

NATURAL HAZARDS STUDY
HUNTINGWOOD TRAILS (COLLINGWOOD) LTD.
HUNTINGWOOD TRAILS
TOWN OF COLLINGWOOD

PREPARED BY:
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1.0 Introduction

CF Crozier & Associates Inc. (Crozier) was retained by Huntingwood Trails (Collingwood) Ltd. to complete a Natural Hazards Study in support of the Huntingwood Trails Development. The 49 ha property is legally described as part of Lots 47, 48 & 49 Concession 12, Town of Collingwood. The subject property is bounded by Highway 26 and Silver Creek Drive to the north, the Silver Glen Preserve subdivision to the east, the Forest Drive Subdivision to the west and the Georgian Trail to the south. Figure 1 shows the location of the property.

Silver Creek bisects the site dividing the proposed land into two development areas. To the west of Silver Creek, the plan is comprised of 60 single family lots, 12 semi detached dwellings, 30 townhouse units, approximately 1,050 m of public roads and a stormwater management facility. To the east of Silver Creek the plan is comprised of approximately 1250 m of public roads, 71 single family lots, 119 townhouse units, 144 walk up apartment units, a retirement home, community center, commercial area, stormwater management facility and internal roadways and parking. A series of trails bisect the residential areas as well as the Environmental Protection areas. The subject concept plan reflecting a total unit count of 436 units is presented as Figure 2.

In support of the application for an Official Plan Amendment, Zoning By-Law Amendment and Draft Plan of Subdivision for the subject lands, three reports have been prepared by Crozier:

- Functional Servicing & Stormwater Management Report,
- Natural Hazards Study and,
- Traffic Impact Study

The purpose of this report, "Natural Hazards Study, Huntingwood Trails Development", is to determine the natural hazards associated with the potential flooding and erosion of Silver Creek across the subject property.

2.0 Background & Site Description

Historic use of the subject property has been primarily for agriculture. A farm house and barn set back approximately 350 m from Silver Creek Drive remain onsite. Much of the property is currently utilized as pasture lands for cattle.

The site generally slopes from the southwest to the northeast with an average slope of less than 1%. The main branch of Silver Creek enters the subject site along the southern property line after passing beneath the Georgian Trail via a former railway bridge. Silver Creek exhibits a pool - riffle sequence throughout the site with an average stream width of approximately 5 metres, average bankfull depth of approximately 1.5 metres and a bankfull width of 7.5m at the largest amplitude meander. Downstream of the site, Silver Creek passes beneath Highway 26 via a 7.5 m x 1.5 m concrete box culvert en route to its eventual outlet at Georgian Bay.

Vegetation to the west of Silver Creek is primarily pasture with clumps of sparse trees. In some instances tree cover has been cleared right up to the creek edge, while in other areas a small buffer of tree cover has been maintained. All drainage from the western portion of the site outlets to Silver Creek upstream of Highway 26.

Vegetal cover to the east of Silver Creek is more varied. A strip of pasture land has been established running alongside the creek edge and the Highway 26 right of way. The remaining lands abutting the Georgian Trail and adjacent Silver Glen Preserve subdivision are a mixture of forested and meadow areas. During the springtime a number of closed depressions contain standing water. Drainage for the eastern portion of the site also drains from southwest to northeast and is primarily collected and conveyed in an intermittent drainage channel which outlets under Highway 26 via a 5.5 m x 1.7 m box culvert. There is virtually no surface runoff contributing to Silver Creek from the lands located east of the creek.

A portion of the northeast corner of the property is part of a Ministry of Natural Resources (MNR) Provincially Significant Wetland (PSW). A number of closed depressions in the southeast quadrant of the site have also been identified as wetlands. These environmental areas are identified on Figure 2, Concept Plan. Refer to the Environmental Impact Statement (EIS) prepared by Hensel Design Group for further details.

3.0 Natural Hazards

Provincial Policy Statement (PPS) 3.1.1 defines hazardous lands adjacent to river and stream systems consisting of flooding and/or erosion prone areas. Flooding hazards are associated with the inundation limits resulting from a Regional storm event. Erosion hazards are dependent on the characteristics of the stream overbank topography and are associated with the meandering of the stream channel or erosion and failure of river bank slopes.

The natural hazards assessment undertaken herein is in accordance with the methodology outlined in the Ministry of Natural Resources publication "Understanding Natural Hazards" (MNR, 2001). Results from this technical guideline include recommended development setbacks based on the hazards associated with Silver Creek. A detailed assessment of each component of the natural hazards is presented below.

3.1 Flooding Hazards

The floodplain of Silver Creek is defined as a "one-zone" floodplain per the Town of Collingwood Official Plan (2009). Notwithstanding, spill zones have also been identified along Silver Creek. These spill zones exist; to the south of the Georgian Trail, to the south of Highway 26 on the subject lands and to the north of Highway 26 on the Consulate property ((CCL, 1989), (Crozier, 2008)).

MNR (2002) provides direction on the interpretation and management flood hazards. "One-zone" floodplain is considered high risk to the public and property. Consequently, new development is directed outside of the "one-zone" floodplain.

Areas susceptible to spill waters are treated in a different manner than one-zone floodplain. Spill is generally characterized by shallow, lower velocity conditions in which flow leaves a watershed to enter a different system. Section 4.13 of the Technical Guide (MNR, 2002) provides the following commentary:

"The effect of spills moving into another watershed should be assessed to determine the potential flood risks. Alternative measures should be investigated to prevent the spill moving into the adjacent watershed".

3.1.1 Previous Floodline Assessments

As explained above, Silver Creek bisects the property and flows in a northerly direction towards Georgian Bay. With a tributary watershed exceeding 26 km² upstream of Highway 26, Silver Creek experiences

flooding conditions on occasion. In 1989, a Cumming Cockburn Limited ("CCL") study entitled "Floodline Mapping Study of Silver Creek, Spring Creek, & Village of Angus" was prepared under the auspices of the Federal Provincial Flood Damage Reduction Program for the Nottawasaga Valley Conservation Authority (NVCA). The study delineated the limits of the Silver Creek floodplain on the subject lands and identified the areas along Silver Creek which are subject to spill conditions.

One of the spill areas identified in the CCL (1989) report was located on the subject lands along Silver Creek at Highway 26. This spill area was denoted Spill Zone "B", where a portion of the flood flows from Silver Creek were said to be conveyed easterly along the south side of Highway 26 toward the Silver Glen Preserve residential development and Cranberry Resort Links golf course and residential development. Since 1989, there have been a number of further flood studies examining Silver Creek. Most recently, Crozier (2007) re-evaluated the Silver Creek floodplain as supporting studies to the proposed residential development "The Preserve at Georgian Bay" proposed by Consulate Development Inc. While this study thoroughly evaluated the Silver Creek floodplain and spill areas north of Highway 26, the study did not examine flood conditions of the subject lands. Consequently, the CCL (1989) work represents the most current floodplain study on record.

3.1.2 Existing Conditions Hydraulic Assessment

The floodline assessment across the Huntingwood lands presented herein builds upon work previously undertaken (Crozier, 2007) concerning Silver Creek. The purpose of the analysis is to update the CCL (1989) delineation of the Regional floodline across the Huntingwood lands based on thorough examination of site conditions and use of accurate site specific topographic mapping.

Silver Creek was previously modeled by CCL using the HEC-2 computer model. A total of six hydraulic sections were evaluated along a 700 m portion of Silver Creek extending from the Georgian Trail to Highway 26. Spill Zone 'B' was also identified upstream of Highway 26 flowing in an easterly direction, however the study did not include a detailed hydraulic assessment of the spill reach.

As part of the updated hydraulic modeling undertaken in support of the Huntingwood Trails development, eleven cross sections have been used to evaluate the floodplain hydraulics of Silver Creek from the Georgian Trail to Highway 26. The approximate location of the six original HEC-2 cross sections completed by CCL (1989) has been preserved. In order to better define the internal floodplain, five new cross sections were added to the model across the subject lands. All cross sections were generated using updated air-photo based topographic mapping produced by First Base Solutions (2008). The contour map of the site and surrounding lands consists of a 0.5-metre contour interval. This mapping is consistent with that applied to the Consulate Development project and is considered acceptable for use in this floodline assessment.

Manning's roughness values have been set at 0.045 for the main channel to reflect the stony pool/riffle sequence, 0.05 for the west overbank to reflect the pasture land use and 0.07 for the east overbank areas to reflect the mix of pasture lands and moderately treed areas. These values were considered representative of onsite landuses and are consistent with or more conservative than those applied in the original HEC-2 model (ie. 0.045 for main channel, 0.05 for overbank areas) used by CCL.

The downstream portion of the Silver Creek model located to the north of the subject site on the Consulate lands was used to ensure model stability. This model was previously approved by the NVCA and helped support the OMB decision concerning the Consulate Development Inc. hearing. The downstream limit of

the model occurs at Georgian Bay; the 100-year long-term high water level of 177.4 m was used as the downstream boundary condition.

The Regional Storm (Timmins) peak flow of 78 m³/s was used in the modeling of Silver Creek through the subject lands with peak flows, reduced to 47 m³/s directly upstream of Highway 26 due to spill route 'B', consistent with the CCL study (1989). Note that subsequent modeling for downstream lands undertaken for Consulate Development Inc. (Crozier, 2008) accounted for the full 78 m³/s peaks flows.

Results from the existing conditions HEC-RAS hydraulic analysis of Silver Creek across the subject lands are illustrated on Figure 3. The detailed output is provided in Appendix A. Computed water surface elevations were between 0.04–0.25 m higher than those of CCL (1989). These elevation changes are due to the more conservative roughness coefficients and more accurate topographic mapping utilized in the subject analysis. Refer to Table 1 for a comparison of existing conditions Regional water surface elevations.

Table 1: Comparison of Existing Conditions Regional Water Surface Elevations between CCL (1989) and Crozier (2011)

Cross Section ID	Description	Regional Water Surface Elevation (m)		Change (+/- m)
		CCL (1989)	Crozier (2011)	
0+775	Updated CCL Section	181.86	182.11	+0.25
0+785	Highway 26 (upstream)	---	182.11	---
0+860	Updated CCL Section	182.08	182.11	+0.03
1+010	Updated CCL Section	182.05	182.23	+0.18
1+100		---	182.52	---
1+205	Updated CCL Section	182.98	183.17	+0.19
1+300		---	183.58	---
1+400	Updated CCL Section	184.06	184.12	+0.06
1+500		---	185.30	---
1+640	Updated CCL Section	185.91	186.13	+0.22
1+670	Southern Property Line/Georgian Trail	---	186.37	---

The Regional floodline located on the west side of Silver Creek is defined on Figure 3. Between Highway 26 and the Georgian Trail, the floodline is generally 30 to 80 m from the creek and encroaches into existing residential areas along Silver Creek Drive immediately upstream of Highway 26 in an ineffective area of the floodplain.

The eastern portion of the Silver Creek floodplain consists of various shallow spill flow areas that are located along the eastern bank of Silver Creek. This was confirmed through field reconnaissance of drainage completed by Crozier during the Spring of 2009 and spillflow tracking of an actual spill event in January 2011. Unlike the CCL report which defined a floodline along the east side of Silver Creek and only a limited spill area adjacent to Highway 26, our review of the hydraulic conditions based on the more detailed contours concludes spill occurs in multiple locations across the eastern portion of the subject property. Once the east bank of Silver Creek is breached, flood waters are removed from the Silver Creek system flowing in an unconfined nature in a north-easterly direction through the subject lands eventually reaching Highway 26 and draining towards Silver Glen Preserve and Cranberry Trail. Hence, there is no defined floodline on the east side of the subject lands.

3.1.3 Post-Development Conditions Hydraulic Assessment

As described above, Crozier has updated the previous floodplain modeling across the subject site. This updated model of existing conditions was then used to evaluate the effects of the proposed Huntingwood

Trails development on the natural hazards posed by Silver Creek. A discussion of the post-development model setup and results is presented in the sections below.

The western development area has been set outside the Silver Creek Regional floodplain, save and except a portion of the site access roadway at Silver Creek Drive. The site access roadway to the western development area will be flood proofed and will confine the post-development flood inundation limit to the eastern boundary of the right of way. Existing properties to the west of the subject development which are currently in the Regional floodplain will be removed from the floodplain.

The eastern development area will be entirely flood-proofed above the Regional flood elevation in order to alleviate the spill across the subject lands. Grading across the eastern development area will be substantially higher than the Regional flood elevation due to servicing constraints.

In order to fully eliminate the spill, it will also be necessary to create a landform through the spill zone adjacent to Highway 26. This landform will consist of compacted material, meeting the specifications necessary for geotechnical engineering certification. The landform will be placed outside of the Provincially Significant Wetland (PSW), extending from the eastern development area to Highway 26.

The floodproofing of the Huntingwood site and introduction of the landform through the spill zone will successfully eliminate the spill and ensure floodwaters of Silver Creek remain in the watershed. There is considerable public benefit associated with elimination of the spill which is summarized in Section 3.1.4.

The elimination of the Silver Creek spill was originally proposed by CCL (1989): "berming and infilling are possible alternatives, however their impact on upstream water levels may be of sufficient magnitude to warrant improvements to the existing bridge (at Highway 26)".

The impact and mitigation measures associated with elimination of the spill are further discussed below.

Modeling Set-Up

The post-development model for Silver Creek was developed by modifying the existing conditions hydraulic sections across the proposed development areas. At this preliminary stage, the development areas were modeled as blocked obstructions in HEC-RAS up to the proposed development limits. Upon detailed design, the grading plan will be used to update and finalize the HEC-RAS model.

As noted above, the access roadway to the western development area will encroach into a portion of the ineffective Regional floodplain. This encroachment is located toward the downstream portion of Silver Creek on the subject property where ineffective flow areas exist due to the downstream flow impediments of Silver Creek Drive. Accordingly, the access roadway into the site has been modeled as a blocked obstruction. Additionally, the platform of Silver Creek Drive has been raised by approximately 0.3m in the model to eliminate spillflows which currently impacts existing residence to the north.

The removal of the eastern development area from the spill was also modeled using blocked obstructions. The blocked obstructions (ie. development limits) were extended to the greater of the limit of the meander belt or 30-metre watercourse setback. Similarly, the proposed landform located between the north limits of the development area and Highway 26 was modeled using blocked obstructions.

