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2010 Annual Overview of Greater Victoria's Drinking Water Quality

(Full Report – Includes All Text and Charts)

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Executive Summary

This report is the annual overview of water quality testing that was conducted in 2010 for the Greater Victoria Drinking Water System. 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 is posted at http://www.crd.bc.ca/water/waterquality/annualreports.htm on the Capital Regional District (CRD) website.

Samples and Tests. In 2010, the Water Quality Division collected 7,675 samples from the Greater Victoria Drinking Water System and analyzed those samples for 47,743 individual tests. Approximately 300 different types of analyses were conducted on these samples. The data collected in 2010 are reported in the water quality data tables (**Tables 1, 2 and 3**) that are posted in the Water Quality section of the CRD website at http://www.crd.bc.ca/water/waterquality/datatables.htm

Bacteria in Source Water. In 2010, 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 late summer and peaked in late August (**Figure 3**). Nevertheless, the quality of the raw water entering the treatment plant continued to easily meet the fecal coliform bacteria (*E. coli*) limit of 20 colony forming units per 100 mL at least 90% of the time as stipulated in the 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 2010, all of the *E. coli* positive samples contained *E. coli* concentrations below 20 CFU/100mL.

Treatment. The treatment process used to disinfect the raw source water entering the distribution system continued to be ultraviolet (UV) disinfection followed by free chlorine and then ammonia (to produce chloramines). The chlorine dosage level was increased four times during the year to keep the chlorine residual in the distribution system relatively constant in response to a significant nitrification event. These changes resulted in monthly median total chlorine residuals ranging from 0.73 to 1.52 mg/L at the entry point to the distribution system (**Figure 4**).

Bacteria at First Customer. While five total coliform positive samples were found in samples taken at the first customer sampling location below the Japan Gulch Disinfection Plant during 2010, the 10% monthly limit was never exceeded (**Figure 4**). The annual total coliform positive sample rate of 2.0% was similar to the previous eight 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 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 2010 and was therefore in compliance with the BC *Drinking Water Protection Regulation*. Over the last 19 years, a broad reduction in total coliform bacteria detection (see inset in **Figure 5**) has been observed and hence, an overall improvement in the bacteriological quality of the water. The relatively low level of total coliform positive samples (under 1%) reflects the balance maintained between reasonable concentrations of chlorine in the distribution system and acceptable levels of positive bacterial samples.

Parasites. In 2010, no *Giardia* cysts were detected in the raw source water entering Japan Gulch Treatment Plant **(Figure 6)**. In addition, none of the 2010 samples contained *Cryptosporidium* oocysts (**Figure 7**). The 10-year average total *Giardia* cyst and total *Cryptosporidium* oocyst concentrations were only 0.02 cysts and 0.04 oocysts per 100 L, respectively (**Figures 6 and 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 Greater Victoria Drinking Water System.

Physical-Chemical-Radiological. All the physical, chemical and radiological parameters were well within the Canadian Guideline limits except for summer water temperatures (aesthetic limit of 15ºC). In 2010, the water temperature was above the 15°C limit for a period of about three months from mid-July to mid-October (**Figure 3**). This is similar to the previous five years and an improvement from earlier years when the water temperature was above the 15°C limit for about 4 months of the year (**Figure 2**). This cooler water is one of the benefits of raising the water level in Sooke Reservoir and the ability to draw from deeper and cooler strata.

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 synthetic organic chemicals including pesticides and herbicides were detected in the raw water entering the treatment plant.

Disinfection By-Products. Disinfection by-products such as total trihalomethanes (TTHMs) were well below (range of 11.0-23.9 μg/L) the Canadian Guideline limit of 100 μg/L in the chloraminated distribution system (**Figure 8**). The TTHMs were higher in a small section of the distribution system in North Saanich that is subject to rechlorination (Upper Dean Park Reservoir) but were still below Guideline values, ranging from 15.4 to 46 µg/L. Similarly, a second group of disinfection by-products, haloacetic acids (referred to as HAA5 because the limit is based on the concentration of a group of five HAAs) were low in the chloraminated distribution system, ranging from 8.45-32.6 μg/L (**Figure 9**) but were unusually elevated at the plant in the summer. The Canadian Guideline limit for HAAs of 80 μg/L was introduced in 2008.

Sooke Reservoir Biological Activity. The overall level of algal activity in Sooke Reservoir is measured using chlorophyll-a, a component of all algal cells. In 2010, the concentration of chlorophyll-a in the south and north basins continued to be elevated (as was observed in past years) following the raising of the water level in Sooke Reservoir (**Figure 10**). In the past 4 years, chlorophyll-a concentrations appear to have reached a steady state (with some variation).

Phosphorus. The primary contributor to the higher levels of chlorophyll-a observed in Sooke Reservoir in 2003 through 2010 was higher levels of total phosphorus, a nutrient that is needed for the algae to grow. The median concentration of total phosphorus was approximately 53% higher than in the years prior to inundation in both the north and south basins of Sooke Reservoir (**Figure 11**). However, the levels of total phosphorus are declining as the median concentration in 2008 through 2010 was only 16% higher than in the years prior to inundation. The highest phosphorus levels coincided with flooding of the newly cleared lands around the margin of Sooke Reservoir when the reservoir was expanded. In 2010, the phosphorus levels were similar, albeit slightly lower, than 2009 and substantially lower than during the inundation.

Algae. In 2010, one distinct, but not particularly significant algal bloom occurred in Sooke Reservoir in spring. The diatom, *Asterionella formosa* (**Figure 12**) was the main contributor to the higher levels of chlorophyll-a during this time (**Figure 10**). *Tabellaria fenestrata* (a diatom) also contributed to the overall increase in algal abundance (**Figure 13**).

Water Quality Complaints. In 2010, the number of water quality complaints received by CRD Water Services was very low (lowest in nineteen years) (**Figure 14**).

Contents

Insert **Map 1** in hard copy version.

In Web version, See **Map 1** at

http://www.crd.bc.ca/water/factsfigures/documents/drinking_water_system.pdf

1. Introduction

This report is the annual overview of the results from water quality samples collected in 2010 from the Greater Victoria Drinking Water System (**Map 1**). This overview report is the first of the 2010 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 by-products within individual municipal water distribution systems are issued separately. All reports are posted on the Capital Regional District (CRD) website http://www.crd.bc.ca/water/waterquality/reports.htm

2. Water Quality Regulations

The CRD Integrated Water Services Department (name changed in January, 2010 from 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 Division 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 http://www.crd.bc.ca/water/waterquality/datatables.htm) under the column titled CANADIAN GUIDELINES

In addition to the Provincial and Federal regulations, on a voluntary basis, CRD Integrated Water Services 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* (see http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/2010-sum_guide-res_recom/sum_guide-res_recom-eng.pdf) fall into one of the five following 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 the **Tables 1, 2** and **3**, these substances are listed as '**No Guideline Required'**.

4. **Archived Parameters.** Guidelines are archived for parameters which are no longer found in Canadian drinking water supplies at levels that could pose a risk to human health, including pesticides which 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 the **Tables 1, 2** and **3**, 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 Division 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**.

3. Multiple Barrier Approach

CRD Integrated Water Services and the municipalities that operate their distribution systems use a multiple barrier approach to prevent the drinking water in the Greater Victoria Drinking Water System 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 the drinking water in that system becoming contaminated. However, if these relatively weak individual barriers are used together in combination with each other and, especially if they are arranged in a fashion 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. However, 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 Greater Victoria Drinking Water System 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 the Vancouver Island Health Authority. This acts as a double check on good system design.

2. **Source Water Protection**. CRD Integrated Water Services 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 the 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 Greater Victoria Drinking Water System is an unfiltered drinking water system that continues to meet the stringent United States Environmental Protection Agency (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. While 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 the Vancouver Island Health Authority has approved this treatment process as

providing safe drinking water for the public.

4. **Distribution System Maintenance.** All Water Suppliers in the Greater Victoria Drinking Water System 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 co-operation with the other Water Suppliers, in 2005, CRD Water Services implemented a regional Cross Connection Control Program throughout the Greater Victoria Drinking Water System.

8. **Water Quality Monitoring**. While 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. Water System Description

In 2010, the Greater Victoria Drinking Water System supplied drinking water to approximately 340,000 people and was the third largest drinking water system operating in British Columbia (**Map 1**).

4.1. Source Water

Drinking water for the Greater Victoria Drinking Water System 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 1900's. 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 Reservoir, Lubbe Reservoir, Goldstream Reservoir and Japan Gulch Reservoir), are typically off-line 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 1200 mm (48") diameter pipelines to the Head Tank and then through the 8.8 km (5.5 mile) long, 2300 mm (91") Kapoor Tunnel and then into 1525 mm (60") and the 1220 mm (48") diameter pipes connecting the Kapoor Tunnel to the Japan Gulch Disinfection Plant where it is disinfected.

Drinking water for the Sooke and East Sooke is also supplied from Sooke Reservoir, but travelled a different route. This water passed through a newly constructed 14.5 km (9 mile) long, 600 mm (24") diameter 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 Integrated Water Services 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 1320 mm (52") diameter pipe into the Japan Gulch Disinfection Plant.

4.2. Water Disinfection

The disinfection process in the Greater Victoria Drinking Water System 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 while Sooke and East Sooke receives 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 which provides disinfection of the water entering the system followed by a secondary disinfectant step which 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 1.8 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 Water Services 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 7 large diameter transmission mains in the Greater Victoria Drinking Water System that are used to deliver bulk quantities of disinfected water to the municipal distribution systems (**Map 1**). These transmission mains range in diameter from 1525 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 Greater Victoria Drinking Water System 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 Integrated Water Services. 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. Operational Changes and Events

5.1. Use of Goldstream Water

In 2010, 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 14 through December 18, 2010 during the period of time that the Kapoor tunnel was being inspected.

