Greater Victoria Drinking Water Quality

2013 Annual Report

DRAFT

Parks & Environmental Services Department | Environmental Protection

Prepared By
Water Quality Program
Capital Regional District
479 Island Highway, Victoria, BC, V9B 1H7
T: (250) 474-9680 F: (250) 474-9691
www.crd.bc.ca

June 2014

Greater Victoria Drinking Water Quality
2013 Annual Report
Executive Summary

This report is the annual overview of water quality testing that was conducted in 2013 within the Greater Victoria Drinking Water System (GVDWS) (Map 1). The test results show that Greater Victoria's drinking water continues to be good quality and is safe to drink. With a few minor exceptions, all the results were within the limits of both the *Guidelines for Canadian Drinking Water Quality* and the BC *Drinking Water Protection Regulation.* This report will be posted on the Capital Regional District's (CRD) website.

Samples and Tests. In 2013, the Water Quality Program collected 6,012 samples from the GVDWS and analyzed those samples for 35,810 individual tests. Approximately 300 different types of analyses were conducted on these samples. The data collected in 2013 are reported in the water quality data tables (see Tables 1, 2 and 3 in Appendix A).

Physical-Chemical-Radiological. All physical, chemical and radiological parameters were well within the Canadian Drinking Water Guideline limits except for summer water temperatures (aesthetic limit of 15ºC). In 2013, the weekly and monthly average water temperatures were above the 15°C limit for a period of about two months from late July to late September (Figure 2 and Figure 3). This is similar to the previous three years and an improvement from the time before the Sooke Lake Reservoir expansion when the water temperature was above the 15°C limit for about four months of the year. This cooler water is one of the benefits of raising the water level in Sooke Lake Reservoir and the ability to draw from deeper and cooler strata. In addition, there was one positive radiological parameter in one sample (gross beta radiation); however, at 0.11 Bq/L this is well below the guideline limit of 1.0 Bq/L

Bacteria in Source Water. In 2013, as in the past few years, the level of total coliform bacteria in the raw (untreated) source water entering the Japan Gulch Disinfection Plant continued to be higher during the fall, peaking in mid-September to mid-October (Figure 2). An increase in total coliform counts was also observed when the Goldstream Reservoir System was used to supply water to the Japan Gulch Plant (December 2-6, 2013) during the period the Kapoor Tunnel was shut down for internal inspection. Nevertheless, the quality of the raw water entering the treatment plant continued to easily meet the *E. coli* limit of 20 colony forming units (CFU) per 100 mL at least 90% of the time as stipulated in the United States Environmental Protection Agency (USEPA) Surface Water Treatment Rule and, therefore, continued to qualify to remain an unfiltered surface water supply under this portion of the USEPA regulations (Figure 3A). In 2013, all of the *E. coli* positive samples contained concentrations below 20 CFU/100 mL.

Treatment. The treatment process used to disinfect the raw source water entering the distribution system continued to be ultraviolet (UV) disinfection followed by the addition of free chlorine and then ammonia (to produce chloramines). The chlorine dosage level was increased twice and decreased once during the year to keep the chlorine residual in the distribution system relatively constant (Figure 4). These changes resulted in monthly median total chlorine residuals ranging from 0.82 to 1.45 mg/L at the entry point to the distribution system.

Bacteria at First Customer. No total coliforms were found in any samples collected at the first customer sampling location below the Japan Gulch Disinfection Plant during 2013 (Figure 4). The annual total coliform-positive sample rate of 0% was lower than the previous years and much better than earlier years before the use of UV and free chlorine as primary disinfectants. No *E. coli* bacteria were found in any of the samples collected at the entry point to the distribution system. This fact provides assurance that Greater Victoria's primary disinfection process is working in a satisfactory manner.

Bacteria in Distribution System. When all of the results from the various municipal distribution systems are grouped together (Figure 5), the percentage of total coliform-positive samples in the Greater Victoria distribution system did not exceed the 10% Guideline limit during any month in 2013 and was, therefore, in compliance with the BC *Drinking Water Protection Regulation*. Over the last 20 years, a broad reduction in total coliform bacteria detection has been observed and, hence, an overall improvement in the bacteriological quality of the water. The relatively low level of total coliform-positive samples (1.2%) reflects the balance maintained between reasonable concentrations of chlorine in the distribution system and acceptable levels of positive bacterial samples.

Parasites. In 2013, no *Giardia* cysts were detected in the raw source water entering Japan Gulch Disinfection Plant (Figure 6). In addition, none of the 2013 samples contained *Cryptosporidium* oocysts (Figure 7). The 10-year average total *Giardia* cyst and total *Cryptosporidium* oocyst concentrations were only 0.020 cysts and 0.031 oocysts per 100 L, respectively (Figure 6 and Figure 7). While these are extremely low values for a surface water supply, the addition of UV disinfection provides assurance that no infective parasites can enter the GVDWS.

Inorganic and Organic Chemicals. All inorganic chemicals, including metals and non-metals, were within Guideline values at the entry point to the distribution system. No organic chemicals, except benzo(a)anthracene, were detected in the raw water entering the treatment plant. It remains to be seen whether or not this represents an actual change in water chemistry or is simply a result of improved lab technology (i.e., the ability of laboratories to detect smaller and smaller quantities). Regardless, this organic chemical does not have a health-related limit in the Canadian Guidelines.

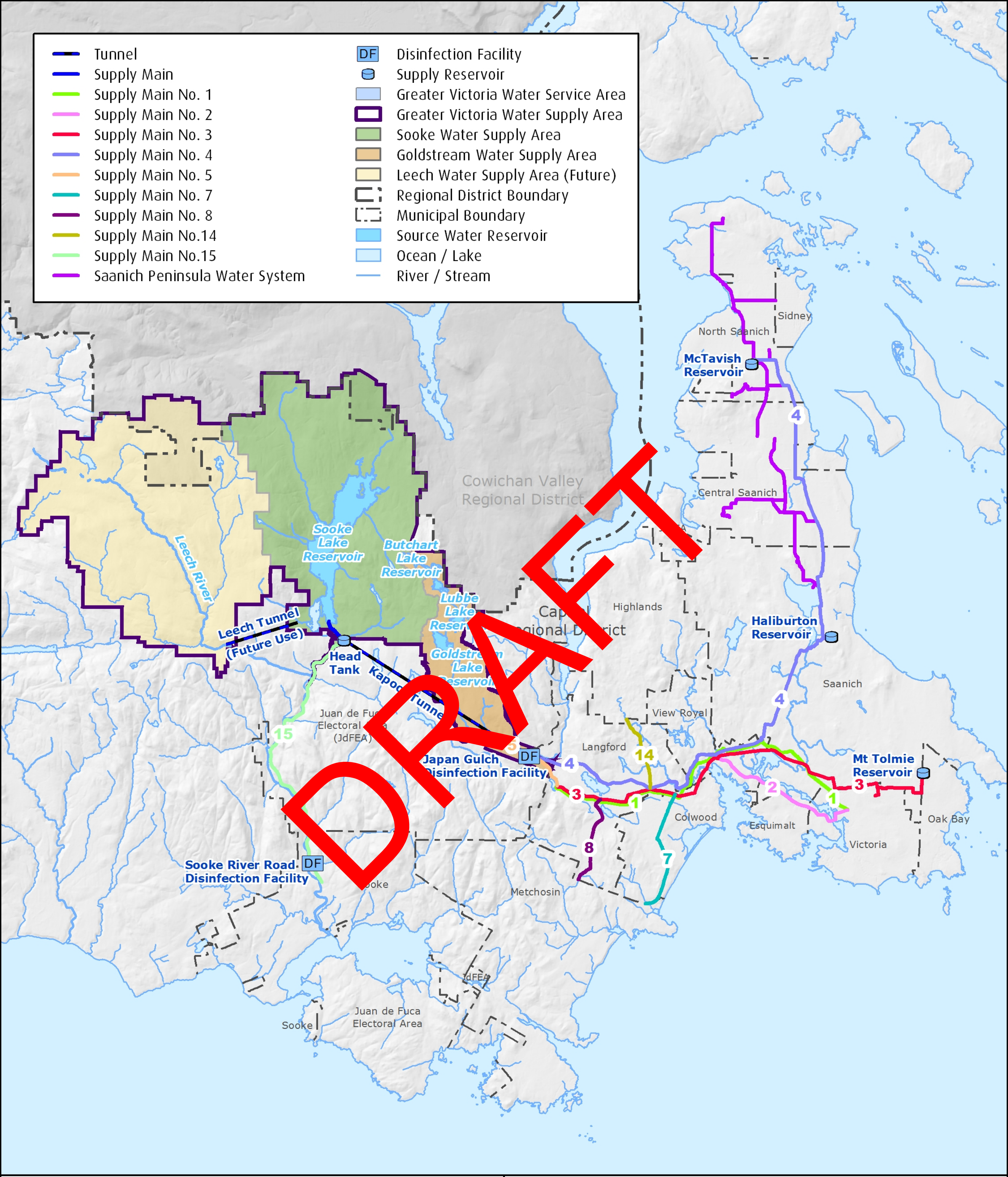
Disinfection Byproducts. Total trihalomethanes (TTHMs), byproducts of the chlorine disinfection process, were well below (range of 6.9-70.2 μg/L for TTHMs) the Canadian Guideline limit of 100 μg/L in the chloraminated distribution system (Figure 8). Similarly, a second group of disinfection byproducts, haloacetic acids (referred to as HAA5 because the limit is based on the concentration of a group of 5 HAAs), were low in the chloraminated distribution system (HAA5 range of 3.98-20.4 μg/L), similar to that seen in 2012 (Figure 9). The Canadian Guideline limit for HAA5s of 80 μg/L was introduced in 2008.

Sooke Reservoir Biological Activity. The overall level of algal activity in Sooke Lake Reservoir is measured using chlorophyll-a, a component of all algal cells (Figure 10). Since 2007, the concentration appears to have reached a steady state with some annual variation. In 2013, the chlorophyll-a concentration peaked in the early spring and early winter for both the south and north basins (see inset Figure 10).

Phosphorus. The primary contributor to the higher levels of the chlorophyll-a observed in Sooke Lake Reservoir in 2004 through 2013 was higher levels of total phosphorus, a nutrient that is needed for the algae to grow. The median concentration of total phosphorus between 2003 and 2007 was approximately 70% higher than in the years before the inundation of the new shoreline in both the north and south basins of Sooke Lake Reservoir (Figure 11). However, the levels of total phosphorus are declining as the median concentration in 2008 through 2013 was only 7.9% higher than in the years before the inundation. The highest phosphorus levels coincided with the flooding of the newly cleared lands around the margin of Sooke Lake Reservoir when the reservoir was expanded. In 2013, the phosphorus levels were similar to that in 2012 and substantially lower than during the inundation.

Algae. In Sooke Lake Reservoir there are a number of species or groups of species that can become dominant during different times of the year. In 2013, there was a notable peak in the chrysophyte group (the genus *Dinobryon*) in May and again in October/November (Figure 12 and Figure 14). Two of the usually dominant algae, the diatoms *Asterionella* (Figure 13) and *Tabellaria* (Figure 15), were present in relatively low numbers compared to previous years. Overall the number of algae in the reservoir in 2013 was similar to the previous five years.

Water Quality Complaints. In 2013, the number of water quality complaints received by CRD Water Quality staff (Table 4) was similar to the previous three years and lower than earlier years (Figure 16).



0 1 2 4 6 8 Kilometres

UTM Zone 10N NAD 1983

N W E S

Greater Victoria Drinking Water Supply System

CRD
Making a difference...together

DISCLAIMER

This map is for general information purposes only and may contain inaccuracies.

February 2014 | GreaterVictoriaDrinkingWatersSupplySystem_8-5x11P.mxd | gis@crd.bc.ca

Greater Victoria Drinking Water Quality
2013 Annual Report

Table of Contents

List of Figures and Appendix

Greater Victoria Drinking Water Quality
2013 Annual Report

1.0 INTRODUCTION

This report is the annual overview of the results from water quality samples collected in 2013 from the GVDWS (Map 1). This overview report is the first of the 2013 series of annual summary reports that provide information on Greater Victoria's drinking water quality. Detailed reports describing the source water quality and the bacteriological, physical-chemical, and disinfection byproducts within individual municipal water distribution systems are issued separately. All reports are posted on the CRD website.

2.0 WATER QUALITY REGULATIONS

The CRD Integrated Water Services Department (IWS) (formerly CRD Water Services) and the municipal water suppliers in the Greater Victoria Drinking Water System must comply with the British Columbia *Drinking Water Protection Act* and *Drinking Water Protection Regulation*. However, due to the limited number of water quality test parameters included in the Regulation, the Water Quality Program also uses the much larger group of water quality parameters listed in the current version of the *Guidelines for Canadian Drinking Water Quality* for compliance purposes. These limits are provided in Tables 1, 2 and 3 (see Appendix A) under the column titled 'Canadian Guidelines'.

In addition to the provincial and federal regulations, on a voluntary basis, CRD IWS also complies with most of the United States Environmental Protection Agency (USEPA) rules and regulations. Some of the limits in the USEPA rules are used as the basis for the department's water treatment goals.

The water quality limits in the *Guidelines for Canadian Drinking Water Quality*[1] fall into one of the following five categories:

1. **Maximum Acceptable Concentration (MAC)**. This is a health-related limit and lists the maximum acceptable concentration of a substance that is known or suspected to cause adverse effects on health. Thus, an exceedence of a MAC can be quite serious and require immediate action by the water supplier.
2. **Aesthetic Objectives (AO)**. These limits apply to certain substances or characteristics of drinking water that can affect its acceptance by consumers or interfere with treatment practices for supplying good quality drinking water. These limits are generally not health related unless the substance is well above the AO.
3. **Parameters without Guidelines**. Some chemical and physical substances have been identified as not requiring a numerical guideline because currently available data indicate that it poses no health risk or aesthetic problem at the levels currently found in drinking water in Canada. In Tables 1, 2 and 3 (see Appendix A); these substances are listed as 'No Guideline Required.'
4. **Archived Parameters**. Guidelines are archived for parameters that are no longer found in Canadian drinking water supplies at levels that could pose a risk to human health, including pesticides that are no longer registered for use in Canada, and for mixtures of contaminants that are addressed individually. Some of these parameters are still being included in the current water quality monitoring program because the analytical laboratory includes them in their scans. In Tables 1, 2 and 3 (see Appendix A); these parameters are listed as 'Guideline Archived'.
5. **Operational Guidance (OG)**. The limit was established based on operational considerations and listed as an Operational Guidance Value. For example, the limit for aluminum is designed to apply only to drinking water treatment plants using aluminum-based coagulants.

It should be noted that not all of the water quality parameters analyzed by the Water Quality Program have Canadian Guideline limits, since some of these parameters are used for operational purposes. Where the Guidelines are silent for a particular parameter, the limit for that parameter is left blank in Tables 1, 2 and 3 (see Appendix A).

[1] (see http://hc-sc.gc.ca/ewh-semt/pubs/water-eau/2012-sum_guide-res_recom/index-eng.php)

3.0 MULTIPLE BARRIER APPROACH

CRD IWS and the municipalities that operate their distribution systems use a multiple barrier approach to prevent the drinking water in the GVDWS from becoming contaminated. Multiple barriers can include procedures, operations, processes and physical components. In a drinking water system, any individual barrier used in isolation may be relatively weak and can be more easily bypassed or defeated. This may result in contamination of the drinking water in that system. However, if these relatively weak individual barriers are used together in combination with each other and, especially if they are arranged so that they complement each other, these multiple barriers are a very powerful means of preventing drinking water contamination. All large drinking water utilities use the multiple barrier approach to prevent drinking water contamination. The exact type of barriers, and how they are used, are often unique to individual drinking water systems.

The following barriers are used in the GVDWS to prevent the drinking water from becoming contaminated:

1. **Good Water System Design**. Good water system design is one of the pre-eminent barriers to drinking water contamination as it allows all of the other components within the water system to operate in an optimal fashion and does not contribute to the deterioration of the quality of the drinking water contained within the system. Good water system design includes such aspects as drinking water treatment plants that are easy to operate, piping appropriately sized to the number of users being supplied and the use of appropriate pipe materials. All new designs are approved by a Public Health Engineer from Island Health. This acts as a double check on good system design.

2. **Source Water Protection**. CRD IWS uses what is considered the ultimate in source water protection: ownership of the catchment (watershed) lands surrounding the source reservoirs. This land area is called the Greater Victoria Drinking Water Supply Area. Within this area, no public access, commercial logging, farming, mining or recreation is permitted and no use of herbicides, pesticides, or fertilizers is allowed. This source water protection barrier eliminates many of organic and inorganic chemicals that can contaminate the source water and virtually eliminates the potential for human disease agents being present. Very few drinking water utilities in Canada and United States can claim this type of protection. In addition, the Watershed Protection Division operates a complete and comprehensive watershed management program that provides additional protection to the quality of Greater Victoria's source water.

3. **Water Disinfection**. The GVDWS is an unfiltered drinking water system that continues to meet the stringent USEPA criteria to remain an unfiltered surface water supply. The treatment process consists of primary disinfection (ultraviolet light and free chlorine) of the raw source water entering the treatment plant and secondary disinfection (chloramination) that provides a disinfectant residual in the distribution system. Although the water treatment barrier used in Greater Victoria is not as rigorous as that provided by most drinking water utilities using a surface water supply, the microbiological quality of the source water is exceptionally good and the Chief Medical Health Officer for Island Health has approved this treatment process as providing safe drinking water for the public.

4. **Distribution System Maintenance**. All water suppliers in the GVDWS provide good distribution system maintenance, including activities such as: annual water main flushing, hydrant maintenance, valve exercising, leak detection, and reservoir cleaning and disinfection. This barrier helps to promote good water quality within the distribution system.

5. **Infrastructure Replacement**. The timely replacement of aging water system infrastructure is an important mechanism to prevent the deterioration of water quality in the pipes and provides a continual renewal of the water system.

6. **Well Trained and Experienced Staff**. All water system operators must receive regular training and be certified to operate water system components. In addition, the laboratory staff cannot analyze drinking water samples unless the laboratory has been inspected by representatives of the BC Ministry of Health and issued an operating certificate.

7. **Cross Connection Control**. Cross connection control provides a barrier to contamination by assisting in the detection of conditions that have the potential to introduce contaminants into the drinking water from another type of system. Therefore, in cooperation with the other water suppliers, in 2005, CRD Water Services implemented a regional Cross Connection Control Program throughout the GVDWS.
8. **Water Quality Monitoring**. Although water quality monitoring is not a barrier in itself to prevent contamination, it is often included as a barrier because it acts as an audit and ensures that the other barriers are operating in a satisfactory manner.

4.0 WATER SYSTEM DESCRIPTION

In 2013, the GVDWS supplied drinking water to approximately 340,000 people and is the third largest drinking water system operating in British Columbia.

4.1 Source Water

Drinking water for the GVDWS comes from a protected watershed called the Greater Victoria Water Supply Area (Map 1). This area, which is approximately 11,000 hectares in size, is located about 30 km northwest of the city. The five reservoirs in the supply area have been used as a source of drinking water since the early 1900s. Sooke Reservoir, the largest of the reservoirs, is the primary water source for the city, supplying approximately 98% of Greater Victoria's drinking water. The four reservoirs in the Goldstream system (Butchart, Lubbe, Goldstream and Japan Gulch reservoirs), are typically offline and are used only as a backup water supply. Controlled releases from the Goldstream Watershed provide water for salmon enhancement in the lower Goldstream River.

Water at the southern end of Sooke Reservoir enters the intake tower and is screened through stainless steel screens (openings of 0.5 mm). From the intake tower, the water passes through two 1,200-mm-diameter (48”) pipelines to the Head Tank and then through the 8.8-km-long (5.5 miles), 2,300-mm (91”) Kapoor Tunnel and then into 1,525-mm (60”) and two 1,220-mm (48”) diameter pipes connecting the Kapoor Tunnel to the Japan Gulch Disinfection Plant where it is disinfected.

