# 2005 Annual Overview of Greater Victoria's Drinking Water Quality

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# *Executive Summary*

This report is the annual overview of water quality testing that was conducted in 2005 in 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.* The full report is posted at http://www.crd.bc.ca/water/waterquality/annualreports.htm on the Capital Regional District (CRD) website.

**Samples and Tests.** In 2005, the Water Quality Division collected 7,990 samples from the Greater Victoria Drinking Water System and analyzed those samples for 36,834 individual tests. Approximately 300 different types of tests were conducted on these samples.

**Bacteria in Source Water**. In 2005, as in the past few years, the level of total coliform bacteria in the raw source water entering the treatment plants continued to be elevated during the summer although the peak was reached in mid-September 2005 rather than in early August as in past years (**Figure 1**). Overall the bacterial levels were lower than in the past few years. The quality of the raw water entering the plant continued to easily meet the fecal coliform (*E. coli*) limit of 20 colony forming units per 100 mL in the USEPA Surface Water Treatment Rule and therefore continued to qualify to remain an unfiltered surface water supply under this portion of their regulations (**Figure 1B**). The level of 20 per 100 mL was only reached once the entire year. Both the median value of 0 per 100 mL and the maximum value of 20 per 100 mL indicate a good quality source that is not subject to contamination.

**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 maintained at 1.5 mg/L for the majority of the year. This dosage level resulted in a monthly average total chlorine residual ranging from 1.13 to 1.47 mg/L at the entry point to the distribution system (**Figure 2**).

**Bacteria at First Customer**. No total coliform bacteria were observed at the first customer sampling location below the Japan Gulch Treatment Plant during 2005 (**Figure 2**). The annual total coliform positive sample rate of 0% was one of the lowest ever observed and was due to the use of the combination of UV and free chlorine as primary disinfectants. No fecal coliform (*E. coli*) bacteria were found in any of the samples collected at this point. This provides further assurance of the bacterial safety of Greater Victoria's drinking water.

**Bacteria in Distribution System**. When all of the results from the various municipal distribution systems are grouped together, the percentage of total coliform positive samples in the distribution system did not exceed the 10% Guideline limit during any month in 2005 and was therefore in compliance with the BC *Drinking Water Protection Regulation*. Over a 14 year period of time, a reduction in total coliform detection and hence, an improvement in the bacteriological water quality (**Figure 2A**) was observed.

**Parasites.** In 2005, the average annual percentage of samples containing *Giardia* cysts was 8.3% (median 0/100 mL) (**Figure 3**). One *Giardia* cyst was detected in each of two samples. However, both cysts were reported as being non-viable and therefore incapable of causing disease. None of the samples contained *Cryptosporidium* oocysts (**Figure 5**). The long term average (1992-2005) *Cryptosporidium* oocyst concentration was 0.08 oocysts per 100 L. While this is an extremely low value for a surface water supply, the addition of UV disinfection provides assurance that no infective *Cryptosporidium* oocysts can enter Greater Victoria's drinking water.

**Physical-Chemical-Radiological**. All the physical, chemical and radiological parameters were well within the Canadian Guideline limits except for water temperature (aesthetic limit of 15ºC). In 2005, the water temperature entering the plant was cooler than in previous years because it was being drawn from a deeper strata in the reservoir. All inorganic chemicals including metals and non-metals were within Guideline values. No synthetic organic chemicals including pesticides and herbicides were detected in the raw water entering the treatment plants.

**Disinfection By-Products**. Disinfection by-products such as total trihalomethanes (TTHMs) were well below (range of 3.5–15.4 μg/L) the Canadian Guideline value of 100 μg/L in the chloraminated portion of the distribution system but were higher in the portion of the distribution system in North Saanich where periodically additional free chlorine is being added to the water to prevent the regrowth of bacteria. In that section of the distribution system, during the period when the additional chlorine is being added, the total trihalomethane concentration ranged from 28 to 56 μg/L. Similarly, in that same portion of the distribution system, 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 also elevated and ranged from 36-86 μg/L. No Canadian limit exists for this parameter.

**Sooke Reservoir Biological Activity**. The overall level of algal activity in Sooke Reservoir can be measured using chlorophyll-a, a component of all algal cells. In 2005, the concentrations of chlorophyll were substantially higher (93% and 77%) than the pre-inundation concentrations but were similar to those observed in 2004 **(Figure 9).** The primary contributor to the higher levels of chlorophyll-a observed in Sooke Reservoir in 2003 through 2005 was the higher levels of total phosphorus, a nutrient that is needed for the algae to grow. As can be seen in **Figure 10**, while the median concentration of total phosphorus was approximately 78% higher than in previous years in both the north and south basins of Sooke Reservoir, the 2005 levels were slightly lower than in 2003 and 2004. The higher levels coincided with flooding of the newly cleared lands around the margin of Sooke Reservoir when the reservoir was expanded. In 2005, the two primary algal contributors to the high levels of chlorophyll-a were two diatoms: *Asterionella* and *Cyclotella bodanica* (**Figures 11 and 12**). Both organisms occur commonly within Sooke Reservoir but the fall bloom of *Asterionella* and the first-ever observed bloom of *Cyclotella bodanica* were unusual.

**Water Quality Complaints**. In 2005, the number of water quality complaints received by the Water Services Department was similar to 2002 and 2004 and much less than the record number received in 2003 (**Figure 13**). A number of calls were received from people experiencing skin sensitivities or allergies prompting the Division to add a new category of complaint called 'Sensitivity'. At present, there is no definitive relationship between the observed skin sensitivities and Greater Victoria's drinking water.

## RECOMMENDATIONS

In conjunction with the Saanich Peninsula Water Commission and the CRD Environmental Services Department, it is recommended that the chlorination process at the Deep Cove Pumphouse on the Saanich Peninsula be changed to a chloramination process reduce the levels of disinfection by-products in that portion of the North Saanich distribution system served from the Deep Cove Pumphouse. This work was planned to be completed in 2005. However, the cost of making these treatment changes was substantively higher than budgeted and was subsequently postponed.

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# 1. Introduction

This report is the annual overview of the results from water quality samples collected in 2005 from the Greater Victoria Drinking Water System (**Map 1**). This overview report is the first of the 2005 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 at on the Capital Regional District (CRD) website.

# 2. Water Quality Regulations

The CRD Water Services Department 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 Services Department 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 shown in **Tables 1, 2** and **3** (at the end of the report) in the column titled 2005 CANADIAN GUIDELINES.

In addition to the Provincial and Federal regulations, on a voluntary basis, the Water Services Department 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 limits in the 2005 *Guidelines for Canadian Drinking Water Quality* fall into one of the four 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.

2. **Interim Maximum Acceptable Concentration** (IMAC). This is also a health-related limit and lists an interim recommended value for those substances where there are insufficient toxicological data to derive a MAC with reasonable certainty.

3. **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.

4. **No Guideline Required**. Some substances have been identified as not requiring a numerical guideline. In the **Tables 1, 2** and **3**, these substances are listed as "No Guideline Required".

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, that parameter is left blank in **Tables 1, 2** and **3**.

# 3. Multiple Barrier Approach

The Water Services Department and municipalities that operate the distribution system 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 by singly may be relatively weak and can be 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 become a are very powerful means of preventing drinking water contamination. All large drinking water utilities use the multiple barrier approach to the prevention of contamination but 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 operations within the water system to run 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 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**. The Water Services Department 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 is allowed nor is any commercial logging, farming, mining, recreation, herbicides, pesticides or fertilizers. This barrier eliminates many of the organic and inorganic chemicals that can contaminate the source 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 source water.

3. **Water Treatment**. 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 of the raw source water entering the treatment plant and secondary disinfection 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 exception 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 procedures 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 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, the CRD Water Services Department is implementing 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 a final check on the effectiveness of the other barriers.

# 4. Water System Description

In 2005, the Greater Victoria Drinking Water System supplied drinking water to approximately 320,000 people and is the second largest drinking water system in British Columbia (**Map 1**).

## 4.1. Source Water

Drinking water for Greater Victoria 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 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, into the 1525 mm (60") and the 1220 mm (48") diameter pipes connecting the Kapoor Tunnel to the Japan Gulch Water Treatment Plant where it is disinfected. Water for the community of Sooke is also supplied from Sooke Reservoir, but travels a different route, first passing through a 1067 mm (42") diameter concrete pipeline (locally called the Flowline), entering the Flowline Control Tank and then continuing to the Charters Water Treatment Plant.

During the brief period of its use (typically used only when the Kapoor Tunnel is out of service for inspection by CRD Water 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 Treatment Plant.

## 4.2. Treatment

The disinfection treatment process in the Greater Victoria Drinking Water System is both simple and effective.

**Primary Disinfection**. The treatment system employs two treatment plants: the large treatment plant at Japan Gulch Treatment Plant which disinfects all of the water in the Greater Victoria Drinking Water System except for Sooke and the small treatment plant at Charters Creek which disinfects the water in Sooke and East Sooke.

At the Japan Gulch Treatment Plant the water passes through a three part disinfection process in sequential order – two primary disinfectant steps followed by a secondary disinfectant step:

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 1.5 mg/L and using approximately 10 minutes (depending upon flow) of 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 5 parts chlorine to 1 part ammonia. 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.

**Re-chlorination**. Periodically during 2005, the CRD Environmental Services Department continued to add additional free chlorine at the Deep Cove Pumphouse to control bacterial regrowth in the North Saanich Distribution System. This pumphouse provides a direct feed of water containing the higher chlorine residuals to Cloake Hill Reservoir which, in turn, supplies water to the majority of the North Saanich Distribution System. Small amounts of additional chlorine are also periodically added at Upper Dawson Reservoir and to Upper Dean Park Reservoir. In Metchosin, the Water Services Department re-chloraminated the water at Rocky Point Reservoir to boost the chlorine residuals near the extremity 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 treatment plants to the distribution systems listed in the next section. The Saanich Peninsula Trunk Water Distribution System receives water at several 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 nine 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 Esquimalt distribution system. The last two distribution systems are owned by the CRD and are operated by the Water Services Department. These latter two systems include the combined distribution system in the Western Communities of Langford, Colwood, Metchosin, and View Royal and a separate system in 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 seven distribution system reservoirs are scattered throughout the municipal distribution systems with many of these reservoirs containing multiple cells (44 cells in total). These reservoirs are used to balance the uneven consumption of water that occurs during the day-to-night cycle.

