
      DUHYD              0302  1  2.0    1.15    0.30  1.33  40.44  n/a   0.000
         MAJOR SYSTEM:   0302  2  2.0    0.00    0.00  1.33  40.44  n/a   0.000
         MINOR SYSTEM:   0302  3  2.0    1.15    0.30  1.33  40.44  n/a   0.000
*
      ADD [0013 + 0302]  0014  3  2.0    1.25    0.30  1.33  38.00  n/a   0.000
*
      ADD [0014 + 0303]  0014  1  2.0    1.25    0.30  1.33  38.00  n/a   0.000
*
  **  CALIB STANDHYD     0202  1  2.0    1.56    0.34  1.37  39.04 0.75   0.000
      [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    0.66    0.18  1.33  41.00 0.78   0.000
      [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD     0203  1  2.0    0.90    0.22  1.33  38.76 0.74   0.000
      [I%=44.0:S%= 2.00]
*
      ADD [0201 + 0202]  0011  3  2.0    2.22    0.50  1.37  39.62  n/a   0.000
*
      ADD [0011 + 0203]  0011  1  2.0    3.12    0.72  1.33  39.37  n/a   0.000
*
      DUHYD              0301  1  2.0    3.12    0.72  1.33  39.37  n/a   0.000
         MAJOR SYSTEM:   0301  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0301  3  2.0    3.12    0.72  1.33  39.37  n/a   0.000
*
      RESRVR [ 2 : 0301] 0501  1  2.0    3.12    0.40  1.47  39.37  n/a   0.000
      {ST=  0.03 ha.m }
*
      ADD [0301 + 0501]  0012  3  2.0    3.12    0.40  1.47  39.37  n/a   0.000
*
  **  CALIB STANDHYD     0220  1  2.0    1.48    0.37  1.33  39.88 0.76   0.000
      [I%=48.0:S%= 2.00]
*
      DUHYD              0304  1  2.0    1.48    0.37  1.33  39.88  n/a   0.000
         MAJOR SYSTEM:   0304  2  2.0    0.00    0.00  1.33  39.88  n/a   0.000
         MINOR SYSTEM:   0304  3  2.0    1.48    0.37  1.33  39.88  n/a   0.000
*
      RESRVR [ 2 : 0304] 0502  1  2.0    1.48    0.32  1.40  39.88  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0304 + 0502]  0015  3  2.0    1.48    0.32  1.40  39.88  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   4 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      CHIC STORM                 10.0
      [ Ptot= 60.45 mm ]
*
  **  CALIB STANDHYD     0120  1  2.0    1.48    0.41  1.33  45.16 0.75   0.000
      [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD     0101  1  2.0    1.07    0.24  1.33  41.66 0.69   0.000
      [I%=39.0:S%= 2.00]
*
  **  CALIB STANDHYD     0103  1  2.0    0.98    0.19  1.37  38.16 0.63   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0102  1  2.0    1.15    0.20  1.37  38.16 0.63   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0101 + 0102]  0001  3  2.0    2.22    0.44  1.37  39.85  n/a   0.000
*
      ADD [0001 + 0103]  0001  1  2.0    3.20    0.63  1.37  39.33  n/a   0.000
*
  **  CALIB STANDHYD     0112  1  2.0    0.98    0.20  1.37  38.16 0.63   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0111  1  2.0    0.74    0.15  1.37  38.16 0.63   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    1.07    0.22  1.33  38.45 0.64   0.000
      [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD     0113  1  2.0    0.82    0.16  1.37  38.16 0.63   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0110 + 0111]  0002  3  2.0    1.81    0.37  1.33  38.33  n/a   0.000
*
      ADD [0002 + 0112]  0002  1  2.0    2.79    0.57  1.33  38.27  n/a   0.000
*
      ADD [0002 + 0113]  0002  3  2.0    3.61    0.73  1.37  38.25  n/a   0.000
*
  **  CALIB STANDHYD     0213  1  2.0    1.29    0.40  1.33  48.77 0.81   0.000
      [I%=53.0:S%= 2.00]
*
      DUHYD              0303  1  2.0    1.29    0.40  1.33  48.77  n/a   0.000
         MAJOR SYSTEM:   0303  2  2.0    0.03    0.06  1.33  48.77  n/a   0.000
         MINOR SYSTEM:   0303  3  2.0    1.26    0.34  1.30  48.77  n/a   0.000
*
  **  CALIB STANDHYD     0212  1  2.0    0.76    0.21  1.33  46.05 0.76   0.000
      [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD     0211  1  2.0    0.49    0.14  1.33  43.96 0.73   0.000
      [I%=37.0:S%= 2.00]
*
      ADD [0211 + 0212]  0013  3  2.0    1.25    0.35  1.33  45.23  n/a   0.000
*
  **  CALIB STANDHYD     0210  1  2.0    1.15    0.36  1.33  47.86 0.79   0.000
      [I%=50.0:S%= 2.00]
*
      DUHYD              0302  1  2.0    1.15    0.36  1.33  47.86  n/a   0.000
         MAJOR SYSTEM:   0302  2  2.0    0.03    0.06  1.33  47.86  n/a   0.000
         MINOR SYSTEM:   0302  3  2.0    1.12    0.30  1.30  47.86  n/a   0.000
*
      ADD [0013 + 0302]  0014  3  2.0    1.28    0.41  1.33  45.29  n/a   0.000
*
      ADD [0014 + 0303]  0014  1  2.0    1.31    0.47  1.33  45.38  n/a   0.000
*
  **  CALIB STANDHYD     0202  1  2.0    1.56    0.40  1.37  46.36 0.77   0.000
      [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    0.66    0.21  1.33  48.47 0.80   0.000
      [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD     0203  1  2.0    0.90    0.26  1.33  46.05 0.76   0.000
      [I%=44.0:S%= 2.00]
*
      ADD [0201 + 0202]  0011  3  2.0    2.22    0.61  1.33  46.98  n/a   0.000
*
      ADD [0011 + 0203]  0011  1  2.0    3.12    0.87  1.33  46.72  n/a   0.000
*
      DUHYD              0301  1  2.0    3.12    0.87  1.33  46.72  n/a   0.000
         MAJOR SYSTEM:   0301  2  2.0    0.08    0.15  1.33  46.72  n/a   0.000
         MINOR SYSTEM:   0301  3  2.0    3.04    0.72  1.30  46.72  n/a   0.000
*
      RESRVR [ 2 : 0301] 0501  1  2.0    3.04    0.41  1.50  46.71  n/a   0.000
      {ST=  0.04 ha.m }
*
      ADD [0301 + 0501]  0012  3  2.0    3.12    0.54  1.33  46.71  n/a   0.000
*
  **  CALIB STANDHYD     0220  1  2.0    1.48    0.44  1.33  47.26 0.78   0.000
      [I%=48.0:S%= 2.00]
*
      DUHYD              0304  1  2.0    1.48    0.44  1.33  47.26  n/a   0.000
         MAJOR SYSTEM:   0304  2  2.0    0.04    0.07  1.33  47.26  n/a   0.000
         MINOR SYSTEM:   0304  3  2.0    1.44    0.37  1.30  47.26  n/a   0.000
*
      RESRVR [ 2 : 0304] 0502  1  2.0    1.44    0.34  1.40  47.26  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0304 + 0502]  0015  3  2.0    1.48    0.39  1.37  47.26  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   5 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      CHIC STORM                 10.0
      [ Ptot= 66.97 mm ]
*
  **  CALIB STANDHYD     0120  1  2.0    1.48    0.47  1.33  50.97 0.76   0.000
      [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD     0101  1  2.0    1.07    0.28  1.33  47.29 0.71   0.000
      [I%=39.0:S%= 2.00]
*
  **  CALIB STANDHYD     0103  1  2.0    0.98    0.22  1.37  43.62 0.65   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0102  1  2.0    1.15    0.23  1.37  43.62 0.65   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0101 + 0102]  0001  3  2.0    2.22    0.51  1.37  45.39  n/a   0.000
*
      ADD [0001 + 0103]  0001  1  2.0    3.20    0.73  1.37  44.85  n/a   0.000
*
  **  CALIB STANDHYD     0112  1  2.0    0.98    0.23  1.37  43.62 0.65   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0111  1  2.0    0.74    0.17  1.37  43.62 0.65   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    1.07    0.25  1.33  43.93 0.66   0.000
      [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD     0113  1  2.0    0.82    0.19  1.37  43.62 0.65   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0110 + 0111]  0002  3  2.0    1.81    0.43  1.33  43.80  n/a   0.000
*
      ADD [0002 + 0112]  0002  1  2.0    2.79    0.66  1.37  43.74  n/a   0.000
*
      ADD [0002 + 0113]  0002  3  2.0    3.61    0.84  1.37  43.71  n/a   0.000
*
  **  CALIB STANDHYD     0213  1  2.0    1.29    0.46  1.33  54.87 0.82   0.000
```

```
     [I%=53.0:S%= 2.00]
*
     DUHYD             0303  1  2.0    1.29    0.46  1.33  54.87  n/a   0.000
        MAJOR SYSTEM:  0303  2  2.0    0.07    0.12  1.33  54.87  n/a   0.000
        MINOR SYSTEM:  0303  3  2.0    1.22    0.34  1.27  54.87  n/a   0.000
*
  **  CALIB STANDHYD    0212  1  2.0    0.76    0.24  1.33  52.02 0.78   0.000
     [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD    0211  1  2.0    0.49    0.17  1.33  49.83 0.74   0.000
     [I%=37.0:S%= 2.00]
*
     ADD [0211 + 0212]  0013  3  2.0    1.25    0.41  1.33  51.16  n/a   0.000
*
  **  CALIB STANDHYD    0210  1  2.0    1.15    0.41  1.33  53.92 0.81   0.000
     [I%=50.0:S%= 2.00]
*
     DUHYD             0302  1  2.0    1.15    0.41  1.33  53.92  n/a   0.000
        MAJOR SYSTEM:  0302  2  2.0    0.06    0.11  1.33  53.92  n/a   0.000
        MINOR SYSTEM:  0302  3  2.0    1.09    0.30  1.27  53.92  n/a   0.000
*
     ADD [0013 + 0302]  0014  3  2.0    1.31    0.52  1.33  51.29  n/a   0.000
*
     ADD [0014 + 0303]  0014  1  2.0    1.38    0.64  1.33  51.46  n/a   0.000
*
  **  CALIB STANDHYD    0202  1  2.0    1.56    0.45  1.37  52.34 0.78   0.000
     [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD    0201  1  2.0    0.66    0.24  1.33  54.56 0.81   0.000
     [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD    0203  1  2.0    0.90    0.30  1.33  52.03 0.78   0.000
     [I%=44.0:S%= 2.00]
*
     ADD [0201 + 0202]  0011  3  2.0    2.22    0.69  1.33  53.00  n/a   0.000
*
     ADD [0011 + 0203]  0011  1  2.0    3.12    0.99  1.33  52.72  n/a   0.000
*
     DUHYD             0301  1  2.0    3.12    0.99  1.33  52.72  n/a   0.000
        MAJOR SYSTEM:  0301  2  2.0    0.17    0.27  1.33  52.72  n/a   0.000
        MINOR SYSTEM:  0301  3  2.0    2.95    0.72  1.27  52.72  n/a   0.000
*
     RESRVR [ 2 : 0301] 0501  1  2.0    2.95    0.42  1.53  52.71  n/a   0.000
     {ST=  0.04 ha.m }
*
     ADD [0301 + 0501]  0012  3  2.0    3.12    0.67  1.33  52.71  n/a   0.000
*
  **  CALIB STANDHYD    0220  1  2.0    1.48    0.50  1.33  53.29 0.80   0.000
     [I%=48.0:S%= 2.00]
*
     DUHYD             0304  1  2.0    1.48    0.50  1.33  53.29  n/a   0.000
        MAJOR SYSTEM:  0304  2  2.0    0.08    0.13  1.33  53.29  n/a   0.000
        MINOR SYSTEM:  0304  3  2.0    1.40    0.37  1.27  53.29  n/a   0.000
*
     RESRVR [ 2 : 0304] 0502  1  2.0    1.40    0.36  1.40  53.29  n/a   0.000
     {ST=  0.01 ha.m }
*
     ADD [0304 + 0502]  0015  3  2.0    1.48    0.46  1.33  53.29  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   6 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     CHIC STORM                10.0
     [ Ptot= 73.49 mm ]
*
  **  CALIB STANDHYD    0120  1  2.0    1.48    0.53  1.33  56.85 0.77   0.000
     [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD    0101  1  2.0    1.07    0.32  1.33  53.02 0.72   0.000
     [I%=39.0:S%= 2.00]
*
  **  CALIB STANDHYD    0103  1  2.0    0.98    0.26  1.37  49.19 0.67   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD    0102  1  2.0    1.15    0.27  1.37  49.19 0.67   0.000
     [I%=27.0:S%= 2.00]
*
     ADD [0101 + 0102]  0001  3  2.0    2.22    0.58  1.37  51.03  n/a   0.000
*
     ADD [0001 + 0103]  0001  1  2.0    3.20    0.83  1.37  50.47  n/a   0.000
*
  **  CALIB STANDHYD    0112  1  2.0    0.98    0.26  1.37  49.19 0.67   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD    0111  1  2.0    0.74    0.20  1.37  49.19 0.67   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD    0110  1  2.0    1.07    0.29  1.33  49.51 0.67   0.000
     [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD    0113  1  2.0    0.82    0.22  1.37  49.19 0.67   0.000
     [I%=27.0:S%= 2.00]
*
     ADD [0110 + 0111]  0002  3  2.0    1.81    0.49  1.33  49.38  n/a   0.000
*
     ADD [0002 + 0112]  0002  1  2.0    2.79    0.75  1.37  49.31  n/a   0.000
*
     ADD [0002 + 0113]  0002  3  2.0    3.61    0.96  1.37  49.28  n/a   0.000
*
  **  CALIB STANDHYD    0213  1  2.0    1.29    0.51  1.33  61.03 0.83   0.000
     [I%=53.0:S%= 2.00]
*
     DUHYD             0303  1  2.0    1.29    0.51  1.33  61.03  n/a   0.000
        MAJOR SYSTEM:  0303  2  2.0    0.11    0.17  1.33  61.03  n/a   0.000
        MINOR SYSTEM:  0303  3  2.0    1.18    0.34  1.27  61.03  n/a   0.000
*
  **  CALIB STANDHYD    0212  1  2.0    0.76    0.27  1.33  58.06 0.79   0.000
     [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD    0211  1  2.0    0.49    0.19  1.33  55.77 0.76   0.000
     [I%=37.0:S%= 2.00]
*
     ADD [0211 + 0212]  0013  3  2.0    1.25    0.46  1.33  57.16  n/a   0.000
*
  **  CALIB STANDHYD    0210  1  2.0    1.15    0.46  1.33  60.03 0.82   0.000
     [I%=50.0:S%= 2.00]
*
     DUHYD             0302  1  2.0    1.15    0.46  1.33  60.03  n/a   0.000
        MAJOR SYSTEM:  0302  2  2.0    0.09    0.16  1.33  60.03  n/a   0.000
        MINOR SYSTEM:  0302  3  2.0    1.06    0.30  1.27  60.03  n/a   0.000
*
     ADD [0013 + 0302]  0014  3  2.0    1.34    0.62  1.33  57.36  n/a   0.000
*
     ADD [0014 + 0303]  0014  1  2.0    1.45    0.80  1.33  57.63  n/a   0.000
*
  **  CALIB STANDHYD    0202  1  2.0    1.56    0.54  1.33  58.39 0.79   0.000
     [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD    0201  1  2.0    0.66    0.28  1.33  60.70 0.83   0.000
     [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD    0203  1  2.0    0.90    0.34  1.33  58.06 0.79   0.000
     [I%=44.0:S%= 2.00]
*
     ADD [0201 + 0202]  0011  3  2.0    2.22    0.81  1.33  59.07  n/a   0.000
*
     ADD [0011 + 0203]  0011  1  2.0    3.12    1.15  1.33  58.78  n/a   0.000
*
     DUHYD             0301  1  2.0    3.12    1.15  1.33  58.78  n/a   0.000
        MAJOR SYSTEM:  0301  2  2.0    0.29    0.43  1.33  58.78  n/a   0.000
        MINOR SYSTEM:  0301  3  2.0    2.83    0.72  1.27  58.78  n/a   0.000
*
     RESRVR [ 2 : 0301] 0501  1  2.0    2.83    0.42  1.53  58.78  n/a   0.000
     {ST=  0.04 ha.m }
*
     ADD [0301 + 0501]  0012  3  2.0    3.12    0.83  1.33  58.78  n/a   0.000
*
  **  CALIB STANDHYD    0220  1  2.0    1.48    0.57  1.33  59.38 0.81   0.000
     [I%=48.0:S%= 2.00]
*
     DUHYD             0304  1  2.0    1.48    0.57  1.33  59.38  n/a   0.000
        MAJOR SYSTEM:  0304  2  2.0    0.12    0.20  1.33  59.38  n/a   0.000
        MINOR SYSTEM:  0304  3  2.0    1.36    0.37  1.27  59.38  n/a   0.000
*
     RESRVR [ 2 : 0304] 0502  1  2.0    1.36    0.36  1.40  59.37  n/a   0.000
     {ST=  0.01 ha.m }
*
     ADD [0304 + 0502]  0015  3  2.0    1.48    0.53  1.33  59.37  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   7 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     CHIC STORM                10.0
     [ Ptot= 24.99 mm ]
*
  **  CALIB STANDHYD    0120  1  2.0    1.48    0.12  1.33  15.64 0.63   0.000
     [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD    0101  1  2.0    1.07    0.07  1.37  13.60 0.54   0.000
     [I%=39.0:S%= 2.00]
*
  **  CALIB STANDHYD    0103  1  2.0    0.98    0.05  1.37  11.55 0.46   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD    0102  1  2.0    1.15    0.05  1.43  11.55 0.46   0.000
     [I%=27.0:S%= 2.00]
*
     ADD [0101 + 0102]  0001  3  2.0    2.22    0.12  1.40  12.54  n/a   0.000
*
     ADD [0001 + 0103]  0001  1  2.0    3.20    0.17  1.37  12.24  n/a   0.000
*
  **  CALIB STANDHYD    0112  1  2.0    0.98    0.05  1.33  11.55 0.46   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD    0111  1  2.0    0.74    0.04  1.33  11.55 0.46   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD    0110  1  2.0    1.07    0.06  1.33  11.73 0.47   0.000
     [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD    0113  1  2.0    0.82    0.04  1.37  11.55 0.46   0.000
     [I%=27.0:S%= 2.00]
*
     ADD [0110 + 0111]  0002  3  2.0    1.81    0.10  1.33  11.66  n/a   0.000
*
     ADD [0002 + 0112]  0002  1  2.0    2.79    0.15  1.33  11.62  n/a   0.000
*
     ADD [0002 + 0113]  0002  3  2.0    3.61    0.19  1.33  11.60  n/a   0.000
*
  **  CALIB STANDHYD    0213  1  2.0    1.29    0.12  1.33  17.17 0.69   0.000
     [I%=53.0:S%= 2.00]
*
     DUHYD             0303  1  2.0    1.29    0.12  1.33  17.17  n/a   0.000
        MAJOR SYSTEM:  0303  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
        MINOR SYSTEM:  0303  3  2.0    1.29    0.12  1.33  17.17  n/a   0.000
*
  **  CALIB STANDHYD    0212  1  2.0    0.76    0.06  1.37  15.58 0.62   0.000
     [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD    0211  1  2.0    0.49    0.04  1.33  14.35 0.57   0.000
     [I%=37.0:S%= 2.00]
*
     ADD [0211 + 0212]  0013  3  2.0    1.25    0.10  1.37  15.10  n/a   0.000
*
  **  CALIB STANDHYD    0210  1  2.0    1.15    0.11  1.33  16.63 0.67   0.000
     [I%=50.0:S%= 2.00]
*
     DUHYD             0302  1  2.0    1.15    0.11  1.33  16.63  n/a   0.000
        MAJOR SYSTEM:  0302  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
        MINOR SYSTEM:  0302  3  2.0    1.15    0.11  1.33  16.63  n/a   0.000
*
     ADD [0013 + 0302]  0014  3  2.0    1.25    0.10  1.37  15.10  n/a   0.000
*
     ADD [0014 + 0303]  0014  1  2.0    1.25    0.10  1.37  15.10  n/a   0.000
*
  **  CALIB STANDHYD    0202  1  2.0    1.56    0.11  1.37  15.75 0.63   0.000
     [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD    0201  1  2.0    0.66    0.06  1.33  16.99 0.68   0.000
     [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD    0203  1  2.0    0.90    0.08  1.33  15.58 0.62   0.000
     [I%=44.0:S%= 2.00]
*
     ADD [0201 + 0202]  0011  3  2.0    2.22    0.18  1.37  16.12  n/a   0.000
*
     ADD [0011 + 0203]  0011  1  2.0    3.12    0.25  1.37  15.96  n/a   0.000
*
     DUHYD             0301  1  2.0    3.12    0.25  1.37  15.96  n/a   0.000
        MAJOR SYSTEM:  0301  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
        MINOR SYSTEM:  0301  3  2.0    3.12    0.25  1.37  15.96  n/a   0.000
*
```

