

Cowichan/Koksilah Water Quality Sampling: Summer and Fall 2017



submitted to:

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Canada

Pêches et Océans
Canada



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Cover Image: Somenos Marsh Wildlife Society Volunteer Jared Bates taking a sample of water from Somenos Creek in November 2017.

Introduction

In 2017 the author was contracted by the Cowichan Watershed Board to design, implement and report on water quality sampling in the Cowichan and Koksilah watersheds in a manner that would complement and continue extant sampling by the provincial Ministry of Environment (Smorong. 2015 and Obee 2011). Water quality sampling was carried out in four areas:

- streams tributary to Cowichan Bay,
- the Koksilah watershed,
- the Somenos and Quamichan watersheds and lower Cowichan River, and
- marine waters in, and adjacent to, Cowichan Bay.

This sampling program adhered to the provincial '5 in 30' sampling standard, that is, at each site samples are taken once a week for five samples over a 30 day span (Epps and Phippen 2011)

This project would not have been possible without funding from the Real Estate Estate foundation of BC. Several organisations lent the support of both their personnel and equipment to help in data collection. The groups were: the Cowichan Watershed Board (Tom Rutherford and Jill Thompson), the Cowichan Land Trust (Kai Reitzel, Meg Loop and Cameron Hepp), the Somenos Marsh Wildlife Society (Dave Preikshot, Elizabeth Aitken, Jared Bates, George Anderson, Chris Jones, and Barry Hetschko), Cowichan Tribes (Tim Kulchyski), Fisheries and Oceans Canada (Willi Jansen), and the BC Ministry of Environment (Deb Epps).

Methods

Fifty seven sites were chosen from four areas in the Cowichan Koksilah area, see Figure 1. Sites were divided into four areas (33 fresh water and 24 marine):

- Lower Cowichan River / Somenos / Quamichan Watersheds (9 sites),
- Koksilah River Watershed (9 sites),
- Tributary stream to Cowichan Bay (15 sites), and
- marine sites in Cowichan Bay (24 sites).

Each area was delegated to a team of volunteers. The Lower Cowichan River / Quamichan / Somenos watershed sites were sampled by a team from the Somenos Marsh Wildlife Society. The Koksilah River Watershed was sampled by volunteers recruited by the Cowichan Watershed Board. Cowichan Bay Tributary sites were sampled by a team from the Cowichan Land Trust

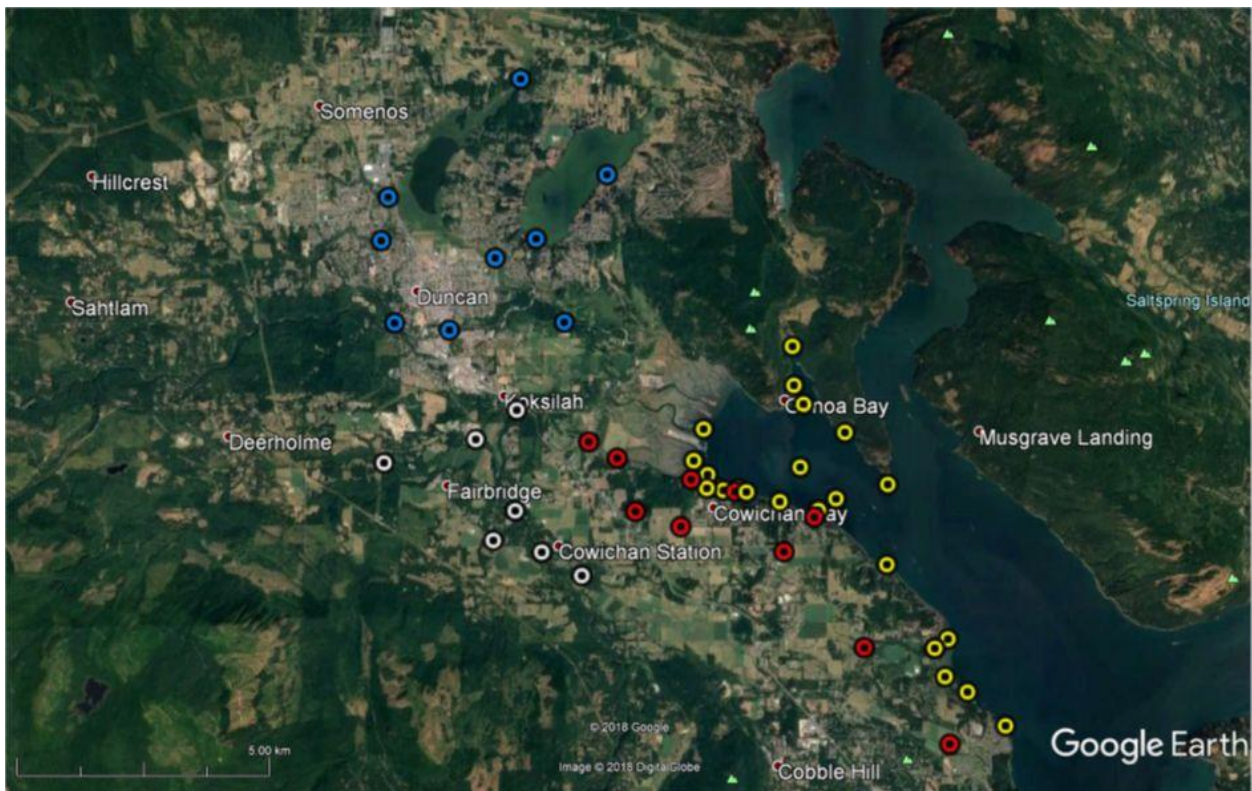


Figure 1: Location of water quality testing sites in the summer and fall of 2017. Marine sites are yellow, Cowichan Bay Tributary sites are red, Koksilah River basin sites are white and lower Cowichan / Quamichan / Somenos basin sites are blue.

Results

E. coli

Primary contact: Recreational activity in which the whole body or the face and trunk are frequently immersed or the face is frequently wetted by spray, and where it is likely that some water will be swallowed. Inadvertent immersion, through being swept into the water by a wave or slipping, would also result in whole body contact. Examples include swimming, surfing, waterskiing, whitewater canoeing/rafting/kayaking, windsurfing or subsurface diving.

Secondary contact: Recreational activity in which only the limbs are regularly wetted and in which greater contact (including swallowing water) is unusual. Examples include rowing, sailing, canoe touring, or fishing.

Targets for Cowichan and Koksilah (Obee 2011) are primary contact: a geometric mean of five samples ≤ 77 CFUs/100 mL and secondary contact: a geometric mean of five samples ≤ 385 CFUs/100 mL

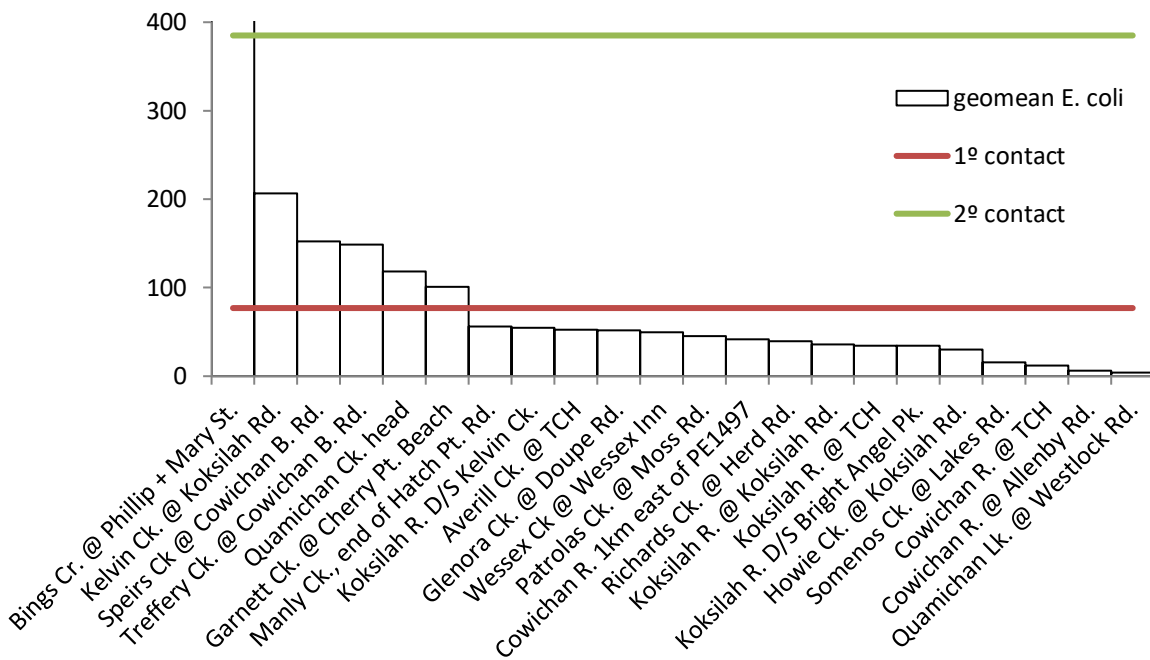


Figure 2: Statistical analysis of test results for E. coli tests in fresh water, summer 2017 (note Bings Creek is 781 CFU).