# 5. Operational Changes and Events

In 2005, there were no substantive changes from previous years in the source of the water being supplied to the Greater Victoria Drinking Water Service Area. In 2005, Goldstream Reservoir was not used at any time to supply water to the system.

### 5.1. Sooke Reservoir Expansion Project

On April 21, 2005, as part of the Inundation Phase of the Sooke Reservoir Expansion Project, the water level in Sooke Reservoir reached a new high water mark of 186.60 m above sea level (asl) (See **chart** on next page). This new high water level inundated a further 0.85 metres of land around the perimeter of the reservoir. However, on the following day, the reservoir level began to slowly decline and reached it 2005 minimum water level of 181.33 m on October 29, 2005. This minimum level was just slightly lower than the old full pool level prior to the reservoir expansion.

### 5.2. Water Temperature

As predicted as one of the impacts of raising the water level in Sooke Reservoir, the temperature of the water entering the Japan Gulch Treatment Plant was substantially cooler during the summer than in previous years (see **Chart** on next page). Normally, prior to the expansion of the reservoir, the water temperature entering the plant reached 15°C by mid-June. However, in 2005, the water temperature remained below 15°C until August 17$^{th}$ and was approximately 2°C cooler than normal until September 7, 2005. Cooler water is beneficial in a distribution system because it reduces the potential for losses of chlorine residual and for the regrowth of bacteria.

### 5.3. Chlorine Residuals

During the majority of 2005, the Water Services Department used a chlorine dosage rate of 1.5 milligrams per litre (mg/L). The chlorine dosage was increased to 1.65 mg/L on June 16$^{th}$ and maintained at this level until August 12$^{th}$ when it was reduced to 1.5 mg/L (See **Figure 2**). In addition, between August 10$^{th}$ and November 3$^{rd}$, the Japan Gulch Plant was switched from a free chlorine process to a chloramination process to accommodate the reconstruction of the road into the Japan Gulch Plant.

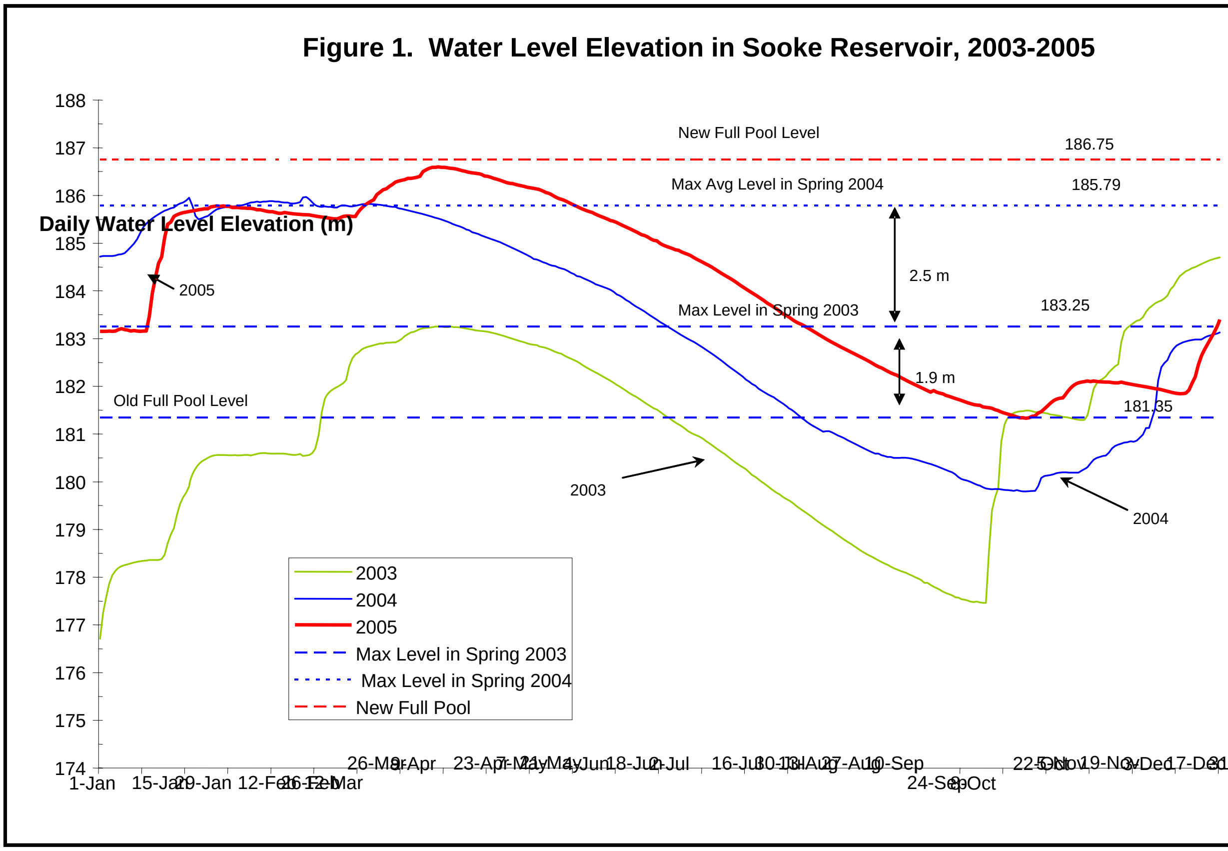
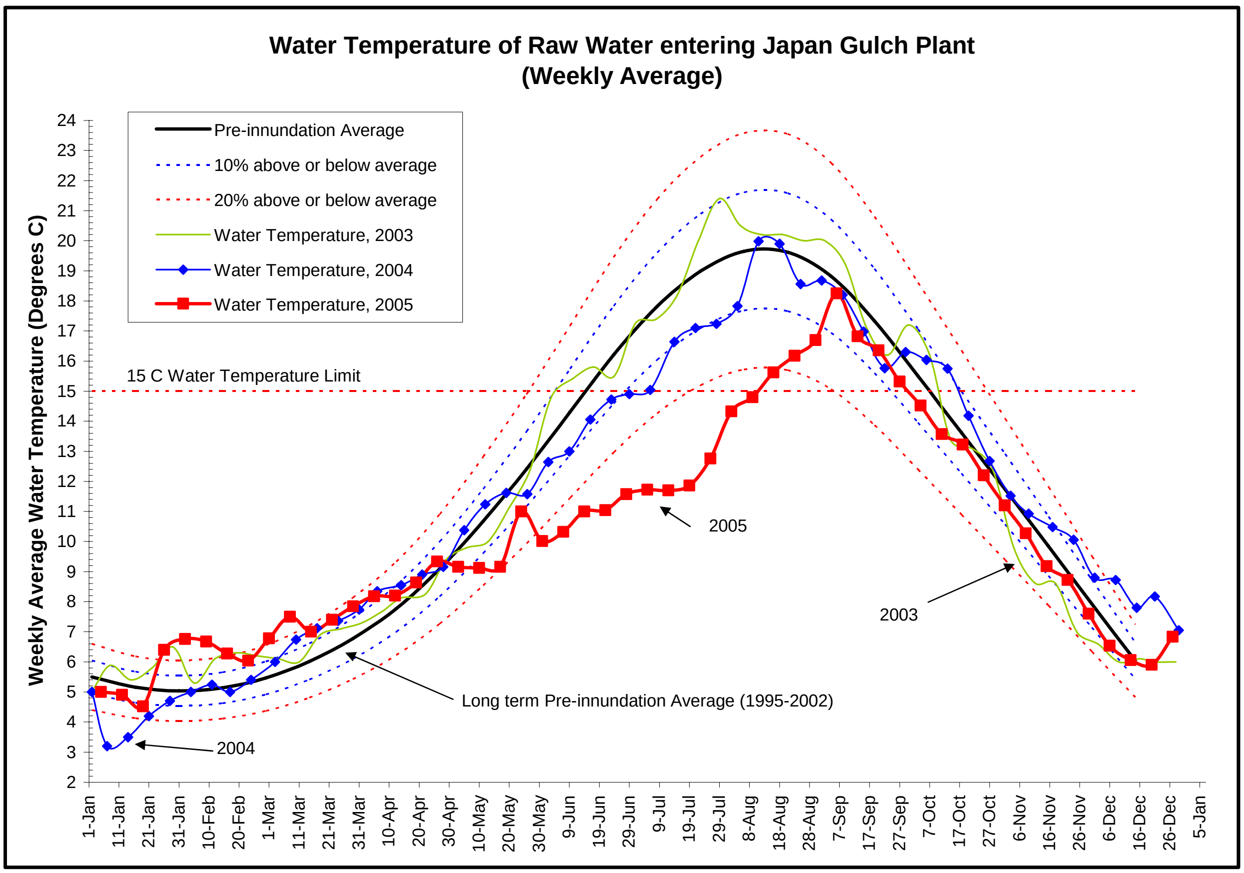


Figure 1. Water Level Elevation in Sooke Reservoir, 2003-2005
Daily Water Level Elevation (m)
New Full Pool Level
186.75
Max Avg Level in Spring 2004
185.79
Max Level in Spring 2003
183.25
Old Full Pool Level
181.35
2.5 m
1.9 m
2003
2004
2005
Max Level in Spring 2003
Max Level in Spring 2004
New Full Pool


Water Temperature of Raw Water entering Japan Gulch Plant
(Weekly Average)
Weekly Average Water Temperature (Degrees C)
Pre-innundation Average
10% above or below average
20% above or below average
Water Temperature, 2003
Water Temperature, 2004
Water Temperature, 2005
15 C Water Temperature Limit
Long term Pre-innundation Average (1995-2002)
2003
2004
2005

# 6. Water Quality Monitoring

The Water Quality Division of the CRD Water Services 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 their own distribution systems.

## 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 conditions.

- **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. All of the data collected under this program is provided to the Chief Medical Health Officer, Vancouver Island Health Authority. This program is audited by staff from the Vancouver Island Health Authority twice annually. The Compliance Monitoring Program provides direction for all other sampling locations in the 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 were 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 drinking water system including performance monitoring of the treatment plants and distribution system.

## 6.2. Sampling Frequency and Parameter Testing

In 2005, the Water Quality Division collected 7,624 samples from the Greater Victoria Drinking Water System and analyzed those samples for 36,834 individual tests. Approximately 300 different types of tests were conducted on these samples.

### 6.2.1. SOURCE WATER BODIES

In 2005, Sooke Reservoir, the primary source of water for the Greater Victoria Drinking Water System, was sampled weekly throughout the year. This was similar to 2003 and 2004 and a change from the earlier previous years when weekly sampling occurred only in the spring, summer and fall. The change in sampling regime resulted from 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 2005, 824 samples were collected from the source tributaries and reservoirs. These data are reported in a separate report titled *2005 Annual Summary of Sooke Reservoir Water Quality*.

