2.0 GRAY CREEK

Gray Creek is currently an alternative potable water supply used by the SCRD to supply water to the Chapman Creek system. Utilization of this source has been minimized in recent years due to the limited treatment and disinfection. Between 2001 and 2006 the amount of water supplied from Gray Creek to the Chapman Creek distribution system has been reduced from 3.5% (175,000 m^3) to 0.4% (22,000 m^3). The only treatment at Gray Creek is gas chlorination. The Gray Creek disinfection facility feeds the adjacent reservoir which has a total volume of 680,000 litres. The reservoir is connected to the Chapman Creek water distribution system.

It was indicated that during start-up of the Gray Creek system the reservoir is "super chlorinated".

2.1 Location

The location of the Gray Creek chlorination building is detailed on Figure 1-1. The chlorination facility is located at an approximate elevation of 175 m geodetic. The intake and chlorination facility are located adjacent to a BC Forest Service Road east of Porpoise Bay Road. The road is accessible from two directions and fairly rough.

The site is relatively remote, taking approximately ten minutes to reach from the nearest paved road.

2.2 Source

The water is from Gray Creek, a mountain stream near the disinfection facility. The creek is a typical coastal BC mountain stream with headwaters located within the higher elevations and subject to variable flows throughout the year. This creek is fed by snowmelt and rainfall and is susceptible to bacterial contamination and elevated turbidity and colour during seasonal rainfall events.

Routine water quality monitoring has not been completed on Gray Creek.

No signs of previous contaminations (e.g. viruses) were identified during the assessment. The history of nearby Chapman Creek does not reveal any spills or contamination incidents. The Gray Creek Watershed is subject to logging, which may impact the water quality and water safety. Logging may increase the chance of landslides or other erosion in to the Creek, especially due to the steep terrain of the area. Vehicular traffic in the area is minimal, limiting the risk this poses. Water contamination due to wildlife activity is a possible contamination source.

The SCRD is in the process of creating a Source Protection Plan for Chapman Creek, but is not for Gray Creek at this time. Development in the Gray Creek area is planned according to the SCRD Official Community Plan (OCP).

2.3 Overview

Figure 2-1 is a line diagram of the Gray Creek water system. At the intake, water is screened by coarse horizontal and vertical grating, and by finer mesh grating. Between the inlet and the disinfection facility, the water passes through a 600 mm ø reinforced concrete pipe into a settling basin, to reduce turbidity. From the settling basin, a 300 mm ø ductile iron pipe transports the water to the disinfection facility, where the

water is chlorinated. After chlorination, the water flows into the holding tank, prior to the 680 m^3 Gray Creek Reservoir.

2.3.1 Redundancy

The intake has no redundancy. Because Gray Creek is currently only used as a supplemental source, intake redundancy is considered to be a low priority. If Gray Creek became a primary source, redundancy could be provided by the Chapman Creek system.

The disinfection process includes one line, but three possible dosage points. There is one dosage point on each inlet pipe and chlorine can also be dosed directly into the holding tank if required.

The single pipe from the intake, with no mechanical or electrical equipment, splits into two lines at the disinfection facility. This provides some level of redundancy.

There is one outlet from the holding tank to the reservoir and one pipe from the reservoir to the distribution system starting at Porpoise Bay Road.

Power to the facility is provided by BC Hydro for lighting, heating and monitoring. There is no back up power; however, power is not required to operate the disinfection facility. The facility is fed by gravity and the chlorine gas disinfection system does not require power to operate.

2.4 Flow Rate

Flow totalizer readings are taken for this system at varying frequencies, ranging from daily to weekly. Typically, peak week flows are around 5% below peak day flows. Based on this data, peak day and average day flows were estimated. Based on the 2005 and 2006 flow data provided by the SCRD, the average daily flow rate is approximately 885 m^3/d. The maximum daily flow rate was 1,785m^3/d occurring in July 2006, as shown in Figure 2-2.