The influence on the hydraulics of the bridge crossing of Highway 26 was also examined. The spill elimination will add approximately 30 m³/s to the hydraulic "load" of the crossing. Based on a sensitivity analysis, it was determined the Silver Creek crossing will require upsizing to avoid overtopping of the highway. Preliminary sizing indicates adding a 10.0 m x 1.5 m relief culvert to the existing 7.5 m x 1.5 m box culvert will allow the full 78.0 m³/s Regional storm peak to pass beneath Highway 26 with no overtopping. This proposed culvert orientation was added to the post-development HEC-RAS model. Confirmation of the final culvert size will be completed at the detailed design stage.

Modeling Results

Results from the post-development hydraulic analysis illustrates that the Regional flood elevations will increase throughout the central portion of the site as a result of blocking the shallow spill flow routes along the east overbank areas of Silver Creek. The increases in water surface elevations range from 0.01 m to 0.17 m which are entirely contained on the Huntingwood property and are limited to cross sections 860 to 1500 inclusive. Floodline elevations at the upstream and downstream limits of the subject property are not increased above pre-development levels. Refer to Table 2 below for a comparison of Existing & Post-Development water surface elevations across the site.

Table 2: Comparison of Regional Water Surface Elevations between Existing and Post-Development Conditions

Cross Section ID	Description	Regional Water Surface Elevation (m)		Change (+/- m)
		Existing Conditions	Post Development	
0+775	Updated CCL Section	182.11	182.10	-0.01
0+785	Upstream of Highway 26	182.11	182.09	-0.02
0+860	Updated CCL Section	182.11	182.13	+0.02
1+010	Updated CCL Section	182.23	182.32	+0.09
1+100		182.52	182.68	+0.16
1+205	Updated CCL Section	183.17	183.23	+0.06
1+300		183.58	183.75	+0.17
1+400	Updated CCL Section	184.12	184.17	+0.05
1+500		185.30	185.31	+0.01
1+640	Updated CCL Section	186.13	186.13	Nil
1+670	Southern Property Line	186.37	186.37	Nil

Due to the minor increase in floodline elevations through the central portion of the property in the post development condition the rear lots of units for the west development area were modified to respect the post-development floodplain limits. Note that these lots will be flood proofed to be at least 0.3 m above the Regional Storm elevation. Likewise, the eastern development area including the proposed landform will be flood-proofed to at least 0.3 m above the Regional storm water surface elevation in order to cut off spill flows from entering the development area or heading east.

The post-development floodline delineation is illustrated on Figure 4 and the detailed output from the HEC-RAS model is provided in Appendix A.

3.1.4 Public Benefit

The flood-proofing measures proposed as part of the Huntingwood Trails development are beneficial to the public:

1. Several existing residential properties on Silver Creek Drive, will be removed from the Silver Creek Regional floodplain.
2. An existing residence located on Highway 26 immediately west of Silver Glen Preserve will be removed from the flood hazard posed by the Silver Creek spill.
3. Cranberry Trail will no longer experience overtopping as a result of the Silver Creek spill waters (there is presently no culvert beneath the roadway; this roadway represents the sole access to the existing Cranberry Development).
4. The flood risk posed by the Silver Creek spill on the properties on Princeton Shores Boulevard will be lessened.
5. Future flood mitigation infrastructure previously proposed for the Consulate Development project will be reduced.

3.2 Erosion Hazards

An erosion hazard assessment of the main branch of Silver Creek was prepared as part of the overall natural hazards assessment described herein. Silver Creek is classified as an "unconfined system" according to the MNR publication *Understanding Natural Hazards* (MNR, 2001). This document defines an unconfined system as those systems where the watercourse is not located within a valley corridor with discernable slopes, but relatively flat to gently rolling plains and is not confined by valley walls. This is consistent with the characteristics of Silver Creek within the study area. Accordingly, the erosion hazard limit associated with unconfined systems is defined by the meander belt allowance.

The meander belt allowance is defined by the maximum extent that a channel migrates (MNR, 2001). A detailed assessment of the meander belt on a reach-specific assessment has been undertaken herein.

MEANDER BELT ALLOWANCE

In order to develop the meander belt allowance for the subject watercourse, a field assessment of the geomorphic characteristics of Silver Creek throughout the subject property was undertaken by Crozier. This assessment was completed using the Rosgen Classification System and detailed air photo topographic survey of the subject lands with reference to the methodology and data presented in the MNR (1996) publication *Morphological Relationships of Rural Watercourses in Southern Ontario and Selected Methods in Fluvial Geomorphology*.

As illustrated in Figure 3, the full 700 m section of Silver Creek throughout the subject lands was evaluated. Detailed investigation of stream meander sections was completed and the stream was analyzed as three distinct reaches. Morphological parameters such as entrenchment ratio, width/depth ratio, sinuosity and slope were computed for each reach based on topographic mapping and field reconnaissance. Based on the morphological parameters described above and the field reconnaissance completed, Silver Creek is classified as a Rosgen Type E stream across the subject site. Type E streams are described by

"low gradient, meandering riffle - pool streams with low width - depth ratios and little deposition" (MNR, 1996).

Utilizing the relationships presented in the *Morphological Relationships of Rural Watercourses in Southern Ontario and Selected Methods in Fluvial Geomorphology* (MNR, 1996), the meander belt width was calculated based on the bankfull stream width, measured at the largest amplitude meander. The meander belt width computed using this methodology ranged from 95 m to 119 m over the three reaches analyzed. This meander belt width is centered on the meander belt axis of each respective stream reach. Refer to Figure 3 for the extents of the meander belt and to Appendix B for detailed calculations.

4.0 Total Hazard Limit

The total natural hazard limit is described by the greater of the flooding limits and the meander belt allowance. The recommended natural hazard limit associated with the Silver Creek through the site is presented in Figure 4. This total natural hazard limit was adopted for the subject lands in order to determine the allowable development areas and establish the development plan which forms the basis of this application. The 6.0 m access allowance for erosion will be provided during detailed site plan preparation.

5.0 Conclusions

This study provides an assessment of the natural hazards associated with the Silver Creek which affect the proposed development from the perspective of potential flooding and erosion. Detailed hydraulic analysis was completed by expanding previously approved HEC-RAS models to determine the flooding associated with Silver Creek and to evaluate the impacts of the proposed development on these floodlines. Additionally, a meander belt assessment of the Silver Creek across the subject site was conducted to determine the erosion hazard limits associated with the unconfined system.

As the proposed development respects the flooding and erosion hazards onsite as determined through this analysis we therefore recommend approval of the uses sought for the subject lands from the perspective of natural hazards management.

Respectfully Submitted,

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Enclosure

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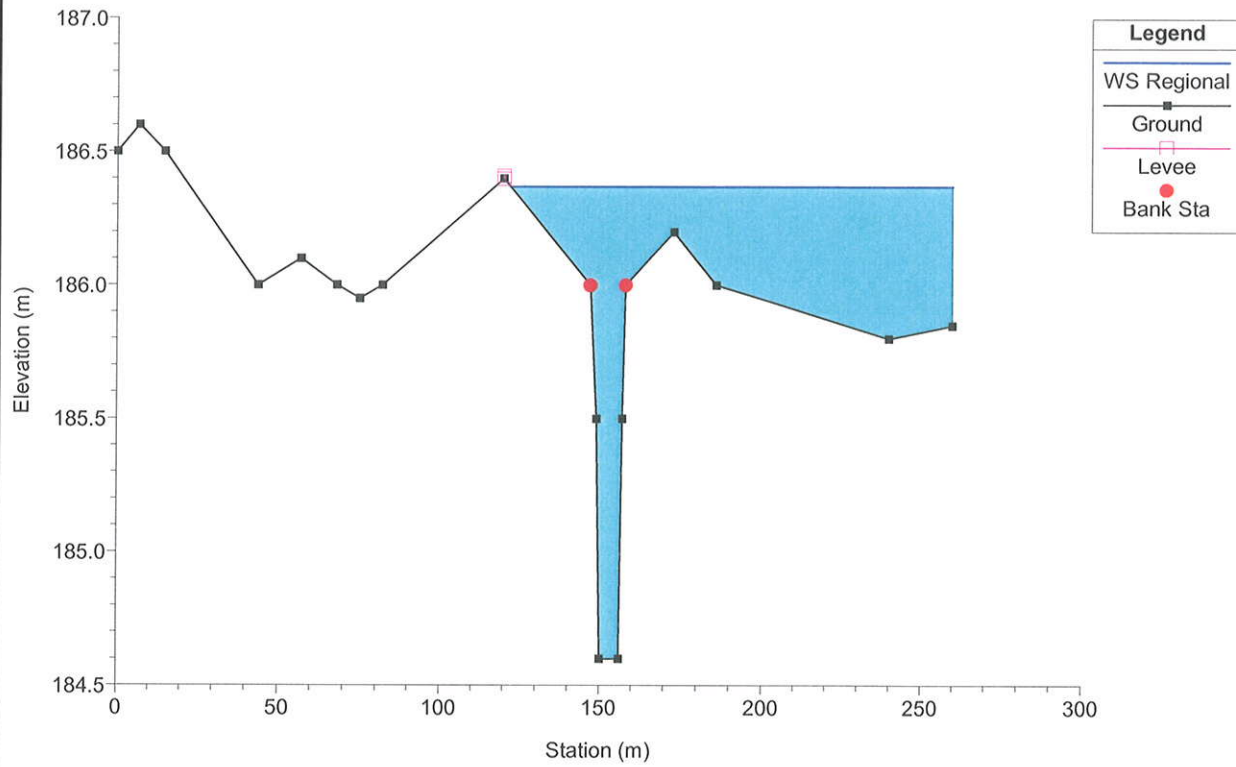
APPENDIX A

Silver Creek Main Branch – HEC-RAS Modeling

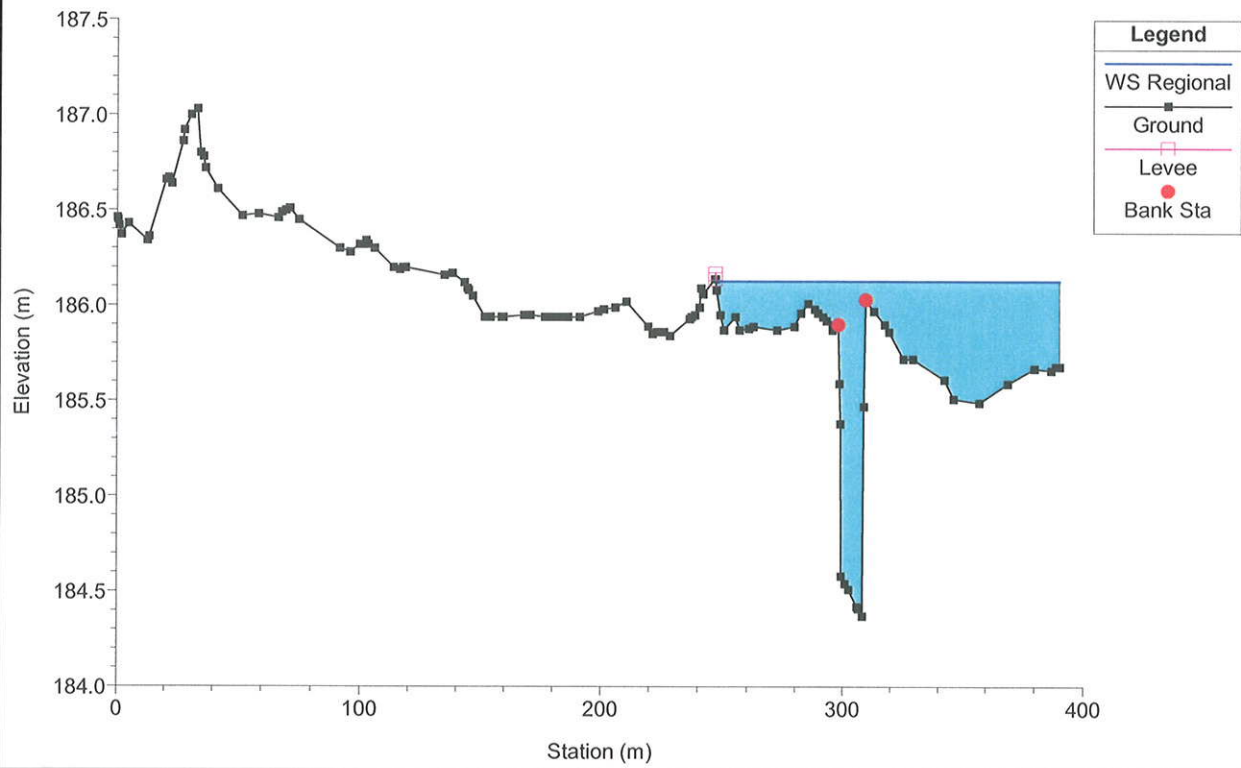
HEC-RAS River: Silver Creek Reach: Main Profile: Regional

