# 2005 Annual Bacteriological Summary of Greater Victoria's Drinking Water

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# *Executive Summary*

The *2005 Annual Bacteriological Summary of Greater Victoria's Drinking Water* is the second report in the Water Quality Division's 2005 annual report series. It extends the bacteriological information given in the *2005 Annual Overview of Greater Victoria's Drinking Water Quality* and details the bacteriological results for the source water, first customer, transmission system, distribution system reservoirs and the distribution systems of individual water suppliers who are part of the Greater Victoria Drinking Water System. When completed, these annual reports are posted on the CRD website at http://www.crd.bc.ca/water/waterquality/annualreports.htm

The primary observations and conclusions contained in this report are listed below:

1. **Overall Summary**. In general, the overall bacteriological quality of the drinking water in Greater Victoria in 2005 continued to be very good and easily met the Provincial and Federal limits for safe, potable drinking water.

2. **Sample Collection**. In 2005, the Water Quality Division collected and analysed 4,372 bacteriological samples from 150 sampling locations in the Greater Victoria Drinking Water System. This included samples collected from the raw source (untreated water), first customer, transmission mains, distribution system reservoirs and distribution systems. A similar number of samples were collected in 2003 and 2004.

3. **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 late summer and peaked on September 22nd (**Figure 1**). The 2005 bacterial levels were similar to those observed in 2004. 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 reached once during 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.

4. **First Customer**. In 2005, no total coliform bacteria were observed at the first customer sampling location below the Japan Gulch Treatment Plant (**Figure 3**). The annual total coliform positive sample rate of 0.0% was less than 2003 and 2004 and one of the lowest ever observed (**Figure 4**). This improved disinfection of the raw source water was primarily due to the use of the combination of ultraviolet light and free chlorine as primary disinfectants. No fecal coliform bacteria were found in any of the samples collected at this sampling location. These charts provide further assurance of the bacterial safety of Greater Victoria's drinking water.

5. **Transmission Mains**. Three of the samples collected from the transmission mains feeding the municipalities contained total coliforms (**Figure 5**). This was slightly worse than in 2004 but nevertheless, the annual total coliform positive sample rate of 0.6% was very low and similar to other years (**Figure 5a**). This low rate of coliform positives in the transmission mains showed that very few total coliform bacteria were being delivered to the municipal distribution systems.

6. **Distribution System Reservoirs**. Samples collected from the distribution system reservoirs showed that the bacteriological levels in these reservoirs continued to be problematic (**Figure 6**) and were primarily due to bacteriological regrowth associated with low chlorine residuals and poor water circulation through the reservoirs (**Figure 6A**). When the distribution system reservoirs are considered as a group, the total coliform Guideline level of 10% positive samples was exceeded in August of 2005 (12.1%). On an individual basis, five of the distribution system reservoirs had an annual percentage positive that exceeded the 10% limit (**Figure 6A**). The level

of total coliform occurrence in the reservoirs was slightly higher than in the past three years. However, while over the past decade, there has been a general improvement in the bacteriological quality of the water in the distribution system reservoirs (**Figure 6B**), a number of the reservoirs continued to exceed the limits.

7. **Greater Victoria Distribution System**. When the results of all the individual distribution systems are considered as a whole, the Greater Victoria Distribution System complied with both the Provincial Regulation and the Federal Guidelines for bacteriological water quality during all months of the year. Total coliforms were found during eight months in 2005 (**Figure 7**). While the total coliform positive rate of 1.4% was slightly higher than that of the previous three years, the trend of declining total coliform positive samples continued in the Greater Victoria Distribution System (**Figure 7a**).

8. **Individual Municipal Distribution Systems**. In 2005, only one of the municipal distribution systems (Central Saanich) slightly exceeded the monthly total coliform limit of 10% in one month. However, in general, the bacteriological water quality of all of the municipal distribution systems has improved over time (since 1992). This includes

    - Central Saanich (**Figure 8** and **Figure 8a)**
    - North Saanich (**Figure 9** and **Figure 9a**)
    - Oak Bay (**Figure 10** and **Figure 10a**)
    - Saanich (**Figure 11** and **Figure 11a**)
    - Sidney (**Figure 12** and **Figure 12a**)
    - Victoria/Esquimalt (**Figure 13** and **Figure 13a**)
    - Juan de Fuca Distribution System (**Figure 14** and **Figure 14a**).

9. **Chlorine Residual**. The median annual chlorine residual at the first customer sampling location below the Japan Gulch Plant was 1.22 mg/L (similar to 2004). Overall, within the distribution system, the median annual chlorine residual was 0.63 mg/L, slightly lower than that found in 2004 (0.65 mg/L) and similar to that found in 2003 (0.63). Within the municipal distribution systems, the median annual chlorine residual varied from a low of 0.36 mg/L for the Western Communities to a high of 0.80 mg/L for Oak Bay.

10. **Water Temperature**. At the Japan Gulch Plant, the coldest daily water temperature recorded was 2.7°C in January while the warmest was 17.9°C in August 2005 (three degrees cooler than in 2004). The Guideline limit of 15°C was exceeded from August 25, 2005 to September 29, 2005 which was better than in previous years. Compared to other Canadian cities, the summer temperature of the drinking water in Greater Victoria is quite warm. The lower water temperature in 2005 was primarily due to the raising of the water level in Sooke Reservoir.

**RECOMMENDATIONS**

1. **Improve Distribution Reservoir Circulation**. It is recommended that the program of improving the circulation of the water in the distribution reservoirs be expanded to include those reservoirs that exceeded the total coliform limits in 2005.

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# 1. Introduction

The *2005 Annual Bacteriological Summary of Greater Victoria's Drinking Water* is the second report in the Water Quality Division's 2005 annual water quality report series. It extends the bacteriological information provided in the *2005 Annual Overview of Greater Victoria's Drinking Water Quality* and details the bacteriological results for the source water, first customer, transmission system, distribution system reservoirs and the distribution systems of individual water suppliers who are part of the Greater Victoria Drinking Water System. All reports are posted on the Capital Regional District (CRD) website at http://www.crd.bc.ca/water/waterquality/annualreports.htm

# 2. Water System Description

In 2005, the Greater Victoria Drinking Water System (**Map 1**) provided drinking water to approximately 320,000 people. It is the second largest drinking water system in British Columbia and is comprised of two service areas:

1. The **Greater Victoria Drinking Water Service Area** supplied water to approximately 311,000 people in Victoria, Saanich, Oak Bay, Esquimalt, the Saanich Peninsula municipalities and the Western Communities via the Japan Gulch Treatment Plant.

2. The **Sooke District Drinking Water Service Area** supplied water to approximately 9,000 people in Sooke and East Sooke via the Charters Treatment Plant.

These two service areas are described below relative to their operation in 2005.

## 2.1. SOURCE WATER SYSTEM

Drinking water for the Greater Victoria Drinking Water System comes from a protected watershed called the Greater Victoria Water Supply Area (**Map 1**). This area, which is approximately 11,000 hectares in size and protected from public access and industrial activities, is located about 30 km northwest of the city.

**Greater Victoria Drinking Water Service Area**

The five reservoirs in the Greater Victoria Drinking Water 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 Greater Victoria, supplying approximately 95% of Greater Victoria's drinking water. The four reservoirs in the Goldstream Watershed system (Butchart Reservoir, Lubbe Reservoir, Goldstream Reservoir and Japan Gulch Reservoir), typically remain off-line throughout most of the year and are used as a backup water supply. Controlled releases from the Goldstream Watershed supply water to the Salmonid Enhancement Fisheries project at Japan Gulch and to the lower Goldstream River.

Water at the southern extremity of Sooke Reservoir enters one of the variable depth gates (typically the bottom gate is used) in the Sooke Reservoir Intake Tower and passes through a 30-mesh stainless steel traveling screen (openings of 0.5 mm). It then continues through two 1220 mm (48") diameter pipelines to the Head Tank, through the 8.8 km (5.5 mile) long, 2300 mm (91") diameter Kapoor Tunnel, into the 1525 mm (60") and/or the 1220 mm (48") diameter pipe connecting the Kapoor Tunnel to the Japan Gulch Treatment Plant and finally

flows into the Japan Gulch UV Treatment Facility.

During the brief periods of its use, (typically only when the tunnel is out of service for inspection by CRD 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. In the Japan Gulch Intake Tower, the water passes through a 14 mesh, stainless steel screen and continues into a 1220 mm (48") diameter pipe to the Japan Gulch Plant.

In 2005, all water received at the Japan Gulch Treatment Plant originated from Sooke Reservoir.

**Sooke District Drinking Water Service Area**

The Districts of Sooke and East Sooke were also supplied with drinking water primarily from Sooke Reservoir. This water flows by gravity to the Charters Treatment Plant via the 42" concrete pipe commonly called the flowline. When the flowline is out of service for maintenance, the source of water for this system comes from Charters Reservoir and the Charters Creek Watershed.

In 2005, all water received at the Charters Treatment Plant originated from Sooke Reservoir.

## 2.2. WATER TREATMENT

The drinking water in Greater Victoria is unfiltered and in 2005, the source water from Sooke Reservoir continued to meet the USEPA criteria to remain an unfiltered drinking water supply.

**Greater Victoria Drinking Water Service Area**

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

1. *UV Disinfection*. In 2004, as the final part of the Enhanced Disinfection Project, ultraviolet (UV) light disinfection was added to the treatment process both the Japan Gulch and Charters Treatment Plants. UV disinfection is the first step of the primary disinfection process (disinfection of the raw source water entering the plants). UV disinfection 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 to the use of free chlorine from the use of chloramines in 2001. The free chlorine is in contact with the water for approximately 10 minutes or so (depending upon flow). The change to free chlorine provides a much stronger oxidant for the disinfection of the source water and is used primarily for the inactivation of bacteria and viruses.

3. *Ammonia Addition*. The third step in the disinfection process is the addition of ammonia at a point 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.

During 2005, the Water Services Department adjusted the free chlorine dosage rate between 1.5 of 1.7 mg/L of free chlorine at the Japan Gulch Treatment Plant.

During this period, the CRD Environmental Services Department continued to periodically rechlorinate portions of the water system on the Saanich Peninsula to control bacterial regrowth.

CRD Water Services also operates a small chloramination plant at Rocky Point Reservoir, supplying water south on Rocky Point Road and to the Becher Bay Reserve.

**Sooke District Drinking Water Service Area**

The dosage of chlorine and ammonia at the Charters Treatment Plant was changed in concert with that used at the Japan Gulch Plant.

## 2.3. TRANSMISSION SYSTEM WATER MAINS

Using a series of large diameter transmission mains, the CRD Water Services Department supplies bulk, treated (disinfected) water to the municipalities of Victoria, Esquimalt, Oak Bay, Saanich and, in the Western Communities, to the Juan de Fuca Water Distribution System. On the Saanich Peninsula, bulk, treated water is supplied to the Saanich Peninsula Water Commission (SPWC) who in turn supply it to Central Saanich, North Saanich and Sidney via the Saanich Peninsula Trunk Water Distribution System. This latter system is operated by the CRD Environmental Services Department for the CRD Water Services Department.

### 2.3.1. REGIONAL TRANSMISSION SYSTEM

In 2005, the Water Services Department used seven large diameter transmission mains to supply water to the municipal distribution systems in the Greater Victoria Drinking Water Service Area (**Map 1**).

- Main #1 is a 1067 mm (42") cement mortar-lined steel pipe that starts at the Humpback pressure regulating valve (PRV) below the Humpback Reservoir Dam and ends at the David Street vault. Over the past decade or so, the majority of this transmission main has been upgraded from a smaller 914 mm (36") diameter, riveted steel pipe to a 42" welded steel pipe. 1.4 kilometres were completed in 2005, with the remaining 1.3 kilometres scheduled for 2006 This water main provides water primarily to the City of Victoria but also services portions of Saanich and the Western Communities.

- Main #2 is a 780 mm (31") diameter steel pipe which starts at the Colwood overpass, parallels Main #1 on the south side of the Gorge water way and runs primarily through Esquimalt and Vic West. Main #2 rejoins Main #1 at the David Street vault after crossing the Point Ellice Bridge. This supply main is 7.6 km in length and provides water to View Royal, Victoria and Esquimalt.

- Main #3 is primarily a 990 mm (39") diameter steel pipe that supplies water from the Humpback PRV and terminates at the Department's Mt. Tolmie Reservoir. There are several sections in this line that include 1220 mm (48") and 810 mm (32") diameter pipe. The 810 mm diameter pipe terminates at the Oak Bay meter vault. This supply main is 21.3 km in length and provides water to the Western Communities, Saanich, Victoria and Oak Bay.

- Main #4, a high pressure transmission main, is primarily a 1220 mm (48") diameter steel pipe that supplies water from the Japan Gulch Plant primarily to Saanich and the

Saanich Peninsula. There are two small sections of 1320 mm (52") and 1372 mm (54") reinforced concrete pipe. This transmission main is 26.2 km in length and terminates near the Saanich-Central Saanich boundary where it transfers water to the 762 mm (30") trunk main extending to McTavish Upper Reservoir supplying the municipalities on the Saanich Peninsula, and to Bear Hill Reservoir and Hamsterly Pump Station near Elk Lake.

- Main #5 is a 1524 mm (60") diameter pipe that connects the Kapoor Tunnel via the Japan Gulch Plant to the Humpback PRV just below the old Humpback Reservoir dam. It is approximately 1.6 km in length and provides water to Mains #1 and #3.

- Main #7 is a 610 mm (24") diameter steel pipe that runs from Goldstream and Whitehead to Metchosin and Duke. It is 4 km in length and provides water to portions of Colwood, Langford and Metchosin.

- Main #8 is a 457 mm (18") diameter steel pipe that runs from Glen Lake School, primarily along Happy Valley Road to Happy Valley and Glenforest. It is 3.6 km in length and provides water to Langford, Colwood and Metchosin.

There are three active interconnections between the high pressure Main #4 and the low pressure Main #1 and #3 where water can be transferred from Main #4 to the other two mains via pressure reducing valve (PRV) stations. These stations are located at Esler's, Adams Storage, and Camden. There are also a series of interconnections between Main #1 and Main #3 with the major interconnections at Esler's, Price Road, Station Road, Tillicum and Dupplin Road.

### 2.3.2. SAANICH PENINSULA TRUNK WATER DISTRIBUTION SYSTEM

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.

The Saanich Peninsula Trunk Water Distribution System is comprised of 46 km of transmission mains including the 750 mm Bear Hill Main, the 400 mm Keating Main, the 400 mm Dean Park Main and the 250-500 mm Saanich Peninsula mains.

At McTavish Reservoir (the terminus of the regional transmission system) the Saanich Peninsula Trunk Distribution System continues further along the peninsula via a 610 mm (24") diameter concrete cylinder pipe. In the vicinity of the airport, this main reduces to a 406 mm (16") diameter asbestos cement pipe that terminates at the Deep Cove Pumphouse. A dedicated 250 mm diameter perm/PVC pipe connects Deep Cove Pumphouse with Cloake Hill Reservoir. A 457 mm (18") diameter transite pipe along Mills Road connects the trunk main to the northwest end of the Sidney Distribution System.

The CRD Environmental Services Department also operates six major pumping stations located at Hamsterly, Martindale, Lowe Road, Dean Park Lower, Dean Park Middle and Deep Cove along with two minor pumping stations located at Mt. Newton and Dawson Upper Reservoir.

## 2.4. BALANCING RESERVOIRS

A number of balancing reservoirs are located within the transmission and distribution system. Some of these reservoirs are quite large (5-6 million gallons) and located at the terminus of transmission mains and service wide areas of the distribution system. Other smaller reservoirs

are located at high points within the distribution system and service smaller local areas. During periods of high demand, balancing reservoirs provide some of the water used by consumers and thereby reduce the flow of water (balance the flows) through the treatment plant.

The balancing reservoirs in the Greater Victoria Drinking Water System are operated by three different agencies: two departments of the CRD and the District of Saanich.

### 2.4.1. CRD WATER SERVICES OPERATED RESERVOIRS

In 2005, CRD Water Services operated 16 balancing reservoirs in the Greater Victoria Drinking Water System:

- Batting Place Reservoir, a 1-cell, 182 cubic metre ($m^{3)}$ (40,000 gallon) reservoir located near the top Triangle Mountain off of Batting Place in Colwood.
- Bear Mountain Reservoir #1, a 2-cell, 1250 $m^3$ (275,000 gallon) reservoir located on the lower slopes of the Bear Mountain development in Langford.
- Coppermine Reservoir, a 1-cell, 455 $m^3$ (100,000 gallon) reservoir located off of Coppermine Road in East Sooke.
- Deer Park Reservoir, a 1-cell, 182 $m^3$ (40,000 gallon) reservoir located downstream of Rocky Point Reservoir near the extremity of the water system off of Deer Park Trail in Metchosin.
- Haliburton Reservoir, a 1-cell, 22,700 $m^3$ (5,000,000 gallon) reservoir located off of Haliburton Road in Saanich.
- Helgesen Reservoir, a 4-cell, 6,973 $m^3$ (153,385 gallon) reservoir located at the west end of Helgesen Road in Sooke.
- Henlyn Reservoir, a 1-cell, 224 $m^3$ (49,270 gallon) reservoir located off of Henlyn Drive in Sooke.
- Kirby Reservoir, a 1-cell, 409 $m^3$ (50,000 gallon) reservoir located off of Meota Drive in Sooke.
- Mt. Tolmie Reservoir, a 2-cell, 27,300 $m^3$ (6,000,000 gallon) reservoir located on Mt. Tolmie at the terminus of Main #3.
- Peacock Reservoir, a 2-cell, 583.8 $m^3$ (128,420 gallon) reservoir located north of the Trans Canada Highway in Langford.
- Rocky Point Reservoir, a 3-cell, 546 $m^3$ (120,000 gallon) reservoir located near the end of Rocky Point Road in Metchosin.
- Silver Spray Reservoir, a 2-cell, 841 $m^3$ (185,000 gallon) reservoir located off of Silver Spray Drive in East Sooke.
- Stirrup Place Reservoir, a 2-cell, 242 $m^3$ (53,230 gallon) reservoir located off of Stirrup Place Road in Metchosin.
- Townview Reservoir, a 2-cell, 546 $m^3$ (120,000 gallon) reservoir located on the eastern slope of Triangle Mountain in Colwood.
- Walfred Reservoir, a 3-cell, 560 $m^3$ (123,180 gallon) reservoir located on Triangle Mountain in Colwood.
- Whisperwind Reservoir, a 2-cell, 570 $m^3$ (125,380 gallon) reservoir located off of Whisperwind Place in Langford.

### 2.4.2. CRD ENVIRONMENTAL SERVICES OPERATED RESERVOIRS

In 2005, CRD Environmental Services operated 8 balancing reservoirs as part of the Saanich Peninsula Trunk Water Distribution System.

- Bear Hill Reservoir, a 1-cell, 4,546 $m^3$ (1,000,000 gallon) reservoir located on Bear Hill in Saanich.
- Cloake Hill Reservoir, a 1-cell, 4,546 $m^3$ (1,000,000 gallon) reservoir located on Cloake Hill in North Saanich.

- Dawson Upper Reservoir, a 1-cell, 455 $m^3$ (100,000 gallon) reservoir located off Benvenuto Ave in Central Saanich.
- Dean Park Lower Reservoir, a 2-cell, 4,546 $m^3$ (1,000,000 gallon) reservoir located beside Dean Park Road in North Saanich.
- Dean Park Middle Reservoir, a 2-cell, 2,730 $m^3$ (600,000 gallon) reservoir located near the bottom of Dean Park in North Saanich.
- Dean Park Upper Reservoir, a 2-cell, 4,546 $m^3$ (1,000,000 gallon) reservoir located near the top end of Dean Park in North Saanich.
- McTavish Upper Reservoir, a 1-cell, 4,546 $m^3$ (1,000,000 gallon) reservoir located at the terminus of Main #4 on the south side of McTavish Road in North Saanich.
- McTavish Lower Reservoir, a 1-cell, 2,280 $m^3$ (500,000 gallon) reservoir located on the south side of McTavish Road in North Saanich.

#### 2.4.3. SAANICH OPERATED RESERVOIRS

In 2005, Saanich operated five balancing reservoirs within its municipal boundaries:

- Cromwell Reservoir, a 2-cell, 45.46 $m^3$ (10,000 gallon) reservoir located at the top of Mt. Tolmie in Saanich.
- Hartland Reservoir, a 1-cell, 454.6 $m^3$ (100,000 gallon) reservoir located on Hartland Road in Saanich.
- Mt. Tolmie Reservoir (Saanich), a 1-cell, 4,545 $m^3$ (1,000,000 gallon) reservoir located on the east side of the summit of Mt. Tolmie near Cromwell Reservoir in Saanich.
- Rithet Reservoir, a 1-cell, 27,300 $m^3$ (6,000,000 gallon) reservoir located at the end of Perez Drive in Broadmead in Saanich.
- Wesley Reservoir, a 2-cell, 3,182 $m^3$ (700,000 gallon) reservoir located at the end of Wesley Road on Haliburton Ridge in Saanich.

## 2.5. DISTRIBUTION SYSTEM

The distribution system of the Greater Victoria Drinking Water Service Area is comprised of eight individual distribution systems. Seven of the eight distribution systems are separately owned and operated by the municipalities of Central Saanich, North Saanich, Oak Bay, Saanich, Sidney, and Victoria (Victoria owns and operates the distribution system in Esquimalt). The eighth distribution system, the Juan de Fuca Water Distribution System is operated by the CRD Water Services Department for the Western Communities of Langford, Colwood, Metchosin and View Royal. (**Note**: Sooke and portions of the Juan de Fuca Electoral Area are included under the jurisdiction of the Juan de Fuca Water Distribution System area but are located in a separate drinking water service area.)

#### 2.5.1. CENTRAL SAANICH DISTRIBUTION SYSTEM

In 2005, ten pressure zones (seven off the Bear Hill Main and three off the Martindale Valley main) supplied the Central Saanich Distribution System. The Bear Hill main supplied the Tanner Ridge area by direct feed, the central area in one pressure zone through three pressure regulating vaults (PRV's), the Saanichton area in two pressure zones through two PRV's, the Brentwood Bay area, and the Tsartlip First Nation through a PRV. Five smaller pressure zones served the rest of Central Saanich. Upper Dawson Reservoir supplied a small area of higher elevation residences in Brentwood Bay. Martindale Pump supplied an agricultural area in the southeast corner of the municipality. The Island View Road area was supplied by the Stelly's Pump Station. The Mount Newton Pump provided water to the northeast corner and to the Tsawout First Nation lands. A municipally-owned pump station on Oldfield Road serviced a small area in the southwest corner.

Bear Hill Reservoir had the largest service population in Central Saanich providing approximately 80% of the Central Saanich's water. It was the primary supply to most of Central Saanich (south of Haldon Road) including Brentwood Bay.

### 2.5.2. NORTH SAANICH DISTRIBUTION SYSTEM

In 2005, water was supplied to the North Saanich Distribution System from a number of points along the SPWC peninsula trunk main. This included Dean Park via the Lowe Road Pump Station, Dean Park Pump Stations and Dean Park Reservoirs, Deep Cove / Lands End area via connections upstream of the Deep Cove Pump Station, Cloake Hill Reservoir via Deep Cove Pump Station and Swartz Bay. In the North Saanich Distribution System, Cloake Hill Reservoir is the largest pressure zone. Water flowed generally in a easterly direction through the Dean Park pressure zone, northwest into the Deep Cove / Lands End area and northeast to the Swartz Bay area. Dean Park Upper Reservoir supplied a small portion of the Dean Park Estates.

The storage reservoirs servicing North Saanich were Dean Park Lower, Middle and Upper Reservoirs, McTavish Upper Reservoir and Cloake Hill Reservoir.

North Saanich provided water to the Greater Victoria Airport via the 8" line on the east side of the airport. Water quality in the airport system falls under Federal jurisdiction and was not tested by the Water Services Department.

### 2.5.3. OAK BAY DISTRIBUTION SYSTEM

In 2005, water was supplied to the Oak Bay Distribution System at Lansdowne and Foul Bay Road from Main #3. The water flowed in a west to east direction across Lansdowne with north and south branches. Oak Bay has a 406 mm (16") combination feeder/collector system, which crosses Oak Bay diagonally from northwest to southeast. Water is collected in the north end and distributed to the south end via the 406 mm main. Oak Bay has an outer loop flow on Beach Drive to the Victoria boundary.

Oak Bay has four local pressure areas supplied by booster pumps. Sylvan Lane Pump Station supplied the Barkley-Sylvan area, Plymouth supplied the North Henderson area, Foul Bay supplied the south Henderson area and Uplands Pump Station (seasonal) supplied the Uplands area. There are 2 interconnections with the Victoria system which are normally closed but which can be used in emergencies.

### 2.5.4. SAANICH DISTRIBUTION SYSTEM

In 2005, water was supplied to the Saanich Distribution System at a number of points from the Department's large transmission mains. Water was supplied from Main #1 at Dupplin, Wilkinson, and Marigold; from Main #3 at Douglas, Tillicum Foul Bay, Admirals, Shelbourne, Richmond and Maplewood Pumphouse and from Main #4 at Burnside, Blue Ridge, Roy Road, Markham, Layritz, Cherry Tree Bend and Sayward. In the Saanich Distribution System, water flowed generally in a northerly direction from Main #1 and #3 and both east and west from Main #4.

There are four major pumping systems in the Saanich Distribution System. Maplewood pumps water north from Main #3, ending in the Gordon Head area. Cherry Tree Bend pumps from Main #4 to Wesley Reservoir and the west central high elevation area. Royal Oak is a booster pump for Rithet Reservoir that is used during peak flows in the summer months. The Mt. Tolmie/Plymouth pump takes water from Main #3 and the Mt. Tolmie Reservoirs and pumps to Saanich's Mt. Tolmie Reservoir and the Gordon Head area via a 610 mm (24") diameter main.

Water from Sayward supplies the north end of the Saanich Distribution System via Main #4 with a southerly flow through Cordova Bay. Saanich also has a number of other small pressure zones controlled by pump stations.

### 2.5.5. SIDNEY DISTRIBUTION SYSTEM

In 2005, water was supplied to the northern portion of the Sidney Distribution System from the 305 mm (12") diameter main at Mills Road via the SPWC 460 mm (18") main on Mills Road. This was in turn connected to the SPWC peninsula main at Mills Road and West Saanich Road upstream of the Deep Cove Pump Station. The southern portion of the distribution system was supplied from a 305 mm (12") main that is connected to the SPWC peninsula main via McTavish Lower Reservoir. Within the Sidney Distribution System, water flowed generally from the west via Mills Road and from the south via McTavish Lower Reservoir and met in the middle of the distribution system with approximately 60% of the water coming from the Mills Road supply.