### 6.2.2. RAW WATER ENTERING PLANT

In 2005, the raw source water entering both the Japan Gulch Treatment Plant and the Charters Treatment Plant were tested throughout the year on a routine sampling schedule of 5 days per week for the Japan Gulch Plant and once per week for the Charters Plant. 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 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**), 15 non-metallic inorganic chemicals, 35 metallic inorganic chemicals, 5 bacteriological parameters, 3 parasites (**Note**: Samples for *Toxoplasma* parasite were collected and stored in the event they were needed for analysis), 2 radiological parameters, 76 pesticides and herbicides, 17 polycyclic aromatic hydrocarbons (PAHs), 27 phenolics, and 72 other synthetic organic chemicals. Two hundred and seventy-one samples were collected at the sampling point where the raw water enters the plant. The sampling frequency for the individual parameters tested is shown in the last column in **Table 1.**

### 6.2.3. UV TREATED WATER

At the Japan Gulch Treatment Plant, the water downstream of the ultraviolet (UV) treatment units was sampled on a routine sampling schedule of 5 days per week. The tests involved the bacteriological parameters of total coliforms, fecal coliforms, heterotrophic plate counts and background bacteria (non-coliforms).

### 6.2.4. TREATED WATER AT FIRST CUSTOMER

At the first customer sampling location below the Japan Gulch Treatment Plant, the testing included the majority of the parameters used to monitor the raw source water except that most 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 residual and the by-products of disinfection. As the disinfection process was essentially the same at both the Japan Gulch Plant and the Charters Plant, the more extensive list of disinfection by-products was tested only at the first customer location below the Japan Gulch Plant (**Table 2**). In 2005, 300 samples were collected from 2 sampling locations at the first customer sampling locations.

#### 6.2.5. TRANSMISSION SYSTEM

Twenty-two permanent sampling locations have been established on the large diameter transmission mains. Monitoring is comprised primarily of chlorine residual testing and bacterial indicator analyses (total and fecal coliforms and heterotrophic bacteria). In 2005, 492 samples were collected from 14 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. In 2005, 2,355 samples were collected from 86 sampling locations. At select locations within the distribution system, disinfection by-products were sampled.

#### 6.2.7. DISTRIBUTION SYSTEM RESERVOIRS

Twenty-four of the 27 reservoirs located in the distribution system were sampled by the Water Quality Division with 38 of the 45 permanent sampling station locations being sampled in 2005. Again, the monitoring program focused on chlorine residuals and indicator bacteria testing. In 2005, 1,038 samples were collected from these reservoirs.

# 7. Water Quality Results

The overview results of the 2005 water quality monitoring program for the Greater Victoria Drinking Water System are provided below. **Table 1** lists the water quality data collected from the raw water entering the Japan Gulch Treatment Plant while **Table 2** lists the data for the treated water collected at the first customer sampling location below the Japan Gulch Treatment Plant. **Table 3** lists the data for the treated water collected at the first customer sampling location below the Charters Plant. 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. **Figures 1** to **12** provide a graphical presentation of selected parameters at specific sampling locations for comparison to previous years.

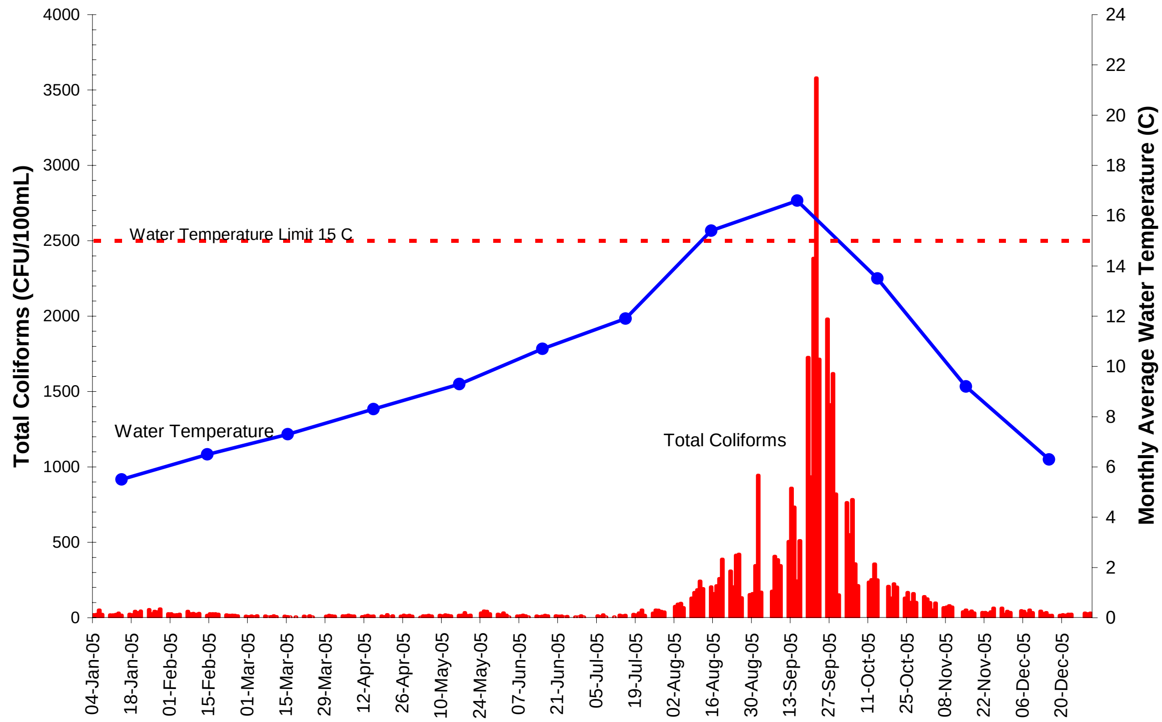
## 7.1. Indicator Bacteria And Chlorine Residual

The Water Quality Division analyses drinking water samples for several different groups of indicator bacteria including total coliforms, fecal coliforms 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 treatment plant and the treated water close to the first customer below the treatment plants. Where appropriate, the Canadian Guideline concentration limits for these bacteria are listed in **Tables 1, 2** and **3** under the heading 2005 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 *2005 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**. As in the previous four years, relatively high (above 200) concentrations of total coliform bacteria were found in the raw source (untreated) water entering the Japan Gulch Treatment Plant during the summer of 2005. Increased colony forming units per 100 millilitres (CFU/100 mL) of total coliforms occurred in late September (**Figure 1**), peaked and then declined by the end of October. The types of coliforms present were not indicative of any particular type of contamination.

**Figure 1. Total Coliforms and Water Temperature of Raw Water Entering Japan Gulch Plant in 2005**




**Background Bacteria**. Unlike the previous two years, background bacteria concentrations remained below 7,000 CFU/100 mL for the entire year in 2005. Similar to previous years, the concentrations were elevated in the summer months (May to end of September) (**Figure 1A**). These elevated background bacterial counts had no particular health significance and were monitored primarily as an operational tool.

**Fecal Coliform (*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 2005, similar to 2004, the low detection of fecal coliform (*E. coli*) bacteria indicated that the raw water entering the Japan Gulch Treatment Plant from Sooke Reservoir was a good quality source and complied with the fecal coliform limit in the USEPA Surface Water Treatment Rule to remain an unfiltered drinking water supply (**Figure 1B**).

**Figure 1A. Background Bacteria in Raw Water Entering Japan Gulch Plant 2003-2005**

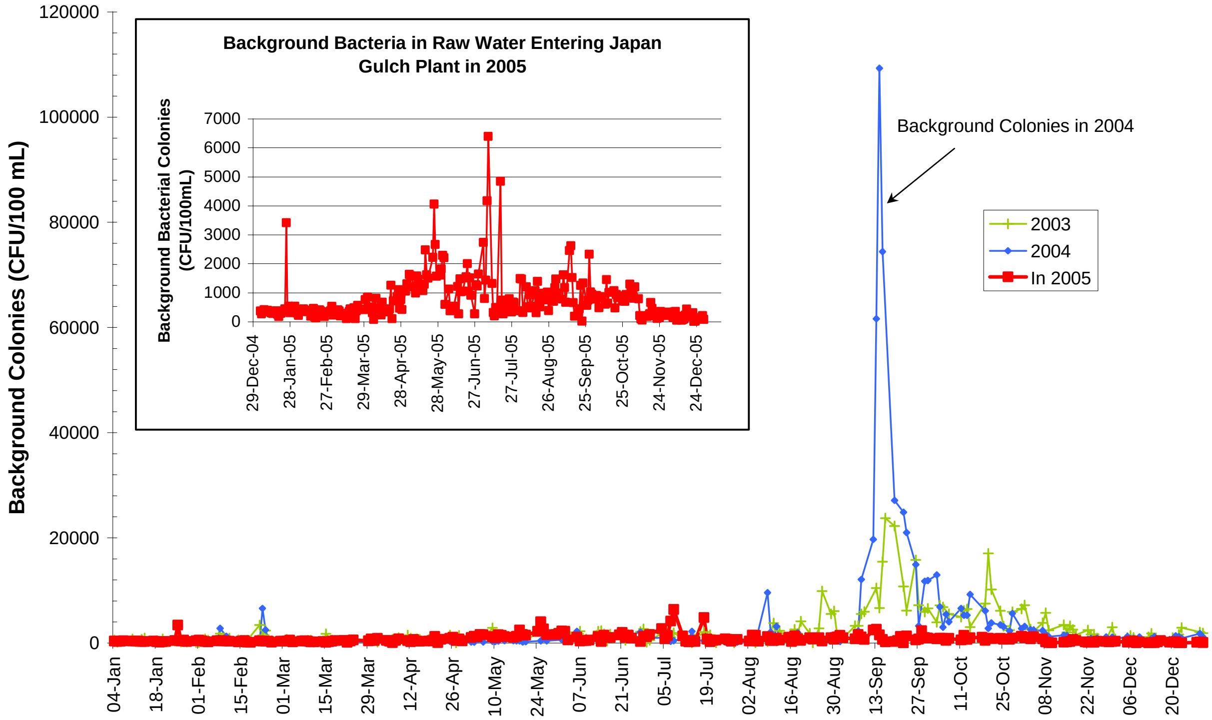
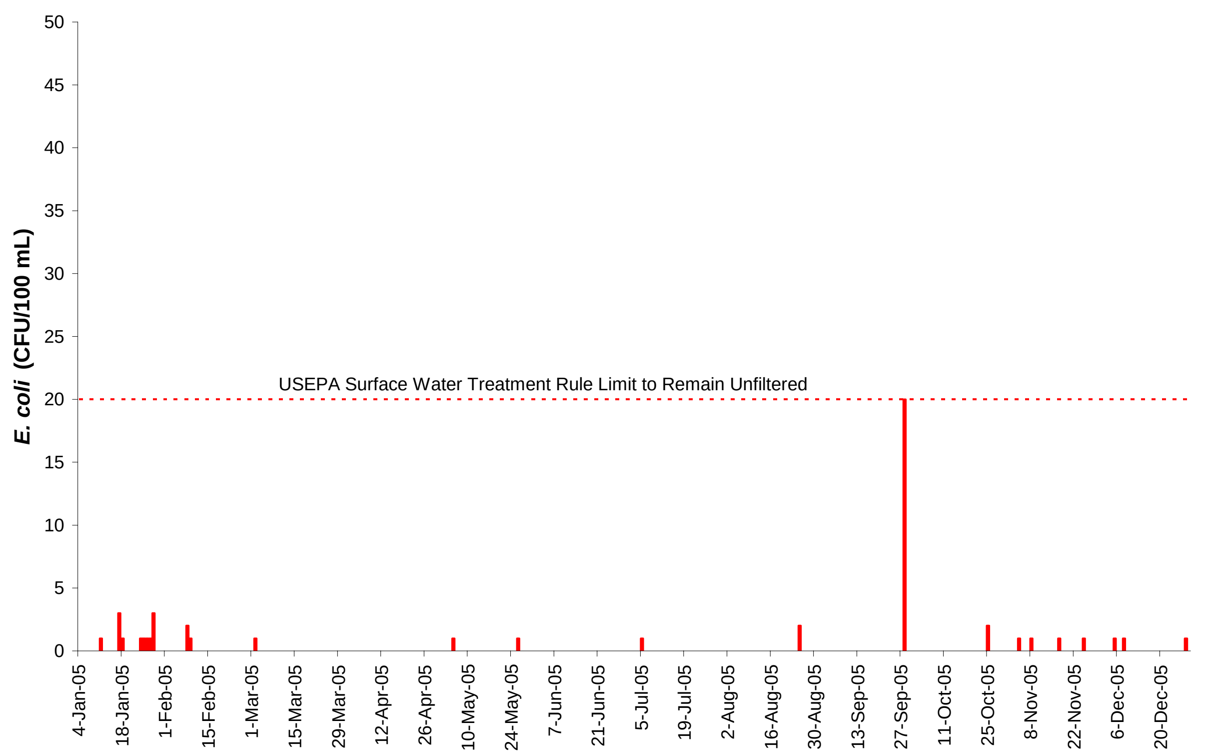



