Ministry of
Transportation
and Infrastructure

M E M O R A N D U M

February 10, 2021

Anastassiya Smirnova
Land and Properties Administrator
Ministry of Transportation and Infrastructure

Re: Holt Creek Trestle Replacement Hydrotechnical Assessment

INTRODUCTION AND SCOPE OF WORK

The Ministry of Transportation and Infrastructure (The Ministry) has completed a Hydrotechnical assessment to confirm the hydraulic capacity of the proposed Holt Creek Trestle upgrade structure. The Trestle bridge is located approximately 8km west of Duncan. The existing structure was constructed in 1922 and was part of the CN rail until 1991. The structure is now part of the Cowichan Valley Trail Network that is used by pedestrians and other non-motorized forms of transportation. A structural assessment was completed by SNC Lavalin in 2019 and it was determined that the bridge has reached the end of its functional life from a structural perspective.

This hydrotechnical report serves to confirm that the proposed upgrade option has adequate hydraulic capacity. The Hydrotechnical assessment considers a 1 in 100-year peak instantaneous flow (Q100i) with consideration for climate change.

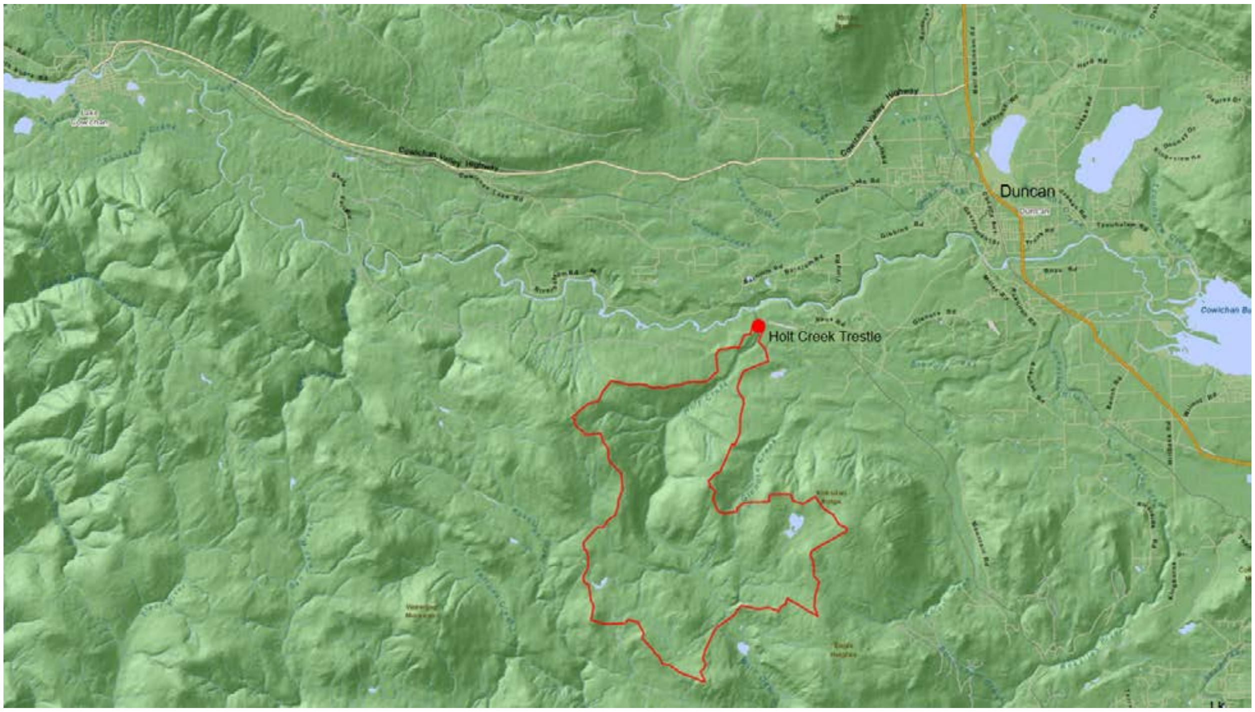

Figure 1: Site location of the Holt Creek Trestle.

DESIGN CODES AND REFERENCES

The following design codes and reference documents have been used for the hydrotechnical design at the Holt Creek Trestle:

Design Codes:

- BC MoTI Supplement to TAC Geometric Design Guide.
- Canadian Highway Bridge Design Code S6-14
- BC Supplement to Canadian Highway Bridge Design Code S6-14

Ministry Standards and Guidelines:

- BC MOTI Standard Specifications for Highway Construction (2020)
- BC Water Sustainability Act (WSA) Regulations (2016)
- Technical Circular T04/19 Resilient Infrastructure Engineering Design

Hydrotechnical Design Guidelines:

- TAC Guide to Bridge Hydraulics (2001)

EGBC Design Guidelines

- Developing Climate Change Resilient Designs for Highway Infrastructure in BC 2020.

WATERSHED DESCRIPTION

Holt Creek watershed lies within the East Vancouver Island hydrologic zones (Zone 28). Holt Creek is 14.5 km in length with an elevation of 740m near the headwaters and 60m near the crossing. The creeks headwaters begin at Lois Lake. The average grade of Holt Creek is 4.4%. The channel gradient at the crossing is approximately 1.3%. This slope was estimated from iMapBC. The Drainage area of Holt Creek is 36 km^2. There are no registered dams or water licenses within the Holt Creek drainage area.

HYDROLOGY

The BC supplement to TAC stipulates that a Q100i design discharge must be used for a structure on a Low Volume Road. The Trestle bridge serves pedestrians, horseback riders and other non-motorized forms of transportation. The Province of BC does not have a design criterion for bridges on pedestrian trails and so the Q100i was applied as a starting point for analysis. The Q100i for Holt Creek was estimated using a regional regression. The regional regression analysis was completed with data from Water Survey of Canada (WSC) gauges within a 42km radius of the Holt Creek Watershed. This included Stations in Zone 28 and 29 that were selected based on drainage area, length of record and watershed characteristics. Other methodologies for determining the Q100i were also used for comparison. These methods are compared in Table 1 below. The full Hydrologic analysis for all methodologies can be found in Appendix A.

Table 1: Summary of Q100i for various methodologies.