### 2.5.6. VICTORIA / ESQUIMALT DISTRIBUTION SYSTEM

In 2005, water was supplied to the Victoria / Esquimalt Distribution System at the David Street vault from Main #1 and Main #2. The system divides into several lesser mains at that vault. Water was also supplied to Victoria from Main #3 at Cook and Mallek, Sommerset and Shelbourne. There is an outer loop of the distribution system along Dallas Road in the Victoria/Esquimalt Distribution System and water flows generally in a north to south direction.

Water was supplied to Vic West and Esquimalt at Tyee from Main #2. Esquimalt was also supplied from Main #2 at Admirals and by connections along Craigflower at Lampson and Burleith.

### 2.5.7. JUAN DE FUCA WATER DISTRIBUTION SYSTEM

In 2005, water was supplied to the Juan de Fuca Water Distribution System (in this report, not including Sooke – see Sooke / East Sooke Distribution System below) primarily from Main #1 and Main #3. Parts of Langford and View Royal were supplied from Main #4 with pressure reduction at Esler's. The development at Bear Mountain in Langford was supplied by Main No. 4. In the Juan de Fuca Water Distribution System, water flowed generally in a northerly and southerly direction away from the supply mains. William Head Prison and the Becher Bay meter vault are located at the southern extremities of this system.

The Capital Regional District received the required documentation and as of February 15, 2005 assumed ownership and operation of various components of the Bear Mountain water system including:

- Pump Station and Storage Tank No. 1
- Supply Main from Millstream Ave. to Pump Station No. 1
- Supply Main from Pump Station No. 1 to Storage Tank No. 1
- Distribution system for Phases 1 and 2

### 2.5.8. SOOKE / EAST SOOKE DISTRIBUTION SYSTEM

The Sooke/East Sooke Distribution System begins at the Sooke River Road Pumphouse, which received UV-chloraminated water from the Charters Treatment Plant. The primary water supply main to the community follows Sooke River Road downstream of the Sooke River Road Pumphouse and splits at Milne's Landing going east toward Sassenos and

west toward the central area of Sooke. Two underwater pipelines across Sooke Harbour supply East Sooke.

# 3. Bacteriological Monitoring Program

The Water Quality Division of the CRD Water Services Department is responsible for monitoring the bacteriological quality of the drinking water in the Greater Victoria Drinking Water System. This monitoring is conducted according to the directions of the Water Quality Division's Water Quality Compliance Monitoring Program. This Program is described in the Water Quality Division's *Water Quality Management Plan* and follows the requirements of both the Provincial 2004 *Drinking Water Protection Act* and the Federal *Guidelines for Canadian Drinking Water Quality (April 2004 update)*.

## 3.1. PARAMETERS AND REGULATIONS

A description of the bacteriological parameters used by the Water Quality Division and the regulatory limits associated with those parameters that were in place in 2005 are outlined below.

### 3.1.1. TOTAL COLIFORM BACTERIA

**Total coliforms.** Total coliforms are a group of bacteria found in high numbers in both human and animal intestinal wastes and therefore, are found in water that has been contaminated with fecal material. Unfortunately, bacteria with the biochemical characteristics of total coliforms are also found in non-contaminated water. Thus, in the absence of fecal coliforms (a more direct indicator of fecal contamination), the presence of total coliforms may indicate older fecal contamination or the presence of decaying organic matter. Although the total coliform bacteria group is a less reliable indicator of sewage contamination, because of its superior survival characteristics, it is preferred as an indicator of treatment adequacy in drinking water supply systems (MOH, 1982).

**Test Method**. In 2005, total coliforms were analyzed by the Water Quality Division's Main Laboratory using the membrane filter test and were reported as colony forming units (CFU) per 100 millilitres (mL) of water. The total coliform test measures the quantity of bacteria capable of producing a red colony with a green sheen on an Endo-type growth medium containing lactose within 24 hours at 35°C. (**Note**: Starting in 2004, for the raw source water, total coliforms were analyzed using the defined substrate technology (DST) method to provide better specificity during periods of high background bacterial levels. Starting in 2005, for treated water, some samples were also analyzed using the DST method.).

The total coliform bacteria test is used by the Water Quality Division to indicate the presence of sewage and/or storm water contamination and ensure compliance with the regulations.

**Regulatory Limits**. In disinfected drinking water, the maximum acceptable concentration (both Federal and Provincial) is zero total coliforms per 100 mL in all samples. However, since total coliform bacteria typically are not uniformly distributed in drinking water and are subject to considerable variation, the maximum acceptable concentration is interpreted as:

- *No sample should contain more than 10 total coliform organisms per 100 mL.*
- *No consecutive sample from the same site should show the presence of coliform organisms*
- *Not more than 10% of the samples based on a minimum of 10 samples should show the presence of coliform organisms.*

### 3.1.2. BACKGROUND BACTERIA

**Background Bacteria**. Background bacteria are used as a general measure of the bacterial population present in a drinking water system and in the raw (undisinfected) source water. Under increasing nutrient conditions and/or a reduction in the concentration of chlorine residual, the background bacteria may increase and provide an early warning of the potential growth of coliforms.

**Test Method**. In 2005, background bacteria were analyzed by the Water Quality Laboratory using membrane filtration and reported as colony forming units (CFU) per 100 mL. The background bacteria test measures the quantity of bacteria capable of growing on an Endo-type growth medium containing lactose within 24 hours at 35°C.

**Regulatory Limits**. In disinfected drinking water, the Federal maximum acceptable concentration of background bacteria is 200 colonies per 100 mL. In 2005, there was no Provincial regulatory limit for this parameter.

### 3.1.3. FECAL COLIFORMS

**Fecal Coliforms**. Fecal coliforms are a subset of the total coliform bacterial group and are also are found in human and animal intestinal wastes. However, they are a more precise indicator of the presence of sewage contamination than total coliforms. The fecal coliform bacteria group includes the genera *Escherichia* and, to a lesser extent, *Klebsiella* and *Enterobacter*.

**Test Method**. In 2005, fecal coliforms were analyzed by the Water Quality Laboratory using the membrane filter method and were reported as colony forming units (CFU) per 100 mL. The fecal coliform bacteria test measures the quantity of bacteria capable of producing gas from EC medium within 24 hours when incubated at 44.5°C.

**Regulatory Limits**. In disinfected drinking water, the maximum acceptable concentration of fecal coliforms (both Federal and Provincial) is zero fecal coliforms per 100 mL.

### *3.1.4. ESCHERICHIA COLI*

***Escherichia coli***. *Escherichia coli* (*E. coli*) is a bacterium that is present in the normal intestinal bacterial flora of human beings and warm-blooded animals. It is also the predominant bacterial species that comprises the fecal coliform group of bacteria. While most members of this species are considered harmless some strains of *E. coli* cause diarrhoeal illness.

**Test Method**. In 2005, *E. coli* was analyzed by the Water Quality Laboratory using the defined substrate technology (DST) method. (**Note**: For the purposes of this report, the term fecal coliform is used for all data using either the membrane filtration (fecal coliform test) or the DST method (*E. coli* test)).

**Regulatory Limits**. In disinfected drinking water, the maximum acceptable concentration of *E. coli* (both Federal and Provincial) is zero *E. coli* per 100 mL.

### 3.1.5. HETEROTROPHIC PLATE COUNT BACTERIA

**Heterotrophic Plate Count Bacteria**. Heterotrophic plate count bacteria are used as a general measure of the bacterial population present in a drinking water system and in the raw source water. Under increasing nutrient conditions and/or a reduction in the concentration of chlorine residual, the heterotrophic bacteria are usually the first group to

increase and provide an early warning of the potential growth of coliforms. Specifically, heterotrophic plate count bacteria are used to monitor the disinfection of the water at the disinfection plants, to track the decline in chlorine residuals in the distribution system and in the balancing reservoirs and to ensure compliance with the regulations.

**Test Method.** In 2005, the Water Quality Division used the HPC7D test to measure the quantity of heterotrophic bacteria capable of growing on m-HPC Medium within 7days at 28°C. This was a change from past years when both this method and the HPC2D methods were used. (**Note**: The HPC2D test measures the quantity of heterotrophic bacteria capable of growing on m-HPC Medium within 48 hours at 35°C).

**Regulatory Limits**. There is no Federal or Provincial regulatory limit on the quantity of HPC7D allowed in drinking water. In the absence of a regulatory limit, the Water Quality Division uses an operational limit of 10,000 HPC7D bacteria per 1.0 mL.

## 3.2. BACTERIOLOGICAL SAMPLING

The number of sampling locations and the sampling frequency used at those stations were based on the population of the community using a formula in accordance with the Federal Guidelines and the complexity of the distribution system.

When positive bacteriological results were found, the Water Quality Division resampled those locations and, depending upon the situation, may have requested the water supplier operating the distribution system to flush the mains at that location and/or drain and disinfect balancing reservoirs.

**Greater Victoria Drinking Water Service Area**

In 2005, bacteriological samples were collected from the raw source water entering the Japan Gulch Treatment Plant, the UV treated water and from the treated water at the first customer sampling location below the plant 5 days per week. The large transmission mains and the Department's large balancing reservoirs were monitored weekly. The smaller balancing system reservoirs in the distribution system were monitored bi-weekly. The majority of the locations within the municipal distribution systems were sampled bi-weekly with a smaller number being sampled monthly. Bacteriological samples were collected from the municipal distribution systems on a bi-weekly schedule with some locations being monitored weekly and some monthly.

The Water Quality Division used 90 permanent, pre-established bacteriological sampling locations within the distribution system of the Greater Victoria Drinking Water Service Area. In addition, 15 sampling locations were used to monitor the transmission mains and 29 sampling locations were used to monitor the balancing reservoirs.

**Sooke District Drinking Water Service Area**

In 2005, weekly bacteriological samples were collected from the raw water upstream of the Charters Treatment Plant and from the treated water at the Sooke River Road Pumphouse (prior to first customer). The distribution system reservoirs were sampled bi-weekly. The Water Quality Division used 7 sampling locations for bacteriological sample collection in the distribution system and 9 sampling locations in the balancing reservoirs of the Sooke District Drinking Water Service Area.

## 3.3. ANALYSIS AND REPORTING

### 3.3.1. ANALYSIS

The bacteriological analysis program was comprised of two components: a field component and a laboratory component for existing water mains and a special testing program for new water mains prior to putting them into service.

**Field Component**. All samples collected were analysed in the field for chlorine residual level and water temperature.

**Laboratory Component**. In general, bacteriological samples were analysed for total coliform (TC) bacteria, fecal coliform (FC) bacteria, background bacteria (TCBK) and heterotrophic plate count bacteria incubated at 28°C for 7 days (HPC7D). Raw water samples were analysed for TC, TCBK, *E. coli* and heterotrophic plate count bacteria at 28ºC for 7 days (HPC7D). During 2005, from 21% to 32% of the samples were tested for total coliforms and *E. coli* rather than for total coliforms, background bacteria and fecal coliforms (using the DST method).

**New Water Mains**. All new water mains were tested for TC, *E. coli*, chlorine residual, and turbidity. All repeat samples from positive locations (resamples) were analysed for TC, *E. coli*, chlorine residual and water temperature.

### 3.3.2. REPORTING

The bacteriological results of the samples collected from the Greater Victoria Drinking Water System were reported in several ways both to the office of the Chief Medical Health Officer and to the seven water suppliers. Written reports containing the previous week's analytical results were faxed weekly and written summaries were provided monthly via the CRD web site. Depending upon the nature of the result, adverse results from positive samples were either faxed or notified directly by telephone.

## 3.4. CERTIFICATION AND AUDITS

To ensure that the analytical testing is performed to the highest possible standard, the Water Quality Laboratory participates in several types of external quality assurance and quality control (QA/QC) programs in addition to rigorous internal quality QA/QC procedures that are included as part of the methodology and are a normal component of good laboratory practice.

### 3.4.1. CERTIFICATION

The Province of British Columbia requires that all laboratories analyzing drinking water samples be approved in writing by the Provincial Health Officer. Laboratory approval requires both an approval certificate and a proficiency testing certificate as noted below:

- **Water Bacteriology Testing Laboratory Approval Certificate**. This certificate is issued by the BC Provincial Health Officer for bacteriological testing of drinking water in the Province of British Columbia. This certificate is renewed every two years via an on-site inspection of the analytical laboratory.

- **Clinical Microbiology Proficiency Testing Program Certificate of Participation**. This certificate is issued by the Advisory Committee for Water Bacteriology Laboratories which is operated by the Department of Pathology and Laboratory Medicine at the University of British Columbia. Satisfactory

performance is required to maintain laboratory certification.

3.4.2. AUDITS

The Vancouver Island Health Authority (VIHA) collects a limited number of drinking water samples from the Greater Victoria Drinking Water System as part of their audit on the Water Quality Division's Drinking Water Compliance Monitoring Program. In 2005, approximately 150 bacteriological samples were collected during two 2-week periods in the spring and fall by VIHA staff. These samples are analyzed by an independent, local laboratory and reported to VIHA. The results for these samples were consistent with the data reported by the Water Quality Laboratory and therefore, satisfactory to the VIHA.

## 3.5. RESPONSIBILITIES OF WATER SUPPLIERS

The *2003 BC Safe Drinking Water Regulation* places the responsibility on the water supplier (owner and/or operator of a distribution supply system) to ensure that the drinking water in municipally-owned distribution systems is bacteriologically safe. In the Juan de Fuca Water Distribution System (comprised of Colwood, Langford, Metchosin, View Royal, Sooke and portions of the Juan de Fuca Electoral Area), the water supplier is the CRD Water Services Department. Therefore, the Department has the direct responsibility for monitoring the bacteriological quality in these municipalities. However, in the municipally-owned and operated distribution systems in the Greater Victoria Drinking Water Service Area, it should be emphasized that while the CRD Water Quality Division collects, analyses and reports the results of the bacteriological samples, the Division collects bacteriological samples in the municipally-owned distribution systems only as a service to the municipalities and they, as the water supplier, are responsible for taking action on any lapses related to the bacteriological quality of the water originating within their system.

# 4. Bacteriological Results

The bacteriological results of the samples collected by Water Quality Division staff in 2005 from the Greater Victoria Drinking Water Service Area are summarised in this section. The bacteriological sample results from the Sooke District Drinking Water Service Area were generally consistent with the results in the Greater Victoria Drinking Water Service Area and, unless specifically noted, are not reported here.

In this report, the bacteriological results are divided into the following groupings according to the type of sampling location:

- Raw Water Entering the Plant **Section 4.1**
- UV Treated Water **Section 4.2**
- First Customer **Section 4.3**
- Transmission Mains **Section 4.4**
- Balancing Reservoirs **Section 4.5**
- Greater Victoria Distribution System **Section 4.6**
- Municipal Distribution Systems **Section 4.7 – 4.13**

## 4.1. RAW WATER ENTERING PLANT

The bacteriological quality of the raw source water is an important indicator of the degree of treatment required to provide the optimum protection from microbiological contaminants and ensure a safe water supply. However, neither the *Guidelines for Canadian Drinking Water Quality* nor the *BC Drinking Water Protection Act* specify a Maximum Acceptable Concentration

(MAC) for total coliforms, fecal coliforms, or *E. coli* in the raw source water. Therefore, in the absence of a Federal or Provincial limit, the quality of the raw source water was compared with the limits specified in the United States Environmental Protection Agency (USEPA) Surface Water Treatment Rule (SWTR):

To avoid the requirement to filter a surface water source, the SWTR states

- *If fecal coliforms are determined, the source water fecal coliform concentration must not exceed 20 per 100 mL or the total coliform concentration must not exceed 100 per 100 mL in more than 10 percent of the samples (running total) for the previous six months.*

- *When monitoring for both parameters has been done, the rule requires that only the fecal coliform limit be met.*

4.1.1. SAMPLES COLLECTED

In 2005, a total of 247 bacteriological samples were collected from the raw source water entering the Japan Gulch Treatment Plant. Typically, 20 samples or so per month were collected, one sample on each weekday. (**Note**: The numerical results are provided in **Table 1** near the end of this report. **Appendix A** provides an explanation of the column headings used in the tables.)

4.1.2. WATER TEMPERATURE

The median annual temperature of the water entering the Japan Gulch Plant was 9.6°C (**Table 1)**. The lowest median monthly temperature was observed in January 2005 at 5.5°C with the highest median monthly temperature observed in September at 16.6°C (**Figure 1**). The coldest daily water temperature recorded was 4.0°C in January while the highest maximum daily water temperature was 19.0°C recorded in September 2005. In 2005, both the median annual temperature and the highest median monthly temperature were from 1.5 to 3.5°C lower respectively, than in previous years. This change resulted from drawing cooler water (from a lower depth) into the intake tower at Sooke Reservoir during the summer months and was a beneficial result of raising the reservoir.

Nevertheless, compared to many other Canadian cities, the temperature of the source water entering the Greater Victoria Drinking Water System in the summer is still quite warm.

4.1.3. BACTERIA

**Total Coliforms**. In 2005, the level of total coliform bacteria in the raw (untreated source) water entering the Japan Gulch Treatment Plant from Sooke Reservoir was relatively high from mid-September through early October, peaking at 3,578 colony-forming units (CFU) per 100 mL on September 22$^{nd}$ (**Figure 1**). Total coliform concentrations exceeded 1,000 CFU/100 mL in samples collected from September 19$^{th}$ to September 28$^{th}$. This level of coliforms was similar to 2004. However, while these concentrations were substantially lower than in recent years (2000-2003), it is difficult to know if the improvement was real or just simply an artefact of the more specific method of coliform detection that was used by the laboratory in 2004 and 2005 (DST) versus that used in previous years (membrane filtration).

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

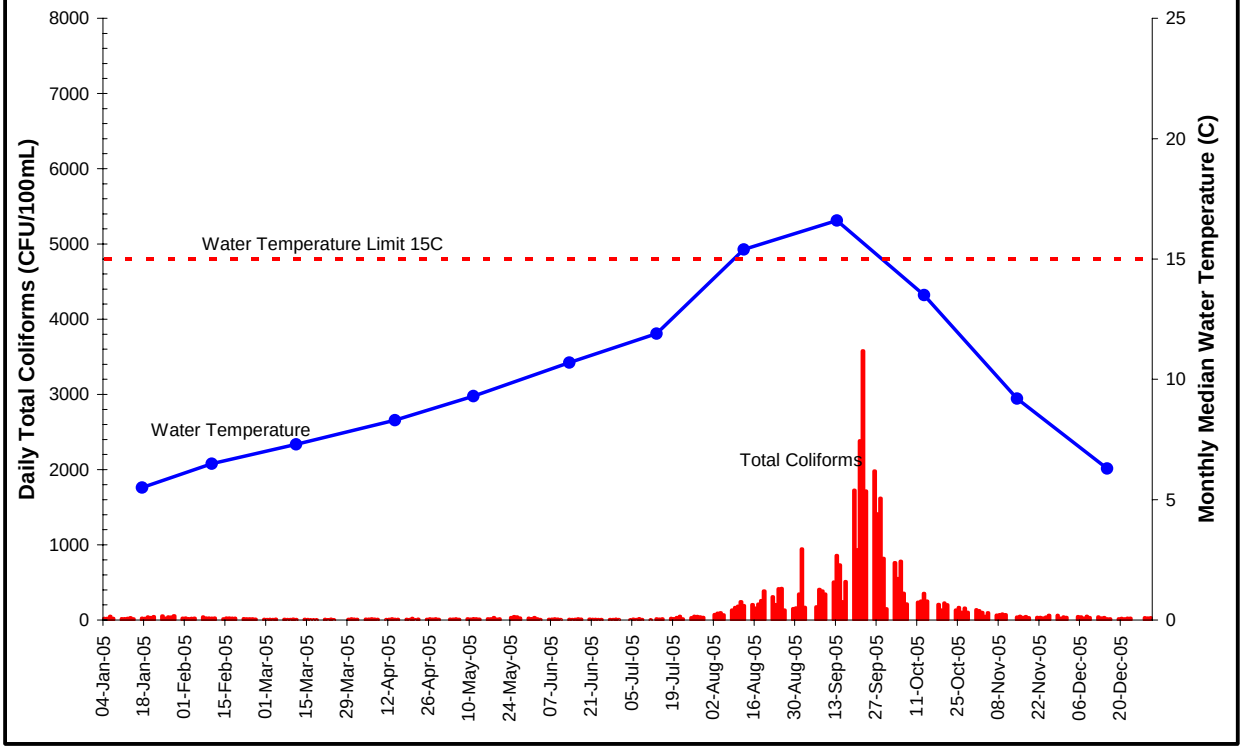
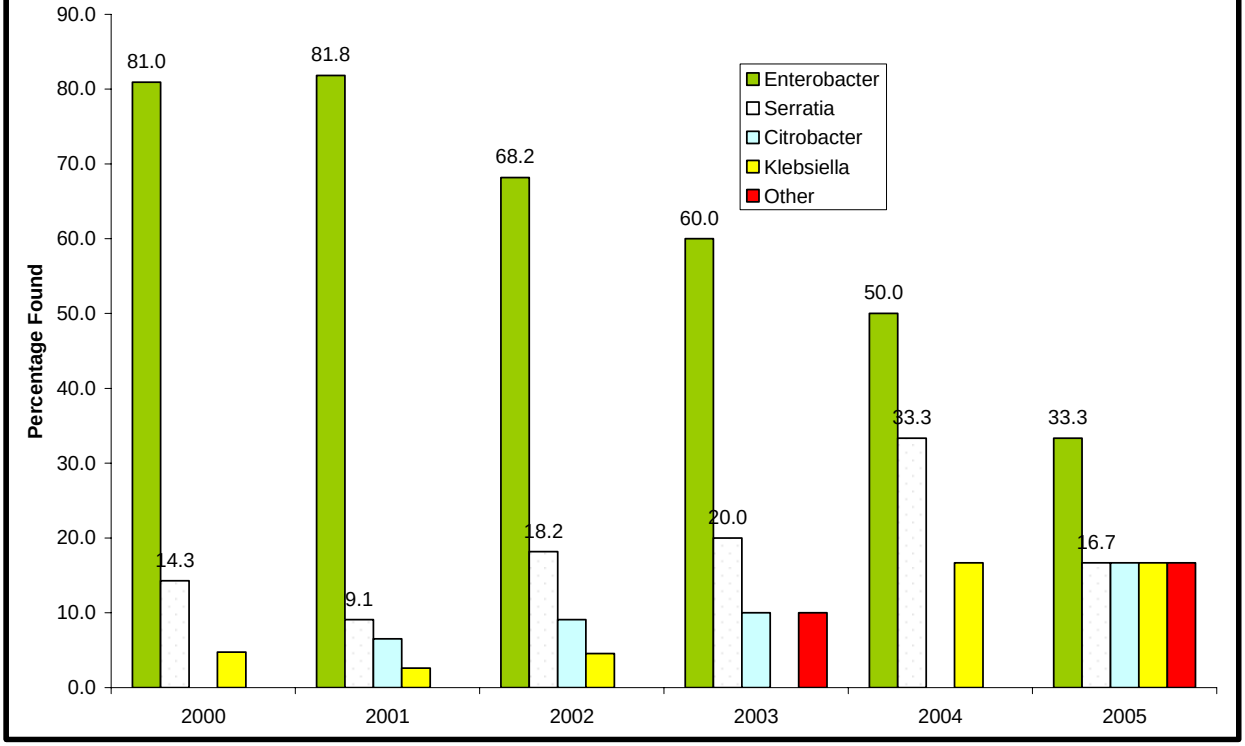



**Figure 1A. Dominant Bacteria in Raw Water entering**
**Japan Gulch Plant, 2000-2005**

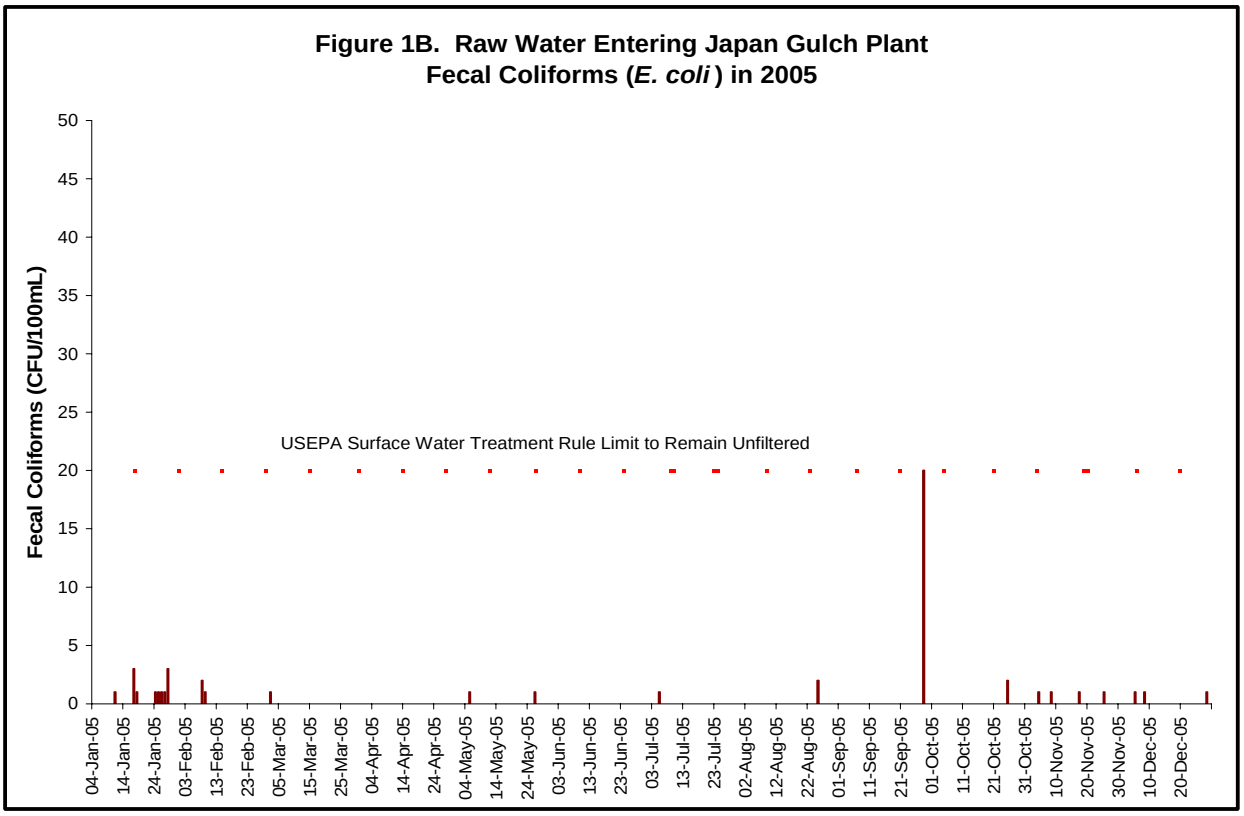


The dominant coliform bacteria in the raw water entering Japan Gulch plant has not changed from 2000 to 2005. The bacterial genus called *Enterobacter* ranged from 82% in 2001 to 33% in 2005. The second most common bacterial genus found was *Serratia*. Both *Enterobacter* and *Serratia* are common types of bacteria which are considered to be part of the normal microflora of fresh surface waters. *Serratia* numbers have varied from a low of 9% in 2001 to a high of 33% in 2004 (**Figure 1A**).