Drinking water for Sooke and East Sooke is also supplied from Sooke Reservoir, but travelled a different route. This water is passed through a newly constructed 14.5-km-long (9 miles), 600-mm-diameter (24”) PVC pipe and ductile iron from a point just above the Head Tank through to the Sooke River Road Disinfection Plant.

During the brief period of its use (typically used only during the winter when the Kapoor Tunnel is out of service for inspection by CRD IWS staff), water in the Goldstream River watershed is released from Goldstream Reservoir and flows down the upper reaches of Goldstream River into Japan Gulch Reservoir. Water from Japan Gulch Reservoir enters the Japan Gulch Intake Tower through a low level intake gate and enters the Japan Gulch Intake Tower, passing through a 14 mesh, stainless steel screen and is then carried in a 1,320-mm-diameter (52”) pipe into the Japan Gulch Disinfection Plant.

4.2 Water Disinfection

The disinfection process in the GVDWS is both simple and effective and uses two disinfection facilities to provide disinfected drinking water to two large service areas:

- Japan Gulch Disinfection Plant supplies the Greater Victoria Service Area (municipalities of Central Saanich, Colwood, Langford, Metchosin, North Saanich, Oak Bay, Saanich, Victoria, View Royal and a small portion of the Highlands)
- Sooke River Road Disinfection Facilities supplies the Sooke and East Sooke Service Area

The Greater Victoria Drinking Water System Service Area receives water from the largest treatment plant, the Japan Gulch Disinfection Plant, whereas Sooke and East Sooke receive water from the smaller Sooke River Road Disinfection Plant, which uses the same disinfection process as the Japan Gulch Disinfection Plant.

At the Japan Gulch Disinfection Plant, the water passes through a three-part disinfection process in sequential order – two primary disinfectant steps that provide disinfection of the water entering the system followed by a secondary disinfectant step that provides continuing disinfection throughout the distribution system:

1. *UV Disinfection*. Ultraviolet (UV) disinfection provides the first step in the primary disinfection process (disinfection of the raw source water entering the plants) and inactivates parasites such as *Giardia* and *Cryptosporidium*, as well as reducing the level of bacteria in the water.
2. *Free Chlorine Disinfection*. Free chlorine disinfection provides the second step in the primary disinfection process using a free chlorine dosage of approximately 1.6 to 2.0 mg/L and a minimum of 10 minutes (depending upon flow) contact time between the free chlorine and the water. The free chlorine disinfection step inactivates bacteria and provides a 4-log (99.99%) kill of viruses.
3. *Ammonia Addition*. The final step in the primary disinfection process is the addition of ammonia to form chloramines at a point downstream where the water has been in contact with the free chlorine for approximately 10 minutes or more. The ammonia is added at a ratio of approximately 1 part ammonia to 5 parts chlorine. In the water, these chemicals combine to produce a chloramine residual. This residual remains in the water and continues to protect the water from bacterial contamination (secondary disinfection) as it travels throughout the pipelines of the distribution system.

Small amounts of additional chlorine are also periodically added at the Upper Dean Park Reservoir on the Saanich Peninsula. In Metchosin, CRD IWS re-chloraminates the water at Rocky Point Reservoir to boost the chlorine residual provided to the extremities of that system.

4.3 Transmission System

There are seven large diameter transmission mains in the GVDWS that are used to deliver bulk quantities of disinfected water to the municipal distribution systems. These transmission mains range in diameter from 1,525 mm (60”) down to 460 mm (18”) and transfer water from the disinfection plants to the distribution systems listed in the next section. The Saanich Peninsula Trunk Water Distribution System receives water at two points on the Saanich Peninsula from the regional transmission system and supplies it to the three municipalities on the Saanich Peninsula.

4.4 Distribution System

The GVDWS contains eight individual distribution systems. Six distribution systems are separately owned and operated by the municipalities of Central Saanich, North Saanich, Oak Bay, Saanich, Sidney and Victoria. Victoria owns and operates the distribution system in Esquimalt. Two distribution systems are owned by the CRD and operated by CRD IWS. These latter two systems include the combined distribution system in the West Shore communities of Langford, Colwood, Metchosin, and View Royal and a separate system supplying water to Sooke and parts of East Sooke. Each distribution system operator is called a water supplier and is responsible for providing safe water to their individual customers.

4.5 Distribution System Reservoirs

Twenty-six distribution system reservoirs are scattered throughout the Greater Victoria distribution system with many of these reservoirs containing multiple cells (45 cells in total). These reservoirs assist in balancing the uneven consumption of water that occurs during the day-to-night cycle.

5.0 OPERATIONAL CHANGES AND EVENTS

5.1 Use of Goldstream Water

In 2013, there was only one substantive operational change from previous years in the source of the water being supplied to the Greater Victoria Drinking Water Service Area: the Goldstream Supply System was used to supply water to the system from December 2-6 during the time that the Kapoor Tunnel was being inspected.

5.2 Sooke Reservoir

In 2013, Sooke Reservoir started the year at full pool level (186.75 m above sea level; Figure 1) earlier than in previous years (2009-2012) and remained at full pool until late April, after which there was a steady decline throughout the summer months. Sooke Reservoir reached its lowest level (183.23 m) in early November 2013. Unlike previous years, due to low precipitation in November and December, the water level was 3.35 m below full pool level at year end.

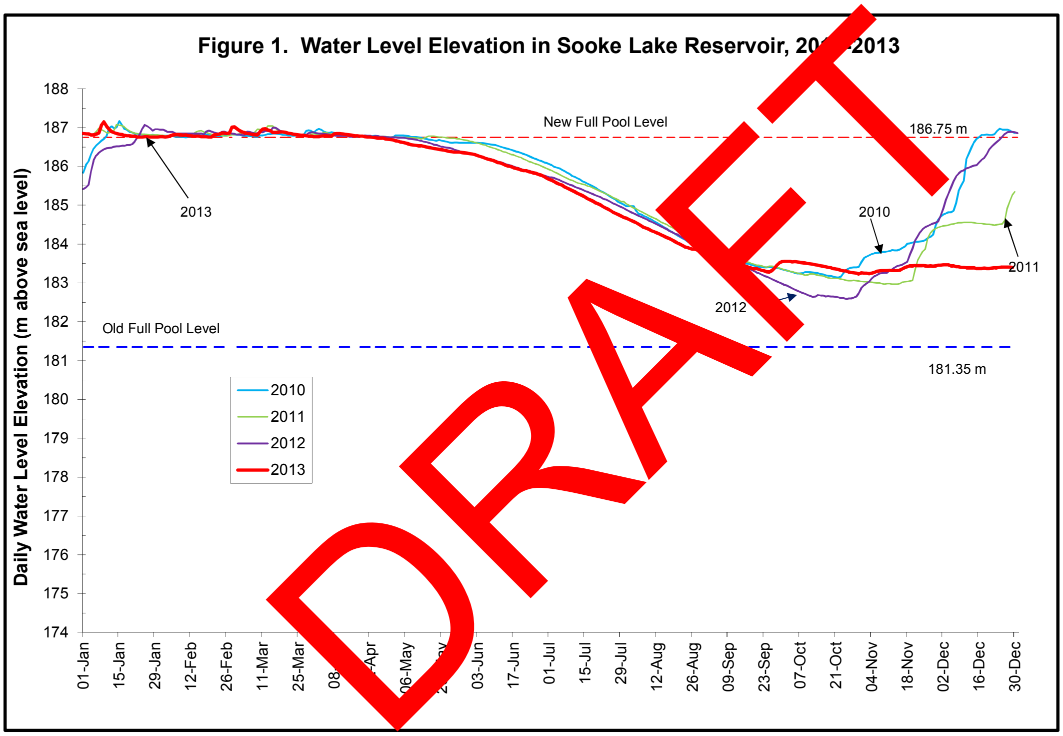


Figure 1 Water Level Elevation in Sooke Lake Reservoir, 2010-2013

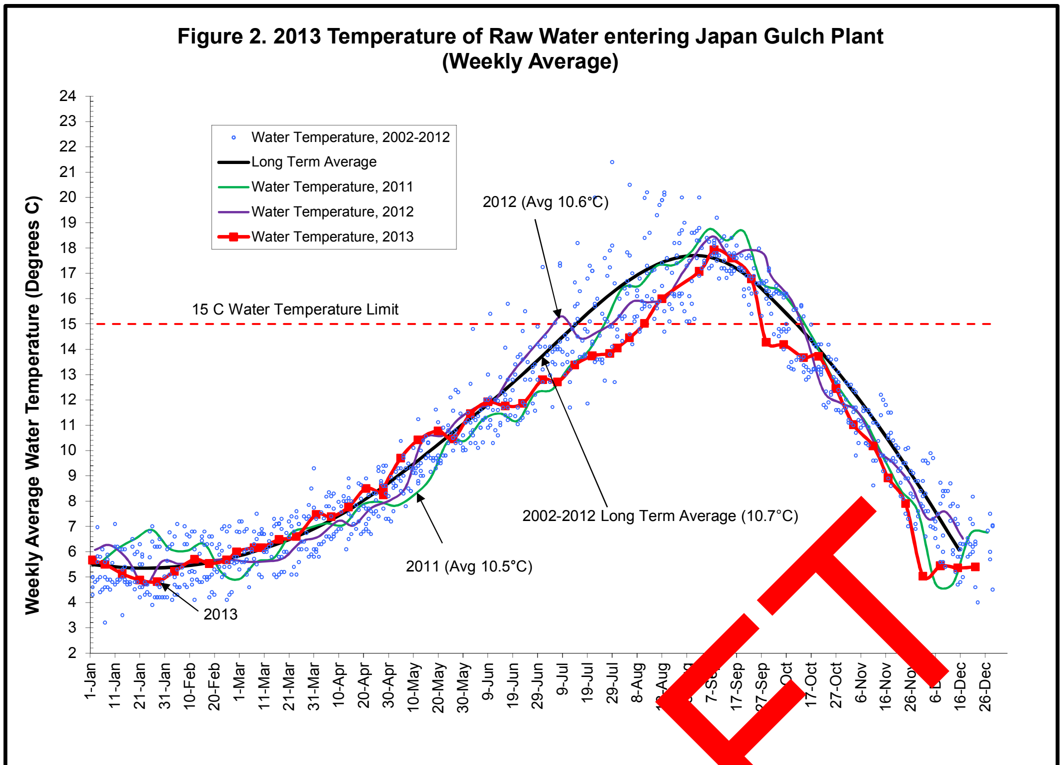


Figure 2 Temperature of Raw Water Entering Japan Gulch Plant (Weekly Average)

5.3 Water Temperature

Similar to recent years, following the inundation of Sooke Reservoir, the temperature of the water entering the Japan Gulch Disinfection Plant was slightly cooler during the summer (Figure 2) than the long-term average. Before the expansion of Sooke Reservoir, the water temperature entering the plant reached 15°C by mid-June. In 2013, the water temperature remained generally below 15ºC until late July and was generally cooler than normal until late October. The temperature remained above 15ºC until late September. Cooler water is beneficial in a distribution system because it reduces the potential for losses of chlorine residual and/or the regrowth of bacteria.

5.4 Chlorine Dosage

During 2013, CRD IWS used a chlorine dosage rate of 1.8 milligrams per litre (mg/L) during the early part of the year, increased the dosage to 1.9 mg/L on June 18 and then increased it again to 2.1 mg/L on September 20 in response to dropping chlorine residuals in the distribution system. The dosage was reduced on December 17 to 2.0 mg/L (Figure 4).

6.0 WATER QUALITY MONITORING

The Water Quality Program, CRD Parks & Environmental Services Department, is responsible for the collection, analysis and reporting of water quality information in all portions of the GVDWS from the source reservoirs to the point of delivery (typically the water meter) to each consumer. The municipal water suppliers are responsible for correcting water quality problems identified in the distribution systems they own and operate.

6.1 Water Quality Monitoring Programs

The Water Quality Program has established three water quality monitoring programs that provide direction for the collection and analysis of water quality samples from the water system.

- **Aquatic Ecology Monitoring Program**. The goal of the Aquatic Ecology Monitoring Program is to understand and document the components that affect or may affect the natural cycles of the source streams and reservoirs. The source reservoirs and streams in the Greater Victoria Water Supply Area (Map 1) are monitored according to the requirements of the Aquatic Ecology Monitoring Program as there are no legislated requirements for either sampling frequency or parameter selection for these water bodies. In recent years, the sampling program has been expanded to provide water quality data on the impacts of raising the water level in Sooke Reservoir. Samples are also collected during severe weather.

- **Compliance Monitoring Program**. The goal of the Compliance Monitoring Program is to ensure that the quality of the water from source to consumer meets the relevant drinking water regulations and guidelines. This program is audited by staff from Island Health. The Compliance Monitoring Program provides direction on most sampling locations in the water system including the raw water entering the plants, the treated water at the first customer sampling location, the sampling locations in the large transmission mains (Map 1), the sampling locations in the municipal distribution systems, and the individual cells of the distribution reservoirs. Under this program, the sampling frequency and parameter selection for these various sampling locations conform to the requirements of the *Guidelines for Canadian Drinking Water Quality.*

- **Water Quality Complaint Monitoring Program**. The goal of the Water Quality Complaint Monitoring Program is to determine the cause of customer water quality complaints and address those complaints in a manner that is satisfactory to the customer. Water samples are collected from taps within individual houses or facilities in response to complaints from customers about the quality of water being received at their address.

In addition, the Water Quality Program provides an audit function on all water quality-related aspects of the GVDWS including performance monitoring of the treatment plants and distribution system.

6.2 Sampling Frequency and Parameter Testing

In 2013, the Water Quality Program collected 6,01[illegible] samples from the GVDWS and analyzed those samples for 35,810 individual tests. Approximately 30[illegible] different types of tests were conducted on these samples. The target sampling frequency for the individual parameters tested is shown in the last column in the tables listed below. These tables can be found in Appendix A.

Table 1	2012 Untreated (Raw) Water Quality Entering Japan Gulch Plant
Table 2	2012 Treated Water Quality Below Japan Gulch Plant
Table 3	2012 Treated Water Quality Below Sooke Plant

6.2.1 Source Water Bodies

In 2013, Sooke Reservoir, the primary source of water for the GVDWS, was sampled approximately every two weeks throughout the year. The secondary reservoirs in the Goldstream Watershed were sampled less frequently as were the tributary streams to these reservoirs. The parameters tested included routine physical-chemical parameters, nutrients, metals, mercury and phytoplankton (commonly called algae). In 2013, over 400 samples were collected from the source tributaries and source reservoirs.

6.2.2 Raw Water Entering Disinfection Plants

In 2013, the raw source water entering both the Japan Gulch Disinfection Plant and the Sooke Disinfection Plant were tested throughout the year on a routine sampling schedule of five days per week for Japan Gulch and once per week for Sooke. As both of these plants were supplied primarily from the same source of water (Sooke Reservoir) most of the testing was conducted on the raw water entering the Japan Gulch Disinfection Plant. This is the sampling point in the GVDWS where the most extensive testing of the water is conducted although not all parameters are tested every year. In 2013, these tests included 15 physical parameters (**Table 1**), 17 non-metallic inorganic chemicals, 31 metallic inorganic chemicals, 3 bacteriological parameters, 2 parasites, 6 radiological parameters, 68 pesticides and herbicides, 17 polycyclic aromatic hydrocarbons (PAHs), 13 phenolics, and 66 other synthetic organic chemicals. Two hundred fifty-one samples were collected at the sampling point where the raw water enters the Japan Gulch Disinfection Plant and 51 samples at the point where the water enters the Sooke Disinfection Plant.

6.2.3 UV Treated Water

At the Japan Gulch Disinfection Plant, the water downstream of the ultraviolet (UV) treatment units was sampled on a routine sampling schedule of five days per week. Tests included the bacteriological parameters of total coliforms, *E. coli* and heterotrophic plate count bacteria. In 2013, 247 samples were collected at this location.

6.2.4 Treated Water at First Customer

At the first customer sampling location below the Japan Gulch Disinfection Plant, testing included most of the parameters used to monitor the raw source water except that many of the organic scan parameters were not included while all of the parameters associated with the treatment process were added. These latter tests included the disinfectant residuals (3 parameters) and the byproducts of disinfection (17 parameters). As the disinfection process was essentially the same at both the Japan Gulch and Sooke plants, the more extensive list of disinfection byproducts was tested only at the first customer location below the Japan Gulch Plant (**Table 2**). In 2013, 302 samples were collected from the two first customer sampling locations (below Japan Gulch and below Sooke Plant).

6.2.5 Transmission System

Eighteen permanent sampling locations have been established on the large diameter transmission mains although not all of these sampling locations are used each year. Monitoring is comprised primarily of chlorine residual testing and bacterial indicator analyses (total coliforms and *E. coli*). In 2013, 435 samples were collected from 12 sampling locations on the transmission mains.

6.2.6 Distribution System

In the various municipal distribution systems, the Water Quality Program has established approximately 150 permanent sampling locations. At these sampling locations, water quality monitoring was comprised primarily of chlorine residual testing and bacterial indicator analyses (including heterotrophic bacteria for locations having low chlorine residuals). In 2013, 2,408 samples were collected from 101 sampling locations (including 8 locations from the Sooke distribution system). At select locations within the distribution system, disinfection byproducts were also sampled.

6.2.7 Distribution System Reservoirs

Twenty-two of the 23 reservoirs located in the distribution system were sampled by the Water Quality Program with 39 permanent sampling station locations being sampled in 2013. Again, the monitoring program focused on chlorine residuals and indicator bacteria testing. In 2013, 918 samples were collected from these reservoirs.

7.0 WATER QUALITY RESULTS

The overview results of the 2013 water quality monitoring program for the GVDWS are provided below. Figures 1 to 14 provide a graphical presentation of selected parameters at specific sampling locations for comparison to previous years. Water Quality data Tables 1, 2 and 3 are listed in Appendix A. Please note that the median (middle value between the high and low) is used in these tables rather than the average value. In a data set, the median eliminates the effect of extreme values (very high or very low) on the average value and provides a more realistic representation of typical conditions.

7.1 Indicator Bacteria and Chlorine Residual

The Water Quality Program analyzes drinking water samples for several different groups of indicator bacteria including total coliforms, *E. coli,* and heterotrophic plate count (HPC) bacteria. These bacterial groups are called indicators because their presence in water may indicate that disease-causing organisms are also present. Samples are collected five days a week from both the raw source water at the disinfection facilities and the treated water close to the first customer below those facilities. Where appropriate, the Canadian Water Quality Guideline concentration limits for these bacteria are listed in Tables 1, 2 and 3 (see Appendix A) under the column titled 'Canadian Guidelines'. A more detailed annual summary showing the results of the bacteriological samples collected from the individual municipal distribution systems is provided in a separate report called the *2013 Annual Bacteriological Summary of Greater Victoria's Drinking Water*. The description below only provides an overview of the bacteriological water quality for broad categories of sampling locations.

7.1.1 Raw Water Entering Plant

Total Coliform Bacteria. Similar to the past eight years, the concentration of total coliform bacteria increased in the raw (untreated) source water entering the Japan Gulch Disinfection Plant during the summer and early fall of 2013 (Figure 3). The total coliform counts declined in mid-October. The types of total coliforms present were not indicative of any particular type of contamination.

***E. coli* Bacteria**. During more than two decades of monitoring bacteria within the GVDWS, it has been found that virtually 100% of the fecal coliform bacteria detected in the source water and the distribution system are *E. coli*. In 2013, as in the period from 2008-2012, the low detection of *E. coli* bacteria indicated that the raw water entering the Japan Gulch Disinfection Plant from Sooke Reservoir was good quality source water and complied with the fecal coliform limit in the USEPA Surface Water Treatment Rule to remain an unfiltered drinking water supply (Figure 3A).

