

**FLOODLINE
ANALYSIS REPORT**

**AQUAVIL
TOWN OF THE BLUE MOUNTAINS**

ROYALTON HOMES INC.

PREPARED BY:

**C.F. CROZIER & ASSOCIATES INC.
40 HURON STREET
COLLINGWOOD, ONTARIO
L9Y 4R3**

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1.0 INTRODUCTION

C.F Crozier & Associates Inc. (Crozier) was retained by Royalton Homes Inc. (Royalton) to prepare a Floodline Analysis Report in support of a Redline Draft Plan Application for the AquaVil Development (Subject Property), formerly Silver Creek at Craigeleith, Town of The Blue Mountains. The Subject Property is bounded by Georgian Bay to the north, Highway 26 to the south, Blue Mountain Drive to the west and Long Point Road to the east in the Town of The Blue Mountains, County of Grey. The property is part of Registered Plan 529, formerly Township of Collingwood, County of Grey. The 25.8 ha Site is divided by Brophy's Lane and wetland area in the center with 15.0 ha of land on the west side and 10.8 ha of land on the east side. Refer to Figure 1 for the Site Location Plan.

The proponent is applying to develop the Subject Property as a mixed-use development consisting of a combination of residential, commercial, recreational, institutional, open space and environmental protection areas that once fully developed, will result in the creation of a sustainable, compact and complete community.

Royalton has assembled a multi-disciplinary team; whose consultants have prepared studies/plans to support the planning application. This report prepared by Crozier should be read in conjunction with the work of the other team members, who include:

- DS Consultants (Geotechnical and Hydrogeological)
- Travis and Associates (Planning)
- CF Crozier & Associates Inc. (Engineering and Environmental Services)

In addition to this report, Crozier has also prepared a Functional Servicing and Stormwater Management Report, Traffic Impact Study and Environmental Impact Study in support of the planning application.

2.0 PROJECT HISTORY

The Subject Property was Draft Plan approved in May 2014 under separate ownership. In support of this Draft Plan Application the following engineering reports were prepared.

- "Preliminary Servicing and Stormwater Management Report" – CFCA (April 2008)
- "Floodline Analysis Report" – CFCA (November 2008)
- "Traffic Impact Study Update" – CFCA (May 2009)

Royalton has since purchased the Subject Property and it is their intent to amend the existing Draft Plan to accommodate minor revisions to the proposed Blocks and internal road alignment. Refer to Figure 2 for the proposed Redlined Draft Plan and Figure 3 for the Development Plan.

Through the initial pre-consultation meetings with the regulatory agencies, the Grey Sauble Conservation Authority (GSCA) requested that the 2008 floodline analysis for Watercourse #1 be updated to support the Redline Draft Plan Application. The proposed Redline Draft Plan Application does not propose any Draft Plan changes in the area of Watercourse #1. As such, the floodline analysis and methodology has remained effectively the same as the 2008 analysis, however has been updated using current model versions and practices.

3.0 BACKGROUND

The lands that make up the AquaVil development have a variety of existing uses under the Town of The Blue Mountains Official Plan (OP). The AquaVil lands east of Brophy's Lane and west of Long Point Road are currently designated as a combination of Craigleith Village Residential, Craigleith Village Commercial, Craigleith Village HSFPSW, Hazard and Wetland under the Town of The Blue Mountains Official Plan.

The Preliminary Servicing and Stormwater Management Report issued by Crozier (September 2019) includes information on existing drainage conditions and the proposed stormwater management strategy for the development. The report does not include detailed hydraulic modeling and mapping of the Watercourse #1 floodplain, which was requested by the GSCA through consultation discussions.

In order to fully understand the nature of the floodline analysis and interpretation of results, it is important to define a series of key floodplain management terms which are used throughout this study. The key terms are defined below.

Floodplain: Lands adjacent to rivers and streams that are subject to recurring inundation.

Floodway: The portion of the floodplain where development and site alteration would cause a danger to public health and safety or property damage.

Regulatory (Regional) Floodplain: Regulated lands adjacent to rivers and streams that are subject to inundation during the Regional (i.e. Timmins) storm event.

Floodline: Limit of flood inundation, typically delineated for the 100-year and/or Regional storm events.

Spills: Where ill-defined channels or top-of-banks are overtopped due to high flows causing spill overland. The spill flows are removed from the originating watershed and conveyed to an adjacent watershed, resulting in a downstream flood flow reduction.

Results of the 2008 floodplain analysis conclude that Watercourse #1 is not capable of conveying significant flood flows within the channel banks adjacent to the Subject Property. This results in spill flow conditions on the Subject Property in a relatively shallow and diffuse manner. It was determined that spill flows enter the northwest portion of the property and are conveyed across private lands before reaching Brophy's Lane south of the Town of The Blue Mountain's (TOBM) Waste Water Treatment Plant (WWTP). Spill flows ultimately reach Georgian Bay through a series of man-made channels and roadside ditches along Long Point Road. It was also determined that the flood flows which spill west from Watercourse #1 do not combine with the Watercourse #1 main channel flows at any point downstream of the spill location.

The principles involved in treating spill flows are outlined in the "Technical Guide; River and Stream Systems: Flooding Hazard Limits (Ministry of Natural Resources, 2002)", which provides technical guidance to assist with evaluating flood hazards under the policies of Section 3.1 of the Provincial Policy Statement. Sections 2.9 and 2.10 of the Technical Guide (MNR, 2002) note that vehicular and pedestrian movement is not to be prevented during times of flooding. In the case where spill flows exist, such as that across the Aquavil lands, Section 4.13 states that "alternative measures should be investigated to prevent spill moving into the adjacent watershed," and maintaining all or a portion of the incoming flood flows within the same watershed.

The current proposed floodplain and spill management strategy is consistent with the 2008 strategy of returning the spill flow to Watercourse #1 and effectively eliminating spill flow and flooding conditions within the Subject Property. Our updated analysis and results are provided in detail below.

4.0 REGIONAL FLOODLINE ASSESSMENT – AQUAVIL LANDS

Watercourse #1 traverses the east limit of the Subject Property and conveys drainage from a watershed area of approximately 4 km² as specified in the Craigleith Camperdown Subwatershed Study (GSCA, 1993). Watercourse #1 originates on the table lands of the Niagara Escarpment within the Town of The Blue Mountains and jurisdiction of the GSCA, and discharges to Georgian Bay within the Town of Collingwood.

Watercourse #1 enters the Subject Property at the southeast property limit via a 3660mm x 1520mm concrete box culvert beneath Highway 26. Downstream of Highway 26, the watercourse traverses the east limit of the Subject Property within the Long Point Road roadside ditch before it makes a 90-degree bend east beneath the road via a pair of 1490mm x 920mm CSPA culverts. The watercourse then passes through several open fields and forested areas before discharging to Georgian Bay approximately 850 m downstream of Long Point Road in the Town of Collingwood. A significant portion of Watercourse #1 was modified in the past as a result of municipal road works and private agricultural operations. The floodplain assessment of Watercourse #1 contained herein was based on the historical modifications and topographic characteristics which currently exist.

A previous floodplain assessment was prepared as part of the Craigleith Camperdown Subwatershed Study (GSCA, 1993). The Regional floodline map presented by GSCA (1993) is illustrated on Figure 3. As shown, a spill flow condition was identified along Watercourse #1 at the southeast portion of the Subject Property. Since the spill flow condition was not further evaluated, the floodline limit was not delineated downstream of the reported spill flow location. This is consistent with standard floodplain mapping procedures where the initial incoming watershed flow is carried downstream to facilitate conservative analyses.

The hydrology of Subwatershed #1 was evaluated by GSCA (1993) using the QUALHYMO hydrologic computer model. Results from the hydrologic modeling include peak flows for Watercourse #1 at various locations for a series of storm events. The peak flow results for Watercourse #1 at the outlet to Georgian Bay are summarized in Table 1 representative of “ultimate development conditions;” the Regional storm QUALHYMO model files are found in Appendix A.

Table 1: Summary of Peak Flows of Subwatershed #1 at Outlet to Georgian Bay (GSCA, 1993)

Storm Event	2-Year	10-Year	25-Year	100-Year	Timmins (Regional)
Peak Flow (m ³ /s)	4.4	8.6	10.3	12.9	19.5

Notes: Peak flows generated using QUALHYMO for Ultimate Development Conditions.

The peak flows along Watercourse #1 as noted in Table 1 were used in the hydraulic analysis in order to evaluate the existing and proposed flooding conditions within the study area, as described in Section 4.1 below.

4.1 HYDRAULIC MODEL SETUP

Preliminary hydraulic modeling was undertaken, and a series of flood flow routes were identified. These are summarized in Table 2.

Table 2: Summary of Flood Flow Routes Evaluated Using Hydraulic Modeling

Flood Flow Route	Description
Main Channel	Watercourse #1 proper.
West Spill	Flood flows leaving Watercourse #1 and entering AquaVil property. Flows removed from Watercourse #1 system.
East Flow Route	Flood flows overtopping Long Point Road and returning to Watercourse #1 immediately downstream. Flows remain within Watercourse #1 system.

The hydraulic analysis of Watercourse #1 and adjacent flow routes was conducted using the US Army Corps of Engineers HEC-RAS v3.13 computer model, which is considered industry standard for such analyses. Input data required for the model includes channel geometry, channel roughness characteristics, hydraulic structures, peak flow data and boundary conditions. Results from the HEC-RAS model include water surface elevations, channel velocities, floodplain widths, and several detailed hydraulic parameters. The HEC-RAS model was also extended in this study to determine the split flow distribution between the three flow routes between Highway 26 north along Long Point Road. A detailed discussion of the model setup for the hydraulic reaches is provided below.

The Watercourse #1 study reach extends approximately 200 metres downstream from Highway 26 and consists of ten hydraulic sections including the Long Point Road crossing. This reach of Watercourse #1 has a relatively consistent geometry with a typical main channel width of 4 metres and channel depth of 1 meter. The overbank areas to the west consist of relatively flat and lightly forested lands. The east overbank area between Highway 26 and Long Point Road consists of the roadway surface of Long Point Road. Consequently, the Manning's roughness values were set at 0.050, 0.100 and 0.013 for the main channel, west overbank areas and east overbank areas, respectively.

The reach boundary condition for the HEC-RAS model of Watercourse #1 was set to normal depth with a downstream slope of 0.4%, which is representative of the watercourse conditions within the study area. Due to the relatively low-lying topography of the overbank areas, a split flow analysis between the main channel and east and west overbank areas was conducted as described below. This was completed in order to determine the distribution of peak flood flows between the three flow routes and to evaluate potential flood mitigation measures.

The potential spill flow conveyance through the west spill route (i.e. Aquavil lands) was initially evaluated using the Flowmaster hydraulic model using a hydraulic control section oriented perpendicular to the spill flow route. In this case, the hydraulic section was taken from the topography of the west top-of-bank of Watercourse #1 since the lands to the west of this area generally fall away from the watercourse. The resulting hydraulic rating curve of the spill flow route was then used as input into the HEC-RAS model in order to calculate the split flow distribution.

The relatively low road elevations along the east bank of Watercourse #1 would cause overtopping of Long Point Road. Consequently, the east flood flow route (i.e. overtopping Long Point Road) was configured similar to the west spill route. A hydraulic control section was initially modeled in Flowmaster to account for the centerline elevations of Long Point Road in order to account for overtopping and conveyance eastward across Long Point Road. In this case, flood flows return to the main channel of Watercourse #1 within the Town of Collingwood. Given the flow distribution to the east and west of the main channel, the left and right limits of the HEC-RAS sections of the main channel were defined by vertical walls.

The existing conditions configuration of the hydraulic model is illustrated on Figure 5, post-development conditions is illustrated on Figure 6 and a photographic representation of a portion of the study reach is provided in Figure 8. The detailed hydraulic sections used in the analysis are provided in Appendix B.

4.2 REGIONAL SPLIT FLOW ANALYSIS

In order to understand the Regional split flow conditions along Watercourse #1, it was necessary to complete a split flow distribution analysis of the total approach flow within Watercourse #1 between the three above-noted flow routes. This section describes the methodology used in determining the proportions of flow to the east, west and to the main channel of Watercourse #1.

The Regional storm approach flow of 19.5 m³/s was distributed to the three flow routes described above in order to understand the existing flooding conditions within the study area. The hydraulic rating curves of the two adjacent flow routes were input into HEC-RAS as lateral diversions between Cross Sections 1200 and 1300, even though the physical diversions extend both upstream of downstream of these sections. Split flow optimizations were then conducted and an equalized Regional water surface elevation across the diversions was calculated. This is considered standard protocol for evaluating split flow distributions. Note that the version of HEC-RAS utilized is unable to model lateral diversions extending over multiple main channel sections, and as a result the water surface elevations computed through the split flow analysis are approximate.

During the existing conditions Regional split flow analysis, the hydraulic control sections converged at a Regional water surface elevation of 181.42 m, where the corresponding peak flow distribution between Watercourse #1 main channel, west spill route (i.e. AquaVil lands) and east flow route (i.e. overtopping Long Point Road) was 6.5 m³/s, 4.5 m³/s and 8.5 m³/s, respectively, as summarized in Table 3. Results from the post-development hydraulic assessment are also presented in Table 3 for comparative purposes and as described later in Section 4.3. Detailed hydraulic model results of both scenarios are provided in Appendix C.

Table 3: Regional Spill Flow (m³/s) Distribution Summary

Development Condition	Inflow	Outflow		
	Watercourse #1 @ Hwy 26	West Spill Flow (AquaVil)	Watercourse #1 Main Channel	East Flow Route (Long Point Road)
Existing Conditions	19.5	4.5	6.5	8.5
Post-Development Conditions	19.5	Nil (Eliminated)	7.0	12.5

Notes: Post-development conditions includes returning spill flow to Watercourse #1.

Results from the split flow distribution analysis provide critical flow information for the analysis of flood mitigation measures and control of spill flows presented in Section 4.3. As shown, approximately 4.5 m³/s (25%) of the Regional storm approach flows would spill onto the AquaVil lands and ultimately reach Georgian Bay in the Town of The Blue Mountains via an alternate route from Watercourse #1. The remaining 15 m³/s (combination of flows from main channel and east flow route) would remain within the Watercourse #1 system and outlet to Georgian Bay at a common location in the Town of Collingwood.

As explained in Section 3.0, the proposed approach for floodplain management across the AquaVil lands involves the modifications to Watercourse #1, associated hydraulic structures and surrounding topography/roadways such that the existing 4.5 m³/s Regional flood spill flows are redirected to the subwatershed of origin, Subwatershed #1. The proposed approach of eliminating spill flows is supported by the floodplain management policies outlined in the Technical Guide (MNR, 2002) and implemented through the Provincial Policy Statement (PPS). A technical discussion and impact analysis of the proposed floodplain management approach is described in Section 4.3.

4.3 FLOOD MITIGATION MEASURES

The existing spill flow conditions along Watercourse #1 create a shallow and diffuse flooding condition across the southeast portion of the AquaVil lands. This is caused by the hydraulic restriction imposed by the existing Long Point Road culverts and relatively low-lying overbank areas. In order to eliminate the potential for spill flow to occur across the Subject Property and direct all approach flows downstream to Subwatershed 1, the following measures are proposed:

- Raise site grades to at least 0.5 m above the Regional water surface elevation;
- Increase size of culverts beneath Long Point Road as recommended by GSCA (1993);
- Provide defined roadway sag along Long Point Road near Watercourse #1 crossing; and,
- Re-channelization of portions of Watercourse #1, as necessary, upstream or downstream.

The proposed flood mitigation strategy involves returning the 4.5 m³/s spill flow downstream to Subwatershed #1 through the physical measures listed above. Specifically, the existing culverts beneath Long Point Road could be replaced with a single 5 m by 1 m box culvert in combination with the re-grading of Long Point Road to provide a 72 m sag to safely convey the Regional flow downstream towards Georgian Bay. The existing topography of lands east of Long Point Road provides a natural draw for accepting the overland spill flow from across Long Point Road and safely redirecting to the Watercourse #1 floodplain. The proposed conditions flood management strategy is illustrated on Figure 7.

The effect of the proposed measures on the downstream flooding impacts to two existing residential dwellings, #111 and #117 Long Point Road, was evaluated by Crozier using the proposed conditions hydraulic modeling. The two residences are located adjacent to Watercourse #1 on the east side of Long Point Road.

Recall that conservative floodplain management protocol involves carrying full flood flows downstream without considering reductions due to spill flow. Therefore, the existing residential properties (#111 & #117 Long Point Rd) are within the spill flow area and floodplain of Watercourse #1. Regardless, Crozier conducted a hydraulic analysis of Watercourse #1 downstream of the AquaVil lands using the above-noted models to determine the relative effect of redirecting the west spill flow towards Watercourse #1 adjacent to the above-noted residences. In this case, the net increase in peak flow from existing to proposed conditions was 4.5 m³/s (i.e. from 15 m³/s to 19.5 m³/s) despite the conservative floodplain modeling already completed downstream of Long Point Road to the outfall at Georgian Bay associated with the Consulate development application (i.e. total peak flow of 19.5 m³/s was applied to the hydraulic analysis).

Results of the downstream impact assessment for Regional storm event are presented in Table 4.