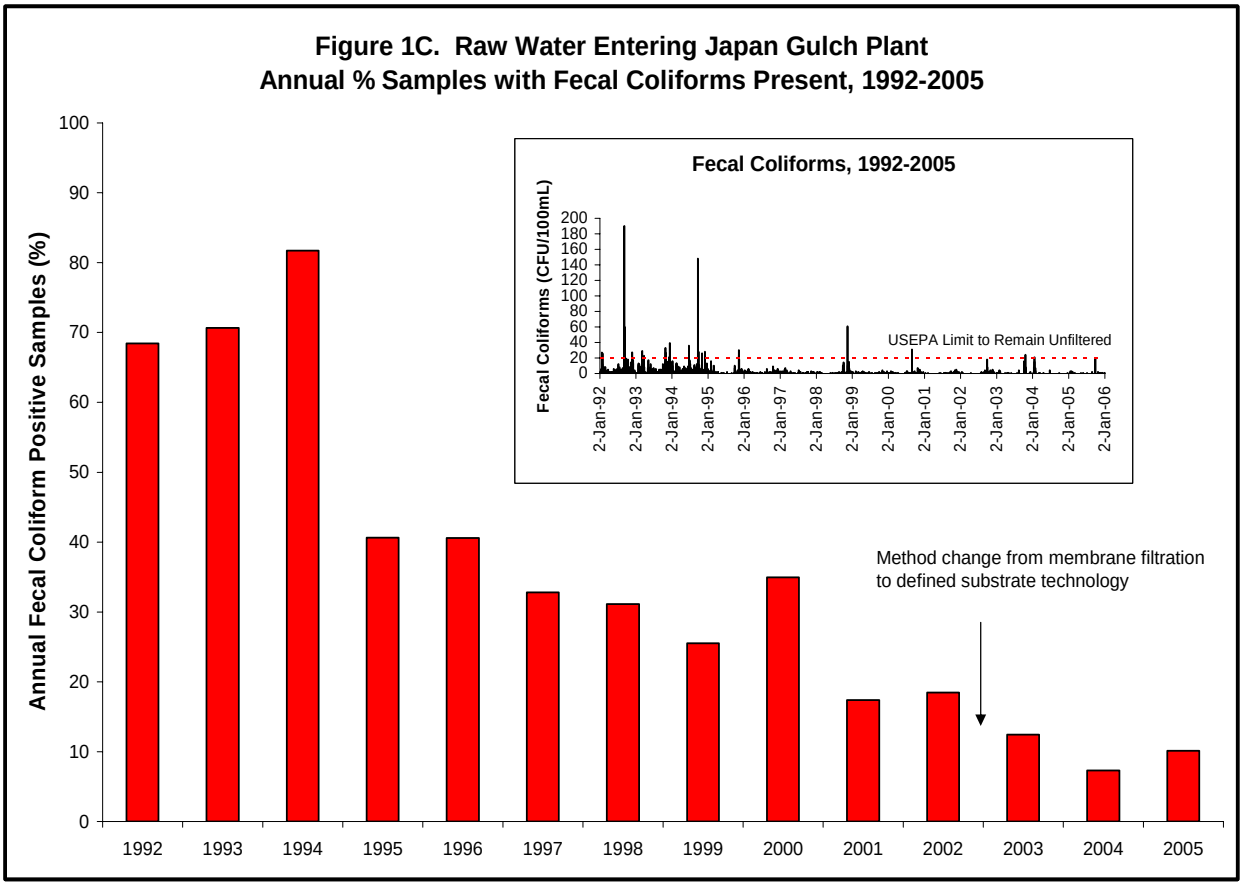
**Fecal Coliforms**. In contrast to the seasonal peak observed for total coliforms in the late summer of 2005, the levels of fecal coliforms (*E. coli*) were similar to those in 2003 and 2004 and did not display any significant seasonal trend although fecal coliform numbers were slightly higher in January (during periods of heavy rainfall) (**Figure 1B**).

The median annual fecal coliform (actually *E. coli* in 2005) bacterial concentration in the raw source water entering the Japan Gulch Plant was 0 CFU/100 mL and ranged from 0 to 20 (**Figure 1B**) easily meeting the fecal coliform limit of 20 CFU/100 mL in the USEPA Surface Water Treatment Rule and therefore continues to qualify to remain an unfiltered surface water supply under this portion of their regulations.

**Figure 1B. Raw Water Entering Japan Gulch Plant**
**Fecal Coliforms (*E. coli*) in 2005**




Over the past decade or so, the annual percentage of samples with fecal coliforms present has decreased from a maximum of 82% positive in 1994 to a minimum of 7.3% in 2004 and 10.1% in 2005 (**Figure 1C**) indicating that the bacterial quality of the source water has improved. The method change in 2003 would not have affected these numbers.




**Total Bacterial Count (Coliforms and Background Bacteria).** Unlike 2004, the total bacterial count observed in 2005 was lower than in previous years with a maximum count of 6,400 in early July compared with 27,000 in 2003 and 110,000 in 2004 (**Figure 1D**). This shows that the high level of the bacteria *Aeromonas* observed in 2004 was not repeated in 2005 and supports the circumstantial evidence that the sudden, large increase in bacterial concentrations in July, 2004 was a result of the transplanting of fish from Deception Creek and Deception Reservoir into Sooke Reservoir (under the direction of Provincial and Federal fisheries officers).

Over the past fourteen years, the background bacteria in the raw water has remained fairly consistent (except for the unusual case in 2004) ranging from a low of 6,395 in 2005 to a high of 25,900 in 2001 (see inset in **Figure 1D**). The method change in 2003 would affect these numbers minimally.

**Heterotrophic Plate Count**. The 2005 concentrations of 7-day heterotrophic plate count bacteria (HPC7D) were similar to the past several years with a median of 420 CFU/mL and a maximum of 4,360 CFU/mL (**Figure 1E)**. Unlike the coliform count, the heterotrophic plate count does not follow a seasonal pattern but remains at a relatively constant level throughout the year (see inset in **Figure 1E**).

**Figure 1D. Total Bacterial Count on m-ENDO (coliforms and non-coliforms) in Raw Water Entering Japan Gulch Plant, 2003-2005**

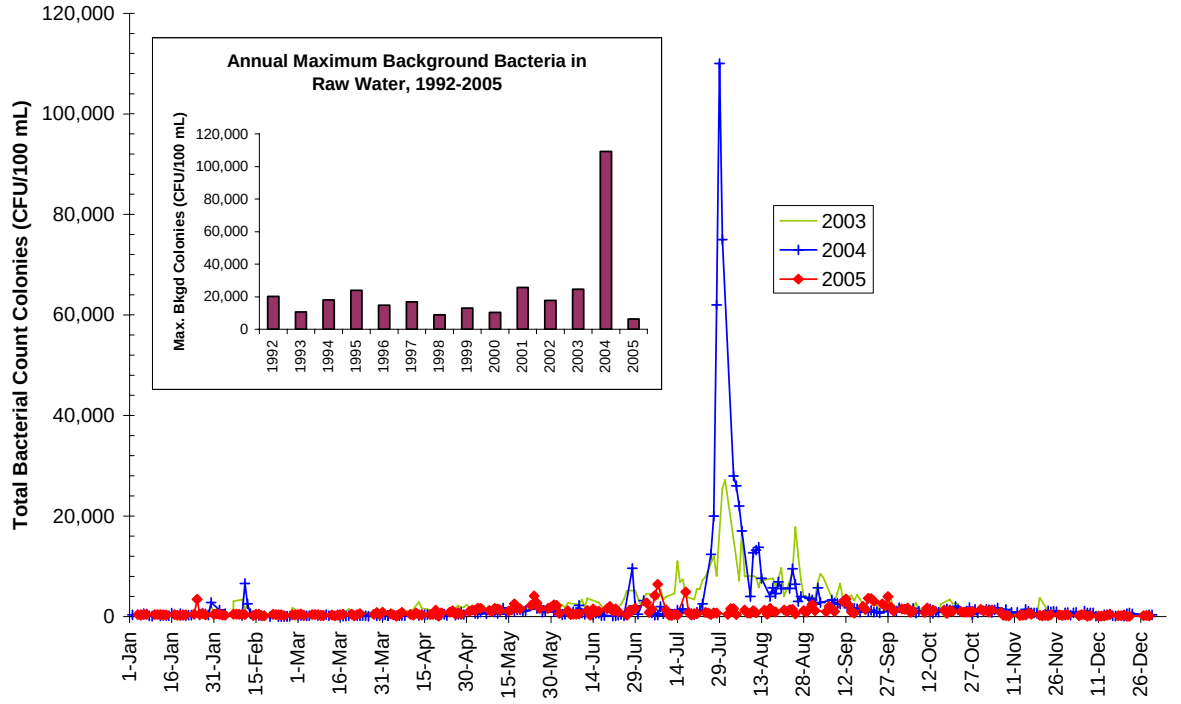
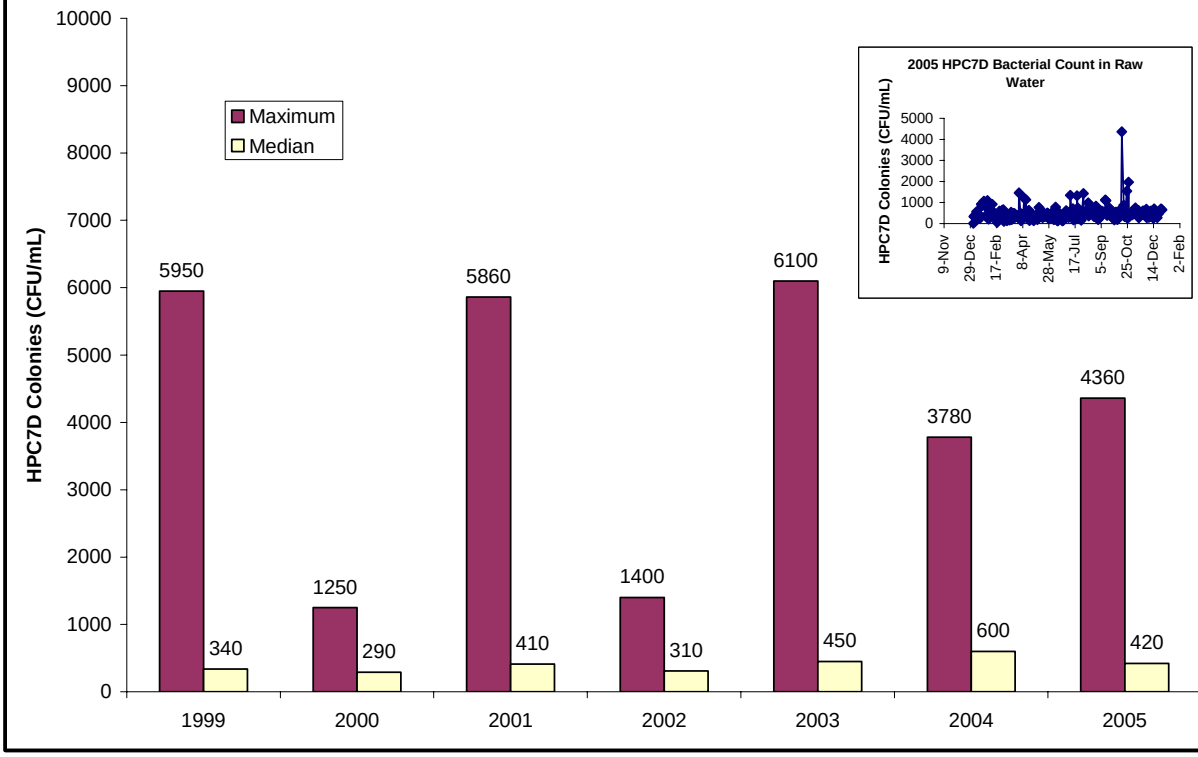



**Figure 1E. Maximum and Median HPC7D Bacterial Count in Raw Water Entering Japan Gulch Plant, 1999-2005**



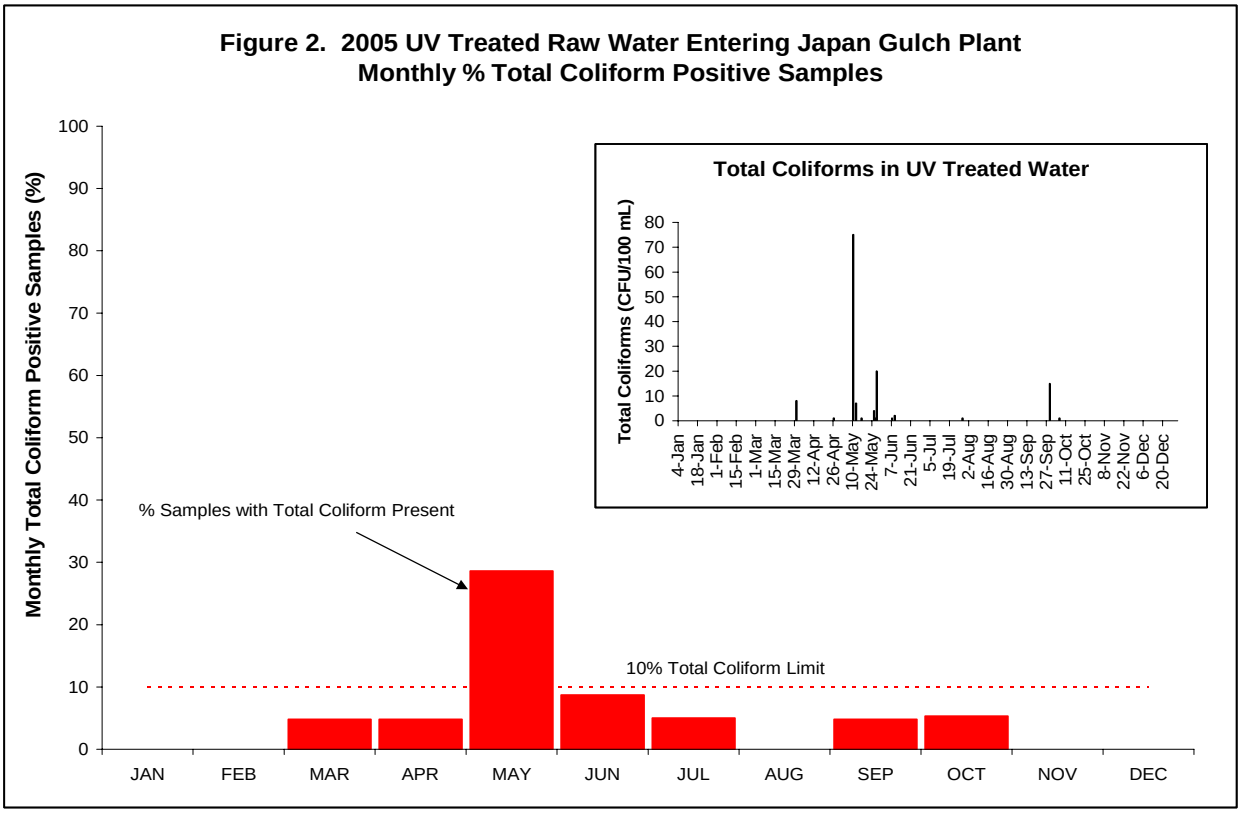
## 4.2. UV TREATED WATER

Ultraviolet (UV) disinfection of the raw water began in January 2004 and a sampling point to monitor this disinfection step was established in March 2004. In 2005, the UV plant had several minor failures lasting for thirty minutes to an hour on January 7th, January 12th, and June 7th.

### 4.2.1. BACTERIA

The level of total coliform bacteria in the UV treated raw water was low ranging from 0 to 75 CFU/100mL with a mean of 0.6 and a median of 0 CFU/100mL. In 2005, coliforms survived the UV disinfection step during seven months, March through July, and September and October (**Figure 2**). The annual coliform positive rate was 5.2% for the UV treated water, well below the 10% positive total coliform limit for drinking water. Nine of the thirteen positives were identified as *Enterobacter* species (78%), *Citrobacter freundii* (11%), and *Serratia fonticola* (11%). These results indicate that the UV disinfection step reduces the coliform bacterial population of the raw source water about 94% and provides good redundancy for primary disinfection (compare inset chart in **Figure 2** with **Figure 1** noting that different scales are used).

**Figure 2. 2005 UV Treated Raw Water Entering Japan Gulch Plant**
**Monthly % Total Coliform Positive Samples**




## 4.3. FIRST CUSTOMER

The bacteriological data collected by the Water Quality Division staff during 2005 from the treated water below the Japan Gulch Plant (downstream of both the UV and chlorine disinfection steps) and prior to the bulk of the first customers in the distribution system are summarised in **Table 2** and charted in **Figure 3**. In this report, this sampling location is referred to as "First Customer".

### 4.3.1. SAMPLES COLLECTED

In 2005, 248 bacteriological samples were collected from the first customer sampling location below the Japan Gulch Plant Treatment (**Table 2**). Typically, one sample was collected each week day with the monthly total ranging from 19-24.

### 4.3.2. BACTERIA

**Total Coliforms**. In 2005, there were no occurrences of total coliform positive samples at the first customer sampling location (**Figure 3** and **Figure 4)**.

In 2005, the annual total coliform positive rate of 0.0% was the lowest ever observed (**Figure 4**), slightly lower than the 0.4% in 2004, the 0.8% seen in 2003 and 2002. In 1995, before the practice of seasonally increasing the chlorine dosage rate in the summer, coliforms were detected in six months of the year. In 1996, 1997, 2000, 2001, 2002 and 2003 coliforms were detected in two months of the year and in 1998 coliforms were detected in five months of the year.

**Fecal Coliforms**. During 2005, no fecal coliforms were detected in any of the 248 samples collected from the first customer location below the Japan Gulch Treatment Plant (**Table 2**). This is significant as it indicates that no sewage-associated contamination was present in the water entering the distribution system and provides an assurance of the bacterial safety of Victoria's drinking water.

**Background Bacteria.** In 2005, there were no samples with background bacterial colonies exceeding 200 per 100 mL (**Table 2**). This is the same as in 2004 and better than in recent years (**Figure 4A**). In 2001, 2002, and 2002, background bacterial colonies exceeded 200 per 100 mL in a total of six samples each year, at an annual rate of 2.4% over the 200 CFU/100mL level.

**Figure 3. Treated Water at First Customer Below Japan Gulch Plant**
**Monthly Total Coliforms and Chlorine Residual in 2005**

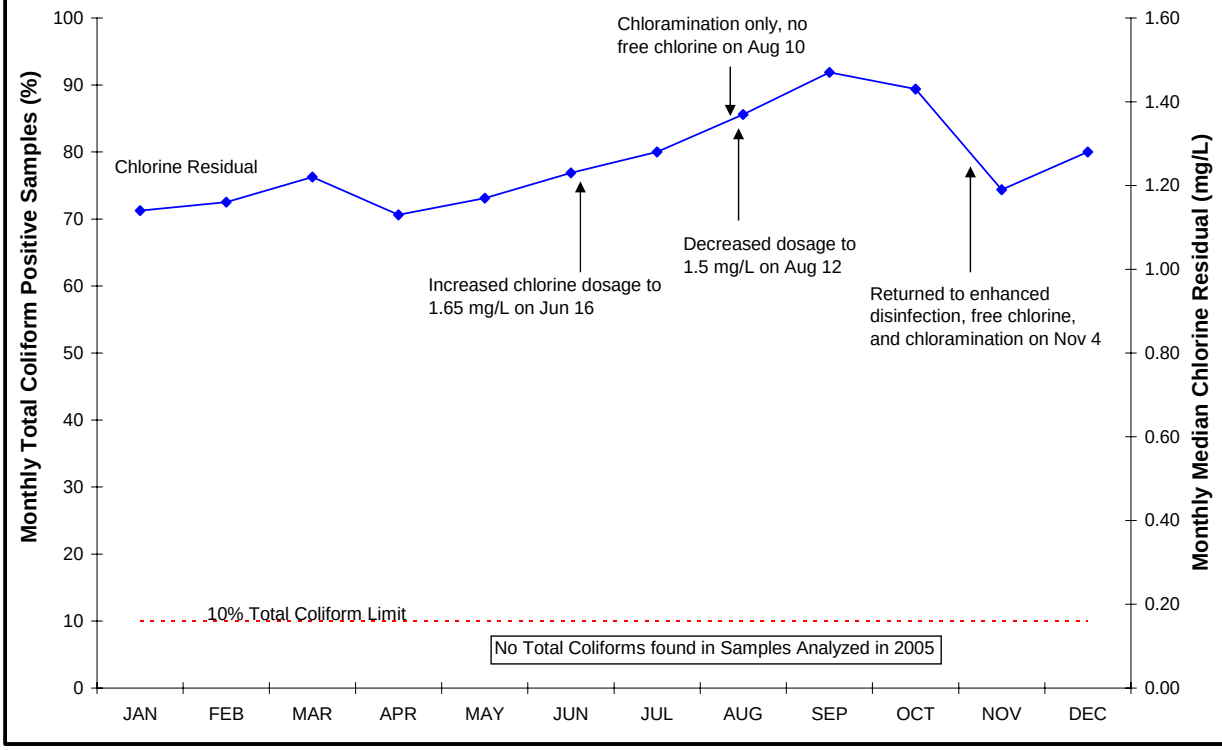



**Figure 4. Treated Water at First Customer below Japan Gulch Plant**
**Annual % Samples with Total Coliforms Present, 1992 - 2005**

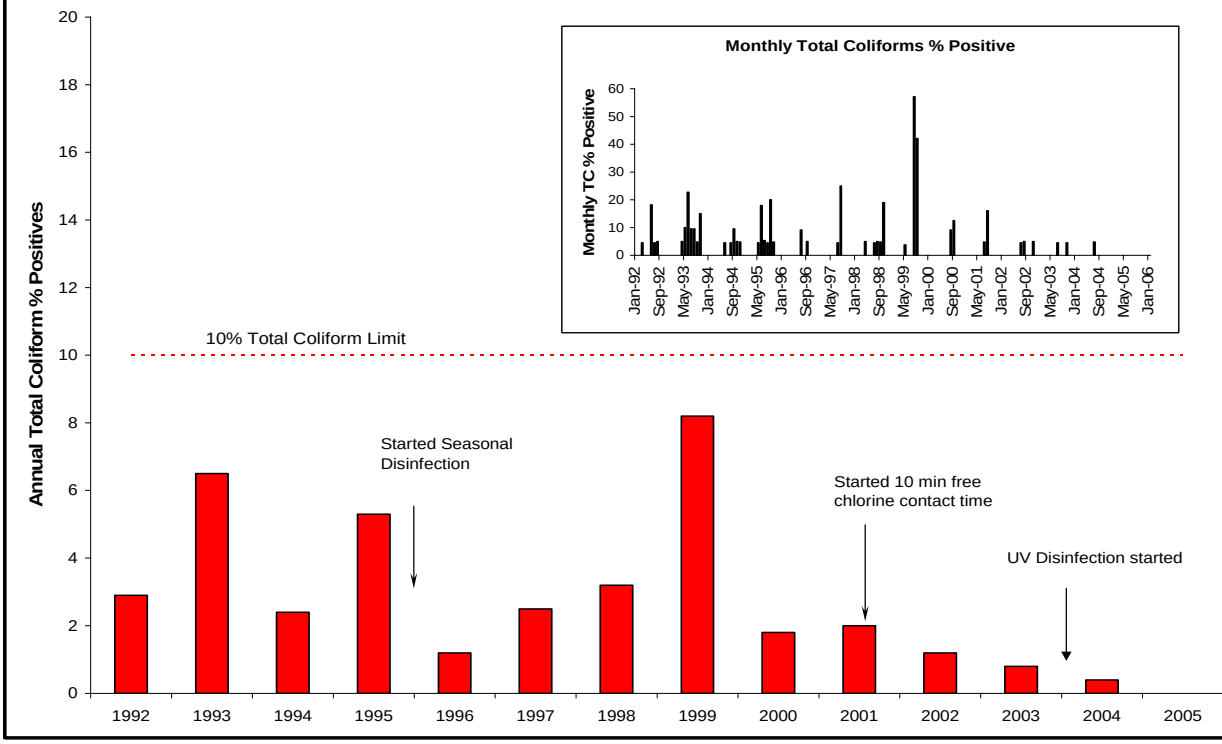


**Figure 4A. Treated Water at First Customer below Japan Gulch Plant**
**% Samples with Backgound Greater than 200 CFU/100mL, 1992-2005**

