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*Report*

# Comox Lake Water Quality Monitoring Program

Prepared for  
**Comox Valley Regional District**

October 2008



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# 1. Introduction

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## 1.1 Background

In 2005, the Comox Valley Regional District (CVRD) initiated a watershed assessment of Comox Lake. The purpose of this work was to identify the major risks to the Comox Lake water source and determine ways to mitigate these risks.

A key finding of the watershed assessment was that human activities upstream of the Lake outlet and the existing drinking water intake are a significant threat to drinking water quality. To address this concern, it was recommended that a new intake be installed in the Lake, and that human activity in and around the Lake be prohibited or severely restricted. It was also determined that Comox Lake should remain the principal water supply source for the Comox Valley.

In 2007, a conceptual design for the new intake was prepared. The purpose was to evaluate the various intake and transmission options and to provide preliminary costs estimates.

The next step now is to conduct a water quality monitoring program for Comox Lake. This will provide important information for the design of the intake and future water treatment requirements.

## 1.2 Scope of Work

The purpose of the work is to prepare a water quality monitoring program for Comox Lake. The two main objectives of this program are:

1. To provide quality assurance of safe drinking water to the public
2. To provide information on Comox Lake water quality in order to evaluate the future treatment requirements

The first section of this report presents the current Federal, Provincial, and Local regulations on drinking water quality. The second section describes the current monitoring program. The last section presents a recommended monitoring program for the future water supply system at Comox Lake.

## 1.3 References

1. BC Ministry of Health. 2001. *British Columbia Drinking Water Protection Act*. April.
2. BC Ministry of Health. 2003. *British Columbia Drinking Water Protection Regulation*. May.
3. Canadian Council of Ministers of the Environment. 2004. *From Source to Tap: Guidance on the Multi-Barrier Approach to Safe Drinking Water*. June.
4. CH2M HILL. 2006. *Comox Lake Watershed Assessment Phase 1 Summary Report.*, June.

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7. Cherry, David/VIHA Environmental Health Officer. 2008. Telephone conversation with Gaelle Le Penven/CH2M HILL. August 5.
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9. Interior Health Authority. 2008. *Issue Paper: Planning for Drinking Water Filtration Recommendation – Criteria Required for the Deferral of Filtration*. February.
10. Ontario Ministry of Environment. 2002. *Ontario Regulation 170/03 Drinking Water Systems*.
11. Ontario Ministry of Environment. 2003a. *Practices for the Collection and Handling of Drinking-Water Samples*. July 2003,
12. Ontario Ministry of Environment. 2003b. *Technical Support for Ontario Drinking Water Standards, Objectives and Guidelines*. June.
13. Vancouver Island Health Authority. 2006. *Guidelines for the Approval of Water Supply Systems*. April.
14. Vancouver Island Health Authority. 2007. *Drinking Water Treatment for Surface Water Supplies Policy*.
15. Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF). 2005. *Standard Methods of Examination of Water and Wastewater*, 21<sup>st</sup> Edition.

## 2. Drinking Water Regulations

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This section reviews the Federal, Provincial, and Local water quality requirements and guidelines. It also reviews the regulatory treatment requirements, as these also refer to parameters that need to be monitored and treated, if necessary.

### 2.1 Federal, Provincial, and Local Requirements

In Canada, drinking water is regulated by the Provincial and Local Governments. While the Federal Government, Health Canada, performs research and publishes recommendations for safe drinking water, each Province has the responsibility to regulate drinking water (in British Columbia [BC], the Ministry of Health has this responsibility). Locally, each water supplier also complies with the local Health Authority requirements (Comox Valley Regional District is under the jurisdiction of the Vancouver Island Health Authority [VIHA]).

This section presents the Federal recommendations, as well as the BC regulations and requirements from the VIHA.

#### 2.1.1 Canadian Drinking Water Quality Guidelines

The Guidelines for Canadian Drinking Water Quality are established by the Federal-Provincial-Territorial Committee on Drinking Water and are published by Health Canada (Ref. 8). They are regularly revised, based on the latest research results. The Guidelines are intended to be used as benchmarks for the Provinces.

The Guidelines consider more than 100 parameters that can, potentially, be found in Canadian drinking water sources: bacteriological pathogens; physical and chemical contaminants, including metals, inorganics, pesticides, and other organics; as well as radionuclides. The Guidelines establish two types of limits for these contaminants. The Maximum Acceptable Concentration (MAC) is based on health considerations, while the Aesthetic Objective (AO) is based on aesthetic considerations.

Appendix A provides the latest revision (May 2008) of the Canadian Drinking Water Guidelines. Exhibit 1 provides a summary.

**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 1**

Canadian Drinking Water Quality Guidelines

<b>Recommended Parameters for Treated Water</b>	<b>Maximum Acceptable Concentration</b> (mg/L unless otherwise noted)	<b>Aesthetic Objective</b> (mg/L unless otherwise noted)	<b>Frequency</b>
<b>Microbiological:</b>			
Escherichia Coli	0/100mL		1 per 1000 persons / month
Total Coliform	0/100 mL		1 per 1000 persons / month
Heterotrophic Plate Count	no increase above baseline		
Cryptosporidium	3 log reduction/ inactivation		
Giardia	3 log reduction /inactivation		
Enteric Viruses	4 log reduction/ inactivation		
<b>Physical and chemical:</b>			
<b>Physical</b>			
Colour		≤15 TCU	
Odour		Inoffensive	
pH		6.5-8.5	
Taste		Inoffensive	
Temperature		≤15°C	
Turbidity	0.3 ntu /1.0 ntu / 0.1 ntu <sup>(1)</sup>		daily
<b>Inorganics</b>			
Bromate	0.01		
Chlorate	1		
Chloride		≤250	
Chlorite	1		
Cyanide	0.2		
Fluoride	1.5		
Nitrate	45		
Nitritotriacetic acid (NTA)	0.4		
Sulphate		≤500	
Sulphide (as H <sub>2</sub> S)		≤0.05	
Total dissolved solids (TDS)		≤500	
<b>Metals</b>			
Aluminum		0.1/0.2 <sup>(2)</sup>	
Antimony	0.006		
Arsenic	0.01		
Barium	1		
Boron	5		
Cadmium	0.005		
Chromium	0.05		
Copper		≤1.0	
Iron		≤0.3	
Lead	0.01		
Manganese		≤0.05	



**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 1**

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<b>Recommended Parameters for Treated Water</b>	<b>Maximum Acceptable Concentration</b> (mg/L unless otherwise noted)	<b>Aesthetic Objective</b> (mg/L unless otherwise noted)	<b>Frequency</b>
Mercury	0.001		
Selenium	0.01		
Sodium		≤200	
Uranium	0.02		
Zinc		≤5.0	
<b>Pesticides &amp; Herbicides</b>			
2,4-Dichlorophenoxyacetic acid (2,4 -D)	0.1		
Aldicarb	0.009		
Aldrin + dieldrin	0.0007		
Atrazine + metabolites	0.005		
Azinphos-methyl	0.02		
Bendiocarb	0.04		
Bromoxynil	0.005		
Carbaryl	0.09		
Carbofuran	0.09		
Chlorpyrifos	0.09		
Cyanazine	0.01		
Diazinon	0.02		
Dicamba	0.12		
Diclofop-methyl	0.009		
Dimethoate	0.02		
Dinoseb	0.01		
Diquat	0.07		
Diuron	0.15		
Glyphosate	0.28		
Malathion	0.19		
Methoxychlor	0.9		
Metolachlor	0.05		
Metribuzin	0.08		
Paraquat (as dichloride)	0.01		
Parathion	0.05		
Phorate	0.002		
Picloram	0.19		
Simazine	0.01		
Terbufos	0.001		
Trifluralin	0.045		
<b>Organics</b>			
1,1-Dichloroethylene	0.014		
1,2-Dichlorobenzene	0.2	≤0.003	
1,2-Dichloroethane	0.005		
1,4-Dichlorobenzene	0.005	≤0.001	
2,3,4,6-Tetrachlorophenol	0.1	≤0.001	
2,4,6-Trichlorophenol	0.005	≤0.002	
2,4-Dichlorophenol	0.9	≤0.0003	
Benzene	0.005		

