



2004 Annual Overview of Greater Victoria's Drinking Water Quality

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March 11, 2005

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Executive Summary

This report is the annual overview of water quality testing that was conducted in 2004 from 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 2004 *Guidelines for Canadian Drinking Water Quality* and the 2003 *BC Drinking Water Protection Regulation*. This report is posted on the CRD website at http://www.crd.bc.ca/water/water_quality/water_quality_reports.htm.

Samples and Tests. In 2004, the Water Quality Division collected 7,473 samples from the Greater Victoria Drinking Water System and analyzed those samples for 36,991 individual tests. Approximately 300 different types of tests were conducted on these samples.

Bacteria in Source Water. In 2004, 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 (**Figure 1**). A bacterial spike was observed in late July, 2004 closely following the transplant of several thousand fish from Deception Creek and Deception Reservoir into Sooke Reservoir (**Figure 1A**) under the direction of Fisheries and Oceans Canada. Nevertheless, as in previous years, the quality of the raw water entering the plant easily met the fecal coliform 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 exceeded once the entire year. Both the median value of 0 per 100 mL and the maximum value of 21 per 100 mL indicate a good quality source that is not subject to contamination.

Treatment. In 2004, ultraviolet (UV) disinfection was added to the disinfection process. For the third year, the Water Services Department used free chlorine followed by chloramines to disinfect the raw source water entering the distribution system. The chlorine dosage level was maintained at 1.6 mg/L for the majority of the year. This dosage level resulted in a monthly average total chlorine residual ranging from 1.08 to 1.29 mg/L at the entry point to the distribution system (**Figure 2**).

Bacteria at First Customer. Total coliform bacteria were observed at the first customer sampling location below the Japan Gulch Treatment Plant during July (**Figure 2**) but did not exceed the Canadian Guideline limit of 10% monthly percentage total coliform positive samples. The annual total coliform positive sample rate of 0.4% was similar to 2003 and 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 2004 and was therefore in compliance with the *BC Drinking Water Protection Regulation*. Over this 13 year period of time, the reduction in total coliform detection, and hence, the improved bacteriological water quality (**Figure 2A**), can be attributed to a number of factors including:

- **1990** Relining of old cast iron water mains in Oak Bay, Saanich and Victoria
- **1993** Annual reservoir cleaning (Water Services Dept. & member municipalities)

- **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 Rechloramination Station.
- **2004** Use of UV disinfection to provide improved bacteriological disinfection

Parasites. In 2004, none of the samples were positive for *Giardia* cysts (**Figure 3**). One sample containing one non-viable *Cryptosporidium* oocyst was found (**Figure 5**). The average annual oocyst concentration was 0.04 per 100 L which is similar to 2002 and 2003 (**Figure 7**). The maximum oocyst concentration in any one sample was 6.2. The long term average (1992-2004) oocyst concentration was 0.09 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 are present in Greater Victoria's drinking water.

Algae. In 2004, a spring bloom of a diatom called *Tabellaria* (**Figure 11**) was the only algal species considered to achieve bloom status in Sooke Reservoir. No specific water quality problems were attributed to this bloom other than contributing to the overall load of particulate material entering the distribution system. As in 2003, a higher level of chlorophyll-a which is an overall measure of algal concentrations (**Figures 8 and 9**) were consistent with an increased level of phosphorus observed in Sooke Reservoir (**Figure 10**).

Physical-Chemical-Radiological. All the physical, chemical and radiological parameters were well within the Canadian Guideline limits except for water temperature (aesthetic limit of 15°C) which cannot be controlled by the Department. 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 5.8-19.1 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 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 32 to 58 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 44-69 µg/L.

Water Quality Complaints. In 2004, the number of water quality complaints received by the Water Services Department was similar to 2002 and much less than the record number received in 2003 (**Figure 12**).

Contents

	<u>Page</u>
<i>Executive Summary</i>	2
<i>Contents</i>	4
1. Introduction	6
2. Water Quality Regulations	6
3. Water System Description	7
3.1. WATER SYSTEM DESCRIPTION	7
3.2. OPERATIONAL CHANGES AND EVENTS	9
4. Water Quality Monitoring	11
4.1. WATER QUALITY MONITORING PROGRAMS	11
4.2. SAMPLING FREQUENCY AND PARAMETER TESTING	11
5. Water Quality Results	14
5.1. INDICATOR BACTERIA AND CHLORINE RESIDUAL	14
5.2. PARASITES	19
5.3. ALGAE	23
5.4. PHYSICAL - CHEMICAL - RADIOLOGICAL	26
5.5. DISINFECTANTS AND DISINFECTION BY-PRODUCTS.....	29
5.6. WATER QUALITY COMPLAINTS	30
6. Conclusions and Recommendations	32
6.1. CONCLUSIONS	32
6.2. RECOMMENDATIONS	33

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

<http://www.crd.bc.ca/water/maps/documents/3637.pdf>

1. Introduction

This report is the annual overview of the results from water quality samples collected in 2004 from the Greater Victoria Drinking Water System ([Map 1](#)). This overview report is the first of the 2004 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-product results of sampling within individual municipalities are issued separately. All reports are posted on the Capital Regional District (CRD) website at http://www.crd.bc.ca/water/water_quality/water_quality_reports.htm

2. Water Quality Regulations

On May 16, 2003, the *Drinking Water Protection Regulation* of the new British Columbia *Drinking Water Protection Act* was enacted. The CRD Water Services Department and the municipal water purveyors in the Greater Victoria Drinking Water System are subject to this new legislation. However, due to the limited number of water quality test parameters included in the regulation, the Water Services Department uses the much larger group of water quality parameters listed in the most recent revision of the *Guidelines for Canadian Drinking Water Quality* (April 2004) as its compliance legislation. These limits are shown in **Tables 1, 2 and 3** in the column titled 2004 CANADIAN GUIDELINES (at the end of the report).

In addition to the Provincial and Federal regulations, where appropriate, the Water Services Department also complies with many of the United States Environmental Protection Agency (USEPA) rules and regulations on a voluntary basis. Some of the limits in the USEPA rules are used as the basis for the Department's water treatment goals.

The limits in the 2004 *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. Water System Description

The following is a brief description of the Greater Victoria Drinking Water System which supplies approximately 320,000 people and is the second largest drinking water system in British Columbia ([Map 1](#)).

3.1. WATER SYSTEM DESCRIPTION

Source. 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/or the 1220 mm (48") diameter pipe 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 only when the 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 can enter the Japan Gulch Intake Tower either through a surface level intake gate or a low level intake gate. Typically, the low level intake gate is used. In the Japan Gulch Intake Tower, the water passes through a 14 mesh, stainless steel screen and continues into a 1320 mm (52") diameter pipe to the Japan Gulch Treatment Plant.

Treatment. The drinking water in Greater Victoria is unfiltered and in 2004, the source water from Sooke Reservoir continued to meet the USEPA criteria to remain an unfiltered drinking water supply.

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.* In 2004, as the final part of the Enhanced Disinfection Project, ultraviolet (UV) disinfection was added to the treatment process at the two treatment plants. UV disinfection provides the first step of 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.* The second step of the primary disinfection process is the addition of free chlorine. This step was changed in 2001, as the first part of the Enhanced Disinfection Project and provides approximately 10 minutes or so (depending upon flow) of contact time between the free chlorine and the water. Previously, the water was disinfected using chloramines. This change provided a much stronger oxidant (free chlorine) for the disinfection of the source water and inactivates bacteria and viruses.
3. *Ammonia Addition.* The third step in the 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.

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"). 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 four customers on the Saanich Peninsula: the municipalities of Central Saanich, North Saanich and Sidney and the Agricultural Research Station.

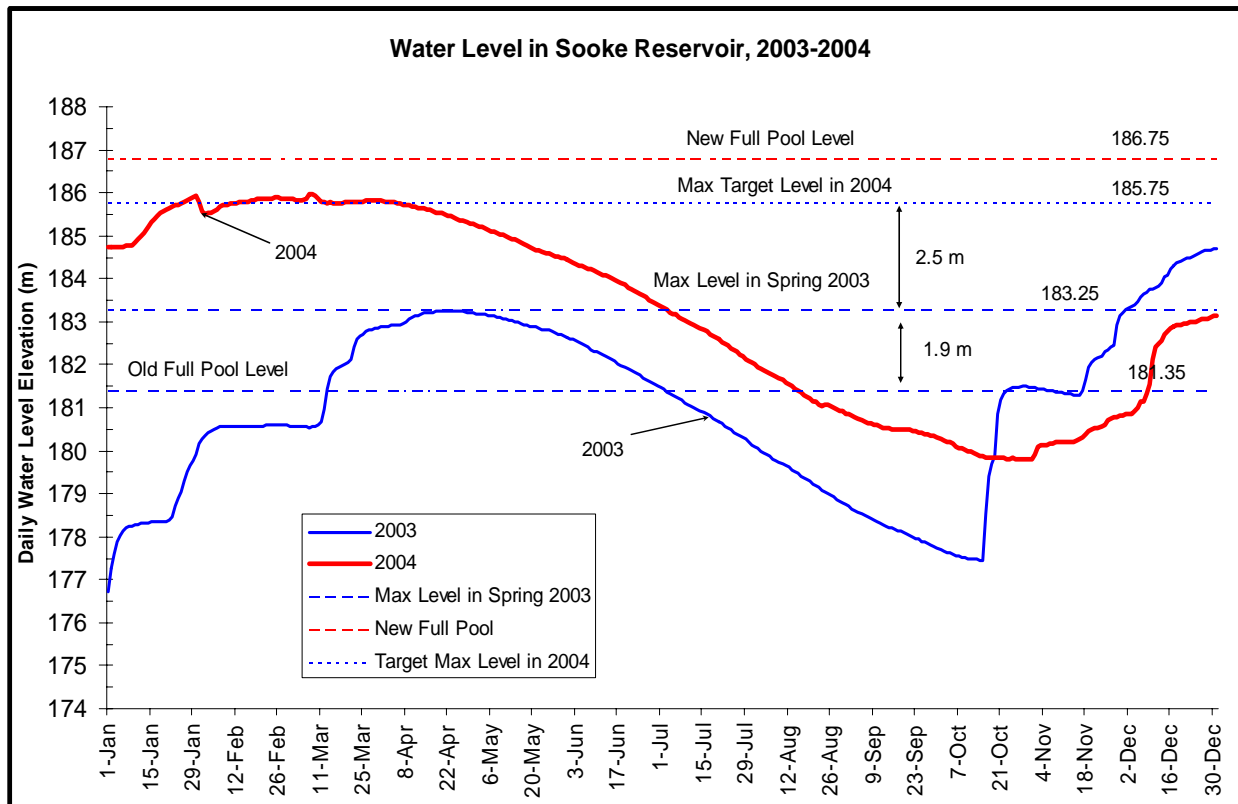
Distribution Systems. The Greater Victoria Drinking Water System contains nine individual distribution systems. Six distribution systems are separately owned and operated by the municipalities of Central Saanich, North Saanich, Oak Bay, Saanich, Sidney and Victoria. Victoria owns and operates the Esquimalt distribution system. The last two distribution systems are owned by the CRD and 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 purveyor and is responsible for providing safe water to their individual customers.