Table 4: Downstream Flood Impact Assessment

Storm Event	Existing Conditions			Proposed Conditions			Δ Water Surface Elevation (+/- m)
	West Spill (m ³ /s)	Main Channel + East Flow (m ³ /s)	Water Surface Elevation (m)	West Spill (m ³ /s)	Main Channel + East Flow (m ³ /s)	Water Surface Elevation (m)	
Regional [19.5 m ³ /s]	4.5	15.0	181.3	Nil (Eliminated)	19.5	181.3	Unchanged

Notes: Downstream water surface elevations taken at Cross Section 1000, immediately downstream of Long Point Road.

As indicated in Table 4, the water surface elevations immediately downstream of Long Point Road are not influenced with the elimination of the west spill flow. The principle reason for this is due to the proposed flood mitigation measures which include reducing the profile of Long Point Road and transition grading upstream and downstream along Watercourse #1. When compared to the finished floor elevations of 181.93 m and 182.49 m at the residences at #111 and #117 Long Point Road, it is evident that the proposed flood mitigation measures proposed by the AquaVil development to eliminate the west spill will not aggravate the existing flooding conditions downstream. In fact, there remains approximately 0.6 m and 1.2 m of freeboard between the finished floor of the respective dwellings at #111 and #117 and that of the Regional flood elevation.

We have also evaluated the effects of the proposed flood mitigation measures on the flooding conditions within the Highway 26 corridor controlled by the Ministry of Transportation. Under existing conditions, the Regional water surface elevation immediately downstream of the Highway 26 culvert (Cross Section 1800) is 182.1 m. Under proposed conditions with the implementation of the flood mitigation measures (i.e. road sag and larger culvert beneath Long Point Rd), the Regional water surface elevation is reduced by approximately 0.2 m. Consequently, the proposed works will not adversely impact the flooding conditions within the MTO-controlled Highway 26 corridor.

5.0 CONCLUSIONS & RECOMMENDATIONS

This study provides a comprehensive hydraulic analysis of the Watercourse #1 and associated spill flow conditions north of Highway 26 across the east portion of the AquaVil lands. The hydraulic analysis was prepared to establish the existing spill flow conditions onto the Subject Property and evaluate possible flood mitigation measures to control and convey the spill flow in a safe and efficient manner.

With guidance from the Technical Guide (MNR, 2002), the proposed flood conveyance measures will convey the total approach flow 19.5 m³/s along Watercourse #1 to downstream of Long Point Road. This flood management strategy prevents spill flow from Subwatershed #1 to enter the neighbouring subwatershed. When compared to actual existing conditions, this will cause an increase in flood flows downstream of Long Point Road. The increase in flows will be conveyed downstream via the replacement of the existing twin arch CSP culverts with a single 5 m by 1 m box culvert in combination with a 72-metre roadway sag across Long Point Road. We conclude that the flooding conditions both upstream (i.e. Highway 26 corridor) and downstream (i.e. private residences) of the AquaVil lands will not be aggravated.

Regardless, as requested by the GSCA, development proposals downstream of the Aquavil lands along Watercourse #1 must consider the original approach flow of 19.5 m³/s for conservative purposes in the

event that upstream spill flows are eliminated. When considering this scenario, the proposed floodplain management proposal of eliminating the spill flow onto AquaVil lands will not have any impacts to flooding conditions downstream.

This floodline analysis report has been prepared in consultation with the GSCA and Towns of The Blue Mountains and Collingwood and is in keeping with current floodplain management practices. We recommend approval of the Planning Applications for the Subject Property from the perspective of floodplain management, subject to detailed design.

Respectfully Submitted,

C.F. CROZIER & ASSOCIATES INC.



Brendan Hummelen, P.Eng.
Project Engineer

C.F. CROZIER & ASSOCIATES INC.



Kurt Vendrig, EIT

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APPENDIX A

QUALHYMO Hydrologic Model (GSCA, 1993)

WATERCOURSE #1

QUALHYMO INPUT

ULTIMATE CONDITIONS

(GSCA, 1993)

```
1234567890 *./-
21
START          1 27
STORE          2  4
GENERATE       3 52
PRINT SPAN     4 10
PLOT SPAN      5 10
ADD SERIES     6  4
POND           7310
REACH          8310
CALIBRATE      9310
POLLUTANT SERIES 10 9
SPLIT SERIES   11310
DUMP PRINT     12 1
EXCEEDANCE CURVES 13310
DUMP PLOT      14 9
SHEAR1         15310
MAXFLW         16 8
SERIES STATS   17 7
PRINT FLOWS    18 8
ROUTE RESERVOIR 19 64
SCAN SERIES    20 16
FINISH         21 0
*
* ***** Q U A L H Y M O *****
*                               VERSION 2.1
*
*      ===== BLUE MOUNTAIN WATERSHED STUDY =====
*      ===== 73.49 =====
*      ===== OUTFALL #1 =====
*
START          START DATE OF SIMULATION 71 05 03
              END DATE OF SIMULATION 71 05 10
              RAINFALL WILL BE READ ON DEVICE 9
              PRECIP IS IN AES HOURLY FORMAT IPFORM 2
              FLOW FILE WILL BE READ ON DEVICE 99
              EVAPORATION FLAG OFF ICASE=0
              SET POLLUTANT FLAG OFF IFDECA=0
              SET SEDIMENTATION FLAG OFF IFSEDT=0
*
GENERATE       ID=1 ISER=101 DT=0.25 DA=191.0 AB=0 FRIMP=0.0
              PVIOUS AREA AA=1 N=2.00 TP=2.5 Smin=56.9 So=56.9
              SK=0.088 APIK=0.9 APII=60 IA=5.0
              BASE FLOW NSVOL=0 BASMIN=0.0 BFACR=2.0
              SVOL=10 SWILT=0.01 SFIELD=1.0
              SLOSKA=0.00005 SLOSKB=0.95
*
*
DUMP PRINT     ID=1
*
GENERATE       ID=2 ISER=102 DT=0.25 DA=129.0 AB=0 FRIMP=0.0
              PVIOUS AREA AA=1 N=2.00 TP=1.9 Smin=111.8 So=111.8
              SK=0.088 APIK=0.9 APII=60 IA=5.0
              BASE FLOW NSVOL=0 BASMIN=0.0 BFACR=2.0
              SVOL=10 SWILT=0.01 SFIELD=1.0
              SLOSKA=0.00005 SLOSKB=0.95
*
*
ADD SERIES     IDOUT=3 1 1 2
*
DUMP PRINT     ID=3
*
*
REACH          IDOUT=4 ISER=105 NDIH=1 ID=3 NIDL=0 IFAORM=2
              NELS=3 SMAX=2.5 XLEN=1000 RTINC=0.0625 RN=0.04
              SF=0.005 SS=0.5 B=100
*
*DUMP PRINT     ID=4
*
GENERATE       ID=5 ISER=103 DT=0.25 DA=71.0 AB=0 FRIMP=0.0
              PVIOUS AREA AA=1 N=2.00 TP=2.9 Smin=111.5 So=111.5
              SK=0.088 APIK=0.9 APII=60 IA=5.0
              BASE FLOW NSVOL=0 BASMIN=0.0 BFACR=2.0
              SVOL=10 SWILT=0.01 SFIELD=1.0
              SLOSKA=0.00005 SLOSKB=0.95
*
*DUMP PRINT     ID=5
*
*
ADD SERIES     IDOUT=6 1 4 5
*
DUMP PRINT     ID=6
*
*
FINISH
0
```

TIMMINS (REGIONAL)

[illegible]

(MM) (MM) (MM) (MM)
193.0000 144.3201 181.4499 146.3623

*
DUMP PRINT ID=1
1 TIME INCREMENT=.250
NAME OF SERIES= 101

FIRST-ORDER DECAY PARAMETER concentrations are in #s/dl and SS concentrations are in mg/l

71 5 3	.25	.868	0.	.0	.0	.0	.0	.0	.0
71 5 3	.50	1.031	0.	.0	.0	.0	.0	.0	.0
71 5 3	.75	1.262	0.	.0	.0	.0	.0	.0	.0
71 5 3	1.00	1.464	0.	.0	.0	.0	.0	.0	.0
71 5 3	1.25	1.717	0.	.0	.0	.0	.0	.0	.0
71 5 3	1.50	1.955	0.	.0	.0	.0	.0	.0	.0
71 5 3	1.75	2.188	0.	.0	.0	.0	.0	.0	.0
71 5 3	2.00	2.426	0.	.0	.0	.0	.0	.0	.0
71 5 3	2.25	2.588	0.	.0	.0	.0	.0	.0	.0
71 5 3	2.50	2.747	0.	.0	.0	.0	.0	.0	.0
71 5 3	2.75	2.902	0.	.0	.0	.0	.0	.0	.0
71 5 3	3.00	3.050	0.	.0	.0	.0	.0	.0	.0
71 5 3	3.25	3.142	0.	.0	.0	.0	.0	.0	.0
71 5 3	3.50	3.209	0.	.0	.0	.0	.0	.0	.0
71 5 3	3.75	3.254	0.	.0	.0	.0	.0	.0	.0
71 5 3	4.00	3.277	0.	.0	.0	.0	.0	.0	.0
71 5 3	4.25	3.296	0.	.0	.0	.0	.0	.0	.0
71 5 3	4.50	3.304	0.	.0	.0	.0	.0	.0	.0
71 5 3	4.75	3.302	0.	.0	.0	.0	.0	.0	.0
71 5 3	5.00	3.294	0.	.0	.0	.0	.0	.0	.0
71 5 3	5.25	3.369	0.	.0	.0	.0	.0	.0	.0
71 5 3	5.50	3.478	0.	.0	.0	.0	.0	.0	.0
71 5 3	5.75	3.617	0.	.0	.0	.0	.0	.0	.0
71 5 3	6.00	3.785	0.	.0	.0	.0	.0	.0	.0
71 5 3	6.25	4.068	0.	.0	.0	.0	.0	.0	.0
71 5 3	6.50	4.437	0.	.0	.0	.0	.0	.0	.0
71 5 3	6.75	4.885	0.	.0	.0	.0	.0	.0	.0
71 5 3	7.00	5.401	0.	.0	.0	.0	.0	.0	.0
71 5 3	7.25	5.924	0.	.0	.0	.0	.0	.0	.0
71 5 3	7.50	6.409	0.	.0	.0	.0	.0	.0	.0
71 5 3	7.75	6.857	0.	.0	.0	.0	.0	.0	.0
71 5 3	8.00	7.267	0.	.0	.0	.0	.0	.0	.0
71 5 3	8.25	7.645	0.	.0	.0	.0	.0	.0	.0
71 5 3	8.50	7.998	0.	.0	.0	.0	.0	.0	.0
71 5 3	8.75	8.325	0.	.0	.0	.0	.0	.0	.0
71 5 3	9.00	8.628	0.	.0	.0	.0	.0	.0	.0
71 5 3	9.25	8.894	0.	.0	.0	.0	.0	.0	.0
71 5 3	9.50	9.097	0.	.0	.0	.0	.0	.0	.0
71 5 3	9.75	9.246	0.	.0	.0	.0	.0	.0	.0
71 5 3	10.00	9.348	0.	.0	.0	.0	.0	.0	.0
71 5 3	10.25	9.410	0.	.0	.0	.0	.0	.0	.0
71 5 3	10.50	9.438	0.	.0	.0	.0	.0	.0	.0
71 5 3	10.75	9.438	0.	.0	.0	.0	.0	.0	.0
71 5 3	11.00	9.415	0.	.0	.0	.0	.0	.0	.0
71 5 3	11.25	9.367	0.	.0	.0	.0	.0	.0	.0
71 5 3	11.50	9.284	0.	.0	.0	.0	.0	.0	.0
71 5 3	11.75	9.171	0.	.0	.0	.0	.0	.0	.0
71 5 3	12.00	9.035	0.	.0	.0	.0	.0	.0	.0
71 5 3	12.25	8.872	0.	.0	.0	.0	.0	.0	.0
71 5 3	12.50	8.660	0.	.0	.0	.0	.0	.0	.0
71 5 3	12.75	8.410	0.	.0	.0	.0	.0	.0	.0
71 5 3	13.00	8.130	0.	.0	.0	.0	.0	.0	.0
71 5 3	13.25	7.827	0.	.0	.0	.0	.0	.0	.0
71 5 3	13.50	7.506	0.	.0	.0	.0	.0	.0	.0
71 5 3	13.75	7.174	0.	.0	.0	.0	.0	.0	.0
71 5 3	14.00	6.837	0.	.0	.0	.0	.0	.0	.0
71 5 3	14.25	6.498	0.	.0	.0	.0	.0	.0	.0
71 5 3	14.50	6.161	0.	.0	.0	.0	.0	.0	.0
71 5 3	14.75	5.828	0.	.0	.0	.0	.0	.0	.0
71 5 3	15.00	5.504	0.	.0	.0	.0	.0	.0	.0
71 5 3	15.25	5.189	0.	.0	.0	.0	.0	.0	.0
71 5 3	15.50	4.885	0.	.0	.0	.0	.0	.0	.0
71 5 3	15.75	4.591	0.	.0	.0	.0	.0	.0	.0
71 5 3	16.00	4.308	0.	.0	.0	.0	.0	.0	.0
71 5 3	16.25	4.036	0.	.0	.0	.0	.0	.0	.0
71 5 3	16.50	3.776	0.	.0	.0	.0	.0	.0	.0
71 5 3	16.75	3.528	0.	.0	.0	.0	.0	.0	.0
71 5 3	17.00	3.298	0.	.0	.0	.0	.0	.0	.0
71 5 3	17.25	3.080	0.	.0	.0	.0	.0	.0	.0
71 5 3	17.50	2.875	0.	.0	.0	.0	.0	.0	.0
71 5 3	17.75	2.681	0.	.0	.0	.0	.0	.0	.0
71 5 3	18.00	2.503	0.	.0	.0	.0	.0	.0	.0
71 5 3	18.25	2.335	0.	.0	.0	.0	.0	.0	.0
71 5 3	18.50	2.177	0.	.0	.0	.0	.0	.0	.0
71 5 3	18.75	2.029	0.	.0	.0	.0	.0	.0	.0
71 5 3	19.00	1.890	0.	.0	.0	.0	.0	.0	.0
71 5 3	19.25	1.758	0.	.0	.0	.0	.0	.0	.0
71 5 3	19.50	1.636	0.	.0	.0	.0	.0	.0	.0
71 5 3	19.75	1.521	0.	.0	.0	.0	.0	.0	.0
71 5 3	20.00	1.405	0.	.0	.0	.0	.0	.0	.0
71 5 3	20.25	1.297	0.	.0	.0	.0	.0	.0	.0
71 5 3	20.50	1.195	0.	.0	.0	.0	.0	.0	.0
71 5 3	20.75	1.100	0.	.0	.0	.0	.0	.0	.0
71 5 3	21.00	.996	0.	.0	.0	.0	.0	.0	.0
71 5 3	21.25	.898	0.	.0	.0	.0	.0	.0	.0
71 5 3	21.50	.806	0.	.0	.0	.0	.0	.0	.0

```
*
GENERATE          ID=2  ISER=102  DT=0.25  DA=129.0  AB=0  FRIMP=0.434
                  IMPERVIOUS AREA  AA=1  N=4.00  TP=1.9  IA=2.0  RC=0.95
                  PERVIOUS AREA      N=2.00  TP=1.9  Smin=111.8  So=111.8
                  SK=0.088  APIK=0.9  APII=60  IA=5.0
BASE FLOW         NSVOL=0  BASMIN=0.0  BFACR=2.0
                  SVOL=10  SWILT=0.01  SFIELD=1.0
                  SLOSKA=0.00005  SLOSKB=0.95
```

- SHAPE CONSTANT, N = 4.000 - UNIT PEAK, QP = .0550 CMS
- THE UH YIELDS .9851 MM VOL SO MULT BY 1.0151 WILL ENSURE A 1 MM UH.

- SHAPE CONSTANT, N = 2.000 - UNIT PEAK, QP = .0393 CMS
- THE UH YIELDS .9778 MM VOL SO MULT BY 1.0227 WILL ENSURE A 1 MM UH.

