Water Quality, Microbiology, and Invertebrate Analysis for the Beck Creek in Nanaimo, British Columbia

Final Report

Submitted By:
Chelsea Eaglestone-April, Sarah Gourlay, and Kristina Haime

Submitted to:
Owen Hargrove at Vancouver Island University
December 4, 2020

Table of Contents

Executive Summary

Beck Creek, located in the south of Nanaimo, was the subject of two water quality and habitat surveys, one in October and one in November of 2020. The purpose for the two sampling dates was to be able to compare results from both low and high flow periods. Four sites were chosen on the basis of them having been surveyed in previous years by other student groups. To determine the health of Beck Creek 3 methods of testing were conducted including water quality, microbiology, and basic hydrology. Water quality samples were analysed both by the field crew at the VIU lab and by ALS laboratory to provide comparable results. The findings from this testing which is discussed in greater detail in the following report indicate that Beck Creek faces seasonal challenges that make it a suitable habitat for aquatic life. During low flow the creek has high temperatures, slow drainage, algae growth and many category 2 & 3 invertebrates. During high flows the temperature drops, turbidity increases, and while there is less diversity of invertebrates there are more category 1 invertebrates present. The following document outlines the procedures taken and provides more details on the results from the two sampling days.

Introduction

Since the Fall of 2017, teams of students from Vancouver Island University's (VIU) Natural Resource Protection Program have accomplished annual water quality and habitat quality surveys at 4 sites on the lower reaches of Beck Creek. For continuity of data, we chose to sample the same 4 sites as the previous years.

Once referred to as Hong Kong Creek, Beck Creek is situated on the eastern side of Vancouver Island, south of Nanaimo in an area known as South Wellington. The headwaters of the 5km creek are at Beck Lake, a small lake surrounded by agricultural residential plots. It flows primarily through Electoral Area A before flowing out through the Nanaimo River Estuary within the City of Nanaimo city limits. The area has a rich history of coal mining and many of the original homesteads and families remain in the area to this day. Between the late 1800s and early 1900s, the area was home to the No. 10 mine, and coal was transported by rail car from the mine site at the south-east end of Beck Lake along the creek on what was referred to as the "Black Track". Much of the surrounding area is built atop mine tailings and a slag pile remains at the south end of the lake along with a large amount of hug-fuel (Blackman, 1980).

Beck Creek has been known to provide important spawning habitat for pacific salmon species. Salmon have historically been known to migrate all the way up to Beck Lake, however, beaver damming, low flow and oxygen levels and poorly maintained culverts have created water quality challenges and blockages to fish passage.

This document aims to examine the challenges this creek faces and offer recommendations on how to improve its condition.

Site Information

From Beck Lake, the creek flows through various landscapes and land-use types, collecting and transporting debris and nutrients. The lower reaches of Beck Creek, where we and past year's groups chose to sample, are highly vulnerable to contamination. This is likely due to its proximity to the Island Highway. Before entering the ocean at the Nanaimo River Estuary, the creek passes through a culvert underneath the Island Highway. We chose to sample two sites upstream from the culvert and two sites downstream in order to compare results and determine water quality changes pre and post highway crossing (Figure 1).

Figure 1. Four sampling locations along Beck Creek. Sites 1 and 2 are upstream of the highway culvert; sites 3 and 4 downstream.

Site number one is located at UTM 10U 433603 E, 5440523 N. It is accessed by Frames rd. where a trail leads up a hill and over some train tracks. The riparian area of this site is dominated by thimbleberry, shrubs and deciduous trees. The site is partially shaded and the banks have a gradient of approximately 25%. We took our samples from the short riffle present in between two pools. On our first sampling date this was easy to do, however it was not as easy on our second sampling date due to high flows.

Site number two is located at UTM 10U 433409 E, 5440990 N and is accessed by the same trail as site 1. This site provides very little riparian coverage and is exposed to a lot of direct sunlight. The Trans Canada Highway culvert is just downstream of this site. The culvert is clearly undersized for the amount of water it is expected to handle, resulting in a wide floodplain near the mouth of the culvert. The riparian area of this site hosted a couple young maple trees, grasses, indian plum, and sword ferns.