**Figure 1B. *E. coli* in Raw Water Entering Japan Gulch Plant in 2005**

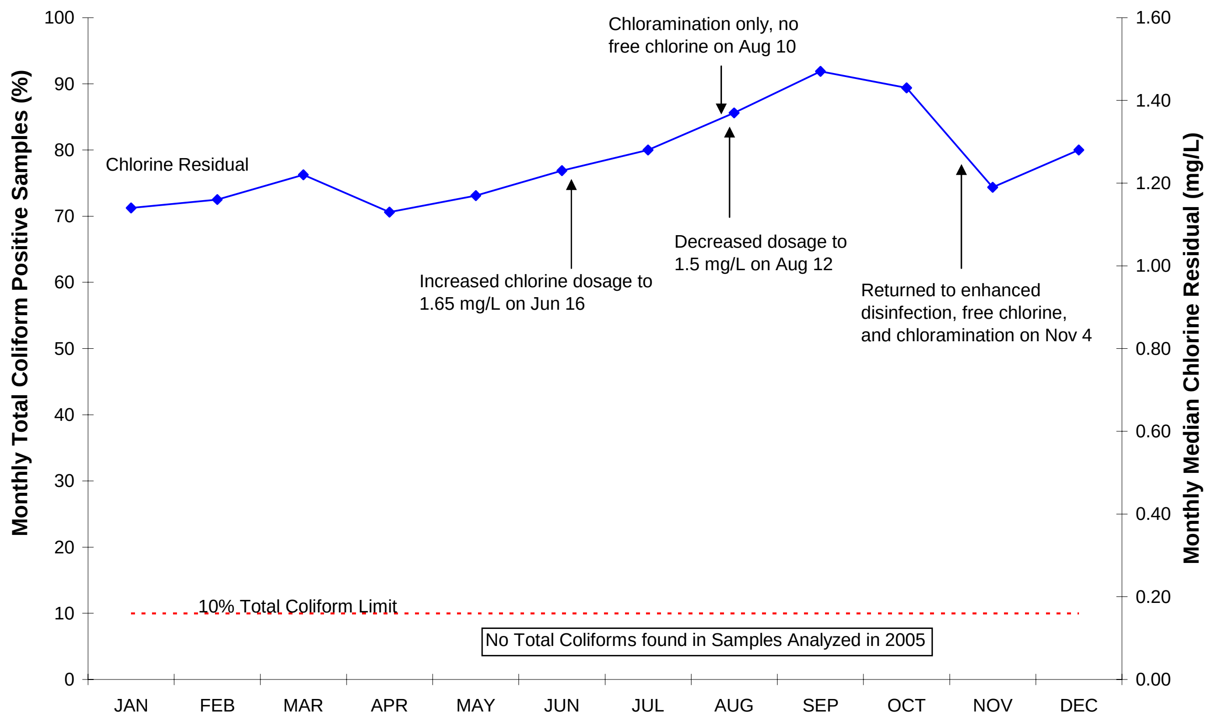


### 7.1.2. TREATED WATER AT FIRST CUSTOMER

**Bacterial Indicators**. The data collected from the treated water sampling location near the first customer below the Japan Gulch Treatment Plant indicated that the bacteriological quality of the disinfected water was good in all months of the year (**Figure 2** and **Table 2**). In 2005, there were no coliform bacteria found in the 248 samples analyzed (**Figure 2**). This was an improvement from 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.

No coliform bacteria were found at the first customer sampling location below the Charters Treatment Plant.

**Figure 2. Treated Water at First Customer Below Japan Gulch Plant**
**Monthly Total Coliforms and Chlorine Residual in 2005**



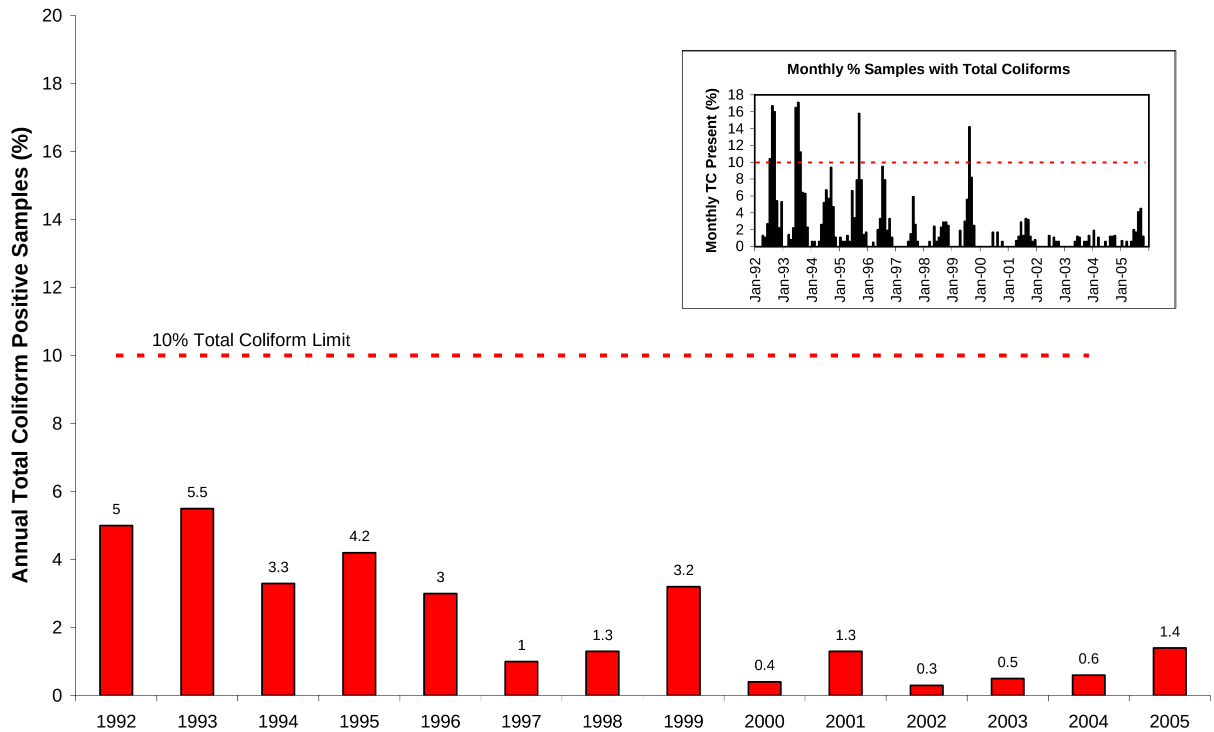

**Chlorine Residual.** The monthly average chlorine residual levels at the first customer sampling location below the Japan Gulch Plant is provided in **Figure 2**. From this figure, it can be seen that the monthly average chlorine residuals at the first customer sampling location increased throughout the summer months and then decreased through October and early November of 2005. The annual median chlorine residual (based on daily readings) at this location was 1.22 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 2005, total coliform bacteria were detected during eight months of the year (January, March, and May through October). However, the percentage of positive total coliform samples did not exceed the 10% total coliform limit during any month in 2005 and was therefore in compliance with the BC *Drinking Water Protection Regulation*. This was similar to the past several years and much better than in earlier years.

In addition, the annual total coliform positive percentage (1.4% in 2005) was quite low and similar to the low levels of coliform positive samples found in the Greater Victoria Distribution System in the past six years (**Figure 2a**).

**Figure 2a. Greater Victoria Distribution System Combined Annual % Samples with Total Coliforms Present, 1992-2005**




Over this 14 year period of time, the reduction in total coliform detection (shown in the inset in **Figure 2a**), 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. & member municipalities to 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 ageing 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 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 0.0 and 1.56 mg/L. The highest value observed (1.58 mg/L at the first customer location) was well below the 3.0 mg/L limit in the Canadian Guidelines for chloramines.