**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 1**

Canadian Drinking Water Quality Guidelines

<b>Recommended Parameters for Treated Water</b>	<b>Maximum Acceptable Concentration</b> (mg/L unless otherwise noted)	<b>Aesthetic Objective</b> (mg/L unless otherwise noted)	<b>Frequency</b>
Benzo[a]pyrene	0.00001		
Bromodichloromethane (BDCM)	0.016		
Carbon tetrachloride	0.005		
Chloramines--total	3		
Dichloromethane	0.05		
Ethylbenzene		≤0.0024	
Haloacetic Acids-Total (HAAs)	0.08		
Methyl tertiary-butyl ether (MTBE)		0.015	
Monochlorobenzene	0.08	≤0.03	
Pentachlorophenol	0.06	≤0.030	
Tetrachloroethylene	0.03		
Toluene		≤0.024	
Trichloroethylene		0.005	
Trihalomethanes-total (THMs)	0.1		
Vinyl chloride	0.002		
Xylenes--total		≤0.3	
<b>Other</b>			
Cyanobacterial toxins-Microcysti	0.0015		
<b>Radiological:</b>			
<b>Natural radionuclides</b>		0.1 Bq/L	
Lead-210		2 Bq/L	
Radium-224		0.6 Bq/L	
Radium-226		0.5 Bq/L	
Radium-228		2 Bq/L	
Thorium-228		0.4 Bq/L	
Thorium-230		0.1 Bq/L	
Thorium-232		20 Bq/L	
Thorium-234		4 Bq/L	
Uranium-234		4 Bq/L	
Uranium-235		4 Bq/L	
Uranium-238		5 Bq/L	
<b>Artificial radionuclides</b>			
Cesium-134		7 Bq/L	
Cesium-137		10 Bq/L	
Iodine-125		10 Bq/L	
Iodine-131		6 Bq/L	
Molybdenum-99		70 Bq/L	
Strontium-90		5 Bq/L	
Tritium		7000 Bq/L	

**Notes:**

- (1) 0.3 ntu for chemically assisted filtration; 1.0 ntu for slow sand filtration; 0.1 ntu for membrane filtration
- (2) for plants using alum-based chemicals only

## 2.1.2 British Columbia Regulations

In BC, drinking water is regulated by the British Columbia Drinking Water Protection Regulation (2003) and the Drinking Water Protection Act (2001). Appendix B provides the Act and Regulation (Refs. 1 and 2, respectively).

The BC Ministry of Health is primarily concerned with bacteria. *Escherichia coli* and fecal coliforms must not be detected. Total coliforms must not be detected 90 percent of the time, and if detected, they must be less than 10 counts per 100 mL (Ref. 2).

The regulations also provide monitoring frequency requirements. They vary with the number of served population. For a water supply system that serves between 5,000 and 90,000 people, it is required that 1 sample per 1,000 people be collected per month. For the CVRD, which currently serves 38,000 people with Comox Lake, 38 samples per month are required (Ref. 2).

Moreover, the bacteriological analyses must be performed by a laboratory which has been approved by the BC Ministry of Health. Appendix C provides the list of approved laboratories (Refs. 1 and 2).

Other requirements include reporting. The water supplier must make public an annual report showing the results of the monitoring. Also, if the standards are not met, the laboratory must immediately inform the health officer and the water supplier. The water supplier must then give a public notice of non-potable water (Refs. 1 and 2).

The regulations also require certification for water systems operators. This will be discussed in the next section of the present report (Refs. 1 and 2).

Exhibit 2 summarizes the BC requirements.

### EXHIBIT 2

British Columbia Drinking Water Protection Regulation and  
Drinking Water Protection Act, Treated Water Quality Requirements

Mandatory Parameters for Treated Water	Standard	Sampling Frequency	Sampling Location	Testing/ Analysis Methodology	Reporting Requirements
<b>Microbiological</b>					
Escherichia Coli	0/100 mL	1 per 1,000 of population/ month	Treated and Distributed Water	By approved laboratory	Annual public report and immediate reporting standard <sup>(1)</sup>
Fecal Coliform	0/100 mL			By approved laboratory	Annual public report and immediate reporting standard <sup>(1)</sup>
Total Coliform	0/100 mL on minimum 90% of samples and <10/100 mL where detected	1 per 1,000 of population/ month	Treated and Distributed Water	By approved laboratory	Annual public report and immediate reporting standard <sup>(1)</sup>

Note:

- (1) When standards are not met, the laboratory must immediately inform the water supplier, the drinking water officer, and the health officer. The water supplier must also give a public notice.

### 2.1.3 Vancouver Island Health Authority Requirements

The CVRD must also comply with the local Health Authority requirements. The VIHA officers evaluate and assess new sources of water for public use, make recommendations for operating permits, review water quality monitoring data, and inspect water systems.

The VIHA has issued two policies regarding drinking water quality. The *Guidelines for the Approval of Water Supply Systems* was issued in 2006 and provides treatment requirements and recommendations on water quality testing before the approval of any new water supply system (Ref. 13).

The *Drinking Water Treatment for Surface Water Supplies Policy*, or *4-3-2-1 Policy*, was issued at the end of 2007 and refers to treatment requirements for water systems supplied by surface water (Ref. 14). Both are discussed below.

#### Guidelines for the Approval of Water Supply Systems

The VIHA *Guidelines for the Approval of Water Supply Systems* requires that before the submission for approval of new water supply system, raw water be characterized for the following parameters:

- Microbiological pathogens: total coliforms, non-coliform bacteria, *Escherichia coli*, heterotrophic plate count
- Physical parameters: colour, conductivity, pH, turbidity
- Chemical parameters: alkalinity, corrosiveness, hardness, organic nitrogen, total dissolved solids (TDS), total organic carbon (TOC), ammonia, chloride, fluoride, nitrate, nitrite, sulphate, arsenic, selenium, and other metals

The guidelines also require treatment providing the following levels:

- 2 log inactivation or reduction for *Cryptosporidium* and 3 log inactivation or reduction for *Giardia*
- 4 log inactivation or reduction for viruses and bacteria
- Minimum CT factor of 12 min.mg/L and chlorine residual of 0.2 mg/L
- Disinfection by-products (trihalomethanes [THMs], haloacetic acids [HAAs], chlorite and bromate) at acceptable levels
- Acceptable colour, odour, and taste

Exhibit 3 summarizes the above requirements. Appendix D provides the VIHA *Guidelines for the Approval of Water Supply Systems*.