Reach	River Sta	Profile	Plan	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Chl W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Friction # Chl
Main	1670	Regional	Post	78.00	184.60	186.37	186.37	186.56	0.009920	2.60	63.77	138.06	0.71
Main	1670	Regional	Pre-Developm	78.00	184.60	186.37	186.37	186.56	0.009920	2.60	63.77	138.06	0.71
Main	1640	Regional	Post	78.00	184.37	186.13	186.13	186.31	0.009005	2.48	63.80	140.71	0.66
Main	1640	Regional	Pre-Developm	78.00	184.37	186.13	186.13	186.30	0.008792	2.45	65.17	143.04	0.65
Main	1500	Regional	Post	78.00	183.52	185.31	185.31	185.48	0.011162	2.58	80.36	133.45	0.73
Main	1500	Regional	Pre-Developm	78.00	183.52	185.30	185.30	185.47	0.011043	2.56	82.70	145.04	0.72
Main	1400	Regional	Post	78.00	182.32	184.17	184.17	184.36	0.008264	2.49	62.38	138.16	0.64
Main	1400	Regional	Pre-Developm	78.00	182.32	184.12	184.12	184.30	0.008147	2.42	67.16	156.67	0.64
Main	1300	Regional	Post	78.00	181.89	183.75	183.61	183.82	0.004448	1.68	87.87	167.50	0.47
Main	1300	Regional	Pre-Developm	78.00	181.89	183.58	183.58	183.62	0.003586	1.35	115.99	234.00	0.41
Main	1205	Regional	Post	78.00	181.52	183.23	183.18	183.33	0.009714	1.93	71.21	178.41	0.66
Main	1205	Regional	Pre-Developm	78.00	181.52	183.17	183.03	183.22	0.006561	1.51	101.17	262.18	0.53
Main	1100	Regional	Post	78.00	180.70	182.08	182.53	182.78	0.005048	1.99	78.56	158.00	0.50
Main	1100	Regional	Pre-Developm	78.00	180.70	182.52	182.48	182.65	0.007564	2.27	82.70	231.50	0.61
Main	1010	Regional	Post	78.00	180.58	182.32	182.21	182.42	0.006667	1.95	72.11	132.00	0.57
Main	1010	Regional	Pre-Developm	78.00	180.58	182.23	182.09	182.27	0.004347	1.49	114.82	289.90	0.46
Main	860	Regional	Post	78.00	180.17	182.13	181.44	182.14	0.000940	0.78	144.13	136.00	0.21
Main	860	Regional	Pre-Developm	78.00	180.17	182.11	181.37	182.12	0.000503	0.57	201.13	276.80	0.16
Main	785	Regional	Post	78.00	179.60	182.09	181.35	182.11	0.000469	0.83	181.24	183.00	0.17
Main	785	Regional	Pre-Developm	47.00	179.60	182.11	180.51	182.11	0.000016	0.15	611.87	468.66	0.03
Main	775	Regional	Post	78.00	179.51	182.10	180.83	182.10	0.000267	0.64	232.79	108.00	0.13
Main	775	Regional	Pre-Developm	47.00	179.51	182.11	180.51	182.11	0.000017	0.16	593.96	468.66	0.03
Main	765		Culvert										
Main	735	Regional	Post	78.00	179.40	181.02	180.47	181.03	0.001514	0.74	206.08	865.73	0.19
Main	735	Regional	Pre-Developm	47.00	179.40	180.84	180.41	180.84	0.001301	0.62	157.94	858.45	0.17
Main	590	Regional	Post	78.00	179.30	180.81	180.39	180.62	0.001950	0.75	230.63	799.12	0.21
Main	590	Regional	Pre-Developm	47.00	179.30	180.65	180.30	180.66	0.001704	0.66	169.70	722.26	0.19
Main	490	Regional	Post	78.00	179.20	180.46	180.29	180.49	0.006506	1.28	122.81	628.53	0.38
Main	490	Regional	Pre-Developm	47.00	179.20	180.32	180.20	180.35	0.006939	1.21	78.30	501.67	0.38
Main	450	Regional	Post	78.00	179.13	180.22	179.98	180.25	0.005633	1.03	140.35	585.11	0.34
Main	450	Regional	Pre-Developm	47.00	179.13	180.08	179.85	180.10	0.005525	0.91	96.45	507.73	0.33
Main	410	Regional	Post	78.00	178.10	179.33	179.33	179.45	0.033041	2.62	83.45	295.90	0.82
Main	410	Regional	Pre-Developm	47.00	178.10	179.24	179.24	179.34	0.027002	2.23	58.38	247.69	0.73
Main	320	Regional	Post	78.00	177.20	178.45		178.47	0.003911	0.99	166.92	297.13	0.29
Main	320	Regional	Pre-Developm	47.00	177.20	178.30		178.31	0.003253	0.82	123.03	261.79	0.26
Main	222	Regional	Post	78.00	177.10	178.23		178.24	0.004554	0.96	177.76	383.73	0.31
Main	222	Regional	Pre-Developm	47.00	177.10	178.07		178.08	0.005256	0.92	119.50	360.23	0.32
Main	155	Regional	Post	78.00	176.70	177.98		177.99	0.002602	0.82	231.23	526.98	0.24
Main	155	Regional	Pre-Developm	47.00	176.70	177.82		177.83	0.002440	0.72	156.13	427.92	0.23
Main	5	Regional	Post	78.00	176.00	177.28	177.28	177.39	0.023588	2.23	95.03	361.93	0.69
Main	5	Regional	Pre-Developm	47.00	176.00	177.20	177.20	177.29	0.019123	1.90	65.53	310.13	0.62

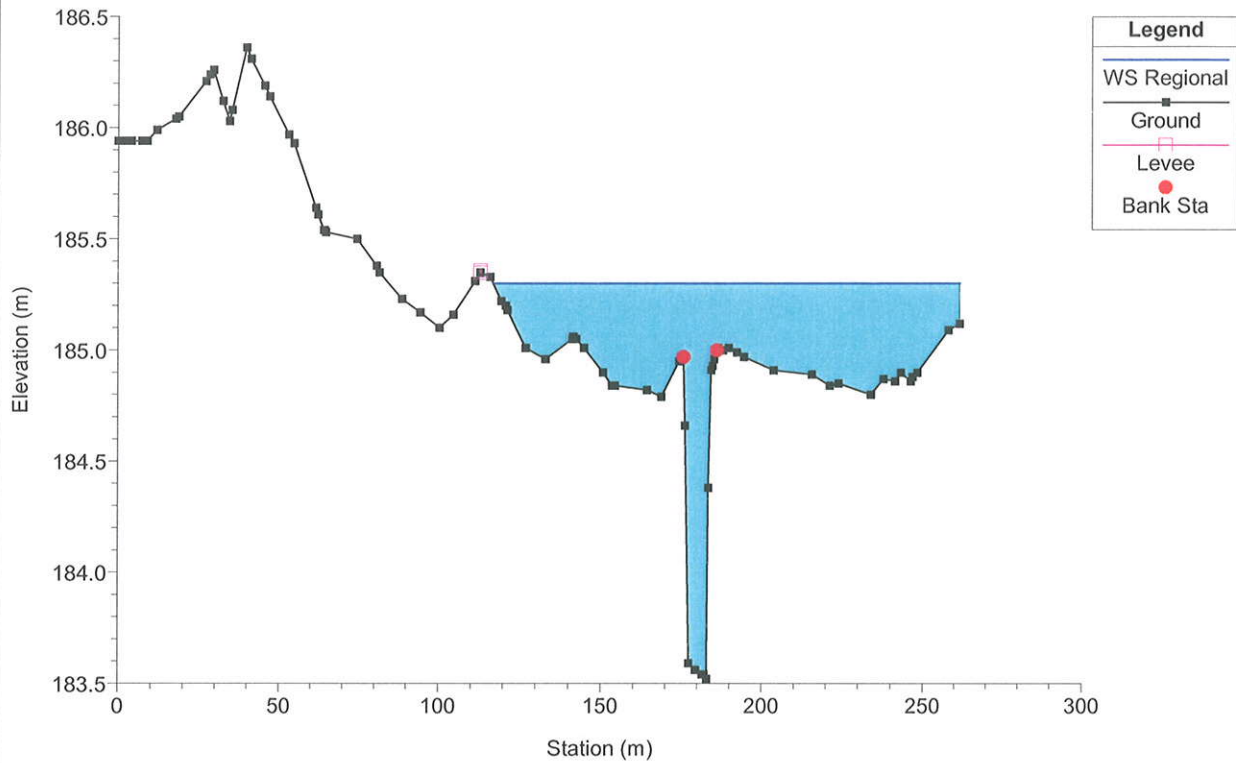
Silver Creek - Huntingwood Reach Plan: Pre-Development 1/27/2011
RS = 1670 Upstream Property limits