5.2. Sooke Reservoir

In 2010, Sooke Reservoir reached the full pool level (186.75 metres above sea level) (**Figure 1**) on January 10th. This was similar to 2007 and 2008 but substantively different than 2009. Sooke Reservoir remained at full pool until mid-May followed by a steady decline throughout the latter part of spring and summer months. Sooke Reservoir reached its lowest level (183.14 m) in late October 2010. In early December, the water level increased steadily due to heavy and persistent rainfall and reached full pool by mid-December and then remained at about the same level until the end of December.

Figure 1. Water Level Elevation in Sooke Reservoir, 2007-2010

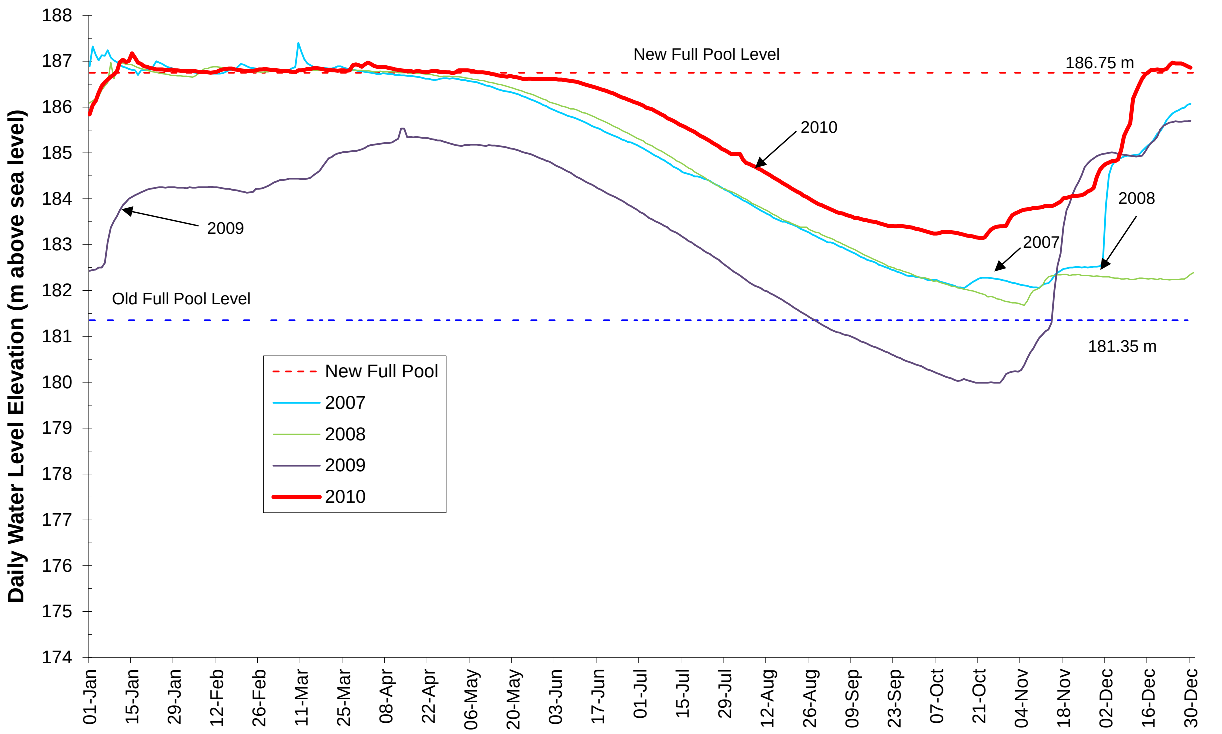
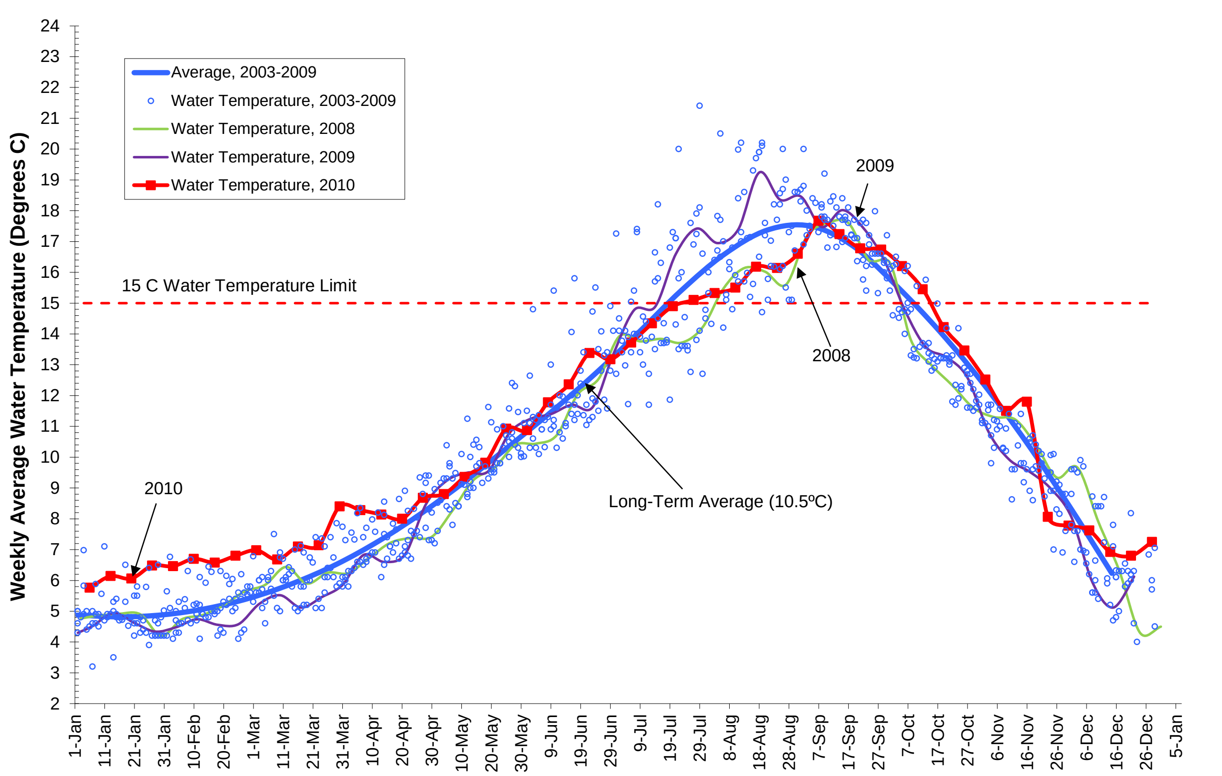


Figure 2. 2010 Temperature of Raw Water entering Japan Gulch Plant (Weekly Average)



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**). Prior to the expansion of Sooke Reservoir, the water temperature entering the plant reached 15°C by mid-June. However, in 2010, the water temperature remained generally below 15ºC until mid-July and was generally cooler than normal until mid-September. The temperature remained above 15ºC until mid-October. Cooler water is beneficial in a distribution system because it reduces the potential for losses of chlorine residual and for the regrowth of bacteria.

5.4. Chlorine Dosage

During 2010, CRD Integrated Water Services used a chlorine dosage rate of 1.6 milligrams per litre (mg/L) during the early part of the year and then increased it to 1.7 mg/L on June 7^{th}, to 1.8 mg/L on September 17^{th} and then to 1.9 mg/L on October 14^{th} in response to falling chlorine residual levels in the distribution system. The chlorine dosage remained at 1.9 mg/L for the remainder of 2010 (See **Figure 4**). The increased dosage was used to respond to falling chlorine residuals in the distribution system because of a substantial nitrification in the distribution system.

6. Water Quality Monitoring

The Water Quality Division of the CRD Environmental Sustainability Department is responsible for the collection, analysis and reporting of water quality information in all portions of the Greater Victoria Drinking Water System from the source reservoirs to the point of deliver (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 Division 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 the Vancouver Island Health Authority. The Compliance Monitoring Program provides direction for the majority of 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 Division provides an audit function on all water quality related aspects of the Greater Victoria Drinking Water System including performance monitoring of the treatment plants and distribution system.

6.2. Sampling Frequency and Parameter Testing

In 2010, the Water Quality Division collected 7,675 samples from the Greater Victoria Drinking Water System and analyzed those samples for 47,743 individual tests (this included 9,949 field tests). Approximately 300 different types of tests were conducted on these samples. The sampling frequency for the individual parameters tested is shown in the last column in following tables (see http://www.crd.bc.ca/water/waterquality/datatables.htm)

Table 1. 2010 Untreated (Raw) Water Quality Entering Japan Gulch Plant
Table 2. 2010 Treated Water Quality Below Japan Gulch Plant
Table 3. Treated Water Quality Below Sooke Plant

6.2.1. SOURCE WATER BODIES

In 2010, Sooke Reservoir, the primary source of water for the Greater Victoria Drinking Water System, was sampled weekly throughout the year. This sampling frequency has been used since 2003 due to the need to provide more detailed information about the impact of the Sooke Reservoir Expansion on the quality of water following the inundation of new soils around the margin of the reservoir. 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, algal toxins and phytoplankton (commonly called algae). In 2010, approximately 1,000 samples were collected from the source tributaries and source reservoirs.