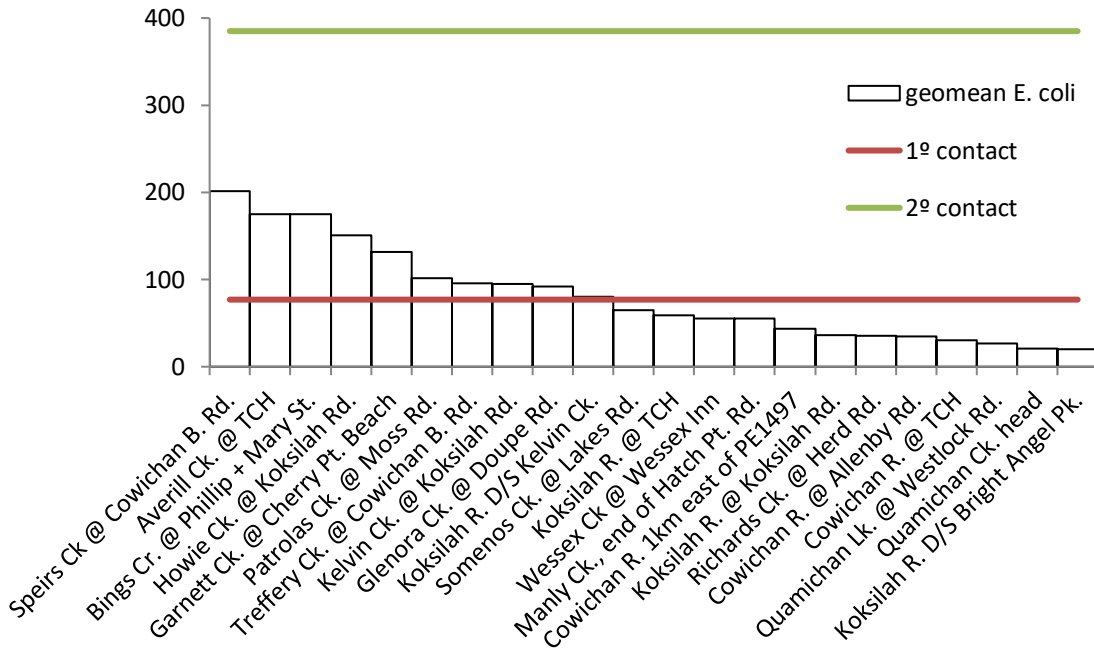


Figure 3: Statistical analysis of test results for E. coli tests in fresh water, winter 2017.

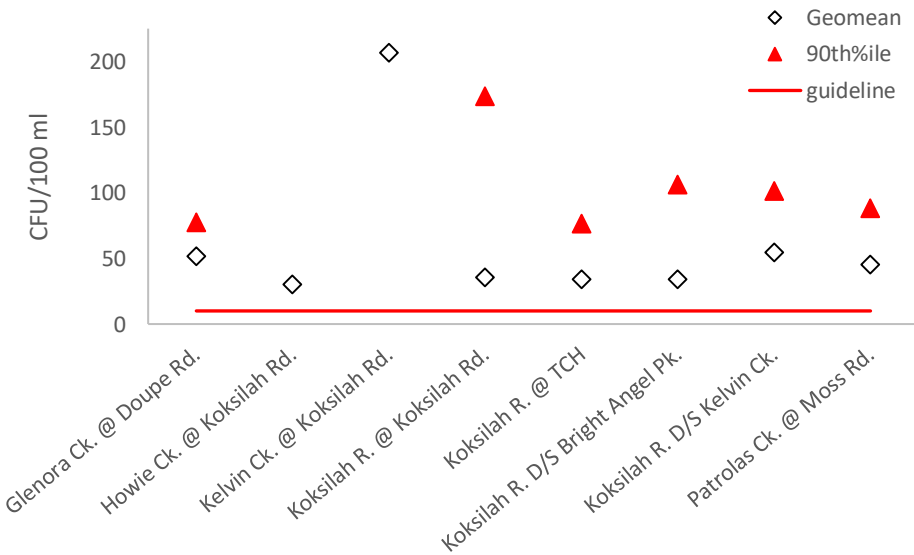


Figure 4: Statistical analysis E. coli samples from Koksilah River sites, summer 2017. Diamonds are the geometric mean and red triangles show the 90th percentile of data distribution for each site. The red line shows the guideline for the 90th percentile of data set by the Ministry of Environment for water quality at sites near to drinking water sources in the area. The 90th percentile for data from Howie Creek and Kelvin Creek are both above the limit of the Y-axis (372 and 678 CFU).

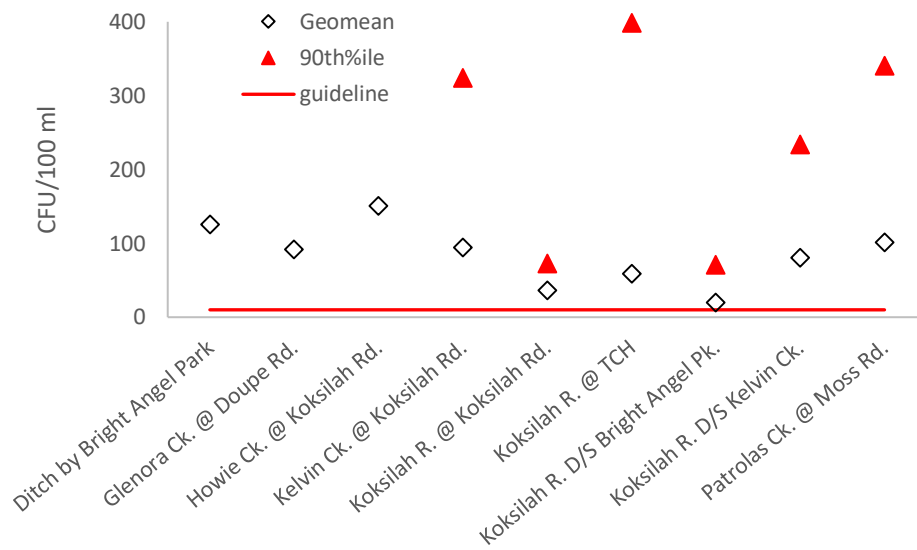


Figure 5: Statistical analysis *E. coli* samples from Koksilah River sites, winter 2017. Diamonds are the geometric mean and red triangles show the 90th percentile of data distribution for each site. The red line shows the guideline for the 90th percentile of data set by the Ministry of Environment for water quality at sites near to drinking water sources in the area. The 90th percentile for data from the Bright Angel Park site, Glenora Creek and Howie Creek were above the limit of the Y-axis (1352, 592, and 1068 CFU).

Turbidity

NTUs (Nephelometric Turbidity Units) light attenuation by particles in water and related to their shape, color, and reflectivity. Targets for Cowichan and Koksilah (Obee 2011) are:

- Low discharge (May to September) 2 NTUs
- High discharge (October to April) 5 NTUs

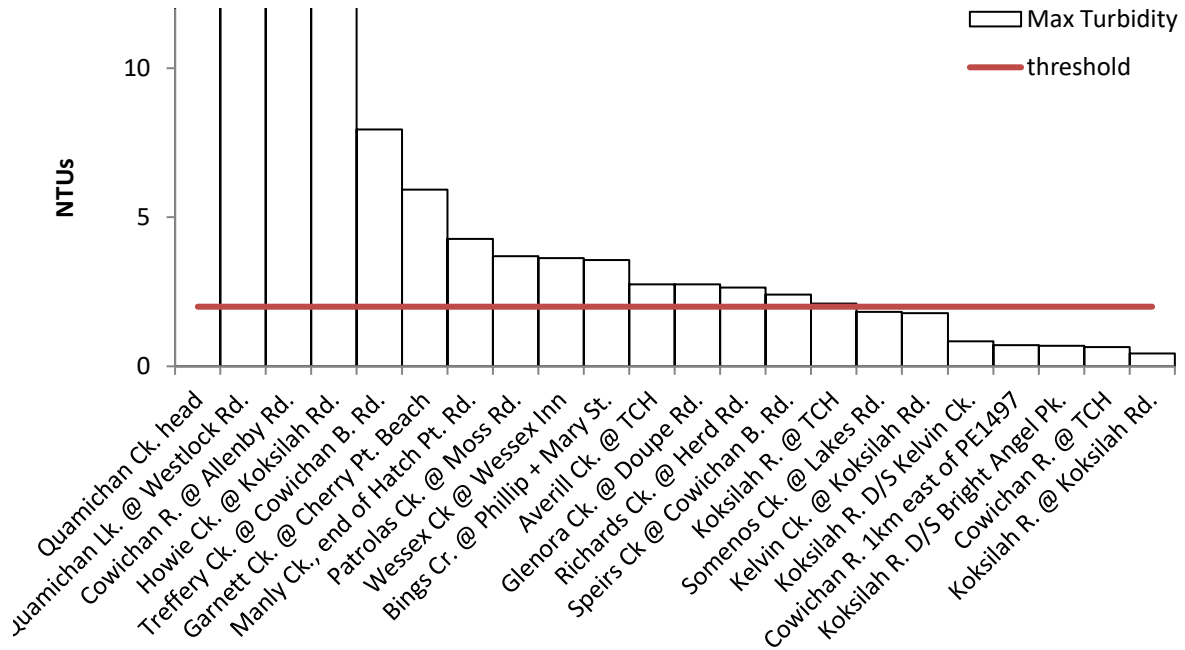


Figure 6: Statistical analysis of test results for turbidity at freshwater sites in summer (low flow) 2017.

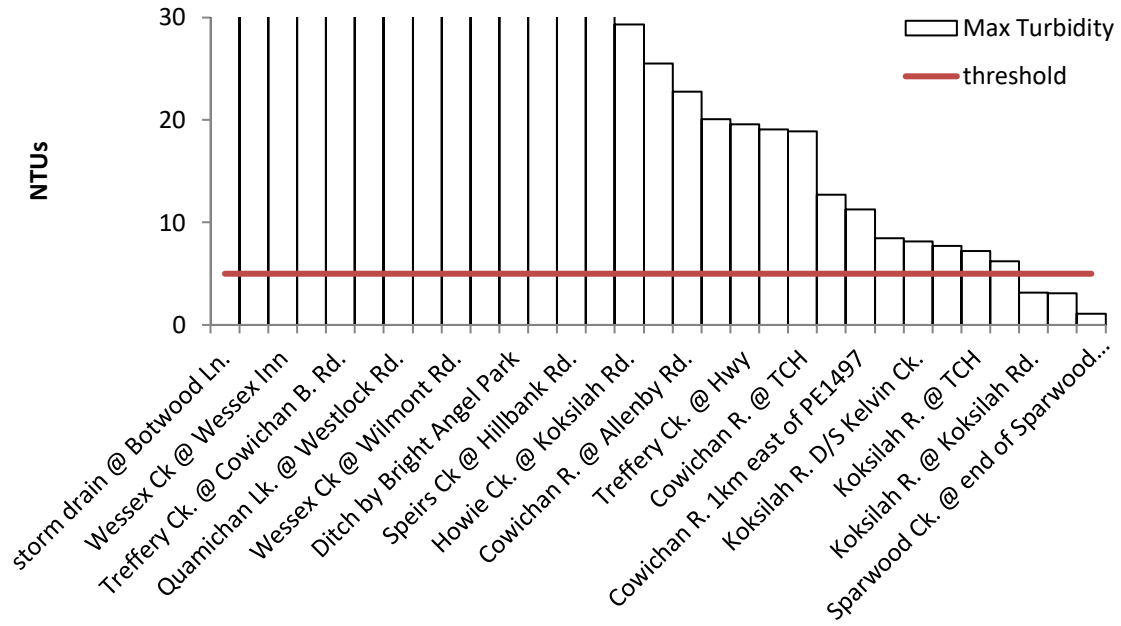


Figure 7: Statistical analysis of test results for turbidity at fresh water sites, winter (high flow) 2017

Phosphorus

Objectives set for low discharge period only mean of 5 samples: 0.005 mg/L max of 5 samples: 0.007 mg/L (Obee 2011).