Site number three is located at UTM 10U 433346 E, 5441612 N and is accessed by Fielding Rd, just after taking the exit to Cedar Rd from the Trans Canada Highway. This is a well shaded part of the stream with good riparian coverage, dominated primarily by young cedar and alder. There is very little understory foliage, other than a few sword ferns. The riparian slopes are relatively steep with a large amount of leaf litter.

Lastly, Site four, located at UTM 10U 433289 E, 5442348 N, is accessed by Maki Rd. This site is where the creek flows into the Nanaimo Estuary via a large culvert that crosses underneath Maki Rd. It has very limited riparian vegetation, and therefore, is exposed to full-sun. The little vegetation that is present is dominated by grasses and shrubs, with a couple young douglas firs and big leaf maple trees.

Sampling Program

Sampling procedures were carried out on two separate occasions in order to compare conditions pre and post heavy rainfall events. The first sampling date occurred on October 28th, 2020 and the second on November 17th, 2020. At each site we collected water samples that were then analysed inside the lab at VIU by our team members. These samples were used to determine a number of parameters ranging from turbidity to alkalinity. At site 1 and 2, in addition to our "in house" samples, we collected samples that would be shipped off to ALS for a more professional analysis. Sites 1 and 2 were also the two sites chosen to take macroinvertebrate samples using a Hess sampler. Site 4, the outlet of the creek into the estuary is where we calculated stream discharge using a ping pong ball and stopwatch.

Methods

Basic Hydrology

Basic hydrology was measured only at site 4 on the first sampling day as it is the sample site furthest downstream and therefore, was most likely to render the most accurate discharge data. The velocity was measured using a floating ball, tape measure and stopwatch. The first team member stood 30 meters upstream and released the ball with a second team member stopping the watch when it crossed the point downstream.The upstream team member released the floating ball three times on the right, center, and left side of the stream, while the downstream team member used a stopwatch to record the length of time it takes the float to reach them. This method was intended to help prevent the results from being skewed. By doing multiple tests, it also prevents any outliers from having a detrimental effect on our results in case the float gets caught in an eddie. The depth of the stream was also taken halfway to the right bank, halfway to the left bank and in the middle of the stream. The wetted width of the stream was also measured and recorded at 44.5 inches.

Once all these measurements were collected, we then determined the average velocity and average depth of the stream at this location. The area was then calculated by multiplying the average depth by the wetted width. Lastly, by multiplying the area by the average velocity, we determined the discharge of the stream which is discussed in the results section in this report.

Water Quality & Microbiology

Field Measurements & Collection

At each site a variety of water quality parameters were tested to determine the health of the stream. The parameters that were tested included the following:

- *Temperature*: measure of heat stored in water affecting the metabolic oxygen demand
- Dissolved oxygen: essential to the respiratory metabolism of most aquatic animals
- *Conductivity (uS/cm)*: measures the ability of water to create an electronic current, and is used to measure total ion content in water
- *PH*: measures hydrogen-ion concentration in water
- *Turbidity:* measures suspended particles in water column
- *Total alkalinity*: measures waters ability to defuse acids
- *Hardness:* measures the hardness of water where it can reduce the toxicity of metals or have a corrosive effect
- *Nitrate (NO3-):* measures the primary form of nitrogen which is used by plants
- *Reactive phosphorus (PO4 3-):* measures organic & inorganic phosphorus. Is a limiting nutrient and can cause algae growth

Samples were then brought back to the lab for further analysis. After analysis was conducted on the samples we were able to determine if the water from Beck creek meets the specified British Columbia Water Quality Guidelines for aquatic life. The results and the final determination is discussed in further detail in the discussion below.

Sample Collection Procedures

To collect the water samples, we followed the guidelines for sampling in a stream established by the Province of British Columbia in the 2013 report, *Ambient Freshwater and Effluent Sampling*.