6.2.2. RAW WATER ENTERING DISINFECTION PLANTS

In 2010, 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 5 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) the majority of the testing was conducted on the raw water entering the Japan Gulch Disinfection Plant. This is the sampling point in the Greater Victoria Drinking Water System where the most extensive testing of the water is conducted although not all parameters are tested every year. These tests included 15 physical parameters (**Table 1**), 17 non-metallic inorganic chemicals, 32 metallic inorganic chemicals, 4 bacteriological parameters, 1 biological toxin, 2 parasites, 2 radiological parameters, 74 pesticides and herbicides, 17 polycyclic aromatic hydrocarbons (PAHs), 24 phenolics, and 70 other synthetic organic chemicals. Two hundred ninety-four (294) samples were collected at the sampling point where the raw water enters the Japan Gulch Disinfection Plant and one hundred (100) 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 5 days per week. Tests included the bacteriological parameters of total coliforms, *E. coli* and heterotrophic plate count bacteria. In 2010, two hundred forty-eight (248) 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, the testing included the majority of the parameters used to monitor the raw source water except that many of the organic scan parameters were deleted while all of the parameters associated with the treatment process were added. These latter tests included the disinfectant residuals (3 parameters) and the by-products 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 by-products was tested only at the first customer location below the Japan Gulch Plant (**Table 2**). In 2010, four hundred thirty-six (436) samples were collected from the two first customer sampling locations (below Japan Gulch and below Sooke Plant).

6.2.5. TRANSMISSION SYSTEM

Twenty-two 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 2010, four hundred nineteen (419) samples were collected from 13 sampling locations on the transmission mains.

6.2.6. DISTRIBUTION SYSTEM

In the various municipal distribution systems, the Water Quality Division has established approximately 120 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 2010, 2,170 samples were collected from 97 sampling locations (this included 6 locations from the Sooke distribution system). At select locations within the distribution system, disinfection by-products were also sampled.

6.2.7. DISTRIBUTION SYSTEM RESERVOIRS

Twenty-five of the 26 reservoirs located in the distribution system were sampled by the Water Quality Division with 43 of the 45 permanent sampling station locations being sampled in 2010. Again, the monitoring program focused on chlorine residuals and indicator bacteria testing. In 2010, 993 samples were collected from these reservoirs.

7. Water Quality Results

The overview results of the 2010 water quality monitoring program for the Greater Victoria Drinking Water System 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 posted on the CRD website at http://www.crd.bc.ca/water/waterquality/datatables.htm. 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.

- **Table 1** lists the water quality data collected from the raw water entering the Japan Gulch Disinfection Plant.
  http://www.crd.bc.ca/water/waterquality/documents/2010JGAnnual.pdf

- **Table 2** lists the data for the treated water collected at the first customer sampling location below the Japan Gulch Disinfection Plant.
  http://www.crd.bc.ca/water/waterquality/documents/Table2.TREATEDJGP.pdf

- **Table 3** lists the data for the treated water collected at the first customer sampling location below the Sooke Disinfection Plant.
  http://www.crd.bc.ca/water/waterquality/documents/Table3_003.pdf

7.1. Indicator Bacteria and Chlorine Residual

The Water Quality Division analyses 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** under the heading 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 *2010 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, relatively high (above 200) concentrations of total coliform bacteria were found in the raw (untreated) source water entering the Japan Gulch Disinfection Plant during the summer of 2010 (**Figure 3**). The total coliform counts declined in early September. The types of total coliforms present were not indicative of any particular type of contamination.

***E. coli* Bacteria.** During more than a decade of monitoring bacteria within the Greater Victoria Drinking Water System, 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 2010, as in the period from 2006-2009, 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 (2006-2010), only about 14% 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/100mL more than 99% of the time. The unusually high concentrations of *E. coli* observed during early December of 2007 was a result of a major 'rain-on-snow' event which caused very high flows and high turbidity in the main tributary (Rithet Creek) to Sooke Reservoir. In 2009 and 2010, higher levels of *E. coli* were found during the period that the drinking water system was fed from Goldstream Reservoir (mid-December). Nevertheless, in 2010, the disinfection process at the two treatment plants provided satisfactory protection and there were no lapses in the safety of the drinking water.

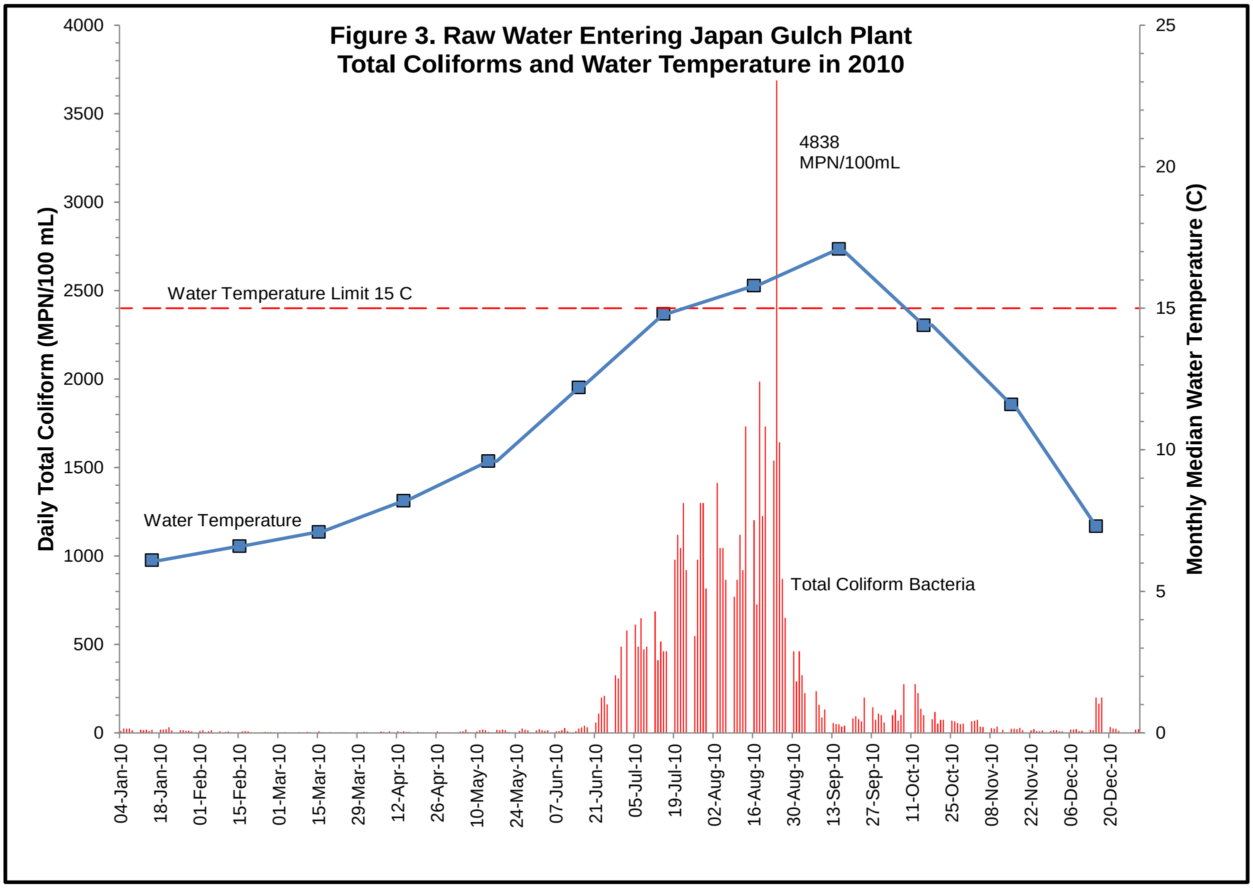


Figure 3. Raw Water Entering Japan Gulch Plant
Total Coliforms and Water Temperature in 2010
Daily Total Coliform (MPN/100 mL)
Monthly Median Water Temperature (C)
4838
MPN/100mL
Water Temperature Limit 15 C
Water Temperature
Total Coliform Bacteria