Annually (2009-2013), only about 12% of the samples collected from the raw source water contain *E. coli* and those that are positive for *E. coli* have levels below 20 CFU/100 mL more than 99% of the time. Similar to previous years, in 2013, higher levels of *E. coli* were found during the period that the drinking water system was fed from Goldstream Reservoir (early December). Nevertheless, in 2013, the disinfection process at the two treatment plants provided satisfactory protection and there were no lapses in the safety of the drinking water.

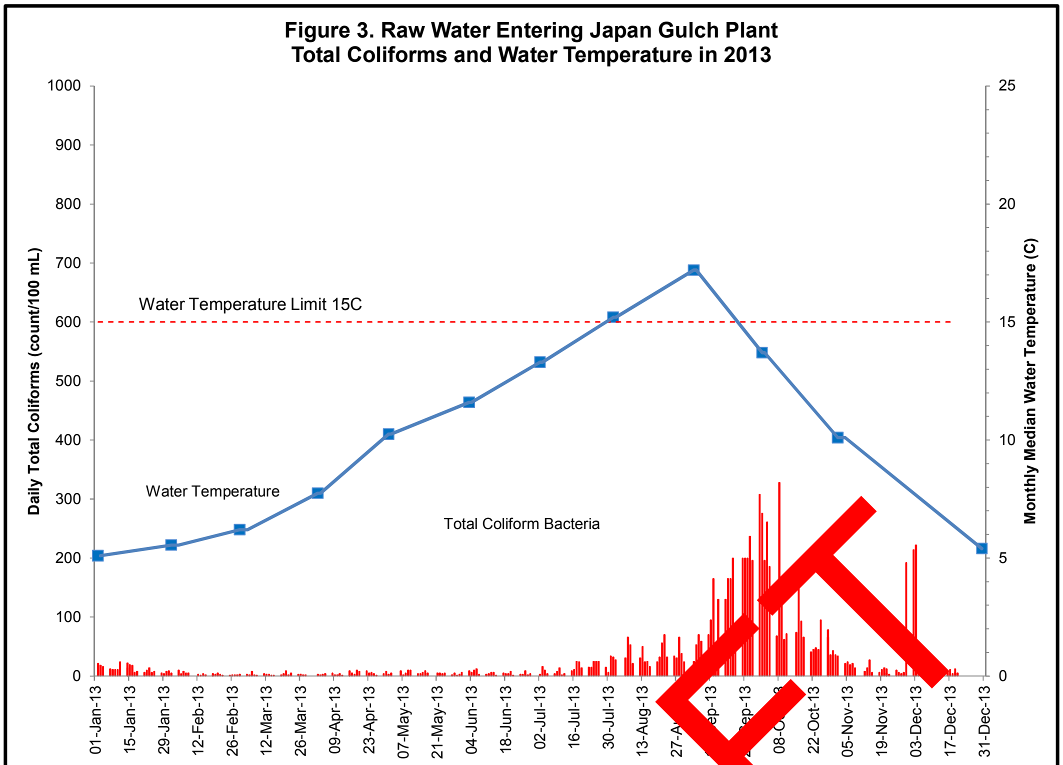


Figure 3 Raw Water Entering Japan Gulch Plant Total Coliforms and Water Temperature in 2013

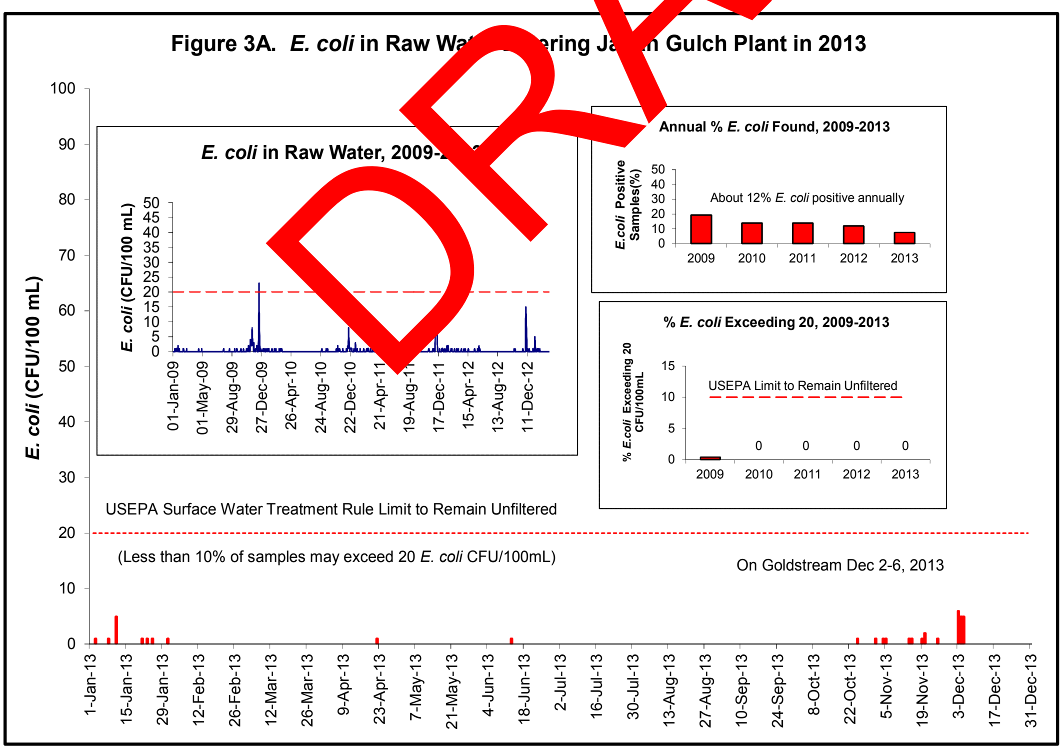


Figure 3A *E.coli* in Raw Water Entering Japan Gulch Plant in 2013

7.1.2 Treated Water at First Customer

Bacterial Indicators. The data collected from the treated water sampling location near the first customer below the Japan Gulch Disinfection Plant indicated that the bacteriological quality of the disinfected water was good in all months of the year (Figure 4 and **Table 2**). In 2013, there were no total coliform-positive samples of in the 247 samples analyzed (Figure 4). This was similar to previous years and is a continued reflection of the improved primary disinfection process implemented in October 2001 and the addition of UV disinfection in January 2004.

In addition, no total coliform-positive samples were found in the 51 samples collected at the first customer sampling location below the Sooke Disinfection Plant.

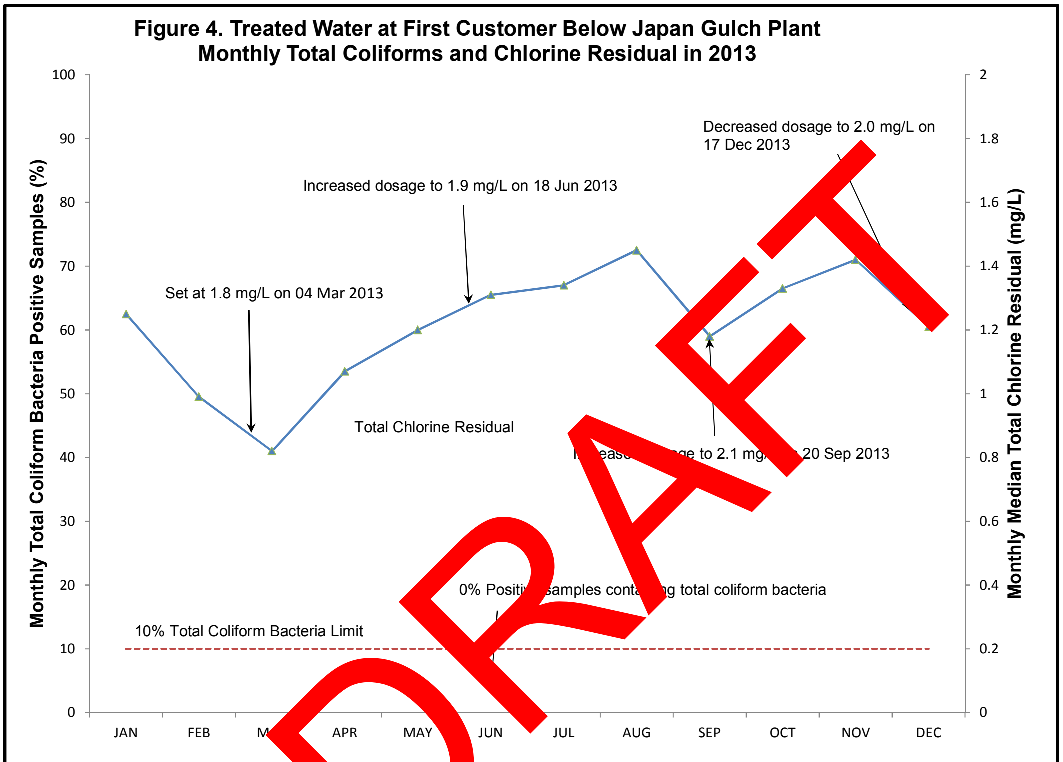


Figure 4 **Treated Water at First Customer below Japan Gulch Plant Monthly Total Coliforms and Chlorine Residual in 2013**

Chlorine Residual. The monthly average chlorine residual levels at the first customer sampling location below the Japan Gulch Plant is provided in Figure 4. From this figure, it can be seen that the monthly average chlorine residuals at the first customer sampling point varied somewhat throughout the year. To ensure a relatively constant chlorine residual level, the dosage rate was raised from 1.8 to 1.9 in June, and from 1.9 to 2.1 mg/L in September, and then dropped back to 2.0 mg/L in December. The annual median chlorine residual at this location was 1.25 mg/L (**Table 2**). Compared to many other drinking water systems across Canada, this is a conservative level.

7.1.3 Distribution System Water

Bacterial Indicators. Considering all of the individual municipal distribution systems together as a single entity called the Greater Victoria Distribution System, during 2013, total coliform bacteria were detected during nine months of the year (February, April, May, June, July, August, September, October and November). However, the percentage of positive total coliform samples did not exceed the 10% total coliform limit during any month in 2013 and, therefore, was in compliance with the BC *Drinking Water Protection Regulation*. This was similar to the past 10 years (2000 onwards) and much better than in earlier years.

In addition, the annual total coliform-positive percentage (1.2% in 2013) was quite low and similar to the low levels of coliform-positive samples found in the Greater Victoria Distribution System in the past 10 years (Figure 5).

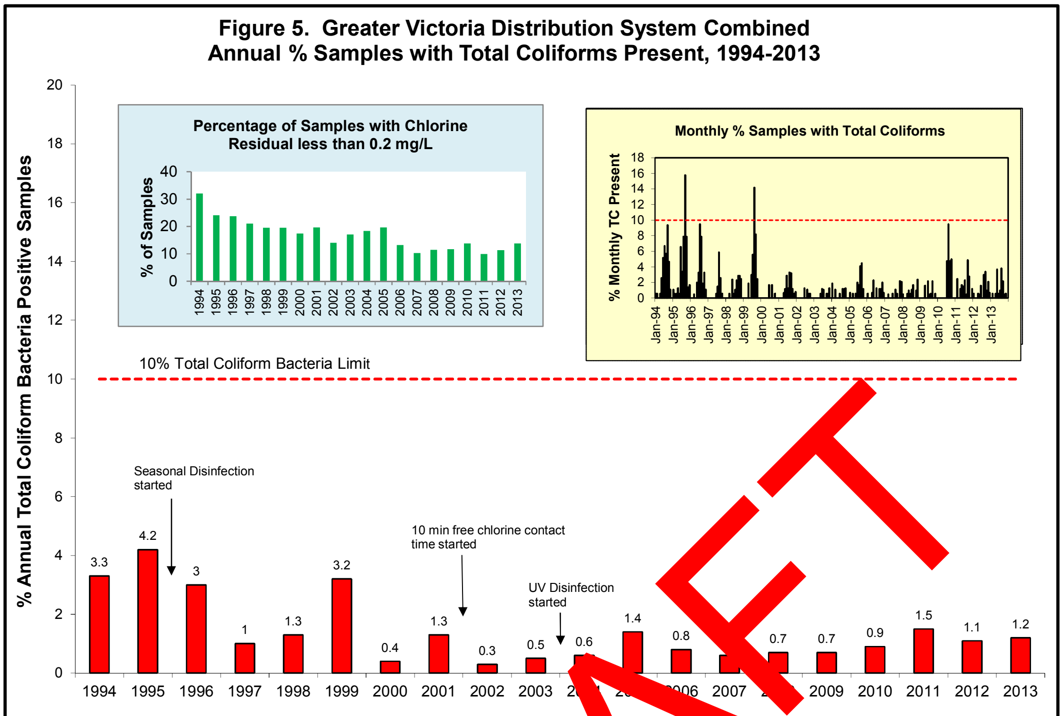


Figure 5 **Greater Victoria Distribution System Combined Annual % Samples with Total Coliforms Present, 1994-2013**

Over this 20-year period of time, the reduction in total coliform detection (shown in the inset in Figure 5), and, hence, the improved bacteriological water quality can be attributed to a number of factors including

1990 Relining of old cast iron water mains in Oak Bay, Saanich and Victoria

1993 Introduction of annual reservoir cleaning (Water Services Dept. and other water suppliers remove the sediment load in the reservoirs)

1995 Introduction of unidirectional flushing in a number of municipal systems to reduce the sediment load in the water mains

1995 Use of water quality as one of the criteria for replacing aging infrastructure (e.g., replaced old cast iron water main to William Head Institute)

1996 Introduction of the seasonal increase in chlorine dosage in summer months to provide better disinfection and chlorine residuals to the extremities

2001 Use of free chlorine for primary disinfection to provide improved bacteriological disinfection of the raw water entering the system

2002 Startup of Rocky Point Rd Re-chloramination Station

2004 Use of UV disinfection to provide improved parasite and bacteriological disinfection

Chlorine Residual. The annual median chlorine residual for samples collected from the various sampling locations within the Greater Victoria Distribution System was 0.63 mg/L. This value is similar to the level observed in previous years. The level of chlorine residual in the distribution system ranged between 0 and 1.83 mg/L. The highest value observed (1.83 mg/L in East Sooke at Rocky Point Road) was well below the 3.0 mg/L limit in the Canadian Guidelines for chloramines.

Nitrification. Nitrification occurs in many chloraminated distribution systems. Nitrification is a bacteriological process in which ammonia is oxidized initially to nitrite and then to nitrate. The process is a complex phenomenon caused by two groups of bacteria that have low growth rates relative to other bacteria. Water temperature appears to be a critical factor for nitrification in distribution systems as it has been almost exclusively associated with warm water temperatures. Nitrification is also associated with high water age (reservoirs, dead-ends, low-flow pipes), and with sediments biofilms.

Monitoring for nitrifying bacteria directly is inefficient; however, the extent of nitrification in the distribution system can be monitored by measuring chlorine residuals and nitrite (also nitrate, free ammonia). When the chlorine residuals drop (in the absence of any pipe break or plant disinfection failure) accompanied by increases of nitrite then nitrification is occurring. Since Greater Victoria's source water has no background nitrite, the presence of nitrite in the distribution system is the best indicator of nitrification.

The control of nitrification in a chloraminated distribution system involves limiting the excess free ammonia leaving the disinfection plant, maintaining an adequate chlorine residual throughout the distribution system, minimizing water age in storage facilities and in the low-flow areas of the distribution system, and maintaining annual flushing routines to limit the accumulation of sediment and biofilm in the distribution system piping.

7.2 Parasites

In 2013, parasite samples were collected approximately bimonthly as part of the Water Quality Program's routine Compliance Monitoring Program and sent to Hyperion Research Laboratories, a contract laboratory in Alberta. This reduced sampling frequency relative to previous years was made after an evaluation of the long-term data showed extremely low detection of these organisms. In 2013, eight samples were collected for parasite analysis from the raw water sampling location at the Japan Gulch Treatment Plant.

Figure 6 and Figure 7 show the results of the parasite monitoring data collected by Water Quality staff. It should be noted that the efficiency of the analysis for detecting *Giardia* and especially *Cryptosporidium* is quite low (typically in the 15-25% range).

Giardia. In 2013, none of the eight samples collected from the raw water entering the Japan Gulch Disinfection Plant were positive for *Giardia* cysts (Figure 6). During the 10-year period from 2004 to 2013, no viable (living) *Giardia* cysts have been detected in Greater Victoria's source water.

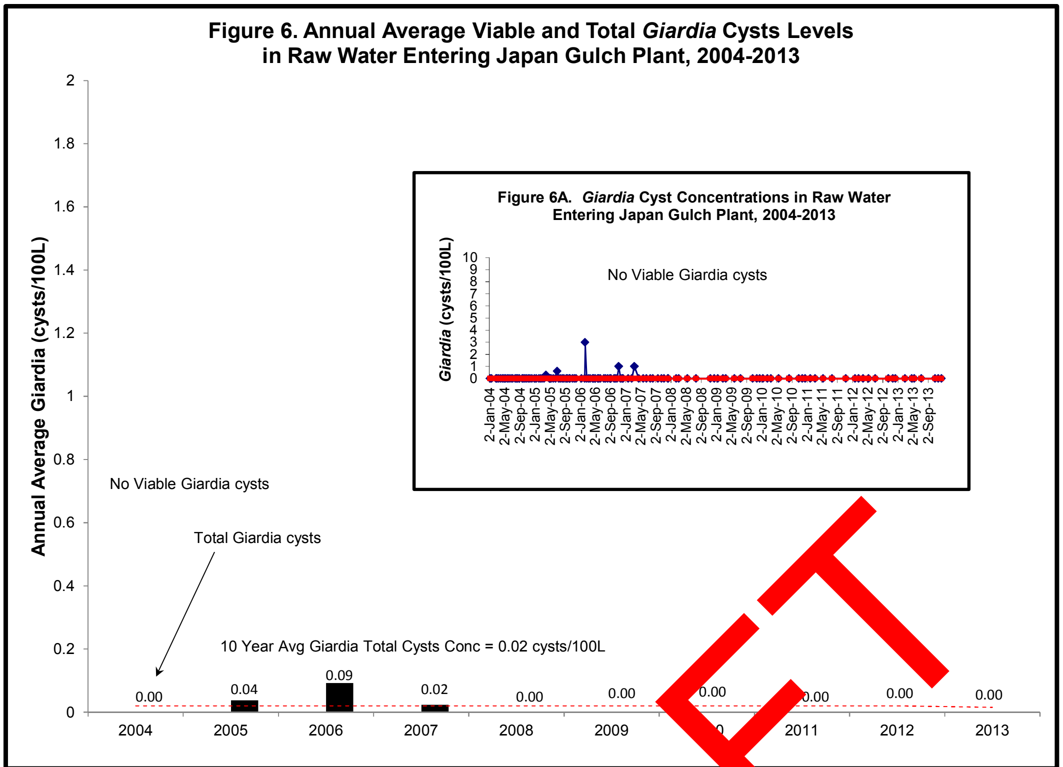


Figure 6 Annual Average Viable and total Giardia Cysts Levels in Raw Water entering Japan Gulch Plant, 2004-2013

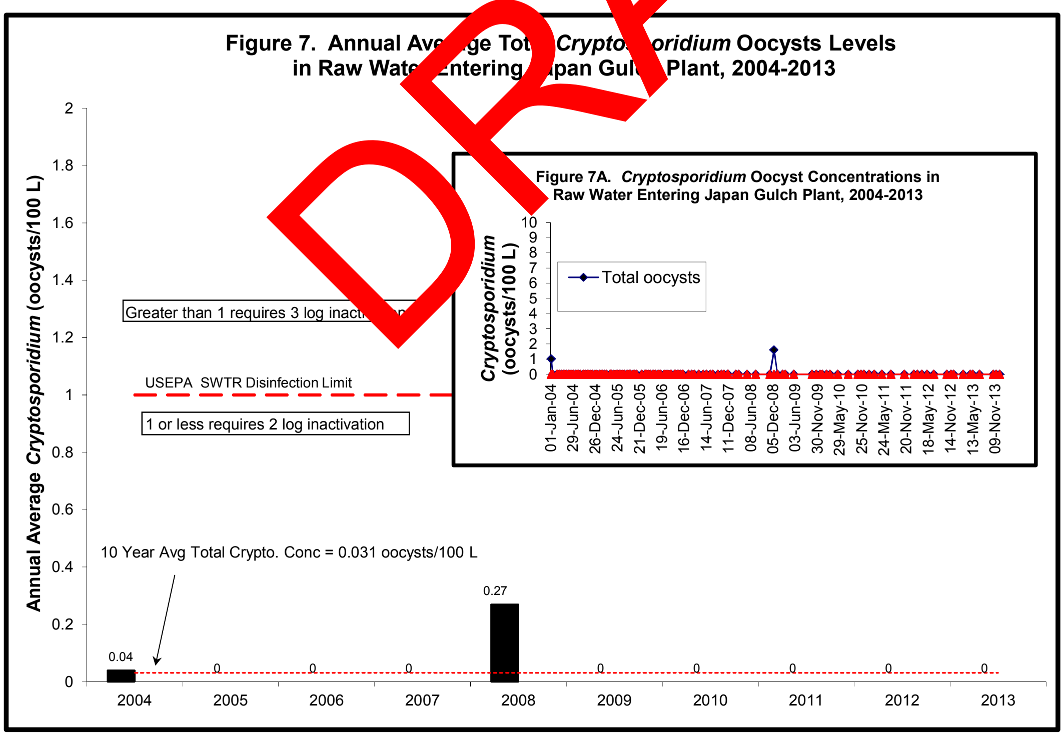


Figure 7 Annual Average Total *Cryptosporidium* Oocysts Levels in Raw Water Entering Japan Gulch Plant, 2004-2013

Cryptosporidium. In 2013, none of the eight samples collected from the raw water entering the Japan Gulch Disinfection Plant were positive for *Cryptosporidium* oocysts (Figure 7). The 10-year average total *Cryptosporidium* oocyst concentration was only 0.031 oocysts per 100 L. This low positive rate requires a 2-log disinfection process be in place, which is provided by the ultraviolet disinfection step.