API REDUCTION FACTOR IS .999E+00 PER TIME STEP OR .900E+00 PER DAY

RECESSION CONSTANT BASE FLOW INVOKED

RAINFALL AND DIRECT RUNOFF TOTALS OVER THE SIMULATION TIME SPAN =====

RAINFALL	PERVIOUS	IMPERVIOUS	TOTAL
(MM)	RUNOFF	RUNOFF	RUNOFF
(MM)	(MM)	(MM)	(MM)
193.0000	117.8919	181.4499	145.4761

ADD SERIES

IDOUT=3 1 1 2

```
ADD BEGINS AT 71 5 3
USES TIME STEP OF .250E+00 HOURS
AND ENDS AT 71 5 10
```

```
*  
DUMP PRINT ID=3  
TIME INCREMENT=.250  
NAME OF SERIES= 1
```

FIRST-ORDER DECAY PARAMETER concentrations are in #s/dl and SS concentrations
re in mg/l

71	5	3	.25	1.456	0.	.0	.0	.0	.0	.0
71	5	3	.50	1.684	0.	.0	.0	.0	.0	.0
71	5	3	.75	2.028	0.	.0	.0	.0	.0	.0
71	5	3	1.00	2.369	0.	.0	.0	.0	.0	.0
71	5	3	1.25	2.836	0.	.0	.0	.0	.0	.0
71	5	3	1.50	3.324	0.	.0	.0	.0	.0	.0
71	5	3	1.75	3.848	0.	.0	.0	.0	.0	.0
71	5	3	2.00	4.409	0.	.0	.0	.0	.0	.0
71	5	3	2.25	4.865	0.	.0	.0	.0	.0	.0
71	5	3	2.50	5.319	0.	.0	.0	.0	.0	.0
71	5	3	2.75	5.745	0.	.0	.0	.0	.0	.0
71	5	3	3.00	6.122	0.	.0	.0	.0	.0	.0
71	5	3	3.25	6.357	0.	.0	.0	.0	.0	.0
71	5	3	3.50	6.506	0.	.0	.0	.0	.0	.0
71	5	3	3.75	6.571	0.	.0	.0	.0	.0	.0
71	5	3	4.00	6.557	0.	.0	.0	.0	.0	.0
71	5	3	4.25	6.497	0.	.0	.0	.0	.0	.0
71	5	3	4.50	6.394	0.	.0	.0	.0	.0	.0
71	5	3	4.75	6.265	0.	.0	.0	.0	.0	.0
71	5	3	5.00	6.124	0.	.0	.0	.0	.0	.0
71	5	3	5.25	6.135	0.	.0	.0	.0	.0	.0
71	5	3	5.50	6.215	0.	.0	.0	.0	.0	.0
71	5	3	5.75	6.381	0.	.0	.0	.0	.0	.0
71	5	3	6.00	6.642	0.	.0	.0	.0	.0	.0
71	5	3	6.25	7.162	0.	.0	.0	.0	.0	.0
71	5	3	6.50	7.863	0.	.0	.0	.0	.0	.0
71	5	3	6.75	8.747	0.	.0	.0	.0	.0	.0
71	5	3	7.00	9.813	0.	.0	.0	.0	.0	.0
71	5	3	7.25	10.929	0.	.0	.0	.0	.0	.0
71	5	3	7.50	12.017	0.	.0	.0	.0	.0	.0
71	5	3	7.75	13.029	0.	.0	.0	.0	.0	.0
71	5	3	8.00	13.919	0.	.0	.0	.0	.0	.0
71	5	3	8.25	14.681	0.	.0	.0	.0	.0	.0
71	5	3	8.50	15.322	0.	.0	.0	.0	.0	.0
71	5	3	8.75	15.854	0.	.0	.0	.0	.0	.0
71	5	3	9.00	16.297	0.	.0	.0	.0	.0	.0
71	5	3	9.25	16.638	0.	.0	.0	.0	.0	.0
71	5	3	9.50	16.861	0.	.0	.0	.0	.0	.0
71	5	3	9.75	16.975	0.	.0	.0	.0	.0	.0
71	5	3	10.00	16.988	0.	.0	.0	.0	.0	.0
71	5	3	10.25	16.915	0.	.0	.0	.0	.0	.0
71	5	3	10.50	16.773	0.	.0	.0	.0	.0	.0
71	5	3	10.75	16.582	0.	.0	.0	.0	.0	.0

71	510	11.00	.0000	0.	.0	.0	.0	.0	.0
71	510	11.25	.0000	0.	.0	.0	.0	.0	.0
71	510	11.50	.0000	0.	.0	.0	.0	.0	.0
71	510	11.75	.0000	0.	.0	.0	.0	.0	.0
71	510	12.00	.0000	0.	.0	.0	.0	.0	.0
71	510	12.25	.0000	0.	.0	.0	.0	.0	.0
71	510	12.50	.0000	0.	.0	.0	.0	.0	.0
71	510	12.75	.0000	0.	.0	.0	.0	.0	.0
71	510	13.00	.0000	0.	.0	.0	.0	.0	.0
71	510	13.25	.0000	0.	.0	.0	.0	.0	.0
71	510	13.50	.0000	0.	.0	.0	.0	.0	.0
71	510	13.75	.0000	0.	.0	.0	.0	.0	.0
71	510	14.00	.0000	0.	.0	.0	.0	.0	.0
71	510	14.25	.0000	0.	.0	.0	.0	.0	.0
71	510	14.50	.0000	0.	.0	.0	.0	.0	.0
71	510	14.75	.0000	0.	.0	.0	.0	.0	.0
71	510	15.00	.0000	0.	.0	.0	.0	.0	.0
71	510	15.25	.0000	0.	.0	.0	.0	.0	.0
71	510	15.50	.0000	0.	.0	.0	.0	.0	.0
71	510	15.75	.0000	0.	.0	.0	.0	.0	.0
71	510	16.00	.0000	0.	.0	.0	.0	.0	.0
71	510	16.25	.0000	0.	.0	.0	.0	.0	.0
71	510	16.50	.0000	0.	.0	.0	.0	.0	.0
71	510	16.75	.0000	0.	.0	.0	.0	.0	.0
71	510	17.00	.0000	0.	.0	.0	.0	.0	.0
71	510	17.25	.0000	0.	.0	.0	.0	.0	.0
71	510	17.50	.0000	0.	.0	.0	.0	.0	.0
71	510	17.75	.0000	0.	.0	.0	.0	.0	.0
71	510	18.00	.0000	0.	.0	.0	.0	.0	.0
71	510	18.25	.0000	0.	.0	.0	.0	.0	.0
71	510	18.50	.0000	0.	.0	.0	.0	.0	.0
71	510	18.75	.0000	0.	.0	.0	.0	.0	.0
71	510	19.00	.0000	0.	.0	.0	.0	.0	.0
71	510	19.25	.0000	0.	.0	.0	.0	.0	.0
71	510	19.50	.0000	0.	.0	.0	.0	.0	.0
71	510	19.75	.0000	0.	.0	.0	.0	.0	.0
71	510	20.00	.0000	0.	.0	.0	.0	.0	.0
71	510	20.25	.0000	0.	.0	.0	.0	.0	.0
71	510	20.50	.0000	0.	.0	.0	.0	.0	.0
71	510	20.75	.0000	0.	.0	.0	.0	.0	.0
71	510	21.00	.0000	0.	.0	.0	.0	.0	.0
71	510	21.25	.0000	0.	.0	.0	.0	.0	.0
71	510	21.50	.0000	0.	.0	.0	.0	.0	.0
71	510	21.75	.0000	0.	.0	.0	.0	.0	.0
71	510	22.00	.0000	0.	.0	.0	.0	.0	.0
71	510	22.25	.0000	0.	.0	.0	.0	.0	.0
71	510	22.50	.0000	0.	.0	.0	.0	.0	.0
71	510	22.75	.0000	0.	.0	.0	.0	.0	.0
71	510	23.00	.0000	0.	.0	.0	.0	.0	.0
71	510	23.25	.0000	0.	.0	.0	.0	.0	.0
71	510	23.50	.0000	0.	.0	.0	.0	.0	.0
71	510	23.75	.0000	0.	.0	.0	.0	.0	.0
71	510	24.00	.0000	0.	.0	.0	.0	.0	.0

REACH

IDOUT=4 ISER=105 NDIH=1 ID=3 NIDL=0 IFAORM=2
NELS=3 SMAX=2.5 XLEN=1000 RTINC=0.0625 RN=0.04
SF=0.005 SS=0.5 B=100

CALCULATED CHANNEL CURVE:

STAGE (M)	STORAGE COEFF. (CMS)	FLOW (CMS)	AREA {HORIZ.} (M**2)	VOLUME (M**3)
.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
.104E+00	.484E+02	.408E+01	.100E+06	.104E+05
.208E+00	.995E+02	.130E+02	.101E+06	.209E+05
.313E+00	.152E+03	.255E+02	.101E+06	.314E+05
.417E+00	.207E+03	.412E+02	.102E+06	.420E+05
.521E+00	.264E+03	.597E+02	.102E+06	.526E+05
.625E+00	.322E+03	.810E+02	.103E+06	.633E+05
.729E+00	.381E+03	.105E+03	.103E+06	.740E+05
.833E+00	.442E+03	.131E+03	.103E+06	.847E+05
.938E+00	.504E+03	.159E+03	.104E+06	.955E+05
.104E+01	.568E+03	.190E+03	.104E+06	.106E+06
.115E+01	.632E+03	.223E+03	.105E+06	.117E+06
.125E+01	.698E+03	.258E+03	.105E+06	.128E+06
.135E+01	.765E+03	.295E+03	.105E+06	.139E+06
.146E+01	.834E+03	.333E+03	.106E+06	.150E+06
.156E+01	.903E+03	.374E+03	.106E+06	.161E+06
.167E+01	.974E+03	.417E+03	.107E+06	.172E+06
.177E+01	.105E+04	.462E+03	.107E+06	.183E+06
.187E+01	.112E+04	.508E+03	.108E+06	.195E+06
.198E+01	.119E+04	.556E+03	.108E+06	.206E+06
.208E+01	.127E+04	.606E+03	.108E+06	.217E+06
.219E+01	.134E+04	.658E+03	.109E+06	.228E+06
.229E+01	.142E+04	.711E+03	.109E+06	.240E+06
.240E+01	.150E+04	.766E+03	.110E+06	.251E+06
.250E+01	.158E+04	.823E+03	.110E+06	.263E+06

TIME STEP OF INPUT FILE IS .250 HOURS
CALCULATION STEP SELECTED IS .0625 HOURS

*DUMP PRINT

ID=4

GENERATE

ID=5 ISER=103 DT=0.25 DA=71.0 AB=0 FRIMP=0.093
IMPERVIOUS AREA AA=1 N=4.00 TP=2.9 IA=2.0 RC=0.95

PERVIOUS AREA AA=1 N=2.00 TP=2.9 Smin=111.5 So=111.5
 SK=0.088 APIK=0.9 APII=60 IA=5.0
 BASE FLOW NSVOL=0 BASMIN=0.0 BFACR=2.0
 SVOL=10 SWILT=0.01 SFIELD=1.0
 SLOSKA=0.00005 SLOSKB=0.95

===== IMPERVIOUS AREA UNIT HYDROGRAPH DATA =====

- SHAPE CONSTANT, N = 4.000 - UNIT PEAK, QP = .0043 CMS
 - THE UH YIELDS .9859 MM VOL SO MULT BY 1.0143 WILL ENSURE A 1 MM UH.

===== PERVIOUS AREA UNIT HYDROGRAPH DATA =====

- SHAPE CONSTANT, N = 2.000 - UNIT PEAK, QP = .0227 CMS
 - THE UH YIELDS .9784 MM VOL SO MULT BY 1.0221 WILL ENSURE A 1 MM UH.

API REDUCTION FACTOR IS .999E+00 PER TIME STEP OR .900E+00 PER DAY

RECESSION CONSTANT BASE FLOW INVOKED

RAINFALL AND DIRECT RUNOFF TOTALS OVER THE SIMULATION TIME SPAN =====

RAINFALL (MM)	PERVIOUS RUNOFF (MM)	IMPERVIOUS RUNOFF (MM)	TOTAL RUNOFF (MM)
193.0000	118.0100	181.4499	123.9099

* DUMP PRINT ID=5

* ADD SERIES IDOUT=6 1 4 5

ADD BEGINS AT 71 5 3
 USES TIME STEP OF .250E+00 HOURS
 AND ENDS AT 71 5 10

* DUMP PRINT ID=6
 TIME INCREMENT= .250
 NAME OF SERIES= 1

FIRST-ORDER DECAY PARAMETER concentrations are in #s/dl and SS concentrations are in mg/l

71 5 3 .25	.384	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 .50	.571	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 .75	.799	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 1.00	1.038	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 1.25	1.321	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 1.50	1.622	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 1.75	1.944	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 2.00	2.290	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 2.25	2.612	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 2.50	2.950	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 2.75	3.300	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 3.00	3.658	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 3.25	3.986	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 3.50	4.300	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 3.75	4.594	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 4.00	4.861	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 4.25	5.106	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 4.50	5.396	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 4.75	5.763	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 5.00	6.040	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 5.25	6.309	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 5.50	6.549	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 5.75	6.781	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 6.00	7.023	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 6.25	7.366	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 6.50	7.788	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 6.75	8.310	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 7.00	8.950	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 7.25	9.667	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 7.50	10.471	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 7.75	11.337	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 8.00	12.234	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 8.25	13.137	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 8.50	14.022	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 8.75	14.868	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 9.00	15.666	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 9.25	16.556	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 9.50	17.373	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 9.75	18.038	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 10.00	18.562	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 10.25	18.954	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 10.50	19.226	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 10.75	19.390	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 11.00	19.462	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 11.25	19.450	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 11.50	19.361	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 11.75	19.205	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 12.00	18.988	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 12.25	18.707	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 12.50	18.361	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 12.75	17.948	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 13.00	17.469	0.	.0	.0	.0	.0	.0	.0	.0
71 5 3 13.25	16.927	0.	.0	.0	.0	.0	.0	.0	.0

$Q_{TIMMINS} = 19.46 \text{ m}^3/\text{s}$
 @ $t = 11.0 \text{ hrs}$

WATERCOURSE #1

QUALHYMO OUTPUT
SUMMARY

Watercourse #1 Peak Flows

Storm Event	Time To Peak	Peak Flow
-	<i>hrs</i>	<i>m³/s</i>
2-Year	6.50	4.4
5-Year	6.50	6.6
10-Year	6.25	8.6
25-Year	6.25	10.3
50-Year	6.25	11.2
100-Year	6.25	12.9
Timmins	11.00	19.5

Per QUALHYMO Model (GSCA, 1993)

APPENDIX B

Hydraulic Model Sections

Cross Section for Existing Conditions - West Spill Flow Route (Aquavil

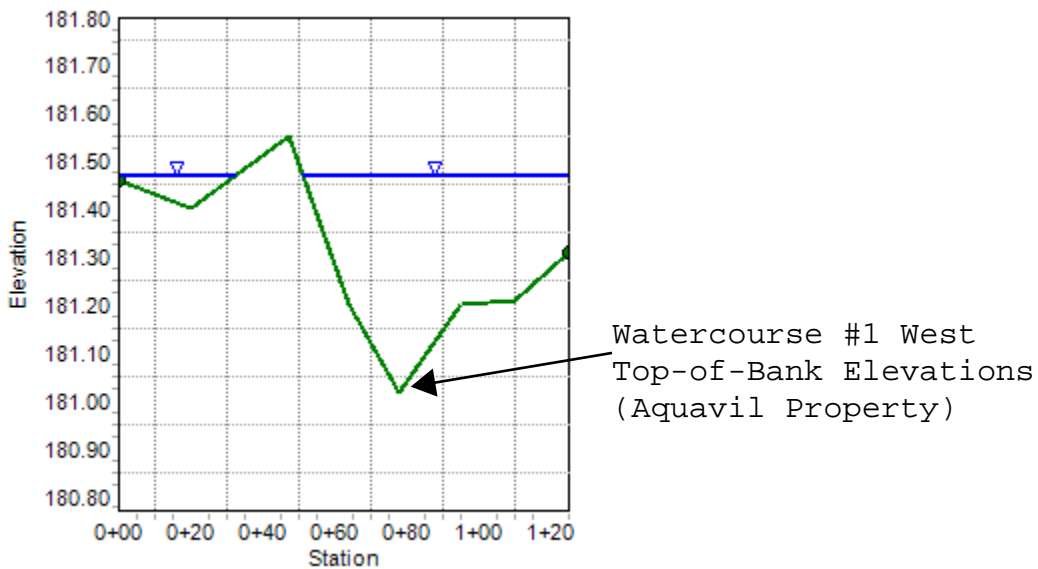
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00220	m/m
Normal Depth	0.45	m
Discharge	5.68	m³/s

Cross Section Image



<-- HWY 26 (South) Georgian Bay (North) -->

Project Description

Input Data

Station (m)	Elevation (m)
-------------	---------------

Roughness Segment Definitions

Water Surface Elevation (m)	Discharge (m³/s)	Velocity (m/s)	Flow Area (m²)	Wetted Perimeter (m)	Top Width (m)
181.05	0.00	0.05	0.08	5.17	5.17
181.10	0.05	0.09	0.55	13.78	13.78
181.15	0.18	0.13	1.46	22.39	22.39
181.20	0.44	0.16	2.79	31.00	31.00
181.25	0.85	0.16	5.20	54.43	54.43
181.30	1.61	0.20	8.17	64.36	64.36

Rating Table for Existing Conditions - West Spill Flow Route

Input Data

Water Surface Elevation (m)	Discharge (m³/s)	Velocity (m/s)	Flow Area (m²)	Wetted Perimeter (m)	Top Width (m)
181.35	2.74	0.24	11.51	68.33	68.29
181.40	4.16	0.28	14.99	70.81	70.71
181.45	5.04	0.26	19.22	98.95	98.81
181.50	6.93	0.28	24.60	113.81	113.57

Existing Conditions Cross Section- East Flow Route (Long Point Road)