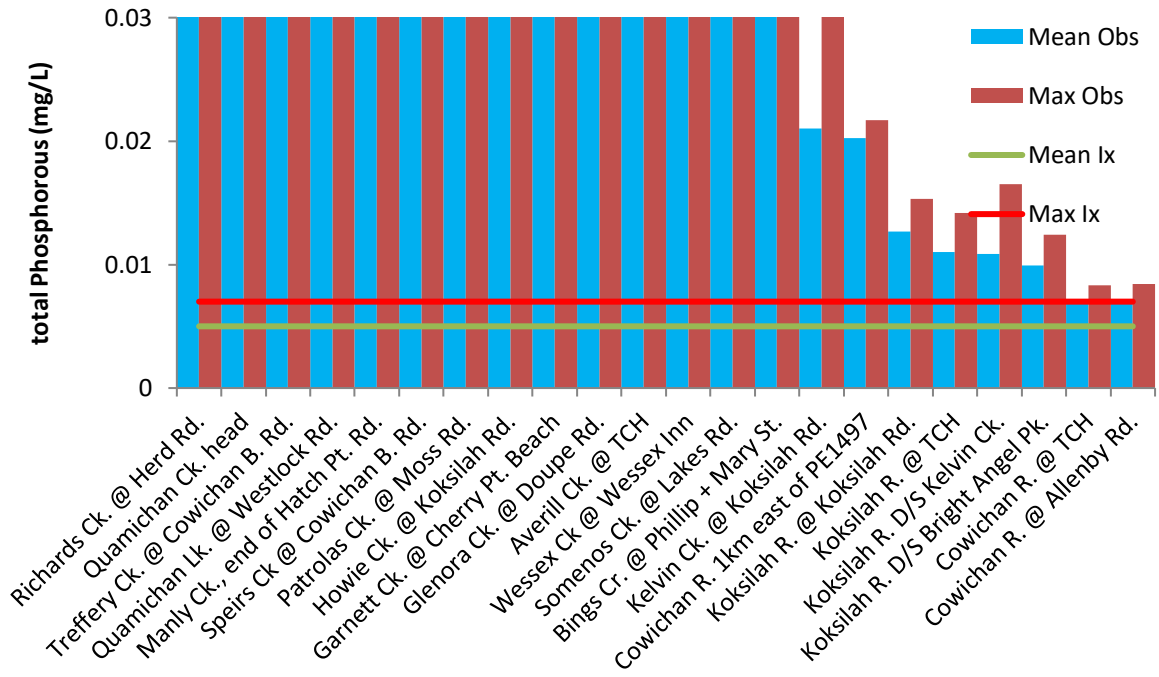


Figure 8: Statistical analysis of test results for phosphorus at fresh water sites in summer 2017 (low flow)

Enterococcus and Fecal Coliforms in the Marine Environment

Health Canada guidelines for Enterococcus in the marine environment area are geometric mean concentration (minimum of five samples): primary contact: ≤ 35 enterococci/100 mL secondary contact: ≤ 175 enterococci/100 mL Single-sample maximum concentration: ≤ 70 enterococci/100 mL

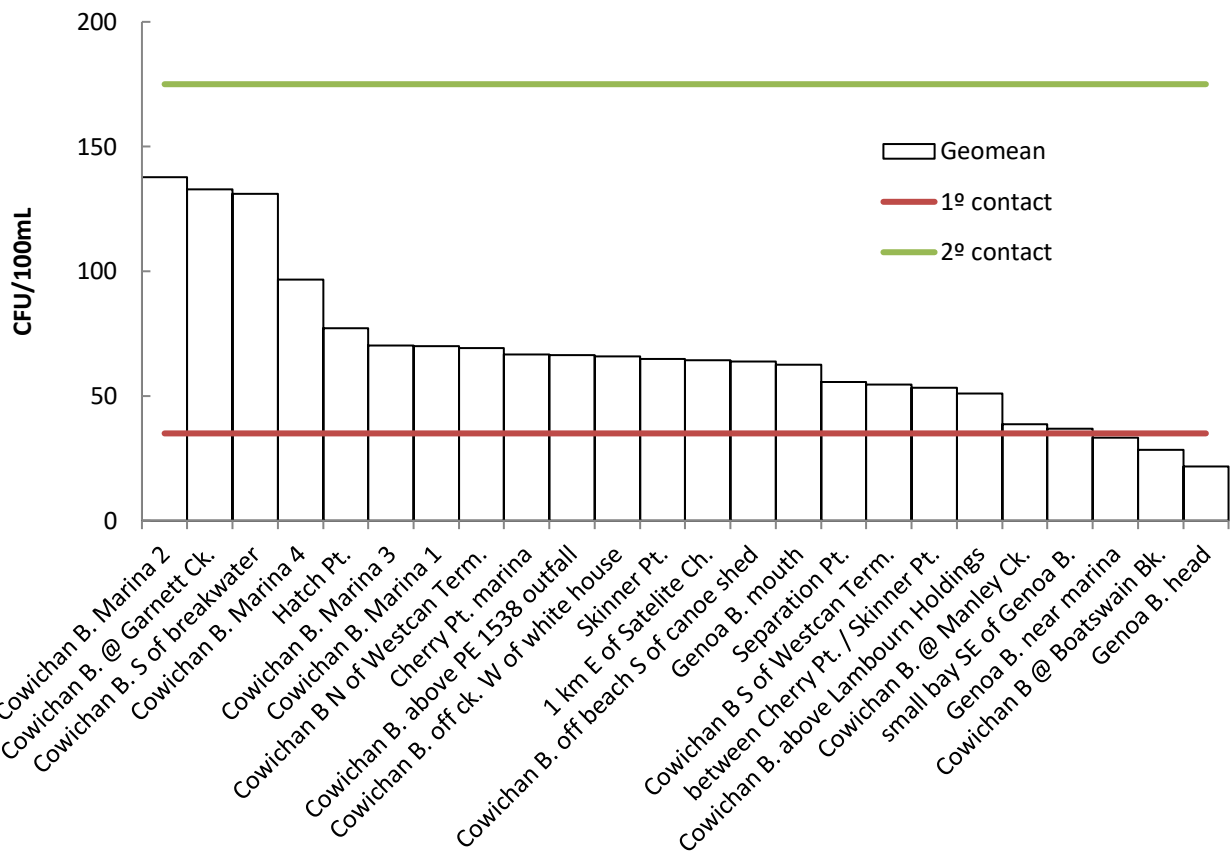


Figure 9: Statistical analysis of test results for Enterococcus at marine sites in winter 2017.

Fecal Coliform

Health Canada guidelines are for the median or geometric mean fecal coliform count does not exceed 14/100 mL, and not more than 10% of the samples exceed a fecal coliform MPN of 43/100 mL, for a five-tube decimal dilution test.

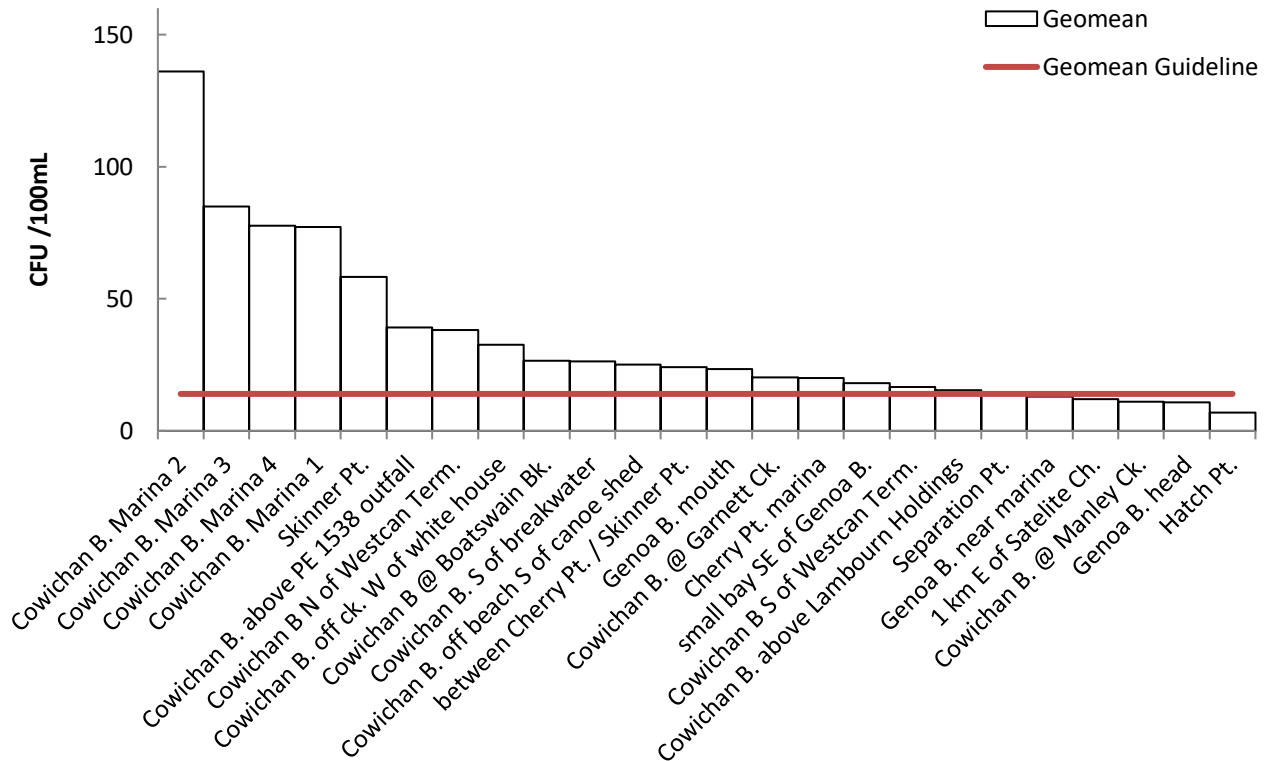


Figure 10: Statistical analysis of test results for fecal coliforms in marine waters in fall 2017.