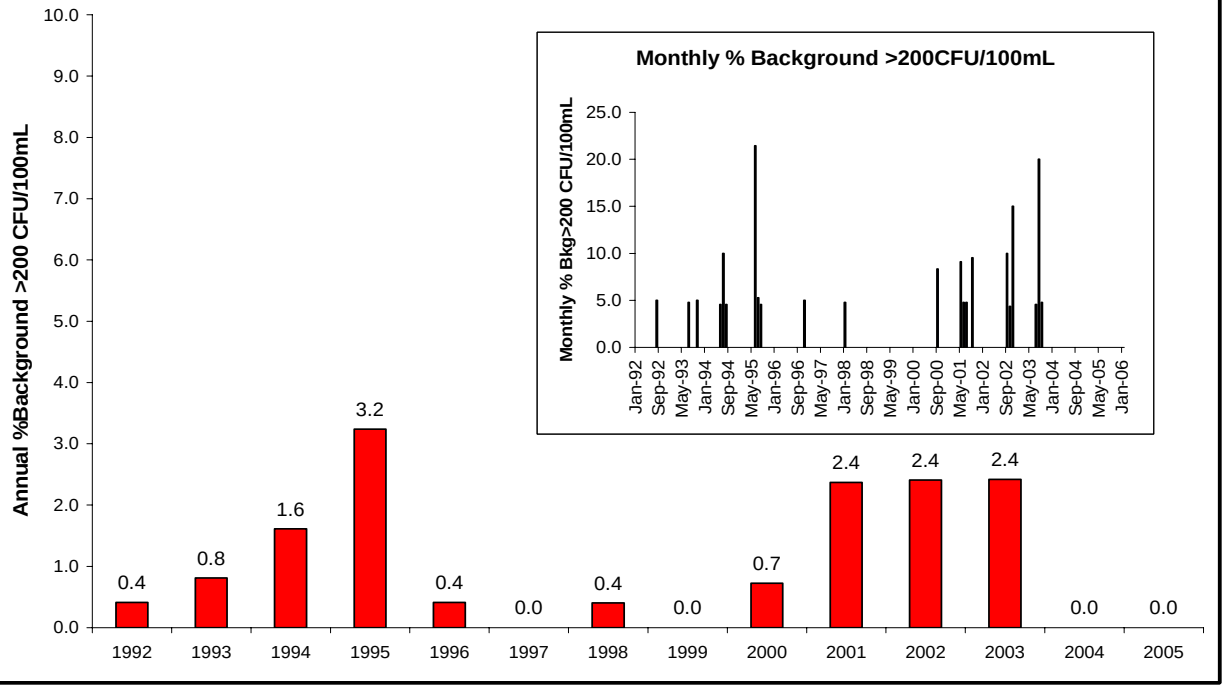
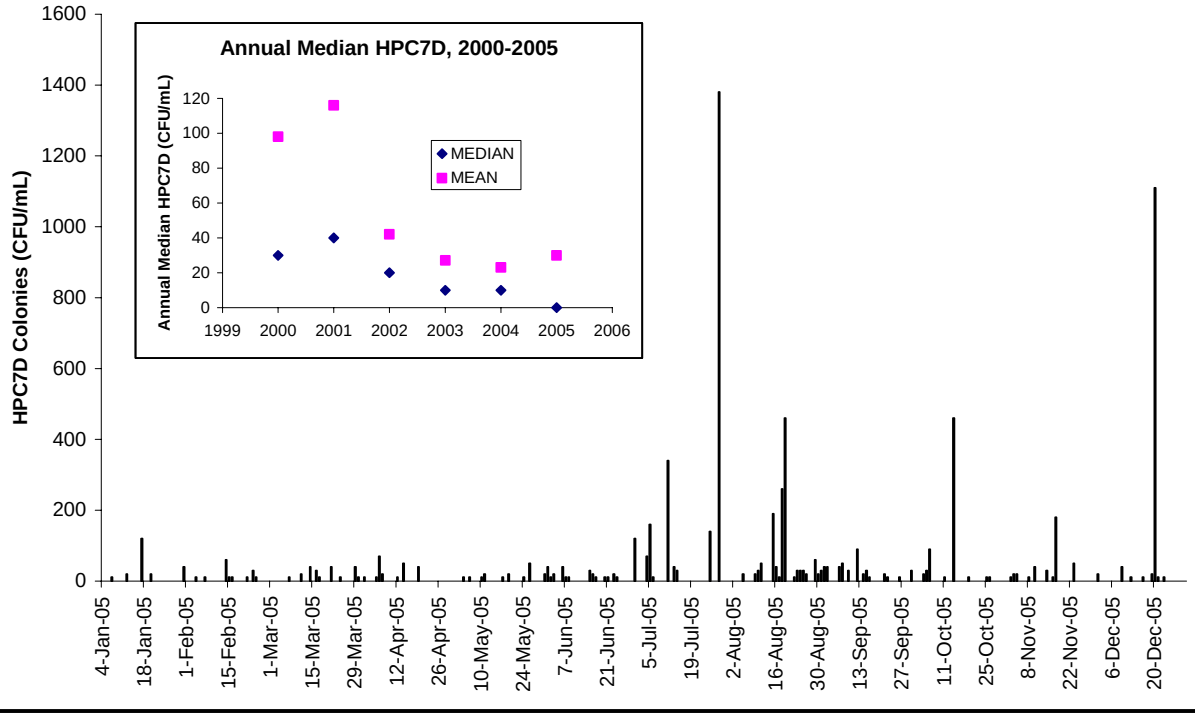



**Figure 4B. Heterotrophic Bacteria (HPC7D) in Treated Water**
**at First Customer below Japan Gulch Plant, 2005**



**Heterotrophic Plate Count Bacteria.** The pattern of HPC bacteria in the treated water at the First Customer location followed a somewhat seasonal pattern with counts rising in the summer months of July and August and then returning to baseline levels (**Figure 4B**). The median HPC counts have remained very low ranging from 0 in 2005 to 40 in 2001. The means have generally remained low as well, ranging from 116 CFU/mL in 2000 to 23 CFU/mL in 2004 (**Figure 4B**). In 2000 through 2005 there has been a 90 to 100% decrease in the heterotrophic bacterial load from the raw water entering Japan Gulch Plant to that entering the distribution system (**Figure 1E and 4B**).

#### 4.3.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

**Chlorine Residual**. The median annual total chlorine residual measured at the first customer sampling point below the Japan Gulch Plant was 1.22 mg/L (**Table 2**). The minimum daily chlorine residual measured below Japan Gulch Plant was 0.93 mg/L in late November. The maximum daily chlorine residual recorded was 1.58 mg/L recorded in early September. The lowest monthly median chlorine residual occurred in April at 1.13 mg/L with the highest in September at 1.47 mg/L (**Table 2**).

To reduce the potential for breakthrough of bacteria through the disinfection process, the chlorine dosage was maintained at 1.5 mg/L from January through mid-June (**Figure 3**) and increased on June 16th to 1.65 mg/L during a period of higher chlorine demand. On August 10$^{th}$ due to road construction near the plant, the chlorine disinfection process was changed with ammonia added before the chlorine. This process change continued until early November. As this process change resulted in higher chlorine residuals in the distribution system, the chlorine dosage was reduced to 1.5 mg/L.

**Water Temperature.** The median annual temperature of the water at the first customer location below the Japan Gulch Plant was 9.1°C (**Table 2**). The highest median monthly temperature was observed in September 2005 at 16.4°C and the lowest was observed in January at 4.5°C. The coldest daily water temperature recorded was 2.7°C in January while the highest maximum daily water temperature was 17.9°C recorded in September 2005. All of the low water temperature values are typical of those observed in previous years. However, all of the high water temperature values are from 1.4 to 3.2°C lower than in 2004 and are reflective of the colder water entering Japan Gulch Plant as a result of raising the water level in Sooke Reservoir.

## 4.4. TRANSMISSION MAINS

The sampling locations on the transmission mains (also called supply mains) included all the major points of supply to the individual municipal distribution systems and provided information on the bacterial levels and chlorine residuals supplied to those distribution systems or portions of a distribution system.

#### 4.4.1. SAMPLES COLLECTED

In 2005, 479 bacteriological samples were collected from the transmission mains feeding the municipal distribution systems (**Table 3**). Many of these samples were collected at the entrances to the municipal distribution systems and provided the baseline bacteriological water quality and chlorine residual being delivered to those municipal distribution systems. Typically, the baseline levels for chlorine residual are somewhat different for those municipalities that are relatively close to the Japan Gulch Plant compared to those that are located some distance from the treatment plant.

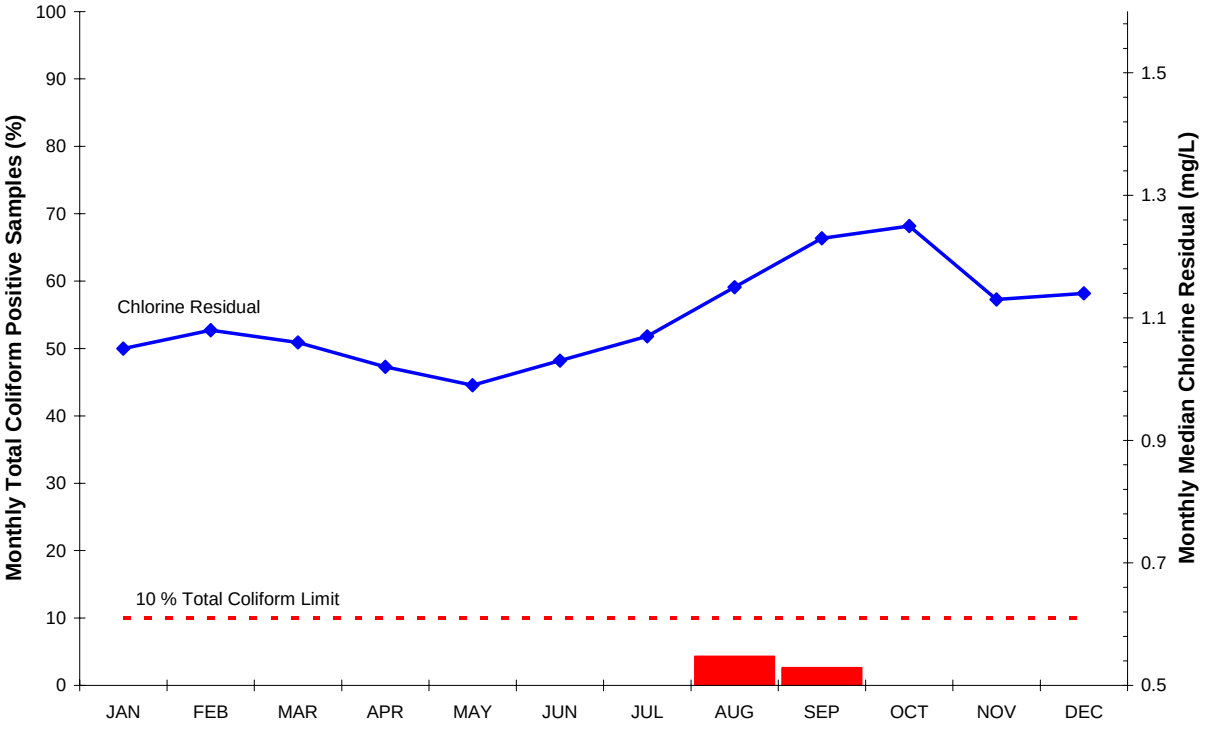
### 4.4.2. BACTERIA

**Total Coliforms**. Three of the samples collected from the transmission mains in 2005 contained total coliform bacteria (**Table 3 and Figure 5**). This result is similar to previous years (**Figure 5A**) and indicates that very few total coliforms are being delivered to the municipal distribution systems.

**Fecal Coliforms**. None of the transmission main samples contained fecal coliform bacteria (**Table 3**).

**Background Bacteria.** One of the samples collected from the transmission mains exceeded the 200 CFU/100 mL background bacteria limit (**Table 3**). This parameter is not considered to be a health consideration but can be used as a general indication of the quality of the water. Excessive concentrations of this general bacterial population may hinder the recovery of coliforms (when mENDO is used as the media) and thereby prevent the detection of a potential health risk.

**Figure 5. Transmission Mains**
**Total Coliforms and Chlorine Residual in 2005**




### 4.4.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

**Chlorine Residual**. The annual median chlorine residual for the transmission main samples was 1.09 mg/L (**Table 3**). The chlorine residual in the transmission mains displayed seasonal variation, decreasing in the winter months, increasing through the summer months following the change in dosage before decreasing again (**Figure 5**). The lowest monthly median chlorine residual occurred during the month of May at 0.99 mg/L and the highest in October at 1.25 mg/L (**Table 3** and **Figure 5**).

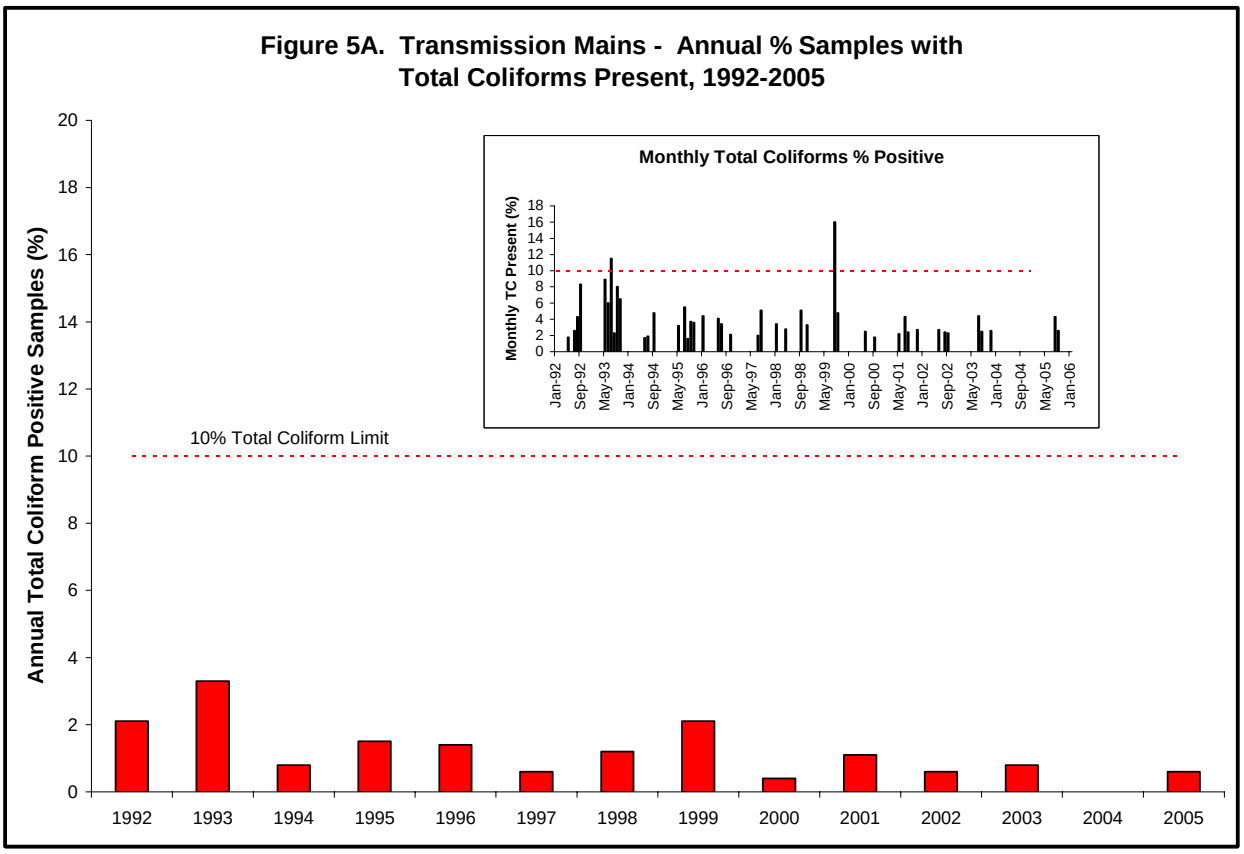



**Figure 5A. Transmission Mains - Annual % Samples with Total Coliforms Present, 1992-2005**

**Water Temperature**. The annual median water temperature for the transmission mains was 9.9°C (**Table 3**). The maximum monthly median temperature of 17.2°C occurred in September while the minimum temperature of 5.3°C occurred in January. As expected, these levels were only marginally different from the temperature of the water at the first customer location below the Japan Gulch Plant. The maximum monthly median temperature was slightly more than 2°C lower than that in 2004.

## 4.5. DISTRIBUTION SYSTEM (BALANCING) RESERVOIRS

The reservoirs located within the Greater Victoria Drinking Water System fall under two main categories: large, supply reservoirs operated by the CRD Water Services Department and the CRD Environmental Services Department and smaller distribution system reservoirs operated by the municipal water suppliers. These smaller reservoirs provide water pressure to a local high elevation area of the distribution system along with local fire protection. For the purposes of this report, all of these reservoirs were grouped together and called balancing reservoirs.

Twenty-four reservoirs located in the Greater Victoria Drinking Water System were sampled during 2005. This number includes all of the supply and local storage reservoirs operated by the Water Services Department, the majority of reservoirs operated by the municipalities and all of the reservoirs operated by the CRD Environmental Services Department on the Saanich Peninsula. Generally, one sampling location was used for each cell of each reservoir.

### 4.5.1. SAMPLES COLLECTED

The total number of bacteriological samples collected by Water Quality Division staff from the Greater Victoria balancing reservoirs in 2005 was 1,028 (**Table 4**). Typically, about 79-92 samples were collected each month. However, during some months the monthly totals were higher, due to the collection of repeat samples when positives were observed. In addition, in 2005, the total number of samples collected increased from that in previous years due to the inclusion of a new reservoir (Bear Mountain Reservoir) in the Western Communities.

### 4.5.2. BACTERIA

**Total Coliforms**. In 2005, forty-seven samples (4.6%) collected from the Greater Victoria Drinking Water System reservoirs contained total coliform bacteria (**Table 4**)**.** The majority of these positive samples (76%) occurred during the warmer weather months of June through September. When the results of all of the reservoirs are grouped together, the 10% positive total coliform limit was exceeded once in 2005 (**Figure 6**). While this was not an improvement from 2004, it was better than in the years prior to the establishment of the annual reservoir cleaning program and the seasonal dosage change (see inset in **Figure 6B**).

None of the positive coliform samples had a total coliform count greater than the 10 CFU/100 mL limit and none of the resamples contained total coliforms. On an annual basis, Helgesen Reservoir (13.3%), Kirby Road Reservoir (28.1%), Walfred Reservoir (17.2%), Haliburton Reservoir (25%), and Batting Place Reservoir (20%) exceeded the 10% total coliform limit (**Figure 6A**). This result is an improvement from the earlier years of 1992 through 1996 but not as good as in 2000 to 2004 (**Figure 6B**). Of all the supply and distribution reservoirs sampled in the Greater Victoria Drinking Water System, Kirby Road Walfred, Haliburton, and Batting Place Reservoirs demonstrated the poorest bacteriological water quality with higher percentage positive samples for total coliforms (**Figure 6A**).

**Figure 6. Distribution System Reservoirs**
**Total Coliforms and Chlorine Residual in 2005**

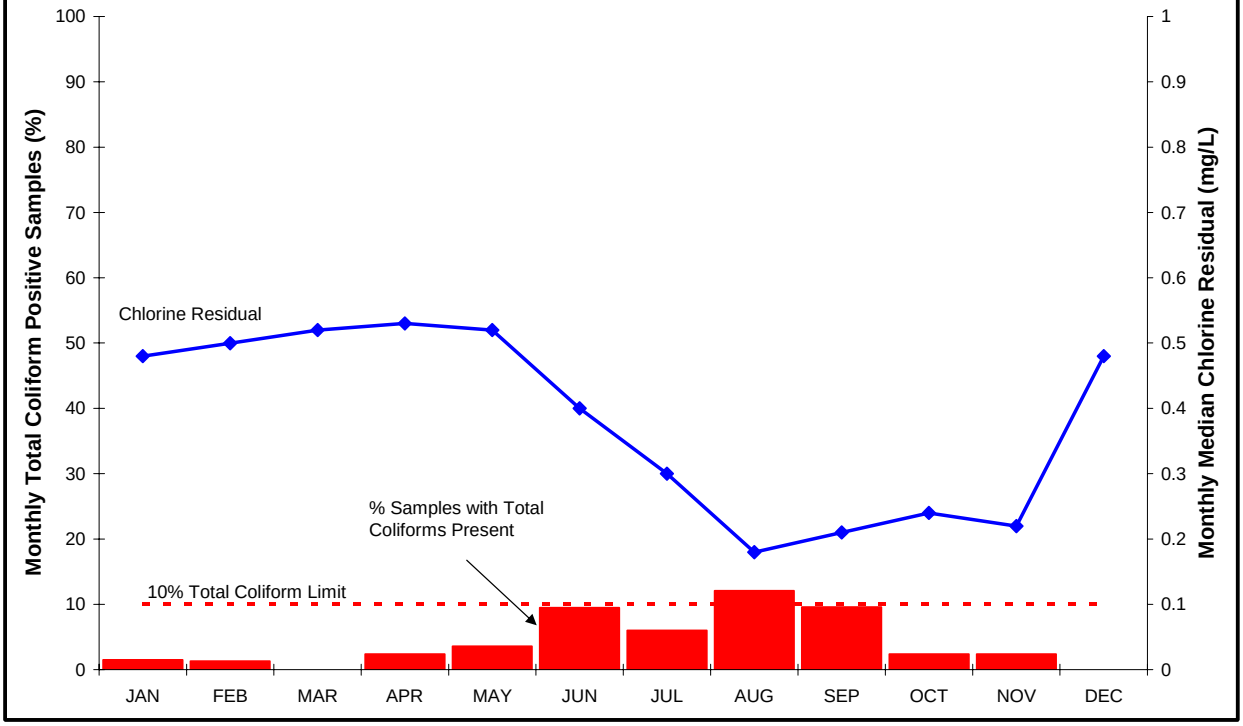



**Figure 6A. Distribution System Reservoirs**
**Total Coliforms and Chlorine Residual in 2005**

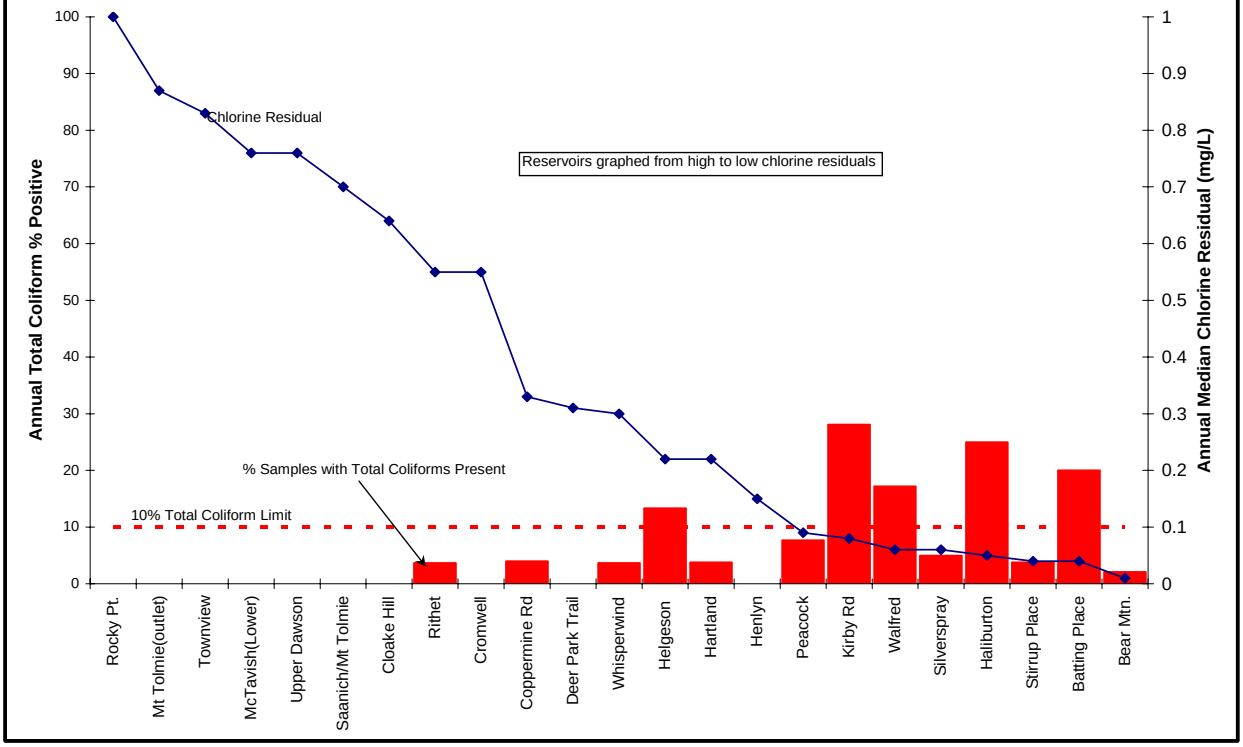


**Figure 6B. Distribution System Reservoirs - Annual % Samples with Total Coliforms Present, 1992-2005**

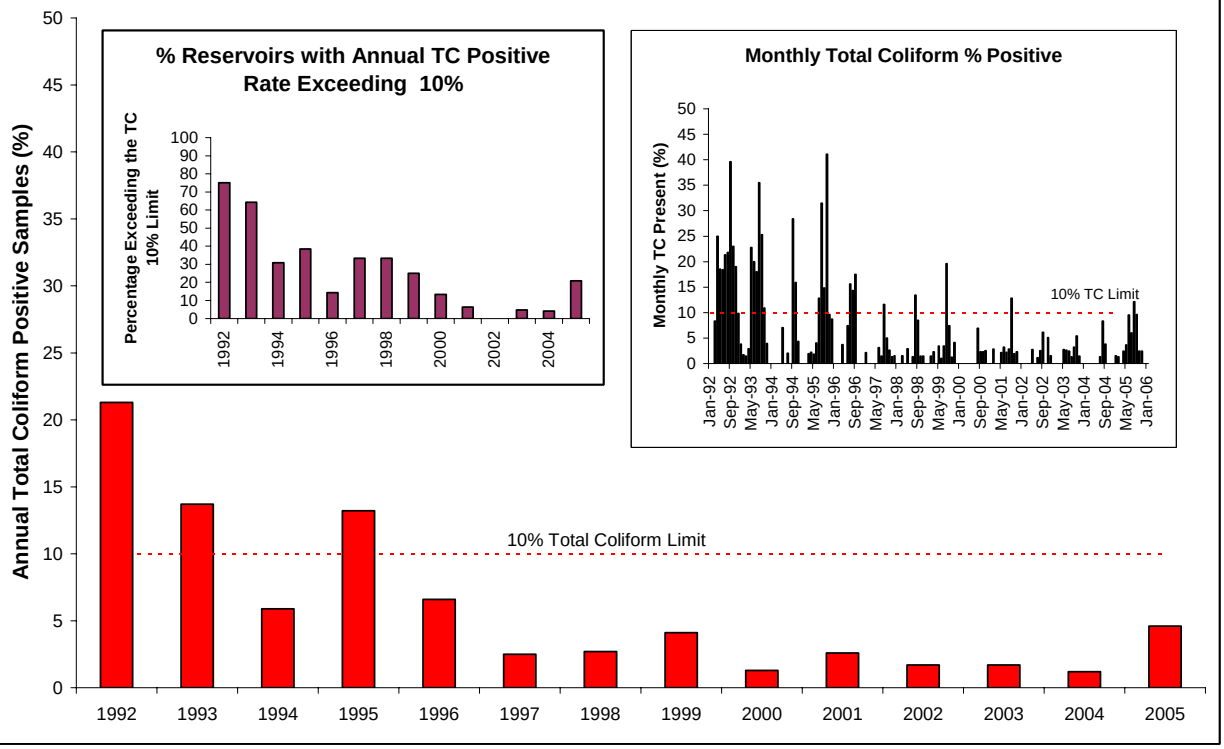
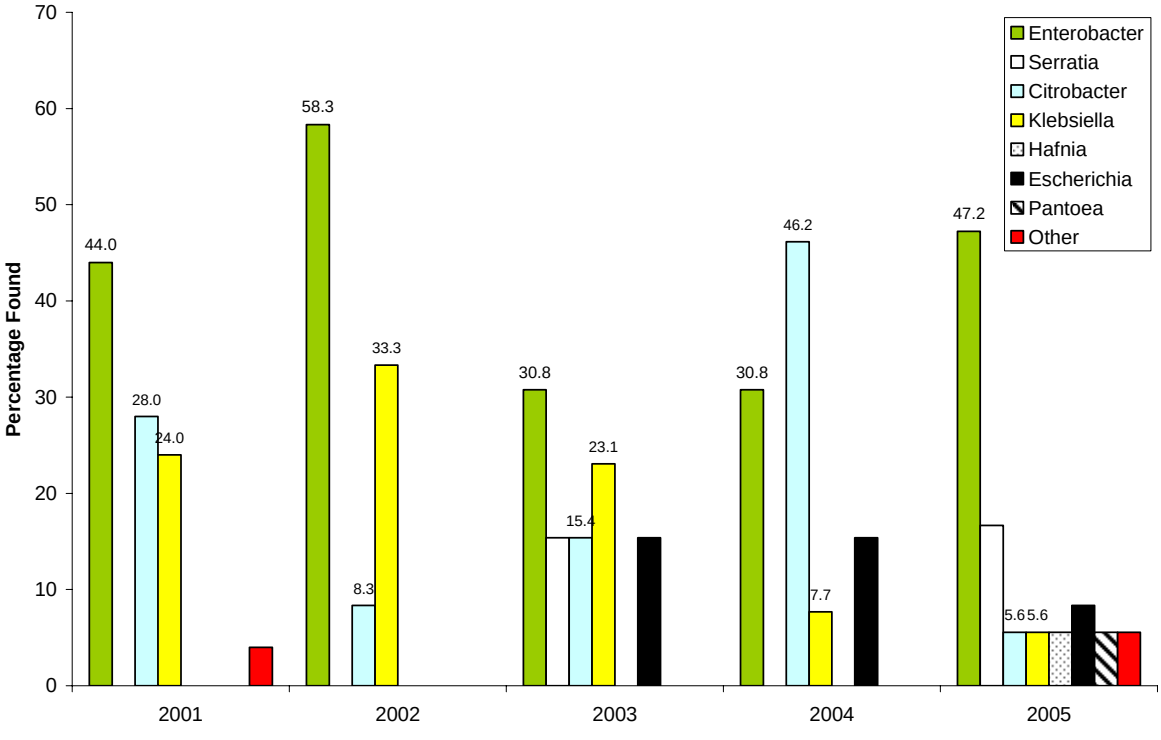



**Figure 6C. Dominant Bacteria in Treated Drinking Water Reservoirs, 2001-2005**



The dominant coliform bacteria identified from the Distribution System Reservoirs was similar to that found in the raw water entering the plant. In the years 2001 through 2005 (with the exception of 2004), *Enterobacter* was most common coliform genera, identified from 31% to 58% of the time. The next most common bacteria identified is *Citrobacter* ranging from a low of 5.6% in 2005 to a high of 46% in 2004 (**Figure 6C**). These groups of bacteria are common inhabitants of fresh water bodies and are not predominant in sewage.