Distribution System Reservoirs. A number of distribution system reservoirs are scattered throughout the municipal distribution systems. These reservoirs are used to balance the uneven consumption of water that occurs during the day-to-night cycle. With the addition in 2004 of Silver Spray Reservoir in East Sooke and Bear Mountain Reservoir #1 in Langford, there are 27 distribution system reservoirs in the Greater Victoria Drinking Water System and many of these reservoirs contain multiple cells (44 cells in total).

3.2. OPERATIONAL CHANGES AND EVENTS

Source of Supply. In 2004, 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 2004, Goldstream Reservoir was used from January 15 to January 29 during the period of time that the Kapoor Tunnel was being drained and inspected. Otherwise, all water received at the Japan Gulch Plant was provided by Sooke Reservoir.

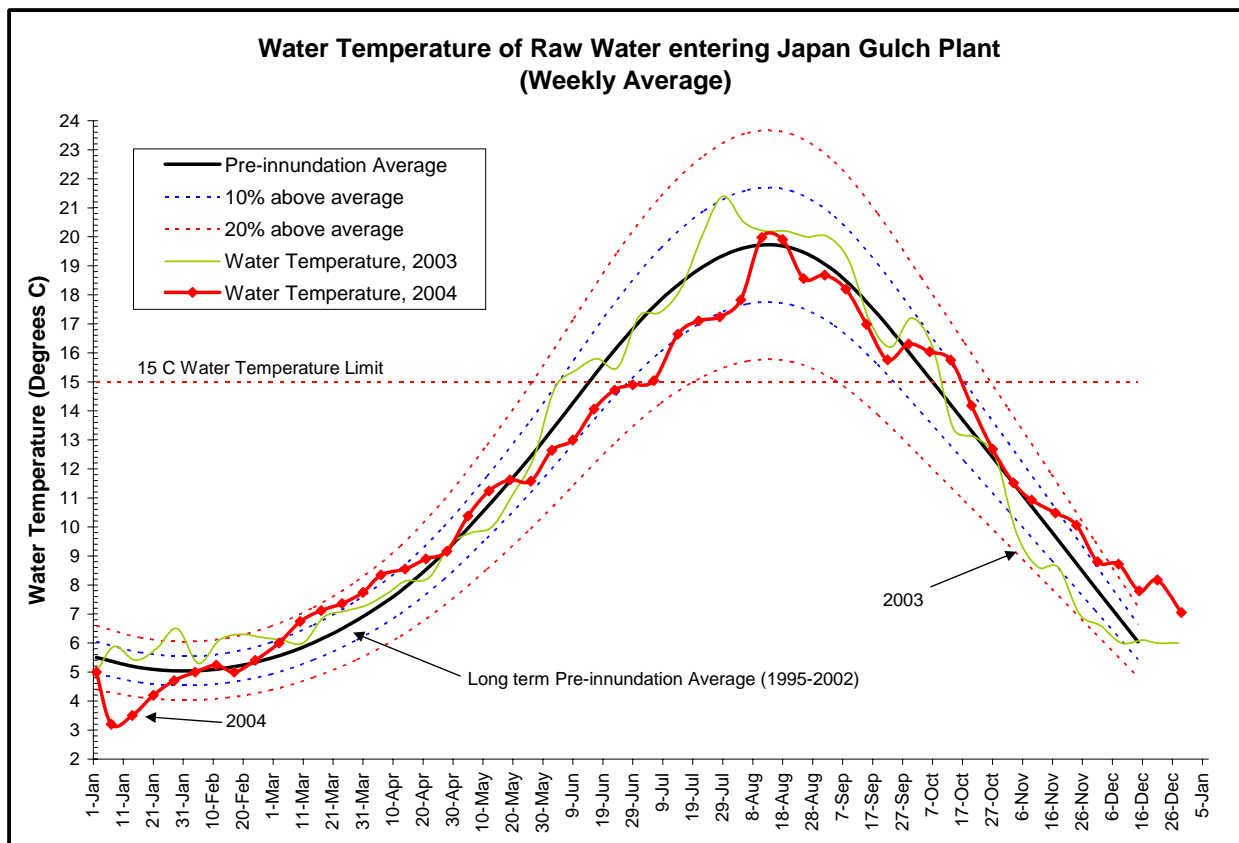
Sooke Reservoir Expansion Project. On January 25, 2004, as part of the Inundation Phase of the Sooke Reservoir Expansion Project, the water level in Sooke Reservoir reached a peak of 185.75 metres above sea level (See **Figure** below). This new level inundated a further 2.5 metres of land around the perimeter of the reservoir. This was the highest water level thus far attained in Sooke Reservoir. In consultation with the Inundation Scientific Advisory Working Group, it was decided to remain at this high water level for 2004 and not inundate the last metre of land. By February 1, 2004 the water level began to decline. In 2005, the reservoir will be allowed to fill the final one metre to full pool.



Chlorine Residuals. The Water Services Department used a chlorine dosage rate of 1.5 milligrams per litre (mg/L) until July 15 when it was increased to 1.6 milligrams per litre (mg/L) and on September 27 to 1.7 mg/L (See **Figure 2**). The increases were required to maintain adequate chlorine residuals in the distribution system during the period of higher water temperature and increased chlorine demand caused by a higher than normal amount of turbidity (cloudier water) entering the treatment plants. On December 16, the dosage rate was reduced to 1.5 mg/L.

Rechlorination. Periodically during 2004, 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.

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 slightly cooler during the early part of the summer than in previous years. The full extent of this reduced temperature which is a result of drawing deeper, cooler water from the reservoir is not expected to be seen until the water level is raised to the full pool water level (186.75 m). Cooler water is beneficial to a distribution system because it reduces the potential for losses of chlorine residual and for the regrowth of bacteria.



Fish Transplant into Sooke Reservoir. In late July, 2004, several thousand fish were transplanted from Deception Creek and Deception Reservoir into Sooke Reservoir. This sudden influx of top predators had the potential to alter the ecology of this drinking water reservoir. A number of changes were noted in the biology of the reservoir following this event.

4. 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 purveyors are responsible for acting on water quality problems identified in their own distribution systems.

4.1. 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. A fourth program is being developed.

- **Aquatic Ecology Monitoring Program.** The goal of this program is to understand and document the components that affect or may affect the natural cycles of the source streams and reservoirs.
- **Compliance Monitoring Program.** The goal of this 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. This program is audited by the Vancouver Island Health Authority twice annually.
- **Water Quality Complaint Monitoring Program.** The goal of this program is to determine the cause of customer water quality complaints and address those complaints in a manner that is satisfactory to the customer.
- **Cross Connection Control Program.** A new program called Cross Connection Control Program was being designed in 2004 and will be implemented in 2005. This program will address the potential for contaminated water to enter the public water system from customer water systems via some typed of backflow event.

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.

4.2. SAMPLING FREQUENCY AND PARAMETER TESTING

In 2004, the Water Quality Division collected 7,473 samples from the Greater Victoria Drinking Water System and analyzed those samples for 36,991 individual tests. Approximately 300 different types of tests were conducted on these samples.

Aquatic Ecology Monitoring Program. 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 regulated 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 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 water mains of the transmission system ([Map 1](#)), the sampling locations in the municipal distribution systems and in 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 2004 *Guidelines for Canadian Drinking Water Quality*.

Water Quality Complaint Monitoring Program. 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.

4.2.1. SOURCE WATER BODIES

In 2004, Sooke Reservoir was sampled weekly throughout the year. This was similar to 2003 and a change from previous years when weekly sampling occurred only in the spring, summer and fall. The change was set in place to coincide with the inundation of new soils around Sooke 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 2004, 646 samples were collected from the source tributaries and reservoirs.

4.2.2. RAW WATER ENTERING PLANT

In 2004, the raw source water entering both the Japan Gulch Treatment Plant and the Charters Treatment Plant was 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, 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](#)), 12 non-metallic inorganic chemicals, 35 metallic inorganic chemicals, 5 bacteriological parameters, 3 parasites (**Note:** samples for *Toxoplasma* 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](#).

4.2.3. UV TREATED WATER

At the Japan Gulch Treatment Plant, starting in March 2004 and continuing through December, 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).

4.2.4. TREATED WATER AT FIRST CUSTOMER

At the first customer sampling location below each of the two treatment plants, 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 2004, the total number of samples analyzed at the two first customer sampling locations was 256.

4.2.5. TRANSMISSION SYSTEM

Twenty-two permanent sampling locations have been established on the large diameter transmission mains; 15 of these locations were sampled in 2004. Monitoring is comprised primarily of chlorine residual testing and bacterial indicator analyses (total and fecal coliforms and heterotrophic bacteria). In 2004, 484 samples were collected from the sampling points on the transmission mains.

4.2.6. DISTRIBUTION SYSTEM

In the various municipal distribution systems, the Water Quality Division has established approximately 120 permanent sampling locations. At these sampling locations and in a similar fashion to the transmission system, water quality monitoring was comprised primarily of chlorine residual testing and bacterial indicator analyses. In 2004, 2,015 samples were collected from 86 sampling locations. At select locations within the distribution system, disinfection by-products were sampled.

4.2.7. DISTRIBUTION SYSTEM RESERVOIRS

Twenty-four of the 27 reservoirs located in the distribution system were sampled by the Water Quality Division with 44 of the 45 permanent sampling station locations being sampled in 2004. Again, the monitoring program focused on chlorine residuals and indicator bacteria testing. In 2004, 911 samples were collected from these reservoirs.