```
      RESRVR [ 2 : 0301] 0501  1  2.0    3.12    0.17  1.50  15.96  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0301 + 0501]  0012  3  2.0    3.12    0.17  1.50  15.96  n/a   0.000
*
  **  CALIB STANDHYD     0220  1  2.0    1.48    0.13  1.33  16.28 0.65   0.000
      [I%=48.0:S%= 2.00]
*
      DUHYD              0304  1  2.0    1.48    0.13  1.33  16.28  n/a   0.000
         MAJOR SYSTEM:   0304  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0304  3  2.0    1.48    0.13  1.33  16.28  n/a   0.000
*
      RESRVR [ 2 : 0304] 0502  1  2.0    1.48    0.12  1.40  16.28  n/a   0.000
      {ST=  0.00 ha.m }
*
      ADD [0304 + 0502]  0015  3  2.0    1.48    0.12  1.40  16.28  n/a   0.000
*
 FINISH

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

WARDEN AVENUE OTTHYMO SUMMARY OUTPUT: 24-HOUR SCS

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

      V    V   I    SSSSS  U   U    A    L
      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 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  *****

  Input   filename: C:\Program Files (x86)\VO Suite 3.0\VO2\voin.dat
  Output  filename: C:\Users\hfaulkner\AppData\Local\Temp\46f3aac1-a747-4f34-9673-
aec68afd0a53\Scenario.out
  Summary filename: C:\Users\hfaulkner\AppData\Local\Temp\46f3aac1-a747-4f34-9673-
aec68afd0a53\Scenario.sum

DATE: 04/06/2023                          TIME: 10:33:07

USER:

COMMENTS: _____

  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      MASS STORM                 12.0
      [ Ptot= 46.40 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.74    0.05 12.00  26.87 0.58   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    1.07    0.08 12.00  27.13 0.58   0.000
      [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD     0113  1  2.0    0.82    0.06 12.03  26.87 0.58   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0112  1  2.0    0.98    0.07 12.00  26.87 0.58   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0110 + 0111]  0002  3  2.0    1.81    0.13 12.00  27.02  n/a   0.000
*
      ADD [0002 + 0112]  0002  1  2.0    2.79    0.19 12.00  26.97  n/a   0.000
*
      ADD [0002 + 0113]  0002  3  2.0    3.61    0.25 12.00  26.95  n/a   0.000
*
  **  CALIB STANDHYD     0120  1  2.0    1.48    0.14 12.00  32.96 0.71   0.000
      [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD     0102  1  2.0    1.15    0.07 12.07  26.87 0.58   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0103  1  2.0    0.98    0.07 12.03  26.87 0.58   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0101  1  2.0    1.07    0.08 12.03  29.92 0.64   0.000
      [I%=39.0:S%= 2.00]
*
      ADD [0101 + 0102]  0001  3  2.0    2.22    0.15 12.03  28.34  n/a   0.000
*
      ADD [0001 + 0103]  0001  1  2.0    3.20    0.22 12.03  27.89  n/a   0.000
*
  **  CALIB STANDHYD     0220  1  2.0    1.48    0.15 12.00  34.53 0.74   0.000
      [I%=48.0:S%= 2.00]
*
      DUHYD              0308  1  2.0    1.48    0.15 12.00  34.53  n/a   0.000
         MAJOR SYSTEM:   0308  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0308  3  2.0    1.48    0.15 12.00  34.53  n/a   0.000
*
      RESRVR [ 2 : 0308] 0504  1  2.0    1.48    0.13 12.07  34.53  n/a   0.000
      {ST=  0.00 ha.m }
*
      ADD [0308 + 0504]  0015  3  2.0    1.48    0.13 12.07  34.53  n/a   0.000
*
  **  CALIB STANDHYD     0202  1  2.0    1.56    0.14 12.03  33.75 0.73   0.000
      [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    0.66    0.07 12.00  35.58 0.77   0.000
      [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD     0203  1  2.0    0.90    0.09 12.00  33.48 0.72   0.000
      [I%=44.0:S%= 2.00]
*
      ADD [0201 + 0202]  0011  3  2.0    2.22    0.20 12.00  34.29  n/a   0.000
*
      ADD [0011 + 0203]  0011  1  2.0    3.12    0.29 12.00  34.06  n/a   0.000
*
      DUHYD              0305  1  2.0    3.12    0.29 12.00  34.06  n/a   0.000
         MAJOR SYSTEM:   0305  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0305  3  2.0    3.12    0.29 12.00  34.06  n/a   0.000
*
      RESRVR [ 2 : 0305] 0503  1  2.0    3.12    0.22 12.10  34.05  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0305 + 0503]  0012  3  2.0    3.12    0.22 12.10  34.05  n/a   0.000
*
  **  CALIB STANDHYD     0212  1  2.0    0.76    0.07 12.03  33.48 0.72   0.000
      [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD     0211  1  2.0    0.49    0.05 12.00  31.66 0.68   0.000
      [I%=37.0:S%= 2.00]
*
      ADD [0211 + 0212]  0013  3  2.0    1.25    0.12 12.00  32.77  n/a   0.000
*
  **  CALIB STANDHYD     0210  1  2.0    1.15    0.12 12.00  35.06 0.76   0.000
      [I%=50.0:S%= 2.00]
*
      DUHYD              0306  1  2.0    1.15    0.12 12.00  35.06  n/a   0.000
         MAJOR SYSTEM:   0306  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0306  3  2.0    1.15    0.12 12.00  35.06  n/a   0.000
*
  **  CALIB STANDHYD     0213  1  2.0    1.29    0.13 12.00  35.85 0.77   0.000
      [I%=53.0:S%= 2.00]
*
      DUHYD              0307  1  2.0    1.29    0.13 12.00  35.85  n/a   0.000
         MAJOR SYSTEM:   0307  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0307  3  2.0    1.29    0.13 12.00  35.85  n/a   0.000
*
      ADD [0013 + 0306]  0014  3  2.0    1.25    0.12 12.00  32.77  n/a   0.000
*
      ADD [0014 + 0307]  0014  1  2.0    1.25    0.12 12.00  32.77  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   2 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      MASS STORM                 12.0
      [ Ptot= 59.80 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.74    0.08 12.00  37.62 0.63   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    1.07    0.11 12.00  37.91 0.63   0.000
      [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD     0113  1  2.0    0.82    0.08 12.00  37.62 0.63   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0112  1  2.0    0.98    0.10 12.00  37.62 0.63   0.000
      [I%=27.0:S%= 2.00]
*
      ADD [0110 + 0111]  0002  3  2.0    1.81    0.19 12.00  37.80  n/a   0.000
*
      ADD [0002 + 0112]  0002  1  2.0    2.79    0.29 12.00  37.74  n/a   0.000
*
      ADD [0002 + 0113]  0002  3  2.0    3.61    0.37 12.00  37.71  n/a   0.000
*
  **  CALIB STANDHYD     0120  1  2.0    1.48    0.19 12.00  44.59 0.75   0.000
      [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD     0102  1  2.0    1.15    0.10 12.03  37.62 0.63   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0103  1  2.0    0.98    0.09 12.00  37.62 0.63   0.000
      [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0101  1  2.0    1.07    0.12 12.03  41.10 0.69   0.000
      [I%=39.0:S%= 2.00]
*
      ADD [0101 + 0102]  0001  3  2.0    2.22    0.22 12.03  39.30  n/a   0.000
*
      ADD [0001 + 0103]  0001  1  2.0    3.20    0.31 12.03  38.79  n/a   0.000
*
  **  CALIB STANDHYD     0220  1  2.0    1.48    0.21 12.00  46.66 0.78   0.000
      [I%=48.0:S%= 2.00]
*
      DUHYD              0308  1  2.0    1.48    0.21 12.00  46.66  n/a   0.000
         MAJOR SYSTEM:   0308  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0308  3  2.0    1.48    0.21 12.00  46.66  n/a   0.000
*
      RESRVR [ 2 : 0308] 0504  1  2.0    1.48    0.18 12.07  46.66  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0308 + 0504]  0015  3  2.0    1.48    0.18 12.07  46.66  n/a   0.000
*
  **  CALIB STANDHYD     0202  1  2.0    1.56    0.19 12.03  45.76 0.77   0.000
      [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    0.66    0.10 12.00  47.86 0.80   0.000
      [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD     0203  1  2.0    0.90    0.12 12.00  45.46 0.76   0.000
      [I%=44.0:S%= 2.00]
*
      ADD [0201 + 0202]  0011  3  2.0    2.22    0.29 12.00  46.39  n/a   0.000
*
      ADD [0011 + 0203]  0011  1  2.0    3.12    0.41 12.00  46.12  n/a   0.000
*
      DUHYD              0305  1  2.0    3.12    0.41 12.00  46.12  n/a   0.000
         MAJOR SYSTEM:   0305  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0305  3  2.0    3.12    0.41 12.00  46.12  n/a   0.000
*
      RESRVR [ 2 : 0305] 0503  1  2.0    3.12    0.30 12.10  46.12  n/a   0.000
      {ST=  0.02 ha.m }
*
      ADD [0305 + 0503]  0012  3  2.0    3.12    0.30 12.10  46.12  n/a   0.000
*
  **  CALIB STANDHYD     0212  1  2.0    0.76    0.10 12.00  45.46 0.76   0.000
      [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD     0211  1  2.0    0.49    0.07 12.00  43.38 0.73   0.000
      [I%=37.0:S%= 2.00]
*
      ADD [0211 + 0212]  0013  3  2.0    1.25    0.17 12.00  44.65  n/a   0.000
*
  **  CALIB STANDHYD     0210  1  2.0    1.15    0.17 12.00  47.26 0.79   0.000
      [I%=50.0:S%= 2.00]
*
      DUHYD              0306  1  2.0    1.15    0.17 12.00  47.26  n/a   0.000
         MAJOR SYSTEM:   0306  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0306  3  2.0    1.15    0.17 12.00  47.26  n/a   0.000
*
  **  CALIB STANDHYD     0213  1  2.0    1.29    0.19 12.00  48.17 0.81   0.000
      [I%=53.0:S%= 2.00]
*
      DUHYD              0307  1  2.0    1.29    0.19 12.00  48.17  n/a   0.000
         MAJOR SYSTEM:   0307  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0307  3  2.0    1.29    0.19 12.00  48.17  n/a   0.000
*
      ADD [0013 + 0306]  0014  3  2.0    1.25    0.17 12.00  44.65  n/a   0.000
*
      ADD [0014 + 0307]  0014  1  2.0    1.25    0.17 12.00  44.65  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   3 **
  ****************************

  W/E COMMAND              HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.   Qbase
```
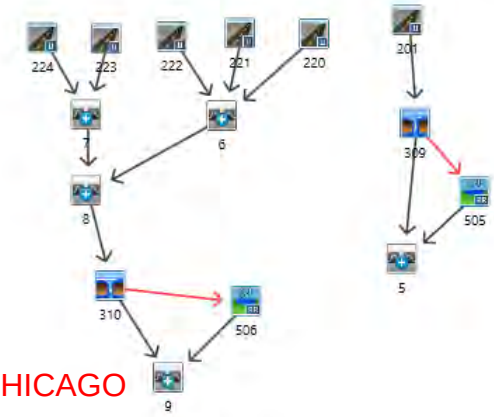

RUN 1 = 2-YEAR
RUN 2 = 5-YEAR
RUN 3 = 10-YEAR
RUN 4 = 25-YEAR
RUN 5 = 50-YEAR
RUN 6 = 100-YEAR

```
                                  min     ha   '  cms   hrs     mm          cms

