

APPENDIX E

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

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FECAL COLIFORM SAMPLING QUALITY ASSURANCE
AND QUALITY CONTROL PROGRAM FOR 2006**

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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 Capital Regional District (CRD) memorandums (Drinnan, 1995; Hutcheson, 1995).

2.0 METHODS FOR FECAL COLIFORM SAMPLING

All water samples were collected in 250 mL wide-mouth polypropylene bottles supplied by the analytical laboratory (MB Laboratories Ltd. in Sidney). Bottles supplied by MB Laboratories Ltd. were washed, rinsed and autoclaved after each use and re-supplied to the CRD as needed. Labelled samples were stored in an insulated cooler with ice packs for protection from prolonged exposure to UV light and delivered the same day to the laboratory. Fecal coliform bacteria were analyzed following the procedures in Standard Methods (APHA, 1998) and reported by the lab as colony forming units per 100 mL (CFU/100 mL). However, to assist the reader the more commonly used reporting of fecal coliform per 100 milliliters (FC/100 mL) is used in this survey.

Care was taken to ensure that the weather on sampling days could be considered representative of the season. 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 storm drain line was followed back to the nearest point where the sample could be taken. A five metre inflatable boat was used to visit discharges located in areas difficult to access from the shore.

2.2 Quality Assurance

2.2.1 Stormwater Sample Replicates (Field Splits)

Ten per cent of the total number of samples was replicated and the field replicate samples are identified as field splits. A single sample was collected in a laboratory prepared one litre (1 L) 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 then labelled and sent to the lab for analysis as separate samples but not identified as field splits.

2.2.2 Quality Control Assessment

To establish the precision criteria (Section 2.3.4) for the field splits collected in 2007, 18 replicates (field splits) were analyzed for fecal coliform bacteria. These field splits were collected from six stormwater discharges on the Saanich Peninsula (the QA assessment was for the CRD Saanich Peninsula and Juan de Fuca and Southern Gulf Islands Electoral Area sampling programs). The discharges were chosen based on previous (on the Saanich Peninsula) 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. The QA sampling for the assessment was for all fecal coliform samples analyzed by MB Laboratories Ltd. For 2007 summer sampling, winter fecal coliform QA data was used. The three levels of fecal coliform concentrations were selected to represent the variance in the samples analyzed during the sampling program. Three individual grab samples were taken at each of the six stations and split into two replicate 250 mL sample bottles. Three blank samples of potable water were also collected in 250 mL sample bottles as part of the assessment. All samples were supplied to the lab with individual numbers.

2.2.3 Calculation of Quality Assurance Results

Laboratory precision for fecal coliform analysis (e.g., a measure of consistency by the lab) is determined by analyzing several pairs of field samples (field splits). The following procedure is from Standard Methods, 20th edition (APHA, 1998).

The data are arranged in pairs (D1 and D2). The log of each field measurement is determined (L1, L2) and the difference (range) in the log value between each pair of field splits is calculated: $R = (L2 - L1)$. 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 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 from six discharges having high, moderate or low levels of fecal coliform bacteria in January 2007. 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

Three blank samples (Greater Victoria tap water) were also submitted to the lab as part of the QA/QC and analyzed for fecal coliform bacteria. All three 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 MB laboratory, using these 18 sets of duplicates, was 0.4532. For comparison with subsequent field replicates this result was rounded to 0.5.

3.1.3 Field Splits

Wet Weather Sampling

Table 2 presents the results for the nine field splits collected during the wet period (winter) of 2007 stormwater sampling program. All of the data were compared to the precision criterion of 0.5, as described in Section 3.1.2. None of the eight field splits analyzed exceeded the precision criterion. Therefore, the results meet the QA requirements.

Dry Weather Sampling

Table 3 provides the results for the four field splits collected during the dry period (summer) of 2007 for the stormwater sampling program. All of the data were compared to the precision criterion of 0.5, as described in Section 3.1.2. One of the four field splits analyzed exceeded the precision criterion. However, one can expect, through randomness, 5% of the samples to exceed the precision criterion. Therefore, the results meet the QA requirements.

Table 1. Laboratory Quality Assurance Exercise Results for 2007

Disch. No.	Pair No.	1 st Duplicate D1	2 nd Duplicate D2	Log D1 L1	Log D2 L2	Range of Logs (Rlog) (Log L1 - Log L2)
426	1	98	25	1.991226	1.39794	0.593286067
	2	36	15	1.556303	1.176091	0.380211242
	3	74	57	1.869232	1.755875	0.113356864
3009	4	0	0	0	0	0
	5	0	0	0	0	0
	6	0	0	0	0	0
3035C	7	1040	861	3.017033	2.935003	0.082030188
	8	976	967	2.98945	2.985426	0.004023344
	9	890	385	2.94939	2.585461	0.363929277
3021A	10	849	600	2.928908	2.778151	0.15075644
	11	947	704	2.97635	2.847573	0.12877732
	12	645	429	2.80956	2.632457	0.177102422
3080B	13	803	566	2.904716	2.752816	0.151899114
	14	1004	939	3.001734	2.972666	0.029068121
	15	1158	996	3.063709	2.998259	0.065449221
458A	16	208000	203200	5.318063	5.307924	0.010139631
	17	195200	193600	5.29048	5.286905	0.00357446
	18	390400	224000	5.59151	5.350248	0.241261791
Mean - Rlog (Sum Rlog/18)						0.138603639
Precision Criterion (3.27 x Mean-Rlog)						0.453233899

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

Date	Discharge	Fecal Coliform Counts for Field Splits	Log	Log Range	Acceptable (A) or Unacceptable (U)
Jan.29	466	2	0.69314718	n/a	A
		0	n/a		
Jan.30	3034D	138	4.92725369	0.596520345	U ¹
		76	4.33073334		
Jan.30	3084	169	5.12989871	0.086473598	A
		155	5.04342512		
Jan.30	3089BB	76	4.33073334	0.082238098	A
		70	4.24849524		
Jan.31	3120	244	5.49716823	0.361369788	A
		170	5.13579844		
Apr.2	3016	4400	8.38935982	0.046520016	A
		4200	8.3428398		
Apr.2	3020	400	5.99146455	0.544727175	U
		232	5.44673737		
Apr.2	3077	100	4.60517019	0.693147181	U ¹
		50	3.91202301		
Apr.2	3095	800	6.68461173	0.287682072	A
		600	6.39692966		
Feb.1	3148	9	2.19722458	0.405465108	A
		6	1.79175947		

¹ This result will be accepted as fecal coliform counts under 200 are considered too small an amount to accurately calculate or compare to a precision criterion (APHA, 1998)

Table 3. Laboratory Quality Assurance Results – Dry Period – 2007

Date	Discharge	Fecal Coliform Counts for Field Splits	Log	Log Range	Acceptable (A) or Unacceptable (U)
Aug. 28	3082	8200	9.01188943	1.315676794	U
		2200	7.69621264		
Sep-12	3005	379	5.93753621	0.302746602	A
		280	5.6347896		
Sep-27	3095	23200	10.0519076	0.109199292	A
		20800	9.94270827		
Sep-27	3059	484	6.18208491	0.228841572	A
		385	5.95324333		

4.0 CONCLUSIONS

All requirements for the Stormwater, Harbours and Watersheds program QA/QC program were carried out in 2007. All of the 2007 QA/QC results were found to be acceptable for the using of rating stormwater discharges for public health concerns.

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.

Drinnan, R.W. 1995. Memo to R. Miller, CRD Engineering, February 7; 4pp.

Hutcheson, D. 1995. Memo to R. Miller, CRD Engineering, February 7; 2pp.