Mercantile Creek Community Watershed
Water Quality Objectives Attainment Report

Environmental Quality Section
Environmental Protection Division
Coast Region

2015

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Approved by _____

Date Approved _____

Executive Summary

The Mercantile Creek watershed is the source of drinking water for the community of Ucluelet. Water Quality Objectives (WQO) were approved for Mercantile Creek in 2012 (Phippen and Obee, 2012) based on data collected from 2002 to 2005. WQO attainment monitoring occurred during summer low flow and fall flush periods in 2010, while continuous data collection occurred from May to December 2010. Grab samples were collected in 2006, 2009 and 2010 as part of the British Columbia (BC) Ministry of Environment's (MOE) benthic invertebrate sampling program. Water quality data from 2006 to 2010 and changes that have occurred in the watershed between 2012 and 2015 are presented in this report.

Generally water quality in Mercantile Creek was good and most WQO were consistently met. Data showed that WQO for *Escherichia coli (E.coli)* and true colour were exceeded during the summer 2010 sampling. During the fall 2010 sampling, only true colour objectives were exceeded. The higher *E.coli* and colour values leading to objective exceedances coincided with rainfall events and were likely natural. The data collected from the continuous water quality station indicated that turbidity exceeded the maximum WQO numerous times between June and December 2010, usually coinciding with rainfall events and accounting for about 2% of the equipment's installation time. It is recommended that, to assist in assessing water quality, continuous water quality monitoring is also conducted during the next WQO attainment period.

In order to get the best representation of summer low flow and first flush events in future monitoring, it is recommended that summer sampling be completed by mid-August, and that the start of fall sampling be determined by assessing the long-range weather forecast in order to choose the first period where significant persistent rain is predicted. Total phosphorous does not appear to be an issue in Mercantile Creek, but more frequent data collection should occur (monthly from May through September) in the next attainment period to confirm this. Though there are no concerns in the benthic invertebrate data in Mercantile Creek at this time, biological data should be considered relative the Vancouver Island biological objectives when Mercantile Creek WQO are re-evaluated in the future.

Introduction

As part of BC MOE's mandate to manage water bodies, WQO reports have been created for a number of lakes, rivers and marine surface waters. These reports provide a list of objectives to protect water quality that are tailored to the specific water body for which they have been created, taking into account natural local water quality, water uses, water movement, and waste discharges. While the WQO currently have no legal standing, they can direct resource managers aiming to protect the water body in question and are used as a standard against which to measure the water quality of that water body. Once objectives have been developed, periodic monitoring (every three to five years) is undertaken to determine whether they are being met (attainment monitoring).

The Mercantile Creek watershed is the source of drinking water for the community of Ucluelet, British Columbia, located on the west coast of Vancouver Island (Figure 1). There are no lakes within the watershed boundaries. WQO were approved for Mercantile Creek in 2012, based on data collected between 2002 and 2005. Some data collection occurred in this watershed between 2006 and 2009, and attainment monitoring occurred between August and November 2010. In addition, continuous water quality data was collected from May 3 to December 7, 2010. This report summarizes all data collected by MOE from 2006 to 2010.