     START @  0.00 hrs
     --------------------
     MASS STORM                12.0
     [ Ptot= 70.80 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.74    0.10 12.00  46.87 0.66   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    1.07    0.14 12.00  47.19 0.67   0.000
     [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD     0113  1  2.0    0.82    0.10 12.00  46.87 0.66   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0112  1  2.0    0.98    0.13 12.00  46.87 0.66   0.000
     [I%=27.0:S%= 2.00]
*
      ADD [0110 + 0111]  0002  3  2.0    1.81    0.24 12.00  47.06  n/a   0.000
*
      ADD [0002 + 0112]  0002  1  2.0    2.79    0.36 12.00  46.99  n/a   0.000
*
      ADD [0002 + 0113]  0002  3  2.0    3.61    0.47 12.00  46.97  n/a   0.000
*
  **  CALIB STANDHYD     0120  1  2.0    1.48    0.24 12.00  54.41 0.77   0.000
     [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD     0102  1  2.0    1.15    0.13 12.03  46.87 0.66   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0103  1  2.0    0.98    0.12 12.00  46.87 0.66   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0101  1  2.0    1.07    0.15 12.00  50.64 0.72   0.000
     [I%=39.0:S%= 2.00]
*
      ADD [0101 + 0102]  0001  3  2.0    2.22    0.28 12.00  48.69  n/a   0.000
*
      ADD [0001 + 0103]  0001  1  2.0    3.20    0.40 12.00  48.13  n/a   0.000
*
  **  CALIB STANDHYD     0220  1  2.0    1.48    0.25 12.00  56.85 0.80   0.000
     [I%=48.0:S%= 2.00]
*
      DUHYD              0308  1  2.0    1.48    0.25 12.00  56.85  n/a   0.000
         MAJOR SYSTEM:   0308  2  2.0    0.00    0.00 12.00  56.85  n/a   0.000
         MINOR SYSTEM:   0308  3  2.0    1.48    0.25 12.00  56.85  n/a   0.000
*
      RESRVR [ 2 : 0308] 0504  1  2.0    1.48    0.21 12.07  56.85  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0308 + 0504]  0015  3  2.0    1.48    0.21 12.07  56.85  n/a   0.000
*
  **  CALIB STANDHYD     0202  1  2.0    1.56    0.24 12.03  55.88 0.79   0.000
     [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    0.66    0.12 12.00  58.15 0.82   0.000
     [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD     0203  1  2.0    0.90    0.15 12.00  55.56 0.78   0.000
     [I%=44.0:S%= 2.00]
*
      ADD [0201 + 0202]  0011  3  2.0    2.22    0.36 12.00  56.56  n/a   0.000
*
      ADD [0011 + 0203]  0011  1  2.0    3.12    0.51 12.00  56.27  n/a   0.000
*
      DUHYD              0305  1  2.0    3.12    0.51 12.00  56.27  n/a   0.000
         MAJOR SYSTEM:   0305  2  2.0    0.00    0.00 12.00  56.27  n/a   0.000
         MINOR SYSTEM:   0305  3  2.0    3.12    0.51 12.00  56.27  n/a   0.000
*
      RESRVR [ 2 : 0305] 0503  1  2.0    3.12    0.35 12.10  56.27  n/a   0.000
      {ST=  0.02 ha.m }
*
      ADD [0305 + 0503]  0012  3  2.0    3.12    0.35 12.10  56.27  n/a   0.000
*
  **  CALIB STANDHYD     0212  1  2.0    0.76    0.12 12.00  55.56 0.78   0.000
     [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD     0211  1  2.0    0.49    0.08 12.00  53.31 0.75   0.000
     [I%=37.0:S%= 2.00]
*
      ADD [0211 + 0212]  0013  3  2.0    1.25    0.21 12.00  54.68  n/a   0.000
*
  **  CALIB STANDHYD     0210  1  2.0    1.15    0.21 12.00  57.50 0.81   0.000
     [I%=50.0:S%= 2.00]
*
      DUHYD              0306  1  2.0    1.15    0.21 12.00  57.50  n/a   0.000
         MAJOR SYSTEM:   0306  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0306  3  2.0    1.15    0.21 12.00  57.50  n/a   0.000
*
  **  CALIB STANDHYD     0213  1  2.0    1.29    0.23 12.00  58.48 0.83   0.000
     [I%=53.0:S%= 2.00]
*
      DUHYD              0307  1  2.0    1.29    0.23 12.00  58.48  n/a   0.000
         MAJOR SYSTEM:   0307  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0307  3  2.0    1.29    0.23 12.00  58.48  n/a   0.000
*
      ADD [0013 + 0306]  0014  3  2.0    1.25    0.21 12.00  54.68  n/a   0.000
*
      ADD [0014 + 0307]  0014  1  2.0    1.25    0.21 12.00  54.68  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   4 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     MASS STORM                12.0
     [ Ptot= 83.10 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.74    0.12 12.00  57.55 0.69   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    1.07    0.17 12.00  57.89 0.70   0.000
     [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD     0113  1  2.0    0.82    0.13 12.00  57.55 0.69   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0112  1  2.0    0.98    0.16 12.00  57.55 0.69   0.000
     [I%=27.0:S%= 2.00]
*
      ADD [0110 + 0111]  0002  3  2.0    1.81    0.29 12.00  57.75  n/a   0.000
*
      ADD [0002 + 0112]  0002  1  2.0    2.79    0.45 12.00  57.68  n/a   0.000
*
      ADD [0002 + 0113]  0002  3  2.0    3.61    0.58 12.00  57.65  n/a   0.000
*
  **  CALIB STANDHYD     0120  1  2.0    1.48    0.29 12.00  65.62 0.79   0.000
     [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD     0102  1  2.0    1.15    0.17 12.03  57.55 0.69   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0103  1  2.0    0.98    0.15 12.00  57.55 0.69   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0101  1  2.0    1.07    0.18 12.00  61.58 0.74   0.000
     [I%=39.0:S%= 2.00]
*
      ADD [0101 + 0102]  0001  3  2.0    2.22    0.35 12.00  59.49  n/a   0.000
*
      ADD [0001 + 0103]  0001  1  2.0    3.20    0.50 12.00  58.90  n/a   0.000
*
  **  CALIB STANDHYD     0220  1  2.0    1.48    0.31 12.00  68.43 0.82   0.000
     [I%=48.0:S%= 2.00]
*
      DUHYD              0308  1  2.0    1.48    0.31 12.00  68.43  n/a   0.000
         MAJOR SYSTEM:   0308  2  2.0    0.03    0.06 12.00  68.43  n/a   0.000
         MINOR SYSTEM:   0308  3  2.0    1.45    0.25 11.93  68.43  n/a   0.000
*
      RESRVR [ 2 : 0308] 0504  1  2.0    1.45    0.22 12.07  68.42  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0308 + 0504]  0015  3  2.0    1.48    0.27 12.00  68.42  n/a   0.000
*
  **  CALIB STANDHYD     0202  1  2.0    1.56    0.30 12.00  67.39 0.81   0.000
     [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    0.66    0.15 12.00  69.81 0.84   0.000
     [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD     0203  1  2.0    0.90    0.19 12.00  67.04 0.81   0.000
     [I%=44.0:S%= 2.00]
*
      ADD [0201 + 0202]  0011  3  2.0    2.22    0.44 12.00  68.11  n/a   0.000
*
      ADD [0011 + 0203]  0011  1  2.0    3.12    0.63 12.00  67.80  n/a   0.000
*
      DUHYD              0305  1  2.0    3.12    0.63 12.00  67.80  n/a   0.000
         MAJOR SYSTEM:   0305  2  2.0    0.06    0.12 12.00  67.80  n/a   0.000
         MINOR SYSTEM:   0305  3  2.0    3.06    0.51 11.93  67.80  n/a   0.000
*
      RESRVR [ 2 : 0305] 0503  1  2.0    3.06    0.39 12.10  67.80  n/a   0.000
      {ST=  0.03 ha.m }
*
      ADD [0305 + 0503]  0012  3  2.0    3.12    0.47 12.00  67.80  n/a   0.000
*
  **  CALIB STANDHYD     0212  1  2.0    0.76    0.15 12.00  67.04 0.81   0.000
     [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD     0211  1  2.0    0.49    0.10 12.00  64.63 0.78   0.000
     [I%=37.0:S%= 2.00]
*
      ADD [0211 + 0212]  0013  3  2.0    1.25    0.25 12.00  66.10  n/a   0.000
*
  **  CALIB STANDHYD     0210  1  2.0    1.15    0.25 12.00  69.12 0.83   0.000
     [I%=50.0:S%= 2.00]
*
      DUHYD              0306  1  2.0    1.15    0.25 12.00  69.12  n/a   0.000
         MAJOR SYSTEM:   0306  2  2.0    0.02    0.04 12.00  69.12  n/a   0.000
         MINOR SYSTEM:   0306  3  2.0    1.13    0.21 11.93  69.12  n/a   0.000
*
  **  CALIB STANDHYD     0213  1  2.0    1.29    0.28 12.00  70.16 0.84   0.000
     [I%=53.0:S%= 2.00]
*
      DUHYD              0307  1  2.0    1.29    0.28 12.00  70.16  n/a   0.000
         MAJOR SYSTEM:   0307  2  2.0    0.02    0.05 12.00  70.16  n/a   0.000
         MINOR SYSTEM:   0307  3  2.0    1.27    0.23 11.90  70.16  n/a   0.000
*
      ADD [0013 + 0306]  0014  3  2.0    1.27    0.29 12.00  66.14  n/a   0.000
*
      ADD [0014 + 0307]  0014  1  2.0    1.29    0.35 12.00  66.22  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   5 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     MASS STORM                12.0
     [ Ptot= 92.10 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.74    0.14 12.00  65.53 0.71   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    1.07    0.21 12.00  65.88 0.72   0.000
     [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD     0113  1  2.0    0.82    0.15 12.00  65.53 0.71   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0112  1  2.0    0.98    0.19 12.00  65.53 0.71   0.000
     [I%=27.0:S%= 2.00]
*
      ADD [0110 + 0111]  0002  3  2.0    1.81    0.35 12.00  65.74  n/a   0.000
*
      ADD [0002 + 0112]  0002  1  2.0    2.79    0.54 12.00  65.67  n/a   0.000
*
      ADD [0002 + 0113]  0002  3  2.0    3.61    0.69 12.00  65.64  n/a   0.000
*
  **  CALIB STANDHYD     0120  1  2.0    1.48    0.33 12.00  73.94 0.80   0.000
     [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD     0102  1  2.0    1.15    0.19 12.03  65.53 0.71   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0103  1  2.0    0.98    0.18 12.00  65.53 0.71   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0101  1  2.0    1.07    0.21 12.00  69.74 0.76   0.000
     [I%=39.0:S%= 2.00]
*
      ADD [0101 + 0102]  0001  3  2.0    2.22    0.40 12.00  67.56  n/a   0.000
*
      ADD [0001 + 0103]  0001  1  2.0    3.20    0.57 12.00  66.94  n/a   0.000
*
  **  CALIB STANDHYD     0220  1  2.0    1.48    0.36 12.00  76.98 0.84   0.000
```

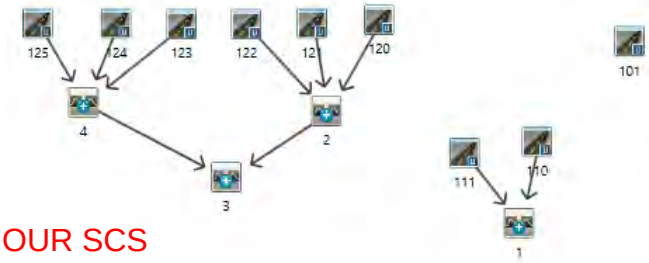
```
     [I%=48.0:S%= 2.00]
*
     DUHYD             0308  1  2.0    1.48    0.36 12.00  76.98  n/a   0.000
        MAJOR SYSTEM:   0308  2  2.0    0.06    0.11 12.00  76.98  n/a   0.000
        MINOR SYSTEM:   0308  3  2.0    1.42    0.25 11.90  76.98  n/a   0.000
*
     RESRVR [ 2 : 0308] 0504  1  2.0    1.42    0.22 12.07  76.98  n/a   0.000
     {ST=  0.01 ha.m }
*
     ADD [0308 + 0504]  0015  3  2.0    1.48    0.32 12.00  76.98  n/a   0.000
*
  **  CALIB STANDHYD     0202  1  2.0    1.56    0.34 12.00  75.90 0.82   0.000
     [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    0.66    0.16 12.00  78.42 0.85   0.000
     [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD     0203  1  2.0    0.90    0.21 12.00  75.54 0.82   0.000
     [I%=44.0:S%= 2.00]
*
     ADD [0201 + 0202]  0011  3  2.0    2.22    0.50 12.00  76.65  n/a   0.000
*
     ADD [0011 + 0203]  0011  1  2.0    3.12    0.72 12.00  76.33  n/a   0.000
*
     DUHYD             0305  1  2.0    3.12    0.72 12.00  76.33  n/a   0.000
        MAJOR SYSTEM:   0305  2  2.0    0.12    0.21 12.00  76.33  n/a   0.000
        MINOR SYSTEM:   0305  3  2.0    3.00    0.51 11.90  76.33  n/a   0.000
*
     RESRVR [ 2 : 0305] 0503  1  2.0    3.00    0.40 12.13  76.33  n/a   0.000
     {ST=  0.03 ha.m }
*
     ADD [0305 + 0503]  0012  3  2.0    3.12    0.57 12.00  76.33  n/a   0.000
*
  **  CALIB STANDHYD     0212  1  2.0    0.76    0.17 12.00  75.54 0.82   0.000
     [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD     0211  1  2.0    0.49    0.12 12.00  73.04 0.79   0.000
     [I%=37.0:S%= 2.00]
*
     ADD [0211 + 0212]  0013  3  2.0    1.25    0.29 12.00  74.56  n/a   0.000
*
  **  CALIB STANDHYD     0210  1  2.0    1.15    0.28 12.00  77.70 0.84   0.000
     [I%=50.0:S%= 2.00]
*
     DUHYD             0306  1  2.0    1.15    0.28 12.00  77.70  n/a   0.000
        MAJOR SYSTEM:   0306  2  2.0    0.04    0.07 12.00  77.70  n/a   0.000
        MINOR SYSTEM:   0306  3  2.0    1.11    0.21 11.90  77.70  n/a   0.000
*
  **  CALIB STANDHYD     0213  1  2.0    1.29    0.32 12.00  78.79 0.86   0.000
     [I%=53.0:S%= 2.00]
*
     DUHYD             0307  1  2.0    1.29    0.32 12.00  78.79  n/a   0.000
        MAJOR SYSTEM:   0307  2  2.0    0.05    0.09 12.00  78.79  n/a   0.000
        MINOR SYSTEM:   0307  3  2.0    1.24    0.23 11.90  78.79  n/a   0.000
*
     ADD [0013 + 0306]  0014  3  2.0    1.29    0.36 12.00  74.65  n/a   0.000
*
     ADD [0014 + 0307]  0014  1  2.0    1.34    0.45 12.00  74.80  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   6 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     MASS STORM                 12.0
     [ Ptot=101.10 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.74    0.16 12.00  73.63 0.73   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    1.07    0.23 12.00  74.00 0.73   0.000
     [I%=28.0:S%= 2.00]
*
  **  CALIB STANDHYD     0113  1  2.0    0.82    0.17 12.00  73.63 0.73   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0112  1  2.0    0.98    0.21 12.00  73.64 0.73   0.000
     [I%=27.0:S%= 2.00]
*
     ADD [0110 + 0111]  0002  3  2.0    1.81    0.40 12.00  73.85  n/a   0.000
*
     ADD [0002 + 0112]  0002  1  2.0    2.79    0.61 12.00  73.77  n/a   0.000
*
     ADD [0002 + 0113]  0002  3  2.0    3.61    0.78 12.00  73.74  n/a   0.000
*
  **  CALIB STANDHYD     0120  1  2.0    1.48    0.37 12.00  82.34 0.81   0.000
     [I%=51.0:S%= 2.00]
*
  **  CALIB STANDHYD     0102  1  2.0    1.15    0.22 12.03  73.63 0.73   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0103  1  2.0    0.98    0.20 12.00  73.64 0.73   0.000
     [I%=27.0:S%= 2.00]
*
  **  CALIB STANDHYD     0101  1  2.0    1.07    0.24 12.00  77.98 0.77   0.000
     [I%=39.0:S%= 2.00]
*
     ADD [0101 + 0102]  0001  3  2.0    2.22    0.46 12.00  75.73  n/a   0.000
*
     ADD [0001 + 0103]  0001  1  2.0    3.20    0.67 12.00  75.09  n/a   0.000
*
  **  CALIB STANDHYD     0220  1  2.0    1.48    0.40 12.00  85.59 0.85   0.000
     [I%=48.0:S%= 2.00]
*
     DUHYD             0308  1  2.0    1.48    0.40 12.00  85.59  n/a   0.000
        MAJOR SYSTEM:   0308  2  2.0    0.09    0.15 12.00  85.59  n/a   0.000
        MINOR SYSTEM:   0308  3  2.0    1.39    0.25 11.87  85.59  n/a   0.000
*
     RESRVR [ 2 : 0308] 0504  1  2.0    1.39    0.23 12.10  85.59  n/a   0.000
     {ST=  0.01 ha.m }
*
     ADD [0308 + 0504]  0015  3  2.0    1.48    0.37 12.00  85.59  n/a   0.000
*
  **  CALIB STANDHYD     0202  1  2.0    1.56    0.38 12.00  84.48 0.84   0.000
     [I%=45.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    0.66    0.18 12.00  87.08 0.86   0.000
     [I%=52.0:S%= 2.00]
*
  **  CALIB STANDHYD     0203  1  2.0    0.90    0.24 12.00  84.10 0.83   0.000
     [I%=44.0:S%= 2.00]
*
     ADD [0201 + 0202]  0011  3  2.0    2.22    0.56 12.00  85.25  n/a   0.000
*
     ADD [0011 + 0203]  0011  1  2.0    3.12    0.80 12.00  84.92  n/a   0.000
*
     DUHYD             0305  1  2.0    3.12    0.80 12.00  84.92  n/a   0.000
        MAJOR SYSTEM:   0305  2  2.0    0.18    0.29 12.00  84.92  n/a   0.000
        MINOR SYSTEM:   0305  3  2.0    2.94    0.51 11.87  84.92  n/a   0.000
*
     RESRVR [ 2 : 0305] 0503  1  2.0    2.94    0.42 12.13  84.92  n/a   0.000
     {ST=  0.03 ha.m }
*
     ADD [0305 + 0503]  0012  3  2.0    3.12    0.67 12.00  84.92  n/a   0.000
*
  **  CALIB STANDHYD     0212  1  2.0    0.76    0.19 12.00  84.10 0.83   0.000
     [I%=44.0:S%= 2.00]
*
  **  CALIB STANDHYD     0211  1  2.0    0.49    0.13 12.00  81.51 0.81   0.000
     [I%=37.0:S%= 2.00]
*
     ADD [0211 + 0212]  0013  3  2.0    1.25    0.32 12.00  83.09  n/a   0.000
*
  **  CALIB STANDHYD     0210  1  2.0    1.15    0.31 12.00  86.34 0.85   0.000
     [I%=50.0:S%= 2.00]
*
     DUHYD             0306  1  2.0    1.15    0.31 12.00  86.34  n/a   0.000
        MAJOR SYSTEM:   0306  2  2.0    0.06    0.10 12.00  86.34  n/a   0.000
        MINOR SYSTEM:   0306  3  2.0    1.09    0.21 11.87  86.34  n/a   0.000
*
  **  CALIB STANDHYD     0213  1  2.0    1.29    0.35 12.00  87.46 0.87   0.000
     [I%=53.0:S%= 2.00]
*
     DUHYD             0307  1  2.0    1.29    0.35 12.00  87.46  n/a   0.000
        MAJOR SYSTEM:   0307  2  2.0    0.07    0.12 12.00  87.46  n/a   0.000
        MINOR SYSTEM:   0307  3  2.0    1.22    0.23 11.87  87.46  n/a   0.000
*
     ADD [0013 + 0306]  0014  3  2.0    1.31    0.43 12.00  83.23  n/a   0.000
*
     ADD [0014 + 0307]  0014  1  2.0    1.38    0.55 12.00  83.45  n/a   0.000
*
 FINISH

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

KENNEDY ROAD OTTHYMO SCHEMATIC

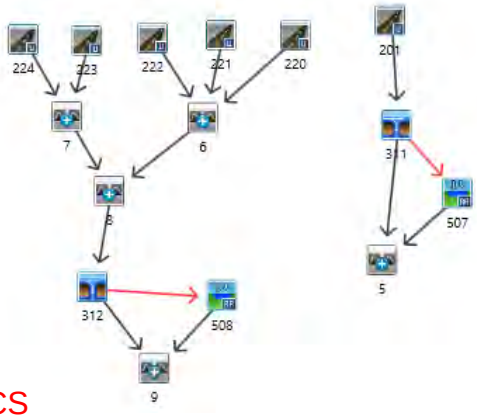
EXISTING 4-HOUR CHICAGO



PROPOSED 4-HOUR CHICAGO



EXISTING 24-HOUR SCS



PROPOSED 24-HOUR SCS

KENNEDY ROAD OTTHYMO SUMMARY OUTPUT: 4-HOUR CHICAGO

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

       V    V   I    SSSSS  U   U    A    L
       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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                  *****  S U M M A R Y   O U T P U T  *****


  Input   filename: C:\Program Files (x86)\VO Suite 3.0\VO2\voin.dat
  Output  filename: C:\Users\hfaulkner\AppData\Local\Temp\4aa3214b-46a2-4046-b18f-
ed8175f89a40\Scenario.out
  Summary filename: C:\Users\hfaulkner\AppData\Local\Temp\4aa3214b-46a2-4046-b18f-
ed8175f89a40\Scenario.sum

DATE: 04/06/2023                          TIME: 10:34:37

USER:

COMMENTS: _____
```

RUN 1 = 2-YEAR
RUN 2 = 5-YEAR
RUN 3 = 10-YEAR
RUN 4 = 25-YEAR
RUN 5 = 50-YEAR
RUN 6 = 100-YEAR
RUN 7 = 25mm

