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2008 Annual Bacteriological Summary of Greater Victoria's Drinking Water

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Executive Summary

The *2008 Annual Bacteriological Summary of Greater Victoria's Drinking Water* is the second report in the Water Quality Division's 2008 annual report series. It extends the bacteriological information given in the *2008 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 municipal 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 2008 continued to be very good and easily met the Provincial and Federal limits for safe, potable drinking water.

2. **Sample Collection**. In 2008, the Water Quality Division collected and analysed 4,384 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 2004 through 2007.

3. **Source Water**. In 2008 the level of total coliform bacteria in the raw source water entering the treatment plants were elevated during mid-September through early October (**Figure 1B**). The 2008 bacterial levels were similar to those observed in 2004 through 2007. As in previous years, the quality of the raw water entering the plant easily met the fecal coliform limit of no more than 10% of the samples having 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 1C**).

4. **First Customer**. In 2008, there was only one occurrence of total coliform bacteria at the first customer sampling location below the Japan Gulch Treatment Plant (**Figure 3**). The annual total coliform positive sample rate of 0.4% was comparable to the last several years (**Figure 4**). No *E. coli* bacteria were found in any of the samples collected at this sampling location. These findings provide further assurance of the bacterial safety of Greater Victoria's drinking water.

5. **Transmission Mains**. None of the samples collected from the transmission mains feeding the municipalities contained total coliforms (**Figure 5**). This result was similar to previous years and indicates that generally very few total coliform bacteria were being delivered to the municipal distribution systems (**Figure 5A**).

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**). This was primarily due to the 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 not exceeded in any month of 2008. However, on an individual basis, one of the distribution system reservoirs had an annual percentage positive that exceeded the 10% limit (**Figure 6A**). The number of total coliform occurrences in the reservoirs was similar to 2000 through 2004 and 2007.

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 2008, similar to 2007

(**Figure 7**). The total coliform positive rate of 0.7% was slightly lower than that of 2005 and 2006 and similar to 2007 and to 2002 to 2004 with a trend of declining total coliform positive samples in the Greater Victoria Distribution System (**Figure 7A**).

8. **Individual Municipal Distribution Systems**. In 2008, none of the municipal distribution systems exceeded the monthly total coliform limit of 10%. 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)**
    - North Saanich (**Figure 9)**
    - Oak Bay (**Figure 10)**
    - Saanich (**Figure 11)**
    - Sidney (**Figure 12**)
    - Victoria/Esquimalt (**Figure 13**
    - Juan de Fuca Distribution System (**Figure 14**).

9. **Chlorine Residual**. The median annual chlorine residual at the first customer sampling location below the Japan Gulch Plant was 1.18 mg/L (similar to 2004 to 2007). Overall, within the distribution system, the median annual chlorine residual was 0.64 mg/L, slightly higher than that found in 2005 and 2003 (0.63 mg/L) and identical to 2004, 2006, and 2007 (0.65 mg/L). Within the municipal distribution systems, the median annual chlorine residual varied from a low of 0.43 mg/L for Sidney to a high of 0.89 mg/L for Sooke.

10. **Water Temperature**. At the Japan Gulch Plant, the coldest daily water temperature recorded was 4.0°C in January while the warmest was 17.8°C in September 2008 (three degrees cooler than in 2004). Similarly, the water at the first customer location was cooler than in past years. The Guideline limit of 15°C was exceeded from August 22 to October 3, 2008 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 through 2008 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 2008.

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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

1. Introduction

The *2008 Annual Bacteriological Summary of Greater Victoria's Drinking Water* is the second report in the Water Quality Division's 2008 annual water quality report series. It extends the bacteriological information provided in the *2008 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 2008, the Greater Victoria Drinking Water System (**Map 1**) provided drinking water to approximately 340,000 people. It is the third 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 330,000 people in Victoria, Saanich, Oak Bay, Esquimalt, the Saanich Peninsula municipalities and the West Shore communities via the Japan Gulch Treatment Plant.

2. The **Sooke District Drinking Water Service Area** supplied water to approximately 10,000 people in Sooke and East Sooke via the Charters Treatment Plant.

These two service areas are described below relative to their operation in 2008.

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. (**Note**: In December 2007, the CRD purchased the majority of the Leech River watershed. This future water supply area does not currently supply water to the system as the lands must be rehabilitated before diverting water from the Leech River into Sooke Reservoir.)

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 source reservoirs, is the primary source of drinking water for Greater Victoria, supplying approximately 98% 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 reservoirs provide water to the Salmonid Enhancement Fisheries project in 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 from the Goldstream River watershed is released from Goldstream Reservoir and flows down the upper reaches of Goldstream River into Japan Gulch Reservoir. Water in 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 Treatment Plant.

During 2008, 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 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 can come from Charters Reservoir and the Charters River Watershed.

In 2008, all water received at the Charters Treatment Plant originated from Sooke Reservoir.

2.2. WATER TREATMENT SYSTEM

The drinking water in Greater Victoria is unfiltered and in 2008, 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 disinfectant steps which provides disinfection of the water entering the system followed by a secondary disinfectant step which provides continuing disinfection throughout the distribution system:

1. *UV Disinfection*. Ultraviolet (UV) disinfection provides the first step in the primary disinfection process (disinfection of the raw source water entering the plants) and inactivates parasites such as *Giardia* and *Cryptosporidium* as well as reducing the level of bacteria in the water.

2. *Free Chlorine Disinfection*. Free chlorine disinfection provides the second step in the primary disinfection process using a free chlorine dosage of approximately 1.6 mg/L and a minimum of 10 minutes (depending upon flow) contact time between the free chlorine and the water. The free chlorine disinfection step inactivates bacteria and provides a 4-log (99.99%) kill of viruses.

3. *Ammonia Addition*. The final step in the primary disinfection process is the addition of ammonia at a point downstream where the water has been in contact with the free chlorine for approximately 10 minutes or more. The ammonia is added at a ratio of approximately 1 part ammonia to 5 parts chlorine. In the water, these chemicals combine to produce a chloramine residual. This residual remains in the water and continues to protect the water from bacterial contamination (secondary disinfection) as it travels throughout the pipelines of the distribution system.

Small amounts of additional chlorine are also periodically added at Upper Dawson Reservoir and to Upper Dean Park Reservoir. In Metchosin, CRD Water Services re-chloraminates the water at Rocky Point Reservoir to boost the chlorine residuals to the extremities of that

system.

Sooke District Drinking Water Service Area

The dosage of chlorine and ammonia at the Charters Treatment Plant was in concert with that used at the Japan Gulch Treatment 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 West Shore 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 2008, the Water Services Department used 7 large diameter transmission mains to supply water to the municipal distribution systems in the Greater Victoria Drinking Water Service Area (**Map 1**). These transmission mains range in diameter from 1525 mm (60") down to 460 mm (18") and transfer water from the treatment plants to the distribution systems listed in **Section 2.5**

- Main #1 is a 1067 mm (42") diameter, cement mortar-lined, welded steel pipe that starts at the Humpback pressure regulating valve (PRV) below the Humpback Reservoir Dam and ends at the David Street vault. This transmission main provides water primarily to the City of Victoria but also services portions of Saanich and the West Shore Communities.

- Main #2 is a 780 mm (31") diameter steel pipe which starts at the Colwood overpass and runs primarily through View Royal, Esquimalt and Vic West along the Old Island Highway and Craigflower Road. Main #2 joins 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 West Shore Communities, Saanich, Victoria and Oak Bay.

- Main #4, a high pressure transmission main, is primarily a 1220 mm (48") diameter, welded 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 which extends to McTavish Upper Reservoir. It supplies 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 Watkiss Way, Millstream at Atkins, and Burnside at Wilkinson. There is 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 (30") Bear Hill Main, the 400 mm (16") Keating Main, the 400 mm (16") Dean Park Main and the 250-500 mm (10-20") Saanich Peninsula mains.

At McTavish Reservoir (the terminus of the regional transmission system), the Saanich Peninsula Trunk Water 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 (10") 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 6 major pumping stations located at Hamsterly, Martindale, Lowe Road, Dean Park Lower, Dean Park Middle and Deep Cove along with 2 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 a transmission main 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 2008, CRD Water Services operated 17 balancing reservoirs in the Greater Victoria Drinking Water System:

- 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 re-chloramination station near the extremity of the water system off of Deer Park Trail in Metchosin.
- Fulton Reservoir, a 2-cell, 4,580 m^3 (1,007,459 gallon) reservoir located at the end of Fulton Rd in Colwood. (New reservoir added to system in 2007)
- 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 (90,000 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 on the slope of Mt. Tolmie in Oak Bay near the Saanich-Oak Bay boundary.
- Peacock Reservoir, a 2-cell, 583.8 m^3 (128,420 gallon) reservoir located north of the Trans Canada Highway off of Peacock Place 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.
- Skirt Mountain Reservoir, a 3-cell, 6,525 m^3 (1,435,300 gallon) reservoir located near the top of Skirt Mountain in the Bear Mountain development in Langford (New reservoir added to system in 2008)
- Stirrup Place Reservoir, a 2-cell, 242 m^3 (53,300 gallon) reservoir located off of Stirrup Place Road in Metchosin.
- Sunriver Reservoir, a 2-cell, 1,800 m^3 (395,944 gallon) reservoir located off of Sunriver Way in Sooke.
- 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 2008, 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 Lower Reservoir, a 1-cell, 2,280 m^3 (500,000 gallon) reservoir located on the south side of McTavish Road 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.

2.4.3. SAANICH OPERATED RESERVOIRS

In 2008, Saanich operated 5 balancing reservoirs within its municipal boundaries:

- Cromwell Reservoir, a 2-cell, 45.5 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 SYSTEMS

The distribution system of the Greater Victoria Drinking Water Service Area is comprised of 7 individual distribution systems. Six of the 7 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 seventh distribution system, the Juan de Fuca Water Distribution System is owned by the CRD and operated by CRD Water Services for the West Shore 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 2008, drinking water was supplied to the Central Saanich Distribution System via ten pressure zones (seven off the Bear Hill main and three off the Martindale Valley main). 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 2008, drinking water was supplied to the North Saanich Distribution System from a number of points along the Sannich Peninsula Trunk Water Distribution System. 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 was 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 balancing 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 Authority via the watermain on the south side and the east side of the airport. As water quality in the airport distribution system falls under Federal jurisdiction, it was not tested by CRD Water Services.

2.5.3. OAK BAY DISTRIBUTION SYSTEM

In 2008, drinking 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 used a 406 mm (16") combination feeder/collector system which crossed Oak Bay diagonally from northwest to southeast. Water was 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 used 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 2008, drinking water was supplied to the Saanich Distribution System at a number of points from CRD Water Services' 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 pumped water north from Main #3, ending in the Gordon Head area. Cherry Tree Bend pumped from Main #4 to Wesley Reservoir and the west central high elevation area. Royal Oak is a booster pump for Rithet Reservoir that was used during peak flows in the summer months. The Mt. Tolmie/Plymouth pump takes water from Main #3 and the Mt. Tolmie Reservoirs and pumped to Saanich's Mt. Tolmie Reservoir and the Gordon Head area via a 610 mm (24") diameter main.

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

2.5.5. SIDNEY DISTRIBUTION SYSTEM

In 2008, drinking water was supplied to the northern portion of the Sidney Distribution System from the 305 mm (12") diameter main on Mills Road via the Sannich Peninsula Water Trunk Distribution System 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 2008, drinking 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 2008, 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. 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.

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. Sunriver Estates came on-line in 2006 and is serviced by a 300 mm (12") pipeline on Phillips Road and the 2-celled Sunriver Reservoir.

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 entire Greater Victoria Drinking Water System. This monitoring is conducted according to the directions of the Water Quality Division's Water Quality Management 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 *Drinking Water Protection Act* (2001) and the Federal *Guidelines for Canadian Drinking Water Quality* (May 2008 update).

3.1. PARAMETERS AND REGULATIONS

A description of the bacteriological parameters used by the Water Quality Division and the regulatory limits that were in place in 2008 for those parameters 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 (fecal) 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 *Escherichia coli*, the presence of total coliforms may indicate older fecal contamination or the presence of decaying organic matter. While the total coliform bacteria group is a less reliable indicator of fecal 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 2008, total coliform bacteria were analyzed using defined substrate technology (DST) at the CRD Water Quality Laboratory for either membrane filtration, most probable number or presence-absence methods. The membrane filtration method used Chromocult media incubated at 35ºC for 24 hours while the most probable number and presence-absence methods used Colilert-18 incubated at 35ºC for 18-22 hours. Test results were reported as colony forming units (CFU) per 100 millilitres (mL) of water when using membrane filtration or most probable number per 100 mL and 'Present' or 'Absent' when using the presence-absence method. Methods employing defined substrate technology rely on the fact that coliforms possess the enzyme β-galactosidase which cleaves a chromogenic substrate, thus releasing a coloured chromogen which can, in turn, be measured.

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. In 2008, about 40% of the samples were tested for total coliform bacteria using either most probable number or presence-absence while the remaining 60% were tested using membrane filtration.

Regulatory Limits. In disinfected drinking water, the maximum acceptable concentration (both Federal and Provincial) is zero total coliform bacteria per 100 mL in all samples. However, since total coliform bacteria are not uniformly distributed in drinking water, 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. ESCHERICHIA COLI

***Escherichia coli* (*E. coli*)**. *E. coli* is the only member of the total coliform bacteria group that is found exclusively in the feces of human beings and warm-blooded animals. While most members of this species are considered harmless, some strains of *E. coli* cause diarrhoeal illness. The presence of *E. coli* in water indicates recent fecal contamination of the water and also the possible presence of intestinal disease-causing bacteria, viruses, and protozoa. The absence of *E. coli* in drinking water generally indicates that the water is free of intestinal disease causing bacteria.

Test Method. In 2008, *E. coli* were analyzed by the CRD Water Quality Laboratory using either membrane filtration (Chromocult media, 35ºC, 24 hour incubation) or most probable number (Colilert-18, 35ºC, 18-22 hour incubation). Test results were reported as colony forming units per 100 mL when using either membrane filtration or most probable number methods. The *E. coli* test measures bacteria possessing the enzymes β-galactosidase and β-glucuronidase.

Regulatory Limits. In disinfected drinking water, the maximum acceptable concentration of *E. coli* (both Federal and Provincial limits) is zero *E. coli* per 100 mL. In 2008, about 40% of the samples were tested for *E. coli* using the most probable number method while the remaining 60% were tested using membrane filtration.

3.1.3. 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 2008, background bacteria were analyzed by the CRD Water Quality Laboratory using membrane filtration (Chromocult media, 35ºC, 24 hour incubation) and reported as colony forming units per 100 mL. The background bacteria test measures the number of bacteria capable of growing on total coliform media but not possessing the total coliform specific enzyme β-galactosidase.

Regulatory Limits. In 2008, there was no Provincial regulatory limit for this parameter. There is also no Federal maximum acceptable concentration of background bacteria. Historically, background colony counts on total coliform membrane filters were used as a surrogate for heterotrophic plate counts. However, while they are no longer used as surrogates, they can still be used as an early waning of the potential growth of coliforms.

3.1.4. HETEROTROPHIC PLATE COUNT BACTERIA

Heterotrophic Plate Count Bacteria. Heterotrophic plate count bacteria (HPC7D) 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 2008, heterotrophic plate count bacteria were analyzed by the CRD Water Quality Laboratory using membrane filtration (R2A media, 22-25ºC, seven day incubation). As heterotrophic bacteria can be measured in several different ways, this method provides

the quantity of heterotrophic bacteria capable of growing on R2A Medium within 7 days at room temperature. Raw water samples and water leaving the treatment plant were analyzed for HPC7D bacteria. In addition, samples with low chlorine residual levels (below 0.2 mg/L) were also analyzed for HPC7D.

Regulatory Limits. There is no Federal or Provincial regulatory limit on the quantity of HPC7D allowed in drinking water. Therefore, in the absence of a regulatory limit, the Water Quality Division uses an operational limit of 10,000 HPC7D bacteria per 1 mL of drinking water.

3.2. BACTERIOLOGICAL SAMPLING

The number of sampling locations and the sampling frequency used at bacteriological sampling stations were based on the population and the complexity of the Water Supplier's distribution system in accordance with the Federal Guidelines.

When positive bacteriological results were found, Water Quality Division staff 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 2008, bacteriological samples were collected from the raw source water entering the Japan Gulch Treatment Plant, the UV disinfected water and from the treated water at the first customer sampling station below the plant 5 days per week. The large transmission mains and the large balancing reservoirs were monitored weekly. The smaller balancing system reservoirs in the distribution system were monitored bi-weekly. The majority of sampling stations 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 sampling stations being monitored weekly and some monthly.

In 2008, the Water Quality Division used 87 permanent, pre-established bacteriological sampling stations within the distribution system of the Greater Victoria Drinking Water Service Area. In addition, 13 sampling stations were used to monitor the transmission mains and 26 sampling stations were used to monitor the balancing reservoirs.

Sooke District Drinking Water Service Area

In 2008, 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 (just prior to first customer). The distribution system reservoirs were sampled bi-weekly. The Water Quality Division used 8 sampling stations for bacteriological sample collection in the distribution system and 11 sampling stations 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 concentration and water temperature.

Laboratory Component. In general, bacteriological samples were analyzed at the CRD Water Quality Laboratory for total coliform bacteria, background bacteria and *E. coli* and some were analyzed for heterotrophic plate count bacteria as described in **Section 3.1.**

New Water Mains. All new water mains were tested for total coliforms, *E. coli*, chlorine residual, and turbidity. All repeat samples from positive locations (resamples) were analyzed for total coliforms, *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 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 as required by the regulations.

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 2008, approximately 150 bacteriological samples were collected during two 2-week periods in the spring and fall by VIHA staff. These samples were 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 *Drinking Water Protection 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, CRD Water Services 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 2008 from the Greater Victoria Drinking Water Service Area are summarized 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**
- Distribution System (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 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 2008, 249 bacteriological samples were collected from the raw source water entering the Japan Gulch Treatment Plant (**Table 1**). Typically, 20 samples or so per month were collected, one sample on each weekday. (**Appendix A** provides an explanation of the column headings used in the tables.)

Table 1. 2008 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	Samples TC>10	Samples Present	Samples Collected	Samples >1 NTU	Median °C
JAN	22	22	100	11	5	22	0	4.8
FEB	21	19	90.5	1	3	21	0	5.1
MAR	19	17	89.5	0	1	19	0	6.1
APR	22	22	100	0	1	21	0	7.0
MAY	21	21	100	3	0	21	0	9.4
JUN	21	21	100	14	0	21	0	11.2
JUL	22	22	100	17	1	22	0	13.7
AUG	20	20	100	20	0	20	0	15.9
SEP	21	21	100	21	0	20	0	17.2
OCT	22	22	100	22	0	22	0	13.1
NOV	19	19	100	19	2	19	0	10.8
DEC	19	19	100	14	0	19	0	7.8
TOTAL	**249**	**245**	100 **98.4%**	**142**	**13 (5.2%)**	**247**	**0**	**10.0**

TC = Total Coliforms, **E. coli** = *Escherichia coli* **Cl_2** = chlorine, **NTU** = Nephelometric turbidity unit.
> = Greater than, **mg/L** = milligrams per litre, **°C** = degrees Celsius

4.1.2. WATER TEMPERATURE

The median annual temperature of the water entering the Japan Gulch Plant was 10.0°C (**Table 1)**. The lowest median monthly temperature was observed in January 2008 at 4.8°C with the highest median monthly temperature observed in September at 17.2°C (**Table 1**). The coldest daily water temperature recorded was 4.0°C in December while the highest maximum daily water temperature was 17.8°C recorded in September 2008.

Since raising Sooke Reservoir, the maximum water temperature entering the Japan Gulch Plant has decreased by almost 2ºC (**Figure 1A**). This beneficial result of raising the reservoir is due to drawing cooler water from a lower depth into the intake tower at Sooke Reservoir. In 2008, the water temperature during the summer months was slightly lower than the post-inundation (2003-2007) summer average temperature.

4.1.3. BACTERIA

Total Coliforms. In 2008, 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 1,300 colony-forming units (CFU)

per 100 mL (**Figure 1B**). Total coliform concentrations exceeded 1,000 CFU/100 mL in samples collected on three dates: September 17, 24, and 25. This level of coliforms was seasonally similar albeit lower than levels found in 2004 through 2007 and lower than levels observed in earlier years (**Figure 1B**).

Escherichia coli. In contrast to the seasonal peak observed for total coliforms in the late summer of 2008, the levels of *E. coli* were similar to those in 2003 through 2007 and did not display any significant seasonal trend (**Figure 1C**). The median annual *E. coli* bacterial concentration in the raw source water entering the Japan Gulch Plant was 0 CFU/100 mL and ranged from 0 to 2 (**Figure 1C**) easily meeting the fecal coliform limit of no more than 10% of samples having higher than 20 CFU/100 mL in the USEPA Surface Water Treatment Rule. Therefore, this source water continues to qualify to remain an unfiltered surface water supply under the USEPA regulations.

Over the past decade or so, the annual percentage of samples with fecal coliforms or *E. coli* present has decreased from a maximum of 82% positive in 1994 to a minimum of 5.2% in 2008 indicating that the bacterial quality of the source water has improved (**Figure 1D**). In 2003 through 2008 the level of *E. coli* has been about 13% annually while the percentage *E. coli* exceeding the 20 CFU/100 mL limit has remained at less than 1% (see insert in **Figure 1D**).