## 7.2. Parasites

As in previous years, parasite samples were collected every two weeks throughout the year as part of the Division's routine compliance monitoring program and sent to Hyperion Research Laboratories, a contract laboratory in Alberta. In 2005, 24 samples were collected for parasite analysis from the raw water sampling location at the Japan Gulch Treatment Plant.

**Figures 3-7** show the results of the data collected by Water Quality Division staff as part of the parasite monitoring program. Data from special samples collected for method development studies were not included here. 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 2005, two of the 25 samples (8.3%) collected from the raw water entering the Japan Gulch Treatment Plant were positive for *Giardia* cysts (**Figures 3 and 4**). However, the cysts were deemed to be non-viable by the analyzing laboratory and therefore incapable of causing disease (one cyst found in May and one in July 2005). During the five year period from 2001 to 2005, no viable (living) *Giardia* cysts were detected in Greater Victoria's source water.

- ***Cryptosporidium**.* In 2005, none of the 24 samples collected from the raw water entering the Japan Gulch Treatment Plant was positive for total *Cryptosporidium* oocysts (**Figure 5**).

Although there is no specific 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 2005 since the *Cryptosporidium* oocyst found in the raw source water was non-viable.

In the 14 year period of time that the Water Quality Division has been monitoring *Cryptosporidium,* 345 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 5 out of the 14 years with the percentage of positive samples ranging from 0% to 8% (**Figure 5**). The maximum number of oocysts in any one sample was 6.2 per 100 L (**Figure 6**). During this period, the overall average concentration of oocysts in the water was 0.08 per 100 L with a maximum annual average concentration of oocysts of 0.28 in 1998 (**Figure 7**). All of the annual average concentrations were well below the disinfection limit specified by the *USEPA Long Term 2 Enhanced Surface Water Treatment Rule* and hence would only require two logs inactivation according to their 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.

**Figure 4. *Giardia* Cyst Concentrations in Raw Water Entering Japan Gulch Plant, 1992-2005**

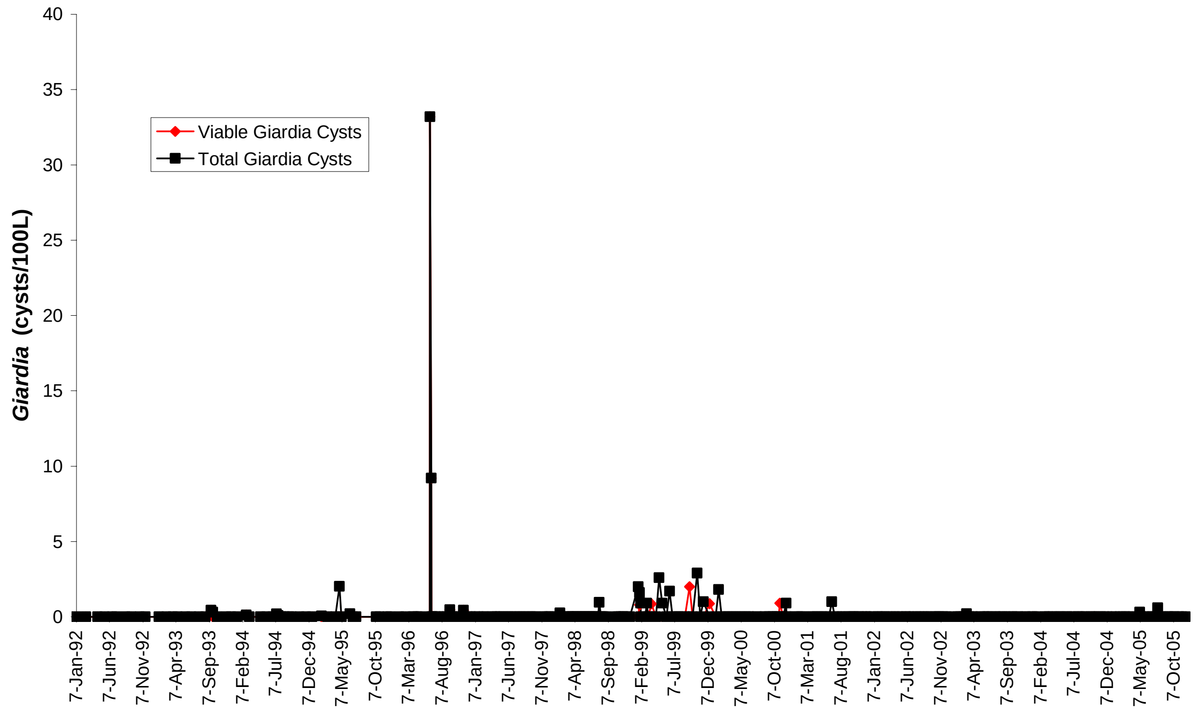



**Figure 5. Percentage of Samples Containing *Cryptosporidium* Oocysts in Raw Water Entering Japan Gulch Plant, 1992- 2005**