Method	Design discharge (Q100i) (m^3/s)	Percent increase to Regional method
Regional Regression Analysis	110	-
Streamflow Inventory Peak Flow map	81	-26%
Station Transfer	103	-6%
Streamflow Inventory Report	213.6	94%

The design discharge that will be used for this analysis is 110 m^3/s.

The BC MOTI Technical Circular T-04/19 requires all new structures to consider climate change. In order to account for climate change, the Intensity Duration Frequency

Climate Change (IDFCC) Tool was used to assess the potential increase of precipitation projecting to 2100 at the Environment Canada North Cowichan and Lake Cowichan Weather stations.

Climate models in the IDFCC Tool were analyzed to determine a percentage increase of precipitation. The PCIC Bias Corrected IDF for future scenarios was used. The average percent increase in precipitation for the Representative Concentration Pathway (RCP) 2.6, 4.5 and 8.5 was calculated. RCP 8.5 gave the highest increase in precipitation. This RCP provides a future concentration scenario that would lead to the most severe climate change impacts, when compared to all other RCPs. The percent increase was estimated to be 23% and 16% for the North Cowichan and Lake Cowichan weather stations respectively. Based on these results, a 23% increase in the previously estimated Q100 was applied to account for climate change. Table 2 summarizes these results. The climate change analysis can be found in Appendix B.

Table 2: Design Discharge for Holt Creek.

Design Discharge (m^3/s)	
Q100i	110
Q100i + Climate Change	135

HYDRAULIC DESIGN

The U.S. Army Corps of Engineers, Hydrologic Engineering Centre River Analysis System (HEC-RAS) model, version 5.0.7 was used to develop a one-dimensional (1-D) model for Holt Creek at the bridge crossing.

The 1-D model for Holt Creek was developed using LiDAR and topographic survey data that did not include bathymetric data.

The proposed bridge has a soffit elevation of approximately 85.5 meters. The spans will be supported with a frame that will be anchored into the bed rock bank at the approximate elevation of 74.8 meters. The channel bed elevation at the centerline of the bridge is 53.8 meters.

A Manning's n coefficient of 0.05 was used for the channel which is characteristic of a mountain stream, no vegetation in channel, steep banks, with a bottom consisting of cobbles with large boulders (Chow, 1959). A Manning's n value of 0.07 was used for the overbank areas. This Manning's n value represents an overbank area that is a heavy stand of timber, a few down trees, little undergrowth with a flood stage below branches.

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The survey that was used to create the HEC-RAS model did not include bathymetric data. Lidar does not penetrate through water and without bathymetric data the channel slope and channel dimensions are not accurate.

The channel dimension in the survey data does not include the area below water and so the model is conservative in relation to the water surface elevation and velocities.

The channel slope can impact the models results and so a sensitivity analysis was completed. The channel slope from the survey was approximately 0%. Geometries for four other channel slopes (0.5%, 1%,2% and 4%) were created in the model. The results at the cross section at the centerline of the bridge are summarized in Table 3 below. The HEC-RAS results for each geometry can be seen in Appendix C.

Table 3: Summary of Slope Sensitivity Analysis for Q100+CC Elevation

Channel Slope	Q100 + CC Elevation at Bride CL (m) (XS 132)	Percent change from 0% Slope	Proposed Soffit Elevation (m)	Proposed Bridge Frame Elevation (m)
0%	56.9	-	85.5	74.8
0.50%	56.9	0%	85.5	74.8
1%	56.9	0%	85.5	74.8
2%	56.9	0%	85.5	74.8
4%	56.53	-0.65%	85.5	74.8

The Q100i+CC water elevation is reduced by less than one percent for the 4% channel slope. As stated in the watershed description, the channel slope is estimated to be 1.3% through the bridge opening. If the channel was steeper than 4%, the water elevation would decrease.

The Q100i+CC design elevation was selected to be 57 meters. There is 28.5 meters between the Q100i + CC and the bridge soffit elevation. There is 17.8 meters of clearance between the Q100i+CC water elevation and the bottom of the bridge frame. Figure 2 outlines the cross section.

Table 4: Summary of Slope Sensitivity Analysis for Q100+CC Velocity

Channel slope	Q100 + CC Velocity at Bridge Centerline (XS 132)	Percent change from 0% Slope
0%	4.11	
0.50%	4.11	0.00%
1%	4.12	0.24%
2%	4.12	0.24%
4%	5.19	26.28%

The Q100+CC velocity is increased by 27 percent for the 4% channel slope. If the channel was steeper than 4%, the velocity would increase. The channel is made up of bedrock and so a velocity is not required to design scour protection.

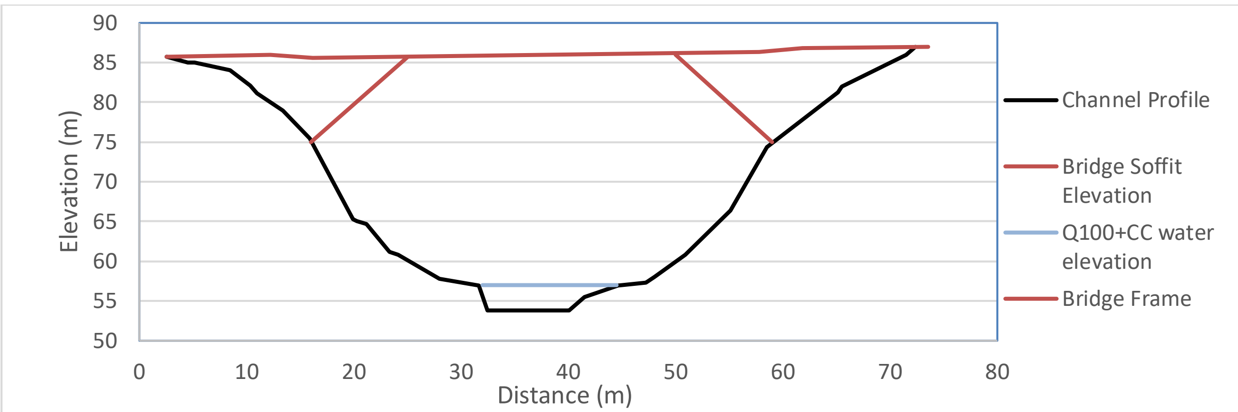

Figure 2: Holt Creek Trestle Centerline Cross Section (HEC-RAS Cross Section 132)

NAVIGABILITY

The elevation between the Q100+CC water level and the soffit of the bridge and the bottom of the frame is 28.5 meters and 17.8 meters respectively and so navigation through the new crossing should be possible.