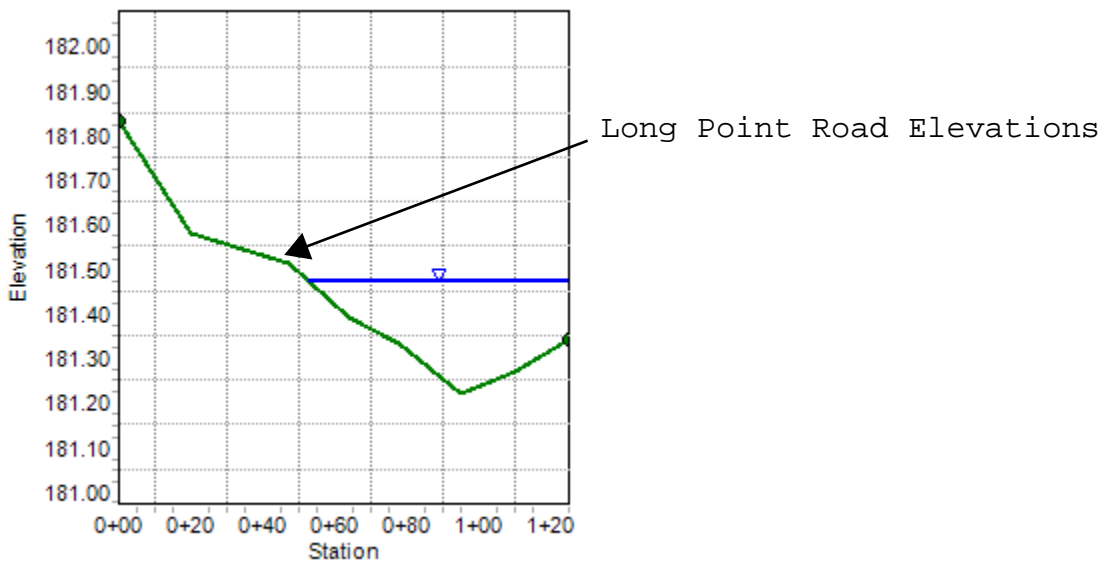
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00311	m/m
Normal Depth	0.25	m
Discharge	13.75	m³/s

Cross Section Image



<-- HWY 26 (South) Georgian Bay (North)-->

Project Description

Friction Method	Manning Formula
-----------------	-----------------

Solve For Discharge

Channel Slope	0.00311	m/m
---------------	---------	-----

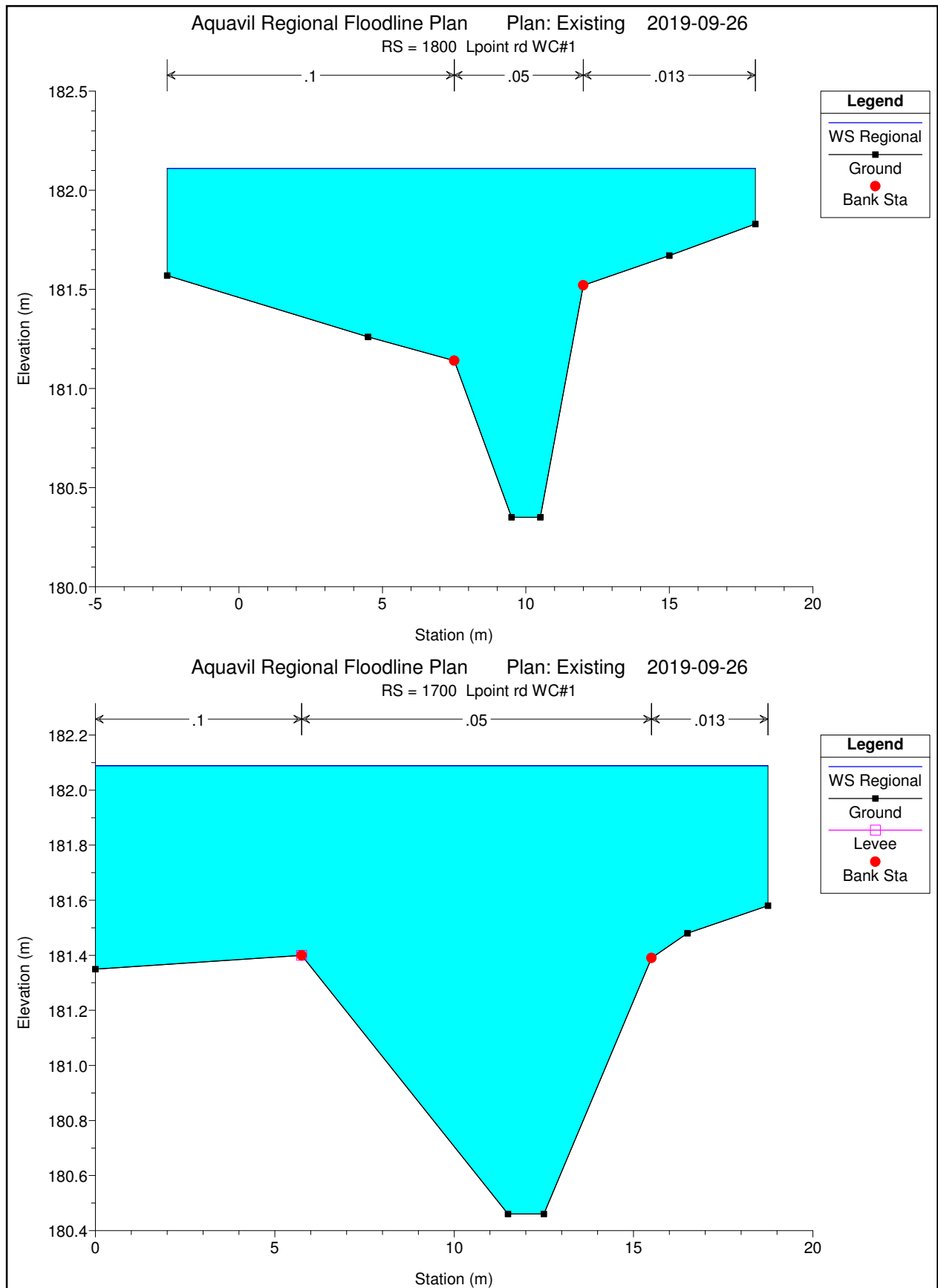
Normal Depth 0.25 m

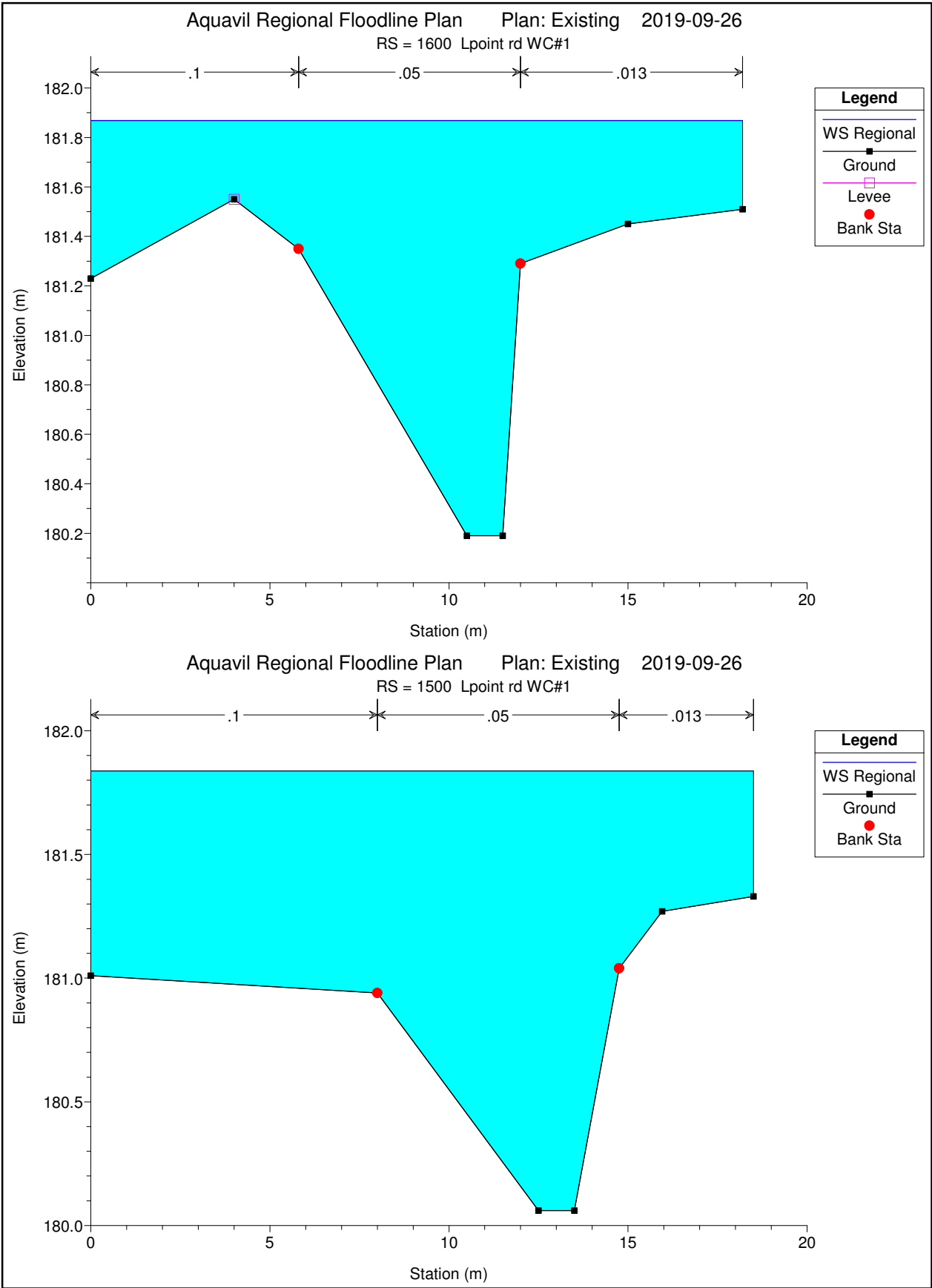
Station (m)	Elevation (m)
-------------	---------------