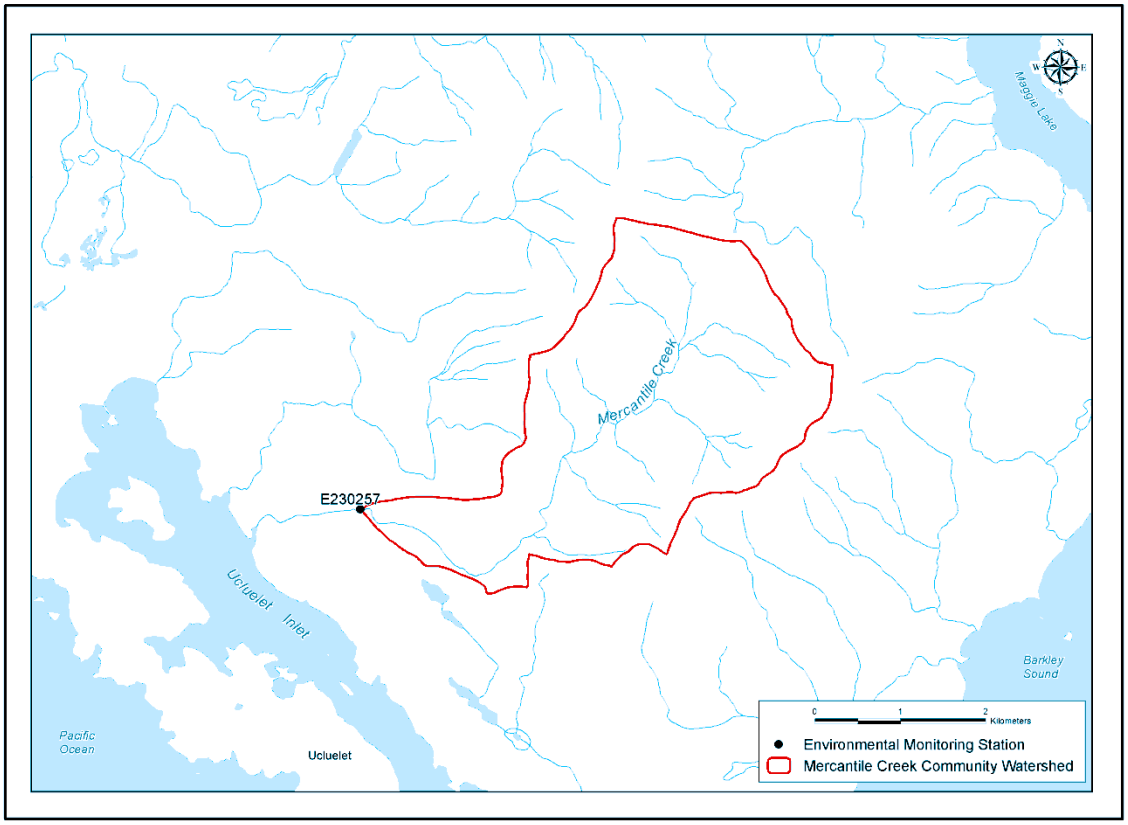

Figure 1: Map of Mercantile Creek Watershed indicating sample site E230257.

Changes in the Watershed since Objectives Development

The following information was available information regarding changes that have occurred in the watershed since WQO were approved in 2012:

i) In 2013 upgrades were carried out on the Mercantile Creek water source. Since, there has been an increasing dependency on groundwater that is high in minerals and causes aesthetic issues for drinking water and discolouration of linens (District of Ucluelet, 2014). This ongoing issue is the subject of public meetings and discussion around the future of drinking water sources in Ucluelet.

ii) The District's Bay street pump station was upgraded to meet current Island Health standards by adding ultraviolet treatment to the raw water drawn from Mercantile Creek (Cannon *pers. comm*., 2015).

iii) Some survey was work done on the bridge that crosses Mercantile Creek, but no further information on this is available (Cannon, *pers. comm.* 2015).

iv) As noted in Phippen and Obee (2012) there are still impacts in the watershed from historic road building and forest harvesting activities. Runoff from these roads has the potential to impact turbidity levels in the creek, particularly during periods of road grading or road construction. Potential impacts from these roads may continue for some time but will decrease as roads are deactivated and reclaimed.

Sampling and Analytical Methods

For attainment monitoring, data from 2006 through 2010 were considered. Following recommendations in the WQO report (Table 1), one water quality site was sampled during the summer low flow, August 11 to September 15, 2010 and during the fall flush, October 13 to November 9, 2010. During both sampling periods five weekly samples were collected over 30 days to calculate 30-day averages and 90th percentiles. One grab sample was also collected in each of January and March of 2006. Samples were collected by District of Ucluelet staff trained by MOE biologists. Benthic invertebrate sampling by MOE staff took place on September 21, 2006, August 20, 2009 and September 15, 2010 as per Canadian Aquatic Biomonitoring Network protocols. Grab sample data from 2006-2010 are summarized in Appendix I. Water quality samples were analyzed by Maxxam Analytics in Burnaby B.C., while benthic invertebrate taxonomy was done by Cordillera Consulting Ltd.