## Comox Valley Regional District - Comox Lake Water Quality Monitoring Program

### EXHIBIT 3

VIHA Guidelines for the Approval of Water Supply Systems

Mandatory Parameters	Raw Water Characterisation Requirements	Testing/ Analysis Methodology	Treatment Requirements for all Water Systems
<b>Microbiological:</b>			
Cryptosporidium			2 log reduction/ inactivation
Giardia			3 log reduction/ inactivation
Enteric Viruses			4 log reduction/ inactivation
Escherichia Coli	x	(1)	4 log reduction/ inactivation
Total Coliform	x	(1)	4 log reduction/ inactivation
Heterotrophic Plate Count	x	(1)	4 log reduction/ inactivation
Non-Coliform Bacteria	x	(1)	
<b>Physical and chemical:</b>			
<b>Physical</b>			
Colour	x	(3)	acceptable
Conductivity	x	(3)	
Odour			acceptable
pH	x	(3)	
Taste			acceptable
Turbidity	x	(3)	
<b>Inorganics</b>			
Alkalinity	x	(3)	
Ammonia	x	(3)	
Bromate			acceptable
Chloride	x	(3)	
Chlorine residual			min 0.2 mg/L <sup>(2)</sup>
Chlorite			acceptable
Corrosiveness	x	(3)	
Fluoride	x	(3)	
Hardness	x	(3)	
Nitrate	x	(3)	
Nitrite	x	(3)	
Organic Nitrogen	x	(3)	
Phosphorus	x	(3)	
Sulphate	x	(3)	
Total Dissolved Solids (TDS)	x	(3)	
<b>Metals</b>			
Aluminum	x	(3)	
Arsenic	x	(3)	
Barium	x	(3)	
Boron	x	(3)	
Cadmium	x	(3)	

**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 3**

VIHA Guidelines for the Approval of Water Supply Systems

<b>Mandatory Parameters</b>	<b>Raw Water Characterisation Requirements</b>	<b>Testing/ Analysis Methodology</b>	<b>Treatment Requirements for all Water Systems</b>
Calcium	x	(3)	
Chromium	x	(3)	
Copper	x	(3)	
Iron	x	(3)	
Lead	x	(3)	
Magnesium	x	(3)	
Manganese	x	(3)	
Mercury	x	(3)	
Molybdenum	x	(3)	
Nickel	x	(3)	
Potassium	x	(3)	
Selenium	x	(3)	
Silver	x	(3)	
Sodium	x	(3)	
Zinc	x	(3)	
<b>Organics</b>			
Total Organic Carbon (TOC)	x	(3)	
Trihalomethanes-total (THMs)			acceptable
Haloacetic Acids-Total (HAAs)			acceptable

Notes:

- (1) Must be performed by approved laboratory
- (2) or 1 mg/L chloramine residual. Minimum CT = 12 min.mg/L
- (3) according to "Standard Methods for the Examination of Water and Wastewater"
- (4) Additional analyses may be required

## Drinking Water Treatment for Surface Water Supplies Policy

More recently, the VIHA issued the *Drinking Water Treatment for Surface Water Supplies Policy* which has stricter requirements on treatment for water systems supplied by surface water.

Treatment goals for surface water systems are the following:

- 4 log inactivation or removal of viruses
- 3 log inactivation or removal of *Cryptosporidium* and *Giardia*
- 2 treatment processes (usually filtration and disinfection)
- 1 ntu turbidity maximum in the finished water

Filtration deferral may be permitted under the following conditions:

- Turbidity be less than 1 ntu 95 percent of the time, and peak turbidity readings be less than 5 ntu for more than 2 days in a 1-year period
- No more than 10 percent of raw water samples exceed 20 *Escherichia coli*/100 mL in any 6-month period
- Two primary disinfectants be used; the two together need to achieve the 4 log inactivation or reduction of viruses and 3 log inactivation or reduction of *Cryptosporidium* and *Giardia*

As well, the VIHA may require additional treatment to address the following:

- High bacterial counts or risks of fecal contamination of source water
- High organic matter that may result in unacceptable levels of disinfection by-products
- Chemicals or other contaminants that may affect potability

Exhibit 4 summarizes these requirements. Appendix D presents the policy.

EXHIBIT 4  
VIHA Drinking Water Treatment for Surface Water Supplies Policy

Mandatory Parameters	Treatment Requirements for Surface Waters	Requirements for Filtration Deferral
General		
Treatment Processes	Two treatment processes	Two primary disinfectants
CT	min 15 min.mg/L	min 15 min.mg/L
Microbiological		
<i>Cryptosporidium</i>	3 log reduction/inactivation	3 log reduction/inactivation
<i>Giardia</i>	3 log reduction/inactivation	3 log reduction/inactivation
Enteric Viruses	4 log reduction/inactivation	4 log reduction/inactivation
<i>Escherichia Coli</i>		< 20/100 mL (90% of time)
Fecal Coliform	acceptable	acceptable
Heterotrophic Plate Count	acceptable	acceptable

## EXHIBIT 4

## VIHA Drinking Water Treatment for Surface Water Supplies Policy

Mandatory Parameters	Treatment Requirements for Surface Waters	Requirements for Filtration Deferral
Physical and chemical		
Turbidity	< 1 ntu	< 1 ntu (95% of time) <sup>(a)</sup>
Trihalomethanes-total (THMs)	acceptable	acceptable
Haloacetic Acids-Total (HAAs)	acceptable	acceptable

## Notes:

- (a) Peak turbidity readings < 5 ntu for no more than 2 days in a 1-year period
- (b) Drinking water shall be free of chemicals or other contaminants that may affect potability

Based on discussion with VIHA, the CVRD will need to comply with this policy for both existing and future system. VIHA is not aware of any algae or cyanobacterial toxins (microcystin-LR) problems in the area.

## 2.2 Other Considerations

In preparing the water quality monitoring plan, some other references have been reviewed. They include:

- *Guidance on the Multi-Barrier Approach to Safe Drinking Water (or From Source to Tap Assessment Guide)*, published by the Canadian Council of Ministers of the Environment (Ref. 3).
- *Issue Paper: Planning for Drinking Water Filtration Recommendation – Criteria Required for the Deferral of Filtration*, issued by the BC Interior Health Authority (IHA) and which is a guide for water suppliers who want to apply for a deferral of filtration in accordance with the Canadian Drinking Water Quality Guidelines exclusion criteria (Ref. 9).
- The Ontario *Regulation 170/03*, which regulates drinking water in Ontario, as well as other water quality guidelines, published by the Ontario Ministry of Environment (Ref. 10).

These regulations and guidelines are generally the same as the ones previously reviewed. Below is a summary of the findings.

The *Source To Tap Guide* makes an inventory of potential contaminants in Canadian drinking water sources and lists the origins of these contaminants (Appendix E). The Comox Lake Watershed Assessment Phase 2 Summary Report completed by CH2M HILL in 2007 (Ref. 5) identified the major human activities around Comox Lake and the potential contaminants generated by these activities (Appendix F). Based on these two documents, a list of specific parameters that could potentially contaminate Comox Lake was prepared. Exhibit 5 lists the potential contaminants in Comox Lake per the Watershed Assessment Report. Exhibit 6 lists the specific parameters that could potentially contaminate Comox Lake.



For the IHA, the water supply systems that may qualify for deferral of filtration must demonstrate a raw water quality with low turbidity and bacteriological contamination and have two disinfection processes. Moreover, IHA has specific requirements on the raw water quality monitoring. Appendix G presents the policy, and Exhibit 7 summarizes these requirements.

The Ontario Government has strict drinking water quality requirements and is concerned with most of the parameters recommended by the *Canadian Drinking Water Quality Guidelines*, along with additional parameters. Exhibit 8 provides a summary of the parameters and testing frequency requirements.