Heterotrophic Plate Count Bacteria The 2008 concentrations of 7-day heterotrophic plate count bacteria (HPC7D) in the raw source water were similar to the past several years with a median of 390 CFU/mL and a maximum of 3,600 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 1A. 2008 Temperature of Raw Water entering Japan Gulch Plant (Weekly Average)

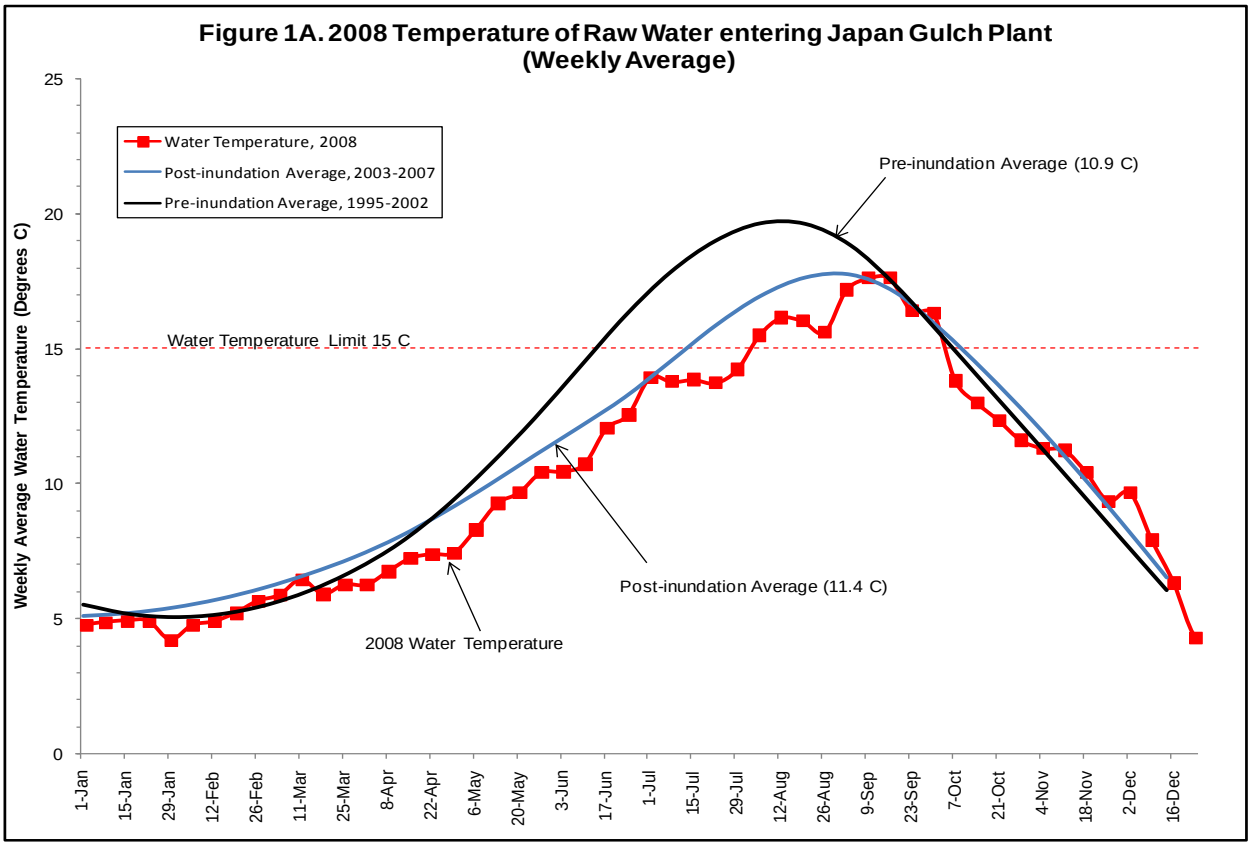


Figure 1B. Raw Water Entering Japan Gulch Plant
Total Coliforms, 2003-2008

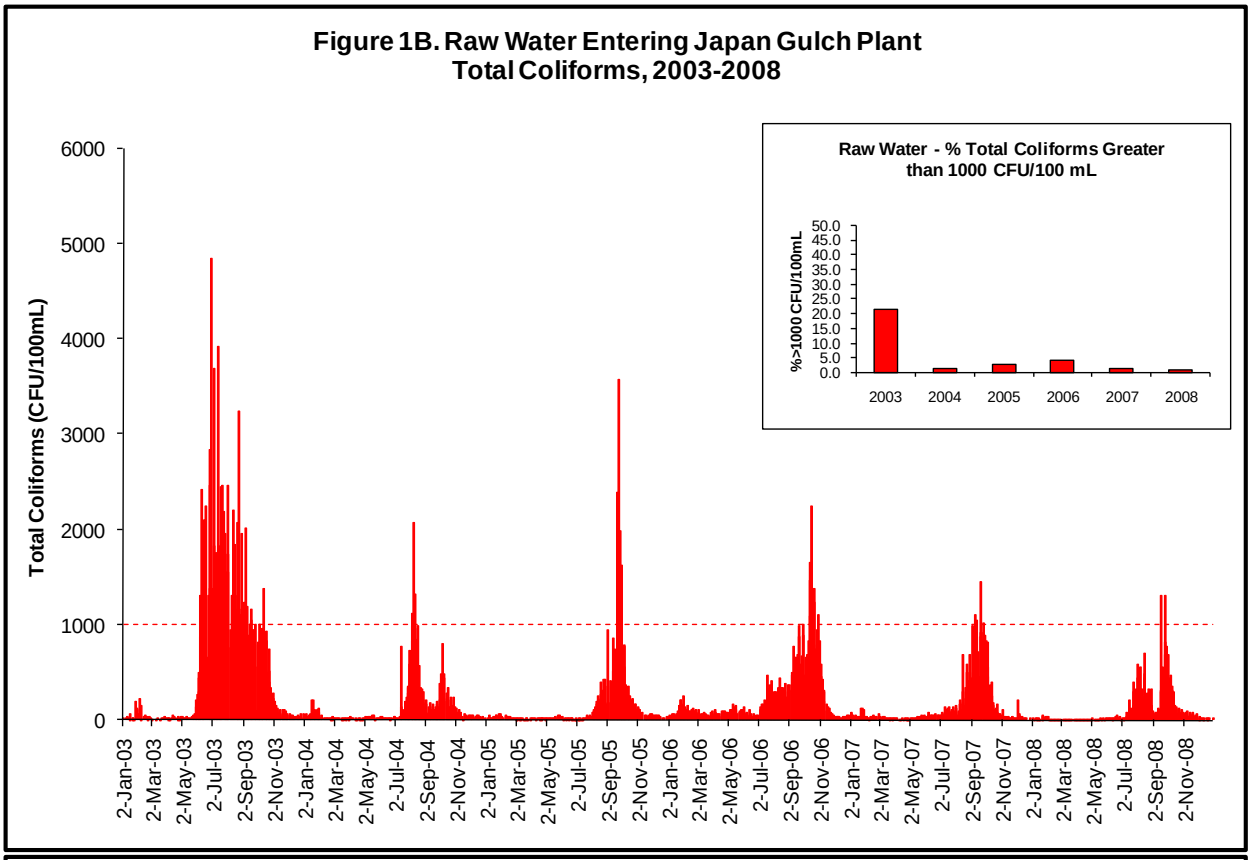


Figure 1C. Raw Water Entering Japan Gulch Plant
***E. coli* in 2008**

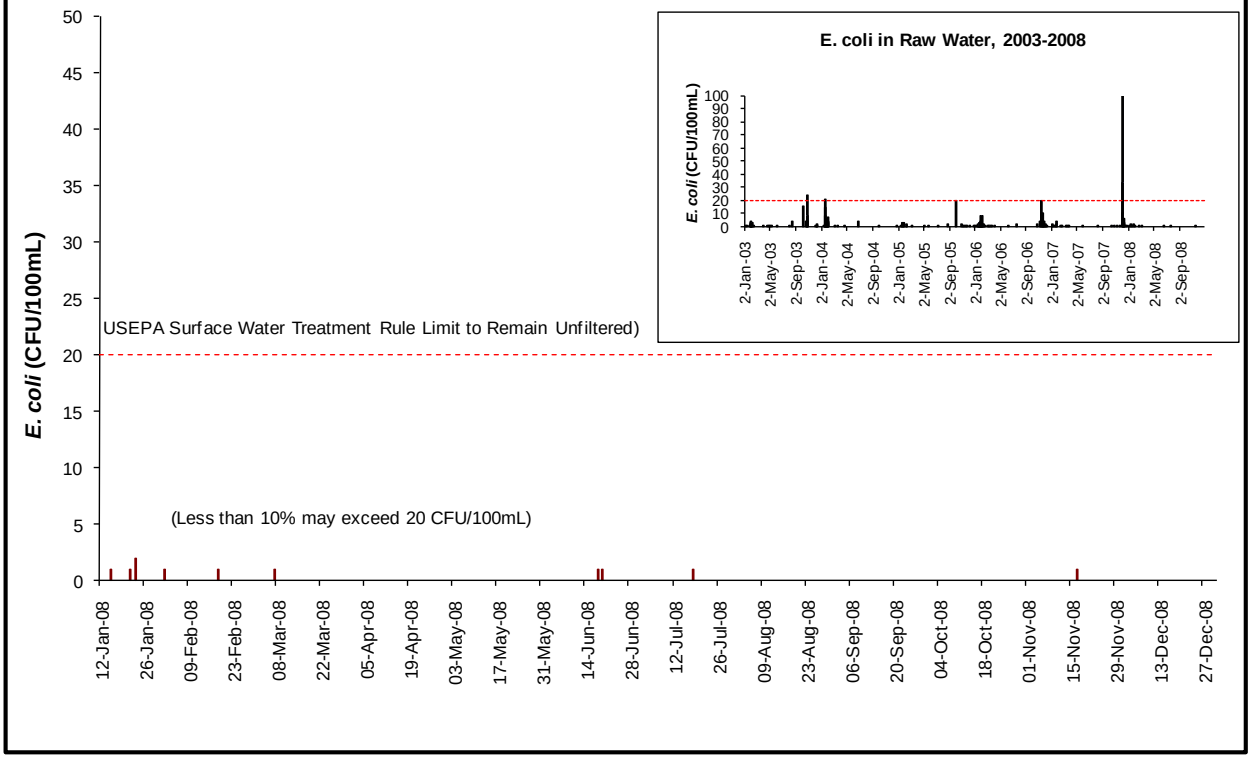


Figure 1D. Raw Water Entering Japan Gulch Plant
Fecal Coliforms and *E.coli*, 1992-2008

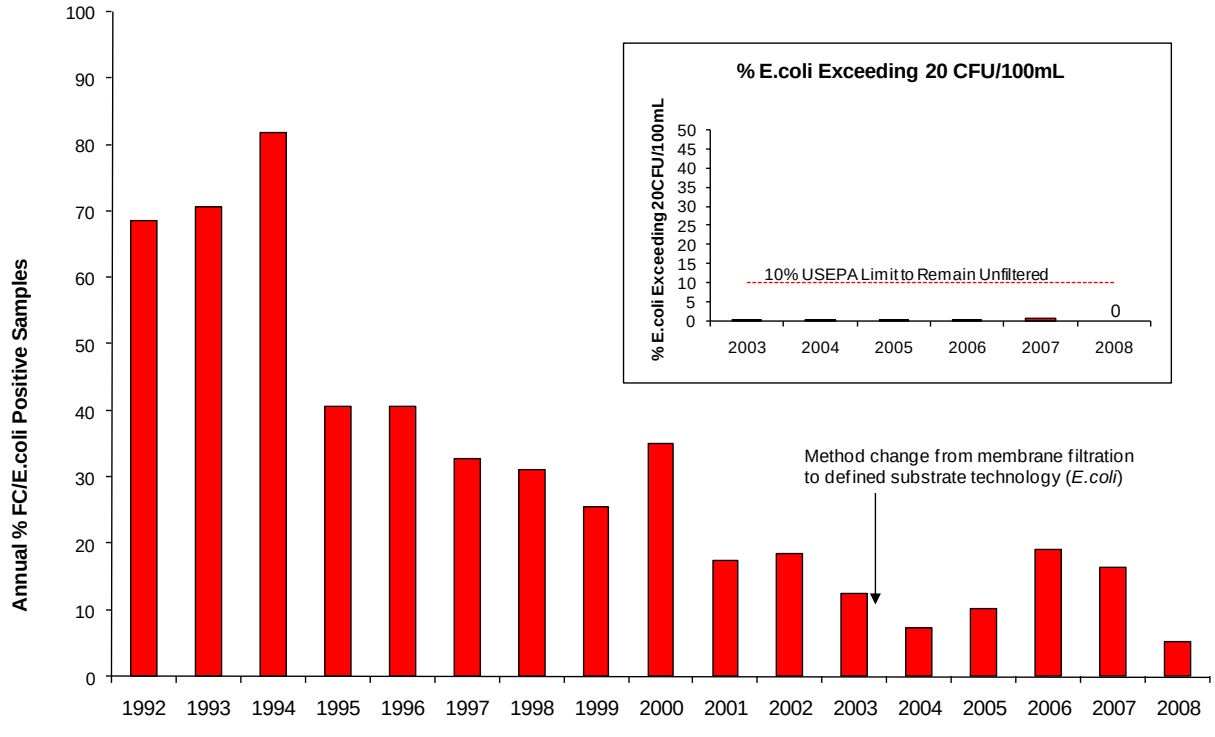
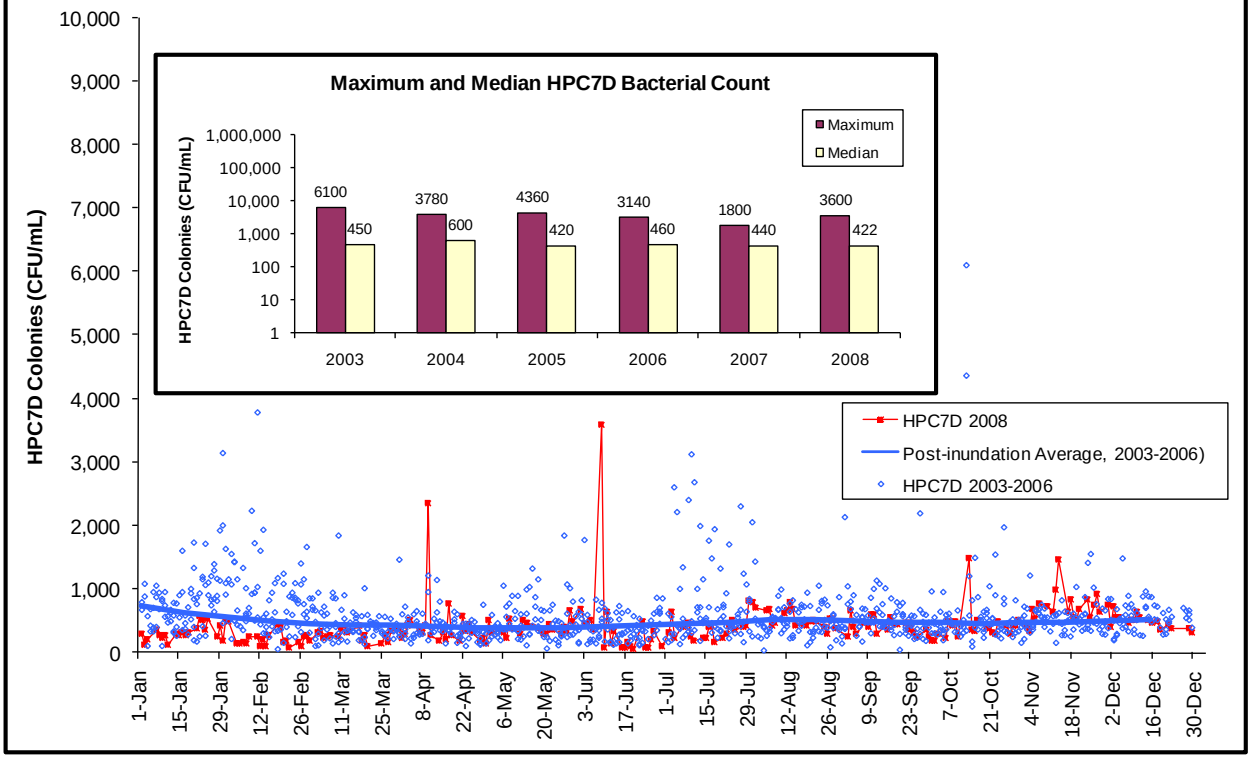


Figure 1E. Raw Water Entering Japan Gulch Plant
HPC7D Bacterial Count, 2003-2008



4.2. UV TREATED WATER

Ultraviolet (UV) disinfection of the raw source water began in January 2004 to inactivate parasites such as *Giardia* and *Cryptosporidium* and provide some bacteriological disinfection. In 2008, although the UV plant had several minor disinfection interruptions lasting for thirty minutes to an hour, none of these interruptions affected the bacteriological disinfection of the treated water since the water continued to be disinfected with chlorine.

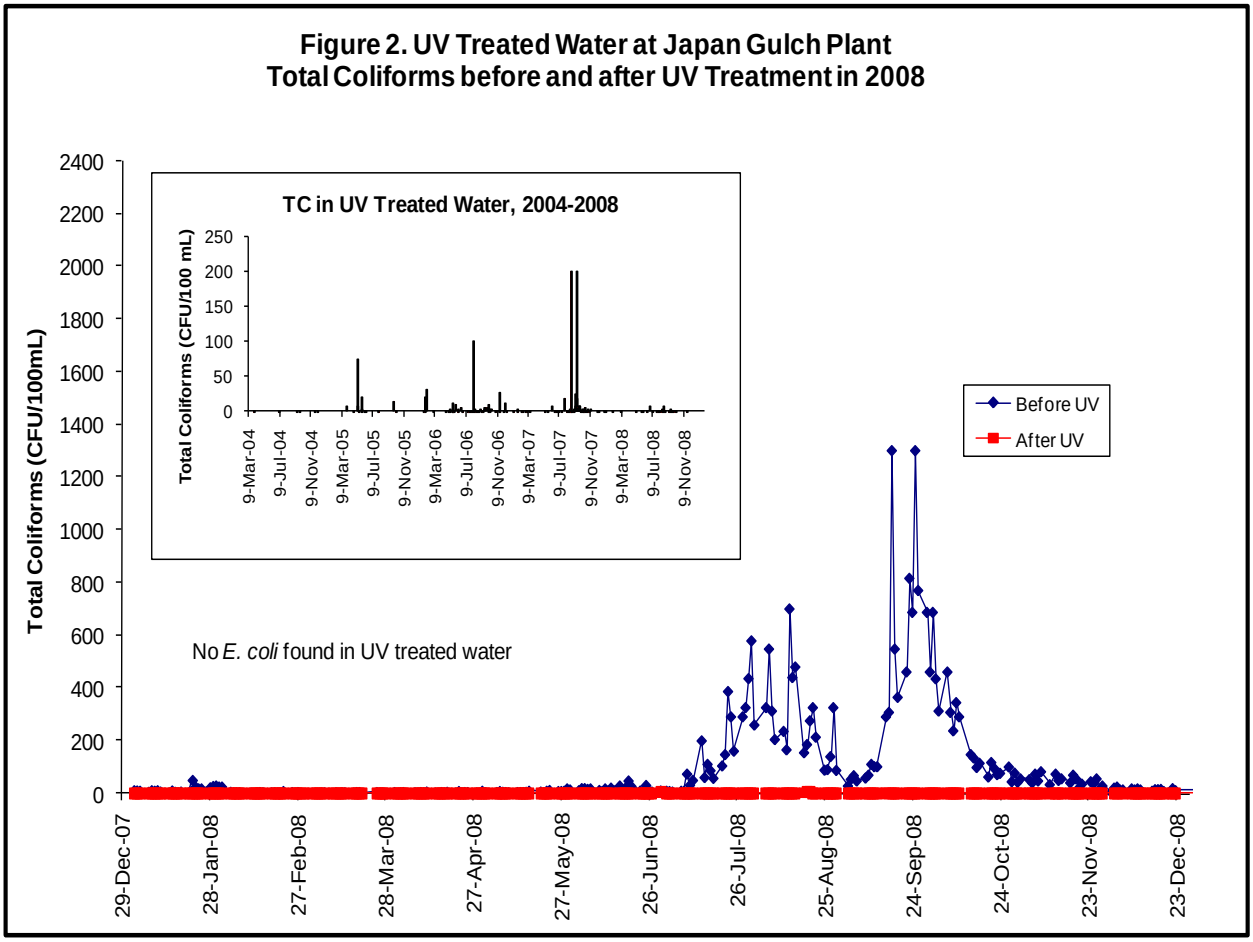
4.2.1. SAMPLES COLLECTED

In 2008, 248 bacteriological samples were collected from the raw water following UV disinfection. Typically, 20 samples per month were collected, one sample on each weekday.

4.2.2. BACTERIA

The level of total coliform bacteria in the UV treated water was low ranging from 0 to 8 CFU/100mL with a mean of 0.25 and a median of 0 CFU/100mL. The annual coliform positive rate was 12.5% for the UV treated water, lower than in 2007 and 2006 (27.9%) but significantly higher than in 2005 (5.2%) and 2004 (3.0%). Nevertheless, the UV disinfection step reduces the coliform bacterial population of the raw source water significantly and provides good redundancy for primary disinfection (**Figure 2**). In 2008, the average percentage decrease in total coliforms after UV disinfection was 86%.

Figure 2. UV Treated Water at Japan Gulch Plant
Total Coliforms before and after UV Treatment in 2008



4.3. FIRST CUSTOMER

The bacteriological data collected by the Water Quality Division staff during 2008 from the treated water below the Japan Gulch Plant (downstream of both the UV and chlorine disinfection steps) and just prior to the bulk of the first customers in the distribution system are summarized 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 2008, 258 bacteriological samples were collected from the first customer sampling station below the Japan Gulch Treatment Plant (**Table 2**). Typically, one sample was collected each week day with the monthly totals ranging from 19-29.

4.3.2. BACTERIA

Total Coliforms. In 2008, there was only one total coliform positive sample at the first customer sampling location. This occurred in May, 2008 (**Table 2**, and **Figure 3)**. The annual total coliform positive rate in 2008 was 0.4% (**Table 2** and **Figure 4**). This is lower than in 2007 (2.0%) and similar to the past few years (0.8% in 2006, 0% in 2005, 0.4% in 2004, and 0.8% in 2003 and 2002). In 1995, before the practice of seasonally increasing the chlorine dosage rate in the summer, total coliforms were detected in six months of the year. In 1996 - 1997, 2000 - 2003 and in 2006, coliforms were detected in two months of the year. In 2007, coliforms were detected in four months of the year and in 1998 coliforms were detected in five months of the year (**Figure 4**). In 2008, total coliforms were detected in only one month of the year at the first customer sampling location.

Table 2. 2008 Bacterial Quality of the Treated Water at the First Customer Location.

		Total Coliform				E. coli	Turbidity		Chlorine Residual	Water Temp.
Month	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10	Samples >0	Samples Collected	Samples >1 NTU	Median mg/L Cl_2	Median ^oC
JAN	22	0	0	0	0	0	22	1	1.09	4.5
FEB	21	0	0	0	0	0	21	0	1.13	4.3
MAR	19	0	0	0	0	0	19	0	1.20	5.5
APR	22	0	0	0	0	0	22	0	1.18	6.6
MAY	21	1	4.8	0	0	0	21	0	1.17	8.6
JUN	29	0	0	0	0	0	30	9	1.23	11.5
JUL	21	0	0	0	0	0	21	0	1.24	13.9
AUG	20	0	0	0	0	0	20	1	1.22	15.8
SEP	23	0	0	0	0	0	23	2	1.17	17.0
OCT	22	0	0	0	0	0	22	0	1.13	12.4
NOV	19	0	0	0	0	0	19	0	1.23	10.3
DEC	19	0	0	0	0	0	19	0	1.16	8.1
TOTAL	**258**	**1**	**0.40**	**0**	**0**	**0**	**259**	**13**	**1.18**	**9.7**

TC = Total Coliforms, **E. coli** = *Escherichia coli* **Cl_2** = chlorine, **NTU** = Nephelometric turbidity unit.
> = Greater than, **mg/L** = milligrams per litre, **°C** = degrees Celsius

E. coli. During 2008, no *E. coli* bacteria were detected in any of the 258 samples collected from the first customer sampling location below the Japan Gulch Treatment Plant (**Table 2**). This is significant as it indicates that no fecal-associated contamination was present in the water entering the distribution system and provides greater assurance of the bacterial safety of Greater Victoria's drinking water.

