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2009 Annual Bacteriological Summary of Greater Victoria's Drinking Water

(Full Report - Includes All Charts and Tables)

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ENVIRONMENTAL SUSTAINABILITY
CAPITAL REGIONAL DISTRICT
479 Island Highway
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Executive Summary

The 2009 Annual Bacteriological Summary of Greater Victoria's Drinking Water is the second report in the Water Quality Annual Report series. It extends the bacteriological information given in the 2009 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 2009 continued to be very good and easily met the Provincial and Federal limits for safe, potable drinking water.
2. **Sample Collection.** In 2009, the Water Quality Division collected and analyzed 4,268 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 bacteriological samples were collected in 2004 through 2008.
3. **Source Water.** In 2009, the level of total coliform bacteria in the raw (untreated source) water entering the Japan Gulch Treatment Plant from Sooke Reservoir was moderately high during the spring and summer (**Figure 2**). Nevertheless, as in previous years, the quality of the raw water entering the plant easily met the USEPA Surface Water Treatment Rule fecal coliform limit of no more than 10% of the samples having 20 colony forming units per 100 mL and therefore continued to qualify to remain an unfiltered surface water supply under this portion of their regulations (**inset in Figure 2B**).
4. **First Customer.** In 2009, there were four occurrences of total coliform bacteria at the first customer sampling location below the Japan Gulch Treatment Plant (**Figure 4**). The annual total coliform positive sample rate of 1.6% was comparable to the last several years (**Figure 4A**). No *E. coli* bacteria were found in any of the samples collected at this sampling location. This latter observation indicates that no fecal-associated contamination was present in the water entering the distribution system and provides greater assurance of the bacterial safety of drinking water.
5. **Transmission Mains.** Only three samples collected from the transmission mains feeding the municipalities contained total coliforms. This result was similar to previous years and indicates that very few total coliform bacteria were being delivered to the municipal distribution systems (**Figure 5A**).
6. **Balancing Reservoirs.** Samples collected from the balancing reservoirs located within the various municipal distribution systems showed that the bacteriological levels in some of these reservoirs continued to be problematic (**Figure 6**). This was primarily due to the bacteriological regrowth associated with poor water circulation through the reservoirs and the resulting low chlorine residuals (**Figure 6A**). One of the balancing reservoirs (Walfred Reservoir) had an annual percentage positive that exceeded the 10% limit (**Figure 6A**). (**Note:** This limit is only one of the indicator limits used and did not compromise the safety of the drinking water.) However, when the balancing reservoirs are considered as a group, the total coliform Guideline level of 10% positive samples was not exceeded in any month of 2009 (**Figure 6**). Broadly, the number of total coliform occurrences in the balancing reservoirs was similar to 2000 through 2004, 2007 and 2008.

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 six months in 2009 (**Figure 7**), similar to 2007 and 2008. The total coliform positive rate of 0.7% was slightly lower than that of 2005 and 2006 and the same as that in 2007 with a trend of declining total coliform positive samples over time in the Greater Victoria Distribution System (**Figure 7A**).

8. **Individual Municipal Distribution Systems.** In 2009, only one of the municipal distribution systems (Sidney) slightly exceeded the monthly total coliform limit of 10%. While this limit was exceeded, it did not compromise the safety of the drinking water as the resample was negative. In general, the bacteriological water quality of all 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 Treatment Plant was 1.21 mg/L (similar to 2004 to 2008). Overall, within the distribution system, the median annual chlorine residual was 0.64 mg/L and very similar to the levels observed since 2004. Within the municipal distribution systems, the median annual chlorine residual varied from a low of 0.39 mg/L for North Saanich to a high of 0.75 for Saanich.

10. **Water Temperature.** At the Japan Gulch Treatment Plant, the coldest daily water temperature recorded was 2.8°C in January while the warmest was 19.4°C in August 2009. Similarly, the water at the first customer location was cooler than in past years. The Guideline limit of 15°C was exceeded from July 15th to October 2, 2009 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 2009 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 continued and include those reservoirs that exceeded the total coliform limits in 2009.

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For hard copy version, insert hard copy of **Map 1** in this page

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

http://www.crd.bc.ca/water/documents/qvdrink_system2010.pdf

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 2009, all water received at the Japan Gulch Treatment Plant originated from Sooke Reservoir with the exception of the period from December 14th to 18th when Goldstream water was used during the Kapoor Tunnel inspection.

Sooke District Drinking Water Service Area

Drinking water for Sooke and East Sooke is also supplied from Sooke Reservoir, but travelled a different route. This water first passed through a 1067 mm (42") pipe (locally called the Flowline), entered the Flowline Control Tank and then continued to the Charters Disinfection Plant. However, in early October, 2009, water for Sooke and East Sooke passed through a newly constructed 14.5 km (9 mile) long, 1067 mm (42") diameter, and ductile iron from a point just above the Head Tank through to the new Sooke River Road Disinfection Plant.

In 2009, all water received either at the Charters Treatment Plant or the new Sooke River Road Disinfection Plant originated from Sooke Reservoir.

2.2. WATER TREATMENT SYSTEM

Drinking water in Greater Victoria is unfiltered and in 2009, 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 provide 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.

In 2009, small amounts of additional chlorine were periodically added at Upper Dawson Reservoir and to Upper Dean Park Reservoir. In Metchosin, the CRD Water Services Department 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, in 2009, CRD Water Services supplied 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 was supplied to the Saanich Peninsula Water Commission (SPWC) who in turn, supplied it to Central Saanich, North Saanich and Sidney via the Saanich Peninsula Trunk Water Distribution System.

2.3.1. REGIONAL TRANSMISSION SYSTEM

In 2009, CRD Water Services used 7 large diameter transmission mains to supply drinking water to the municipal distribution systems in the Greater Victoria Drinking Water Service Area (**Map 1**). These transmission mains range in diameter to 460 mm (18") and transfer water from the treatment plant to the distribution systems in **Section 2.5**

- Main #1 is a 460 mm (18") 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 ductile iron pipe that 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 ductile iron pipe that starts at the Humpback PRV and terminates at the Department of Water Services vault. There are several sections in this line that include 1220 mm (48") diameter ductile iron 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 a 762 mm (30") diameter ductile iron pipe that starts at the Japan Gulch Plant and runs primarily to Saanich and the Saanich Peninsula. There are two small sections of 540 mm (21") reinforced concrete pipe. This transmission main terminates near the Saanich-Central Saanich boundary where it transfers water to the 762 mm (30") diameter ductile iron pipe which extends to Metavish 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 runs from 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 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 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 inter-connections 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 inter-connections between Main #1 and Main #3 with the major inter-connections 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 area of a 406 mm (16") diameter asbestos cement pipe. A dedicated 250 mm (10") diameter perm/PVC pipe connects Deep Cove Pumphouse with Cloake Hill Reservoir. A 457 mm diameter pipe 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 large 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.

In 2009, the balancing reservoirs in the Greater Victoria Drinking Water System were operated by three different agencies: two departments of the CRD and the District of Saanich.

2.4.1. CRD WATER SERVICES OPERATED RESERVOIRS

In 2009, CRD Water Services operated 17 balancing reservoirs in the Greater Victoria Drinking Water System:

- Bear Mountain Reservoir #1, a 2-cell, 1250 m³ (275,000 gallon) reservoir located on the lower slopes of the Bear Mountain development in Langford.
- Coppermine Reservoir, a 1-cell, 455 m³ (100,000 gallon) reservoir located off of Coppermine Road in East Sooke.
- Deer Park Reservoir, a 1-cell, 182 m³ (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 m³ (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 m³ (5,000,000 gallon) reservoir located off of Haliburton Road in Saanich.
- Helgesen Reservoir, a 4-cell, 6,973 m³ (153,385 gallon) reservoir located at the west end of Helgesen Road in Sooke.
- Henlyn Reservoir, a 1-cell, 224 m³ (49,270 gallon) reservoir located off of Henlyn Drive in Sooke.
- Kirby Reservoir, a 1-cell, 409 m³ (90,000 gallon) reservoir located off of Meota Drive in Sooke. (Decommissioned in Sept 2009)
- Mt. Tolmie Reservoir, a 2-cell, 27,300 m³ (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 m³ (128,420 gallon) reservoir located north of the Trans Canada Highway off of Peacock Place in Langford.
- Rocky Point Reservoir, a 3-cell, 546 m³ (120,000 gallon) reservoir located near the end of Rocky Point Road in Metchosin.
- Silver Spray Reservoir, a 2-cell, 841 m³ (185,000 gallon) reservoir located off of Silver Spray Drive in East Sooke.
- Skirt Mountain Reservoir, a 3-cell, 6,525 m³ (1,435,300 gallon) reservoir located near the top of Skirt Mountain in the Bear Mountain development in Langford.
- Stirrup Place Reservoir, a 2-cell, 242 m³ (53,300 gallon) reservoir located off of Stirrup Place Road in Metchosin.
- Sunriver Reservoir, a 2-cell, 1,800 m³ (395,944 gallon) reservoir located off of Sunriver Way in Sooke.
- Walfred Reservoir, a 3-cell, 560 m³ (123,180 gallon) reservoir located on Triangle Mountain in Colwood.
- Whisperwind Reservoir, a 2-cell, 570 m³ (125,380 gallon) reservoir located off of Whisperwind Place in Langford.

2.4.2. CRD ENVIRONMENTAL SERVICES OPERATED RESERVOIRS

In 2009, 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 m³ (1,000,000 gallon) reservoir located on Bear Hill in Saanich.
- Cloake Hill Reservoir, a 1-cell, 4,546 m³ (1,000,000 gallon) reservoir located on Cloake Hill in North Saanich.
- Dawson Upper Reservoir, a 1-cell, 455 m³ (100,000 gallon) reservoir located off Benvenuto Ave in Central Saanich.
- Dean Park Lower Reservoir, a 2-cell, 4,546 m³ (1,000,000 gallon) reservoir located beside Dean Park Road in North Saanich.

- Dean Park Middle Reservoir, a 2-cell, 2,730 m³ (600,000 gallon) reservoir located near the bottom of Dean Park in North Saanich.
- Dean Park Upper Reservoir, a 2-cell, 4,546 m³ (1,000,000 gallon) reservoir located near the top end of Dean Park in North Saanich.
- McTavish Lower Reservoir, a 1-cell, 2,280 m³ (500,000 gallon) reservoir located on the south side of McTavish Road in North Saanich.
- McTavish Upper Reservoir, a 1-cell, 4,546 m³ (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 2009, Saanich operated 5 balancing reservoirs within its municipal boundaries:

- Cromwell Reservoir, a 2-cell, 45.5 m³ (10,000 gallon) reservoir located at the top of Mt. Tolmie in Saanich.
- Hartland Reservoir, a 1-cell, 454.6 m³ (100,000 gallon) reservoir located on Hartland Road in Saanich.
- Mt. Tolmie Reservoir (Saanich), a 1-cell, 4,545 m³ (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 m³ (6,000,000 gallon) reservoir located at the end of Perez Drive in Broadmead in Saanich. (**Note:** This reservoir was taken out of service in Sept 2008 and is expected to be returned to service in March 2010.)
- Wesley Reservoir, a 2-cell, 3,182 m³ (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 2009, 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 pressure zones through three pressure regulating pressure zones through three pressure regulating pressure zones 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 S 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

Central Saanich (south of Haldon Road) including Brentwood Bay.

2.5.2. NORTH SAANICH DISTRIBUTION SYSTEM

In 2009, 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 an 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 the Water Quality Division.

2.5.3. OAK BAY DISTRIBUTION SYSTEM

In 2009, 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 2009, drinking water was supplied to the Saanich Distribution System at a number of points from CRD large transmission mains. Water was supplied from Main #1 at Dupplin, Wilkinson and Marigold; from Main #3 at Douglas, Tillicum, Admirals, Shelbourne, Richmond, Foul Bay, Mt Tolmie 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. The Mt. Tolmie/Plymouth Pump Station pumped water from Main #3 and the Mt. Tolmie Reservoirs to Saanich's Mt. Tolmie Reservoir and the G (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 2009, 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 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 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

Note: The City of Victoria owns and operates the water distribution system in Esquimalt.

In 2009, drinking water was supplied to the Victoria/Esquimalt Distribution System from Main #1 and Main #2 at David Street/Gorge Street and David Street/Rock Bay Avenue. From these supply points, the system divides into several smaller looped water mains within the distribution system. Water was also supplied to Victoria from Main #3 at Cook Street/Mallek Crescent, Sommerset Street/Tolmie Avenue, Douglas Street/Tolmie Avenue and Shelbourne/North Dairy. In general, water flows from a north to south direction.

Water was supplied at multiple locations to Vic West and Esquimalt from Main #2. These locations included Tyee Road/Bay Street, Burlieith Crescent/Craigflower Road, Garthland Road/Craigflower Road and Admirals Road/Maple Bank Road.

2.5.7. JUAN DE FUCA WATER DISTRIBUTION SYSTEM

In 2009, 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 until late August, 2009 when the new Sooke River Road Disinfection Facility was put into service. The primary water supply main to the community follows Sooke River Road downstream of the Sooke River Road Pumphouse and splits at 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 (in 2010, the Water Quality Division became part of the CRD Environmental Sustainability Department) is responsible for monitoring the bacteriological quality of the drinking water in the entire Greater Victoria Drinking Water System. This monitoring is described in the *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 2009 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 2009, (same as 2008 and 2007) total coliform bacteria were analyzed using defined substrate technology (DST) at the CRD Water Quality Laboratory for membrane filtration, most probable number or presence-absence methods. The membrane filtration method used Chromocult media incubated at 35°C for 24 hours while the most probable number and presence-absence methods used Colilert-18 incubated at 35°C 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' with 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 2009, 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 2009, *E. coli* were analyzed by the CRD Water Quality Laboratory using either membrane filtration (Chromocult media, 35°C, 24 hour incubation) or most probable number (Colilert-18, 35°C, 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 -galactosidase and -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 2009, 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 2009, background bacteria were analyzed by the CRD Water Quality Laboratory using membrane filtration (Chromocult media, 35°C, 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 -galactosidase.

Regulatory Limits. In 2009, 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 warning 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 2009, heterotrophic plate count bacteria were analyzed by the CRD Water Quality Laboratory using membrane filtration (R2A media, 22-25°C, 7 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 system in accordance with the Federal Guidelines.

Water

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 2009, 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 2009, the Water Quality Division used 89 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 2009, weekly bacteriological samples were collected from the raw water entering the Charters Treatment Plant and from the treated water leaving the plant (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 13 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 analyzed 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 or e-mailed 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) typically 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. However, in 2009, no audit samples were collected by VIHA staff and analyzed by an independent, local laboratory and reported to 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 2009 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 |
| • 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* specifies 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 2009, 248 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. 2009 Bacterial Quality of the Raw Water Entering the Japan Gulch Plant.

Month	Total Coliforms			Samples TC>10	E. coli Samples Present	Turbidity		Water Temp. Median °C
	Samples Collected	Samples TC>0	Percent TC>0			Samples Collected	Samples >1 NTU	
JAN	21	21	100	18	9	21	0	4.8
FEB	20	19	95.0	19	3	20	0	4.6
MAR	22	22	100	16	0	22	0	5.2
APR	20	20	100	19	2	20	0	6.7
MAY	20	20	100	20	0	20	0	9.6
JUN	22	22	100	22	0	22	0	11.6
JUL	22	22	100	22	1	22	0	16.0
AUG	20	20	100	20	1	20	0	18.2
SEP	21	21	100	21	3	21	0	17.7
OCT	21	21	100	21	4	21	0	13.5
NOV	20	20	100	20	15	20	0	9.6
DEC	19	19	100	18	10	19	0	5.8
TOTAL	248	247	99.6%	236	48 (19%)	248	0	9.7

TC = Total Coliforms, E. coli = *Escherichia coli* Cl₂ = 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 9.7°C (**Table 1**). The lowest median monthly temperature was observed in February 2009 at 4.6°C with the highest median monthly temperature observed in August at 18.2°C (**Table 1**). The coldest daily water temperature recorded was 4.1°C in February while the highest maximum daily water temperature was 20.1°C recorded in August 2009.

Since raising Sooke Reservoir, the maximum water temperature entering the Japan Gulch Plant has decreased by 1°C (**Figure 1**). 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 2009, the water temperature during the summer months was slightly higher than the post-inundation (2003-2007) summer average temperature.

4.1.3. BACTERIA

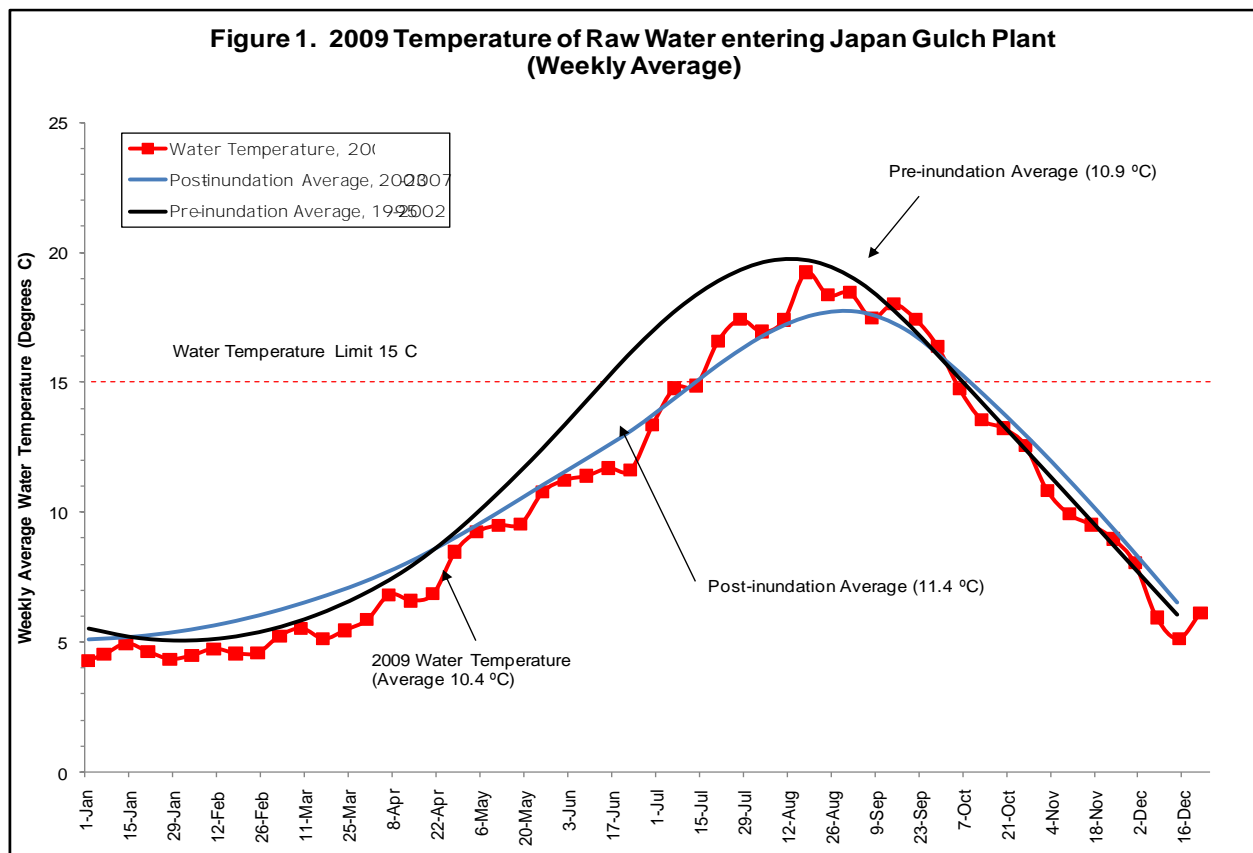
Total Coliforms. In 2009, the level of total coliform bacteria in the raw (untreated source) water entering the Japan Gulch Treatment Plant from Sooke Reservoir was moderately high during the spring and summer, peaking at 1,300 colony-forming units (CFU) per 100 mL in May and again at 1,414 colony-forming units (CFU) per 100 mL in August (**Figure**