Although there is no federal or provincial numerical limit for *Giardia* or *Cryptosporidium*, the Canadian Guideline statement that "*It is desirable...that no viruses or protozoa be detected"* was met in 2013.

In the 24-year period that the Water Quality Program has been monitoring *Cryptosporidium,* 431 routine samples have been collected for *Cryptosporidium* analysis. This is a large number of samples and is higher than the collection frequency typically used by many other drinking water utilities in Canada. During this period of time, oocysts were detected in only six out of the 24 years. In the last 10 years, annual average oocysts concentrations ranged from 0 to 0.27 oocysts per 100 mL (Figure 7). The maximum number of oocysts in any one sample was 1.8 per 100 L (Figure 7A). All annual average concentrations were well below the disinfection limit specified by the USEPA *Surface Water Treatment Rule* and hence, only require 2-log (99%) inactivation according to the USEPA rules.

All of these parasite numbers are extremely low for a surface water supply and demonstrate the excellent protection provided to Greater Victoria's drinking water, not only by controlling activities in the Greater Victoria Water Supply Area, but also by the inability of the oocysts to gain access to the intake tower from within the relatively large Sooke Reservoir.

7.3 Physical – Chemical - Radiological

The Water Quality Program analyzes water samples for a variety of physical, chemical and radiological parameters to provide not only compliance information, but also to monitor operational changes within the GVDWS.

7.3.1 Physical Parameters

The physical parameters monitored by the Water Quality Program in the raw water entering the Japan Gulch Treatment Plant are listed in **Table 1** in the section called Physical Parameters. The sampling frequency for the physical parameters varies and is dependent on the variability of the data for the parameter being monitored and how it is used. In 2013, turbidity and water temperature were analyzed daily, whereas ultraviolet transmittance, colour, conductivity, pH, and ultraviolet absorption were analyzed weekly and hardness was analyzed bi-weekly. Alkalinity, carbon and solids were analyzed monthly.

The raw water entering the Japan Gulch Disinfection Plant (**Table 1**) is very soft (median value for hardness of 17.2 mg/L), it has a neutral pH (median of 7.14), moderate colour (median of 6.4 true colour units) and low turbidity or cloudiness (median of 0.30 nephelometric turbidity units). It is also low in acid buffering capacity having an alkalinity of 15.5 mg/L, has low ionic strength (conductivity of 42.0 µS/cm), relatively low solids (total dissolved solids of 26.8 mg/L, total suspended solids of 0.37 mg/L, and total solids of 27.2 mg/L), and moderate levels of total and dissolved organic carbon (1.8 and 1.7 mg/L, respectively). **Table 1** lists both the annual median value, the range of values over the year, the Guideline limit (as a reference only for the raw source water) along with the results observed over the long term (previous 10 years).

The disinfection process slightly changed one or two of these parameters as shown in **Table 2**. Some additional changes were observed in some areas of the distribution system; however, most of these parameters changed very little in the distribution system and was similar to previous years.

In 2013, the values for all of the physical parameters were within the Canadian Guideline limits except for water temperature (aesthetic objective of 15°C) during the summer months.

7.3.2 Non-Metallic Inorganic Chemicals

The non-metallic inorganic chemicals monitored by the Water Quality Program in the raw water entering the Japan Gulch Disinfection Plant are listed in **1** in the section titled Non-Metallic Inorganic Chemicals. The list includes most of the various forms of nitrogen and phosphorus (nutrients), fluoride, chloride, and several other miscellaneous chemicals. The sampling frequency for these parameters is either monthly or semi-annually.

- **Ammonia**. The concentration of ammonia increased from a median of 3.28 µg/L in the raw water entering the Japan Gulch Plant (**Table 1**) to 95.1 µg/L in the treated water at the first customer location (**Table 2**), as a result of the disinfection treatment process of adding ammonia to the water. There is no health concern at these low levels; however, this parameter is of interest as bacteria can use the ammonia in the distribution system as a food source, which may result in a phenomenon called bacterial regrowth. As in previous years, ammonia was sampled monthly.

- **Fluoride**. CRD IWS does not fluoridate the drinking water in Greater Victoria. Nevertheless, a tiny amount of fluoride (although not detectable in 2013) is present naturally in the water (**Table 2**). This tiny amount is well below the 1.5 mg/L limit in the Canadian Guidelines. It is also inadequate for dental purposes; therefore, individuals should provide their own fluoride supplements for dental protection if they so desire. In accordance with the Guidelines, fluoride was sampled semi-annually.

- **Nutrients**. All of the nutrient levels are relatively low and there is nothing particularly unusual about the various forms of nitrogen and phosphorus nutrients in the raw water entering the Japan Gulch Plant (**Table 1**). These chemicals are monitored as part of the control of the regrowth of bacteria in the distribution system. The sampling frequency for nutrients was monthly.

All of the non-metallic inorganic chemicals were well within the Canadian Guideline limits and the values are consistent with a high quality water source.

7.3.3 Metals

The metallic inorganic chemicals monitored by the Water Quality Program in the raw water entering the Japan Gulch Disinfection Plant are listed in **Table 1** in the section titled Metallic Inorganic Chemicals. The list includes a variety of the so-called 'heavy metals' such as copper, lead, iron, zinc and mercury. Most of these heavy metals have either health-related or aesthetic Canadian Guideline limits. The vast majority of metals are sampled monthly. Questions are often asked about the following metals:

- **Lead**. Lead was not detected in the raw water entering the Japan Gulch Plant. Historically, the level of lead has ranged from undetected to a maximum of 0.6 µg/L and at this level can be considered virtually absent from the water (**Table 1**). In the past, this parameter has also been measured in the distribution system where it is also virtually absent in flushed water samples. In addition, there are no known lead service lines in the distribution system.

  NOTE: Residents should be aware that brass taps in the household often contain some lead that can dissolve into the water that is contained within the body of the tap during overnight standing. To eliminate this small amount of dissolved lead from the water, simply run the tap for 30 seconds each morning before using the water for drinking or preparing food. The water entering a residence from the distribution system is virtually free of lead.

- **Mercury**. Mercury was not detected in the raw water entering the Japan Gulch Plant in 2013 (**Table 1**), similar to the last 10 years (median values have been less than the detection limit).

- **Selenium**. In 2013, selenium was not detected in the raw water entering Japan Gulch Plant (**Table 1**). This parameter is of interest to people who take selenium supplements.

- **Sodium**. The level of sodium naturally present in the water is low (2013 median value of 1.74 mg/L; **Table 1**). This value is of interest to those people on low sodium diets.

All metals were well within the Canadian Guideline limits and the values are consistent with a high quality drinking water source.

7.3.4 Radiological Parameters

The radiological parameters monitored by the Water Quality Program in the raw water entering the Japan Gulch Disinfection Plant are listed in **1** in the section titled Radiological Parameters. The list includes two general, screening-type measures of radioactivity: gross alpha and gross beta radiation, as well as four more specific parameters: iodine-131, cesium-134, cesium-137, and ruthenium-103 that were tested as a result of the emissions from Japan.

The general screening radiological parameters are usually tested twice per year as suggested in the Canadian Guidelines (**Table 1**). In 2013, no gross alpha radiation was detected in the raw water. The median value for gross beta radiation was 0.06 Bq/L due to one positive screen. The positive screen, however, was far below the Guideline limit for gross beta screening type analyses. There was no iodine-131, cesium-134, cesium-137, or ruthenium-103 detected in the raw water entering the plant.

7.3.5 Organics

The organic chemicals monitored by the Water Quality Program in the raw water entering the Japan Gulch Disinfection Plant are listed starting in **1** in the section titled Organic Parameters. The list includes a wide range of pesticides and herbicides, polycyclic aromatic hydrocarbons (PAH), phenols, and other synthetic organic chemicals that may come from a variety of industrial sources.

The organic chemicals are monitored twice per year as suggested in the Canadian Guidelines. All organic chemicals except one PAH, benzo(a)anthracene, were undetectable in the raw water entering the treatment plant. The hit for the PAH resulted from an improved laboratory detection limit. It remains to be seen whether or not this represents an actual change in water chemistry or is simply a result of improved lab technology (i.e., the ability of laboratories to detect smaller and smaller quantities). Regardless, this organic chemical does not have a health-related limit in the Canadian Guidelines.

7.4 Disinfectants and Disinfection Byproducts

The disinfection of the water with chlorine produces a number of byproducts of the disinfection process. Trihalomethanes (THM) and haloacetic acids (HAA) are two groups of these disinfection byproducts that are regularly monitored by the Water Quality Program at a number of locations within the distribution system.

In 2013, disinfection byproduct samples were collected six times during the year. The monitoring locations included the treated water below the Japan Gulch Plant, the supply point to the Saanich Peninsula, at the extremity of the distribution system in North Saanich, and Upper Dean Park Reservoir in North Saanich.

The Canadian Guideline limits for the substances of concern are listed in **Table 2** in the section titled Disinfectants and in **Table 2** in the section titled Disinfection Byproducts. An overview of the disinfectants and disinfection byproducts results for the distribution system is provided below:

- **Chloramines**. The maximum total chlorine (chloramines) residual in the distribution system in 2012 was 1.83 mg/L (occurred at Rocky Point Road in East Sooke). This value falls well under the disinfectant Canadian Guideline limit of 3.0 mg/L for chloramines. Chloramines, measured daily at the first customer location, occur as monochloramines most of the time. This is the most desirable form of this disinfectant as it produces the least perception of a chlorinous taste and odour.

- **Trihalomethanes**. In 2013, the average level of total trihalomethanes (TTHM) at the first customer sampling location below the Japan Gulch Disinfection Plant was 17.2 µg/L (median of 18.9), which is well below the Canadian Guideline limit of 100 µg/L (**Table 2**). (Note: The Canadian Guidelines require this parameter to be collected at least quarterly and the quarterly results to be averaged.) The TTHM concentration does not change appreciably throughout the chloraminated distribution system (Figure 8), with the exception of Upper Dean Park, which is subject to rechlorination so sees higher TTHM concentrations during those periods, although still well below the Guideline limit. Thus, the vast majority of the 340,000 people in the GVDWS receive water with these relatively low levels of disinfection byproducts.

- **Haloacetic Acids**. Haloacetic acids (HAA) are a second group of disinfection byproducts that are produced when chlorine is used as a disinfecting chemical. The HAAs are comprised of mono-, di-, and trichloroacetic acids plus mono- and dibromoacetic acids. For regulatory purposes, the regulatory agencies use the five HAAs (referred to as HAA5) that are most commonly found in drinking water. The USEPA set a maximum contaminant level (MCL) of 60 µg/L for HAA5 effective January 2002. In 2008, Canada set a maximum acceptable concentration (MAC) limit of 80 µg/L for HAA5.

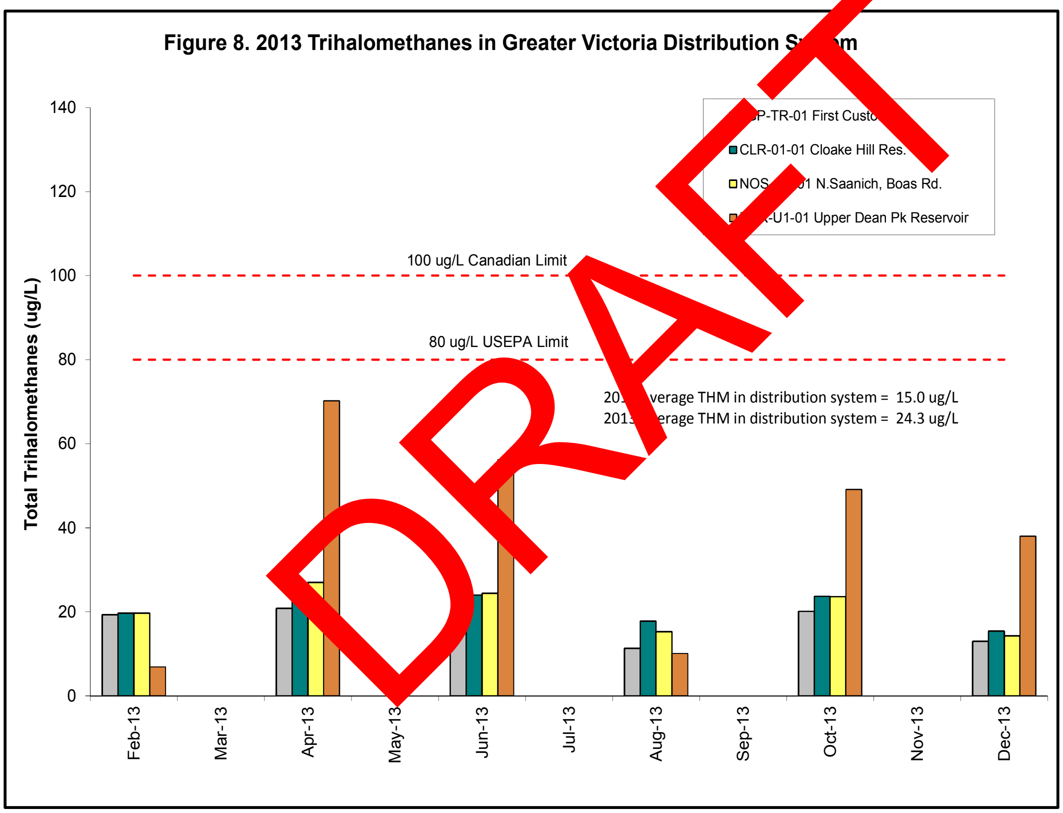


Figure 8 2013 Trihalomethanes in Greater Victoria Distribution System

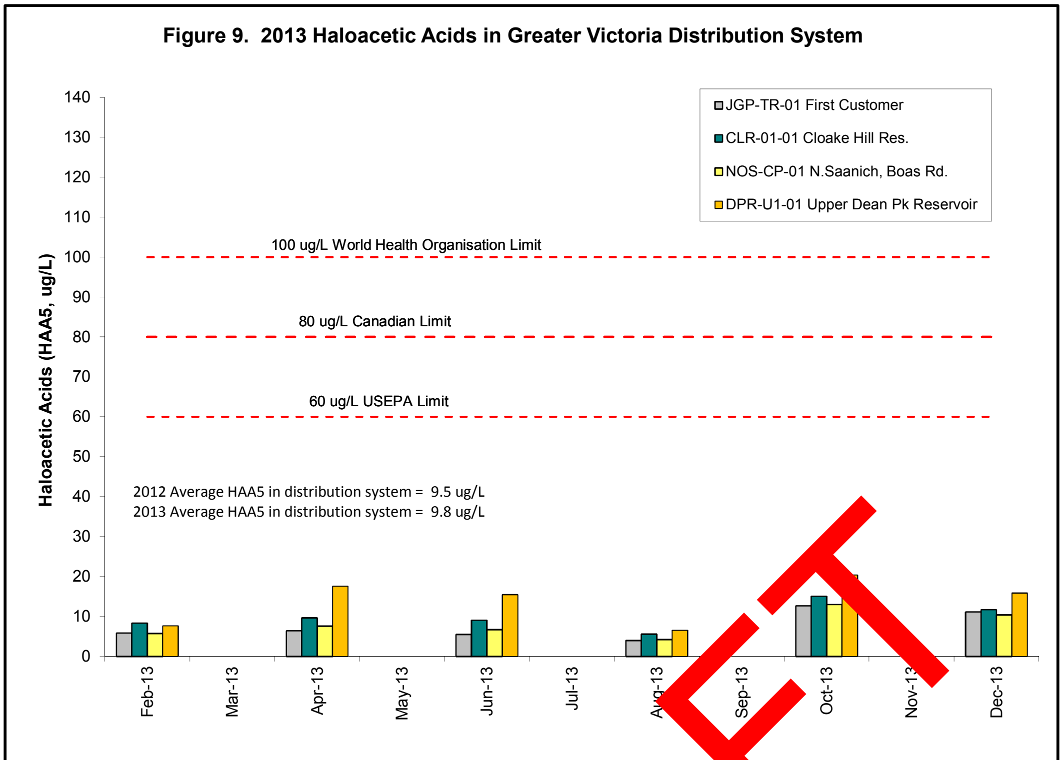


Figure 9 2013 Haloacetic Acids in Greater Victoria Distribution System

The Water Quality Program has been monitoring HAA5 for a number of years as part of the USEPA Information Collection Rule (used to collect data to determine levels for compliance). In 2013, the average level of HAA5 at the first customer sampling location was 7.60 µg/L (median of 6.14 µg/L), which is well below both the USEPA limit and the 2008 Canadian limit (Figure 9). Likewise, the HAA5 levels in the distribution system were well below both USEPA limit and the new Canadian limit (Figure 9).

A detailed summary of disinfection byproducts showing the results of sampling within the individual municipalities is provided in a report titled *2013 Annual Summary of Disinfection Byproducts in Greater Victoria's Drinking Water* available on the CRD website.

7.5 Algae and Source Water Nutrients

The source reservoirs in the Greater Victoria Water Supply Area (Map 1) contain a variety of biological communities including bacteria, periphyton (algae attached to submerged surfaces), phytoplankton (algae floating within the water column), zooplankton (tiny animals also floating within the water column), aquatic insects, sponges, mussels, fish and macrophytes (aquatic plants). Together these biological communities interact and assist in keeping the water in the reservoirs clean and healthy.