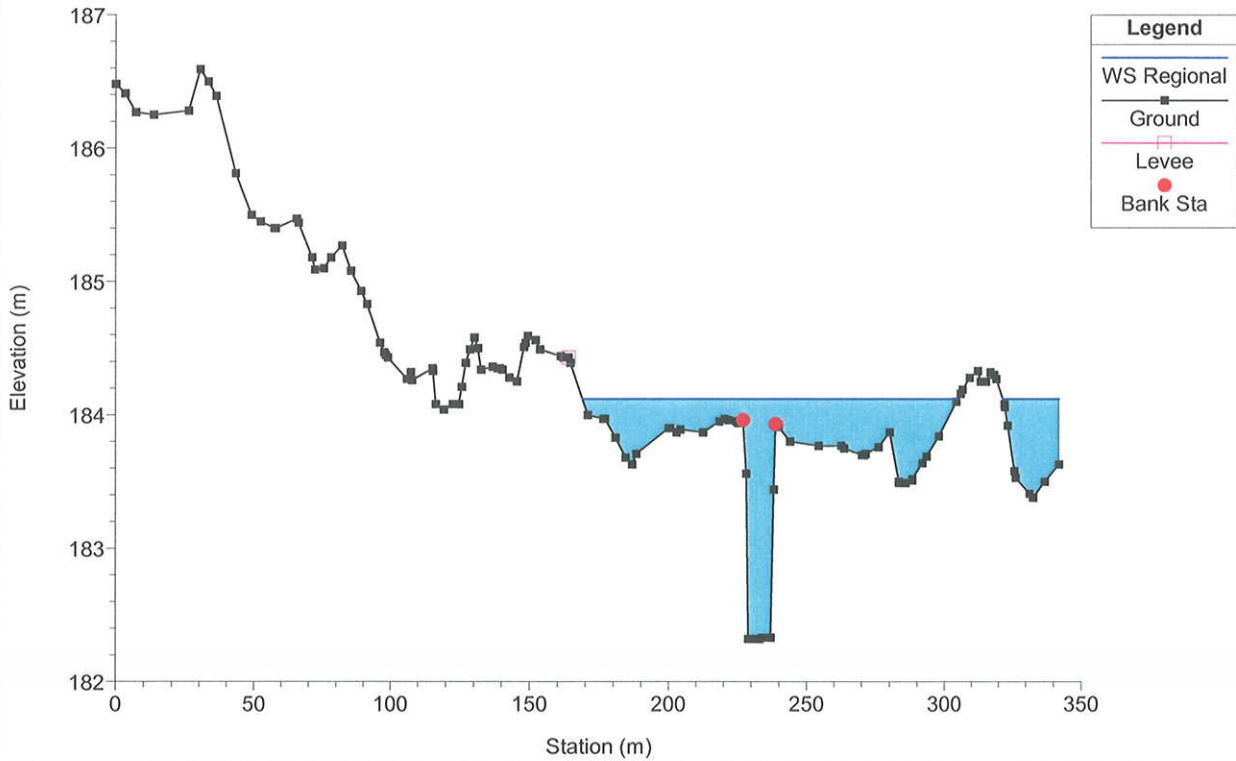
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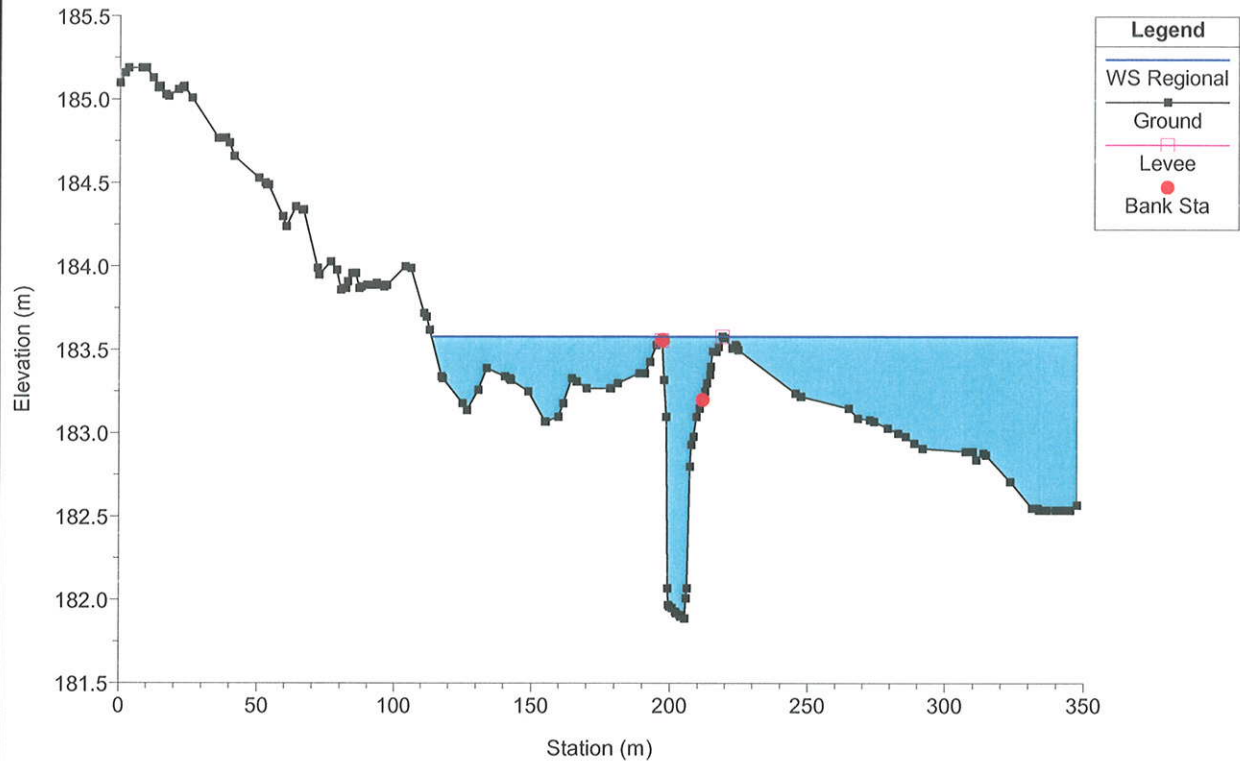
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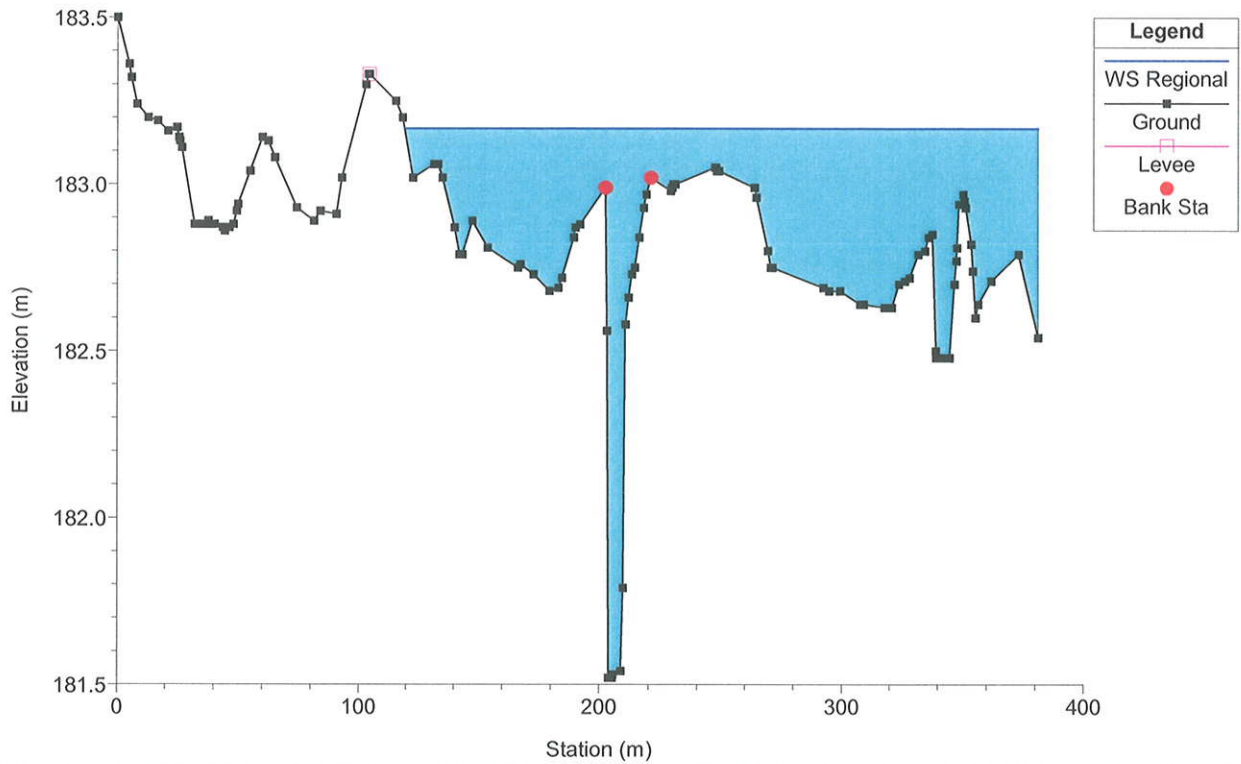
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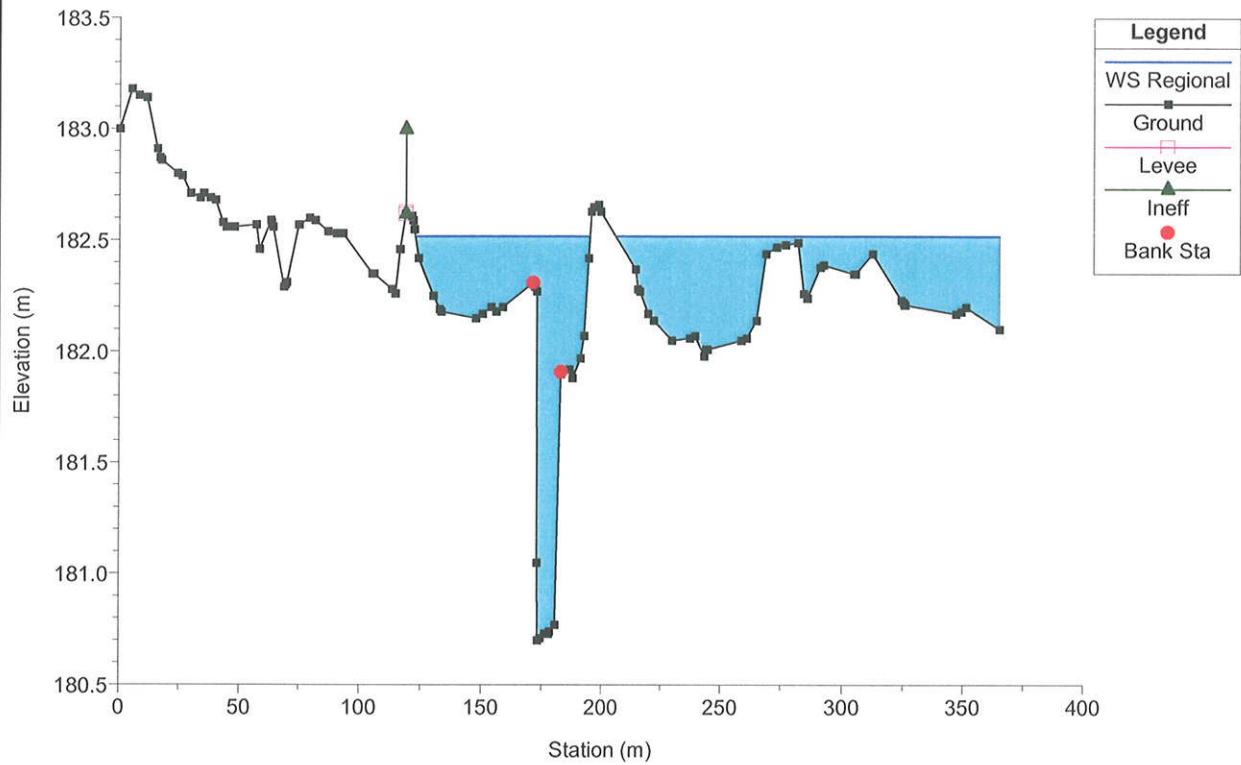
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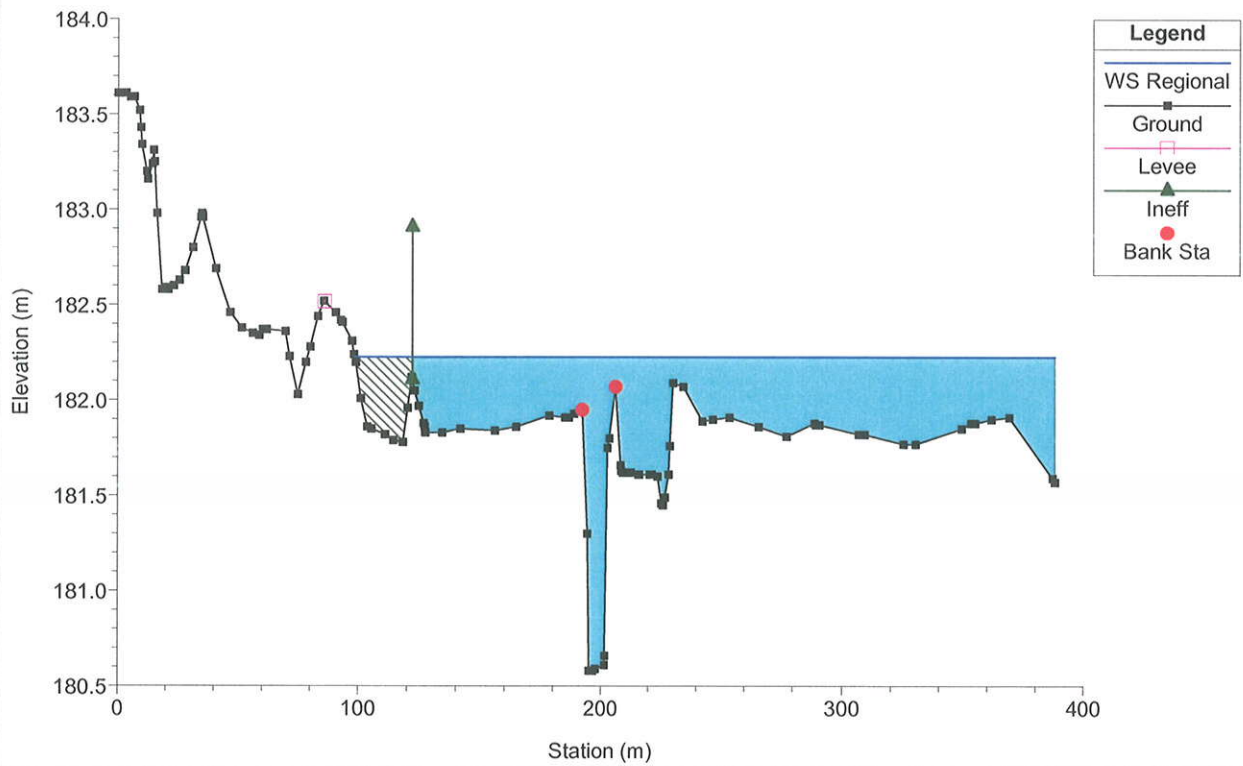
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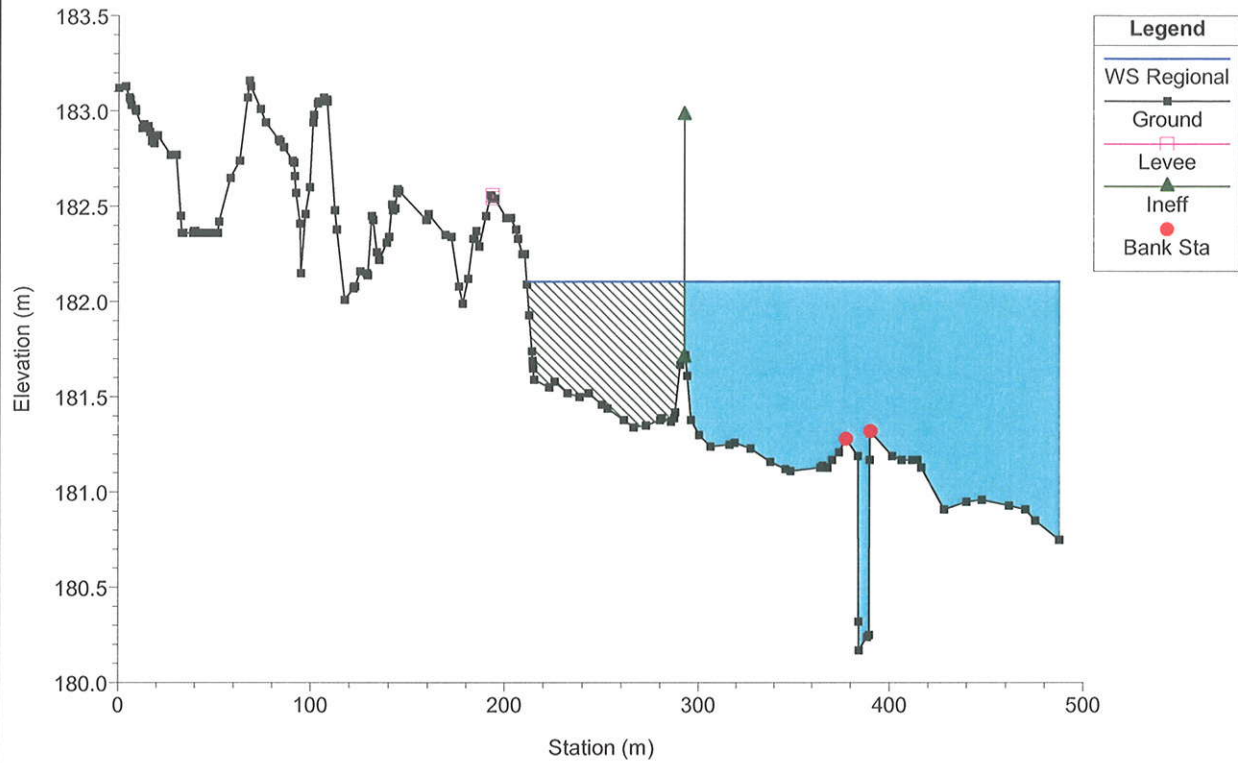
Silver Creek - Huntingwood Reach Plan: Pre-Development 1/27/2011
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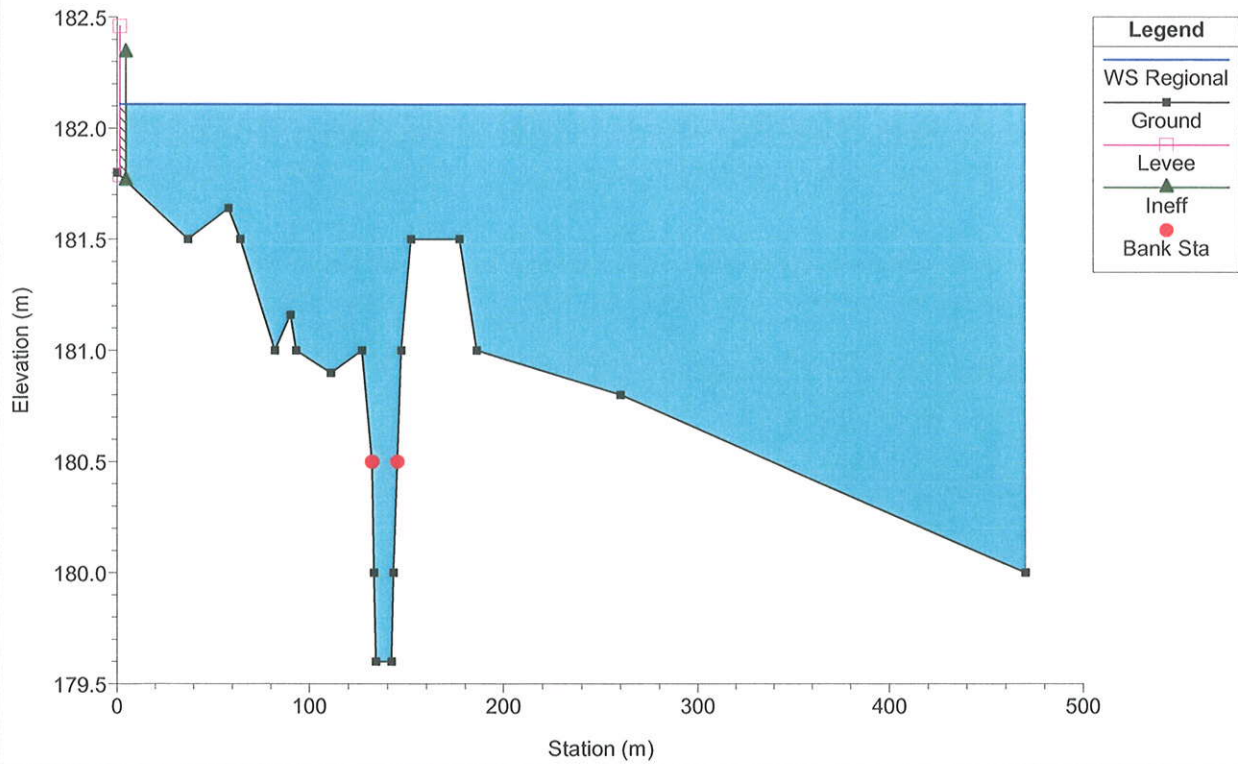
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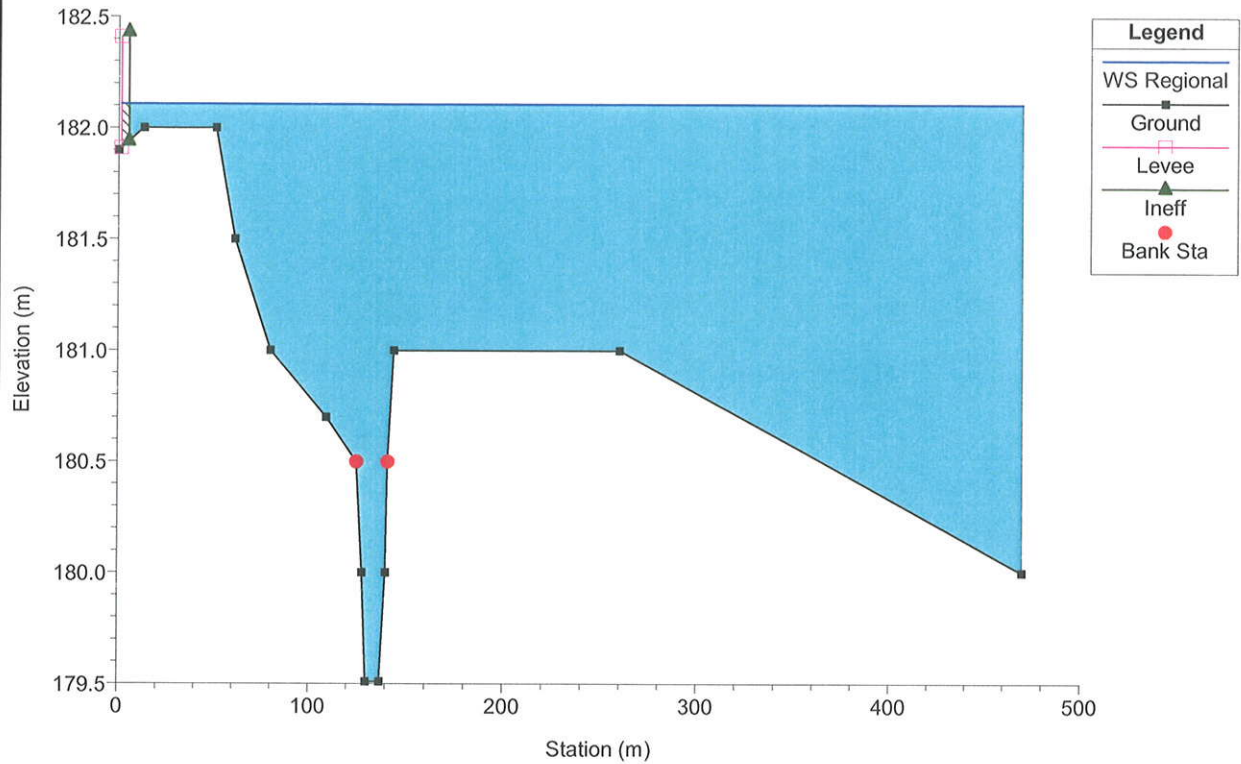
Silver Creek - Huntingwood Reach Plan: Pre-Development 1/27/2011
RS = 860