Using labeled bottles, we will make the safest attempt to wade into the middle of the stream, then walk upstream to the sample site. In the event of high water levels or fast flows we will find the best possible location. Once at the sample location the sampler will stand facing upstream, remove the lid and rinse out the bottle 3 times. Then they will take the labelled sample container and plunge it beneath the surface then tilt upstream to catch the water, remove it by forcing it forward into the current, and replace the cap immediately. The samples will each be directly placed into a cooler and recorded in a chain of custody form.

Quality Assurance

To ensure quality we followed the guidelines from the *Ambient Freshwater and Effluent Sampling* Guidelines (Province of British Columbia 2013).

To protect the samples from contamination a variety of precautions will be taken. For the sample bottles we used bottles and caps that had been cleaned by the laboratory. The bottles were properly labelled before using, bottle lids will remain on until taking the sample, and the inside was not touched with anything except the sample water.

Once the samples were taken the bottles were then placed in a cooler to keep them clean and away from potential pollutants. Equipment used while sampling was stored either in their carrying cases or in plastic bags in the cooler keeping them away from potential pollutants and contaminants.

Once at the lab only one test was performed per sample. No sample will be tested for 2 different parameters. We ensured we tested a fresh sample each time to reduce the risk of contaminants that could potentially skew the results of the next test.

Quality Control

In order to control the quality of the sample we took two different sets of samples, one for our lab testing and one set for ALS testing. This involved using a container filled with the sample water stored in the cooler with the other samples to use to compare if there was any contamination to the samples. By using this measure, it helped to identify if there were any contaminants introduced to the samples outside of the water or through human error.

Stream Invertebrate Communities

Sample Collection Procedures:

Invertebrates will be sampled a single time on the first sample day at the end of October. Our invertebrate sampling methodology is based off the invertebrate assessment method described in The Stream Keeper's Handbook (Munro and Taccogna 1995).One field member will hold the Hess sampler in place on the stream bed of a riffle with the screen facing upstream allowing water to flow through the sampler easily, carrying the cod-end of the net downstream.

The second field member will reach into the cylinder and gently stir the gravel for exactly one minute. Larger rocks will be rubbed inside the cylinder to remove any invertebrates clinging to them.

After one minute, the sampler will be moved to a new location in the riffle. We will swoosh the sampler in the upstream direction when lifting and carry the sample with the cod-end hanging down to ensure none of the sample is lost.

This process will be repeated twice more, for a total of three minutes of sample time at each sample site. After three minutes of sampling is complete, the top of the net will be rinsed down to the cod-end to wash any invertebrates clinging to the net into the sample. The sample will then be emptied into a bottle, and a wash bottle used to remove the entire sample from the cod-end. Only 2-3 of the sample sites will be sampled for invertebrates as enumeration of these samples is extremely time consuming and we do not possess the lab time to enumerate more than a couple samples.

Laboratory and Data Analysis:

The samples will be transported back to the VIU lab where they will be carefully sorted and identified using a dissecting microscope. The specimens will be identified by referencing the Key to Invertebrate Groups found in The Stream keeper’s Handbook (Munro and Taccogna 1995). Once counted, they will be placed in a separate container. All counts will be recorded in a field notebook and then transferred to an excel spreadsheet.

Once the data has been organized into excel, the data from each creek will be analyzed to determine the EPT Index, the Pollution Tolerance Index, and the Predominant Taxon Diversity Index for each site. Using these indices an overall site assessment rating can be determined. Separately, The Shannon-Weiner Diversity Index will also be calculated. Details about these indices can be found in The Stream Keeper's Handbook (Munro and Taccogna 1995).

Results and Discussion

Water Quality Sampling

Table 1: Water Chemistry Sampling for Beck Creek, October 27, 2020.