*E. coli*, was detected three times during the period from 2001 through 2005. In early October of 2003, *E. coli* was found in Batting Place Reservoir, in late August of 2004 it occurred in Kirby Reservoir, and in late April of 2005 in Whisperwind Reservoir. In all cases resamples were negative for total and fecal coliforms.

In the long term, there has been a significant improvement in the bacteriological quality of the Greater Victoria Distribution System Reservoirs as evidenced by the general reduction in the annual percentage of samples with total coliforms present from a high of 21% in 1992 to a low of 1.2% in 2004 (**Figure 6B**). There has also been a reduction in the number of months where total coliform occurrence was over the 10% positive limit from a high of eight months in 1992 to a low of no months having exceeded the 10% positive total coliform limit in 2002, 2003 and 2004. There has also been a reduction in the number of Reservoirs having annual total coliform percentages over the 10% positive limit from a high of 75% in 1992 to a low of 4.2% in 2004 (21% in 2005) (**Figure 6B**).

**Fecal Coliforms**. One of the distribution system reservoir samples contained fecal coliform bacteria (**Table 4**). The fecal positive was from Whisperwind Reservoir in late April. The bacterium was identified as *Escherichia coli*. The reservoir was rechlorinated and the resample following the rechlorination was negative for both total coliforms and *E. coli*.

**Background Bacteria.** Health Canada has deemed (through extensive research) that background bacteria do not pose a health threat and so have suggested that water suppliers only use background bacteria counts as one means of monitoring their systems for operational needs. In 2005, five reservoirs were tested with the defined substrate technology (DST) and thus were not tested for background bacteria. A further seven reservoirs were only tested for background bacteria for part of the year (late fall and winter months). The reservoirs tested with the newer DST technology were those that had previously been shown to have higher levels of background bacteria (especially in the summer months) and required extensive confirmation to determine whether or not they contained coliforms. The DST method requires no confirmation as the growth of total coliforms is not compromised by high background bacteria.

Eight samples collected from the Greater Victoria distribution system reservoirs in 2005 had background bacterial counts that exceeded 200 CFU/100 mL. The majority of these positives occurred during the warm months of the year (June through October).

In future years new bacteriological media will be used that does not require the confirmation of background bacteria.

### 4.5.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

**Chlorine Residual.** The combined median monthly chlorine residual for all the distribution system reservoirs sampled by the Water Quality Division remained steady from December through mid-May and then decreased during the latter part of May through mid-August before slowly increasing during the fall and winter months. (**Figure 6**).

A number of the reservoirs in the Greater Victoria distribution system demonstrated relatively poor circulation of water or long detention times for the water in the reservoir as evidenced by low chlorine residuals in those reservoirs. This was particularly evident in the Western Communities where a number of reservoirs had annual median chlorine residuals below 0.2 mg/L: Bear Mountain Reservoir (0.01), Batting Place Reservoir (0.04), Stirrup Place Reservoir (0.04), Walfred Reservoir (0.06), Silverspray Reservoir (0.06), Kirby Road Reservoir (0.08), and Peacock Reservoir (0.09) (**Figure 6A**).

**Water Temperature**. The median monthly temperature of the water in all of the distribution system reservoirs combined was lowest in January at 5.9$^{o}$C and highest in August 2005 at 17.5$^{o}$C (**Table 4**).

## 4.6. GREATER VICTORIA DISTRIBUTION SYSTEM

The 2005 bacteriological results of the samples collected each month from all of the individual municipal distribution systems were combined together into a single dataset. In combining this data together, it is assumed that the distribution is one large distribution system irrespective of municipal boundaries. In this report, this overall distribution system is called the Greater Victoria Distribution System. The sampling locations in this dataset included all the distribution system locations within individual municipalities and excluded the large supply main sampling locations and the distribution system reservoirs located in those municipalities.

### 4.6.1. SAMPLES COLLECTED

In 2005, a total of 2,122 bacteriological samples were collected from the individual distribution system sampling locations and combined into a single dataset for the Greater Victoria Distribution System (**Table 5**).

### 4.6.2. BACTERIA

**Total Coliforms**. Twenty-nine samples (1.4%) collected from the Greater Victoria Distribution System contained total coliform bacteria (**Table 5**). Total coliform bacteria were detected during eight months of the year (January, March, and May through October) (**Figure 7**) but these occurrences did not exceed the 10% total coliform limit during any month of the year. These results are similar to 2001 and only slightly higher than the past three years.

Thus, the Greater Victoria Distribution System was in compliance with the total coliform limit in the *BC Drinking Water Protection Act* during all months in 2005. This was similar to 2001 and a marked improvement from results observed in the early to mid 1990's when the entire system was out of compliance in one or more months of the year (**Figure 7A**).

None of the resamples collected contained total coliforms while five samples contained 10 or more total coliforms per 100 mL (**Table 5**).

In recent years (2001-2005), the dominant coliform bacteria identified in the distribution system was *Enterobacter,* ranging from a low of 24% in 2005 to a high of 54% in 2001 (**Figure 7B**). *Klebsiella* was identified in all years except for 2005 while *Serratia* was common in 2005 (33%) and found in 2001, 2003 and 2004 at 4%, 22% and 15%, respectively. *Enterobacter* and *Serratia* are not particularly prevalent in sewage but are common inhabitants of fresh water. *Klebsiella* is found in both environmental and fecal sources. In addition, *Enterobacter*, *Citrobacter* and *Serratia* frequently colonize pipe sediments. In 2001 through 2004, *Enterobacter, Serratia, Citrobacter*, and *Klebsiella*

constituted 100% of the coliform bacteria identified while in 2005 they made up 57% of the coliform bacteria group.

**Figure 7. Greater Victoria Distribution System (Combined Dataset)
Total Coliforms and Chlorine Residual in 2005**

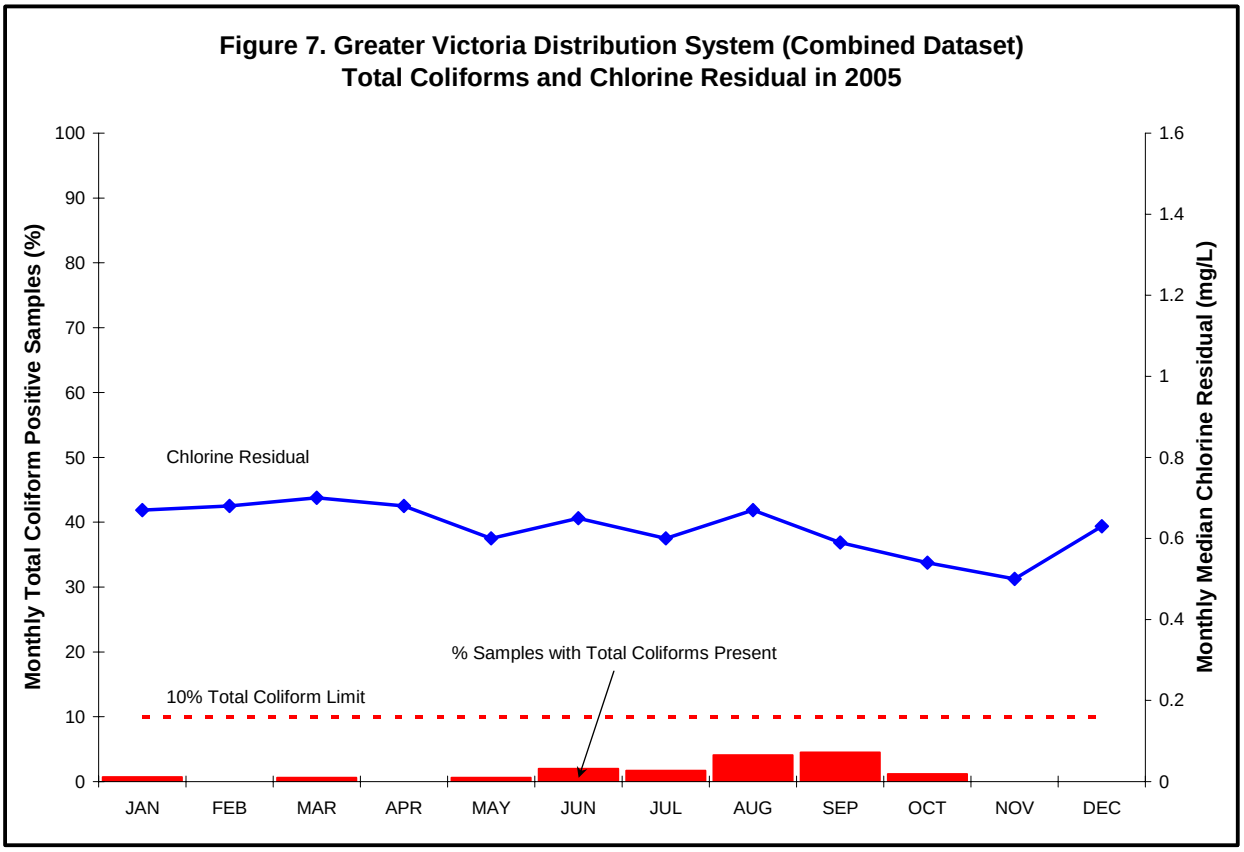


**Figure 7A. Greater Victoria Distribution System Combined Annual % Samples with Total Coliforms Present, 1992-2005**

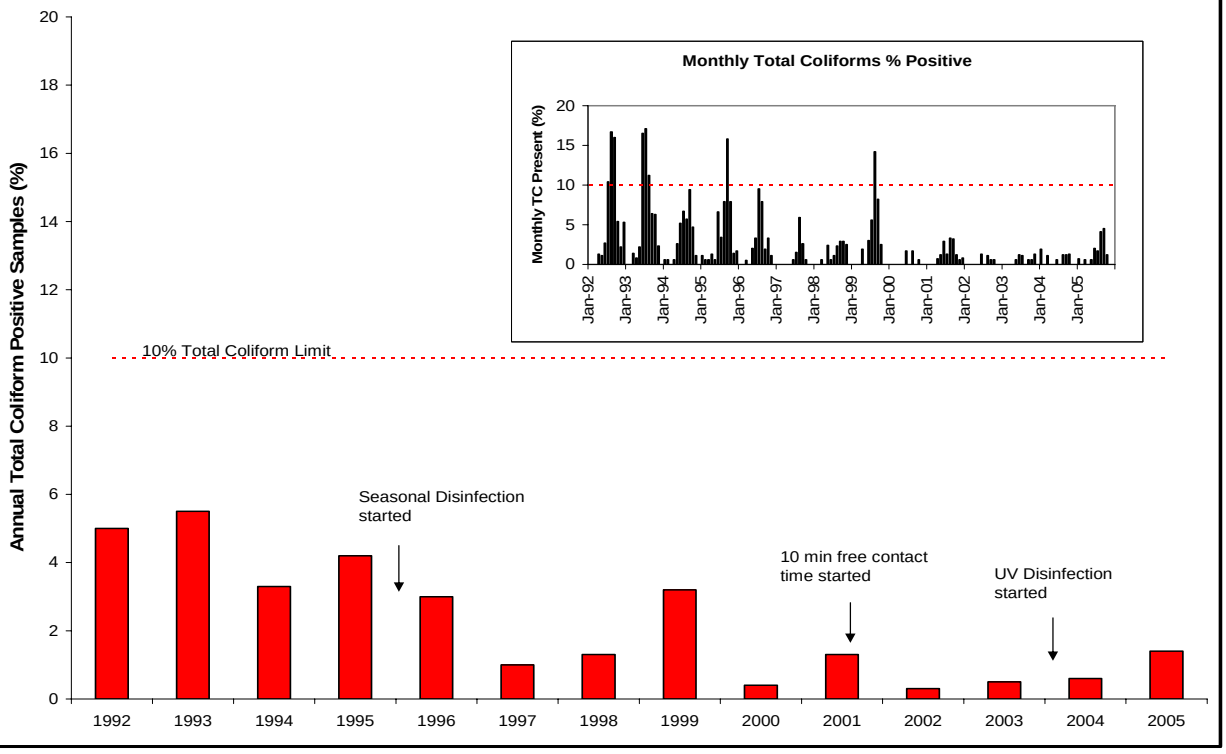
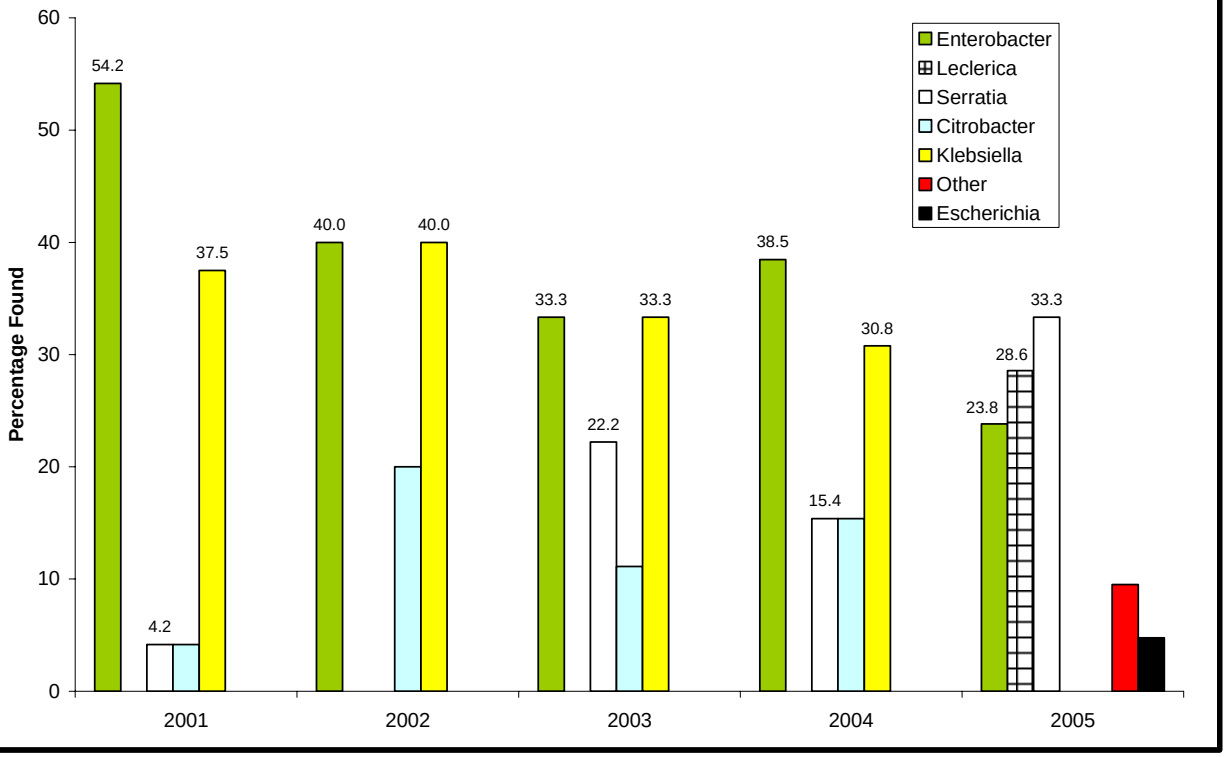



**Figure 7B. Dominant Bacteria in Greater Victoria Distribution System, 2001-2005**



In 2005, 29% of the coliform positives were identified as *Leclercia adecaroxylata*. This particular organism has been isolated from various environmental sources including water, food and milk. There is no evidence that it causes diarrhea or intestinal infections. Prior to 2005, this organism was found once (in 2004) in the treated water at the first customer location (**Figure 7B**).

**Fecal Coliforms**. Although no *E. coli* were found in 2005 (**Table 5)**, one of the total coliforms found in late July from the Saanich Cedar Hill pumphouse was identified as *Escherichia hermannii*, - a bacterium that is found in the intestines of warm-blooded animals. No explanation for this occurrence is available. The resample was negative for total and fecal coliforms.

#### 4.6.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

**Chlorine Residual**. The annual median chlorine residual observed in the Greater Victoria Distribution System (combined sampling stations) was 0.63 mg/L (**Table 5**). This value is somewhat higher than the level observed in 2003 and similar to 2004 and previous years. The level of chlorine residual in the distribution system ranged between 0.0 and 1.56 mg/L. The highest value observed was well below the 3.0 mg/L limit in the Canadian Guidelines for chloramines. The chlorine residual remained fairly constant from January through mid-August and then dropped slightly from mid-August to mid-November before rising in December reflecting the steady dosage rate for the majority of the year (**Figure 7**).

**Water Temperature**. The annual median water temperature for the Greater Victoria Distribution System was 12.2°C and was 2.6°C higher (9.6°C) than the temperature of the water entering the water system at the Japan Gulch Plant. The median monthly temperature ranged from 7.3°C in January to 17.9°C in September (**Table 5**). The maximum daily water temperature of 22.8°C was reached in Sidney during the month of August. This was substantively warmer than the temperature of the water entering the Japan Gulch Treatment Plant from Sooke Reservoir.

## 4.7. CENTRAL SAANICH DISTRIBUTION SYSTEM

Thirteen sampling locations were used by the Water Quality Division to monitor the bacteriological quality of the water in the Central Saanich Distribution System. Ten locations were sampled bi-weekly and three monthly.

#### 4.7.1. SAMPLE COLLECTION

During 2005, a total of 281 bacteriological samples were collected from the Central Saanich Distribution System (**Table 6**).

#### 4.7.2. BACTERIA

**Total Coliforms**. Total coliforms were found in samples collected in June and September from two locations (Amwell and Aston in September and Welch Rd. at Martindale in June) in the Central Saanich Distribution System (**Table 6**). The Central Saanich Distribution System complied with the 10% total coliform positive limit for all months of the year during 2005 except for June. The annual total coliform percentage positive was well below the 10% limit at 1.8% (**Figure 8)**. The organism responsible for the coliform positives was identified as *Enterobacter amnigenus*, a common inhabitant of fresh waters.

Over the long term, since 1999, there has been an improvement in the bacteriological

quality of the water in the Central Saanich Distribution System as evidenced by the reduction in the annual percentage of samples with total coliforms positive and the general trend of reduction of the number of months where total coliform positives were observed (**Figure 8a**). In addition, since 1999, the Central Saanich Distribution System has complied with the 10% total coliform positive limit for all months with the exception of June 2005 (**Figure 8a**).

**Fecal Coliforms**. None of the samples contained fecal coliforms in 2005 (**Table 6**).

4.7.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

**Chlorine Residual**. The annual median chlorine residual for the Central Saanich Distribution System was 0.69 mg/L (**Table 6**). The monthly median chlorine residual remained fairly constant throughout the year with the exception of July and August when the residual dipped slightly (**Figure 8**).

**Water Temperature**. The annual median water temperature in the Central Saanich Distribution System was 11.6°C with monthly medians ranging between 7.5°C and 17.7°C (**Table 6**).

**Figure 8. Central Saanich Distribution System**
**Total Coliforms and Chlorine Residual in 2005**

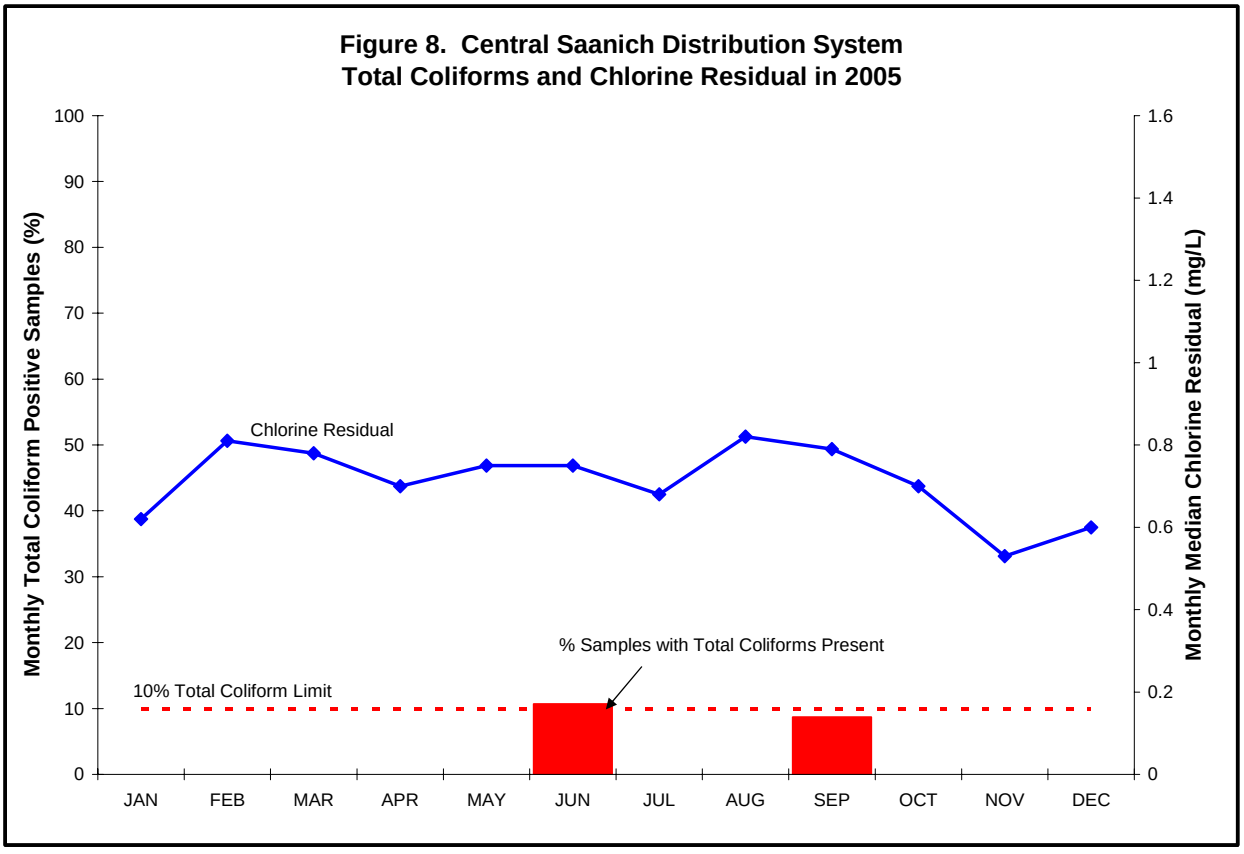
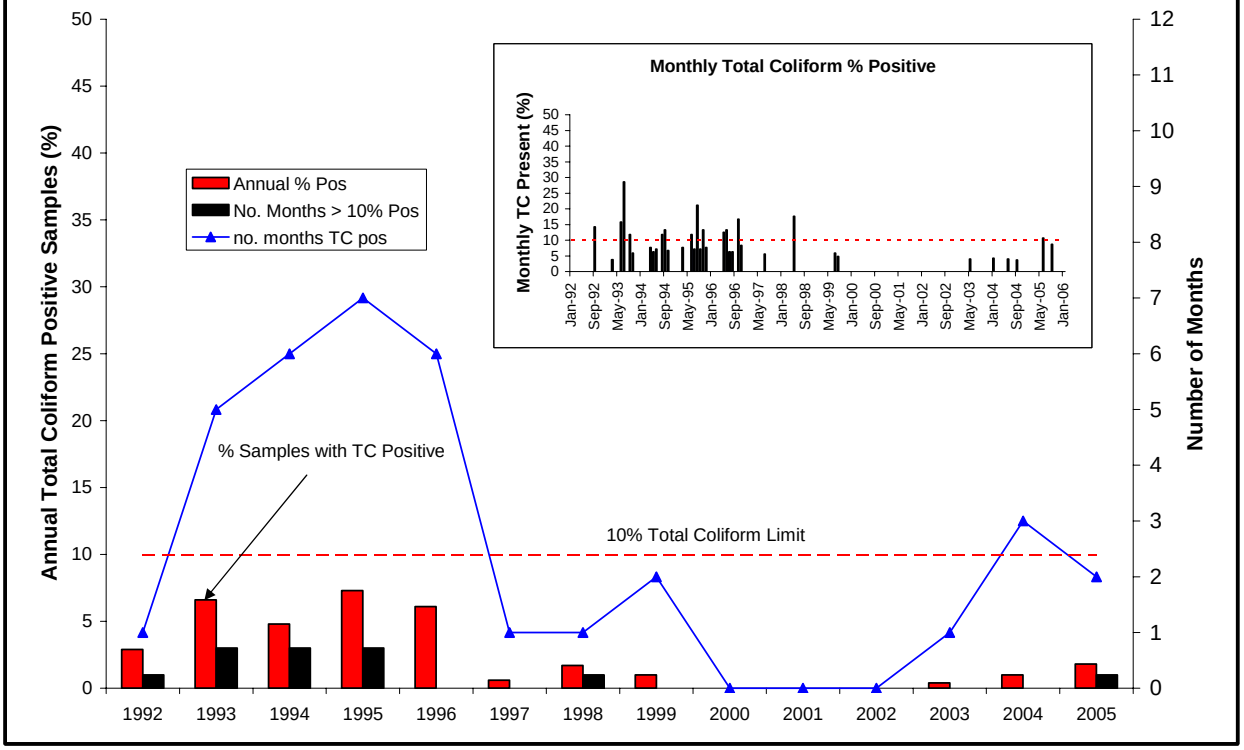


**Figure 8a. Central Saanich Distribution System**
**Long Term Summary of Total Coliforms**




## 4.8. NORTH SAANICH DISTRIBUTION SYSTEM

Eight sampling locations were used to monitor the bacteriological quality of the drinking water in the North Saanich Distribution System. One of these locations was sampled weekly, five locations bi-weekly and two locations monthly. The majority of these sampling locations are extremities of the distribution system.