Heterotrophic Plate Count Bacteria. There was no discernable pattern of HPC bacteria in the treated water at the first customer sampling location (**Figure 4A**). The median HPC counts have remained very low ranging from 0 in 2005 to 40 in 2001 (see inset in **Figure 4A**). The means (averages) have also remained low, ranging from 116 CFU/mL in 2000 to 23 CFU/mL in 2004 (see inset in **Figure 4A**). Since the start of UV disinfection, the heterotrophic bacterial load entering the distribution system has decreased by 95-100% from that of the raw water entering Japan Gulch Plant (inset in **Figure 4A**).

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 1.18 mg/L (**Table 2**). The minimum daily chlorine residual measured below Japan Gulch Plant was 0.66 mg/L in early January, 2008, while the maximum daily chlorine residual was 1.76 mg/L recorded in late June. (**Note**: This increased residual was in response to a turbidity excursion on June 25, caused by high summer water flows through the plant.) The lowest monthly median chlorine residual occurred in January at 1.09 mg/L with the highest in July at 1.24 mg/L (**Table 2** and **Figure 3**).

Figure 3. Treated Water at First Customer Below Japan Gulch Plant
Monthly Total Coliforms and Chlorine Residual in 2008

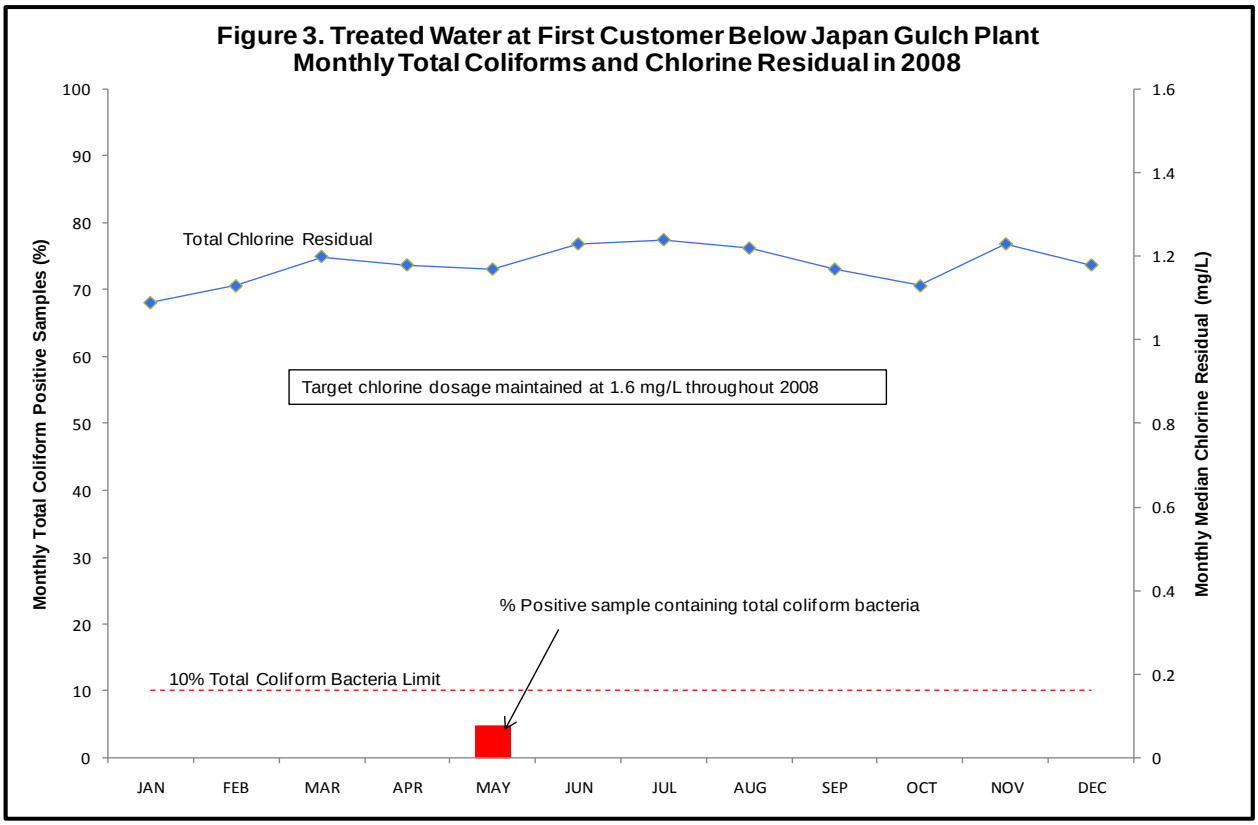


Figure 4. Treated Water at First Customer below Japan Gulch Plant
Annual % Samples with Total Coliforms Present, 1992 - 2008

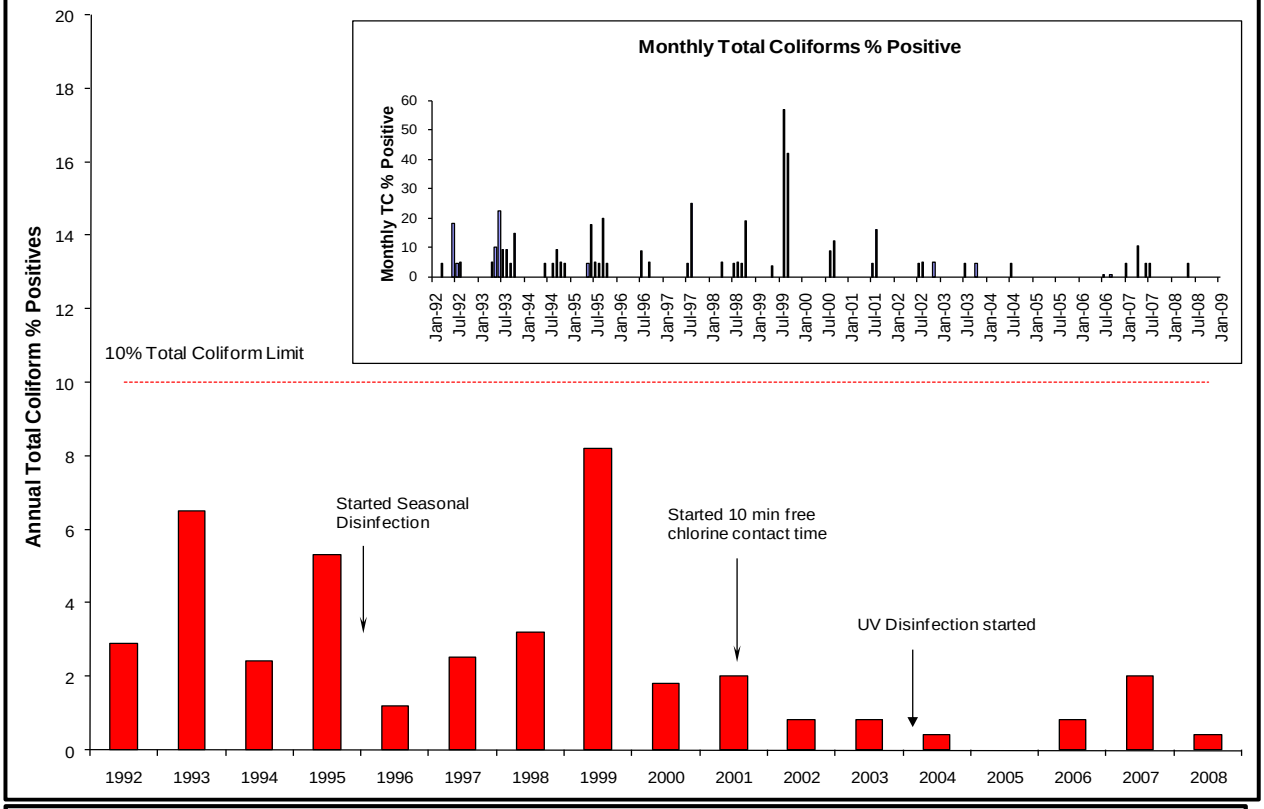
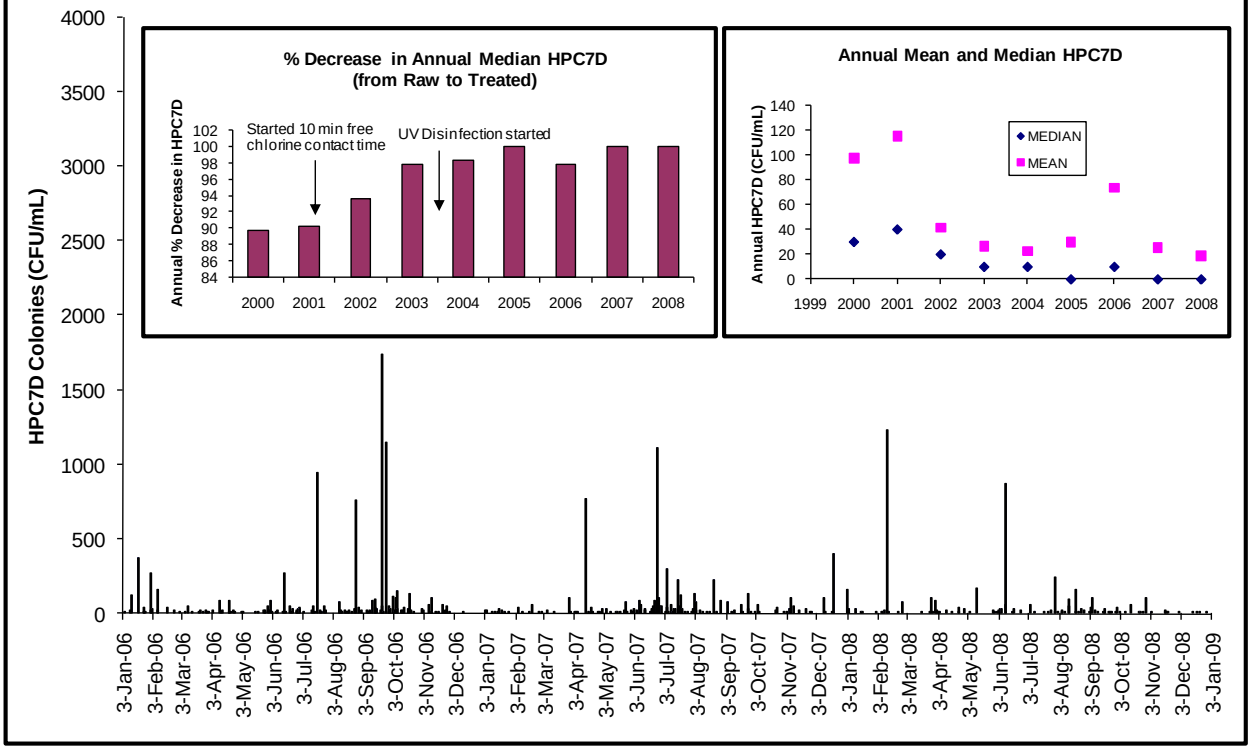
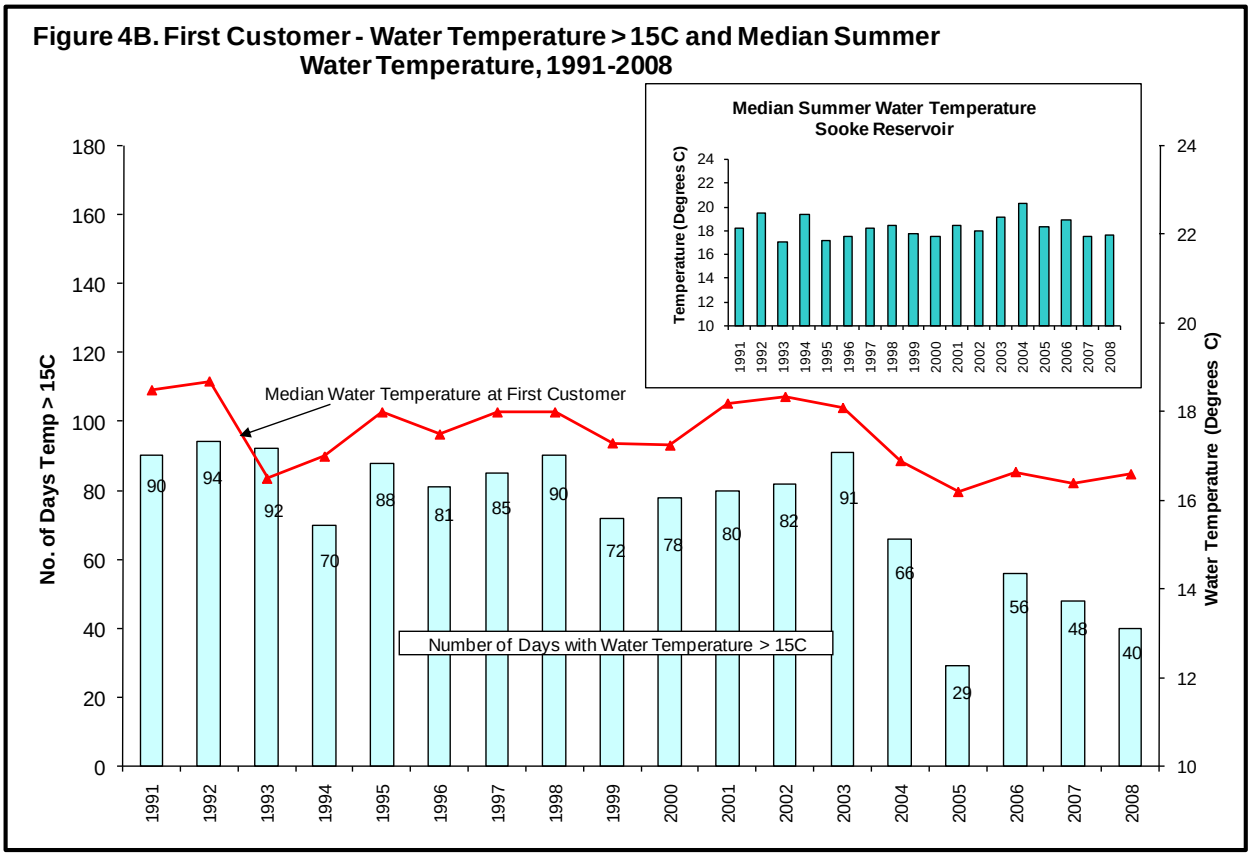


Figure 4A. Treated Water at First Customer below Japan Gulch Plant
Heterotrophic Bacteria (HPC7D) in 2008





Water Temperature. The median annual temperature of the water at the first customer location below the Japan Gulch Plant was 9.7°C (**Table 2**). The highest median monthly temperature was observed in September 2008 at 17.0°C and the lowest was observed in February at 4.3°C. The coldest daily water temperature recorded was 3.3°C in January while the highest maximum daily water temperature was 17.7°C recorded in September 2008. 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 1.5 to 3°C lower than in 2003 and are reflective of the colder water entering Japan Gulch Plant as a result of raising the water level in Sooke Reservoir.

In the long term (1991-2008), the average number of sampling days that the water temperature was above 15ºC was 76 days. Generally, the period with higher water temperatures was from mid to late May until early October. The median water temperature during this period was 17.5ºC. Similar to the raw water, the weekly average water temperature of the treated water was significantly cooler in the summer period during the post-inundation years (2003-2008) versus the pre-inundation years (1991-2002). In the years 2005 through 2008 both the number of days with water temperatures greater than 15ºC and the median water temperature during this time decreased substantially (44 days vs 76 days and 16.4ºC vs 17.5ºC, respectively) (**Figure 4B**).

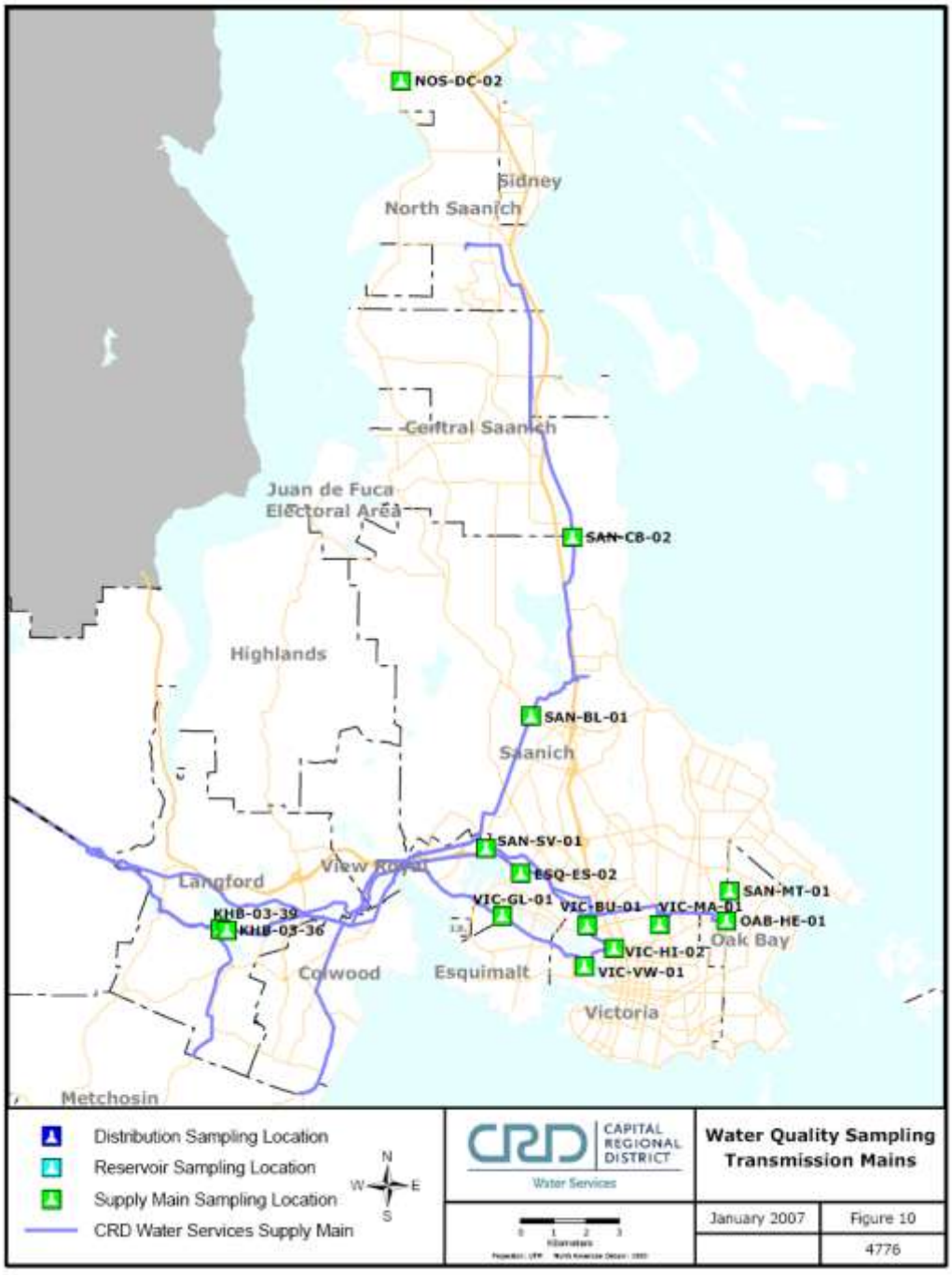
Further evidence that this improvement in cooler summer water temperature is real can be seen by examining the surface water temperature of Sooke Reservoir during the same time span. In the years 1991 through 2008, the summer surface water temperature of Sooke Reservoir has not changed significantly (see insert in **Figure 4B**). The median summer surface water temperature for Sooke Reservoir from 1991-2002 was 18.1ºC similar to the post-inundation years 2003 through 2008 at 18.9ºC. The improvement in summer water temperature at the first customer location is a result of drawing cooler water (from a lower depth) into the intake tower at Sooke Reservoir following the raising

of the Reservoir in 2005 and 2006 (2003 and 2004 to a lesser extent).

4.4. TRANSMISSION MAINS

The sampling locations (**Map 2**) on the transmission mains (also called supply mains) included the majority of 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.

Map 2. Water Quality Sampling Locations for Transmission Water Mains.



4.4.1. SAMPLES COLLECTED

In 2008, 456 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 (see attached map). 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 plant.

4.4.2. BACTERIA

Total Coliforms. None of the samples collected from the transmission mains in 2008 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.

E. coli. None of the transmission main samples contained *E. coli* bacteria (**Table 3**).

4.4.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

Chlorine Residual. The annual median chlorine residual for the transmission main samples was 1.03 mg/L (**Table 3**). The chlorine residual in the transmission mains remained fairly constant throughout 2008, similar to 2007, and in contrast to 2006 when the residual decreased in the summer months and gradually increased through the winter and spring (**Figure 5**). In 2008, the lowest monthly median chlorine residual occurred during the month of September at 0.93 mg/L and the highest in June at 1.11 mg/L (**Table 3** and **Figure 5**).

Table 3. 2008 Bacteriological Quality of the Transmission Water Mains.