```
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      CHIC STORM                10.0
      [ Ptot= 32.09 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.06  1.37  17.11 0.53   0.000
      [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.05  1.37  17.51 0.55   0.000
      [I%=33.0:S%= 2.00]
*
      ADD [0110 + 0111]  0001  3  2.0    1.44    0.11  1.37  17.28  n/a   0.000
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.10  1.37  17.11 0.53   0.000
      [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.08  1.40  16.91 0.53   0.000
      [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.10  1.40  17.11 0.53   0.000
      [I%=31.0:S%= 2.00]
*
      ADD [0120 + 0121]  0002  3  2.0    2.61    0.18  1.40  17.03  n/a   0.000
*
      ADD [0002 + 0122]  0002  1  2.0    4.02    0.28  1.40  17.06  n/a   0.000
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.11  1.33  19.54 0.61   0.000
      [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.06  1.33  16.91 0.53   0.000
      [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.12  1.33  23.39 0.73   0.000
      [I%=62.0:S%= 2.00]
*
      ADD [0123 + 0124]  0004  3  2.0    1.71    0.17  1.33  18.49  n/a   0.000
*
      ADD [0004 + 0125]  0004  1  2.0    2.57    0.29  1.33  20.13  n/a   0.000
*
      ADD [0002 + 0004]  0003  3  2.0    6.59    0.55  1.37  18.26  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.06  1.33  21.77 0.68   0.000
      [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.11  1.37  21.07 0.66   0.000
      [I%=43.0:S%= 2.00]
*
      DUHYD              0309  1  2.0    1.05    0.11  1.37  21.07  n/a   0.000
         MAJOR SYSTEM:   0309  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0309  3  2.0    1.05    0.11  1.37  21.07  n/a   0.000
*
      RESRVR [ 2 : 0309] 0505  1  2.0    1.05    0.04  1.67  21.02  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0309 + 0505]  0005  3  2.0    1.05    0.04  1.67  21.02  n/a   0.000
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.16  1.37  21.70 0.68   0.000
      [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.14  1.40  20.03 0.62   0.000
      [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.15  1.40  20.87 0.65   0.000
      [I%=42.0:S%= 2.00]
*
      ADD [0220 + 0221]  0006  3  2.0    3.38    0.29  1.40  20.46  n/a   0.000
*
      ADD [0006 + 0222]  0006  1  2.0    4.82    0.44  1.40  20.83  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.14  1.33  19.83 0.62   0.000
      [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.16  1.33  21.82 0.68   0.000
      [I%=46.0:S%= 2.00]
*
      ADD [0223 + 0224]  0007  3  2.0    2.66    0.30  1.33  20.78  n/a   0.000
*
      ADD [0006 + 0007]  0008  3  2.0    7.48    0.73  1.37  20.81  n/a   0.000
*
      DUHYD              0310  1  2.0    7.48    0.73  1.37  20.81  n/a   0.000
         MAJOR SYSTEM:   0310  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0310  3  2.0    7.48    0.73  1.37  20.81  n/a   0.000
*
      RESRVR [ 2 : 0310] 0506  1  2.0    7.48    0.55  1.47  20.81  n/a   0.000
      {ST=  0.03 ha.m }
*
      ADD [0310 + 0506]  0009  3  2.0    7.48    0.55  1.47  20.81  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   2 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      CHIC STORM                10.0
      [ Ptot= 43.49 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.10  1.37  25.61 0.59   0.000
      [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.08  1.37  26.10 0.60   0.000
      [I%=33.0:S%= 2.00]
*
      ADD [0110 + 0111]  0001  3  2.0    1.44    0.18  1.37  25.82  n/a   0.000
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.17  1.37  25.61 0.59   0.000
      [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.13  1.37  25.37 0.58   0.000
      [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.16  1.40  25.61 0.59   0.000
      [I%=31.0:S%= 2.00]
*
      ADD [0120 + 0121]  0002  3  2.0    2.61    0.29  1.40  25.51  n/a   0.000
*
      ADD [0002 + 0122]  0002  1  2.0    4.02    0.46  1.37  25.55  n/a   0.000
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.17  1.33  28.55 0.66   0.000
      [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.09  1.33  25.37 0.58   0.000
      [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.18  1.33  33.19 0.76   0.000
      [I%=62.0:S%= 2.00]
*
      ADD [0123 + 0124]  0004  3  2.0    1.71    0.27  1.33  27.28  n/a   0.000
*
      ADD [0004 + 0125]  0004  1  2.0    2.57    0.45  1.33  29.26  n/a   0.000
*
      ADD [0002 + 0004]  0003  3  2.0    6.59    0.88  1.37  26.99  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.10  1.33  31.23 0.72   0.000
      [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.17  1.37  30.69 0.71   0.000
      [I%=43.0:S%= 2.00]
*
      DUHYD              0309  1  2.0    1.05    0.17  1.37  30.69  n/a   0.000
         MAJOR SYSTEM:   0309  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0309  3  2.0    1.05    0.17  1.37  30.69  n/a   0.000
*
      RESRVR [ 2 : 0309] 0505  1  2.0    1.05    0.05  1.70  30.63  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0309 + 0505]  0005  3  2.0    1.05    0.05  1.70  30.63  n/a   0.000
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.25  1.33  31.45 0.72   0.000
      [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.22  1.40  29.44 0.68   0.000
      [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.25  1.40  30.44 0.70   0.000
      [I%=42.0:S%= 2.00]
*
      ADD [0220 + 0221]  0006  3  2.0    3.38    0.47  1.40  29.95  n/a   0.000
*
      ADD [0006 + 0222]  0006  1  2.0    4.82    0.70  1.37  30.39  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.22  1.33  29.19 0.67   0.000
      [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.25  1.33  31.61 0.73   0.000
      [I%=46.0:S%= 2.00]
*
      ADD [0223 + 0224]  0007  3  2.0    2.66    0.47  1.33  30.34  n/a   0.000
*
      ADD [0006 + 0007]  0008  3  2.0    7.48    1.16  1.37  30.38  n/a   0.000
*
      DUHYD              0310  1  2.0    7.48    1.16  1.37  30.38  n/a   0.000
         MAJOR SYSTEM:   0310  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0310  3  2.0    7.48    1.16  1.37  30.38  n/a   0.000
*
      RESRVR [ 2 : 0310] 0506  1  2.0    7.48    0.87  1.47  30.37  n/a   0.000
      {ST=  0.04 ha.m }
*
      ADD [0310 + 0506]  0009  3  2.0    7.48    0.87  1.47  30.37  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   3 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      CHIC STORM                10.0
      [ Ptot= 52.36 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.13  1.37  32.65 0.62   0.000
      [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.11  1.37  33.19 0.63   0.000
      [I%=33.0:S%= 2.00]
*
      ADD [0110 + 0111]  0001  3  2.0    1.44    0.24  1.37  32.89  n/a   0.000
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.22  1.37  32.66 0.62   0.000
      [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.17  1.37  32.38 0.62   0.000
      [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.23  1.40  32.65 0.62   0.000
```

```
     [I%=31.0:S%= 2.00]
*
     ADD [0120 + 0121]  0002  3  2.0    2.61    0.39  1.40  32.54  n/a   0.000
*
     ADD [0002 + 0122]  0002  1  2.0    4.02    0.61  1.37  32.58  n/a   0.000
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.23  1.33  35.91 0.69   0.000
     [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.12  1.33  32.38 0.62   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.23  1.33  41.06 0.78   0.000
     [I%=62.0:S%= 2.00]
*
     ADD [0123 + 0124]  0004  3  2.0    1.71    0.35  1.33  34.51  n/a   0.000
*
     ADD [0004 + 0125]  0004  1  2.0    2.57    0.58  1.33  36.70  n/a   0.000
*
     ADD [0002 + 0004]  0003  3  2.0    6.59    1.16  1.37  34.19  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.13  1.33  38.88 0.74   0.000
     [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.22  1.37  38.48 0.73   0.000
     [I%=43.0:S%= 2.00]
*
     DUHYD              0309  1  2.0    1.05    0.22  1.37  38.48  n/a   0.000
        MAJOR SYSTEM:   0309  2  2.0    0.00    0.00  1.37  38.48  n/a   0.000
        MINOR SYSTEM:   0309  3  2.0    1.05    0.22  1.33  38.48  n/a   0.000
*
     RESRVR [ 2 : 0309] 0505  1  2.0    1.05    0.05  1.70  38.42  n/a   0.000
     {ST=  0.02 ha.m }
*
     ADD [0309 + 0505]  0005  3  2.0    1.05    0.05  1.70  38.42  n/a   0.000
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.32  1.33  39.32 0.75   0.000
     [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.29  1.40  37.09 0.71   0.000
     [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.32  1.40  38.20 0.73   0.000
     [I%=42.0:S%= 2.00]
*
     ADD [0220 + 0221]  0006  3  2.0    3.38    0.61  1.40  37.66  n/a   0.000
*
     ADD [0006 + 0222]  0006  1  2.0    4.82    0.92  1.37  38.15  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.31  1.33  36.82 0.70   0.000
     [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.32  1.33  39.51 0.75   0.000
     [I%=46.0:S%= 2.00]
*
     ADD [0223 + 0224]  0007  3  2.0    2.66    0.63  1.33  38.10  n/a   0.000
*
     ADD [0006 + 0007]  0008  3  2.0    7.48    1.53  1.37  38.13  n/a   0.000
*
     DUHYD              0310  1  2.0    7.48    1.53  1.37  38.13  n/a   0.000
        MAJOR SYSTEM:   0310  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
        MINOR SYSTEM:   0310  3  2.0    7.48    1.53  1.37  38.13  n/a   0.000
*
     RESRVR [ 2 : 0310] 0506  1  2.0    7.48    0.97  1.50  38.13  n/a   0.000
     {ST=  0.06 ha.m }
*
     ADD [0310 + 0506]  0009  3  2.0    7.48    0.97  1.50  38.13  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   4 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     CHIC STORM                10.0
     [ Ptot= 60.45 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.15  1.37  39.33 0.65   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.13  1.37  39.91 0.66   0.000
     [I%=33.0:S%= 2.00]
*
     ADD [0110 + 0111]  0001  3  2.0    1.44    0.28  1.37  39.58  n/a   0.000
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.28  1.37  39.33 0.65   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.20  1.37  39.03 0.65   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.27  1.40  39.33 0.65   0.000
     [I%=31.0:S%= 2.00]
*
     ADD [0120 + 0121]  0002  3  2.0    2.61    0.47  1.37  39.21  n/a   0.000
*
     ADD [0002 + 0122]  0002  1  2.0    4.02    0.75  1.37  39.25  n/a   0.000
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.27  1.33  42.83 0.71   0.000
     [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.16  1.33  39.04 0.65   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.27  1.33  48.37 0.80   0.000
     [I%=62.0:S%= 2.00]
*
     ADD [0123 + 0124]  0004  3  2.0    1.71    0.43  1.33  41.32  n/a   0.000
*
     ADD [0004 + 0125]  0004  1  2.0    2.57    0.70  1.33  43.68  n/a   0.000
*
     ADD [0002 + 0004]  0003  3  2.0    6.59    1.42  1.33  40.98  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.15  1.33  46.03 0.76   0.000
     [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.27  1.37  45.75 0.76   0.000
     [I%=43.0:S%= 2.00]
*
     DUHYD              0309  1  2.0    1.05    0.27  1.37  45.75  n/a   0.000
        MAJOR SYSTEM:   0309  2  2.0    0.03    0.05  1.37  45.75  n/a   0.000
        MINOR SYSTEM:   0309  3  2.0    1.02    0.22  1.30  45.75  n/a   0.000
*
     RESRVR [ 2 : 0309] 0505  1  2.0    1.02    0.06  1.73  45.69  n/a   0.000
     {ST=  0.02 ha.m }
*
     ADD [0309 + 0505]  0005  3  2.0    1.05    0.09  1.37  45.70  n/a   0.000
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.40  1.33  46.66 0.77   0.000
     [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.37  1.37  44.26 0.73   0.000
     [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.40  1.37  45.46 0.75   0.000
     [I%=42.0:S%= 2.00]
*
     ADD [0220 + 0221]  0006  3  2.0    3.38    0.77  1.37  44.87  n/a   0.000
*
     ADD [0006 + 0222]  0006  1  2.0    4.82    1.16  1.37  45.40  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.37  1.33  43.97 0.73   0.000
     [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.38  1.33  46.87 0.78   0.000
     [I%=46.0:S%= 2.00]
*
     ADD [0223 + 0224]  0007  3  2.0    2.66    0.75  1.33  45.35  n/a   0.000
*
     ADD [0006 + 0007]  0008  3  2.0    7.48    1.88  1.37  45.39  n/a   0.000
*
     DUHYD              0310  1  2.0    7.48    1.88  1.37  45.39  n/a   0.000
        MAJOR SYSTEM:   0310  2  2.0    0.24    0.35  1.37  45.39  n/a   0.000
        MINOR SYSTEM:   0310  3  2.0    7.24    1.53  1.30  45.39  n/a   0.000
*
     RESRVR [ 2 : 0310] 0506  1  2.0    7.24    1.03  1.50  45.38  n/a   0.000
     {ST=  0.07 ha.m }
*
     ADD [0310 + 0506]  0009  3  2.0    7.48    1.28  1.37  45.38  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   5 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     CHIC STORM                10.0
     [ Ptot= 66.97 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.19  1.37  44.84 0.67   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.15  1.37  45.45 0.68   0.000
     [I%=33.0:S%= 2.00]
*
     ADD [0110 + 0111]  0001  3  2.0    1.44    0.34  1.37  45.11  n/a   0.000
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.33  1.37  44.84 0.67   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.23  1.37  44.54 0.67   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.32  1.40  44.84 0.67   0.000
     [I%=31.0:S%= 2.00]
*
     ADD [0120 + 0121]  0002  3  2.0    2.61    0.55  1.37  44.72  n/a   0.000
*
     ADD [0002 + 0122]  0002  1  2.0    4.02    0.87  1.37  44.76  n/a   0.000
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.31  1.33  48.52 0.72   0.000
     [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.18  1.33  44.54 0.67   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.31  1.33  54.33 0.81   0.000
     [I%=62.0:S%= 2.00]
*
     ADD [0123 + 0124]  0004  3  2.0    1.71    0.50  1.33  46.94  n/a   0.000
*
     ADD [0004 + 0125]  0004  1  2.0    2.57    0.80  1.33  49.41  n/a   0.000
*
     ADD [0002 + 0004]  0003  3  2.0    6.59    1.63  1.33  46.57  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.17  1.33  51.88 0.77   0.000
     [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.32  1.33  51.71 0.77   0.000
     [I%=43.0:S%= 2.00]
*
     DUHYD              0309  1  2.0    1.05    0.32  1.33  51.71  n/a   0.000
        MAJOR SYSTEM:   0309  2  2.0    0.07    0.10  1.33  51.71  n/a   0.000
        MINOR SYSTEM:   0309  3  2.0    0.98    0.22  1.27  51.71  n/a   0.000
*
     RESRVR [ 2 : 0309] 0505  1  2.0    0.98    0.06  1.73  51.65  n/a   0.000
     {ST=  0.02 ha.m }
*
     ADD [0309 + 0505]  0005  3  2.0    1.05    0.14  1.33  51.65  n/a   0.000
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.46  1.33  52.66 0.79   0.000
     [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.43  1.37  50.14 0.75   0.000
     [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.46  1.37  51.40 0.77   0.000
     [I%=42.0:S%= 2.00]
*
     ADD [0220 + 0221]  0006  3  2.0    3.38    0.89  1.37  50.78  n/a   0.000
*
     ADD [0006 + 0222]  0006  1  2.0    4.82    1.33  1.37  51.34  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.43  1.33  49.83 0.74   0.000
     [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.43  1.33  52.89 0.79   0.000
     [I%=46.0:S%= 2.00]
*
     ADD [0223 + 0224]  0007  3  2.0    2.66    0.86  1.33  51.29  n/a   0.000
*
     ADD [0006 + 0007]  0008  3  2.0    7.48    2.15  1.37  51.32  n/a   0.000
*
     DUHYD              0310  1  2.0    7.48    2.15  1.37  51.32  n/a   0.000
        MAJOR SYSTEM:   0310  2  2.0    0.46    0.62  1.37  51.32  n/a   0.000
        MINOR SYSTEM:   0310  3  2.0    7.02    1.53  1.30  51.32  n/a   0.000
*
     RESRVR [ 2 : 0310] 0506  1  2.0    7.02    1.07  1.53  51.32  n/a   0.000
```