Parameter	Units	Site 1	Site 2	Site 3	Site 4	Guideline for Aquatic Life
Temperature	Celcius	11.3	11.5	10.4	10.5	Max. 8-10 (Spawning)
Conductivity	µS/cm	453	447	378	366	None
PH	No Units	7.76	7.98	8.01	7.6	6.5-9.0
Dissolved Oxygen	mg/L	7.67	10.13	10.74	11.62	Min. 4.0
Turbidity	NTU	3.54	2.26	1.78	3.95	Max. 5
Total Alkalinity	mg/L CaCO3	142	137	105	92	Variable
Hardness	mg/L as CaCO3	85.0	83.2	79.3	76	None
Nitrate	mg/L NO3	0.05	0.04	0.5	0.38	Max. 200

Reactive Phosphorus	mg/L PO4 3-	0.08	0.05	0.7	0.03	None

The temperature of the creek during our first round of water sampling was considerably high and outside of the range that supports spawning salmonids. This is worrying for this time of the season as this should be prime spawning time for many species of salmonid. Lake fed systems, such as Beck Creek, tend to be much more variable in temperature than groundwater fed creeks. Though turn over of the lake is certain to have happened by this point in the fall, it seems that the temperature is remaining quite high. This could suggest temperatures of the lake were exceedingly high through the summer and may be taking a longer time period to cool down (Table 1).

Conductivity was found to be relatively high and outside of the range of what is normal in this region. This could be the result of something natural concerning the geology of the area. This could also, potentially, be human-caused as a result of run off from the abandoned mine in the watershed (Table 1).

Turbidity, pH, and dissolved oxygen are all within a normal, healthy range. It should, however, be noted that the dissolved oxygen reading at site 1 was significantly lower than the other sites. This isn't unusual however, when you consider the large amount of pooling in this area as slower flows will lead to less mixing and thus, less oxygenation (Table 1).

Alkalinity is also relatively high. While this isn't unhealthy, a higher alkalinity increases the acid neutralizing capacity of the water. It can be caused by similar reasons to conductivity, namely, geological composition of the watershed and mine run off (Table 1).

The hardness readings fell evenly between the hard water range and soft water range. The nitrate level fell within the guideline for aquatic life and the phosphate level was within a relatively normal range as well. These two nutrients however, are more worrying from an ecological viewpoint as excess amounts of them can lead to eutrophication which affects a whole host of other factors that have both positive and negative effects on the health of a stream. Any positive effects that are felt, such as increased growth and carrying capacity due to the productivity of a water body are eventually outweighed by negative effects such as decreased dissolved oxygen levels as eutrophication persists. Phosphorus is the limiting factor in freshwater systems and a water body needs as little as 0.03 mg/L of phosphate to be considered eutrophic. Our water samples easily reached this level at all 4 of our sample sites (Table 1).

Table 2: Water Chemistry Sampling for Beck Creek, November 18, 2020.

Parameter	**Units**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Guideline for Aquatic Life**
Temperature	Celcius	6.5	6.4	7.1	7.1	Max. 8-10 (Spawning)
Conductivity	uS/cm	309	314	167	155	None
PH	No Units	7.5	7.51	7.25	7.9	6.5-9.0
Dissolved Oxygen	mg/L	7.8	10.17	10.36	11.11	Min. 4.0
Turbidity	NTU	5.72	5.55	7.13	8.87	Max. 5
Total Alkalinity	mg/L CaCO3	66	61	29	31	Variable
Hardness	mg/L as CaCO3	73.9	73.1	40.6	52	None
Nitrate	mg/L NO3	0.04	0.06	0.28	0.14	Max. 200

Reactive Phosphorus	mg/L PO4 3-	3.71	1.12	1.09	0.64	None

Many of our water quality readings from our second round of sampling in November were very similar to our first round with a couple key differences. Thankfully, the temperature of the creek fell considerably and was now well within the range that supports spawning salmonids (Table 2).

Turbidity was significantly higher and was outside the guideline for aquatic life. This wasn't surprising considering the water level which had risen significantly in just the few days prior to sampling. When flow increases significantly there will always be an increase in turbidity as loose soils and sediments get washed downstream (Table 2).