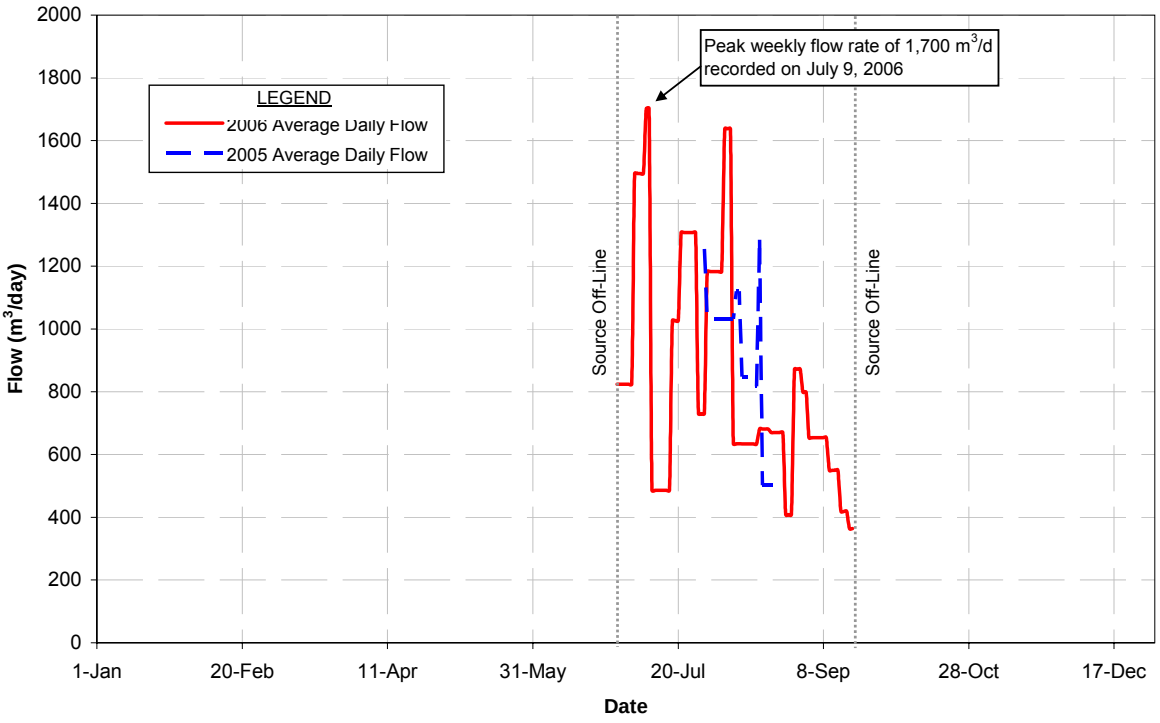

Figure 2-2: Historic Gray Creek Utilization

It is understood that the use of this source is restricted based on the lack of treatment, and because the multi-stage treatment at Chapman Creek makes it the preferred source. Gray Creek is typically used to supplement Chapman Creek during high demand. The water

licence C110344 allows the SCRD to divert up to 1,244,500 m^3 per year. A maximum of 3,400 m^3/day (750,000 Igal/day) is also stipulated.

The gas chlorine feed system is a Capital Controls NXT3000 which has a maximum daily capacity of 230 kg/d, which is well above the requirement of 4 kg/d based on the maximum daily flow rate of 1,785 m^3 using a 2 mg/L dose.

2.5 Existing Treatment System

The water is treated with gas chlorine prior to entering the concrete holding tank. No other treatment is currently in place.

Typically, overall level of treatment for surface water should comply with the 4-3-2-1-0 treatment rule currently stipulated by the Health Authority, detailed as follows:

- 4-Log (99.99%) virus removal/inactivation,
- 3-Log (99.9%) protozoa removal/inactivation,
- minimum of 2 treatment barriers,
- maximum turbidity of 1 NTU,
- zero total coliform or *E.Coli*.

For surface water systems the recommended level of treatment is filtration, chlorination with contact time and UV disinfection to achieve a multi-barrier treatment system. For coastal BC creek sources colour removal is also typically required to prevent disinfection by-product formation.

The current system achieves chlorine contact time between the point of chlorination and the distribution system. Due to variable water level in the reservoir and the holding tanks no disinfection credit is provided. The in-pipe contact time provides a CT value of 64 mg/L-min, based on a residual chlorine concentration of 0.7 mg/L. This CT provides to

a 4-log virus reduction, approximately 1-log *Giardia* reduction and no *Cryptosporidium* reduction at a water temperature of 0.5 °C.

There is inadequate data to determine if turbidity is an issue at this source. However, assuming similar water quality characteristics as the Chapman Creek, turbidity is less of an issue than colour. No disinfection by-product data is available.