Discussion

Water quality sampling for summer of 2017 yielded some surprising results, especially in the very high concentrations of phosphorus observed at all sites and extremely elevated phosphorus concentrations in samples from the Somenos and Quamichan watersheds in particular. *E. coli* concentrations in stations from the Koksilah River and its tributaries were of note because previous monitoring had suggested a potential threat to drinking water obtained from nearby wells (Obee 2011). Sampling for Enterococcus and fecal coliforms suggest that conditions are unfit for either primary contact through recreational activities or the consumption of shellfish in most of Cowichan Bay.

E. coli in Freshwater

The observed quantities of *E. coli* at the Bings Creek site was surprisingly high. The highest observed value, 10400 CFU/100ml is 135 times the guideline for primary contact and 27 times

the guideline for secondary contact. Because of the high number of children that play in the Creek and a number of people who access the creek incidentally, there is a potential threat to health of people in the community. It is also likely that the local population of homeless may come into contact with the creek in transit to temporary shelter within Somenos Marsh or as a source of bathing, cooking or drinking water. Future monitoring of Bings Creek is essential to identify the source of the *E. coli* in order to formulate management actions to bring numbers down to acceptable values.

A positive result from sampling for *E. coli* was that concentrations appear to be lower in the Koksilah river than previous years. *E. Coli* concentrations measured in 2002, 2003, and 2008 had been identified as a threat to drinking water in the Koksilah basin (Obee 2011). In response to this situation, the ministries of Agriculture and Environment began work with local farmers and governance groups, e.g., the Cowichan Watershed Board to manage agricultural practices such as the spreading of manure and the movement of livestock to minimise movement of *E. coli* into the aquatic environment. Results from the monitoring in summer 2017 suggest that these mitigation measures may be working as most of the *E. coli* data are lower than in previous years. In 2003 for example the average value for the 90th percentile of summer data was 455 CFU/100ml (Obee 2011). By comparison the average of the 90th percentiles for Koksilah River stations in the summer of 2017 was 226 CFU/ 100ml about half the 2003 value.

Continued monitoring of these sites will be necessary to ensure that management efforts towards controlling the movement of *E. coli* to the aquatic environment in the Koksilah watershed continue to improve. Concentrations of *E. coli* in the Koksilah watershed remain higher than the management guideline for drinking water at most sites.

Marine Fecal Coliforms and Enterococcus

Testing for bacteria at sites in Cowichan Bay in 2017 suggests that these waters are unsuitable for many recreational activities including the harvesting of shellfish. From the sampling conducted in the fall of 2017 we can see that 19 of 24 sites (almost 80%) were over the target for the geometric mean of samples. This means that the majority of Cowichan Bay would be deemed to be ineligible for shellfish harvesting. Given that harvesting of clams and oysters has been, and remains, a significant portion of the diet of Cowichan Tribes members these results show that much work remains to revive this resource for local First Nations people. The harvest of shellfish in Cowichan Bay is also compromised by the presence of metals and other contaminants. Therefore, the goal of reopening Cowichan Bay to shellfish harvesting will require significant management action to remediate pollutants entering the area from the Cowichan and Koksilah Rivers. Monitoring of pollutants including fecal coliforms and enterococcus will also likely need to be increased in frequency in order to allow the public and managers the ability to see whether policy targets are being obtained and whether human health is being threatened.

Phosphorus

High phosphorus concentrations in freshwater is a common problem in Southwestern British Columbia and is the primary agent responsible for persistent blue-green algae blooms in many urban and rural lakes (Nordin 2015). These blue green algae blooms threaten the integrity of

many salmon and trout ecosystems on Southern Vancouver Island and can even pose a threat to the health of people and their pets (Preikshot 2016). Analysis of the phosphorus concentrations obtained in the summer of 2017 shows that several sites in the Somenos and Quamichan watersheds were well above guidelines required for fish habitat. For example, the site at the head of Quamichan Creek was 100 times higher than the target for mean sample concentrations (0.005 mg/l) and the maximum observed sample was more than 200 times the maximum guideline desired concentration for any sample in the series (0.007 mg/l). The values for Richards Creek were even higher. Just over half of all the sites sampled were observed to have more than ten times the guideline concentrations of phosphorus. All sites were observed to be in excess of phosphorus guidelines.

It is well established that such high levels of phosphorus in the aquatic environment is due to anthropogenic effects, e.g., deforestation, urbanisation, and agriculture. The close proximity of septic fields and high intensity agriculture in the Quamichan and Somenos watersheds have yielded a situation in which persistent high concentrations of phosphorus will be seen in waters for the entire summer. This has allowed blue-green algae to dominate these ecosystems and has exacerbated the dominance of invasive species like Pumpkinseed Sunfish and Bullfrogs (Preikshot 2016).

Continued monitoring of phosphorus in these systems will be required as well as dramatic management interventions to mitigate the effect of high phosphorus in the aquatic environment.

Turbidity

Analysis of data collected in 2017 shows that for most sites, turbidity guidelines were exceeded in both summer and fall. It should not be surprising that fall turbidity was usually higher than summer. It may be the case that the winter guidelines may require revisiting. East Coast Vancouver Island streams typically experience their highest discharges in the fall and early winter, whereas many streams on the mainland experience peak discharge in the late spring during glacial melt. The timing of fall sampling thus coincides with both first flush and high discharge for streams in the Koksilah and Cowichan areas.

Summer turbidity was observed to exceed guideline targets for most stations. The exception to this situation was stations on the Cowichan River which were all within the turbidity standard.

Because turbidity is a general parameter which simply indicates the relative ease of light transmission through a water sample it can not be stated whether the source of interference is organic, inorganic, natural, or anthropogenic. It does seem likely that, given the high concentrations of anthropogenic phosphorus in the environment, sedimentation from agricultural and urban run off and associated blue-green algae production are the primary cause of high turbidity in the region. Future research may be necessary to identify the sources of this persistent and systemic high turbidity in order to allow the formulation of effective management options.

References

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Nordin, R. 2015. Water Quality Sampling Program for Elk Lake 2014-2015: Overview, Status and Phosphorus Budget. Freshwater Fisheries Society of BC: 57 p.

Obee, N. 2011. Water quality assessment and objectives for the Cowichan and Koksilah rivers: first update. British Columbia Ministry of Environment, Environmental Protection Division, Environmental Sustainability & Strategic Policy Division, Nanaimo: 71 p.

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Smorong. 2015. Cowichan River and Koksilah River Water Quality Objectives Attainment Report 2012-14. British Columbia Ministry of Environment, Environmental Protection Division, Environmental Quality Section: 33 p.

Appendices

Appendix Table 1: Location of fresh water water quality sampling site from the summer and fall 2017 surveys. The three fresh water areas are the Cowichan Bay Tributaries (CBT), the Koksilah River basin (KRB) and the lower Cowichan / Somenos / Quamichan watersheds (LCSQ).

Area	Site	Latitude	Longitude	EMS
CBT	Garnett Ck. @ Cherry Pt. Beach	48.7103	-123.5564	E291150
CBT	Garnett Ck. @ Telegraph Rd.	48.7108	-123.5774	E291151
CBT	Manly Ck., end of Hatch Pt. Rd.	48.6924	-123.5528	E291149
CBT	Sparwood Ck. @ end of Sparwood Rd.	48.7360	-123.5936	E291192
CBT	Speirs Ck @ Cowichan B. Rd.	48.7469	-123.6491	E291160
CBT	Speirs Ck @ Hillbank Rd.	48.7368	-123.6437	E291161
CBT	storm drain @ Botwood Ln.	48.7405	-123.6146	E291155
CBT	storm drain @ Botwood Ln.	48.7405	-123.6146	E291155
CBT	Storm Drain @ Cherry Pt. marina	48.7356	-123.5915	E291152
CBT	Treffery Ck. @ Cowichan B. Rd.	48.7500	-123.6574	E291163
CBT	Treffery Ck. @ Hwy	48.7436	-123.6590	E291162
CBT	Waldy Ck. @Cherry Pt. Rd.	48.7293	-123.6009	E295430
CBT	Wessex Ck @ Wessex Inn	48.7428	-123.6275	E291158
CBT	Wessex Ck @ Wilmont Rd.	48.7340	-123.6306	E291159
KRB	Ditch by Bright Angel Park	48.7377	-123.6777	E291189
KRB	Glenora Ck. @ Doupe Rd.	48.7460	-123.7168	E230099
KRB	Howie Ck. @ Koksilah Rd.	48.7312	-123.6851	E234128
KRB	Kelvin Ck. @ Koksilah Rd.	48.7488	-123.6953	E207427
KRB	Koksilah R. @ Koksilah Rd.	48.7288	-123.6710	E206976
KRB	Koksilah R. @ TCH	48.7561	-123.6784	O123981
KRB	Koksilah R. D/S Bright Angel Pk.	48.7368	-123.6788	E295429
KRB	Koksilah R. D/S Kelvin Ck.	48.7505	-123.6903	E207433
KRB	Patrolas Ck. @ Moss Rd.	48.7245	-123.6593	E230098
LCSQ	Averill Ck. @ TCH	48.7968	-123.6593	E245217
LCSQ	Bings Cr. @ Phillip + Mary St.	48.7887	-123.7179	E245221
LCSQ	Cowichan R. @ Allenby Rd.	48.7728	-123.7139	E234125
LCSQ	Cowichan R. @ TCH	48.7715	-123.6981	O120802
LCSQ	Cowichan R. 1km east of PE1497	48.7730	-123.6646	E206106
LCSQ	Quamichan Ck. head	48.7890	-123.6727	E234127
LCSQ	Quamichan Lk. @ Westlock Rd.	48.8013	-123.6521	E309288
LCSQ	Richards Ck. @ Herd Rd.	48.8198	-123.6773	E236489
LCSQ	Richards Ck. @ Herd Rd.	48.8198	-123.6773	E236489
LCSQ	Somenos Ck. @ Lakes Rd.	48.7853	-123.6847	E309426

Appendix Table 2: Location of marine water quality sampling sites from the summer and fall 2017 surveys.