The phosphate reading increased significantly, which can be expected considering the amount of agricultural activity surrounding the upper reaches of the creek and the lake that feeds it. With the recent heavy rains, this would be a key time when significant input of fertilizers may occur through run off from the surrounding lands. The distribution of phosphate in the samples is also consistent with this theory, as it was concentrated in the upper reaches which had significant pooling and less was found in the samples from the lower reaches of the creek (Table 2).

Benthic Stream Invertebrate Sampling

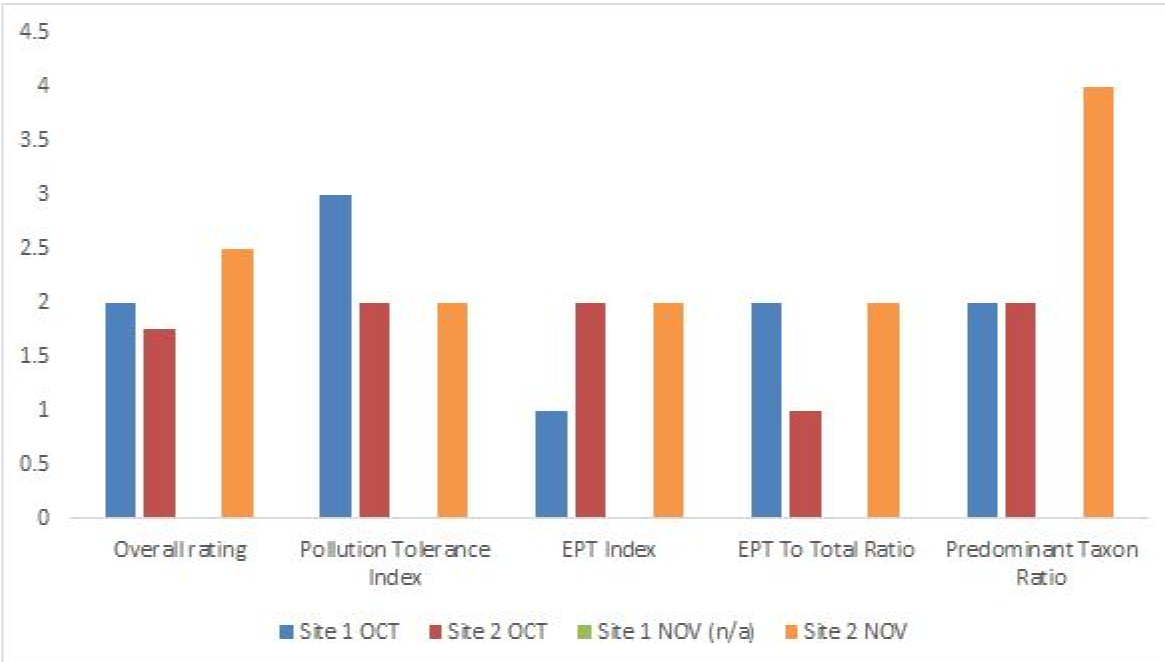

Figure 1: Invertebrate Sampling Results for Beck Creek taken on October 27, 2020 and November 18, 2020.

The first set of samples taken from site 1 and site 2 on October 27, 2020 yielded results that suggested an overall stream health of poor to marginal. The single sample we were able to obtain in November yielded moderately better results, but contained much fewer invertebrates in general. The predominant taxon ratio was much higher in the November sample as there wasn't a significant number of individuals of any single taxon. In the October samples there were a great number of amphipods from both site 1 and site 2, which were almost missing entirely from the November sample. Amphipods are a species of moderate pollution tolerance which, if we had found few pollution intolerant species, might have suggested a decline in water quality. However, we found significantly more pollution intolerant species in the November sample than we did the October samples so this is unlikely to be the case. The pollution tolerance rating for site 1 in October was notably higher than all the other samples. This was the result of just two pollution intolerant species being found in the samples for that site (Appendix 1, Figure 1)

<u>Basic Hydrology:</u>

Table 3. Basic hydrological measurements taken at Beck Creek, site 4 on October 27,2020.

