October 10th, 2024

Attn: Mr. Tom Williams, P. Eng.
President
XCG Consulting Engineers & Scientists
820 Trillium Drive, Kitchener, Ontario, Canada N2R 1K4
☎: 519.741.5774 ext. 7233; C. 519.502.3237 ✉: tom.williams@xcg.com

Re: Site Specific Flood Study – 529 Tiffin Street, Barrie, ON

Dear Tom,

Aquafor Beech Limited (Aquafor) was engaged by XCG to fulfill the permitting requirements for the proposed development at 529 Tiffin Street in the City of Barrie, as specified by the Nottawasaga Valley Conservation Authority (NVCA). To ensure compliance with these requirements, Aquafor conducted a hydraulic assessment to determine the regulatory flooding limitations associated with the subject property.

To ensure an accurate representation of the site-specific conditions, Aquafor updated the NVCA's hydraulic model, incorporating the most recent DTM data. This technical memo provides a summary of the methodology and results of the hydraulic assessment, adhering to the guidelines outlined in the MNRF's Flood Hazard Technical Guidelines (2002), the more recent Technical Guidelines for Flood Hazard Mapping (2017) as well as the NVCA Natural Hazard Technical Guide (2013).

1 STUDY AREA

Bear Creek emerges along the steep slopes of the Algonquin Bluffs south of Ardagh Road in Barrie. The rollicking springs combine and slow as they enter a series of wetlands, which extend into Essa Township. The creek flows downstream through the Tiffin Centre for Conservation and over the dam at the Utopia Conservation Area before discharging to the Nottawasaga River at County Road 90 in Angus. Unfortunately, the conversion of agricultural land and urban developments have resulted in significant loss of wetlands in the region. Along the base of the Algonquin Bluffs, a valuable arc of wetlands and lowland forests, spanning from the Bear Creek Wetland to Baxter Swamp, has been affected.

The subject property is situated approximately 165 meters above the right bank of Bear Creek, as depicted in Figure 1 below. It is in close proximity to the river corridor, making it susceptible to potential floodplain overflow beyond the designated river bank corridor during regulatory events.

2 CONTEXT

Nottawasaga Valley Conservation Authority (NVCA), by Ontario Regulation 172/06 is the authority that manages regulation of development, interference with wetlands, and alteration to shorelines and watercourses within the Bear Creek. The NVCA has the responsibility for ecosystem enhancement and the protection of people from natural hazards such as flood and

erosion hazards. In the context of developing the property at 529 Tiffin Street, a hydraulic assessment to confirm the regulatory flood level and the extent of the regulatory flood lines impacting the subject property has been undertaken. The existing NVCA HECRAS model for the Bear Creek has been used to perform the assessment along the DTM LiDAR derived (OMAFRA 2022 – Lake Simcoe) provided by Geohub open-source data (MNRF). Updates to the model were made to obtain site-specific results, and are described here-in. As per the *River & Stream Systems: Flooding Hazard Limit Technical Guide, MNR, 2002*, within NVCA watershed, the flood regulation is produced by the Timmins Storm or the 100-year flood flow, whichever is the greater.

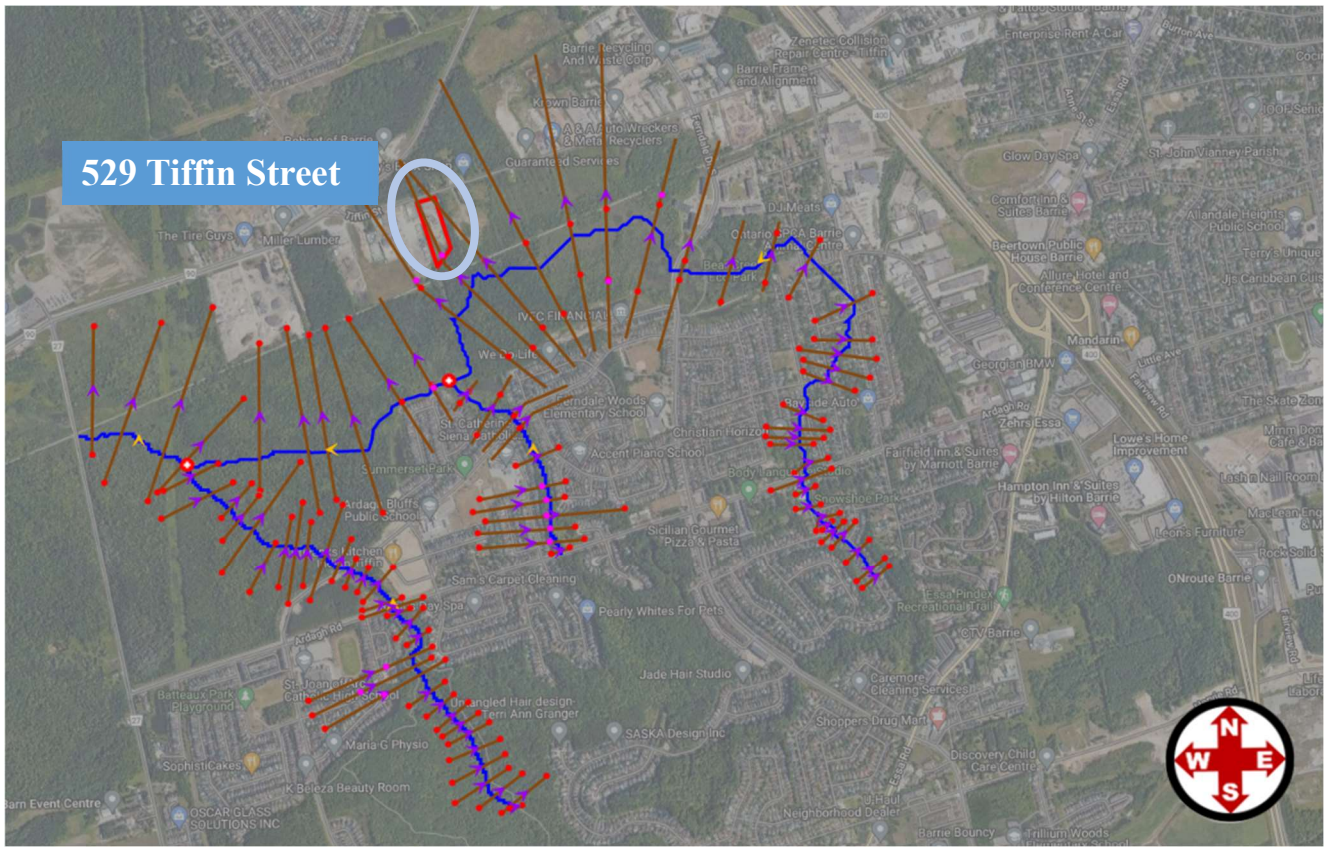


Figure 1. Bear Creek and 529 Tiffin Street Property Location.

3 HYDROLOGY ASSESSMENT

The existing NVCA HEC-RAS model for Bear Creek was provided for the flood hazard assessment. However, only one design storm labeled PF1was available in the model. It should be noted that due to the lack of information related to the assigned design storm PF1, it will be assumed to represent the regional storm (Timmins).

A summary of the flow rates available in the existing NVCA model is provided in Table 1 below. The study area is located along river BEA- F1A, reach 2, and therefore, the regional peak flow of Bear Creek is estimated to be 16.19 m3/s surrounding the study area.

Table 1. Existing HEC-RAS Conditions Summary (U/S and D/S of Study Site).

River and Reach	HECRAS Cross-section	PF1 Flow (m^3/s)
BEA-F1A, reach 2	5588.099	16.19
BEA-F1A1, reach 1	1335.372	9.79
BEA-F1A, reach 1	1001.999	24.74
BEA-F, reach 2	3269.378	3.54
BEA-F, reach 1	438.2717	27.72

To be able to identify which storm of the regional event and the 100-year storm is the largest, and therefore, is considered as the regulatory storm, Aquafor performed a hydrology analysis in order to estimate the100-year peak flow of Bear creek along the study area. To do so, Aquafor used the methodology developed and described in the NVCA's Watershed Hydrology Study for Nottawasaga, Pretty and Batteaux Rivers, Black Ash, Silver and Surgeon Creeks completed by Maclaren Plansearch in 1988. In this study, the watercourses within the NVCA watershed have been discretized into 191 sub-catchments and design storms at each sub-catchment outlet have been estimated by modelling process using the QUALHYMO software. The 529 Tiffin street property is located within the sub-catchment numbered 600 which is a headwater catchment. To estimate flows at headwater watercourses locations the study recommends to apply the equation developed by regression analysis. Indeed. the Maclaren study entailed a linear regression analysis using peak flow versus drainage area correlation and concluded with the development of the following equation:

$$Q = CA^n$$

Where:
Q is the flow in m^3/s;
A is the drainage area in km^2;
C and n are unitless constant coefficients defined by the drainage region (Table 3-18 of the Maclaren Study - c= 0.112 and n=0.757 for the 100-year peak flow).

At study area location the drainage area of Bear Creek is estimated at 1.9 km^2. Result of the application of the equation is provided in Table below.