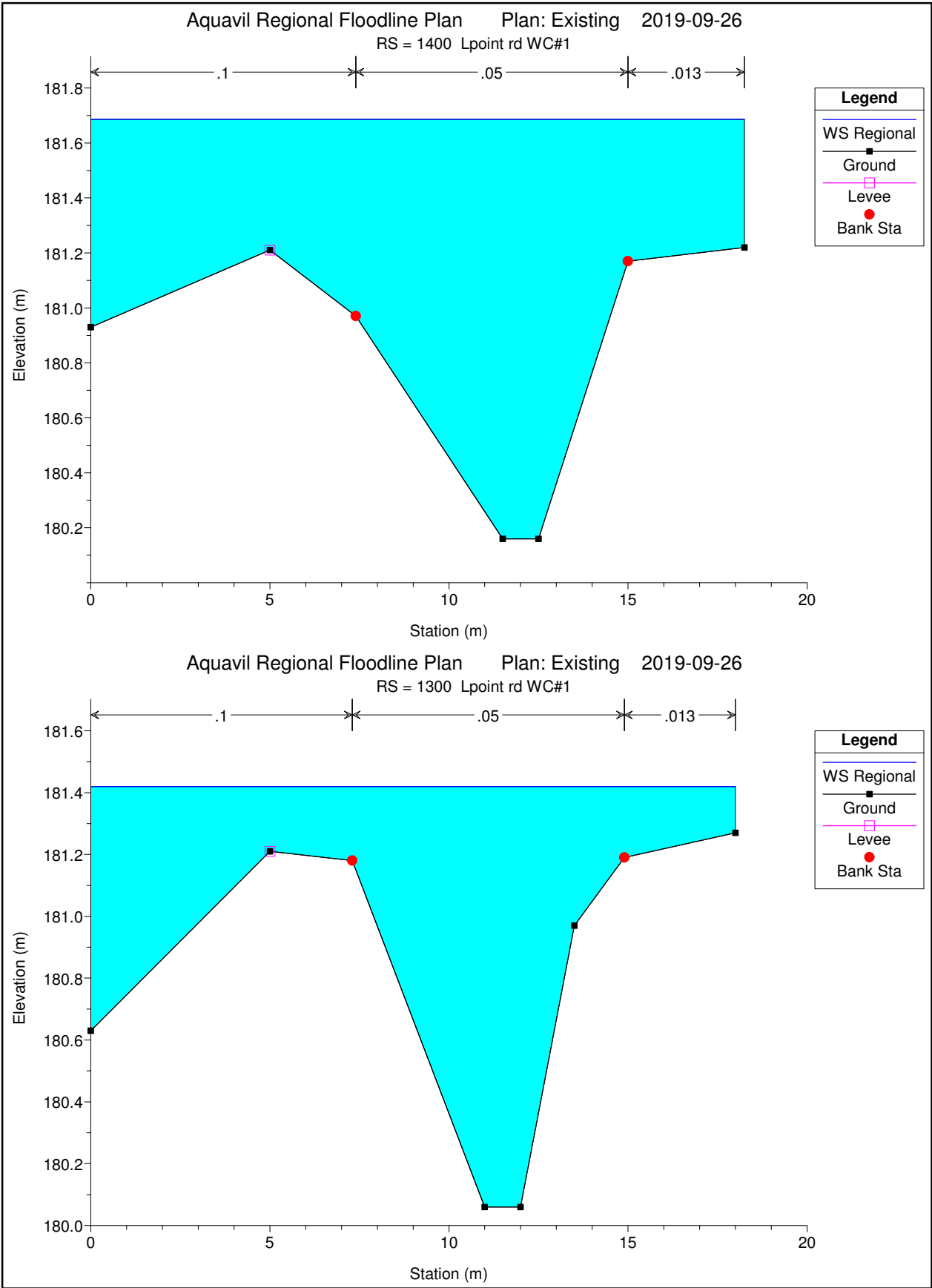
Roughness Segment Definitions

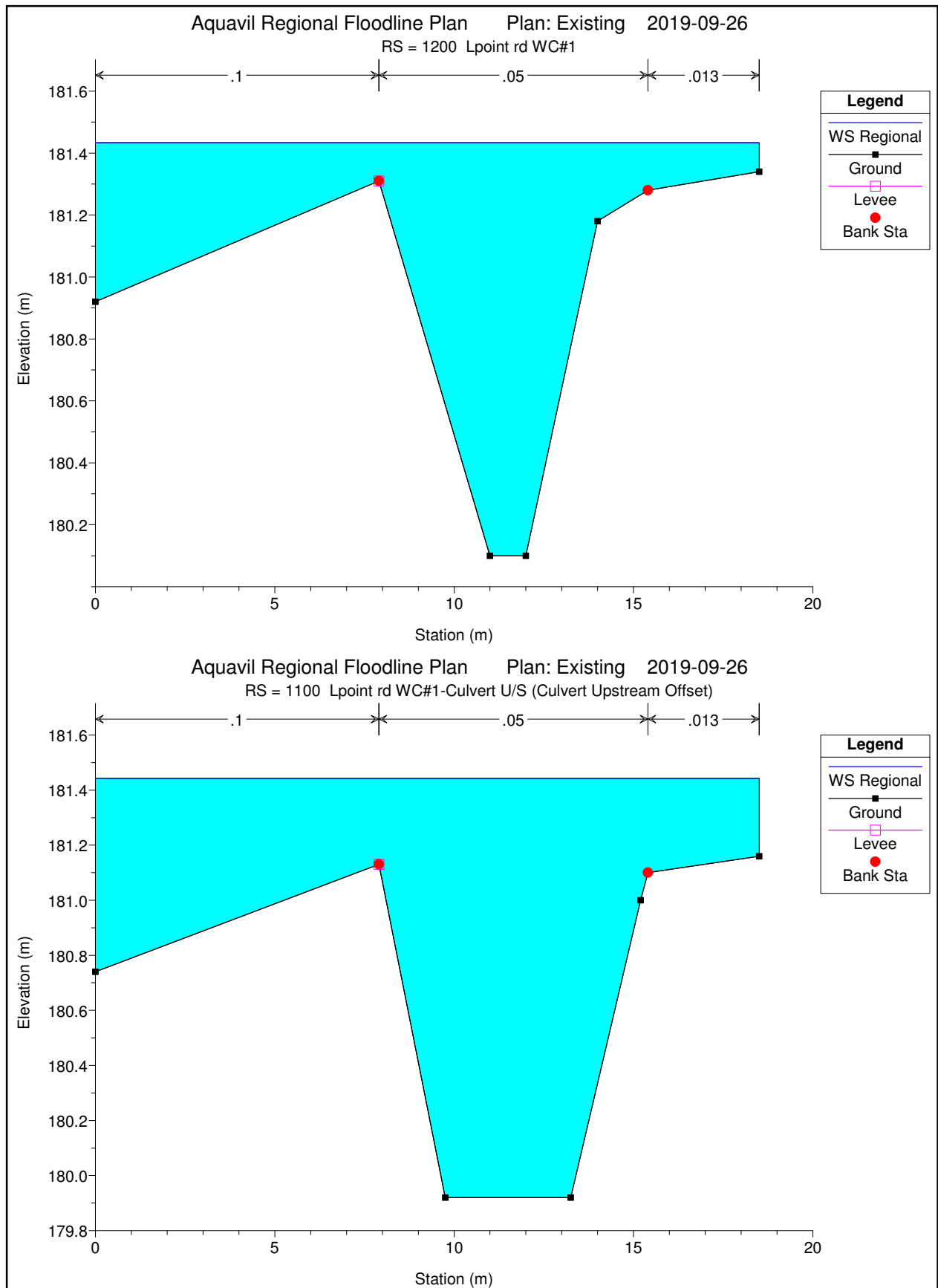
(0+00, 181.83)	(1+25, 181.34)	0.013
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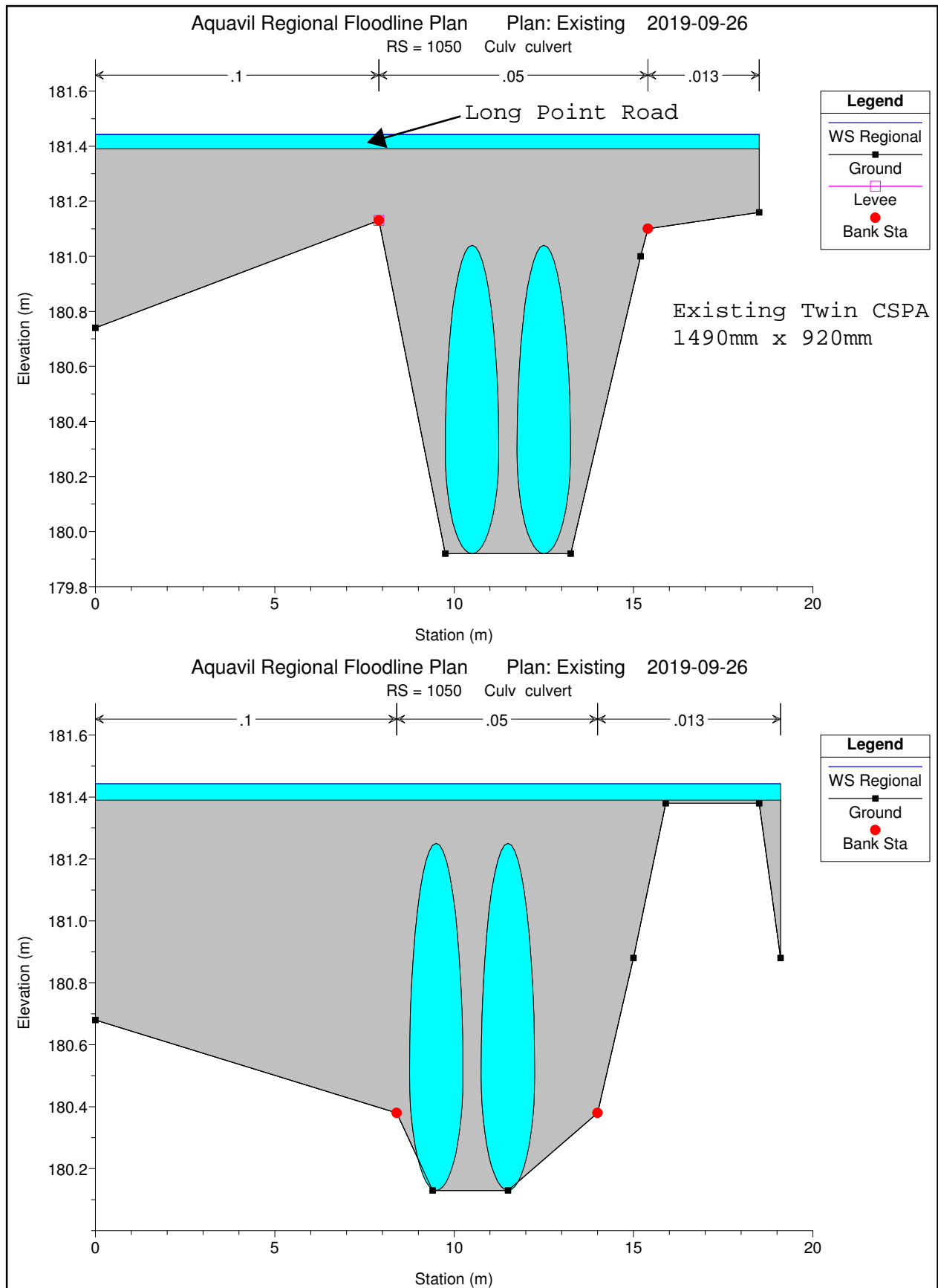
Bentley Systems, Inc. Haestad Methods Solution Center
2019-09-26 4:46:02 PM 27 Siemens Company Drive Suite 200 W Watertown, CT 06795 USA +1-203-755-1666 Page 1 of 1