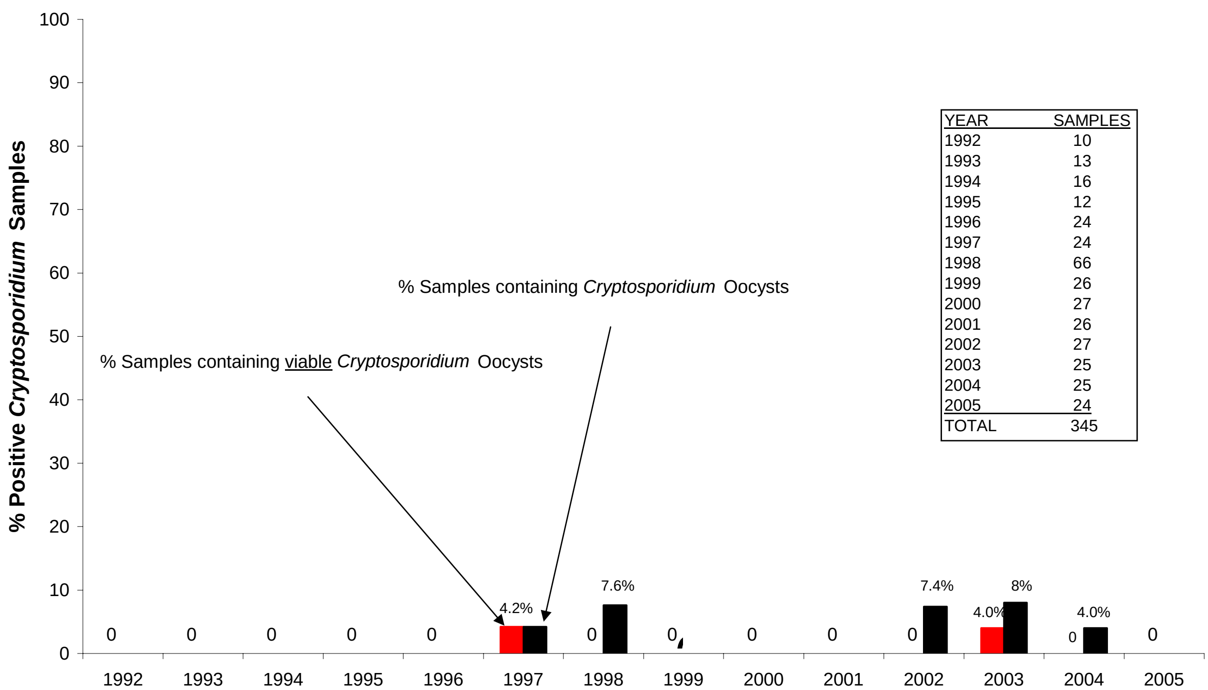


**Figure 6. *Cryptosporidium* Oocyst Concentrations in Raw Water Entering Japan Gulch Plant, 1992-2005**

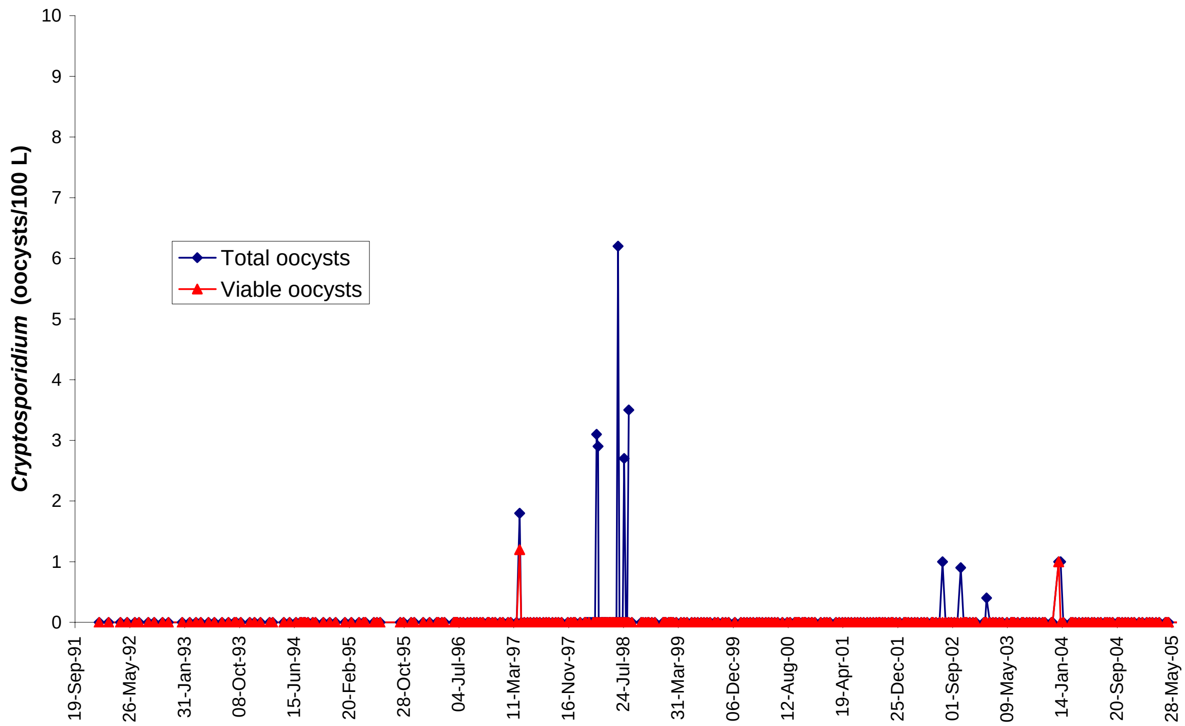
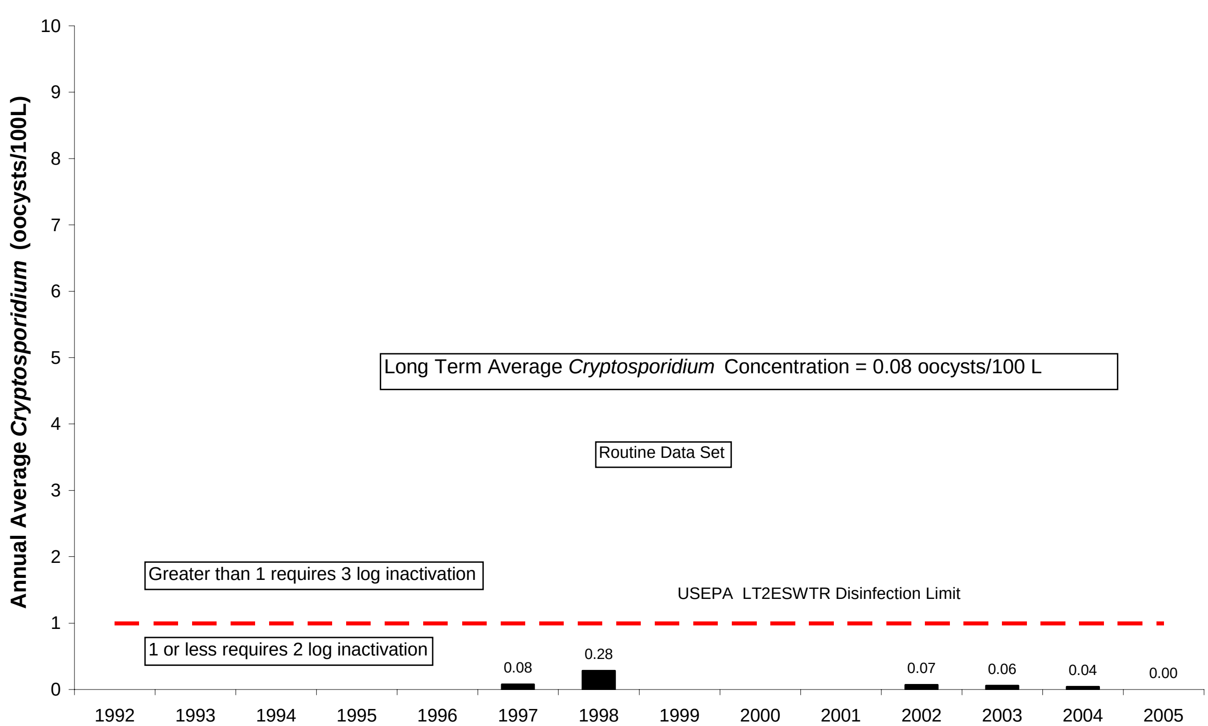



**Figure 7. Annual Average Total *Cryptosporidium* Oocysts Levels in Raw Water Entering Japan Gulch Plant, 1992-2005**



## 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** under the title **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 2005, ultraviolet transmittance, turbidity and water temperature were analysed daily, while colour, conductivity, pH and ultraviolet absorption were analysed weekly. Alkalinity was analysed every two weeks. Carbon, solids and hardness were analysed monthly.

The raw water entering the Japan Gulch Treatment Plant is very soft (median value for hardness of 17.3 mg/L) (**Table 1**), has a neutral pH (median of 7.16 and ranging from 6.78 to 7.47), moderate colour (median of 7.4 true colour units and ranging from 5 to 11) and low turbidity or cloudiness (median of 0.4 nephelometric turbidity units and ranging from 0.21 to 0.77). It is also low in acid buffering capacity having an alkalinity of 15.6 mg/L, has low ionic strength (conductivity of 42.6 μS/cm), relatively low solids (total dissolved solids of 24.6 mg/L, total suspended solids of 1.0 mg/L and total solids of 26 mg/L), and moderate level of total and dissolved organic carbon (2.5 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 2005, the values for all of the physical parameters were within the Canadian Guideline limits except for water temperature during the summer months.

- **Water Temperature**. The annual median water temperature of the raw water entering the Plant was 9.5°C and ranged from 4.0 to 19°C (**Table 1**). In the summer, the water temperature was above the 15°C limit for a period of 2 months lasting from early August to late September (**Figure 1**). This is an improvement from previous years when the water temperature was above the 15°C limit for about 4 months. In the summer months, the water in the Greater Victoria Drinking Water System is very warm compared to many large drinking water systems in Canada. This can have a detrimental effect on the bacteriological quality in the distribution system as the warm water promotes the regrowth of bacteria in the distribution system and also impacts consumer acceptance as tastes and odours are more noticeable in warmer water.

### 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 Treatment Plant are listed on **Page 1** in **Table 1** under the title **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 3.2 μg/L in the raw water entering the Japan Gulch Plant (**Table 1**) to 271 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 and result in a phenomenon called bacterial regrowth. As in previous years, this parameter was sampled monthly.

- **Fluoride.** The Water Services Department does not fluoridate the drinking water in Greater Victoria. Nevertheless, a tiny amount of fluoride (14 μg/L) is present naturally in the water (**Table 2**). This tiny amount is well below the 1500 μg/L limit in the Canadian Guidelines. It is also inadequate for dental purposes as individuals must 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 Treatment Plant are listed on **Page 2** in **Table 1** under the title **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 0.0005 mg/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. (**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 10-15 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 0.67 nanograms/L (parts per trillion) (**Table 1**). This value is more than 1,000 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 0.0003 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, 1.77 mg/L (**Table 1**). This parameter 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 Treatment Plant are listed on **Page 3** in **Table 1** under the title **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 2005, the median values for gross alpha and gross beta radiation were less than 0.03 and 0.04 Bq/L, respectively (**Table 1**). These values were within the Guideline limits for gross alpha and beta screening type analyses and therefore, did not require more specific analyses.

#### 7.3.5. ORGANICS

The organic chemicals monitored by the Water Quality Division in the raw water entering the Japan Gulch Treatment Plant are listed starting on **Page 4** in **Table 1** under the title **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. In fact, none of these organic chemicals has ever been detected in the raw source water entering the Japan Gulch Plant. This is consistent with the source water protection provided by the Greater Victoria Water Supply Area in which no public access, agriculture, mining or commercial logging is permitted. The use of herbicides, pesticides and fertilizers is also prohibited. This dataset provides an excellent baseline for pristine surface waters in this area of the Province.

### 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 is one group of these disinfection by-products (DBPs) that are monitored by the Water Quality Division at a number of locations within the distribution system. In 2005, DBP samples were collected six times during the year.

The monitoring locations included the treated water below the plants, several locations within the distribution system receiving chloraminated water and several locations within the parts of the distribution system on the Saanich Peninsula where free chlorine is added to increase the chlorine residual.

Testing was also conducted for several other groups of disinfection by-products. None of these latter chemicals have Canadian Guideline limits. A detailed summary of disinfection by-products showing the results of sampling within the individual municipalities is provided in a report titled *2005 Annual Summary of Disinfection By-Products in Greater Victoria's Drinking Water*.

The Canadian Guideline limits for the substances of concern are listed on **Page 3** in **Table 2** in the section titled **Disinfectants** and on **Page 4** in **Table 2** in the section titled **Disinfection By-Products**. An overview of the disinfection by-products results for the distribution system is provided below:

- **Chloramines**. The maximum total chlorine (chloramines) residual in the distribution system in 2005 was 1.56 mg/L. This value falls well under the disinfectant Canadian Guideline limit of 3.0 mg/L for chloramines. Approximately 75% of the chloramines occurred as monochloramine. This is the most desirable form of this disinfectant as it produces the least perception of a chlorinous taste and odour.

- **Trihalomethanes**. In 2005, the average level of total trihalomethanes (TTHMs) at the first customer sampling location below the Japan Gulch Treatment Plant was 10.1 μg/L (median of 11.2) which is well below the Canadian Guideline limit of 100 μg/L (**Table 2**). (**Note**: The Canadian Guidelines require this parameter to be collected quarterly and the quarterly results to be averaged.) The TTHM concentration value does not change appreciably throughout the chloraminated portion of the distribution system and did not change appreciably following the addition of the UV disinfection process step. The vast majority of the 320,000 people in the Greater Victoria Drinking Water System receive water with these relatively low levels. In 2005, trihalomethanes (THM) were sampled 6 times (every two months).

  In the rechlorinated parts of the system on the Saanich Peninsula substantially higher levels of TTHMs were found ranging between 28 and 56 μg/L (average less than 50 μg/L). Nevertheless, all of the individual TTHM values collected from that part of the distribution system were below the Canadian Guideline limit of 100 μg/L.

- **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. The regulatory agencies use a group of 5 haloacetic acids (referred to as HAA5) for regulatory purposes. At present, Canada is reviewing whether or not to it should set a limit for this group of disinfection by-products. Currently, Canada does not have a limit. The US Environmental Protection Agency (USEPA) set a maximum contaminant level (MCL) of 60 µg/L for HAA5 effective January 2002. However, for a temporary period, the USEPA has relaxed the limit to 100 µg/L to allow utilities to improve their systems following a monitoring change in the Disinfectants/Disinfection By-Products Rule. Starting in 2006, large US utilities will be required to submit an Initial Distribution System Evaluation (IDSE) plan and begin a one year monitoring program based on those locations. The IDSE requires that locations be identified where maximum disinfection are expected to be found in the distribution system. The numerical value of 60 µg/L will be retained.

  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 2005, the average level of HAA5 at the first customer sampling location was 13.1 µg/L (median of 14.2 µg/L), which is well below the USEPA limit. However, similar to the total trihalomethanes in the rechlorinated parts of the distribution system in North Saanich, substantially higher levels of HAA5 were found at the designated sampling locations (36-86 µg/L, average of 57 µg/L). Six of the fifteen samples (40%) would have exceeded the USEPA limit of 60 µg/L had it still been in force. In the other areas of the distribution system, HAA5 values were well below the USEPA limit.

## 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, a component of all algal cells. The typical seasonal pattern of spring growth and summer die-off of the phytoplankton shows quite clearly in these chlorophyll measurements. In 2005, the late spring and early summer levels of chlorophyll-a were higher than in 2004 or 2003 and substantively higher than the long term average **(Figure 8).**

  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 2005, the concentration of chlorophyll-a was substantively higher than in the years prior to inundation (**Figures 8 and 9**).