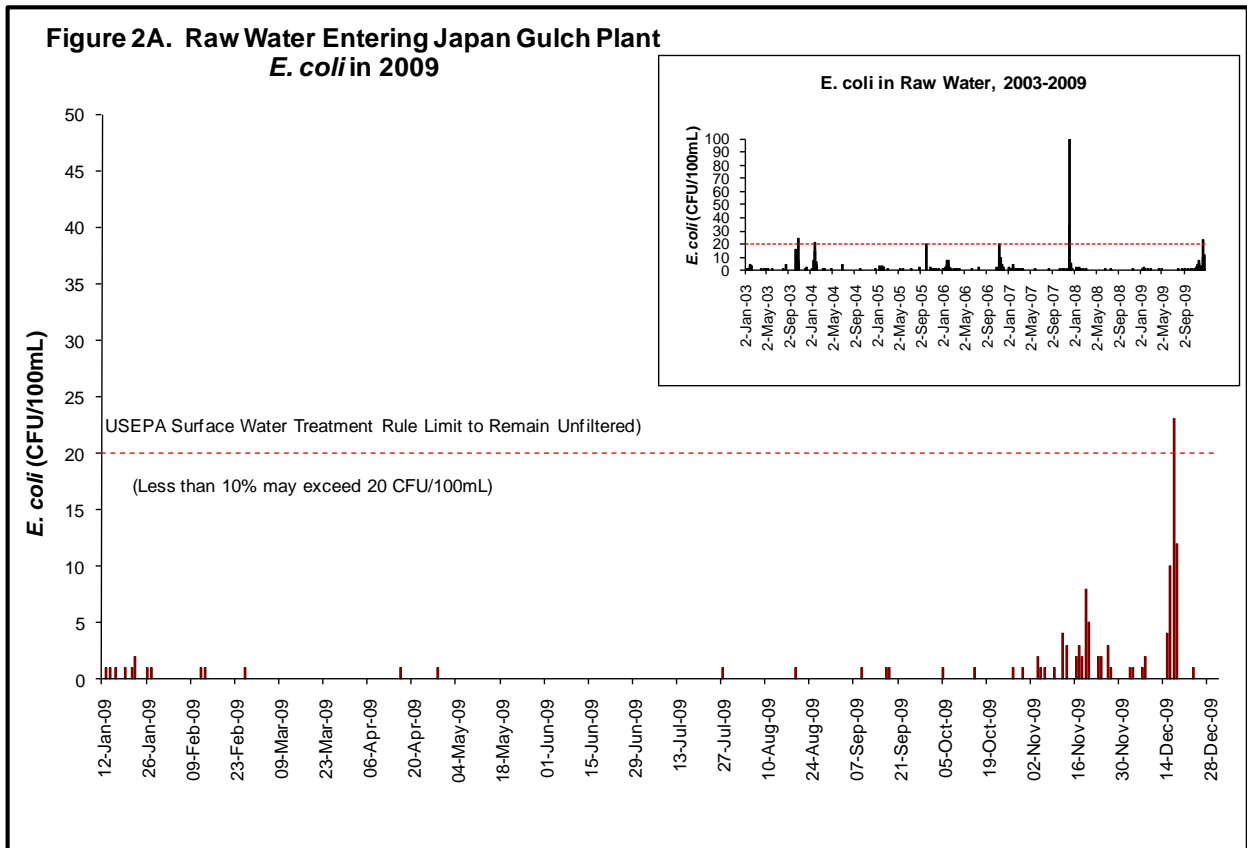
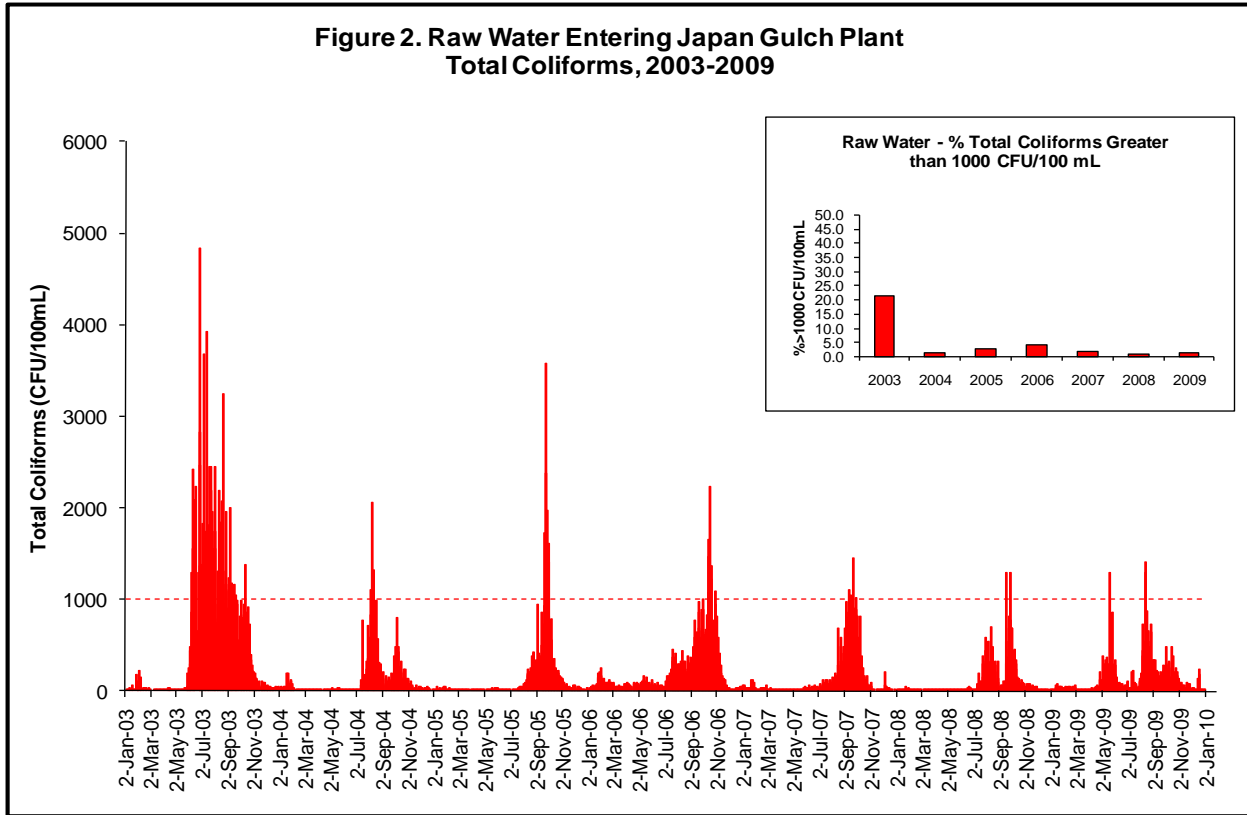
2). Total coliform concentrations exceeded 1,000 CFU/100 mL in samples collected on three dates: May 21, August 12, and August 13. This level of coliforms was seasonally similar albeit lower than levels found in 2004 through 2008 and lower than levels observed in earlier years (Figure 2).

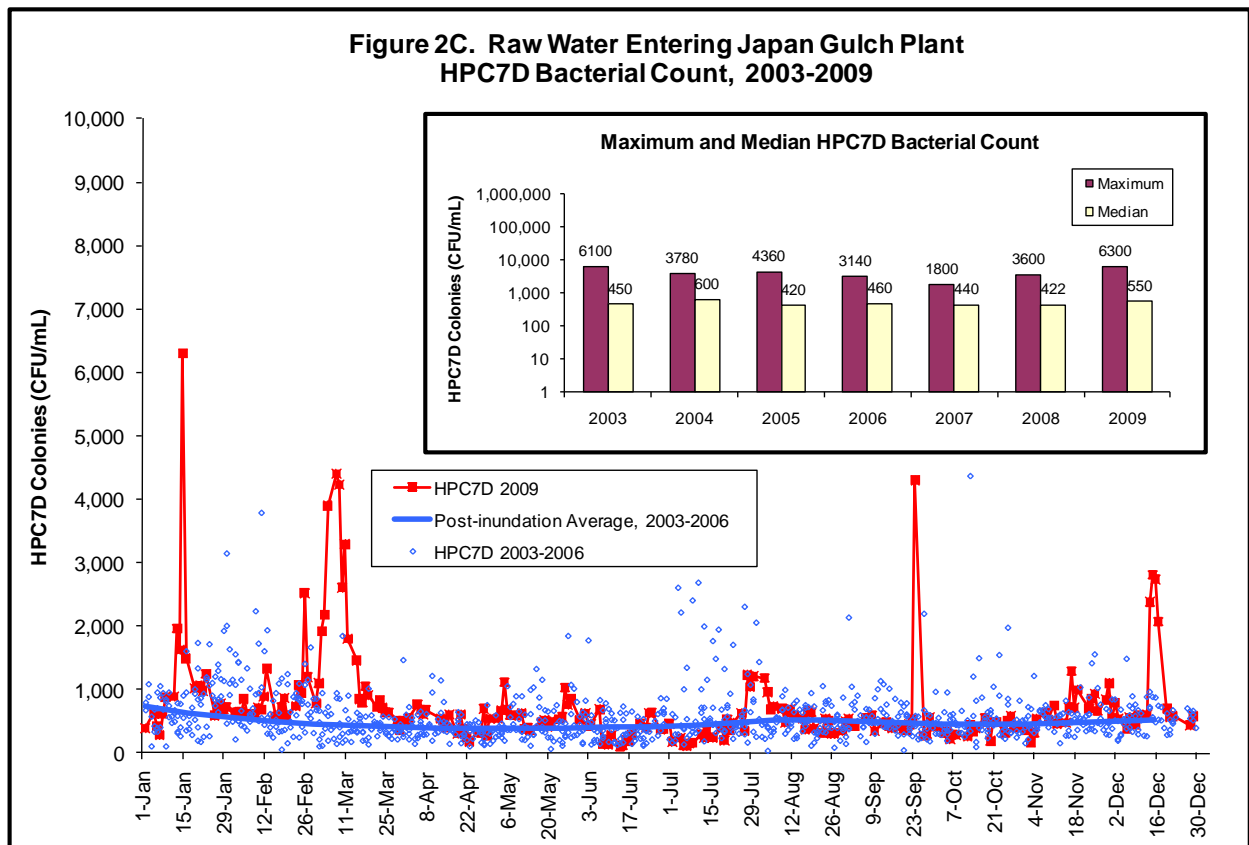
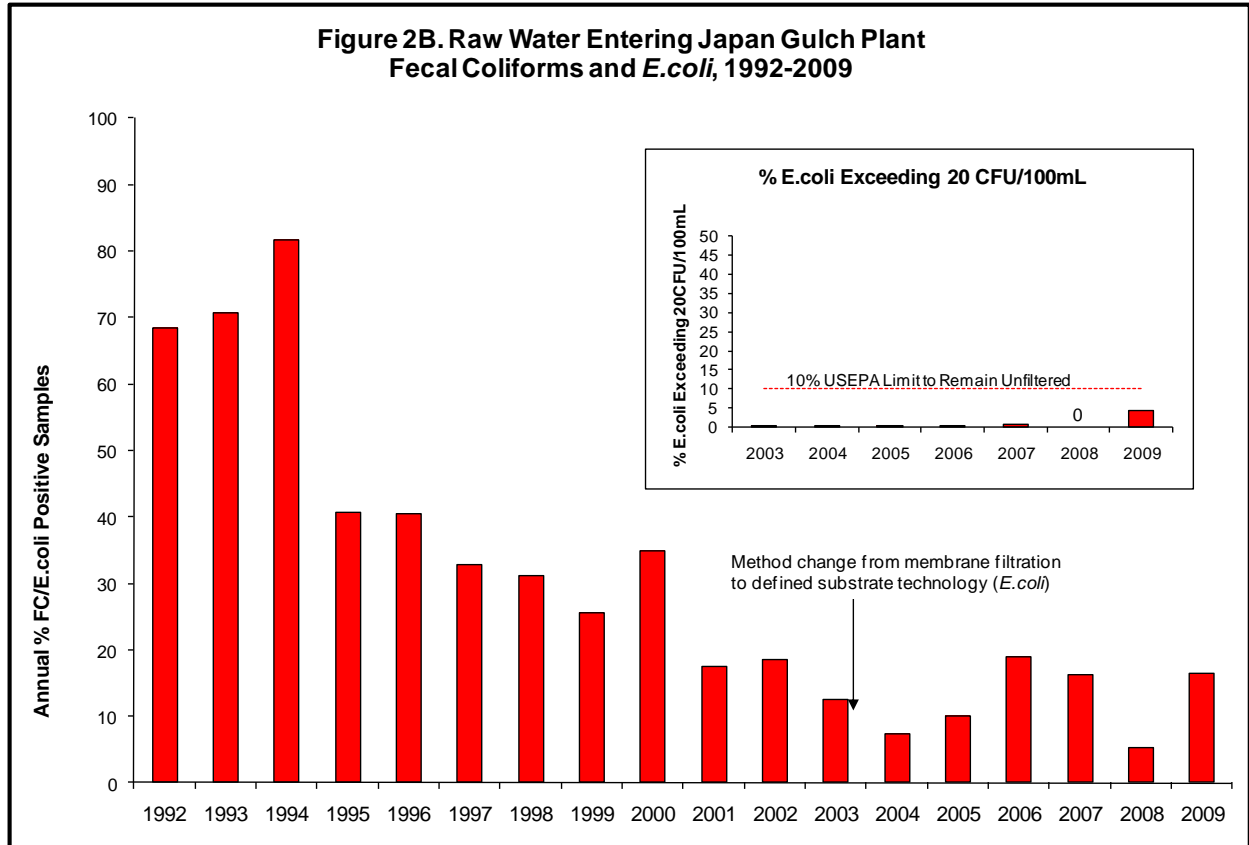
Escherichia coli. In contrast to the seasonal peaks observed for total coliforms in the spring and summer of 2009, the levels of *E. coli* were similar to those in 2003 through 2008 and did not display any significant seasonal trend (Figure 2A). The median annual *E. coli* bacterial concentration in the raw source water entering the Japan Gulch Plant was 0 CFU/100 mL and ranged from 0 to 23 (Figure 2B) 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 2B). In 2003 through 2009 the level of *E. coli* has been about 12% annually while the percentage *E. coli* exceeding the 20 CFU/100 mL limit has remained at less than 1% (see insert in Figure 2B).

Heterotrophic Plate Count Bacteria. The 2009 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 550 CFU/mL and a maximum of 6,300 CFU/mL (insert in Figure 2C). Unlike the coliform count, the heterotrophic plate count does not follow a seasonal pattern but remains at a relatively constant level throughout the year albeit with higher counts in the early spring of 2009 (Figure 2C).







4.2. UV TREATED WATER

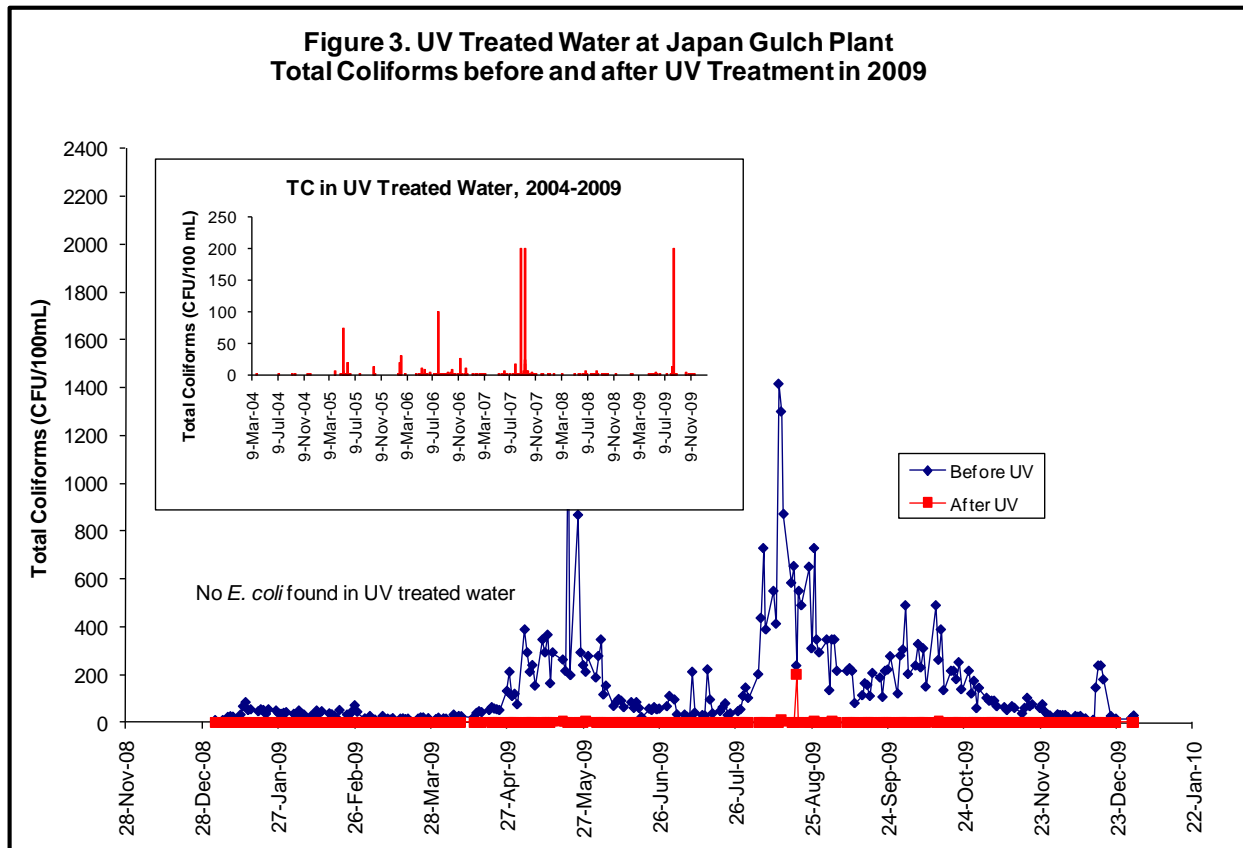
Ultraviolet (UV) disinfection of the raw source water began in January 2004 to inactivate parasites such as *Giardia* and *Cryptosporidium* and provide some bacteriological disinfection. In 2009, although the UV plant had several UV disinfection interruptions lasting between thirty minutes to four hours, 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 2009, 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 relatively low ranging from 0 to 200 CFU/100mL with a mean of 1.1 and a median of 0 CFU/100mL. The annual coliform positive rate was 16.5% for the UV treated water, similar to 2008 (12.5%) and 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 reduced the total coliform bacterial population of the raw source water significantly and provided good redundancy for primary disinfection (**Figure 3**). In 2009, the average percentage decrease in total coliforms after UV disinfection was 83%.



4.3. FIRST CUSTOMER

The bacteriological data collected by the Water Quality Division staff during 2009 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 4**. In this report, this sampling location is referred to as 'First Customer'.

4.3.1. SAMPLES COLLECTED

In 2009, 250 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 19-23.

4.3.2. BACTERIA

Total Coliforms. In 2009, there were four total coliform positive samples at the first customer sampling location. The coliform positives occurred in May, 2009 and in August 2009 (**Table 2**, and **Figure 4**). The annual total coliform positive rate in 2009 was 1.6% (**Table 2**). This is higher than in 2008 (0.4%) but 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 and 2009, 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 4A**).

Table 2. 2009 Bacterial Quality of the Treated Water at the First Customer Location.

Month	Samples Collected	Total Coliform				E. coli Samples >0	Turbidity Samples Collected >1 NTU	Chlorine Residual Median mg/L Cl ₂	Water Temp. Median °C
		Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10				
JAN	22	0	0	0	0	22	1	1.09	3.9
FEB	20	0	0	0	0	20	0	1.14	3.7
MAR	22	0	0	0	0	22	0	1.17	4.8
APR	20	0	0	0	0	20	0	1.19	6.7
MAY	20	1	5.0	0	0	20	0	1.17	9.2
JUN	23	0	0	0	0	23	0	1.21	11.6
JUL	22	0	0	0	0	22	0	1.21	16.2
AUG	20	3	15.0	0	0	20	0	1.17	18.3
SEP	21	0	0	0	0	21	0	1.20	17.7
OCT	21	0	0	0	0	21	0	1.36	13.0
NOV	20	0	0	0	0	20	0	1.37	8.7
DEC	19	0	0	0	0	19	1	1.34	5.2
TOTAL	250	4	Av 1.6	0	0	250	2	1.18	9.3

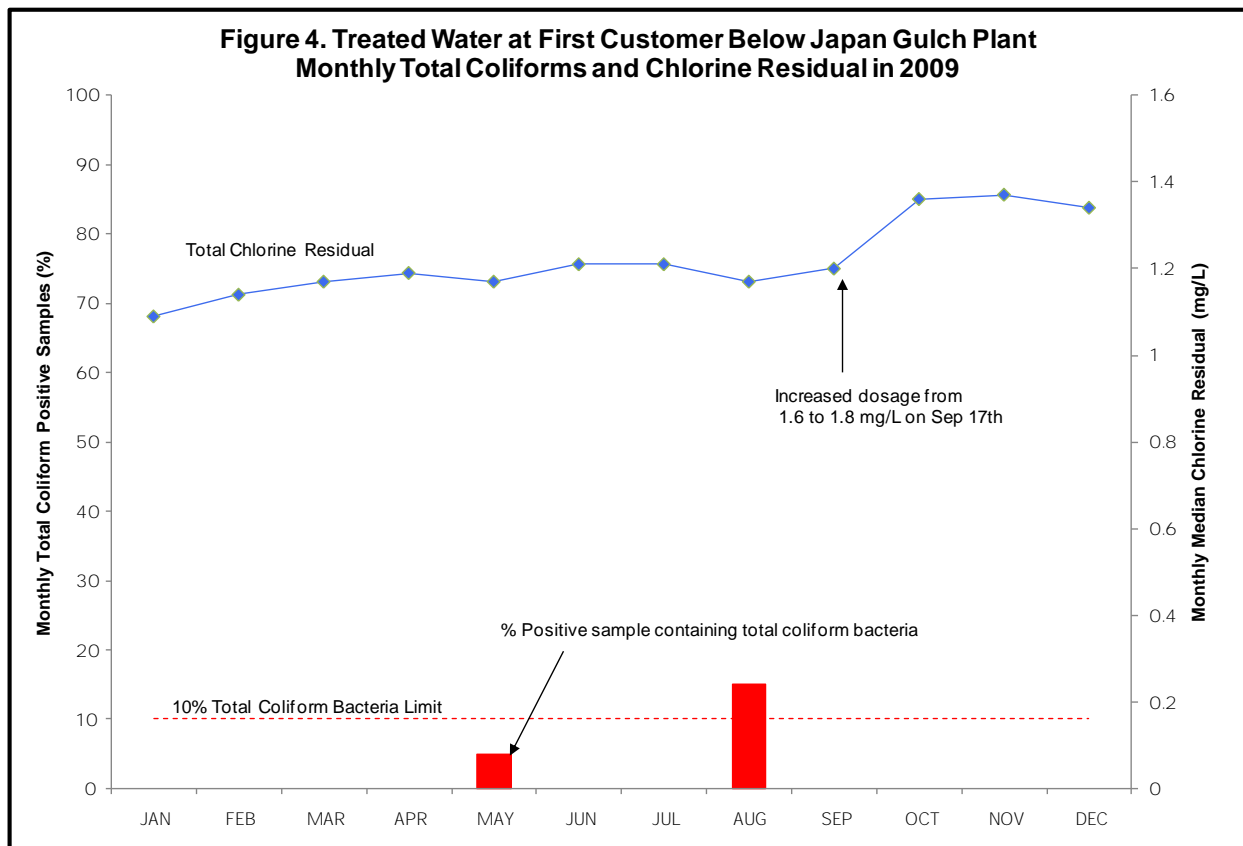
TC = Total Coliforms, E. coli = *Escherichia coli* Cl₂ = chlorine, NTU = Nephelometric turbidity unit.
> = Greater than, mg/L = milligrams per litre, °C = degrees Celsius