2.6 Water Quality

Raw water samples were collected on July 26, 2007 by SCRD Staff.

A summary of the results are provided in Table 2-1, the complete test results are available in Appendix 2.

TABLE 2-1
GRAY CREEK RAW WATER QUALITY DATA

Parameter	Units	GRAY CREEK RAW	Canadian Guideline for Drinking Water Quality	
			MAC	AO
Fluoride (F)	mg/L	0.02	≤ 1.5	
Calculated Parameters				
Total Hardness (CaCO3)	mg/L	2.7	≤ 500	
Alkalinity (Total as CaCO3)	mg/L	2.3		
Bicarbonate (HCO3)	mg/L	2.8		
Anions				
Dissolved Sulphate (SO4)	mg/L	1.2		≤ 500
Total Arsenic (As)	ug/L	0.3	≤ 25	
Total Lead (Pb)	ug/L	2.4	≤ 10	
Total Uranium (U)	ug/L	0.04	≤ 20	
MISCELLANEOUS				
True Colour	Col. Unit	10		≤ 15
Physical Properties				
Conductivity	uS/cm	8		
pH	pH Units	6.7		6.5 to 8.5
Physical Properties				
Total Dissolved Solids	mg/L	24		
Turbidity	NTU	0.2	≤ 1	
Total Metals by ICP				
Total Aluminum (Al)	mg/L	0.07	≤ 0.2	
Total Barium (Ba)	mg/L	0.003	≤ 1	
Total Calcium (Ca)	mg/L	0.96		
Total Iron (Fe)	mg/L	0.032		≤ 0.3
Total Magnesium (Mg)	mg/L	0.08		
Total Manganese (Mn)	mg/L	0.001		≤ 0.05
Dissolved Hardness (CaCO3)	mg/L	2.7		
Dissolved Metals by ICP				
Dissolved Aluminum (Al)	mg/L	0.07		
Dissolved Barium (Ba)	mg/L	0.003		
Dissolved Calcium (Ca)	mg/L	0.92		
Dissolved Iron (Fe)	mg/L	0.015		
Dissolved Silicon (Si)	mg/L	0.92		
Dissolved Sodium (Na)	mg/L	0.37		
Dissolved Strontium (Sr)	mg/L	0.005		
Dissolved Sulphur (S)	mg/L	0.3		
Dissolved Metals by ICPMS				
Dissolved Lead (Pb)	ug/L	1		

Turbidity in the sample was 0.2 NTU, well below the maximum allowable 1 NTU. The observed flow in August 2007 was fairly low. It is likely however that seasonal colour and turbidity events occur.

All other parameters meet the Canadian Drinking Water Quality Guidelines water quality guidelines for this grab sample. A detailed water quality monitoring program would be required to determine the impact of seasonal variation on the water quality.

2.7 Photos

The following photos show the existing system.

Photo 2-1: Gray Creek Intake Location

Photo 2-1 shows the wooden weir directing creek flow into the grating of the intake shown in Photo 2-2.

Photo 2-2: Gray Creek Intake

The horizontal and vertical bars prevent large debris from entering the intake and protect the intake from damage that might cause. A finer mesh screen filters out smaller debris beyond the grating.

Photo 2-3: Gray Creek Treatment Plant

Photo 2-3 shows the chlorine tanks in front of the disinfection facility. The chlorine tanks are protected by a roof and a chain link fence from the ground to the underside of the roof. Access is via a padlocked gate. A sign on two sides of the enclosure warns of danger due to chlorine gas.

Photo 2-4: Piping at Gray Creek

Photo 2-4 shows one pipe into the holding tank, and its chlorine dosage point.

Photo 2-5: Gray Creek Holding Tank

Photo 2-5 shows the concrete holding tank, two inlet pipes, level sensor, chlorine dosage point and outlet drain. A small amount of water remains in the tank because the lip of the outlet is slightly above the floor of the tank.

Photo 2-6: Gray Creek Reservoir

Photo 2-6 shows the Gray Creek Reservoir located just behind the disinfection facility.

2.8 Assessment

Treatment

1. As noted in Section 2.5 this source should meet a multi-barrier treatment standard, which typically involves filtration, chemical disinfection with chlorine and contact time, followed by UV disinfection. Alternatively, the source could be used following a disinfection upgrade and the implementation of an automatic

turbidity or colour shut down procedure. This approach would require an exception from filtration from the local Health Authority.