5. Water Quality Results

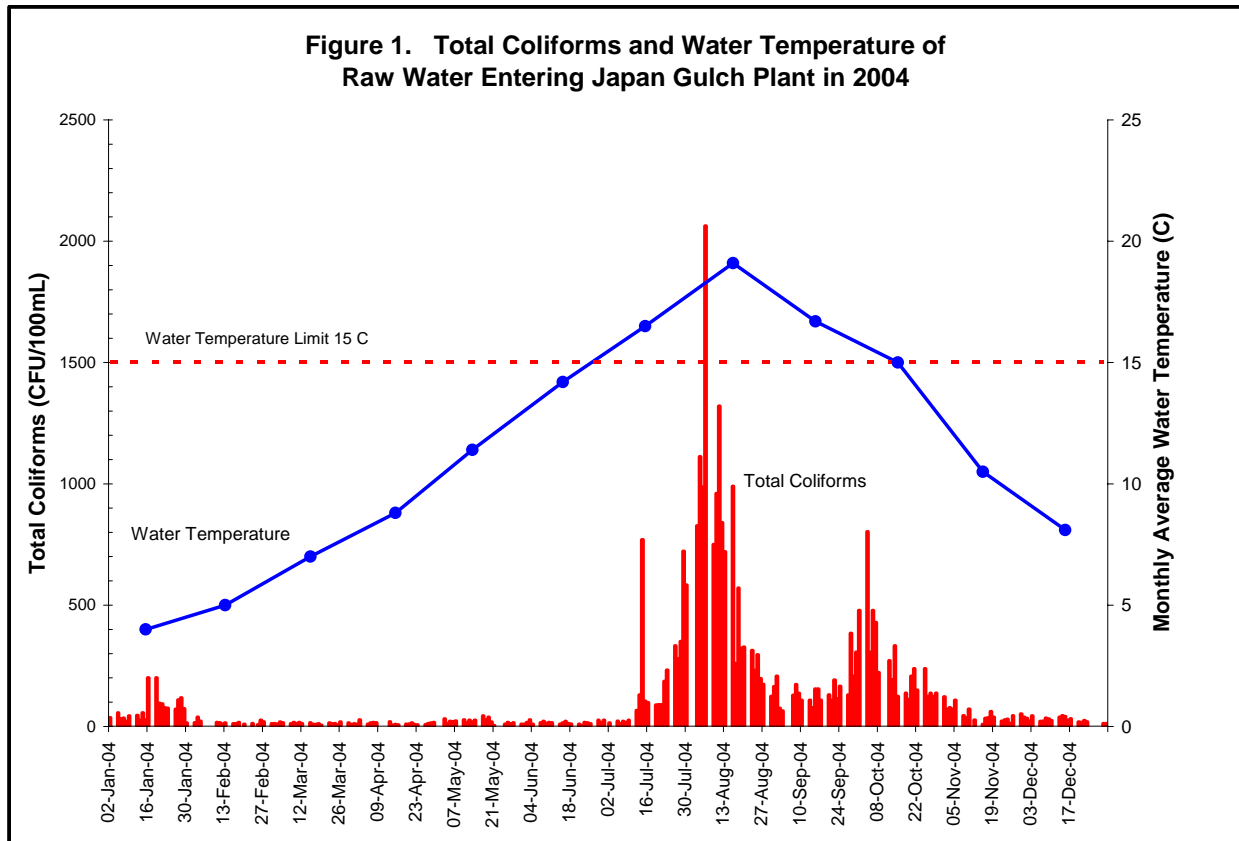
The overview results of the 2004 water quality monitoring program for the Greater Victoria Drinking Water System are provided below. [Table 1](#) lists the water quality data collected from the raw water entering the Japan Gulch Treatment Plant while [Table 2](#) lists the data for the treated water 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.

5.1. 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 2004 CANADIAN GUIDELINES. A more detailed annual summary showing the results of the bacteriological samples collected from within the individual municipal distribution systems is provided in a separate report called the *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.

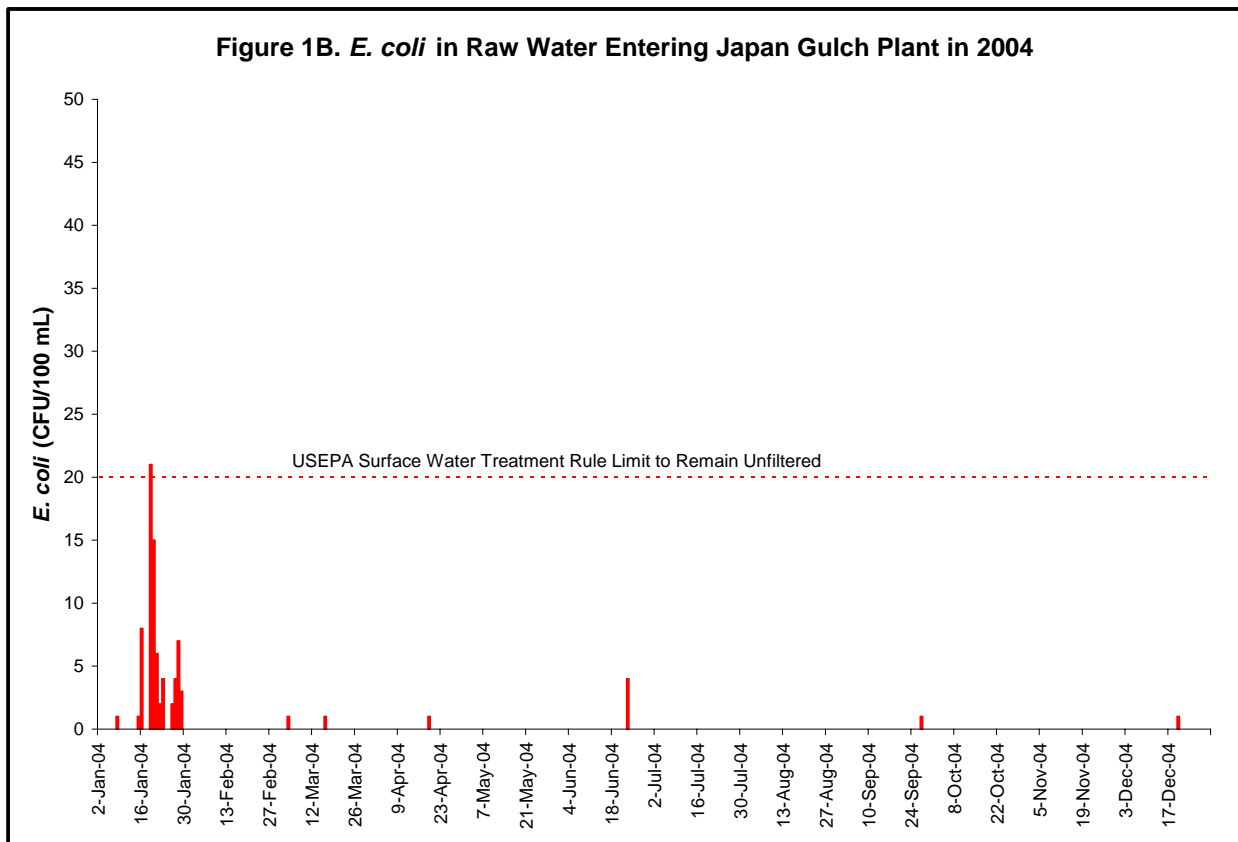
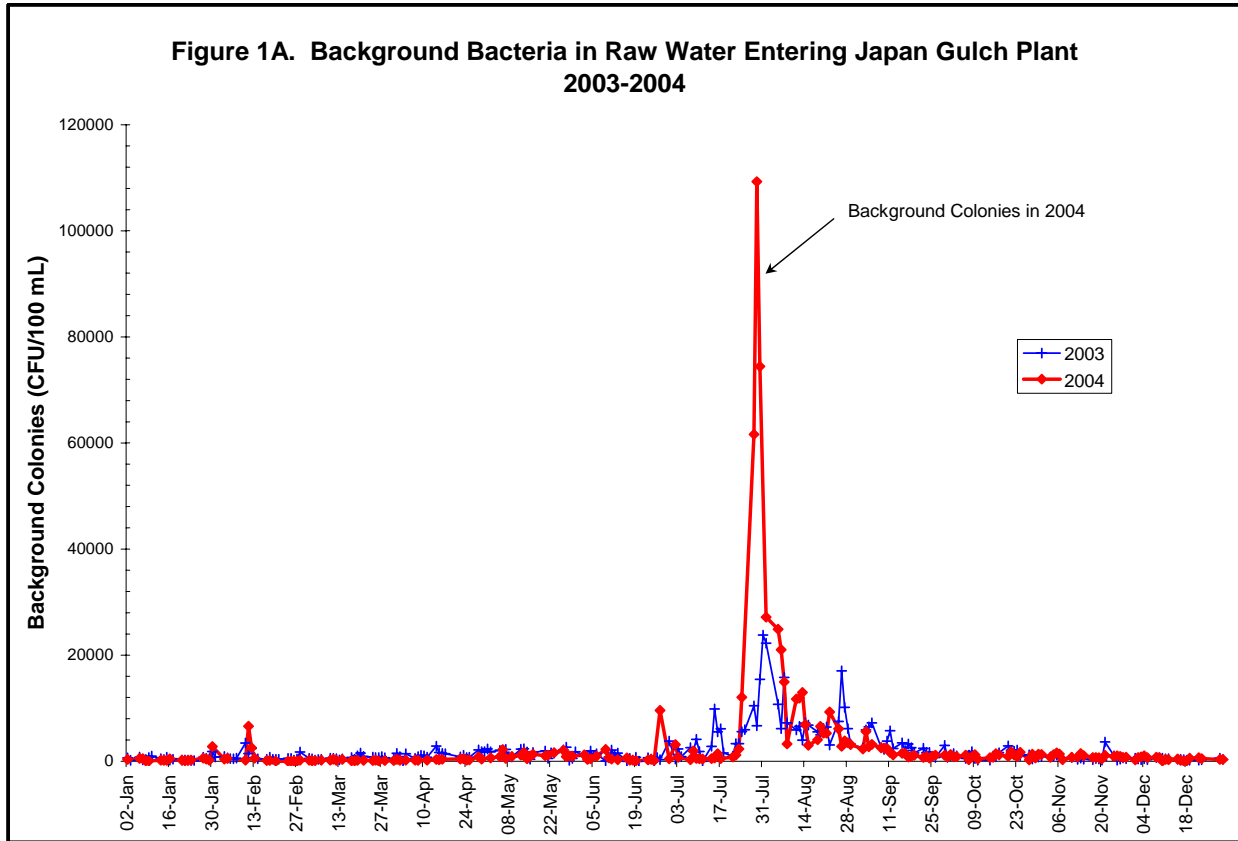
5.1.1. RAW WATER ENTERING PLANT

Total Coliform Bacteria. As in the previous four years, relatively high (above 100) concentrations of total coliform bacteria were found in the raw source (untreated) water entering the Japan Gulch Treatment Plant during the summer of 2004. Increased colony forming units per 100 millilitres (CFU/100 mL) of total coliforms occurred in late June (**Figure 1**), remained at high levels and then declined by the end of August. The types of coliforms present were not indicative of any particular type of contamination.