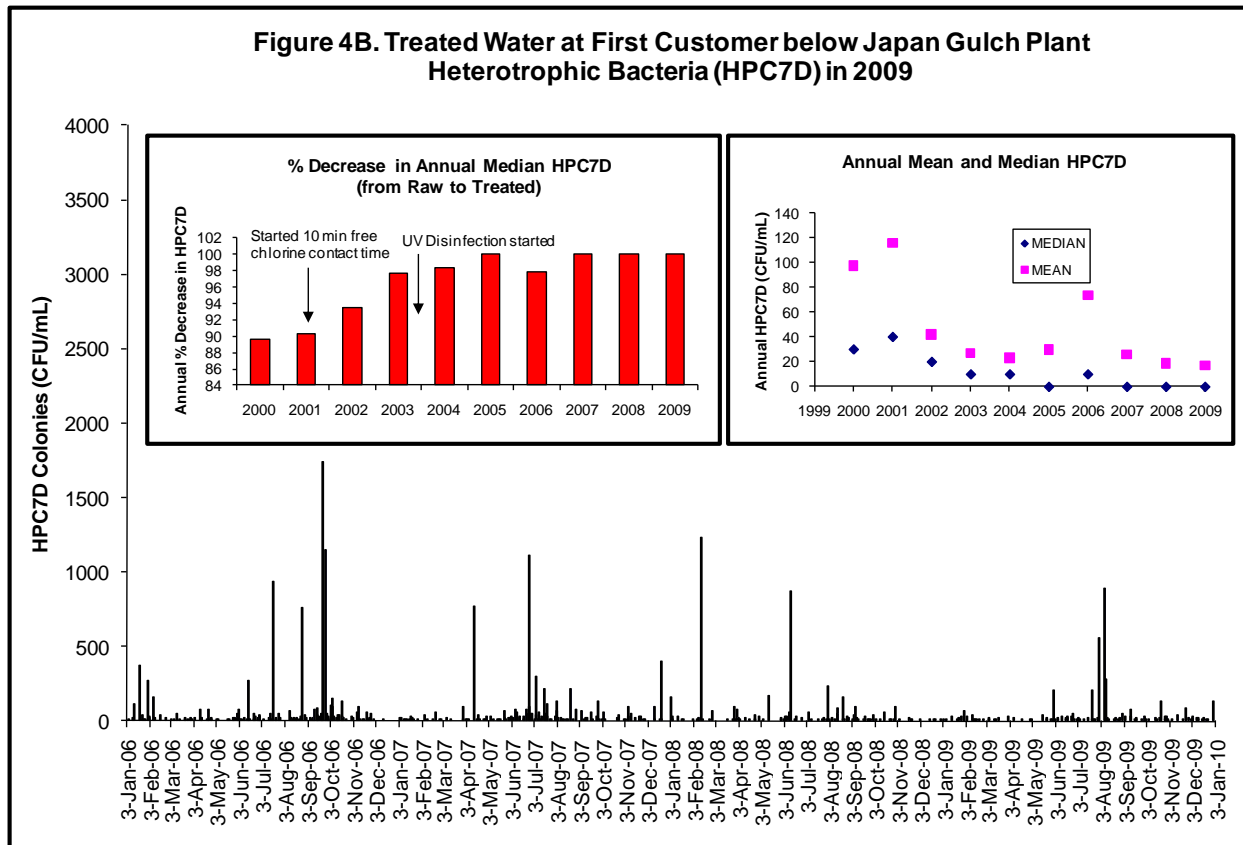
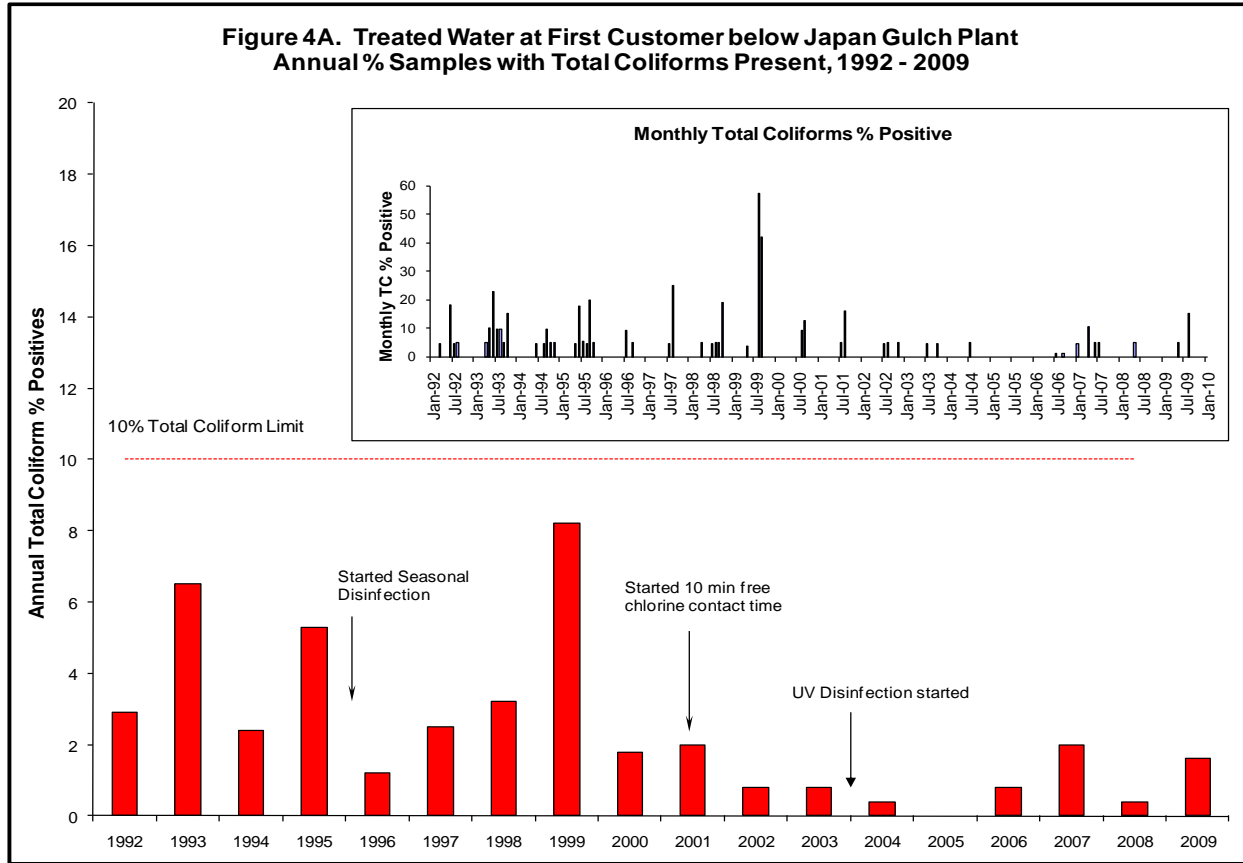
E. coli. During 2009, no *E. coli* bacteria were detected in any of the 250 samples collected from the first customer sampling location below the Japan Gulch Treatment Plant (**Table 2**). This is significant as it indicates that no fecal-associated contamination was present in the water entering the distribution system and provides greater assurance of the bacterial safety of drinking water. Greater Victoria's d

Heterotrophic Plate Count Bacteria. There was no discernable pattern of HPC bacteria in the treated water at the first customer sampling location (**Figure 4B**). The median HPC counts have remained very low ranging from 0 in 2005 to 40 in 2001 (see inset in **Figure 4B**). The means (averages) have also remained low, ranging from 116 CFU/mL in 2000 to 23 CFU/mL in 2004 (see inset in **Figure 4B**). 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 4B**).

4.3.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

Chlorine Residual. The median annual total chlorine residual measured at the first customer sampling point below the Japan Gulch Plant was 1.21 mg/L (**Table 2**). The minimum daily chlorine residual measured below Japan Gulch Plant was 0.87 mg/L in late May 2009, while the maximum daily chlorine residual was 1.53 mg/L recorded in early December. (**Note:** The increased residual was in response to total coliform positives in August and the subsequent increasing of the dosage from 1.6 to 1.8 mg/L on September 17th (**Table 2** and **Figure 4**).

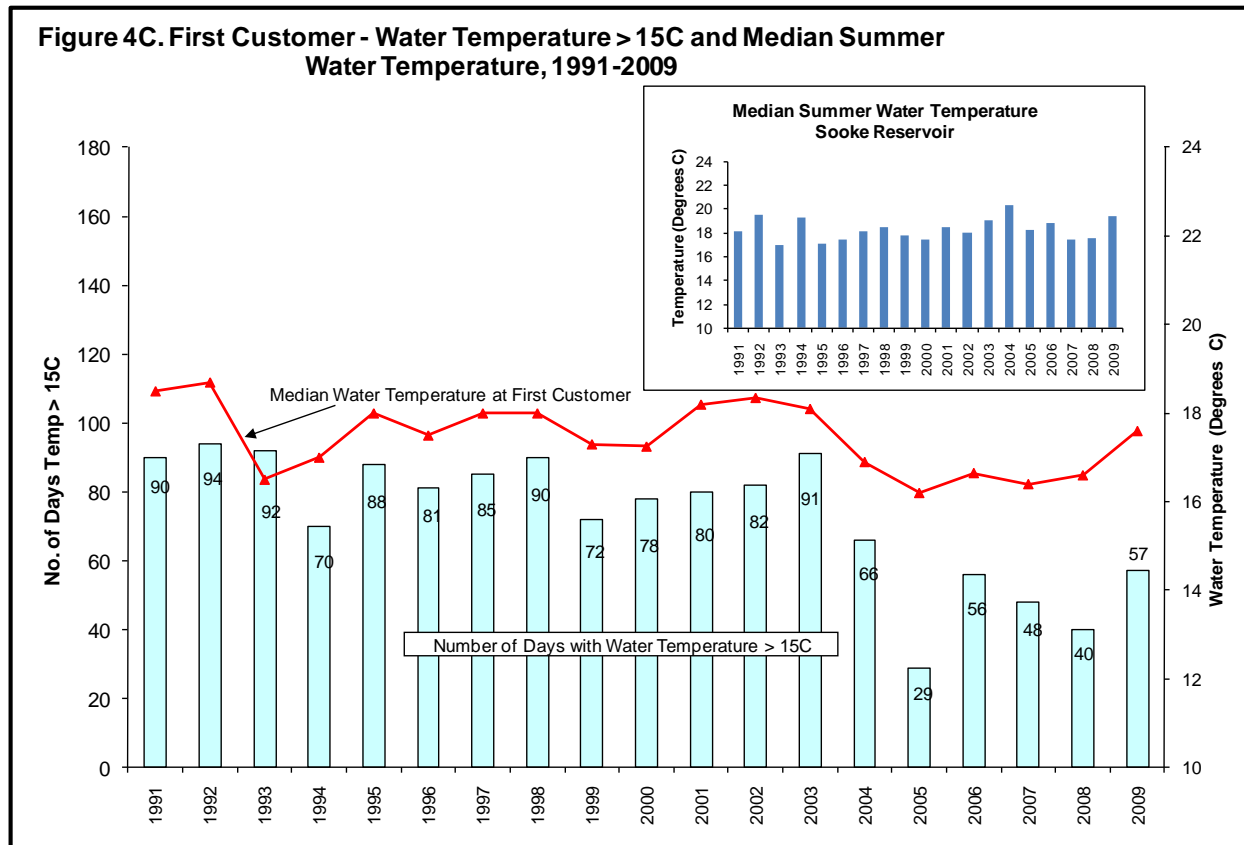




Water Temperature. The median annual temperature of the water at the first customer location below the Japan Gulch Plant was 9.3°C (**Table 2**). The highest median monthly temperature was observed in August 2009 at 18.3°C and the lowest was observed in February at 3.7°C. The coldest daily water temperature recorded was 2.8°C in January while the highest maximum daily water temperature was 19.4°C recorded in August 2009.

In the long term (1991-2009), the average number of sampling days that the water temperature was above 15°C was 73 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 17.5°C. 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 (2003-2009) versus the pre-inundation years (1991-2002). In the years 2005 through 2009, both the number of days with water temperatures greater than 15°C and the median water temperature during this time decreased (46 days vs. 76 days and 16.7°C vs. 17.5°C, respectively) (**Figure 4C**).

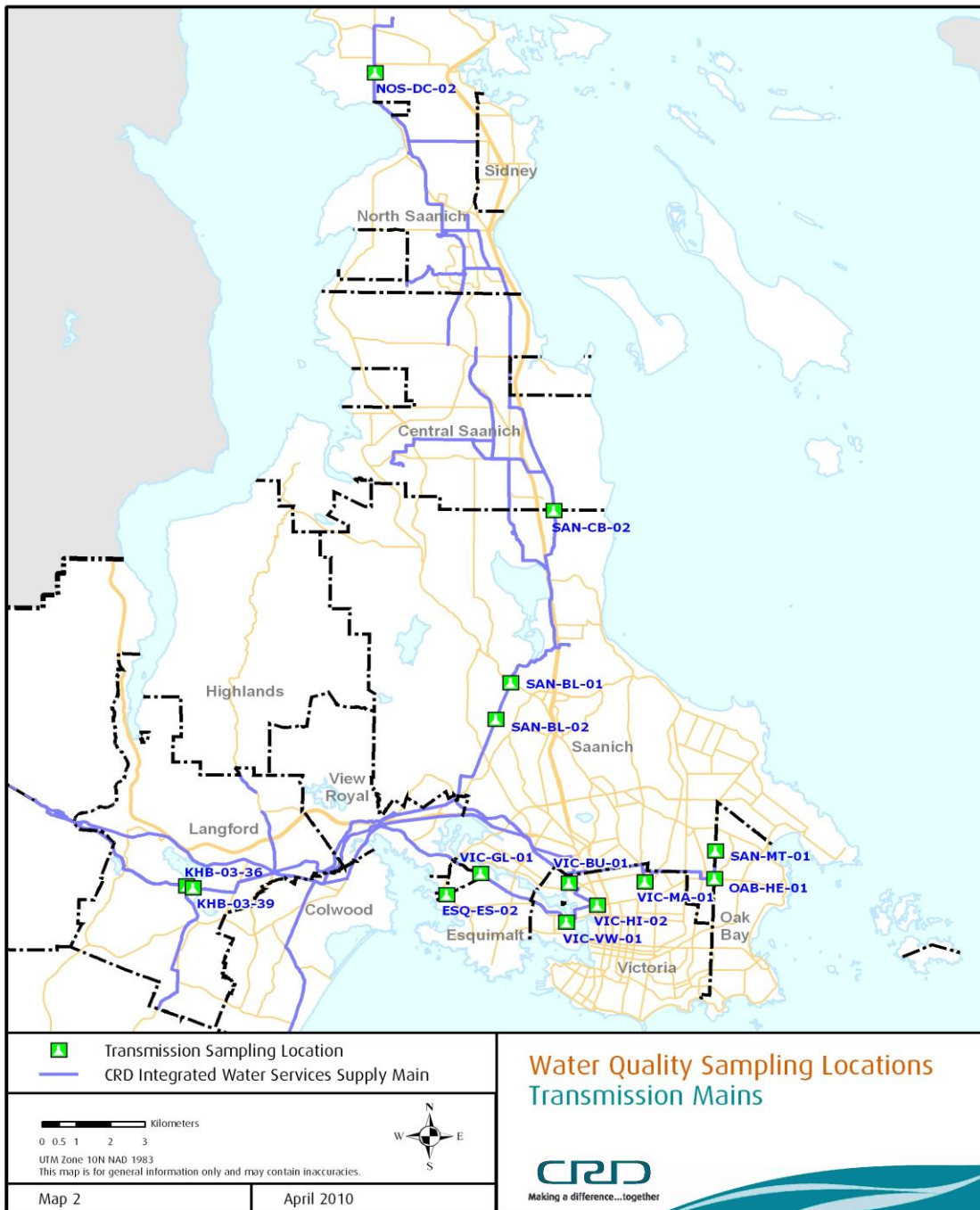
Further evidence that this improvement in cooler summer water temperature is real can be seen by examining the surface water temperature of Sooke Reservoir during the same time span. In the years 1991 through 2009, the summer surface water temperature of Sooke Reservoir has not changed significantly (see insert in **Figure 4C**). The median summer surface water temperature for Sooke Reservoir from 1991-2002 was 18.1°C similar to the post-inundation years 2003 through 2009 at 18.7°C. 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 2009, 442 bacteriological samples were collected from the transmission mains feeding the municipal distribution systems (**Table 3**). Many of these samples were collected at the entrances to the municipal distribution systems and provided the baseline bacteriological water quality and chlorine residual being delivered to those municipal distribution systems. Typically, 30-40 samples are collected each month from these sampling locations.

4.4.2. BACTERIA

Total Coliforms. Three of the samples collected from the transmission mains in 2009 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**).

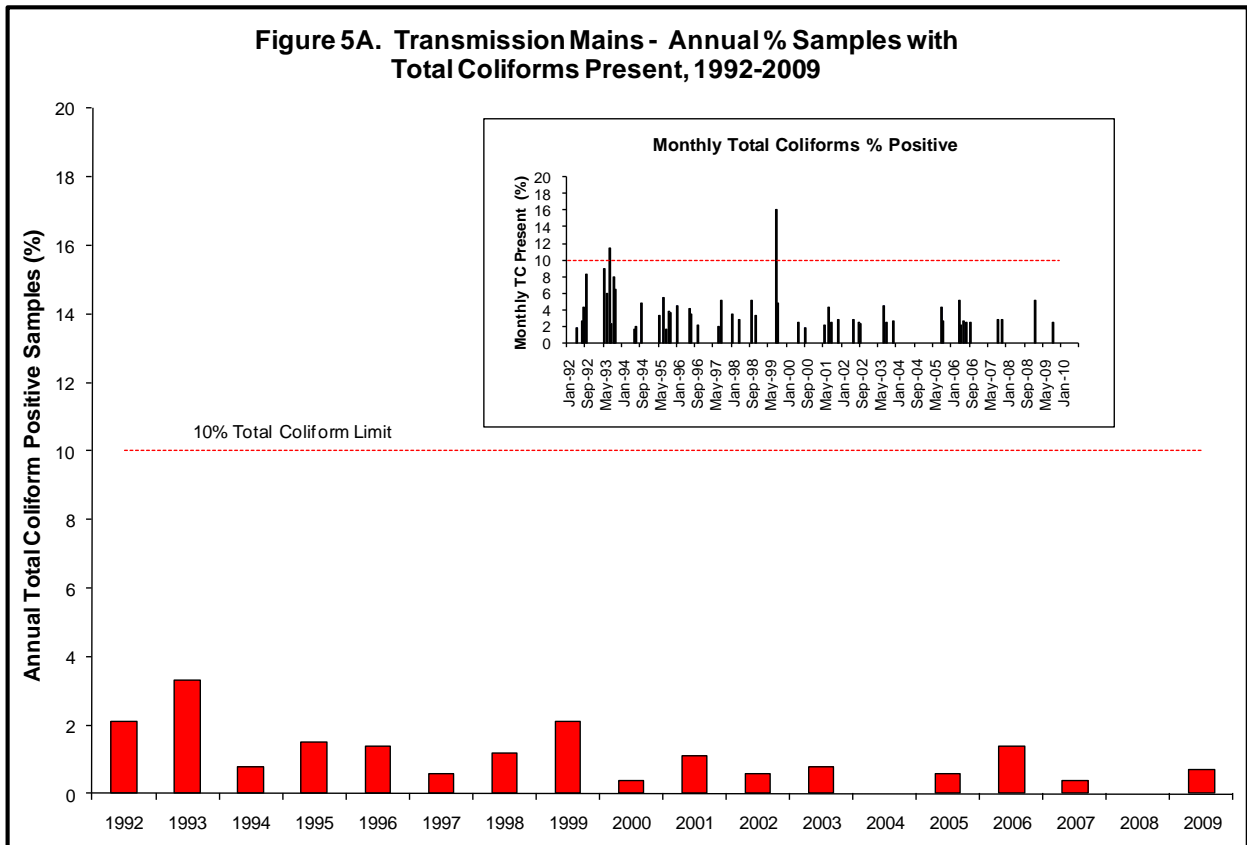
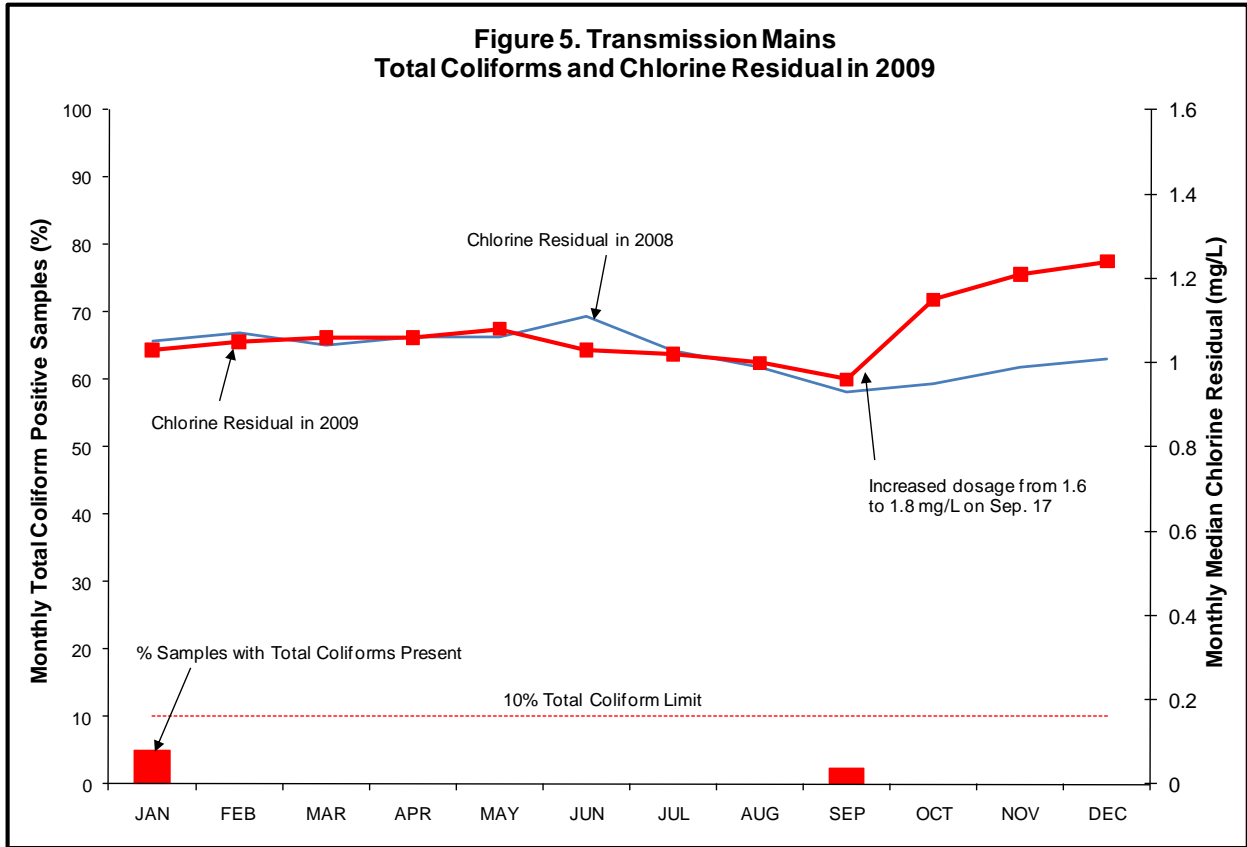
4.4.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