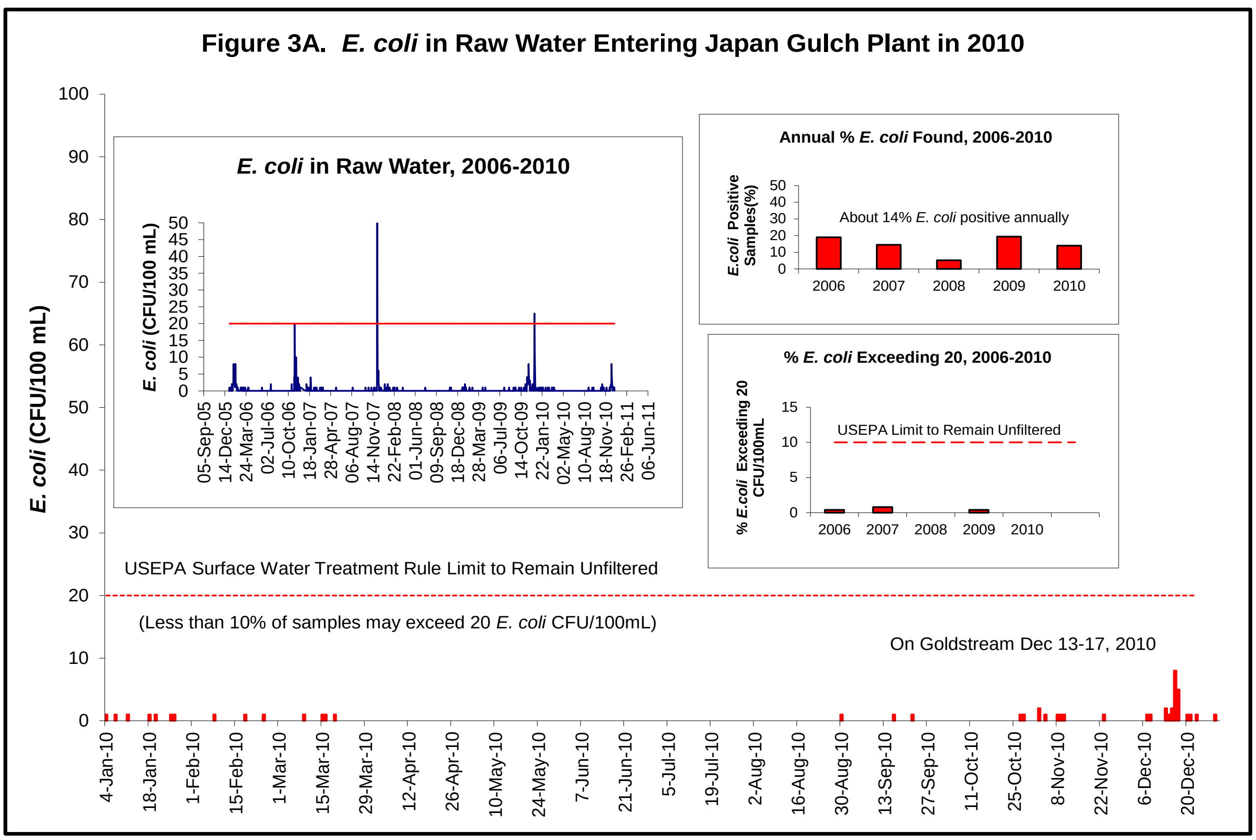


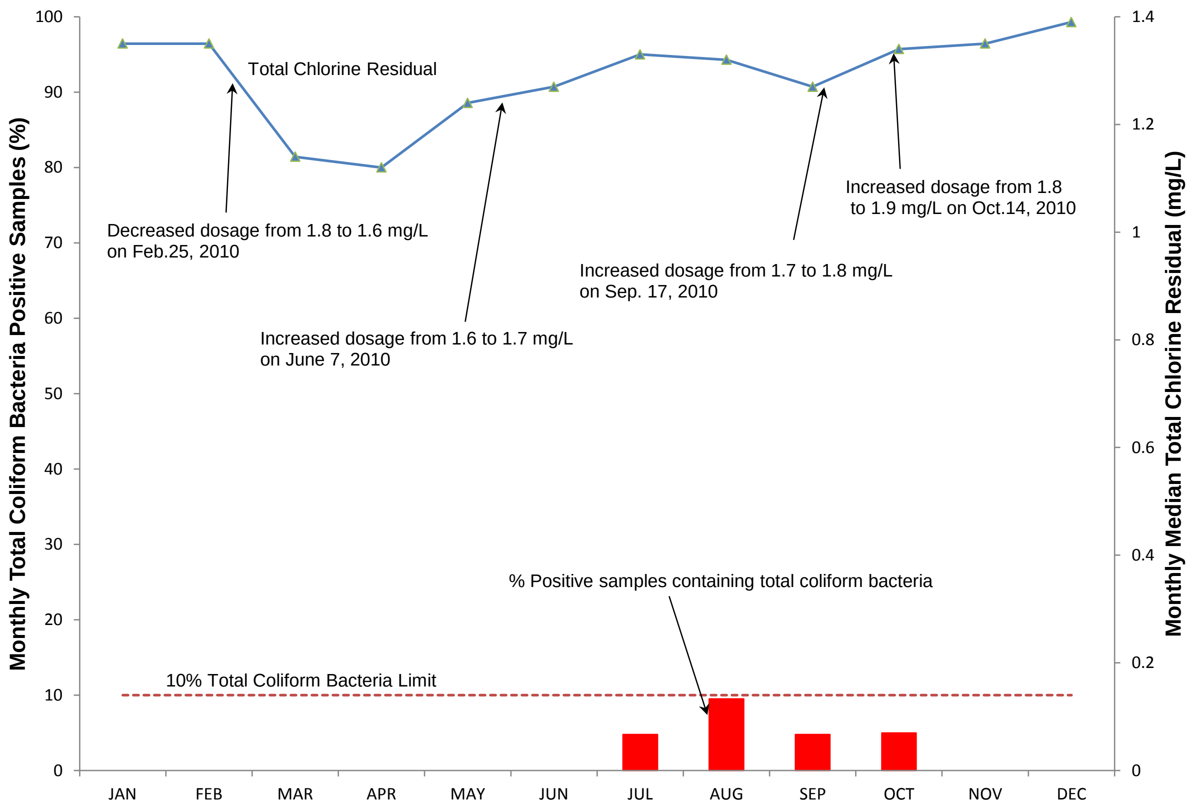
Figure 3A. E. coli in Raw Water Entering Japan Gulch Plant in 2010
E. coli (CFU/100 mL)
E. coli in Raw Water, 2006-2010
E. coli (CFU/100 mL)
Annual % E. coli Found, 2006-2010
E.coli Positive Samples(%)
About 14% E. coli positive annually
% E. coli Exceeding 20, 2006-2010
% E.coli Exceeding 20 CFU/100mL
USEPA Limit to Remain Unfiltered
USEPA Surface Water Treatment Rule Limit to Remain Unfiltered
(Less than 10% of samples may exceed 20 E. coli CFU/100mL)
On Goldstream Dec 13-17, 2010

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 2010, there were only five total coliform positive samples found (2.0%) in the 248 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.

Only one total coliform positive sample was found in the 49 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 2010



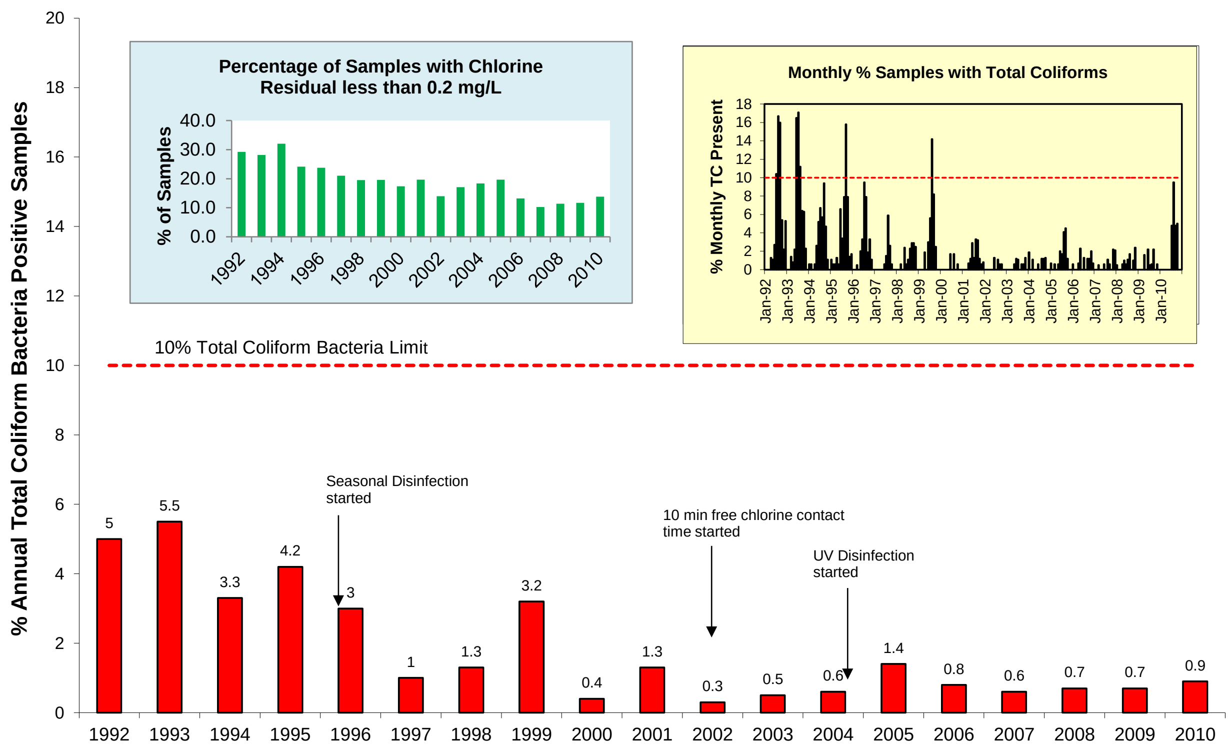
Chlorine Residual. The monthly average chlorine residual levels at the first customer sampling location below the Japan Gulch Plant is provided in **Figure 4**. From this figure, it can be seen that the monthly average chlorine residuals at the first customer sampling decreased up to mid-April and then remained relatively constant through mid-October aided by increasing the chlorine dosage at the plant. The chlorine dosage then increased gradually through December. The annual median chlorine residual (daily readings) at this location was 1.30 mg/L (**Table 2**). Compared to many other drinking water systems across Canada, this is a relatively low 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 2010, total coliform bacteria were detected during nine months of the year (January, March, April, June, July, August, September, October and December). However, the percentage of positive total coliform samples did not exceed the 10% total coliform limit during any month in 2010 and therefore, was in compliance with the BC *Drinking Water Protection Regulation*. This was similar to the past ten years (2000 onwards) and much better than in earlier years.

In addition, the annual total coliform positive percentage (0.9% in 2010) was quite low and similar to the low levels of coliform positive samples found in the Greater Victoria Distribution System in the past ten years (**Figure 5**).

Figure 5. Greater Victoria Distribution System Combined Annual % Samples with Total Coliforms Present, 1992-2010



Over this 19 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. & 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** Start up 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 0.68 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 1.54 mg/L. The highest value observed (1.54 mg/L in the West Shore communities) 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 2010, parasite samples were collected monthly during the rainy months and less frequently during the summer as part of the Water Quality Division's routine Compliance Monitoring Program and sent to Hyperion Research Laboratories, a contract laboratory in Alberta. This sampling frequency is similar to 2008-2009 and a change from earlier years when samples were collected every two weeks prior to 2007, monthly in 2007. The change was made after evaluation of the long-term data and consultation with the Chief Medical Health Officer. In 2010, 8 samples were collected for parasite analysis from the raw water sampling location at the Japan Gulch Treatment Plant.