**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 5**

Potential Contaminants in Comox Lake

Potential Contaminants	Source Industries/Activities											
	Forestry	Mining	Agriculture	Lakeshore Cabins	Camping	Beach use	Boating	Transportation	Trail Use	Development	Landfill	Flooding
Sediments <sup>(1)</sup>	x	x	x					x	x	x		x
Nutrients <sup>(2)</sup>	x		x									
Hydrocarbons	x	x	x	x	x		x	x		x		
Acid drainage <sup>(3)</sup>		x										
Metals		x										
Sulphide	x	x										
Animal wastes <sup>(4)</sup>			x				x		x			
Pesticides			x									
Wastewater <sup>(4)</sup>				x	x					x		
Household chemicals				x	x					x		
Garbage				x	x	x	x		x	x		
Human waste <sup>(4)</sup>					x	x			x			
Paint							x					
Vehicle fluids								x				
Landfill leachate <sup>(5)</sup>											x	
Pathogens												x

Notes:

(1): Includes suspended solids, dissolved solids, turbidity

(2): Includes nitrate, phosphate, sulfate

(3): Includes sulphides, iron, zinc, copper, nickel

(4): Includes fecal coliforms, escherichia coli

(5): Includes dissolved organic matter, sulfate, chloride, iron, aluminium, zinc, ammonia, heavy metals (Pb, Ni, Cu, Hg), halogenated organics



**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 6**

Recommended Parameters to Monitor at Comox Lake per the Watershed Assessment Study and the "From Source to Tap" Guide

Potential Contaminants	Recommended Analysis
<b>Microbiological:</b>	
Cryptosporidium	X
Giardia	X
Toxoplasma gondii	
Escherichia Coli	X
Total coliforms	X
<b>Physical and chemical:</b>	
<b>Physical</b>	
Colour	X
Turbidity	X
<b>Inorganics</b>	
Ammonia	X
Chloride	X
Cyanide	X
Fluoride	
Hardness	X
Monochloramine	X
Nitrate & Nitrite	X
Phosphate	X
Sulphate	X
Sulphide	X
Total dissolved solids (TDS)	X
<b>Metals</b>	
Aluminium	X
Arsenic	X
Barium	X
Boron	X
Cadmium	X
Chromium	X
Copper	X
Iron	X
Lead	X
Mercury	X
Nickel	X
Uranium	X
Zinc	X
<b>Pesticides &amp; Herbicides</b>	
2,4-Dichlorophenoxyacetic acid (2,4 -D)	X
Aldicarb	X
Aldrin + dieldrin	X
Atrazine + metabolites	X
Azinphos-methyl	X
Bendiocarb	X
Bromoxynil	X
Carbaryl	X
Carbofuran	X
Chlorpyrifos	X

**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 6**

Recommended Parameters to Monitor at Comox Lake per the Watershed Assessment Study and the "From Source to Tap" Guide

Potential Contaminants	Recommended Analysis
Cyanazine	X
Diazinon	X
Dicamba	X
Diclofop-methyl	X
Dimethoate	X
Dinoseb	X
Diquat	X
Diuron	X
Glyphosate	X
Malathion	X
Methoxychlor	X
Metolachlor	X
Metribuzin	X
Paraquat (as dichloride)	X
Parathion	X
Phorate	X
Picloram	X
Simazine	X
Terbufos	X
Trifluralin	X
Organics	
1,1-Dichloroethylene	
1,2-Dichloroethane	X
Benzene	X
Benzo[a]pyrene	X
Carbon tetrachloride	X
Chlorophenols	X
Dichlorobenzene	X
Dichloromethane	
Ethylbenzene	X
Monochlorobenzene	
Nitritotriacetic acid (NTA)	X
Tetrachloroethylene	
Toluene	X
Trichloroethylene	X
Trihalomethanes-total (THMs)	X
Vinyl chloride	X
Xylenes	X

**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 7**

Interior Health Authority - Monitoring Program for Filtration Deferral

Recommended Parameters to Test	Frequency	Testing Methodology	Sampling Location	Criteria for Filtration Deferral
<u>Microbiological:</u>				
Cryptosporidium	monthly	(1)	Raw water	
Giardia	monthly	(1)	Raw water	
Escherichia Coli	weekly	(1)	Raw water	< 20/100 mL for 90% of samples in 6-month period
Total Coliform	weekly	(1)	Raw water	< 100/100 mL for 90% of samples in 6-month period
<u>Physical and chemical:</u>				
<u>Physical</u>				
Colour	weekly	(1)	Raw water	
pH	weekly	(1)	Raw water	
Temperature	weekly	(1)	Raw water	
Turbidity	every 4 hours	(1)	Raw water	average daily turbidity <1 ntu for 95% of the time in 3-month period peak turbidity readings <5 ntu for more than 2 days in 1-year period
UV transmittance	weekly	(1)	Raw water	
<u>Other chemical</u>				
Alkalinity	bi-weekly	(1)	Raw water	
Hardness	bi-weekly	(1)	Raw water	
Total Organic Carbon (TOC)	bi-weekly	(1)	Raw water	
Trihalomethanes - total		(1)	Distributed water <sup>(2)</sup>	annual average < 0.1 mg/L

Notes:

- (1) Performed by approved laboratory
- (2) At farthest location from treatment
- (3) Additional criteria for filtration deferral:
  - Treatment: 4 log for viruses, 3 log for Giardia & Cryptosporidium, 2 disinfection processes
  - Watershed control program
  - Monitoring for at least one year





**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 8**

Monitoring Frequency Requirements for Ontario Water Supply Systems

<b>Recommended Parameters</b>	<b>Raw Water</b>	<b>Treated Water</b>	<b>Distributed Water</b>
<u>Microbiological:</u>			
Escherichia Coli	weekly	8 samples + 1 per 1000 people / month	weekly
Total Coliform	weekly	8 samples + 1 per 1000 people / month	weekly
<u>Physical and chemical:</u>			
<u>Physical</u>			
Turbidity	continuous	continuous	
<u>Inorganics</u>			
Chlorine residual		continuous	min 7 samples / week
Fluoride		every 60 months	
Nitrate & Nitrite		every 3 months	
Antimony	annually		
Arsenic	annually		
Barium	annually		
Boron	annually		
Cadmium	annually		
Chromium	annually		
Lead			12 samples twice/ year
Mercury	annually		
Selenium	annually		
Sodium		every 60 months	
Uranium	annually		
<u>Pesticides, Herbicides &amp; Other Organics</u>			
1,1-Dichloroethylene	annually		
1,2-Dichlorobenzene	annually		
1,2-Dichloroethane	annually		
1,4-Dichlorobenzene	annually		
2,3,4,6-Tetrachlorophenol	annually		
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	annually		
2,4,6-Trichlorophenol	annually		
2,4-Dichlorophenol	annually		
2,4-Dichlorophenoxyacetic acid (2,4 -D)	annually		
Alachlor	annually		
Aldicarb	annually		
Aldrin + dieldrin	annually		
Atrazine + metabolites	annually		
Azinphos-methyl	annually		
Bendiocarb	annually		
Benzene	annually		
Benzo[a]pyrene	annually		
Bromoxynil	annually		
Carbaryl	annually		
Carbofuran	annually		

**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 8**

Monitoring Frequency Requirements for Ontario Water Supply Systems

<b>Recommended Parameters</b>	<b>Raw Water</b>	<b>Treated Water</b>	<b>Distributed Water</b>
Carbon tetrachloride	annually		
Chlordane (Total)	annually		
Chlorpyrifos	annually		
Cyanazine	annually		
Diazinon	annually		
Dicamba	annually		
Dichlorodiphenyltrichloroethane (DDT) + metabolites	annually		
Dichloromethane	annually		
Diclofop-methyl	annually		
Dimethoate	annually		
Dinoseb	annually		
Diquat	annually		
Diuron	annually		
Glyphosate	annually		
Heptachlor + Heptachlor Epoxide	annually		
Lindane (Total)	annually		
Malathion	annually		
Methoxychlor	annually		
Metolachlor	annually		
Metribuzin	annually		
Monochlorobenzene	annually		
Paraquat (as dichloride)	annually		
Parathion	annually		
Pentachlorophenol	annually		
Phorate	annually		
Picloram	annually		
Polychlorinated Biphenyls (PCB)	annually		
Prometryne	annually		
Simazine	annually		
Terbufos	annually		
Tetrachloroethylene	annually		
Trichloroethylene	annually		
Trifluralin	annually		
Trihalomethanes-total (THMs)			every 3 months
Vinyl chloride	annually		
<u>Radiological:</u>			
Alpha	annually		
Gross beta	annually		

## 3. Current Monitoring Program

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CVRD operates and manages several water systems, including:

- Comox Valley water system: Water originates in Comox Lake and is taken from the Puntledge River, and this system supplies over 38,000 people
- Black Creek water system: Water originates in the groundwater wells and from the Oyster River, and this system supplies 2,600 people
- Oyster Bay - Buttle Lake water system: Water originates in John Hart Lake and this system supplies 2,700 people
- Denman Island water system: Water is drawn from wells and the system supplies 30 people
- Arden water system
- Greaves Crescent water system
- England Road water system
- Marsden/Camco water system

The Comox Valley water system is the main water supply system operated by CVRD. The purpose of this section is to describe the current water quality monitoring program for the Comox Valley water system.