- **Total Phosphorus**. The primary contributor to the higher levels of chlorophyll-a observed in Sooke Reservoir in 2003 through 2005 was the higher levels of total phosphorus, a nutrient that is needed for the algae to grow. As can be seen in **Figure 10**, the concentration of total phosphorus was approximately 78% higher than in previous years in both the north and south basins of Sooke Reservoir. These higher levels coincided with flooding of the newly cleared lands around the margin of Sooke Reservoir as part of the Reservoir Expansion Project.

- **Algae**. In 2005, the two primary contributors to the high levels of chlorophyll-a were two diatoms: *Asterionella formosa* and *Cyclotella bodanica* (**Figures 11 and 12**). Both organisms occur commonly within Sooke Reservoir but the fall bloom of *Asterionella* and the first-ever observed bloom of *Cyclotella bodanica* were unusual The concentrations of these organisms were substantially higher than the long-term average.

  Other algal species which were problematic in 2004, such as the diatom *Tabellaria*, were of little consequence in 2005.

**Figure 8. 2005 Chlorophyll-a in Sooke Reservoir South basin, 1 m depth (SOL-01-01)**

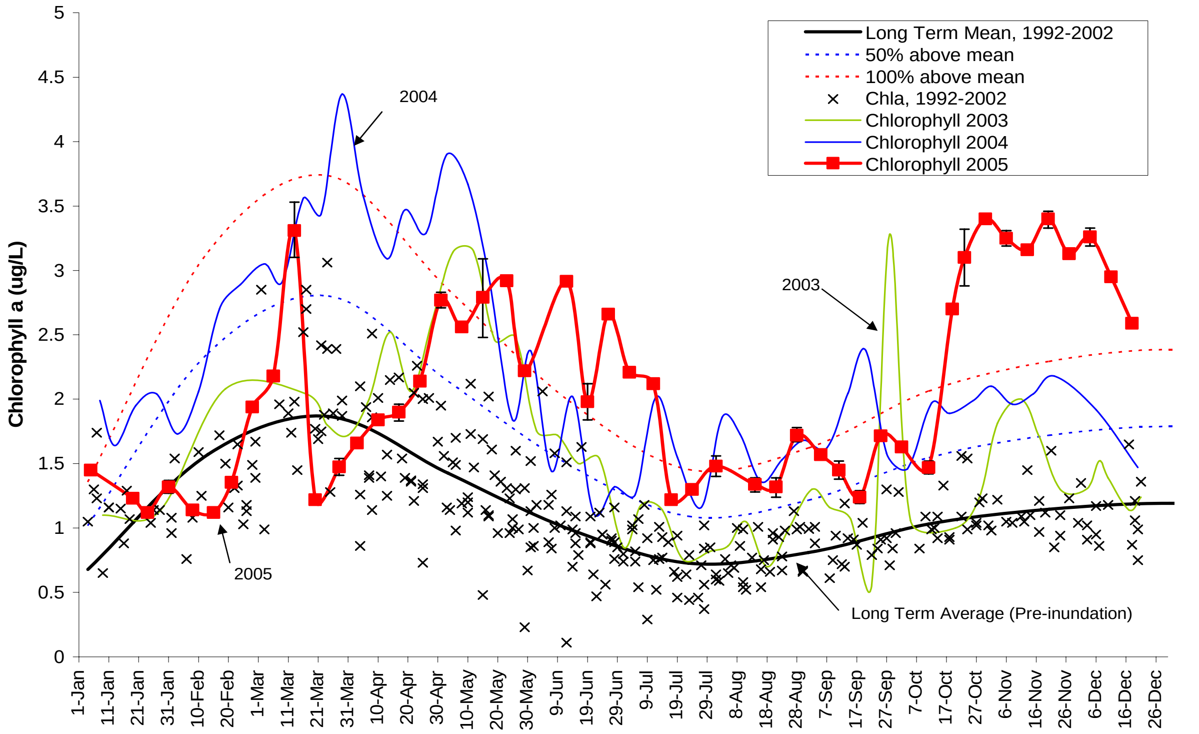



**Figure 9. Chlorophyll-a Concentrations in Sooke Reservoir, 1995-2005**

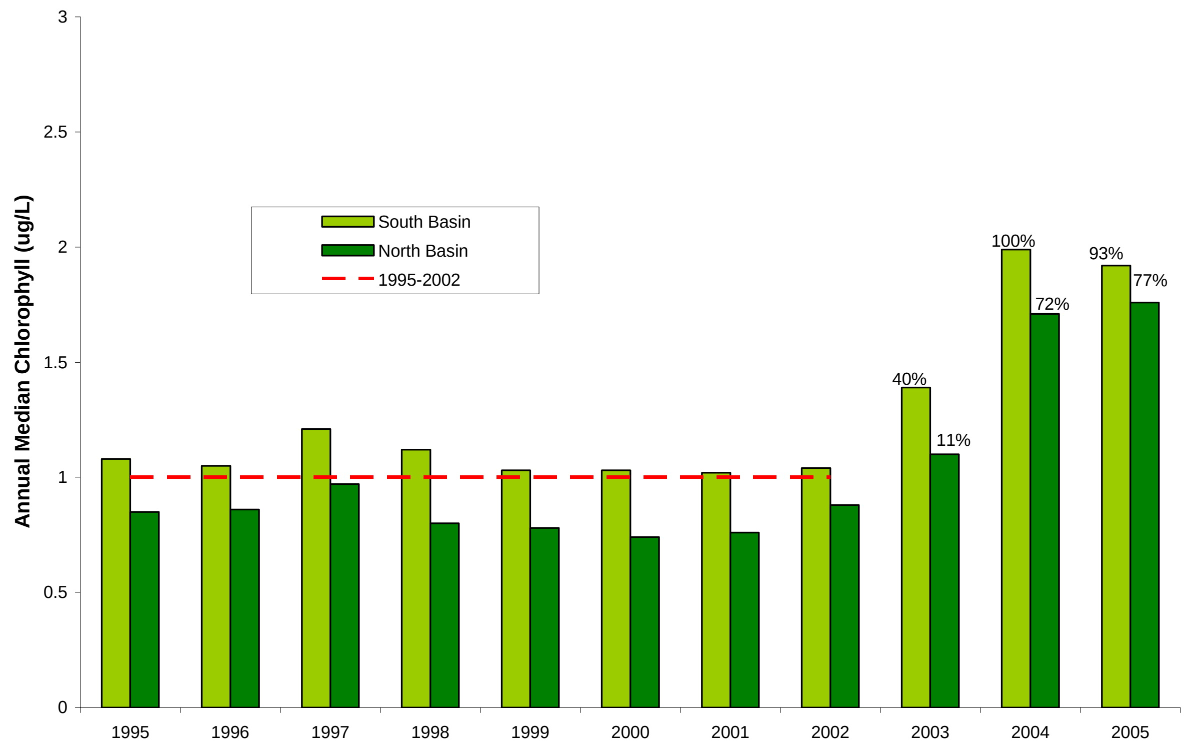


**Figure 10. Total Phosphorus Concentrations in Sooke Reservoir 1992-2005**

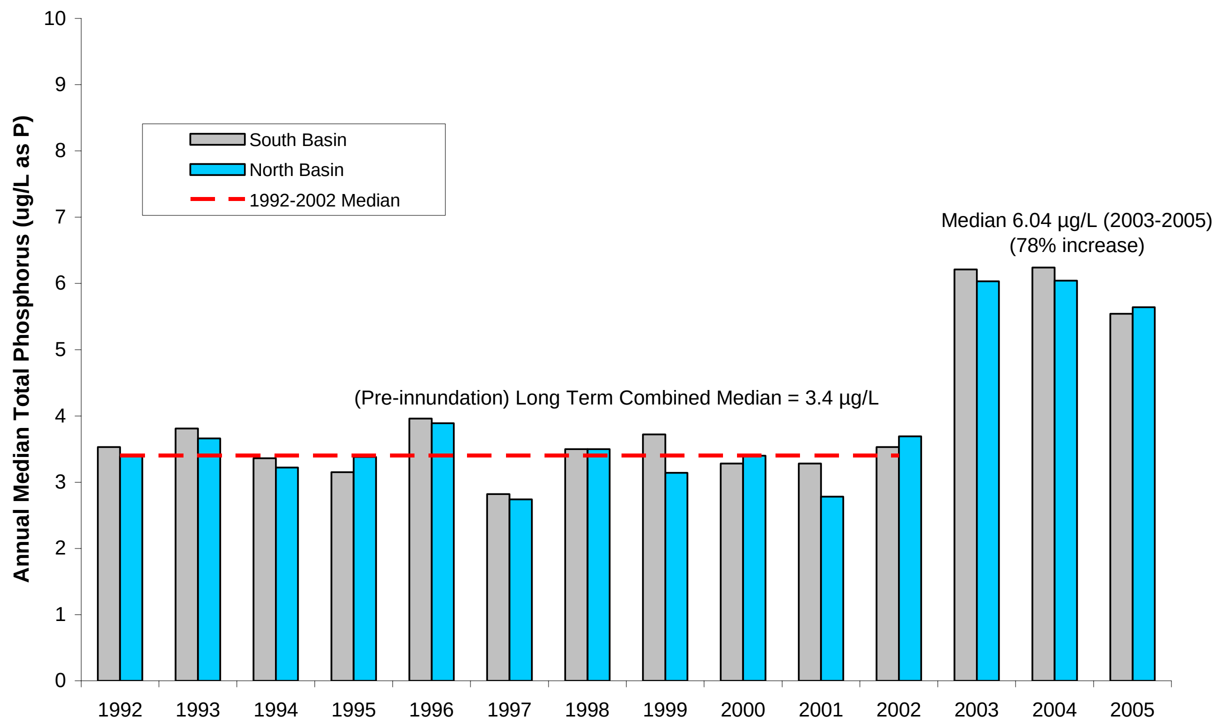



**Figure 11. *Asterionella spp*. in Sooke Reservoir, Intake Forebay, 1m depth (SOL-00-01)**

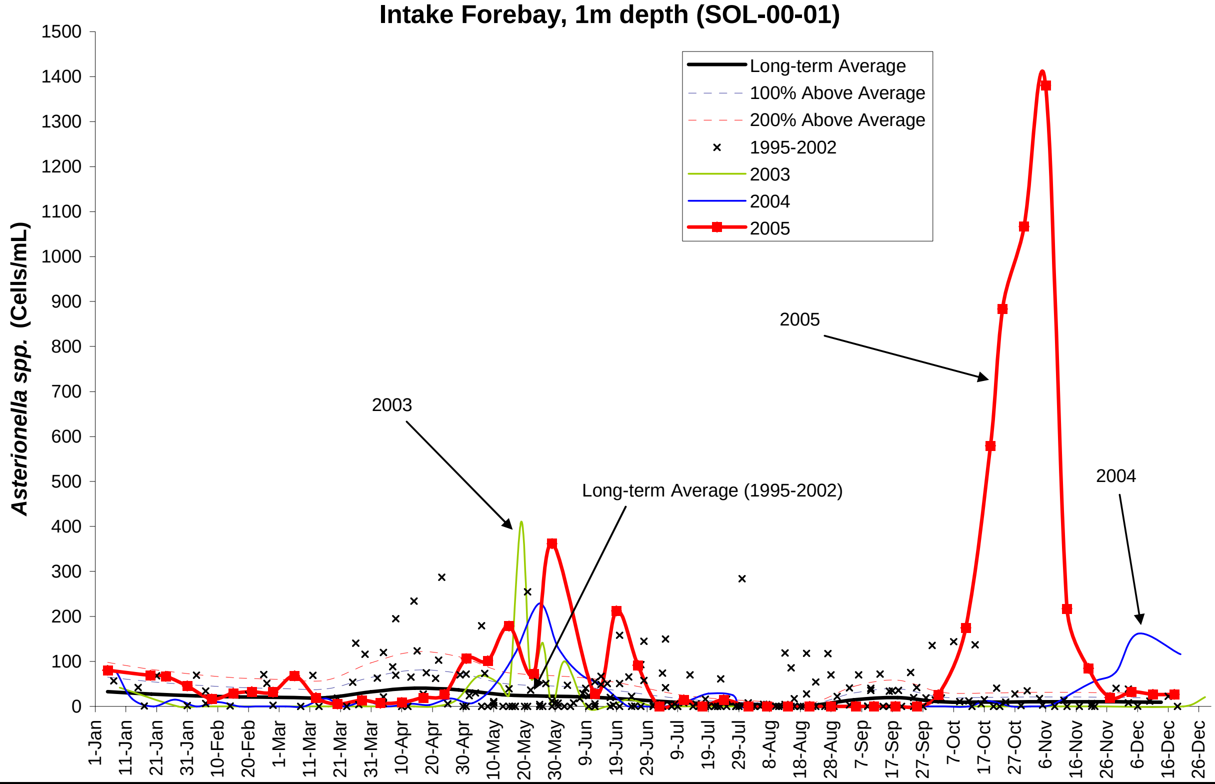
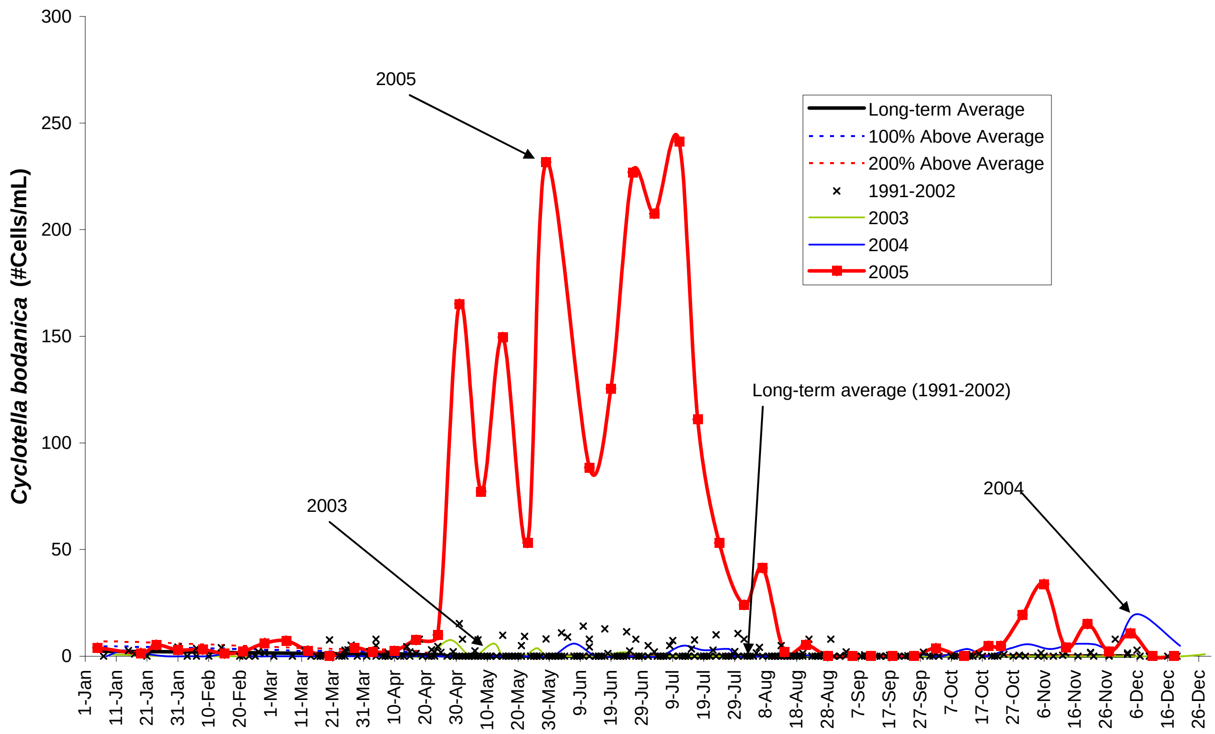


**Figure 12. *Cyclotella bodanica* in Sooke Reservoir, Intake Forebay, SOL-00-01 (1m depth)**




## 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 approximately 120 in 1997 to a high of about 415 in 2003 (**Figure 13**). The peak in 2003 was associated with a short duration algal bloom in September of 2003. In 2005, one hundred and seventy-one water quality complaints were received by the Water Quality Division. 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. Since the influence of raising the water level in Sooke Reservoir will continue to affect the quality of water in Sooke Reservoir for several years, the slightly higher number of complaints received in 2005 was not unexpected.

**Figure 13. Annual Water Quality Complaints from the Greater Victoria Drinking Water System, 1992-2005**


Information on the types of water quality complaints received each month during 2005 is provided in the Table below.

| Month | Total Number of Complaints[1] | Taste and/or Odour | Chlorine[2] | Colour | Particulates | Safety Concerns | Filter Clogging | Customer's Plumbing | Sensitivity | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| January | 18 | 1 | 2 | 8 | 3 | 6 | 1 | 1 | New category - introduced June 2005 | 4 |
| February | 8 | 0 | 1 | 1 | 0 | 2 | 0 | 1 | | 3 |
| March | 9 | 2 | 1 | 0 | 1 | 1 | 1 | 2 | | 2 |
| April | 8 | 0 | 0 | 1 | 2 | 0 | 1 | 2 | | 2 |
| May | 8 | 2 | 1 | 1 | 1 | 1 | 0 | 2 | | 0 |
| June | 14 | 2 | 1 | 1 | 0 | 2 | 2 | 2 | 3 | 2 |
| July | 12 | 0 | 0 | 3 | 1 | 2 | 5 | 1 | 1 | 0 |
| August | 27 | 11 | 2 | 7 | 2 | 3 | 8 | 0 | 0 | 0 |
| September | 18 | 5 | 0 | 9 | 5 | 0 | 1 | 3 | 1 | 0 |
| October | 21 | 2 | 0 | 8 | 3 | 5 | 2 | 0 | 2 | 1 |
| November | 19 | 6 | 1 | 2 | 4 | 2 | 5 | 1 | 0 | 2 |
| December | 9 | 2 | 0 | 4 | 4 | 0 | 2 | 0 | 0 | |
| **Total** | **171** | **33** | **9** | **45** | **26** | **24** | **28** | **15** | **7** | **16** |