Table 2. Estimated 100-year Peak Flow as per Linear Regression Equation for Headwater Watercourse Developed in 1988 Maclaren Study

Maclaren Modeled Flow at Catchment 600				Flow Entered in NVCA HECRAS Model	Calculated Pro-Rated Flow
Regional Storm (Timmins)		100-year		Regional Storm (Timmins)	100-year
1988	Future	1988	Future	16.19	6 *
39.4	54	6.9	9		

** It is important to note that the drainage area unit used in the regression equation is km^2 while the report mentions that the area should be in hectare. However, using hectare unit the 100-year flow would be 0.18 m^3/s. Comparing with downstream flow rate from the model (9 m^3/s), the estimation of 6m^3/s at study area location is more relevant. Moreover, based on Aquafor experience with studies completed by MacLaren Plansearch, we know that an errata has been highlighted post study completion to correct the hectare unit with the use of km^2 in the headwater regression equation.*

The estimated 100-year peak flow within the study area is 6 m^3/s The hydrologic assessment allows to confirm that the regional (Timmins) storm event is considered as the regulatory storm for this segment of Bear Creek.

4 HYDRAULIC MODEL UPDATES

The existing HEC-RAS model for Bear Creek provided by NVCA was used for the hydraulic analysis. The georeferencing of the existing model was conducted using the NAD83 CSRS/UTM zone 17N(m) coordinate system.

4.1 DTM and Vertical Datum Correction

In order to enhance the existing hydraulic model, a Digital Terrain Model LiDAR Derived was used. This Digital Terrain Model (DTM) was provided by the online Geohub database tool (MNRF) and was acquired between May 5th-7th, 2022 (OMAFRA Lake Simcoe package). The vertical datum of the DTM was in Canadian Geodetic Vertical Datum of 2013 (CGVD2013). However, the NVCA HEC-RAS model initially relied on the data provided by NVCA, which was finalized on September 28th, 2012, is in Canadian Geodetic Vertical Datum of 1928 (CGVD28). Therefore, in order to ensure a consistent elevation data between, the Geohub's DTM (CGVD2013) and the HECRAS model (CGVD28), Aquafor corrected the vertical datum of the DTM. As per the Height Reference System Modernization (NRcan)'s recommendations, a constant offset has been applied to the DTM and as per the study area location, a height correction of 0.376 meters was applied as detailed in **Appendix A**. The corrected vertical DTM (in CGVD28) was then used to redefine the geometry of the hydraulic model.

4.2 Existing NVCA HEC-RAS Scenario

The regional flow used in this hydraulic assessment is from the existing NVCA's HEC-RAS hydraulic model, while the 100-year peak flow was estimated by Aquafor as detailed in the section 4 HYDRAULIC MODEL UPDATES. The existing NVCA HECRAS model includes multiple cross-sections on Bear Creek, however, there is no HEC-RAS cross-section intersecting the subject property, as shown in Figure 2.

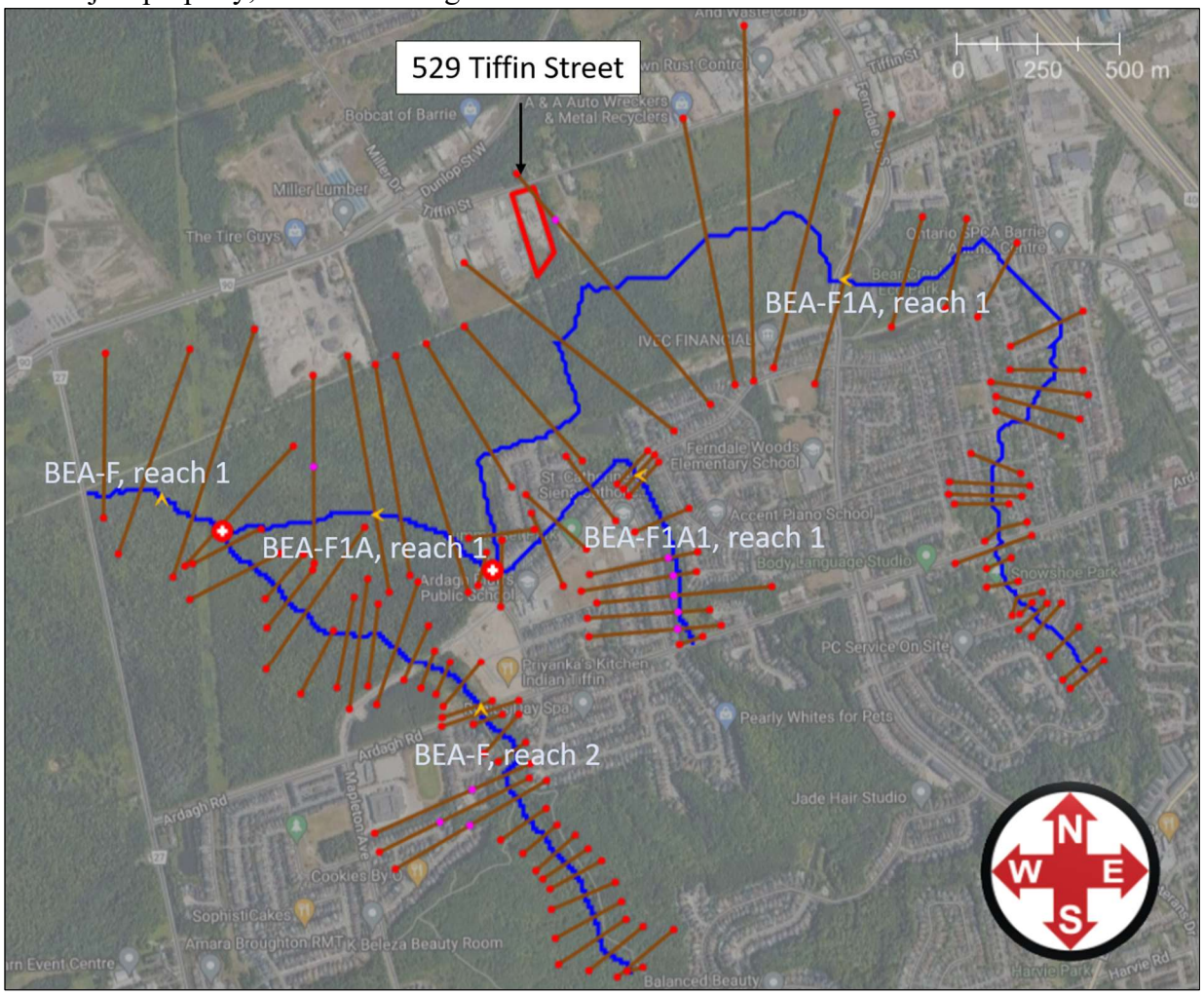


Figure 2. Existing NVCA HECR-RAS Model Planform

4.3 Updated Existing HEC-RAS scenario

Opportunities to improve the accuracy of the existing model were applied. To do so, an updated existing conditions scenario has been created, where a cross-section within the private property was added using the DTM to extract the geometry (XS # 2062.384). To comprehensively characterize the entire floodplain of Bear Creek, the cross-sections from the existing model were extended in River Reach BEA-F1A, specifically focusing on the area of interest. Bank stations and manning's N coefficients have been changed for multiple cross-sections surrounding the study area. Furthermore, in this updated existing scenario, the creek center-line as well as the

river cross-sections of the downstream reach (BEA-F1A1, reach 1) have been updated using the DTM in order to reflect the recent development at Summerset Drive and the new alignment of the creek. This realignment was based on an estimation of the river's true location, employing Geohub's DTM and satellite imagery. The HEC-RAS planform of the Updated Existing Scenario is provided in Figure 3 below.