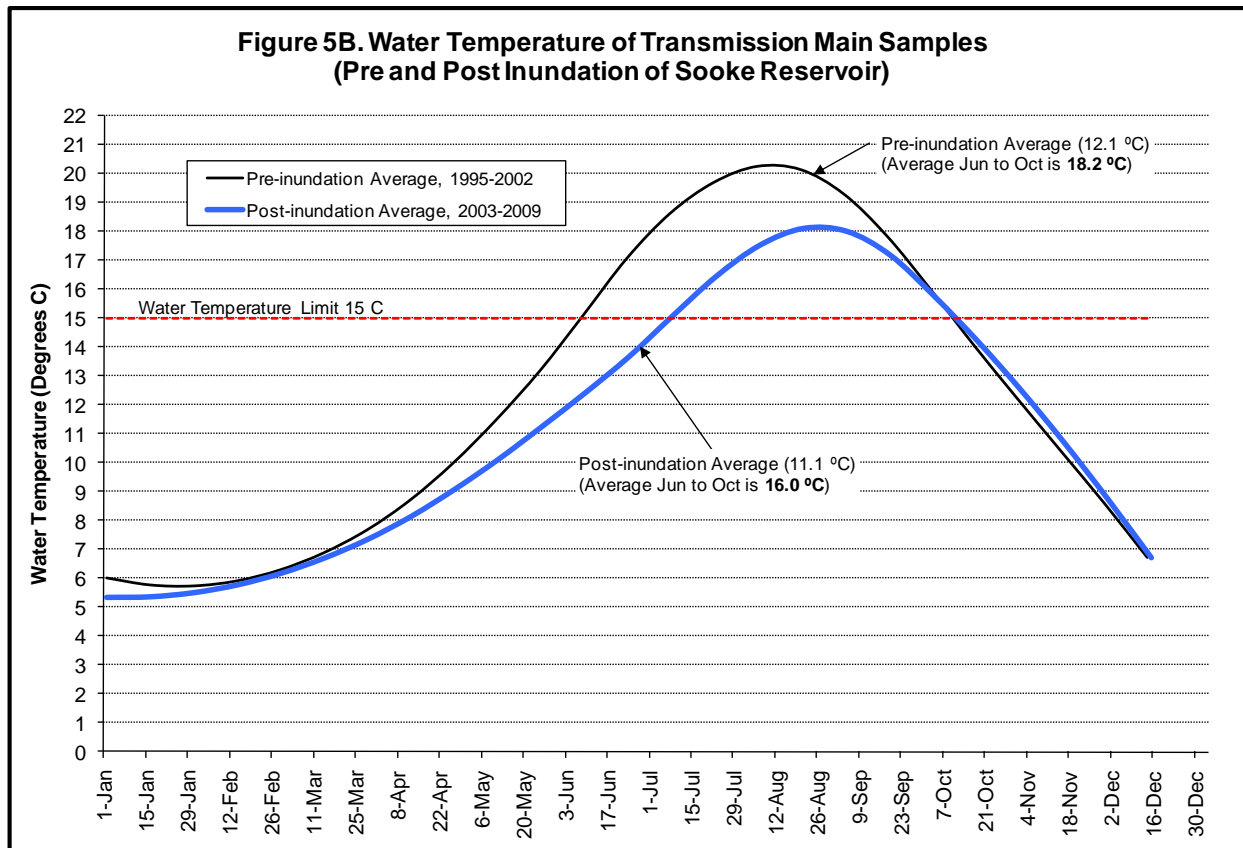
Chlorine Residual. The annual median chlorine residual for the transmission main samples was 1.06 mg/L (**Table 3**). The chlorine residual in the transmission mains remained fairly constant from January through mid-September and then increased following the increased dosage at the treatment plant on September 17th. In 2009, the lowest monthly median chlorine residual occurred during the month of September at 0.96 mg/L and the highest in December at 1.24 mg/L (**Table 3 and Figure 5**).

Table 3. 2009 Bacteriological Quality of the Transmission Water Mains.

Month	Total Coliform					E. coli	Turbidity		Chlorine Residual	Water Temp.
	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 °C
JAN	39	2	5.1	0	0	0	7	0	1.03	4.7
FEB	35	0	0	0	0	0	6	0	1.05	4.7
MAR	41	0	0	0	0	0	7	0	1.06	5.4
APR	36	0	0	0	0	0	6	0	1.06	7.3
MAY	34	0	0	0	0	0	6	0	1.08	9.9
JUN	40	0	0	0	0	0	8	0	1.03	12.6
JUL	36	0	0	0	0	0	6	0	1.02	16.6
AUG	38	0	0	0	0	0	7	0	1.00	18.5
SEP	42	1	2.4	0	0	0	6	0	0.96	18.3
OCT	33	0	0	0	0	0	6	0	1.15	13.6
NOV	38	0	0	0	0	0	7	0	1.21	10.1
DEC	30	0	0	0	0	0	4	0	1.24	6.4
Total	442	3	0.7%	0	0	0	76	0	1.06	10.1

TC = Total Coliforms, E. coli = *Escherichia coli* Cl₂ = chlorine, NTU = Nephelometric turbidity unit.
> = Greater than, mg/L = milligrams per litre, °C = degrees Celsius





Water Temperature. The annual median water temperature for the transmission mains was 10.1°C (Table 3). The maximum monthly median temperature of 18.5°C occurred in August while the minimum temperature of 4.7°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 18.2°C while the post-inundation average water temperature (2003-2009) was only 16.0°C (Figure 5B).

4.5. 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 2009. 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

In 2009, the total number of bacteriological samples collected by Water Quality Division staff from the Greater Victoria balancing reservoirs was 950 (Table 4). Typically, about 73-78 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 Balancing Reservoirs.

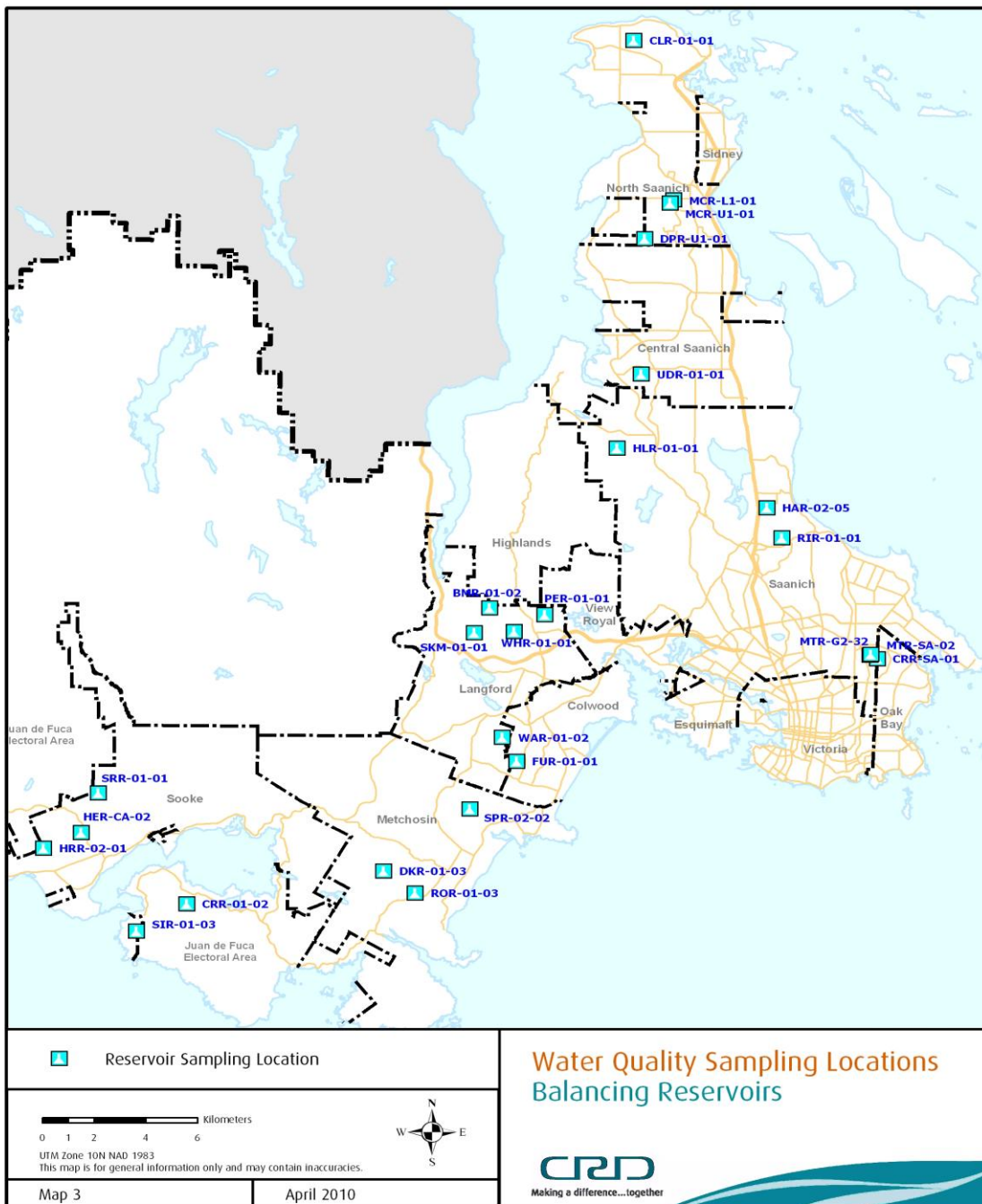


Table 4. 2009 Bacterial Quality of Greater Victoria Balancing Reservoirs.

Month	Total Coliform					E. coli Samples >0	Turbidity		Chlorine Residual Median mg/L Cl ₂	Water Temp. Median °C
	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10		Samples Collected	Samples >1 NTU		
JAN	73	0	0	0	0	0	5	0	0.69	5.3
FEB	74	0	0	0	0	0	5	0	0.68	5.2
MAR	76	0	0	0	0	0	3	0	0.64	5.8
APR	80	0	0	0	0	0	5	0	0.65	8.3
MAY	73	0	0	0	0	0	4	0	0.49	10.9
JUN	87	3	3.4	0	0	0	3	0	0.39	14.1
JUL	88	1	1.1	0	0	0	3	0	0.30	17.1
AUG	84	4	4.8	0	0	0	3	0	0.25	18.8
SEP	83	6	7.2	1	0	0	4	0	0.16	18.2
OCT	78	1	1.3	0	0	0	3	0	0.38	14.1
NOV	76	0	0	0	0	0	3	0	0.38	10.5
DEC	78	1	1.3	0	0	0	3	0	0.59	6.8
TOTAL	950	16	1.7	1	0	0	44	0	0.43	11.1

TC = Total Coliforms, E. coli = *Escherichia coli* Cl₂ = chlorine, NTU = Nephelometric turbidity unit.
> = Greater than, mg/L = milligrams per litre, °C = degrees Celsius

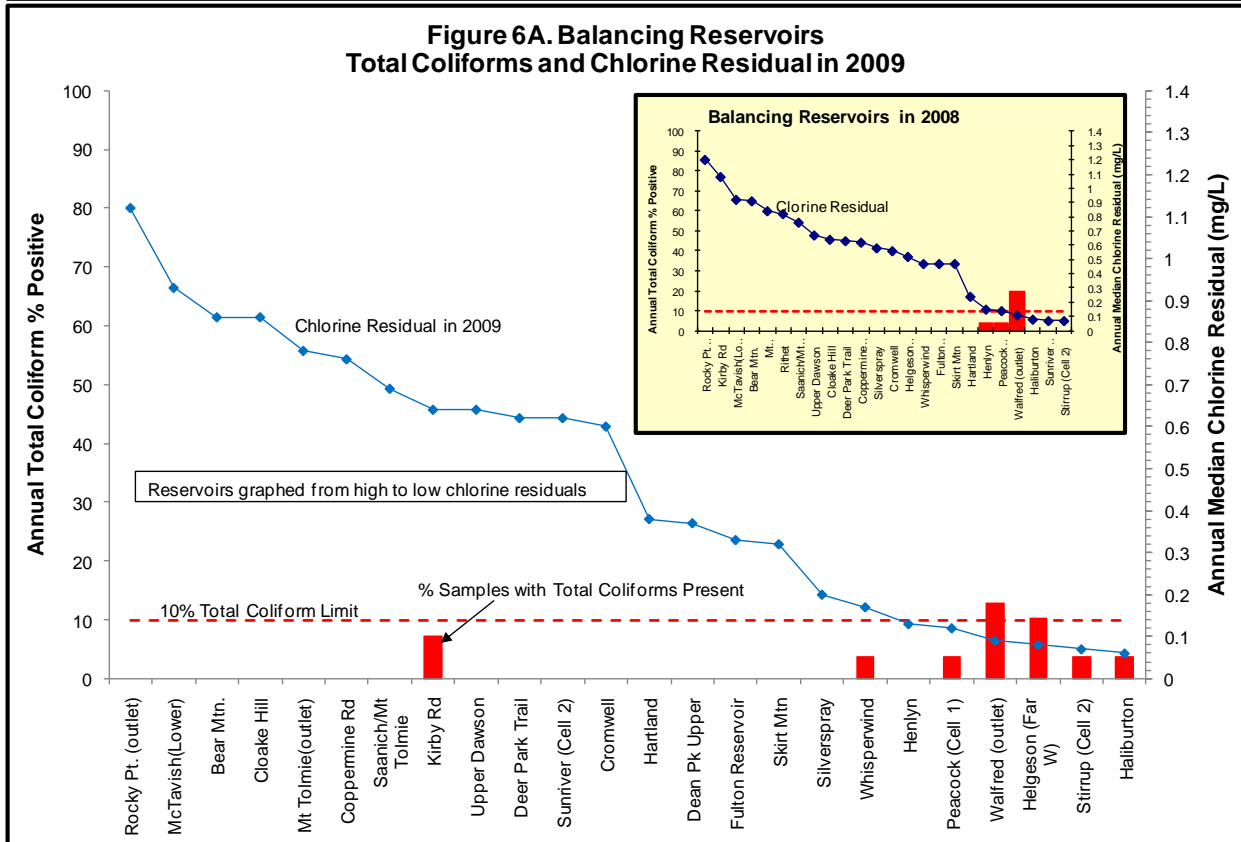
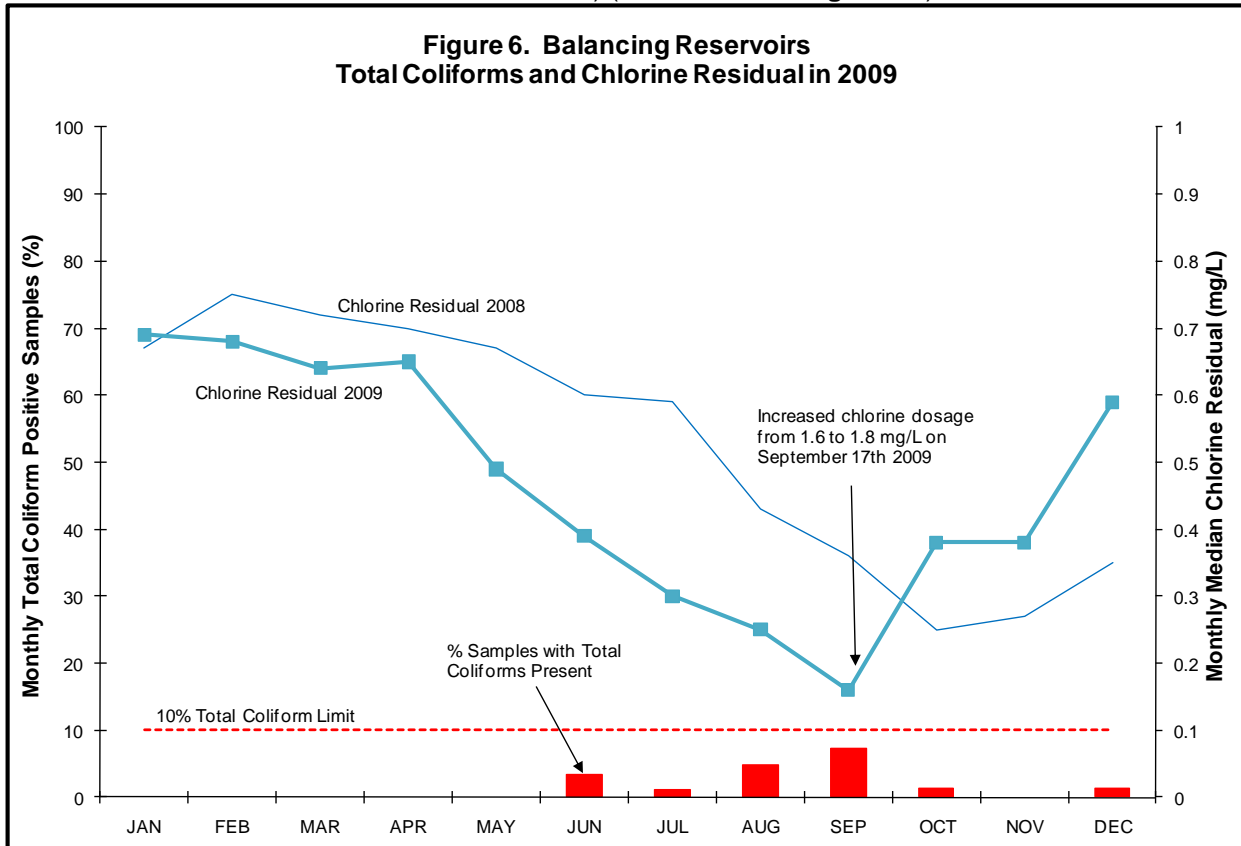
4.5.2. BACTERIA

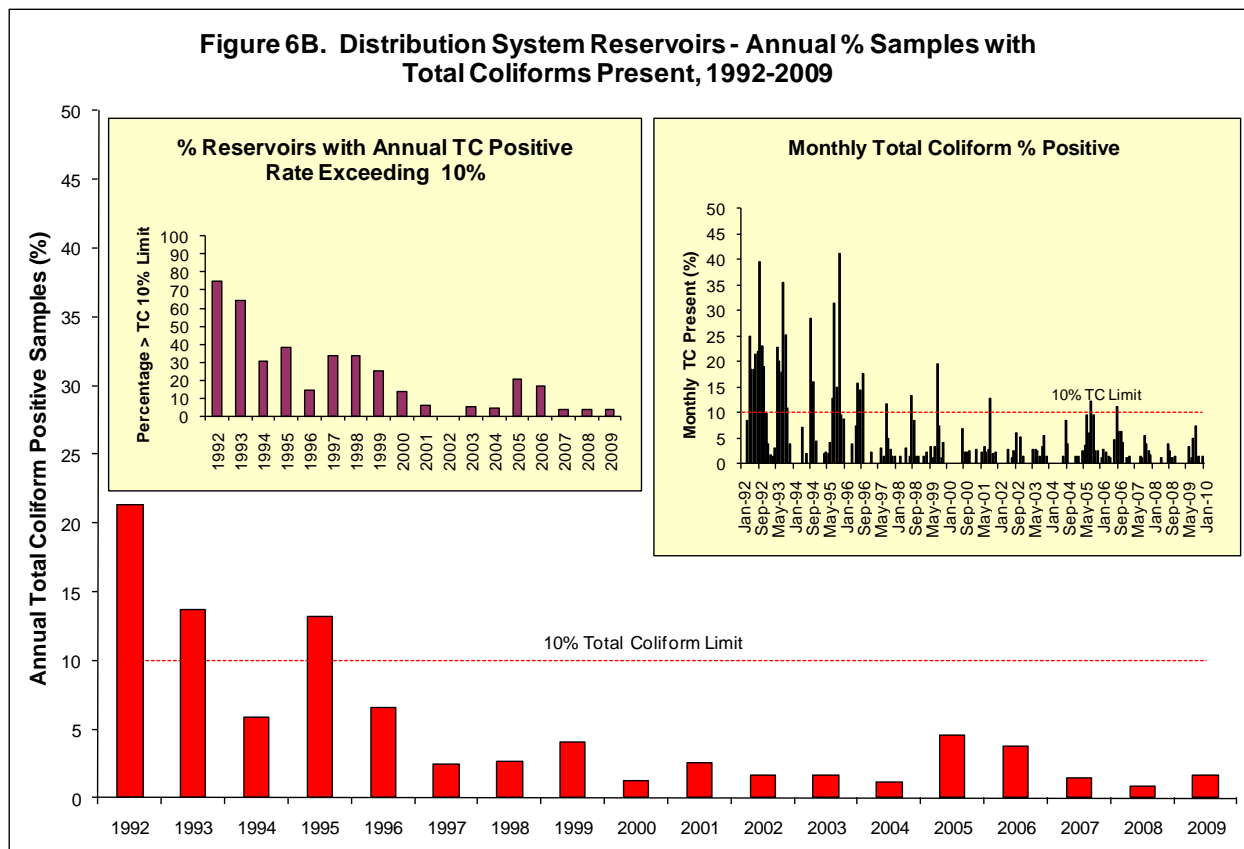
Total Coliforms. In 2009, sixteen samples (1.7%) collected from the balancing reservoirs contained total coliform bacteria (**Table 4**). Total coliforms were found in June through October and in December 2009. However, when the results of all of the reservoirs are grouped together, the 10% positive total coliform limit was never exceeded in 2009 (**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.