[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.

In 2005, the majority of water quality complaints (45) were due to visible colour in the water followed by taste and odour (33), filter clogging (28), particulates (26) and safety (24). The highest number of complaints were received in August, 2005.

In 2005 a new category of water quality complaint called '**Sensitivity'** was introduced because a number of people were questioning whether or not a skin sensitivity or allergic skin reaction that they were noticing could be attributed to the drinking water. In many cases, the individuals had eliminated a number of other variables which left the water as one of the prime suspects. While this type of complaint had been encountered very infrequently in earlier years, this was the first year that it was being presented more commonly and from various locations within the distribution system.

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 wanted 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

# 8. Conclusions and Recommendations

## 8.1. Conclusions

1. The data collected in 2005 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 12 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 data collected in 2005 indicate that the change in primary disinfection (late October 2001) and the addition of UV disinfection (2004) was successful in reducing both the number and level of total coliform occurrences at the first customer sampling location.

3. The bacteriological quality of the raw source water did not change appreciably from 1999 through 2005 except for the brief spike in late July, 2004. The fecal coliform (*E. coli*) bacterial levels in the raw source water were extremely low and did not display any particular seasonal trend.

4. Currently, the majority of 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. However, the use of free chlorine in a portion of the North Saanich distribution system resulted in elevated levels of trihalomethanes and haloacetic acids. The use of free chlorine at the Japan Gulch Treatment Plant (first initiated in October 2001) has slightly increased the overall levels of trihalomethanes and the haloacetic acids above that observed in previous years.

5. In 2005 as in 2003 and 2004, a higher concentration of chlorophyll-a was observed in Sooke Reservoir. In both years, this change was driven primarily by an overall increase in the concentration of total phosphorus. This increase appeared to be largely related to the inundation of the new land area around the margin of Sooke Reservoir and to a lesser degree to some storm water flows.

6. The number of water quality complaints received in 2005 was similar to that received in previous years and unlike the high number of complaints received in 2003 as a result of the algal bloom in September 2003.

## 8.2. Recommendations

1. In conjunction with the Saanich Peninsula Water Commission and the CRD Environmental Services Department, it is recommended that the chlorination process at the Deep Cove Pumphouse on the Saanich Peninsula be changed to a chloramination process to reduce the levels of disinfection by-products in the portion of the North Saanich distribution system that is served from the Deep Cove Pumphouse. This work was planned to be completed in 2005. However, the cost of making these treatment changes was substantively higher than budgeted and was subsequently postponed.

For web version see **Map 1** on the CRD Water Services Department web site at

http://www.crd.bc.ca/water/factsfigures/documents/drinking_water_system.pdf#view=Fit