SCOUR ASSESSMENT

The channel through the crossing consists of bedrock according to geotechnical investigations that were completed for the project. The bridge frame will be secured 18 meters above the highwater level into bedrock so there is no scour risk at this site.

CLOSURE

The hydrotechnical analysis that was completed for this crossing confirms that the proposed crossing has adequate hydraulic capacity. The minimum freeboard criteria as per the BC supplement to the CHBDC is 1.5 meters between the bridge soffit and the Q100i +CC elevation. The proposed bridge has 28.5 meters of freeboard. There is no expected scour of the channel bed and so no scour mitigation measures are required.

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We trust that the above design meets your needs, and should you have any questions, please contact the undersigned.

Yours Truly,

PROFESSIONAL
PROVINCE OF
A. N. PICCINI
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ENGINEER

Feb 18, 2021

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Reviewed By:

Feb 10, 2021

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Appendix A: Hydrology

The BC supplement to TAC stipulates that a Q100i design discharge must be used for a structure on a Low Volume Road. The Trestle bridge serves pedestrians, horseback riders and other non-motorized forms of transportation. BC does not have a design criterion for bridges on pedestrian trails and so the Q100i was applied as a starting point for analysis. The Q100i for Holt Creek was estimated using a regional regression analysis for Hydrologic Zone 28 – Eastern Vancouver Island. The regional regression analysis was completed with data from Water Survey of Canada (WSC) gauges within a 42km radius. This included Stations in Zone 28 and 29 that were selected based on drainage area, length of record and watershed characteristics. The regional analysis was compared to other methodologies for estimating the instantaneous flow. The table below summarizes the findings. The initial gauges that were within the 42km radius are listed below

Table 5: Zone 15 WSC Watersheds used for the Regional Regression Analysis

Environment Canada Station	Station Name	Hydrologic Region	Regulated or Natural	Years of data	Drainage Area (km2)
08HA070	Harris Cr Near Lk Cowichan	29	Natural	24	28
08HA069	Renfrew Cr Near Port Renfrew	29	Natural	24	8.12
08HA017	Leech R at mouth	28	Natural	4	104
08HA039	Goldstream R	28	Regulated	3	NA
08HA065	Bilston Cr At Glen Forest Way	28	Regulated	6	NA
08HA064	Metchosin Cr at Happy Valley Cr	28	Natural	6	3.97
08HA034	Craigflower Cr	28	Natural	8	13.5
08HA068	Garbage Cr near the mouth	29	Natural	24	2.88
08HA016	Bings Cr Near the mouth	28	Natural	60	15.5
08HA003	Koksilah R at Cowichan Stn	28	Natural	73	209
08HA014	Somenos Cr Near Duncan	28	Regulated	10	63.7
08HA072	Cottonwood Cr Headwaters	29	Natural	23	13
08HA041	Jump Cr at the mouth	28	Regulated	51	62.2
08HA015	Avril Creek near Duncan	28	Natural	7	17
08HA008	Bings Cr Near Duncan	28	Natural	4	14.8
08HA043	Bings Cr at Drinkwater Rd	28	Natural	3	2.99
08HA042	Bings Cr W branch	28	Natural	3	2.25
08HA045	Koksilag R below Kevlin Cr	28	Natural	2	282
08HA056	Glenora Cr Near Duncan	28	Natural	7	22.8
08HA019	Patrolas Cr Near Cowichan Stn	28	Natural	2	NA
08HA033	Shawnigan Cr Near Mill Bay	28	Regulated	36	94
08HA067	Handysen Cr Near Mill Bay	28	Natural	4	3.5
08HA066	Wilken Cr near mill bay	28	Natural	4	n/a
08HA036	Cowan Brook Near YOUBOU	28	Regulated	5	0.73
08HA092	S Nanaimor R near Jnctn	28	Regulated	24	211
08HB034	Nanaimo R Near Cassidy	28	Regulated	57	676
08HA001	Chemainus R Near Westholme	28	Natural	75	355
08HA073	Bonsall Cr near the mouth	28	?	3	na
08HA059	Sooke R Above Charters R	28	Regulated	10	262

08HA047	Colquitz R	28	Regulated	19	na
08HA037	Colquitx R at Hyacinth R	28	Regulated	6	na
08HA071	Graham Cr a Stellys	28	Regulated	5	5.77
08HA063	Hagan Cr Near the mouth	28	Regulated	3	na

These initial stations were sorted to remove any station that did not meet the criteria of a minimum of 10 years of data, and a natural watershed. The final list used for the regression analysis is shown in the table below.

Environment Canada Station	Station Name	Hydrologic Region	Regulated or Natural	Years of data	Drainage Area (km2)
08HA070	Harris Cr Near Lk Cowichan	29	Natural	24	28
08HA069	Renfrew Cr Near Port Renfrew	29	Natural	24	8.12
08HA068	Garbage Cr near the mouth	29	Natural	24	2.88
08HA016	Bings Cr Near the mouth	28	Natural	60	15.5
08HA003	Koksilah R at Cowichan Stn	28	Natural	73	209
08HA072	Cottonwood Cr Headwaters	29	Natural	23	13
08HA001	Chemainus R Near Westholme	28	Natural	75	355
08HB032	Millstone River Near Wellington	28	Natural	56	86

Each station's data was checked to confirm that it was Independent and Identically Distributed. A frequency analysis was completed for each of these stations to estimate flood discharge for various return periods. These results are used to build a regression curve between drainage area and flood discharges for the watersheds chosen for the analysis. The results of the regional regression analysis can be seen below in Figure 2. A Q100i discharge can be estimated from the equation produced by the regional regression analysis.