### 4.8.1. SAMPLE COLLECTION

During 2005, a total of 182 bacteriological samples were collected from the North Saanich Distribution System (**Table 7**).

### 4.8.2. BACTERIA

**Total Coliforms**. None of the samples collected from the North Saanich Distribution System contained total coliform bacteria (**Table 7** and **Figure 9**).

Over the long term, in a similar fashion to Central Saanich, the bacteriological quality of the water in the North Saanich Distribution System has improved from 1999 onwards as evidenced by the reduction in the annual percentage of samples with total coliforms positive and the reduction of the number of months where total coliform positives were observed (**Figure 9a**). In addition, since 1996, the North Saanich Distribution System has complied with the 10% total coliform positive limit for all months up to and including 2005 (**Figure 9a**).

**Fecal Coliforms**. No fecal coliforms were present in any of the samples collected from the North Saanich Distribution System.

### 4.8.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

**Chlorine Residual**. The annual median chlorine residual for the North Saanich Distribution System was 0.45 mg/L. The monthly median chlorine residuals ranged from a low of 0.24 mg/L in November to a high of 0.80 in March (**Table 7**). This chlorine residual pattern was slightly different than that observed in other municipal distribution systems and is a reflection of the rechlorination used by the CRD Environmental Services Department primarily in the water supplied to the municipal system from the Deep Cove Pumping Station (**Figure 9**). It is interesting to note that the annual median chlorine residual in the North Saanich Distribution System was lower than the annual median residual for the combined distribution system and was the second lowest observed for any of the municipal distribution systems even with the rechlorination of the water.

**Water Temperature**. The annual median water temperature in the North Saanich Distribution System was 11.9°C (**Table 7**), similar to that found in 2000, 2001, 2002 and 2004 and lower than in 2003.

**Figure 9. North Saanich Distribution System**
**Total Coliforms and Chlorine Residual in 2005**

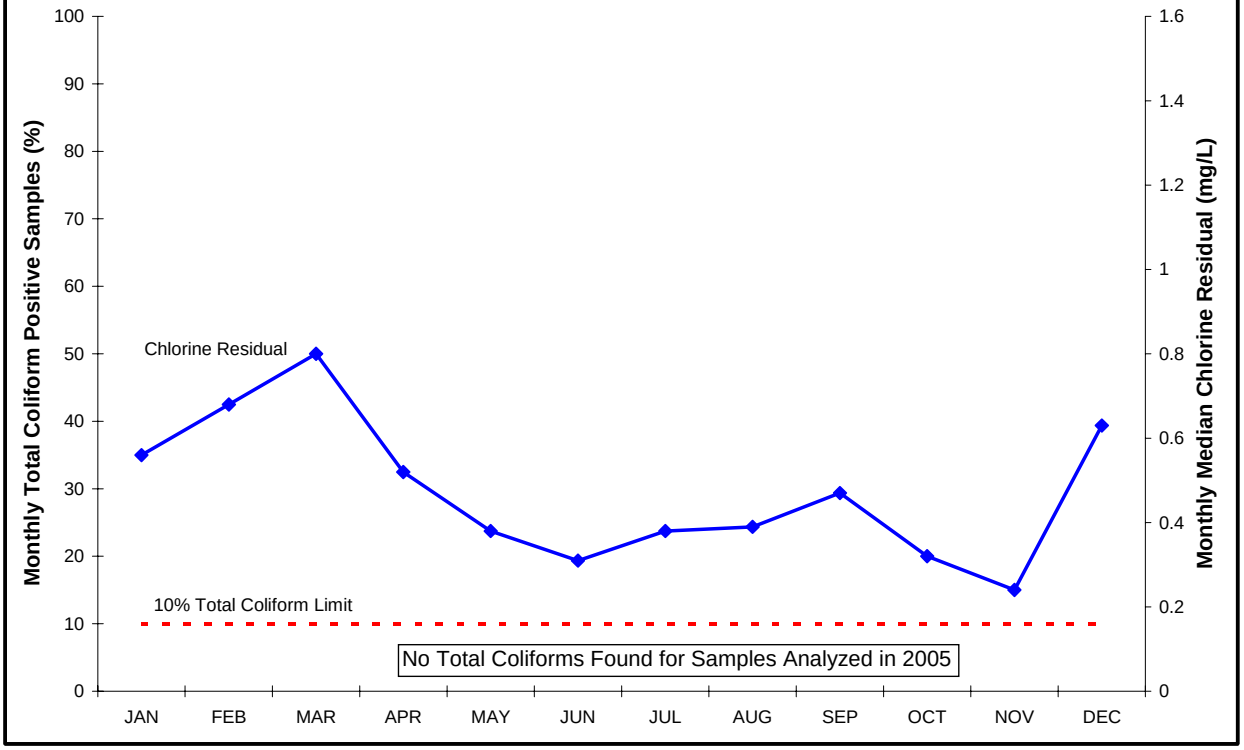
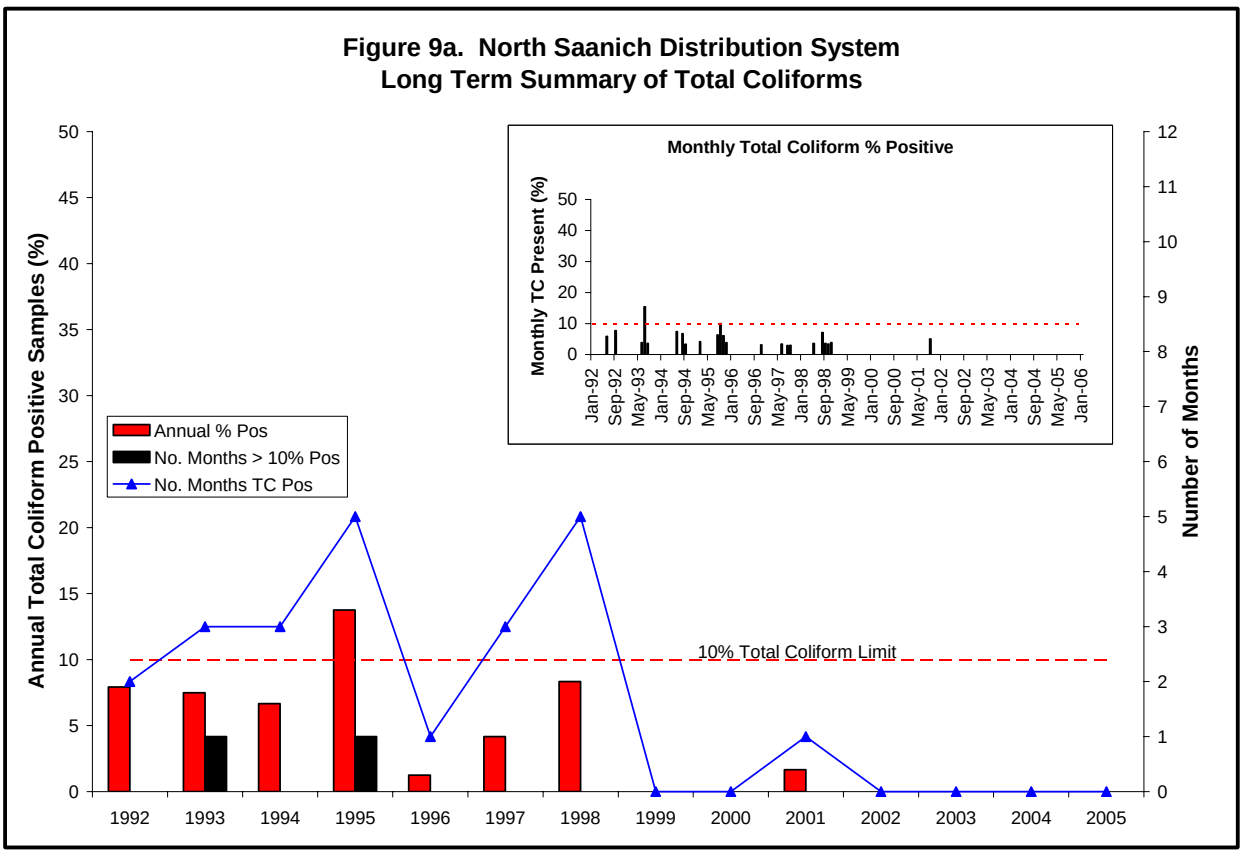



**Figure 9a. North Saanich Distribution System**
**Long Term Summary of Total Coliforms**



## 4.9. OAK BAY DISTRIBUTION SYSTEM

Seven sampling locations were used to monitor the bacteriological quality of the drinking water in the Oak Bay Distribution System. All seven locations were sampled bi-weekly.

### 4.9.1. SAMPLE COLLECTION

During 2005, a total of 166 bacteriological samples were collected from the Oak Bay Distribution System (**Table 8**).

### 4.9.2. BACTERIA

**Total Coliforms**. One of the samples collected from the Oak Bay Distribution System contained total coliform bacteria (**Table 8** and **Figure 10**). This is similar to 2000 to 2004 and an improvement from 1999 when coliforms were found during two months of the year. The positive coliform sample was from King George Terrace and was identified as the organism *Leclercia adecaroxylata* This particular organism has been isolated from various environmental sources including water, food and milk. There is no evidence that it causes diarrhea or intestinal infections. The resample was negative for coliforms.

Over the long term, the bacteriological quality of the water in the Oak Bay Distribution System has improved over time as evidenced by the reduction in the annual percentage of samples with total coliforms positive and the reduction of the number of months where total coliform positives were observed (**Figure 10a**). From 2000 through 2004, the Oak Bay Distribution System complied with the 10% total coliform positive limit for all months as no coliforms were observed (**Figure 10a**).

**Fecal Coliforms**. No fecal coliform bacteria were observed in any of the samples collected from the Oak Bay Distribution System.

### 4.9.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

**Chlorine Residual**. The annual median chlorine residual for the Oak Bay Distribution System was 0.80 mg/L (**Table 8**) and, as was the case in previous years, was the highest observed for the municipal distribution systems. The lowest monthly median chlorine residual occurred in November (0.40 mg/L) and the highest in September (1.05 mg/L) (**Figure 10**).

**Water Temperature**. The annual median water temperature in the Oak Bay Distribution System was 12.3°C (**Table 8**) with monthly median values ranging from 7.4°C to 18.1°C.

**Figure 10. Oak Bay Distribution System**
**Total Coliforms and Chlorine Residual in 2005**

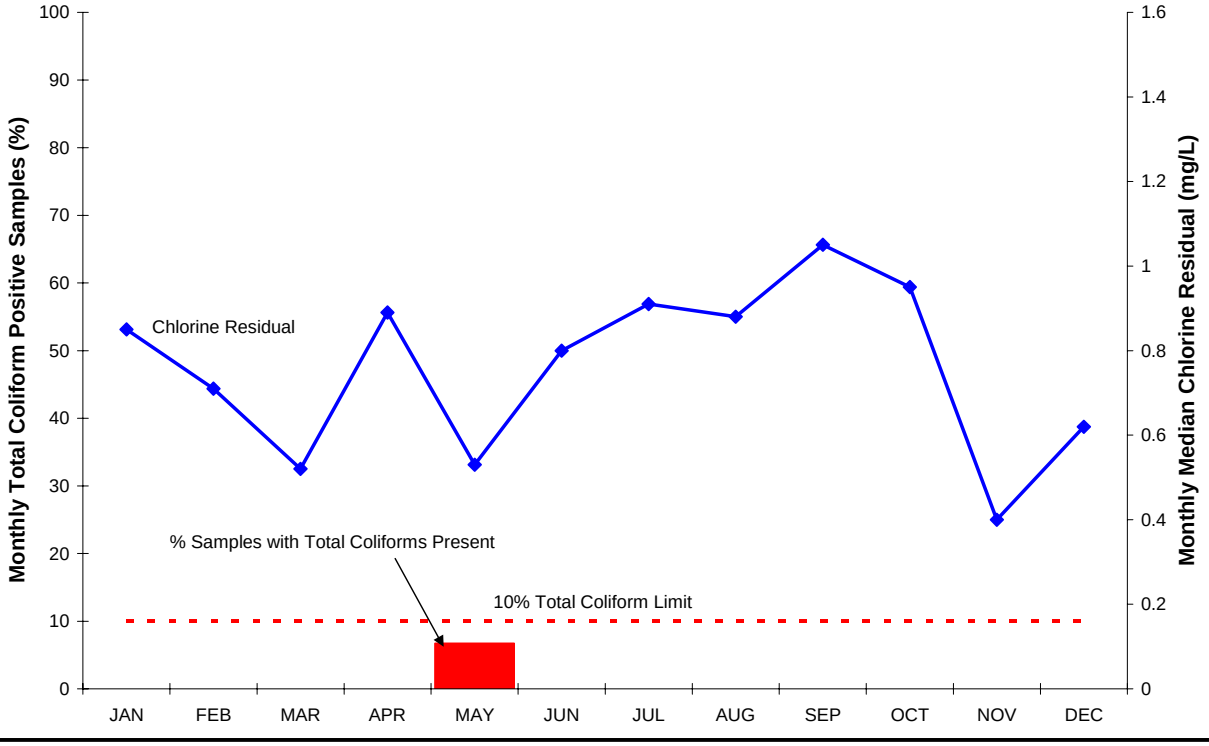
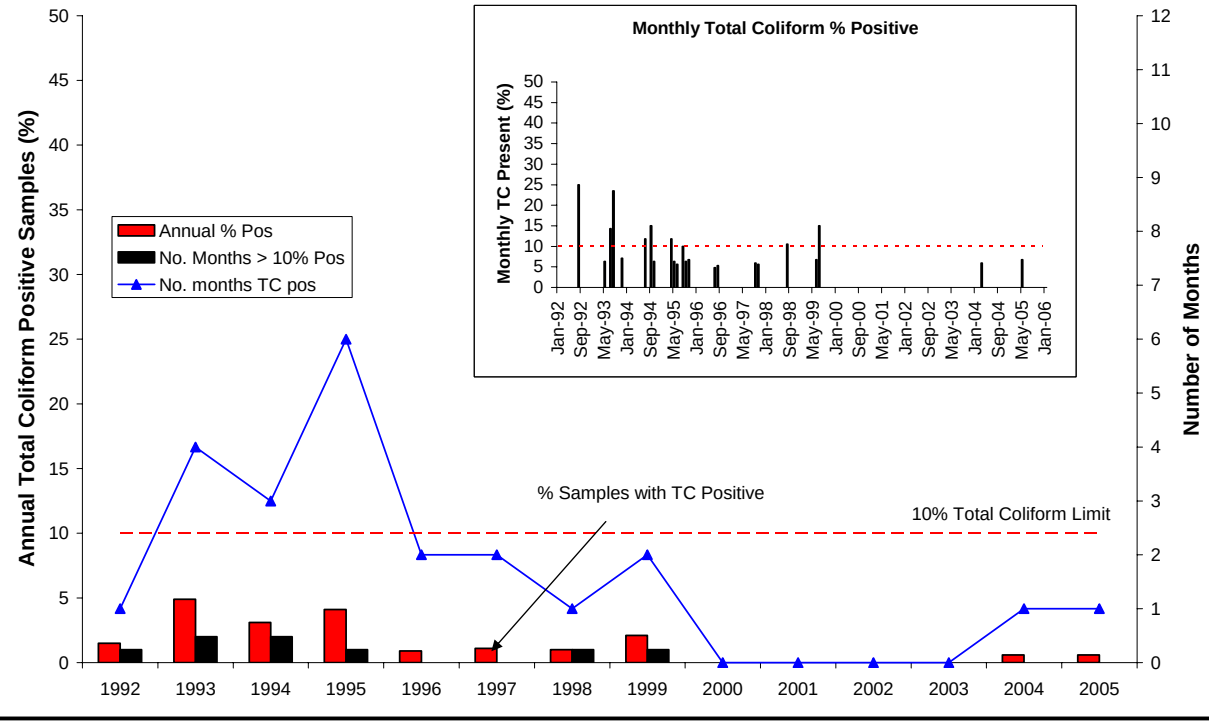



**Figure 10a. Oak Bay Distribution System**
**Long Term Summary of Total Coliforms**



## 4.10. SAANICH DISTRIBUTION SYSTEM

Nineteen sampling locations were used to monitor the bacteriological quality of the drinking water in the Saanich Distribution System. Fifteen locations were sampled bi-weekly, three were sampled monthly and one was sampled weekly.

### 4.10.1. SAMPLE COLLECTION

During 2005, a total of 475 bacteriological samples were collected from the Saanich Distribution System (**Table 9**). This is the largest municipal distribution system in the area with the largest population and this is reflected in the number of samples collected from the system.

### 4.10.2. BACTERIA

**Total Coliforms**. Seven samples collected from four locations in the Saanich Distribution System in March, and July through September contained total coliform bacteria (**Table 9**). All of the resamples were negative for coliforms. Expressed on an annual percentage basis, the total coliform positive rate was 1.5%. All monthly percentages for total coliform positive samples were under the 10% total coliform positive limit (**Figure 11**). One sample collected from the Prospect Lake area contained more than 10 coliforms, identified as *Serratia marcescens* (generally found in the natural environment). All of these results are similar to the previous five years and an improvement from 1999.

Over the long term, there has been an improvement in the bacteriological quality of the Saanich Distribution System water as evidenced by the general reduction in the percentage of samples with total coliforms present and a reduction in the number of months where total coliforms were observed (**Figure 11a**). The Saanich Distribution System has complied with the 10% total coliform positive limit for all months of the years 2000 through 2005 (**Figure 11a**).

**Fecal Coliforms**. None of the samples collected in 2005 contained fecal coliform bacteria.

### 4.10.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

**Chlorine Residual**. The annual median chlorine residual for the Saanich Distribution System was 0.70 mg/L (**Table 9**) which was slightly higher than that for the Greater Victoria Distribution System as a whole (0.63). The lowest monthly median chlorine residual occurred in October (0.52) and the highest in December (0.80) (**Figure 11**).

**Water Temperature**. The annual median water temperature in the Saanich Distribution System was 12.2°C, and ranged from a monthly median of 7.2°C in January to 17.8°C in December (**Table 9**).

**Figure 11. Saanich Distribution System**
**Total Coliforms and Chlorine Residual in 2005**

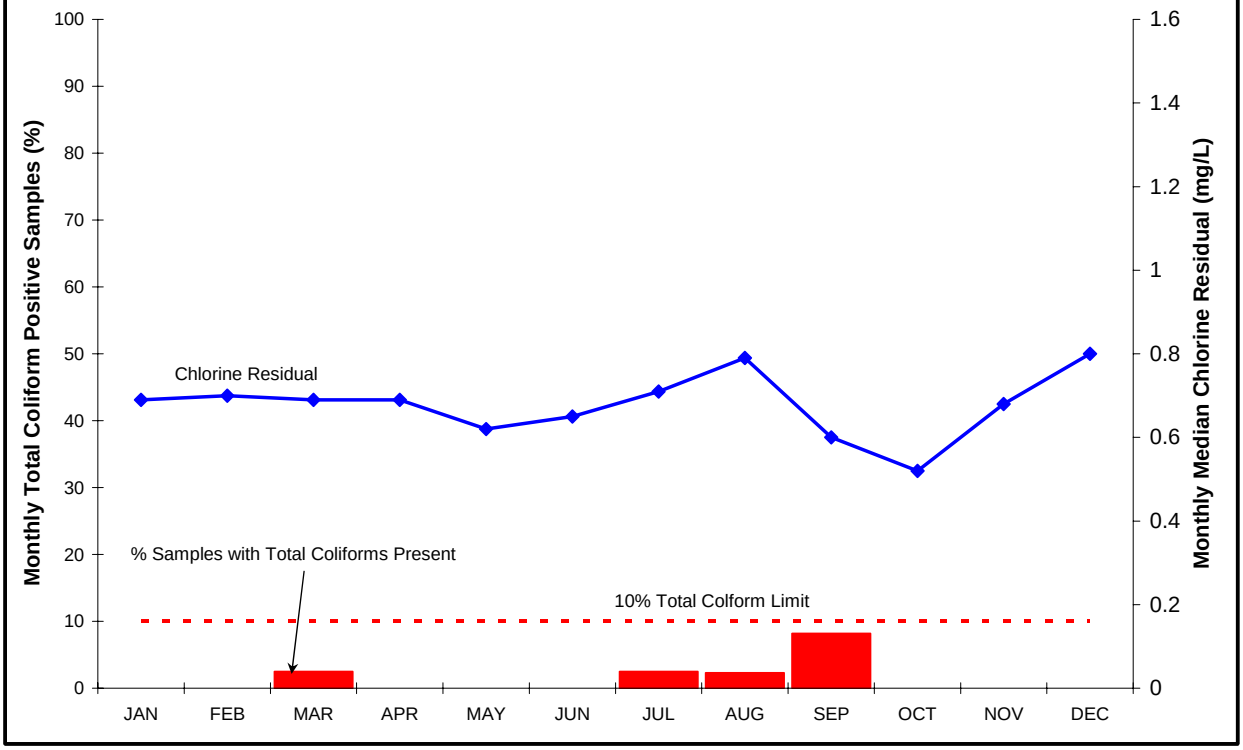
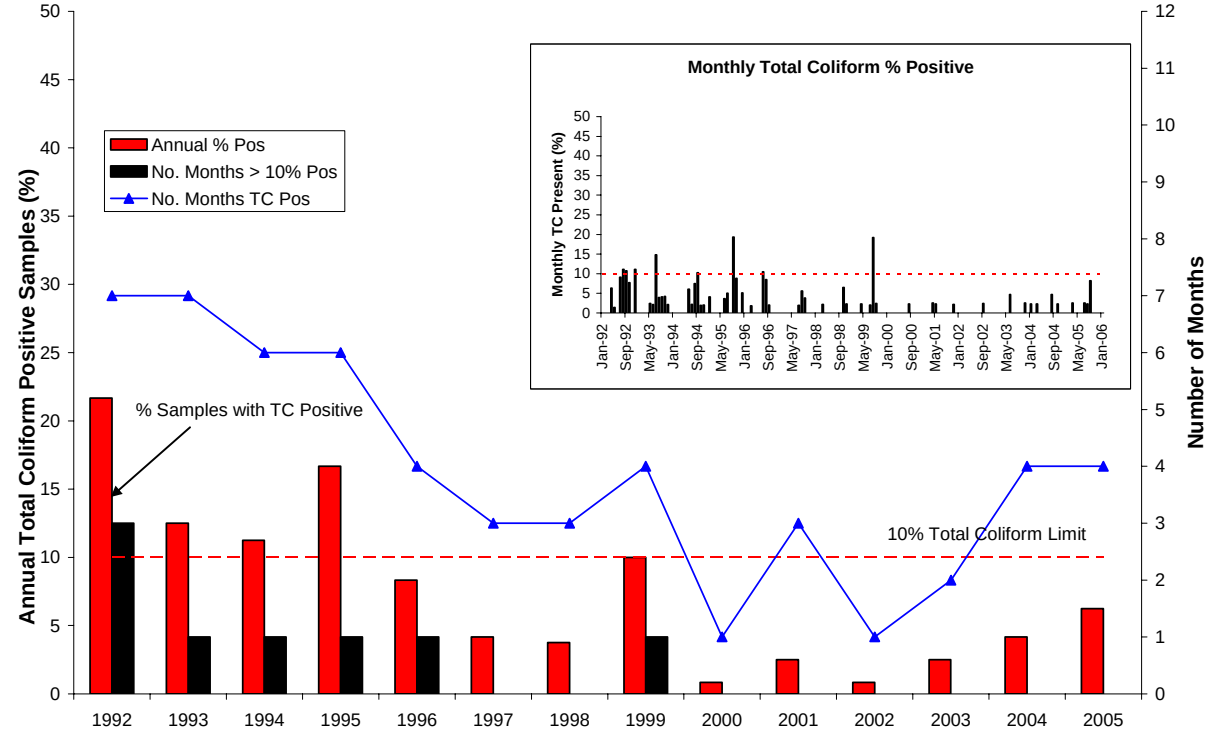



**Figure 11a. Saanich Distribution System**
**Long Term Summary of Total Coliforms**



## 4.11. SIDNEY DISTRIBUTION SYSTEM

Six sampling locations were used to monitor the bacteriological quality of drinking water in the Sidney Distribution System. Five locations were sampled bi-weekly with one location sampled monthly (extremity).

### 4.11.1. SAMPLE COLLECTION

During 2005, a total of 134 bacteriological samples were collected from the Sidney Distribution System (**Table 10**).