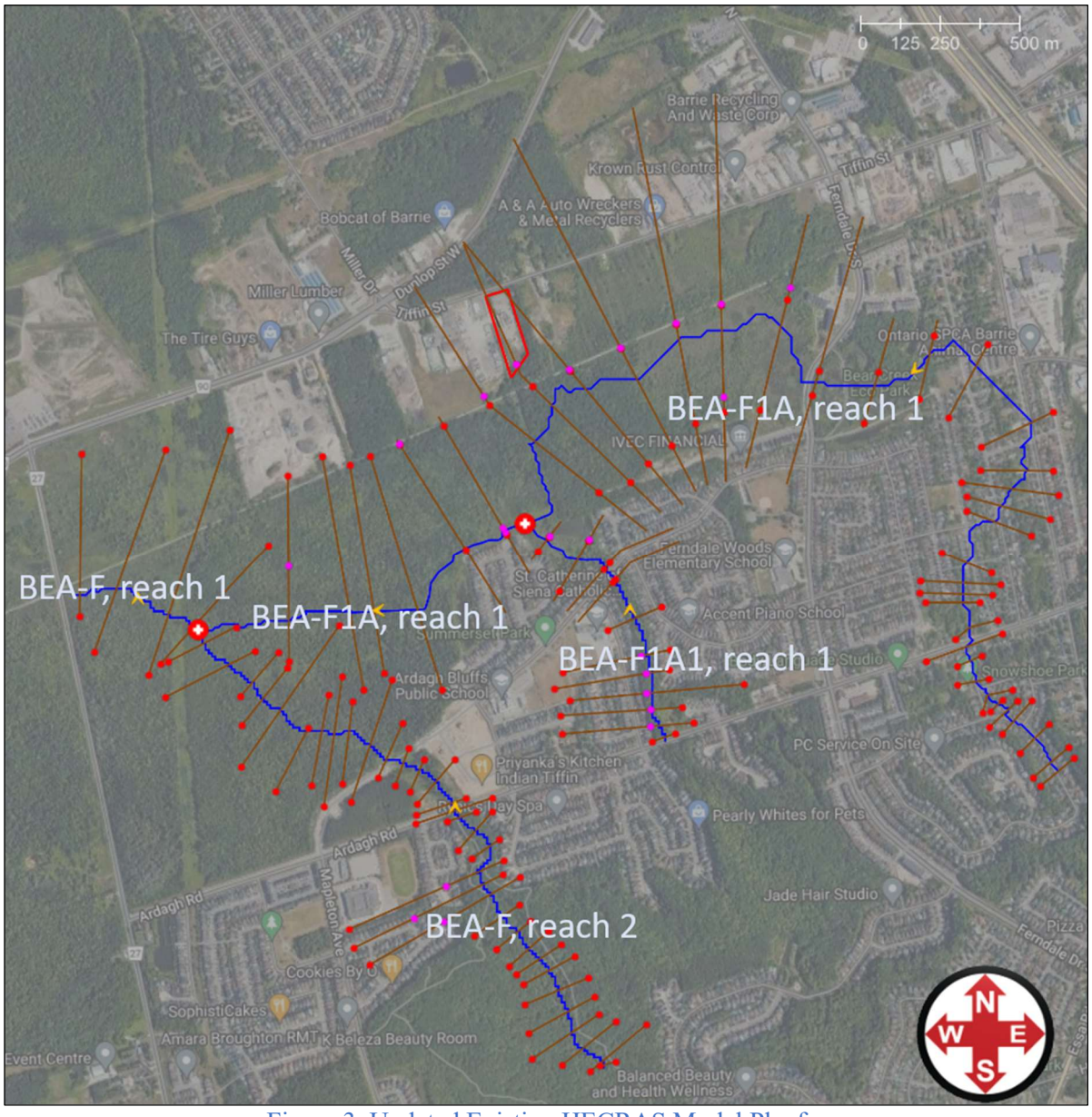


Figure 3. Updated Existing HECRAS Model Planform

4.4 Proposed HECRAS Scenario

The proposed scenario has been developed duplicating the updated existing scenario. In this proposed scenario the cross-section # 2062.384 located within the private property was updated to reflect the proposed grading on 529 Tiffin Street. The rest of the model remains unchanged, therefore, the Planform of the HEC-RAS model is also the same. Comparison of the Cross-section geometry is provided in Figure 4.

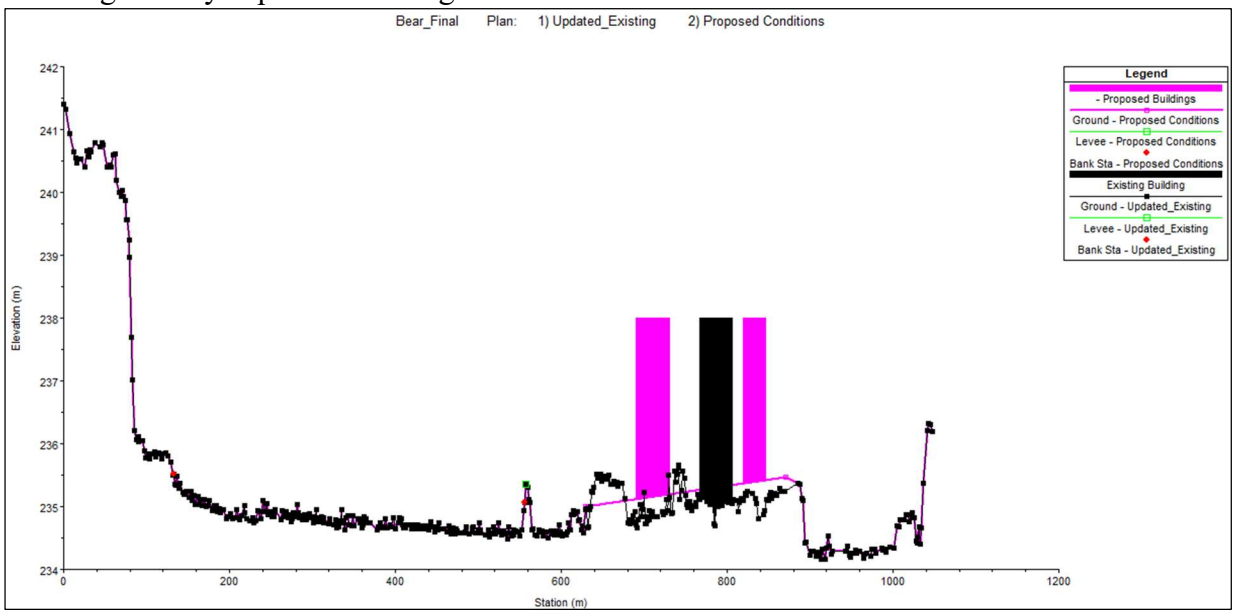


Figure 4. Updated Existing and Proposed Scenarios Geometry Comparison

4.5 Hydraulic Modelling Updates Overview

An overview of the changes made when preparing the updated existing conditions and proposed conditions modelling scenarios is presented in Table 3.

Table 3. Comparison of Flow and Geometry Conditions for NVCA Existing, Updated Existing and Proposed Conditions Modelling Scenarios

	Existing NVCA Scenario (Plan Name: Bear_Final)	Updated Existing Scenario (Plan Name: Updated Existing)	Proposed Scenario (Plan Name: Proposed Conditions)
Flows	Existing steady flow scenario provided in the HEC-RAS model including PF1 Flow Rates. Steady Flow Scenario Name: Existing_NVCA_Flow	Steady Flow revised to take into account the downstream creek centerline change (BEA-F1A1) and the Junction location change (junction 65). Addition of the estimated 100-year peak flow Steady Flow Scenario Name: Updated_Existing_Flow	Same as Updated Existing scenario Steady Flow Scenario Name: Updated_Existing_Flow

		Existing NVCA Scenario (Plan Name: Bear_Final)	Updated Existing Scenario (Plan Name: Updated Existing)	Proposed Scenario (Plan Name: Proposed Conditions)
Geometry	Reaches	As per existing NVCA Model	BEA-F1A1, reach 1 centerline updated Junction location 65 changed	Same as Updated Existing scenario
	Cross-Section	As per existing NVCA Model	XS # 2064.384 on BEA-F1A reach 2 added using DTM elevation XS extension from XS # 2061.384 to 2855.603 Bank stations and manning's N changed from XS # 2061.384 to 3318.255 on BEA-F1A reach 2. Levees placed where appropriate XS location, bank stations and manning's N changed from XS # 619.6823 to 692.6615 on BEA-F1A1 reach 1. Levees placed where appropriate XS location, bank stations and manning's N changed for XS # 826.7271 and # 827.7271 on BEA-F1A reach 1	Same as Updated Existing scenario with XS # 2064.384 updated as per proposed grading

5 HYDRAULIC RESULTS

The model was run under a subcritical flow regime to confirm the flood level of Bear Creek, and in turn, to delineate the updated regulatory flood lines surrounding the subject property. Results of the updated existing and proposed scenarios are presented below, with the intent of illustrating flooding conditions and regulatory floodplain delineation in both cases, existing and proposed conditions.

5.1 Water Surface Elevation and Velocity Comparison

The regional water surface elevation results at river cross-section #2062.384 under both updated existing and proposed scenarios is presented in the Figure 5. Furthermore, Table 4 summarizes

the regional water surface elevation upstream and downstream the study area. Additionally, detailed HECRAS model result outputs are provided in **Appendix B**.

Modelling results show that the property would experience flooding during the regional storm event under existing conditions but as well as under proposed grading conditions. The proposed regrading doesn't block any conveying flow, and as shown in Table 4 , the proposed grading at 529 Tiffin Street will not have an impact on the flood level as all along Bear Creek the water surface elevation will remain the same.

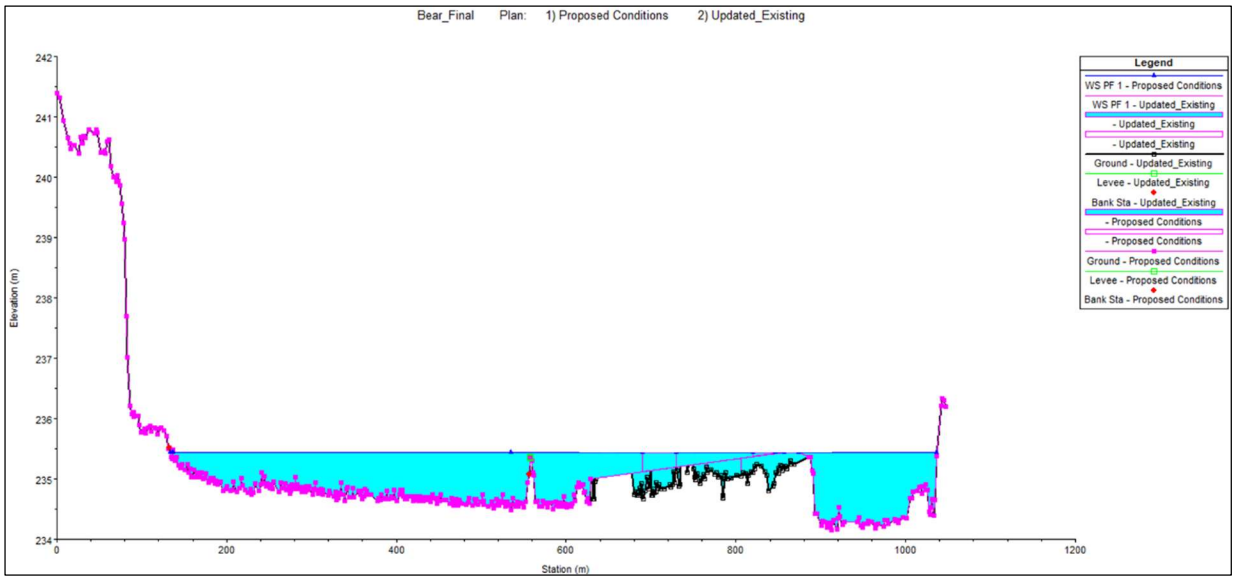


Figure 5. Estimated Regulatory Water Surface Elevation at Cross-section # 2062.384 (1D Overview)