Continuous water quality data was recorded every 15 minutes using an YSI 600 OMS Sonde and collected by MOE staff from May 3 to December 7, 2010 to assist in the interpretation of 2010 grab sample data. These data are summarized in a separate assessment report available through MOE staff, Nanaimo, B.C. (Obee, 2012).

Table 1: Water quality sampling program as recommended in the 2012 WQO report

Site Name	**EMS ID**	**Parameters measured**	**Frequency and timing**
Mercantile Creek at the main water intake	E230257	dissolved organic carbon (DOC), dissolved metals, *E. coli*, fecal coliform, hardness, pH, specific conductivity, temperature, total organic carbon (TOC), total phosphorus, total suspended solids (TSS), true colour, turbidity	● Mid-July to mid-August (low flow season) ● October to November (fall flush) →Both seasons: five weekly samples in a 30-d period
		Benthic invertebrate sampling	●Once every 5 years

Objectives Attainment

A list of the WQO for Mercantile Creek, along with a summary of the exceedances observed from the attainment monitoring, are presented in Table 2. Of the parameters measured, only those that exceeded the Mercantile Creek WQO or that warranted more detailed consideration will be discussed in this report.

Table 2: Summary of WQO and attainment information for grab samples from Mercantile Creek. ("Y =objectives met, "N"= objectives not met, "N/A"= not applicable as sample frequency insufficient to compare to objective.)

PARAMETER	UNITS	OBJECTIVE TYPE	OBJECTIVE VALUE	SUMMER 2010 DATA	FALL 2010 DATA	2006-2009	2010 CONT. DATA
				Objective Met (Yes/No/Not Applicable)			
Dissolved Aluminum (Al-D)	mg/L	Maximum	0.10	Y	Y	Y	N/A
		Average	0.05	N/A	N/A	N/A	N/A
Total Organic Carbon (TOC)	mg/L	Maximum	4	Y	Y	Y	N/A
True Colour	CU	Maximum	15	N	N	Y	N/A
E.Coli	CFU/100mL	Average (90th Percentile)	≤60	N	Y	N/A	N/A
Residue, Non filterable (TSS)	mg\L	Maximum	26	Y	Y	Y	N/A
		Average	6	Y	Y	N/A	N/A
Turbidity	NTU	Maximum	5	Y	Y	Y	N
		Average	2	Y	Y	N/A	N/A
Temperature	°C	Maximum	15	Y	Y	Unknown	Unknown

During the 2010 summer low flow sampling period, *E.coli* and true colour objectives were not met; whereas during the 2010 fall flush sampling period only the true colour objectives were not met. The summer exceedances occurred on September 1, 2010 and were most likely due to rain events two days prior to sampling (August 30 and 31, 2010 had 45.6 and 15.2 mm of precipitation, respectively (Environment Canada, 2015)), which was also the first major flushing event after a drier summer season (minor precipitation events had occurred on August 6, 7 and July 1, 2010). On September 1, 2010, most other parameters tested were also slightly elevated; while the other four summer sample dates had very low results (Table 3). First flush events can happen earlier on the west coast of Vancouver Island; starting the summer low flow sample period earlier in Mercantile Creek would likely avoid this period having first flush influences.

Assessing the long range weather forecast to ensure fall flush sampling occurs around the time of the first flushing event would ensure worst case scenario flushing events were captured. The fall grab sampling started after the fall flush period had begun. The November 9, 2010 true colour exceedance occurred after it had rained for 21/31 days (Environment Canada, 2015). Though some other parameters were slightly elevated in grab samples on this date relative to the rest of the fall flush period, no other exceedances occurred in the fall grab sample data. As noted in the WQO report, occasional high colour levels are observed in this ecoregion and the source of this colour is likely natural processes within the watershed (Phippen and Obee, 2012).

Table 3: Summer and Fall 2010 attainment monitoring grab sample results.