```
     {ST=  0.07 ha.m }
*
     ADD [0310 + 0506]  0009  3  2.0    7.48    1.57  1.37  51.32  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   6 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     CHIC STORM                10.0
     [ Ptot= 73.49 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.21  1.37  50.46 0.69   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.17  1.33  51.10 0.70   0.000
     [I%=33.0:S%= 2.00]
*
     ADD [0110 + 0111]  0001  3  2.0    1.44    0.38  1.37  50.74  n/a   0.000
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.37  1.37  50.46 0.69   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.28  1.37  50.14 0.68   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.36  1.40  50.46 0.69   0.000
     [I%=31.0:S%= 2.00]
*
     ADD [0120 + 0121]  0002  3  2.0    2.61    0.64  1.37  50.33  n/a   0.000
*
     ADD [0002 + 0122]  0002  1  2.0    4.02    1.01  1.37  50.38  n/a   0.000
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.35  1.33  54.30 0.74   0.000
     [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.21  1.33  50.14 0.68   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.34  1.33  60.36 0.82   0.000
     [I%=62.0:S%= 2.00]
*
     ADD [0123 + 0124]  0004  3  2.0    1.71    0.56  1.33  52.64  n/a   0.000
*
     ADD [0004 + 0125]  0004  1  2.0    2.57    0.90  1.33  55.23  n/a   0.000
*
     ADD [0002 + 0004]  0003  3  2.0    6.59    1.87  1.33  52.27  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.19  1.33  57.80 0.79   0.000
     [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.36  1.33  57.73 0.79   0.000
     [I%=43.0:S%= 2.00]
*
     DUHYD              0309  1  2.0    1.05    0.36  1.33  57.73  n/a   0.000
        MAJOR SYSTEM:   0309  2  2.0    0.11    0.14  1.33  57.73  n/a   0.000
        MINOR SYSTEM:   0309  3  2.0    0.94    0.22  1.27  57.73  n/a   0.000
*
     RESRVR [ 2 : 0309] 0505  1  2.0    0.94    0.06  1.77  57.67  n/a   0.000
     {ST=  0.03 ha.m }
*
     ADD [0309 + 0505]  0005  3  2.0    1.05    0.19  1.33  57.68  n/a   0.000
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.51  1.33  58.72 0.80   0.000
     [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.49  1.37  56.10 0.76   0.000
     [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.52  1.37  57.41 0.78   0.000
     [I%=42.0:S%= 2.00]
*
     ADD [0220 + 0221]  0006  3  2.0    3.38    1.00  1.37  56.76  n/a   0.000
*
     ADD [0006 + 0222]  0006  1  2.0    4.82    1.50  1.37  57.35  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.48  1.33  55.77 0.76   0.000
     [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.49  1.33  58.97 0.80   0.000
     [I%=46.0:S%= 2.00]
*
     ADD [0223 + 0224]  0007  3  2.0    2.66    0.97  1.33  57.30  n/a   0.000
*
     ADD [0006 + 0007]  0008  3  2.0    7.48    2.43  1.37  57.33  n/a   0.000
*
     DUHYD              0310  1  2.0    7.48    2.43  1.37  57.33  n/a   0.000
        MAJOR SYSTEM:   0310  2  2.0    0.71    0.90  1.37  57.33  n/a   0.000
        MINOR SYSTEM:   0310  3  2.0    6.77    1.53  1.27  57.33  n/a   0.000
*
     RESRVR [ 2 : 0310] 0506  1  2.0    6.77    1.10  1.53  57.33  n/a   0.000
     {ST=  0.08 ha.m }
*
     ADD [0310 + 0506]  0009  3  2.0    7.48    1.86  1.37  57.33  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   7 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     CHIC STORM                10.0
     [ Ptot= 24.99 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.04  1.40  12.23 0.49   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.04  1.37  12.57 0.50   0.000
     [I%=33.0:S%= 2.00]
*
     ADD [0110 + 0111]  0001  3  2.0    1.44    0.08  1.37  12.38  n/a   0.000
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.07  1.37  12.24 0.49   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.05  1.40  12.06 0.48   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.07  1.43  12.24 0.49   0.000
     [I%=31.0:S%= 2.00]
*
     ADD [0120 + 0121]  0002  3  2.0    2.61    0.12  1.40  12.16  n/a   0.000
*
     ADD [0002 + 0122]  0002  1  2.0    4.02    0.19  1.40  12.19  n/a   0.000
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.08  1.33  14.28 0.57   0.000
     [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.04  1.33  12.06 0.48   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.09  1.33  17.52 0.70   0.000
     [I%=62.0:S%= 2.00]
*
     ADD [0123 + 0124]  0004  3  2.0    1.71    0.12  1.33  13.40  n/a   0.000
*
     ADD [0004 + 0125]  0004  1  2.0    2.57    0.21  1.33  14.78  n/a   0.000
*
     ADD [0002 + 0004]  0003  3  2.0    6.59    0.39  1.37  13.20  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.05  1.33  16.15 0.65   0.000
     [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.08  1.37  15.40 0.62   0.000
     [I%=43.0:S%= 2.00]
*
     DUHYD              0309  1  2.0    1.05    0.08  1.37  15.40  n/a   0.000
        MAJOR SYSTEM:   0309  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
        MINOR SYSTEM:   0309  3  2.0    1.05    0.08  1.37  15.40  n/a   0.000
*
     RESRVR [ 2 : 0309] 0505  1  2.0    1.05    0.03  1.70  15.35  n/a   0.000
     {ST=  0.01 ha.m }
*
     ADD [0309 + 0505]  0005  3  2.0    1.05    0.03  1.70  15.35  n/a   0.000
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.11  1.37  15.93 0.64   0.000
     [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.10  1.43  14.53 0.58   0.000
     [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.11  1.43  15.23 0.61   0.000
     [I%=42.0:S%= 2.00]
*
     ADD [0220 + 0221]  0006  3  2.0    3.38    0.21  1.43  14.89  n/a   0.000
*
     ADD [0006 + 0222]  0006  1  2.0    4.82    0.31  1.40  15.20  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.10  1.37  14.36 0.57   0.000
     [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.11  1.33  16.02 0.64   0.000
     [I%=46.0:S%= 2.00]
*
     ADD [0223 + 0224]  0007  3  2.0    2.66    0.21  1.33  15.15  n/a   0.000
*
     ADD [0006 + 0007]  0008  3  2.0    7.48    0.51  1.37  15.18  n/a   0.000
*
     DUHYD              0310  1  2.0    7.48    0.51  1.37  15.18  n/a   0.000
        MAJOR SYSTEM:   0310  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
        MINOR SYSTEM:   0310  3  2.0    7.48    0.51  1.37  15.18  n/a   0.000
*
     RESRVR [ 2 : 0310] 0506  1  2.0    7.48    0.40  1.50  15.18  n/a   0.000
     {ST=  0.02 ha.m }
*
     ADD [0310 + 0506]  0009  3  2.0    7.48    0.40  1.50  15.18  n/a   0.000
*
 FINISH

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

KENNEDY ROAD OTTHYMO SUMMARY OUTPUT: 24-HOUR SCS

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


       V    V   I    SSSSS  U   U    A    L
       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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                  *****  S U M M A R Y   O U T P U T  *****


  Input   filename: C:\Program Files (x86)\VO Suite 3.0\VO2\voin.dat
  Output  filename: C:\Users\hfaulkner\AppData\Local\Temp\4954432d-6967-40ff-a739-
7343d2c967a8\Scenario.out
  Summary filename: C:\Users\hfaulkner\AppData\Local\Temp\4954432d-6967-40ff-a739-
7343d2c967a8\Scenario.sum

DATE: 04/06/2023                          TIME: 10:35:53

USER:

COMMENTS: _____

  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      MASS STORM                12.0
      [ Ptot= 46.40 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.05 12.07  27.88 0.60   0.000
      [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.05 12.03  28.39 0.61   0.000
      [I%=33.0:S%= 2.00]
*
      ADD [0110 + 0111]  0001  3  2.0    1.44    0.10 12.03  28.10  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.05 12.00  33.72 0.73   0.000
      [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.13 12.03  34.01 0.73   0.000
      [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.12 12.07  31.92 0.69   0.000
      [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.13 12.07  32.96 0.71   0.000
      [I%=42.0:S%= 2.00]
*
      ADD [0220 + 0221]  0006  3  2.0    3.38    0.25 12.07  32.45  n/a   0.000
*
      ADD [0006 + 0222]  0006  1  2.0    4.82    0.38 12.03  32.92  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.12 12.03  31.66 0.68   0.000
      [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.13 12.00  34.18 0.74   0.000
      [I%=46.0:S%= 2.00]
*
      ADD [0223 + 0224]  0007  3  2.0    2.66    0.25 12.00  32.87  n/a   0.000
*
      ADD [0006 + 0007]  0008  3  2.0    7.48    0.62 12.03  32.90  n/a   0.000
*
      DUHYD              0312  1  2.0    7.48    0.62 12.03  32.90  n/a   0.000
         MAJOR SYSTEM:   0312  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0312  3  2.0    7.48    0.62 12.03  32.90  n/a   0.000
*
      RESRVR [ 2 : 0312] 0508  1  2.0    7.48    0.48 12.13  32.90  n/a   0.000
      {ST=  0.03 ha.m }
*
      ADD [0312 + 0508]  0009  3  2.0    7.48    0.48 12.13  32.90  n/a   0.000
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.09 12.07  27.89 0.60   0.000
      [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.07 12.07  27.63 0.60   0.000
      [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.09 12.03  27.89 0.60   0.000
      [I%=31.0:S%= 2.00]
*
      ADD [0120 + 0121]  0002  3  2.0    2.61    0.16 12.07  27.78  n/a   0.000
*
      ADD [0002 + 0122]  0002  1  2.0    4.02    0.25 12.03  27.82  n/a   0.000
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.05 12.00  27.63 0.60   0.000
      [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.09 12.00  30.93 0.67   0.000
      [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.09 12.00  35.75 0.77   0.000
      [I%=62.0:S%= 2.00]
*
      ADD [0123 + 0124]  0004  3  2.0    1.71    0.14 12.00  29.62  n/a   0.000
*
      ADD [0004 + 0125]  0004  1  2.0    2.57    0.24 12.00  31.67  n/a   0.000
*
      ADD [0002 + 0004]  0003  3  2.0    6.59    0.48 12.00  29.32  n/a   0.000
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.09 12.03  33.22 0.72   0.000
      [I%=43.0:S%= 2.00]
*
      DUHYD              0311  1  2.0    1.05    0.09 12.03  33.22  n/a   0.000
         MAJOR SYSTEM:   0311  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0311  3  2.0    1.05    0.09 12.03  33.22  n/a   0.000
*
      RESRVR [ 2 : 0311] 0507  1  2.0    1.05    0.02 12.43  33.07  n/a   0.000
      {ST=  0.01 ha.m }
*
      ADD [0311 + 0507]  0005  3  2.0    1.05    0.02 12.43  33.07  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   2 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      MASS STORM                12.0
      [ Ptot= 59.80 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.08 12.03  38.78 0.65   0.000
      [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.07 12.03  39.36 0.66   0.000
      [I%=33.0:S%= 2.00]
*
      ADD [0110 + 0111]  0001  3  2.0    1.44    0.14 12.03  39.03  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.07 12.00  45.45 0.76   0.000
      [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.18 12.03  46.06 0.77   0.000
      [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.18 12.07  43.68 0.73   0.000
      [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.19 12.03  44.87 0.75   0.000
      [I%=42.0:S%= 2.00]
*
      ADD [0220 + 0221]  0006  3  2.0    3.38    0.37 12.07  44.29  n/a   0.000
*
      ADD [0006 + 0222]  0006  1  2.0    4.82    0.55 12.03  44.82  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.18 12.00  43.39 0.73   0.000
      [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.18 12.00  46.28 0.77   0.000
      [I%=46.0:S%= 2.00]
*
      ADD [0223 + 0224]  0007  3  2.0    2.66    0.36 12.00  44.77  n/a   0.000
*
      ADD [0006 + 0007]  0008  3  2.0    7.48    0.88 12.03  44.80  n/a   0.000
*
      DUHYD              0312  1  2.0    7.48    0.88 12.03  44.80  n/a   0.000
         MAJOR SYSTEM:   0312  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0312  3  2.0    7.48    0.88 12.03  44.80  n/a   0.000
*
      RESRVR [ 2 : 0312] 0508  1  2.0    7.48    0.69 12.10  44.80  n/a   0.000
      {ST=  0.04 ha.m }
*
      ADD [0312 + 0508]  0009  3  2.0    7.48    0.69 12.10  44.80  n/a   0.000
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.14 12.07  38.78 0.65   0.000
      [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.10 12.03  38.49 0.64   0.000
      [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.14 12.03  38.79 0.65   0.000
      [I%=31.0:S%= 2.00]
*
      ADD [0120 + 0121]  0002  3  2.0    2.61    0.24 12.03  38.66  n/a   0.000
*
      ADD [0002 + 0122]  0002  1  2.0    4.02    0.38 12.03  38.71  n/a   0.000
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.07 12.00  38.49 0.64   0.000
      [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.13 12.00  42.27 0.71   0.000
      [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.12 12.00  47.78 0.80   0.000
      [I%=62.0:S%= 2.00]
*
      ADD [0123 + 0124]  0004  3  2.0    1.71    0.20 12.00  40.76  n/a   0.000
*
      ADD [0004 + 0125]  0004  1  2.0    2.57    0.33 12.00  43.11  n/a   0.000
*
      ADD [0002 + 0004]  0003  3  2.0    6.59    0.69 12.00  40.42  n/a   0.000
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.13 12.03  45.17 0.76   0.000
      [I%=43.0:S%= 2.00]
*
      DUHYD              0311  1  2.0    1.05    0.13 12.03  45.17  n/a   0.000
         MAJOR SYSTEM:   0311  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
         MINOR SYSTEM:   0311  3  2.0    1.05    0.13 12.03  45.17  n/a   0.000
*
      RESRVR [ 2 : 0311] 0507  1  2.0    1.05    0.03 12.40  45.01  n/a   0.000
      {ST=  0.02 ha.m }
*
      ADD [0311 + 0507]  0005  3  2.0    1.05    0.03 12.40  45.01  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   3 **
  ****************************

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

      START @  0.00 hrs
      --------------------
      MASS STORM                12.0
      [ Ptot= 70.80 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.10 12.03  48.13 0.68   0.000
      [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.08 12.00  48.75 0.69   0.000
      [I%=33.0:S%= 2.00]
*
      ADD [0110 + 0111]  0001  3  2.0    1.44    0.18 12.03  48.40  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.09 12.00  55.35 0.78   0.000
      [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.23 12.00  56.21 0.79   0.000
      [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.22 12.03  53.63 0.76   0.000
```

RUN 1 = 2-YEAR
RUN 2 = 5-YEAR
RUN 3 = 10-YEAR
RUN 4 = 25-YEAR
RUN 5 = 50-YEAR
RUN 6 = 100-YEAR

```
     [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.24 12.03  54.92 0.78   0.000
     [I%=42.0:S%= 2.00]
*
     ADD [0220 + 0221]  0006  3  2.0    3.38    0.46 12.03  54.29  n/a   0.000
*
     ADD [0006 + 0222]  0006  1  2.0    4.82    0.69 12.03  54.86  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.22 12.00  53.31 0.75   0.000
     [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.22 12.00  56.45 0.80   0.000
     [I%=46.0:S%= 2.00]
*
     ADD [0223 + 0224]  0007  3  2.0    2.66    0.44 12.00  54.81  n/a   0.000
*
     ADD [0006 + 0007]  0008  3  2.0    7.48    1.11 12.00  54.84  n/a   0.000
*
     DUHYD              0312  1  2.0    7.48    1.11 12.00  54.84  n/a   0.000
        MAJOR SYSTEM:   0312  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
        MINOR SYSTEM:   0312  3  2.0    7.48    1.11 12.00  54.84  n/a   0.000
*
     RESRVR [ 2 : 0312] 0508  1  2.0    7.48    0.73 12.13  54.84  n/a   0.000
     {ST=  0.06 ha.m }
*
     ADD [0312 + 0508]  0009  3  2.0    7.48    0.73 12.13  54.84  n/a   0.000
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.17 12.07  48.13 0.68   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.13 12.03  47.82 0.68   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.17 12.03  48.13 0.68   0.000
     [I%=31.0:S%= 2.00]
*
     ADD [0120 + 0121]  0002  3  2.0    2.61    0.30 12.03  48.00  n/a   0.000
*
     ADD [0002 + 0122]  0002  1  2.0    4.02    0.48 12.03  48.05  n/a   0.000
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.10 12.00  47.81 0.68   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.16 12.00  51.90 0.73   0.000
     [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.15 12.00  57.86 0.82   0.000
     [I%=62.0:S%= 2.00]
*
     ADD [0123 + 0124]  0004  3  2.0    1.71    0.26 12.00  50.27  n/a   0.000
*
     ADD [0004 + 0125]  0004  1  2.0    2.57    0.41 12.00  52.81  n/a   0.000
*
     ADD [0002 + 0004]  0003  3  2.0    6.59    0.87 12.00  49.91  n/a   0.000
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.16 12.03  55.24 0.78   0.000
     [I%=43.0:S%= 2.00]
*
     DUHYD              0311  1  2.0    1.05    0.16 12.03  55.24  n/a   0.000
        MAJOR SYSTEM:   0311  2  2.0    0.00    0.00  0.00   0.00  n/a   0.000
        MINOR SYSTEM:   0311  3  2.0    1.05    0.16 12.03  55.24  n/a   0.000
*
     RESRVR [ 2 : 0311] 0507  1  2.0    1.05    0.04 12.40  55.09  n/a   0.000
     {ST=  0.02 ha.m }
*
     ADD [0311 + 0507]  0005  3  2.0    1.05    0.04 12.40  55.09  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   4 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     MASS STORM                 12.0
     [ Ptot= 83.10 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.12 12.03  58.89 0.71   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.10 12.00  59.56 0.72   0.000
     [I%=33.0:S%= 2.00]
*
     ADD [0110 + 0111]  0001  3  2.0    1.44    0.22 12.03  59.18  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.10 12.00  66.63 0.80   0.000
     [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.28 12.00  67.73 0.82   0.000
     [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.28 12.03  64.98 0.78   0.000
     [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.30 12.03  66.35 0.80   0.000
     [I%=42.0:S%= 2.00]
*
     ADD [0220 + 0221]  0006  3  2.0    3.38    0.58 12.03  65.68  n/a   0.000
*
     ADD [0006 + 0222]  0006  1  2.0    4.82    0.86 12.03  66.29  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.27 12.00  64.64 0.78   0.000
     [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.27 12.00  68.01 0.82   0.000
     [I%=46.0:S%= 2.00]
*
     ADD [0223 + 0224]  0007  3  2.0    2.66    0.54 12.00  66.25  n/a   0.000
*
     ADD [0006 + 0007]  0008  3  2.0    7.48    1.38 12.00  66.28  n/a   0.000
*
     DUHYD              0312  1  2.0    7.48    1.38 12.00  66.28  n/a   0.000
        MAJOR SYSTEM:   0312  2  2.0    0.16    0.27 12.00  66.28  n/a   0.000
        MINOR SYSTEM:   0312  3  2.0    7.32    1.11 11.93  66.28  n/a   0.000
*
     RESRVR [ 2 : 0312] 0508  1  2.0    7.32    0.77 12.17  66.27  n/a   0.000
     {ST=  0.07 ha.m }
*
     ADD [0312 + 0508]  0009  3  2.0    7.48    0.99 12.00  66.27  n/a   0.000
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.22 12.07  58.89 0.71   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.16 12.03  58.56 0.70   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.22 12.03  58.89 0.71   0.000
     [I%=31.0:S%= 2.00]
*
     ADD [0120 + 0121]  0002  3  2.0    2.61    0.38 12.03  58.75  n/a   0.000
*
     ADD [0002 + 0122]  0002  1  2.0    4.02    0.61 12.03  58.80  n/a   0.000
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.12 12.00  58.56 0.70   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.20 12.00  62.93 0.76   0.000
     [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.18 12.00  69.32 0.83   0.000
     [I%=62.0:S%= 2.00]
*
     ADD [0123 + 0124]  0004  3  2.0    1.71    0.32 12.00  61.19  n/a   0.000
*
     ADD [0004 + 0125]  0004  1  2.0    2.57    0.50 12.00  63.91  n/a   0.000
*
     ADD [0002 + 0004]  0003  3  2.0    6.59    1.09 12.00  60.79  n/a   0.000
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.20 12.00  66.70 0.80   0.000
     [I%=43.0:S%= 2.00]
*
     DUHYD              0311  1  2.0    1.05    0.20 12.00  66.70  n/a   0.000
        MAJOR SYSTEM:   0311  2  2.0    0.02    0.04 12.00  66.70  n/a   0.000
        MINOR SYSTEM:   0311  3  2.0    1.03    0.16 11.93  66.70  n/a   0.000
*
     RESRVR [ 2 : 0311] 0507  1  2.0    1.03    0.04 12.37  66.54  n/a   0.000
     {ST=  0.03 ha.m }
*
     ADD [0311 + 0507]  0005  3  2.0    1.05    0.07 12.03  66.55  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   5 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     MASS STORM                 12.0
     [ Ptot= 92.10 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.15 12.03  66.93 0.73   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.12 12.00  67.63 0.73   0.000
     [I%=33.0:S%= 2.00]
*
     ADD [0110 + 0111]  0001  3  2.0    1.44    0.26 12.00  67.23  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.12 12.00  74.98 0.81   0.000
     [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.32 12.00  76.26 0.83   0.000
     [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.32 12.03  73.39 0.80   0.000
     [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.34 12.03  74.82 0.81   0.000
     [I%=42.0:S%= 2.00]
*
     ADD [0220 + 0221]  0006  3  2.0    3.38    0.66 12.03  74.12  n/a   0.000
*
     ADD [0006 + 0222]  0006  1  2.0    4.82    0.97 12.03  74.76  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.31 12.00  73.04 0.79   0.000
     [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.31 12.00  76.55 0.83   0.000
     [I%=46.0:S%= 2.00]
*
     ADD [0223 + 0224]  0007  3  2.0    2.66    0.62 12.00  74.71  n/a   0.000
*
     ADD [0006 + 0007]  0008  3  2.0    7.48    1.57 12.00  74.74  n/a   0.000
*
     DUHYD              0312  1  2.0    7.48    1.57 12.00  74.74  n/a   0.000
        MAJOR SYSTEM:   0312  2  2.0    0.31    0.46 12.00  74.74  n/a   0.000
        MINOR SYSTEM:   0312  3  2.0    7.17    1.11 11.90  74.74  n/a   0.000
*
     RESRVR [ 2 : 0312] 0508  1  2.0    7.17    0.78 12.17  74.74  n/a   0.000
     {ST=  0.07 ha.m }
*
     ADD [0312 + 0508]  0009  3  2.0    7.48    1.20 12.00  74.74  n/a   0.000
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.25 12.03  66.93 0.73   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.19 12.03  66.58 0.72   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.26 12.03  66.93 0.73   0.000
     [I%=31.0:S%= 2.00]
*
     ADD [0120 + 0121]  0002  3  2.0    2.61    0.45 12.03  66.79  n/a   0.000
*
     ADD [0002 + 0122]  0002  1  2.0    4.02    0.70 12.03  66.84  n/a   0.000
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.14 12.00  66.58 0.72   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.22 12.00  71.14 0.77   0.000
     [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.21 12.00  77.79 0.84   0.000
     [I%=62.0:S%= 2.00]
*
     ADD [0123 + 0124]  0004  3  2.0    1.71    0.36 12.00  69.33  n/a   0.000
*
     ADD [0004 + 0125]  0004  1  2.0    2.57    0.57 12.00  72.16  n/a   0.000
*
     ADD [0002 + 0004]  0003  3  2.0    6.59    1.26 12.00  68.91  n/a   0.000
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.23 12.00  75.18 0.82   0.000
     [I%=43.0:S%= 2.00]
*
     DUHYD              0311  1  2.0    1.05    0.23 12.00  75.18  n/a   0.000
        MAJOR SYSTEM:   0311  2  2.0    0.05    0.07 12.00  75.18  n/a   0.000
        MINOR SYSTEM:   0311  3  2.0    1.00    0.16 11.90  75.18  n/a   0.000
*
     RESRVR [ 2 : 0311] 0507  1  2.0    1.00    0.05 12.37  75.02  n/a   0.000
```