Table 4. Updated Existing and Proposed Conditions Water Surface Elevation Comparison

Location	River & Reach	HECRAS River Cross-section	Flow (m3/s)	Water Surface elevation for PF1 Storm Event (m - CGVD28)		Difference (m - CGVD28)
				Updated Existing Conditions	Proposed Conditions	
Upstream Area	BEA-F1A, reach 2	3318.255	16.19	235.9	235.9	0
	BEA-F1A, reach 2	3073.679	16.19	235.72	235.72	0
	BEA-F1A, reach 2	2855.603	16.19	235.65	235.65	0
	BEA-F1A, reach 2	2711.981	16.19	235.57	235.57	0
	BEA-F1A, reach 2	2360.737	16.19	235.47	235.47	0
	BEA-F1A, reach 2	2359.737	16.19	235.45	235.45	0

Location	River & Reach	HECRAS River Cross-section	Flow (m3/s)	Water Surface elevation for PF1 Storm Event (m - CGVD28)		Difference (m - CGVD28)
				Updated Existing Conditions	Proposed Conditions	
529 Tiffin St	**BEA-F1A, reach 2**	**2062.384**	**16.19**	**235.44**	**235.44**	**0**
Downstream Area	BEA-F1A, reach 2	2061.384	16.19	235.44	235.44	0
	BEA-F1A, reach 1	827.7271	24.74	235.42	235.42	0
	BEA-F1A, reach 1	826.7271	24.74	234.95	234.95	0
	BEA-F1A, reach 1	825.7271	24.74	234.92	234.92	0

In addition, the velocity is another parameter analysed in this assessment. Figure 6 provides a cross-sectional view of the velocity repartition at river cross-section # 2062.384 and Table 5 summarizes the velocities for each cross-section for the regional storm event under both updated and proposed conditions scenarios.

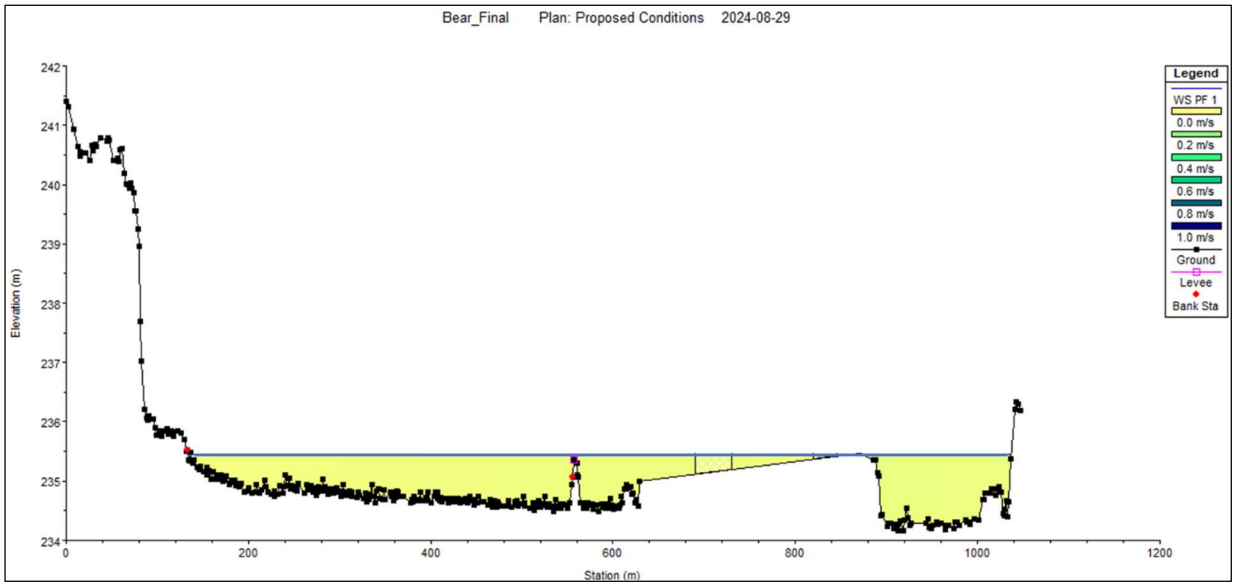


Figure 6. Estimated Velocity under Regional Storm for the Proposed Conditions at Cross-section # 2062.384

Table 5. Updated Existing and Proposed Conditions Velocity Comparison

Location	River & Reach	HECRAS River Cross-section	Flow (m3/s)	Channel velocity (m/s)		Difference (m2/s)	Total cross-section velocity (m/s)		Difference (m2/s)
				Updated Existing	Proposed		Updated Existing	Proposed	
Upstream Area	BEA-F1A, reach 2	3318.255	16.19	0.39	0.39	0	0.39	0.12	-0.27
	BEA-F1A, reach 2	3073.679	16.19	0.12	0.12	0	0.12	0.12	0
	BEA-F1A, reach 2	2855.603	16.19	0.12	0.12	0	0.12	0.23	0.11
	BEA-F1A, reach 2	2711.981	16.19	0.23	0.23	0	0.23	0.12	-0.11
	BEA-F1A, reach 2	2360.737	16.19	0.12	0.12	0	0.12	0.07	-0.05
	BEA-F1A, reach 2	2359.737	16.19	0.07	0.07	0	0.07	0.03	-0.04
529 Tiffin St	**BEA-F1A, reach 2**	**2062.384**	**16.19**	**0.05**	**0.03**	**-0.02**	**0.05**	**0.05**	**0**
Downstream Area	BEA-F1A, reach 2	2061.384	16.19	0.05	0.05	0	0.05	0.09	0.04
	BEA-F1A, reach 1	827.7271	24.74	0.09	0.09	0	0.09	0.13	0.04
	BEA-F1A, reach 1	826.7271	24.74	0.13	0.13	0	0.13	0.09	-0.04
	BEA-F1A, reach 1	825.7271	24.74	0.09	0.09	0	0.09	0.12	0.03

Modelling results show that the proposed grading and development will not have a negative impact on the velocity of flooded area under the regional event since the water velocity changes slightly and remains in the same range as the velocity observed under existing conditions. It is important to note that the estimated regional velocity within the flooded prone area will not reach the 0.2m/s under the proposed conditions.

5.2 Flood Lines Analysis

As discussed in section 5.1 Water Surface Elevation and Velocity Comparison, the water surface elevation remains constant between the proposed and updated existing conditions (235.44m – CGVD28). Even with the proposed grading the regional flood level will stay unchanged. To visualize the delineation of flood extent under both updated existing and proposed scenarios, flood lines were plotted using the corrected DTM (CGVD28), and GeoHECRAS software.

Figure 7 offers a visual representation of the potential flood extent resulting from the proposed regrading. By mapping these flood lines for the updated existing and proposed conditions scenarios, it can be confirmed that 1- Bear Creek has a wide shallow floodplain under the regional storm event, 2- the regional flood lines extent is the same for both updated existing and proposed scenarios except within the 529 Tiffin Street property where minor changes are expected due to the propose grading.

Note that a potential spill area was identified and highlighted in the figure below. The spill is located outside and of the study area. However, because the spill is located upstream with a non-identified amount of water leaving the system, a conservative approach was undertaken where the maximum flow (not accounting for the spilled flow) was using in this hydraulic assessment.

