McKelvie Creek Community Watershed
Water Quality Objectives Attainment Report

Environmental Quality Section
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Approved by _____

Date Approved _____

Executive Summary

Water Quality Objectives (WQOs) were approved for McKelvie Creek in 2007 (Epps and Phippen, 2007) based on data collected from 2001 to 2004. The McKelvie Creek watershed is the source of drinking water for the community of Tahsis. WQO attainment monitoring occurred during summer low flow and fall flush periods in 2009, while continuous data collection occurred from August 2009 to May 2010. Grab samples were collected in August 2008 as part of the Ministry of Environment's (MOE's) benthic invertebrate sampling program. Water quality data from 2005 to May 2010 and changes that have occurred in the watershed between 2005 and 2012 are presented in this report. Data showed that water quality objectives for fecal coliforms, *Escherichia coli*, true colour and total organic carbon were exceeded during the summer 2009 sampling. During the fall 2009 sampling turbidity objectives were exceeded. The higher values leading to objective exceedences coincided with rainfall events. It is recommended that, to assist in assessing water quality, continuous water quality monitoring be conducted during the next attainment sampling 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.

Introduction

As part of the Province of British Columbia MOE's mandate to manage water bodies, water quality objective 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 water quality objectives 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 McKelvie Creek watershed is the source of drinking water for the community of Tahsis, British Columbia, located on the west coast of Vancouver Island (Figure 1). WQOs were approved for McKelvie Creek in 2007, based on data collected between 2001 and 2004. Some data collection occurred in this watershed between 2005 and 2008, and attainment monitoring occurred from August to November 2009. In addition, continuous water quality data was collected from August 2009 to May 2010. This report summarizes all data collected from 2005 to 2010.

Figure 1. Map of McKelvie Creek indicating sample site E230718.

Changes in the Watershed since Objectives Development

The following notable activities have occurred in the watershed since 2005:
Synex International Inc. has acquired a water license in order to install a clean energy project in the creek. The proposed clean energy project will be located approximately 50 meters upstream of the Village of Tahsis' existing water intake (Baldwin, pers comm. 2012). The project is still under development, with no installations taking place in the watershed as of November 2012. However, a portion of an existing road which enables access to the proposed project site has been widened in preparation for the project. Furthermore a log jam adjacent to where the proposed intake would be located was blasted with dynamite in an attempt to remove it. This occurred in August 2008, prior to attainment monitoring. When the log jam was removed, a sediment wedge was transported downstream and filled the Village intake reservoir (i.e. area behind the dam). This sediment had to be removed with heavy equipment. There was concern about future sediment deposition at the community water intake as a result of the clean energy project.

Sampling and Analytical Methods

For attainment monitoring, one water quality site was sampled during summer low flow, August 10 to September 8, and during fall flush, October 13 to November 9, 2009, following recommendations in the WQOs report (Table 1). During both sampling periods five weekly samples were collected over 30 days (5-in-30 sampling) to calculate 30-day averages and 90th percentiles. Samples were collected by the Village of Tahsis. A sixth turbidity grab sample was collected on November 16, 2009 by MOE staff and compared with continuous WQ data for quality assurance and quality control (QA/QC) purposes. Benthic invertebrate sampling by MOE staff took place on August 19, 2008, as per Canadian Aquatic Biomonitoring Network protocols; however, only the water quality data (not benthic invertebrate data) from this sampling are presented in this report. Samples were analyzed by Maxxam Analytics in Burnaby B.C. with the exception of bacteriological analysis which was completed by Cantest Laboratories. Continuous water quality data (recorded every 15 minutes) using a YSI 600 OMS Sonde were collected by MOE staff from August 2009 to May 2010 to assist in the interpretation of attainment grab sampling that was conducted in 2009. These data are summarized in a separate assessment report available through the Ministry of Environment, Nanaimo, B.C. (Obee, 2012). Monthly grab samples were collected from February to June 2005 as part of the original WQO development dataset but were not included in the 2007 WQOs report; therefore, the samples are included in this WQO attainment report. All grab sample data are summarized in the Appendix.