None of the positive coliform samples had a total coliform count greater than the 10 CFU/100 mL limit. One of the resamples contained total coliforms. On an annual basis, only Walfred Reservoir (12.9%) exceeded the 10% total coliform limit (**Figure 6A**). (**Note:** while this limit was exceeded, it did not compromise the safety of the drinking water). 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 balancing 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 in 2009 (**Figure 6A**).

In the long term, there has been a significant improvement in the bacteriological quality of the Greater Victoria balancing 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 0.9% in 2008 and 1.7% in 2009 (**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 0.9% 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, 2008 and 2009) (second inset in Figure 6B).





E. coli. None of the balancing 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 balancing reservoirs sampled by the Water Quality Division showed a steady decline from April through September before increasing in October and December (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 early April 2009. In addition, the chlorine dosage at Japan Gulch Treatment Plant was increased from 1.6 to 1.8 mg/L on September 17th which would have increased the chlorine residual in the reservoirs as a whole.

Four reservoirs were drained, cleaned, and refilled in January, six in February, and one in March. Five reservoirs required rechlorination (Peacock, Helgeson, Silverspray, Stirrup Place and Walfred) in response to adverse bacteriological results.

Similar to previous years, a number of the balancing reservoirs in the Greater Victoria Drinking Water System demonstrated low chlorine residuals which were directly related to either poor circulation or long detention of the water within the 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: Whisperwind Reservoir (0.09 mg/L), Stirrup Place Reservoir (0.07), Walfred Reservoir (0.09) and Peacock Reservoir (0.12) (Figure 6A).

Water Temperature. The median monthly temperature of the water in all of the balancing reservoirs combined was lowest in February at 5.2°C and highest in August 2009 at 18.8°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 by about 1 degree Celsius.

4.6. GREATER VICTORIA DISTRIBUTION SYSTEM

The 2009 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 2009, 2,130 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. Fourteen samples (0.7%) collected from the Greater Victoria Distribution System contained total coliform bacteria (**Table 5**). Total coliform bacteria were detected during six months of the year (April, June through September 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 2009. 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 (inset in **Figure 7A**).

However, while one sample contained 10 or more total coliforms per 100 mL, none of the resamples collected contained total coliforms (**Table 5**).

In 2009, 50% 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* and *Enterobacter amnigenus*). The remaining 50% of the coliform positives were coliforms that are found in both environmental sources and in fecal matter and sewage (*Enterobacter*). Nevertheless, the presence of these coliforms is not necessarily related to fecal contamination (as explained below).

***E. coli*.** In 2009, 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 2009 (based on the analysis of the samples collected).

Table 5. 2009 Bacterial Quality of the Greater Victoria Distribution System.

Month	Total Coliform					E. coli	Turbidity		Chlorine Residual	Water Temp
	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 °C
JAN	184	0	0	0	0	0	27	4	0.65	6.2
FEB	170	0	0	0	0	0	26	1	0.66	6.2
MAR	179	0	0	0	0	0	30	3	0.67	6.8
APR	183	3	1.6	0	0	0	30	1	0.67	9.0
MAY	172	0	0	0	0	0	25	0	0.65	11.6
JUN	179	4	2.2	0	0	0	25	2	0.67	14.3
JUL	196	1	0.5	0	0	0	33	0	0.59	17.6
AUG	172	1	0.6	0	0	0	24	0	0.52	19.3
SEP	178	4	2.2	0	0	0	21	0	0.48	18.6
OCT	178	0	0	0	0	0	22	1	0.64	14.6
NOV	172	1	0.6	0	1	0	24	3	0.77	11.1
DEC	167	0	0	0	0	0	19	0	0.87	7.8
TOTAL	2130	14	0.7%	0	1	0	306	15	0.64	11.6

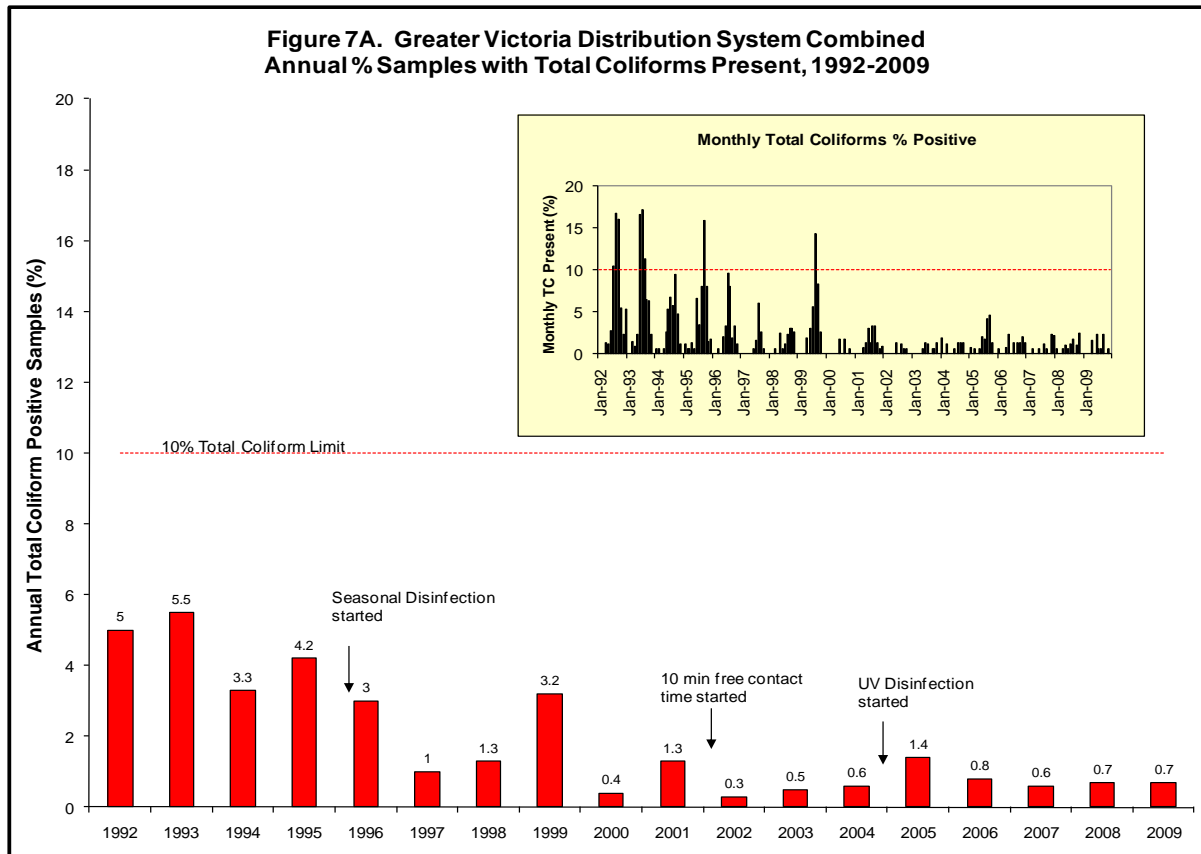
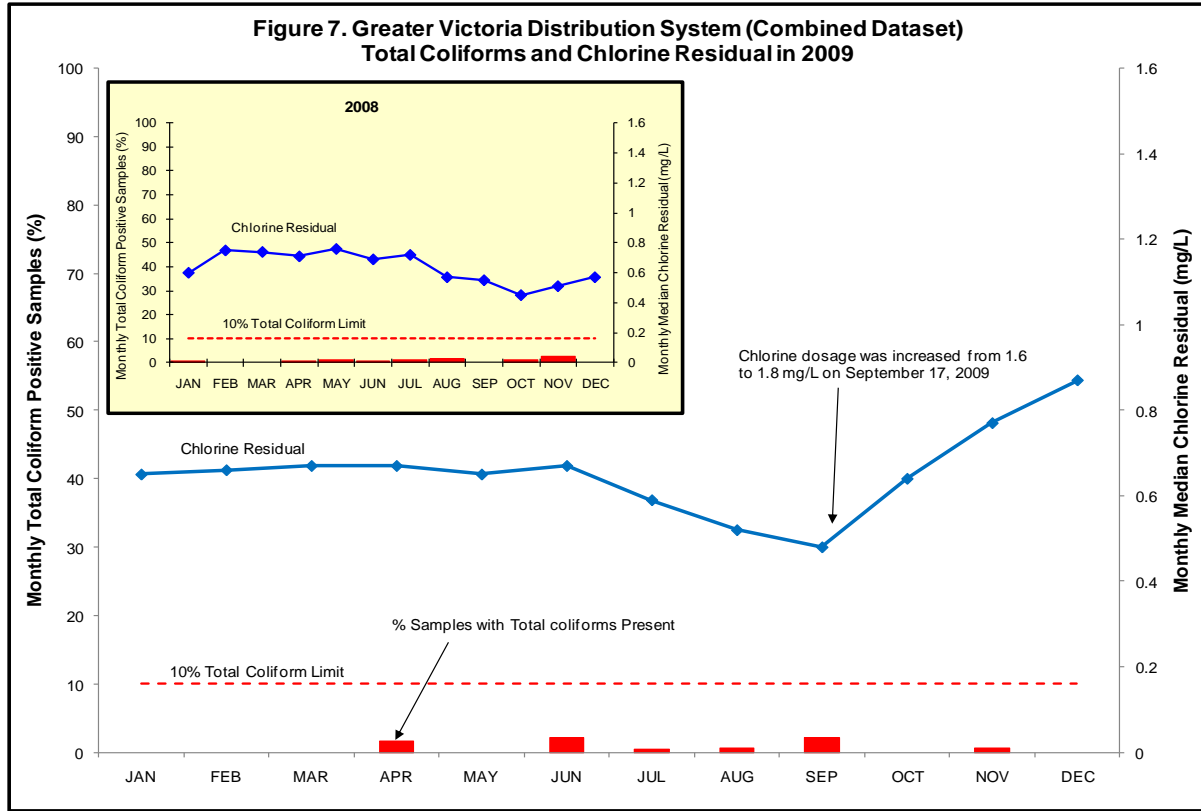
TC = Total Coliforms, E. coli = *Escherichia coli* Cl₂ = chlorine, NTU = Nephelometric turbidity unit.
 > = Greater than, mg/L = milligrams per litre, °C = degrees Celsius

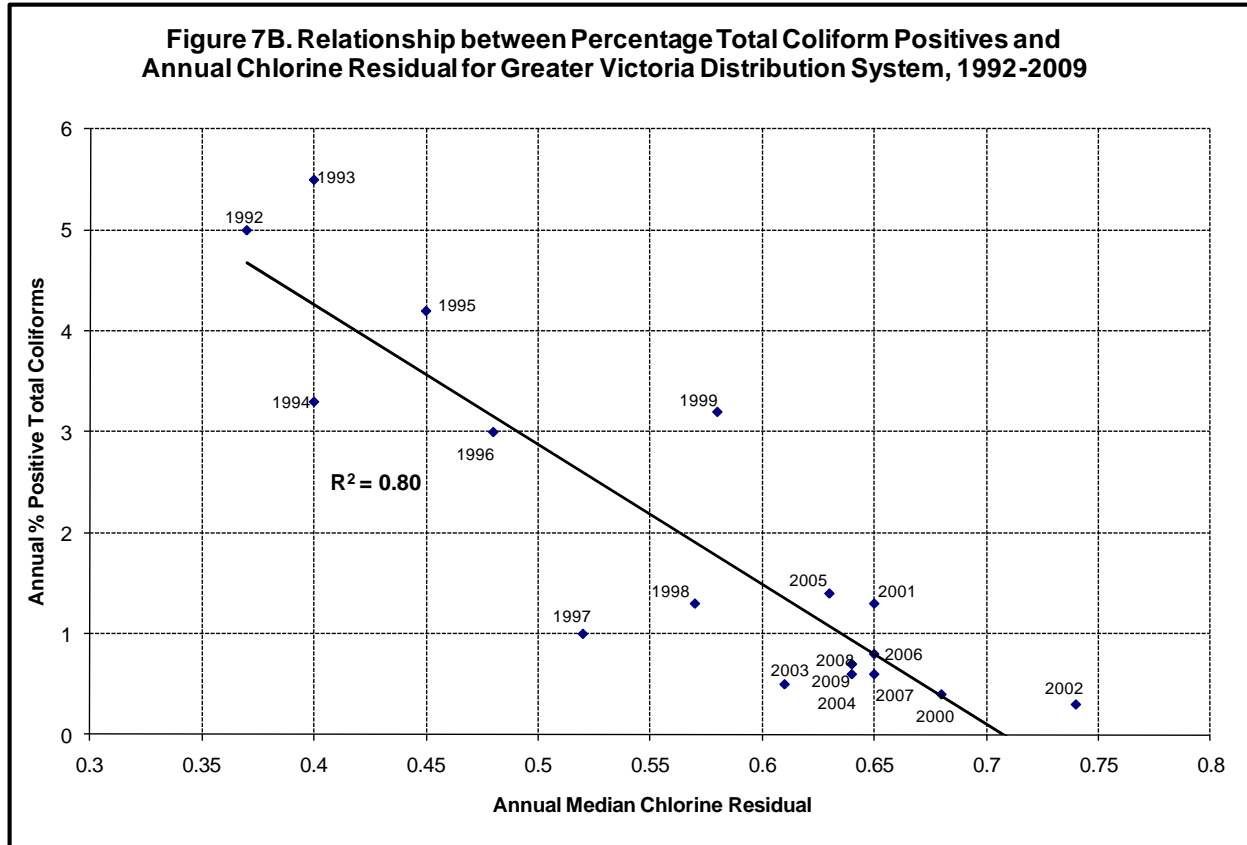
4.6.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

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 through 2008 and similar to previous recent years. In individual samples, the level of chlorine residual in the distribution system ranged between 0.0 and 1.65 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 January through mid-June and then dropped from July to mid-September. On September 17th in response to total coliform positives, the chlorine dosage was increased from 1.6 to 1.8 mg/L and left at this level through to the end of the year (**Figure 7**).

As expected, the median annual chlorine residual was highest at the first customer location (1.21 mg/L) and lowest in North Saanich (0.39 mg/L) followed closely by distribution system reservoirs (0.43 mg/L) and by Sidney (0.45 mg/L). The minimum median monthly chlorine residual was lowest in the distribution system reservoirs (0.16 mg/L), followed closely by the North Saanich distribution system (0.25 mg/L), the West Shore distribution system (0.27 mg/L) and the Sooke distribution system (0.30 mg/L).

Over the past eighteen 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 2009, the median annual chlorine residual was more than 0.6 mg/L and the median total coliform percentage positive rate was only 0.6%.





Water Temperature. In 2009, the annual median water temperature for the Greater Victoria Distribution System was 11.6°C. This was 2.3°C higher (9.3°C) than the temperature of the water entering the water system at the Japan Gulch Plant. The median monthly temperature ranged from 6.2°C in January and February to 19.3°C in August (**Table 5**). The maximum daily water temperature of 23.4°C was reached in Colwood (West Shore) during the month of July. This was substantively warmer than the temperature of the water entering the Japan Gulch Treatment Plant from Sooke Reservoir.

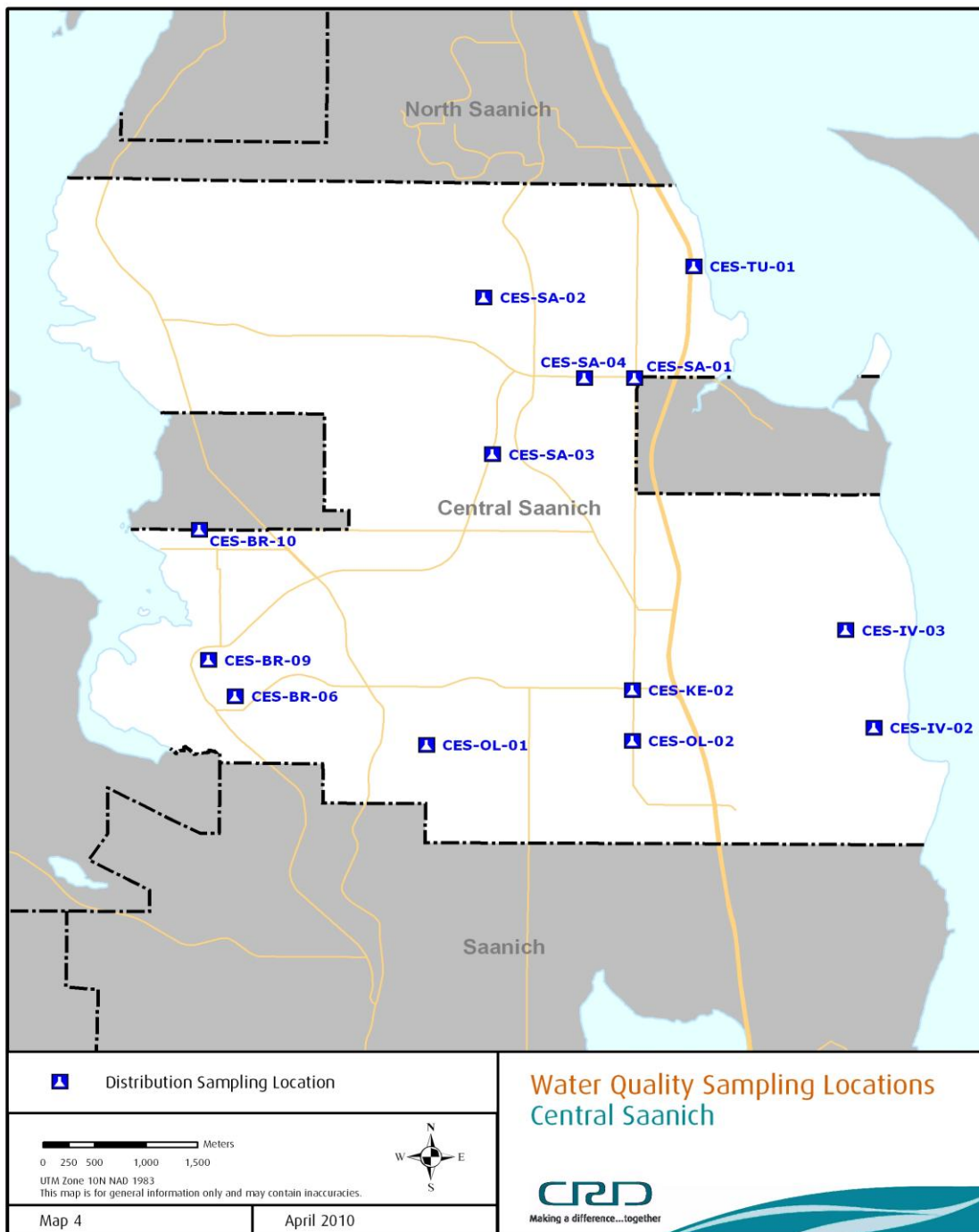
In the individual municipalities the highest annual median water temperature was reached in Victoria (12.4°C) followed closely by Sidney (11.9°C) and Oak Bay (11.9°C) while the lowest annual median water temperature was in the Central Saanich and North Saanich distribution systems (11.2°C) followed by Saanich and the West Shore at 11.3°C.

In 2009, similar to other years following the expansion of Sooke Reservoir, the water temperature in the distribution system was generally cooler by 0.5°C to 2.5°C in the period from mid-June to the end of August compared with the years prior to the raising of the reservoir. 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

In 2009, 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 2009 (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 2009, 280 bacteriological samples were collected from the Central Saanich Distribution System (**Table 6**).