### 3.1 Water Supply Description

Water for the Comox Valley system is drawn from the Puntledge River, just downstream of its outlet from Comox Lake, through joint-use of the BC Hydro penstock which feeds the generation station about 15 km downstream. A 750-mm-diameter steel main from the penstock supplies water to the chlorination building, which is located a short distance from the generation station. A standby pump station alongside the generating station provides water to the system from the lower river when the penstock supply is unavailable for maintenance or other reasons.

The design of the supply system somewhat reduces the risk of water contamination. By drawing water from the BC Hydro penstock on the Puntledge River, rather than from the River itself, the Regional District avoids contamination risks associated with the downstream reach of the Puntledge River.

The standby pump station includes two self-cleaning travelling screens and four 225 kW, 1,760 rpm multistage pumps (Aurora 1110 Series, 4 stage 14RH with 158 L/s capacity at 108 m TDH). The pumps are run once a month and 1 to 2 weeks a year.

Chlorination is the only treatment currently provided. The chlorination building was upgraded in 2004. There are two mains in the chlorination building, a 1,050-mm-diameter main to East Courtenay, and a 900-mm-diameter main to West Courtenay. Magmeters in these lines measure the flow, and chlorine is fed to each main.

Using 1-tonne cylinders, the chlorine system includes: scales (4 cylinders), vacuum regulators, ejectors, booster pumps for ejector water, and residual analyzers. The entire chlorine system for each supply main is duplicated, except for the rotameters. This provides a good level of redundancy and safety in the event of equipment failure. The first customers on both the east and west mains are 20 minutes downstream of the chlorination building.

Safety features include a chlorine leak detector, eye wash, shower, and a 1-tonne US Filter chlorine gas scrubber which uses 20 percent caustic soda. A 100 kVA/100 kW Cummins Diesel standby generator is available in the event of a power failure.

With the exception of the semi-annual standby pumping, the water system operates by gravity.

## 3.2 Water Quality Monitoring Description

### 3.2.1 Water Quality Testing

The current water quality monitoring program for the Comox Valley water system include the following analyses:

- Weekly bacteriological analysis on distributed water
- Continuous chlorine residual analysis of the treated water
- Monthly metal scan and hardness analysis on raw water
- Annual testing on distributed water for trihalomethanes (THMs), alkalinity, chloride, fluoride, sulphate, and the parameters listed above.

Analyses are currently performed by North Island Laboratories in Courtenay, which is approved by VIHA.

Exhibit 9 lists the parameters, as well as their testing frequency.

Raw water is sampled at the lake discharge. Treated water is tested at the chlorination building. Distributed water is sampled at four locations on the distribution system, which are: West Courtenay Reservoir, Marsden Reservoir, East Courtenay Reservoir, and Comox Reservoir. Exhibit 10 shows the reservoir locations.

### 3.2.2 Recording and Reporting

Currently, chlorine residual is recorded on a paper chart at the chlorination building. The CVRD archives the laboratory results, but there is currently no tool in use for trend analysis.

Water quality reports are submitted by the laboratory to VIHA on a weekly basis. The annual analysis results are published on the CVRD internet site for public information.