2. As this source is not consistently used during the year the system disinfection should comply with the AWWA Standard C651 – disinfection prior to start-up.

3. Chlorine residual should be monitored prior to the reservoir to confirm the achieved level of disinfection.

Piping

1. The chlorine head tank does not allow for control of the top water level, which is required for chlorine disinfection. An overflow weir and baffled interior would typically be required.

2. The gas chlorine PVC piping is accessible from the exterior of the building and only protected by a chain link fence. Vandalism could undermine the ability to achieve disinfection. Because a vacuum regulator controls the system, there is limited risk of a gas leak.

3. The existing piping is rusted.

Monitoring/Operation

1. There is limited use of this system, especially during the winter months. Prior to start-up, the reservoir and piping should be flushed and disinfected, as per AWWA standard C651.

2. A comprehensive water quality evaluation should be undertaken to evaluate the future water treatment requirements. This should include daily turbidity, UVT and colour tests, as well as weekly raw water *E.coli* testing.

   Additional testing should include water potability and total organic carbon (TOC) total and dissolved metals. The data should then be referenced to applicable water quality guidelines.

   Distribution system microbial samples should be taken as required by the Drinking Water Officer and the operating permit when the system is on-line.

   Table 2-2 summarizes recommendations for a water quality monitoring program for Gray Creek. This program should last a minimum of 12 – 18 months.

TABLE 2-2
MONITORING PROGRAM RECOMMENDATIONS

Parameter	Daily	Weekly	Monthly	Semi-Annually	Annually
Flow *	X				
Turbidity	X				
Chlorine Residual *	X				
Colour	X				
UVT	X				
pH		X			
Raw Water Heterotrophic Plate Count (HPC)		X			
Raw Water *E.coli*		X			
Raw Water Total Coliforms (TC)		X			
Total Organic Carbon (TOC)			X		
Potability				X	
Metals					X
Treated Water *E.coli* *	As per operating certificate				
Treated Water total coliforms (TC) *	As per operating certificate				

*Test at the recommended frequency when the system is in operation.

3. Inspection of the settling basin should be undertaken regularly, to ensure reasonable sediment levels.

Overall System Evaluation

The hydrological capacity and seasonal flow pattern of Gray Creek should be evaluated to determine the variations in flow in order to determine the impact of low flow events and the potential impact to the SCRD's utilization of this source. As this source has no upstream flow control, such as a reservoir, there is an increase potential for low summertime flows.

2.9 Discussion and Cost Estimates

If Gray Creek is to become a primary supply of potable water then the existing water treatment will likely need to be upgraded. This source is likely subject to elevated colour and turbidity; therefore if the source is to be used as a continuous supply then filtration would be necessary. However, an interim alternative could be implemented which would automatically shut-down this supply in the event of high colour or turbidity. If it is determined that further reliance on this source is necessary, then a second stage treatment upgrade would be necessary.

Class "D" estimates for the staged approached are discussed below. The cost estimates were developed assuming the historic peak day flow of 1785 m^3/d. Due to the lack of data regarding the water quality a UVT of 70% is assumed. This is the minimum UVT which UV disinfection can be provided. As additional data is collected the cost of the UV units can be revised.

Stage 1 – High turbidity shut-off valve and UV disinfection

Requirements for stage 1 would include the following:

- Duty and standby UV reactors – 100% redundancy
- On-line, continuous turbidity monitoring, colour and UVT monitoring
- Control logic to monitor turbidity and control the shut-off valve
- Conversion of the existing reservoir to a fixed volume contact tank (or construction of a new contact tank with a volume of approximately 310 m^3)
- Construction of a disinfection building

Table 2-3 summarizes the estimated stage 1 upgrade costs, including engineering and contingency. The cost to supply three-phase power to the site is not included. Building costs assume a masonry block building with wood frame roof. Alternatives such as prefabricated building or reduced system redundancy could be reviewed as part of pre-design in order to reduce the capital costs. The pre-design review should be completed following the collection of adequate water quality which would likely include the spring freshet.

