

**APPENDIX E**

**FECAL COLIFORM SAMPLING QUALITY  
ASSURANCE AND QUALITY CONTROL  
PROGRAM – 2007**

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## APPENDIX D

### FECAL COLIFORM SAMPLING QUALITY ASSURANCE AND QUALITY CONTROL PROGRAM – 2007

#### 1.0 INTRODUCTION

Quality assurance and quality control (QA/QC) programs are a set of protocols that are adopted to ensure that the results of any study are valid, internally consistent and comparable with other similar projects. These protocols are set out in writing and are based on the most current and relevant research on the related topics. This appendix discusses:

- field sampling methods
- sample handling procedures
- analytical procedures
- field and laboratory replication (quality control)
- data assessment

The data collected for the QA program are used to ensure consistency in field handling and analytical methods. If the data exceed a specified precision criterion then the lab is notified of a potential problem in the procedure and steps are taken to resolve the issue. The QA protocols presented in this appendix are based on two CRD memorandums (Drinnan, 1995 and Hutcheson, 1995).

#### 2.0 METHODS FOR FECAL COLIFORM SAMPLING AND ANALYSIS

All water samples were collected in 500 mL wide-mouth disposable bottles containing 1.5 mL of sodium thiosulphate. Bottles were supplied by Cantest Ltd. in Victoria, BC. Labelled samples were stored in an insulated cooler with ice packs and delivered the same day to the laboratory. Samples were analyzed for fecal coliform bacteria following the procedures in Standard Methods (APHA, 1998) and reported as colony forming units/100 mL (CFU/100 mL). However, to assist the reader, the more commonly used reporting of fecal coliform per 100 millilitres (FC/100 mL) is used in this survey.

Care was taken to ensure that the weather on sampling days were representative of the sampling season (wet or dry). Conditions such as "first flush", major storms or any other effect that might tend to prejudice the results were avoided.

##### 2.1 Stormwater Discharge Sampling

Where possible, stormwater discharge samples were collected from the point of discharge. Where this was not possible, the watercourse was followed upstream to the nearest point where the sample could be taken. Care was taken to avoid contamination of the sample with substances that did not originate in the stormwater (e.g. salt water, other discharges) that may confuse the results.

##### 2.2 Nearshore Surface Water Sampling

Nearshore surface water samples were collected by boat at 28 sites in Esquimalt Lagoon, Esquimalt Harbour, Victoria Harbour, the Gorge and Selkirk waters and Portage Inlet. All sites were sampled in 2007, where tides permitted, during wet and dry weather conditions. Subsurface samples were collected by rapidly submerging an inverted 500 mL sample bottle to a depth of approximately 200 mm and then allowing the bottle to fill.

## 2.3 Quality Assurance

### 2.3.1 Stormwater Sample Replicates (Field Splits)

Ten per cent of the samples collected were replicated in the field and identified as "field splits". A single sample was collected in a 500 mL sample bottle and inverted 30 times to ensure that the sample was well-mixed. The sample was then split evenly into two separate sample bottles. The two bottles were labeled and sent to Cantest Ltd. for analysis. These samples were submitted to the laboratory as blind samples (not identified as field splits).

### 2.3.2 Quality Control Assessment

In 2007, 18 field splits were collected from six stormwater discharges in the core area of the CRD and analyzed for fecal coliform levels. These field splits were used to establish the 2007 precision criteria (Section 2.3.4) for the CRD core area, Salt Spring Island Electoral Area, District of Sooke and Juan de Fuca Electoral Area sampling programs. The discharges were chosen based on previously identified high, moderate or low levels of fecal coliform concentrations (two discharges sampled for each category) to represent the varying fecal coliform counts that would be analyzed. Three individual 500 mL grab samples were collected at each of the six stations and split into two replicate sample bottles. Three blank samples of potable water were also collected in 500 mL sample bottles as part of the assessment. All samples were submitted with unique identifying numbers to Cantest Ltd.

### 2.3.3 Calculation of Quality Assurance Results

Laboratory precision for fecal coliform analysis (e.g., a measure of consistency by the lab) is determined by analyzing 18 pairs of field samples (field splits). The following, taken from Standard Methods, 18th edition (APHA, 1998), explains the procedure for calculating the precision criteria and determining whether the log ranges for the field splits are "acceptable" or "unacceptable":

- The data are arranged in pairs ( $D_1$  and  $D_2$ ). The log of each field measurement is determined ( $L_1$ ,  $L_2$ ) and the difference (range) in the log value between each pair of field splits is calculated:  $R = (L_2 - L_1)$ . An average range (Mean-R) is then determined for all of the pairs.
- The precision criterion is calculated by multiplying the Mean-R by 3.27 and is rounded to one decimal place.
- The log range (R) is calculated for each of the field splits and compared to the precision criterion, to determine whether the sample is acceptable or not, according to the following criteria:

Acceptable (A) - If the calculation is less than the precision criterion, then the field data are within normal variability.