**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

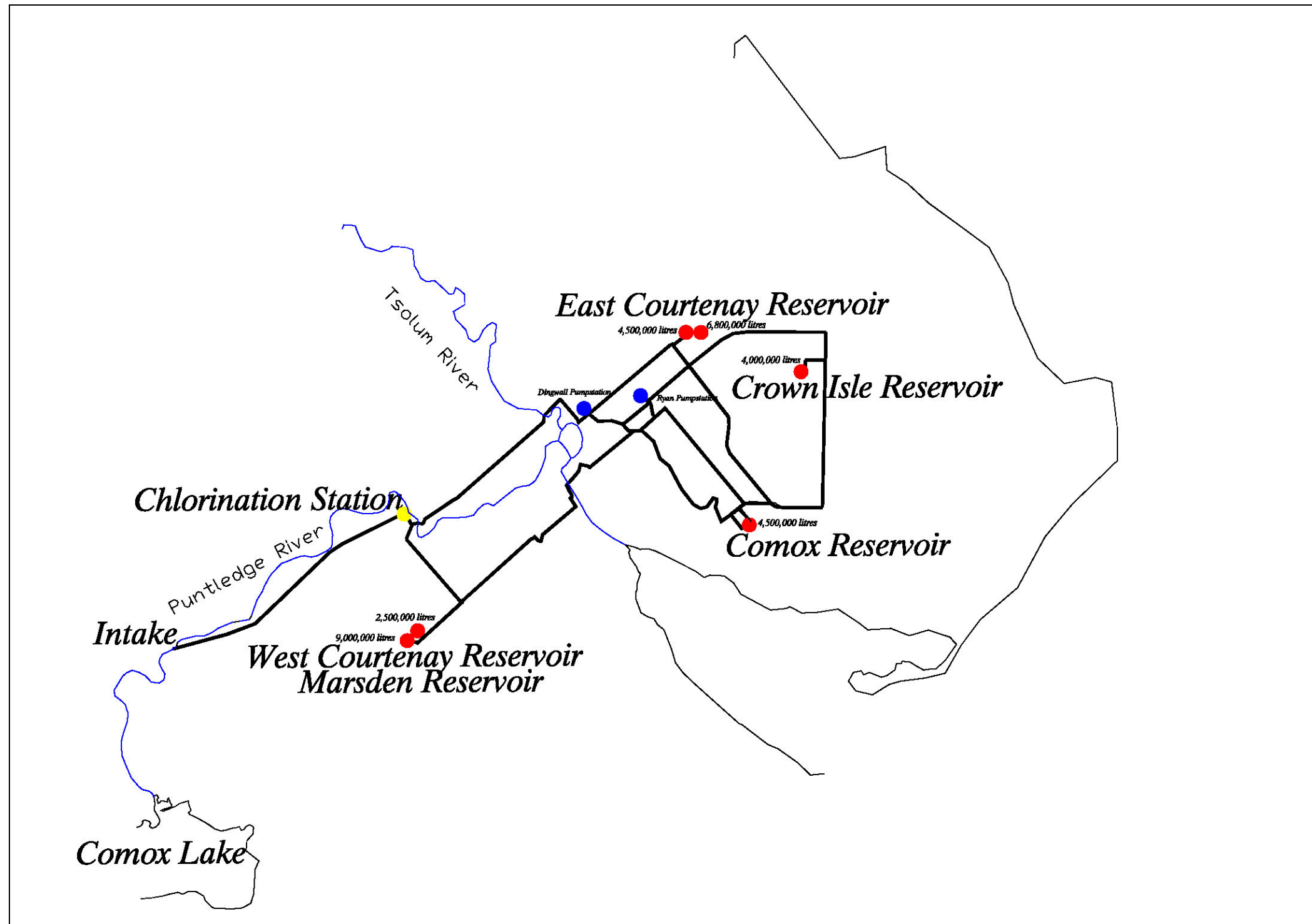
**EXHIBIT 9**

Current Water Quality Monitoring for the Comox Valley Water System

	Raw Water		Treated Water		Distributed Water	
	Parameter Tested	Frequency	Parameter Tested	Frequency	Parameter Tested	Frequency
<u>Microbiological:</u>						
Escherichia Coli					x	weekly
Total Coliform					x	weekly
Heterotrophic Plate Count					x	annually
Non-Coliform Bacteria					x	weekly
<u>Physical and chemical:</u>						
Physical						
Temperature					x	annually
Inorganics						
Alkalinity					x	annually
Chloride					x	annually
Chlorine residual			x	continuous		
Fluoride					x	annually
Hardness	x	monthly			x	annually
Sulphate					x	annually
Metals						
Aluminum	x	monthly			x	annually
Antimony	x	monthly			x	annually
Arsenic	x	monthly			x	annually
Barium	x	monthly			x	annually
Beryllium	x	monthly				
Boron	x	monthly			x	annually
Cadmium	x	monthly			x	annually
Calcium	x	monthly				
Chromium	x	monthly			x	annually
Cobalt	x	monthly				
Copper	x	monthly			x	annually
Iron	x	monthly			x	annually
Lead	x	monthly			x	annually
Magnesium	x	monthly				
Manganese	x	monthly			x	annually
Mercury	x	monthly				
Molybdenum	x	monthly				
Nickel	x	monthly				
Potassium	x	monthly				
Selenium	x	monthly				
Silicon	x	monthly				
Silver	x	monthly				
Sodium	x	monthly			x	annually
Strontium	x	monthly				
Thallium	x	monthly				
Tin	x	monthly				
Titanium	x	monthly				
Uranium	x	monthly			x	annually
Zinc	x	monthly			x	annually
Organics						
Trihalomethanes-total (THMs)					x	annually



EXHIBIT 10  
Current Water Quality Monitoring For The Existing Comox Lake Supply System – Additional Recommended Testing







## 4. Proposed Monitoring Program

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The purpose of this section is to describe the future water system at Comox Lake and propose a water quality monitoring program for this future system. It also provides some recommendations on sampling, testing, recording, and reporting.

### 4.1 Water System Description

The Comox Lake Intake Conceptual Design performed by CH2M HILL in 2007 evaluated several options for the new intake and transmission main. The most viable option in terms of costs is described below.

The new intake would be about 800 m upstream and southwest of the Lake outlet, at a depth of 20 to 30 m, and would consist of a submerged pipeline.

A surface pipeline about 8-km long would transmit water from the new intake to the existing chlorination building. At this location the new supply system would tie-in to the existing distribution system.

Two possible locations of the water treatment plant (WTP) were identified: on the lakeshore and about 3 km from the lakeshore. Treatment requirements for the future WTP have not been identified yet, as water quality data of the new intake need to be gathered.

### 4.2 Water Quality Testing

#### 4.2.1 Parameters to Analyze

Based on the regulatory requirements presented in the first section of this report and on CH2M HILL's experience on similar projects, this section presents the parameters that should be included in the water monitoring program for the new intake.

##### Raw Water

Exhibit 11 presents the list of mandatory and recommended parameters to test on raw water, along with their testing frequency.

##### *Mandatory Parameters for Raw Water*

The parameters that should be tested according to the BC regulations and the VIHA requirements are:

- Bacteriological: Esherichia Coli, fecal and total coliforms, heterotrophic count plate (HPC) and non-coliform bacteria should be tested on a weekly basis on raw water.
- Physical: Colour and conductivity be tested every two weeks. pH should be tested on a daily basis and turbidity should be tested continuously or every 4 hours on raw water.

- Inorganics: Alkalinity and hardness should be tested every 2 weeks on raw water. Corrosiveness, total dissolved solids (TDS), ammonia, chloride, fluoride, nitrate and nitrite, organic nitrogen, phosphorus, and sulphate should be tested every 3 months on raw water.
- Metals: A metal scan (including: aluminum, arsenic, barium, boron, cadmium, chromium, copper, lead, magnesium, mercury, molybdenum, nickel, potassium, selenium, silver, and uranium) should be performed every 3 months on raw water. In addition, calcium, iron, manganese, and sodium should be tested every two weeks on raw water.
- Organics: total organic carbon (TOC) should be tested on a weekly basis on raw water.

### ***Recommended Parameters for Raw Water***

Additional recommended parameters to test include the following:

- Bacteriological: *Cryptosporidium* and *Giardia* should be tested on a monthly basis on raw water to set up a baseline.
- Physical: Temperature and UV transmittance (filtered and apparent) should be tested on a daily basis on raw water. The new 4-3-2-1 policy requires at least two treatment processes. Depending on the turbidity and bacteriological quality, this may be either filtration or secondary disinfection, such as ultraviolet (UV). UV transmittance information is essential to size UV equipment.
- Inorganics: As identified in Section 2.2 of the present report, human activities, such as forestry and mining, could release other inorganic contaminants. They include cyanide and sulphide, which should be tested every 3 months on raw water.
- Organics and Pesticides: As identified in Section 2.2 of the present report, human activities, such as recreational and farming, could release other contaminants. It is recommended that organics, herbicides, and pesticides be tested on raw water. They should be tested at least every year on raw water. A complete list of organics and pesticides is presented in Exhibit 11.

**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 11**

Water Quality Monitoring Plan - Raw Water

	<b>Mandatory Testing <sup>(1)</sup></b>	<b>Raw Water Recommended Testing</b>	<b>Frequency <sup>(2)</sup></b>
<b>Microbiological:</b>			
Cryptosporidium		x	monthly
Giardia		x	monthly
Enteric Viruses			
Escherichia Coli	x		weekly
Fecal Coliform	x		weekly
Total Coliform	x		weekly
Heterotrophic Plate Count	x		weekly
Non-Coliform Bacteria	x		weekly
<b>Physical and chemical:</b>			
<b>Physical</b>			
Colour	x		bi-weekly
Conductivity	x		bi-weekly
pH			daily
Temperature		x	daily
Turbidity	x		continuous
UV Absorbance/Transmittance		x	daily
<b>Inorganics</b>			
Alkalinity	x		bi-weekly
Ammonia	x		quaterly
Chloride	x		quaterly
Chlorine residual			
Corrosiveness	x		quaterly
Cyanide		x	quaterly
Fluoride	x		quaterly
Hardness	x		bi-weekly
Nitrate	x		quaterly
Nitrite	x		quaterly
Chloramines			
Organic Nitrogen	x		quaterly
Phosphate		x	quaterly
Phosphorus	x		quaterly
Silica			quaterly
Sulphate	x		quaterly
Sulphide		x	quaterly
Total Dissolved Solids (TDS)	x		quaterly
<b>Metals</b>			
Aluminum	x		quaterly
Arsenic	x		quaterly
Barium	x		quaterly
Boron	x		quaterly
Cadmium	x		quaterly
Calcium	x		quaterly

**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 11**

Water Quality Monitoring Plan - Raw Water

	<b>Mandatory Testing <sup>(1)</sup></b>	<b>Raw Water Recommended Testing</b>	<b>Frequency <sup>(2)</sup></b>
Chromium	x		quaterly
Copper	x		quaterly
Iron	x		quaterly
Lead	x		quaterly
Magnesium	x		quaterly
Manganese	x		quaterly
Mercury	x		quaterly
Molybdenum	x		quaterly
Nickel	x		quaterly
Potassium	x		quaterly
Selenium	x		quaterly
Silver	x		quaterly
Sodium	x		quaterly
Uranium		x	quaterly
Zinc	x		quaterly
<b>Organics</b>			
Dissolved Organic Carbon (DOC)		x	bi-weekly
Total Organic Carbon (TOC)	x		bi-weekly
Trihalomethanes-total (THMs)			
Haloacetic Acids-Total (HAAs)			
1,1-Dichloroethylene		x	annually
1,2-Dichloroethane		x	annually
Benzene		x	annually
Benzo[a]pyrene		x	annually
Carbon tetrachloride		x	annually
Chlorophenols		x	annually
Dichlorobenzene		x	annually
Dichloromethane		x	annually
Ethylbenzene		x	annually
Monochlorobenzene		x	annually
Nitrilotriacetic acid (NTA)		x	annually
Tetrachloroethylene		x	annually
Toluene		x	annually
Trichloroethylene		x	annually
Vinyl chloride		x	annually
Xylenes		x	annually
<b>Pesticides &amp; Herbicides</b>			
2,4-Dichlorophenoxyacetic acid (2,4 -D)		x	annually
Aldicarb		x	annually
Aldrin + dieldrin		x	annually
Atrazine + metabolites		x	annually
Azinphos-methyl		x	annually
Bendiocarb		x	annually
Bromoxynil		x	annually
Carbaryl		x	annually
Carbofuran		x	annually
Chlorpyrifos		x	annually