Table 1. Water quality sampling program as recommended in the 2007 WQO report.

Site Name	EMS ID	Parameters measured	Description
McKelvie Creek at the main water intake	E230718	Turbidity, true colour, total suspended solids, total organic carbon, dissolved organic carbon, specific conductivity, temperature, *E. coli*, fecal coliform, total and dissolved metals, nutrients, and pH	Upstream from the main water intake near the dam

Objectives Attainment

A list of the water quality objectives for McKelvie 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 exceed the McKelvie Creek water quality objectives will be discussed in this report.

Table 2. Water quality objective and attainment information. "Y" indicates objectives were met, "N" indicates objectives were not met.

Parameter	Objective*	McKelvie Creek Summer 2009	McKelvie Creek Fall 2009
Fecal Coliform Bacteria	≤ 60 CFU/100 ml (90th percentile)	N	Y
Escherichia coli	≤ 60 CFU/100 ml (90th percentile)	N	Y
Turbidity	2 NTU (average)	Y	N
	5 NTU (maximum)	Y	N
True Colour	15 TCU (maximum)	N	Y
Total Suspended Solids	25 mg/L (maximum in a 24-hour period)	Y	Y
	5 mg/L (average)	Y	Y
Total Organic Carbon	4.0 mg/L (maximum)	N	Y

*all calculations for 90th percentiles and averages are based on 5-in-30 sampling

During the summer low flow sampling period bacteriological, true colour, and total organic carbon objectives were not met, while in the fall objectives were met for all parameters except turbidity.

The summer exceedences are primarily due to a rain event which produced 31.4 mm of precipitation on August 10, 2009 (Environment Canada, 2012) and acted as a first flush event after the dryer summer season. On this date all parameters were elevated, while the remaining four sample dates had very low results (Table 3). If the summer low flow samples were collected prior to the rain event, it is likely that no exceedances would have occurred.

Grab samples taken as part of other projects in 2008 had turbidity, true color, TSS and TOC values well below the maximum instantaneous water quality objectives, and as such were not included in the tables.

Table 3. Attainment monitoring grab sample results showing parameters in exceedence of WQOs for the McKelvie Creek sample site. Highlighted values indicate exceedence. * indicates value was considered representative of fall flush conditions and was included in average calculations (based on 6 samples in 34 days). "–"indicates date where no data were collected.

Sampling Date	Fecal coliform (CFU/100mL)	*E Coli* (CFU/100mL)	True Color (Col.unit)	Total Organic Carbon (mg/L)	Turbidity (NTU)
Summer					
2009-08-10	610	430	20	5.4	1.4
2009-08-16	1	1	< 5	0.5	0.5
2009-08-24	3	2	5	0.5	0.5
2009-08-31	2	1	-	-	-
2009-09-02	-	-	5	0.5	0.1
2009-09-08	9	9	5	1	0.4
2009-09-15	-	-	20	114	-
90th percentile	369.6	261.6	°	°	°
average	125	88.6	10	20	0.6
max	610	430	20	114	1.4
Fall					
2009-10-13	5	5	5	0.5	0.3
2009-10-20	2	1	5	0.5	0.3
2009-10-26	6	4	15	2	0.3
2009-11-02	10	10	15	1.3	3.5
2009-11-09	6	6	15	2.2	5.5
2009-11-16	-	-	-	-	*4.4
90th percentile	9	5	°	°	°
average	6	3	11	1.3	2.4
max	10	10	15	2.2	5.5