```
     {ST=  0.03 ha.m }
*
     ADD [0311 + 0507]  0005  3  2.0    1.05    0.10 12.00  75.03  n/a   0.000
*
  ****************************
  ** SIMULATION NUMBER:   6 **
  ****************************

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

     START @  0.00 hrs
     --------------------
     MASS STORM                 12.0
     [ Ptot=101.10 mm ]
*
  **  CALIB STANDHYD     0111  1  2.0    0.82    0.17 12.03  75.08 0.74   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0110  1  2.0    0.62    0.14 12.00  75.81 0.75   0.000
     [I%=33.0:S%= 2.00]
*
     ADD [0110 + 0111]  0001  3  2.0    1.44    0.30 12.00  75.40  n/a   0.000
*
  **  CALIB STANDHYD     0101  1  2.0    0.51    0.13 12.00  83.42 0.83   0.000
     [I%=54.0:S%= 2.00]
*
  **  CALIB STANDHYD     0222  1  2.0    1.44    0.36 12.00  84.85 0.84   0.000
     [I%=46.0:S%= 2.00]
*
  **  CALIB STANDHYD     0221  1  2.0    1.66    0.36 12.03  81.88 0.81   0.000
     [I%=38.0:S%= 2.00]
*
  **  CALIB STANDHYD     0220  1  2.0    1.72    0.38 12.03  83.36 0.82   0.000
     [I%=42.0:S%= 2.00]
*
     ADD [0220 + 0221]  0006  3  2.0    3.38    0.74 12.03  82.64  n/a   0.000
*
     ADD [0006 + 0222]  0006  1  2.0    4.82    1.09 12.00  83.30  n/a   0.000
*
  **  CALIB STANDHYD     0224  1  2.0    1.39    0.35 12.00  81.52 0.81   0.000
     [I%=37.0:S%= 2.00]
*
  **  CALIB STANDHYD     0223  1  2.0    1.27    0.34 12.00  85.15 0.84   0.000
     [I%=46.0:S%= 2.00]
*
     ADD [0223 + 0224]  0007  3  2.0    2.66    0.70 12.00  83.25  n/a   0.000
*
     ADD [0006 + 0007]  0008  3  2.0    7.48    1.79 12.00  83.28  n/a   0.000
*
     DUHYD              0312  1  2.0    7.48    1.79 12.00  83.28  n/a   0.000
        MAJOR SYSTEM:   0312  2  2.0    0.45    0.68 12.00  83.28  n/a   0.000
        MINOR SYSTEM:   0312  3  2.0    7.03    1.11 11.87  83.28  n/a   0.000
*
     RESRVR [ 2 : 0312] 0508  1  2.0    7.03    0.80 12.20  83.28  n/a   0.000
     {ST=  0.08 ha.m }
*
     ADD [0312 + 0508]  0009  3  2.0    7.48    1.42 12.00  83.28  n/a   0.000
*
  **  CALIB STANDHYD     0121  1  2.0    1.52    0.29 12.03  75.09 0.74   0.000
     [I%=31.0:S%= 2.00]
*
  **  CALIB STANDHYD     0120  1  2.0    1.09    0.22 12.03  74.72 0.74   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0122  1  2.0    1.41    0.29 12.00  75.09 0.74   0.000
     [I%=31.0:S%= 2.00]
*
     ADD [0120 + 0121]  0002  3  2.0    2.61    0.51 12.03  74.93  n/a   0.000
*
     ADD [0002 + 0122]  0002  1  2.0    4.02    0.79 12.03  74.99  n/a   0.000
*
  **  CALIB STANDHYD     0123  1  2.0    0.68    0.15 12.00  74.72 0.74   0.000
     [I%=30.0:S%= 2.00]
*
  **  CALIB STANDHYD     0124  1  2.0    1.03    0.25 12.00  79.44 0.79   0.000
     [I%=43.0:S%= 2.00]
*
  **  CALIB STANDHYD     0125  1  2.0    0.86    0.23 12.00  86.32 0.85   0.000
     [I%=62.0:S%= 2.00]
*
     ADD [0123 + 0124]  0004  3  2.0    1.71    0.41 12.00  77.56  n/a   0.000
*
     ADD [0004 + 0125]  0004  1  2.0    2.57    0.64 12.00  80.49  n/a   0.000
*
     ADD [0002 + 0004]  0003  3  2.0    6.59    1.42 12.00  77.13  n/a   0.000
*
  **  CALIB STANDHYD     0201  1  2.0    1.05    0.26 12.00  83.73 0.83   0.000
     [I%=43.0:S%= 2.00]
*
     DUHYD              0311  1  2.0    1.05    0.26 12.00  83.73  n/a   0.000
        MAJOR SYSTEM:   0311  2  2.0    0.07    0.10 12.00  83.73  n/a   0.000
        MINOR SYSTEM:   0311  3  2.0    0.98    0.16 11.90  83.73  n/a   0.000
*
     RESRVR [ 2 : 0311] 0507  1  2.0    0.98    0.05 12.37  83.57  n/a   0.000
     {ST=  0.03 ha.m }
*
     ADD [0311 + 0507]  0005  3  2.0    1.05    0.13 12.00  83.58  n/a   0.000
*
 FINISH

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

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix E

LID Lifecycle Cost Assessment

BIORETENTION OVERVIEW

Design Guidance

- Bioretention is an ideal technology for fitting functional vegetation into urban landscapes and treating runoff collected from nearby impervious surfaces.
- Components include: a 'filter bed' with filter media, storage layer of resovoir aggregate, planting and a finishing surface layer of mulch and/or stone.
- Additional components include an underdrain to remove excess water and soil additives to enhance pollutant removal.
- Tool defaults based on STEP recommendations:
  - Maximum drainage area to surface area ratio of 20:1
  - Default depth of 0.75 meters.
  - Default mulch depth of 75 millimeters.
  - An underdrain (minimum 200 mm perforated pipe) is only needed when native soil infiltration is less than 15 mm/hr or infiltration is percluded.

Bioretention cell capturing / treating runoff from adjacent parking lot. Northgate Centre, Vaughan.
Source: https://wiki.sustainabletechnologies.ca/images/b/be/IMG_2457_750X500.jpg

Tool Instructions and Assumptions

- **Green cells** are for mandatory user-input values. Do not leave green cells blank.
- **Purple cells** are where users can edit defaults. The defaults are based on STEP's LID Planning & Design Guide.
- **Red cells** indicate Tool conditions are not being met. Adjust user-input values in accordance with the error message.
- **Orange Cells** highlight the top 5 construction costs.
- Designs include pretreatment through stone diaphragms at curb inlets. Pretreatment through settling forebay and vegetated filter strip not included.
- The tool calculates costs for new designs and includes costs for contractor overhead and profit, material, delivery, labour, equipment (rental, operating and operator costs), hauling and disposal. Mobilization and demobilization costs not included. The tool adds 10% contingency and additional overhead.
- **Design and Engineering cost estimates are not calculated by the tool and must be supplied by the user.**
- Unit costs are based on 2018 pricing; the tool automatically adds inflation. See the Assumptions sheet for details.
- The cost of retrofitting is ~16% higher than the cost of new construction.
- Retrofit costs are included in the 'Costs Summary' section and can be added to the Total Construction Cost for increased accuracy.

For more information on design guidance, please review STEP's LID Planning and Design Guide at: www.wiki.sustainabletechnologies.ca

For further instructions on how to use the tool, please review the STEP Lifecycle Costing Tool User Guide.

User-Input | **Editable Defaults** | **Design Error** | **Top 5 costs**

STEP 2: DESIGN AND CONSTRUCTION ESTIMATES

SITE AND DESIGN INFORMATION	Default	Value	Units
User Inputs			
Drainage Area (DA)		100	m^2
Native Soil Infiltration Rate [1]		25	mm/hr
Design type [2]		Partial Infiltration	Unitless
Drainage period [3]		48	hours
BR surface area length to width ratio		2.5	Unitless
Project land value classification		None	Unitless
Design Defaults			
Max. drainage area to surface area (DA/SA) ratio [4]	20	20	Unitless
Instantaneous Rainfall Capture (Water Quality Design Event) [5]	25	25	mm
Filter Media Depth [6]	1	1	m
Ponding depth	0.2	0.2	m
Safety factor	2.5	2.5	Unitless
Porosity [7]	40	40	%
Mulch depth	0.075	0.075	m
Pea gravel depth	0.1	0.1	m
Gravel storage layer depth	1.4	0.5	m
Underdrain diameter	0.2	0.2	m
Filter media infiltration rate [8]	25	25	mm/hr
Design Calculations			
Filter media depth [9]		1.00	m
Total depth [10]		1.68	m
Surface area (SA)		12.50	m^2
Length		5.59	m
Width		2.24	m
Maximum duration of ponding		8.00	hours
Water storage volume [11]		8.38	m^3
Maximum rainfall captured		83.75	mm
Design Check			

The actual DA/SA ratio calculated is 8:1. It is within the recommended range of 5:1 and 20:1
Ponding duration is OK

User Notes

CONSTRUCTION COSTS	Value	Unit	Cost	Cost adjustment	Sales tax / HST (%)
					13%
Pre-Construction					
Test pits (2)	6.00	m^3	$ 1,437.02	0%	
Infiltration tests (2 per test pit)	4.00	tests	$ 619.48	0%	
Stakeout of utilities	1.00	visit(s)	$ 654.99	0%	
Erosion and sediment controls:					
2" Submersible gas pump	3.00	days	$ 117.30	0%	
Silt sack in catchbasin	1.00	each	$ 88.19	0%	
Silt fence 2 m around excavation	35.03	m	$ 297.50	0%	
Value of project land	12.50	m^2	$ -	0%	
Add additional costs if necessary			**$ -**		
Excavation					
Excavation	50.54	m^3	$ 160.18	0%	
Loading	15%	% of excavation cost	$ 24.03	0%	
Hauling	1.67	hours	$ 383.21	0%	
Safety fencing 6 m around excavation	63.65	m (1 week rental)	$ 1,566.98	0%	
Trenching for pipe to sewer	3.24	m	$ 161.96	0%	
Add additional costs if necessary			**$ -**		
Materials and Installation					
Impermeable membrane	0.00	m^2	$ -	0%	
Underdrain	5.59	m	$ 462.09	0%	
Clean out pipes (2 pipes)	2.75	m	$ 105.59	0%	
Overflow pipes	2.78	m	$ 151.04	0%	
Pipe to sewer	3.24	m	$ 176.14	0%	
Monitoring pipes	2.00	each	$ 258.32	0%	
Fittings (materials & labour)	Yes	$	**$ 5,732.25**	0%	
Manhole adaptor	Yes	units	$ 377.24	0%	
Delivery	2.00	each	$ 523.18	0%	
Pre-treatment Sump [12] Ignore	1.00	each	$ -	0%	
Stone inlets	0.10	m^3	$ 8.98	0%	
Stone for storage layer, 50 mm clearstone	6.25	m^3	$ 561.05	0%	
Pea gravel, including hauling and placement	1.25	m^3	$ 103.91	0%	
Geotextile (sides, splashpads, monitoring wells)	35.26	m^2	$ 82.44	0%	
Backfill	24.66	m^3	$ 56.41	0%	
Curbs & gutter with curb inlets	15.65	m	**$ 1,908.97**	0%	
Vegetation [13]	8.33	m^2	**$ 891.13**	0%	
Wood mulch	11.50	m^2	$ 171.37	0%	
Filter media	15.63	Lm^3	**$ 1,912.41**	0%	
Add additional costs if necessary			**$ -**		
Inspections					
Construction Inspections	5.00	visit	$ 680.20	0%	
Project Acceptance Inspections [14]	2.50	visit	**$ 1,345.65**	0%	
Option #1 Surface infiltration testing	1.00	tests	$ 355.67	0%	
Option #2 Natural event testing	1.00	tests	$ -	-100%	
Option #3 6 months water level monitoring	1.00	tests	$ -	-100%	
Add additional costs if necessary			**$ -**		
Totals					
Sub-total			**$ 21,374.87**		
Overhead	10%		$ 2,137.49		
Design and engineering costs	0%		$ -		
Grand Total			**$ 23,512.36**		

User-Input **Editable Defaults** **Design Error**

STEP 3: MAINTENANCE AND LIFE CYCLE COSTS

Users: Select maintenance level and the **DEFAULTS** will be populated in the table below. Be sure to copy any defaults you prefer to the **ASSUMED** column. Only the **ASSUMED** column is used in the calculations.

	Annual Frequency (# of times/year)			Life Cycle Occurrence (every X years)			Cost (every X years)
MAINTENANCE OPTIONS	Default	Assumed	Unit Cost	Occurrence	Default	Assumed	
Routine Operation Inspections	1.00	1.00	$ 67.86	Periodic	1.00	1	$ 67.86
Watering - Year 1 only	9.00	9.00	$ 4.31	Once	1.00	1	$ 38.75
Watering - Year 2 only	5.00	5.00	$ 4.31	Once	2.00	2	$ 21.96
Annual watering - Starts in Year 3	6.00	6.00	$ 0.43	Periodic	1.00	1	$ 2.58
Drought watering	1.00	1.00	$ 4.31	Periodic	5.00	5	$ 4.31
Remove litter and debris	Low = 2, High= 4	2.00	$ 3.00	Periodic	1.00	1	$ 6.00
Prune	1.00	1.00	$ 8.58	Periodic	1.00	2	$ 8.58
Weed	Low = 2, High= 4	2.00	$ 3.03	Periodic	1.00	1	$ 6.05
Add mulch to maintain 75 mm - Starts Year 2	1.00	1.00	$ 85.69	Periodic	2.00	3	$ 85.69
Replace lost vegetation - Starts Year 2	1.00	1.00	$ 89.11	Periodic	1.00	3	$ 89.11
Unclog underdrain - Starts Year 2	1.00	1.00	$ 98.48	Ignore	1.00	1	$ -
User added additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
User added additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
User added additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
User added additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
Rehabilitation	n/a	n/a	n/a	Ignore	25.00	25	$ -
DISCRETIONARY MAINTENANCE OPTIONS							
Maintenance Inspections	1.00	1.00	$ 158.33	Ignore	5.00	5	$ -
Performance Verification Inspections	1.00	1.00	$ 415.18	Ignore	15.00	15	$ -
PV Option #1: Surface infiltration testing	1.00	1.00	$ 550.72	Ignore	15.00	15	$ -
PV Option #2: Natural event testing	1.00	1.00	$ 2,260.00	Ignore	15.00	15	$ -
PV Option #3: Simulated event testing	1.00	1.00	$ 3,580.42	Ignore	15.00	15	$ -
PV Option #4: 6 months water level monitoring	1.00	1.00	$ 6,780.00	Ignore	15.00	15	$ -
Sediment removal - Starts Year 2	Low = 1, High= 2	1.00	$ 3.34	Ignore	1.00	0	$ -

User Notes

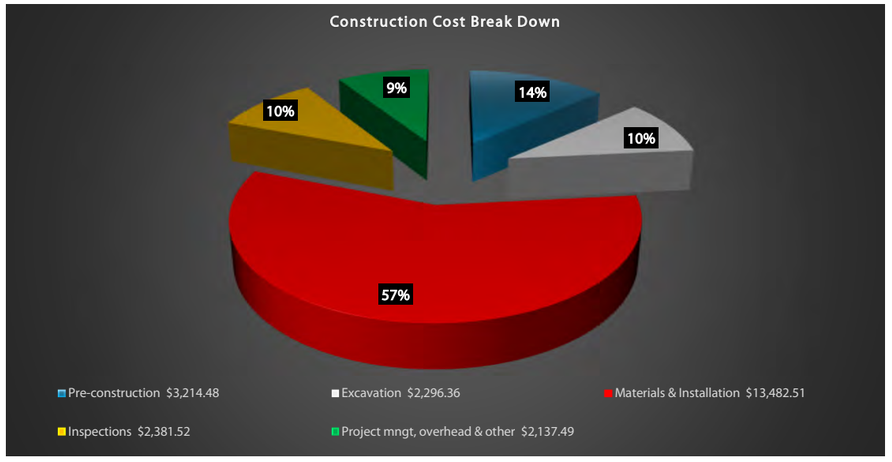
LIFE CYCLE COSTS		Value
Life Cycle Costing Inputs		
	Inflation Rate (%)	3%
	Discount Rate (%)	5%
	Construction Costs	$ 23,512.36
Life Cycle Costing Results (present value, 50 years)		
	Life Cycle Cost of Rehabilitation	$ -
Average Annual Maintenance Cost		
	50 year evaluation period	$ 144.69
	30 Year evaluation period	$ 147.76

Notes

If rehabilitation is performed, some tasks only performed at the start (ie. watering) will be costed again.
Rehabilitation occurs on schedule, even during the last year of the evaluation period.
The discount rate accounts for time value of money and the risk of anticipated future cash flows.
All life cycle results are Net Present Value (considering annual interest & discount rates starting in year 2).
Life cycle cost of rehabilitation takes into account differences in maintenance when rehabilitation is performed.
Average Annual Maintenance costs does not include annual inflation, rehabilitation costs or discount rate.