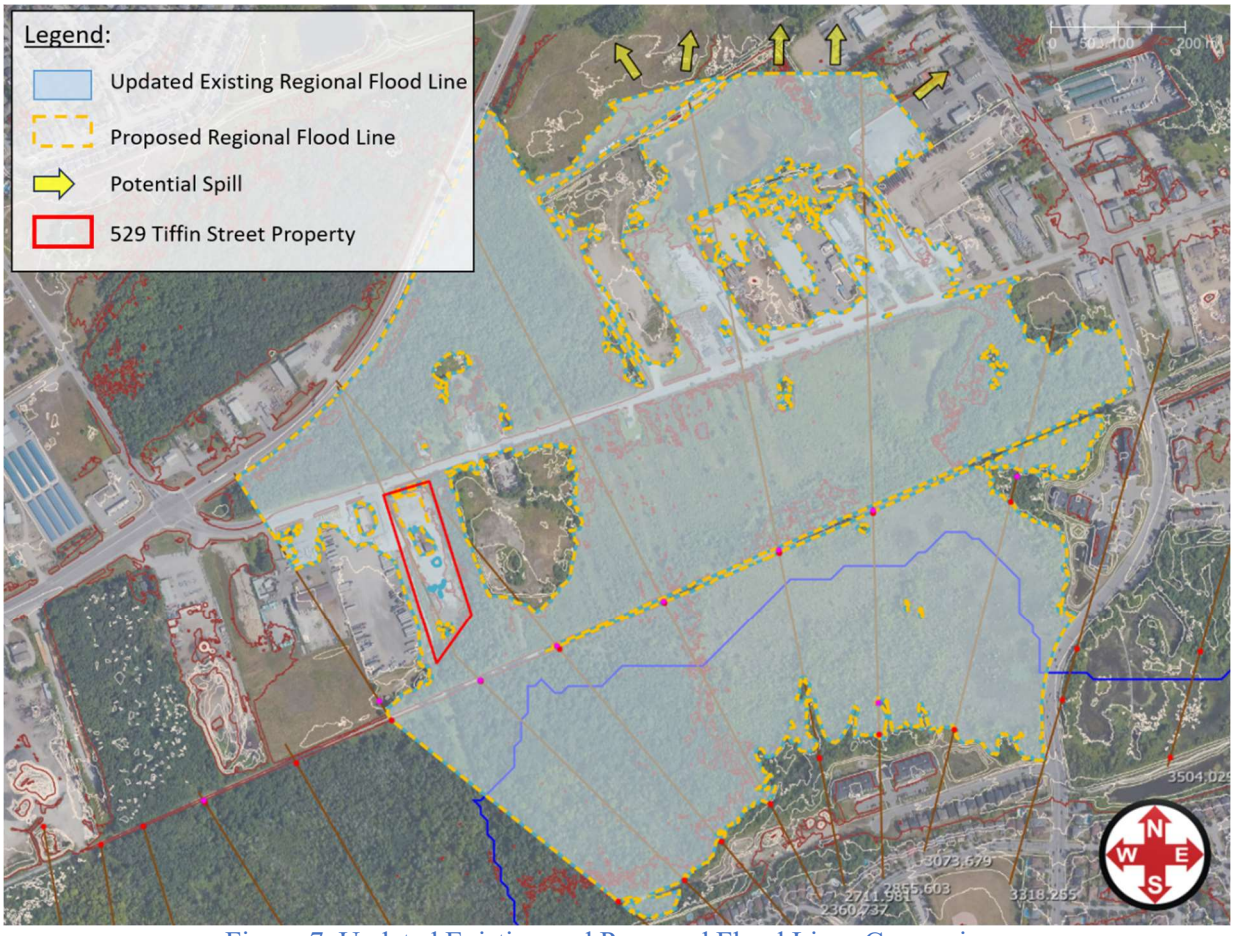


Figure 7. Updated Existing and Proposed Flood Lines Comparison

5.3 Proposed Works Impact on 529 Tiffin Street

- Cut and Fill Balance

A cut and fill balance analysis has been performed by Jones Consulting and as part of the regrading process within the private property, approximately 93 square meters of material will be cut (removing) from the original existing conditions. Overall, the cut and fill balance is negative, meaning that under proposed conditions, the available volume to allow the water flooding the floodplain within the property limits is increased compared to the original available volume under the existing conditions.

- Access/Egress Criteria and Acceptable Risk

  The NVCA defines an area with acceptable risk for new development if the following criterion are met within the lot:

  - Flood depths less than or equal to 0.8 m;
  - Velocities less than or equal to 1.7 m/s; and
  - Depth-Velocity Product less than or equal to 0.4 m^2/s

  In addition to the criterion above a maximum of 0.3 m of depth of flooding is allowed for vehicular access. Using the GeoHECRAS software, all the parameters and thresholds have been reviewed within 529 Tiffin Street and mappings have been developed. Figure 8 Figure 9 and Figure 10 illustrates the estimated water depth, Velocity, and the depth-velocity product, respectively.