		Total Coliform				E. coli	Turbidity		Chlorine Residual	Water Temp.
Month	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10	Samples >0	Samples Collected	Samples >1 NTU	Median mg/L Cl_2	Median ^{o}C
JAN	39	0	0	0	0	0	6	0	1.05	5.0
FEB	36	0	0	0	0	0	5	0	1.07	5.0
MAR	40	0	0	0	0	0	8	0	1.04	6.3
APR	39	0	0	0	0	0	6	0	1.06	7.4
MAY	37	0	0	0	0	0	5	0	1.06	9.4
JUN	40	0	0	0	0	0	7	0	1.11	12.0
JUL	42	0	0	0	0	0	6	0	1.03	15.0
AUG	36	0	0	0	0	0	6	0	0.99	16.5
SEP	42	1	0	0	0	0	9	0	0.93	17.4
OCT	38	0	0	0	0	0	7	1	0.95	13.0
NOV	36	0	0	0	0	0	6	0	0.99	11.0
DEC	31	0	0	0	0	0	6	0	1.01	9.0
Total	**456**	**1**	**0%**	**0**	**0**	**0**	**77**	**1**	**1.03**	**10.6**

TC = Total Coliforms, **E. coli** = *Escherichia coli* **Cl_2** = chlorine, **NTU** = Nephelometric turbidity unit.
> = Greater than, **mg/L** = milligrams per litre, °**C** = degrees Celsius

Figure 5. Transmission Mains - Total Coliforms and Chlorine Residual in 2008

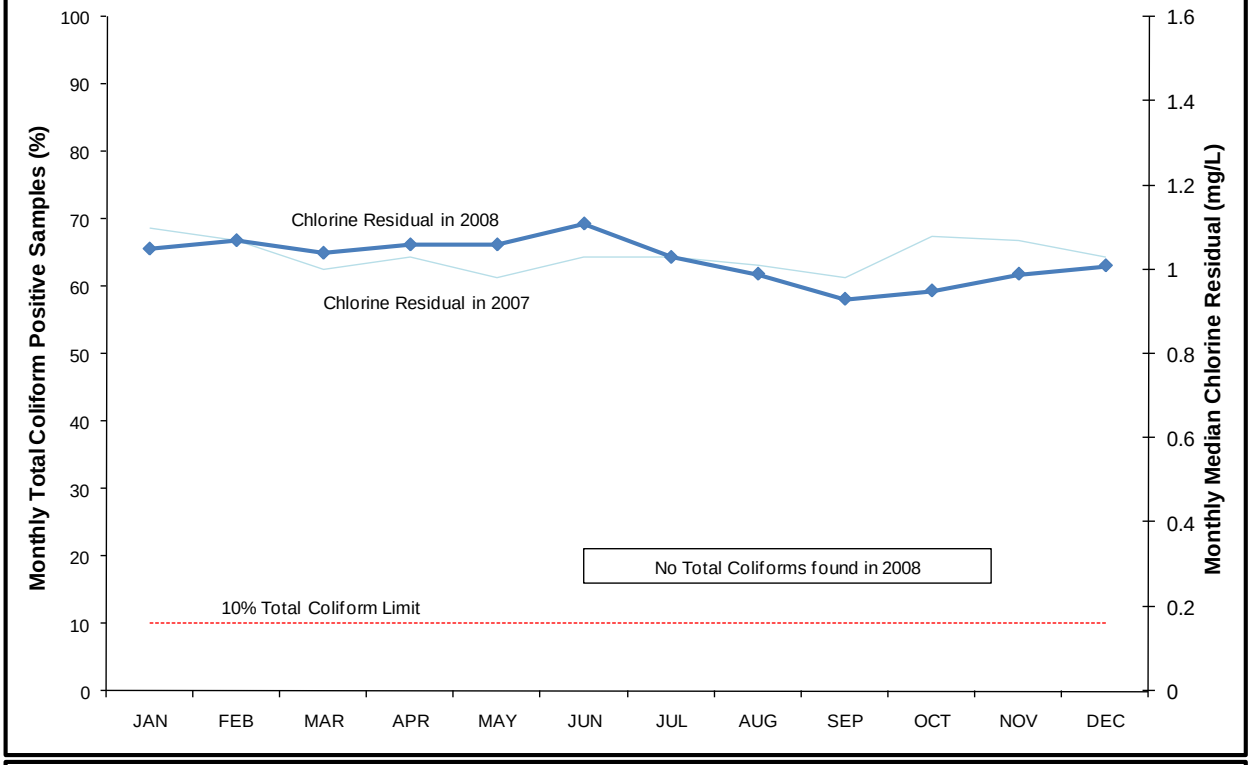
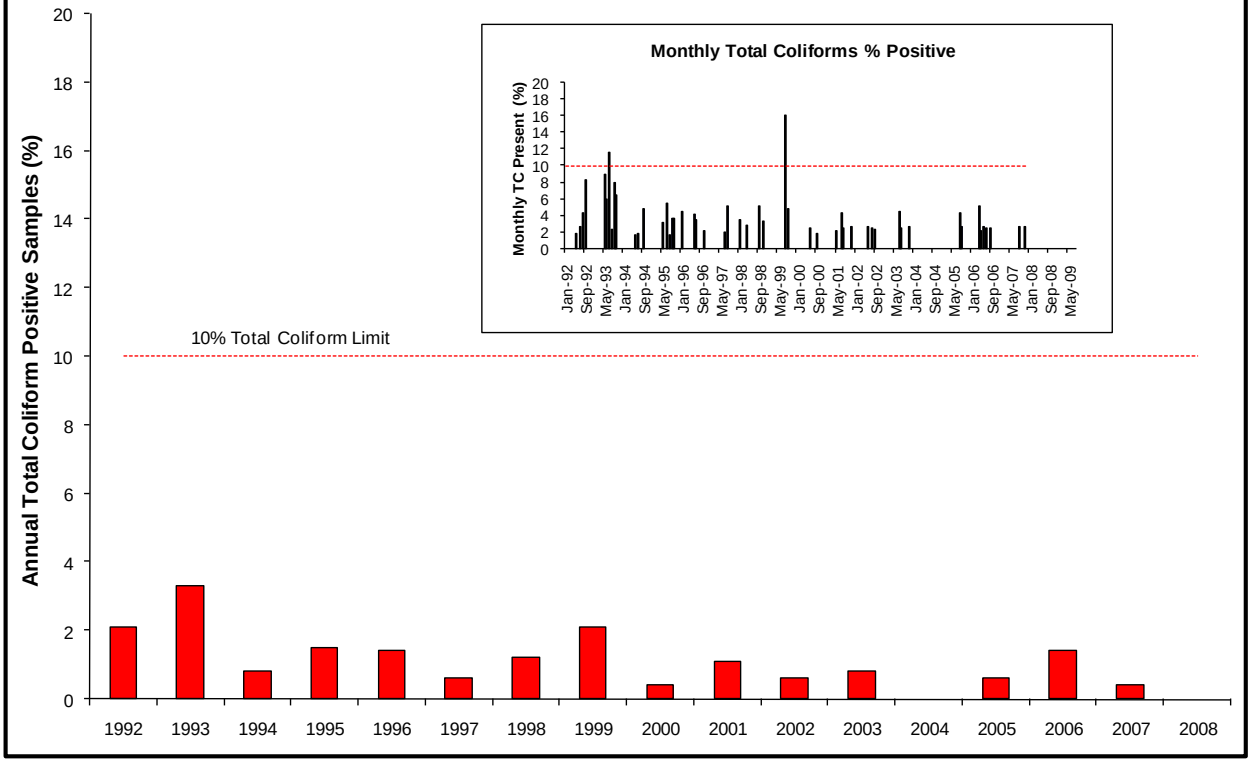
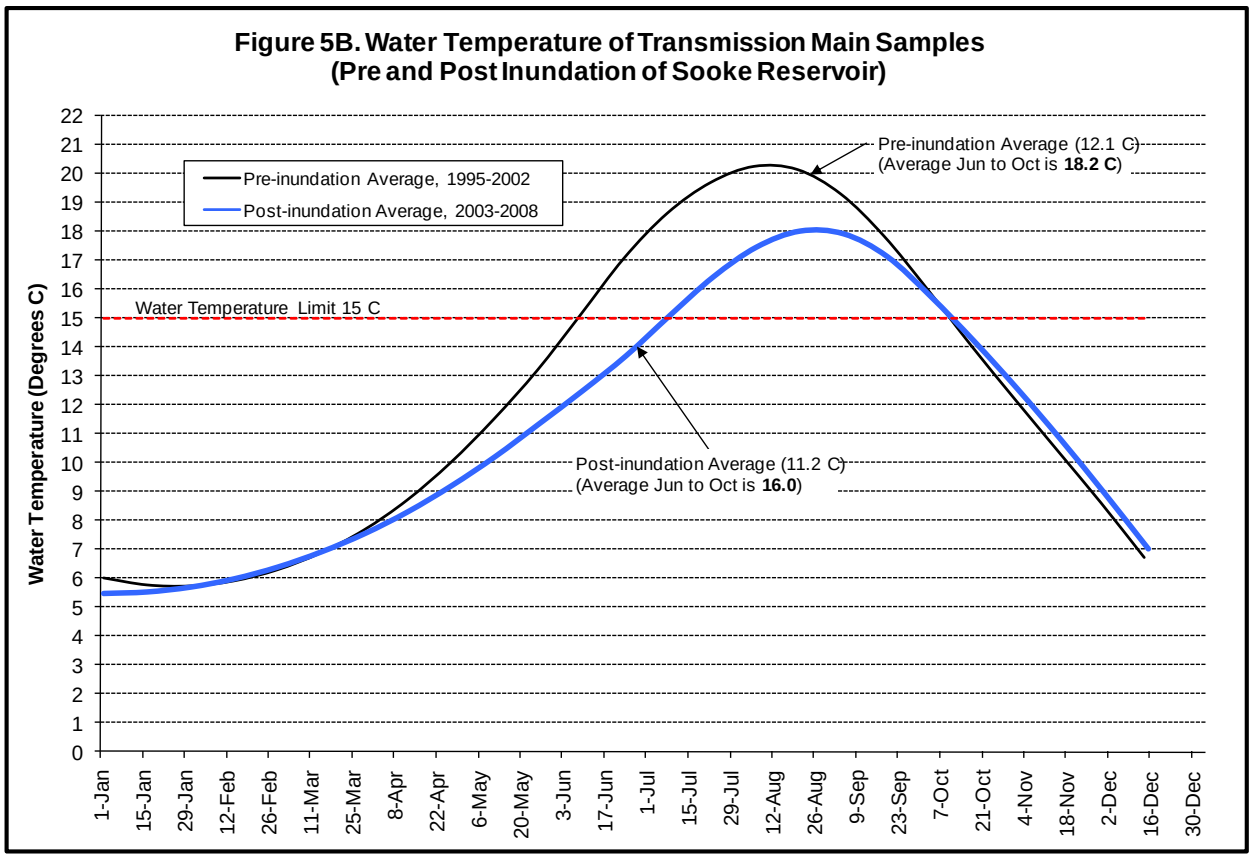


Figure 5A. Transmission Mains - Annual % Samples with Total Coliforms Present, 1992-2008





Water Temperature. The annual median water temperature for the transmission mains was 10.6°C (**Table 3**). The maximum monthly median temperature of 17.4°C occurred in September while the minimum temperature of 5.0°C occurred in January and February. 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 colder water entering Japan Gulch Plant as a result of raising the water level in Sooke Reservoir has caused the lowering of the summer water temperature in the supply mains as well. The average summer water temperature (June to October) pre-inundation (1995-2002) was 18.2ºC while the post-inundation average water temperature (2003-2008) was only 16.0ºC (**Figure 5B**).

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 CRD Water Services and CRD Environmental Services and smaller distribution system reservoirs operated either by the municipal Water Suppliers or CRD Water Services. These smaller reservoirs provide water pressure to local high elevation areas of the distribution system along with local fire protection. For the purpose of this report, all of these reservoirs were grouped together and called balancing reservoirs.

Twenty-six reservoirs (**Map 3**) located in the Greater Victoria Drinking Water System were sampled during 2008. This number includes all of the supply and local storage reservoirs operated by CRD Water Services, the majority of reservoirs operated by the municipalities and the majority of the reservoirs operated by CRD Environmental Services 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 2008 was 932 (**Table 4**). Typically, about 72-76 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.

Map 3. Water Quality Sampling Locations for Distribution System Reservoirs.

Table 4. 2008 Bacterial Quality of Greater Victoria Distribution System Reservoirs.

		Total Coliform				E. coli	Turbidity		Chlorine Residual	Water Temp.
Month	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10	Samples >0	Samples Collected	Samples >1 NTU	Median mg/L Cl_2	Median ^oC
JAN	81	0	0	0	0	0	6	0	0.67	5.4
FEB	72	0	0	0	0	0	7	1	0.75	5.5
MAR	73	0	0	0	0	0	5	0	0.72	6.7
APR	79	0	0	0	0	0	6	0	0.70	7.8
MAY	84	1	1.2	0	0	0	5	0	0.67	10.5
JUN	76	0	0	0	0	0	5	0	0.60	12.8
JUL	79	0	0	0	0	0	7	0	0.59	15.9
AUG	78	3	3.8	1	1	0	5	0	0.43	17.2
SEP	85	2	2.4	0	0	0	5	0	0.36	17.0
OCT	87	1	1.1	0	0	0	6	0	0.25	13.1
NOV	75	1	1.3	0	0	0	5	0	0.27	10.7
DEC	63	0	0	0	0	0	5	0	0.36	8.2
TOTAL	**932**	**8**	**0.9**	**1**	**1**	**0**	**67**	**1**	**0.57**	**10.8**

TC = Total Coliforms, **E. coli** = *Escherichia coli* **Cl_2** = chlorine, **NTU** = Nephelometric turbidity unit.
> = Greater than, **mg/L** = milligrams per litre, **°C** = degrees Celsius

4.5.2. BACTERIA

Total Coliforms. In 2008, eight samples (0.9%) collected from the balancing reservoirs contained total coliform bacteria (**Table 4**)**.** Total coliforms were found in May and in August to November 2008. When the results of all of the reservoirs are grouped together, the 10% positive total coliform limit was not exceeded in 2008 (**Figure 6**). These results are similar to the past several years and better than in the years before the start of an annual reservoir cleaning program.

One of the positive coliform samples had a total coliform count greater than the 10 CFU/100 mL limit. In addition, one of the resamples contained total coliforms. On an annual basis, only Walfred Reservoir (19.4%) exceeded the 10% total coliform limit (**Figure 6A**). This result is slightly better than in 2005, 2006, and 2007, and an improvement from the earlier years of 1992 through 1996 (**Figure 6B**). Of all the supply and distribution reservoirs sampled in the Greater Victoria Drinking Water System, Walfred Reservoir demonstrated the poorest bacteriological water quality with the highest percentage of positive samples for total coliforms (**Figure 6A**).

In the long term, there has been a significant improvement in the bacteriological quality of the Greater Victoria Distribution System reservoirs. This means that there has been a general reduction in the annual percentage of samples with total coliforms present - a high of 21% in 1992 to a low of 1.2% in 2004 and 0.9% in 2008 (**Figure 6B**). There has also been a reduction in the number of reservoirs with annual total coliform percentages over the 10% positive limit (high of 75% of the balancing reservoirs in 1992 to a low of 3.8% in 2007 and in 2008) (first inset in **Figure 6B**). Further, there has also been a reduction in the number of months when total coliform occurrence was over the 10% positive limit (high of eight months in 1992 to no occurrences exceeding the 10% positive total coliform limit in 2002, 2003, 2004, 2007, and 2008) (second inset in **Figure 6B**).

**Figure 6. Distribution System Reservoirs
Total Coliforms and Chlorine Residual in 2008**

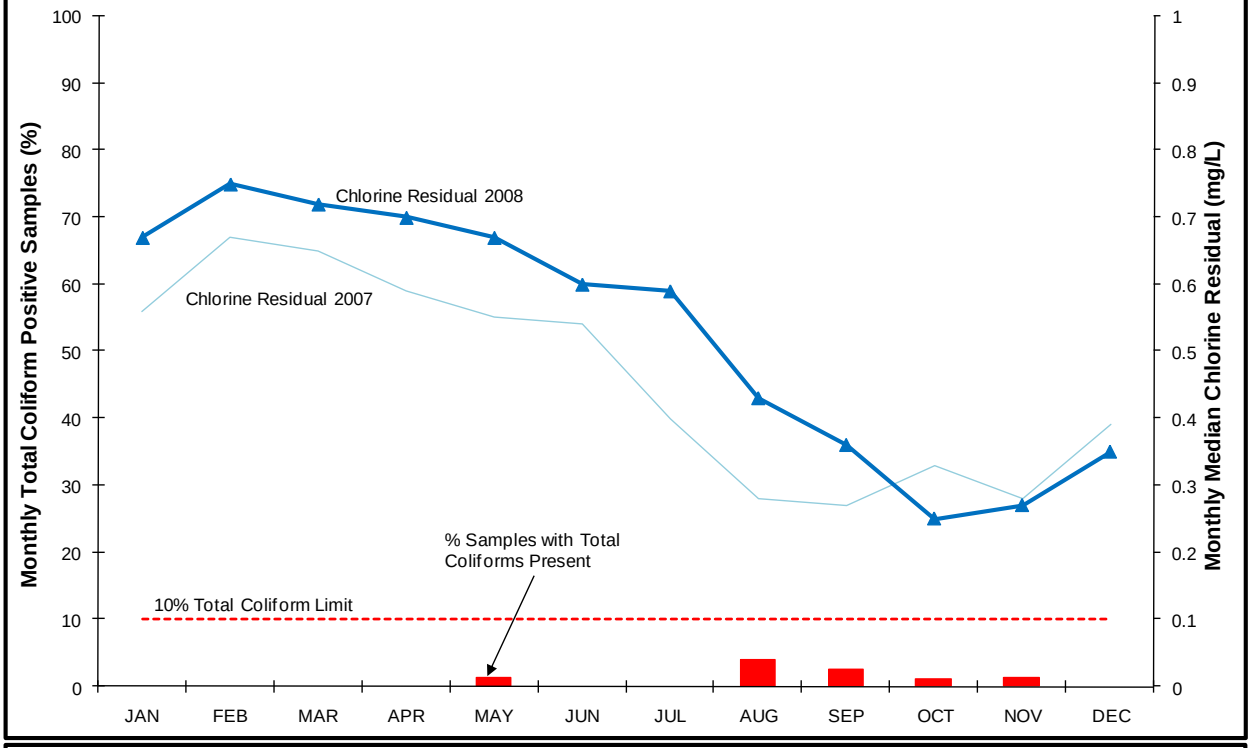


**Figure 6A. Distribution System Reservoirs
Total Coliforms and Chlorine Residual in 2008**

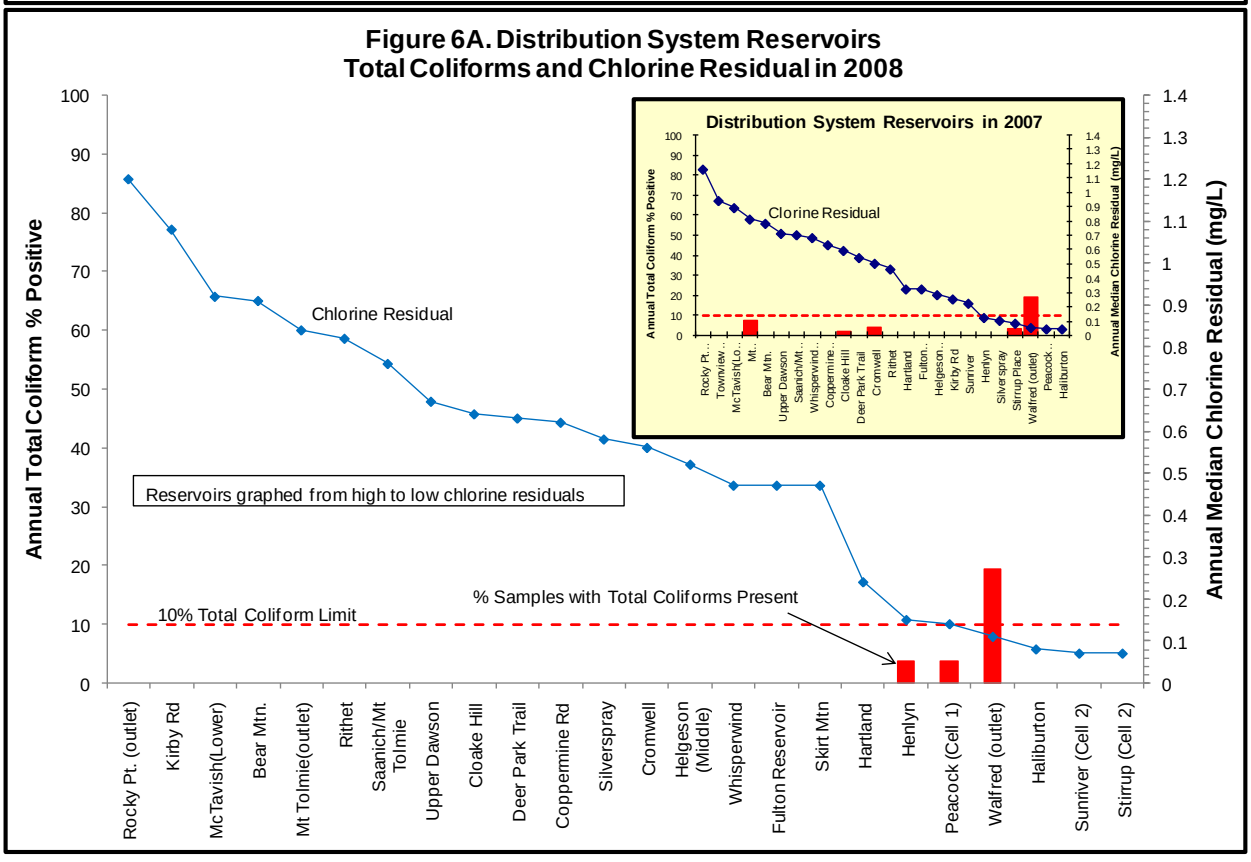


Figure 6B. Distribution System Reservoirs - Annual % Samples with Total Coliforms Present, 1992-2008

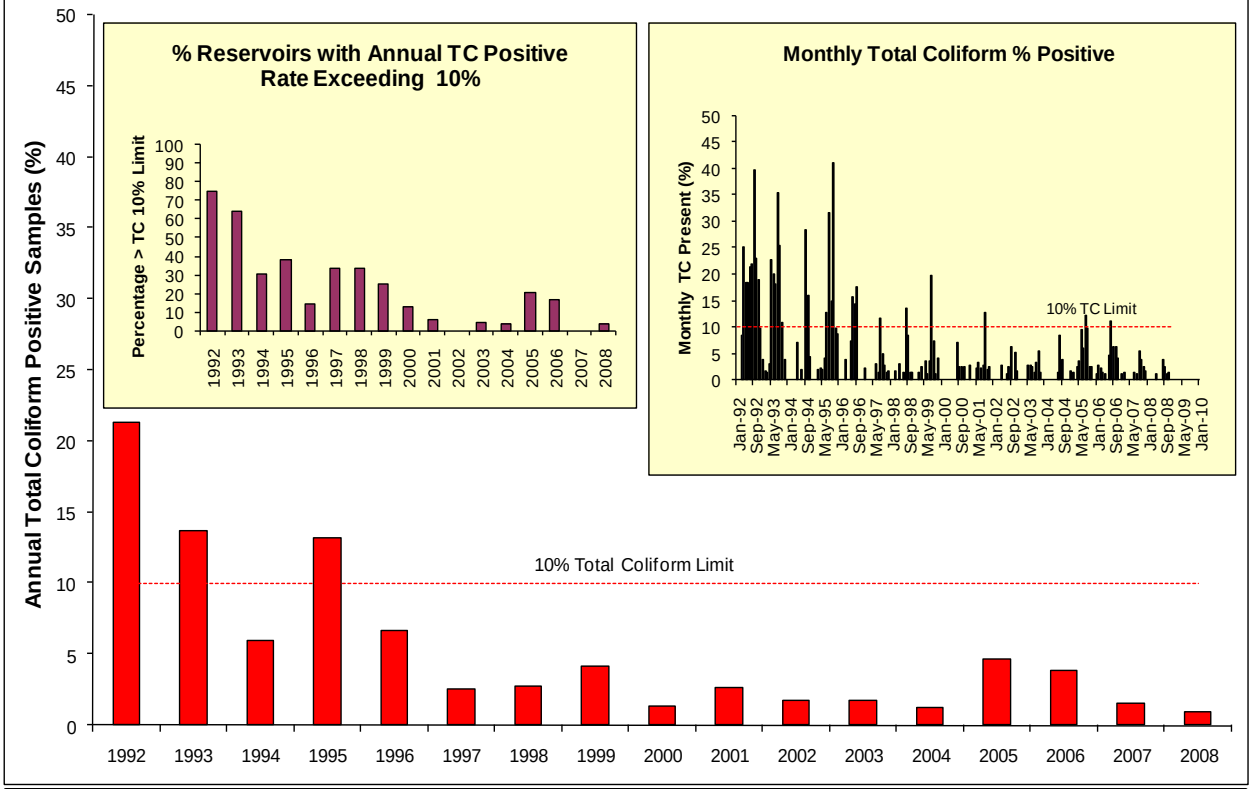


Figure 6C. Water Temperature in Distribution System Reservoirs (Pre and Post Inundation of Sooke Reservoir)