### 4.11.2. BACTERIA

**Total Coliforms**. None of the samples collected in 2005 from the Sidney Distribution System contained total coliform bacteria (**Table 10** and **Figure 12**). These results are similar to the previous four years and an improvement from 1999.

Over the long term the bacteriological quality of the water in the Sidney Distribution system has improved over time as evidenced by the general reduction in the annual percentage of samples with total coliforms positive and the reduction of the number of months where total coliform positives were observed (**Figure 12a**). The Sidney Distribution System has complied with the 10% total coliform positive limit for all months of 2000 through 2005 (**Figure 12a**).

**Fecal Coliforms**. None of the samples from the Sidney Distribution System contained fecal coliform bacteria.

### 4.11.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

**Chlorine Residual**. The annual median chlorine residual for the Sidney Distribution System was 0.48 mg/L (**Table 10**) with the lowest monthly median chlorine residual occurring in November (0.29) and the highest in December (0.62) (**Figure 12**).

**Water Temperature**. The annual median water temperature in the Sidney Distribution System was 12.1°C, ranging from a low monthly median of 7.0°C in January to a high of 18.2°C in September (**Table 10**).

**Figure 12. Sidney Distribution System**
**Total Coliforms and Chlorine Residual in 2005**

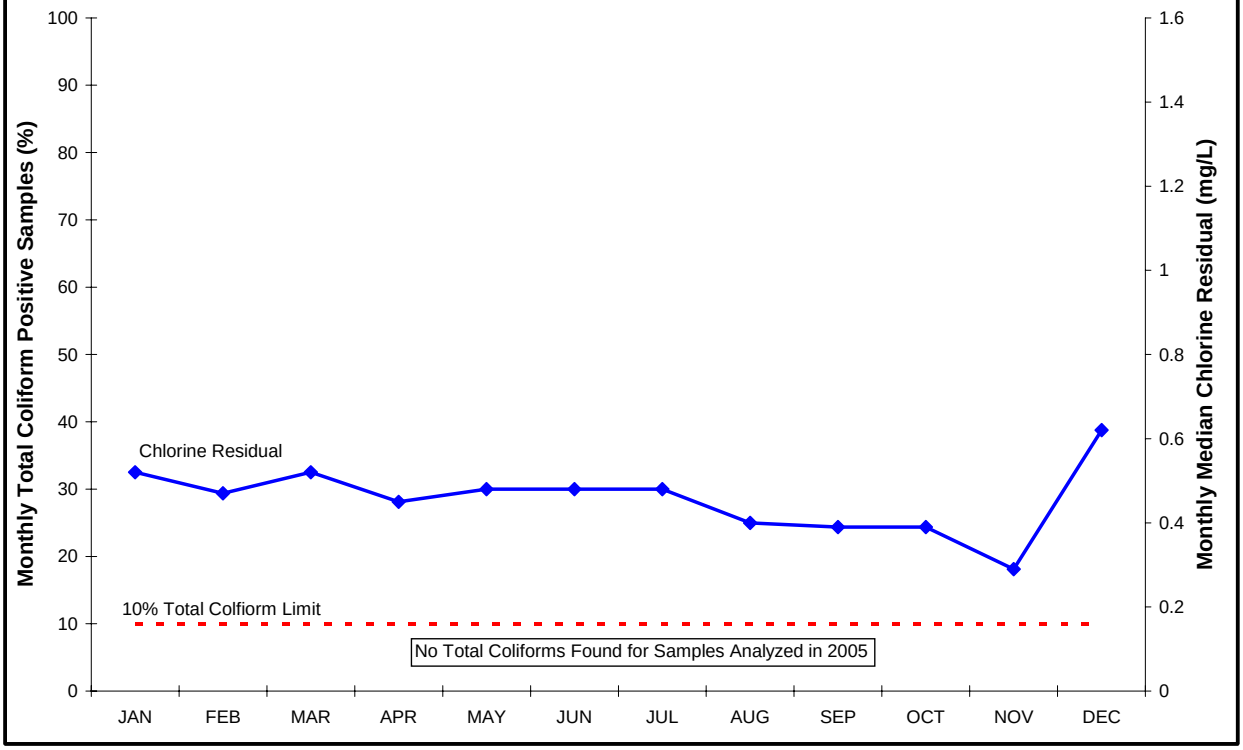
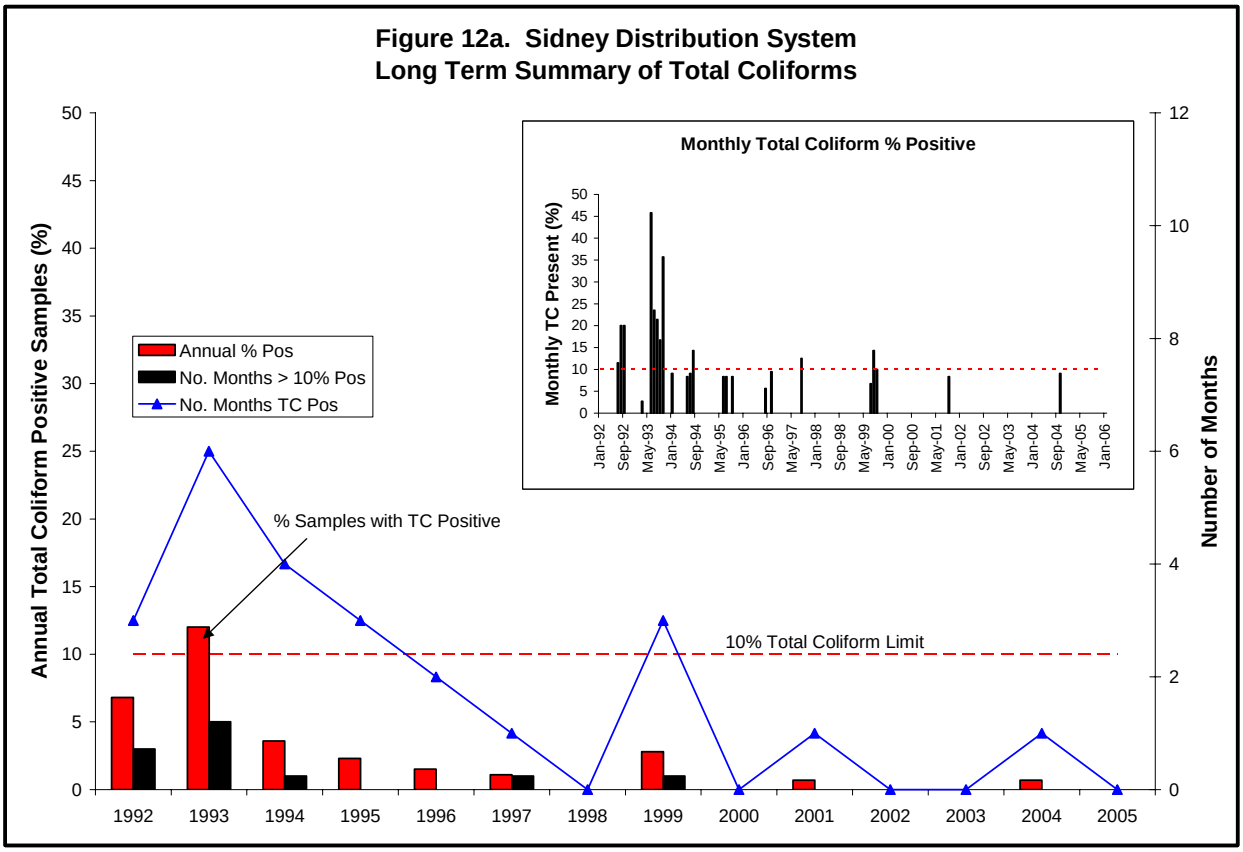



**Figure 12a. Sidney Distribution System**
**Long Term Summary of Total Coliforms**



## 4.12. VICTORIA / ESQUIMALT DISTRIBUTION SYSTEM

Eleven sampling locations were used to monitor the bacteriological quality of drinking water in the City of Victoria and Esquimalt Distribution System. (**Note**: The City of Victoria owns and operates the distribution system in Esquimalt.) These locations were all sampled bi-weekly with the exception of one location sampled monthly.

### 4.12.1. SAMPLE COLLECTION

During 2005, a total of 266 bacteriological samples were collected from the sampling locations in the Victoria/Esquimalt Distribution System (**Table 11**).

### 4.12.2. BACTERIA

**Total Coliforms**. One of the samples collected from 1540 Dallas Road contained one total coliform bacteria identified as an *Enterobacter* species (**Figure 13**). The resample was negative for coliforms (**Table 11**).

Overall, these results are similar to the good results in previous years. In general, the bacteriological quality of the Victoria / Esquimalt Distribution System water has improved over the long term (**Figure 13a**). There has been a reduction in the annual percentage samples having total coliforms as well as the number of months with coliforms present. The Victoria / Esquimalt Distribution System has been in compliance with the monthly 10% limit for coliforms for all months of the years 2000 through 2005 (**Figure 13a**).

**Fecal Coliforms**. There were no fecal coliform positives samples from the Victoria/Esquimalt Distribution System in 2005.

### 4.12.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

**Chlorine Residual**. The annual median chlorine residual for the Victoria / Esquimalt Distribution System was 0.76 mg/L (**Table 11**) with the lowest monthly median chlorine residual occurring in July (0.68) and the highest in January (0.81). The annual median chlorine residual in the Victoria / Esquimalt Distribution System was higher than the annual median residual for the Greater Victoria Distribution System. The chlorine residual showed very slight seasonal variation during 2005 decreasing through the early summer before returning to winter levels from mid-September onwards (**Figure 13**).

All sampling locations within the Victoria / Esquimalt Distribution System had satisfactory chlorine residuals (above 0.2 mg/L) with the exception of the supply to the HMC Malahat building which had a median residual of only 0.09 mg/L (ranging from 0.02 to 0.23). This is similar to previous years for this location.

**Water Temperature**. The annual median water temperature in the Victoria / Esquimalt Distribution System was 12.9°C (**Table 11**), similar to past years. The monthly median water temperatures ranged from a low of 7.5°C in January to a high of 18.7°C in August. The daily maximum water temperature of 20.9°C was recorded in August at the Yates Street Firehall.

**Figure 13. Victoria/Esquimalt Distribution System**
**Total Coliforms and Chlorine Residual in 2005**

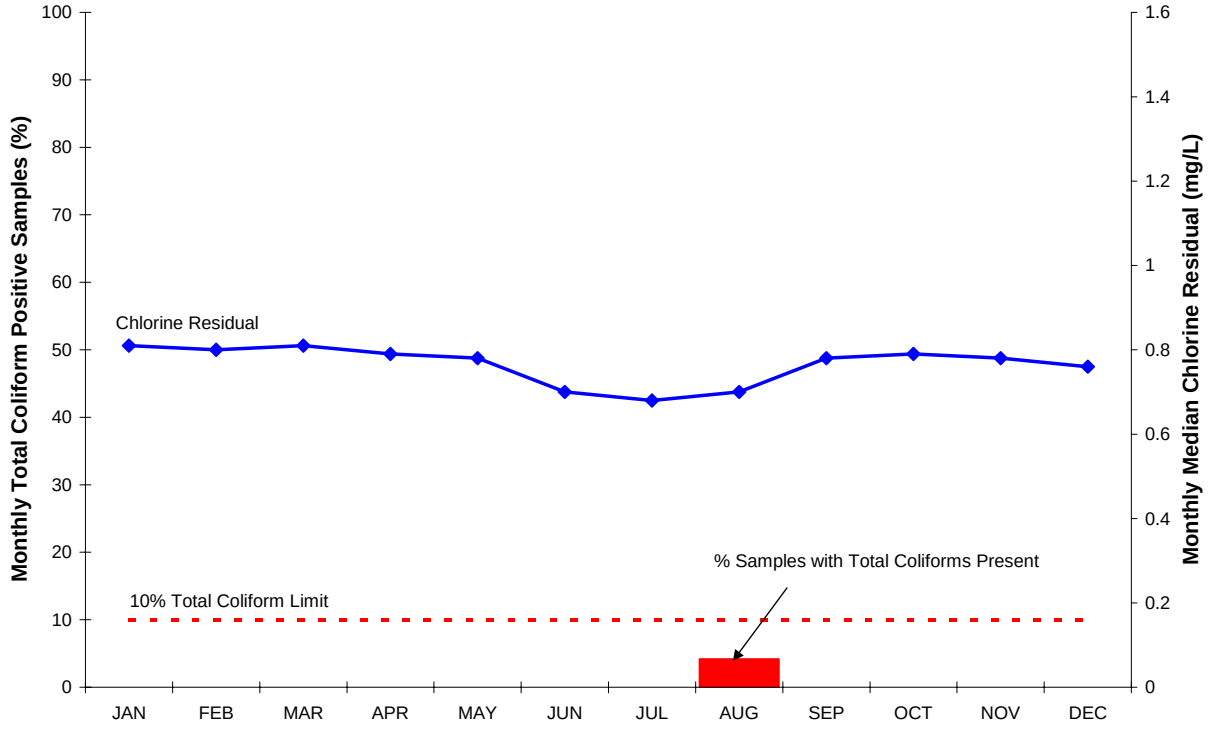
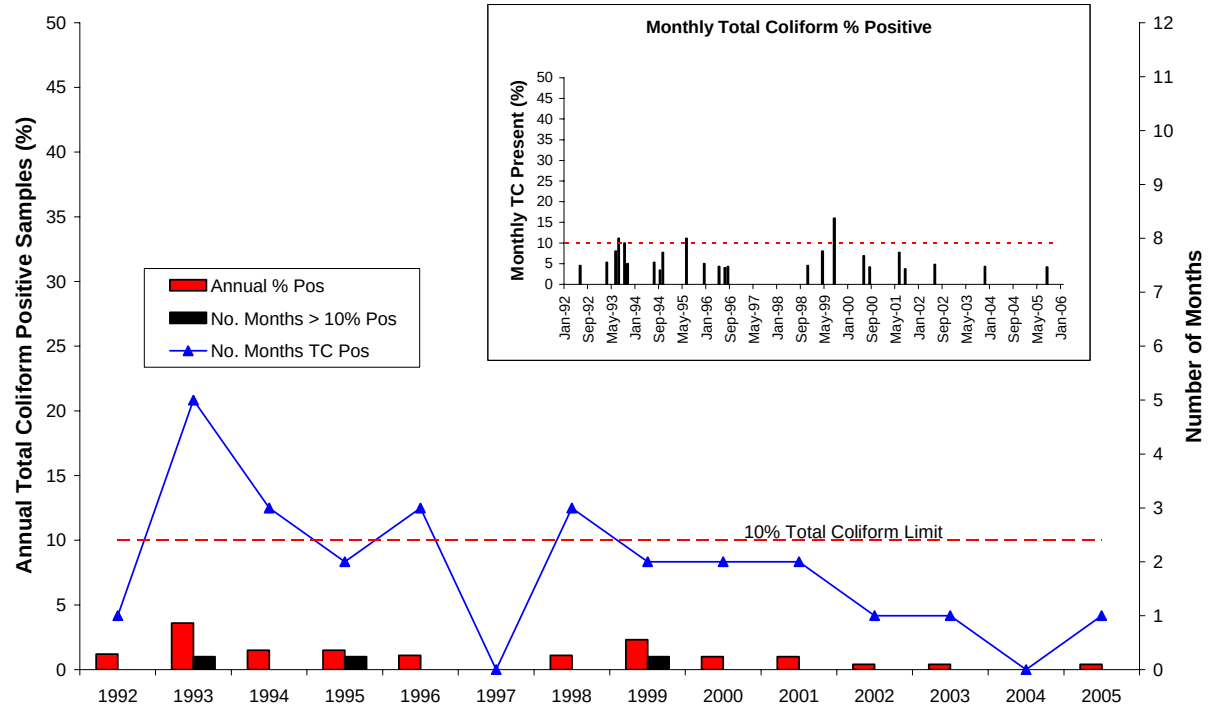



**Figure 13a. Victoria/Equimalt Distribution System**
**Long Term Summary of Total Coliforms**



## 4.13. JUAN DE FUCA WATER DISTRIBUTION SYSTEM

Twenty sampling locations were used to monitor the bacteriological quality of drinking water in the Juan de Fuca Water Distribution System which includes the municipalities of Colwood, Langford, Metchosin and View Royal. **(Note**: The distribution systems in Sooke and East Sooke are not included in this data set as these systems are supplied by a different treatment plant – Charters Treatment Plant. No bacteriological problems were found in those systems in 2005.)

Eleven locations were sampled bi-weekly, seven were sampled weekly (one mid-zone, one extremity, and five from the new Bear Mountain development), and two locations were sampled monthly.

### 4.13.1. SAMPLE COLLECTION

During 2005, a total of 618 bacteriological samples were collected from the Juan de Fuca Water Distribution System (**Table 12**). This is a higher sampling frequency than would normally be expected for the population size in the Juan de Fuca Water Distribution System. However, the distribution system is quite spread out with some long distances between users and is more complex than some of the other municipal distribution systems. Thus, this type of system requires additional monitoring to ensure bacteriologically safe drinking water.

### 4.13.2. BACTERIA

**Total Coliforms**. Fifteen samples (2.4%) collected from four locations contained total coliform bacteria (**Table 12**). Total coliform positive samples were observed in January, and in June through October (**Figure 14**).

The monthly percentage positives for total coliform samples did not exceed the 10% total coliform positive limit for any month of the year. This is similar to 2004, 2003 and 2002 and an improvement from 2001 when the Juan de Fuca Water Distribution System was the only distribution system to exceed this limit. None of the resamples contained total coliforms and three of the samples collected contained more than 10 total coliforms. Overall, these results are similar to those in recent years with the exception of the number of months in which coliforms were detected (**Figure 14a**). The coliforms were identified as *Enterobacter* species, *Serratia marcescens*, *Leclercia adecarboxylata*, and *Pantoea* species. The latter two organisms used to be known as *Enterobacter agglomerans*. All of these organisms are common in water and found throughout the natural environment. *Pantoea* has been isolated from plants seeds, fruits and soils.

Over the long term, there has been a general improvement in the bacteriological quality of the water in the Juan de Fuca Water Distribution System (with the exception of 1999 and 2001) as evidenced by the reduction in the overall annual percentage positive samples having coliforms and the number of months when coliforms were present (**Figure 14a**). However, due to the length of the distribution system relative to the low population, which increases the detention time of the water in the distribution system and contributes to the loss of chlorine residual and the regrowth of bacteria, the improvement in water quality has not been as dramatic as in other Greater Victoria municipal distribution systems.

At or near the extremity of the distribution system in Metchosin, water is supplied to three federal facilities: the Department of National Defence (DND) and William Head Correctional Institute via a single water main on William Head Road and the Becher Bay Reserve.

**Figure 14. Juan de Fuca Water Distribution System**
**Total Coliforms and Chlorine Residual in 2005**

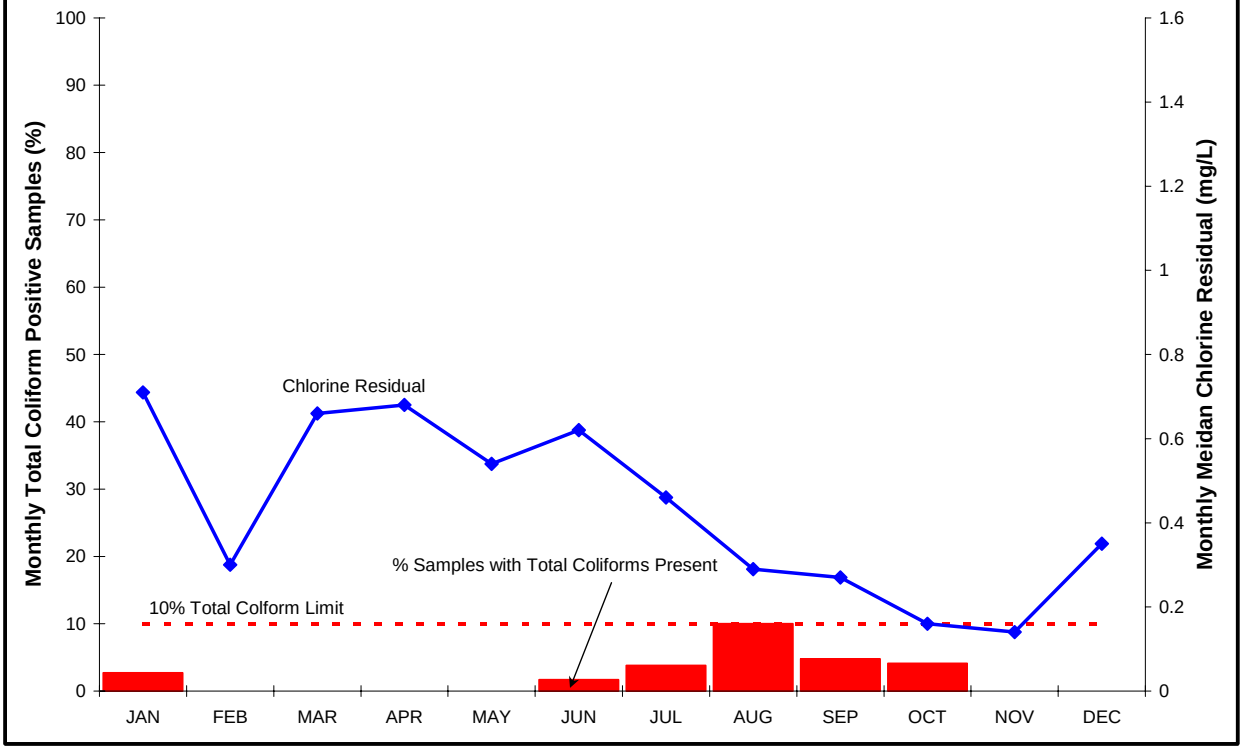
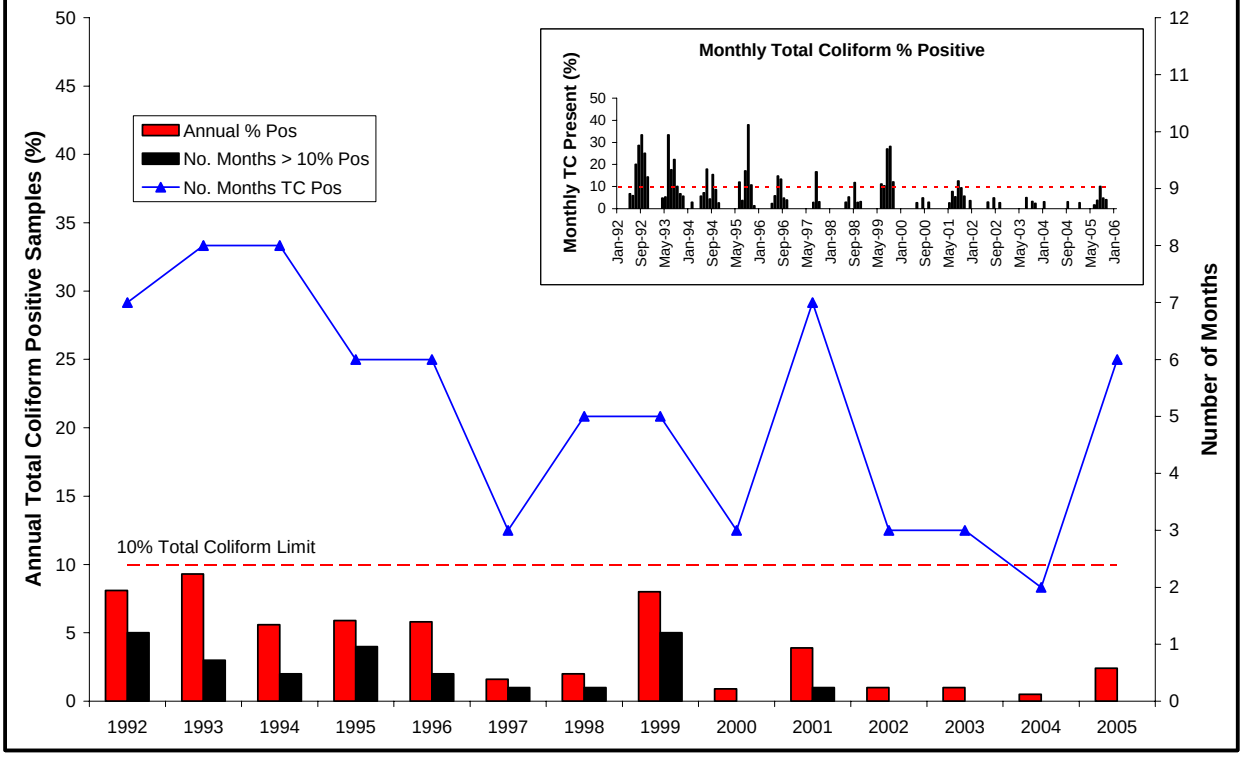



**Figure 14a. Juan de Fuca Water Distribution System**
**Long Term Summary of Total Colforms**



The results of samples collected from the three points of supply to these facilities are provided below:

- **DND**. In 2005, the supply to the Mary Hill Reservoir (operated by DND) was sampled monthly. Low to moderate total chlorine residuals (ranging from 0.12 to 0.31 mg/L and a median of 0.19 mg/L) were observed with no evidence of total coliforms exceeding the limits. However, as the water in this reservoir loses its chlorine residual, DND rechlorinates the water in the reservoir and provides it to their internal distribution system on the base.

- **William Head Correctional Institute**. In 2005, the supply to William Head Correctional Institute was sampled every 2 weeks. Low total chlorine residuals (ranging from 0.05 to 0.27 mg/L and a median of 0.10 mg/L) were observed with three samples containing total coliform bacteria identified as *Serratia marcescens*. Within the internal distribution system of the Institute, the chlorine residuals fall to zero leaving it vulnerable to bacterial regrowth. In 2002, Public Works Canada installed a rechlorination facility within the Institute to enhance chlorine residuals within that internal distribution system.

- **Becher Bay Reserve**. In 2005, the supply to the Becher Bay Reserve was sampled weekly. Typically, the chlorine residuals at this location were low (ranging from 0.03 to 0.38 mg/L with a median of 0.13 mg/L). Total coliforms were detected in three samples collected in 2005 (5.4% positive). The coliform bacteria were identified as *Enterobacter* species and *Serratia marcescens.* This is similar to 2004, 2003 and 2002 and a vast improvement from 2001 when this one location accounted for 76% of the positive samples observed in the Juan de Fuca Water Distribution System. In September 2002, a rechloramination station was installed at Rocky Point Reservoir to address the problem of low chlorine residuals at this location and within this general area.

**Fecal Coliforms**. None of the samples collected in the Western Communities was found to contain fecal coliforms in 2005.