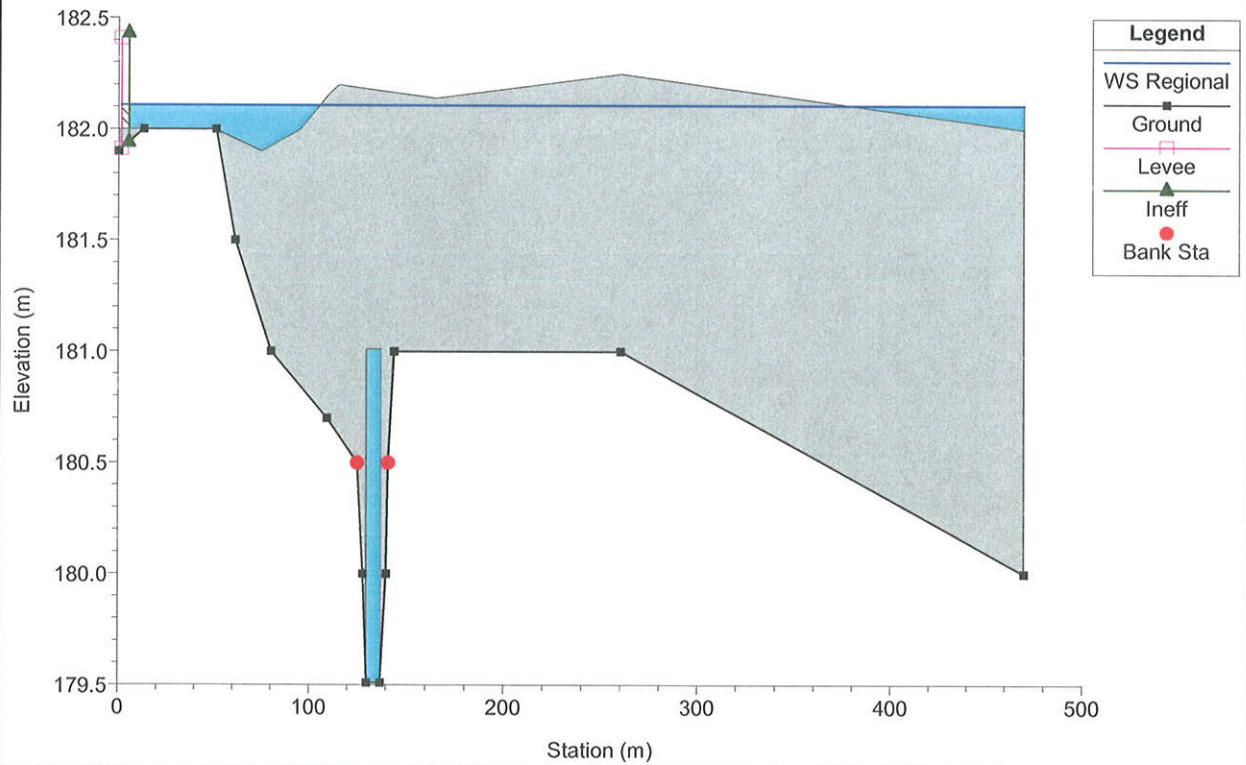
Silver Creek - Huntingwood Reach Plan: Pre-Development 1/27/2011
RS = 785 Downstream Property Limits



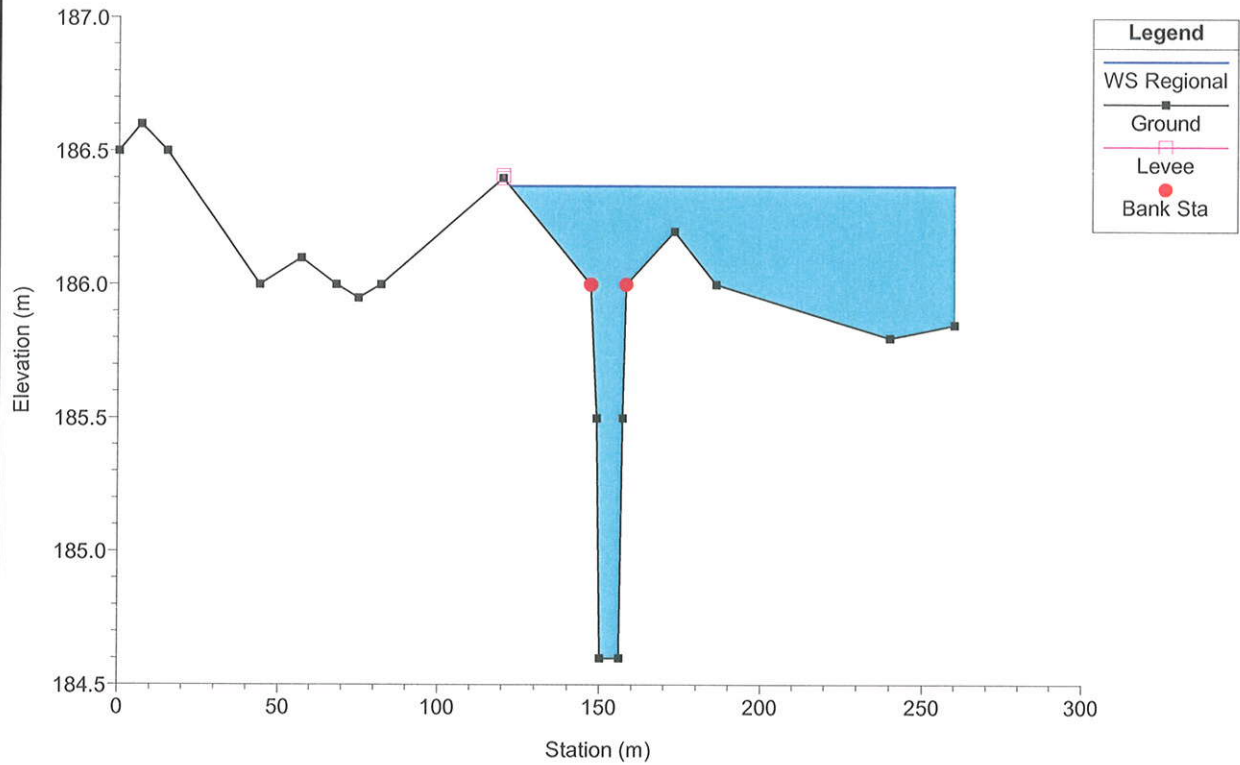
Silver Creek - Huntingwood Reach Plan: Pre-Development 1/27/2011
RS = 775 Upstream of HWY 26



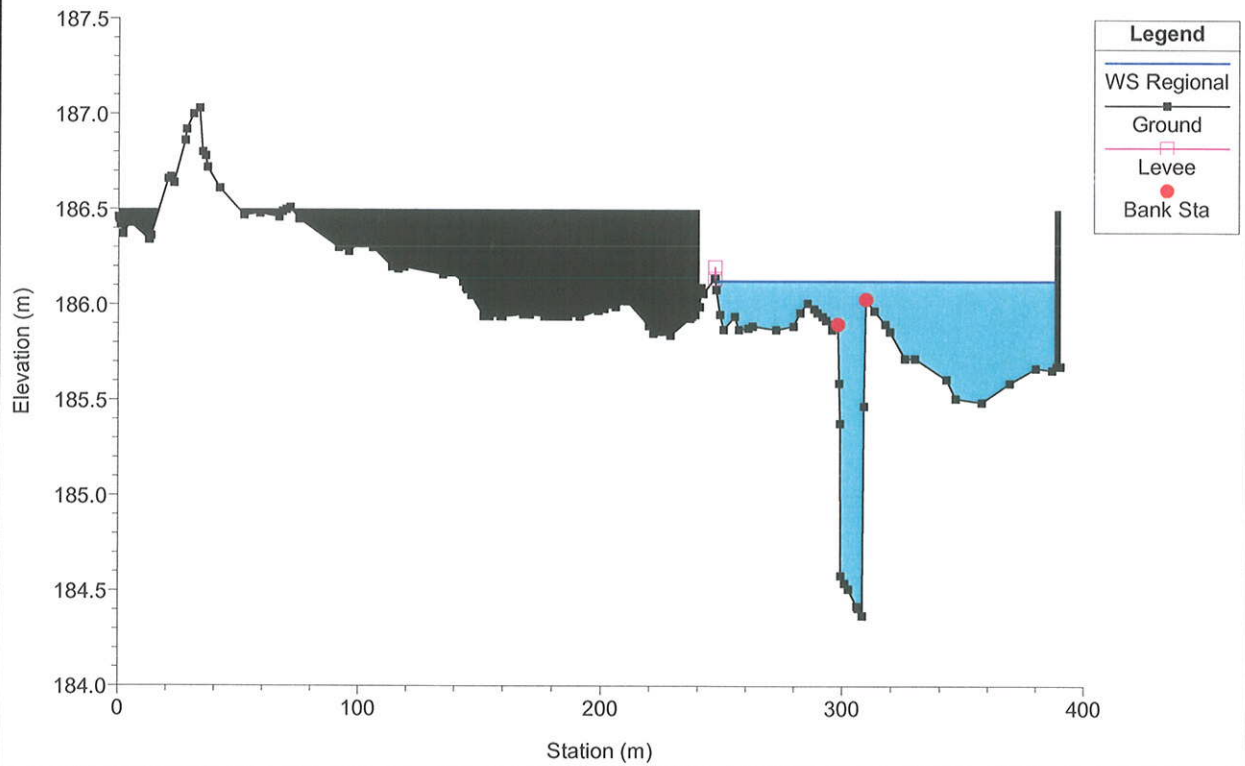
Silver Creek - Huntingwood Reach Plan: Pre-Development 1/27/2011
RS = 755 Culv



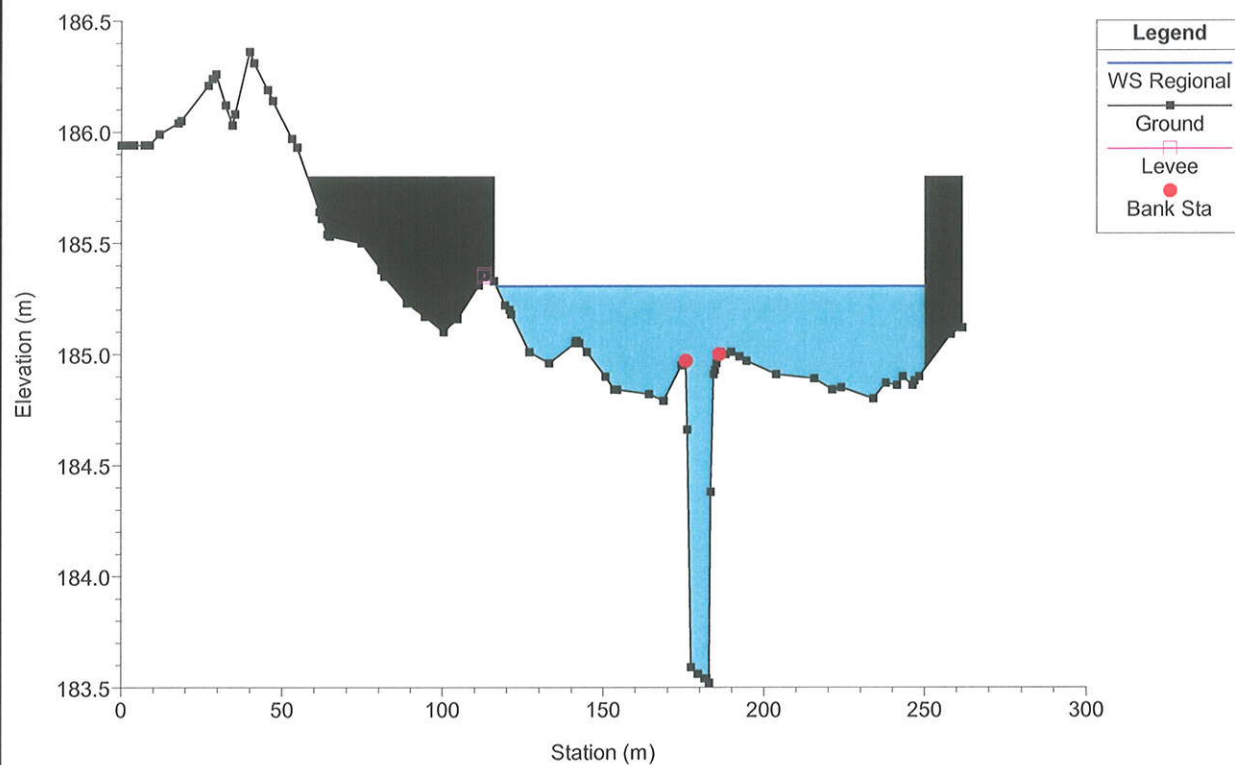
Silver Creek - Huntingwood Reach Plan: Post-Development 1/27/2011
RS = 1670 Upstream Property limits