- **Chlorophyll-a**. The overall level of algal activity in Sooke Reservoir can be measured using chlorophyll-a, which is a component of all living algal cells. For the past several years as the rising water levels flooded new lands around the margin of the reservoir during the Inundation Phase of the Sooke Reservoir Expansion Project, the Water Quality Program has been intensively monitoring the physical, chemical and biological aspects of this project.

  In 2003 through 2013, the concentration of chlorophyll-a was substantively higher than in the years before inundation. For the first few years after inundation (2005), the concentration of chlorophyll-a declined. Since 2007, however, the concentration appears to have reached steady state with some variation (Figure 10). In 2013, the chlorophyll-a concentration peaked in early spring and early winter for both the south and north basins (see inset Figure 10).

- **Total Phosphorus**. The primary contributor to the higher levels of chlorophyll-a observed in Sooke Reservoir in 2003 through 2013 was the continuing effects of the higher levels of total phosphorus (Figure 11) resulting from the flooding of the newly cleared lands around the margin of Sooke Reservoir in 2003-2006.

  In 2013, similar to 2008-2012, the concentrations of total phosphorus in both the south and north basins of Sooke Reservoir were lower than that in the previous five years (Figure 11) and seem to be returning to pre-inundation levels.

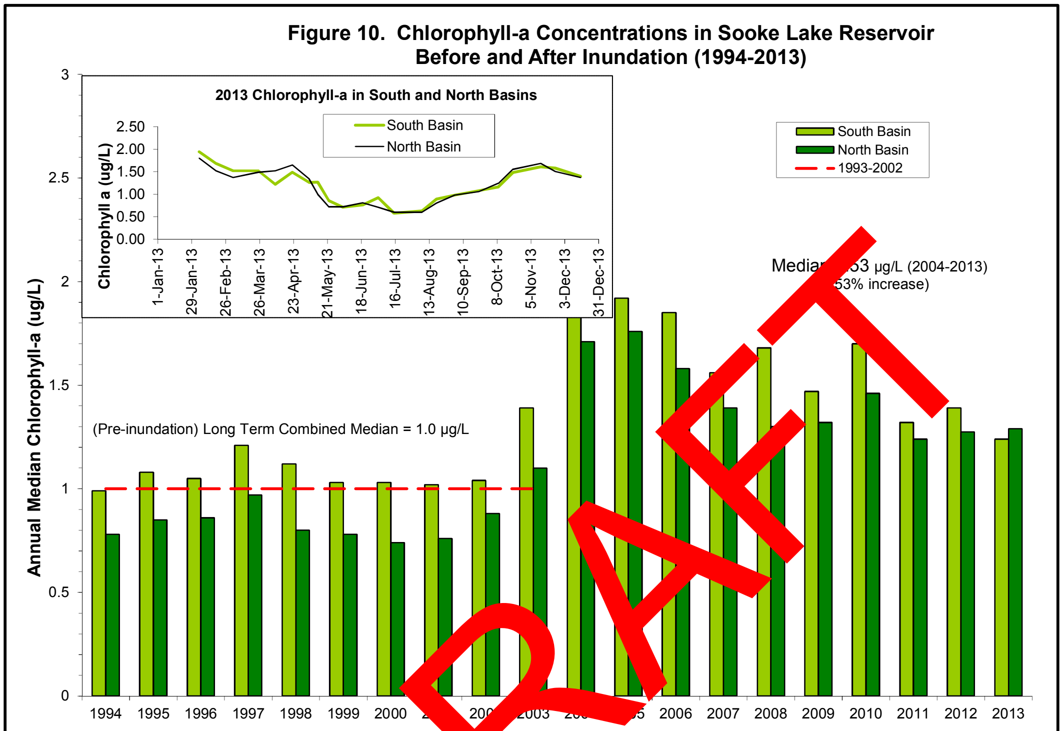


Figure 10 Chlorophyll-a Concentrations in Sooke Lake Reservoir Before and After Inundation (1994-2013)

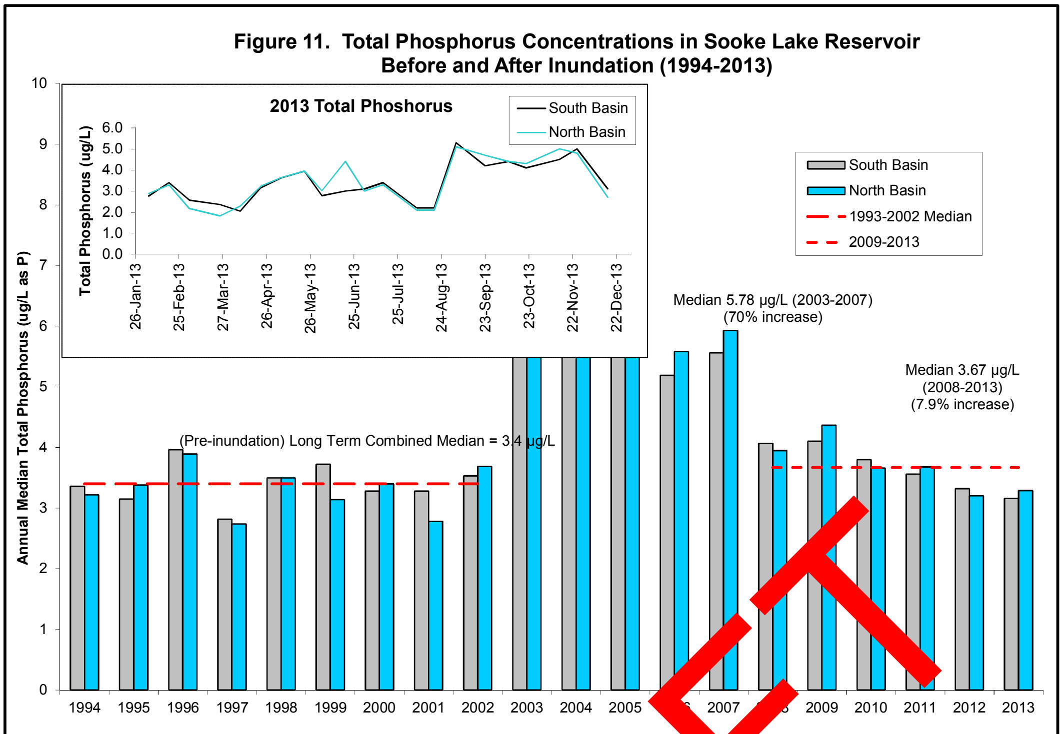


Figure 11 **Total Phosphorus Concentrations in Sooke Lake Reservoir Before and After Inundation (1994-2013)**

- **Algae**. In 2013, the highest numbers of algae in Sooke Lake Reservoir occurred in January through May (Figure 12) and was the continuation of a peak in numbers of the diatom, *Asterionella formosa* (Figure 13) that began in December 2012 and a peak in numbers of *Dinobryon* (Figure 14) in April and May. This late winter and early spring peak in algal numbers was coincident with the highest chlorophyll-a in 2013 (Figure 1[illegible]).

  Chlorophyll-a concentrations decreased in late spring, but began to increase again in August and showed a second plateau in concentration beginning in September coincident with increasing numbers of algae.

  The autumn and winter algal community was a diverse one with *Dinobryon,* a golden-brown alga, comprising a major component. Another diatom, *Tabellaria fenestrata,* which is usually a significant secondary component of the phytoplankton (Figure 15) was present in unusually low numbers in 2013.

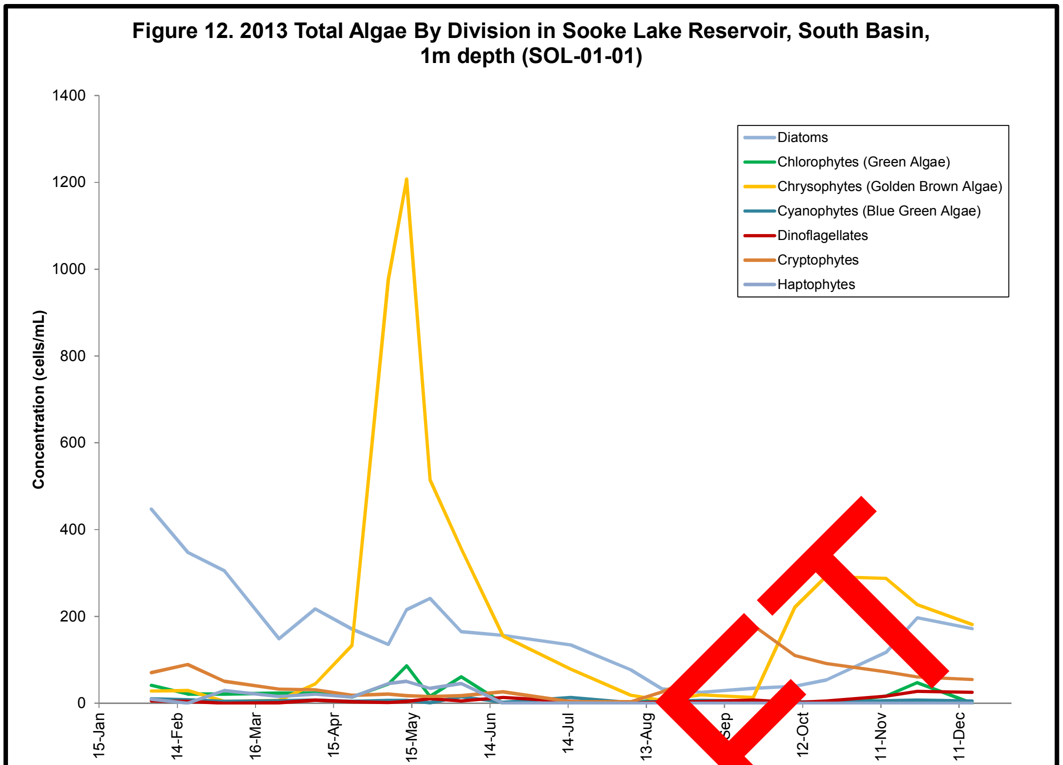


Figure 12 2013 Total Algae by Division in Sooke Lake Reservoir, South basin, 1m depth (SOL-01-01)

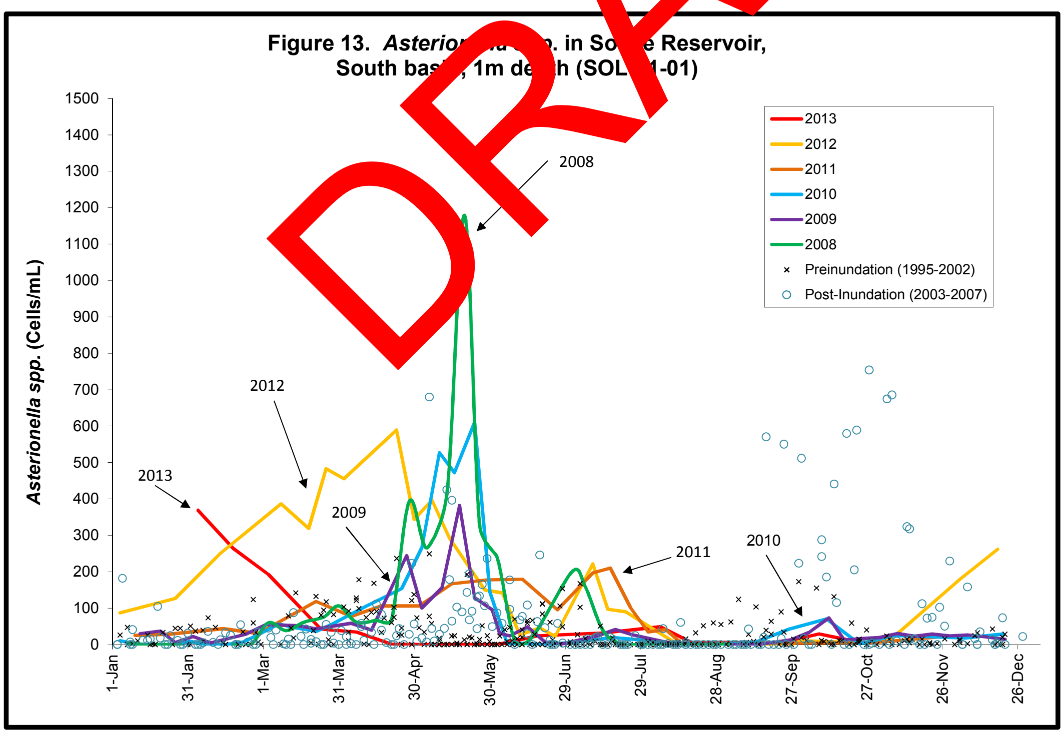


Figure 13 2013 *Asterionella spp.* in Sooke Lake Reservoir, South basin, 1m depth (SOL-01-01)

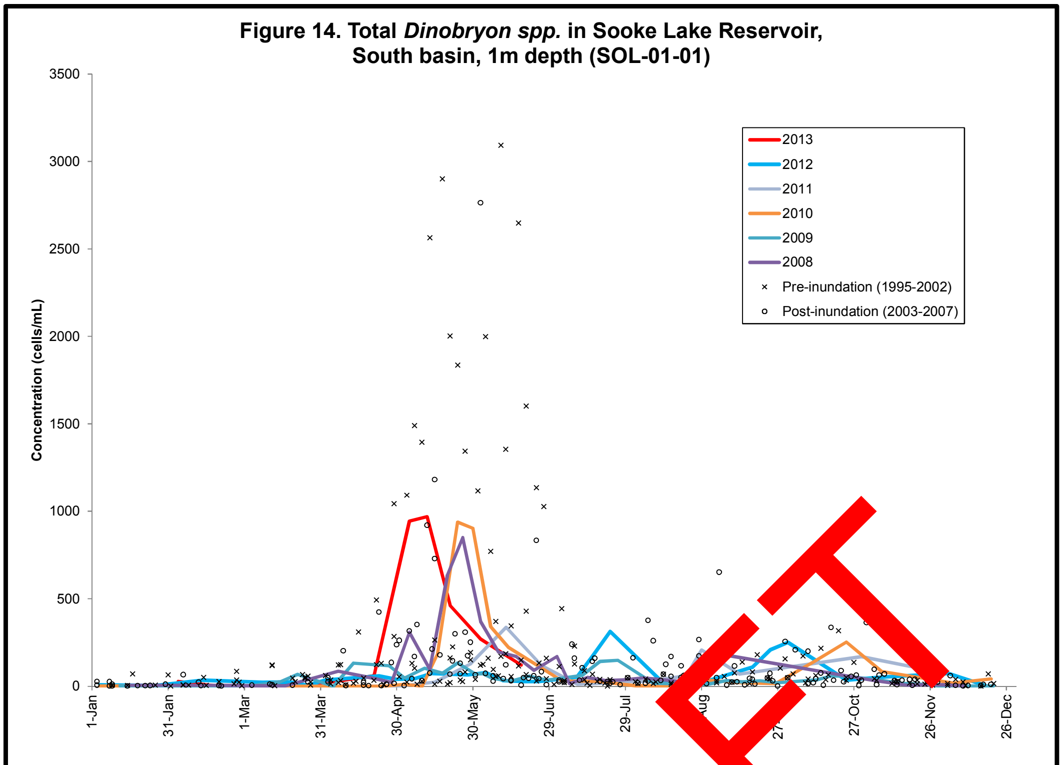


Figure 14 2013 *Dinobryon spp.* in Sooke Lake Reservoir, South basin, 1m depth (SOL-01-01)

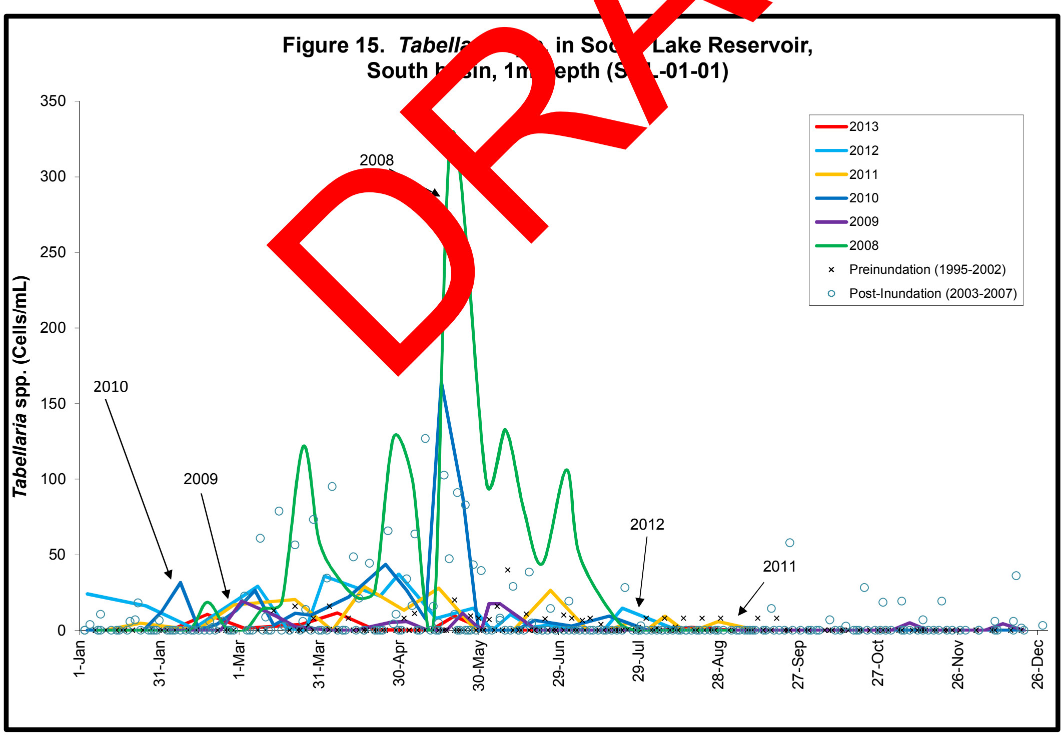


Figure 15 *Tabellaria spp.* in Sooke Lake Reservoir, South basin, 1m depth (SOL-01-01)

7.6 Water Quality Complaints

Records of customer complaints about drinking water quality have been maintained since 1992. During this period, the number of complaints received by the Water Quality Program ranged from a low of 83 in 2010 to a high of 424 in 2006 (Figure 16). The peaks in 2003 and 2006 were associated with short duration algal blooms in September of 2003 and in May of 2006.

During the years that Sooke Reservoir was being expanded and the water level in the reservoir raised, it was expected that a higher number of water quality complaints would be received. The influence of raising the water level on the algal populations in Sooke Reservoir has begun to decline and this in turn should lead to a decline in water quality complaints.

In 2013, as was the case in 2008 to 2013, there was no single category of water quality complaint that stood out among the rest. The highest number of complaints resulted from visible colour in the water (30), safety concerns (23), taste and/or odour of the water (21), chlorinous taste/odour (16), followed by plumbing (5), sensitivity (4), and filter clogging (3). (See inset in Figure 16 and Table 4).

In addition to complaints, the Water Quality Program received a number of queries from people who were concerned about the general safety of their drinking water. When queries like this are received from the public, they are treated like an actual water quality complaint because there is usually some aspect of the water quality that is disagreeable and prompted the call. These concerns were addressed individually and, in general, most customers are content to know that the Water Quality Program was actively sampling both the source water and the drinking water being delivered to their homes. Further, for those people wanting to know more about the composition of their drinking water, they were either provided with a report mailed to their home or directed to the CRD website.