Location	Lat.	Lon.	EMS
Cowichan B. above PE 1538 outfall	48.7437	-123.6227	O150360
small bay SE of Genoa B.	48.7518	-123.5826	E219323
Separation Pt.	48.7418	-123.5701	E219324
Cherry Pt. marina	48.7369	-123.5903	E219325
Genoa B. mouth	48.7573	-123.5947	E219326
1 km E of Satellite Ch.	48.7264	-123.5704	E291121
between Cherry Pt. / Skinner Pt.	48.7452	-123.5956	E291122
Skinner Pt.	48.7103	-123.5564	E291123
Cowichan B. out from Botwood Lane storm drain	48.7410	-123.6140	E291124
Cowichan B. creek west of Cherry Point Marina	48.7385	-123.6016	E291125
Cowichan B S of Westcan Term.	48.7464	-123.6267	E291126
Cowichan B N of Westcan Term.	48.7525	-123.6238	E291127
Cowichan B. above Lambourn Holdings	48.7391	-123.5852	E291128
Cowichan B @ Boatswain Bk.	48.7048	-123.5534	E291132
Hatch Pt.	48.6954	-123.5359	E291133
Genoa B. head	48.7684	-123.5979	E291134
Cowichan B. @ Manley Ck.	48.7019	-123.5468	E291135
Cowichan B. @ Garnett Ck.	48.7121	-123.5525	E291136
Cowichan B. S of breakwater	48.7405	-123.6115	E291193
Genoa B. near marina	48.7609	-123.5975	E291369
Cowichan B. Marina 1	48.7411	-123.6229	E294495
Cowichan B. Marina 2	48.7413	-123.6222	E294496
Cowichan B. Marina 3	48.7414	-123.6206	E294497
Cowichan B. Marina 4	48.7407	-123.6181	E294485

Appendix Table 3: Test results for turbidity, phosphorus and E. coli for fresh water water quality testing on 08 August, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

Area	Location	Time	Turbidity (NTU)	Phosphorus (mg/l)	E. coli (# per 100 ml)
CBT	Garnett Ck. @ Cherry Pt. Beach	12:08	1.64	0.0637	240
CBT	Garnett Ck. @ Telegraph Rd.	11:58	5.41	0.1220	30
CBT	Manly Ck., end of Hatch Pt. Rd.	11:23	4.27	0.2050	100
CBT	Speirs Ck @ Cowichan B. Rd.	14:43	1.04	0.1260	80
CBT	Speirs Ck @ Hillbank Rd.	14:50	2.81	0.0787	320
CBT	storm drain @ Botwood Ln.	13:35	0.89	0.0899	20
CBT	storm drain @ Botwood Ln.	13:35	0.84	0.0933	30
CBT	storm drain @ Lighthouse Rest.	14:05	2.65	0.2340	1
CBT	storm drain @ Masthead Rest.	13:55	1.13	0.0267	40
CBT	Treffery Ck. @ Cowichan B. Rd.	14:53	2.99	0.4240	240
CBT	Treffery Ck. @ Hwy	10:33	3.10	0.1960	2000
CBT	Waldy Ck. @Cherry Pt. Rd.	13:15	7.17	0.0920	100
CBT	Wessex Ck @ Wessex Inn	14:15	0.56	0.0700	60
KRB	Glenora Ck. @ Doupe Rd.	14:19	0.54	0.0459	51
KRB	Howie Ck. @ Koksilah Rd.	13:23	2.47	0.0432	600
KRB	Howie Ck. @ Koksilah Rd.	13:23	2.36	0.0430	600
KRB	Kelvin Ck. @ Koksilah Rd.	13:48	0.91	0.0168	300
KRB	Koksilah R. @ Koksilah Rd.	12:23	0.33	0.0119	13
KRB	Koksilah R. @ TCH	14:40	0.50	0.0096	11
KRB	Koksilah R. D/S Bright Angel Pk.	13:01	0.42	0.0086	22
KRB	Koksilah R. D/S Kelvin Ck.	14:08	0.42	0.0094	36
KRB	Patrolas Ck. @ Moss Rd.	11:58	1.75	0.1180	10
LCSQ	Averill Ck. @ TCH	11:33	2.76	0.0713	240
LCSQ	Bings Cr. @ Phillip + Mary St.	12:26	1.09	0.0337	510
LCSQ	Bings Cr. @ Phillip + Mary St.	12:26	1.08	0.0323	690
LCSQ	Cowichan R. @ Allenby Rd.	14:26	0.31	0.0070	15
LCSQ	Cowichan R. @ TCH	14:13	0.50	0.0083	13
LCSQ	Cowichan R. 1km east of PE1497	13:50	0.57	0.0214	59
LCSQ	Quamichan Ck. head	13:20	5.19	0.2330	130
LCSQ	Quamichan Lk. @ Westlock Rd.	13:13	55.60	0.4210	2
LCSQ	Richards Ck. @ Herd Rd.	12:45	2.17	7.9500	12
LCSQ	Somenos Ck. @ Lakes Rd.	13:04	1.50	0.0364	16

Appendix Table 4: Test results for turbidity, phosphorus and E. coli for fresh water water quality testing on 15 August, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

Area	Location	Time	Turbidity (NTU)	Phosphorus (mg/l)	E. coli (# per 100 ml)
CBT	Garnett Ck. @ Cherry Pt. Beach	11:20	2.48	0.0496	60
CBT	Garnett Ck. @ Telegraph Rd.	11:13	2.94	0.1240	3
CBT	Manly Ck., end of Hatch Pt. Rd.	11:00	3.44	0.1550	22
CBT	Speirs Ck @ Cowichan B. Rd.	13:26	0.80	0.1140	160
CBT	storm drain @ Botwood Ln.	12:25	2.78	0.0888	20
CBT	Treffery Ck. @ Cowichan B. Rd.	13:40	1.58	0.3780	80
CBT	Waldy Ck. @Cherry Pt. Rd.	12:15	1330.00	0.4690	60
CBT	Wessex Ck @ Wessex Inn	12:54	0.47	0.0636	42
CBT	Wessex Ck @ Wessex Inn	12:54	0.50	0.0617	36
KRB	Glenora Ck. @ Doupe Rd.	14:40	2.76	0.0744	34
KRB	Glenora Ck. @ Doupe Rd.	14:40	0.73	0.0719	36
KRB	Howie Ck. @ Koksilah Rd.	14:00	3.94	0.0965	30
KRB	Kelvin Ck. @ Koksilah Rd.	14:15	0.66	0.0150	180
KRB	Koksilah R. @ Koksilah Rd.	13:40	0.30	0.0153	17
KRB	Koksilah R. @ TCH	15:10	0.49	0.0096	20
KRB	Koksilah R. D/S Bright Angel Pk.	13:45	0.35	0.0095	17
KRB	Koksilah R. D/S Kelvin Ck.	14:30	0.45	0.0088	40
KRB	Patrolas Ck. @ Moss Rd.	13:20	2.30	0.1190	46
LCSQ	Averill Ck. @ TCH	11:35	1.68	0.0604	43
LCSQ	Averill Ck. @ TCH	11:35	1.49	0.0579	38
LCSQ	Bings Cr. @ Phillip + Mary St.	11:55	3.56	0.0524	350
LCSQ	Cowichan R. @ Allenby Rd.	14:18	0.52	0.0065	1
LCSQ	Cowichan R. @ TCH	13:57	0.65	0.0077	12
LCSQ	Cowichan R. 1km east of PE1497	13:40	0.51	0.0185	30
LCSQ	Quamichan Ck. head	13:10	15.50	0.2940	60
LCSQ	Quamichan Lk. @ Westlock Rd.	12:52	19.40	0.2660	50
LCSQ	Richards Ck. @ Herd Rd.	12:15	1.02	0.1810	70
LCSQ	Somenos Ck. @ Lakes Rd.	12:33	1.82	0.0483	60

Appendix Table 5: Test results for turbidity, phosphorus and E. coli for fresh water water quality testing on 22 August, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

Area	Location	Time	Turbidity (NTU)	Phosphorus (mg/l)	E. coli (# per 100 ml)
CBT	Garnett Ck. @ Cherry Pt. Beach	11:43	2.96	0.0691	160
CBT	Garnett Ck. @ Telegraph Rd.	11:55	6.48	0.1500	99
CBT	Manly Ck., end of Hatch Pt. Rd.	11:30	3.66	0.1530	150
CBT	Speirs Ck @ Cowichan B. Rd.	13:00	2.40	0.1360	96
CBT	storm drain @ Lighthouse Rest.	12:43	2.77	0.2810	45
CBT	storm drain @ Masthead Rest.	12:18	32.40	0.0927	410
CBT	Treffery Ck. @ Cowichan B. Rd.	13:10	2.51	0.5040	93
CBT	Treffery Ck. @ Cowichan B. Rd.	13:10	2.46	0.4880	102
CBT	Wessex Ck @ Wessex Inn	12:42	0.70	0.0573	37
KRB	Glenora Ck. @ Doupe Rd.	12:30	0.65	0.0546	40
KRB	Howie Ck. @ Koksilah Rd.	12:00	5.00	0.1130	7
KRB	Kelvin Ck. @ Koksilah Rd.	12:10	1.14	0.0190	50
KRB	Koksilah R. @ Koksilah Rd.	11:20	0.44	0.0148	23
KRB	Koksilah R. @ TCH	13:00	2.10	0.0105	78
KRB	Koksilah R. @ TCH	13:00	0.51	0.0124	81
KRB	Koksilah R. D/S Bright Angel Pk.	11:40	0.34	0.0112	132
KRB	Koksilah R. D/S Kelvin Ck.	12:20	0.53	0.0113	102
KRB	Patrolas Ck. @ Moss Rd.	11:10	2.05	0.1190	70
LCSQ	Averill Ck. @ TCH	11:14	1.85	0.0663	60
LCSQ	Bings Cr. @ Phillip + Mary St.	11:28	1.57	0.0391	120
LCSQ	Cowichan R. @ Allenby Rd.	13:51	48.90	0.0082	12
LCSQ	Cowichan R. @ Allenby Rd.	13:51	0.51	0.0086	7
LCSQ	Cowichan R. @ TCH	13:37	0.50	0.0071	7
LCSQ	Cowichan R. 1km east of PE1497	13:19	0.52	0.0196	170
LCSQ	Quamichan Ck. head	12:39	26.40	0.4000	1200
LCSQ	Quamichan Lk. @ Westlock Rd.	12:20	14.00	0.4400	1
LCSQ	Richards Ck. @ Herd Rd.	11:47	2.64	0.2270	90
LCSQ	Somenos Ck. @ Lakes Rd.	12:55	1.80	0.0376	11