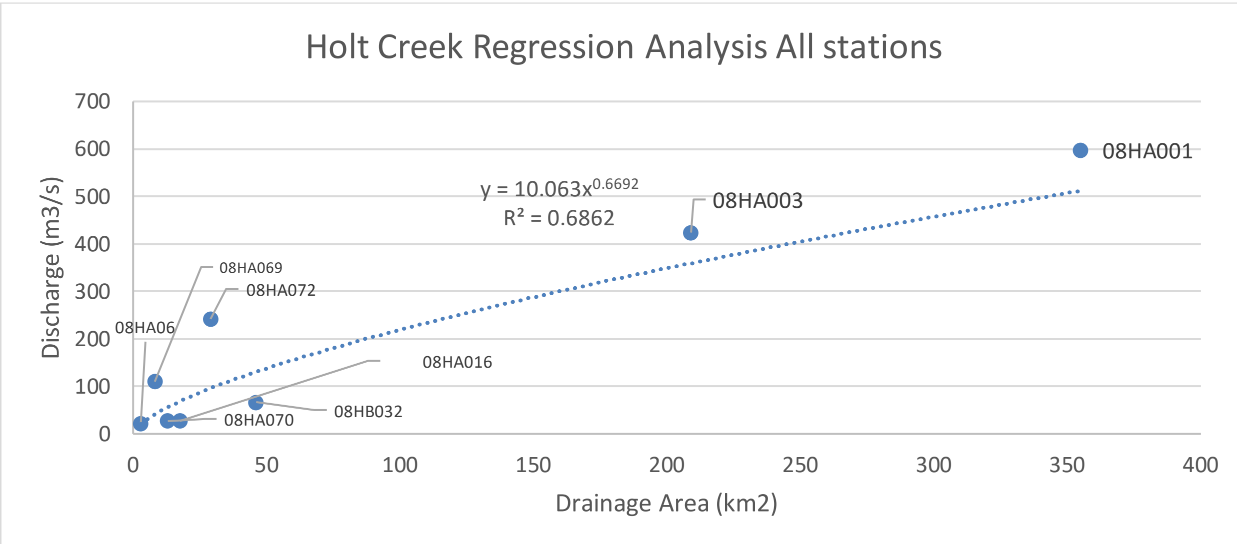


Figure 3: The Q100 Regional Regression Analysis for Holt Creek.

The Q100i discharge for Holt creek is estimated to be 110 m^3/s.

The discharge of Holt Creek during a Q100i discharge was estimated using the BC Streamflow Inventory (SFI) Peak Flow Map. The Q100i was estimated to be 81 m^3/s. The equation used to estimate this is outlined below.

$$Q_{H100i} = \left(\frac{A_H}{100km^2}\right)^{0.785} * Q_{Isoline}$$

$$Q_{H100i} = \left(\frac{36km^2}{100km^2}\right)^{0.785} * 180\frac{m^3}{s}$$

$$Q_{H100i} = 81\frac{m^3}{s}$$

Where Q_{H100i} = Holt Creek Q100i
A_H = Area of Holt Creek
$Q_{isoline}$ = the flow interpolated from the SFI Map.

This Q100i discharge estimate is approximately 28% less than the Regional analysis.

The Holt Creek watershed shares its South and west boundary with the Koksilah River (Station # 08HA003). The Roads and Transportation Association of Canada, Volume 1, Section 2.5.4 states that a known discharge can be transposed onto an adjacent basin if the basins have similar characteristics. This method should be used as a check and regional regression curves are the preferred method. The Koksilah River Q100i was transposed onto the Holt Creek watershed using the below expression as a check.

$$Q_{H100i} = \left(\frac{A_H}{A_K}\right)^{0.785} * Q_{K100i}$$

Where Q_{H100i} = Holt Creek Q100i
A_H = Area of Holt Creek
Ak = Area of the Koksilah River
Q_{K100i} = the flow of the Koksilah River

$$Q_{H100i} = \left(\frac{36km^2}{209km^2}\right)^{0.8} * 424\frac{m^3}{s}$$

$$Q_{H100i} = 103\frac{m^3}{s}$$

This Q100i discharge estimate is approximately 8% less than the Regional Analysis estimate.

The Streamflow inventory report was used to estimate the design flow for Holt Creek. From the Figure below, the Q100i was estimated for Holt Creek with a Q10 unit discharge of 4300L/s/km^2 and a Q100/Q10 ratio of 1.38. The Q100i was estimated to be 213.6 m^3/s.

This Q100i discharge estimate is approximately 90% more than the Regional Analysis estimate.

PEAK FLOW IN THE VANCOUVER ISLAND REGION
10-Year Peak Flow Curves

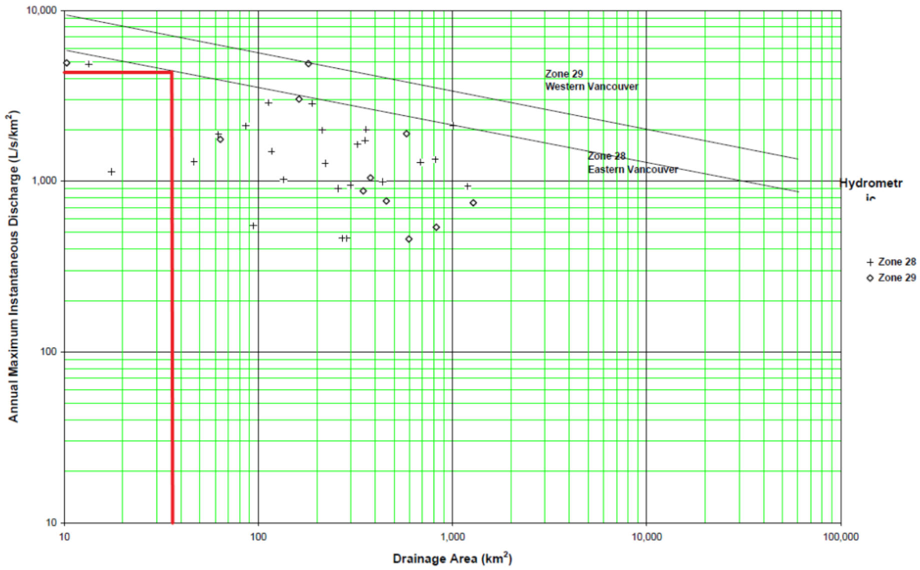


Figure 3 Watershed Peak Flow (page 2 of 2)

Below is a summary of various methodologies to estimate Q100i.