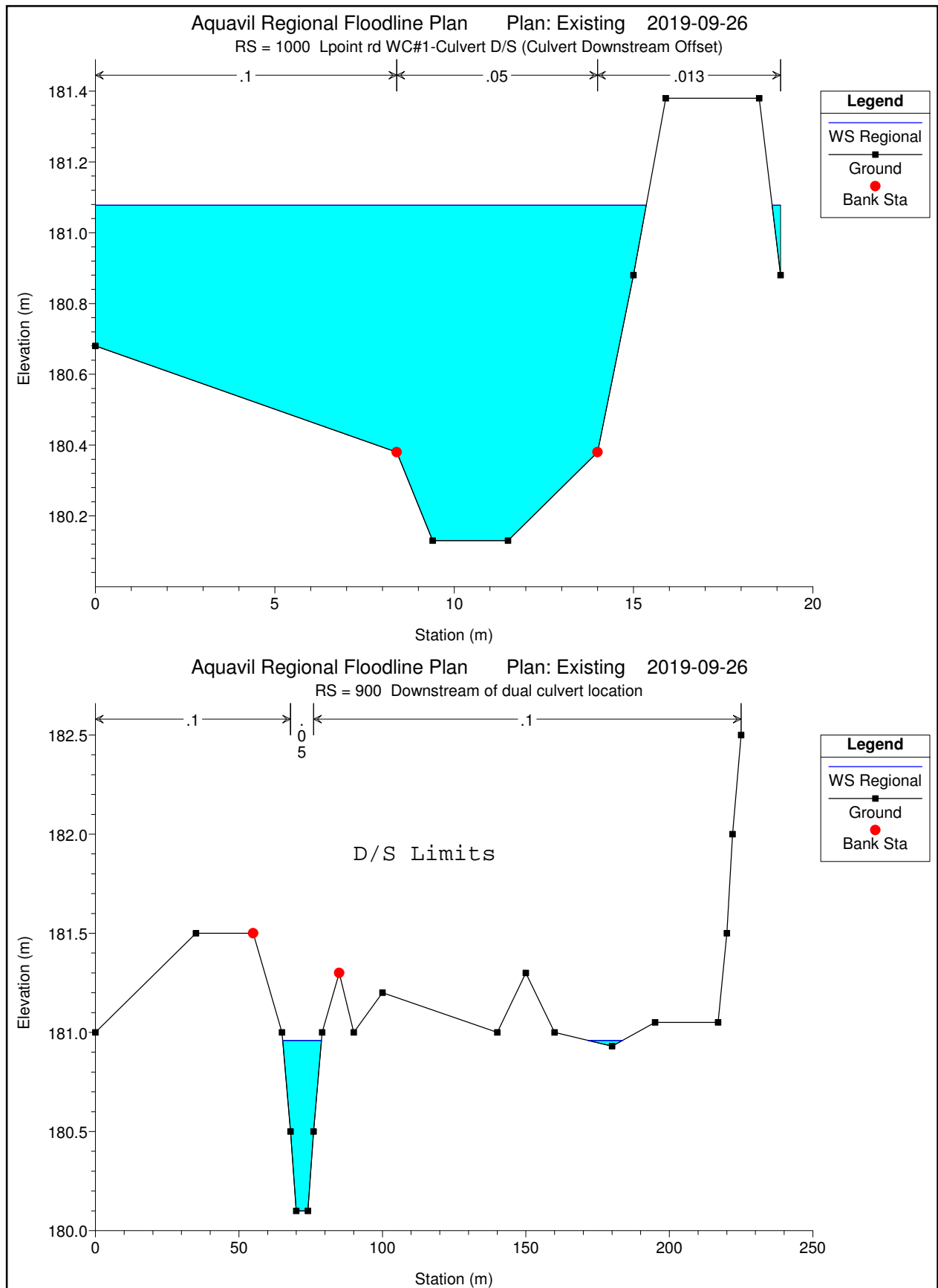


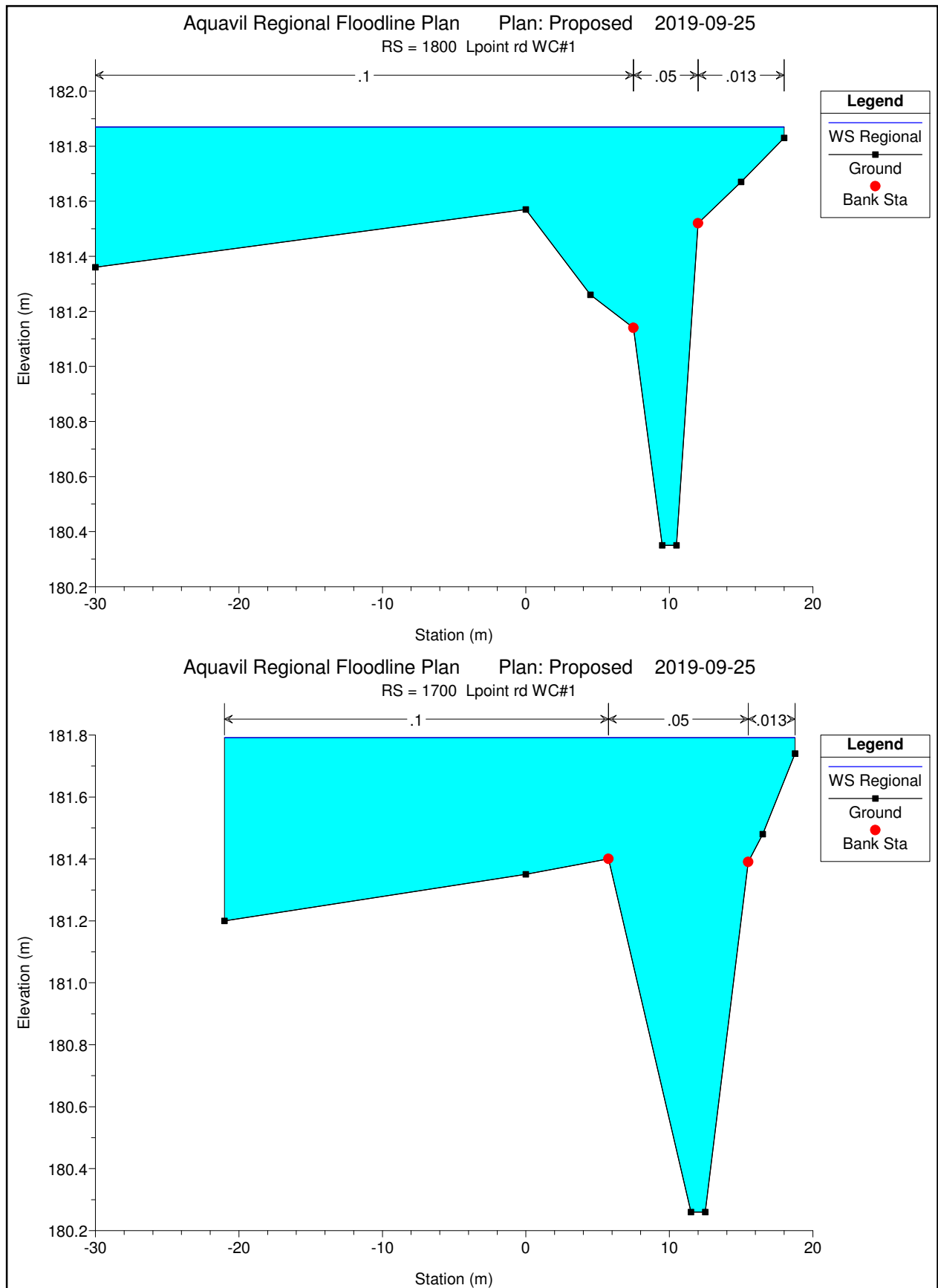


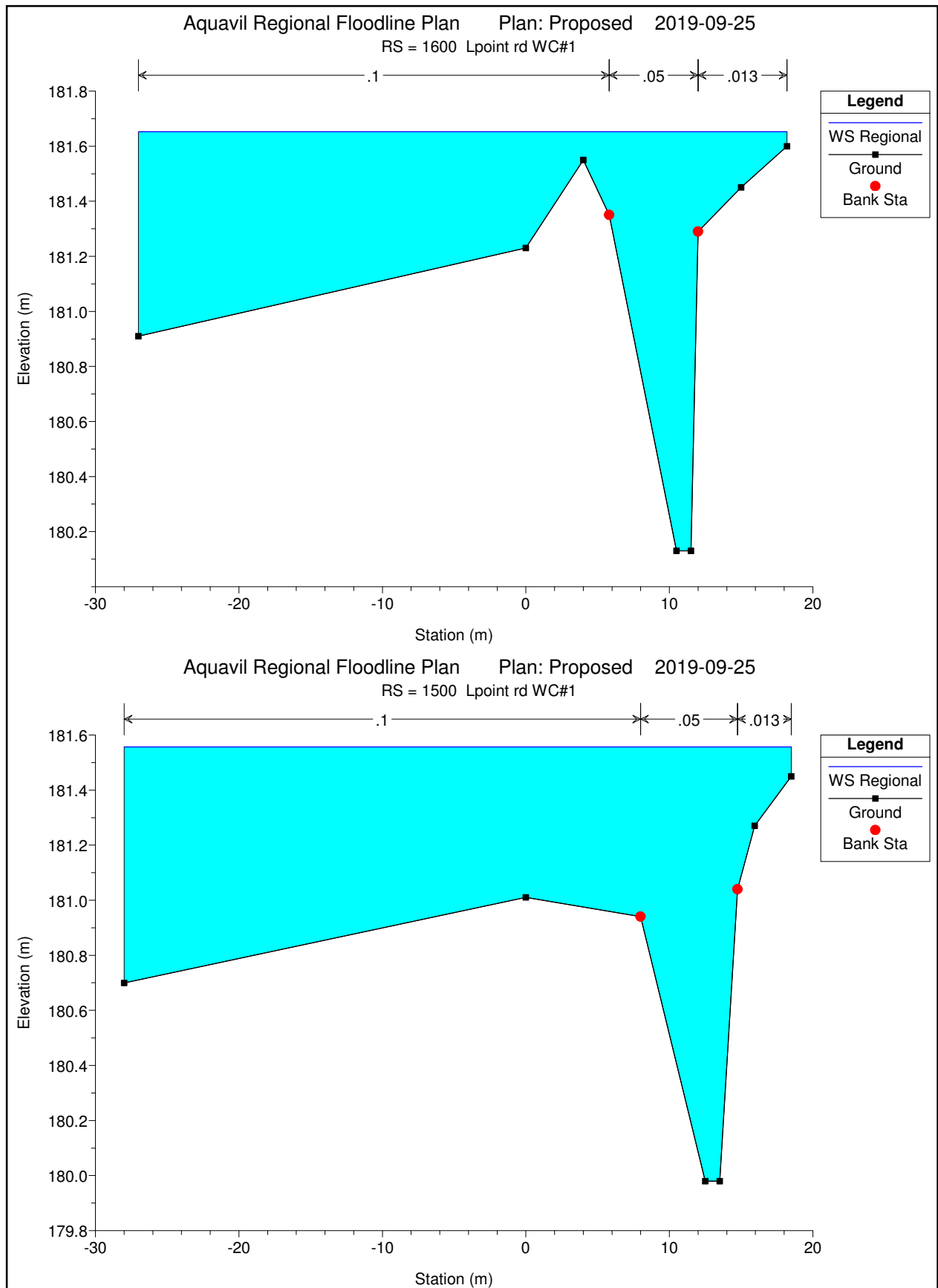


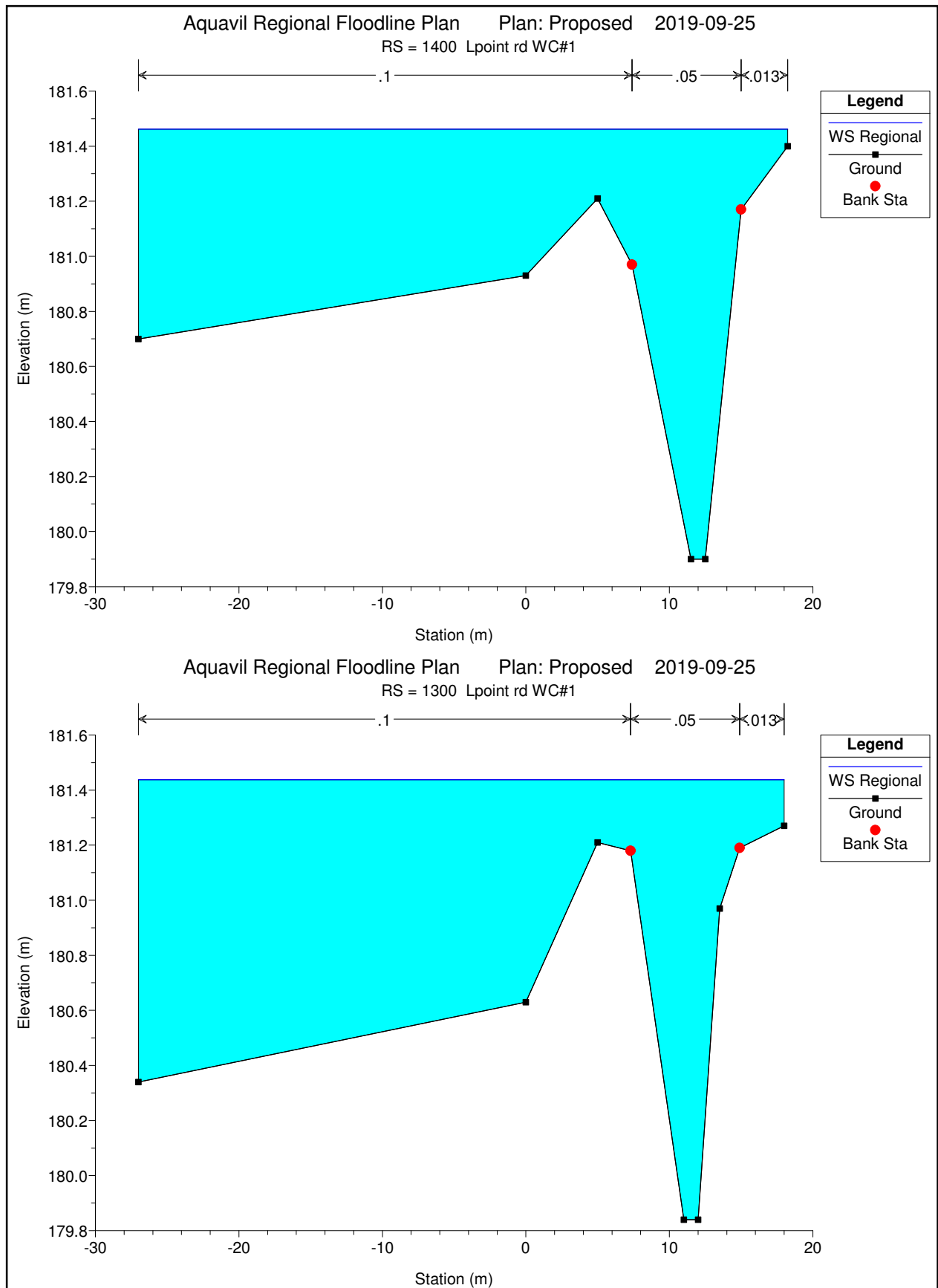


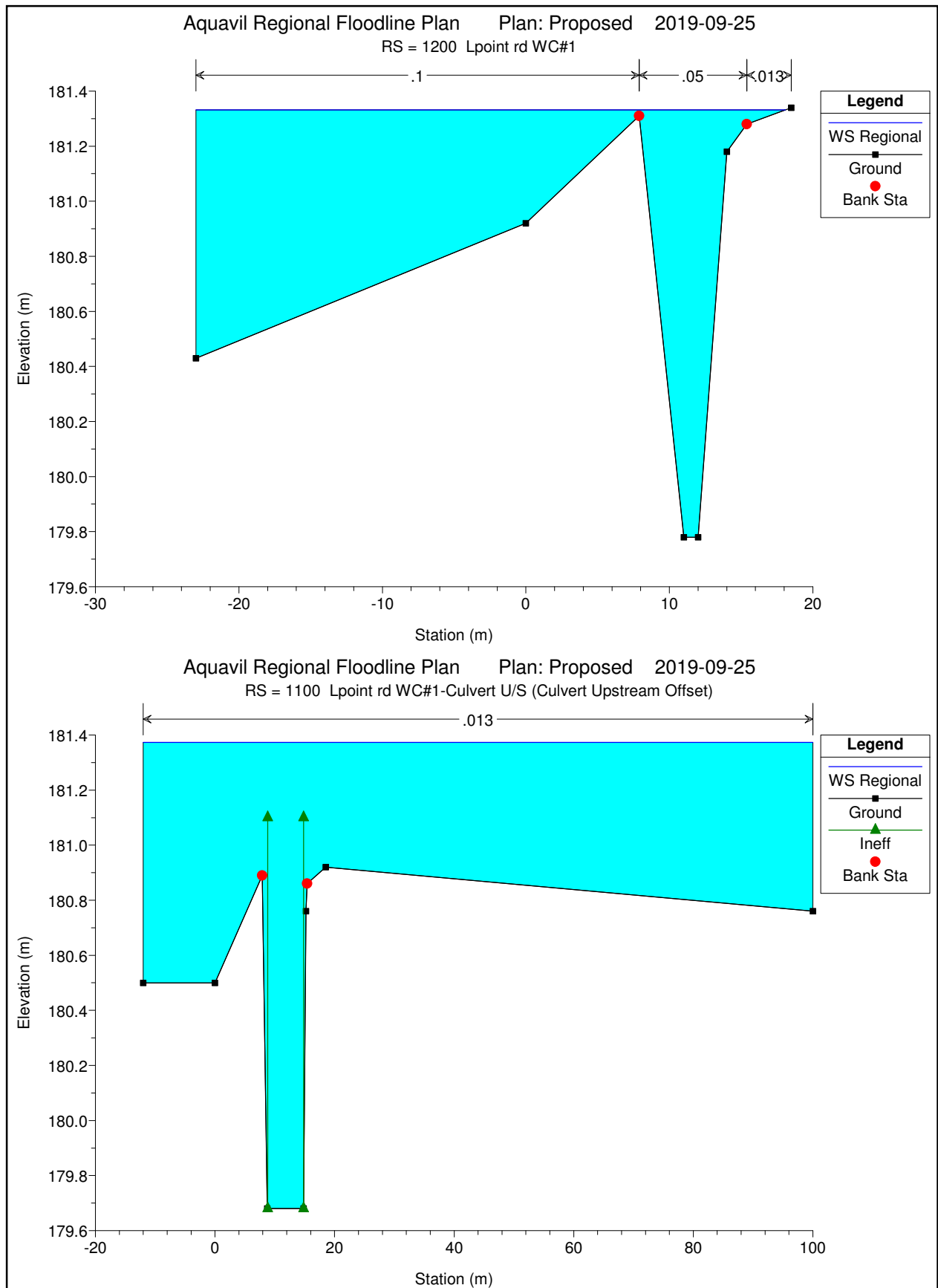


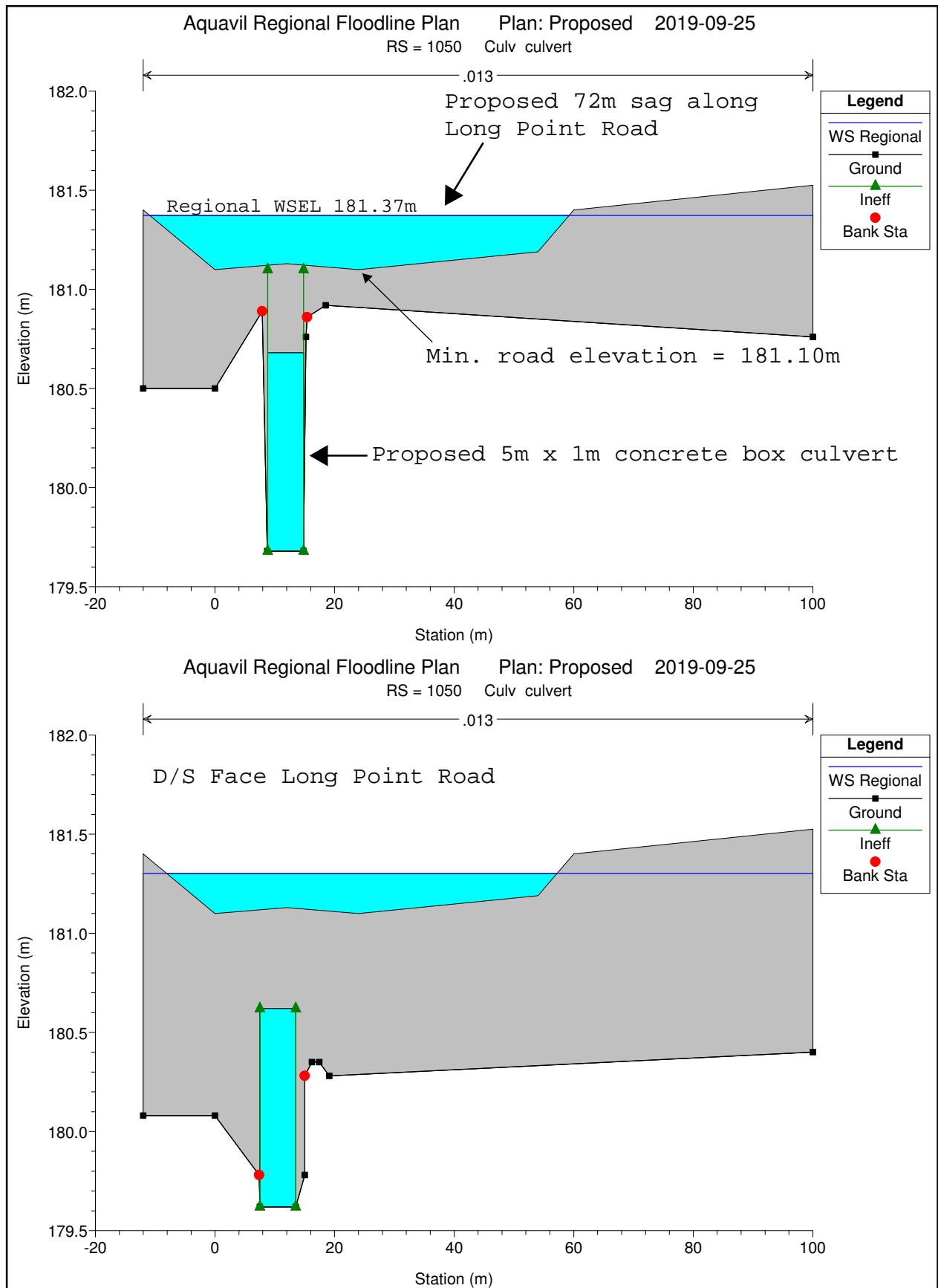


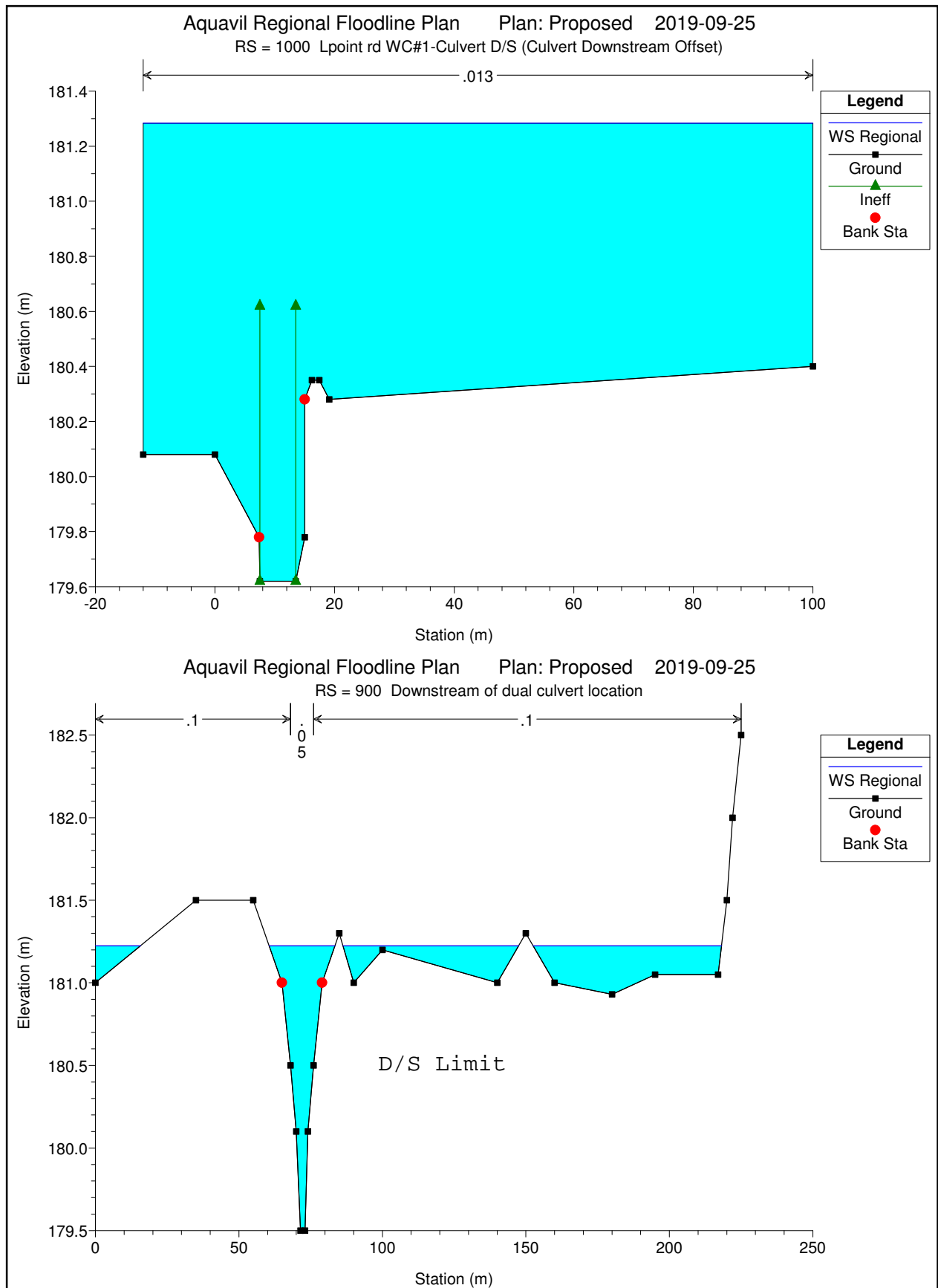












APPENDIX C

Hydraulic Model Results

Project Description

Input Data

Station (m)	Elevation (m)
0	100.00
10	100.00
20	100.00
30	100.00
40	100.00
50	100.00
60	100.00
70	100.00
80	100.00
90	100.00
100	100.00

Roughness Segment Definitions

Options

Results

Bentley Systems, Inc. Haestad Methods Solution Center, MicroStation V8i (SELECTseries 1) [08.11.01.03]

Existing Conditions - West Spill Flow Route (Aquavil Lands)

Results

Top Width	106.71	m
Normal Depth	0.45	m
Critical Depth	0.24	m
Critical Slope	0.07572	m/m
Velocity	0.27	m/s
Velocity Head	0.00	m
Specific Energy	0.45	m
Froude Number	0.19	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.45	m
Critical Depth	0.24	m
Channel Slope	0.00220	m/m
Critical Slope	0.07572	m/m

Worksheet for Existing Conditions - East Flow Route (Long Point Road)

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00311	m/m
Normal Depth	0.25	m

Section Definitions

Station (m)	Elevation (m)
0+00	181.83
0+20	181.58
0+47	181.51
0+64	181.39
0+78	181.33
0+95	181.22
1+10	181.27
1+25	181.34

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 181.83)	(1+25, 181.34)	0.013

Options

Current Roughness weighted Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results

Discharge	13.75	m³/s
Elevation Range	181.22 to 181.83 m	
Flow Area	11.16	m²
Wetted Perimeter	72.46	m
Hydraulic Radius	0.15	m

Worksheet for Existing Conditions - East Flow Route (Long Point Road)

Results

Top Width	72.33	m
Normal Depth	0.25	m
Critical Depth	0.25	m
Critical Slope	0.00310	m/m
Velocity	1.23	m/s
Velocity Head	0.08	m
Specific Energy	0.33	m
Froude Number	1.00	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.25	m
Critical Depth	0.25	m
Channel Slope	0.00311	m/m
Critical Slope	0.00310	m/m

Existing Conditions

HEC-RAS Plan: Existing River: Pretty Reach: Main Profile: Regional

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
Main	1800	Regional	19.50	180.35	182.11		182.28	0.003759	1.41	16.48	20.50	0.38
Main	1700	Regional	19.50	180.46	182.09	181.63	182.21	0.002534	1.13	17.80	18.75	0.33
Main	1600	Regional	19.50	180.19	181.87	181.61	182.10	0.004656	1.41	12.82	18.20	0.41
Main	1500	Regional	19.50	180.06	181.84		181.97	0.002475	1.19	18.50	18.50	0.32
Main	1400	Regional	19.50	180.16	181.69	181.37	181.87	0.004672	1.46	14.78	18.25	0.44
Main	1300	Regional	19.50	180.06	181.42	181.40	181.73	0.021533	2.45	9.75	18.00	0.87
Main	1275		Lat Struct	West spill to Aquavil lands								
Main	1225		Lat Struct	East flood flow route (Long Point Road)								
Main	1200	Regional	6.66	180.10	181.43	181.03	181.48	0.004163	1.00	8.37	18.50	0.37
Main	1100	Regional	6.66	179.92	181.44	180.57	181.46	0.000713	0.57	14.00	18.50	0.17
Main	1050		Culvert	Long Point Road								
Main	1000	Regional	6.66	180.13	181.08		181.12	0.002414	0.89	9.97	15.59	0.30
Main	900	Regional	6.66	180.10	180.96	180.62	181.00	0.004005	0.91	7.51	25.54	0.39