TABLE 2-3
STAGE 1 HIGH TURBIDITY SHUT-OFF AND UV DISINFECTION
CAPITAL COST ESTIMATE

Description of Item	Quantity	Unit	Unit Price	Cost
Site preparation	1	L.Sum	$ 55,000	$ 55,000
New building	75	Sq.m	$ 3,000	$ 225,000
Conversion of reservoir to controlled contact tank	1	L.Sum	$ 50,000	$ 50,000
Back up power	1	L.Sum	$ 40,000	$ 40,000
UV units	2	Each	$ 85,000	$ 170,000
Flow meters	2	Each	$ 8,500	$ 17,000
HVAC	1	L.Sum	$ 20,000	$ 20,000
Power/Electrical	1	L.Sum	$125,000	$ 125,000
Piping/Valves	1	L.Sum	$ 95,000	$ 95,000
Instrumentation and Controls including turbidimeter, control logic.	1	L.Sum	$ 70,000	$ 70,000
Subtotal				$ 867,000
Engineering Fee and 25% Contingency				$ 300,000
Total Class "D" Estimate				**$1,167,000**

Stage 2 – Filtration

Requirements for stage 2 would include the following:

- Chemical pre-treatment such as coagulation and flocculation,
- Sedimentation or dissolved air flotation,
- Multi-media filtration or membrane filtration,
- Residuals handling and disposal.

Table 2-4 summarizes the estimated stage 2, including engineering and contingency. It is assumed that a building in addition to that constructed as part of stage 1 would be required.

TABLE 2-4
STAGE 2 – FILTRATION UPGRADE

Description of Item	Quantity	Unit	Unit Price	Cost
New building	400	Sq.m	$ 2,500	$1,000,000
Residuals settlement ponds	40	Sq.m	$ 1,250	$ 50,000
Equalization storage or holding tank	1	L.Sum	$ 90,000	$ 90,000
Back up power	1	L.Sum	$140,000	$ 140,000
Filtration - package system	1	L.Sum	$800,000	$ 800,000
Flow meters	4	Each	$ 8,500	$ 34,000
HVAC	1	L.Sum	$ 80,000	$ 80,000
Power/Electrical	1	L.Sum	$375,000	$ 375,000
Piping/Valves	1	L.Sum	$125,000	$ 125,000
Instrumentation and Controls	1	L.Sum	$100,000	$ 100,000
Integration of UV System	1	L.Sum	$150,000	$ 150,000
Subtotal				$2,794,000
Engineering Fee and 25% Contingency				$ 980,000
Total Class "D" Estimate				**$3,774,000.00**

2.10 Recommendations

1. The sustainability of the Gray Creek watershed should also be evaluated, based on the licenced water allowance, summer flow rates and potential climate change effects. A Source to Tap study for the entire Gray Creek system could be used to provide this evaluation.

2. It is recommended that the SCRD further evaluate the potential for disinfection upgrade through a pre-design review. This stage 1 upgrade would involve a continuous, on-line turbidity monitor and colour monitor would be used to control a raw water shut-off valve for the system. The valve would close when the turbidity or colour exceed a set threshold (i.e.: 1 NTU or 15 TCU). It is understood that the duration of turbidity events is typically less than twelve hours. During these events potable water demand would have to be supplied from alternative sources, such as the Chapman Creek water treatment plant.

   The disinfection system would require upgrading to provide the ultraviolet disinfection necessary for the 3-log protozoa inactivation. The existing chlorination system could be upgraded to provide the necessary 4-log viruses treatment.

   The SCRD would have to request a filtration exception from the local Health Authority as noted in the Canadian Drinking Water Guidelines. The criteria necessary for meeting this requirement are summarized below:

   1. The inactivation is met using a minimum of two disinfectants:
      a. ultraviolet irradiation or ozone to inactive cysts/oocysts;
      b. chlorine (free chlorine) to inactivate viruses;
      c. chlorine or chloramines to maintain a residual in the distribution system.

2. Prior to the point where the disinfectant is applied, the number of *E.Coli* bacteria in the source water does not exceed 20/100 mL in at least 90% of the weekly samples from the previous 6 months.
3. Average daily source water turbidity levels measured at equal intervals (at least every 4 hours) immediately prior to where the disinfectant is applied, are around 1.0 NTU but do not exceed 5.0 NTU for more than 2 days in a 12-month period.
4. A watershed control program is maintained that minimizes the potential for faecal contamination in the source water.