4.7.2. BACTERIA

Total Coliforms. Total coliforms were found in two samples collected in June and November from one location (Amwell and Aston) (**Table 6**). The Central Saanich Distribution System complied with the 10% total coliform positive limit for all months of the year during 2009. The annual total coliform percentage positive was well below the 10% limit at only 0.7% (**Figure 8**).

E. coli. None of the samples contained *E. coli* in 2009 (**Table 6**).

4.7.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

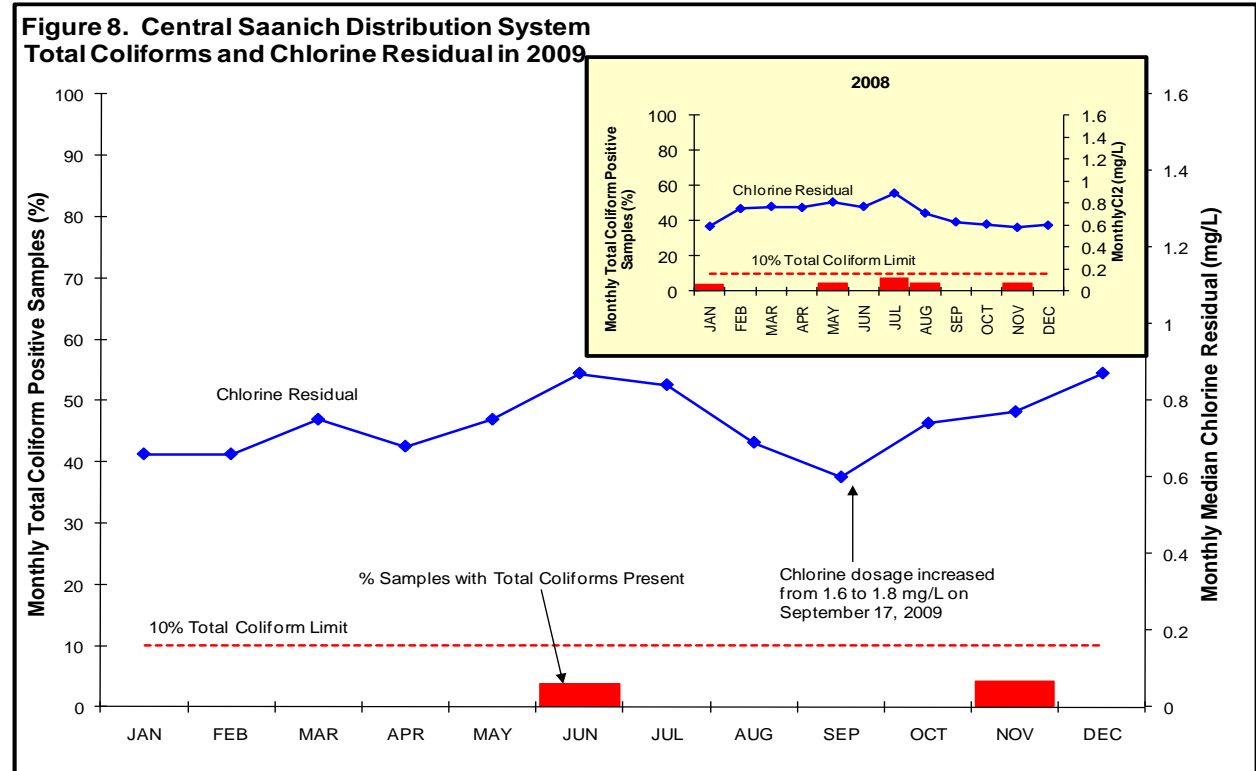
Chlorine Residual. The annual median chlorine residual for the Central Saanich Distribution System was 0.74 mg/L (**Table 6**). The monthly median chlorine residual peaked in June, and then declined reaching a minimum of 0.60 mg/L (monthly median) in September before increasing again to the end of the year (**Figure 8**).

Water Temperature. The annual median water temperature in the Central Saanich Distribution System was 11.2°C virtually the same as in the past six years with monthly medians ranging between 6.1°C (February) and 18.9°C (August) (**Table 6**).

Table 6. 2009 Bacterial Quality of the Central Saanich Distribution System.

Month	Total Coliform					E. coli	Turbidity		Chlorine Residual	Water Temp.
	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 °C
JAN	24	0	0	0	0	0	3	0	0.66	6.2
FEB	23	0	0.0	0	0	0	3	0	0.66	6.1
MAR	24	0	0.0	0	0	0	3	0	0.75	6.8
APR	24	0	0.0	0	0	0	4	0	0.68	8.5
MAY	22	0	0	0	0	0	2	0	0.75	11.2
JUN	26	1	3.8	0	0	0	3	0	0.87	13.8
JUL	23	0	0	0	0	0	4	0	0.84	16.8
AUG	22	0	0	0	0	0	3	0	0.69	18.9
SEP	24	0	0.0	0	0	0	2	0	0.60	18.6
OCT	23	0	0.0	0	0	0	3	0	0.74	14.4
NOV	24	1	4.2	0	1	0	4	1	0.77	11.1
DEC	21	0	0	0	0	0	3	0	0.87	8.2
TOTAL	280	2	0.7%	0	1	0	37	1	0.74	11.2

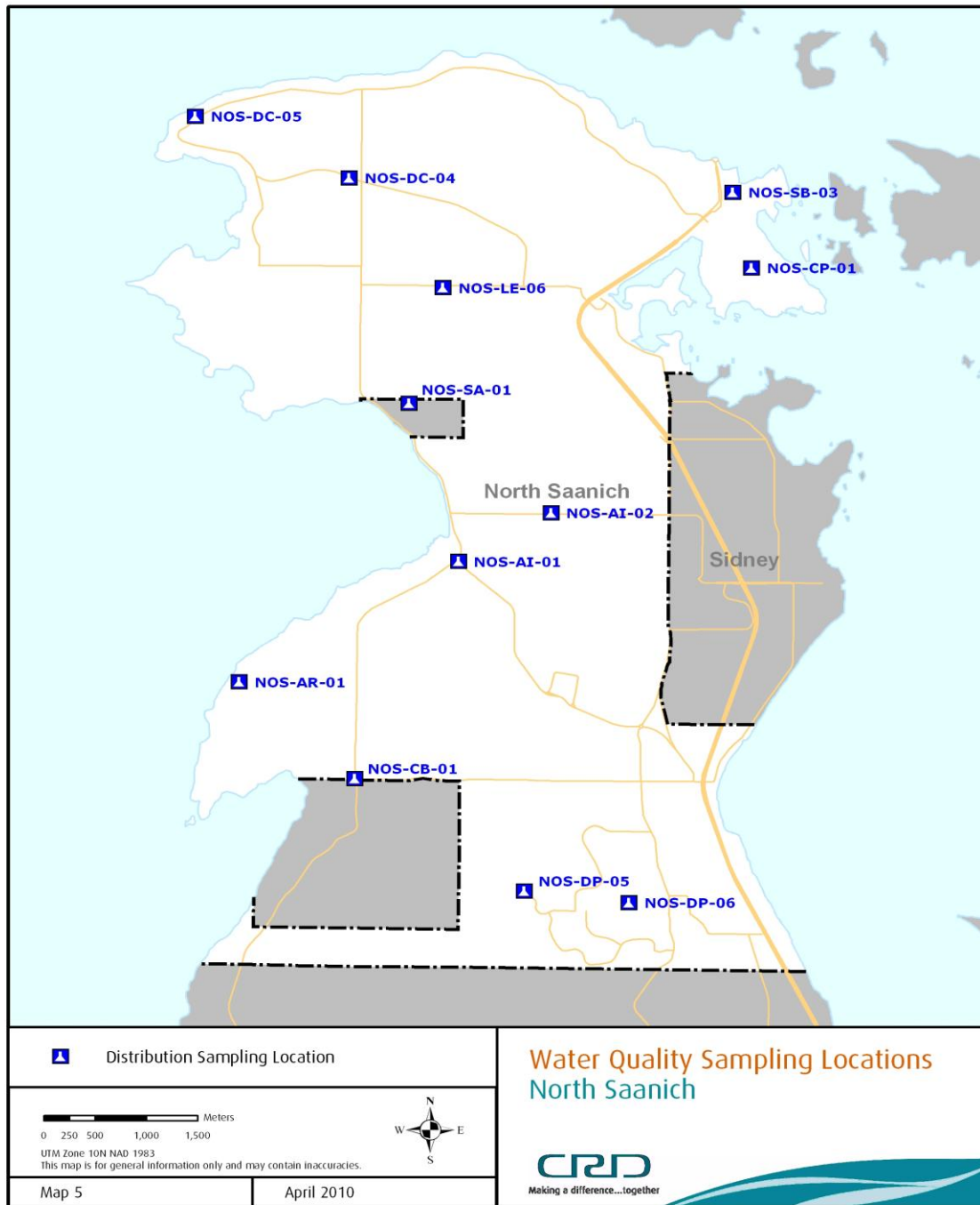
TC = Total Coliforms, E. coli = *Escherichia coli* Cl₂ = chlorine, NTU = Nephelometric turbidity unit.
> = Greater than, mg/L = milligrams per litre, °C = degrees Celsius



4.8. NORTH SAANICH DISTRIBUTION SYSTEM

In 2009, twelve sampling locations were used to monitor the bacteriological quality of the drinking water in the North Saanich Distribution System (**Map 5**). Eight of these locations were sampled bi-weekly while the remaining four were sampled 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 2009, 242 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 2009 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 2009.

4.8.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

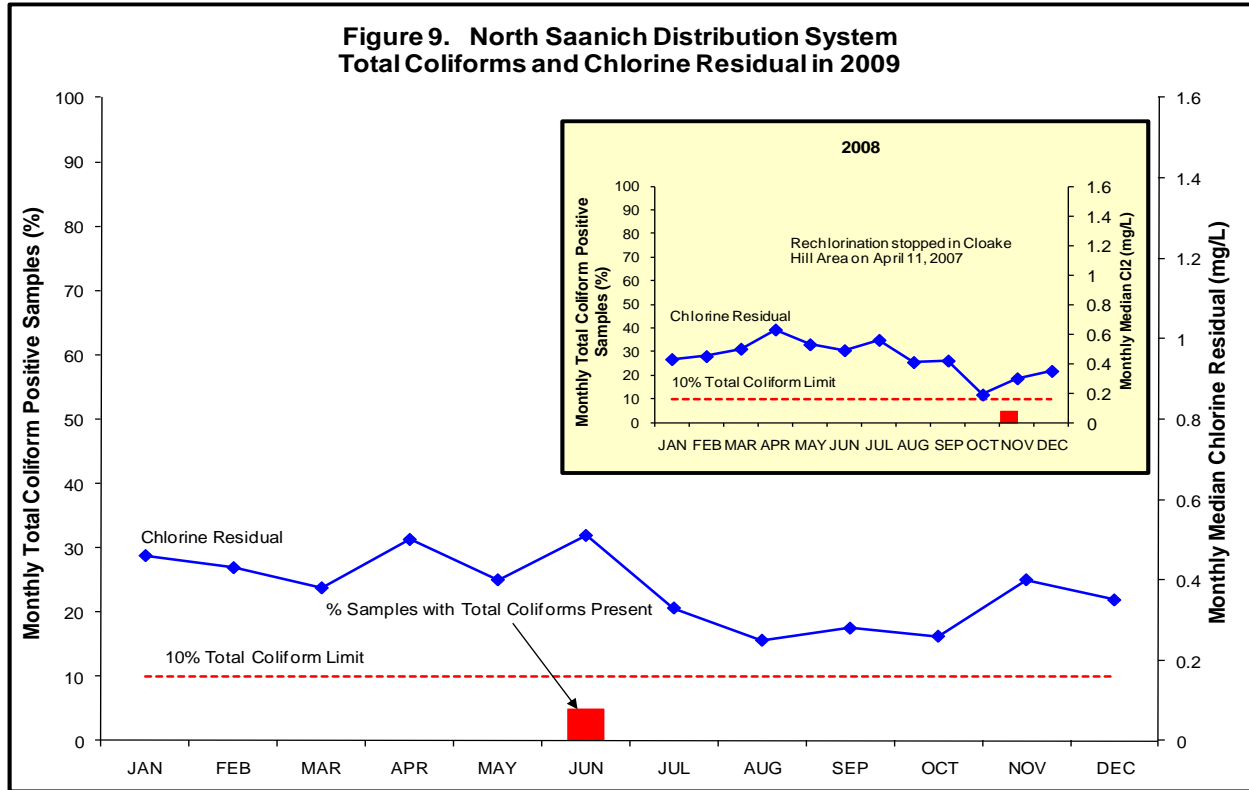
Chlorine Residual. The annual median chlorine residual for the North Saanich Distribution System was 0.39 mg/L. The monthly median chlorine residuals ranged from a low of 0.25 mg/L in August to a high of 0.51 in June (**Table 7**). Prior to April 2007, rechlorination was used by the CRD Environmental Services Department in the water supplied to the municipal system from the Deep Cove Pump Station (**Figure 9**). However, due to the risk of excessive disinfection by-product formation associated with this rechlorination, this practice was stopped in April 2007 with little adverse impact upon the bacteriological quality of the water. Some rechlorination was used at the Upper Dean Park Reservoir to maintain chlorine residuals in that part of the system.

Water Temperature. The annual median water temperature in the North Saanich Distribution System was 11.2°C (**Table 7**), similar to that found in 2005 through 2008.

Table 7. 2009 Bacterial Quality of the North Saanich Distribution System.

Month	Total Coliform					E. coli Samples >0	Turbidity Samples Collected >1 NTU	Chlorine Residual Median mg/L Cl ₂	Water Temp. Median °C	
	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10					
JAN	23	0	0	0	0	0	1	0	0.46	6.5
FEB	18	0	0	0	0	0	1	0	0.43	6.5
MAR	20	0	0	0	0	0	1	0	0.38	6.8
APR	20	0	0	0	0	0	2	0	0.50	8.7
MAY	21	0	0	0	0	0	1	0	0.40	11.2
JUN	21	1	4.8	0	0	0	1	0	0.51	14.1
JUL	21	0	0	0	0	0	1	0	0.33	16.3
AUG	19	0	0	0	0	0	1	0	0.25	18.4
SEP	21	0	0	0	0	0	0	0	0.28	18.1
OCT	20	0	0	0	0	0	0	0	0.26	14.5
NOV	19	0	0	0	0	0	0	0	0.40	11.1
DEC	19	0	0	0	0	0	1	0	0.35	8.6
TOTAL	242	1	0.4%	0	0	0	10	0	0.39	11.2

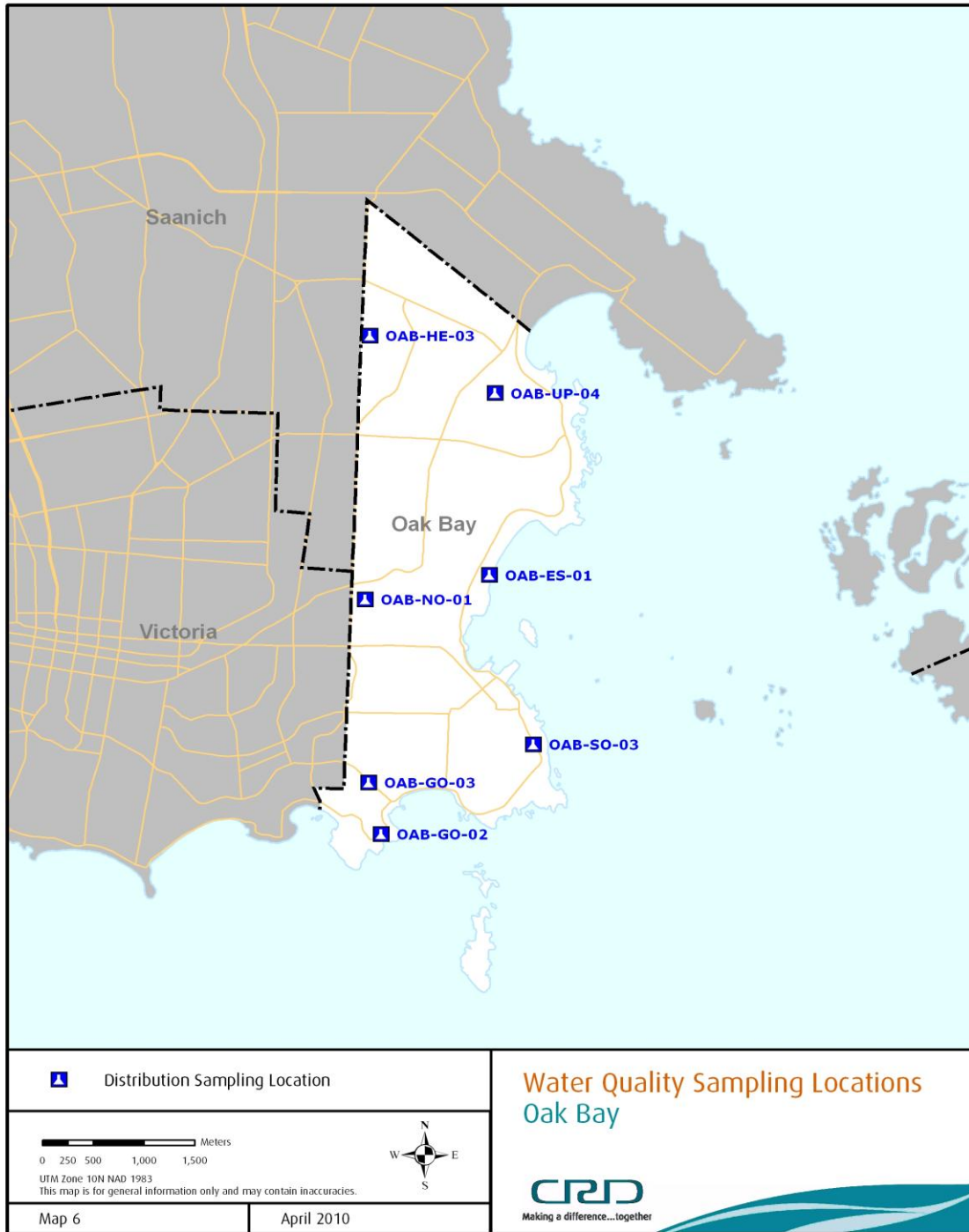
TC = Total Coliforms, E. coli = *Escherichia coli* Cl₂ = chlorine, NTU = Nephelometric turbidity unit.
> = Greater than, mg/L = milligrams per litre, °C = degrees Celsius



4.9. OAK BAY DISTRIBUTION SYSTEM

In 2009, seven sampling locations were used to monitor the bacteriological quality of the drinking water in the Oak Bay Distribution System (**Map 6**). All seven locations were sampled bi-weekly.

Map 6. Sampling Locations in Oak Bay Distribution System.



4.9.1. SAMPLE COLLECTION

In 2009, a total of 180 bacteriological samples were collected from the Oak Bay Distribution System (**Table 8**).

4.9.2. BACTERIA

Total Coliforms. One of the samples collected from the Oak Bay Distribution System contained total coliform bacteria (**Figure 10**). The coliform positive was from the Willows Beach Concession in June 2009. The resample from this location was negative for coliforms. This is similar to recent years.

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

Table 8. 2009 Bacterial Quality of the Oak Bay Distribution System.

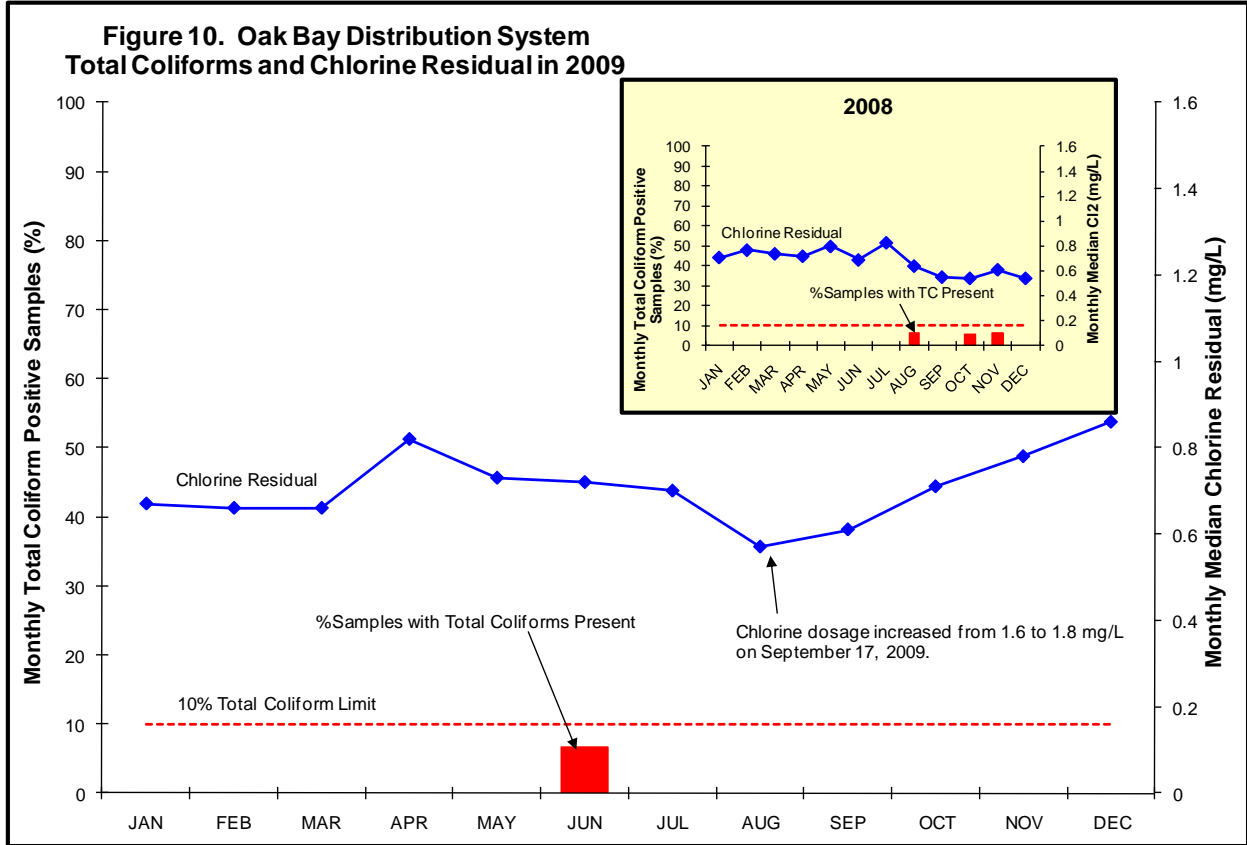
Month	Samples Collected	Total Coliform			Samples >0	Turbidity Collected	Chlorine Residual Median mg/L Cl ₂	Water Temp. Median °C	
		Samples TC>0	Percent TC>0	Resamples TC>0					
JAN	15	0	0	0	0	1	0	.67	6.3
FEB	14	0	0	0	0	2	0	.66	6.4
MAR	15	0	0	0	0	2	0	.66	7.3
APR	17	0	0	0	0	4	0	.82	10.0
MAY	14	0	0	0	0	2	0	.73	11.8
JUN	15	1	6.7	0	0	2	0	.72	14.8
JUL	17	0	0	0	0	2	0	.70	17.6
AUG	15	0	0	0	0	2	0	.57	19.8
SEP	16	0	0	0	0	2	0	.61	18.7
OCT	15	0	0	0	0	1	0	.71	14.7
NOV	14	0	0	0	0	1	0	.78	11.0
DEC	13	0	0	0	0	1	0	.86	7.8
TOTAL	180	1	0.6%	0	0	22	0	0.71	11.9

TC = Total Coliforms, *E. coli* = *Escherichia coli*, Cl₂ = 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 0.71 mg/L (**Table 8**). The lowest monthly median chlorine residual occurred in August (0.57 mg/L) and the highest in December (0.86 mg/L) (**Figure 10**). This is similar to 2007 and 2008.