Appendix Table 6: Test results for turbidity, phosphorus and E. coli for fresh water water quality testing on 29 August, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

Area	Location	Time	Turbidity (NTU)	Phosphorus (mg/l)	E. coli (# per 100 ml)
CBT	Garnett Ck. @ Cherry Pt. Beach	12:34	2.75	0.1720	40
CBT	Manly Ck., end of Hatch Pt. Rd.	12:07	3.72	0.1600	19
CBT	Speirs Ck @ Cowichan B. Rd.	13:10	1.52	0.1240	500
CBT	Speirs Ck @ Cowichan B. Rd.	13:10	1.06	0.1320	400
CBT	Treffery Ck. @ Cowichan B. Rd.	13:25	2.39	0.5090	300
CBT	Wessex Ck @ Wessex Inn	12:58	0.62	0.0638	120
KRB	Glenora Ck. @ Doupe Rd.	11:40	1.06	0.0495	58
KRB	Howie Ck. @ Koksilah Rd.	11:00	14.10	0.1330	20
KRB	Kelvin Ck. @ Koksilah Rd.	11:15	1.13	0.0183	150
KRB	Koksilah R. @ Koksilah Rd.	10:20	0.29	0.0097	260
KRB	Koksilah R. @ TCH	12:00	0.49	0.0103	72
KRB	Koksilah R. D/S Bright Angel Pk.	10:45	0.35	0.0079	14
KRB	Koksilah R. D/S Kelvin Ck.	11:25	0.37	0.0084	33
KRB	Patrolas Ck. @ Moss Rd.	10:10	3.69	0.1250	80
KRB	Patrolas Ck. @ Moss Rd.	10:10	2.83	0.1300	40
LCSQ	Averill Ck. @ TCH	11:23	2.00	0.0668	10
LCSQ	Bings Cr. @ Phillip + Mary St.	11:39	1.08	0.0377	1110
LCSQ	Cowichan R. @ Allenby Rd.	14:05	0.43	0.0062	6
LCSQ	Cowichan R. @ TCH	13:52	0.50	0.0064	8
LCSQ	Cowichan R. @ TCH	13:52	0.38	0.0068	15
LCSQ	Cowichan R. 1km east of PE1497	13:30	0.53	0.0217	36
LCSQ	Quamichan Ck. head	12:54	28.90	0.3540	250
LCSQ	Quamichan Lk. @ Westlock Rd.	12:39	112.00	0.4780	1
LCSQ	Richards Ck. @ Herd Rd.	11:58	1.35	0.0709	41
LCSQ	Somenos Ck. @ Lakes Rd.	12:22	1.38	0.0373	14

Appendix Table 7: Test results for turbidity, phosphorus and E. coli for fresh water water quality testing on 05 September, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

Area	Location	Time	Turbidity (NTU)	Phosphorus (mg/l)	E. coli (# per 100 ml)
CBT	Garnett Ck. @ Cherry Pt. Beach	13:38	5.93	0.0715	112
CBT	Manly Ck., end of Hatch Pt. Rd.	14:00	4.12	0.1670	100
CBT	Manly Ck., end of Hatch Pt. Rd.	14:00	3.98	0.1640	78
CBT	Speirs Ck @ Cowichan B. Rd.	13:20	0.56	0.1210	150
CBT	Treffery Ck. @ Cowichan B. Rd.	12:53	7.95	0.4870	130
CBT	Wessex Ck @ Wessex Inn	13:06	3.64	0.0659	30
KRB	Glenora Ck. @ Doupe Rd.	10:40	1.50	0.1790	90
KRB	Howie Ck. @ Koksilah Rd.	11:35	17.20	0.1520	10
KRB	Kelvin Ck. @ Koksilah Rd.	11:10	1.78	0.0359	930
KRB	Koksilah R. @ Koksilah Rd.	12:12	0.32	0.0118	44
KRB	Koksilah R. @ TCH	12:50	0.68	0.0142	37
KRB	Koksilah R. @ TCH	12:50	0.94	0.0146	57
KRB	Koksilah R. D/S Bright Angel Pk.	12:00	0.69	0.0124	67
KRB	Koksilah R. D/S Kelvin Ck.	10:58	0.84	0.0165	100
KRB	Patrolas Ck. @ Moss Rd.	12:24	2.73	0.1220	100
LCSQ	Averill Ck. @ TCH	11:28	2.16	0.0710	70
LCSQ	Bings Cr. @ Phillip + Mary St.	11:46	0.97	0.0374	10400
LCSQ	Cowichan R. @ Allenby Rd.	14:20	0.76	0.0061	11
LCSQ	Cowichan R. @ TCH	14:05	0.47	0.0060	20
LCSQ	Cowichan R. 1km east of PE1497	13:48	0.70	0.0200	12
LCSQ	Quamichan Ck. head	13:20	708.00	1.5900	10
LCSQ	Quamichan Lk. @ Westlock Rd.	13:01	61.00	0.4760	10
LCSQ	Richards Ck. @ Herd Rd.	12:20	1.84	0.0672	41
LCSQ	Richards Ck. @ Herd Rd.	12:20	1.53	0.0665	22
LCSQ	Somenos Ck. @ Lakes Rd.	12:41	1.64	0.0513	6

Appendix Table 8: Test results for turbidity, phosphorus and E. coli for fresh water water quality testing on 24 October, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

Area	Location	Time	Turbidity	Phosphorus	E. coli
CBT	Garnett Ck. @ Cherry Pt. Beach	9:54	10.20	0.0970	150
CBT	Garnett Ck. @ Telegraph Rd.	9:45	17.80	0.1710	50
CBT	Manly Ck., end of Hatch Pt. Rd.	9:35	5.16	0.1960	100
CBT	Sparwood Ck. @ end of Sparwood Rd.	10:23	0.67	0.0315	1
CBT	Speirs Ck @ Cowichan B. Rd.	11:38	3.47	0.0804	30
CBT	Speirs Ck @ Hillbank Rd.	11:30	6.40	0.0440	70
CBT	storm drain @ Botwood Ln.	10:42	3.21	0.0635	54
CBT	storm drain @ Botwood Ln.	10:42	3.58	0.0626	72
CBT	Storm Drain @ Cherry Pt. marina	10:06	1.80	0.1410	150
CBT	Treffery Ck. @ Cowichan B. Rd.	9:17	4.32	0.1200	10
CBT	Treffery Ck. @ Hwy	11:45	2.55	0.2840	20
CBT	Waldy Ck. @Cherry Pt. Rd.	10:35	10.50	0.1780	132
CBT	Wessex Ck @ Wessex Inn	11:11	2.32	0.0509	38
CBT	Wessex Ck @ Wilmont Rd.	11:20	27.10	0.2690	7500
KRB	Ditch by Bright Angel Park	11:36	2.96	0.0779	50
KRB	Glenora Ck. @ Doupe Rd.	12:34	0.65	0.0198	53
KRB	Howie Ck. @ Koksilah Rd.	10:56	3.06	0.0422	10
KRB	Kelvin Ck. @ Koksilah Rd.	12:00	0.96	0.0196	99
KRB	Koksilah R. @ Koksilah Rd.	10:37	0.80	0.0082	79
KRB	Koksilah R. @ TCH	13:02	0.91	0.0127	44
KRB	Koksilah R. D/S Bright Angel Pk.	11:42	0.96	0.0075	41
KRB	Koksilah R. D/S Kelvin Ck.	12:15	1.11	0.0188	68
KRB	Patrolas Ck. @ Moss Rd.	10:24	1.81	0.0607	58
LCSQ	Averill Ck. @ TCH	11:21	3.49	0.0476	104
LCSQ	Bings Cr. @ Phillip + Mary St.	11:35	2.35	0.0758	61
LCSQ	Cowichan R. @ Allenby Rd.	13:46	1.54	0.0080	20
LCSQ	Cowichan R. @ TCH	13:10	1.59	0.0109	25
LCSQ	Cowichan R. 1km east of PE1497	13:28	2.54	0.0216	31
LCSQ	Quamichan Ck. head	12:49	952.00	3.0000	170
LCSQ	Quamichan Lk. @ Westlock Rd.	12:34	90.30	0.4290	250
LCSQ	Richards Ck. @ Herd Rd.	12:00	3.60	0.2150	15
LCSQ	Richards Ck. @ Herd Rd.	12:00	3.86	0.0812	16
LCSQ	Somenos Ck. @ Lakes Rd.	12:20	8.06	0.1310	86

Appendix Table 9: Test results for turbidity, phosphorus and E. coli for fresh water water quality testing on 31 October, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