STEP 4: DESIGN SUMMARY	Value	Units
Drainage Area (DA)	100	m^2
Native Soil Infiltration Rate	25	mm/hr
Surface Area	12.50	m^2
Design type	Partial Infiltration	unitless
Storage Volume	8.38	m^3

COST SUMMARY		Value
Construction Cost Break Down		
	Pre-construction	$ 3,214.48
	Excavation	$ 2,296.36
	Materials & Installation	$ 13,482.51
	Inspections	$ 2,381.52
	Project mngt, overhead & other	$ 2,137.49
	Total Construction Cost	$ 23,512.36
Life Cycle Totals		
	50 Year Evaluation Period	
	Present Value of maintenance and rehabilitation	$ 4,703.41
	Present Value of all costs	$ 28,215.77
	30 Year evaluation period	
	Present Value of maintenance and rehabilitation	$ 3,385.94
	Present Value of all costs	$ 26,898.30
Estimated Retrofit Cost		
	Percentage of total cost	16%
	Total construction cost with retrofit	$ 27,274.33



ENHANCED GRASS SWALE OVERVIEW

Design Guidance

- Enhanced grass swales (EGS) are an ideal technology for sloped sites and cheaply retrofitting and improving the performance of existing grass swales.
- Components include: graded channel, resilient turf grass or other planting, check dams to facilitate short term ponding.
- Additional components include amended soil or filter media to increase infiltration to soils below, and turf reinforcement to prevent scour
- Swales can provide pre-treatment for other BMPs (bioretention, soakaways, perforated pipes) or be designed in series with other practices as part of a treatment train.
- Tool requirements based on STEP recommendations:
    - Designed with a trapezoidal or triangular cross section.
    - Length between culverts should be 5 meters or greater.
    - Designed with a bottom width between 0.6-2.4 m (allows shallow flows and adequate water treatment).
    - Longitudinal slope should be between 0.5 and 4%. Check dams shuld be incorporated on slopes greater than 3%.
    - Side slopes should be flat to aid in providing pre-treatment for lateral incoming flows and maximize swale filtering surface.
    - Steeper side slopes may be susceptible to erosion from incoming lateral flows. A maximum slope of 2.5:1 is recommended (Tool default).
    - Maximum flow depth should be 50% of grass height for regularly mown swales, to maximum of 75 mm.
    - For infrequently mown swales, STEP recommends maximum flows of 33% of vegetation height.
    - Designed for a maximum velocity of 0.3 m/s.
    - Convey locally required design storm (~10 mm year storm) at non-erosive velocities.

Enhanced grass swales can be applied in road rights-of-ways or along parking lots.
Source: Thomas Engineering PA

Tool Instructions and Assumptions

- **Green cells** are for mandatory user-input values. Do not leave green cells blank.
- **Purple cells** are where users can edit defaults. The defaults are based on STEP's LID Planning & Design Guide.
- **Red cells** indicate Tool conditions are not being met. Adjust user-input values in accordance with the error message.
- **Orange Cells** highlight the top 5 construction costs.
- The Tool assumes an in-line system.
- The Tool assumed curb-and-gutter around the circumfrence of the facility with curb-cut inlets every 6 to 0.5 meter squared and stone splash pads.
- The greater the slope, the more check dams placed by Tool. The unit cost for check dams is for the amount of material required, not number of dams.
- If configuration include driveway (2 laned), a culvert pipe connects the EGS and an extra 0.1m of gravel is added beneath culvert.
- Swales which cross multiple driveways or smaller driverways can be accounted for by multiplying or dividing these costs in the Additional Costs cells.
- The Tool calculates costs for new designs and includes costs for contractor overhead and profit, material, delivery, labour, equipment (rental, operating and operator costs), hauling and disposal. Mobilization and demobilization costs not included. The tool adds 10% contingency and additional overhead.
- **Design and Engineering cost estimates are not calculated by the tool and must be supplied by the user.**
- Unit costs are based on 2018 pricing; the tool automatically adds inflation. See the Assumptions sheet for details.
- The cost of retrofitting is ~16% higher than the cost of new construction.
- Retrofit costs are included in the 'Costs Summary' section and can be added to the Total Construction Cost for increased accuracy.

For more information on design guidance, please review STEP's LID Planning and Design Guide at: www.wiki.sustainabletechnologies.ca

For further instructions on how to use the tool, please review the STEP Lifecycle Costing Tool User Guide.

User-Input | Editable Defaults | Design Error | Top 5 costs

STEP 2: DESIGN AND CONSTRUCTION ESTIMATES

SITE AND DESIGN INFORMATION	Default	Value	Units
User Inputs			
Drainage area [1]		100	m^2
Option to stormsewer		Catchbasin	unitless
Is there a driveway separating the EGS?		No	
Swale shape		Linear	unitless
Longitudinal slope		2	%
Check dams		No	unitless
Check dam type		N/A	unitless
Project land value classification		None	Unitless
Design Defaults			
Drainage area to swale area ratio [2]	10	10	:1
Pipe to catchbasin length	5	5	m
Bottom width	0.75	0.75	m
Depth of swale	0.5	0.5	m
Side slopes	2.5	2.5	X:1
Driveway culvert diameter	0.3	0.3	m
Driveway width	8.4	8.4	m
Design Calculations			
Check dam height		0.00	m
Surface area at top		10.00	m^2
Width at top		4.75	m
Length of bottom		2.11	m
Distance between check dams		n/a	m
Number of check dams		0.00	unitless
Design Check			
DA/SA ratio is OK			
Check dam specification OK			
User Notes			

CONSTRUCTION COSTS	Value	Unit	Cost	Cost adjustment	Sales tax / HST (%)
Pre-Construction					13%
Test pits (2)	2.00	m^3	$ 287.40	0%	
Infiltration tests (2 per test pit)	4.00	tests	$ 223.73	0%	
Stakeout of utilities	1.00	visit	**$ 654.99**	0%	
Erosion and sediment controls:					
2" Submersible gas pump	3.00	days	$ 117.30	0%	
Silt sack in catchbasin	1.00	each	$ 88.19	0%	
Silt fence around excavation	21.71	m	$ 184.37	0%	
Value of project land	10.00	m^2	$ -	0%	
Add additional costs if necessary			**$ -**		
Excavation					
Excavator	8.24	m^3	$ 18.19	0%	
Loading	15%	% of excavation cost	$ 2.73	0%	
Hauling	0.33	trips	$ 76.64	0%	
Top soil salvage	2.50	m^3	$ 47.66	0%	
Safety fencing	61.71	m (1 week rental)	**$ 1,519.18**	0%	
Culvert to stormsewer trenching	0.00	m	$ 200.19	0%	
Pipe to catchbasin trenching	5.00	m	$ 250.24	0%	
Add additional costs if necessary			**$ -**		
Materials and Installation					
Culvert to stormsewer and 1 headwall	0.00	each	$ -	0%	
Catchbasin	1.00	each	**$ 4,199.21**	0%	
Pipe to catchbasin (HDPE)	5.00	m	**$ 460.77**	0%	
Pipe to catchbasin delivery	1.00	each	$ 261.59	0%	
Pipe for driveway culvert (incl delivery)	0.00	m	$ -	0%	
Top soil amendments			$ 22.22	0%	
Curbs & gutter with curb inlets	2.11	m	$ 256.76	0%	
Sod	31.11	m^2	$ 195.96	0%	
Check dams	0.00	m	$ -	0%	
Stone inlets	0.05	m^3	$ 16.25	0%	
Stone inlets geotextile	0.50	m^2	$ 1.17	0%	
Headwalls for driveway culvert	0.00	units	$ -	0%	
50 mm clear stone	0.00	Cm^3/Bm^3	$ -	0%	
Compact stone [3]	0.00	Em^3	$ -	0%	
Add additional costs if necessary			**$ -**		
Inspections					
Construction Inspections	5.00	visit	**$ 568.11**	0%	
Project Acceptance Inspections [4]	2.50	visit	$ 340.92	0%	
Option #1 Surface infiltration testing	1.00	tests	$ 355.67	0%	
Option #2 Natural event testing	1.00	tests	$ -	-100%	
Option #3 Simulated event testing	1.00	tests	$ -	-100%	
Add additional costs if necessary			**$ -**		
Totals					
Sub-total			**$ 10,349.44**		
Overhead	10%		$ 1,034.94		
Engineering and Design	0%		$ -		
Grand Total			**$ 11,384.38**		

User-Input **Editable Defaults** **Design Error**

STEP 3: MAINTENANCE AND LIFE CYCLE COSTS

Users: Select maintenance level and the **DEFAULTS** will be populated in the table below. Be sure to copy any defaults you prefer to the **ASSUMED** column. Only the **ASSUMED** column is used in the calculations.

Select maintenance level >>>	**Low**
Sales tax/HST (%)	**13%**

	Annual Frequency (# of times/year)			Life Cycle Occurrence (every X years)			Unit Cost (every X years)
MAINTENANCE OPTIONS	Default	Assumed	Unit Cost	Occurrence	Default	Assumed	
Routine Inspection	1	1.00	$ 45.24	Periodic	1	1	$ 45.24
Watering - Year 1 only	9	9.00	$ 16.07	Once	1	1	$ 144.66
Watering - Year 2 only	5	5.00	$ 16.07	Once	2	2	$ 81.97
Annual watering - Starts in Year 3	6	6.00	$ 1.61	Periodic	1	1	$ 9.64
Drought watering	1	1.00	$ 16.07	Periodic	5	5	$ 16.07
Remove litter and debris	Low = 2, High= 4	2.00	$ 2.40	Periodic	1	1	$ 4.80
Vacuum clean catchbasin	1	1.00	$ 750.90	Ignore	4	4	$ -
Mowing	Low = 5, High= 10	5.00	$ 3.43	Periodic	1	1	$ 17.17
Replace sod - Starts Year 2	1	1.00	$ 19.60	Periodic	1	3	$ 19.60
Weed	Low = 2, High= 4	2.00	$ 11.30	Ignore	1	1	$ -
Prune	1	1.00	$ 32.04	Ignore	1	3	$ -
User added additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
User added additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
User added additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
User added additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
Rehabilitation	n/a	n/a		Ignore	25	25	$ -
DISCRETIONARY MAINTENANCE OPTIONS							
Maintenance Verification	1	1.00	$ 135.71	Ignore	5	5	$ -
Performance Verification	1	1.00	$ 386.91	Ignore	15	15	$ -
PV Option #1: Surface infiltration testing	1	1.00	$ 550.72	Ignore	15	15	$ -
PV Option #2: Natural event testing	1	1.00	$ 2,260.00	Ignore	15	15	$ -
PV Option #3: Simulated event testing	1	1.00	$ 3,580.42	Ignore	15	15	$ -
PV Option #4: 6 months water level monitoring	1	1.00	$ 6,780.00	Ignore	15	15	$ -
Sediment removal - Starts Year 2	Low = 1, High= 2	1.00	$ 3.34	Ignore	1	3	$ -

LIFE CYCLE COSTS

Life Cycle Costing Inputs

Inflation Rate (%)	3%
Discount Rate (%)	5%
Construction Costs	$ 11,384.38

Life Cycle Costing Results (present value, 50 years)

Life Cycle Cost of Rehabilitation	$ -

Average Annual Maintenance Cost

50 year evaluation period	**$ 90.49**
30 Year evaluation period	**$ 93.52**

Notes:

Maintenance costs are scaled based on the size of the practice.
If rehabilitation is performed, some tasks only performed at the start (ie. watering) will be costed again
Rehabilitation occurs on schedule, even during the last year of the evaluation period.
The discount rate accounts for time value of money and the risk of anticipated future cash flows.
All life cycle results are Net Present Value (considering annual interest & discount rates starting in year 2).
Life cycle cost of rehabilitation takes into account differences in maintenance when rehabilitation is performed.
Average Annual Maintenance costs does not include annual inflation, rehabilitation costs or discount rate.

User Notes

STEP 4: COST SUMMARY

Construction Cost Break Down

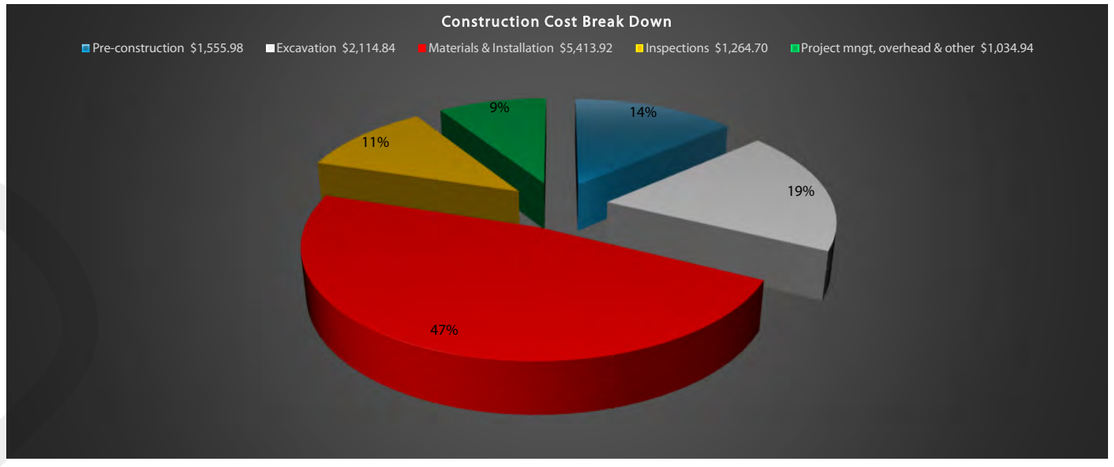
Pre-construction	$	1,555.98
Excavation	$	2,114.84
Materials & Installation	$	5,413.92
Inspections	$	1,264.70
Project mngt, overhead & other	$	1,034.94
Total Construction Cost	**$**	**11,384.38**

Life Cycle Totals

50 Year Evaluation Period		
Present Value of maintenance and rehabilitation	$	3,001.43
Present Value of all costs	$	14,385.81
30 Year evaluation period		
Present Value of maintenance and rehabilitation	$	2,193.48
Present Value of all costs	$	13,577.86

Estimated Retrofit Cost

Percentage of total cost		16%
Total construction cost with retrofit	$	13,205.88



INFILTRATION TRENCH OVERVIEW

Design Guidance

- Infiltration trenches are an ideal technology for installing below any type of landscape with requirements to infiltrate excess stormwater whilst conveying excess.
- Components include: layers of coarse aggregate (to bed the pipe, store and redistribute water), perforated pipe and geotextile.
- Tool requirements based on STEP recommendations:
    - Designed with an impervious drainage area to treatment facility area ratio of between 5:1 and 20:1.
    - Maximum ratio of 10:1 is recommended from facilities receiving road or parking lot runoff.
    - Should be set back at least four metres from building foundations.
    - Overflow pipes should discharge to pervious areas located at least 2m from building foundations and slope away from building or to a storm sewer.
    - Trench bottom width is generally between 600 and 2400 mm.
    - Not be deeper than 3 or 4 metres, as there are cost implications with using trench boxes to retain the side walls

Geotextile being used to prevent fines from entering the trench above.
Source: https://wiki.sustainabletechnologies.ca/images/f/f5/North_Dakota_State_U_infiltration_trench.jpg

Tool Instructions and Assumptions

- **Green cells** are for mandatory user-input values. Do not leave green cells blank.
- **Purple cells** are where users can edit defaults. The defaults are based on STEP's LID Planning & Design Guide.
- **Red cells** indicate Tool conditions are not being met. Adjust user-input values in accordance with the error message.
- **Orange Cells** highlight the top 5 construction costs.
- Hydrodynamic Separator (OGS) is used for pre-treatment in road runoff applications
- The tool calculates costs for new designs and includes costs for contractor overhead and profit, material, delivery, labour, equipment (rental, operating and operator costs), hauling and disposal. Mobilization and demobilization costs not included. The tool adds 10% contingency and additional overhead.
- **Design and Engineering cost estimates are not calculated by the tool and must be supplied by the user.**
- Unit costs are based on 2018 pricing; the tool automatically adds inflation. See the Assumptions sheet for details.
- The cost of retrofitting is ~16% higher than the cost of new construction.
- Retrofit costs are included in the 'Costs Summary' section and can be added to the Total Construction Cost for increased accuracy.