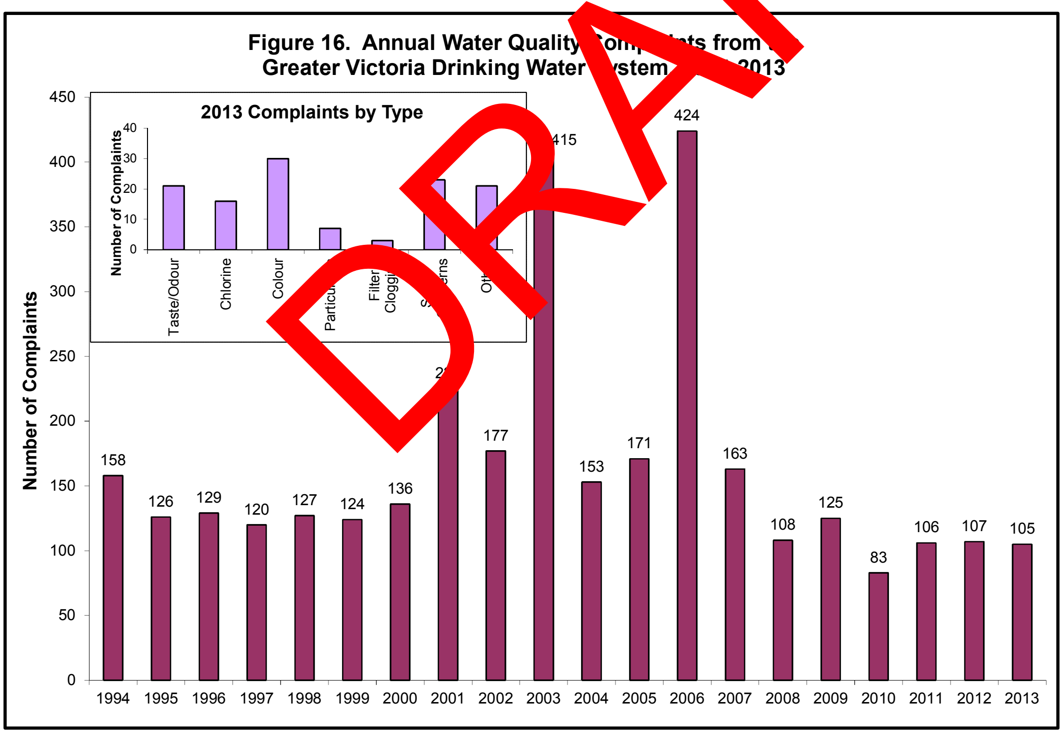


Figure 16 Annual Water Quality Complaints from the GVDWS, 1993-2013

Information on the types of water quality complaints received each month during 2013 is provided in Table 4.

Table 4 Water Quality Complaints Received by the Water Quality Program in 2013

Month	Total Complaints[1]	Taste and/or Odour	Chlorine[2]	Colour	Particulates	Safety Concerns	Filter Clogging	Customer's Plumbing	Sensitivity	Other
January	5	1	0	0	0	2	1	0	0	1
February	8	1	2	0	2	3	0	0	0	2
March	11	2	2	3	2	1	0	1	0	1
April	8	1	0	4	0	1	0	1	1	1
May	9	1	0	5	0	2	0	0	0	2
June	8	3	1	2	0	3	0	0	0	1
July	6	2	1	2	1	0	0	0	1	0
August	4	0	0	1	1	2	0	0	0	0
September	8	5	0	1	1	2	1	1	1	0
October	10	1	2	3	0	3	0	0	1	2
November	14	3	4	2	0	4	1	2	0	0
December	14	1	4	7	0	0	0	0	0	2
Total	**105**	**21**	**16**	**30**	**7**	**23**	**3**	**5**	**4**	**12**

8.0 CONCLUSIONS

1. The water quality data collected in 2013 indicate that the drinking water in Greater Victoria is good quality and safe to drink. With the exception of water temperature in the summer (an aesthetic limit), the water quality data were within both the *Guidelines for Canadian Drinking Water Quality* and the *BC Drinking Water Protection Regulation.* Over the past 17 years, there has been a substantive reduction in the number of coliform-positive samples and a general improvement to the bacteriological quality of the drinking water. As in previous years, Greater Victoria continues to enjoy a water supply in which *Giardia* and *Cryptosporidium* parasites are below the levels commonly considered by the health authorities to be responsible for disease outbreaks.

2. The bacteriological quality of the raw source water did not change appreciably from 1999 through 2013 except for a brief spike in late July 2004. In 2013, the *E. coli* bacterial levels in the raw source water were low for the entire year with the exception of a small spike during the time the water was supplied from the Goldstream Watershed in early December (during Kapoor Tunnel inspection).

3. Currently, consumers in the GVDWS receive drinking water that has very low disinfection byproducts compared to other water systems in Canada. The use of free chlorine at the Japan Gulch Disinfection Plant (first initiated in October 2011) has slightly increased the overall levels of trihalomethanes and the haloacetic acids above that observed in previous years.

4. The concentration of chlorophyll-a in Sooke Reservoir appears to have reached a steady state (with some variation) over the past five years.

5. In 2013, there were no significant algal blooms in Sooke Reservoir that resulted in water quality issues.

6. The number of water quality complaints received by the Water Quality Program, in 2013, was similar to that in 2012, and was the second lowest recorded in the past 20 years.

APPENDIX A

Table 1. 2013 Untreated (Raw) Water Quality Entering Japan Gulch Plant
(Guideline values provide reference only for untreated water)

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
				Range						
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Minimum	Maximum		10 Year Median	Samples Analyzed	Range Minimum-Maximum	
PHYSICAL PARAMETERS (ND means less than instrument can detect)										
Alkalinity, Total	mg/L	15.5	12	12.4	19.1		14.7	167	7.8 - 19.1	12/yr
Carbon, Dissolved Organic	mg/L as C	1.7	11	1.6	2.2		2.3	116	1.6 - 4.6	12/yr
Carbon,Total Organic	mg/L as C	1.8	11	1.5	2.1	Guideline Archived	2.3	116	1.5 - 5.2	12/yr
Colour, True	TCU	6.4	55	4.2	7.9	≤[illegible] AO	7.0	561	2.8 - 17.0	52/yr
Conductivity @ 25 C	uS/cm	42	56	39.3	47.0		41.5	528	27.5 - 47.0	52/yr
Hardness as $CaCO_3$	mg/L	17.2	22	7.0	19.3	No [illegible]line Required	17.0	210	7.0 - 34.7	24/yr
pH	pH units	7.14	56	6.91	7.53	6.5 [illegible]5 AO	7.21	528	6.68 - 7.66	52/yr
Tannins and Lignins	mg/L	0.32	1	0.32	0.32	Guideline [illegible]chived	0.26	25	0.11 - 0.35	2/yr
Total Dissolved Solids	mg/L	26.8	8	25.9	28.7	≤500 A[illegible]	25.7	230	13.0 - 49.0	12/yr
Total Suspended Solids	mg/L	0.37	8	0.1	0.9		0.75	230	ND - 7.67	12/yr
Total Solids	mg/L	27.2	8	26.4	29.3		26.5	229	14.0 - 50.0	12/yr
Turbidity, Grab Samples	NTU	0.3	249	0.19	1.18	[illegible].0 Operational Guideline	0.37	2,479	0.19 - 2.80	250/yr
Ultraviolet Absorption, 5 cm	Abs.@254 nm	0.24	51	0.19	[illegible]		0.29	511	0.16 - 0.58	52/yr
Ultraviolet Transmittance	%	89.3	51	85	91.[illegible]		87.0	1,851	76.0 - 94.4	52/yr
Water Temp., Grab Samples	degrees C	10.1	258	3.9	[illegible]9.1	≤15 AO	10.0	2,606	3.0 - 20.9	250/yr
NON-METALLIC INORGANIC CHEMICALS (ND means less than instrument can detect)										
Ammonia, Total	ug/L as N	3.28	10	[illegible]2	6.[illegible]	No Guideline Required	4.00	112	ND - 25.5	12/yr
Bromide	ug/L as Br	ND	10				2.76	116	ND - 22.79	12/yr
Bromate	ug/L as BrO_3	ND	2			10 MAC	ND	15	ND - 5.98	2/yr
Chloride	mg/L as Cl	3.23	2	[illegible]	[illegible]	≤ 250 AO	3.02	19	1.81 - 6.37	2/yr
Cyanide	mg/L as Cn	ND	2			0.2 MAC	ND	21		2/yr
Fluoride	mg/L as F	ND	[illegible]			1.5 MAC	0.01	19	ND - 0.13	2/yr
Nitrate, Dissolved	ug/L as N	7.1	10	[illegible].3	18.7		17.2	115	0.3 - 69.2	12/yr
Nitrite, Dissolved	ug/L as N	ND	10				ND	115		12/yr
Nitrogen, Total	ug/L as N	76.2	[illegible]	[illegible]57	87.2		89.6	115	56.9 - 304	12/yr
Phosphate, Ortho, Dissolved	ug/L as P	0.42	10	ND	2		0.45	115	ND - 3.17	12/yr
Phosphate, Total, Dissolved	ug/L as P	1.16	10	0.74	1.71		2.63	113	0.40 - 7.8	12/yr
Phosphate,Total	ug/L as P	3.9	10	2.75	5.19		4.93	115	ND - 13.1	12/yr
Silica	mg/L as SiO_2	3.85	8	3.50	4.42		3.88	89	0.09 - 6.31	12/yr
Silicon	mg/L as Si	1.82	10	0.68	2.06		1.81	106	0.68 - 22.8	12/yr
Sulphate	mg/L as SO_4	1.65	10	1.45	1.78	≤ 500 AO	1.71	114	ND - 3.96	12/yr
Sulphide	mg/L as H_2S	0.01	2	ND	0.01	≤ 0.05 AO	ND	22	ND - 0.02	2/yr
Sulphur	mg/L as S	ND	10			-	ND	112	ND - 3.0	12/yr
METALLIC INORGANIC CHEMICALS (ND means less than instrument can detect)										
Aluminum	ug/L as Al	10.7	10	3.9	15.7	200 Operational Guideline	17.5	118	ND - 172	12/yr
Antimony	ug/L as Sb	ND	10			6 MAC	ND	119		12/yr

Table 1. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Minimum	Range Maximum		10 Year Median	Samples Analyzed	Range Minimum-Maximum	
Arsenic	ug/L as As	ND	10			10 MAC	ND	120	ND - 0.3	12/yr
Barium	ug/L as Ba	3.75	10	1.6	4.1	1000 MAC	4.0	118	ND - 40.0	12/yr
Beryllium	ug/L as Be	ND	10				ND	118		12/yr
Bismuth	ug/L as Bi	ND	10				ND	111		12/yr
Boron	ug/L as B	ND	10			5000 MAC	ND	118	ND - 329	12/yr
Cadmium	ug/L as Cd	ND	10			5 MAC	ND	119	ND - 2.0	12/yr
Calcium	mg/L as Ca	5.12	10	2.06	5.67	No Guideline Required	4.99	118	2.06 - 10.2	12/yr
Cerium	ug/L as Ce	Last analyzed in 2002					0.01	1		Irregular
Cesium	ug/L as Cs	Last analyzed in 2002					ND	1		Irregular
Chromium	ug/L as Cr	ND	10			[illegible]0 MAC	ND	118	ND - 44.0	12/yr
Cobalt	ug/L as Co	ND	10				ND	119		12/yr
Copper	ug/L as Cu	1.66	10	0.46	3.83	≤ 1000 AO	1.5	118	ND - 900	12/yr
Dysprosium	ug/L as Dy	Last analyzed in 2002				_	0.01	1		Irregular
Erbium	ug/L as Er	Last analyzed in 2002				_	0.01	1		Irregular
Europium	ug/L as Eu	Last analyzed in 2002				_	0.002	1		Irregular
Gallium	ug/L as Ga	Last analyzed in 2002				_	ND	1		Irregular
Gadolinium	ug/L as Gd	Last analyzed in 2002				_	ND	1		Irregular
Germanium	ug/L as Ge	Last analyzed in 2002				_	ND	1		Irregular
Gold	mg/L as Au	Last analyzed in 2006				_	ND	6		Irregular
Hafnium	ug/L as Hf	Last analyzed in 2002				_	ND	1		Irregular
Holmium	ug/L as Ho	Last analyzed in 200[illegible]				_	0.0027	1		Irregular
Iron	ug/L as Fe	27.8	10	15.7	88.[illegible]	≤ 300 AO	36.6	118	14.6 - 169	12/yr
Lanthanum	mg/L as La	Last analyzed in 200[illegible]					ND	6		Irregular
Lead	ug/L as Pb	ND	10			10 MAC	ND	119	ND - 0.6	12/yr
Lithium	ug/L as Li	ND	10				ND	85		12/yr
Lutetium	ug/L as Lu	Last analyzed in 2002					ND	1		Irregular
Magnesium	mg/L as Mg	1.19	10	[illegible].44	1.32	No Guideline Required	1.17	118	0.44 - 2.22	12/yr
Manganese	ug/L as Mn	4.95	10	[illegible].4	18.3	≤ 50 AO	6.0	118	ND - 41.0	12/yr
Mercury, Total	ug/L as Hg	ND	[illegible]			1.0 MAC	ND	130	ND - 0.16	12/yr
Molybdenum	ug/L as Mo	ND	10				ND	118		12/yr
Neodymium	ug/L as Nd	Last analyzed in 2002					0.02	1		Irregular
Nickel	ug/L as Ni	ND	10				ND	118	ND - 8.0	12/yr
Phosphorus	mg/L as P	Last analyzed in 2007					ND	51	ND - 0.22	Irregular
Potassium	mg/L as K	0.14	10	0.08	0.17		0.19	121	ND - 1.09	12/yr
Praseodymium	ug/L as Pr	Last analyzed in 2002					0.01	1		Irregular
Rubidium	ug/L as Rb	Last analyzed in 2002					0.22	1		Irregular
Samarium	ug/L as Sm	Last analyzed in 2002					0.01	1		Irregular
Scandium	mg/L as Sc	Last analyzed in 2006					ND	6		Irregular
Selenium	ug/L as Se	ND	10			10 MAC	ND	120		12/yr
Silver	ug/L as Ag	ND	10	ND	0.02	No Guideline Required	ND	119	ND - 0.02	12/yr

Table 1. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range			10 Year Median	Samples Analyzed	Range Minimum-Maximum	
				Minimum	Maximum					
Sodium	mg/L as Na	1.74	10	0.65	1.96	≤ 200 AO	1.7	121	ND - 2.59	12/yr
Strontium	ug/L as Sr	15.3	10	6.3	17.5	5000 MAC	15.3	118	ND - 32.0	12/yr
Tantalum	ug/L as Ta	Last analyzed in 2002					ND	1		Irregular
Tellurium (52)	mg/L as Te	Last analyzed in 2004					ND	12		Irregular
Thallium	ug/L as Tl	ND	10				ND	113	ND - 30.0	12/yr
Thorium	ug/L as Th	Last analyzed in 2002					ND	1		Irregular
Thulium	ug/L as Tm	Last analyzed in 2002					ND	1	ND - 0.001	Irregular
Tin	ug/L as Sn	ND	10				ND	112		12/yr
Titanium	mg/L as Ti	ND	10				ND	118	ND - 12.0	12/yr
Tungsten	mg/L as W	Last analyzed in 2006					ND	6	ND - 72	Irregular
Vanadium	ug/L as V	ND	10				ND	118		12/yr
Ytterbium	ug/L as Yb	Last analyzed in 2002					0.01	1		Irregular
Yttrium	ug/L as Y	Last analyzed in 2002					0.04	1		Irregular
Zinc	ug/L as Zn	ND	10			≤ 5000 AO	ND	118	ND - 46.0	12/yr
Zirconium	ug/L as Zr	ND	10			-	ND	112		12/yr
MICROBIAL PARAMETERS										
Coliform Bacteria										
Coliforms, Total	Coliforms/100 mL	9	251	0	328		25	2487	0 - 4,838	250/yr
E. coli	E. coli/100 mL	0	251	0	6		0	2487	0 - 165	250/yr
Coliforms, Background	CFU/100 mL	Discontinued in May 2008					208	1078	0 - 109,278	Discontinued
Heterotrophic / Other Bacteria										
Hetero. Plate Count, 28C (7 day)	CFU/1 mL	290	246	0	231	No Guideline Required	410	2465	0 - 6,300	250/yr
Hetero. Plate Count, 35C (2 day)	CFU/1 mL	Discontinued in 200[illegible]				No Guideline Required	37	243	0 - 910	Discontinued
Aeromonas species	CFU/100 mL	Discontinued in 2[illegible]12					64	2054	0 - 51,000	Special
Cyanobacterial Toxins										
Anatoxin a	ug/L	Last analyzed in 2[illegible]5					ND	3		Special
Microcystin-LR	ug/L	Last analyzed in 201[illegible]				1.5 MAC (Total Microcystins)	ND	12	ND - 0.34	Special
Other Microcystins	ug/L	Last analyzed in 2003					ND	2		Special
Parasites						No MAC Established				
Cryptosporidium, Total oocysts	oocysts/100 L	0	7			Zero detection desirable	0	129	0 - 1.6	4/yr
Cryptosporidium,Viable oocysts	oocysts/100 L	0	7			Zero detection desirable	0	122		4/yr
Giardia, Total cysts	cysts/100 L	0	7			Zero detection desirable	0	129	0 - 1.3	4/yr
Giardia, Viable cysts	cysts/100 L	0	7			Zero detection desirable	0	122		4/yr
RADIOLOGICAL PARAMETERS (ND means less than instrument can detect)										
Gross alpha radiation	Bq/L	ND	2			0.5 (Screening)	ND	25	ND - 0.05	2/yr
Gross beta radiation	Bq/L	0.06	2	ND	0.11	1.0 (Screening)	0.02	25	ND - 0.11	2/yr
Iodine-131	Bq/L	ND	2			6 Bq/L	ND	9		Special
Cesium-134	Bq/L	ND	2			7 Bq/L (Calculated)	ND	9	ND - 0.2	Special
Cesium-137	Bq/L	ND	2			10 Bq/L	ND	9		Special
Ruthenium-103	Bq/L	ND	2			200 Bq/L	ND	9		Special

Table 1. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Minimum	Range Maximum		10 Year Median	Samples Analyzed	Range Minimum-Maximum	
Uranium	ug/L as U	ND	10			20 MAC	ND	87		12/yr
ORGANIC PARAMETERS (ND means less than instrument can detect)										
Pesticides/Herbicides										
1,4-DDD	ug/L	ND	2				ND	17		2/yr
1,4'-DDE	ug/L	ND	2				ND	20		2/yr
1,4'-DDT	ug/L	ND	2			Guideline Archived	ND	20		2/yr
2,4,5-T	ug/L	ND	2			Guideline Archived	ND	20		2/yr
2,4,5-TP (Silvex)	ug/L	ND	2			Guideline Archived	ND	20		2/yr
2,4-D	ug/L	ND	2			100 MAC	ND	20		2/yr
2,4-D (BEE)	ug/L	ND	2				ND	8		2/yr
2,4-DB	ug/L	ND	2				ND	20		2/yr
2,4-DP (Dichlorprop)	ug/L	ND	2				ND	8		2/yr
3-Hydroxy Carbofuran	ug/L	Last analyzed in 2009					ND	12		Irregular
4,4'-DDD	ug/L	ND	2				ND	20		2/yr
4,4'-DDE	ug/L	ND	2				ND	20		2/yr
4,4'-DDT	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Alachlor	ug/L	Last analyzed in 2012					ND	16		2/yr
Aldicarb	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Aldicarb Sulfone	ug/L	Last analyzed in 2009					ND	12		Irregular
Aldicarb Sulfoxide	ug/L	Last analyzed in 2009					ND	12		Irregular
Aldrin	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Ametryn	ug/L	Last analyzed in 2011					ND	1		Irregular
Atrazine	ug/L	ND	1			5.0 MAC	ND	19		2/yr
Azinphos-methyl	ug/L	ND	1			20 MAC	ND	18		2/yr
BHC (alpha)	ug/L	ND	2				ND	20		2/yr
BHC (beta)	ug/L	ND	2				ND	19		2/yr
BHC (delta)	ug/L	ND	2				ND	20		2/yr
Bendiocarb	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Bromacil	ug/L	Last analyzed in 2009					ND	12		Irregular
Bromoxynil	ug/L	Last analyzed in 2012				5.0 MAC	ND	16		2/yr
Butylate	ug/L	Last analyzed in 2009					ND	12		Irregular
Carbaryl	ug/L	ND	2			90 MAC	ND	20		2/yr
Carbofuran	ug/L	ND	2			90 MAC	ND	20		2/yr
Chlordane (alpha)	ug/L	ND	2			Guideline Archived	ND	14		2/yr
Chlordane (gamma)	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Chlordane (Total)	ug/L	ND	2			Guideline Archived	ND	6		2/yr
Chlorfenvinphos	ug/L	Last analyzed in 2009					ND	12		Irregular
Chlorpropham	ug/L	Last analyzed in 2009					ND	12		Irregular
Chlorpyrifos (Dursban)	ug/L	ND	1			90 MAC	ND	18		2/yr
Cyanazine (Bladex)	ug/L	ND	1			Guideline Archived	ND	9		2/yr