Figures 6 and 7 show the results of the parasite monitoring data collected by Water Quality Division 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 2010, none of the 8 samples collected from the raw water entering the Japan Gulch Disinfection Plant were positive for *Giardia* cysts (**Figure 6**). During the ten year period from 2001 to 2010, 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, 2001-2010

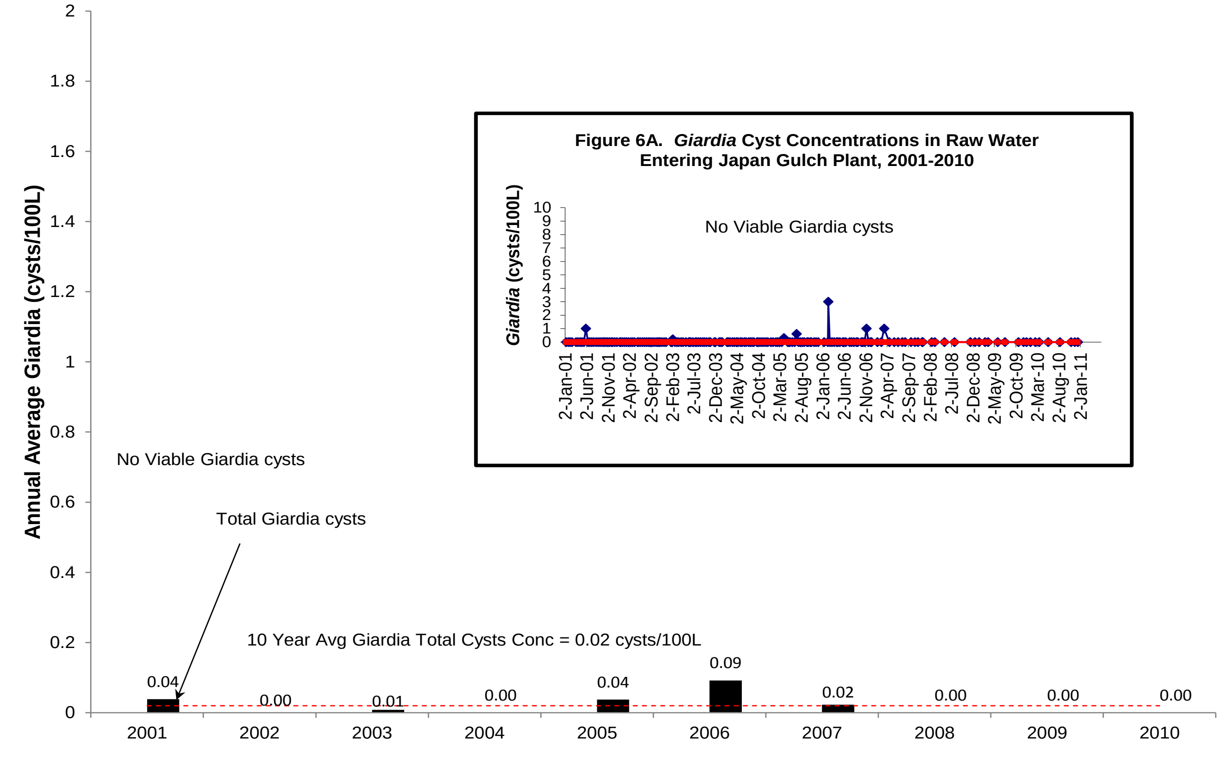
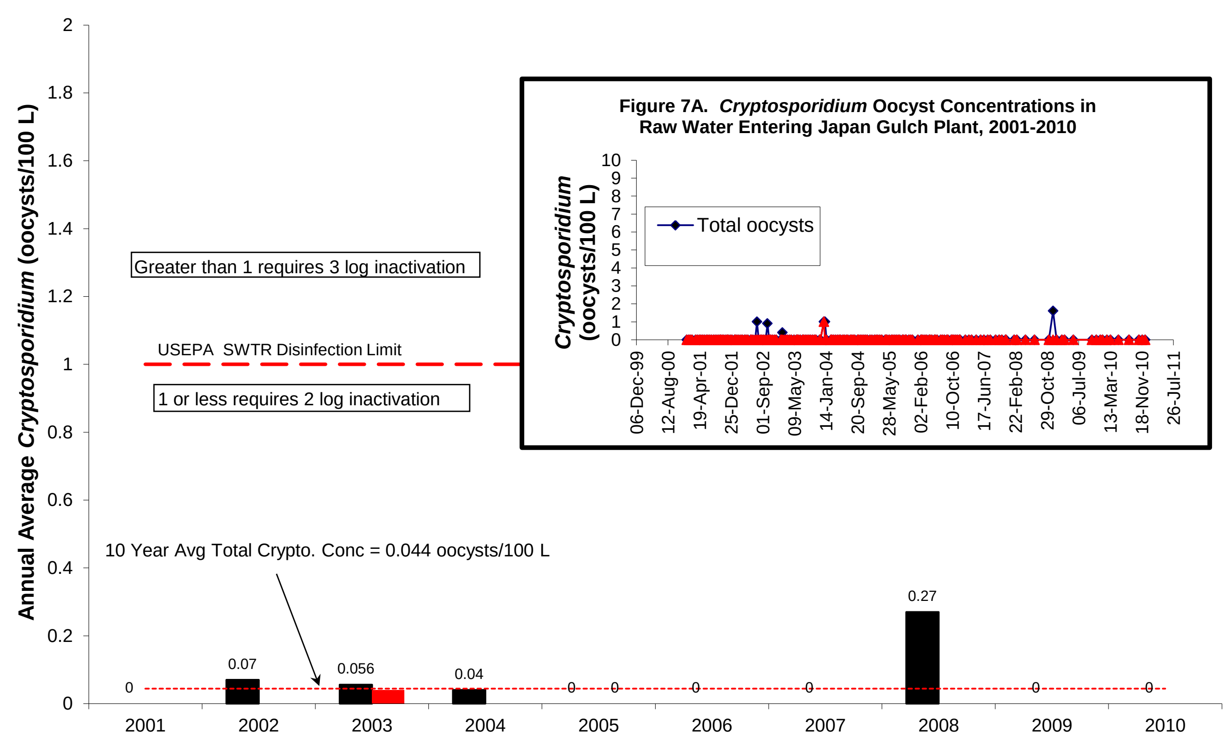


Figure 7. Annual Average Total *Cryptosporidium* Oocysts Levels in Raw Water Entering Japan Gulch Plant, 2001-2010



- ***Cryptosporidium***. In 2010, none of the 8 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 0.04 oocysts/100 L. This low positive rate, requires a 2-log disinfection process be in place and 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 2010.

  In the 19 year period of time that the Water Quality Division has been monitoring *Cryptosporidium,* 405 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 6 out of the 19 years. In the last ten 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 1.6 per 100 L (**Figure 7A**). All of the annual average concentrations were well below the disinfection limit specified by the USEPA *Surface Water Treatment Rule* and hence, only require two 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 Division analyses 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 Greater Victoria Drinking Water System.

7.3.1. PHYSICAL PARAMETERS

The physical parameters monitored by the Water Quality Division in the raw water entering the Japan Gulch Treatment Plant are listed on **Page 1** in **Table 1** in the section titled **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 2010, ultraviolet transmittance, turbidity and water temperature were analyzed daily, while colour, conductivity, pH and ultraviolet absorption were analyzed weekly. Alkalinity, carbon, solids and hardness were analyzed monthly.

The raw water entering the Japan Gulch Disinfection Plant is very soft (median value for hardness of 16.6 mg/L) (**Table 1**), it has a neutral pH (median of 7.19), moderate colour (median of 7.0 true colour units and low turbidity or cloudiness (median of 0.31 nephelometric turbidity units). It is also low in acid buffering capacity having an alkalinity of 15.6 mg/L, has low ionic strength (conductivity of 41.8 μS/cm), relatively low solids (total dissolved solids of 27.5 mg/L, total suspended solids of 0.7 mg/L and total solids of 29.3 mg/L), and moderate level of total and dissolved organic carbon (2.2 mg/L). **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 on

Page 1 in **Table 2**. Some additional changes were observed in some areas of the distribution system. However, the majority of these parameters changed very little in the distribution system and was similar to previous years.

In 2010, the values for all of the physical parameters were within the Canadian Guideline limits except for water temperature during the summer months.

7.3.2. NON-METALLIC INORGANIC CHEMICALS

The non-metallic inorganic chemicals monitored by the Water Quality Division in the raw water entering the Japan Gulch Disinfection Plant are listed on **Page 1** in **Table 1** in the section titled **Non-Metallic Inorganic Chemicals**. The list includes the majority 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 5.8 μg/L in the raw water entering the Japan Gulch Plant (**Table 1**) to 140 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 Integrated Water Services does not fluoridate the drinking water in Greater Victoria. Nevertheless, a tiny amount of fluoride (0.005 mg/L) 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 as 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 Division in the raw water entering the Japan Gulch Disinfection Plant are listed on **Page 2** 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 semi-annually. Questions are often asked about the following metals:

- **Lead**. The level of lead in the raw water entering the Japan Gulch Plant was less than 0.2 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 which 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**. The level of mercury in the raw water entering the Japan Gulch Plant was less than 20 ng/L (parts per trillion) (**Table 1**). This value is more than 1000 times lower than the Canadian Guideline limit and therefore can also be considered virtually absent from the water.

- **Selenium**. The level of selenium naturally present in the water is less than 0.0001 mg/L and at this level is considered to be virtually absent (**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, 1.68 mg/L (**Table 1**). This value is of interest to those people on low sodium diets.

All of the 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 Division in the raw water entering the Japan Gulch Disinfection Plant are listed on **Page 4** in **Table 1** in the section titled **Radiological Parameters**. The list includes two general, screening-type measures of radioactivity: gross alpha and gross beta radiation.

The radiological parameters are tested twice per year as suggested in the Canadian Guidelines. In 2010, the median values for gross alpha and gross beta radiation were 0.03 and less than 0.02 Bq/L, respectively (**Table 1**). These values were both below the Guideline limits for gross alpha and beta screening type analyses.