SUMMER 2010							
START DATE	Al-D (mg/L)	Carbon Total Organic (mg/L)	Color True (Col.unit)	*E Coli* (CFU/100 mL)	Total Phosporus (P--T) (mg/L)	Residue Non-filterable (TSS) (mg/L)	Turbidity (NTU)
11-Aug	0.02	1.4	5		0.006	<1	0.3
11-Aug				2			
18-Aug				4			
18-Aug		0.5	5		0.006	<1	0.3
25-Aug		0.6	5		0.008	<1	0.4
25-Aug				1			
01-Sep		3.3	20		0.006	1	0.7
01-Sep				400			
08-Sep		1.1	5		0.003	<1	0.4
08-Sep				15			
15-Sep			5		0.004	<1	0.2
15-Sep							
Count	1	5	6	5	6	1	6
Min	0.02	0.5	5	1	0.003	1	0.2
Max	0.02	3.3	20	400	0.008	1	0.7
Std Dev	N/A	1.1	6	177	0.002	N/A	0.2
Average	0.0200	1.4	8	84	0.006	N/A	0.4
90th Percentile	N/A	N/A	N/A	246	N/A	N/A	N/A
FALL 2010							
13-Oct	0.075	3.8	15		0.003	3	1.1
13-Oct				4			
20-Oct		2.9	10		0.004	<1	0.2
20-Oct				3			
27-Oct				1			
27-Oct		1.4	10		0.003	2	0.9
03-Nov		1.7	5		0.002	1	0.5
03-Nov				1			
09-Nov				8			
09-Nov		3.5	30		0.005	4	1.9
Count	1	5	5	5	5	4	5
Min	0.075	1.4	5	1	0.002	1	0.2
Max	0.075	3.8	30	8	0.005	4	1.9
Std Dev	N/A	1.1	10	3	0.001	1	0.6
Average	N/A	2.7	14	3	0.003	3	0.9
90th Percentile	N/A	N/A	N/A	6	N/A	N/A	N/A

Shaded cells indicate exceedances of objectives.

The turbidity distribution data shows that 90% of the values were below 1 NTU, 98% of the values were below 5 NTU, and that about 2% of the time or about 88 of the 3,950 hours when turbidity was measured over the course of the study, turbidity values exceeded the maximum WQO of 5 NTU. Most turbidity events occurred in September (25%), October (27%) or November (27%). The longest turbidity event occurred in June following a substantial rainfall during the latter part of May (Figures 1 and 2). The only elevated turbidity event that did not correlate with rainfall occurred on July 12 and was most likely due to the work being carried out at the water intake by the District of Ucluelet between July 9 and 15 (Obee, 2012). The monthly average objective of 2 NTU was met in every month.

Continuous monitoring equipment was installed in May 3, 2010, but it should be noted that due to battery failure there was a large data gap from July 13 to August 10. Figure 1 shows the precipitation data during the sampling periods. These data support that several rain events may not have been captured by grab sampling. This emphasized the importance of collecting continuous data during an attainment monitoring period.

Dissolved aluminum was tested for once during each of the summer and fall grab sampling periods. Due to this insufficient sampling frequency, the results could not be compared to the average objective. The maximum value measured was 0.075 mg/L in the fall on October 13, 2010. If aluminum was to stay at this level there is potential for the average objective to be exceeded. As noted in the Mercantile Creek Community Watershed Technical Report (Phippen and Obee, 2012), the elevated concentrations of dissolved aluminum in Mercantile Creek are almost certainly a result of the natural geography of the area rather than any anthropogenic activities. Future sampling of dissolved metals should occur at the required frequency (5 weekly samples in 30 days) to allow comparison to the average objective.

Hardness can affect the toxicity of copper and some other metals and this relationship varies seasonally and between ecoregions (Phippen and Obee, 2012). Although there are no current provincial hardness objectives, to allow metals data to be compared to metals guidelines, it is recommended that hardness continues to be part of the monitoring program.