Q=4.5m³/s
Q=8.5m³/s

* Used to determine split flow distribution

Existing Conditions
Split Flow Summary

HEC-RAS Plan: Existing River: Pretty Reach: Main Profile: Regional

Reach	River Sta	Profile	Q US (m3/s)	Q Leaving Total (m3/s)	Q DS (m3/s)	Q Weir (m3/s)	Q Gates (m3/s)	Wr Top Width (m)	Weir Max Depth (m)	Weir Avg Depth (m)	Min El Weir Flow (m)	E.G. US. (m)	W.S. US. (m)	E.G. DS (m)	W.S. DS (m)
Main	1275	Regional	19.50	4.51	6.66	0.00	0.00	0.00	0.00	0.00	0.00	181.73	181.42	181.73	181.42
Main	1225	Regional	19.50	8.11	6.66	0.00	0.00	0.00	0.00	0.00	0.00	181.73	181.42	181.73	181.42

West Spill (Aquavil) - River Sta. 1275
East Flow (Long Point Road) - River Sta. 1225

Existing Conditions
Sensitivity for D/S
Impact Assessment

HEC-RAS Plan: Ex (Sens) River: Pretty Reach: Main Profile: Regional

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
Main	1800	Regional	19.50	180.35	182.13		182.30	0.003377	1.36	16.97	20.50	0.36
Main	1700	Regional	19.50	180.46	182.12	181.63	182.23	0.002291	1.09	18.35	18.75	0.31
Main	1600	Regional	19.50	180.19	181.94	181.62	182.15	0.003353	1.24	14.10	18.20	0.35
Main	1500	Regional	19.50	180.06	181.93		182.04	0.001850	1.07	20.15	18.50	0.28
Main	1400	Regional	19.50	180.16	181.83	181.37	181.98	0.002730	1.21	17.42	18.25	0.34
Main	1300	Regional	19.50	180.06	181.75	181.39	181.93	0.004321	1.38	15.74	18.00	0.41
Main	1275		Lat Struct	West Flow Route Not applicable in this scenario								
Main	1225		Lat Struct	East Flow Route								
Main	1200	Regional	15.00	180.10	181.73	181.42	181.85	0.004170	1.25	13.77	18.50	0.40
Main	1100	Regional	15.00	179.92	181.76		180.96	0.001196	0.86	19.81	18.50	0.22
Main	1050		Culvert	Long Point Road								
Main	1000	Regional	15.00	180.13	181.31		181.44	0.004482	1.42	13.74	16.30	0.43
Main	900	Regional	15.00	180.10	181.21	180.91	181.25	0.004007	0.95	32.50	162.79	0.42

$$Q_{\text{total}} = \text{Main Channel} + \text{East Flow Route}$$

Proposed Conditions

HEC-RAS Plan: Proposed River: Pretty Reach: Main Profile: Regional

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
Main	1800	Regional	19.50	180.35	181.87		181.98	0.007357	1.74	22.55	48.00	0.52
Main	1700	Regional	19.50	180.26	181.79		181.86	0.004181	1.28	23.97	39.75	0.41
Main	1600	Regional	19.50	180.13	181.65		181.73	0.005694	1.39	24.69	45.20	0.44
Main	1500	Regional	19.50	179.98	181.56		181.60	0.002647	1.08	33.10	46.50	0.32
Main	1400	Regional	19.50	179.90	181.46		181.51	0.003788	1.24	28.97	45.25	0.38
Main	1300	Regional	19.50	179.84	181.44		181.46	0.002418	0.89	36.59	45.00	0.29
Main	1200	Regional	19.50	179.78	181.33		181.40	0.009249	1.52	22.73	41.07	0.55
Main	1100	Regional	19.50	179.68	181.37	180.71	181.38	0.000020	0.41	72.51	112.00	0.11
Main	1050		Culvert			Long Point Road						
Main	1000	Regional	19.50	179.62	181.28	180.62	181.29	0.000004	0.21	117.23	112.00	0.05
Main	900	Regional	19.50	179.50	181.22	180.87	181.28	0.004001	1.18	36.40	165.53	0.40

Q_{total} = Entire approach flow due to elimination of
spill flow from Aquavil lands

* Includes flood mitigation measures:

- 1) 5.0m x 1.0m concrete box culvert
- 2) Roadway sag

Proposed Conditions

HEC-RAS Plan: Proposed River: Pretty Reach: Main Profile: Regional

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(m)	(m)	(m)	(m)	(m)	(m ³ /s)	(m ³ /s)	(m)	(m/s)	(m/s)
Main	1050 Culvert #1	Regional	181.38	181.37	181.29	181.38	181.10	7.01	12.49	0.09	1.17	1.17

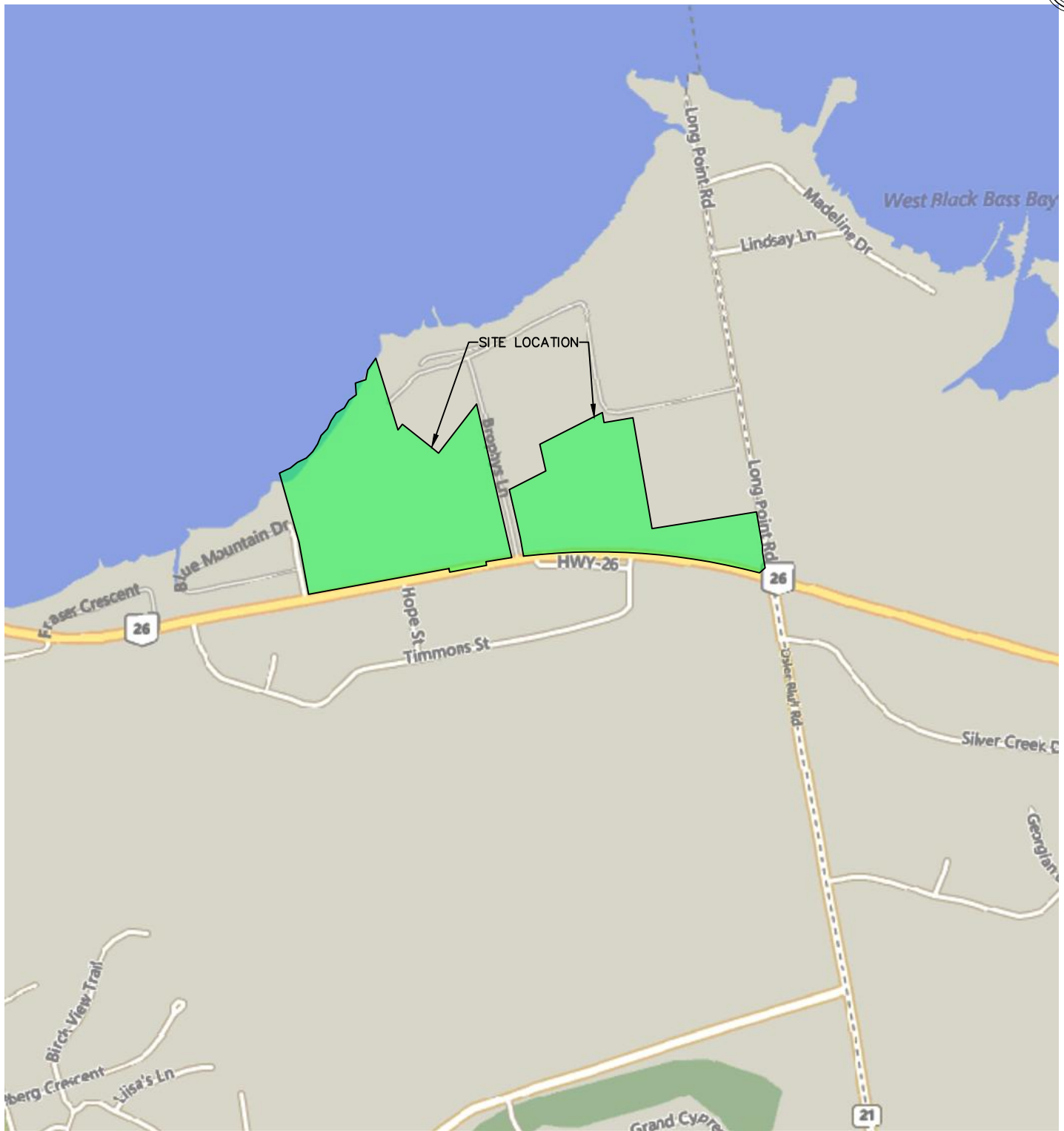
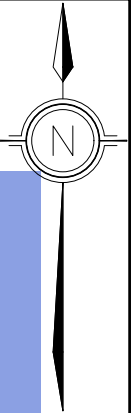
1) 2)

1) Main Channel Flow Capacity


2) East Overland Flow Route

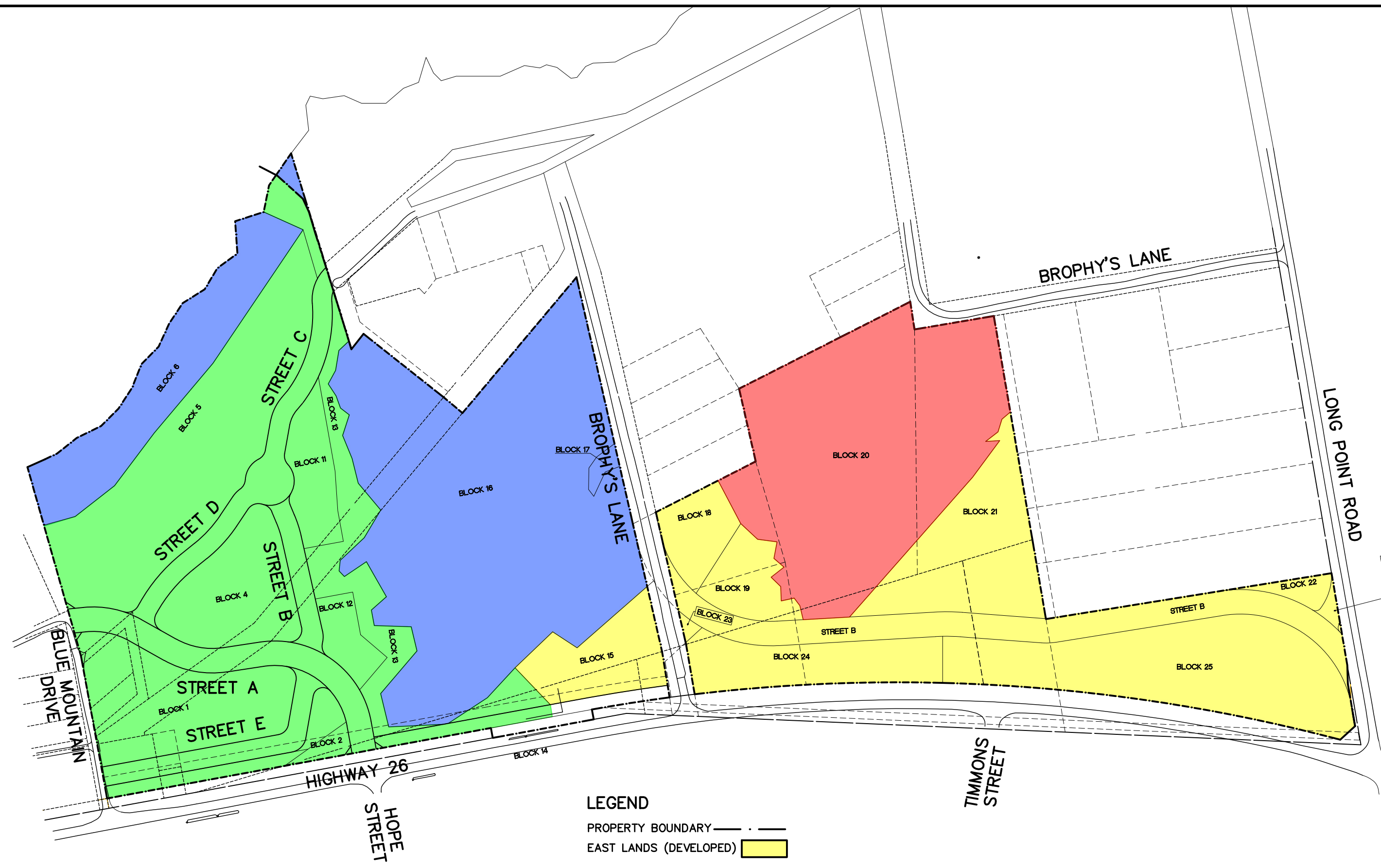
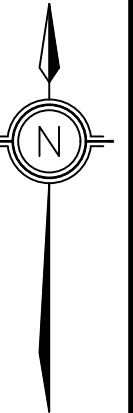
FIGURES

FIGURE 1	Site Location Plan
FIGURE 2	Draft Plan
FIGURE 3	Development Concept Plan
FIGURE 4	Regional Floodline (GSCA, 1993)
FIGURE 5	Existing Conditions Regional Flood Plan
FIGURE 6	Post-Development Conditions Regional Flood Plan
FIGURE 7	Photographic Summary of Existing Flood Prone Areas
FIGURE 8	Flood Mitigation Plan




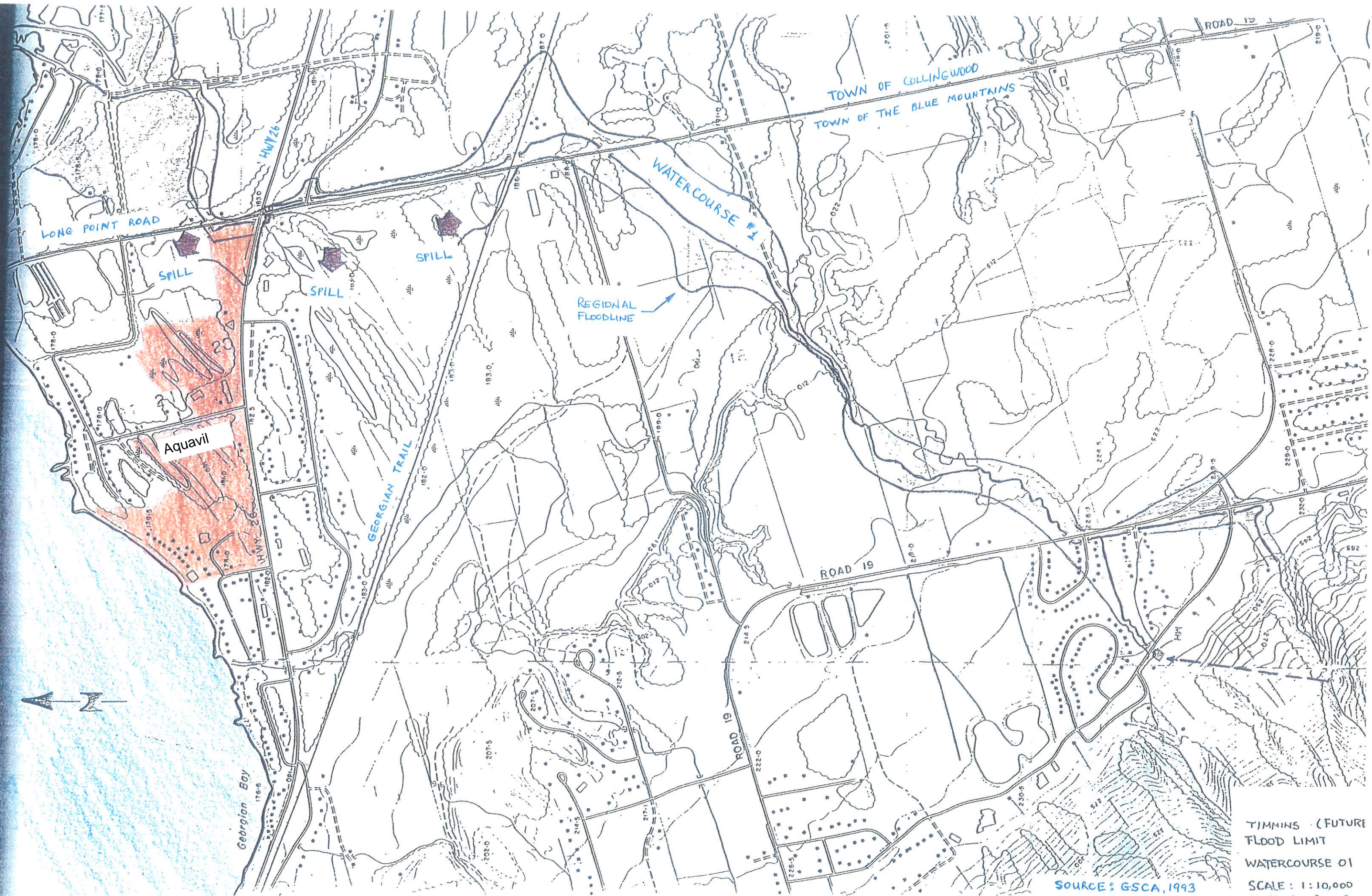
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Project		AQUAVIL TOWN OF THE BLUE MOUNTAINS		 <div>CROZIER CONSULTING ENGINEERS</div> <div>8 MARKET STREET SUITE 600 TORONTO, ON M5E 1M6 416-477-3392 T WWW.CFCROZIER.CA</div>										
Drawing		SITE LOCATION												
Drawn By		M.V.R.	Design By		M.V.R.	Project		876-4866						
Scale		1:12500		Date		SEP/27/2019		Check By		B.H.	Drawing		FIG 1	



- LEGEND**
- PROPERTY BOUNDARY — . —
 - EAST LANDS (DEVELOPED) [Yellow Box]
 - EAST LANDS (UNDEVELOPED) [Red Box]
 - WEST LANDS (DEVELOPED) [Green Box]
 - WEST LANDS (UNDEVELOPED) [Blue Box]

Project		AQUAVIL TOWN OF THE BLUE MOUNTAINS		 THE HARBOUREDGE BUILDING, 40 HURON STREET, SUITE 301, COLLINGWOOD, ON L9Y 4R3 705 446-3510 T 705 446-3520 F WWW.CFROZIER.CA INFO@CFROZIER.CA	
Drawing		DEVELOPMENT PLAN		876-4866	
Drawn By	M.V.R.	Design By	M.V.R.	Project	FIG 3
Scale	1:3000	Date	SEP/27/2019	Check By	B.H.