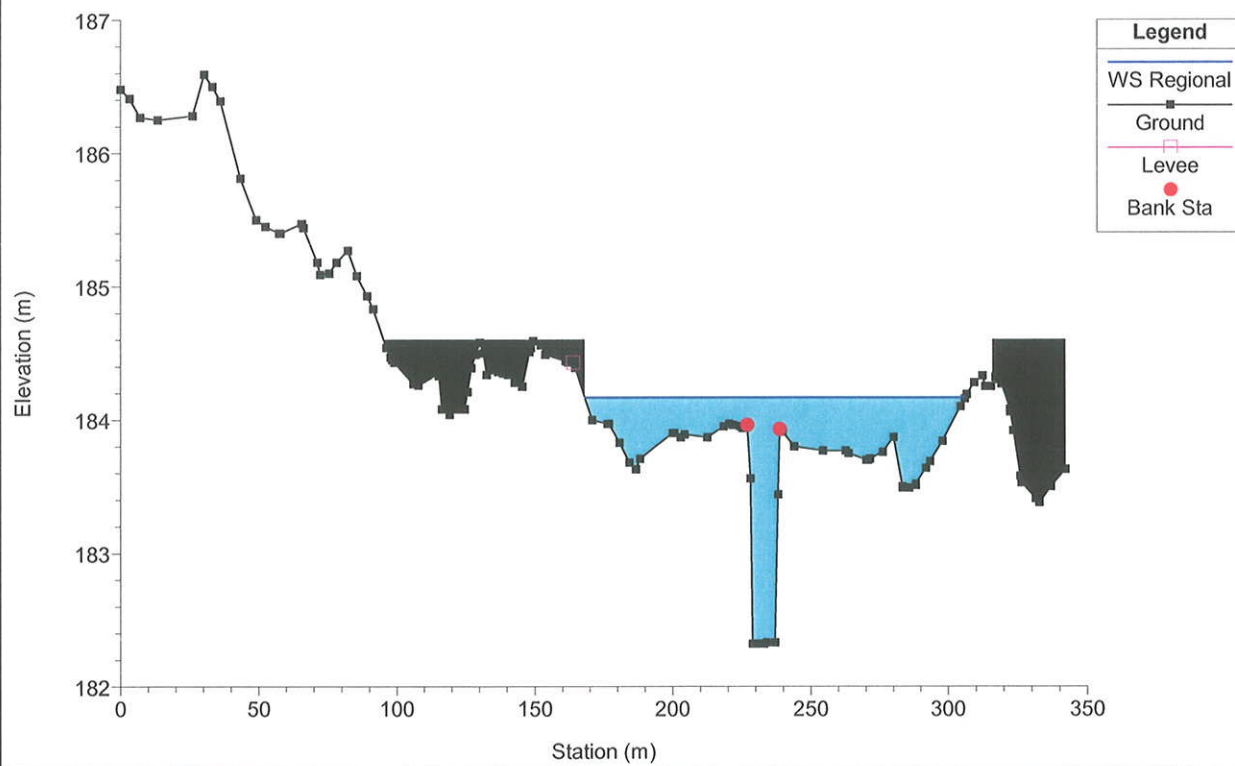
Silver Creek - Huntingwood Reach Plan: Post-Development 1/27/2011
RS = 1640



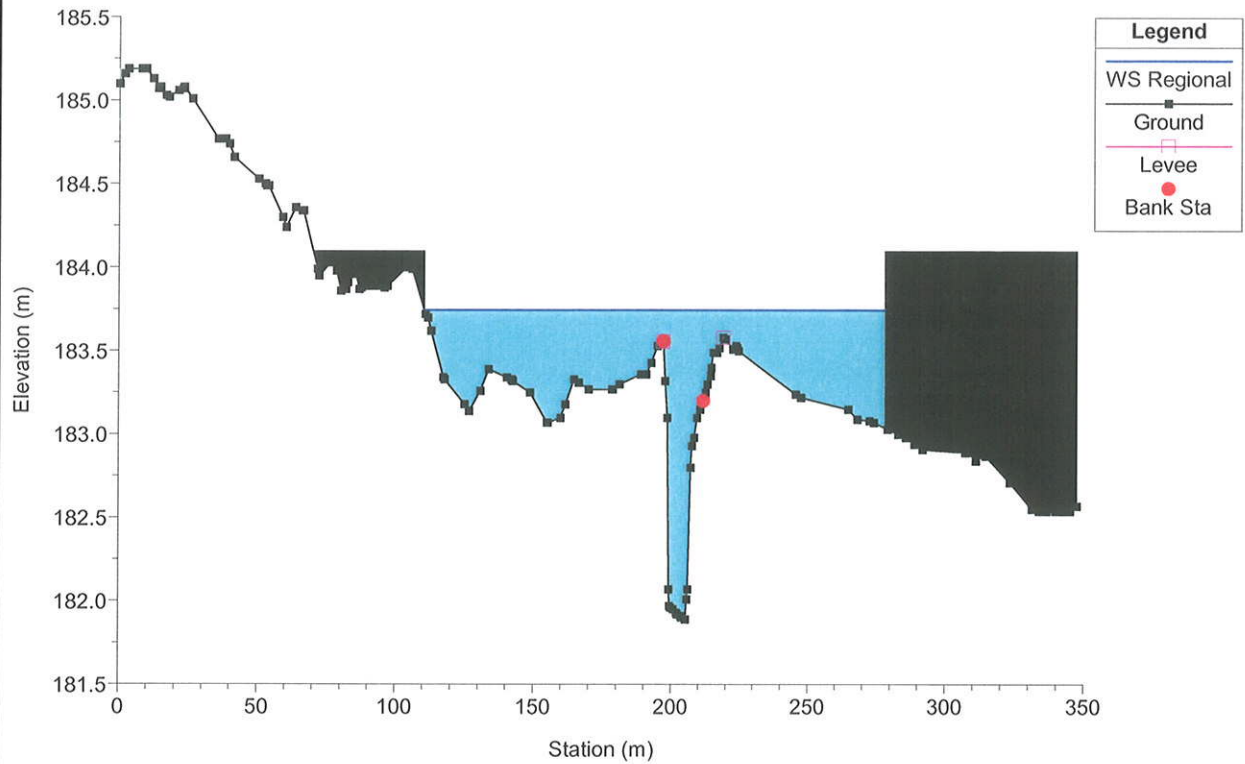
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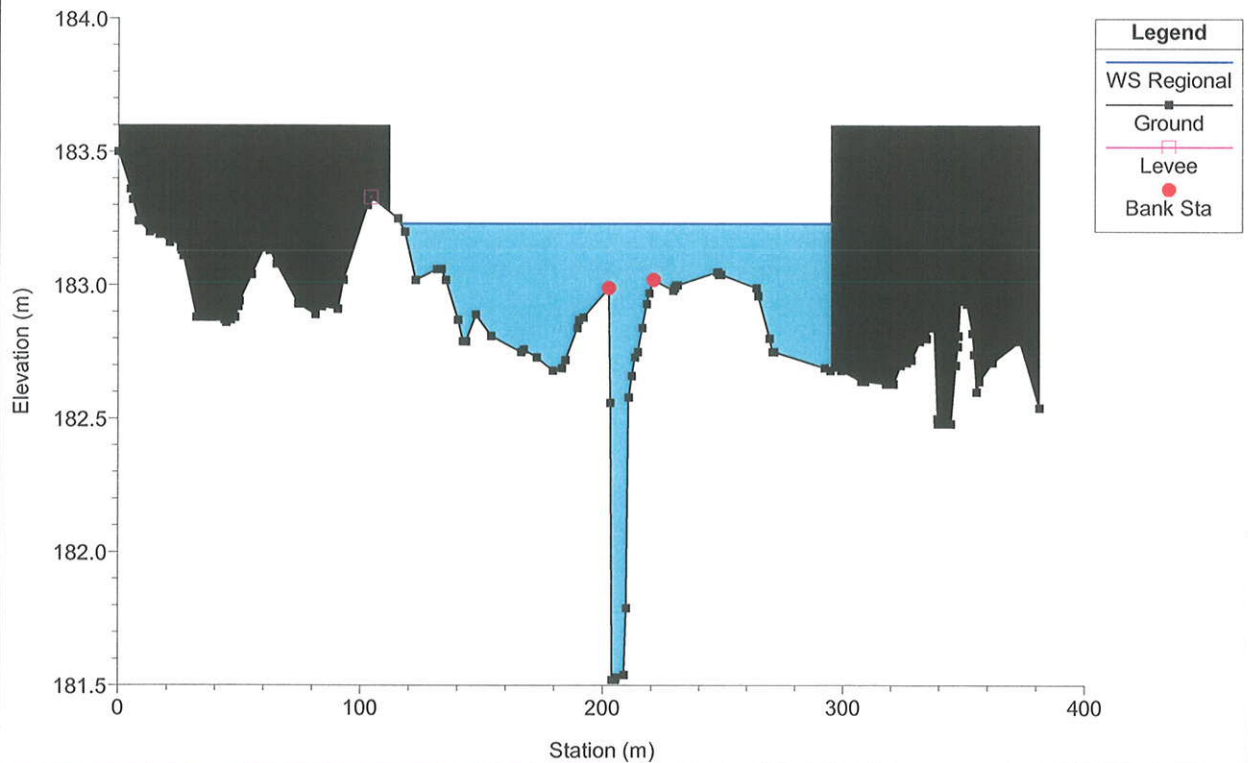
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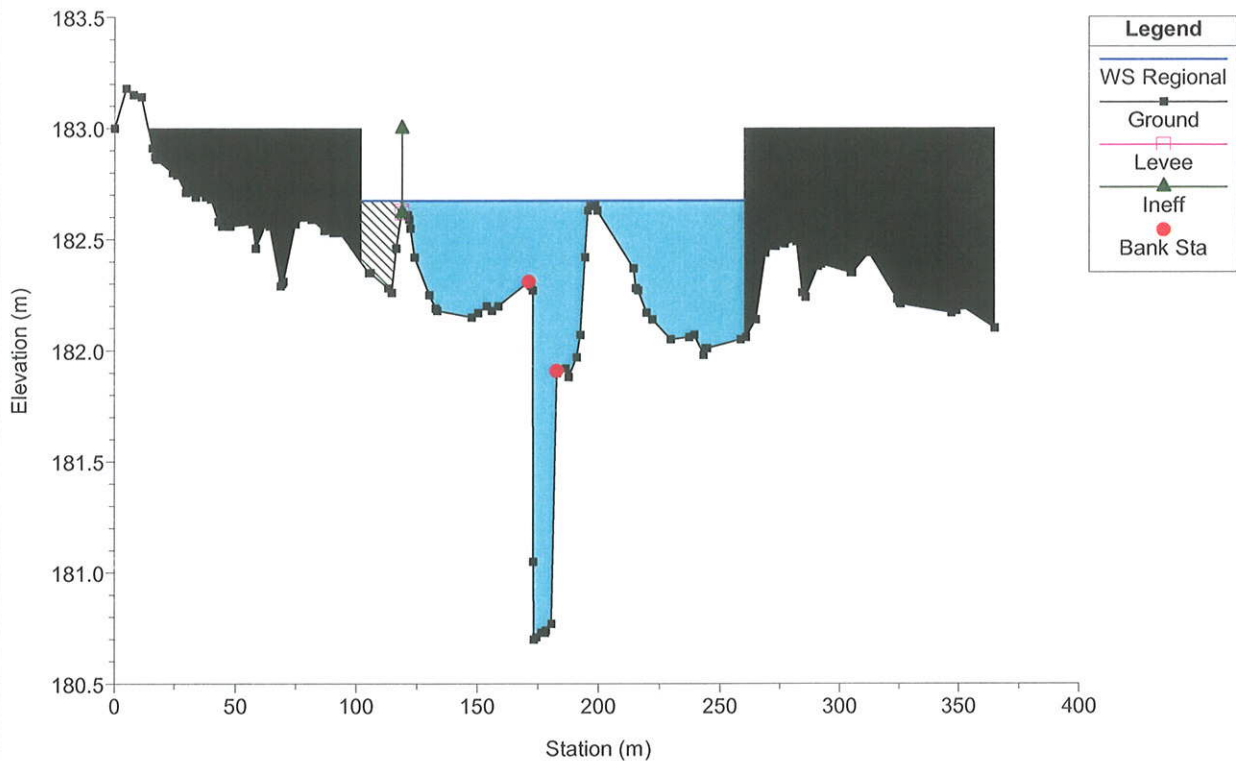
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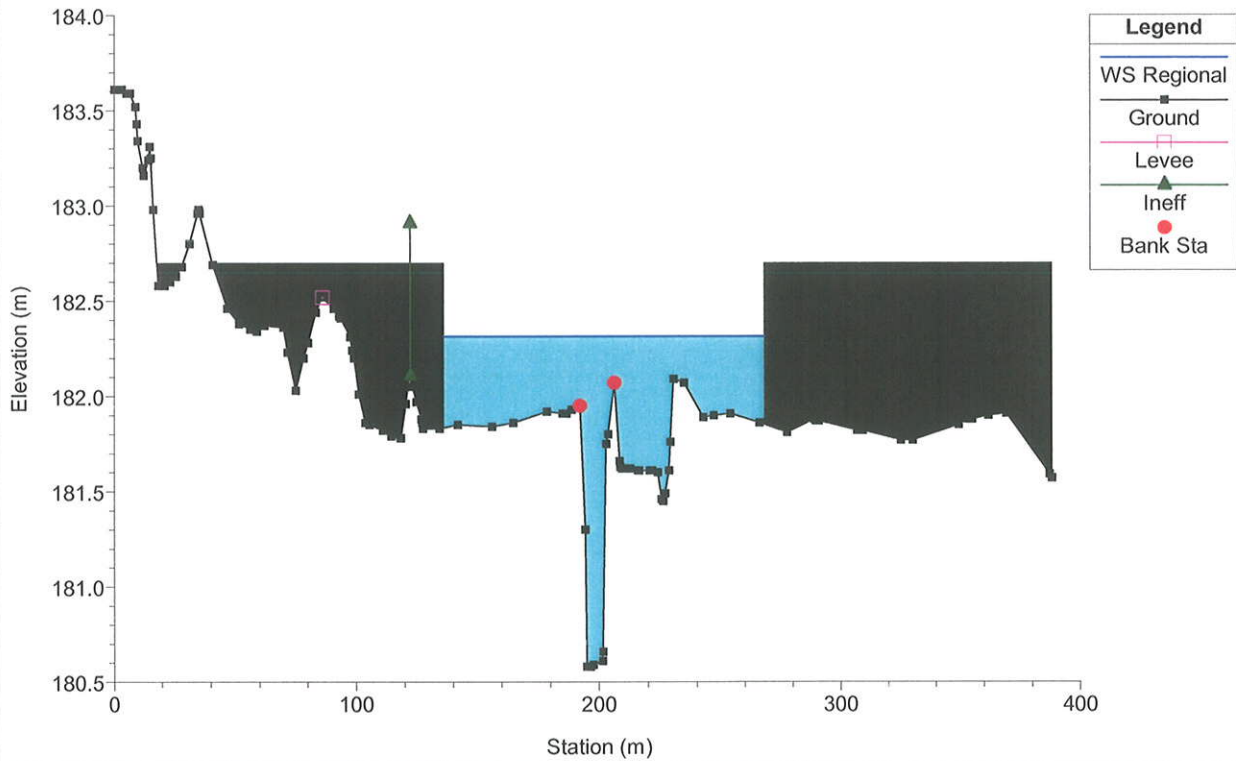
Silver Creek - Huntingwood Reach Plan: Post-Development 1/27/2011
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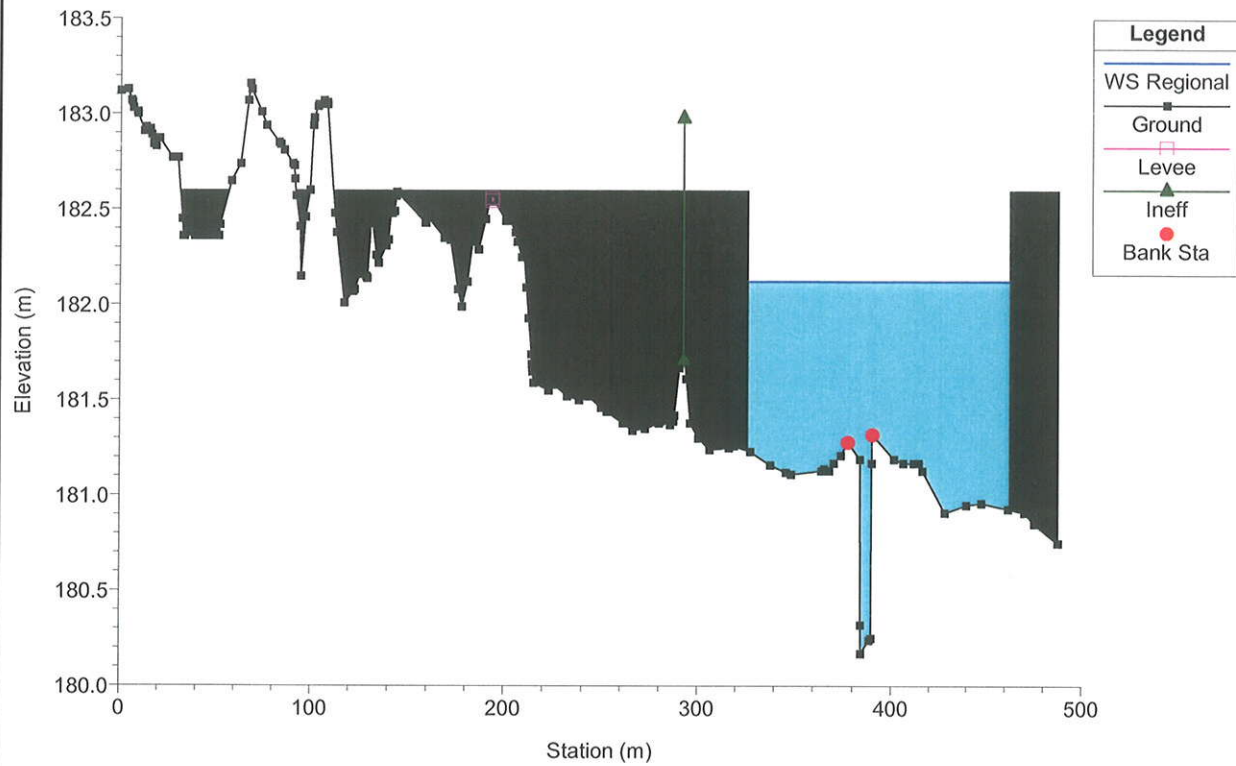
Silver Creek - Huntingwood Reach Plan: Post-Development 1/27/2011
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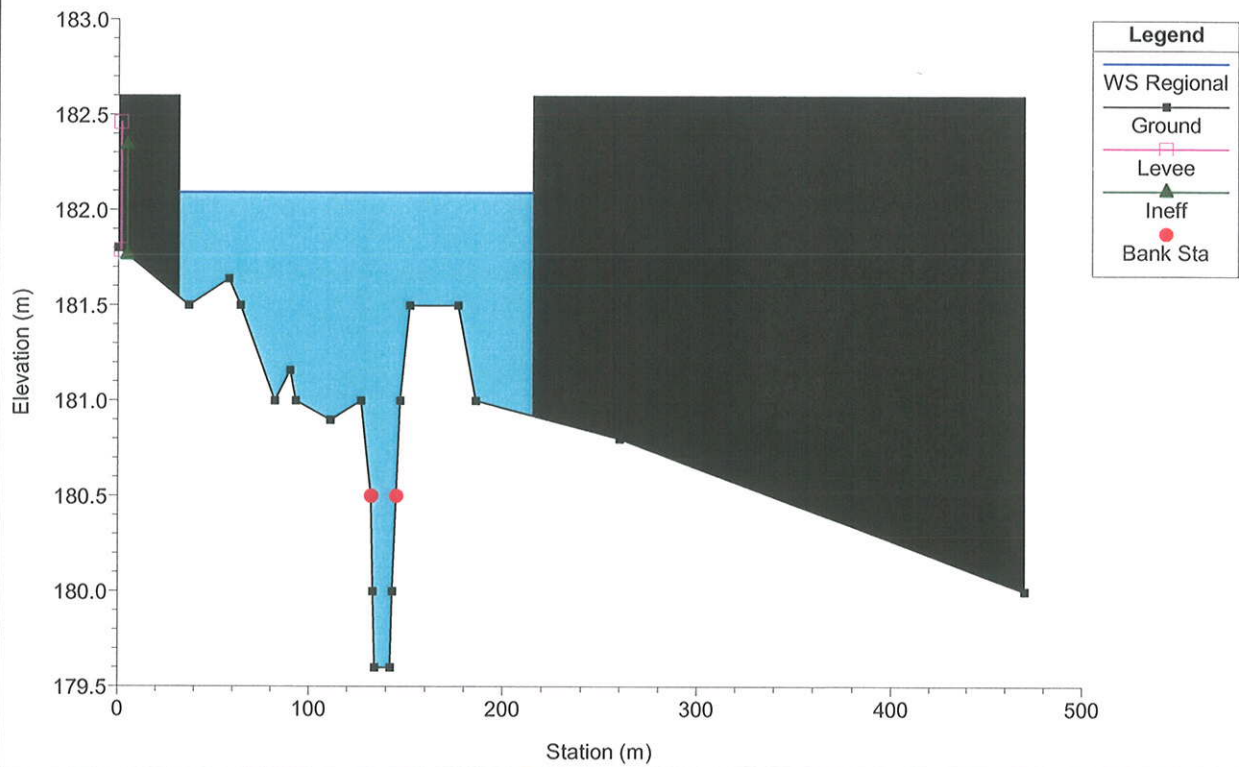
Silver Creek - Huntingwood Reach Plan: Post-Development 1/27/2011
RS = 1010