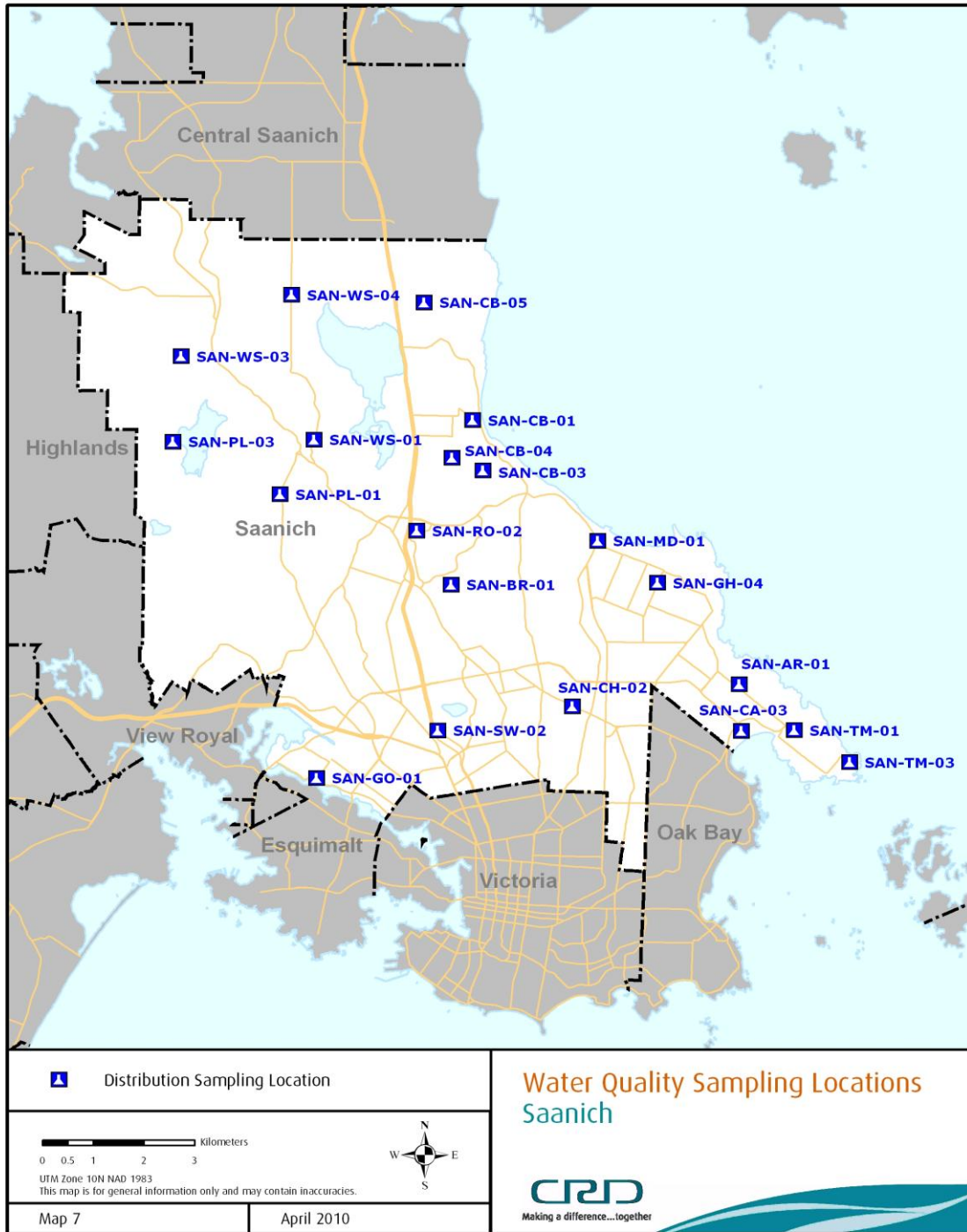
Water Temperature. The annual median water temperature in the Oak Bay Distribution System was 11.9°C (**Table 8**) with monthly median values ranging from 6.3°C in January to 19.8°C in August. This range is similar to that of the last several years.



4.10. SAANICH DISTRIBUTION SYSTEM

In 2009, twenty sampling locations were used to monitor the bacteriological quality of the drinking water in the Saanich Distribution System (**Map 7**). All locations were sampled bi-weekly.

Map 7. Sampling Locations in the Saanich Distribution System



4.10.1. SAMPLE COLLECTION

In 2009, 499 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 two samples were positive for total coliforms, one from the Pearkes Centre location in September and the other from opposite 3005 Baynes Road location collected in April 2009 (**Table 9**). The resamples were negative for coliforms. Expressed on an annual percentage basis, the total coliform positive rate was 0.4%. 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 eight years and an improvement from 1999 and prior years.

E. coli. No *E. coli* bacteria were observed in any of the samples collected from the Saanich Distribution System in 2009.

Table 9. 2009 Bacterial Quality of the Saanich Distribution System.

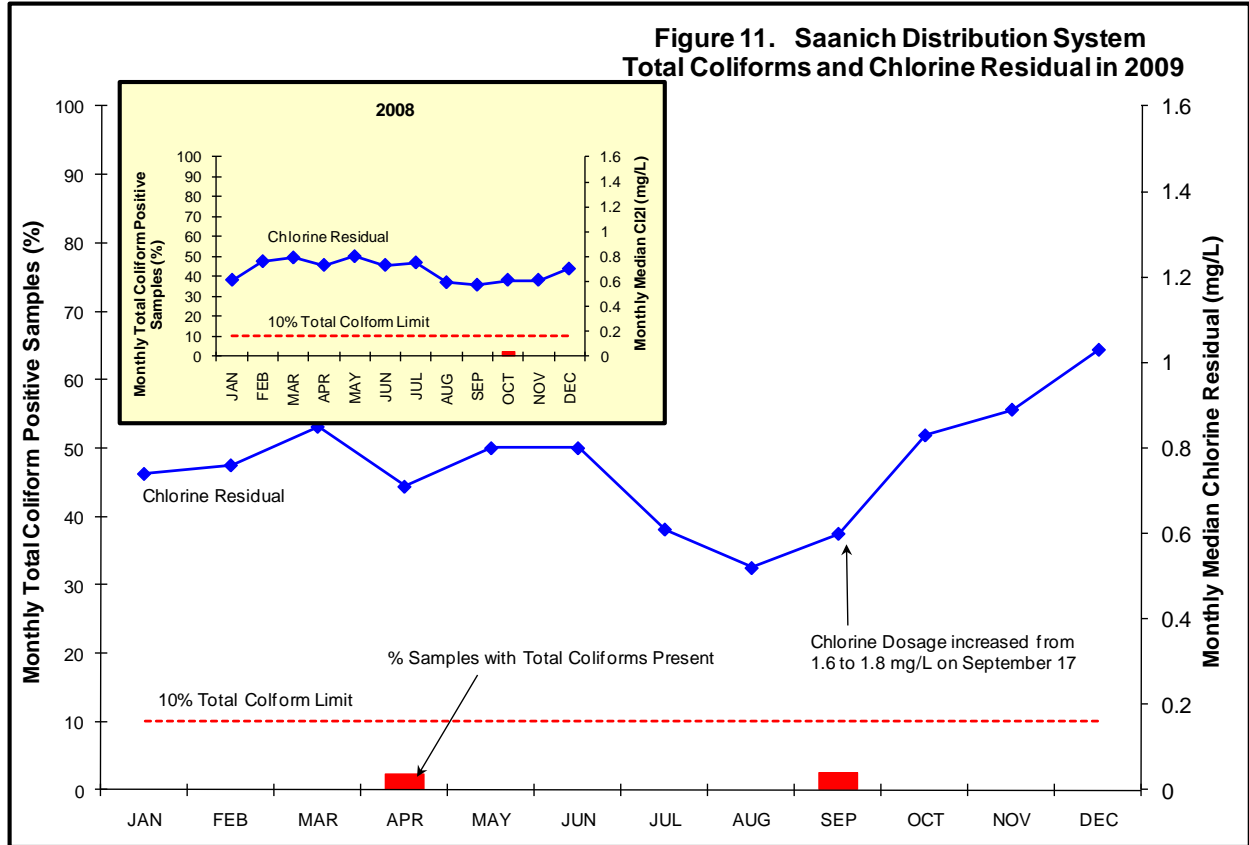
Month	Total Coliform				E. coli Samples >0	Turbidity Samples Collected >1 NTU	Chlorine Residual Median mg/L Cl ₂	Water Temp. Median °C	
	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0					
JAN	46	0	0	0	0	4	0	0.74	5.9
FEB	40	0	0	0	0	4	0	0.76	6.0
MAR	40	0	0	0	0	4	0	0.85	6.6
APR	42	1	2.4	0	0	4	0	0.71	8.9
MAY	41	0	0	0	0	5	0	0.80	11.2
JUN	42	0	0	0	0	5	0	0.80	13.9
JUL	44	0	0	0	0	7	0	0.61	17.6
AUG	39	0	0	0	0	4	0	0.52	19.2
SEP	40	1	2.5	0	0	4	0	0.60	18.6
OCT	46	0	0	0	0	4	0	0.83	14.9
NOV	41	0	0	0	0	4	0	0.89	11.1
DEC	38	0	0	0	0	4	0	1.03	7.4
TOTAL	499	2	0.4%	0	0	53	0	0.75	11.3

TC = Total Coliforms, E. coli = *Escherichia coli* Cl₂ = 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 0.75 mg/L (**Table 9**) which was higher than that for the Greater Victoria Distribution System as a whole (0.64). The lowest monthly median chlorine residual occurred in August (0.52) and the highest in December (1.03) (**Figure 11**).

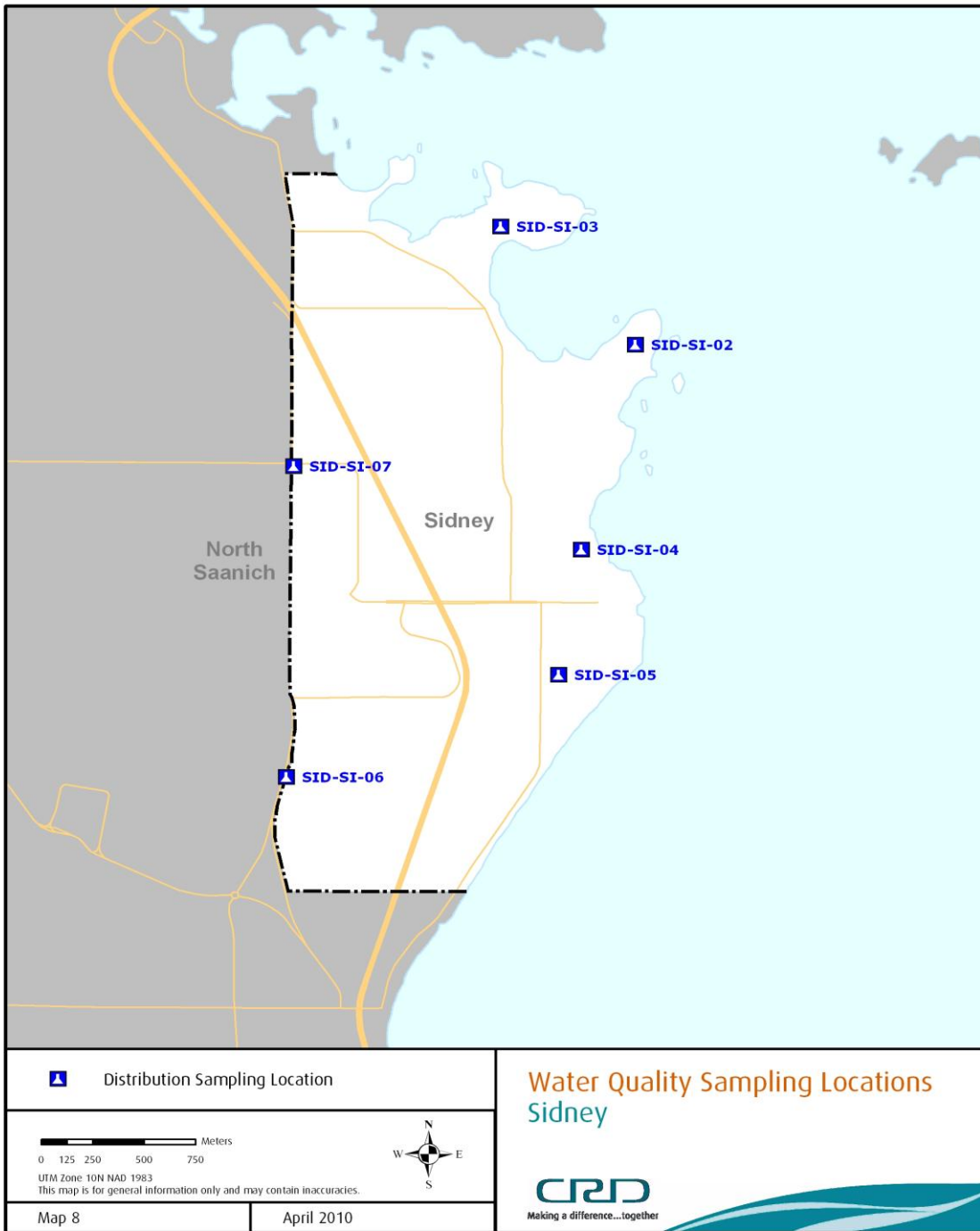
Water Temperature. The annual median water temperature in the Saanich Distribution System was 11.3°C, and ranged from a monthly median of 5.9°C in January to 19.2°C in August (**Table 9**).



4.11. SIDNEY DISTRIBUTION SYSTEM

In 2009, six sampling locations were used to monitor the bacteriological quality of drinking water in the Sidney Distribution System (**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 2009, 142 bacteriological samples were collected from the Sidney Distribution System (**Table 10**).

4.11.2. BACTERIA

Total Coliforms. Three of the samples collected in 2009 from the Sidney Distribution System contained total coliform bacteria (**Table 10** and **Figure 12**). The total coliform positives were from 2045 Mills Rd at McDonald in April and from Orchard and Fourth St and 9535 Canora Rd in September. These latter two positive samples pushed the monthly total coliform positive percentage above the 10% limit. While this limit was exceeded, it did not compromise the safety of the water as all of the resamples collected were negative for coliforms.

E. coli. No *E. coli* bacteria were observed in any of the samples collected from the Sidney Distribution System in 2009.

Table 10. 2009 Bacterial Quality of the Sidney Distribution System.

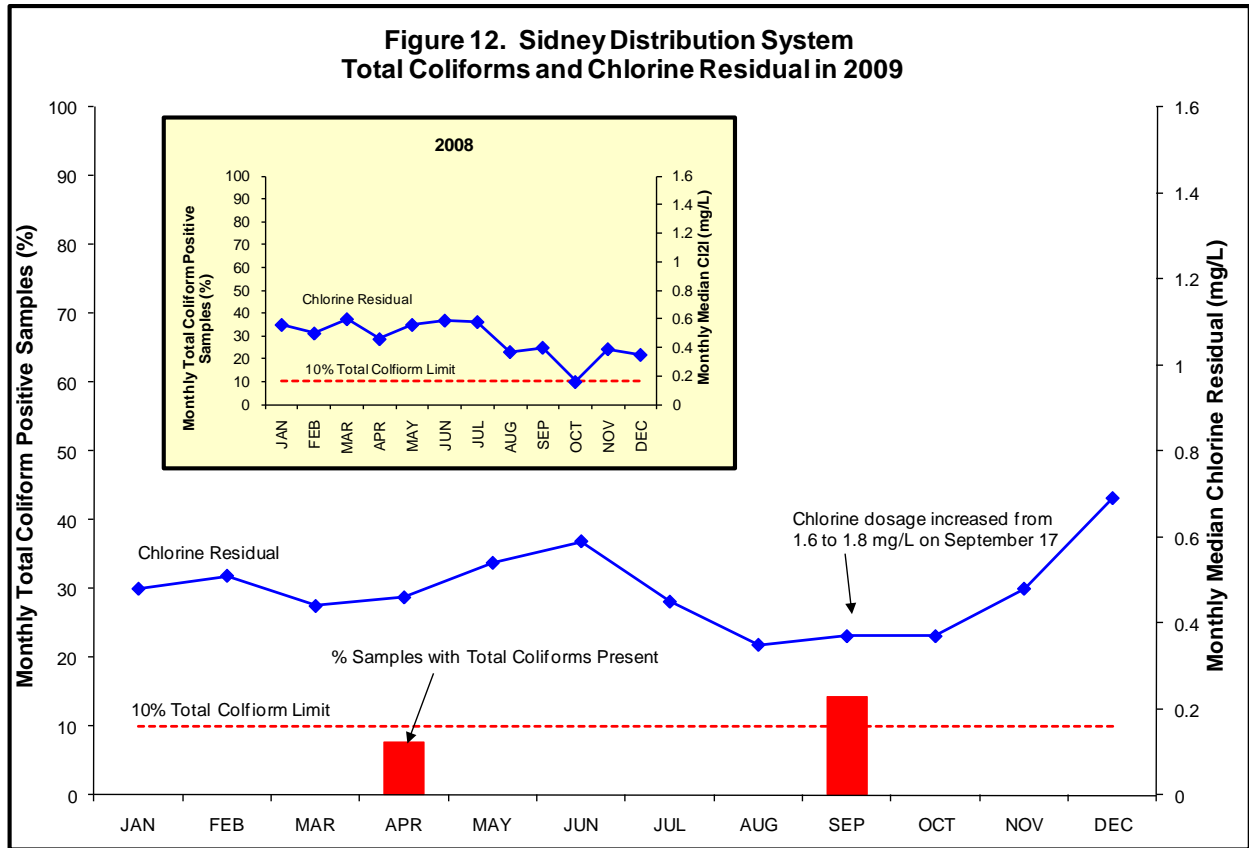
Month	Total Coliform				E. coli Samples >0	Turbidity Samples Collected >1 NTU	Chlorine Residual Median mg/L Cl ₂	Water Temp. Median °C	
	Samples Collected	Samples TC>0	Percent TC>0	Resamples TC>0					
JAN	12	0	0	0	0	3	2	0.48	6.6
FEB	12	0	0	0	0	2	1	0.51	6.6
MAR	13	0	0	0	0	4	2	0.44	7.4
APR	13	1	7.7	0	0	2	1	0.46	9.2
MAY	12	0	0	0	0	0	0	0.54	12.1
JUN	11	0	0	0	0	0	0	0.59	14.5
JUL	12	0	0	0	0	0	0	0.45	17.6
AUG	11	0	0	0	0	0	0	0.35	19.3
SEP	14	2	14.3	0	0	1	0	0.37	18.5
OCT	11	0	0	0	0	0	0	0.37	15.2
NOV	10	0	0	0	0	0	0	0.48	11.5
DEC	11	0	0	0	0	0	0	0.69	8.1
Total	142	3	2.1%	0	0	12	6	0.45	11.9

TC = Total Coliforms, E. coli = *Escherichia coli*, Cl₂ = 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 0.45 mg/L (**Table 10**) with the lowest monthly median chlorine residual occurring in August (0.35) and the highest in December (0.69) (**Figure 12**).