To protect Vancouver Island streams from potential aquatic life habitat decline and aesthetic issues from excess phosphorous during the algal growing season, BC MOE has developed phosphorus objectives for Vancouver Island: the total phosphorus objective is an average of 5 µg/L and a maximum of 10 µg/L based on monthly samples collected from May through September (BCMOE, *in press*). Though total phosphorous data were not collected in Mercantile Creek at the frequency required to compare to the Vancouver Island objective, the existing data were assessed in this report. Total phosphorus concentrations in Mercantile Creek ranged from 2 µg/L to a maximum of 8 µg/L for eight values during the summer months. These samples were not collected monthly, but do not suggest any potential phosphorous concerns in Mercantile Creek. The next attainment sampling period should include monthly samples for total phosphorous from May through September to confirm this initial observation.

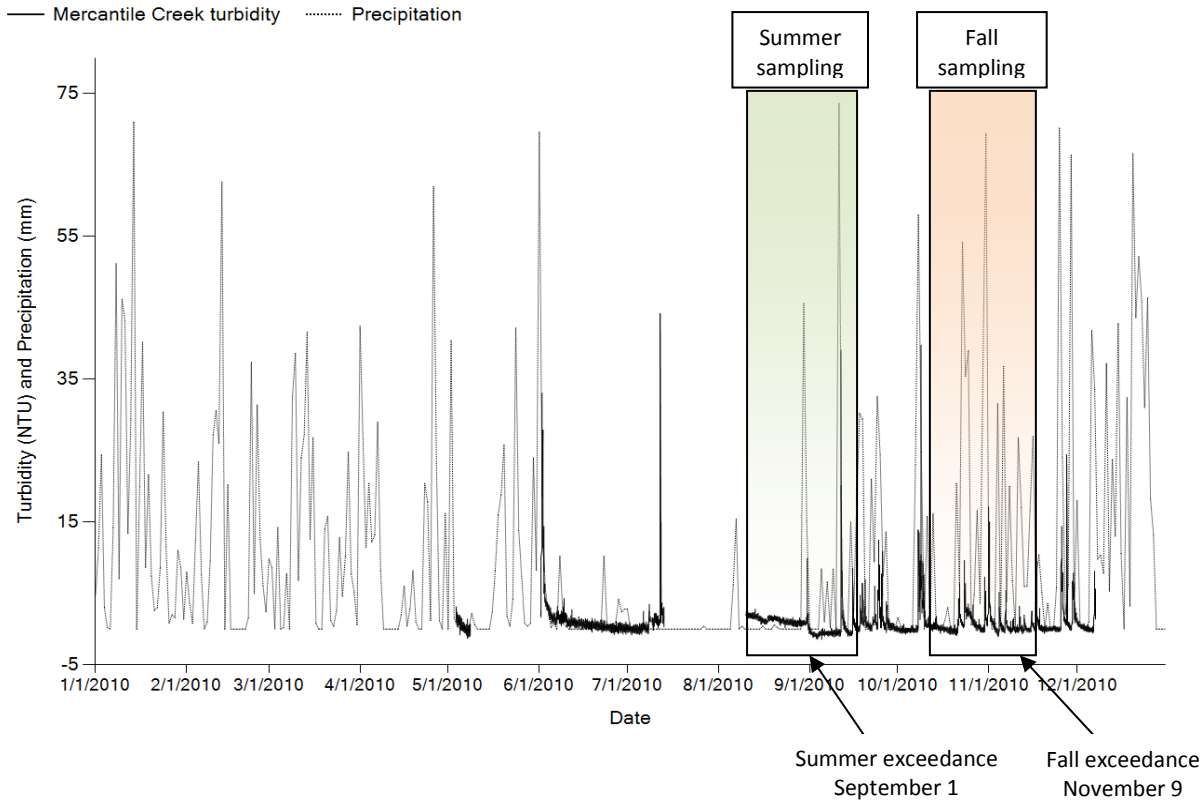

Figure 1: Turbidity measured by MOE's continuous water quality station and precipitation data as reported by Environment Canada at nearby Ucluelet Kennedy Camp (Environment Canada, 2015).