Method	Design discharge (Q100i) (m3/s)	Percent increase to Regional method
Regional Regression Analysis	110	-
Streamflow Inventory Peak Flow map	81	-26%
Station Transfer	103	-6%
Streamflow Inventory Report	213.6	94%

Appendix B: Climate Change Results

North Cowichan

IDF based on historical data

Precipitation (mm)

t\T	2	5	10	20	25	50	100
60	9.1	11.1	12.52	13.95	14.41	15.91	17.46
120	13.79	16.67	18.43	20.01	20.49	21.91	23.23
360	29.47	33.86	35.92	37.44	37.84	38.9	39.71
720	44.41	51.53	54.5	56.49	56.99	58.23	59.1
1440	60.37	73.52	79.98	84.91	86.26	89.85	92.71

PCIC corrected

RCP 2.6

	2	5	10	20	25	50	100
1 h	9.71	12.17	13.81	15.78	16.48	18.62	21.21
2 h	14.9	18	19.71	21.74	22.39	23.9	25.41
6 h	31.57	36.41	38.52	41.03	41.67	42.89	43.92
12 h	47.7	56.42	60.19	64.18	65.13	67.32	69.16
24 h	63.2	77.3	84.31	92.26	94.47	99.5	103.5

RCP 4.5	2	5	10	20	25	50	100
1 h	9.82	12.25	14.03	15.81	16.39	18.56	21.02
2 h	15.07	18.11	19.92	21.51	21.97	23.56	25.06
6 h	31.91	36.58	38.89	40.45	40.87	41.97	43.34
12 h	48.21	56.69	60.68	63.39	64.1	65.92	67.3
24 h	63.89	77.63	85.21	90.92	92.57	97.18	102.57

RCP8.5	2	5	10	20	25	50	100
1 h	9.98	12.62	14.55	16.79	17.56	20.04	22.91
2 h	15.3	18.73	20.9	22.9	23.55	25.63	27.78
6 h	32.43	37.91	40.87	43.05	43.59	45.59	47.56
12 h	49.01	58.79	63.85	67.47	68.29	71.16	73.76
24 h	64.94	80.47	89.47	96.76	98.9	105.94	113.03

PERCENT
INCREASE

RCP 2.6

2	5	10	20	25	50	100	AVERAGE of 100
7%	10%	10%	13%	14%	17%	21%	
8%	8%	7%	9%	9%	9%	9%	
7%	8%	7%	10%	10%	10%	11%	
7%	9%	10%	14%	14%	16%	17%	
5%	5%	5%	9%	10%	11%	12%	14%

RCP 4.5

2	5	10	20	25	50	100	
8%	10%	12%	13%	14%	17%	20%	
9%	9%	8%	7%	7%	8%	8%	
8%	8%	8%	8%	8%	8%	9%	
9%	10%	11%	12%	12%	13%	14%	
6%	6%	7%	7%	7%	8%	11%	12%

RCP8.5

2	5	10	20	25	50	100	
10%	14%	16%	20%	22%	26%	31%	
11%	12%	13%	14%	15%	17%	20%	
10%	12%	14%	15%	15%	17%	20%	
10%	14%	17%	19%	20%	22%	25%	
8%	9%	12%	14%	15%	18%	22%	23%

Lake Cowichan

IDF based on historical data
Precipitation
(mm)

t\T	2	5	10	20	25	50	100
60	11.49	13.15	14.32	15.49	15.87	17.08	18.34
120	18.07	21.25	23.79	26.61	27.6	30.92	34.71
360	43.19	49.09	52.17	54.65	55.34	57.26	58.86
720	66.27	71.26	73.6	75.32	75.78	76.98	77.9
1440	95.16	113.12	123.4	132.21	134.8	142.25	148.89

IDF CC PCIC

RCP 2.6

	2	5	10	20	25	50	100
1 h	12.23	14.01	15	16.36	16.79	18.19	19.86
2 h	19.22	22.69	25	27.92	29.15	32.74	37.17
6 h	46.06	51.98	54.74	57.66	58.29	60.69	63.11
12 h	70.61	75.32	77.19	79.65	80.05	81.44	83.08
24 h	101.47	119.95	129.52	139.48	141.93	151.19	159.52

RCP 4.6

	2	5	10	20	25	50	100
1 h	12.41	14.22	15.36	16.38	16.78	18	19.32
2 h	19.49	22.93	25.56	28.12	29.11	32.52	36.68
6 h	46.77	53.02	55.86	57.79	58.51	60.49	61.75
12 h	71.7	76.91	79.18	80.49	80.72	81.68	82.45
24 h	103.02	122.21	131.93	139.6	142.12	149.57	155.64

RCP 8.5

	2	5	10	20	25	50	100
1 h	12.63	14.73	16.22	17.79	18.22	19.57	21.45
2 h	19.86	23.8	26.92	30.64	31.77	35.52	40.39
6 h	47.47	54.93	59.65	62.49	63.29	65.54	67.95
12 h	72.82	79.73	84.16	86.25	86.81	88.26	90.03
24 h	104.58	126.58	141.11	151.2	154.14	163.03	172.21

PERCENT
INCREASE

RCP 2.6

2	5	10	20	25	50	100	
6%	7%	5%	6%	6%	6%	8%	
6%	7%	5%	5%	6%	6%	7%	
7%	6%	5%	6%	5%	6%	7%	
7%	6%	5%	6%	6%	6%	7%	
7%	6%	5%	5%	5%	6%	7%	7%