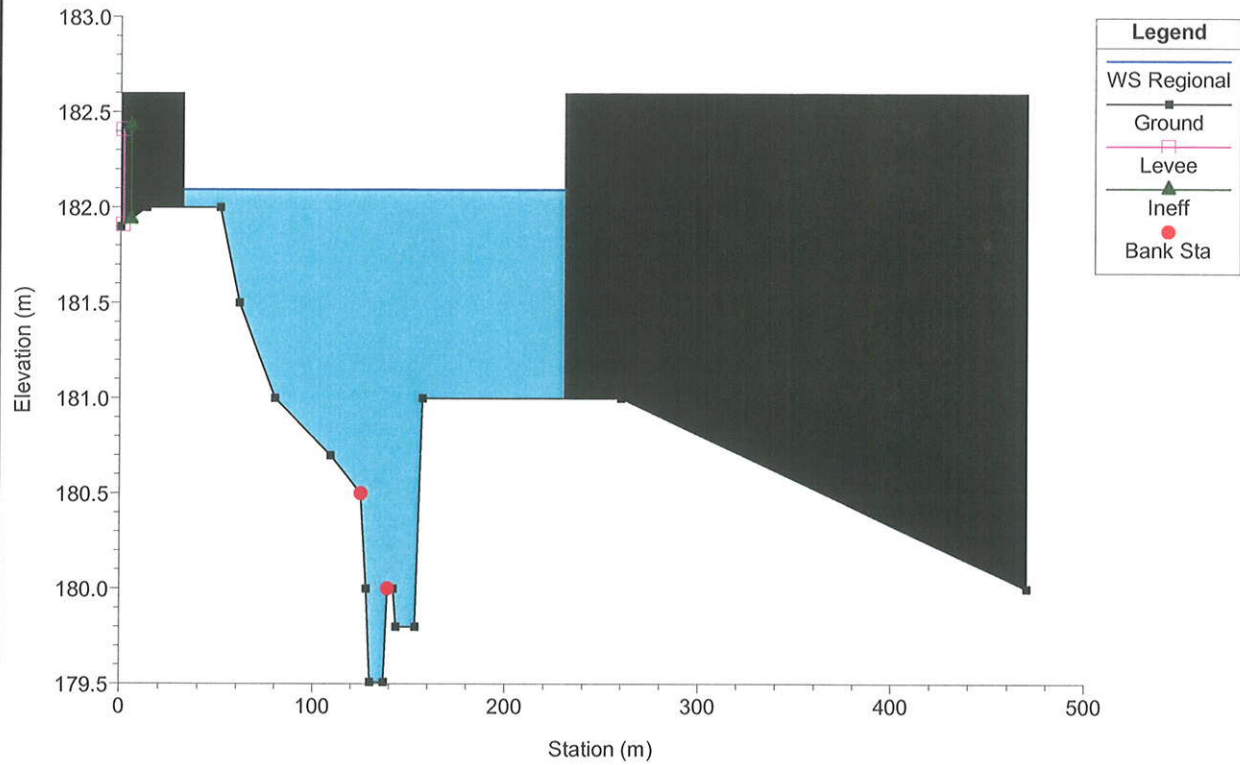
Silver Creek - Huntingwood Reach Plan: Post-Development 1/27/2011
RS = 860



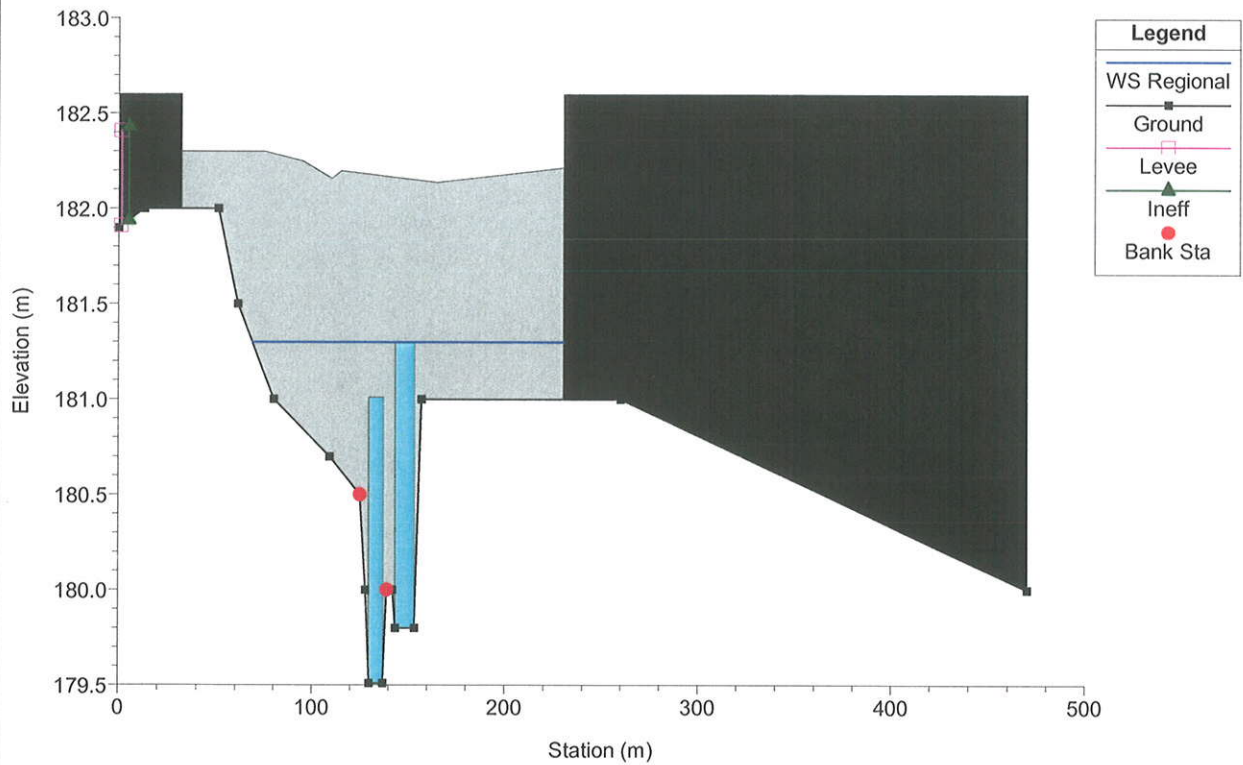
Silver Creek - Huntingwood Reach Plan: Post-Development 1/27/2011
RS = 785 Downstream Property Limits