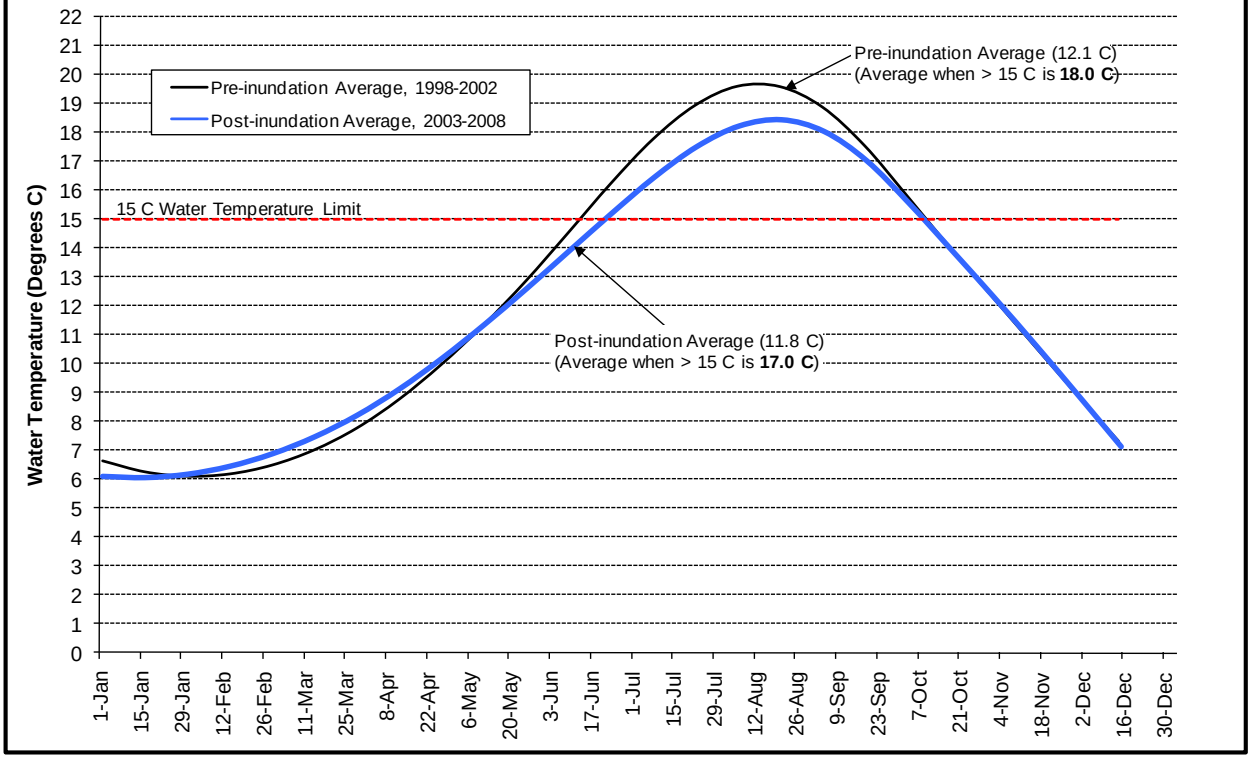
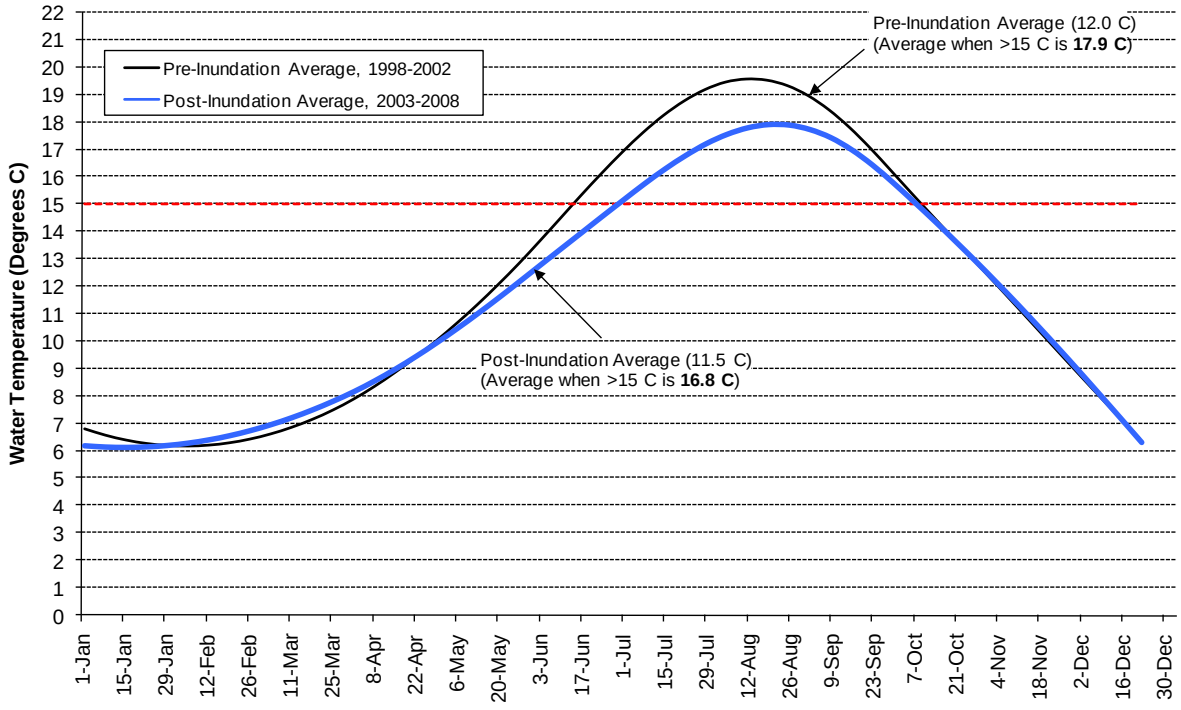


Figure 6D. Water Temperature in D/S Reservoirs (Non Western Communities) (Pre and Post Inundation of Sooke Reservoir)



E. coli. None of the distribution system reservoir samples contained *E. coli* bacteria (**Table 4**).

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 showed a steady decline from February through October before increasing in November (**Figure 6**). Some of this variation is due to rechlorinating (supplemental disinfection) reservoirs at different times during the year and refilling of reservoirs with fresh water containing higher chlorine residuals particularly between January and April 2008. Three reservoirs were rechlorinated in August and September, one in October and one in November. Only three reservoirs required rechlorination (Peacock, Stirrup Place and Walfred) in response to adverse bacteriological results.

Similar to previous years, 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 West Shore Communities where a number of reservoirs had annual median chlorine residuals below 0.2 mg/L: Stirrup Place Reservoir (0.07 and 0.14), Walfred Reservoir (0.11) and Peacock Reservoir (0.14) (**Figure 6A**).

Water Temperature. The median monthly temperature of the water in all of the distribution system reservoirs combined was lowest in January at 5.4^{o}C and highest in August 2007 at 17.2^{o}C (**Table 4**).

The expansion of Sooke Reservoir and drawing in cooler water into the Japan Gulch Plant has had some effect, albeit small, on lowering the average summer temperature of

most of the reservoirs. The pre-inundation (1998-2002) summer average temperature was 18ºC versus 17.0ºC post-inundation (2003-2008) (**Figure 6C**). However, if the reservoirs in the Western Communities are excluded from the overall reservoir grouping, then the difference in average summer water temperatures is more pronounced with the pre-inundation summer temperature averaging 17.9ºC versus only 16.8ºC post-inundation, a difference of over one degree (**Figure 6D**).

4.6. GREATER VICTORIA DISTRIBUTION SYSTEM

The 2008 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 system 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 2008, 2,142 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. Sixteen samples (0.7%) 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, April through August, October and, November) (**Figure 7**) but these occurrences did not exceed the 10% total coliform limit during any month of the year.

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 2008. This was similar to recent years 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 (inset in **Figure 7A**).

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

In 2008, 46% of the coliform positives from the Greater Victoria Distribution System were identified as coliforms of non-fecal origin that are commonly isolated from various environmental sources including water, food and plants (*Pantoea, Serratia, Enterobacter amnigenus)*. The remaining 54% of the coliform positives were coliforms that are found in both environmental sources and in fecal matter and sewage *(Enterobacter, Klebsiella*). However, the presence of these coliforms is not necessarily related to fecal contamination.

E. coli. In 2008, no *E. coli* were found in any of the Greater Victoria Distribution System samples (**Table 5**). Since *E. coli* is the only coliform almost exclusively associated with a fecal source, this means that the Greater Victoria Distribution System was free of fecal contamination in 2008 (based on the analysis of the samples collected).

Table 5. 2008 Bacterial Quality of the Greater Victoria Distribution System.

		Total Coliform				E. coli	Turbidity		Chlorine Residual	Water Temp
Month	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10	Samples >0	Samples Collected	Samples >1 NTU	Median mg/L Cl_2	Median ^oC
JAN	187	1	0.5	0	0	0	22	0	0.60	6.5
FEB	176	0	0	0	0	0	21	0	0.75	6.5
MAR	163	0	0	0	0	0	23	2	0.74	7.6
APR	181	1	0.6	0	0	0	33	0	0.71	8.7
MAY	192	2	1.0	0	1	0	33	1	0.76	11.1
JUN	177	1	0.6	0	0	0	25	0	0.69	13.5
JUL	190	2	1.1	0	1	0	27	1	0.72	16.0
AUG	178	3	1.7	0	0	0	23	0	0.57	17.6
SEP	172	0	0	0	0	0	25	0	0.55	17.5
OCT	203	2	1.0	0	0	0	28	2	0.45	13.9
NOV	170	4	2.4	0	0	0	29	2	0.51	11.6
DEC	153	0	0	0	0	0	22	0	0.57	9.6
TOTAL	**2142**	**16**	**0.7%**	**0**	**2**	**0**	**311**	**8**	**0.64**	**11.6**

TC = Total Coliforms, **E. coli** = *Escherichia coli* **Cl_2** = chlorine, **NTU** = Nephelometric turbidity unit.
> = Greater than, **mg/L** = milligrams per litre, **°C** = degrees Celsius

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 0.64 mg/L (**Table 5**). This is virtually identical to 2006 and 2007 and similar to previous recent years. In individual samples, 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. As a reflection of the steady dosage rate that was applied at the Japan Gulch Plant, the median chlorine residual remained fairly constant from February through mid-July and then dropped from mid-July to October before rising gradually in December (**Figure 7**).

As expected, the median annual chlorine residual was highest at the first customer location (1.18 mg/L) and lowest in Sidney (0.43 mg/L) followed closely by North Saanich (0.44 mg/L) and by the distribution system reservoirs (0.57 mg/L). The minimum median monthly chlorine residual was lowest in the Sidney distribution system (0.16 mg/L) followed closely by the North Saanich distribution system (0.19 mg/L) and the distribution system reservoirs (0.25 mg/L).

Over the past seventeen years, there is a correlation between the annual percentage positive total coliforms and the median annual chlorine residual in the distribution system (**Figure 7B**). The data suggests that the higher the median annual chlorine residual, the lower the percentage of total coliforms found in the distribution system. In the years 1992 through 1999, the median annual chlorine residual was less than 0.6 mg/L and the median total coliform percentage positive rate was 3.2% while in the years 2000 through 2008, the median annual chlorine residual was more than 0.6 mg/L and the median total coliform percentage positive rate was only 0.6%.

**Figure 7. Greater Victoria Distribution System (Combined Dataset)
Total Coliforms and Chlorine Residual in 2008**

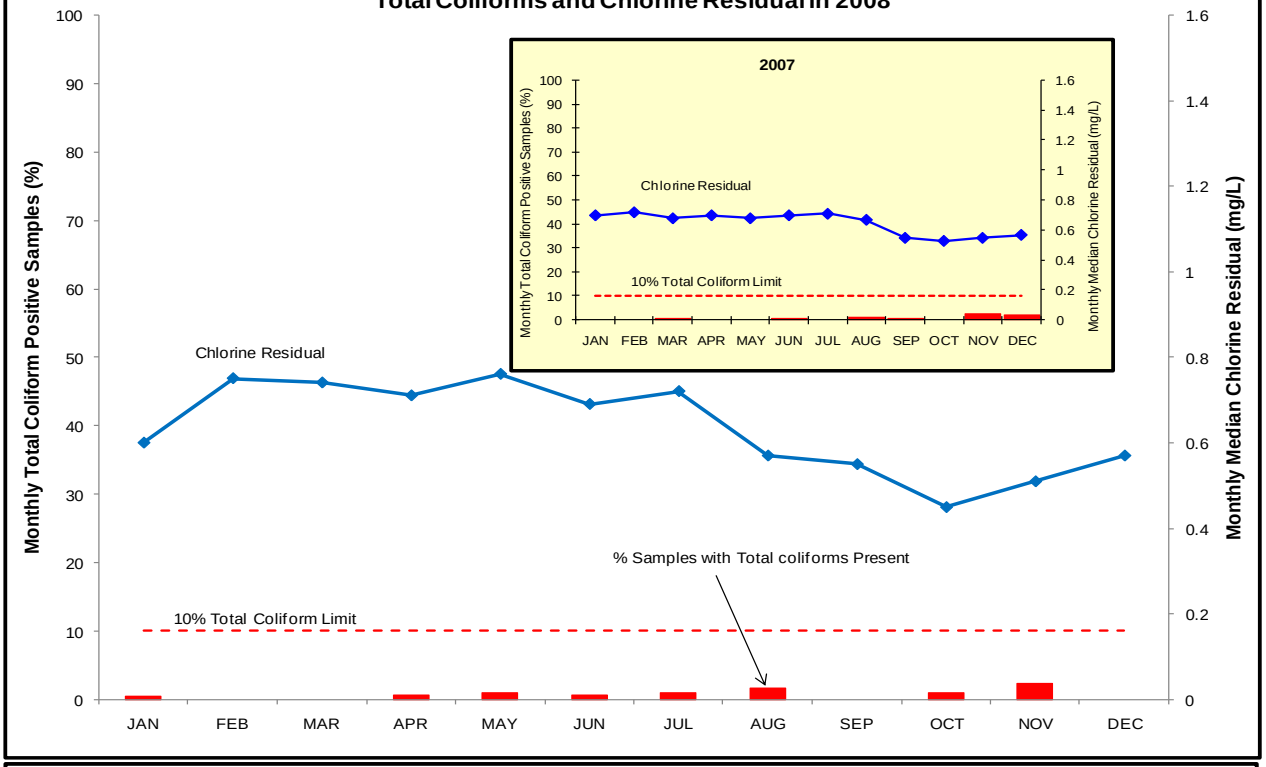


**Figure 7A. Greater Victoria Distribution System Combined
Annual % Samples with Total Coliforms Present, 1992-2008**

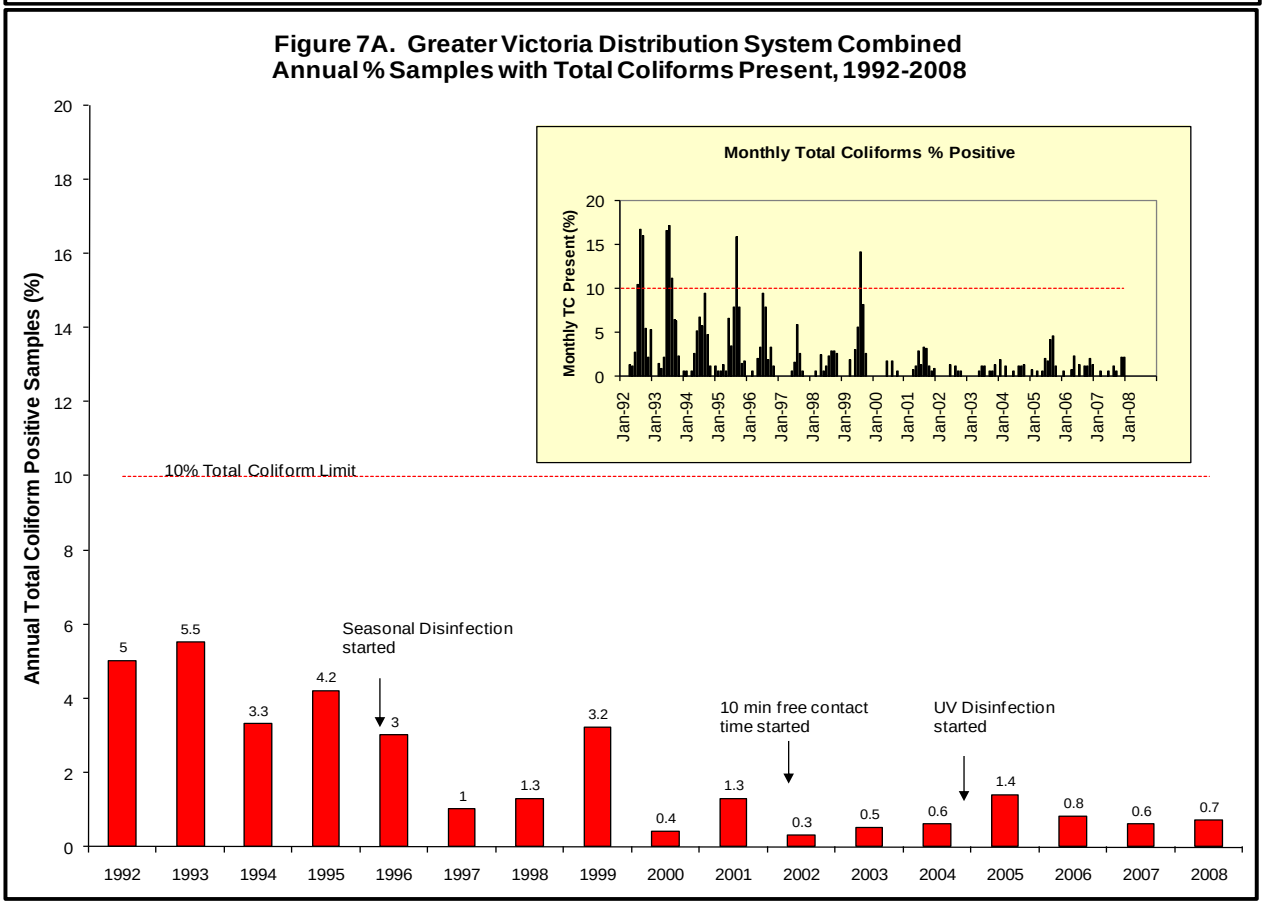


Figure 7B. Relationship between Percentage Total Coliform Positives and Annual Chlorine Residual for Greater Victoria Distribution System, 1992-2008

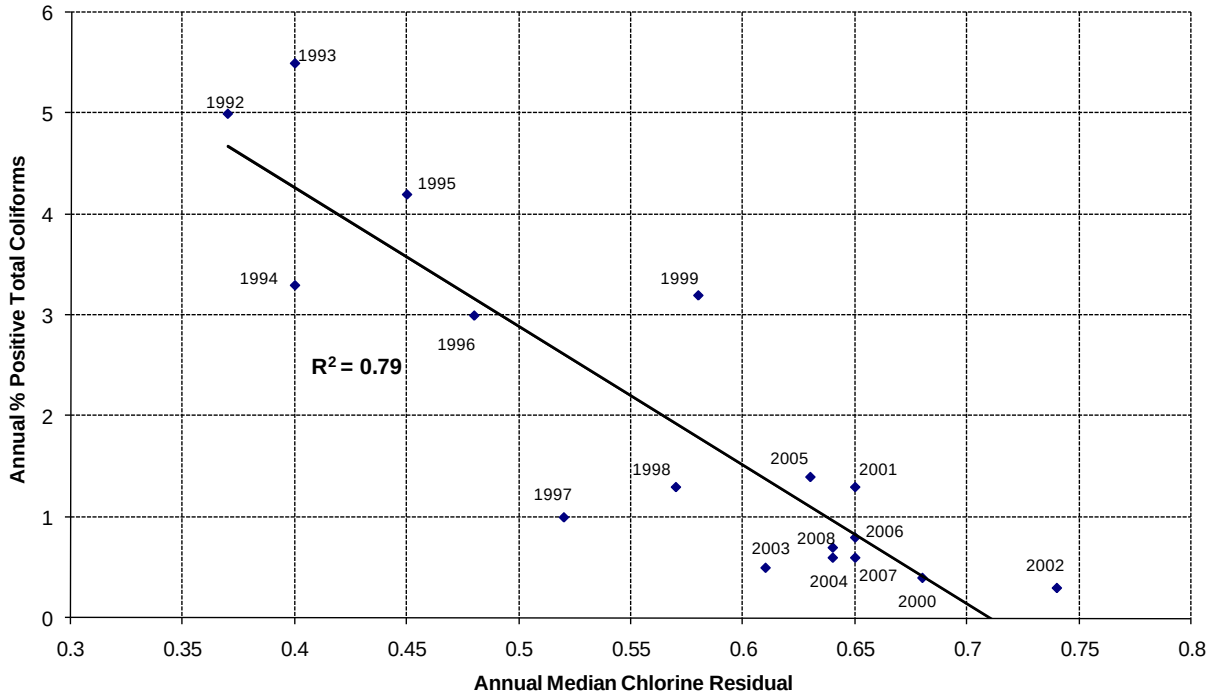
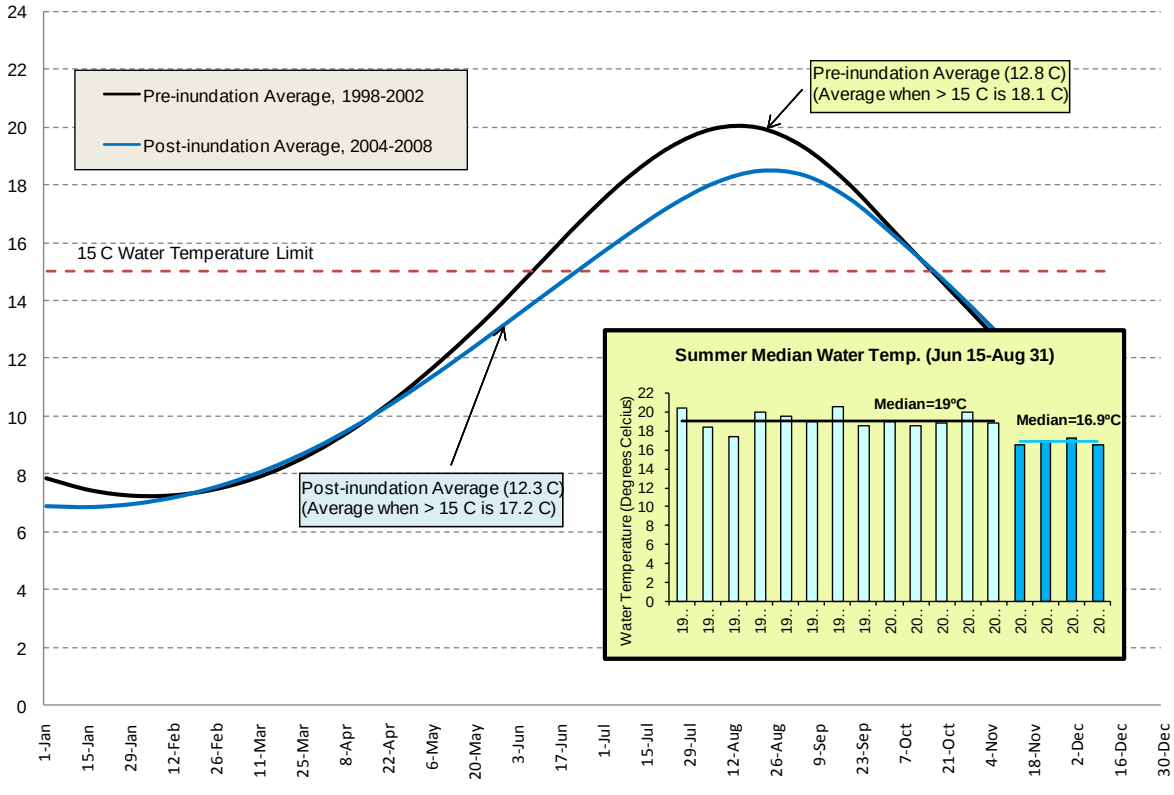


Figure 7C. Water Temperature in Greater Victoria Distribution System (Pre and Post Inundation of Sooke Reservoir)



Water Temperature. in 2008, the annual median water temperature for the Greater Victoria Distribution System was 11.6°C. This was 1.9°C higher (9.7°C) than the temperature of the water entering the water system at the Japan Gulch Plant. The median monthly temperature ranged from 6.5°C in January and February to 17.6°C in August (**Table 5**). The maximum daily water temperature of 21.2°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.