CBT	Garnett Ck. @ Cherry Pt. Beach	11:00	1.68	0.0315	16
CBT	Garnett Ck. @ Telegraph Rd.	10:55	4.76	0.1940	2
CBT	Manly Ck., end of Hatch Pt. Rd.	10:35	3.09	0.1510	8
CBT	Speirs Ck @ Cowichan B. Rd.	12:20	0.82	0.0993	23
CBT	Speirs Ck @ Cowichan B. Rd.	12:20	0.87	0.1160	15
CBT	Speirs Ck @ Hillbank Rd.	12:10	5.56	0.0488	10
CBT	storm drain @ Botwood Ln.	11:30	1.04	0.1760	27
CBT	Storm Drain @ Cherry Pt. marina	11:10	6.67	0.1500	24
CBT	Treffery Ck. @ Cowichan B. Rd.	12:24	1.55	0.4070	6
CBT	Waldy Ck. @Cherry Pt. Rd.	11:20	62.30	0.1610	18
CBT	Wessex Ck @ Wessex Inn	11:45	1.16	0.0604	8
KRB	Glenora Ck. @ Doupe Rd.	11:17	0.55	0.0226	32
KRB	Howie Ck. @ Koksilah Rd.	10:20	1.29	0.0440	570
KRB	Kelvin Ck. @ Koksilah Rd.	11:00	0.50	0.0124	47
KRB	Koksilah R. @ Koksilah Rd.	11:48	0.30	0.0057	26
KRB	Koksilah R. @ TCH	12:04	0.50	0.0068	19
KRB	Koksilah R. D/S Bright Angel Pk.	10:40	0.41	0.0052	16
KRB	Koksilah R. D/S Bright Angel Pk.	10:44	0.56	0.0047	17
KRB	Koksilah R. D/S Kelvin Ck.	11:30	0.50	0.0078	28
KRB	Patrolas Ck. @ Moss Rd.	10:03	1.35	0.0431	29
LCSQ	Averill Ck. @ TCH	10:37	1.23	0.0314	29
LCSQ	Bings Cr. @ Phillip + Mary St.	10:47	0.82	0.0402	20
LCSQ	Cowichan R. @ Allenby Rd.	14:11	1.87	0.0095	11
LCSQ	Cowichan R. @ TCH	14:00	1.41	0.0096	11
LCSQ	Cowichan R. 1km east of PE1497	13:42	2.03	0.0272	48
LCSQ	Quamichan Ck. head	12:06	52.60	0.6490	8
LCSQ	Quamichan Lk. @ Westlock Rd.	11:50	169.00	1.0600	2
LCSQ	Quamichan Lk. @ Westlock Rd.	11:50	53.50	1.2800	4
LCSQ	Richards Ck. @ Herd Rd.	11:15	2.78	0.3640	77
LCSQ	Somenos Ck. @ Lakes Rd.	11:30	11.40	0.1750	31

Appendix Table 10: Test results for turbidity, phosphorus and E. coli for fresh water water quality testing on 07 November, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

CBT	Garnett Ck. @ Cherry Pt. Beach	11:03	3.22	0.0319	20
CBT	Garnett Ck. @ Telegraph Rd.	11:00	28.50	0.3950	1910
CBT	Manly Ck., end of Hatch Pt. Rd.	10:40	3.85	0.1190	11
CBT	Speirs Ck @ Cowichan B. Rd.	12:26	0.95	0.0922	1770
CBT	Speirs Ck @ Hillbank Rd.	12:21	4.78	0.0308	110
CBT	storm drain @ Botwood Ln.	11:40	9.45	0.0834	18
CBT	Storm Drain @ Cherry Pt. marina	11:15	0.78	0.2030	36
CBT	Treffery Ck. @ Cowichan B. Rd.	12:33	1.37	0.3180	50
CBT	Waldy Ck. @Cherry Pt. Rd.	11:25	101.00	0.0780	24
CBT	Wessex Ck @ Wessex Inn	12:05	0.63	0.0489	11
CBT	Wessex Ck @ Wilmont Rd.	10:40	1.83	0.1210	13
KRB	Ditch by Bright Angel Park	10:30	0.33	0.0044	3
KRB	Glenora Ck. @ Doupe Rd.	11:10	0.56	0.0211	12
KRB	Howie Ck. @ Koksilah Rd.	10:50	0.42	0.0200	30
KRB	Kelvin Ck. @ Koksilah Rd.	11:00		0.0117	22
KRB	Koksilah R. @ Koksilah Rd.	10:18	2.04	0.0046	16
KRB	Koksilah R. @ TCH	11:42	1.11	0.0086	7
KRB	Koksilah R. D/S Bright Angel Pk.	11:10	0.38	0.0225	2
KRB	Koksilah R. D/S Kelvin Ck.	11:25	0.57	0.0083	41
KRB	Patrolas Ck. @ Moss Rd.	10:05	2.83	0.0475	95
LCSQ	Averill Ck. @ TCH	10:25	1.59	0.0278	64
LCSQ	Bings Cr. @ Phillip + Mary St.	10:50	2.71	0.0552	820
LCSQ	Cowichan R. @ Allenby Rd.	13:04	0.80	0.0124	11
LCSQ	Cowichan R. @ TCH	12:48	0.74	0.0146	13
LCSQ	Cowichan R. 1km east of PE1497	12:27	1.06	0.0379	29
LCSQ	Cowichan R. 1km east of PE1497	12:27	1.76	0.0317	32
LCSQ	Quamichan Ck. head	11:55	46.30	0.5170	4
LCSQ	Quamichan Lk. @ Westlock Rd.	11:39	93.60	0.7500	4
LCSQ	Richards Ck. @ Herd Rd.	11:05	1.57	0.0960	16
LCSQ	Somenos Ck. @ Lakes Rd.	11:20	12.70	0.2500	35

Appendix Table 11: Test results for turbidity, phosphorus and E. coli for fresh water water quality testing on 14 November, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

CBT	Garnett Ck. @ Cherry Pt. Beach	11:19	23.30	0.2770	1300
CBT	Garnett Ck. @ Telegraph Rd.	11:13	34.80	0.3170	530
CBT	Manly Ck., end of Hatch Pt. Rd.	11:00	8.21	0.2090	140
CBT	Sparwood Ck. @ end of Sparwood Rd.	11:40	1.09	0.1600	1
CBT	Speirs Ck @ Cowichan B. Rd.	12:55	21.40	0.1380	660
CBT	Speirs Ck @ Hillbank Rd.	12:50	17.70	0.0950	780
CBT	storm drain @ Botwood Ln.	12:06	43.10	0.1120	1160
CBT	Storm Drain @ Cherry Pt. marina	11:29	48.60	0.2910	2110
CBT	Treffery Ck. @ Cowichan B. Rd.	13:00	36.30	0.2730	1800
CBT	Treffery Ck. @ Hwy	10:42	14.70	0.0952	220
CBT	Waldy Ck. @Cherry Pt. Rd.	11:55	23.60	0.1780	160
CBT	Wessex Ck @ Wessex Inn	0:35	33.50	0.1460	180
CBT	Wessex Ck @ Wessex Inn	12:35	34.70	0.1380	190
CBT	Wessex Ck @ Wilmont Rd.	12:40	26.00	0.2880	710
KRB	Ditch by Bright Angel Park	10:35	57.40	0.6720	1170
KRB	Glenora Ck. @ Doupe Rd.	11:05	3.50	0.0422	490
KRB	Howie Ck. @ Koksilah Rd.	10:20	29.30	0.1260	1400
KRB	Kelvin Ck. @ Koksilah Rd.	10:46	3.58	0.0387	180
KRB	Koksilah R. @ Koksilah Rd.	10:16	1.66	0.0097	63
KRB	Koksilah R. @ TCH	11:15	3.64	0.0242	247
KRB	Koksilah R. D/S Bright Angel Pk.	10:30	2.35	0.0098	25
KRB	Koksilah R. D/S Kelvin Ck.	10:55	2.90	0.0248	150
KRB	Patrolas Ck. @ Moss Rd.	10:05	5.32	0.1100	210
KRB	Patrolas Ck. @ Moss Rd.	10:05	4.55	0.1030	740
LCSQ	Averill Ck. @ TCH	10:30	14.50	0.0947	1320
LCSQ	Bings Cr. @ Phillip + Mary St.	10:48	11.10	0.0964	290
LCSQ	Bings Cr. @ Phillip + Mary St.	10:48	11.40	0.0993	370
LCSQ	Cowichan R. @ Allenby Rd.	13:00	10.20	0.0481	350
LCSQ	Cowichan R. @ TCH	12:45	9.07	0.0501	298
LCSQ	Cowichan R. 1km east of PE1497	12:23	3.11	0.0390	114
LCSQ	Quamichan Ck. head	11:59	21.60	0.4610	10
LCSQ	Quamichan Lk. @ Westlock Rd.	11:41	3.20	0.0541	43
LCSQ	Richards Ck. @ Herd Rd.	11:06	4.27	0.1180	113
LCSQ	Somenos Ck. @ Lakes Rd.	11:21	3.35	0.1080	85

Appendix Table 12: Test results for turbidity, phosphorus and E. coli for fresh water water quality testing on 21 November, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

CBT	Garnett Ck. @ Cherry Pt. Beach	11:11	99.40	0.3450	630
CBT	Garnett Ck. @ Telegraph Rd.	11:05	138.00	0.3750	1800
CBT	Manly Ck., end of Hatch Pt. Rd.	10:55	32.10	0.2540	380
CBT	Manly Ck., end of Hatch Pt. Rd.	10:55	32.80	0.2590	450
CBT	Sparwood Ck. @ end of Sparwood Rd.	11:35	0.48	0.0494	1
CBT	Speirs Ck @ Cowichan B. Rd.	12:45	534.00	1.2300	500
CBT	Speirs Ck @ Hillbank Rd.	12:36	72.50	0.1850	830
CBT	storm drain @ Botwood Ln.	11:55	996.00	1.2100	1710
CBT	Storm Drain @ Cherry Pt. marina	11:22	233.00	0.5460	1430
CBT	Treffery Ck. @ Cowichan B. Rd.	12:47	366.00	1.3800	1500
CBT	Treffery Ck. @ Hwy	10:37	19.60	0.1070	800
CBT	Waldy Ck. @Cherry Pt. Rd.	11:50	38.60	0.1800	210
CBT	Wessex Ck @ Wessex Inn	12:20	624.00	1.4000	850
CBT	Wessex Ck @ Wilmont Rd.	12:30	107.00	0.5790	2000
KRB	Ditch by Bright Angel Park	10:20	100.00	0.4290	1430
KRB	Glenora Ck. @ Doupe Rd.	10:56	25.50	0.0783	660
KRB	Howie Ck. @ Koksilah Rd.	10:40	11.30	0.0567	350
KRB	Howie Ck. @ Koksilah Rd.	10:40	13.10	0.0569	300
KRB	Kelvin Ck. @ Koksilah Rd.	10:45	7.73	0.0400	420
KRB	Koksilah R. @ Koksilah Rd.	10:10	3.18	0.0144	30
KRB	Koksilah R. @ TCH	11:30	7.21	0.0416	500
KRB	Koksilah R. D/S Bright Angel Pk.	10:15	3.08	0.0118	91
KRB	Koksilah R. D/S Kelvin Ck.	11:12	8.15	0.0356	290
KRB	Patrolas Ck. @ Moss Rd.	10:00	8.49	0.1420	140
LCSQ	Averill Ck. @ TCH	10:48	19.10	0.0920	650
LCSQ	Bings Cr. @ Phillip + Mary St.	11:07	20.10	0.0924	500
LCSQ	Cowichan R. @ Allenby Rd.	13:15	22.80	0.0605	60
LCSQ	Cowichan R. @ TCH	12:58	16.30	0.0467	20
LCSQ	Cowichan R. @ TCH	12:58	18.90	0.0506	30
LCSQ	Cowichan R. 1km east of PE1497	12:40	11.30	0.0357	30
LCSQ	Quamichan Ck. head	12:16	17.90	0.3430	70
LCSQ	Quamichan Lk. @ Westlock Rd.	12:01	3.29	0.0504	108
LCSQ	Richards Ck. @ Herd Rd.	11:25	6.19	0.1000	26
LCSQ	Somenos Ck. @ Lakes Rd.	11:41	10.30	0.0544	148