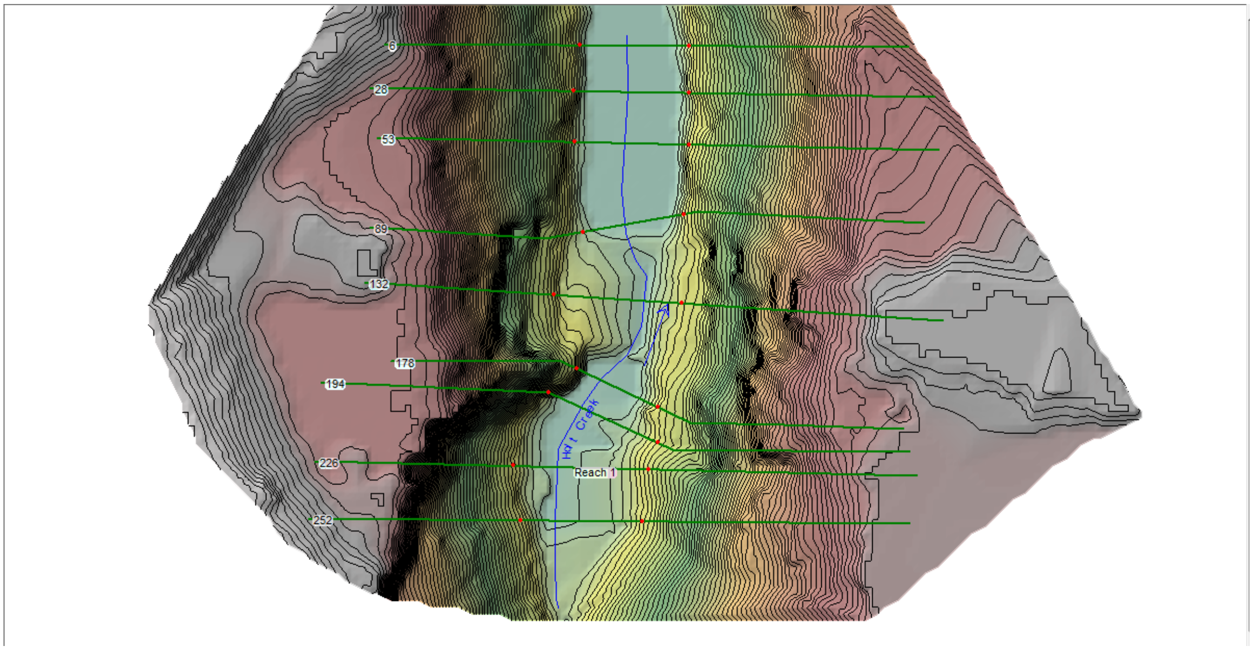
RCP 4.6

2	5	10	20	25	50	100	
8%	8%	7%	6%	6%	5%	5%	
8%	8%	7%	6%	5%	5%	6%	
8%	8%	7%	6%	6%	6%	5%	
8%	8%	8%	7%	7%	6%	6%	
8%	8%	7%	6%	5%	5%	5%	5%

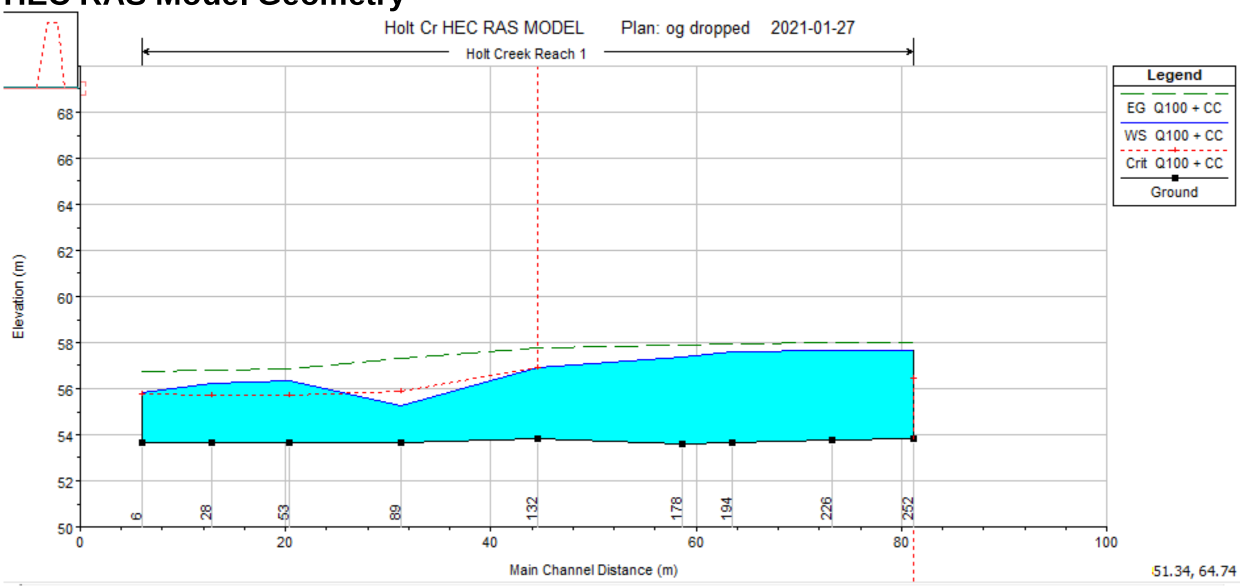
RCP 8.5

2	5	10	20	25	50	100	
10%	12%	13%	15%	15%	15%	17%	
10%	12%	13%	15%	15%	15%	16%	
10%	12%	14%	14%	14%	14%	15%	
10%	12%	14%	15%	15%	15%	16%	
10%	12%	14%	14%	14%	15%	16%	16%