Both the continuous sampling and fall grab sampling started slightly after the fall rains had begun (Environment Canada, 2012). It should be noted that, even though the continuous monitoring equipment was installed in August 2009, due to operational error and battery failure there were two large data gaps: September 16 to October 13, 2009 and October 29 to November 9, 2009. The November 16th turbidity sample, collected for QA/QC comparison to continuous water quality data, captured a rain event and was included in the calculation of a 6 samples in 34 days fall flush average (2.4 NTU). Though this is not a 5 in 30 average the 34 day period accurately reflected site conditions at the time and was considered relative to objective recommendations, which it exceeded. For the same 34 day period as fall grab samples were taken, the average turbidity from the continuous data (with the exception of the missing data from October 29 to November 9, 2012) was 2.1 NTU, also exceeding the average turbidity objective. While the turbidity grab sample and continuous data averages were very similar, maximum turbidity during fall flush grab samples exceeded guidelines measuring 5.0 NTU on November 9, 2009 (Table3), and the maximum value measured by the continuous equipment

was 208.8 NTU during the same time period (Figure 2). Turbidity events generally followed immediately after rain events (Obee, 2012, Environment Canada, 2012). When comparing the grab sample data with continuous monitoring data it is seen that the grab samples collected did not capture several large turbidity events (Figure 2).

Higher 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.

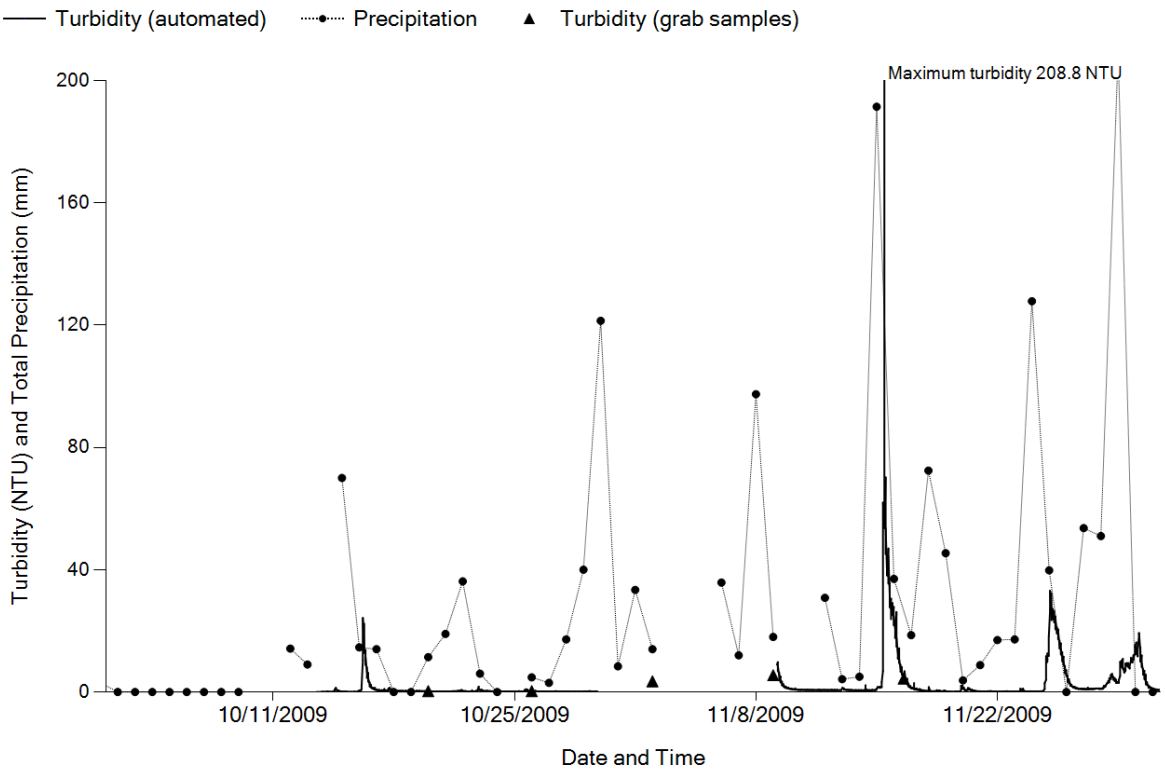

Figure 2. McKelvie Creek fall flush 2009 turbidity data (grab and continuous samples).