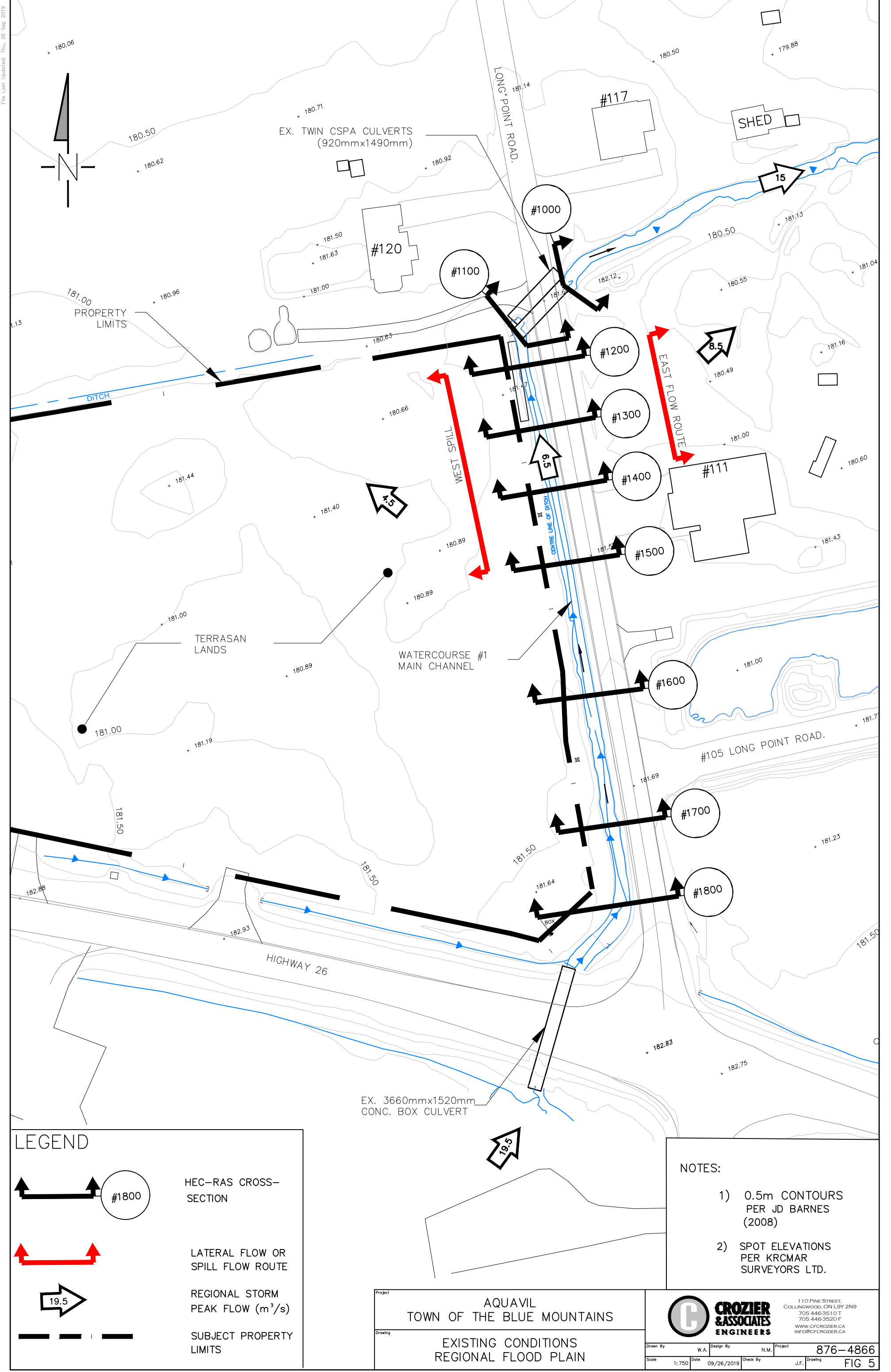
SOURCE: GSCA, 1993

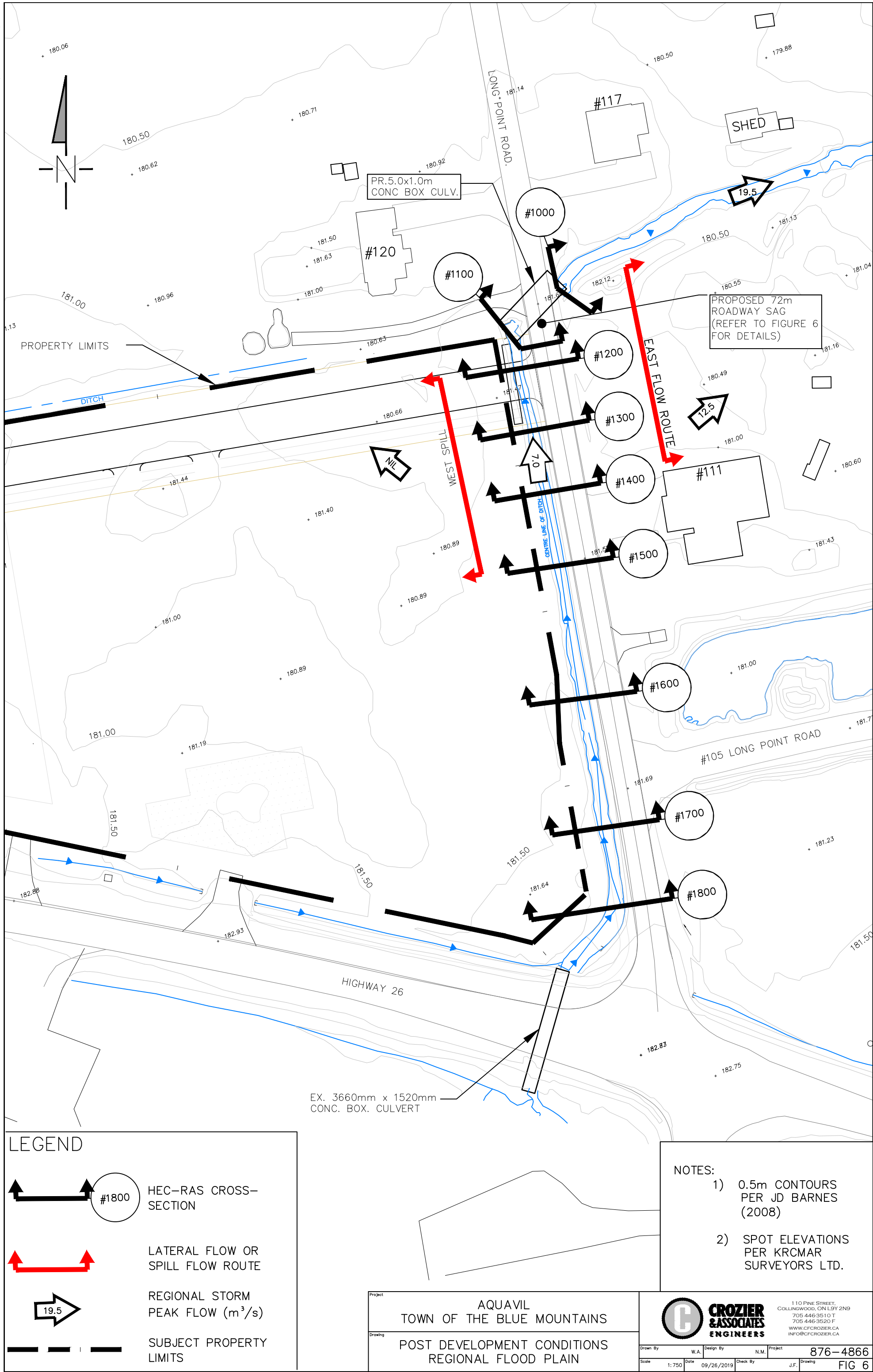
TIMMINS (FUTURE
FLOOD LIMIT

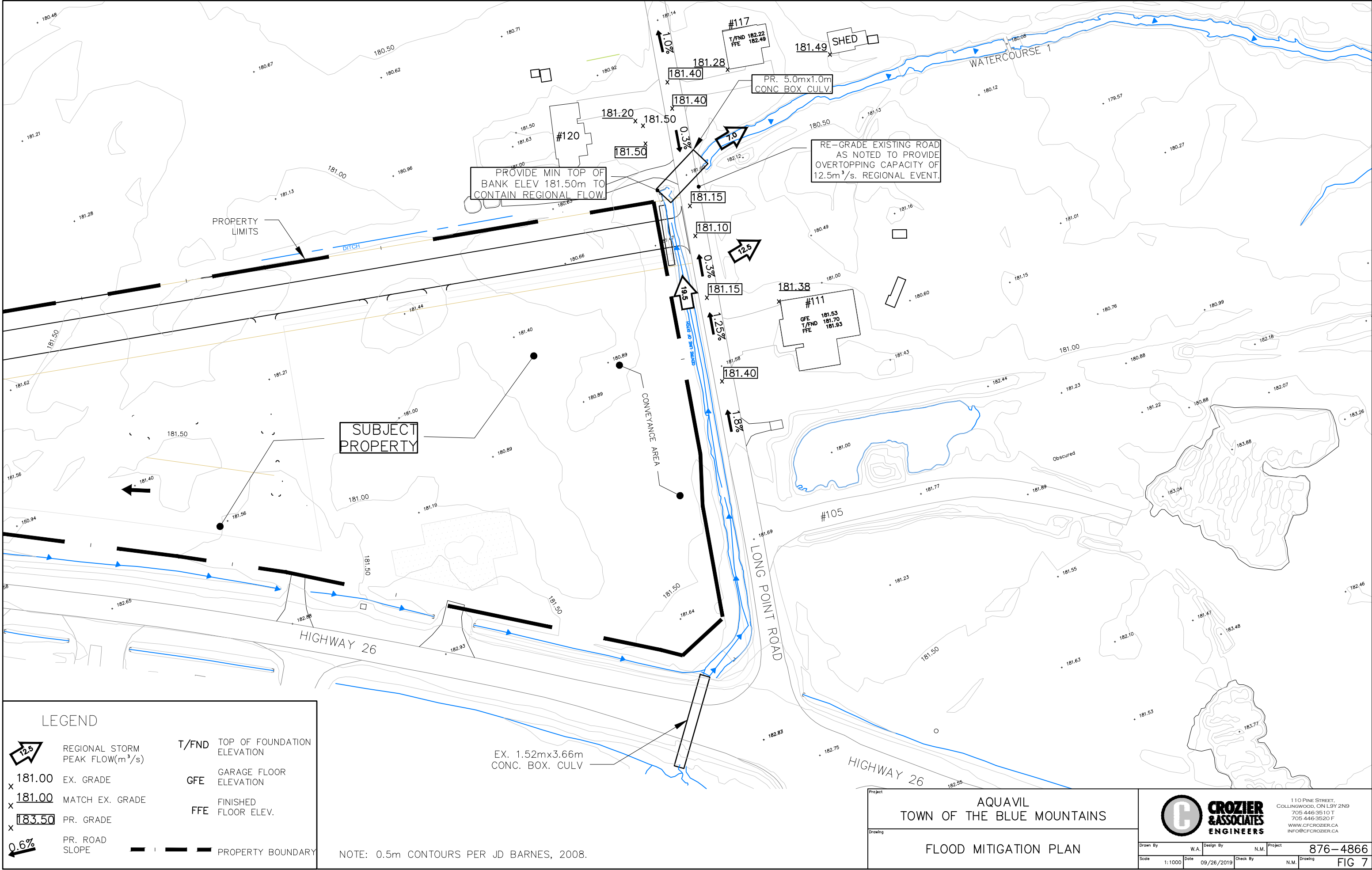
WATERCOURSE 01

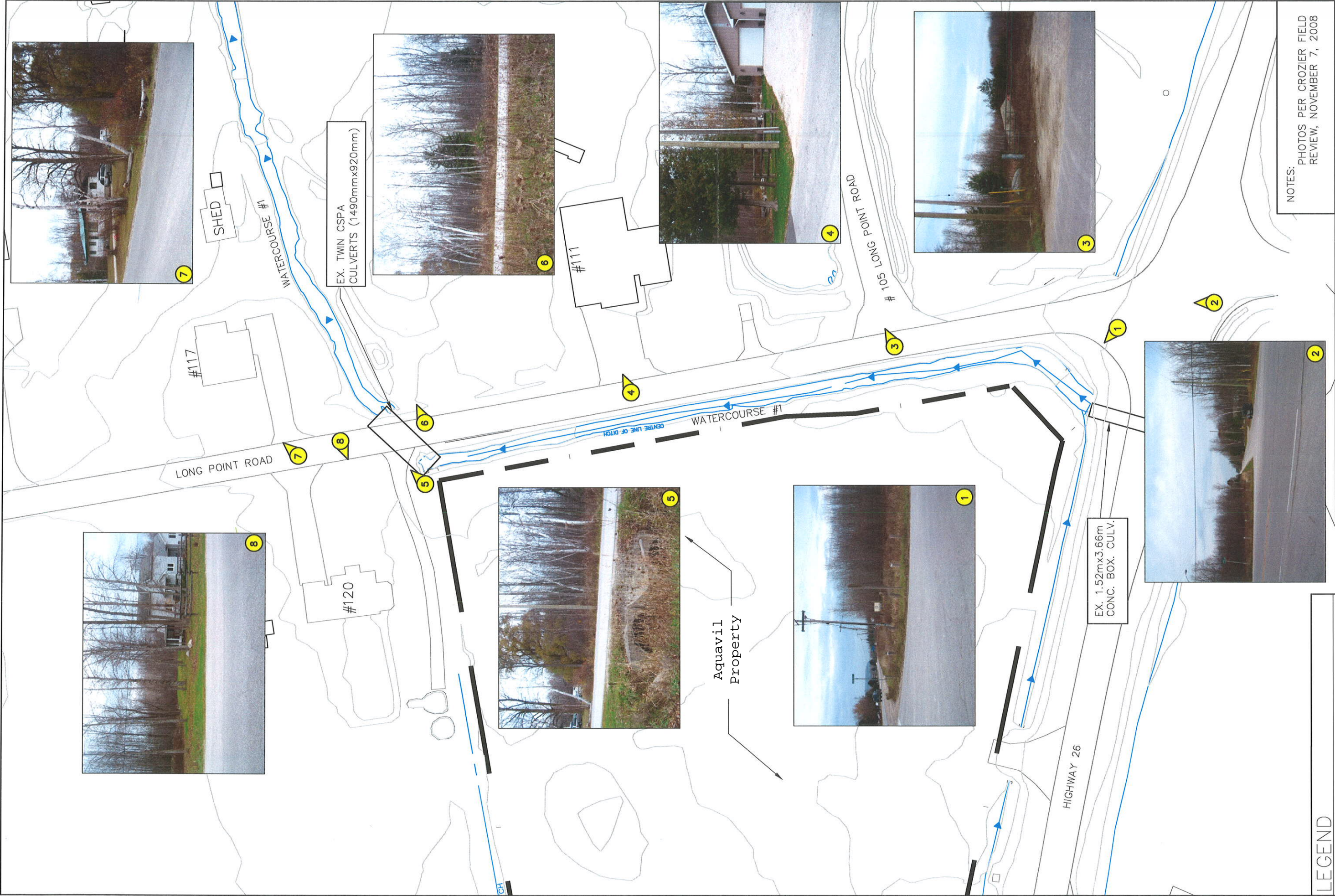
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FIGURE 3









LEGEND		PROJECT	
SUBJECT PROPERTY		AQUAVIL	
LIMITS		TOWN OF THE BLUE MOUNTAINS	
		PHOTOGRAPHIC SUMMARY OF EXISTING FLOODPLAIN AREAS	
		CROZIER & ASSOCIATES ENGINEERS	
		110 PINE STREET, COLLINGWOOD, ON L4Y 2N9	
		705 446-3810 T 705 446-3265 F	
		WFO@CROZIER.CA INFO@CROZIER.CA	
Drawn By	W.A.	Design By	N.M.
Scale	1:750	Date	09/24/2019
		Job No.	876-4866
		Project	J.F.
		Drawing	FIG 8