Background Bacteria. Elevated background bacteria concentrations were observed in the raw water entering the Japan Gulch Plant during the late summer of 2004 (**Figure 1A**). The background bacteria peaked in late August and then gradually returned to baseline levels. This pattern was similar to previous years but differed substantially in quantity. In 2004, the background bacteria rose to over 100,000 CFU/100 mL and was comprised primarily of bacteria called *Aeromonas hydrophila*. Previously, the level of background bacteria had never exceeded approximately 30,000 CFU/100 mL. Overwhelming circumstantial evidence tied this sudden increase in bacterial concentrations to the transplanting of several thousand fish from Deception Creek and Deception Reservoir into Sooke Reservoir that occurred under the direction of Provincial and Federal fisheries officers. Nevertheless, because the treatment process was able to inactivate these bacteria when they reached the treatment plant, the elevated background bacterial counts had no particular health significance.

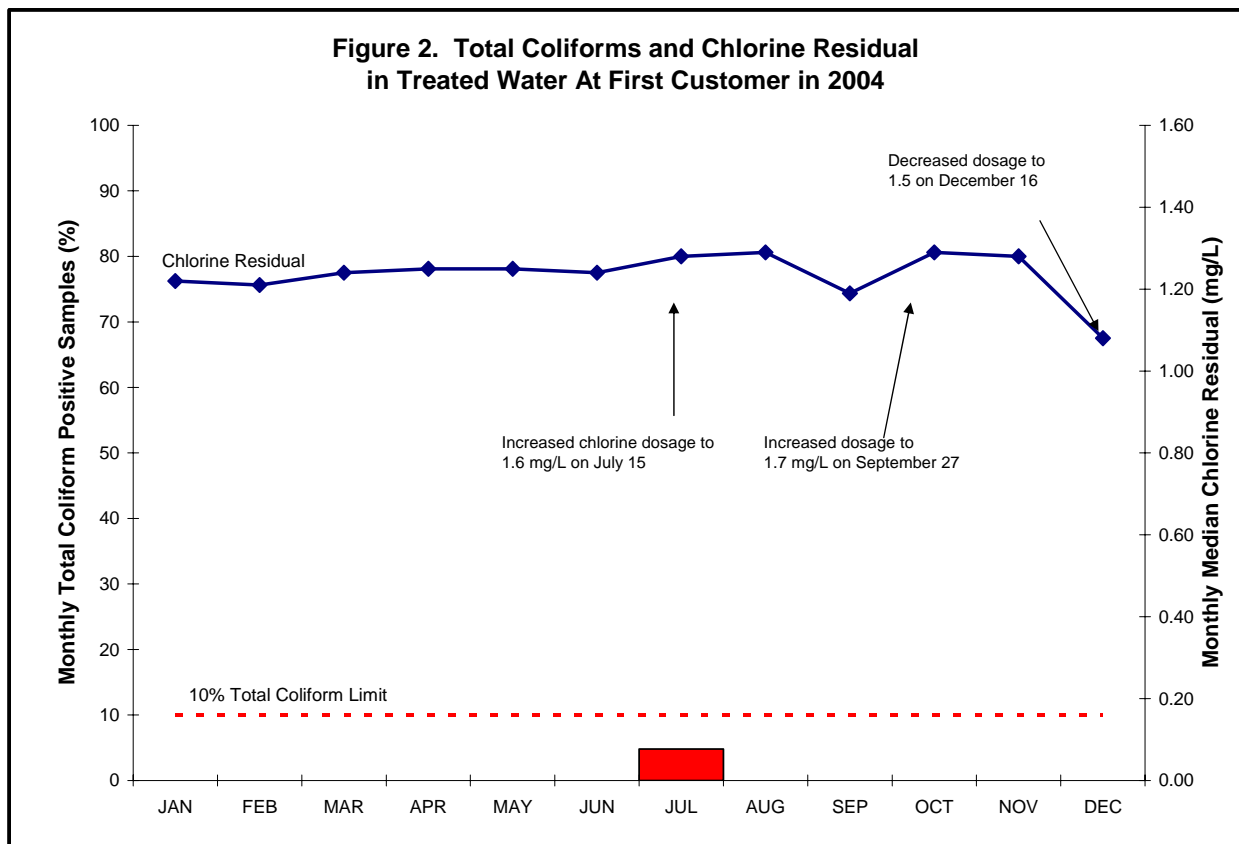
Fecal Coliform (*E. coli*) Bacteria. During more than a decade of monitoring bacteria within the Greater Victoria Drinking Water System, it has been found that virtually 100% of the fecal coliform bacteria in the source water and the distribution system are *E. coli*. In 2004, the low detection of fecal 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**).



5.1.2. 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 2004, the percentage of total coliforms detected never exceeded the 10% Canadian Guideline limit (**Figure 2**). This was an improvement from previous years and is a reflection of the improved primary disinfection process implemented in October 2001 and the addition of UV disinfection in January 2004. During 2004, there was only one minor occurrence of positive total coliforms at the first customer sampling location. No fecal coliform bacteria were detected at this location during this time period.

The first customer sampling location below the Charters Treatment Plant was found to contain one total and fecal coliform bacteria occurrence in October 2004 ([Table 3](#)).

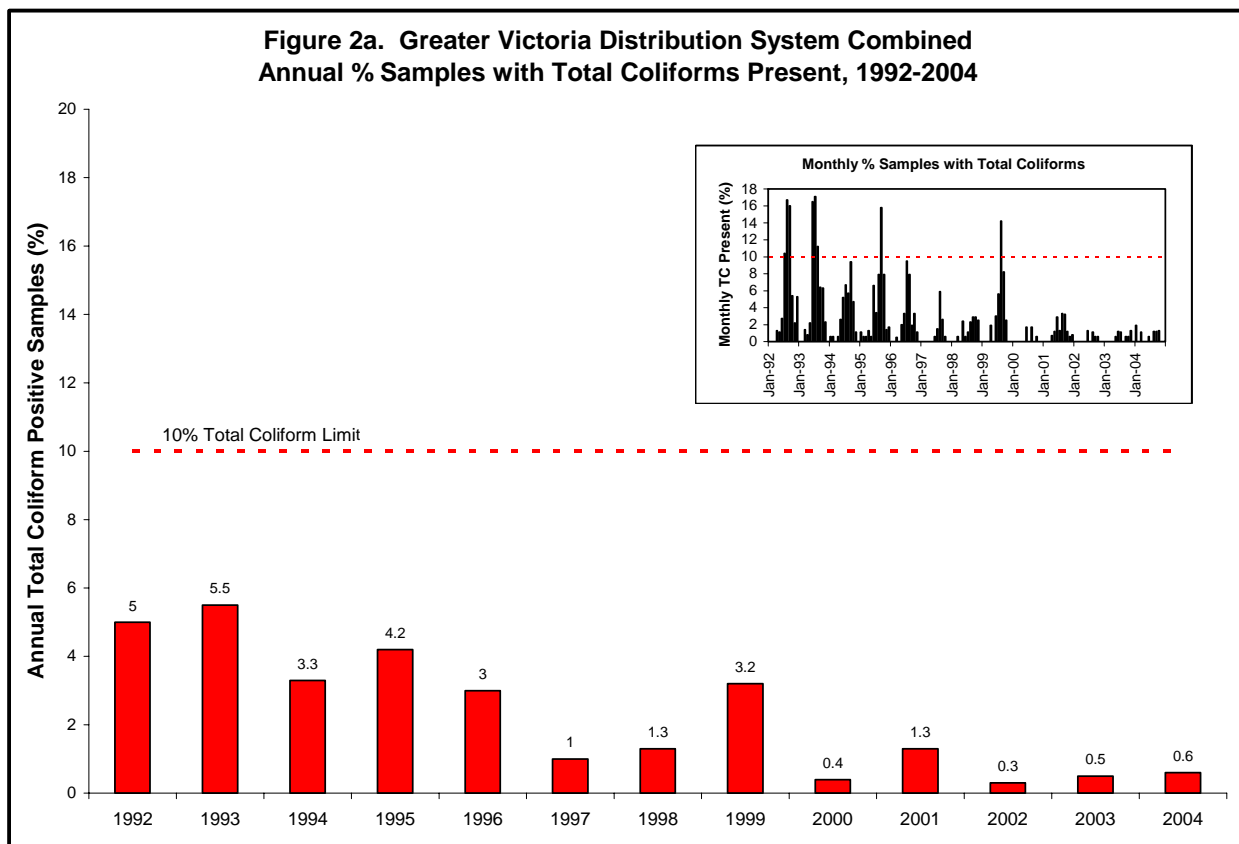


Chlorine Residual. The monthly average chlorine residual levels at the first customer sampling location below the Japan Gulch Plant is provided in **Figure 2**. From this figure, it can be seen that the monthly average chlorine residuals at the first customer sampling location remained fairly constant throughout the majority of the year. The annual median chlorine residual (based on daily readings) at this location was 1.25 mg/L ([Table 2](#)).

5.1.3. 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 2004, total coliform bacteria were detected during six months of the year (January, March, June, August, September, and October). However, the percentage of positive total coliform samples did not exceed the 10% total coliform limit during any month in 2004 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 (0.6% in 2004) was among the lowest in the past decade and continued the trend of declining total coliform positive samples in the Greater Victoria distribution system (**Figure 2A**).



Over this 13 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** Annual reservoir cleaning (Water Services Dept. & member municipalities)
- **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

- 1996 (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 Rechloramination Station.
- 2004 Use of UV disinfection to provide improved bacteriological disinfection

However, the occurrence of coliform positive samples at the extremities of the water system is a continuing concern. Typically, these locations have very low chlorine residuals and the bacteria are able to grow or regrow. This is the reason for the additional chlorine being added to the North Saanich distribution system and the extremities of the system in Metchosin. In the Western Communities, a new rechloramination station was commissioned in the fall of 2002. This station now provides increased chlorine residuals at Rocky Point Reservoir and protects against bacterial contamination in that localized pressure zone of the distribution system.