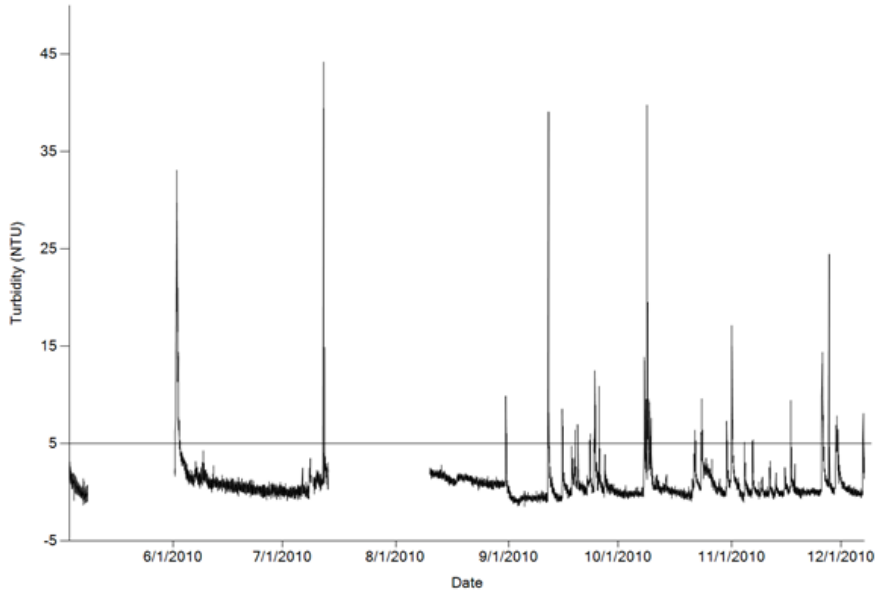

Figure 2: Turbidity levels in Mercantile Creek, May to December 2010. The horizontal line indicates the maximum water quality objective of 5 NTU.

Biological Monitoring

No biological objectives are currently approved for Mercantile Creek. However, benthic invertebrate community data have been introduced in the below discussion and should be considered when objectives are re-evaluated in the future.

Objectives development has traditionally focused on physical, chemical and bacteriological parameters. However, as aquatic life is typically the most sensitive use of water bodies, the inclusion of biological data into the overall objective development program is crucial. In partnership with Canada's national biomonitoring program (Canadian Aquatic Biomonitoring Network (CABIN)), benthic macroinvertebrates have been collected from British Columbia streams for bioassessment purposes for many years. Using this information, biological objectives have been developed for Vancouver Island as outlined in Gaber (2013). The biological objective development process is summarized in the following paragraph:
Using a network of 102 minimally impacted (reference) streams on Vancouver Island and Gwaii Haanas National Park, ecologically-based numerical benchmarks were created by calculating the similarity of the benthic macroinvertebrate community of these sites to each other using the Bray-Curtis Coefficient (BCC). BCC is an ecological distance metric with values of 0 representing complete difference from the reference community and values of 100 representing a community identical to the reference community. By measuring the similarity of a test site to the 102 reference sites, its BCC score can be calculated, indicating its position relative to the ecological benchmarks. These ecological benchmarks were set as the 1st, 10th, and 20th percentiles (a score of 15.2, 23.8, and 27.3, respectively) of the distribution of BCC scores for the 102 reference streams. The 20th percentile score is recommended as the biological objective for Vancouver Island (*i.e.* a stream must have a score of 27.3 or greater to meet the objective), with values between the 20th and the 10th percentile score indicating further investigation required, and values between the 10th and the 1st percentile score indicating that activities adversely affecting stream conditions should cease. It is also recommended that, when a test site's BCC score does not meet the Vancouver Island biological objective, year over year scores should be increasing, indicating an improvement in the condition of that stream (Gaber, 2013).

At the Mercantile Creek site, benthic invertebrate samples were collected on September 21, 2006, August 20, 2009 and September 15, 2010. Only the BCC score for September 15, 2010 was calculated and its interpretation regarding invertebrate community health is a BCC score of 37.2. This is greater than the 20th percentile of 27.3 and thus met the biological objective for Vancouver Island. There are no concerns in the benthic invertebrate data at this time and no objective update is proposed, but biological objectives should be evaluated for Mercantile Creek in the future.

Summary and Recommendations

Results show that for the majority of the sampling period water quality was good in Mercantile Creek. Most of the WQO were consistently met. Higher *E coli* and true colour values associated with rainfall events are likely natural and represent background conditions as little to no human activity was present in the watershed when attainment monitoring took place.