Summary and Recommendations

Results show that water quality in McKelvie Creek was good during the 2009 attainment monitoring. As the observed exceedences coincided with rainfall events and few anthropogenic impacts currently exist in this watershed, the exceedences were likely a result of natural conditions. As long as the exceedances are minor and infrequent there should be no concerns and additional investigation is not warranted. It is recommended that during the next attainment monitoring program continuous water quality monitoring should coincide with grab sampling to assist in the assessment of water quality. Large persistent rain events often occur earlier in the late summer and early fall in northern and west coast regions of Vancouver Island compared with southern and east coast regions. These early rain storms can flush sediment and

contaminants into the creek, especially if they occur after an extended dry period. As such, it is recommended that the summer low-flow sampling be completed by mid-August, and that the start of the fall sampling be determined by analyzing the long-range weather forecast and choosing the first period where significant and persistent rain is predicted for that year. This will help ensure the summer low flow and fall flush events are captured in grab samples during the 5-in-30 attainment sampling. Fall flush grab sampling should also coincide with rainstorm events to try and capture some of the larger turbidity events as seen in the continuous data.

References

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Obee, N. 2012. Assessment of continuous water quality data for McKelvie Creek, August 2009 to May 2010. British Columbia Ministry of Environment. Nanaimo, B.C.

Appendix

Table 4. Summary statistics for grab samples taken at the McKelvie Creek sample site from February 2005 to November 2011. Shaded cells indicate values below minimum detection limits.

Location Name	E230718 McKELVIE CREEK AT MAIN WATER INTAKE				
Parameter	Min	Max	Average	Standard Deviation	Number of Samples
Ag-D (mg/L)	0.000005	0.000005	0.000005		1
Ag-T (mg/L)	0.000005	0.000005	0.000005	0	3
Al-D (mg/L)	0.0508	0.0508	0.0508		1
Al-T (mg/L)	0.0105	0.0889	0.0554	0.040424	3
As-D (mg/L)	0.00003	0.00003	0.00003		1
As-T (mg/L)	0.00004	0.00005	4.33E-05	5.77E-06	3
B--D (mg/L)	0.05	0.05	0.05		1
B--T (mg/L)	0.05	0.05	0.05	8.5E-18	3
Ba-D (mg/L)	0.00027	0.00027	0.00027		1
Ba-T (mg/L)	0.00007	0.00031	0.000217	0.000129	3
Be-D (mg/L)	0.00001	0.00001	0.00001		1
Be-T (mg/L)	0.00001	0.00001	0.00001	0	3
Bi-D (mg/L)	0.000005	0.000005	0.000005		1
Bi-T (mg/L)	0.000005	0.000005	0.000005	0	3
Ca-D (mg/L)	3.43	3.43	3.43		1
Ca-T (mg/L)	2.77	3.53	3.216667	0.397157	3
Cd-D (mg/L)	0.000021	0.000021	0.000021		1
Cd-T (mg/L)	0.000005	0.000026	0.000018	1.14E-05	3
Co-D (mg/L)	0.000039	0.000039	0.000039		1
Co-T (mg/L)	0.000006	0.000064	0.00004	3.03E-05	3
Cr-D (mg/L)	0.0001	0.0001	0.0001		1
Cr-T (mg/L)	0.0001	0.0002	0.000167	5.77E-05	3
Cu-D (mg/L)	0.00444	0.00444	0.00444		1
Cu-T (mg/L)	0.00022	0.00454	0.001983	0.002267	3
Fe-T (mg/L)	0.004	0.004	0.004		1
Li-D (mg/L)	0.0007	0.0007	0.0007		1
Li-T (mg/L)	0.0005	0.0006	0.000533	5.77E-05	3
Mg-D (mg/L)	0.69	0.69	0.69		1
Mg-T (mg/L)	0.58	0.72	0.65	0.07	3
Mn-D (mg/L)	0.00166	0.00166	0.00166		1
Mn-T (mg/L)	0.00013	0.00343	0.001577	0.001687	3
Mo-D (mg/L)	0.00005	0.00005	0.00005		1
Mo-T (mg/L)	0.00005	0.00005	0.00005	0	3