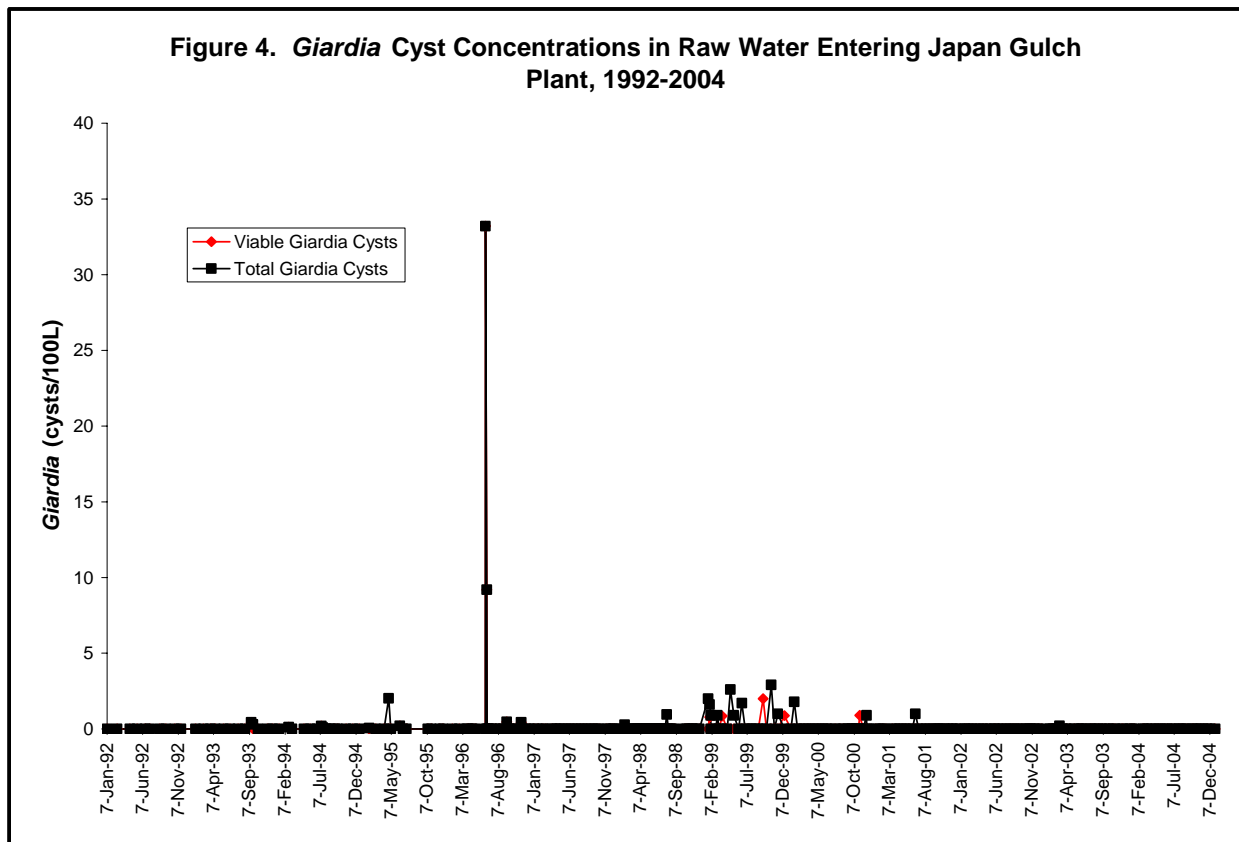
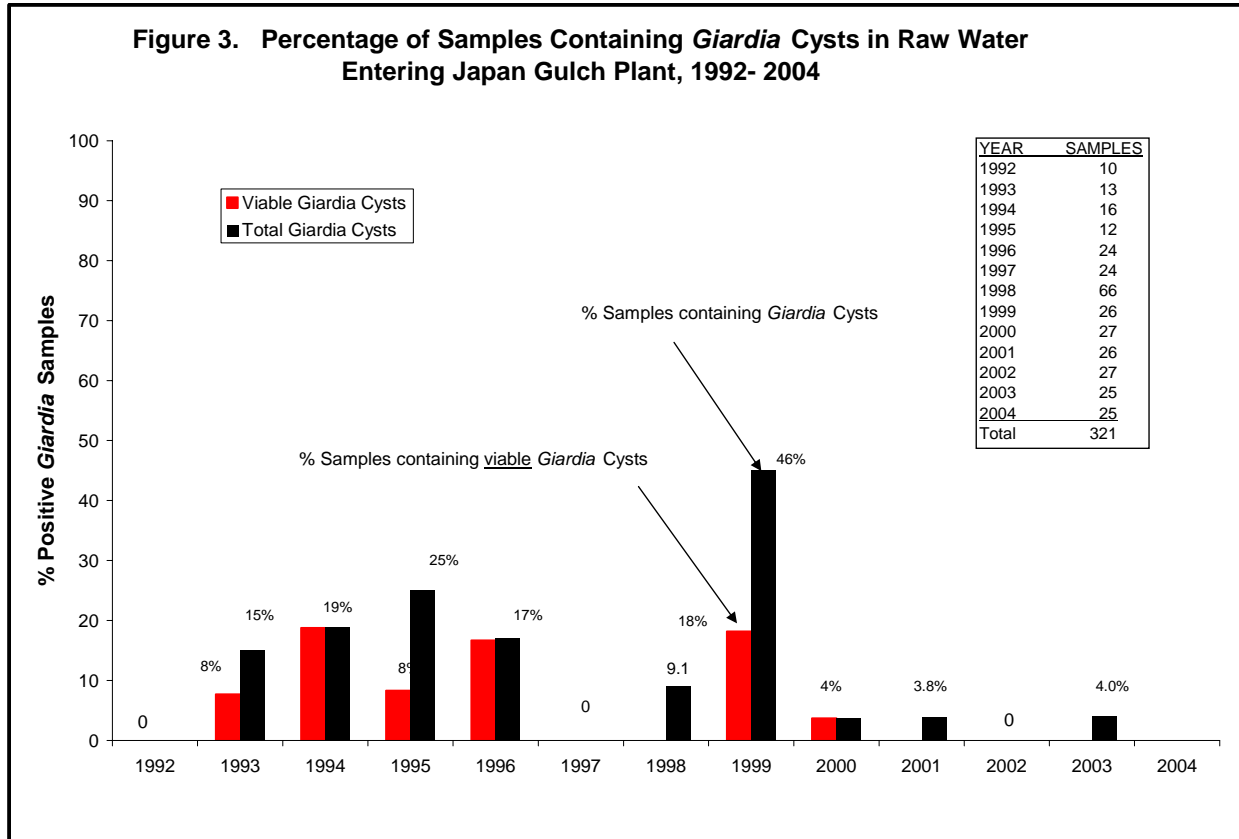
Chlorine Residual. The annual median chlorine residual for samples collected from the various sampling locations within the Greater Victoria Distribution System was 0.68 mg/L. This value is similar to the level observed in previous years. The level of chlorine residual in the distribution system ranged between 0.0 and 1.34 mg/L. The highest value observed (1.48 mg/L at the first customer location) was well below the 3.0 mg/L limit in the Canadian Guidelines for chloramines.

5.2. PARASITES

As in previous years, parasite samples were collected every two weeks throughout the year and sent to Hyperion Research Laboratories, a contract laboratory in Alberta as part of the Division's routine compliance monitoring program. In 2004, 25 samples were collected for parasite analysis from the raw water entering the Japan Gulch Treatment Plant.

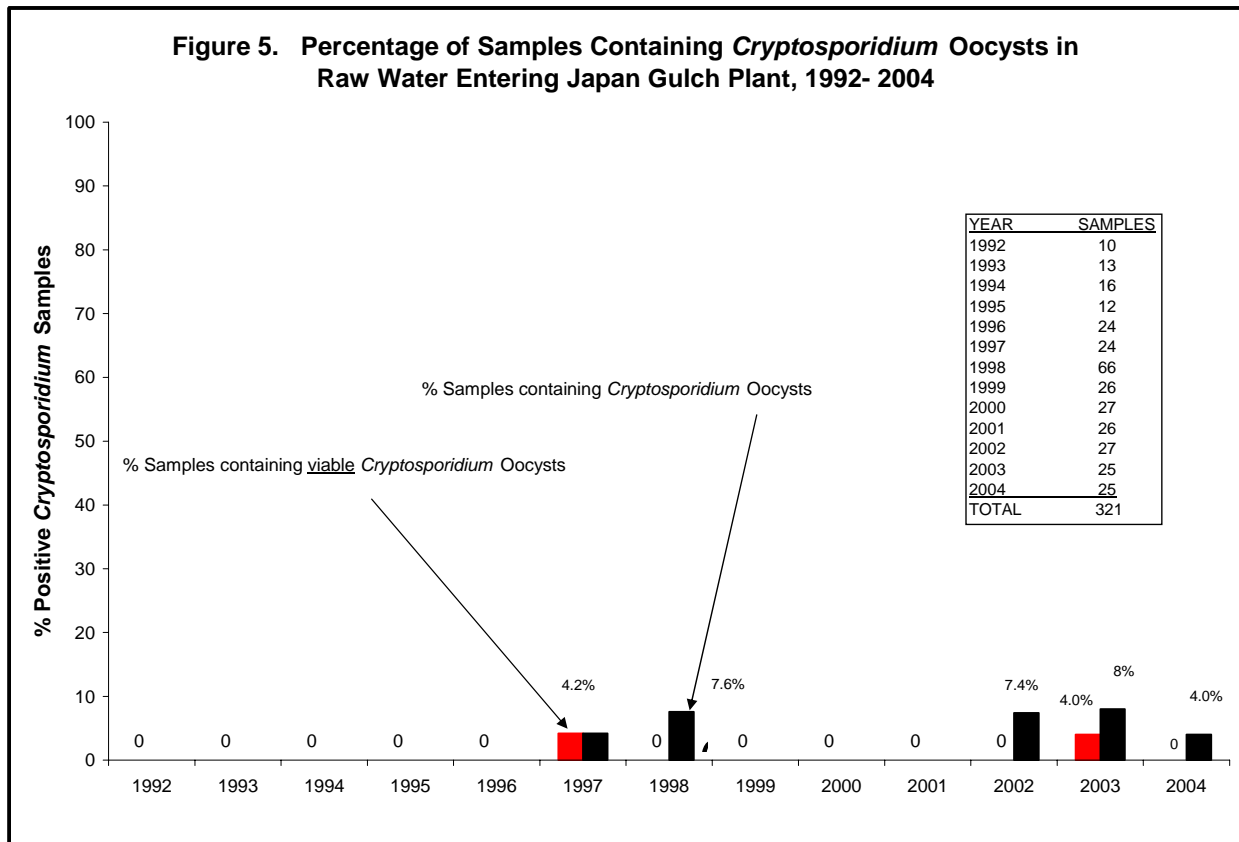
Figures 3-7 show the results of the data collected by Water Quality Division staff as part of this monitoring program. Data from special samples collected for method development studies were not included here. It should be noted that the efficiency of the analysis for detecting *Giardia* and especially *Cryptosporidium* is quite low (typically in the 15-25% range).

Giardia. In 2004, no *Giardia* cysts were detected in samples collected from the raw water entering the Japan Gulch Treatment Plant (**Figures 3 and 4**). During the four year period from 2001 to 2004, no viable (living) *Giardia* cysts were detected in Greater Victoria's source water.