Table 1. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Minimum	Range Maximum	≤ = Less than or equal to	10 Year Median	Samples Analyzed	Range Minimum-Maximum	
DDT + Metabolites	ug/L	Last analyzed in 2012				Guideline Archived	ND	6		2/yr
Dematon	ug/L	ND	1				ND	19		2/yr
Diazinon	ug/L	ND	1			20 MAC	ND	19		2/yr
Dicamba	ug/L	ND	2			120 MAC	ND	20		2/yr
Diclofop-methyl	ug/L	Last analyzed in 2012				9.0 MAC	ND	8		2/yr
Dichlorvos	ug/L	ND	1				ND	7		2/yr
Dieldrin	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Dimethoate	ug/L	ND	1			20 MAC	ND	19		2/yr
Dinoseb	ug/L	Last analyzed in 2012				Guideline Archived	ND	7		2/yr
Dioxacarb	ug/L	Last analyzed in 2009					ND	12		Irregular
Diquat	ug/L	ND	2			70 MAC	ND	12		2/yr
Disulfoton	ug/L	Last analyzed in 2009					ND	12		Irregular
Endosulfan I	ug/L	ND	2				ND	20		2/yr
Endosulfan II	ug/L	ND	2				ND	20		2/yr
Endosulfan Sulphate	ug/L	ND	2				ND	20		2/yr
Endosulfan (Total)	ug/L	ND	2				ND	8		2/yr
Endrin	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Endrin Aldehyde	ug/L	ND	2				ND	20		2/yr
Endrin Ketone	ug/L	ND	2				ND	8		2/yr
Ethion	ug/L	ND	1				ND	18		2/yr
Ethyl Parathion	ug/L	ND	2				ND	8		2/yr
Fenchlorophos (Ronnel)	ug/L	ND	1				ND	7		2/yr
Fenitronthion	ug/L	Last analyzed in 2009					ND	12		Irregular
Fenthion	ug/L	ND	1				ND	18		2/yr
Fonofos	ug/L	ND	1				ND	19		2/yr
Glyphosate	ug/L	ND	2			280 MAC	ND	20		2/yr
Heptachlor	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Heptachlor Epoxide	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Hexazinone	ug/L	Last analyzed in 2009					ND	12		Irregular
Isofenphos	ug/L	Last analyzed in 2009					ND	12		Irregular
Lindane (BHC-gamma)	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Malathion	ug/L	ND	1			190 MAC	ND	19		2/yr
2-Methyl-4-chlorophenoxyacetic acid	ug/L	ND	2			100 MAC	ND	20		2/yr
MCPP	ug/L	ND	2				ND	20		2/yr
Methidathion	ug/L	Last analyzed in 2009					ND	12		Irregular
Methiocarb	ug/L	Last analyzed in 2009					ND	12		Irregular
Methomyl	ug/L	Last analyzed in 2009					ND	12		Irregular
Methoxychlor	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Methyl Parathion	ug/L	ND	2			Guideline Archived	ND	19		2/yr
Metolachlor	ug/L	ND	1			50 MAC	ND	19		2/yr

Table 1. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Minimum	Range Maximum		10 Year Median	Samples Analyzed	Range Minimum-Maximum	
Metribuzin (Sencor)	ug/L	Last analyzed in 2011				80 MAC	ND	6		2/yr
Mevinphos	ug/L	ND	1				ND	19		2/yr
Mirex	ug/L	ND	2			Guideline Archived	ND	8		2/yr
Monocrotophos	ug/L	Last analyzed in 2009					ND	12		Irregular
Nitrilotriacetic acid (NTA)	mg/L	ND	2			0.4 MAC	ND	12		2/yr
Oxamyl	ug/L	Last analyzed in 2009					ND	12		Irregular
Parathion	ug/L	Last analyzed in 2009				50 MAC	ND	12		Irregular
Paraquat (ion)	ug/L	ND	2			7 MAC	ND	12		2/yr
Phorate	ug/L	ND	2			2.0 MAC	ND	18		2/yr
Phosalone	ug/L	Last analyzed in 2009					ND	12		Irregular
Phosmet	ug/L	ND	1				ND	19		2/yr
Picloram	ug/L	ND	2			190 MAC	ND	20		2/yr
Promecarb	ug/L	Last analyzed in 2009					ND	12		Irregular
Prometryne	ug/L	ND	1				ND	6		2/yr
Propazine	ug/L	Last analyzed in 2009					ND	13		Irregular
Propoxur	ug/L	Last analyzed in 2009					ND	12		Irregular
Simazine	ug/L	ND	1			10 MAC	ND	18		2/yr
Simetryn	ug/L	Last analyzed in 2011					ND	1		Irregular
Temephos	ug/L	Last analyzed in 2010				Guideline Archived	ND	1		Irregular
Terbufos	ug/L	ND	1			1.0 MAC	ND	18		2/yr
Terbutryne	ug/L	Last analyzed in 2011					ND	1		Irregular
Tetrachlovinphos	ug/L	Last analyzed in 2009					ND	12		Irregular
Toxaphene	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Trichlopyr	ug/L	Last analyzed in 2009					ND	1		Irregular
Trifluralin	ug/L	ND	1			45 MAC	ND	10		2/Yyr
Polycyclic Aromatic Hydrocarbons (PAHs)										
Acenaphthene	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Acenaphthylene	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Acridine	ug/L	Last analyzed in 2009				Guideline Archived	ND	12		Irregular
Anthracene	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Benzo(a)anthracene	ug/L	ND	2	ND	0.02	Guideline Archived	ND	20	ND - 0.02	2/yr
Benzo(a)pyrene	ug/L	ND	2			0.01 MAC	ND	18		2/yr
Benzo(b)fluoranthene	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Benzo(g,h,i)perylene	ug/L	ND	2			Guideline Archived	ND	20	ND - 0.05	2/yr
Benzo(k)fluoranthene	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Chrysene	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Dibenz(a,h)anthracene	ug/L	ND	2			Guideline Archived	ND	20	ND - 0.04	2/yr
Fluoranthene	ug/L	ND	2			Guideline Archived	ND	20	ND - 0.02	2/yr
Fluorene	ug/L	ND	2			Guideline Archived	ND	20	ND - 0.03	2/yr
Indeno(1,2,3-c,d)pyrene	ug/L	ND	2			Guideline Archived	ND	20		2/yr

Table 1. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Minimum	Range Maximum		10 Year Median	Samples Analyzed	Range Minimum-Maximum	
Naphthalene	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Phenanthrene	ug/L	ND	2			Guideline Archived	ND	20	ND - 0.08	2/yr
Pyrene	ug/L	ND	2			Guideline Archived	ND	20		2/yr
Volatile Hydrocarbons	ug/L	ND	2				ND	14		2/yr
Phenols										
2,3,4,5-Tetrachlorophenol	ug/L	Last analyzed in 2009					ND	12		Irregular
2,3,4,6-Tetrachlorophenol	ug/L	Last analyzed in 2012				100 MAC and ≤ 1.0 AO	ND	16		2/yr
2,3,5,6-Tetrachlorophenol	ug/L	Last analyzed in 2009					ND	4		Irregular
2,3,4-Trichlorophenol	ug/L	Last analyzed in 2009					ND	12		Irregular
2,3,5-Trichlorophenol	ug/L	Last analyzed in 2009					ND	12		Irregular
2,3,6-Trichlorophenol	ug/L	Last analyzed in 2009					ND	12		Irregular
2,3-Dichlorophenol	ug/L	Last analyzed in 2009					ND	12		Irregular
2,4,5-Trichlorophenol	ug/L	Last analyzed in 2009					ND	12		Irregular
2,4,6-Trichlorophenol	ug/L	ND	2			5.0 MAC and ≤ 2.0 AO	ND	18		2/yr
2,4-Dichlorophenol	ug/L	ND	2			900 MAC and ≤ 0.3 AO	ND	20		2/yr
2,4-Dimethylphenol	ug/L	ND	2				ND	20		2/yr
2,4-Dinitrophenol	ug/L	ND	2				ND	20		2/yr
2,5-Dichlorophenol	ug/L	ND	2				ND	19		2/yr
2,6-Dichlorophenol	ug/L	Last analyzed in 2009					ND	12		Irregular
2-Chlorophenol	ug/L	ND	2				ND	20		2/yr
2-Methylphenol	ug/L	Last analyzed in 2009					ND	12		Irregular
2-Nitrophenol	ug/L	ND	2				ND	19		2/yr
3,4,5-Trichlorophenol	ug/L	Last analyzed in 2009					ND	12		Irregular
3,4-Dichlorophenol	ug/L	Last analyzed in 2009					ND	12		Irregular
3,5-Dichlorophenol	ug/L	Last analyzed in 2009					ND	12		Irregular
3-Chlorophenol	ug/L	Last analyzed in 2009					ND	12		Irregular
3-Methylphenol	ug/L	Last analyzed in 2009					ND	4		Irregular
4,6-Dinitro-2-Methylphenol	ug/L	ND	2				ND	20		2/yr
4-Chloro-3-Methylphenol	ug/L	ND	[illegible]				ND	12		2/yr
4-Chlorophenol	ug/L	Last analyzed in 2009					ND	11		Irregular
4-Methylphenol	ug/L	Last analyzed in 2009					ND	12		Irregular
4-Nitrophenol	ug/L	ND	2				ND	20		2/yr
Alpha-Terpineol	ug/L	ND	2				ND	8		2/yr
Pentachlorophenol	ug/L	ND	2			60 MAC and ≤ 30 AO	ND	17		Irregular
Phenol	ug/L	ND	2				ND	20	ND - 6.2	2/yr
Total Phenolics	mg/L	Last analyzed in 2009				Guideline Archived	ND	12	ND - 0.004	Irregular
Total Trichlorophenols	ug/L	Last analyzed in 2009					ND	11		Irregular
Total Tetrachlorophenols	ug/L	Last analyzed in 2009					ND	12		Irregular
Total Chlorinated Phenols	ug/L	Last analyzed in 2009					ND	12		Irregular
Polychlorinated Biphenyls (PCBs)										

Table 1. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Minimum	Range Maximum		10 Year Median	Samples Analyzed	Range Minimum-Maximum	
PCB-1016	ug/L	ND	2			Guideline Archived	ND	8		Irregular
PCB-1221	ug/L	ND	2			Guideline Archived	ND	8		Irregular
PCB-1232	ug/L	ND	2			Guideline Archived	ND	8		Irregular
PCB-1242	ug/L	ND	2			Guideline Archived	ND	8		Irregular
PCB-1248	ug/L	ND	2			Guideline Archived	ND	8		Irregular
PCB-1254	ug/L	ND	2			Guideline Archived	ND	8		Irregular
PCB-1260	ug/L	ND	2			Guideline Archived	ND	8		Irregular
PCB-1262	ug/L	Last analyzed in 2010				Guideline Archived	ND	1		Irregular
PCB-1268	ug/L	Last analyzed in 2010				Guideline Archived	ND	1		Irregular
Total PCBs	ug/L	ND	2			Guideline Archived	ND	8		Irregular
Other Synthetic Chemicals										
1,1,1-Trichloroethane	ug/L	ND	2				ND	20		2/yr
1,1,1,2-Tetrachloroethane	ug/L	ND	2				ND	8		2/yr
1,1,2,2-Tetrachloroethane	ug/L	ND	2				ND	20		2/yr
1,1,2-Trichloroethane	ug/L	ND	2				ND	20		2/yr
1,1-Dichloroethane	ug/L	ND	2				ND	20	ND - 0.1	2/yr
1,1-Dichloroethylene	ug/L	ND	2			14 MAC	ND	19		2/yr
1,2,3-Trichlorobenzene	ug/L	Last analyzed in 2012					ND	1		Irregular
1,2,4-Trichlorobenzene	ug/L	ND	2				ND	20	ND - 0.2	2/yr
1,2-Dibromoethane	ug/L	Last analyzed in 2012					ND	13		Irregular
1,2-Dichlorobenzene	ug/L	ND	2			200 MAC and ≤ 3.0 AO	ND	20		2/yr
1,2-Dichloroethane	ug/L	ND	2			5.0 MAC	ND	20		2/yr
1,2-Dichloroethylene (cis)	ug/L	ND	2				ND	20		2/yr
1,2-Dichloroethylene (trans)	ug/L	ND	2				ND	20		2/yr
1,2-Dichloropropane	ug/L	ND	2				ND	20		2/yr
1,2-Diphenylhydrazine	ug/L	ND	2				ND	8		2/yr
1,3-Dichlorobenzene	ug/L	ND	2				ND	20		2/yr
1,3-Dichloropropene (cis)	ug/L	ND	2				ND	20		2/yr
1,3-Dichloropropene (trans)	ug/L	ND	[illegible]				ND	20		2/yr
1,4-Dichlorobenzene	ug/L	ND	2			5.0 MAC and ≤ 1.0 AO	ND	20		2/yr
2,4-Dinitrotoluene	ug/L	ND	2				ND	20		2/yr
2,6-Dinitrotoluene	ug/L	ND	2				ND	20		2/yr
2-Butanone	ug/L	Last analyzed in 2009					ND	12		Irregular
2-Chloronaphthalene	ug/L	ND	2				ND	20		2/yr
2-Hexanone	ug/L	Last analyzed in 2009					ND	12		Irregular
2-Methylnaphthalene	ug/L	ND	2				ND	20		2/yr
2-Nitroaniline	ug/L	Last analyzed in 2009					ND	12		Irregular
3,3'-Dichlorobenzidene	ug/L	ND	2				ND	20		2/yr
3-Nitroaniline	ug/L	Last analyzed in 2009					ND	12		Irregular
4-Bromophenyl-phenylether	ug/L	ND	2				ND	20		2/yr

Table 1. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Minimum	Range Maximum		10 Year Median	Samples Analyzed	Range Minimum-Maximum	
4-Chloroaniline	ug/L	Last analyzed in 2009					ND	12		Irregular
4-Chlorophenyl-phenylether	ug/L	ND	2				ND	20		2/yr
4-Methyl-2-pentanone	ug/L	Last analyzed in 2009					ND	12		Irregular
4-Nitroaniline	ug/L	Last analyzed in 2009					ND	12		Irregular
Aminomethylphosphonic Acid (AMPA)	ug/L	Last analyzed in 2009					ND	11		Irregular
Aniline	ug/L	Last analyzed in 2009					ND	12		Irregular
Atrazine	ug/L	ND	2			5.0 MAC	ND	19		2/yr
Atrazine + Desethyl Atrazine	ug/L	Last analyzed in 2012					ND	4		2/yr
Azobenzene	ug/L	Last analyzed in 2009					ND	12		Irregular
Benzene	ug/L	ND	2			5.0 MAC	ND	20		2/yr
Benzyl Alcohol	ug/L	Last analyzed in 2009					ND	12		Irregular
Benzidine	ug/L	ND	2				ND	8		Irregular
Bis(-2-chloroethoxy) methane	ug/L	ND	2				ND	20		2/yr
Bis(-2-chloroethyl) ether	ug/L	ND	2				ND	20		2/yr
Bis(2-chloroisopropyl) ether	ug/L	ND	2				ND	20		2/yr
Bis(2-ethylhexyl) phthalate	ug/L	ND	2				ND	22	ND - 31	2/yr
Bisphenol A (BPA)	ug/L	Last analyzed in 2008					ND	1		Irregular
Bromomethane	ug/L	ND	2				ND	20		2/yr
Butylbenzyl phthalate	ug/L	ND	2				ND	20		2/yr
Carbon Tetrachloride	ug/L	ND	2			5.0 MAC	ND	20		2/yr
Chloroethane	ug/L	ND	2				ND	20		2/yr
Chloromethane	ug/L	ND	2				ND	19		2/yr
Desethyl Atrazine	ug/L	Last analyzed in 2012					ND	4		2/yr
Dibenzofuran	ug/L	Last analyzed in 2009					ND	12		Irregular
Dibromochloromethane	ug/L	ND	2				ND	20		2/yr
Dibromoethane	ug/L	Last analyzed in 2011					ND	3		Irregular
Dibromomethane	ug/L	Last analyzed in 2009					ND	12		Irregular
Dichlorodifluoromethane	ug/L	Last analyzed in 2012					ND	15		Irregular
Dichloromethane	ug/L	ND	2			50 MAC	ND	8		2/yr
Diethyl phthalate	ug/L	ND	2				ND	20	ND - 0.6	2/yr
Dimethyl phthalate	ug/L	ND	2				ND	20		2/yr
Di-n-butyl phthalate	ug/L	ND	2				ND	20		2/yr
Di-n-ocyl phthalate	ug/L	ND	2				ND	20		2/yr
Diuron	ug/L	Last analyzed in 2010				150 MAC	ND	13		Irregular
Ethylbenzene	ug/L	ND	2			≤ 2.4 AO	ND	20		2/yr
Formaldehyde	ug/L	ND	2			No Guideline Required	ND	18	ND - 20	2/yr
Hexachlorobenzene	ug/L	ND	2				ND	20		2/yr
Hexachlorobutadiene	ug/L	ND	2				ND	20		2/yr
Hexachlorocyclopentadiene	ug/L	ND	2				ND	20		2/yr
Hexachloroethane	ug/L	ND	2				ND	20		2/yr

Table 1. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range			10 Year Median	Samples Analyzed	Range Minimum-Maximum	
				Minimum	Maximum					
Isophorone	ug/L	ND	2				ND	20		2/yr
Methylene Chloride	ug/L	Last analyzed in 2009					ND	12		Irregular
Methyltertiarybutylether (MTBE)	ug/L	ND	3			15 AO	ND	14		Irregular
Monochlorobenzene	ug/L	ND	2			80 MAC and ≤ 30 AO	ND	20		2/yr
N-nitrosodimethylamine (NDMA)	ug/L	ND	2			0.04 MAC	ND	8		Irregular
Nitrobenzene	ug/L	ND	2				ND	20		2/yr
N-nitroso-di-n-propylamine	ug/L	ND	2				ND	20		2/yr
N-nitrosodiphenylamine	ug/L	ND	2				ND	20		2/yr
Octachlorostyrene	ug/L	ND	2				ND	8		2/yr
Styrene	ug/L	ND	2				ND	20		2/yr
Tetrachloroethylene	ug/L	ND	2			30 MAC	ND	20		2/yr
Toluene	ug/L	ND	2			≤ 24 AO	ND	20		2/yr
Triallate	ug/L	ND	1			Guideline Archived	ND	7		2/yr
Trichloroethylene	ug/L	ND	2			5.0 MAC	ND	20		2/yr
Trichlorofluoromethane	ug/L	ND	2				ND	20		2/yr
Trichlorotrifluoroethane	ug/L	Last analyzed in 2012					ND	3		Irregular
Vinyl Chloride	ug/L	ND	2			2.0 MAC	ND	20		2/yr
o-Xylene	ug/L	ND	2				ND	8		Irregular
m&p-Xylene	ug/L	ND	2				ND	8		Irregular
Xylenes (Total)	ug/L	ND	2			≤ 300 AO	ND	20		2/yr