**Comox Valley Regional District - Comox Lake Water Quality Monitoring Program**

**EXHIBIT 11**

Water Quality Monitoring Plan - Raw Water

	<b>Mandatory Testing <sup>(1)</sup></b>	<b>Raw Water Recommended Testing</b>	<b>Frequency <sup>(2)</sup></b>
Cyanazine		x	annually
Diazinon		x	annually
Dicamba		x	annually
Diclofop-methyl		x	annually
Dimethoate		x	annually
Dinoseb		x	annually
Diquat		x	annually
Diuron		x	annually
Glyphosate		x	annually
Malathion		x	annually
Methoxychlor		x	annually
Metolachlor		x	annually
Metribuzin		x	annually
Paraquat (as dichloride)		x	annually
Parathion		x	annually
Phorate		x	annually
Picloram		x	annually
Simazine		x	annually
Terbufos		x	annually
Trifluralin		x	annually

Notes:

- (1) British Columbia regulations & Vancouver Island Health Authority requirements
- (2) Recommended frequency, except for E. Coli, fecal and total coliforms (mandatory frequency on raw water)

## Treated Water

Exhibit 12 presents the list of mandatory and recommended parameters to test on treated water, along with their testing frequency.

EXHIBIT 12  
Water Quality Monitoring Plan – Treated Water

Parameter	Mandatory Testing <sup>(1)</sup>	Recommended Testing	Frequency
<u>Microbiological:</u>			
Escherichia Coli	x		weekly
Fecal Coliform	x		weekly
Total Coliform	x		weekly
<u>Physical and chemical:</u>			
Physical			
Turbidity	x		continuous
Inorganics			
Chlorine residual	x		daily

Note

(1) BC regulations and VIHA requirements

### *Mandatory Parameters for Treated Water*

Treated water should be tested for Escherichia coli, fecal coliforms, total coliforms on a weekly basis. Chlorine residual should also be tested on a daily basis.

If the future treatment includes filtration, turbidity should also be analyzed continuously or at least every 4 hours.

### *Recommended Parameters for Treated Water*

There are none in addition to the above mentioned.

## Distributed Water

Exhibit 13 presents the list of mandatory and recommended parameters to test on the distribution system, along with their testing frequency.

EXHIBIT 13  
Water Quality Monitoring Plan – Distributed Water

Parameter	Mandatory Testing <sup>(1)</sup>	Recommended Testing	Frequency
<u>Microbiological:</u>			
Escherichia Coli	x <sup>(2)</sup>		weekly
Fecal Coliform	x <sup>(2)</sup>		weekly
Total Coliform	x <sup>(2)</sup>		weekly

EXHIBIT 13  
Water Quality Monitoring Plan – Distributed Water

Parameter	Mandatory Testing <sup>(1)</sup>	Recommended Testing	Frequency
<u>Physical and chemical:</u>			
Inorganics			
Chlorine residual	x		daily
Chloramines		x	quarterly
Organics			
Trihalomethanes-total (THMs)		x	quarterly
Haloacetic Acids-Total (HAAs)		x	quarterly

Notes:

- (1) BC regulations and VIHA requirements
- (2) At least sample/1,000 people per month are required per the BC regulations

Mandatory Parameters for Distributed Water

Distributed water should be tested for Escherichia coli, fecal coliforms, total coliforms on a weekly basis. Chlorine residual should be tested on a daily basis.

Recommended Parameters for Distributed Water

Disinfection by-products, such as chloramines, trihalomethanes (THMs) and haloacetic acids (HAAs) should be tested every 3 months in the distribution system.

## 4.3 Standard Operating Procedures

### 4.3.1 Sampling

#### Sampling Locations

Samples should be representative of the water quality of the system. Samples should be taken at the same location and at the same time to be representative.

#### *Raw Water*

Raw water samples should be taken at the location of the future raw water intake, as presented in the previous study; that is to say about 800 m from the lakeshore and at a depth of 20 to 30 m. A temporary sampling system that will allow representative sampling should be installed. The system could consist of a 25-mm line with a float at the intake location. The line could be anchored to the bottom of the Lake up to a station on the lakeshore where operators can grab samples.

It is recommended that CVRD conduct a more detailed analysis to evaluate siting conditions, construction and land constraints as well as evaluate costs of the proposed sampling station.

### *Treated Water*

Sampling of treated water should be performed at the point of entry of the water to the distribution system, after the minimum disinfection contact time and before the first consumer.

### *Distributed Water*

Samples of distributed water should represent and cover the whole distribution system. Per the BC regulations, at least 46 different locations should be selected for sampling and testing. The location criteria are the following:

- Beyond the point of entry to the distribution system
- Where the degradation of water quality and disinfection residual are possible and the formation of disinfection by-products is likely to happen
- At elevated storage tanks
- At dead ends
- In aging water mains
- In distribution loops
- Where there is potential for cross connection/back flow
- At extremities of the distribution system

Dedicated sampling stations are preferred over sampling at resident taps.

A detailed distribution map of the Comox Valley water system would be needed to locate appropriate locations.

## **Collection and Handling**

### *Training/Certification*

As per discussion with David Cherry at the VIHA, there is no special certification or training required for water sampling and on-site testing other than the regular WTP operator certification (Ref. 7).

### *Collection*

Sampling containers provided by the laboratory should be used. The use of intermediate containers is not recommended, as this can create contamination. In addition, disposable gloves should be worn, and care should be taken not to touch the inside of the container.

### *Preservatives*

Appropriate preservatives should be added once the water is collected. Appendix A lists the preservatives to be used. Alternatively, the laboratory should give instructions on which preservatives to use. If the containers have been pre-filled with preservatives, containers should not be rinsed. Care should be taken not to accidentally contaminate the sample with the wrong preservative. Preservatives should be stored separately to avoid cross-contamination.



### *Distribution Sampling*

Taps where samples are taken should be flushed. In the distribution system, sampling should be taken from cold-water taps (once the temperature has reached a constant temperature).

### *Microbiological Sampling*

For microbiological sampling, the container should be recapped immediately after the sample has been taken. The sample should then be refrigerated and transported as soon as possible to the laboratory.

### *Labelling*

Each sample container should be appropriately labelled. Labels should include the following information:

- Type (raw, treated, distributed water) and name of water system
- Date and time of sample collection
- Name of sampler
- Preservatives used
- Parameter to analyze

### *Shipping*

Samples should be delivered as soon as possible to the laboratory. Microbiological samples should be shipped in coolers with ice packs.

A chain-of-custody form should be kept with the samples until they are delivered to the laboratory.

## 4.3.2 Testing

### On-site Testing

Some on-site testing can be performed by CVRD personnel. This includes:

- Turbidity: An on-line nephelometer can be used for raw water and treated water
- pH: an on-line pH-meter can be used on raw water
- Temperature: An on-line thermometer can be used for raw water
- UV Transmittance: An on-line UV absorbance or transmittance analyzer can be used for raw water
- Chlorine Residual: An on-line free and total chlorine analyzer can be used on treated water, and a portable free and total chlorine analyzer can be used on distribution samples

These instruments could be connected to the existing SCADA system. These tests will require minimal operational and maintenance efforts.

### Laboratory Testing

Parameters not mentioned above should be tested by a laboratory.