Location Name	E230718 McKELVIE CREEK AT MAIN WATER INTAKE				
Parameter	Min	Max	Average	StdDev	Number of Samples
N.Kjel:T (mg/L)	0.02	0.04	0.03	0.014142	2
NO2+NO3 (mg/L)	0.03	0.1	0.065	0.049497	2
Ni-D (mg/L)	0.00045	0.00045	0.00045		1
Ni-T (mg/L)	0.00003	0.00093	0.0004	0.000471	3
P--T (mg/L)	0.002	0.006	0.004	0.002828	2
Pb-D (mg/L)	0.000083	0.000083	0.000083		1
Pb-T (mg/L)	0.000005	0.000117	0.000068	5.73E-05	3
Sb-D (mg/L)	0.00002	0.00002	0.00002		1
Sb-T (mg/L)	0.00002	0.00002	0.00002	0	3
Se-D (mg/L)	0.00004	0.00004	0.00004		1
Se-T (mg/L)	0.00004	0.00005	4.33E-05	5.77E-06	3
Si-T (mg/L)	1.97	1.97	1.97		1
Sn-D (mg/L)	0.00019	0.00019	0.00019		1
Sn-T (mg/L)	0.00001	0.00022	0.000103	0.000107	3
Sr-D (mg/L)	0.00711	0.00711	0.00711		1
Sr-T (mg/L)	0.00592	0.00724	0.00667	0.000678	3
Ti-T (mg/L)	0.0005	0.0005	0.0005		1
Tl-D (mg/L)	0.000002	0.000002	0.000002		1
Tl-T (mg/L)	0.000002	0.000002	0.000002	0	3
U--D (mg/L)	0.000002	0.000002	0.000002		1
U--T (mg/L)	0.000002	0.000002	0.000002	0	3
V--D (mg/L)	0.0004	0.0004	0.0004		1
V--T (mg/L)	0.0004	0.0005	0.000433	5.77E-05	3
Zn-D (mg/L)	0.0067	0.0067	0.0067		1
Zn-T (mg/L)	0.0002	0.0082	0.004467	0.004027	3
pH (pH units)	7.4	7.5	7.45	0.070711	2
Ammonia Dissolved (mg/L)	0.005	0.005	0.005	0	2
Ammonia: Total (mg/L)	0	0	0		1
Carbon Dissolved Organic (mg/L)	0.5	5.2	1.7	1.526434	9
Carbon Total Organic (mg/L)	0.5	114	11.67273	33.96934	11
Chlorophyll A (g/m2)	0.3	4.3	1.9	2.116601	3
True Color (Col.unit)	5	20	10.45455	6.501748	11
E. Coli (CFU/100mL)	1	430	46.9	134.6472	10
Fecal coliform (CFU/100mL)	1	610	65.4	191.3764	10
Hardness Total (D) (mg/L)	11.4	11.4	11.4		1
Hardness Total (T) (mg/L)	9.3	11.49111	10.73037	1.239574	3

Location Name	E230718 McKELVIE CREEK AT MAIN WATER INTAKE				
Parameter	Min	Max	Average	Standard Deviation	Number of Samples
Nitrate (NO3) Dissolved (mg/L)	0.044	0.106	0.075	0.043841	2
Nitrate + Nitrite Diss. (mg/L)	0.044	0.106	0.075	0.043841	2
Nitrogen - Nitrite Diss. (mg/L)	0.002	0.002	0.002	0	2
Nitrogen Organic-Total (mg/L)	0.02	0.04	0.03	0.014142	2
Nitrogen Total (mg/L)	0.05	0.14	0.095	0.06364	2
Ortho-Phosphate Dissolved (mg/L)	0.001	0.002	0.0015	0.000707	2
Residue Total (mg/L)	23	29	26	4.242641	2
Filterable Residue 1.0u (mg/L)	22	28	25	4.242641	2
Non-filterable Residue (mg/L)	1	7	1.909091	2.071451	11
Specific Conductance (uS/cm)	19	28	23.33333	4.50925	3
Turbidity (NTU)	0.1	5.5	1.466667	1.886475	12