	Measurement
Average Time (seconds)	7.5
Distance (m)	35
Velocity (m/s)	4.67
Depth (m)	0.23
Wetted Width (m)	1.13
Discharge (m^3/s)	1.12

Unfortunately, due to the high flows we had during the week where we conducted sampling in November, we were unable to collect a second round of hydrological data. Flows that were measured in October were about half of bankfull width. The flows in November were right around 100% bankfull, so we can assume the discharge of the creek will most likely have doubled. When compared with results from fall 2019, our discharge in October was much higher than either result collected last fall (Cooper et al. 2019, Table 3).

Conclusions and Recommendations

The high flows that November brought were limiting to our sampling regime, but also identified other problems that we may not have otherwise identified. For example, the culvert that diverts the stream below the highway is significantly undersized for the amount of flow it is expected to handle at this time of year. There was significant flooding around its intake, however, the steep riparian banks were able to contain most of it.

Acknowledgements

Acknowledgements for the report are made to VIU professors for the knowledge and assistance with organizing materials and lab assistance, ALS Laboratories for performing the water quality testing for two testing periods, and for the City of Nanaimo for allowing us to use their land to access these sites to conduct our research.

Works Cited

Blackman, R. (1980). Lake Surveys: Nanaimo River Watershed. Nanaimo: British Columbia Ministry of Environment. Retrieved from http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=33160

Cavanagh N, et al. 1998. Guidelines For Interpreting Water Quality Data. Victoria: British Columbia. Province of British Columbia. 109pp.

K. Cooper, B. Farrow, and K. Munroe. 2019. Water Quality and Stream Invertebrate Assessment for Beck Creek, Nanaimo, BC (Fall 2019). Vancouver Island University.

Munro K, Taccogna G, British Columbia. Ministry of Environment, Lands and Parks, Fraser River Action Plan (Canada), Salmonid Enhancement Program (Canada). Community Involvement Division, Canada. Environment Canada. 1995 The Streamkeepers handbook: practical guide to stream and wetland care. Vancouver, B.C: Fisheries and Oceans, Fraser River Action Plan.

Province of British Columbia. 2013. Ambient Freshwater and Effluent Sampling. Field Sampling Manual. 148pp.

Regional District of Nanaimo. (2020). Regional District of Nanaimo WaterMap. Retrieved from Regional District of Nanaimo: https://www.rdn.bc.ca/watermap

Appendix 1

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: Beck Creek		Date: Oct. 27, 2020	
Station Name: Site 1		Flow status: Moderate	
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 Pollution Intolerant	Caddisfly Larva (EPT)	2	1
	Mayfly Nymph (EPT)		
	Stonefly Nymph (EPT)		
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total			1
Category 2 Somewhat Pollution Tolerant	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	2	1
	Cranefly Larva		
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Amphipod (freshwater shrimp)	21	3
	Watersnipe Larva		
Sub-Total			4
Category 3 Pollution Tolerant	Aquatic Worm (oligochaete)	12	1
	Blackfly Larva	2	2
	Leech		
	Midge Larva (chironomid)	2	1
	Planarian (flatworm)		
	Pouch and Pond Snails	1	1
	True Bug Adult	4	1
	Water Mite		
Sub-Total			6
TOTAL		46	11

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: **46**

DENSITY: Invertebrate density per total area sampled:

46 ÷ 0.27 (From page 1) m^2 = **170.37** / m^2

PREDOMINANT TAXON:
Invertebrate group with the highest number counted (in Col. C): **Amphipod**

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Acceptable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

'3 *____+ 2 x _____+ _____ = **17**

EPT INDEX: Total number of EPT taxa.

Good	Acceptable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

_____ + _____ + _____ = **1**

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Acceptable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(_____ + _____ + _____) / _____= **0.043478261**

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: **11**

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S1) divided by CT.