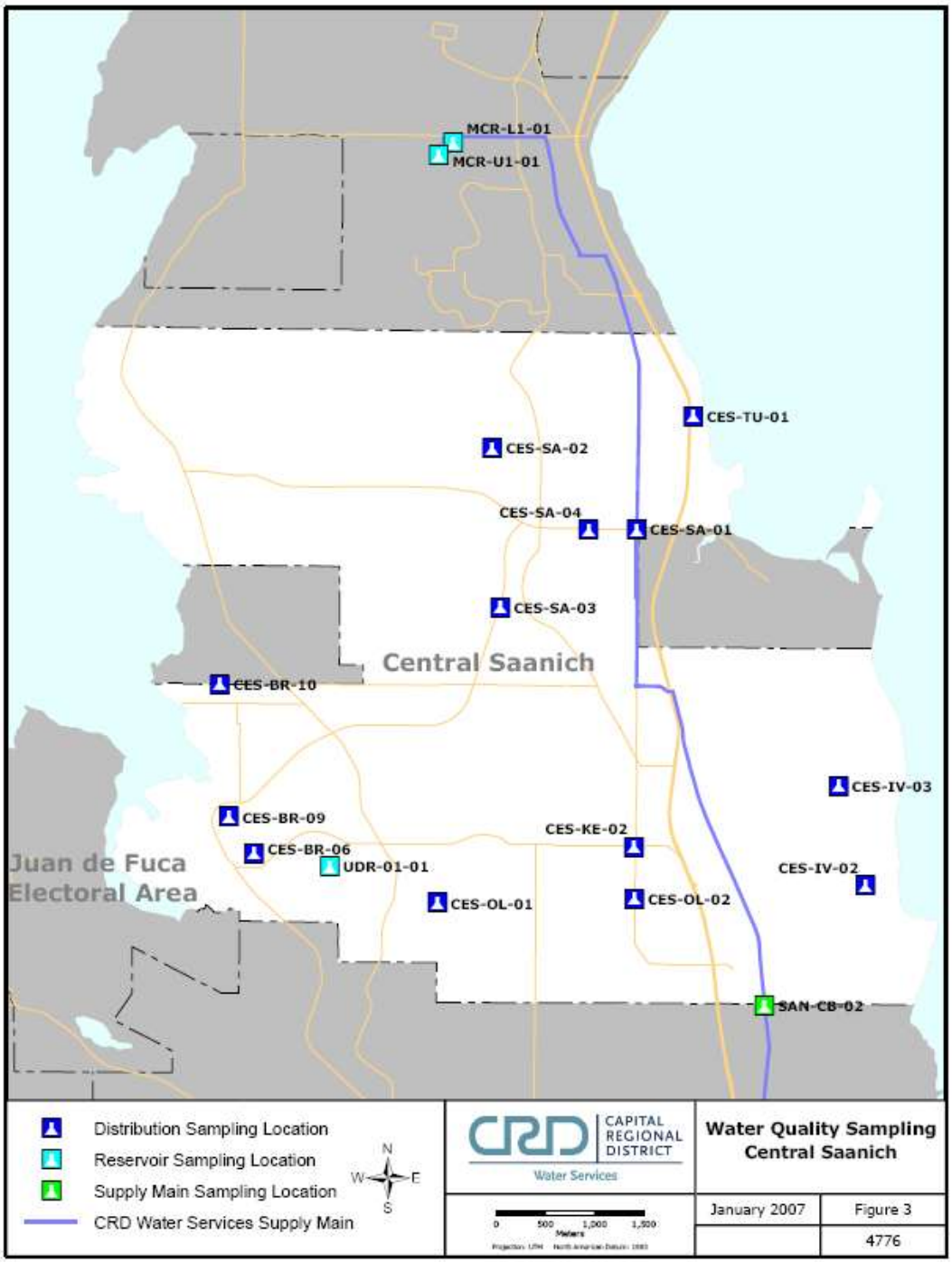
In the individual municipalities the highest annual median water temperature was reached in Victoria (12.3ºC) followed closely by Sidney (12ºC) and Oak Bay (11.8ºC) while the lowest annual median water temperature was in the Sooke and Central Saanich distribution systems (11.3ºC) followed by Saanich at 11.4ºC.

In 2008, similar to other years following the expansion of Sooke Reservoir, the water temperature in the distribution system was generally cooler by 0.5ºC to 2.5ºC in the period from mid-June to the end of August compared with the years prior to the raising of the reservoir. The average maximum temperature reached in the pre-inundation years was 20ºC compared with 18.5ºC in the post-inundation years (**Figure 7C**). The median water temperature for the period mid-June to the end of August is 19ºC for the years 1992-2004 and only 16.9ºC for the years 2005-2008 (insert **Figure 7C**). In addition, when the temperature is over 15ºC, the average is 18.1ºC pre-inundation and only 17.2ºC post-inundation. This temperature difference is reflective of the colder water entering Japan Gulch Plant as a result of raising the water level in 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 in 2008 (**Map 4**). Ten locations were sampled bi-weekly and three monthly.

Map 4. Sampling Locations in Central Saanich Distribution System



4.7.1. SAMPLE COLLECTION

In 2008, 288 bacteriological samples were collected from the Central Saanich Distribution System (**Table 6**).

4.7.2. BACTERIA

Total Coliforms. Total coliforms were found in 6 samples collected in January, May, July, August and November from five locations (Larkvale and Jeffree in January, 8161 Lochside Drive in July, Central Saanich at Styan in July, Welch at Martindale in August, and 1003 Stelly X Road in November) 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 2008. The annual total coliform percentage positive was well below the 10% limit at 2.1% (**Figure 8)**. The organisms responsible for the coliform positives were identified as *Enterobacter, Citrobacter, Klebsiella, Serratia* and *Pantoea species.* All resamples were negative for coliforms.

E. coli. None of the samples contained *E. coli* in 2008 (**Table 6**).

Table 6. 2008 Bacterial Quality of the Central Saanich Distribution System.

		Total Coliform				E. coli	Turbidity		Chlorine Residual	Water Temp.
Month	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10	Samples >0	Samples Collected	Samples >1 NTU	Median mg/L Cl_2	Median ^{o}C
JAN	27	1	3.7	0	0	0	3	0	0.59	6.8
FEB	23	0	0.0	0	0	0	3	0	0.75	6.4
MAR	22	0	0.0	0	0	0	2	0	0.77	7.4
APR	25	0	0.0	0	0	0	5	0	0.76	8.4
MAY	22	1	4.5	0	1	0	3	0	0.81	10.6
JUN	25	0	0.0	0	0	0	2	0	0.77	13.1
JUL	27	2	7.4	0	1	0	4	0	0.89	15.7
AUG	23	1	4.3	0	0	0	2	0	0.71	17.7
SEP	24	0	0.0	0	0	0	2	0	0.63	17.4
OCT	26	0	0.0	0	0	0	4	0	0.61	14.0
NOV	23	1	4.3	0	0	0	3	0	0.58	11.6
DEC	21	0	0	0	0	0	4	0	0.60	9.4
TOTAL	**288**	**6**	**2.1%**	**0**	**2**	**0**	**37**	**0**	**0.70**	**11.3**

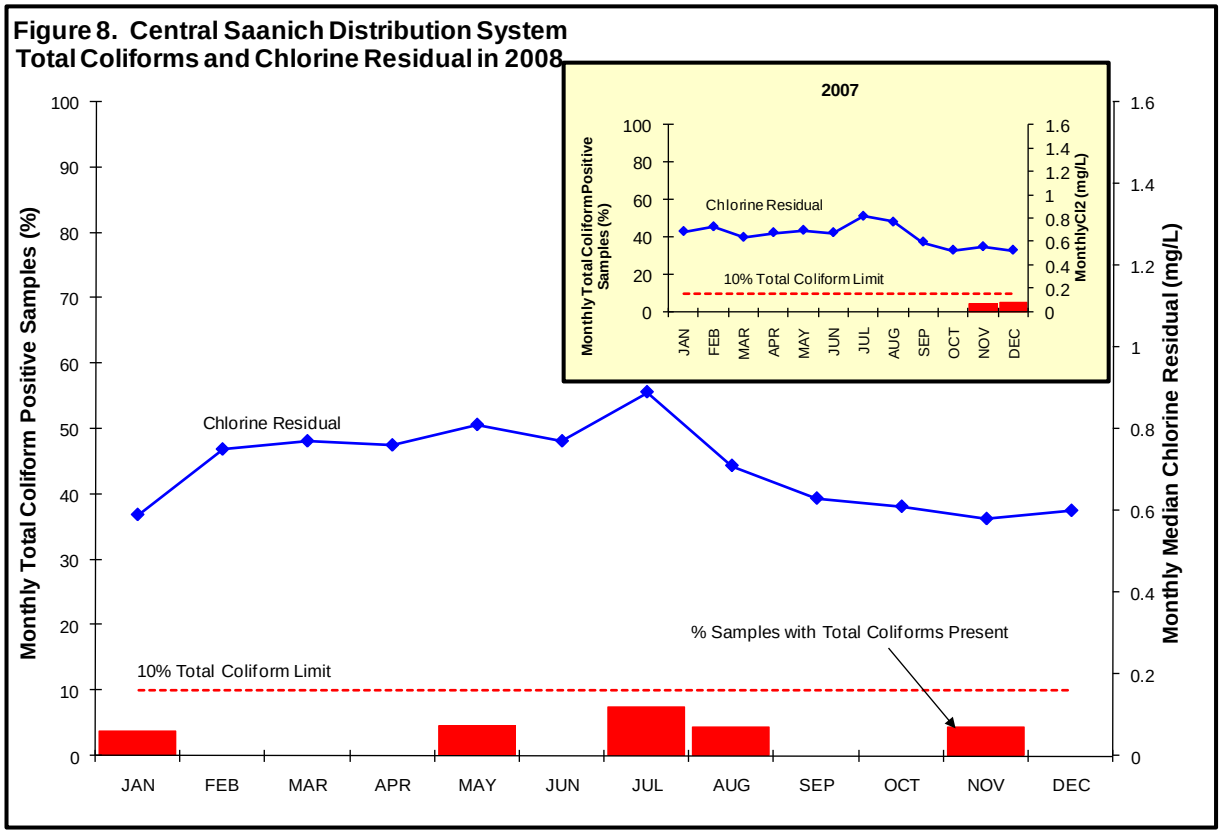
TC = Total Coliforms, **E. coli** = *Escherichia coli* **Cl_2** = chlorine, **NTU** = Nephelometric turbidity unit.
> = Greater than, **mg/L** = milligrams per litre, **°C** = degrees Celsius

4.7.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

Chlorine Residual. The annual median chlorine residual for the Central Saanich Distribution System was 0.70 mg/L (**Table 6**). The monthly median chlorine residual remained relatively steady through June, increased through July and then declined reaching a minimum of 0.58 mg/L (monthly median) in November (**Figure 8**).

Water Temperature. The annual median water temperature in the Central Saanich Distribution System was 11.3°C virtually the same as in the past six years with monthly medians ranging between 6.4°C (February) and 17.7°C (August) (**Table 6**).

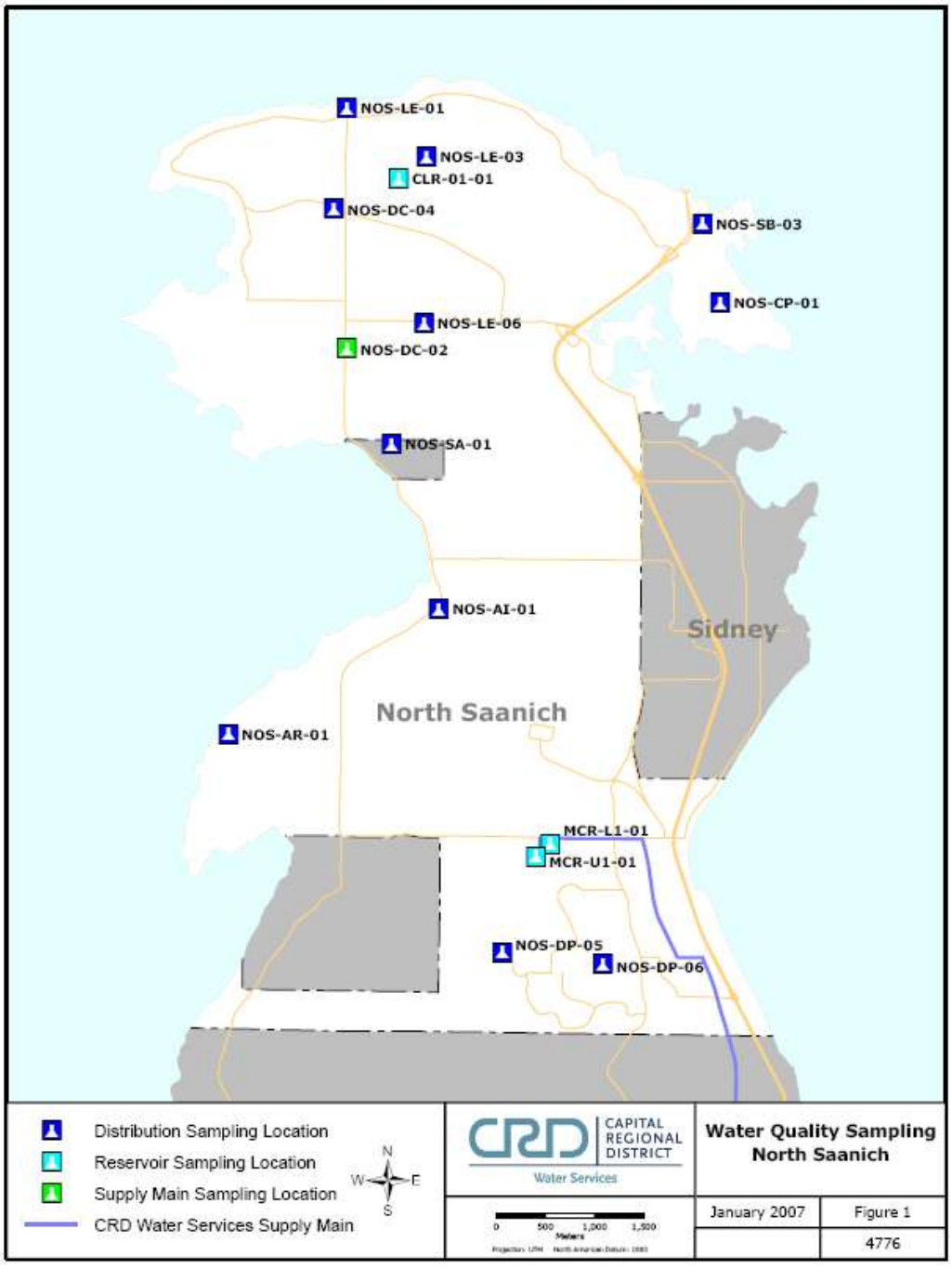
Figure 8. Central Saanich Distribution System Total Coliforms and Chlorine Residual in 2008



4.8. NORTH SAANICH DISTRIBUTION SYSTEM

Ten sampling locations were used to monitor the bacteriological quality of the drinking water in the North Saanich Distribution System in 2008 (**Map 5**). Two of these locations was sampled weekly, six locations bi-weekly and two locations monthly. The majority of these sampling locations are extremities of the distribution system.

Map 5. Sampling Locations in North Saanich Distribution System



4.8.1. SAMPLE COLLECTION

In 2008, 257 bacteriological samples were collected from the North Saanich Distribution System (**Table 7**).

4.8.2. BACTERIA

Total Coliforms. Only one sample collected from the North Saanich Distribution System in 2008 contained total coliform bacteria (**Table 7** and **Figure 9**).

E. coli. No *E. coli* bacteria were present in any of the samples collected from the North Saanich Distribution System in 2008.

Table 7. 2008 Bacterial Quality of the North Saanich Distribution System.

	Total Coliform						E. coli	Turbidity		Chlorine Residual	Water Temp.
Month	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10		Samples >0	Samples Collected	Samples >1 NTU	Median mg/L Cl_2	Median ^oC
JAN	22	0	0	0	0		0	1	0	0.43	6.5
FEB	23	0	0	0	0		0	1	0	0.45	6.5
MAR	19	0	0	0	0		0	1	0	0.50	7.4
APR	21	0	0	0	0		0	1	0	0.63	8.3
MAY	21	0	0	0	0		0	1	0	0.53	10.8
JUN	21	0	0	0	0		0	1	0	0.49	13.0
JUL	21	0	0	0	0		0	1	0	0.56	15.7
AUG	24	0	0	0	0		0	1	0	0.41	17.1
SEP	21	0	0	0	0		0	1	0	0.42	17.1
OCT	23	0	0	0	0		0	1	0	0.19	13.7
NOV	21	1	4.8	0	0		0	1	0	0.30	11.7
DEC	20	0	0	0	0		0	1	0	0.35	9.6
TOTAL	**257**	**0**	**0.4%**	**0**	**0**	**0**	**0**	**12**	**0**	**0.44**	**11.6**

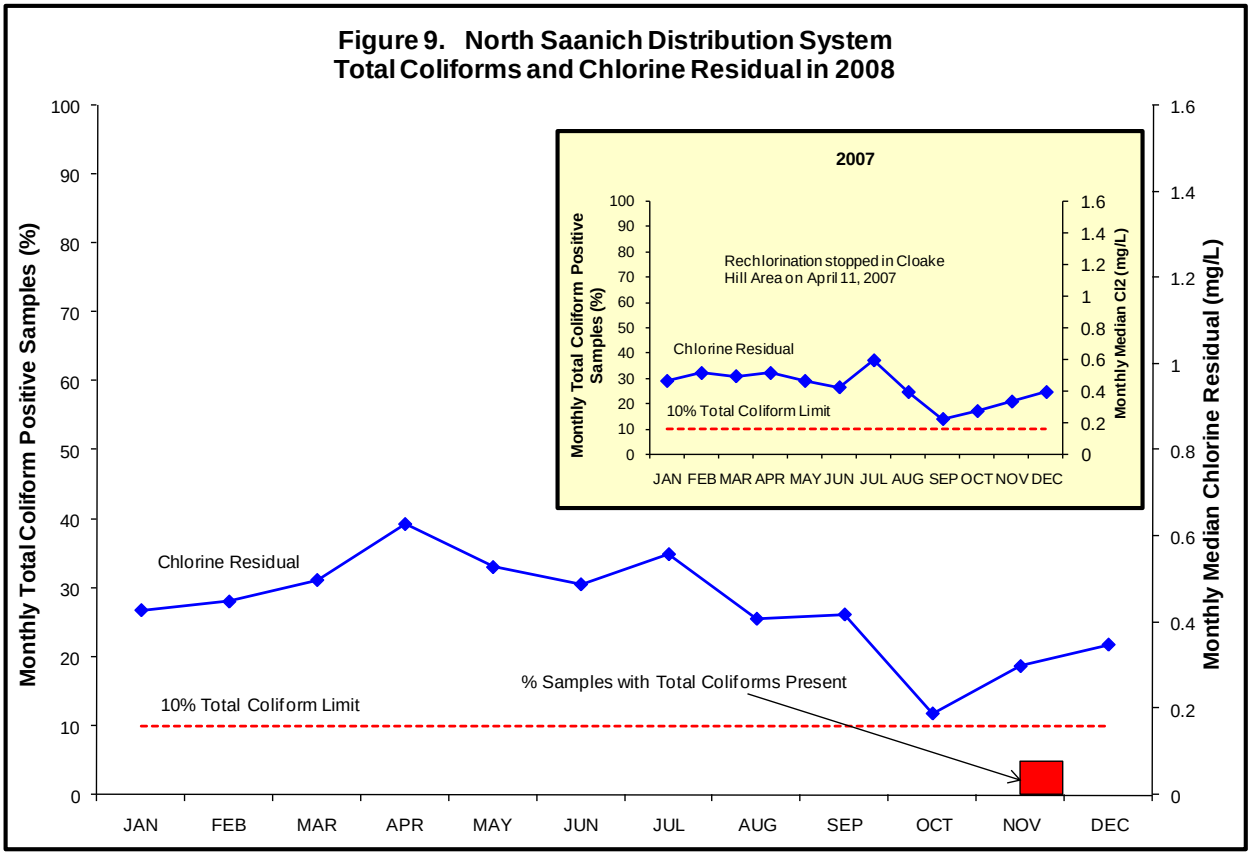
TC = Total Coliforms, **E. coli** = *Escherichia coli* **Cl_2** = chlorine, **NTU** = Nephelometric turbidity unit.
> = Greater than, **mg/L** = milligrams per litre, **°C** = degrees Celsius

CHLORINE RESIDUAL AND WATER TEMPERATURE

Chlorine Residual. The annual median chlorine residual for the North Saanich Distribution System was 0.44 mg/L. The monthly median chlorine residuals ranged from a low of 0.19 mg/L in October to a high of 0.63 in April (**Table 7**). Prior to April 2007, rechlorination was used by the CRD Environmental Services Department in the water supplied to the municipal system from the Deep Cove Pump Station (**Figure 9**). Due to the risk of excessive disinfection by-product formation associated with rechlorination, this practise was stopped in April 2007. It is interesting to note that in 2007, there were no total coliform positives for the North Saanich Distribution System even though the annual median chlorine residual in the North Saanich was lower than the annual median residual for the combined distribution system and was the lowest observed for any of the municipal distribution systems. Likewise, in 2008 there was only coliform positive from the 959 Tatlow sampling location in November (chlorine residual of 0.23 mg/L).