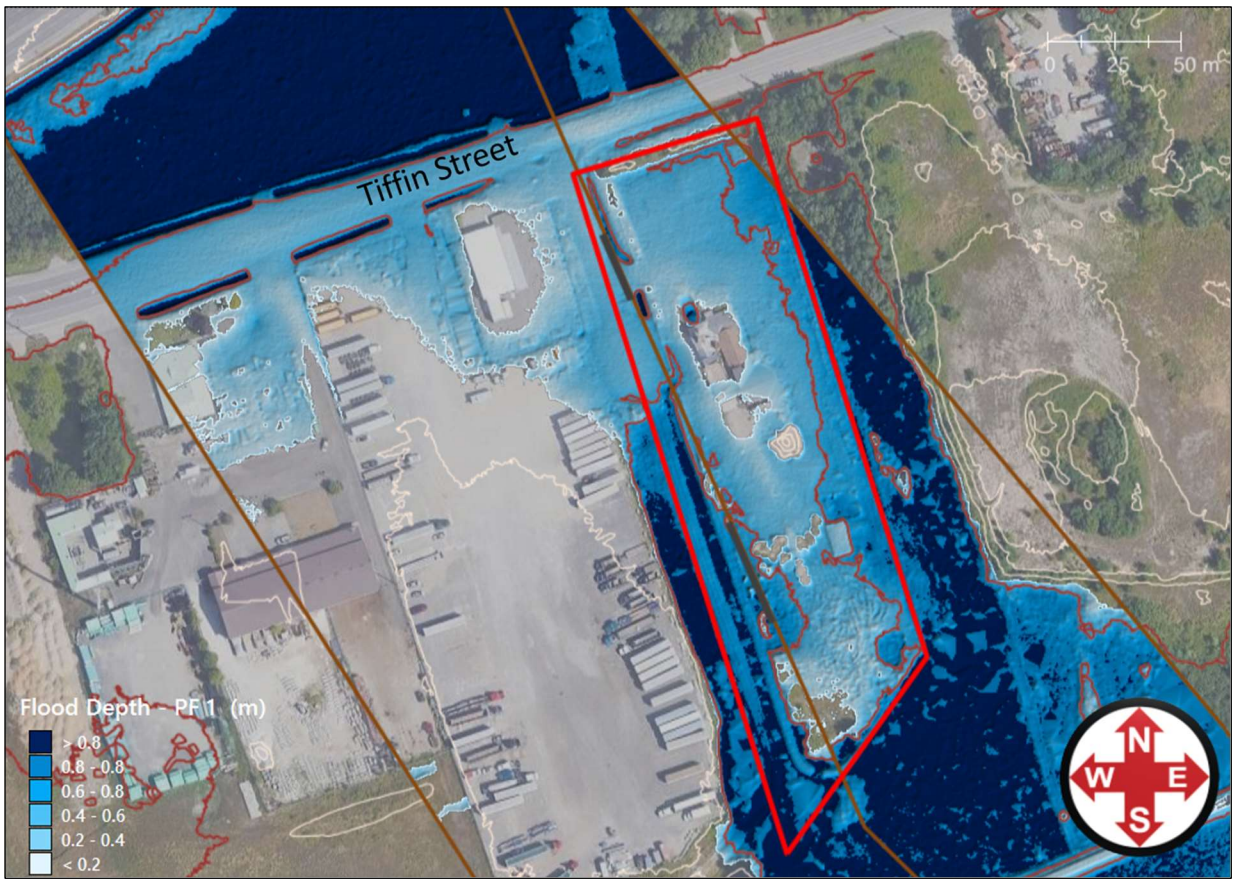


Figure 8. Estimated Water Depth within 529 Tiffin Street Property

Figure 9. Estimated Velocity within 529 Tiffin Street Property

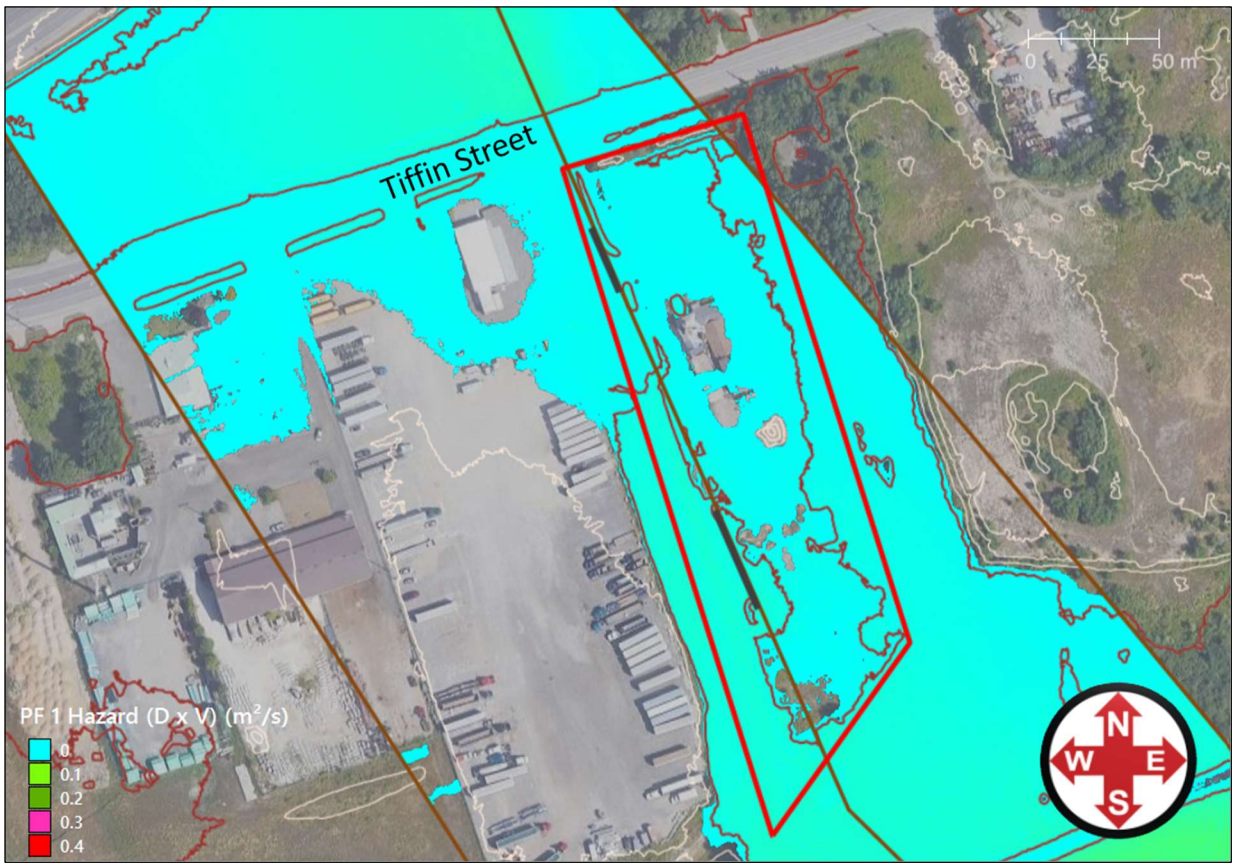


Figure 10. Estimated Water Depth and Velocity Product within 529 Tiffin Street Property

Reviewing all the hydraulic parameters, it can be confirmed that NVCA's thresholds are not met and the private property is considered with hydraulicly acceptable risk and allowed a safety access/egress during the regional storm event.

- Floodproofing
  As per modelling results the water surface elevation within the subject property (529 Tiffin Street) is estimated to be 235.44masl (meters above the sea level) for the regional storm event and under both existing and proposed conditions. Appropriate floodproofing strategy (0.3m buffer above the regional level on all building openings) must be undertaken as defined in the NVCA Natural Hazard Technical Guideline and NVCA planning policies if the lot is to be developed.

6 CONCLUSIONS

In the framework of the development of 529 Tiffin Street in the City of Barrie, Aquafor has completed a hydraulic modeling assessment in order to assess the Bear Creek Regional flooding extents and associated flood level.

The modelling was completed using the existing NVCA HECRAS model and the DTM Lidar derived retained form Geohub tool (MNRF). River flow rates used in this assessment were also from the existing NVCA hydraulic model.

Opportunities to improve the accuracy of the existing model were applied by developing an updated existing conditions scenario; a cross-section within the flood-prone property was added to demonstrate the extents of flooding specifically associated with the subject property. Moreover, surrounding cross-sections were extended, bank station locations, Maning's N as well as levees have been updated to ensure the correct characterization of the neighboring regions of the interested private property. The downstream watercourse was also realigned to accurately represent the present conditions. Afterward, and from this updated existing scenario, a proposed scenario has been developed reflecting the proposed grading as per Jones Consulting design.

A cut/fill analysis has been performed by Jones Consulting to quantify the balance of cut and fill areas expecting by the proposed grading. Approximately 93 square meters of material will be cut (removing), showing a negative balance in overall, meaning that additional space will be available within as floodplain within the private property.

Results show no increase in water surface elevation will result from the proposed grading as well as no negative impact in term of velocity increase is expected. The estimated flood lines for the updated existing and proposed conditions scenarios were plotted using the corrected DTM (CGVD28) and using GeoHEC-RAS software, confirming that the proposed development will not have any negative impact on the flood line extent. Furthermore, the proposed development will not have a negative impact in the water surface elevation and velocity on Bear Creek and floodplain upstream and downstream of the private property.

In addition, and as per NVCA requirement, the water depth, the velocity as well as the depth-velocity product have been assessed, in order to evaluate the hydraulic risk within the private property due to the regional storm event and confirm that the subject property will allow a safe access/egress for vehicles and people during the regional event.

We trust this hydraulic analysis will allow the property owner and Nottawasaga Valley Conservation Authority to accurately understand the existing hydraulic conditions of the regional flood event surrounding the 529 Tiffin Street property located in the City of Barrie to support further planning of the development and associated regulatory permitting.

Should you require any additional information or clarification, please do not hesitate to contact Kyle Haley at 416.436.4336 or via email at haley.k@aquaforbeech.com.

October 10th, 2024

Sincerely,

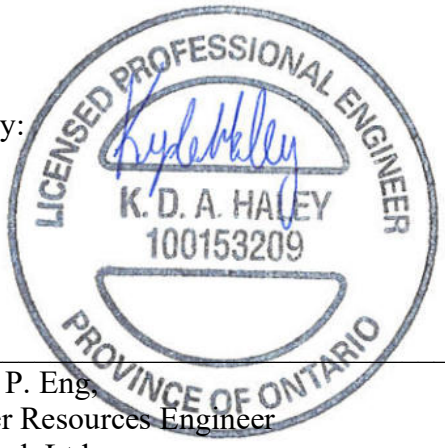
AQUAFOR BEECH LIMITED

Written By:

Julie Michel

Julie Michel, MSc (Fr)
Water Resources Analyst
Aquafor Beech Ltd

Reviewed By:



Kyle Haley, P. Eng,
Senior Water Resources Engineer
Aquafor Beech Ltd

Appendix A: Vertical Datum Correction

Vertical Datum Correction

The Digital Terrain Model (DTM) was provided by the online Geohub database tool (MNRF) and was acquired between May 5th-7th, 2022 (OMAFRA Lake Simcoe package). The vertical datum of the DTM is in Canadian Geodetic Vertical Datum of 2013 (CGVD2013).

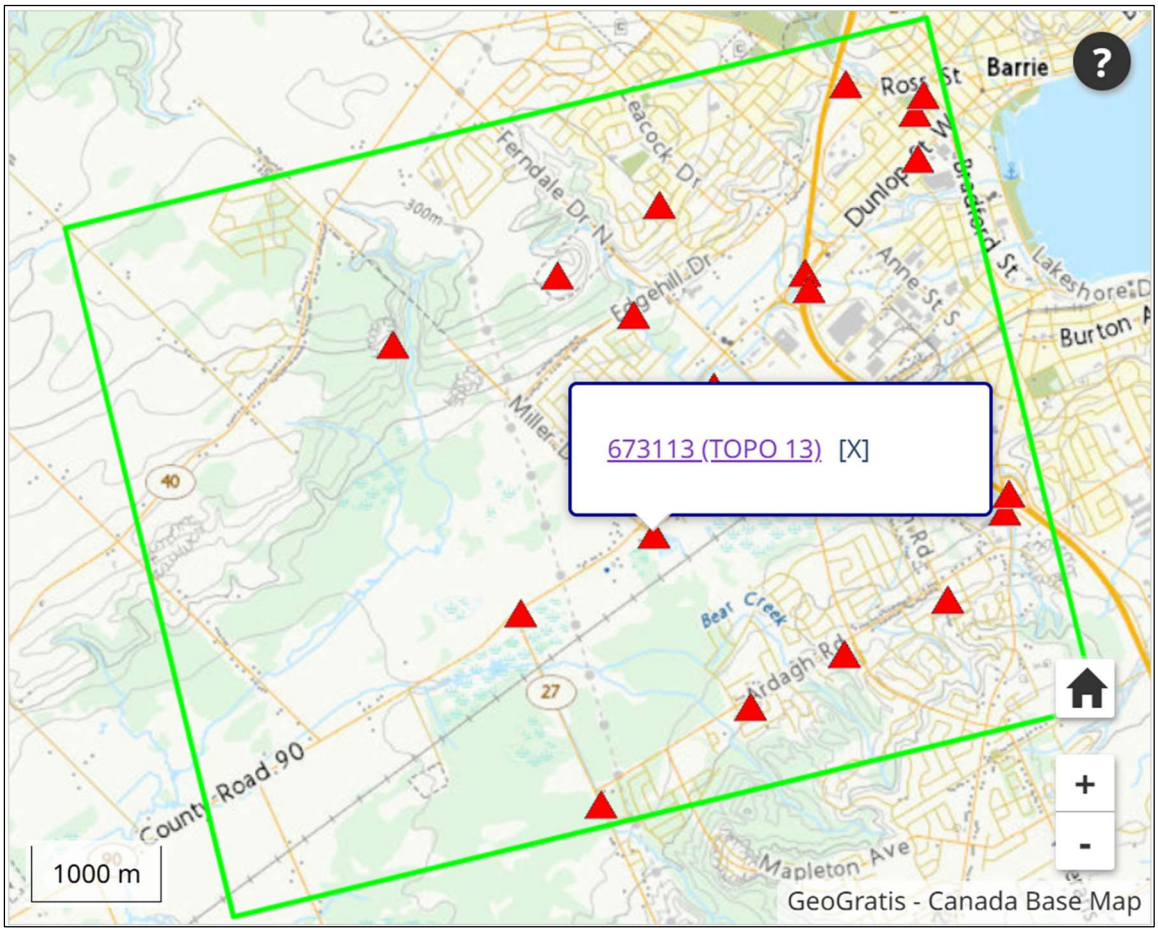
The Height Reference System Modernization (Natural Resources Canada, 2020) recommends for local study area with municipal infrastructure design that requires a heights precision in the vertical data (as for municipal infrastructure design for example) that the vertical datum should be corrected applying a constant offset. To know the difference heights between both vertical datum referential, the methodology of benchmark comparison analysis was performed using the Natural Resources Canada Passive Control Networks database as per the link provided below:

https://webapp.csrs-scrs.nrcan-rncan.gc.ca/geod/data-donnees/station/report-rapport.php?id=673113

The station used is the station # 673113, and the vertical correction applied between CGVD2013 and CGVD28 is + 0.376m.