### 4.13.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

**Chlorine Residual**. The annual median chlorine residual for the Juan de Fuca Water Distribution System was 0.66 mg/L (**Table 12**). This was the second lowest chlorine residual observed among the municipal distribution systems and is a reflection of this extended distribution system. The lowest monthly median chlorine residual occurred in March (0.38) and the highest in May (0.78). (**Figure 14**). Four of the seventeen locations within the distribution system had very low annual median chlorine residuals (0.04, 0.17, 0.18, and 0.18 mg/L).

**Water Temperature**. The annual median water temperature in the Juan de Fuca Water Distribution System was 12.5°C, similar to previous years (**Table 12**).

# APPENDIX A. Headings Used In Tables

The tables listed in this report contain the following column headings:

**Samples Collected.** This column shows the number of bacteriological samples that were collected monthly from the sampling points in the drinking water system.

**Total Coliforms - Samples TC>0.** This column shows the number of samples collected in which total coliforms were present.

**Total Coliforms - Percent TC>0.** This column shows the number of samples that contained total coliforms as a percentage of the total number of monthly samples collected. To meet the microbiological standard, the BC Safe Drinking Water Regulation specifies that 90% or more of the samples collected within a 30-day period must have 0 total coliforms per 100 mL. Stated another way, the Guidelines for Canadian Drinking Water Quality specify that not more than 10% of the samples should show the presence of coliform organisms. If only one sample is collected in a 30 day period then that sample must not contain any total coliforms.

**Total Coliforms - Resamples TC>0.** This column shows the number of special samples (resamples) that were collected as a follow up to an earlier sample that contained total coliform bacteria. The Federal regulations specify that resamples should not contain total coliforms.

**Total Coliforms - Samples TC>10.** This column shows the number of samples collected in which total coliforms exceeded 10 colony forming units per100 mL.

**E. coli - Samples >0.** This column shows the number of samples collected in which *Escherichia coli* (*E. coli*) were present. *E. coli* is an indicator of recent fecal contamination.

**TCBK Samples TCBK > 200.** This column shows the instances when the background colonies (non-coliform) exceeded 200 colony forming units per 100 mL.

**FC Samples FC>0.** This column shows the number of samples collected in which fecal coliforms were present. Fecal coliforms (FC) are the bacterial group that is used to indicate the presence of fecal (sewage) contamination in drinking water.

**HPC2D – Samples Collected.** This column shows the number of samples that were analysed for heterotrophic plate count bacteria incubated for a two-days at 35°C.

**HPC2D – Samples >500.** This column shows the number of samples that contained more than 500 HPC2D colony forming units per millilitre.

**Turbidity – Adverse > 1 NTU.** This column shows the number of samples that had turbidity values greater than 1NTU as listed in the Guidelines for Canadian Drinking Water Quality. Generally, selected sites in the distribution systems are monitored for turbidity every two weeks.

**Chlorine Residual Median.** This column shows the monthly median (central value between the high and the low) chlorine residual, in milligrams per litre, for the samples collected from the specified area during any particular month.

**Water Temperature Median.** This column shows the monthly median water temperature, in degrees Celsius, for the samples collected from the specified area during any particular month.

# Table 1. 2005 Bacterial quality of the raw water entering the Japan Gulch Plant.

| | | Total Coliforms | | | | | E. coli | Turbidity | | Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples Present | Samples Collected | Samples >1 NTU | Median °C |
| JAN | 20 | 20 | 100 | | 20 | 19 | 8 | 20 | 0 | 5.5 |
| FEB | 20 | 20 | 100 | | 19 | 16 | 2 | 20 | 0 | 6.5 |
| MAR | 23 | 23 | 100 | | 5 | 19 | 1 | 21 | 0 | 7.3 |
| APR | 21 | 21 | 100 | | 10 | 19 | 0 | 21 | 0 | 8.3 |
| MAY | 21 | 20 | 95.2 | | 19 | 21 | 2 | 21 | 0 | 9.3 |
| JUN | 22 | 22 | 100 | | 9 | 22 | 0 | 23 | 0 | 10.7 |
| JUL | 20 | 20 | 100 | | 15 | 20 | 1 | 20 | 0 | 11.9 |
| AUG | 22 | 22 | 100 | | 22 | 22 | 1 | 22 | 0 | 15.4 |
| SEP | 21 | 21 | 100 | | 21 | 19 | 1 | 21 | 0 | 16.6 |
| OCT | 19 | 19 | 100 | | 19 | 19 | 1 | 19 | 0 | 13.5 |
| NOV | 21 | 21 | 100 | | 21 | 16 | 4 | 20 | 0 | 9.2 |
| DEC | 19 | 19 | 100 | | 19 | 7 | 4 | 19 | 0 | 6.3 |
| **TOTAL** | **249** | **248** | **99.6%** | | **199** | **219** | **25** | **247** | 0<br>**0** | **9.6** |

# Table 2. 2005 Bacterial quality of the treated water at the first customer.

| | | Total Coliform | | | | | Fecal Coliform | Turbidity | | Chlorine Residual | Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples FC>0 | Samples Collected | Samples >1 NTU | Median mg/L $Cl_2$ | Median °C |
| JAN | 20 | 0 | 0.0 | 0 | 0 | 0 | 0 | 19 | 0 | 1.14 | 4.5 |
| FEB | 20 | 0 | 0.0 | 0 | 0 | 0 | 0 | 20 | 0 | 1.16 | 5.6 |
| MAR | 21 | 0 | 0.0 | 0 | 0 | 0 | 0 | 20 | 0 | 1.22 | 6.6 |
| APR | 21 | 0 | 0.0 | 0 | 0 | 0 | 0 | 21 | 0 | 1.13 | 7.8 |
| MAY | 21 | 0 | 0.0 | 0 | 0 | 0 | 0 | 21 | 0 | 1.17 | 8.9 |
| JUN | 23 | 0 | 0.0 | 0 | 0 | 0 | 0 | 23 | 0 | 1.23 | 10.1 |
| JUL | 20 | 0 | 0.0 | 0 | 0 | 0 | 0 | 19 | 0 | 1.28 | 11.4 |
| AUG | 22 | 0 | 0.0 | 0 | 0 | 0 | 0 | 22 | 0 | 1.37 | 14.6 |
| SEP | 21 | 0 | 0.0 | 0 | 0 | 0 | 0 | 21 | 0 | 1.47 | 16.4 |
| OCT | 19 | 0 | 0.0 | 0 | 0 | 0 | 0 | 19 | 0 | 1.43 | 12.7 |
| NOV | 21 | 0 | 0.0 | 0 | 0 | 0 | 0 | 21 | 0 | 1.19 | 8.7 |
| DEC | 19 | 0 | 0.0 | 0 | 0 | 0 | 0 | 19 | 0 | 1.28 | 6.1 |
| **TOTAL** | **248** | **0** | **0.0%** | **0** | **0** | **0** | **0** | **245** | **0** | **1.22** | **9.1** |

**TC** = Total Coliforms, **TCBK** = Background colonies on Total Coliform test filter, **FC** = Fecal Coliforms
**$Cl_2$** = chlorine, **NTU** = Nephelometric turbidity unit.
**>** = Greater than, **mg/L** = milligrams per litre, °**C** = degrees Celsius

# Table 3. 2005 Bacterial quality of the transmission mains.

| | | Total Coliform | | | | | Fecal or E. coli | Turbidity | | Chlorine Residual | Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples >0 | Samples Collected | Samples >1 NTU | Median mg/L $Cl_2$ | Median $^{o}C$ |
| JAN | 40 | 0 | 0.0 | 0 | 0 | 0 | 0 | 9 | 0 | 1.05 | 5.3 |
| FEB | 37 | 0 | 0.0 | 0 | 0 | 0 | 0 | 5 | 0 | 1.08 | 6.3 |
| MAR | 40 | 0 | 0.0 | 0 | 0 | 0 | 0 | 5 | 0 | 1.06 | 7.2 |
| APR | 37 | 0 | 0.0 | 0 | 0 | 0 | 0 | 6 | 0 | 1.02 | 8.4 |
| MAY | 43 | 0 | 0.0 | 0 | 0 | 0 | 0 | 7 | 0 | 0.99 | 9.8 |
| JUN | 41 | 0 | 0.0 | 0 | 0 | 1 | 0 | 5 | 0 | 1.03 | 11.2 |
| JUL | 37 | 0 | 0.0 | 0 | 0 | 0 | 0 | 5 | 0 | 1.07 | 13.2 |
| AUG | 46 | 2 | 4.3 | 0 | 0 | 0 | 0 | 6 | 0 | 1.15 | 16.1 |
| SEP | 39 | 1 | 2.6 | 0 | 0 | 0 | 0 | 6 | 0 | 1.23 | 17.2 |
| OCT | 40 | 0 | 0.0 | 0 | 0 | 0 | 0 | 6 | 0 | 1.25 | 13.4 |
| NOV | 42 | 0 | 0.0 | 0 | 0 | 0 | 0 | 5 | 0 | 1.13 | 9.7 |
| DEC | 37 | 0 | 0.0 | 0 | 0 | 0 | 0 | 6 | 0 | 1.14 | 7.2 |
| **Total** | **479** | **0** | **0.6%** | **0** | **0** | **1** | **0** | **71** | **0** | **1.09** | **9.9** |

# Table 4. 2005 Bacterial quality of the distribution system reservoirs.

| | | Total Coliform | | | | | Fecal Coliform | Turbidity | | Chlorine Residual | Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples FC>0 | Samples Collected | Samples >1 NTU | Median mg/L $Cl_2$ | Median $^{o}C$ |
| JAN | 67 | 1 | 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0.48 | 5.9 |
| FEB | 79 | 1 | 1.3 | 0 | 0 | 1 | 0 | 4 | 0 | 0.50 | 7.1 |
| MAR | 92 | 0 | 0.0 | 0 | 0 | 1 | 0 | 4 | 0 | 0.52 | 8.1 |
| APR | 83 | 2 | 2.4 | 0 | 0 | 0 | 1 | 5 | 0 | 0.53 | 9.7 |
| MAY | 84 | 3 | 3.6 | 0 | 0 | 0 | 0 | 4 | 0 | 0.52 | 11.7 |
| JUN | 95 | 9 | 9.5 | 0 | 0 | 1 | 0 | 5 | 0 | 0.40 | 13.9 |
| JUL | 83 | 5 | 6.0 | 0 | 0 | 1 | 0 | 4 | 0 | 0.30 | 15.3 |
| AUG | 107 | 13 | 12.1 | 0 | 0 | 2 | 0 | 5 | 0 | 0.18 | 17.5 |
| SEP | 94 | 9 | 9.6 | 0 | 0 | 0 | 0 | 4 | 0 | 0.21 | 17.1 |
| OCT | 85 | 2 | 2.4 | 0 | 0 | 2 | 0 | 4 | 0 | 0.24 | 13.3 |
| NOV | 82 | 2 | 2.4 | 0 | 0 | 0 | 0 | 6 | 0 | 0.22 | 9.6 |
| DEC | 77 | 0 | 0.0 | 0 | 0 | 0 | 0 | 3 | 1 | 0.48 | 7.3 |
| **TOTAL** | **1028** | **47** | **4.6%** | **0** | **0** | **8** | **1** | **48** | **1** | **0.40** | **11.4** |

**TC** = Total Coliforms, **TCBK** = Background colonies on Total Coliform test filter, **FC** = Fecal Coliforms
**$Cl_2$** = chlorine, **NTU** = Nephlometric turbidity units
**>** = Greater than, **mg/L** = milligrams per litre, °**C** = degrees Celsius

# Table 5. 2005 Bacterial quality of the Greater Victoria Distribution System.

| | | Total Coliform | | | | | Fecal or E. coli | Turbidity | | Chlorine Residual | Water Temp |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples >0 | Samples Collected | Samples >1 NTU | Median mg/L $Cl_2$ | Median $^{o}C$ |
| JAN | 151 | 1 | 0.7 | 0 | 0 | 1 | 0 | 17 | 1 | 0.67 | 7.3 |
| FEB | 162 | 0 | 0.0 | 0 | 0 | 0 | 0 | 21 | 0 | 0.68 | 7.9 |
| MAR | 178 | 1 | 0.6 | 0 | 0 | 0 | 0 | 28 | 0 | 0.70 | 8.8 |
| APR | 176 | 0 | 0.0 | 0 | 0 | 0 | 0 | 26 | 1 | 0.68 | 10.1 |
| MAY | 176 | 1 | 0.6 | 0 | 0 | 0 | 0 | 26 | 0 | 0.60 | 12.3 |
| JUN | 200 | 4 | 2.0 | 0 | 1 | 1 | 0 | 25 | 1 | 0.65 | 14.0 |
| JUL | 177 | 3 | 1.7 | 0 | 0 | 0 | 0 | 25 | 2 | 0.60 | 15.7 |
| AUG | 196 | 8 | 4.1 | 0 | 2 | 1 | 0 | 26 | 1 | 0.67 | 17.7 |
| SEP | 201 | 9 | 4.5 | 0 | 2 | 1 | 0 | 27 | 1 | 0.59 | 17.9 |
| OCT | 170 | 2 | 1.2 | 0 | 0 | 1 | 0 | 23 | 2 | 0.54 | 14.5 |
| NOV | 174 | 0 | 0.0 | 0 | 0 | 0 | 0 | 24 | 2 | 0.50 | 10.9 |
| DEC | 161 | 0 | 0.0 | 0 | 0 | 0 | 0 | 22 | 1 | 0.63 | 8.1 |
| **TOTAL** | **2122** | **29** | **1.4%** | **0** | **5** | **5** | **0** | **290** | **12** | **0.63** | **12.2** |

# Table 6. 2005 Bacterial quality of the Central Saanich Distribution System.

| | | Total Coliform | | | | | Fecal or E. coli | Turbidity | | Chlorine Residual | Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples >0 | Samples Collected | Samples >1 NTU | Median mg/L $Cl_2$ | Median $^{o}C$ |
| JAN | 23 | 0 | 0.0 | 0 | 0 | 0 | 0 | 3 | 0 | 0.62 | 7.5 |
| FEB | 22 | 0 | 0.0 | 0 | 0 | 0 | 0 | 3 | 0 | 0.81 | 7.9 |
| MAR | 21 | 0 | 0.0 | 0 | 0 | 0 | 0 | 3 | 0 | 0.78 | 8.8 |
| APR | 25 | 0 | 0.0 | 0 | 0 | 0 | 0 | 3 | 0 | 0.70 | 10.0 |
| MAY | 23 | 0 | 0.0 | 0 | 0 | 0 | 0 | 3 | 0 | 0.75 | 11.6 |
| JUN | 28 | 3 | 10.7 | 0 | 1 | 1 | 0 | 6 | 0 | 0.75 | 13.4 |
| JUL | 23 | 0 | 0.0 | 0 | 0 | 0 | 0 | 3 | 0 | 0.68 | 15.3 |
| AUG | 26 | 0 | 0.0 | 0 | 0 | 0 | 0 | 4 | 0 | 0.82 | 17.1 |
| SEP | 23 | 2 | 8.7 | 0 | 0 | 1 | 0 | 3 | 0 | 0.79 | 17.7 |
| OCT | 22 | 0 | 0.0 | 0 | 0 | 0 | 0 | 3 | 0 | 0.70 | 14.5 |
| NOV | 23 | 0 | 0.0 | 0 | 0 | 0 | 0 | 4 | 0 | 0.53 | 11.3 |
| DEC | 22 | 0 | 0.0 | 0 | 0 | 0 | 0 | 3 | 0 | 0.60 | 8.4 |
| **TOTAL** | **281** | **5** | **1.8%** | **0** | **1** | **2** | **0** | **41** | **0** | **0.71** | **11.6** |

**TC** = Total Coliforms, **TCBK** = Background colonies on Total Coliform test filter, **FC** = Fecal Coliforms
**$Cl_2$** = chlorine, **NTU** = Nephlometric turbidity units
**>** = Greater than, **mg/L** = milligrams per litre, °**C** = Degrees Celsius

# Table 7. 2005 Bacterial quality of the North Saanich Distribution System.

| | | Total Coliform | | | | | Fecal or E. coli | Turbidity | | Chlorine Residual | Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples >0 | Samples Collected | Samples >1 NTU | Median mg/L $Cl_2$ | Median $^oC$ |
| JAN | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.56 | 7.4 |
| FEB | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.68 | 7.8 |
| MAR | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.80 | 8.6 |
| APR | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0.59 | 9.9 |
| MAY | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.52 | 12.0 |
| JUN | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.38 | 13.7 |
| JUL | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.31 | 14.7 |
| AUG | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.38 | 17.6 |
| SEP | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.39 | 17.5 |
| OCT | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.32 | 14.7 |
| NOV | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.24 | 10.9 |
| DEC | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.63 | 8.4 |
| **TOTAL** | **182** | **0** | **0** | **0** | **0** | **0** | **0** | **11** | **2** | **0.45** | **11.9** |

# Table 8. 2005 Bacterial quality of the Oak Bay Distribution System.

| | | Total Coliform | | | | | Fecal or E. coli | Turbidity | | Chlorine Residual | Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples >0 | Samples Collected | Samples >1 NTU | Median mg/L $Cl_2$ | Median $^oC$ |
| JAN | 11 | 0 | 0.0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.85 | 7.4 |
| FEB | 12 | 0 | 0.0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.71 | 8.0 |
| MAR | 13 | 0 | 0.0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.52 | 9.2 |
| APR | 13 | 0 | 0.0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.89 | 10.5 |
| MAY | 15 | 1 | 6.7 | 0 | 0 | 0 | 0 | 2 | 0 | 0.53 | 12.3 |
| JUN | 16 | 0 | 0.0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.80 | 14.0 |
| JUL | 14 | 0 | 0.0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.91 | 15.3 |
| AUG | 15 | 0 | 0.0 | 0 | 0 | 0 | 0 | 2 | 1 | 0.88 | 17.6 |
| SEP | 16 | 0 | 0.0 | 0 | 0 | 0 | 0 | 2 | 0 | 1.05 | 18.1 |
| OCT | 15 | 0 | 0.0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.95 | 14.3 |
| NOV | 14 | 0 | 0.0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.40 | 10.9 |
| DEC | 12 | 0 | 0.0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.62 | 8.3 |
| **TOTAL** | **166** | **1** | **0.6%** | **0** | **0** | **0** | **0** | **23** | **1** | **0.80** | **12.3** |

**TC** = Total Coliforms, **TCBK** = Background colonies on Total Coliform test filter, **FC** = Fecal Coliforms
**$Cl_2$** = chlorine, **NTU** = Nephlometric turbidity units
**>** = Greater than, **mg/L** = milligrams per litre, °**C** = Degrees Celsius

# Table 9. 2005 Bacterial quality of the Saanich Distribution System.

| | | Total Coliform | | | | | Fecal or E. coli | Turbidity | | Chlorine Residual | Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples >0 | Samples Collected | Samples >1 NTU | Median mg/L $Cl_2$ | Median $^{o}C$ |
| JAN | 35 | 0 | 2.3 | 0 | 0 | 0 | 0 | 3 | 0 | 0.69 | 7.2 |
| FEB | 37 | 0 | 0.0 | 0 | 0 | 0 | 0 | 3 | 0 | 0.70 | 7.9 |
| MAR | 40 | 1 | 2.5 | 0 | 0 | 0 | 0 | 6 | 0 | 0.69 | 8.8 |
| APR | 40 | 0 | 0.0 | 0 | 0 | 0 | 0 | 5 | 0 | 0.69 | 10.2 |
| MAY | 35 | 0 | 0.0 | 0 | 0 | 0 | 0 | 4 | 0 | 0.62 | 12.2 |
| JUN | 43 | 0 | 0.0 | 0 | 0 | 0 | 0 | 4 | 0 | 0.65 | 13.9 |
| JUL | 40 | 1 | 2.5 | 0 | 0 | 0 | 0 | 4 | 1 | 0.71 | 15.7 |
| AUG | 43 | 1 | 2.3 | 0 | 0 | 0 | 0 | 4 | 0 | 0.79 | 17.7 |
| SEP | 49 | 4 | 8.2 | 0 | 1 | 0 | 0 | 7 | 0 | 0.60 | 17.8 |
| OCT | 37 | 0 | 0.0 | 0 | 0 | 0 | 0 | 4 | 0 | 0.52 | 14.3 |
| NOV | 37 | 0 | 0.0 | 0 | 0 | 0 | 0 | 4 | 0 | 0.68 | 10.8 |
| DEC | 39 | 0 | 0.0 | 0 | 0 | 0 | 0 | 4 | 0 | 0.80 | 8.1 |
| **TOTAL** | **475** | **7** | **1.5%** | **0** | **1** | **0** | **0** | **52** | **1** | **0.70** | **12.2** |

# Table 10. 2005 Bacterial quality of the Sidney Distribution System.

| | | Total Coliform | | | | | Fecal or E. coli | Turbidity | | Chlorine Residual | Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples FC>0 | Samples Collected | Samples >1 NTU | Median mg/L $Cl_2$ | Median $^{o}C$ |
| JAN | 9 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.52 | 7.0 |
| FEB | 11 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.47 | 7.5 |
| MAR | 12 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.52 | 9.0 |
| APR | 11 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.45 | 10.4 |
| MAY | 12 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.48 | 12.1 |
| JUN | 12 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.48 | 14.3 |
| JUL | 11 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.48 | 15.6 |
| AUG | 12 | 0 | 0.0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.40 | 17.7 |
| SEP | 12 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.39 | 18.2 |
| OCT | 11 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.39 | 14.6 |
| NOV | 11 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.29 | 11.6 |
| DEC | 10 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.62 | 8.1 |
| **Total** | **134** | **0** | **0.0%** | **0** | **0** | **0** | **0** | **1** | **0** | **0.48** | **12.1** |

**TC** = Total Coliforms, **TCBK** = Background colonies on Total Coliform test filter, **FC** = Fecal Coliforms
**$Cl_2$** = chlorine, **NTU** = Nephlometric turbidity units
**>** = Greater than, **mg/L** = milligrams per litre, °**C** = Degrees Celsius

# Table 11. 2005 Bacterial quality of the Victoria/Esquimalt Distribution System.

| | | Total Coliform | | | | | Fecal or E. coli | Turbidity | | Chlorine Residual | Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples >0 | Samples Collected | Samples >1 NTU | Median mg/L $Cl_2$ | Median $^{o}C$ |
| JAN | 21 | 0 | 0.0 | 0 | 0 | 0 | 0 | 7 | 1 | 0.81 | 7.5 |
| FEB | 21 | 0 | 0.0 | 0 | 0 | 0 | 0 | 7 | 0 | 0.80 | 7.9 |
| MAR | 22 | 0 | 0.0 | 0 | 0 | 0 | 0 | 8 | 0 | 0.81 | 9.6 |
| APR | 24 | 0 | 0.0 | 0 | 0 | 0 | 0 | 8 | 0 | 0.79 | 11.1 |
| MAY | 22 | 0 | 0.0 | 0 | 0 | 0 | 0 | 9 | 0 | 0.78 | 13.0 |
| JUN | 23 | 0 | 0.0 | 0 | 0 | 0 | 0 | 6 | 1 | 0.70 | 14.8 |
| JUL | 21 | 0 | 0.0 | 0 | 0 | 0 | 0 | 9 | 1 | 0.68 | 16.9 |
| AUG | 24 | 1 | 4.2 | 0 | 0 | 0 | 0 | 8 | 0 | 0.70 | 18.7 |
| SEP | 23 | 0 | 0.0 | 0 | 0 | 0 | 0 | 7 | 0 | 0.78 | 18.3 |
| OCT | 23 | 0 | 0.0 | 0 | 0 | 0 | 0 | 8 | 0 | 0.79 | 14.5 |
| NOV | 23 | 0 | 0.0 | 0 | 0 | 0 | 0 | 7 | 1 | 0.78 | 11.0 |
| DEC | 19 | 0 | 0.0 | 0 | 0 | 0 | 0 | 7 | 0 | 0.76 | 8.1 |
| **Total** | **266** | **1** | **0.4%** | **0** | **0** | **0** | **0** | **91** | **4** | **0.76** | **12.9** |

# Table 12. 2005 Bacterial quality of the Juan de Fuca Water Distribution System.

| | | Total Coliform | | | | | Fecal or E. coli | Turbidity | | Chlorine Residual | Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Samples Collected | Samples TC>0 | Percent TC>0 | Resamples TC>0 | Samples TC>10 | Samples TCBK>200 | Samples >0 | Samples Collected | Samples >1 NTU | Median mg/L $Cl_2$ | Median $^{o}C$ |
| JAN | 37 | 1 | 2.7 | 0 | 0 | 1 | 0 | 2 | 0 | 0.71 | 7.0 |
| FEB | 43 | 0 | 0.0 | 0 | 0 | 0 | 0 | 5 | 0 | 0.30 | 7.5 |
| MAR | 57 | 0 | 0.0 | 0 | 0 | 0 | 0 | 8 | 0 | 0.66 | 8.4 |
| APR | 47 | 0 | 0.0 | 0 | 0 | 0 | 0 | 6 | 0 | 0.68 | 10.0 |
| MAY | 54 | 0 | 0.0 | 0 | 0 | 0 | 0 | 7 | 0 | 0.54 | 12.5 |
| JUN | 60 | 1 | 1.7 | 0 | 0 | 0 | 0 | 6 | 0 | 0.62 | 14.3 |
| JUL | 53 | 2 | 3.8 | 0 | 0 | 0 | 0 | 6 | 0 | 0.46 | 15.9 |
| AUG | 60 | 6 | 10.0 | 0 | 2 | 1 | 0 | 6 | 0 | 0.29 | 17.8 |
| SEP | 62 | 3 | 4.8 | 0 | 1 | 0 | 0 | 7 | 1 | 0.27 | 17.7 |
| OCT | 49 | 2 | 4.1 | 0 | 0 | 1 | 0 | 6 | 2 | 0.16 | 14.3 |
| NOV | 50 | 0 | 0.0 | 0 | 0 | 0 | 0 | 6 | 1 | 0.14 | 10.8 |
| DEC | 46 | 0 | 0.0 | 0 | 0 | 0 | 0 | 6 | 0 | 0.35 | 8.2 |
| **Total** | **618** | **15** | **2.4%** | **0** | **3** | **0<br>3** | **0** | **71** | **4** | **0.36** | **12.5** |

**TC** = Total Coliforms, **TCBK** = Background colonies on Total Coliform test filter, **FC** = Fecal Coliforms
**$Cl_2$** = chlorine, **NTU** = Nephlometric turbidity units
**>** = Greater than, **mg/L** = milligrams per litre, °**C** = Degrees Celsius

For written version, insert hard copy of **Map 1** in this page
For web version see **Map 1** on the CRD web site at

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