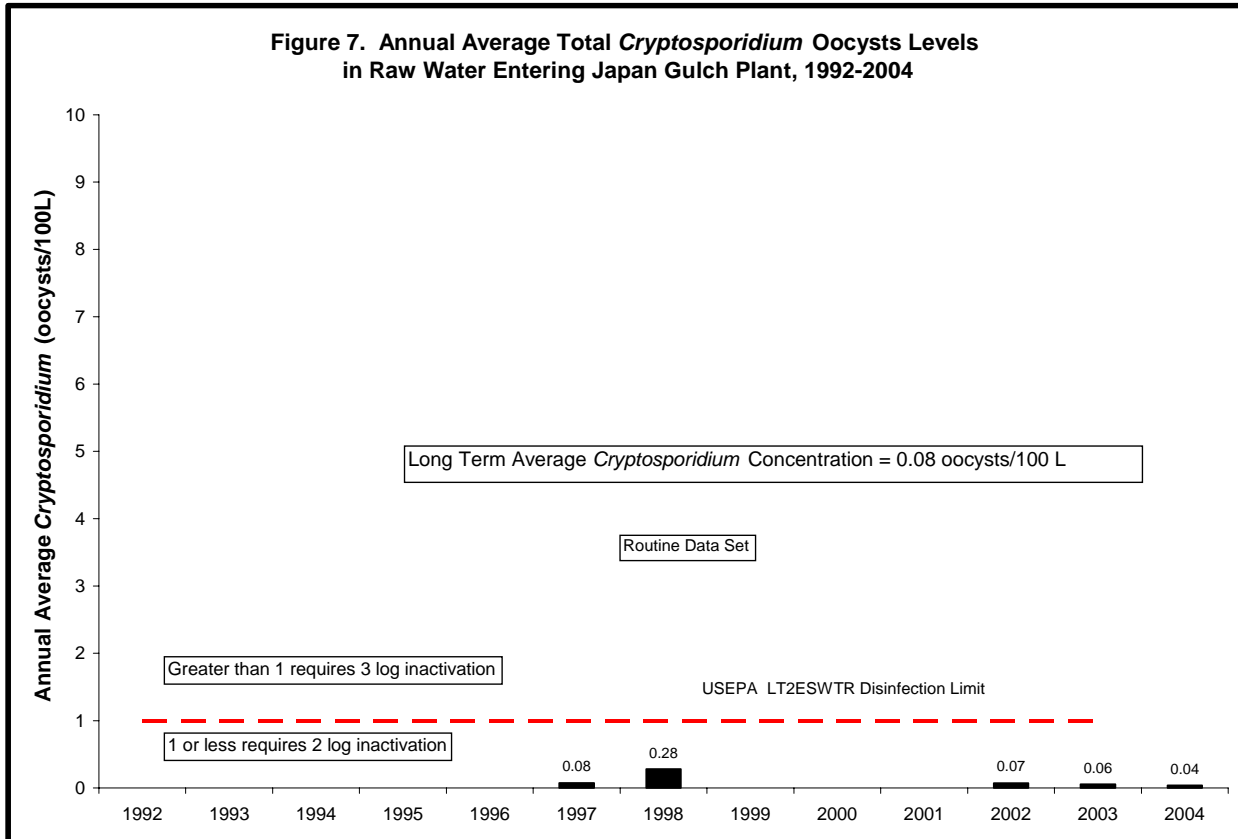
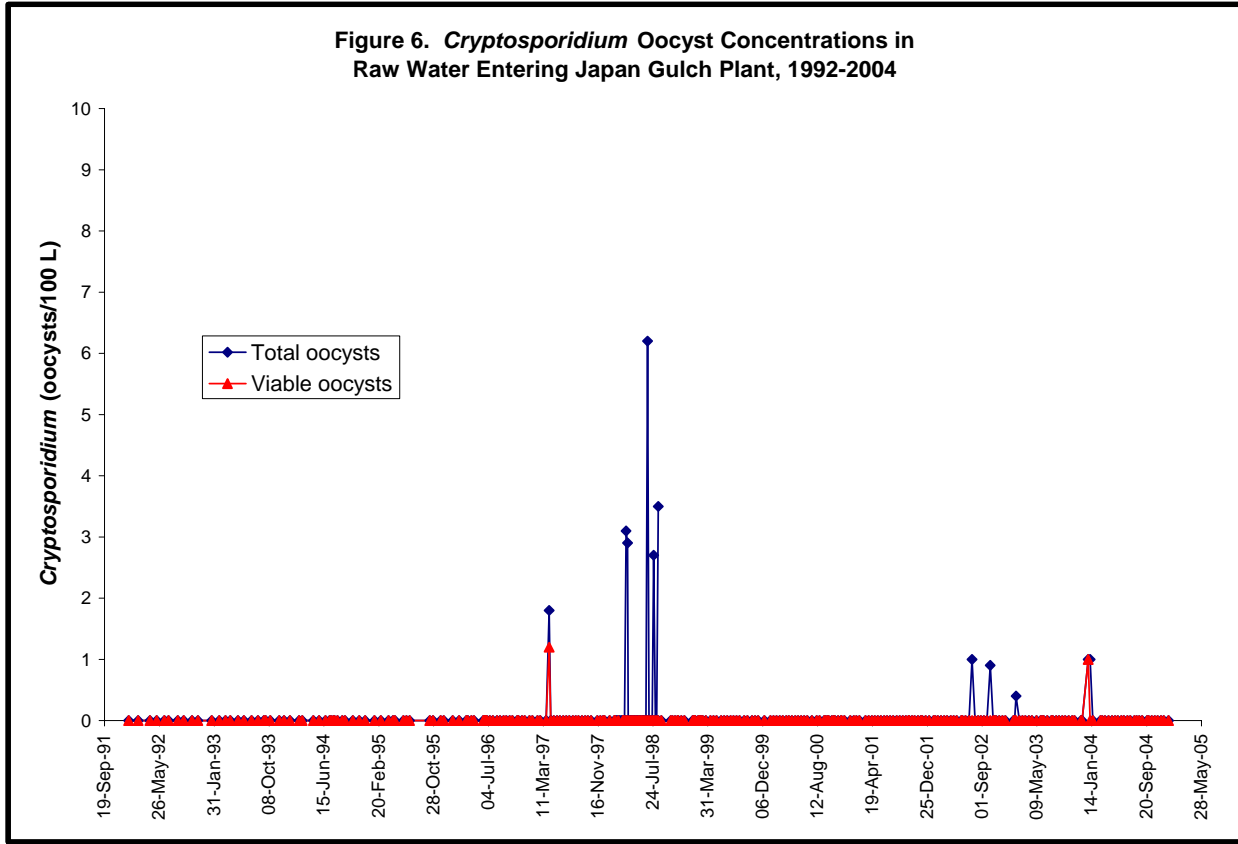


Cryptosporidium. In 2004, one of the 25 samples (4%) collected from the raw water entering the Japan Gulch Treatment Plant was positive for total *Cryptosporidium* oocysts (**Figure 5**). However, the oocyst was deemed to be non-viable by the analyzing laboratory and therefore incapable of causing disease. In 2004, the maximum number of oocysts found in any one sample was only 1 per 100 L (**Figure 6**) and the annual average number of *Cryptosporidium* oocysts in samples was 0.04 per 100 L (**Figure 7**).

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 2004 since the *Cryptosporidium* oocyst found in the raw source water was non-viable.



In the 13 year period of time that the Water Quality Division has been monitoring *Cryptosporidium*, 321 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 13 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 good 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.

5.3. ALGAE

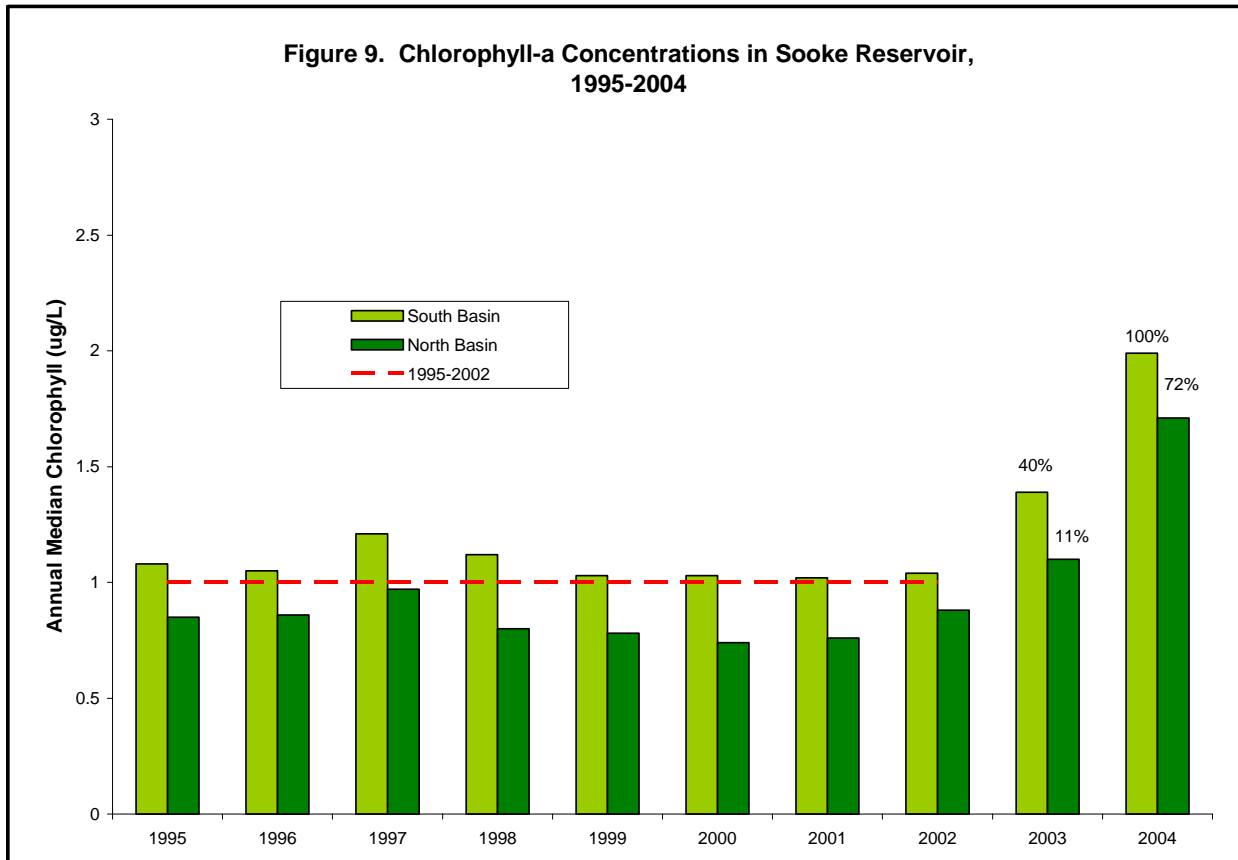
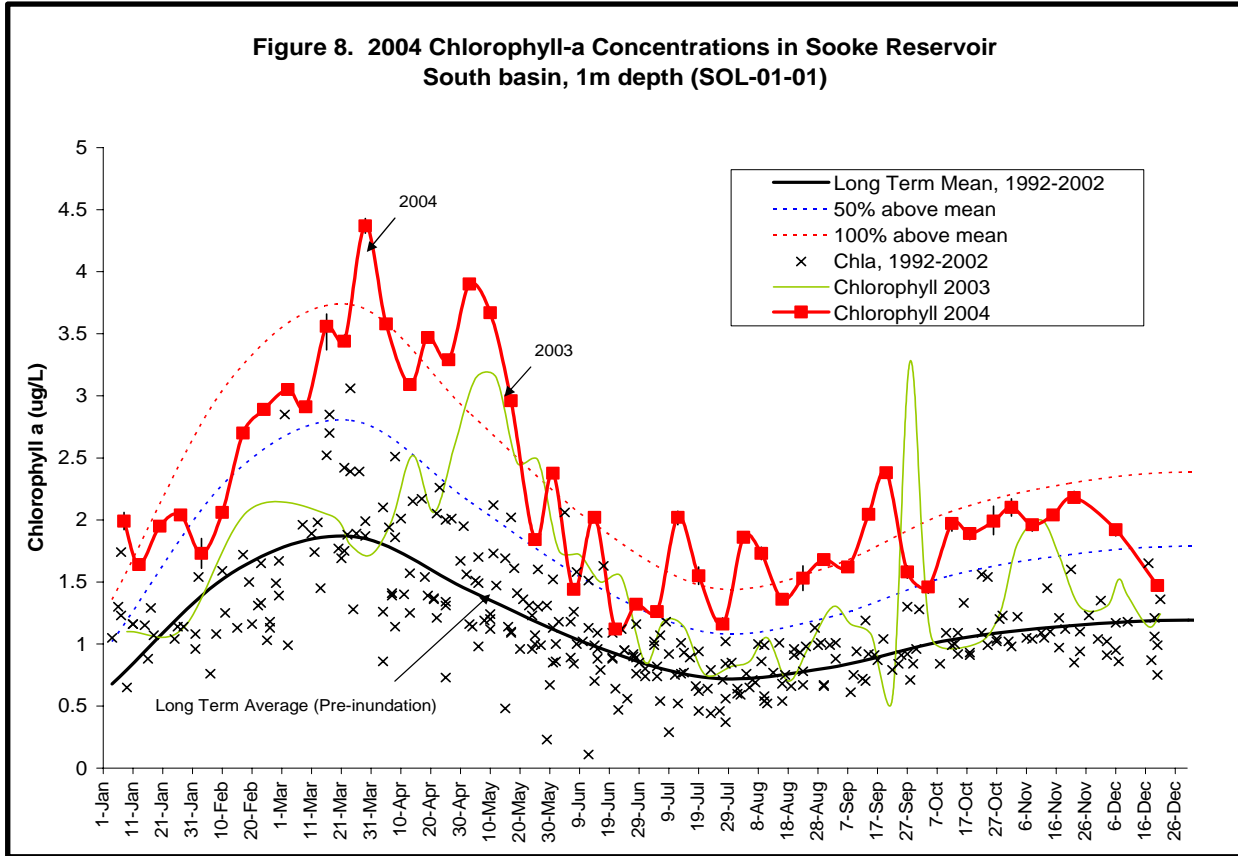
The source reservoirs in the Greater Victoria Water Supply Area (**Map 1**) contain a variety of biological communities including bacteria, periphyton (algae attached to submerged surfaces), phytoplankton (algae floating within the water column), zooplankton (tiny animals also floating within the water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