Good	Acceptable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S1 / CT

_____ / _____ = **0.456521739**

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S2, S3, S4, S5), then calculate the average.

Assessment Rating	
Good	4
Acceptable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	3
EPT Index	1
EPT To Total Ratio	2
Predominant Taxon Ratio	2

Average Rating
Average of R1, R2, R3, R4
2

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: Beck Creek		Date: Oct. 27, 2020	
Station Name: Site 2		Flow status: Moderate	
Sampler Used: Hess	Number of replicates: 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates: 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	9	1
	Mayfly Nymph (EPT)	1	1
	Stonefly Nymph (EPT)		
	Dobsonfly (hellgrammite)	2	1
Pollution Intolerant	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		12	3
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	1	1
	Cranefly Larva		
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva	4	1
	Fishfly Larva	1	1
	Amphipod (freshwater shrimp)	54	1
	Watersnipe Larva		
Sub-Total		60	4
Category 3	Aquatic Worm (oligochaete)	6	1
	Blackfly Larva	1	1
	Leech		
	Midge Larva (chironomid)	16	1
	Planarian (flatworm)		
Pollution Tolerant	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		23	3
TOTAL		95	10

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: **95**

DENSITY: Invertebrate density per total area sampled:

95 ÷ 0.27 (From page 1) m^2 = 351.852 / m^2

PREDOMINANT TAXON: Amphipod

Invertebrate group with the highest number counted (in Col. C)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Acceptable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

'3 *____+ 2 x _____ + _____ = **20**

EPT INDEX: Total number of EPT taxa.

Good	Acceptable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

_____ + _____ + _____ = **2**

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Acceptable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(_____ + _____ + _____) / _____= **0.105263158**

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: **10**

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S1) divided by CT.

Good	Acceptable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S1 / CT

_____ / _____ = **0.568421053**

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S2, S3, S4, S5), then calculate the average.

Assessment Rating	
Good	4
Acceptable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	2
EPT Index	2
EPT To Total Ratio	1
Predominant Taxon Ratio	2

Average Rating
Average of R1, R2, R3, R4
1.75

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: Beck Creek		Date: Nov. 18, 2020	
Station Name: Site 2		Flow status: High	
Sampler Used: Hess	Number of replicates: 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates: 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	1	1
	Mayfly Nymph (EPT)	4	1
	Stonefly Nymph (EPT)	4	1
	Dobsonfly (hellgrammite)		
Pollution Intolerant	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		9	3
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	2	1
	Cranefly Larva		
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Amphipod (freshwater shrimp)	4	1
	Watersnipe Larva	1	1
Sub-Total		7	3
Category 3	Aquatic Worm (oligochaete)	5	1
	Blackfly Larva	3	1
	Leech		
	Midge Larva (chironomid)	2	1
	Planarian (flatworm)		
Pollution Tolerant	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		10	3
TOTAL		26	9

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 26

DENSITY: Invertebrate density per total area sampled:

26 ÷ 0.27 (From page 1) m^2 = 96.2963 / m^2

PREDOMINANT TAXON:
Invertebrate group with the highest number counted (in Col. C): Aquatic Worm

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Acceptable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

'3 * ____ + 2 x _____ + _____ = 18

EPT INDEX: Total number of EPT taxa.

Good	Acceptable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

_____ + _____ + _____ = 3

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Acceptable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(_____ + _____ + _____) / _____= 0.346153846

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 9

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S1) divided by CT.

Good	Acceptable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S1 / CT

_____ / _____ = 0.192307692

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S2, S3, S4, S5), then calculate the average.

Assessment Rating	
Good	4
Acceptable	3
Marginal	2
Poor	1

Assessment	**Rating**
Pollution Tolerance Index	2
EPT Index	2
EPT To Total Ratio	2
Predominant Taxon Ratio	4

Average Rating
Average of R1, R2, R3, R4
2.5