For more information on design guidance, please review STEP's LID Planning and Design Guide at: www.wiki.sustainabletechnologies.ca

For further instructions on how to use the tool, please review the STEP Lifecycle Costing Tool User Guide.

User-Input | **Editable Defaults** | **Design Error** | **Top 5 costs**

STEP 2: DESIGN AND CONSTRUCTION ESTIMATES

SITE AND DESIGN INFORMATION	Default	Value	Units
User Inputs			
Roof drainage area		0	
Road drainage area		100	m2
Drainage period [1]		48	
Inlet locations (manholes)		1	Unitless
Subgrade Infiltration Rate [2]		25	
Rainfall capture target		25	mm
Project land value classification		None	
Design Defaults			
Safety factor	2.5	2.5	Unitless
Porosity	40	40	%
Width of trench	2	2	m
Maximum acceptable drainage area ratio	20	20	x:1
Total drainage area (DA)		100.00	m2
Drainage type		Road Only	Unitless
Depth of trench[3]		0.48	m
Length of trench		5.86	m
Drainage ratio		8.53	x:1
Rainfall captured		25.00	mm
Total drainage area to surface area ratio (DA:SA)[4]		8.53	x:1, unitless
Water storage volume		2.50	m3
Design Check			
Drainage ratio OK			
User Notes			

CONSTRUCTION COSTS	Value	Unit	Cost	Cost adjustment	Sales tax / HST (%)
					13%
Test pits (2)	4.00	m^3	$ 479.01	0%	
Infiltration tests (2 per test pit)	4.00	tests/pit	$ 223.73	0%	
Stakeout of utilities	1.00	visit	$ 654.99	0%	
Erosion and sediment controls	5.86	m	$ 49.79	0%	
Value of project land	11.73	m^2	$ -	0%	
Add additional costs if necessary			**$ -**		
Topsoil salvage, haul to stockpile & return to site	2.93	m^3	$ 55.89	0%	
Excavate trench with trench box	15.60	m^3	$ 83.97	0%	
Loading	15%	% of excavation cost	$ 12.60	0%	
Hauling	0.33	hours	$ 76.64	0%	
Safety Fencing	14.00	m (1 week rental)	$ 344.65	0%	
			$ -		
Materials and Installation					
Manhole (4' dia.) & inlet attachment	1.00	each	**$ 4,755.43**	0%	
Geotextile (Polypropylene filtration fabric)	31.00	m^2	$ 72.49	0%	
Roof to system attachment	0.00	each	$ -	0%	
			$ 1,695.00	0%	
Overflow attachment	1.00	each	$ 278.11	0%	
Perforated Pipe (300 mm)	5.26	m	**$ 891.02**	0%	
Line pipe with expandable rings (Optional)[5]	5.52	m^2	$ -	-100%	
Monitoring wells (150 mm)	0.00	each	$ -	0%	
Place and compact stone (50 mm clear)	5.21	Bm^3 & Cm^3	$ 493.54	0%	
Place and compact fill [6]	8.79	Bm^3 & Cm^3	$ 466.94	0%	
Add additional costs if necessary			**$ -**		
Inspections					
Construction Inspections	5	visit	**$ 836.89**	0%	
				0%	
Option #2 Natural event testing	1	tests	**$ 2,260.00**	0%	
				-100%	
Option #3 6 months water level monitoring	1	tests	$ -	-100%	
			$ -		
TOTALS					
Sub-total			**$ 14,149.13**		
Overhead	10%		$ 1,414.91		
Design and engineering	0%		$ -		
GRAND TOTAL			**$ 15,564.05**		

User-Input **Editable Defaults** **Design Error**

STEP 3: MAINTENANCE AND LIFE CYCLE COSTS

Users: Select maintenance level and the **DEFAULTS** will be populated in the table below. Be sure to copy any defaults you prefer to the **ASSUMED** column. Only the **ASSUMED** column is used in the calculations.

Select maintenance level >>>	**Low**
Sales tax/HST (%)	**13%**

	Annual Frequency (# of times/year)			Life Cycle Occurrence (every X years)			Unit Cost
MAINTENANCE OPTIONS	Default	Assumed	Unit Cost	Occurrence	Default	Assumed	(every X years)
Routine inspection	1	1.00	$ 122.14	Periodic	1	1	$ 122.14
Remove litter	Low = 2, High= 4	2.00	$ 1.41	Periodic	1	1	$ 2.82
Replace filter cloth & dispose sediment	1	1.00	$ 187.44	Ignore	High = 4, Low = 8	8	
Clean out catchbasin - Starts Year 2	1	1.00	$ -	Periodic	1	1	$ -
Clean out HDS - Starts Year 2	1	1.00	$ 1,571.98	Periodic	1	1	$ 1,571.98
Flush out pipes	1	1.00	$ 92.72	Periodic	10	10	$ 92.72
Add additional options	n/a	n/a	-	Periodic	n/a	-	-
Add additional options	n/a	n/a	-	Periodic	n/a	-	
Add additional options	n/a	n/a	-	Periodic	n/a	-	-
Add additional options	n/a	n/a	-	Periodic	n/a	-	
Rehabilitation	n/a	n/a		Periodic	0	0	$ -
DISCRETIONARY MAINTENANCE OPTIONS							
Maintenance inspection	1	1.00	$ 212.62	Ignore	5	5	$ -
Performance verification	1	1.00	$ 122.14	Ignore	15	15	$ -
PV Option #1: Natural event testing	1	1.00	$ 2,260.00	Ignore	15	15	$ -
PV Option #2: Simulated event testing	1	1.00	$ 3,580.42	Ignore	15	15	$ -
PV Option #3: 6 months water level monitoring	1	1.00	$ 6,780.00	Ignore	15	15	

User Notes

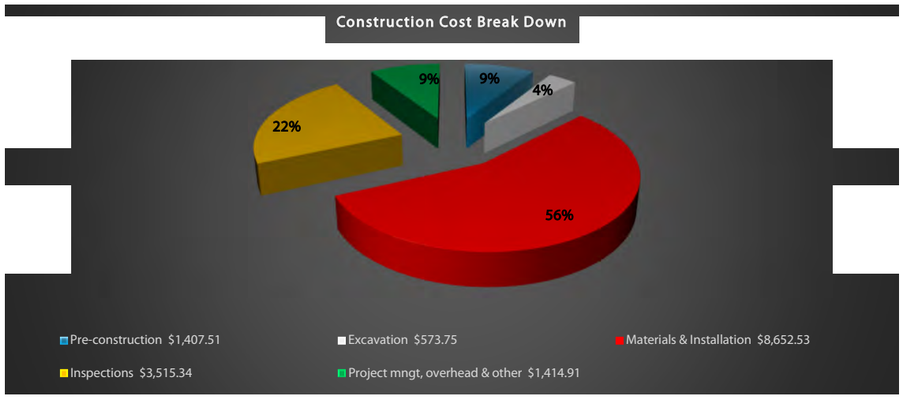
LIFE CYCLE COSTS	VALUE
Inflation Rate (%)	3%
Discount Rate (%)	5%
Construction Costs	$ 15,564.05
50 year evaluation period	**$ 1,674.76**
30 Year evaluation period	**$ 1,653.80**

Notes:

Rehabilitation occurs on schedule, even during the last year of the evaluation period.
The discount rate accounts for time value of money and the risk of anticipated future cash flows.
All life cycle results are Net Present Value (considering annual interest & discount rates starting in year 2).
Life cycle cost of rehabilitation takes into account differences in maintenance when rehabilitation is performed.
Average Annual Maintenance costs does not include annual inflation, rehabilitation costs or discount rate.

STEP 4: COST SUMMARY

		Value
Construction Cost Break Down		
Pre-construction	$	1,407.51
Excavation	$	573.75
Materials & Installation	$	8,652.53
Inspections	$	3,515.34
Project mngt, overhead & other	$	1,414.91
Total Construction Cost	$	**15,564.05**
Life Cycle Totals		
50 Year Evaluation Period		
Present Value of maintenance and rehabilitation	$	53,734.21
Present Value of all costs	$	69,298.26
30 Year evaluation period		
Present Value of maintenance and rehabilitation	$	37,678.78
Present Value of all costs	$	53,242.83
Estimated Retrofit Cost		
Percentage of total cost		16%
Total construction cost with retrofit	$	18,054.29



INFILTRATION CHAMBER OVERVIEW

Design Guidance

- Infiltration chambers are an ideal technology for installing below any type of surface or landscape and for receiving and infiltrating large volumes of water.
- Tool requirements based on STEP recommendations:
  - Designed with an impervious drainage area to treatment facility area ratio of between 5:1 and 20:1.
  - A maximum ratio of 10:1 is recommended from facilities receiving road or parking lot runoff.
  - Facilities receiving road or parking lot runoff should not be located within the two year time-of-travel of wellhead protection areas.
  - Facilities cannot be located on natural slopes greater than 15%.
  - The bottom of the facility should be vertically separated by one metre from the seasonally high water table or top of bedrock elevation.
  - Facilities should be setback a minimum of four metres from building foundations.
  - Pretreatment device options include leaf screens for roof runoff, and vegetated filter strips, grass swales or oil grit separators for road runoff.
  - The tool automatically includes an OGS for facilities recieving road runoff.
  - The inlet and overflow outlet to the facility should be installed below the maximum frost penetration depth to prevent freezing.
  - The overflow outlet can be the pipe inlet that backs up when capacity's reached (discharging to pervious area), or it can be a pipe connected to a storm sewer.
  - Outlet pipes must have capacity equal to or greater than the inlet.
  - Capped and vertical non-perforated pipes connected to the inlet and outlet pipes are recommended for inspecting and flushing as part of routine maintenance.
  - Manholes and inspection ports should be installed in infiltration chambers to provide access for monitoring and maintenance activities (Tool defaults).
  - Compaction, erosion and sediment control are main concerns during construction. Facilities are vulnerable to failure during the construction phase.
  - Construction sediment can clog the excavation if construction instructions incorrectly followed.
  - Heavy construction can also result in compaction of the soil, which can reduce the soil's infiltration rate.

Infiltration chambers being installed. Chamber systems can be large, both in depth and footprint.

Source: https://wiki.sustainabletechnologies.ca/wiki/File:20170605_164302.jpg

Tool Instructions and Assumptions

- **Green cells** are for mandatory user-input values. Do not leave green cells blank.
- **Purple cells** are where users can edit defaults. The defaults are based on STEP's LID Planning & Design Guide.
- **Red cells** indicate Tool conditions are not being met. Adjust user-input values in accordance with the error message.
- **Orange Cells** highlight the top 5 construction costs.
- Cost for piping from roof to system, parking lot to system and overflow from system are not included in this costing.
- Costs of the control manhole and overflow, and pre-treatment via an OGS (when the facility takes road runoff) are included.
- The tool calculates costs for new designs and includes costs for contractor overhead and profit, material, delivery, labour, equipment (rental, operating and operator costs), hauling and disposal. Mobilization and demobilization costs not included. The tool adds 10% contingency and additional overhead.
- **Design and Engineering cost estimates are not calculated by the tool and must be supplied by the user.**
- Unit costs are based on 2018 pricing; the tool automatically adds inflation. See the Assumptions sheet for details.
- The cost of retrofitting is ~16% higher than the cost of new construction.
- Retrofit costs are included in the 'Costs Summary' section and can be added to the Total Construction Cost for increased accuracy.

For more information on design guidance, please review STEP's LID Planning and Design Guide at: www.wiki.sustainabletechnologies.ca

For further instructions on how to use the tool, please review the STEP Lifecycle Costing Tool User Guide.

User-Input | Editable Defaults | Design Error | Top 5 costs

STEP 2: DESIGN AND CONSTRUCTION ESTIMATES

SITE AND DESIGN INFORMATION	Default	Value	Units
User Inputs			
Roof drainage area		0	m^2
Road drainage area		100	m^2
Maximum desired drainage period [1]		48	hours
Inlet locations		1	Unitless
Native Soil Infiltration Rate [2]		25	mm/hr
Length of the IC area (determines IC column length)		5	m
Design basis for sizing of facility		DA:SA	Unitless
User specified DA:SA ratio		20	x:1
Rainfall captured		25	mm
Project land value classification		None	Unitless
Design Defaults			
Porosity	40	40	%
Safety factor	2.5	2.5	Unitless
Fill depth below asphalt	0.39	0.39	m
Bedding depth below & above chambers, 50 mm stone	0.1524	0.1524	m
Chamber height	0.762	0.762	m
Chamber width	1.295	1.295	m
Chamber length	2.169	2.169	m
Design Calculations			
Total drainage area (DA)		100.00	m^2
Drainage type		Road Only	Unitless
Storage volume of a single chamber		1.39	m^3
Number of chambers recommended [3]		0.00	Chambers
Total length of chamber installation area [4]		4.95	m
Total width of chamber installation area		1.01	m
Total depth of chambers & bedding		1.07	m
Surface area of excavation (SA)		5.00	m^2
Total drainage area to surface area ratio (DA:SA) [5]		20.00	x:1
Water storage volume		2.13	m^3
Potential rainfall capture		21.34	mm
Estimated drainage period [6]		42.67	hours
Does this satisfy the drainage period target?		Yes	Yes/No
Design Check			
Design based on the drainage ratio. Rainfall capture target NOT needed.			
The estimated drainage period is below the mamximum drainage period.			
User Notes			

CONSTRUCTION COSTS	Value	Unit	Cost	Cost adjustment	Sales tax / HST (%)
					13%
Test pits (2)	6.00	m^3	**$ 718.51**	0%	
Infiltration tests (2 per test pit)	4.00	tests/pit	$ 223.73	0%	
Stakeout of utilities	1.00	visit	$ 654.99	0%	
Silt fence around excavation	4.95	m	$ 42.02	0%	
Value of project land	5.00	m^2	$ -	0%	
Add additional costs if necessary			**$ -**		
Topsoil salvage, haul to stockpile	1.25	m^3	$ 23.83	0%	
Excavator	30.27	m^3	$ 95.94	0%	
Loading	15%	% of excavation cost	$ 14.39	0%	
Hauling	1.00	hours	$ 229.92	0%	
Safety Fencing (1 week rental)	59.92	m	**$ 1,475.01**	0%	
Add additional costs if necessary			**$ -**		
Manhole (4' dia.) & inlet attachment	1.00	each	**$ 4,653.55**	0%	
Hydrodynamic Separator & Piping [8] Ignore	0.00	each	$ -	0%	
Sediment Trap (i.e. Isolated Row) [9] Ignore	0.00	m^2	$ -	0%	
Roof to system attachment	0.00	each	$ -	0%	
Overflow attachment	1.00	each	$ 278.11	0%	
				0%	
Infiltration chambers & end caps	0.00	m	$ -	0%	
			$ 687.84	0%	
Place and compact fill [10]	1.95	Bm^3 & Cm^3	$ 447.76	0%	
			$ -		
Inspections					
Construction Inspections	5.00	visit	$ 384.52	0%	
Project Acceptance Inspections [11]	2.50	visit	$ 192.26	0%	
Option #1 Natural event testing	1.00	tests	**$ 2,260.00**	0%	
Option #2 Simulated event testing	1.00	tests	$ -	-100%	
Option #3 6 months water level monitoring	1.00	tests	$ -	-100%	
Add additional costs if necessary			**$ -**		
Sub-total			**$ 12,444.44**		
	10%		$ 1,244.44		
Design and engineering	0%		$ -		

STEP 3: MAINTENANCE AND LIFE CYCLE COSTS

Users: Select maintenance level and the **DEFAULTS** will be populated in the table below. Be sure to copy any defaults you prefer to the **ASSUMED** column. Only the **ASSUMED** column is used in the calculations.

Select maintenance level >>>	

	Annual Frequency (# of times/year)			Life Cycle Occurrence (every X years)			Unit Cost (every X years)
MAINTENANCE OPTIONS	Default	Assumed	Unit Cost	Occurrence	Default	Assumed	
Routine inspection	1	1.00	$ 31.67	Periodic	1	1	$ 31.67
Remove litter	Low = 2, High= 4	2.00	$ 1.20	Periodic	1	1	$ 2.40
Clean out sediment trap (i.e. Isolated Row)	1	1.00	$ -	Periodic	High = 4, Low = 8	8	$ -
Clean out catchbasin - Starts Year 2	1	1.00	$ -	Periodic	1	1	$ -
Clean out HDS - Starts Year 2	1	1.00	$ -	Once	1	1	$ -
Add additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
Add additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
Add additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
Add additional options	n/a	0.00	$ -	Periodic	n/a	0	$ -
Rehabilitation	0	n/a		Ignore	0	0	$ -
DISCRETIONARY MAINTENANCE OPTIONS							
Maintenance inspection	1	1.00	$ 31.67	Ignore	5	5	$ -
Performance verification	1	1.00	$ 31.67	Ignore	15	15	$ -
PV Option #1: Natural event testing	1	1.00	$ -	Ignore	15	15	$ -
PV Option #2: Simulated event testing	1	1.00	$ -	Ignore	15	15	$ -
PV Option #3: 6 months water level monitoring	1	1.00	$ -	Ignore	15	15	$ -

User Notes

LIFE CYCLE COSTS		Value
Life Cycle Costing Inputs		
	Inflation Rate (%)	3%
	Discount Rate (%)	5%
	Construction Costs	$ 13,688.89
Life Cycle Costing Results (present value, 50 years)		
Average Annual Maintenance Cost		
	50 year evaluation period	$ 34.07
	30 Year evaluation period	$ 34.07
Notes		

The discount rate accounts for time value of money and the risk of anticipated future cash flows.
All life cycle results are Net Present Value (considering annual interest & discount rates starting in year 2).
Life cycle cost of rehabilitation takes into account differences in maintenance when rehabilitation is performed.
Average Annual Maintenance costs does not include annual inflation, rehabilitation costs or discount rate.

STEP 4: COST SUMMARY

STEP 4: COST SUMMARY		Value
Construction Cost Break Down		
	Pre-construction	$ 1,639.24
	Excavation	$ 1,839.09
	Materials & Installation	$ 6,129.33
	Inspections	$ 2,836.78
	Project mngt, overhead & other	$ 1,244.44
	Total Construction Cost	$ 13,688.89
Life Cycle Totals		
	50 Year Evaluation Period	
	Present Value of maintenance and rehabilitation	$ 1,104.78
	Present Value of all costs	$ 14,793.66
	30 Year evaluation period	
	Present Value of maintenance and rehabilitation	$ 784.06
	Present Value of all costs	$ 14,472.94
Estimated Retrofit Cost		
	Percentage of total cost	16%
	Total construction cost with retrofit	$ 15,879.11