- Natural Resources Canada Passive Control Networks database

Vertical Datum Separation				
Datum 1 - Datum 2	**Elevation 1 (m)**	**Elevation 2 (m)**	**Elevation Difference (m)**	**Epoch**
CGVD28 (lev) - CGVD2013 (lev)	236.140	235.764	0.376	2010.0
IGLD85 (lev) - CGVD2013 (lev)	236.195	235.764	0.431	2010.0
IGLD85 (lev) - CGVD28 (lev)	236.195	236.140	0.055	


Barrie
Ross St
Dunlop St W
Bradford St
Lakeshore D
Burton A
Ferndale Dr N
Leacock Dr
Edgehill Dr
Anne St S
300m
673113 (TOPO 13) [X]
Miller
40
27
Bear Creek
Mapleton Ave
County Road 90
1000 m
GeoGratis - Canada Base Map

Appendix B: HEC-RAS Model Outputs

HEC-RAS Profile: PF 1

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Froude # Chl	Vel Chnl	Vel Right
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m2)	(m)		(m/s)	(m/s)
2	5588.099	PF 1	Updated_Existing	16.19	279.90	280.49		280.59	0.054022	11.09	31.09	0.78	1.46	
2	5588.099	PF 1	Existing_NVCA	16.19	279.90	280.49		280.59	0.054003	11.09	31.10	0.78	1.46	
2	5588.099	PF 1	Proposed Conditions	16.19	279.90	280.49		280.59	0.054022	11.09	31.09	0.78	1.46	
2	5552.215	PF 1	Updated_Existing	16.19	278.96	279.73	279.43	279.77	0.012277	18.42	36.38	0.39	0.88	
2	5552.215	PF 1	Existing_NVCA	16.19	278.96	279.73	279.43	279.77	0.012282	18.42	36.37	0.39	0.88	
2	5552.215	PF 1	Proposed Conditions	16.19	278.96	279.73	279.43	279.77	0.012277	18.42	36.38	0.39	0.88	
2	5455.993	PF 1	Updated_Existing	16.19	276.87	277.34	277.30	277.45	0.066151	10.80	33.88	0.85	1.50	
2	5455.993	PF 1	Existing_NVCA	16.19	276.87	277.34	277.30	277.45	0.066136	10.80	33.88	0.85	1.50	
2	5455.993	PF 1	Proposed Conditions	16.19	276.87	277.34	277.30	277.45	0.066151	10.80	33.88	0.85	1.50	
2	5368.367	PF 1	Updated_Existing	16.19	274.94	275.91		275.94	0.007617	20.08	31.49	0.32	0.81	
2	5368.367	PF 1	Existing_NVCA	16.19	274.94	275.91		275.94	0.007617	20.08	31.49	0.32	0.81	
2	5368.367	PF 1	Proposed Conditions	16.19	274.94	275.91		275.94	0.007617	20.08	31.49	0.32	0.81	
2	5313.375	PF 1	Updated_Existing	16.19	273.99	274.76	274.76	274.91	0.095191	9.52	32.49	1.00	1.70	
2	5313.375	PF 1	Existing_NVCA	16.19	273.99	274.76	274.76	274.91	0.095207	9.52	32.48	1.00	1.70	
2	5313.375	PF 1	Proposed Conditions	16.19	273.99	274.76	274.76	274.91	0.095191	9.52	32.49	1.00	1.70	
2	5272.731	PF 1	Updated_Existing	16.19	272.39	273.69		273.74	0.011401	16.88	27.57	0.39	0.96	
2	5272.731	PF 1	Existing_NVCA	16.19	272.39	273.69		273.74	0.011396	16.88	27.57	0.39	0.96	
2	5272.731	PF 1	Proposed Conditions	16.19	272.39	273.69		273.74	0.011401	16.88	27.57	0.39	0.96	
2	5225.692	PF 1	Updated_Existing	16.19	272.07	272.58	272.53	272.68	0.062590	11.50	38.08	0.82	1.41	
2	5225.692	PF 1	Existing_NVCA	16.19	272.07	272.58	272.53	272.68	0.062740	11.49	38.06	0.82	1.41	
2	5225.692	PF 1	Proposed Conditions	16.19	272.07	272.58	272.53	272.68	0.062590	11.50	38.08	0.82	1.41	
2	5161.624	PF 1	Updated_Existing	16.19	268.43	269.11		269.22	0.046974	10.77	25.98	0.75	1.50	
2	5161.624	PF 1	Existing_NVCA	16.19	268.43	269.11		269.22	0.046930	10.77	25.98	0.75	1.50	
2	5161.624	PF 1	Proposed Conditions	16.19	268.43	269.11		269.22	0.046974	10.77	25.98	0.75	1.50	
2	5090.515	PF 1	Updated_Existing	16.19	263.94	264.59	264.59	264.80	0.086119	8.08	19.95	1.01	2.00	
2	5090.515	PF 1	Existing_NVCA	16.19	263.94	264.59	264.59	264.80	0.086025	8.08	19.95	1.00	2.00	
2	5090.515	PF 1	Proposed Conditions	16.19	263.94	264.59	264.59	264.80	0.086119	8.08	19.95	1.01	2.00	
2	5041.889	PF 1	Updated_Existing	16.19	261.45	262.01		262.05	0.026863	18.18	63.37	0.53	0.89	
2	5041.889	PF 1	Existing_NVCA	16.19	261.45	262.01		262.05	0.026838	18.18	63.37	0.53	0.89	
2	5041.889	PF 1	Proposed Conditions	16.19	261.45	262.01		262.05	0.026863	18.18	63.37	0.53	0.89	
2	4970.499	PF 1	Updated_Existing	16.19	258.08	258.56	258.56	258.69	0.102568	10.29	41.77	1.01	1.57	
2	4970.499	PF 1	Existing_NVCA	16.19	258.08	258.56	258.56	258.69	0.102626	10.29	41.77	1.01	1.57	
2	4970.499	PF 1	Proposed Conditions	16.19	258.08	258.56	258.56	258.69	0.102568	10.29	41.77	1.01	1.57	
2	4884.176	PF 1	Updated_Existing	16.19	251.35	252.39		252.43	0.023551	18.45	59.47	0.50	0.88	
2	4884.176	PF 1	Existing_NVCA	16.19	251.35	252.39		252.43	0.023536	18.45	59.47	0.50	0.88	
2	4884.176	PF 1	Proposed Conditions	16.19	251.35	252.39		252.43	0.023551	18.45	59.47	0.50	0.88	
2	4858.402	PF 1	Updated_Existing	16.19	250.94	251.35	251.32	251.43	0.073814	12.67	54.78	0.85	1.28	
2	4858.402	PF 1	Existing_NVCA	16.19	250.94	251.35	251.32	251.43	0.073933	12.66	54.77	0.85	1.28	
2	4858.402	PF 1	Proposed Conditions	16.19	250.94	251.35	251.32	251.43	0.073814	12.67	54.78	0.85	1.28	
2	4822.945	PF 1	Updated_Existing	16.19	249.41	249.92		249.95	0.026440	19.32	72.92	0.52	0.84	
2	4822.945	PF 1	Existing_NVCA	16.19	249.41	249.92		249.95	0.026414	19.33	72.93	0.52	0.84	
2	4822.945	PF 1	Proposed Conditions	16.19	249.41	249.92		249.95	0.026440	19.32	72.92	0.52	0.84	
2	4755.663	PF 1	Updated_Existing	16.19	246.18	246.76	246.76	246.95	0.089913	8.56	23.84	1.01	1.89	
2	4755.663	PF 1	Existing_NVCA	16.19	246.18	246.76	246.76	246.95	0.090119	8.55	23.83	1.01	1.89	
2	4755.663	PF 1	Proposed Conditions	16.19	246.18	246.76	246.76	246.95	0.089913	8.56	23.84	1.01	1.89	
2	4556.878	PF 1	Updated_Existing	16.19	241.66	242.31		242.33	0.008921	27.42	77.49	0.32	0.59	
2	4556.878	PF 1	Existing_NVCA	16.19	241.66	242.31		242.33	0.008900	27.44	77.50	0.32	0.59	
2	4556.878	PF 1	Proposed Conditions	16.19	241.66	242.31		242.33	0.008921	27.42	77.49	0.32	0.59	
2	4496.92	PF 1	Updated_Existing	16.19	240.14	240.92	240.92	241.01	0.116005	11.97	66.67	1.02	1.35	
2	4496.92	PF 1	Existing_NVCA	16.19	240.14	240.92	240.92	241.01	0.116592	11.95	66.63	1.02	1.36	
2	4496.92	PF 1	Proposed Conditions	16.19	240.14	240.92	240.92	241.01	0.116005	11.97	66.67	1.02	1.35	
2	4430.865	PF 1	Updated_Existing	16.19	238.43	239.30		239.31	0.005401	31.32	74.17	0.25	0.52	
2	4430.865	PF 1	Existing_NVCA	16.19	238.43	239.30		239.32	0.005346	31.43	74.25	0.25	0.52	
2	4430.865	PF 1	Proposed Conditions	16.19	238.43	239.30		239.31	0.005401	31.32	74.17	0.25	0.52	
2	4349.119	PF 1	Updated_Existing	16.19	237.39	238.02	238.02	238.14	0.101906	10.83	47.13	1.00	1.49	
2	4349.119	PF 1	Existing_NVCA	16.19	237.39	238.02	238.02	238.14	0.106839	10.66	46.88	1.02	1.52	
2	4349.119	PF 1	Proposed Conditions	16.19	237.39	238.02	238.02	238.14	0.101906	10.83	47.13	1.00	1.49	
2	4165.148	PF 1	Updated_Existing	16.19	236.03	237.11		237.11	0.000465	82.07	130.94	0.08	0.20	
2	4165.148	PF 1	Existing_NVCA	16.19	236.03	237.07		237.07	0.000565	76.65	127.85	0.09	0.21	
2	4165.148	PF 1	Proposed Conditions	16.19	236.03	237.11		237.11	0.000465	82.08	130.94	0.08	0.20	
2	3920.011	PF 1	Updated_Existing	16.19	236.18	236.93		236.93	0.001294	62.20	141.23	0.13	0.26	
2	3920.011	PF 1	Existing_NVCA	16.19	236.18	236.80		236.81	0.002732	45.60	113.86	0.18	0.36	
2	3920.011	PF 1	Proposed Conditions	16.19	236.18	236.93		236.93	0.001294	62.20	141.23	0.13	0.26	
2	3719.565	PF 1	Updated_Existing	16.19	236.21	236.63		236.64	0.001613	40.38	195.05	0.28	0.40	
2	3719.565	PF 1	Existing_NVCA	16.19	235.90	236.75		236.75	0.000095	166.01	230.92	0.04	0.10	
2	3719.565	PF 1	Proposed Conditions	16.19	236.21	236.63		236.64	0.001614	40.38	195.05	0.28	0.40	
2	3504.029	PF 1	Updated_Existing	16.19	235.73	236.28		236.29	0.001633	35.46	142.53	0.29	0.46	0.03
2	3504.029	PF 1	Existing_NVCA	16.19	235.81	236.73		236.73	0.000102	167.56	249.45	0.04	0.10	
2	3504.029	PF 1	Proposed Conditions	16.19	235.73	236.28		236.29	0.001632	35.47	142.53	0.29	0.46	0.03
2	3318.255	PF 1	Updated_Existing	16.19	235.26	235.90		235.91	0.002734	41.20	104.92	0.18	0.39	0.40
2	3318.255	PF 1	Existing_NVCA	16.19	235.01	236.71		236.71	0.000064	209.98	307.93	0.03	0.08	