Notes: mg/L=milligrams per litre; ug/L=micrograms per litre; ND=Not Detected; CFU=Colony Forming Units; NTU=Nephelometric Units; TCU=True Colour; AO=Aesthetic Objective; MAC=Max. Acceptable Conc.; Median=middle point of all values

mg/L = parts per million   ug/L = parts per billion

Table 2. 2013 Treated Water Quality below Japan Gulch Plant

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Min.	Range Max.		10 Year Median	Samples Analyzed	Range Min.-Max.	
PHYSICAL PARAMETERS (ND means less than instrument can detect)										
Alkalinity, Total	mg/L	13.2	11	11.8	18.8		13.3	160	6.70 - 18.8	12/yr
Carbon, Dissolved Organic	mg/L	1.80	11	1.26	2.10		2.30	123	1.26 - 3.83	12/yr
Carbon, Total Organic	mg/L	1.80	11	1.40	2.10	Guideline Archived	2.34	123	1.40 - 4.20	12/yr
Colour, True	TCU	3.8	52	1.8	5.5	≤ 15 AO	4.7	561	1.3 - 12.0	52/yr
Conductivity @ 25 C	uS/cm	43.8	52	42.2	46.4		43.6	515	30.5 - 55.4	52/yr
Hardness as $CaCO_3$	mg/L	17.5	22	7.2	20.1	No Guideline Required	17.2	177	7.19 - 30.7	12/yr
Odour	Flavour Profile	Trace	246	Odour free	Strong	Inoffensive	Weak	2,470	Odour free - Strong	250/yr
pH	pH units	7.10	52	6.81	7.36	6.5 - 8.5 AO	7.09	515	6.53 - 7.99	52/yr
Taste	Flavour Profile	Trace	246	Taste free	Moderate	Inoffensive	Weak	2,466	Taste free - Moderate	250/yr
Total Dissolved Solids	mg/L	27.6	8	26.7	29.1	≤500 AO	26.2	230	13.2 - 33.0	12/yr
Total Suspended Solids	mg/L	0.31	8	0.10	1.20		0.50	230	ND - 11.0	12/yr
Total Solids	mg/L	28.3	8	27.2	30.0		27.0	229	14.0 - 40.0	12/yr
Turbidity, Grab Samples	NTU	0.33	245	0.20	1.4	Operational and ≤ 5 AO	0.38	2,484	0.19 - 38.1	250/yr
Water Temperature, Grab Samples	degrees C	9.2	281	4.0	19.[illegible]	≤ 15 AO	9.5	2,538	2.7 - 21.1	250/yr
NON-METALLIC INORGANIC CHEMICALS (ND means less than instrument can detect)										
Ammonia, Total	ug/L as N	95.1	10	3.88	[illegible]	No Guideline Required	133	118	ND - 433	12/yr
Bromide	ug/L as Br	ND	10				1.27	113	ND - 27.7	12/yr
Chloride	mg/L as Cl	4.97	2	4.50	5.[illegible]	≤ 250 AO	4.13	19	2.55 - 6.57	2/yr
Cyanide	mg/L as Cn	ND	2			0.2 MAC	ND	21		2/yr
Fluoride	mg/L as F	ND	2			1.5 MAC	ND	19	ND - 0.13	2/yr
Nitrate, Total	ug/L as N	17.7	10	[illegible]	27.6	10000 MAC	21.7	113	3.57 - 75.1	12/yr
Nitrite, Total	ug/L as N	ND	10			3200 MAC	ND	114	ND - 0.30	12/yr
Nitrogen, Total	ug/L as N	203	10	60.1	223		274	113	60.1 - 534	12/yr
Phosphate, Ortho, Dissolved	ug/L as P	0.43	10	ND	1.21		0.59	114	ND - 2.41	12/yr
Phosphate, Total, Dissolved	ug/L as P	1.16	10	0.71	1.77		3.17	113	0.71 - 6.81	12/yr
Phosphate, Total	ug/L as P	3.87	[illegible]	2.76	6.09		5.05	113	2.44 - 8.60	12/yr
Silica	mg/L as SiO_2	3.70	8	3.50	4.29		3.72	81	0.09 - 5.90	12/yr
Silicon	mg/L as Si	1.80	10	0.69	2.16		1.82	102	0.69 - 19.3	12/yr
Sulphate	mg/L as SO_4	1.61	10	1.46	1.74	≤ 500 AO	1.71	113	1.08 - 3.97	12/yr
Sulphide	mg/L as H_2S	0.05	2	ND	0.09	≤ 0.05 AO	ND	22	ND - 0.09	2/yr
Sulphite	mg/L as SO_3	Last analyzed in 2009					ND	1		Irregular
Sulfur	mg/L as S	ND	10				ND	108	ND - 4.0	12/yr
METALLIC INORGANIC CHEMICALS (ND means less than instrument can detect)										
Aluminum	ug/L as Al	11.8	10	4.90	17.4	100 AO and 200 Operational	16.5	114	ND - 173	12/yr
Antimony	ug/L as Sb	ND	10			6 MAC	ND	115	ND - 0.50	12/yr
Arsenic	ug/L as As	ND	10			10 MAC	ND	116	ND - 0.20	12/yr

Table 2. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Min.	Range Max.		10 Year Median	Samples Analyzed	Range Min.-Max.	
Barium	ug/L as Ba	3.85	10	1.40	4.20	1000 MAC	4.00	114	ND - 12.0	12/yr
Beryllium	ug/L as Be	ND	10				ND	114	ND - 0.10	12/yr
Bismuth	ug/L as Bi	ND	10				ND	108	ND - 50.0	12/yr
Boron	ug/L as B	ND	10			5000 MAC	ND	114	ND - 236	12/yr
Cadmium	ug/L as Cd	ND	10	ND	0.01	5 MAC	ND	115	ND - 0.30	12/yr
Calcium	mg/L as Ca	5.20	10	2.10	5.91	No Guideline Required	5.01	114	2.10 - 8.98	12/yr
Cerium	ug/L as Ce	Last analyzed in 2002					0.010	1		Irregular
Cesium	ug/L as Cs	Last analyzed in 2002					ND	1		Irregular
Chromium	ug/L as Cr	ND	10			50 MAC	ND	114	ND - 19.0	12/yr
Cobalt	ug/L as Co	ND	10				ND	115	ND - 21.0	12/yr
Copper	ug/L as Cu	22.2	10	11.8	41.5	≤ 1000 AO	17.7	114	ND - 44.3	12/yr
Dysprosium	ug/L as Dy	Last analyzed in 2002				_	0.010	1		Irregular
Erbium	ug/L as Er	Last analyzed in 2002				_	ND	1		Irregular
Europium	ug/L as Eu	Last analyzed in 2002				_	0.003	1		Irregular
Gallium	ug/L as Ga	Last analyzed in 2002				_	ND	1		Irregular
Gadolinium	ug/L as Gd	Last analyzed in 2002				_	ND	1		Irregular
Germanium	ug/L as Ge	Last analyzed in 2002				_	ND	1		Irregular
Gold	mg/L as Au	Last analyzed in 2006					ND	6		Irregular
Hafnium	ug/L af Hf	Last analyzed in 2002					ND	1		Irregular
Holmium	ug/L as Ho	Last analyzed in 2002					0.003	1		Irregular
Iron	ug/L as Fe	27.6	10	[illegible]3.9	8[illegible].5	≤ 300 AO	33.6	114	13.9 - 174	12/yr
Lanthanum	mg/L as La	Last analyzed in 20[illegible]6					ND	6		Irregular
Lead	ug/L as Pb	0.31	10	ND	0.5[illegible]	10 MAC	ND	115	ND - 1.60	12/yr
Lithium	ug/L as Li	ND	10				ND	81		Irregular
Lutetium	ug/L as Lu	Last analyzed in 2002					ND	1		Irregular
Magnesium	mg/L as Mg	1.20	10	0.4[illegible]	1.37	No Guideline Required	1.18	114	0.47 - 2.00	12/yr
Manganese	ug/L as Mn	3.68	10	ND	18.8	≤ 50 AO	6.00	114	ND - 35.0	12/yr
Mercury, Total	ug/L as Hg	ND	10			1.0 MAC	ND	118	ND - 0.04	12/yr
Molybdenum	Ug/L as Mo	ND	10				ND	114	ND - 26.0	12/yr
Neodymium	ug/L as Nd	Last analyzed in 2002					ND	1		Irregular
Nickel	mg/L as Ni	ND	10				ND	114	ND - 16.0	12/yr
Phosphorus	mg/L as P	Last analyzed in 2007					ND	51	ND - 0.20	12/yr
Potassium	mg/L as K	0.14	10	0.07	0.18	Guideline Under Review	0.18	117	ND - 1.05	12/yr
Praseodymium	ug/L as Pr	Last analyzed in 2002					0.004	1		Irregular
Rubidium	ug/L as Rb	Last analyzed in 2002					0.21	1		Irregular
Samarium	ug/L as Sm	Last analyzed in 2002					ND	1		Irregular
Scandium	mg/L as Sc	Last analyzed in 2006					ND	6		Irregular
Selenium	ug/L as Se	ND	10			10 MAC	ND	116	ND - 0.10	12/yr
Silver	ug/L as Ag	ND	10			No Guideline Required	ND	115	ND - 0.04	12/yr
Sodium	mg/L as Na	1.75	10	0.67	2.07	≤ 200 AO	1.70	117	ND - 2.80	12/yr

Table 2. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES ≤ = Less than or equal to	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Min.	Range Max.		10 Year Median	Samples Analyzed	Range Min.-Max.	
Strontium	ug/L as Sr	15.4	10	6.30	18.6		15.4	114	6.30 - 28.0	12/yr
Tantalum	ug/L as Ta	Last analyzed in 2002					ND	1		Irregular
Tellurium	mg/L as Te	Last analyzed in 2004					ND	12		Irregular
Thallium	ug/L as Tl	ND	10				ND	109		12/yr
Thorium	ug/L as Th	Last analyzed in 2002					ND	1		Irregular
Thulium	ug/L as Tm	Last analyzed in 2002					ND	1		Irregular
Tin	ug/L as Sn	ND	10				ND	108	ND - 20.0	12/yr
Titanium	ug/L as Ti	ND	10				ND	114	ND - 21.0	12/yr
Tungsten	mg/L as W	Last analyzed in 2006					ND	6	ND - 55.0	Irregular
Uranium	ug/L as U	ND	10			[illegible]0 MAC	ND	83		12/yr
Vanadium	ug/L as V	ND	10				ND	114		12/yr
Yttrium	ug/L as Y	Last analyzed in 2002					40.0	1		Irregular
Ytterbium	ug/L as Yb	Last analyzed in 2002					1.0	1		Irregular
Zinc	ug/L as Zn	ND	10	ND	8.60	≤ 5000 AO	ND	114	ND - 82.0	12/yr
Zirconium	ug/L as Zr	ND	10				ND	108		12/yr
MICROBIAL PARAMETERS (ND means less than method or instrument can detect)										
Coliform Bacteria										
Coliforms, Total	CFU/100 mL	0	247			0 MAC	0	2,497	0 - 21	250/yr
E. coli	CFU/100 mL	0	247			0 MAC	0	1,934		250/yr
Coliforms, Background	CFU/100 mL	Discontinued in July 2006				No Guideline Required	0	635	0 - 149	Discontinued
Heterotrophic Bacteria										
Hetero. Plate Count, 28C (7 day)	CFU/1 mL	0	244	0	6[illegible]	No Guideline Required	0	2,454	0 - 9,400	250/yr
Hetero. Plate Count, 35C (2 day)	CFU/1 mL	Discont[illegible]ed in 20[illegible]					0	246	0 - 157	Discontinued
Aeromonas species	CFU/100 mL	Discontinued in 2012				No MAC Established	0	2,038	0 - 44	Special
DISINFECTANTS (ND means less than instrument can detect)										
Disinfectants										
Chlorine, Total Residual	mg/L as Cl_2	1.25	288	0.50	1.67	3.0 MAC (chloramines)	1.23	2,592	ND - 1.99	250/yr
Dichloramine	mg/L as Cl_2	0.27	265	ND	1.22		0.13	2,282	ND - 1.22	250/yr
Monochloramine	mg/L as Cl_2	0.68	[illegible]65	ND	1.66		1.00	2,286	ND - 1.66	250/yr
BIOLOGICAL TOXINS (ND means less than instrument can detect)										
Cyanobacterial Toxins										
Anatoxin A	ug/L	Last analyzed in 2003					ND	9		Special
Microcystin-LR	ug/L	Last analyzed in 2003				1.5 MAC (Total Microcystins)	ND	10		Special
Other Microcystins	ug/L	Last analyzed in 2003					ND	10		Special
DISINFECTION BY-PRODUCTS (ND means less than instrument can detect)										
Trihalomethanes (THMs)										
Bromodichloromethane (BDCM)	ug/L	1.20	6	0.50	1.60		0.95	62	ND - 2.60	6/yr
Bromoform (BRFM)	ug/L	ND	6				ND	62		6/yr
Chloroform (CHLF)	ug/L	17.6	6	10.2	19.5		12.5	62	ND - 21.9	6/yr
Dibromochloromethane (DBCM)	ug/L	ND	6				ND	62	ND - 1.50	6/yr

Table 2. continued

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES	TEN YEAR RESULTS (2004-2013)			Target Sampling Frequency
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Min.	Range Max.	< = Less than or equal to	10 Year Median	Samples Analyzed	Range Min.-Max.	
Total Trihalomethanes (TTHM)	ug/L	18.9	6	11.3	20.8	100 MAC	13.2	62	ND - 22.3	6/yr
Haloacetic Acids (HAAs)										
Bromochloroacetic Acid (BCAA)	ug/L	0.15	6	ND	0.28		0.43	61	ND - 1.21	6/yr
Bromodichloroacetic Acid (BDCAA)	ug/L	ND	6				ND	61	ND - 0.33	6/yr
Chlorodibromoacetic Acid (CDBAA)	ug/L	ND	6				ND	60		6/yr
Dibromoacetic Acid* (DBAA)	ug/L	ND	6				ND	60	ND - 0.53	6/yr
Dichloroacetic Acid* (DCAA)	ug/L	2.81	6	1.68	6.35		8.37	61	0.23 - 43.0	6/yr
Monobromoacetic Acid* (MBAA)	ug/L	0.28	6	ND	1.68		ND	61	ND - 2.19	6/yr
Monochloroacetic Acid* (MCAA)	ug/L	ND	6	ND	0.25		ND	61	ND - 12.6	6/yr
Tribromoacetic Acid (TBAA)	ug/L	ND	6				ND	61	ND - 1.00	6/yr
Trichloroacetic Acid* (TCAA)	ug/L	2.38	6	1.84	6.11		4.74	61	0.78 - 22.0	6/yr
Haloacetic Acids (*5 Total, HAA5)	ug/L	6.14	6	3.98	12.7	80 MAC	13.7	61	1.01 - 65.0	6/yr
Haloacetic Acids (9 Total, HAA9)	ug/L	6.27	6	3.98	13.0		13.7	61	1.87 - 66.2	6/yr
Other Disinfection By-Products										
1,1,1-Trichloro-2-propanone	ug/L	Last analyzed in 2002					1.4	2	1.1 - 1.6	Special
1,1,-Dichloropropanone	ug/L	Last analyzed in 2002					1.0	2	0.9 - 1.1	Special
Bromate	ug/L	ND	2			10 MAC	ND	15	ND - 6.77	2/yr
Bromochloroacetonitrile	ug/L	Last analyzed in 2002					ND	2		Special
Chloral Hydrate	ug/L	Last analyzed in 2002					0.9	1		Special
Cyanogen Chloride	ug/L	Last analyzed in 2002					ND	2		Special
Chloropicrin	ug/L	Last analyzed in 2002					ND	2		Special
Dibromoacetonitrile	ug/L	Last analyzed in 2002					ND	2		Special
Dichloroacetonitrile	ug/L	Last analyzed in 2002					ND	2		Special
N-nitrosodimethylamine (NDMA)	ug/L	Last analyzed in 2008					ND	2		Special
Trichloroacetonitrile	ug/L	Last analyzed in 2002					ND	2	ND - 0.6	Special

Notes: mg/L=milligrams per litre; ug/L=micrograms per litre; ND=Not Detected; CFU=Colony Forming Units; NTU=Nephelometric Units; TCU=True Colour; AO=Aesthetic Objective; MAC=Max. Acceptable Conc.; Median=middle point of all values

mg/L = parts per million   ug/L = parts per billion

Table 3. 2013 Treated Water Quality below Sooke Plant

PARAMETER		2013 ANALYTICAL RESULTS				CANADIAN GUIDELINES	LONG TERM RESULTS (SEP 2009-2013)			Target
Parameter Name	Units of Measure	Median Value	Samples Analyzed	Range Min	Range Max	≤ = Less than or equal to	5 Year Median	Samples Analyzed	Range Min-Max	Sampling Frequency
PHYSICAL PARAMETERS (ND means less than instrument can detect)										
Alkalinity, Total	mg/L	16.0	11	14.3	19.2		15.8	54	13.0 - 19.2	12/yr
Colour, True	TCU	3.2	50	1.2	6.2	≤ 15 AO	3.2	218	0.9 - 6.2	52/yr
Conductivity @ 25 C	uS/cm	57.4	51	49.6	66.7		55.0	219	49.0 - 66.7	52/yr
Odour	Flavour Profile	Trace	50	Odour Free	Weak	Inoffensive	Trace	219	Odour Free - Strong	52/yr
pH	pH units	7.22	51	6.95	7.66	6[illegible] - 8.5 AO	7.31	219	6.32 - 7.88	52/yr
Taste	Flavour Profile	Trace	50	Taste Free	Weak	[illegible]noffensive	Trace	219	Taste Free - Moderate	52/yr
Turbidity, Grab Samples	NTU	0.27	51	0.19	0.78	[illegible]1 MAC	0.29	220	0.18 - 1.7	52/yr
Ultraviolet Transmittance	%	Last analyzed in 2012					90.3	7	86.7 - 93.0	Special
Water Temperature, Grab Samples	degrees C	10.0	52	4.3	18.1	≤ 15[illegible]O	10.2	226	4.3 - 18.6	52/yr
Microbial Parameters										
Coliform Bacteria										
Coliform, Total	CFU/100 mL	0	51			0 MAC	0	224	0 - 12	52/yr
E. coli	CFU/100 mL	0	51			0 MAC	0	224		52/yr
Coliform, Background	CFU/100 mL	0	46			[illegible]o Guideline Required	0	205	0 - 55	52/yr
Heterotrophic Bacteria										
Hetero. Plate Count, 28C (7 day)	CFU/1 mL	0	50	0	1[illegible]0	No Guideline Required	0	215	0 - 1,190	52/yr
Disinfectants (ND means less than instrument can detect)										
Disinfectants										
Chlorine, Total Residual	mg/L as Cl_2	1.25	52	0[illegible]3	1.69	3.0 MAC (chloramines)	1.19	227	0.42 - 1.69	52/yr
Dichloramine	mg/L as Cl_2	0.24	49	[illegible]	0.66		0.08	213	ND - 0.74	52/yr
Monochloramine	mg/L as Cl_2	0.69	49	0.17	1.12		0.97	213	0.12 - 1.50	52/yr

Notes: mg/L=milligrams per litre; ug/L=micrograms per litre; ND=Not Detected; CFU=Colo[illegible]ing Un[illegible] NTU=Nephelometric Units; TCU=True Colour; AO=Aesthetic Objective; MAC=Max. Acceptable Conc.; Median=middle point of all values