Water Temperature. The annual median water temperature in the North Saanich Distribution System was 11.6°C (**Table 7**), similar to that found in 2005, 2006, and 2007.

Figure 9. North Saanich Distribution System Total Coliforms and Chlorine Residual in 2008



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 in 2008 (**Map 6**). All seven locations were sampled bi-weekly.

Map 6. Sampling Location in Oak Bay Distribution System.

4.9.1. SAMPLE COLLECTION

During 2008, a total of 179 bacteriological samples were collected from the Oak Bay Distribution System (**Table 8**).

4.9.2. BACTERIA

Total Coliforms. Three of the samples collected from the Oak Bay Distribution System contained total coliform bacteria (**Figure 10**). The coliform positives were from the Oak Bay Recreation Centre in August, and from the Willows Beach Concession in October and November 2008. None of the resamples were positive for coliforms. This is similar to recent years and an improvement from 1995 when coliforms were found during six months of the year.

E. coli No *E. coli* bacteria were observed in any of the samples collected from the Oak Bay Distribution System.

Table 8. 2008 Bacterial Quality of the Oak Bay Distribution System.

	Total Coliform					E. coli	Turbidity		Chlorine Residual	Water Temp.
Month	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10	Samples >0	Samples Collected	Samples >1 NTU	Median mg/L Cl_2	Median ^oC
JAN	17	0	0	0	0	0	2	0	.71	6.3
FEB	14	0	0	0	0	0	2	0	.77	6.7
MAR	14	0	0	0	0	0	2	0	.74	8.1
APR	15	0	0	0	0	0	2	0	.72	9.2
MAY	16	0	0	0	0	0	2	0	.80	11.5
JUN	13	0	0	0	0	0	1	0	.69	14.2
JUL	17	0	0	0	0	0	3	0	.83	16.5
AUG	15	1	6.7	0	0	0	2	0	.64	18.1
SEP	14	0	0	0	0	0	2	0	.55	18.2
OCT	18	1	0	0	0	0	3	0	.54	14.0
NOV	15	1	0	0	0	0	1	0	.61	11.7
DEC	11	0	0	0	0	0	0	0	.54	9.7
TOTAL	**179**	**3**	**1.7%**	**0**	**0**	**0**	**22**	**0**	**0.68**	**11.8**

TC = Total Coliforms, **E. coli** = *Escherichia coli* **Cl_2** = chlorine, **NTU** = Nephelometric turbidity unit.
> = Greater than, **mg/L** = milligrams per litre, **°C** = degrees Celsius

4.9.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

Chlorine Residual. The annual median chlorine residual for the Oak Bay Distribution System was 0.68 mg/L (**Table 8**). The lowest monthly median chlorine residual occurred in October (0.54 mg/L) and the highest in July (0.83 mg/L) (**Figure 10**). This is similar to 2007 and slightly lower than the prior eight years by 0.08-0.12 mg/L.

Water Temperature. The annual median water temperature in the Oak Bay Distribution System was 11.8°C (**Table 8**) with monthly median values ranging from 6.3°C in January to 18.2°C in September. This range is similar to that of the last several years.

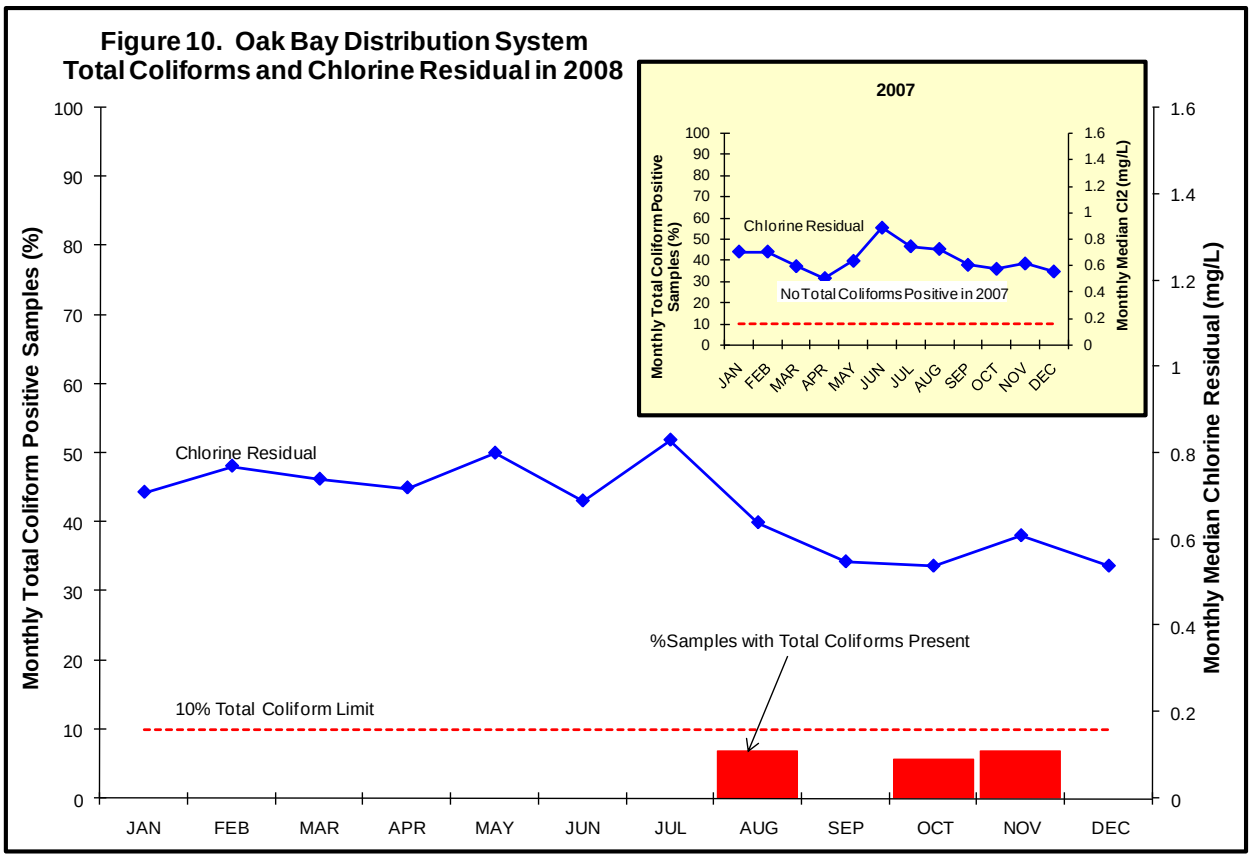
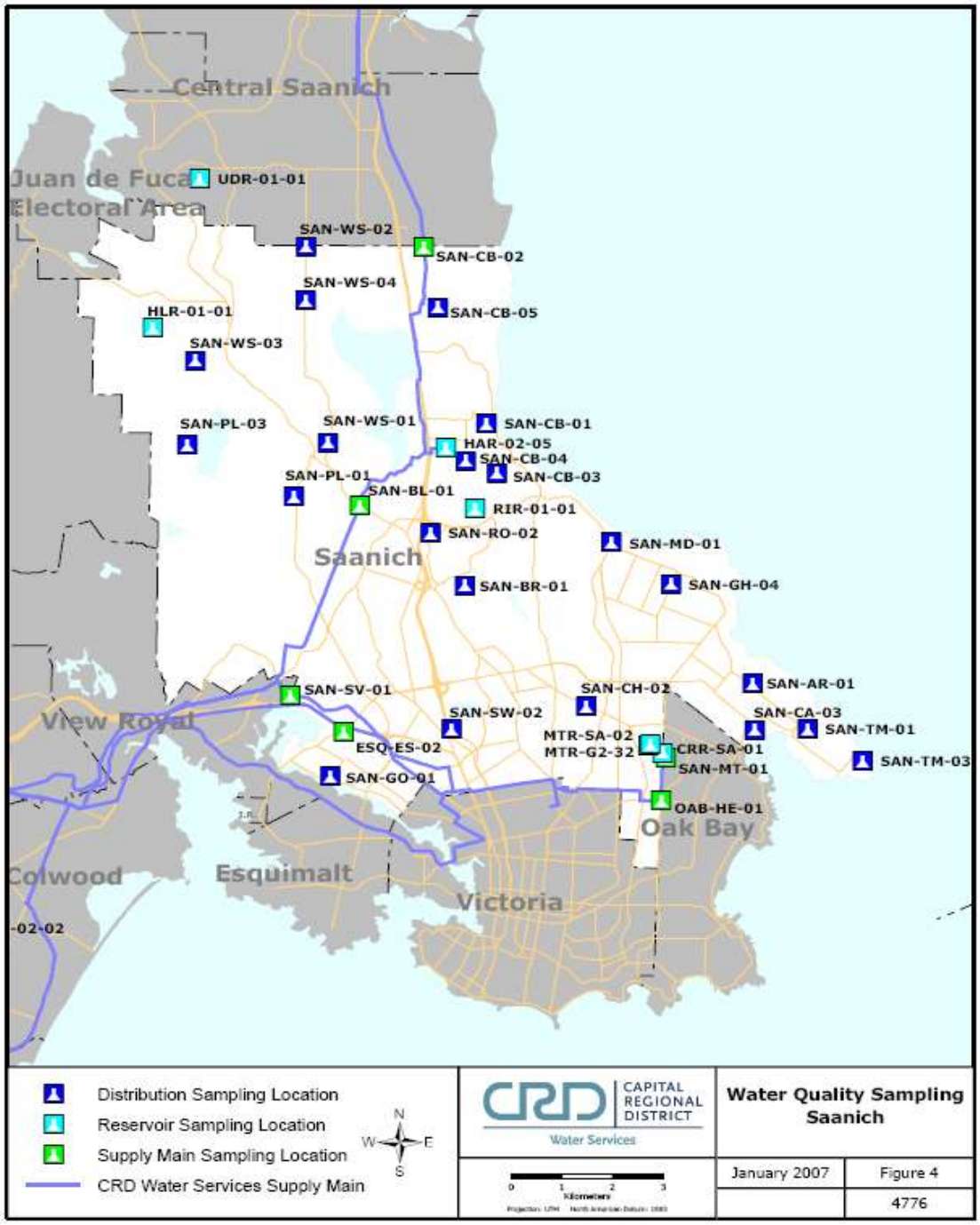


Figure 10. Oak Bay Distribution System
Total Coliforms and Chlorine Residual in 2008
2007
Monthly Total Coliform Positive Samples (%)
Monthly Median Cl2 (mg/L)
Chlorine Residual
No Total Coliforms Positive in 2007
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Monthly Total Coliform Positive Samples (%)
Monthly Median Chlorine Residual (mg/L)
Chlorine Residual
%Samples with Total Coliforms Present
10% Total Coliform Limit

4.10. SAANICH DISTRIBUTION SYSTEM

Twenty sampling locations were used to monitor the bacteriological quality of the drinking water in the Saanich Distribution System in 2008 (**Map 7**). Seventeen locations were sampled bi-weekly, two were sampled monthly and one was sampled weekly.

Map 7. Sampling Locations in the Saanich Distribution System



4.10.1. SAMPLE COLLECTION

In 2008, 493 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 larger number of samples collected from that system.

4.10.2. BACTERIA

Total Coliforms Only one sample collected from the sampling location at Haliburton east of Lochside in October (SAN-CB-01) contained one total coliform bacteria (**Table 9**). The resample was negative for coliforms. Expressed on an annual percentage basis, the total coliform positive rate was 0.2%. All monthly percentages for total coliform positive samples were under the 10% total coliform positive limit (**Figure 11**). All of these results are similar to the previous seven years and an improvement from 1999 and prior years.

E. coli None of the samples collected in 2008 contained *E. coli* bacteria.

Table 9. 2008 Bacterial Quality of the Saanich Distribution System.

	Total Coliform					E. coli	Turbidity		Chlorine Residual	Water Temp.
Month	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10	Samples >0	Samples Collected	Samples >1 NTU	Median mg/L Cl_2	Median ^oC
JAN	45	0	0	0	0	0	4	0	0.61	6.7
FEB	44	0	0	0	0	0	4	0	0.76	6.3
MAR	38	0	0	0	0	0	5	0	0.79	7.5
APR	42	0	0	0	0	0	6	0	0.73	8.6
MAY	45	0	0	0	0	0	5	0	0.80	11.0
JUN	40	0	0	0	0	0	4	0	0.73	13.3
JUL	44	0	0	0	0	0	4	0	0.75	15.8
AUG	41	0	0	0	0	0	4	0	0.59	17.4
SEP	39	0	0	0	0	0	4	0	0.57	17.3
OCT	46	1	2.2	0	0	0	4	0	0.61	13.7
NOV	36	0	0	0	0	0	4	0	0.61	11.5
DEC	33	0	0	0	0	0	4	0	0.70	9.6
TOTAL	**493**	**1**	**0.2%**	**0**	**0**	**0**	**52**	**0**	**0.69**	**11.4**

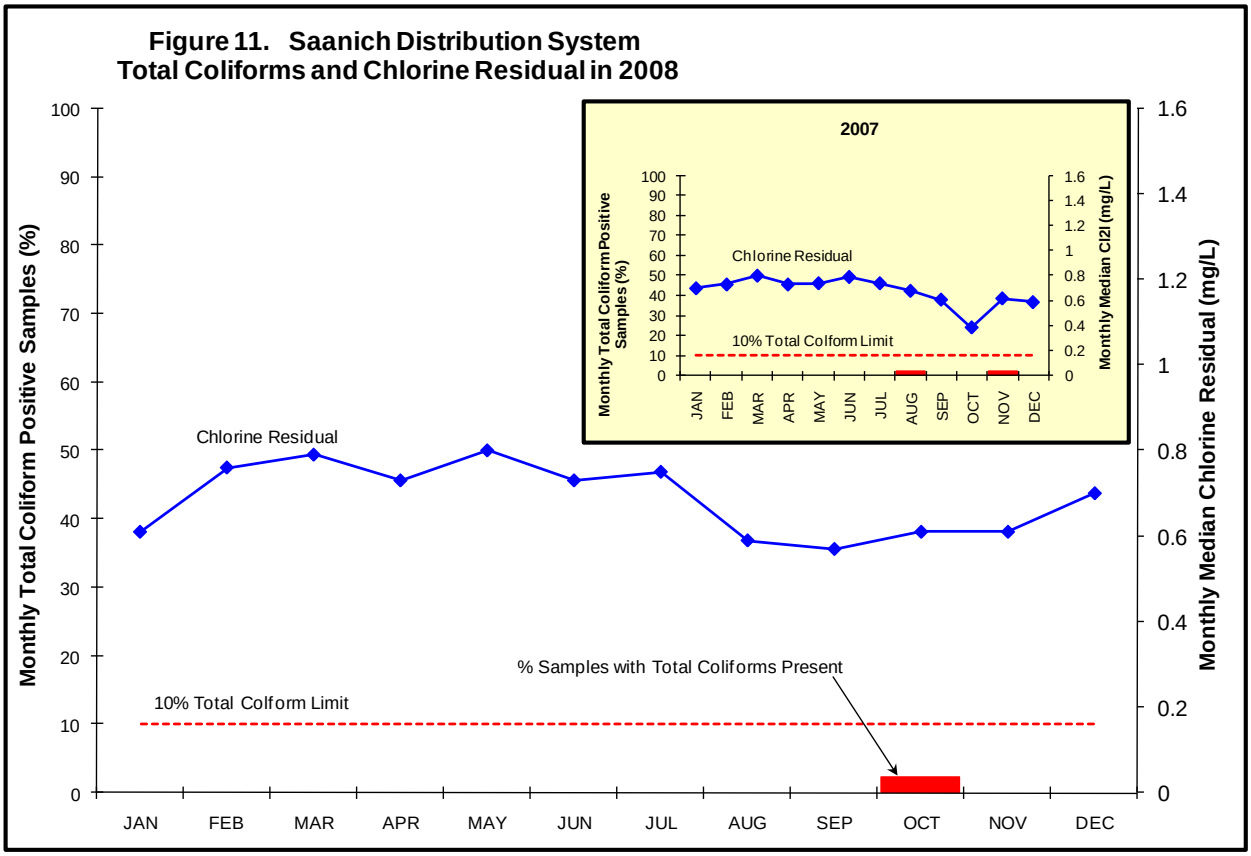
TC = Total Coliforms, **E. coli** = *Escherichia coli* **Cl_2** = chlorine, **NTU** = Nephelometric turbidity unit.
> = Greater than, **mg/L** = milligrams per litre, **°C** = degrees Celsius

4.10.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

Chlorine Residual. The annual median chlorine residual for the Saanich Distribution System was 0.69 mg/L (**Table 9**) which was slightly higher than that for the Greater Victoria Distribution System as a whole (0.64). The lowest monthly median chlorine residual occurred in September (0.57) and the highest in May (0.80) (**Figure 11**).

Water Temperature. The annual median water temperature in the Saanich Distribution System was 11.4°C, and ranged from a monthly median of 6.3°C in February to 17.4°C in August (**Table 9**).

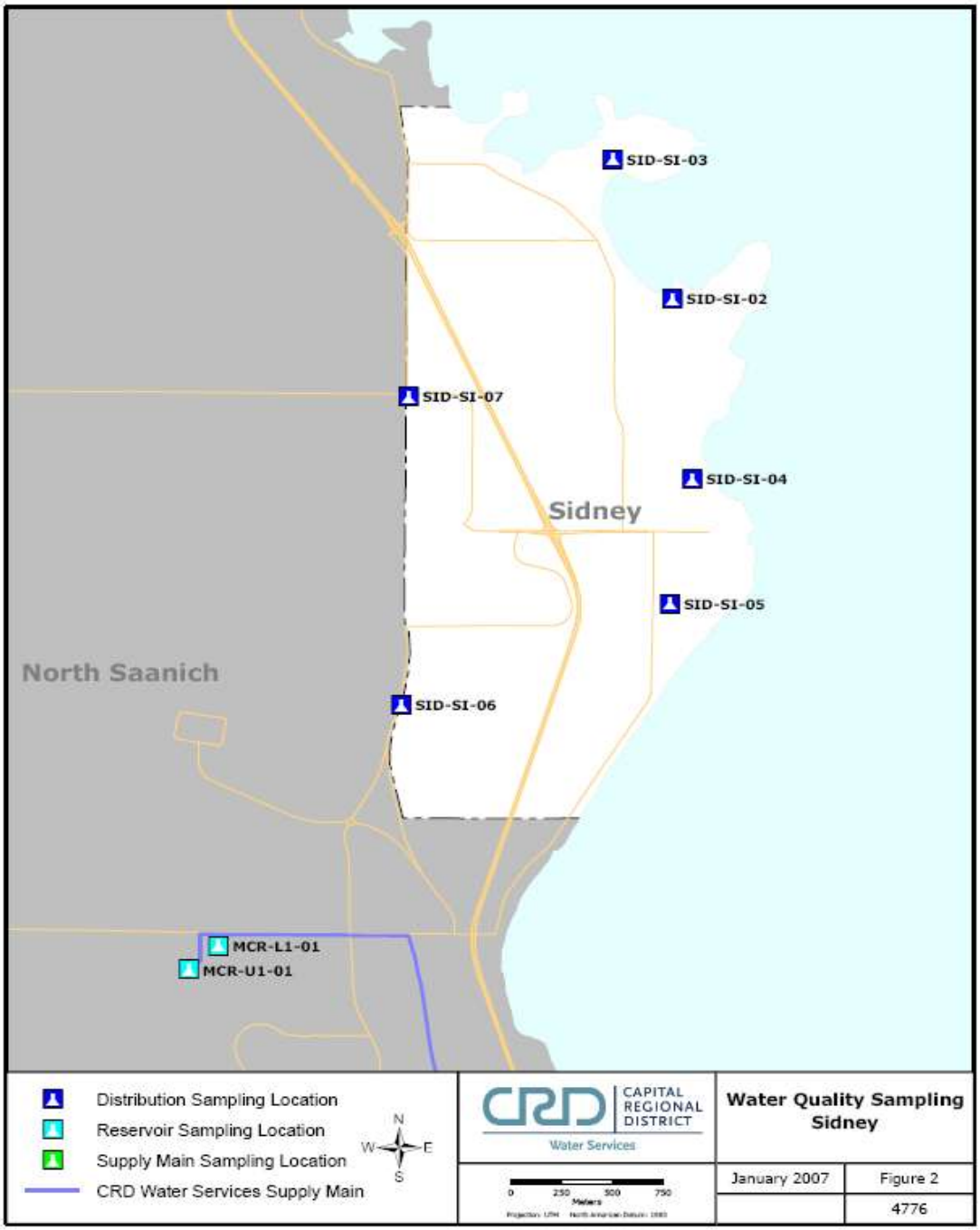
Figure 11. Saanich Distribution System
Total Coliforms and Chlorine Residual in 2008



4.11. SIDNEY DISTRIBUTION SYSTEM

Six sampling locations were used to monitor the bacteriological quality of drinking water in the Sidney Distribution System in 2008 (**Map 8**). Five locations were sampled bi-weekly with one location sampled monthly (extremity).

Map 8. Sampling Locations in the Sidney Distribution System.



4.11.1. SAMPLE COLLECTION

In 2008, 137 bacteriological samples were collected from the Sidney Distribution System (**Table 10**).

4.11.2. BACTERIA

Total Coliforms. None of the samples collected in 2008 from the Sidney Distribution System contained total coliform bacteria (**Table 10** and **Figure 12**).

E. coli. None of the samples collected from the Sidney Distribution System contained *E. coli* bacteria in 2008.

Table 10. 2008 Bacterial Quality of the Sidney Distribution System.