The maximum turbidity objective was exceeded during the fall and winter months, but the average turbidity objective was consistently met. Turbidity was usually elevated following precipitation events, and based on the precipitation data it is likely that additional turbidity events occurred during the months when turbidity data were not collected. To support the interpretation of the attainment grab sample results, it is recommended that continuous water quality equipment be deployed at this site during the next attainment monitoring period, and that it be run for an entire year to adequately capture a full winter season.

For best representation of summer low flow events, it is recommended to complete summer low flow sampling by mid-August, and to assess the long range forecast to capture the first flush event of the fall.

Currently, no objective has been proposed for phosphorus in Mercantile Creek. During the next attainment monitoring period, total phosphorous samples should be collected monthly from May through September, and the need for a phosphorous objective for Mercantile Creek should be evaluated.

No biological objectives are currently proposed in Mercantile Creek and there are no concerns in the benthic invertebrate data in Mercantile Creek at this time. Biological data should be considered relative the Vancouver Island biological objectives when Mercantile Creek WQO are re-evaluated in the future.

References

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Appendix I

Table 4: Summary of 2006-2010 general chemistry water grab sample statistics taken at Mercantile Creek EMS Site E230257 near the District of Ucluelet water intake.

Parameter	Min	Max	Average	Std Dev	Count
MICROBIAL					
***E Coli* (CFU/100mL)**	1	400	44	125	10
Coli:Fec (CFU/100mL)	1	510	58	159	10
GENERAL					
Amonia Dissolved (mg/L)	<0.005	<0.005	N/A	N/A	2
Amonia:T (mg/L)	0	0	N/A	N/A	1
Carbon Dissolved Organic (mg/L)	0.5	3.5	1.7	1.0	11
Carbon Total Organic (mg/L)	0.5	3.8	2.0	1.3	12
Chlorophyll A (g/m2)	1.1	1.4	1.3	0.2	3
Color True (Col.unit)	5	30	10	8	13
Hardness (Dissolved) (mg/L)	10.9	22.3	16.6	8.1	2
Hardness Total (T) (mg/L)	10.5	23.6	18.3	6.0	4
N.Kjel:T (mg/L)	0.06	0.11	0.09	0.04	2
NO2+NO3 (mg/L)	0.12	0.25	0.19	0.09	2
Nitrate (NO3) Dissolved (mg/L)	0.091	0.421	0.174	0.121	7
Nitrate + Nitrite Diss. (mg/L)	0.091	0.424	0.175	0.122	7
Nitrogen (Kjel.) Tot Diss (mg/L)	0.05	0.05	0.05	0.00	1
Nitrogen - Nitrite Diss. (mg/L)	<0.002	0.003	0.002	0.000	7
Nitrogen Organic-Total (mg/L)	0.05	0.06	0.06	0.01	2
Nitrogen Total (mg/L)	0.18	0.47	0.34	0.15	3
Nitrogen Total Dissolved (mg/L)	0.474	0.474	0.474	0.000	1
Ortho-Phosphate Dissolved (mg/L)	0.002	0.004	0.003	0.001	4
P--T (mg/L)	<0.002	0.008	0.004	0.002	15
Phosphorus Tot. Dissolved (mg/L)	0.003	0.005	0.004	0.001	2
Res:Tot (mg/L)	<43	<49	N/A	N/A	2
Residue Filterable 1.0u (mg/L)	42	48	45	4	2
Residue Non-filterable (mg/L)	<1	5	2	1	14
Specific Conductance (uS/cm)	28	67	47	15	5
Turbidity (NTU)	0.2	2.6	0.7	0.7	15
pH (pH units)	6.97	7.8	7.32	0.23	10
METALS/SEMI-METALS					
Ag-D (mg/L)	<0.000005	<0.000005	N/A	N/A	2
Ag-T (mg/L)	<0.000005	<0.00002	N/A	N/A	5
Al-D (mg/L)	0.02	0.075	0.048	0.039	2
Al-T (mg/L)	0.0188	0.104	0.051	0.039	5
As-D (mg/L)	0.00045	0.00071	0.00058	0.00018	2