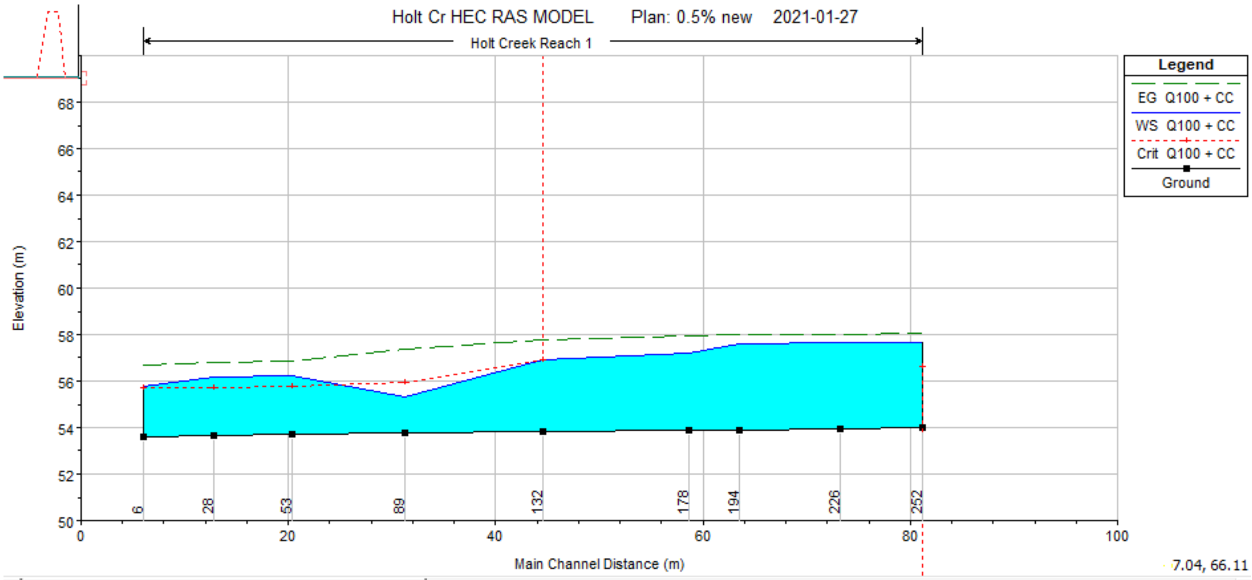
Appendix B: HEC-RAS Model Results



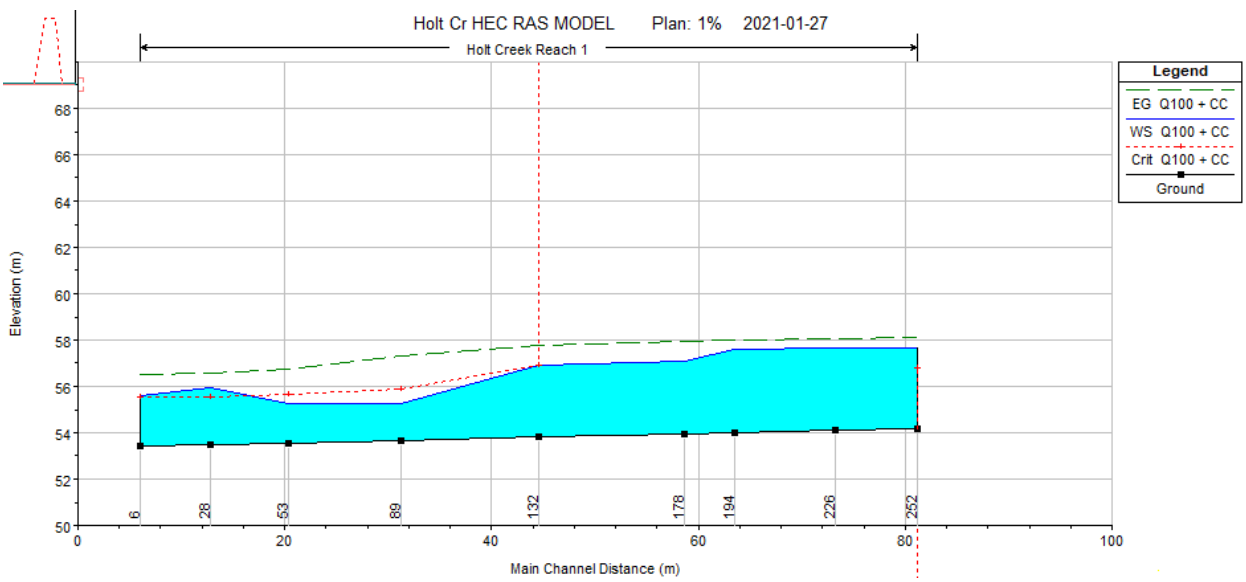
HEC RAS Model Geometry



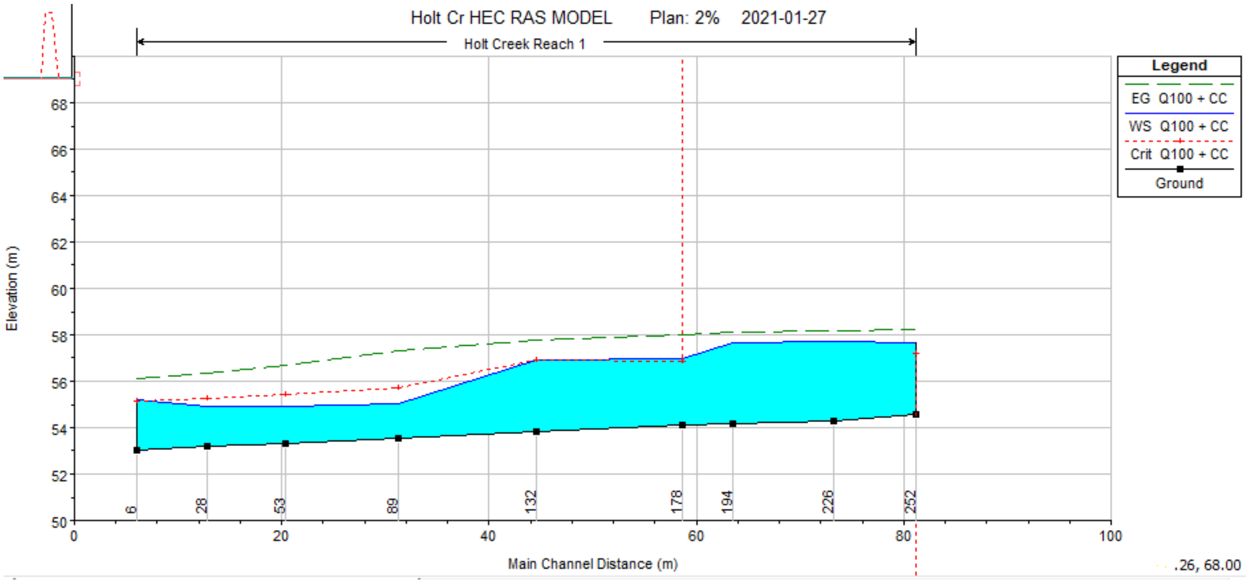
Channel Profile with Original Survey Slope