Unacceptable (U) - If the calculation is greater than the precision criterion, then the field data are outside of the normal variability. All data collected after the last "acceptable" set of data should be discarded and no further analysis should be done until the source of the problem is identified by the lab.

It is important not to put too severe an interpretation on the results from the QA calculation, especially when they are close to the "unacceptable" guideline. Each result represents a value within a 95% confidence interval, which gets proportionately larger as the actual result gets smaller. Therefore, one can expect, through randomness, 5% of the samples to be outside of the precision criterion. Also, any fecal coliform count under 200 FC/100 mL is considered too small an amount to accurately calculate or compare to a precision criterion (APHA, 1998). It is also important to note that discharges with fecal coliform counts lower than 200 FC/100 mL receive a low public health concern rating.

The results should be rounded to one decimal place and compared to the precision criterion (e.g., 0.3). If the calculated value from the duplicate results still exceeds the criterion (e.g., 0.35 or greater) then an informal investigation of the laboratory should be initiated. If only a few duplicates are unacceptable (e.g., one out of every 20 pairs of duplicates) the lab is probably meeting the guideline.

The overall process is intended to act as an "alarm", alerting the study group to potential problems with the sampling and analytical procedures. As part of the review, the following elements are considered:

- the number of pairs exceeding the criterion
- the actual fecal coliform value of the pairs of data
- field notes on the "field split" procedure
- comments from the laboratory

### **3.0 RESULTS**

#### **3.1 Quality Assurance Results**

For the 2007 QA programs, 18 pairs of stormwater samples were collected in January of each year from six discharges having high, moderate or low levels of fecal coliform bacteria. The samples were sent to the lab for analysis of the fecal coliform concentration and the data used to calculate the precision criteria.

##### **3.1.1 Blanks**

In 2007, three blank samples (Greater Victoria tap water) were submitted to Cantest Ltd. along with the field samples. All blanks were reported as having <10 FC/100 mL. Therefore, the results meet the QA requirements.

##### **3.1.2 Precision Criteria**

Table 1 shows the lab results of the 18 pairs of samples used to determine the precision criteria for 2007 stormwater monitoring program. The calculated precision criterion for this laboratory, using these 18 sets of duplicates, was 0.42923. For comparison with subsequent field replicates this result was rounded to 0.4.

##### **3.1.3 Field Splits**

###### Wet Weather Sampling

Table 2 presents the results for the field splits collected in the core area during the wet period (February) of the 2007 stormwater sampling programs. Data were compared to the precision criteria (0.4), as described in Section 3.1.2. Some of the field splits exceeded the precision criteria; however, the fecal coliform levels were below 200 FC/100 mL. Fecal coliform counts lower than 200 FC/100 mL are not expected to meet the precision criteria due to the small numbers (refer to Section 2.3.4). Also, one set of field splits exceeded the criteria and were not below the 200 FC/100 mL. It is possible, due to randomness, that 5% of the samples will exceed the precision criteria. Therefore, the results meet the QA requirements.

###### Dry Weather Sampling

Table 3 presents the results for the field splits collected in the core area during the dry period (September) of the 2007 stormwater sampling programs. Data were compared to the precision criteria of 0.4, as described in Section 3.1.2; however, the fecal coliform levels were below 200 FC/100 mL. Fecal coliform counts lower than 200 FC/100 mL are not expected to meet the precision criteria due to the small numbers (refer to Section 2.3.4). Therefore, the results meet the QA requirements.

**Table 1. Laboratory Quality Assurance Exercise Results for 2007**

CRD Data, Batch Samples: January 16 and 25, 2007						
Disch. No.	Pair No.	1 <sup>st</sup> Duplicate D1	2 <sup>nd</sup> Duplicate D2	Log D1 L1	Log D2 L2	Range of Logs (Rlog) (Log L1 - Log L2)
238	1	43000	40000	4.6335	4.6021	0.0314
	2	49000	48000	4.6902	4.6812	0.0090
	3	39000	28000	4.5911	4.4472	0.1439
245	4	63000	58000	4.7993	4.7634	0.0359
	5	130000	56000	5.1139	4.7482	0.3658
	6	68000	44000	4.8325	4.6435	0.1891
301	7	820	660	2.9138	2.8195	0.0943
	8	910	890	2.9590	2.9494	0.0097
	9	870	750	2.9395	2.8751	0.0645
320	10	5700	2400	3.7559	3.3802	0.3757
	11	5300	3200	3.7243	3.5051	0.2191
	12	3800	3400	3.5798	3.5315	0.0483
641	13	80	40	1.9031	1.6021	0.3010
	14	100	60	2.0000	1.7782	0.2218
	15	300	290	2.4771	2.4624	0.0147
777A	16	210	200	2.3222	2.3010	0.0212
	17	210	140	2.3222	2.1461	0.1761
	18	220	200	2.3424	2.3010	0.0414
Mean - R <sub>log</sub> (Sum R <sub>log</sub> /18)						0.1313
Precision Criterion (3.27 x Mean-R <sub>log</sub> )						<b>0.4292</b>