	Total Coliform					E. coli	Turbidity		Chlorine Residual	Water Temp.
Month	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10	Samples >0	Samples Collected	Samples >1 NTU	Median mg/L Cl_2	Median ^{o}C
JAN	12	0	0	0	0	0	0	0	0.56	6.3
FEB	12	0	0	0	0	0	0	0	0.50	6.4
MAR	10	0	0	0	0	0	0	0	0.60	7.9
APR	11	0	0	0	0	0	4	3	0.46	8.8
MAY	12	0	0	0	0	0	3	0	0.56	11.2
JUN	12	0	0	0	0	0	2	0	0.59	13.8
JUL	11	0	0	0	0	0	1	1	0.58	16.6
AUG	12	0	0	0	0	0	2	0	0.37	18.1
SEP	11	0	0	0	0	0	2	0	0.40	18.0
OCT	13	0	0	0	0	0	3	1	0.16	14.7
NOV	11	0	0	0	0	0	2	1	0.39	12.0
DEC	10	0	0	0	0	0	2	1	0.35	9.9
Total	**137**	**0**	**0%**	**0**	**0**	**0**	**21**	**7**	**0.43**	**12.0**

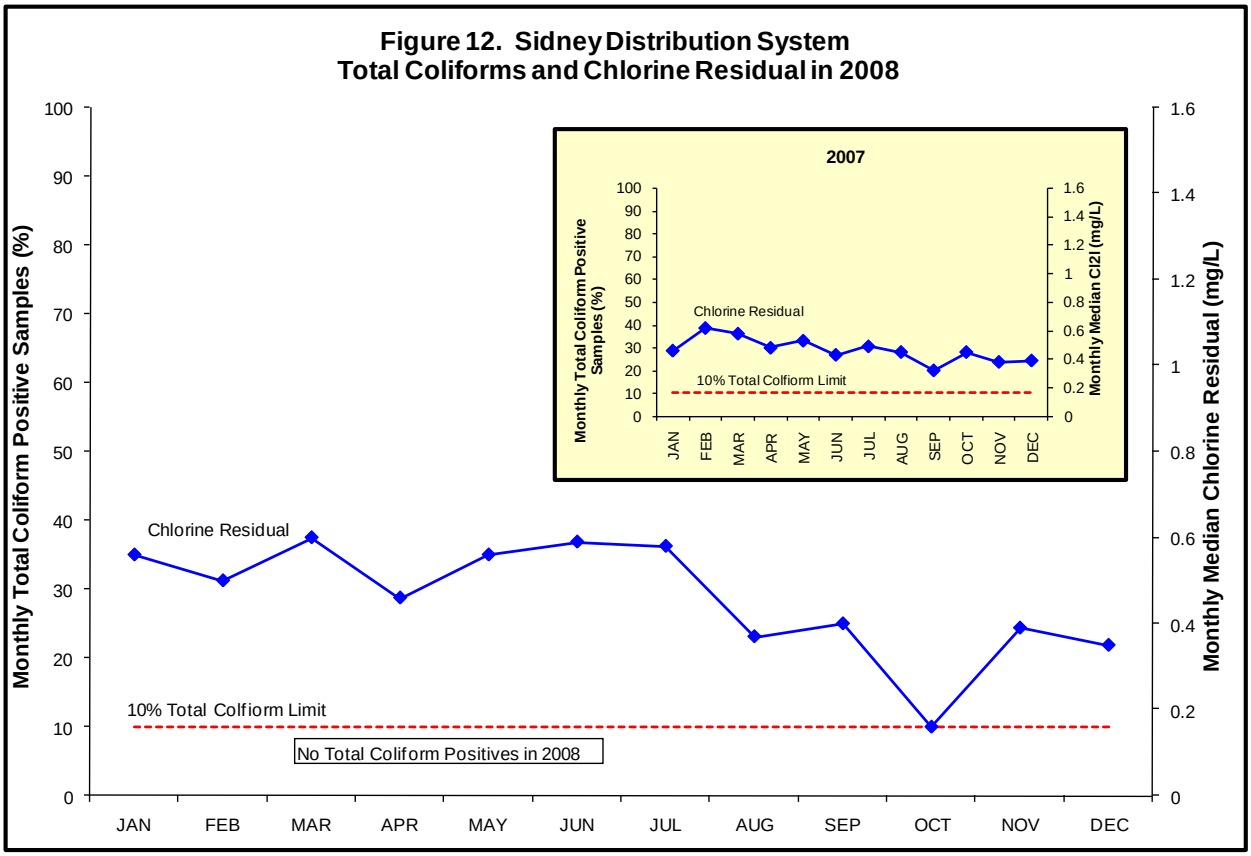
TC = Total Coliforms, **E. coli** = *Escherichia coli* **Cl_2** = chlorine, **NTU** = Nephelometric turbidity unit.
> = Greater than, **mg/L** = milligrams per litre, °**C** = degrees Celsius

4.11.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

Chlorine Residual. The annual median chlorine residual for the Sidney Distribution System was 0.43 mg/L (**Table 10**) with the lowest monthly median chlorine residual occurring in October (0.16) and the highest in March (0.60) (**Figure 12**).

Water Temperature. The annual median water temperature in the Sidney Distribution System was 12.0°C, ranging from a low monthly median of 6.3°C in January to a high of 18.1°C in August (**Table 10**).

Figure 12. Sidney Distribution System
Total Coliforms and Chlorine Residual in 2008



4.12. VICTORIA / ESQUIMALT DISTRIBUTION SYSTEM

Fourteen sampling locations were used to monitor the bacteriological quality of drinking water in the City of Victoria and Esquimalt Distribution System in 2008 (**Map 9**). (**Note**: The City of Victoria owns and operates the distribution system in Esquimalt.) These locations were all sampled bi-weekly.

Map 9. Sampling Locations in the Victoria / Esquimalt Distribution System

4.12.1. SAMPLE COLLECTION

In 2008, 351 bacteriological samples were collected from the sampling locations in the Victoria/Esquimalt Distribution System (**Table 11**).

4.12.2. BACTERIA

Total Coliforms. Only one of the samples collected contained total coliform bacteria, Royal Jubilee Powerhouse location in August 2008 (**Figure 13**). The resample was negative for coliforms (**Table 11**). The annual percentage positive for the Victoria/Esquimalt Distribution System was 0.3%.

E. coli. There were no *E. coli* positives samples from the Victoria/Esquimalt Distribution System in 2008.

Table 11. 2008 Bacterial Quality of the Victoria/Esquimalt Distribution System.

	Total Coliform					E. coli	Turbidity		Chlorine Residual	Water Temp.
Month	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10	Samples >0	Samples Collected	Samples >1 NTU	Median mg/L Cl_2	Median ^0C
JAN	30	0	0	0	0	0	7	0	0.75	6.7
FEB	28	0	0	0	0	0	6	0	0.84	6.6
MAR	26	0	0	0	0	0	7	0	0.74	8.3
APR	32	0	0	0	0	0	9	0	0.74	9.5
MAY	30	0	0	0	0	0	8	0	0.72	12.8
JUN	30	0	0	0	0	0	9	1	0.68	14.9
JUL	32	0	0	0	0	0	7	0	0.71	17.3
AUG	29	1	3.4	0	0	0	7	0	0.57	18.6
SEP	29	0	0	0	0	0	8	0	0.49	18.3
OCT	32	0	0	0	0	0	7	0	0.52	14.2
NOV	28	0	0	0	0	0	8	0	0.55	12.0
DEC	25	0	0	0	0	0	6	0	0.59	8.9
Total	**351**	**1**	**0.3%**	**0**	**0**	**0**	**89**	**1**	**0.62**	**12.3**

TC = Total Coliforms, **E. coli** = *Escherichia coli* **Cl_2** = chlorine, **NTU** = Nephelometric turbidity unit.
> = Greater than, **mg/L** = milligrams per litre, **°C** = degrees Celsius

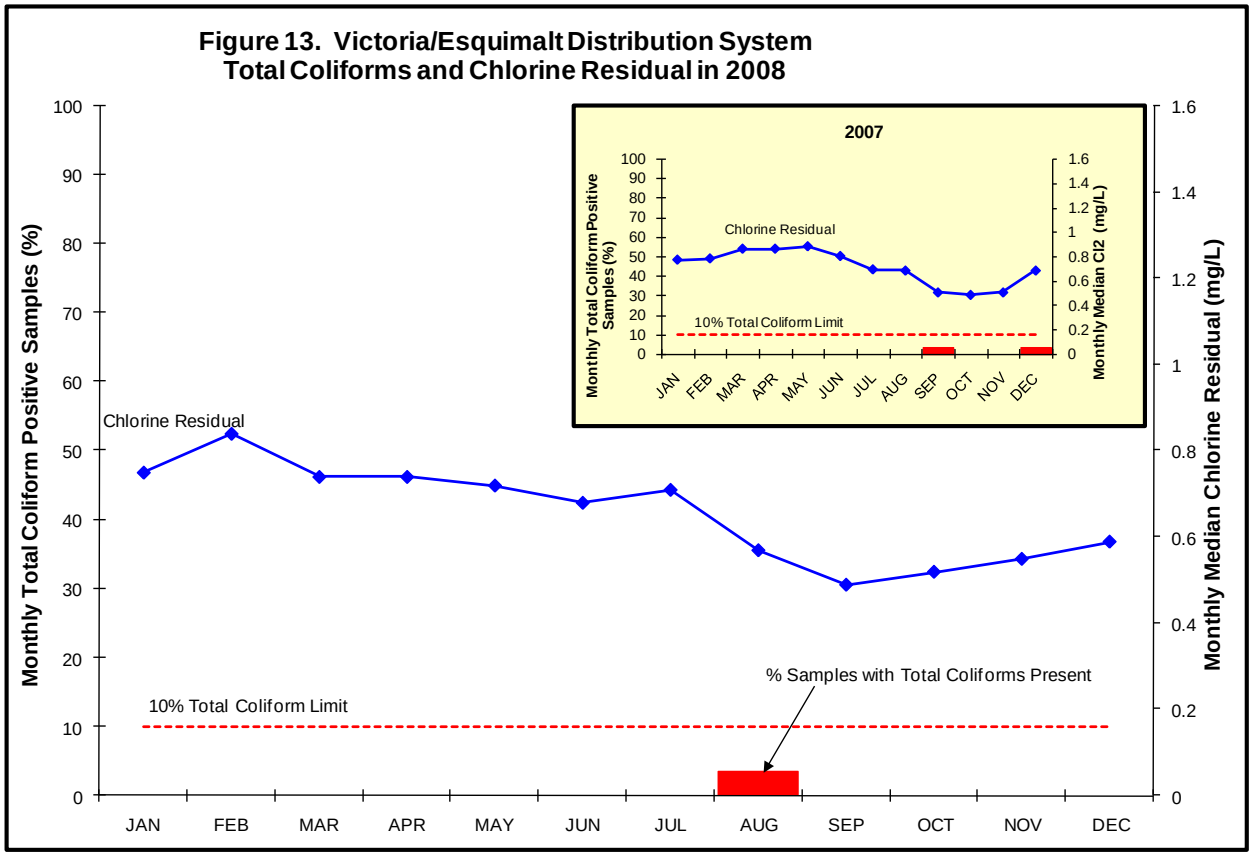
4.12.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

Chlorine Residual. The annual median chlorine residual for the Victoria / Esquimalt Distribution System was 0.62 mg/L (**Table 11**) with the lowest monthly median chlorine residual occurring in September (0.49) and the highest in February (0.84). The annual median chlorine residual in the Victoria/Esquimalt Distribution System was only slightly lower than the annual median residual for the Greater Victoria Distribution System. The chlorine residual showed some seasonal variation during 2008 decreasing through the late summer, and then remaining relatively steady in the spring fall and winter (**Figure 13**).

All sampling locations within the Victoria / Esquimalt Distribution System had satisfactory chlorine residuals (averages above 0.2 mg/L).

Water Temperature. The annual median water temperature in the Victoria/Esquimalt Distribution System was 12.3°C (**Table 11**), similar to past years. The monthly median water temperatures ranged from a low of 6.6°C in February to a high of 18.6°C in July. The daily maximum water temperature of 21.2°C was recorded in August at the 1261 Rockcrest Avenue sampling location (similar to 2007).

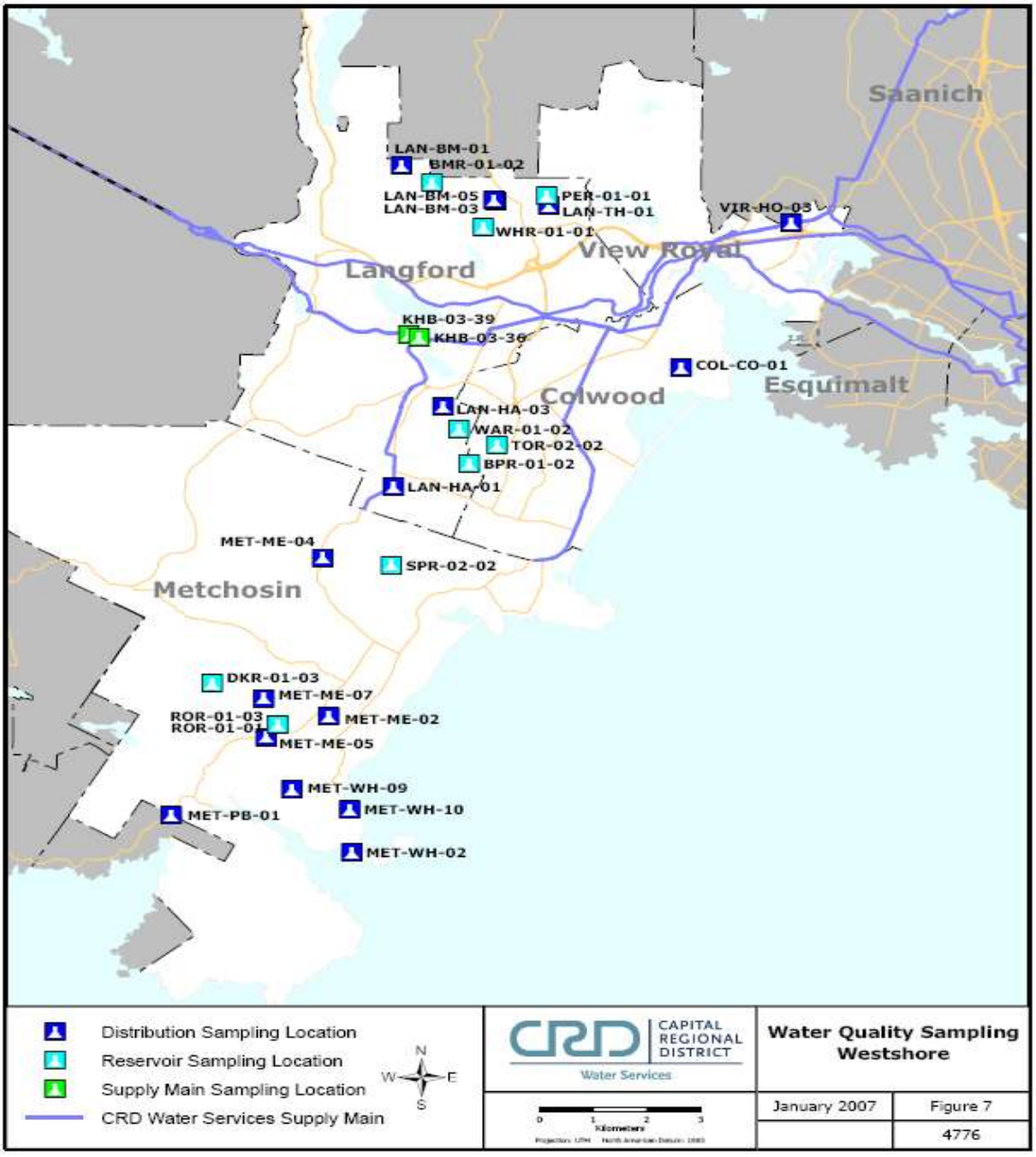
Figure 13. Victoria/Esquimalt Distribution System Total Coliforms and Chlorine Residual in 2008



4.13. JUAN DE FUCA WATER DISTRIBUTION SYSTEM (WEST SHORE)

Seventeen sampling locations were used to monitor the bacteriological quality of drinking water in the Juan de Fuca Water Distribution System in 2008 (**Map 10**). Fourteen locations were sampled bi-weekly, one was sampled weekly and two locations were sampled monthly. **(Note**: In this report, this system includes only the municipalities of Colwood, Langford, Metchosin and View Royal. 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 latter systems in 2008.)

Map 10. Sampling Locations in the Juan de Fuca Water Distribution System



4.13.1. SAMPLE COLLECTION

In 2008, 437 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.

Table 12. 2008 Bacterial Quality of the Juan de Fuca Water Distribution System.

		Total Coliform				E. coli	Turbidity		Chlorine Residual	Water Temp.
Month	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10	Samples >0	Samples Collected	Samples >1 NTU	Median mg/L Cl_2	Median ^{o}C
JAN	34	0	0	0	0	0	5	0	0.72	6.3
FEB	32	0	0	0	0	0	5	0	0.96	6.1
MAR	34	0	0	0	0	0	6	0	0.88	7.6
APR	35	1	2.9	0	0	0	6	0	0.87	8.3
MAY	46	1	2.2	0	0	0	11	0	0.90	10.6
JUN	36	1	2.8	0	0	0	6	0	0.81	13.3
JUL	38	0	0	0	0	0	7	0	0.79	15.9
AUG	34	0	0	0	0	0	5	0	0.58	17.2
SEP	34	0	0	0	0	0	6	0	0.48	17.2
OCT	45	0	0	0	0	0	8	2	0.39	13.4
NOV	36	1	2.8	0	0	0	8	1	0.30	11.3
DEC	33	0	0	0	0	0	5	0	0.61	9.2
Total	**437**	**4**	**0.9%**	**0**	**0**	**0**	**78**	**3**	**0.73**	**11.5**

4.13.2. BACTERIA

Total Coliforms. Four samples (0.9%) collected from the distribution system in Colwood, Langford and Metchosin contained total coliform bacteria (**Table 12**, **Figure 14**). One positive coliform bacteria sample was from the 842 Bear Mountain Parkway location in Langford. The chlorine residual at the time of this positive was low at 0.15 mg/L. In May, the Glenforest pumphouse sampling location was positive for coliform bacteria (high chlorine residual of 0.82 mg/L). In June, the Pearson College sampling location tested positive for coliform bacteria (chlorine residual of 0.33mg/L). In November, the Rocky Point pumphouse location sample was positive for total coliforms (chlorine residual of 0.27mg/L)

All of the resamples collected in response to the coliform positives were negative for coliform bacteria.

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 2002 through 2007 and an improvement from 2001 when the Juan de Fuca Water Distribution System was the only distribution system to exceed this limit. Overall, these results are similar to those in recent years

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

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

- **William Head Correctional Institute**. In 2008, the supply to William Head Correctional Institute was sampled every 2 weeks. Low to moderate total chlorine residuals (ranging from 0.07 to 0.66 mg/L and a median of 0.38 mg/L) were observed with no samples containing total coliform bacteria. 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 2008, the supply to the Becher Bay Reserve was sampled weekly. Typically, the chlorine residuals at this location were moderate (ranging from 0.12 to 1.56 mg/L with a median of 1.02 mg/L). Total coliforms were not detected in any sample. This is similar to 2002 through 2007 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.

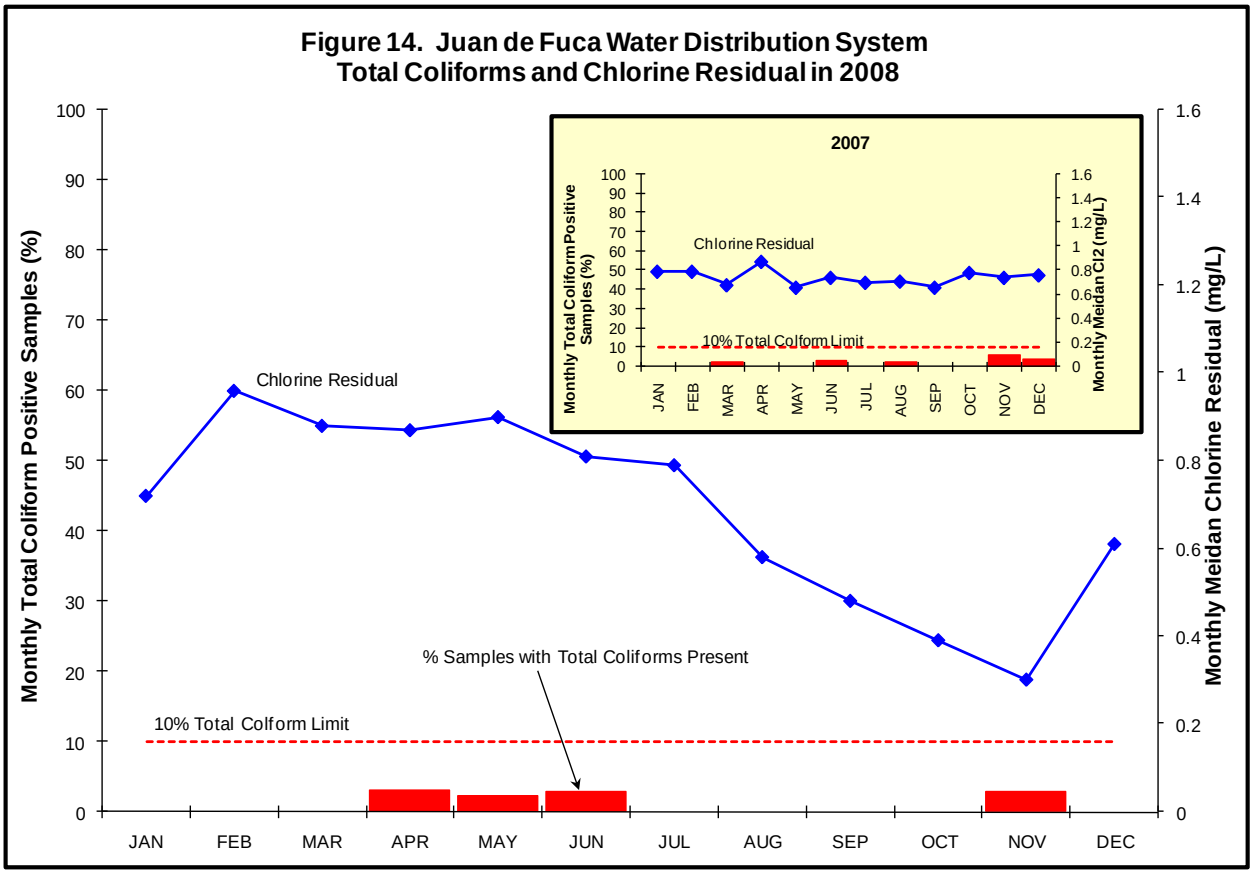
E. coli. None of the samples collected in the Juan de Fuca Water Distribution System were found to contain *E. coli* in 2008.

4.13.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

Chlorine Residual. The annual median chlorine residual for the Juan de Fuca Water Distribution System was 0.73 mg/L (**Table 12**). The lowest monthly median chlorine residual occurred in November (0.30) and the highest in February (0.96) (**Figure 14**). The pattern of chlorine residual in 2008 was dramatically different than the previous year, with the residual declining steadily from mid-July through November (**Figure 14**). This decline in chlorine residual was due in part to the change in operation of two sampling locations, the Children Activity Center in Colwood (not used from September onwards), and the Glenforest pumphouse location (no longer used for filling the local reservoir).

Water Temperature. The annual median water temperature in the Juan de Fuca Water Distribution System was 11.5°C, similar to previous years (**Table 12**).

Figure 14. Juan de Fuca Water Distribution System
Total Coliforms and Chlorine Residual in 2008



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 (i.e. greater than zero).

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 per 100 mL.

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

Turbidity – Samples Collected. This column shows the number of samples that were analyzed for turbidity.

Turbidity – Adverse > 1 NTU. This column shows the number of samples that had turbidity values greater than 1 Nephelometric Turbidity Units (NTU) 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.