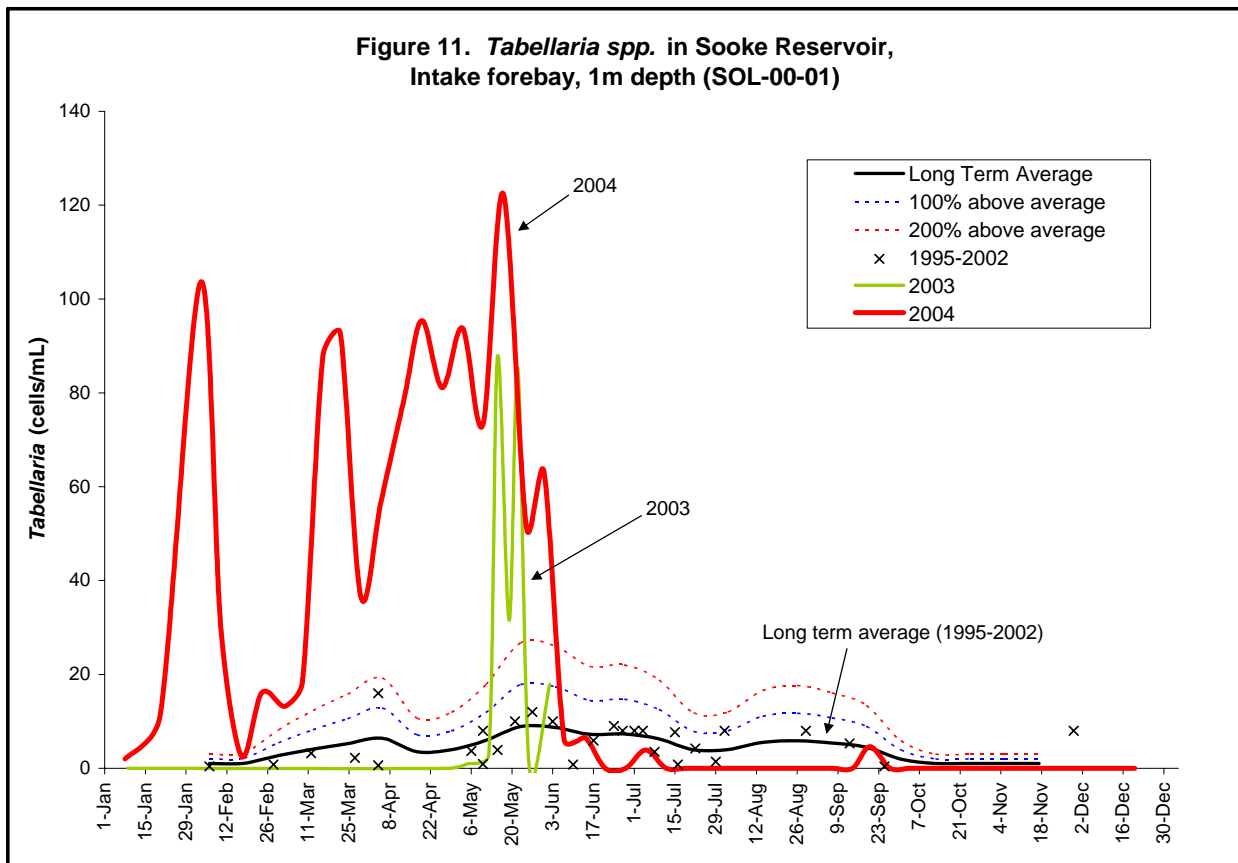
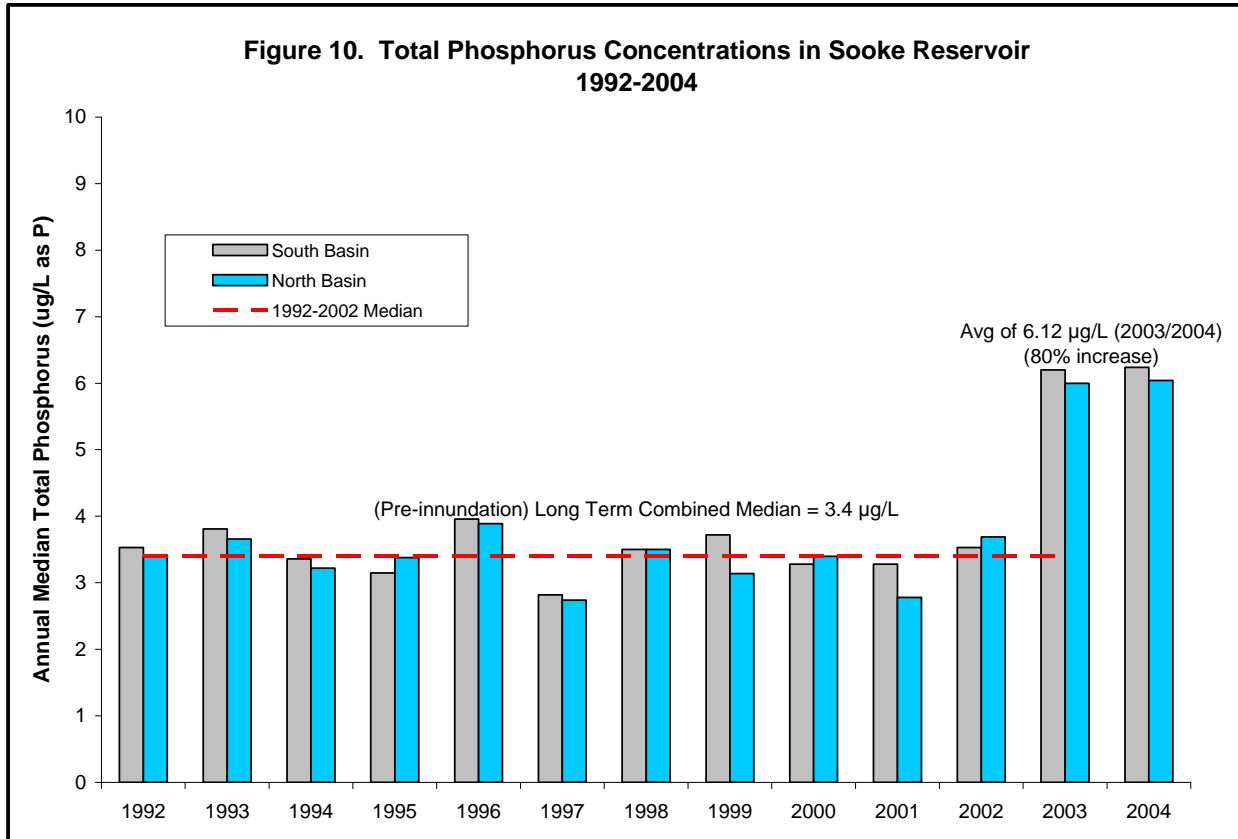
Chlorophyll-a. The overall level of algal activity in Sooke Reservoir can be measured using chlorophyll-a which is a component of all algal cells and the typical seasonal pattern of spring growth and summer die-off of the phytoplankton shows quite clearly in these chlorophyll measurements. In 2004, the spring levels of chlorophyll-a were higher than in 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 and particularly in 2004, 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 and 2004 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 80% 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 2004, the primary contributor to the higher levels of chlorophyll-a was a spring bloom of the diatom, *Tabellaria* (**Figure 11**). This alga has been seen within Sooke Reservoir but not to this degree. This bloom started relatively early in the year and continued until June with the concentrations being well above those of 2003. Other algal species that were problematic in 2003 were of little consequence in 2004.