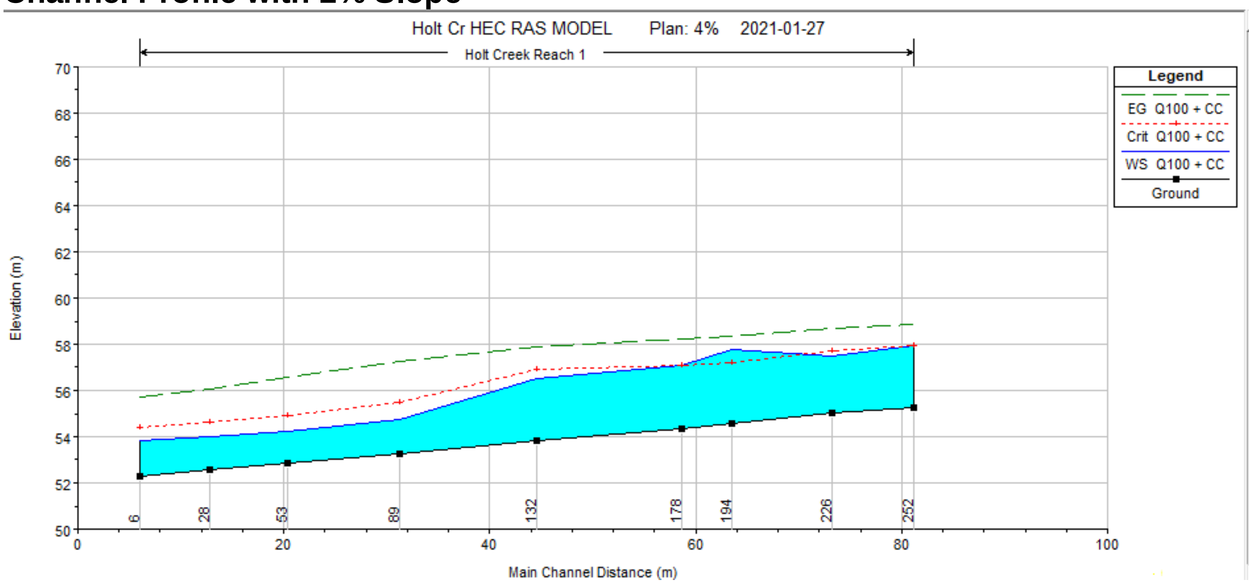
Channel Profile with 0.5% Slope



Channel Profile with 1% Slope



Channel Profile with 2% Slope



Channel Profile with 4% Slope

HEC RAS Summary Tables

0% OG										
River Station	Q total	Min Channel elevation	W.S. Elevation	Critical W.S.	E.G. Elevation	E.G Slope	Vel Channel	Flow Area	Top width	Froude #
252	135	53.84	57.67	56.48	58.01	0.003	2.58	52.75	19.51	0.48
226	135	53.76	57.67		57.97	0.0028	2.46	55.08	20.59	0.47
194	135	53.66	57.63		57.95	0.0027	2.5	54.28	19.08	0.46
178	135	53.61	57.36		57.9	0.005	3.26	41.64	14.32	0.59
132	135	53.81	56.9	56.9	57.76	0.0141	4.11	33.04	19.84	0.99
89	135	53.68	55.25	55.87	57.34	0.0442	6.41	21.22	15.44	1.72
53	135	53.66	56.35	55.74	56.88	0.0058	3.24	42.07	18.07	0.66
28	135	53.66	56.24	55.73	56.83	0.0069	3.4	39.91	17.37	0.71
6	135	53.66	55.81	55.77	56.73	0.013	4.24	31.99	16.8	0.97
.5% slope										
252	135	53.99	57.68	56.63	58.06	0.0035	2.71	50.01	19.14	0.52
226	135	53.96	57.67		58.02	0.0035	2.65	51.09	20.11	0.52
194	135	53.91	57.6		57.98	0.0038	2.75	49.19	18.35	0.53
178	135	53.88	57.18		57.92	0.0082	3.81	35.44	13.37	0.74
132	135	53.81	56.9	56.9	57.76	0.0141	4.11	33.04	19.84	0.99
89	135	53.75	55.34	55.94	57.35	0.0416	6.29	21.64	15.5	1.67
53	135	53.69	56.25	55.77	56.84	0.0069	3.42	39.79	17.84	0.72
28	135	53.65	56.17	55.72	56.79	0.0074	3.48	38.94	17.29	0.73
6	135	53.62	55.77	55.73	56.69	0.013	4.24	31.99	16.79	0.97
1% Slope										
252	135	54.18	57.65	56.82	58.09	0.0046	2.95	45.94	18.58	0.59
226	135	54.1	57.64		58.05	0.0044	2.83	47.65	19.68	0.58
194	135	54	57.59		58	0.0043	2.86	47.2	18.04	0.56
178	135	53.95	57.09		57.93	0.0099	4.05	33.3	13.16	0.81
132	135	53.81	56.9	56.9	57.76	0.0142	4.12	32.91	19.81	1
89	135	53.68	55.25	55.87	57.33	0.0442	6.4	21.23	15.45	1.71
53	135	53.57	55.25	55.65	56.77	0.0305	5.45	24.76	16.48	1.42
28	135	53.49	55.93	55.56	56.59	0.0083	3.6	37.61	17.19	0.77
6	135	53.43	55.58	55.54	56.5	0.013	4.24	31.99	16.8	0.97
2% slope										

252	135	54.54	57.65	57.18	58.25	0.0074	3.43	39.33	17.72	0.73
226	135	54.27	57.71		58.16	0.005	2.96	45.68	19.43	0.61
194	135	54.19	57.64		58.11	0.005	3.01	44.81	17.7	0.6
178	135	54.09	56.97	56.87	58.01	0.0136	4.51	29.93	12.79	0.94
132	135	53.81	56.9	56.9	57.76	0.0142	4.12	32.91	19.81	1
89	135	53.53	55.04	55.72	57.3	0.0502	6.67	20.37	15.33	1.82
53	135	53.33	54.89	55.41	56.68	0.0396	5.93	22.75	16.27	1.6
28	135	53.18	54.89	55.25	56.32	0.0279	5.31	25.43	16.2	1.35
6	135	53.05	55.2	55.16	56.12	0.013	4.24	31.99	16.8	0.97
4% Slope										
252	135	55.28	57.92	57.92	58.87	0.0145	4.32	31.28	16.71	1.01
226	135	55.04	57.49	57.73	58.7	0.0217	4.88	27.68	17.05	1.22
194	135	54.56	57.77	57.19	58.33	0.0067	3.33	40.54	17.19	0.69
178	135	54.32	57.09	57.09	58.23	0.0154	4.72	28.63	12.64	1
132	135	53.81	56.53	56.89	57.91	0.0297	5.19	25.99	18.49	1.4
89	135	53.28	54.72	55.47	57.26	0.0601	7.06	19.23	15.17	1.97
53	135	52.85	54.24	54.93	56.54	0.0579	6.72	20.09	15.98	1.91
28	135	52.54	53.98	54.61	56.07	0.0498	6.41	21.07	15.85	1.77
6	135	52.27	53.84	54.39	55.7	0.0404	6.05	22.32	15.87	1.62