**Table 2. Laboratory Quality Assurance Results – Wet Period 2007**

Date	Discharge Number	Fecal Coliform Counts	Log	Log Range	Acceptable (A) or Unacceptable (U)
25-Jan-07	810	930	6.8352	0.1138	A
		830	6.7214		
27-Mar-07	222	4300	8.3664	0.0723	A
		4000	8.2940		
29-Jan-07	325	10	2.3026	2.3026	U <sup>1</sup>
		1	0.0000		
30-Jan-07	528	10	2.3026	2.3026	U <sup>1</sup>
		1	0.0000		
30-Jan-07	573	1	0.0000	0.0000	A
		1	0.0000		
22-Mar-07	627	13000	9.4727	0.0000	A
		13000	9.4727		
21-Mar-07	659	20	2.9957	0.0000	A
		20	2.9957		
6-Feb-07	689	120	4.7875	0.4055	A
		80	4.3820		
6-Feb-07	704	10	2.3026	2.3026	U <sup>1</sup>
		1	0.0000		
7-Feb-07	712B	1	0.0000	0.0000	A
		1	0.0000		
8-Feb-07	726	110	4.7005	1.0116	U <sup>1</sup>
		40	3.6889		
21-Mar-07	764	150	5.0106	1.3218	U <sup>1</sup>
		40	3.6889		
25-Jan-07	810	930	6.8352	0.1138	A
		830	6.7214		
23-Mar-07	854	7300	8.8956	0.0278	A
		7100	8.8679		
19-Apr-07	925	10	2.3026	2.3026	U <sup>1</sup>
		1	0.0000		

<sup>1</sup> Any fecal coliform count under 200 is considered too small an amount to calculate precision (APHA, 1992). However, any discharge with fecal coliform counts that are lower than 200 FC/100 mL receives a low rating for public health concern.

**Table 3. Laboratory Quality Assurance Results - Dry Period 2006**

Date	Discharge Number	Fecal Coliform Counts	Log	Log Range	Acceptable (A) or Unacceptable (U)
27-Sep-07	308A	2700000	14.8088	0.3001	A
		2000000	14.5087		
28-Aug-07	323	160	5.0752	0.0645	A
		150	5.0106		
26-Sep-07	325	20	2.9957	2.9957	U <sup>1</sup>
		1	0.0000		
26-Oct-07	308A	22000	9.9988	0.0000	A
		22000	9.9988		
26-Oct-07	310A	150000	11.9184	0.0000	A
		150000	11.9184		
13-Sep-07	550	50	3.9120	1.6094	U <sup>1</sup>
		10	2.3026		
19-Sep-07	589	250	5.5215	0.3857	A
		170	5.1358		
26-Sep-07	610	24000	10.0858	0.0870	A
		22000	9.9988		
10-Aug-07	636	22000	9.9988	0.0465	A
		21000	9.9523		
11-Sep-07	659	22000	9.9988	0.6931	U <sup>2</sup>
		11000	9.3057		
10-Sep-07	764	1	0.0000	0.0000	A
		1	0.0000		
26-Sep-07	873	10	2.3026	2.3026	A
		1	0.0000		
13-Sep-07	580	230	5.4381	0.3629	A
		160	5.0752		

<sup>1</sup> Any fecal coliform count under 200 is considered too small an amount to calculate precision (APHA, 1992). However, any discharge with fecal coliform counts that are lower than 200 FC/100 mL receives a low rating for public health concern.

<sup>2</sup> It is possible, due to randomness, that 5% of the samples may exceed the precision criteria.

#### 4.0 CONCLUSIONS

All requirements for the Core Area QA/QC program were carried out in 2007. All of the QA/QC results were acceptable for use to rate stormwater discharges for public health concern.

#### 5.0 REFERENCES

APHA, 1998. American Public Health Association, American Water Works Association, Water Pollution Control Federation, 20th Edition. Standard Methods for the Examination of Water and Wastewater.

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