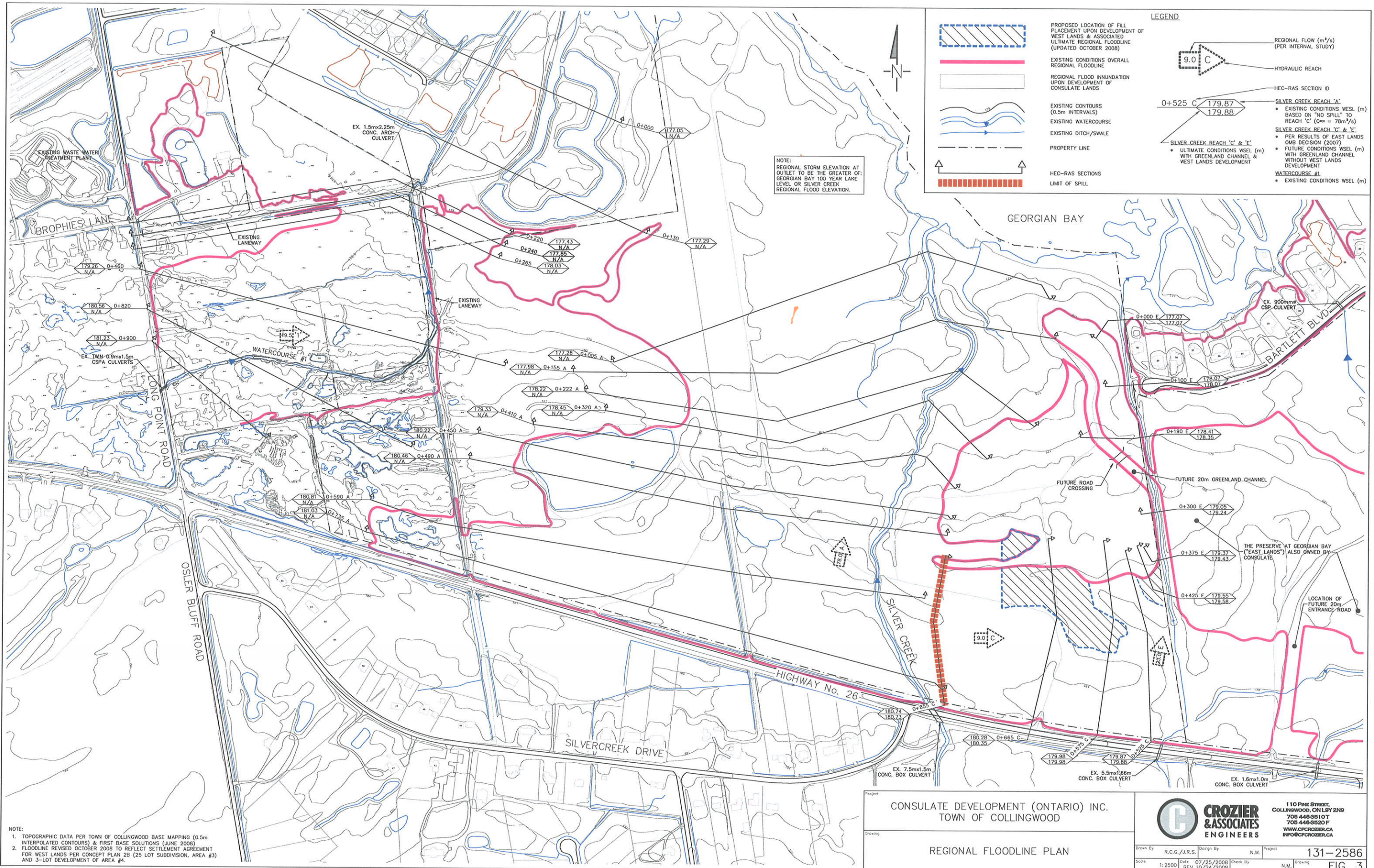


Silver Creek - Huntingwood Reach Plan: Post-Development 1/27/2011
RS = 775 Upstream of HWY 26



Silver Creek - Huntingwood Reach Plan: Post-Development 1/27/2011
RS = 755 Culv





NOTE:
1. TOPOGRAPHIC DATA PER TOWN OF COLLINGWOOD BASE MAPPING (0.5m INTERPOLATED CONTOURS) & FIRST BASE SOLUTIONS (JUNE 2008)
2. FLOODLINE REVISED OCTOBER 2008 TO REFLECT SETTLEMENT AGREEMENT FOR WEST LANDS PER CONCEPT PLAN 2B (25 LOT SUBDIVISION, AREA #3) AND 3-LOT DEVELOPMENT OF AREA #4.

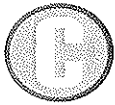
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Scale: 1:2500		Date: 07/25/2008 REV 10/24/2008	Check By: N.M.
Drawn By: R.C.G./J.R.S.		Design By: N.M.	Project: 131-2586
Scale: 1:2500		Date: 07/25/2008 REV 10/24/2008	Check By: N.M.

CROZIER & ASSOCIATES
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APPENDIX B

Meander Belt Calculations



HUNTINGWOOD - MEANDER BELT ANALYSIS

Project: Huntingwood Development
Project No.: 281-2769
File: Meander Belt
Design by: JMP / NM
Date: January 23, 2009
Updated: January 2011

Reach Characteristics

Reach # 1

Upper Elevation	181.45 m	Entrenchment Ratio	31.3
Lower Elevation	179.85 m	Width / Depth Ratio	5.3
Reach Length	285 m	Sinuosity	1.05
Channel Length	298 m	Valley Slope	0.0056
Bankfull Channel Width	6.4 m	Channel Slope	0.0054
Bankfull Channel Depth	1.2 m		
Flood Prone Width	200 m		

Rosgen Classification E

Meander Belt Width $\Gamma = AW_b^B$

Type E

A =	6.69	
B =	1.43	
W_b	6.4	m
Γ =	95.1	m

Reach # 2

Upper Elevation	183.85 m	Entrenchment Ratio	12.0
Lower Elevation	181.45 m	Width / Depth Ratio	3.8
Reach Length	284 m	Sinuosity	1.51
Channel Length	430 m	Valley Slope	0.0085
Bankfull Channel Width	7.5 m	Channel Slope	0.0056
Bankfull Channel Depth	2 m		
Flood Prone Width	90 m		

Rosgen Classification E

Meander Belt Width $\Gamma = AW_b^B$

Type E

A =	6.69	
B =	1.43	
W_b	7.5	m
Γ =	119.3	m

Reach # 3

Upper Elevation	185.5 m	Entrenchment Ratio	23.1
Lower Elevation	183.85 m	Width / Depth Ratio	4.6
Reach Length	163 m	Sinuosity	1.10
Channel Length	180 m	Valley Slope	0.0101
Bankfull Channel Width	6.5 m	Channel Slope	0.0092
Bankfull Channel Depth	1.4 m		
Flood Prone Width	150 m		

Rosgen Classification E

Meander Belt Width $\Gamma = AW_b^B$

Type E

A =	6.69	
B =	1.43	
W_b	6.5	m
Γ =	97.3	m



Key Map

CONCEPT PLAN

LAND USE	UNITS	AREA
RESIDENTIAL SINGLE DETACHED LOTS	1 to 99	7.36 ha
BLOCK 1 - RESIDENTIAL SEMI'S (12 SEMI-DETACHED UNITS)	12	0.84 ha
BLOCK 2 - RESIDENTIAL TOWNHOUSES (18 TOWNHOUSE UNITS)	18	0.74 ha
BLOCK 3 - RESIDENTIAL TOWNHOUSES (12 TOWNHOUSE UNITS)	12	0.43 ha
BLOCK 4 - STORMWATER MANAGEMENT (DEDICATED TO MUNICIPALITY)		1.20 ha
BLOCK 5 - RESIDENTIAL HIGH DENSITY (5 - 36 UNIT WALK UP APARTMENT BUILDINGS)	144	2.05 ha
BLOCK 6 - STORMWATER MANAGEMENT (TO BE DEDICATED TO MUNICIPALITY)		1.15 ha
BLOCK 7 - LOCAL COMMERCIAL		0.55 ha
BLOCK 8 - RESIDENTIAL TOWNHOUSES (75 TOWNHOUSE UNITS)	75	1.69 ha
BLOCK 9 - RESIDENTIAL TOWNHOUSES (33 TOWNHOUSE UNITS)	32	0.82 ha
BLOCK 10 - RESIDENTIAL TOWNHOUSES (12 TOWNHOUSE UNITS)	12	0.32 ha
BLOCK 11 - RESIDENTIAL SINGLE DETACHED (32 FREEHOLD SINGLE DETACHED LOTS)	32	2.67 ha
BLOCK 12 - SENIORS COMPLEX		0.40 ha
BLOCK 13 - COMMUNITY CENTER + OPEN SPACE + ENVIRONMENTAL PROTECTION (DEDICATED TO TOWN)		7.61 ha
BLOCK 14 - OPEN SPACE + ENVIRONMENTAL PROTECTION (DEDICATED TO TOWN)		2.11 ha
BLOCK 15 - OPEN SPACE + ENVIRONMENTAL PROTECTION (DEDICATED TO TOWN)		14.33 ha
BLOCK 16+17 - WALKWAY (DEDICATED TO TOWN)		0.07 ha
ROADS		4.63 ha
TOTAL	436	48.97 ha

- PROTECTED WETLANDS
- 30 METER SETBACK FROM SILVER CREEK
- PUBLIC TRAIL

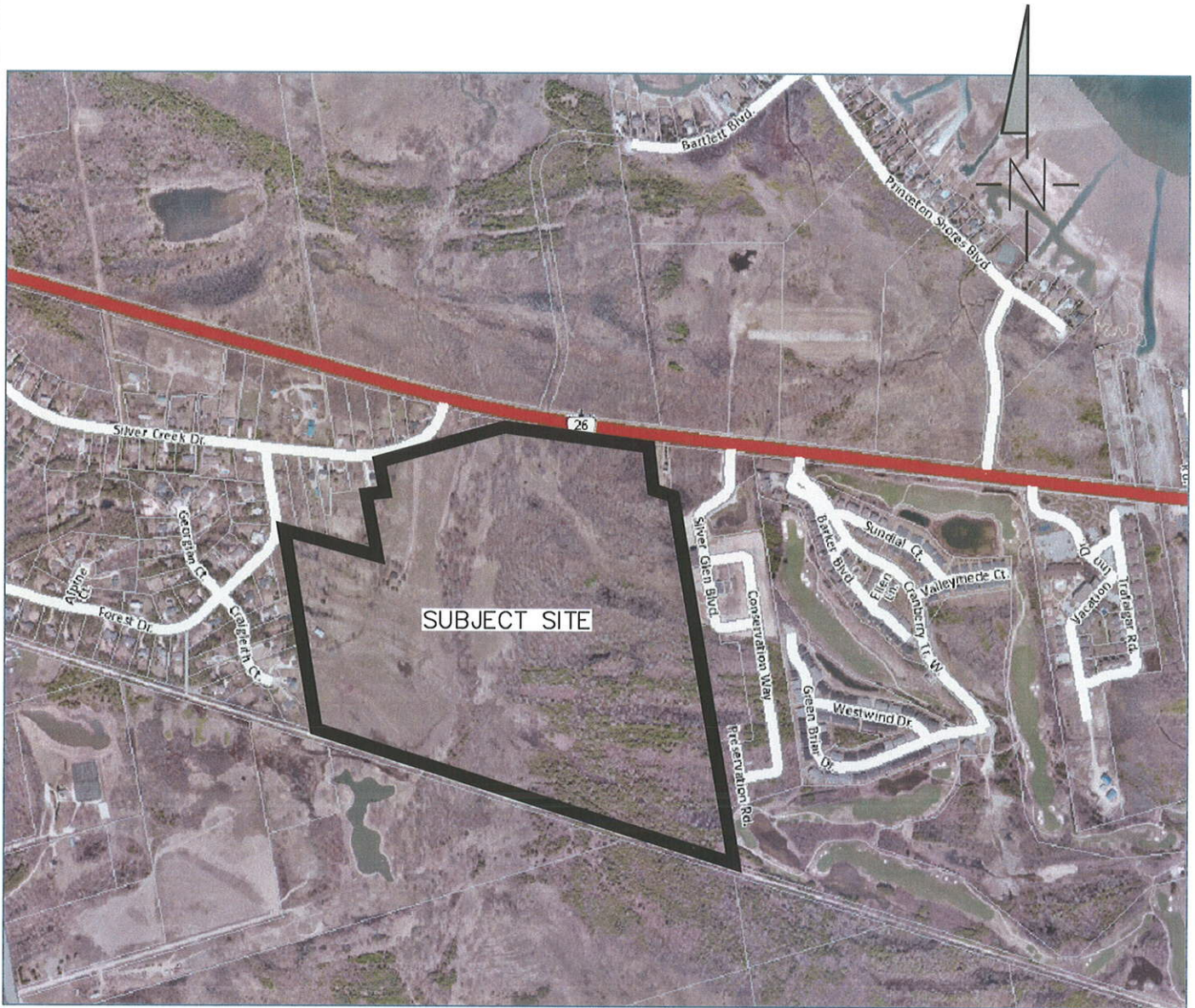
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METRIC
DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY
DIVIDING BY 0.3048
PROJECT: 704-10 DRAWN: AP DATE: JAN 19/2010

DWG: 704-10-Concept Plan

FIGURES

- | | |
|------------------|--|
| Figure 1: | Site Location |
| Figure 2: | Concept Plan |
| Figure 3: | Existing Conditions Natural Hazard Limits Plan |
| Figure 4: | Post Development Conditions Natural Hazard Limits Plan |



Project	HUNTINGWOOD DEVELOPMENT TOWN OF COLLINGWOOD	 CROZIER & ASSOCIATES Consulting Engineers 110 PINE STREET, COLLINGWOOD, ON L9Y 2N9 705 446-3510 T 705 446-3520 F WWW.CFCROZIER.CA INFO@CFCROZIER.CA					
Drawing	SITE LOCATION	Drawn By	J.O.	Design By	J.O.	Project	281-2769
		Scale	N.T.S.	Date	01/20/2011	Check By	J.P./C.F.C.
							Drawing
							Fig. 1

Fig. 1



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DCS D.C. Slade Consultants Inc.
Planning & Development
243 Hurontario Street, Collingwood, ON Phone: 705.4441.930