> **NOTE:** In 2011, additional radiological analyses were conducted as a result of the emissions from Japan. These results are posted on the CRD website at http://www.crd.bc.ca/water/waterquality/radiationtesting.htm

7.3.5. ORGANICS

The organic chemicals monitored by the Water Quality Division in the raw water entering the Japan Gulch Disinfection Plant are listed starting on **Page 5** in **Table 1** in the section titled **Organic Parameters**. The list includes a wide range of pesticides and herbicides, polycyclic aromatic hydrocarbons (PAHs), 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 of the organic chemicals tested were well within the Guideline limits. No synthetic organic chemicals including pesticides and herbicides were detected in the raw water entering the Japan Gulch Disinfection Plant.

7.4. Disinfectants and Disinfection By-Products

The disinfection of the water with chlorine produces a number of by-products of that disinfection process. Trihalomethanes (THMs) and haloacetic acids (HAAs) are two groups of these disinfection by-products (DBPs) that are regularly monitored by the Water Quality Division at a number of locations within the distribution system.

In 2010, disinfection by-products samples were collected five 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 (subject to rechlorination).

The Canadian Guideline limits for the substances of concern are listed on **Page 4** in **Table 2** in the section titled **Disinfectants** and on **Page 5** in **Table 2** in the section titled **Disinfection By-Products**. An overview of the disinfectants and disinfection by-products results for the distribution system is provided below:

- **Chloramines**. The maximum total chlorine (chloramines) residual in the distribution system in 2010 was 1.54 mg/L (occurred at East Sooke Road at Rocky Point Road). 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 about 83% 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 2010, the average level of total trihalomethanes (TTHMs) at the first customer sampling location below the Japan Gulch Disinfection Plant was 15.3 μg/L (median of 15.8) 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**). Thus, the vast majority of the 340,000 people in the Greater Victoria Drinking Water System receive water with these relatively low levels of disinfection by-products.

  One exception to these relatively low levels is the water in Upper Dean Park Reservoir which requires rechlorination because of its low turnover rate and loss of chlorine residual. A sample collected early in 2010 showed an elevated TTHM concentration (**Figure 8**) and rechlorination was stopped to determine the outcome if rechlorination was discontinued. No rechlorination was used over the summer months and TTHM concentrations remained low. However, rechlorination was restarted in the fall because of the potential for bacterial regrowth and higher TTHM concentrations were observed. Nevertheless, all of these subsequent TTHM concentrations were within limits. This water is distributed to a small service area just below Dean Park.

- **Haloacetic Acids**. Haloacetic acids (HAAs) are a second group of disinfection by-products that are produced when chlorine is used as a disinfecting chemical. The haloacetic acids are comprised of mono-, di-, and trichloroacetic acids plus mono- and dibromoacetic acids. For regulatory purposes, the regulatory agencies use the 5 haloacetic acids (referred to as HAA5) that are most commonly found in drinking water. The US Environmental Protection Agency (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 the HAA5.

Figure 8. 2010 Trihalomethanes in Greater Victoria Distribution System

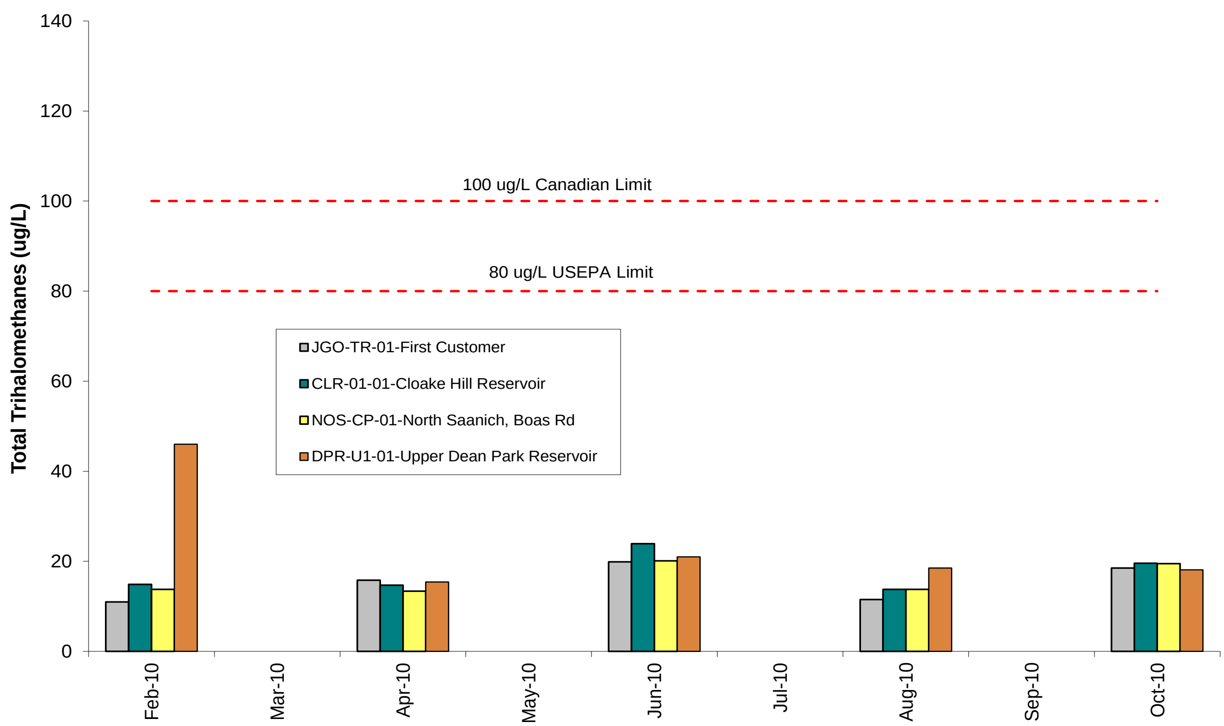
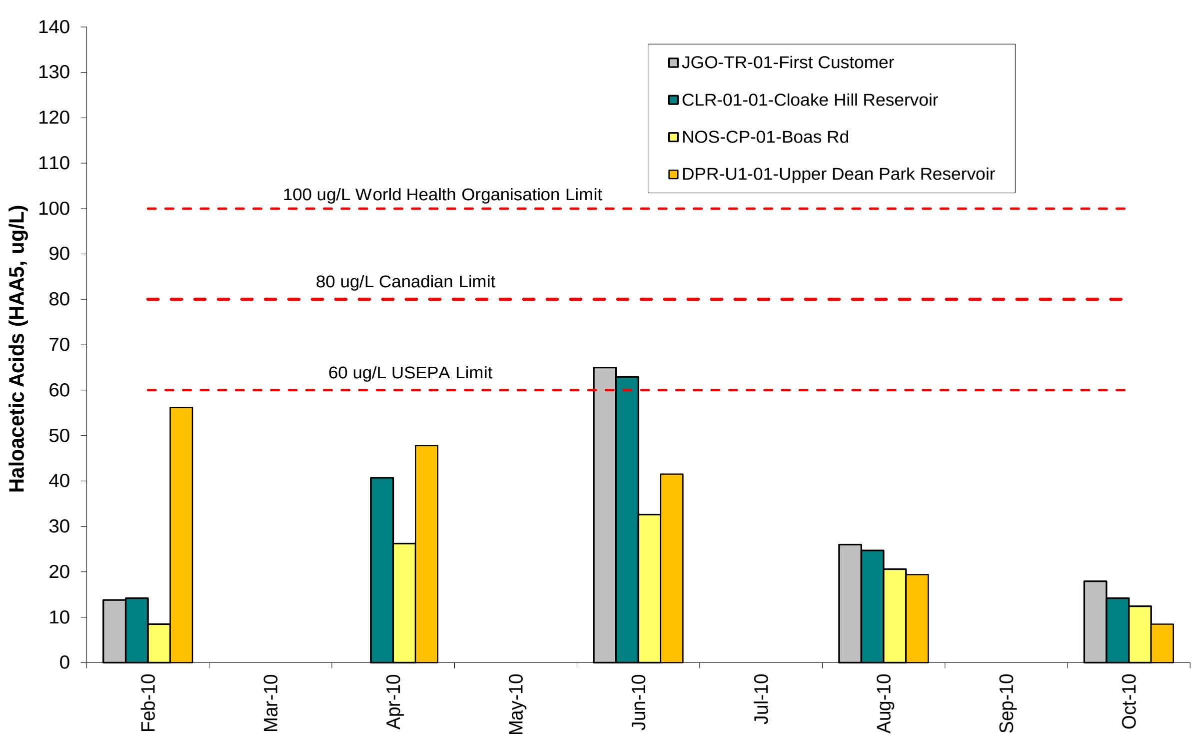


Figure 9. 2010 Haloacetic Acids in Greater Victoria Distribution System



The Water Quality Division has been monitoring HAAs for a number of years as part of the USEPA Information Collection Rule (used to collect data to determine levels for compliance). In 2010, the average level of HAA5 at the first customer sampling location was 30.7 µg/L (median of 21.9 µg/L), which is well below both the USEPA limit and the 2008 Canadian limit. Likewise, the HAA5 levels in the distribution system were well below both USEPA limit and the new Canadian limit with the exception of the Upper Dean Park Reservoir which is subject to rechlorination (**Figure 9**).

A detailed summary of disinfection by-products showing the results of sampling within the individual municipalities is provided in a report titled *2010 Annual Summary of Disinfection By-Products in Greater Victoria's Drinking Water*
(see http://www.crd.bc.ca/water/waterquality/annualreports.htm)

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 Division has been intensively monitoring the physical, chemical and biological aspects of this project.

  In 2003 through 2010, the concentration of chlorophyll-a was substantively higher than in the years prior to inundation. For the first few years after inundation, the concentration of chlorophyll-a declined. However, since 2007, the concentration appears to have leveled out (**Figure 10**). In 2010, the chlorophyll-a concentration peaked in the spring for both the south and north basins **(**see **insert Figure 10).**

- **Total Phosphorus**. The primary contributor to the higher levels of chlorophyll-a observed in Sooke Reservoir in 2003 through 2010 was the higher levels of total phosphorus, a nutrient that is needed for the algae to grow. These higher levels coincided with flooding of the newly cleared lands around the margin of Sooke Reservoir as part of the Reservoir Expansion Project.