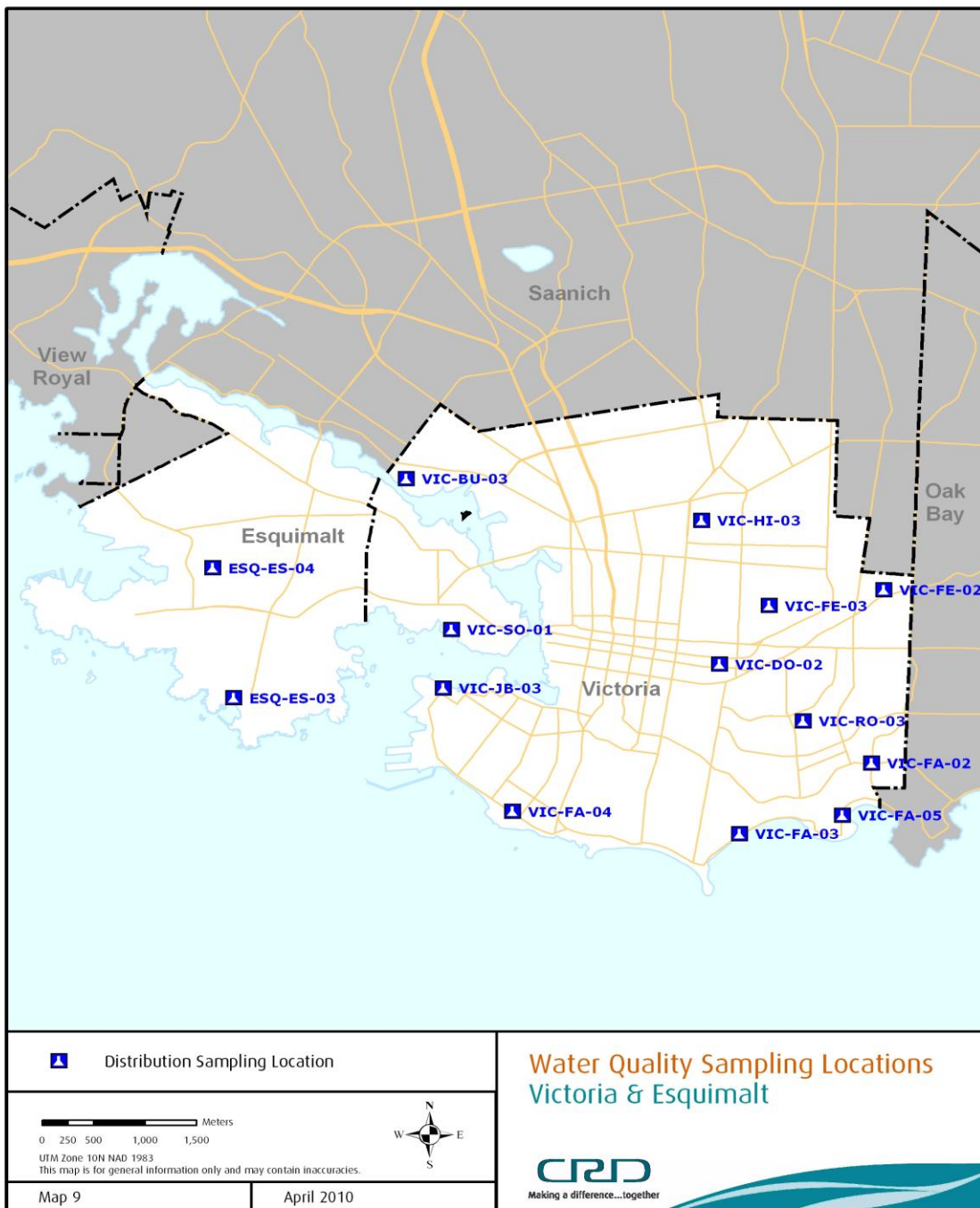
Water Temperature. The annual median water temperature in the Sidney Distribution System was 11.9°C, ranging from a low monthly median of 6.6°C in January and February to a high of 19.3°C in August (**Table 10**).



4.12. VICTORIA / ESQUIMALT DISTRIBUTION SYSTEM

In 2009, fourteen sampling locations were used to monitor the bacteriological quality of drinking water in the City of Victoria and Esquimalt Distribution System (**Map 9**). (**Note:** The City of Victoria owns and operates the distribution system in Esquimalt.) These locations were all sampled bi-weekly. Sampling at several locations was discontinued.

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



4.12.1. SAMPLE COLLECTION

In 2009, 354 bacteriological samples were collected from the sampling locations in the Victoria/Esquimalt Distribution System (**Table 11**).

4.12.2. BACTERIA

Total Coliforms. Only two of the samples collected contained total coliform bacteria, the Fairfield pump house at Foul Bay in June 2009, and the Royal Jubilee Hospital power house location in April (**Figure 13**). The resamples were negative for coliforms (**Table 11**). The annual percentage positive for the Victoria/Esquimalt Distribution System was 0.6%, similar to the past nine years.

E. coli. No *E. coli* bacteria were observed in any of the samples collected from the Victoria/Esquimalt Distribution System in 2009.

Table 11. 2009 Bacterial Quality of the Victoria/Esquimalt Distribution System.

Month	Samples Collected	Total Coliform			Samples TC>10	E. coli Samples >0	Turbidity		Chlorine Residual Median mg/L Cl ₂	Water Temp. Median °C
		Samples TC>0	Percent TC>0	Resamples TC>0			Samples Collected	Samples >1 NTU		
JAN	29	0	0	0	0	0	7	0	0.70	6.2
FEB	29	0	0	0	0	0	7	0	0.74	6.5
MAR	32	0	0	0	0	0	9	0	0.72	7.2
APR	29	1	3.4	0	0	0	7	0	0.74	9.7
MAY	28	0	0	0	0	0	8	0	0.65	12.7
JUN	30	1	3.3	0	0	0	8	1	0.66	15.7
JUL	33	0	0	0	0	0	9	0	0.50	18.4
AUG	30	0	0	0	0	0	8	0	0.53	20.2
SEP	28	0	0	0	0	0	6	0	0.47	19.2
OCT	30	0	0	0	0	0	8	1	0.73	14.9
NOV	30	0	0	0	0	0	9	1	0.81	11.2
DEC	26	0	0	0	0	0	5	0	1.03	7.4
Total	354	2	0.6%	0	0	0	91	3	0.67	12.4

TC = Total Coliforms, E. coli = *Escherichia coli* Cl₂ = chlorine, NTU = Nephelometric turbidity unit.
> = Greater than, mg/L = milligrams per litre, °C = degrees Celsius

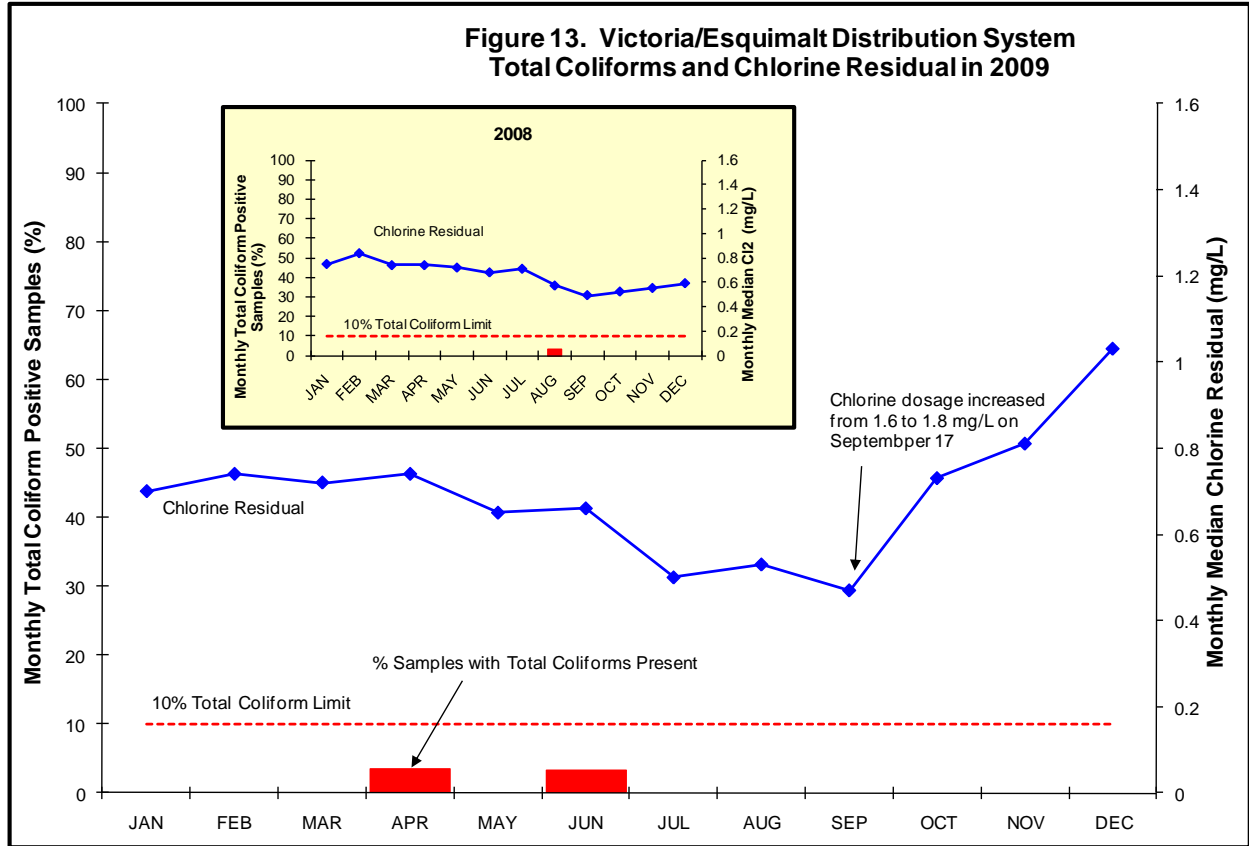
4.12.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

Chlorine Residual. The annual median chlorine residual for the Victoria / Esquimalt Distribution System was 0.67 mg/L (**Table 11**) with the lowest monthly median chlorine residual occurring in September (0.47) and the highest in December (1.03). 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 2009 decreasing from April through September (**Figure 13**) and then increasing steadily to the end of the year following the increase in chlorine dosage at the Japan Gulch Plant in mid-September.

All sampling locations within the Victoria / Esquimalt Distribution System had satisfactory

chlorine residuals (averages above 0.2 mg/L).

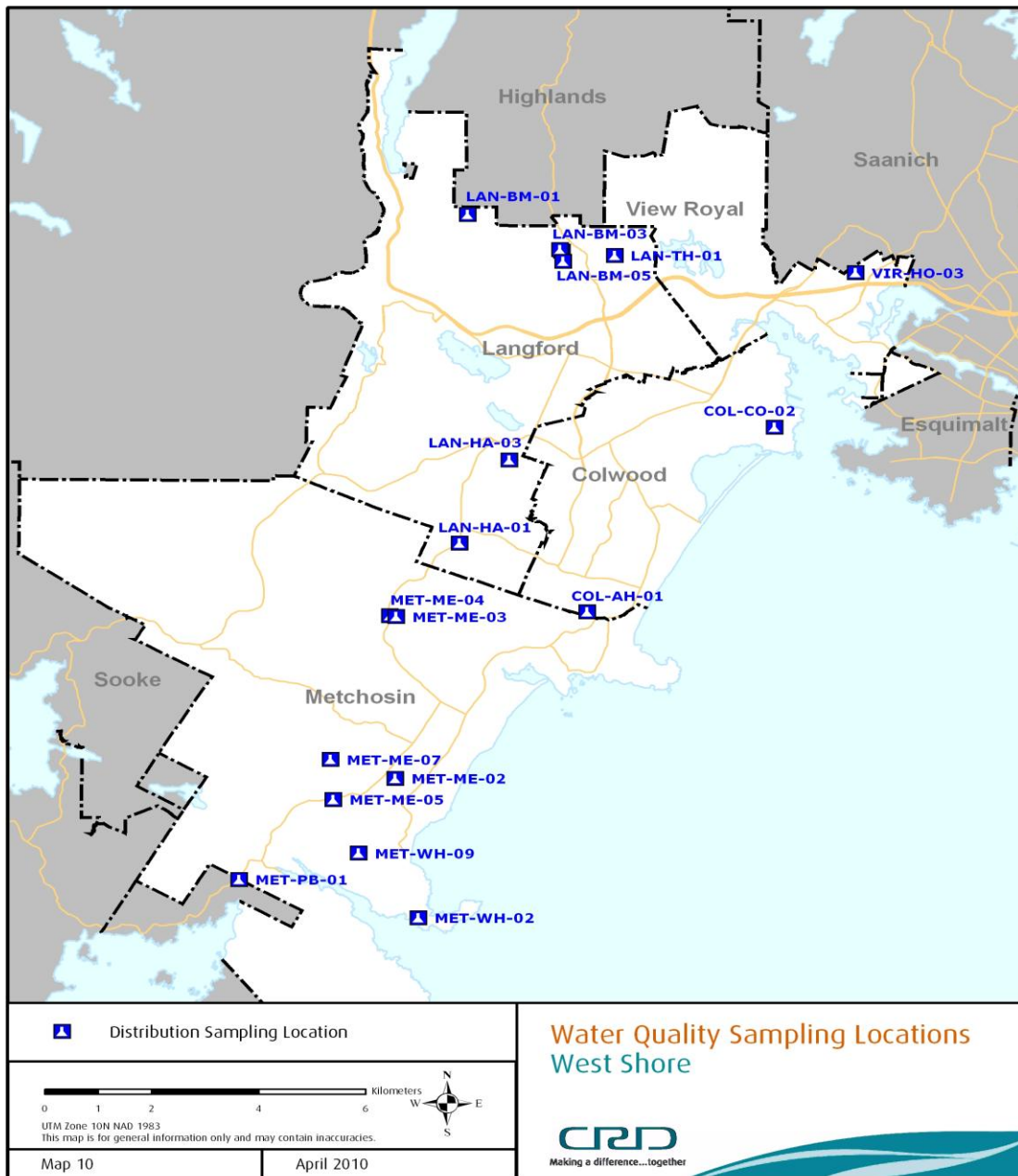
Water Temperature. The annual median water temperature in the Victoria/Esquimalt Distribution System was 12.4°C (Table 11), similar to past years. The monthly median water temperatures ranged from a low of 6.2°C in January to a high of 20.2°C in August. The daily maximum water temperature of 22.6°C was recorded in July at the 1261 Rockcrest Avenue sampling location (similar to 2007 and 2008).



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

In 2009, seventeen sampling locations were used to monitor the bacteriological quality of drinking water in the Juan de Fuca Water Distribution System in 2009 (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 dataset as these systems were supplied by a different treatment plant – Charters Treatment Plant. No bacteriological problems were found in those latter systems in 2009.)

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



4.13.1. SAMPLE COLLECTION

In 2009, 433 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. 2009 Bacterial Quality of the Juan de Fuca Water Distribution System.

Month	Samples Collected	Total Coliform				E. coli Samples >0	Turbidity		Chlorine Residual Median mg/L Cl ₂	Water Temp. Median °C
		Samples TC>0	Percent TC>0	Resamples TC>0	Samples TC>10		Samples Collected	Samples >1 NTU		
JAN	35	0	0	0	0	8	2	0.70	5.8	
FEB	34	0	0	0	0	7	0	0.66	6.0	
MAR	35	0	0	0	0	7	1	0.89	6.6	
APR	38	0	0	0	0	7	0	0.66	8.7	
MAY	34	0	0	0	0	7	0	0.75	11.1	
JUN	34	0	0	0	0	6	2	0.63	14.2	
JUL	46	1	2.2	0	0	10	0	0.59	17.3	
AUG	36	1	2.8	0	0	6	0	0.43	19.2	
SEP	35	1	2.9	0	0	6	0	0.27	18.1	
OCT	33	0	0	0	0	6	0	0.43	14.2	
NOV	34	0	0	0	0	6	1	0.84	10.6	
DEC	39	0	0	0	0	5	0	0.95	7.6	
Total	433	3	0.7%	0	0	81	6	0.63	11.3	

4.13.2. BACTERIA

Total Coliforms. Three samples (0.7%) collected from the distribution system in Colwood and Metchosin contained total coliform bacteria (**Table 12, Figure 14**). One positive coliform bacteria sample was from the meter vault in front of the William Head prison in Metchosin. The chlorine residual at the time of this positive was low at 0.13 mg/L. The resample was negative for coliforms. In August and September the sampling location at the Childre Crescent in Colwood was positive for total coliforms (chlorine residual of only 0.01 mg/L). All resamples collected at these locations were negative for coliforms.

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 2008 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 the water main on William Head Road and the Becher Bay Reserve on Rocky Point Road.

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

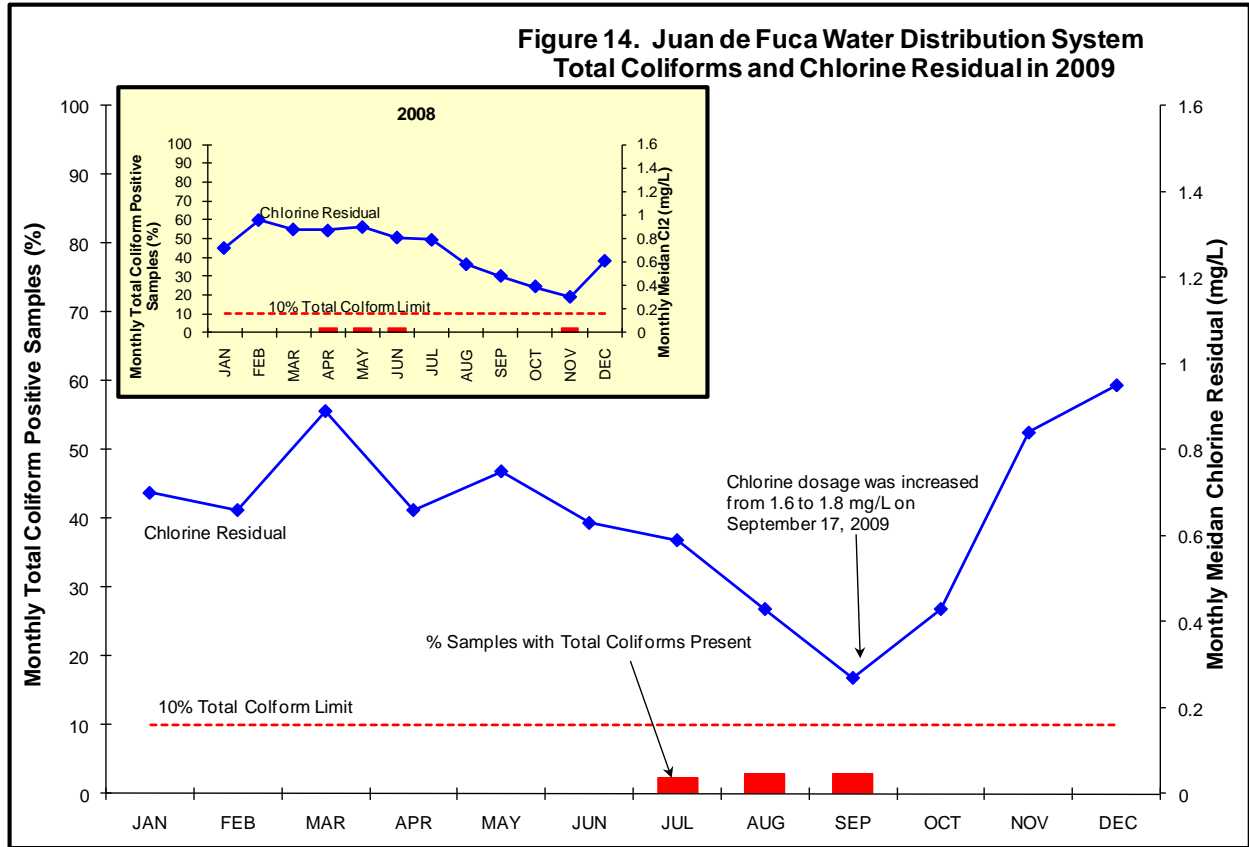
- **William Head Correctional Institute.** In 2009, the supply to William Head Correctional Institute was sampled every 2 weeks. Low to moderate total chlorine residuals (ranging from 0.09 to 0.44 mg/L and a median of 0.29 mg/L) were observed with only one sample containing total coliform bacteria. In 2002, Public Works Canada installed a rechlorination facility within the Institute to enhance chlorine residuals within that internal distribution system. No bacteriological samples were received from that internal distribution in 2009.
- **Becher Bay Reserve.** In 2009, the supply to the Becher Bay Reserve was sampled weekly. Typically, the chlorine residuals at this location were moderate (ranging from 0.20 to 1.65 mg/L with a median of 1.00 mg/L). Total coliforms were not detected in any sample. This is similar to 2002 through 2008 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. No *E. coli* bacteria were observed in any of the samples collected from the Juan de Fuca Water Distribution System in 2009.

4.13.3. CHLORINE RESIDUAL AND WATER TEMPERATURE

Chlorine Residual. The annual median chlorine residual for the Juan de Fuca Water Distribution System was 0.63 mg/L (**Table 12**). The lowest monthly median chlorine residual occurred in September (0.27) and the highest in December (0.95) (**Figure 14**). The pattern of chlorine residual in 2009 was similar to the previous year, with the residual declining steadily from mid-June through mid-September (**Figure 14**). Once the chlorine dosage was increased (September 17th) at Japan Gulch Plant, the chlorine residual increased steadily through December.

Water Temperature. The annual median water temperature in the Juan de Fuca Water Distribution System was 11.3°C, similar to previous years (**Table 12**).



APPENDIX A. Headings Used In Tables

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

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

Total Coliforms - Samples TC>0. This column shows the number of samples collected in which total coliforms were present (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 Drinking Water Protection 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). 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.