Parameter	Min	Max	Average	Std Dev	Count
As-T (mg/L)	0.0005	0.00089	0.00065	0.00016	5
B--D (mg/L)	<0.05	<0.05	N/A	N/A	2
B--T (mg/L)	<0.05	<0.05	N/A	N/A	4
Ba-D (mg/L)	0.00159	0.00277	0.00218	0.00083	2
Ba-T (mg/L)	0.00173	0.00275	0.00204	0.00042	5
Be-D (mg/L)	<0.00001	0.00001	N/A	0.00000	2
Be-T (mg/L)	<0.00001	<0.00002	N/A	N/A	5
Bi-D (mg/L)	<0.000005	<0.000005	N/A	N/A	2
Bi-T (mg/L)	<0.000005	<0.00002	N/A	N/A	5
Ca-D (mg/L)	3.22	6.97	5.10	2.65	2
Ca-T (mg/L)	3.11	7.61	5.73	2.04	4
Cd-D (mg/L)	<0.000005	0.000068	0.000037	0.000045	2
Cd-T (mg/L)	<0.000005	0.000079	0.000021	0.000033	5
Co-D (mg/L)	0.000021	0.000023	0.000022	0.000001	2
Co-T (mg/L)	0.00001	0.000044	0.000023	0.000015	5
Cr-D (mg/L)	<0.0001	<0.0001	N/A	N/A	2
Cr-T (mg/L)	<0.0001	<0.0002	0.00012	0.00004	5
Cu-D (mg/L)	0.00015	0.00043	0.00029	0.00020	2
Cu-T (mg/L)	0.00014	0.00053	0.00029	0.00016	5
Li-D (mg/L)	0.0005	0.0005	0.0005	0.0000	2
Li-T (mg/L)	0.00021	<0.0005	0.00044	0.00013	5
Mg-D (mg/L)	0.7	1.2	1.0	0.4	2
Mg-T (mg/L)	0.66	1.16	0.96	0.23	4
Mn-D (mg/L)	0.00116	0.00782	0.00449	0.00471	2
Mn-T (mg/L)	0.00056	0.00924	0.00330	0.00368	5
Mo-D (mg/L)	0.00006	0.00026	0.00016	0.00014	2
Mo-T (mg/L)	0.00005	0.00031	0.00017	0.00011	5
Ni-D (mg/L)	0.00003	0.00006	0.00005	0.00002	2
Ni-T (mg/L)	0.00002	0.00008	0.00005	0.00002	5
Pb-D (mg/L)	0.000006	0.000026	0.000016	0.000014	2
Pb-T (mg/L)	0.000008	0.000157	0.000057	0.000061	5
Sb-D (mg/L)	<0.00002	0.00002	0.00002	0.00000	2
Sb-T (mg/L)	0.000007	0.00004	0.00002	0.00001	5
Se-D (mg/L)	<0.00004	0.00005	0.00005	0.00001	2
Se-T (mg/L)	0.00004	<0.0002	0.00008	0.00007	5
Sn-D (mg/L)	<0.00001	<0.00001	N/A	N/A	2
Sn-T (mg/L)	<0.00001	<0.00001	N/A	N/A	5
Sr-D (mg/L)	0.0162	0.0326	0.0244	0.0116	2
Sr-T (mg/L)	0.0161	0.0327	0.0246	0.0072	5
Tl-D (mg/L)	0.000002	0.000002	0.000002	0.000000	2
Tl-T (mg/L)	<0.000002	0.000007	0.000003	0.000002	5

Parameter	Min	Max	Average	Std Dev	Count
U--D (mg/L)	<0.000002	0.000006	0.000004	0.000003	2
U--T (mg/L)	<0.000002	0.000015	0.000010	0.000005	5
V--D (mg/L)	0.0002	0.0006	0.0004	0.0003	2
V--T (mg/L)	<0.0002	0.0006	0.0004	0.0002	5
Zn-D (mg/L)	<0.0001	0.0002	0.0002	0.0001	2
Zn-T (mg/L)	<0.0001	0.0016	0.0006	0.0006	5