Appendix Table 13: Test results for Enterococcus and fecal coliform bacteria for marine water quality testing on 24 October, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

Location	Time	Enterococcus (#/100ml)	Coliform Bacteria (#/100ml)
1 km E of Satellite Ch.	11:10	78	26
between Cherry Pt. / Skinner Pt.	11:24	182	37
Cherry Pt. marina	11:20	199	14
Cowichan B @ Boatswain Bk.	12:04	105	36
Cowichan B N of Westcan Term.	11:55	82	25
Cowichan B S of Westcan Term.	11:45	155	42
Cowichan B. @ Garnett Ck.	12:15	70	28
Cowichan B. @ Manley Ck.	12:09	146	40
Cowichan B. @ Manley Ck.	12:09	138	46
Cowichan B. @ Manley Ck.	12:09	154	34
Cowichan B. above Lambourn Holdings	12:01	33	13
Cowichan B. above PE 1538 outfall	11:50	86.5	77.5
Cowichan B. above PE 1538 outfall	11:50	52	34
Cowichan B. above PE 1538 outfall	11:50	121	121
Cowichan B. Marina 1	16:55	161	82
Cowichan B. Marina 2	10:57	150	60
Cowichan B. Marina 3	10:54	102	60
Cowichan B. Marina 4	11:00	104	60
Cowichan B. off beach S of canoe shed	11:36	60	33
Cowichan B. off ck. W of white house	11:42	75	35
Cowichan B. S of breakwater	12:30	154	38
Genoa B. head	10:50	12	5
Genoa B. mouth	10:55	85	6
Genoa B. near marina	11:01	56	19
Hatch Pt.	12:22	168	29
Separation Pt.	11:14	75	31
Skinner Pt.	11:30	77	17
small bay SE of Genoa B.	11:06	119	21

Appendix Table 14: Test results for Enterococcus and fecal coliform bacteria for marine water quality testing on 01 November, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

Location	Time	Enterococcus (#/100ml)	Coliform Bacteria (#/100ml)
1 km E of Satellite Ch.	12:47	25	6
1 km E of Satellite Ch.	12:47	20	10
1 km E of Satellite Ch.	12:47	30	2
between Cherry Pt. / Skinner Pt.	13:41	20	3
Cherry Pt. marina	13:39	20	7
Cowichan B @ Boatswain Bk.	13:00	10	23
Cowichan B N of Westcan Term.	13:26	10	4
Cowichan B S of Westcan Term.	13:58	10	1.5
Cowichan B S of Westcan Term.	13:58	10	2
Cowichan B S of Westcan Term.	13:58	10	1
Cowichan B. @ Garnett Ck.	13:04	10	9
Cowichan B. @ Manley Ck.	13:09	10	3
Cowichan B. above Lambourn Holdings	13:27	10	2
Cowichan B. above PE 1538 outfall	13:59	20	4
Cowichan B. Marina 1	12:15	10	38
Cowichan B. Marina 2	12:18	20	150
Cowichan B. Marina 3	12:22	10	150
Cowichan B. Marina 4	12:30	20	10
Cowichan B. off beach S of canoe shed	13:52	30	22
Cowichan B. off ck. W of white house	13:31	10	55
Cowichan B. S of breakwater	13:46	10	2
Genoa B. head	12:16	7	4
Genoa B. mouth	12:21	10	7
Genoa B. near marina	12:23	10	4
Hatch Pt.	13:11	10	1
Separation Pt.	12:54	20	6
Skinner Pt.	12:07	40	65
small bay SE of Genoa B.	12:32	10	9

Appendix Table 15: Test results for Enterococcus and fecal coliform bacteria for marine water quality testing on 07 November, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

Location	Time	Enterococcus (#/100ml)	Coliform Bacteria (#/100ml)
1 km E of Satellite Ch.	12:17	8	6
between Cherry Pt. / Skinner Pt.	11:59	4	7
Cherry Pt. marina	13:12	2	8
Cowichan B @ Boatswain Bk.	12:30	2	12
Cowichan B N of Westcan Term.	11:20	42	26
Cowichan B S of Westcan Term.	11:13	4	5
Cowichan B. @ Garnett Ck.			
Cowichan B. @ Manley Ck.	12:33	2	4
Cowichan B. above Lambourn Holdings	12:00	10	6
Cowichan B. above PE 1538 outfall	11:08	4	6
Cowichan B. Marina 1	11:50	10	13
Cowichan B. Marina 2	11:53	140	32
Cowichan B. Marina 3	11:59	10	12
Cowichan B. Marina 3	11:50	18	4
Cowichan B. Marina 3	11:59	2	20
Cowichan B. Marina 4	11:59	60	41
Cowichan B. off beach S of canoe shed	12:10	4	4
Cowichan B. off ck. W of white house	12:07	10	4
Cowichan B. S of breakwater	12:45	130	15
Genoa B. head	11:38	2	1
Genoa B. mouth	11:44	16	15
Genoa B. near marina	11:34	2	1
Hatch Pt.	12:37	46	1
Separation Pt.	13:04	24	12
Skinner Pt.	11:26	26	30
small bay SE of Genoa B.	11:09	2	3

Appendix Table 16: Test results for Enterococcus and fecal coliform bacteria for marine water quality testing on 14 November, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

Location	Time	Enterococcus (#/100ml)	Coliform Bacteria (#/100ml)
1 km E of Satellite Ch.	10:45	280	4
between Cherry Pt. / Skinner Pt.	10:40	260	198
Cherry Pt. marina	10:30	276	67
Cowichan B @ Boatswain Bk.	10:15	22	22
Cowichan B N of Westcan Term.	11:25	232	82
Cowichan B S of Westcan Term.	11:20	194	64
Cowichan B. @ Garnett Ck.	10:05	334	11
Cowichan B. @ Manley Ck.	10:10	18	6
Cowichan B. above Lambourn Holdings	10:20	300	110
Cowichan B. above PE 1538 outfall	10:50	250	122
Cowichan B. Marina 1	12:15	120	270
Cowichan B. Marina 2	12:18	120	450
Cowichan B. Marina 3	12:10	244	194
Cowichan B. Marina 3	12:16	120	190
Cowichan B. Marina 3	12:10	368	198
Cowichan B. Marina 4	12:10	120	380
Cowichan B. off beach S of canoe shed	11:30	396	57
Cowichan B. off ck. W of white house	10:25	276	80
Cowichan B. S of breakwater	11:25	292	123.5
Cowichan B. S of breakwater	11:25	290	114
Cowichan B. S of breakwater	11:25	294	133
Genoa B. head	11:05	120	110
Genoa B. mouth	11:15	258	63
Genoa B. near marina	11:10	214	81
Hatch Pt.	10:00	114	9
Separation Pt.	10:35	24	2
Skinner Pt.	10:45	168	186
small bay SE of Genoa B.	11:00	296	65

Appendix Table 17: Test results for Enterococcus and fecal coliform bacteria for marine water quality testing on 21 November, 2017. Boxes are colour coded to reflect the relative score for each site to the range of scores for that parameter at all sites in the summer: Greener scores were lower and redder scores were higher.

Location	Time	Enterococcus (#/100ml)	Coliform Bacteria (#/100ml)
1 km E of Satellite Ch.	12:00	250	64
between Cherry Pt. / Skinner Pt.	12:37	115	53.5
between Cherry Pt. / Skinner Pt.	12:37	122	56
between Cherry Pt. / Skinner Pt.	12:37	108	51
Cherry Pt. marina	12:35	600	60
Cowichan B @ Boatswain Bk.	12:11	400	60
Cowichan B N of Westcan Term.	11:19	200	380
Cowichan B S of Westcan Term.	12:15	400	65
Cowichan B. @ Garnett Ck.	12:06	1330	60
Cowichan B. @ Manley Ck.	12:13	1660	60
Cowichan B. above Lambourn Holdings	11:52	350	49
Cowichan B. above PE 1538 outfall	12:05	750	400
Cowichan B. Marina 1	12:03	870	250
Cowichan B. Marina 2	12:12	980	360
Cowichan B. Marina 3	12:02	690	210
Cowichan B. Marina 4	12:15	560	300
Cowichan B. off beach S of canoe shed	11:54	370	60
Cowichan B. off ck. W of white house	12:37	600	60
Cowichan B. S of breakwater	12:45	660	91
Genoa B. head	11:35	240	70
Genoa B. mouth	11:38	270	176
Genoa B. near marina	11:31	168	60
Hatch Pt.	12:17	310	57
Separation Pt.	12:45	620	148
Skinner Pt.	11:24	86	110
small bay SE of Genoa B.	11:58	98	51.5
small bay SE of Genoa B.	11:58	92	48
small bay SE of Genoa B.	11:58	104	55