5.4. 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. The Canadian Guideline limits for the substances of concern are listed in the **Tables 1, 2 and 3**. [Table 1](#) provides the water quality data collected from the raw water entering the Japan Gulch Treatment Plant. [Table 2](#) provides data for the treated water at the first customer sampling location below the treatment process at the Japan Gulch Plant. [Table 3](#) provides data for the treated water below the Charter's Treatment Plant. The description below provides an overview of the physical, chemical, and radiological aspects of the water quality.

5.4.1. PHYSICAL

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 2004, 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, while carbon, solids and hardness were analysed monthly.

The raw water entering the Japan Gulch Treatment Plant is very soft (median value for hardness of 17.2 mg/L) ([Table 1](#)), has a neutral pH (median of 7.17 and ranging from 6.85 to 7.55), moderate colour (median of 8.4 true colour units and ranging from 5 to 10) and low turbidity or cloudiness (median of 0.42 nephelometric turbidity units and ranging from 0.22 to 1.60). It is also low in acid buffering capacity having an alkalinity of 14.8 mg/L, has low ionic strength (conductivity of 42.0 μ S/cm), relatively low solids (total dissolved solids of 24.8 mg/L, total suspended solids of 0.4 mg/L and total solids of 26 mg/L), and moderate level of total and dissolved organic carbon (2.6 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 2004, 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 11.1°C and ranged from 3.0 to 20.9°C ([Table 1](#)). In the summer, the water temperature was above the 15°C limit for a period of 4 months lasting from late June to mid-October (**Figure 1**). In the summer months, the water in the Greater Victoria

Drinking Water System is very warm compared to many large 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.

5.4.2. NON-METALLIC INORGANICS

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 7.5 µg/L in the raw water entering the Japan Gulch Plant ([Table 1](#)) to 266 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. However, a tiny amount of fluoride (9.4 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.

5.4.3. 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 0.83 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 0.0005 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, 1.76 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.

5.4.4. 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 2004, the median values for gross alpha and gross beta radiation were less than 0.02 and 0.03 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.

5.4.5. 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 a well protected watershed and water supply area in which no public access, agriculture, mining or commercial logging is permitted. The use of herbicides, pesticides and fertilizers is prohibited within the Water Supply Area. This data set provides an excellent baseline for pristine surface waters in this area of the Province.

5.5. 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 2004, DBP samples were collected 8 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 additional 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 future report as only the results at the first customer sampling locations are given in the tables (**Tables 2** and **3**).

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 2004 was 1.39 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 2004, the average level of total trihalomethanes (TTHMs) at the first customer sampling location below the Japan Gulch Treatment Plant was 13.1 µg/L (median of 12.8) which is well below the Canadian Guideline limit of 100 µg/L (**Table 2**). (**Note:** The Canadian Guidelines require this parameter to be collected 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 2004, THMs were sampled 8 times (monthly from January through May and then in July, October and December)

In the rechlorinated parts of the system on the Saanich Peninsula substantially higher levels of TTHMs were found ranging between 32 and 58 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.

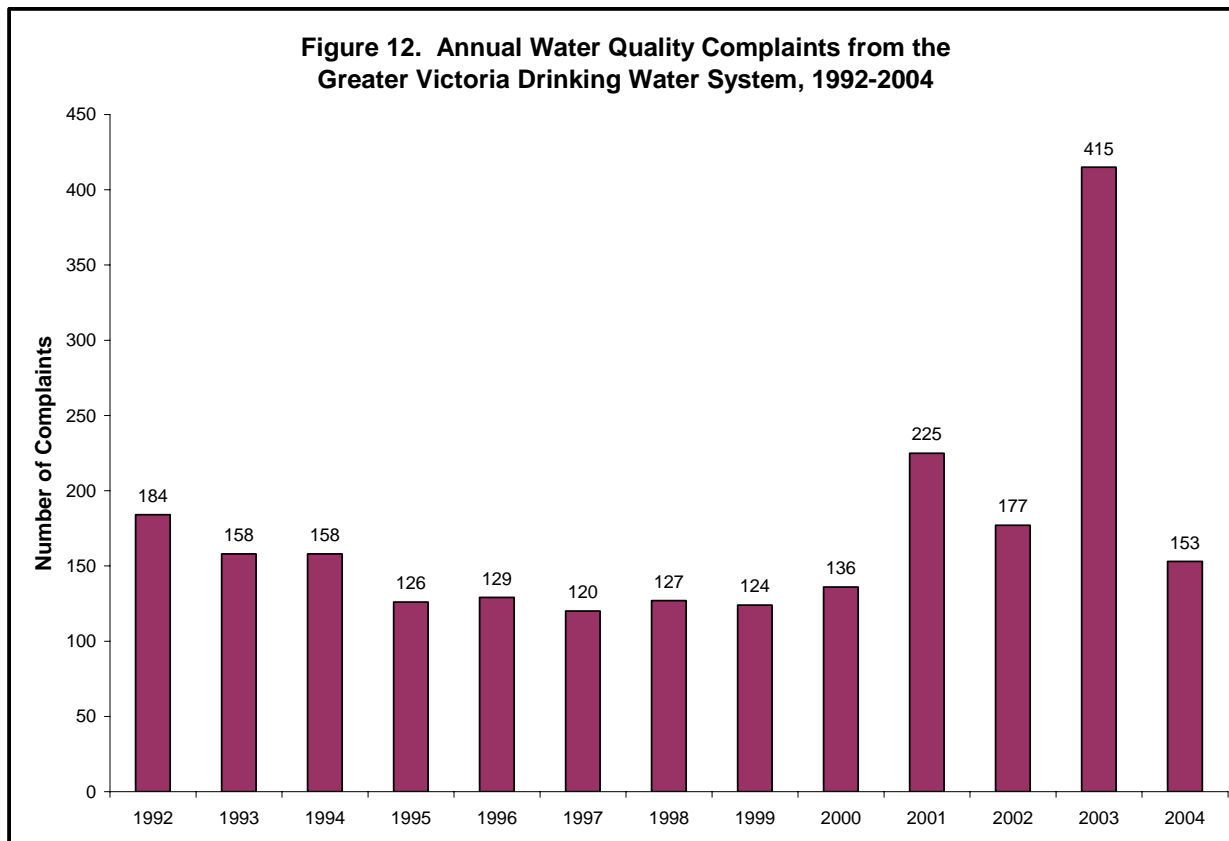
Haloacetic Acids. Haloacetic acids (HAAs) are a second group of disinfection by-products that are produced when chlorine is used as a disinfecting chemical. The haloacetic acids are comprised of mono-, di-, and trichloroacetic acids plus mono- and dibromoacetic acids. The regulatory agencies use a group of 5 haloacetic acids (referred to as HAA5) for regulatory purposes. At present, Canada has no guideline limit for this group of disinfection by-products. 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. The limit will return to 60 µg/L and then potentially fall to 30 µg/L some time in the future.

In 2004, HAAs were collected monthly from January through May and then in July, October and December. In 2004, the average level of HAA5 at the first customer sampling location was 12.3 µg/L (median of 13.3 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 (44-69 µg/L, average of 54 µg/L). Five of the twenty-four samples would have exceeded the USEPA limit of 60 µg/L had it still been in force.

The Water Quality Division has been monitoring HAAs for about 7 years as part of the USEPA Information Collection Rule (used to collect data to determine if contaminants need to be regulated). In the other areas of the distribution system, HAA5 were well below the USEPA limit.

5.6. WATER QUALITY COMPLAINTS

Records of customer complaints about drinking water quality have been maintained since 1992. During this period, the number of these complaints ranged from a low of approximately 120 in 1997 to a high of about 415 in 2003 (**Figure 12**). The peak in 2003 was associated with a short duration algal bloom in September of 2003. In 2004, the number of water quality complaints was similar to that received in earlier years.



The detail of the types of water quality complaints received each month during 2004 is provided in the Table below. In 2004, the majority of water quality complaints was due to the presence of visible particulates in the water.

Month	Total Number of Complaints ¹	Taste and/or Odour	Chlorine ²	Colour	Particulates	Safety Concerns	Filter Clogging	Customer's Plumbing	Other
January	9	1	1	1	2	1	0	3	1
February	10	1	1	2	0	2	1	0	3
March	12	2	1	1	0	2	0	4	4
April	9	2	0	1	2	3	0	2	1
May	11	3	0	1	1	1	5	0	1
June	21	4	1	2	6	2	8	1	2
July	14	6	2	0	6	0	1	1	0
August	17	1	1	4	3	0	3	2	4
September	16	1	0	1	9	1	1	0	4
October	17	4	2	2	3	4	2	0	0
November	9	1	1	0	3	0	1	0	3
December	8	1	0	4	2	1	0	0	2
Total	153	27	10	19	37	17	22	13	25

¹Totals don't always reflect the numbers to the right, as some complaints fall into more than one category.

²Chlorine taste and odour are separated out from other taste and odour complaints.

In addition to complaints, the Water Quality Division received a number of general queries from people who were concerned about the safety of their drinking water or wanting to know more about the composition of their drinking water. Most customers are content to know that the Water Quality Division is actively sampling both the source water and the potable water being delivered to their homes and that they can see the data either in a report mailed to them or posted on the CRD web site http://www.crd.bc.ca/water/water_quality/water_quality_reports.htm.

6. Conclusions and Recommendations

6.1. CONCLUSIONS

1. The data collected in 2004 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 2004 *Guidelines for Canadian Drinking Water Quality* and the 2003 *BC Drinking Water Protection Regulation*. These exceptions were water temperature in the summer, the few incidences of total coliform detection and one *Cryptosporidium* positive sample. Over the past 11 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 2004 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 2004 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. The use of free chlorine at the Japan Gulch Treatment Plant (first initiated in October 2001) has slightly increased the levels of trihalomethanes and the haloacetic acids beyond that observed in previous years.
5. In 2004 as in 2003, 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. A bloom of the diatom, *Tabellaria* occurred in the spring.
6. The number of water quality complaints received in 2004 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.

6.2. RECOMMENDATIONS

1. In conjunction with the Saanich Peninsula Water Commission and the CRD Environmental Services Department, alter the rechlorination process at the Deep Cove Pump house on the Saanich Peninsula to reduce the levels of disinfection by-products in the portion of the North Saanich distribution system that is currently rechlorinated. Note: Funding has been provided in the 2005 Capital Budget to undertake this work.
2. Continue to take appropriate steps in 2005 to mitigate the potential water quality impact of raising the water level in Sooke Reservoir to avoid a repetition of the water quality complaints received in 2003.