HEC-RAS Profile: PF 1 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Froude # Chl	Vel Chnl	Vel Right
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m2)	(m)		(m/s)	(m/s)
2	3318.255	PF 1	Proposed Conditions	16.19	235.26	235.90		235.91	0.002734	41.20	104.92	0.18	0.39	0.40
2	3073.679	PF 1	Updated_Existing	16.19	235.19	235.72	235.38	235.72	0.000360	130.69	345.13	0.06	0.12	
2	3073.679	PF 1	Existing_NVCA	16.19	234.70	236.71		236.71	0.000001	1054.47	656.45	0.00	0.02	
2	3073.679	PF 1	Proposed Conditions	16.19	235.19	235.72	235.38	235.72	0.000359	130.71	345.13	0.06	0.12	
2	2855.603	PF 1	Updated_Existing	16.19	235.02	235.65	235.24	235.65	0.000273	130.72	281.42	0.06	0.12	0.05
2	2855.603	PF 1	Existing_NVCA	16.19	234.38	236.71		236.71	0.000000	1656.70	919.54	0.00	0.01	
2	2855.603	PF 1	Proposed Conditions	16.19	235.02	235.65	235.24	235.65	0.000273	130.75	281.42	0.06	0.12	0.05
2	2711.981	PF 1	Updated_Existing	16.19	235.05	235.57	235.27	235.57	0.001382	70.89	205.39	0.12	0.23	
2	2711.981	PF 1	Existing_NVCA	16.19	234.32	236.71		236.71	0.000001	1204.88	668.89	0.00	0.01	
2	2711.981	PF 1	Proposed Conditions	16.19	235.05	235.57	235.27	235.57	0.001380	70.92	205.41	0.12	0.23	
2	2360.737	PF 1	Updated_Existing	16.19	234.84	235.47	235.06	235.47	0.000328	131.47	327.85	0.06	0.12	0.03
2	2360.737	PF 1	Proposed Conditions	16.19	234.84	235.47	235.06	235.47	0.000326	131.64	327.89	0.06	0.12	0.03
2	2359.737	PF 1	Updated_Existing	16.19	234.66	235.45	234.85	235.45	0.000064	224.71	368.75	0.03	0.07	0.03
2	2359.737	PF 1	Existing_NVCA	16.19	234.40	236.71	234.75	236.71	0.000001	1012.79	618.01	0.00	0.02	
2	2359.737	PF 1	Proposed Conditions	16.19	234.66	235.45	234.85	235.45	0.000064	224.92	368.81	0.03	0.07	0.03
2	2062.384	PF 1	Updated_Existing	16.19	234.49	235.44	234.73	235.44	0.000007	553.27	840.90	0.01	0.03	0.03
2	2062.384	PF 1	Proposed Conditions	16.19	234.49	235.44	234.73	235.44	0.000009	522.06	818.86	0.01	0.03	0.03
2	2061.384	PF 1	Updated_Existing	16.19	234.40	235.44	234.68	235.44	0.000031	298.68	456.31	0.02	0.05	0.05
2	2061.384	PF 1	Existing_NVCA	16.19	234.52	236.71		236.71	0.000001	1133.15	687.52	0.00	0.01	
2	2061.384	PF 1	Proposed Conditions	16.19	234.40	235.44	234.68	235.44	0.000031	298.68	456.31	0.02	0.05	0.05
2	1705.613	PF 1	Existing_NVCA	16.19	234.64	236.71		236.71	0.000001	817.70	548.64	0.01	0.02	
2	1475.961	PF 1	Existing_NVCA	16.19	234.17	236.71		236.71	0.000001	853.54	402.88	0.00	0.02	
2	1175.774	PF 1	Existing_NVCA	16.19	234.63	236.71		236.71	0.000033	170.21	110.14	0.02	0.10	
1	1001.999	PF 1	Existing_NVCA	24.74	236.20	236.56	236.56	236.67	0.111740	17.46	88.47	1.02	1.42	
1	827.7271	PF 1	Updated_Existing	24.74	234.30	235.42	235.42	235.42	0.000071	286.62	391.39	0.03	0.09	0.09
1	827.7271	PF 1	Proposed Conditions	24.74	234.30	235.42	235.42	235.42	0.000071	286.62	391.39	0.03	0.09	0.09
1	826.7271	PF 1	Updated_Existing	24.74	234.14	234.95	234.40	234.95	0.000251	196.22	386.91	0.06	0.13	0.11
1	826.7271	PF 1	Proposed Conditions	24.74	234.14	234.95	234.40	234.95	0.000251	196.22	386.91	0.06	0.13	0.11
1	825.7271	PF 1	Updated_Existing	24.74	233.04	234.92		234.92	0.000084	280.08	415.48	0.03	0.09	
1	825.7271	PF 1	Existing_NVCA	24.74	233.04	234.92		234.92	0.000084	280.06	415.46	0.03	0.09	
1	825.7271	PF 1	Proposed Conditions	24.74	233.04	234.92		234.92	0.000084	280.08	415.48	0.03	0.09	
1	608.6562	PF 1	Updated_Existing	24.74	233.29	234.88		234.89	0.000268	200.06	425.94	0.06	0.12	
1	608.6562	PF 1	Existing_NVCA	24.74	233.29	234.88		234.89	0.000268	200.04	425.93	0.06	0.12	
1	608.6562	PF 1	Proposed Conditions	24.74	233.29	234.88		234.89	0.000268	200.06	425.94	0.06	0.12	
1	510.2429	PF 1	Updated_Existing	24.74	233.54	234.87		234.87	0.000105	259.23	403.07	0.04	0.10	
1	510.2429	PF 1	Existing_NVCA	24.74	233.54	234.87		234.87	0.000105	259.21	402.95	0.04	0.10	
1	510.2429	PF 1	Proposed Conditions	24.74	233.54	234.87		234.87	0.000105	259.23	403.07	0.04	0.10	
1	303.6807	PF 1	Updated_Existing	24.74	234.01	234.72	234.72	234.78	0.129908	23.36	205.00	1.00	1.06	
1	303.6807	PF 1	Existing_NVCA	24.74	234.01	234.72	234.72	234.78	0.129881	23.36	205.00	1.00	1.06	
1	303.6807	PF 1	Proposed Conditions	24.74	234.01	234.72	234.72	234.78	0.129908	23.36	205.00	1.00	1.06	