Analyses should be performed according to the *Standard Methods of Examination of Water and Wastewater*, 21<sup>st</sup> Edition, published by the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF) (Ref. 15).

All bacteriological analyses should be performed by a laboratory approved by the BC Ministry of Health. Appendix B shows the latest list of the approved laboratories.

### 4.3.3 Recording

It is strongly recommended that water quality data, from both on-site and laboratory testing, be recorded in an electronic format such that trend analysis and other statistic analyses can be performed. This will facilitate the water quality analysis during the evaluation of treatment upgrade requirements. Data management could be realized using Excel and/or WaterTrax.

WaterTrax is an online database which allows laboratories and water operators to directly report their test results into the database. WaterTrax can also generate reports that can be exported into Excel files. It can also trigger alerts if quality standards are not met. Some advantages of WaterTrax are accountability and independence.

It is recommended that CVRD attend a WaterTrax demonstration so that it can determine if the software meet their needs.

### 4.3.4 Reporting

The annual public report, as currently published, presents the laboratory results. A suggestion for improvement would be to make the format more public-friendly and the content more simple only showing the most critical information such as: parameters, concentration, and regulatory limits. The City of Calgary, for example, publishes a report that is easy to understand and nice to read for the public. Appendix I presents the 2007 water quality report.

## 4.4 Costs

On a preliminary basis, the CVRD should budget the following for the proposed water quality monitoring program:

- Design and construction costs for the sampling stations at the new intake and in the distribution system: allow \$95,000
- New testing equipment purchase and installation: allow \$42,000
- WaterTrax subscription: allow \$10,000 per year
- Laboratory costs: allow \$15,000 per year

The detailed costs should be further analysed in a future study.

## 5. Summary

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Based on the information presented in the previous sections, the recommended water quality monitoring program for the Comox Lake water system is presented in Exhibit 14.

The next step in implementing the water quality monitoring program for the Comox Valley water system is to prepare detailed cost estimates as per Section 4.4.



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Comox Valley Regional District - Comox Lake Water Quality Monitoring Program

EXHIBIT 14

Water Quality Monitoring Plan for the Comox Lake Supply System

	Mandatory Testing <sup>(1)</sup>	Raw Water Recommended Testing	Frequency <sup>(2)</sup>	Mandatory Testing <sup>(1)</sup>	Treated Water Recommended Testing	Frequency	Mandatory Testing <sup>(1)</sup>	Distributed Water Recommended Testing	Frequency
<b>Microbiological:</b>									
Cryptosporidium		x	monthly						
Giardia		x	monthly						
Enteric Viruses									
Escherichia Coli	x		weekly	x		weekly	x <sup>(3)</sup>		weekly
Fecal Coliform	x		weekly	x		weekly	x <sup>(3)</sup>		weekly
Total Coliform	x		weekly	x		weekly	x <sup>(3)</sup>		weekly
Heterotrophic Plate Count	x		weekly						
Non-Coliform Bacteria	x		weekly						
<b>Physical and chemical:</b>									
<b>Physical</b>									
Colour	x		bi-weekly						
Conductivity	x		bi-weekly						
pH	x		daily						
Temperature		x	daily						
Turbidity	x		continuous	x		continuous			
UV Absorbance/Transmittance		x	daily						
<b>Inorganics</b>									
Alkalinity	x		bi-weekly						
Ammonia	x		quaterly						
Chloride	x		quaterly						
Chlorine residual				x		daily	x		daily
Corrosiveness	x		quaterly						
Cyanide		x	quaterly						
Fluoride	x		quaterly						
Hardness	x		bi-weekly						
Nitrate	x		quaterly						
Nitrite	x		quaterly						
Chloramines								x	quaterly
Organic Nitrogen	x		quaterly						
Phosphate		x	quaterly						
Phosphorus	x		quaterly						
Silica			quaterly						
Sulphate	x		quaterly						
Sulphide		x	quaterly						
Total Dissolved Solids (TDS)	x		quaterly						
<b>Metals</b>									
Aluminum	x		quaterly						
Arsenic	x		quaterly						
Barium	x		quaterly						
Boron	x		quaterly						
Cadmium	x		quaterly						
Calcium	x		quaterly						

Comox Valley Regional District - Comox Lake Water Quality Monitoring Program

EXHIBIT 14

Water Quality Monitoring Plan for the Comox Lake Supply System

	Raw Water			Treated Water			Distributed Water		
	Mandatory Testing <sup>(1)</sup>	Recommended Testing	Frequency <sup>(2)</sup>	Mandatory Testing <sup>(1)</sup>	Recommended Testing	Frequency	Mandatory Testing <sup>(1)</sup>	Recommended Testing	Frequency
Chromium	x		quaterly						
Copper	x		quaterly						
Iron	x		quaterly						
Lead	x		quaterly						
Magnesium	x		quaterly						
Manganese	x		quaterly						
Mercury	x		quaterly						
Molybdenum	x		quaterly						
Nickel	x		quaterly						
Potassium	x		quaterly						
Selenium	x		quaterly						
Silver	x		quaterly						
Sodium	x		quaterly						
Uranium		x	quaterly						
Zinc	x		quaterly						
Organics									
Dissolved Organic Carbon (DOC)		x	bi-weekly						
Total Organic Carbon (TOC)	x		bi-weekly						
Trihalomethanes-total (THMs)							x		quaterly
Haloacetic Acids-Total (HAAs)							x		quaterly
1,1-Dichloroethylene		x	annually						
1,2-Dichloroethane		x	annually						
Benzene		x	annually						
Benzo[a]pyrene		x	annually						
Carbon tetrachloride		x	annually						
Chlorophenols		x	annually						
Dichlorobenzene		x	annually						
Dichloromethane		x	annually						
Ethylbenzene		x	annually						
Monochlorobenzene		x	annually						
Nitritotriacetic acid (NTA)		x	annually						
Tetrachloroethylene		x	annually						
Toluene		x	annually						
Trichloroethylene		x	annually						
Vinyl chloride		x	annually						
Xylenes		x	annually						
Pesticides & Herbicides									
2,4-Dichlorophenoxyacetic acid (2,4 -D)		x	annually						
Aldicarb		x	annually						
Aldrin + dieldrin		x	annually						
Atrazine + metabolites		x	annually						
Azinphos-methyl		x	annually						
Bendiocarb		x	annually						
Bromoxynil		x	annually						
Carbaryl		x	annually						
Carbofuran		x	annually						
Chlorpyrifos		x	annually						

Comox Valley Regional District - Comox Lake Water Quality Monitoring Program

EXHIBIT 14

Water Quality Monitoring Plan for the Comox Lake Supply System

	Mandatory Testing <sup>(1)</sup>	Raw Water Recommended Testing	Frequency <sup>(2)</sup>	Mandatory Testing <sup>(1)</sup>	Treated Water Recommended Testing	Frequency	Mandatory Testing <sup>(1)</sup>	Distributed Water Recommended Testing	Frequency
Cyanazine		x	annually						
Diazinon		x	annually						
Dicamba		x	annually						
Diclofop-methyl		x	annually						
Dimethoate		x	annually						
Dinoseb		x	annually						
Diquat		x	annually						
Diuron		x	annually						
Glyphosate		x	annually						
Malathion		x	annually						
Methoxychlor		x	annually						
Metolachlor		x	annually						
Metribuzin		x	annually						
Paraquat (as dichloride)		x	annually						
Parathion		x	annually						
Phorate		x	annually						
Picloram		x	annually						
Simazine		x	annually						
Terbufos		x	annually						
Trifluralin		x	annually						

Notes:

- (1) British Columbia regulations & Vancouver Island Health Authority requirements
- (2) Recommended frequency, except for E. Coli, fecal and total coliforms (mandatory frequency on raw water)
- (3) At least 1 sample /1000 people per month are required per the BC regulations