  In 2010, similar to 2008 and 2009, the concentration of total phosphorus in both the south and north basins of Sooke Reservoir was lower than that in the previous 5 years (**Figure 11)**.

Figure 10. Chlorophyll-a Concentrations in Sooke Reservoir before and after inundation (1995-2010)

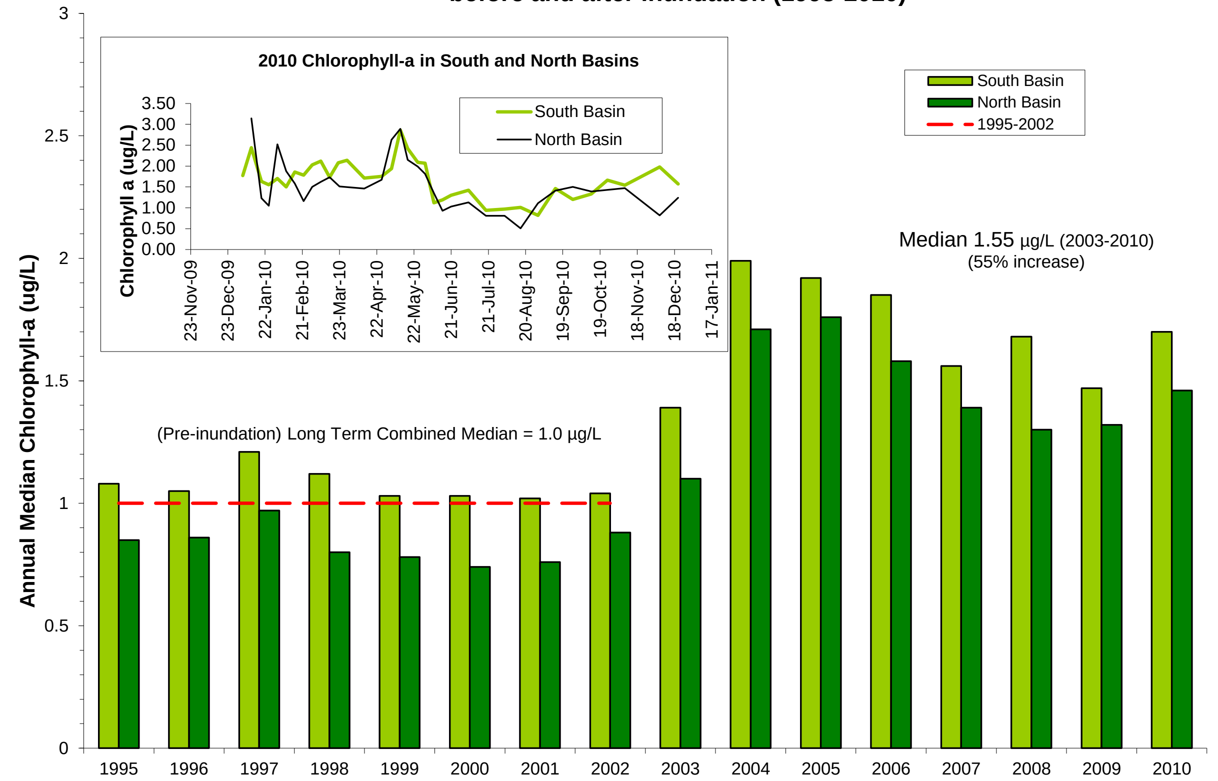
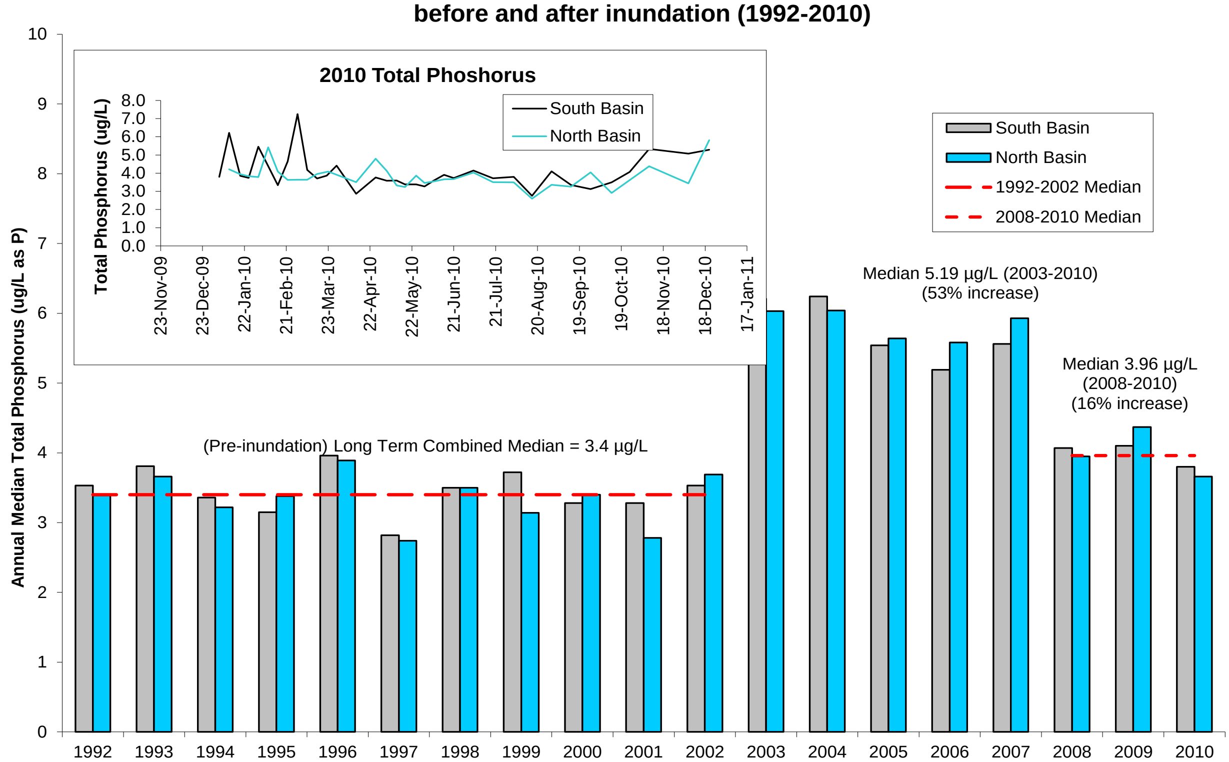


Figure 11. Total Phosphorus Concentrations in Sooke Reservoir before and after inundation (1992-2010)



- **Algae**. Similar to previous years, there was a spring diatom bloom in Sooke Reservoir which peaked in May. While the bloom was more pronounced in the south basin than in the north basin, it was not particularly significant as total algal concentrations were similar to past years. *Asterionella formosa* and *Tabellaria fenestrata* along with *Dinobryon bavaricum* were the primary contributors to the bloom.

  Asterionella formosa and *Tabellaria fenestrata* are diatoms that have been observed historically in Sooke Reservoir but only began forming blooms (of variable magnitudes) each year since the Sooke Reservoir expansion in 2003 (**Figure 12 and 13**). *Dinobryon bavaricum* is a chrysophyte (golden-brown algae) which also tends to peak in concentration in May.

  The abundance of all three dominant species during the bloom was below critical concentrations for production of odorous compounds. Consequently, no water quality issues were associated with the bloom.

  There was no fall diatom bloom in Sooke Reservoir in 2010. This is continuing a trend that began in 2008 which is in contrast to the years immediately following the raising of the water level in Sooke Reservoir where a second yearly diatom bloom was observed in the fall.

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 Division ranged from a low of 83 in 2010 to a high of 424 in 2006 (**Figure 14**). 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 2010, as was the case in 2007, 2008 and 2009, there was no single category of water quality complaint that stood out among the rest. The highest number of complaints resulted from the visible colour in the water (22) followed by taste and/or odour of the water (18) then safety concerns (16), particulates (9), and filter clogging (2) (see inset in **Figure 14** and **Table 4**).

In addition to complaints, the Water Quality Division 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 to call. These concerns were addressed individually and, in general, most customers are content to know that the Water Quality Division 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 http://www.crd.bc.ca/water/waterquality/annualreports.htm?mb

Figure 12. *Asterionella spp.* in Sooke Reservoir, South basin, 1m depth (SOL-01-01)

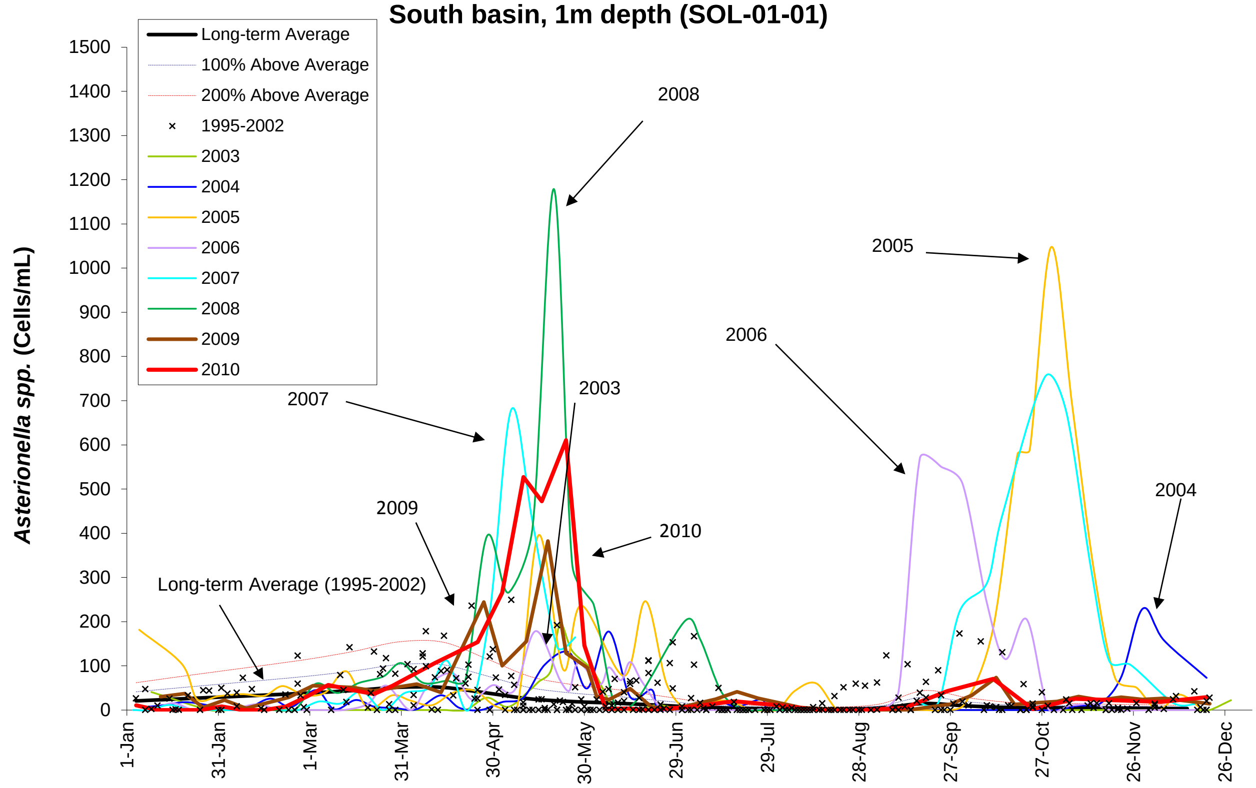


Figure 13. *Tabellaria spp.* in Sooke Reservoir, South basin, 1m depth (SOL-01-01)

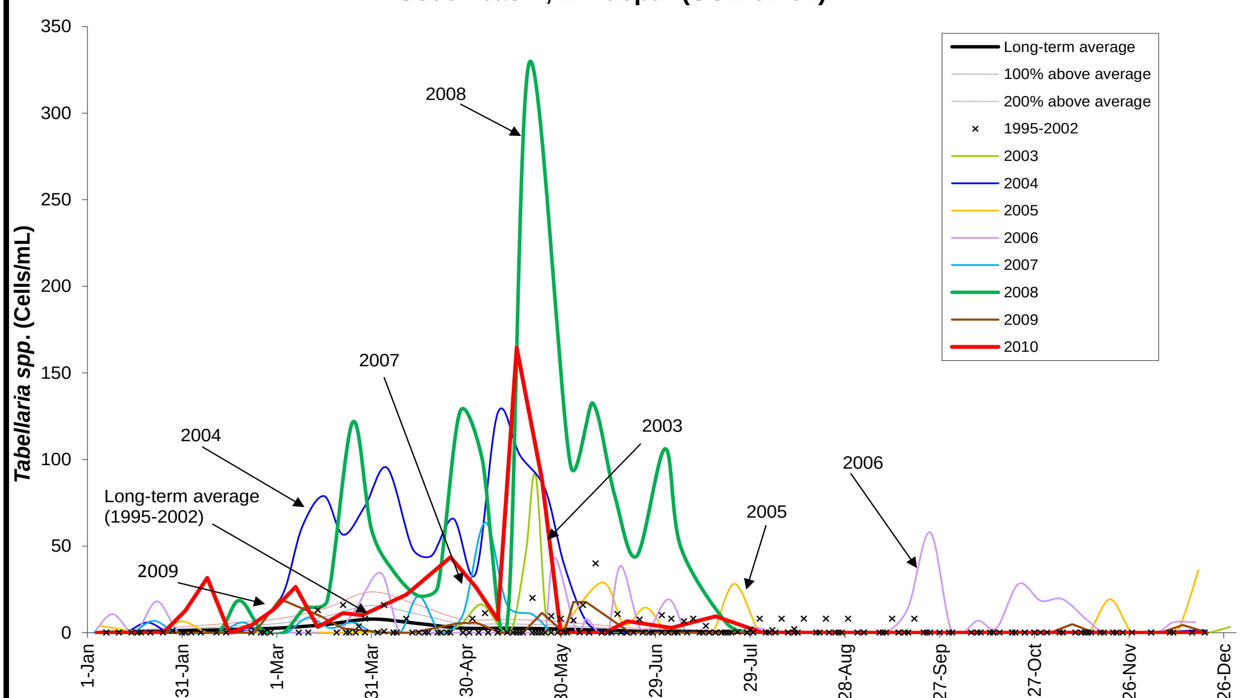
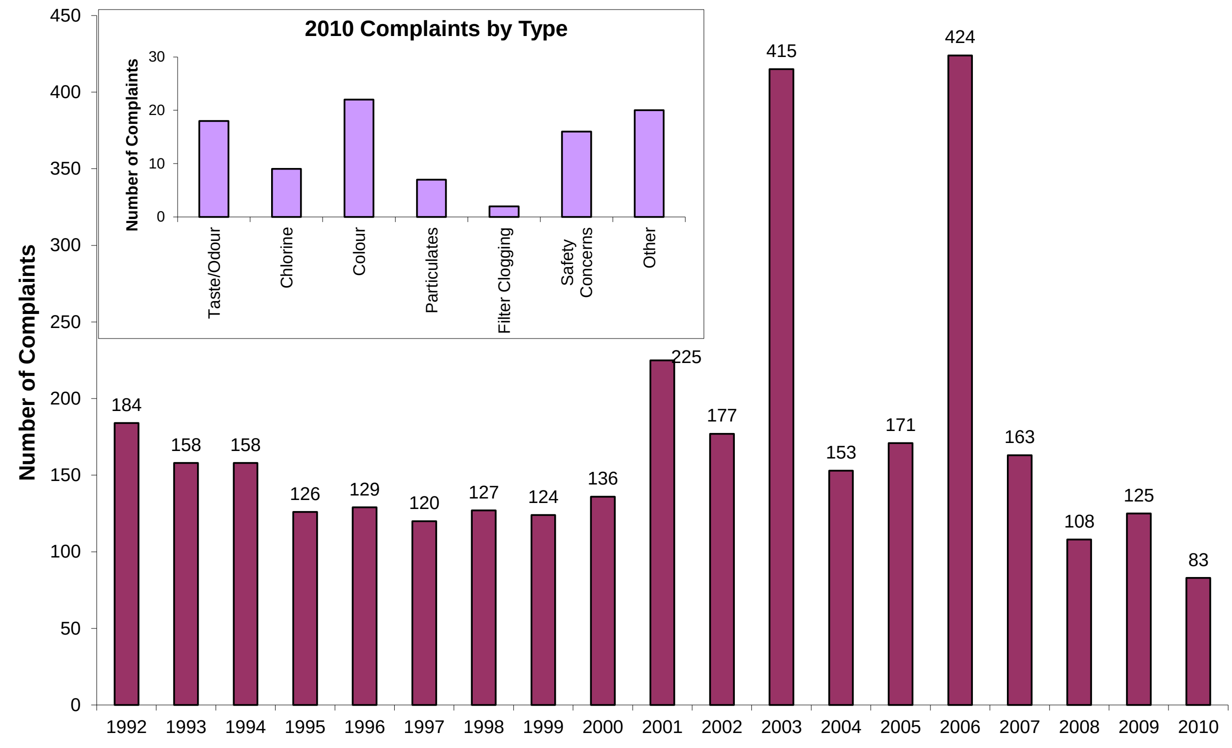


Figure 14. Annual Water Quality Complaints from the Greater Victoria Drinking Water System, 1992-2010



Information on the types of water quality complaints received each month during 2010 is provided in the **Table 4** below.

Table 4. Water Quality Complaints Received by the Water Quality Division in 2010.

Month	Total Number of Complaints[1]	Taste and/or Odour	Chlorine[2]	Colour	Particulates	Safety Concerns	Filter Clogging	Customer's Plumbing	Sensitivity	Other
January	13	2	1	5	1	0	0	0	0	4
February	11	2	0	2	0	4	0	4	0	2
March	6	2	0	1	0	2	1	3	0	1
April	4	1	0	0	0	2	0	0	1	0
May	4	0	0	2	0	1	0	0	0	1
June	7	2	1	2	0	1	0	0	0	1
July	12	1	2	6	1	2	0	0	1	0
August	13	5	3	2	2	1	1	1	0	0
September	8	1	2	0	2	2	0	1	0	0
October	5	2	0	2	1	1	0	0	0	0
November	0	0	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0		
Total	**83**	**18**	**9**	**22**	**7**	**16**	**2**	**9**	**2**	**9**

[1]Totals don't always reflect the numbers to the right, as some complaints fall into more than one category.
[2]Chlorine taste and odour are separated out from other taste and odour complaints.

8. Conclusions

1. The water quality data collected in 2010 indicate that the drinking water in Greater Victoria is good quality and safe to drink. With a few minor exceptions, the water quality data were within both the *Guidelines for Canadian Drinking Water Quality* and the *BC Drinking Water Protection Regulation.* These exceptions were water temperature in the summer, and the few incidences of total coliform detection. Over the past 16 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 2010 except for a brief spike in late July, 2004. In 2010, 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 mid-December (during Kapoor tunnel inspection).

3. Currently, consumers in the Greater Victoria Drinking Water System receive drinking water that has very low disinfection by-products compared to other water systems in Canada. The use of free chlorine at the Japan Gulch Disinfection Plant (first initiated in October 2001) 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 a reached a steady state (with some variation) over the past 4 years.

5. In 2010, 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 Division in 2010 was the lowest recorded in the past 18 years.