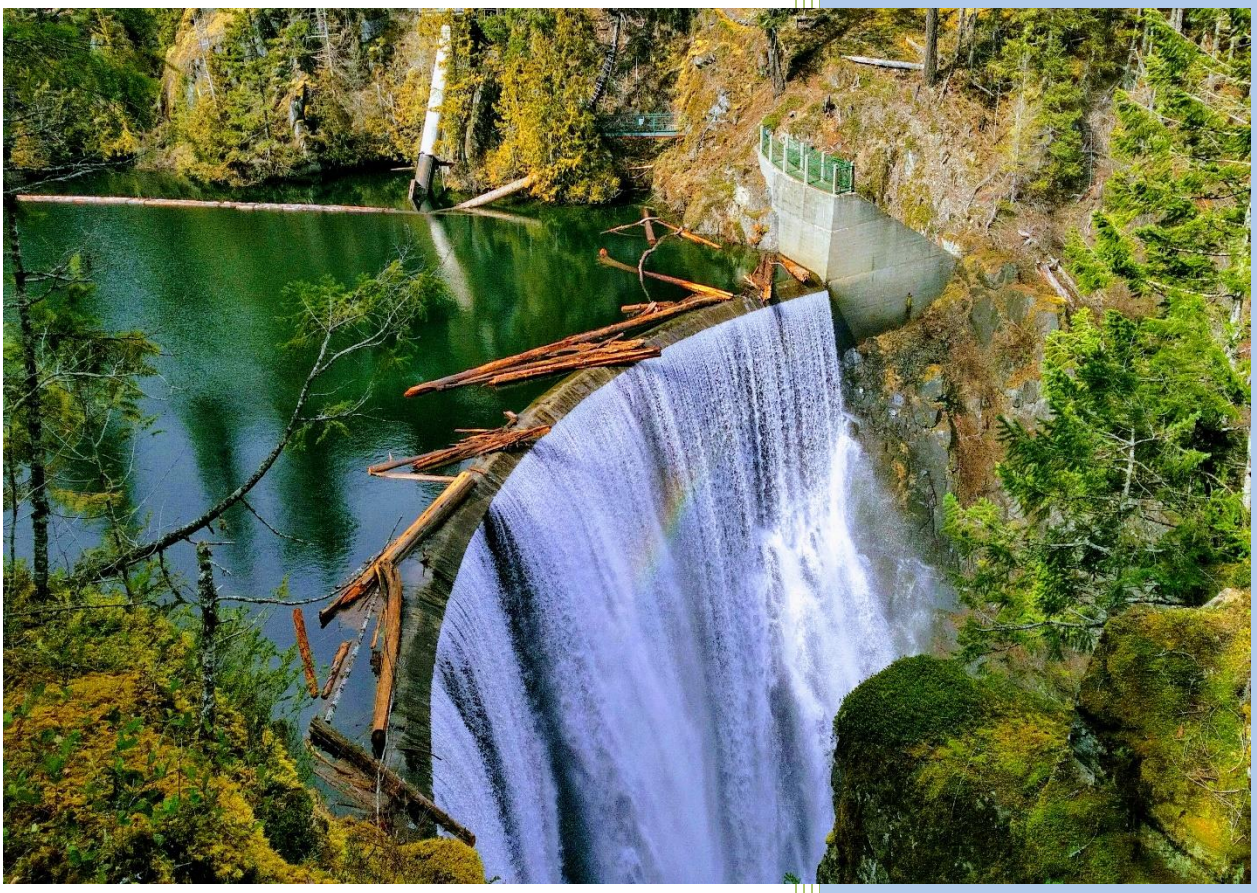
CITY OF NANAIMO
THE HARBOUR CITY
WATER RESOURCES

2020

Annual Water Quality Report



City of Nanaimo

March 10, 2021

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front cover photograph location: South Fork dam and water intake

1. INTRODUCTION

The City of Nanaimo (City) continually strives to provide high quality drinking water to its citizens through responsible operation, monitoring, evaluation and management of its water system.

raw water sampling at a Jump Creek tributary

Under the British Columbia Drinking Water Protection Act all water purveyors are required to provide customers (the public) with an annual report on the quality of their drinking water. The City has compiled the following information to help you better understand your drinking water.

This report also describes where your water comes from, how it is distributed, and how we ensure it is safe to drink.

Drinking water is a complex issue and much of the information in the report is technical. We have tried to provide it in a format that is as understandable as possible. Throughout the report there are some terms which are *italicized*. An explanation of these terms can be found in the glossary at the back of this report. If you have any questions please contact the staff contacts listed in this report.

This annual report covers the period from January 1, 2020 to December 31, 2020.

The City operates its water system under Water Licences for Jump Creek dam and for South Fork dam issued by the British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

2. CITY OF NANAIMO - DRINKING WATER SYSTEM

The City's water system originates in a large protected watershed area at the headwaters of the south fork of the Nanaimo River. There are two dams in the watershed which capture precipitation and supply the *surface water* to the City of Nanaimo, Snuneymuxw First Nation and South West Extension Water District. The City can also provide an emergency supply to Lantzville and North Cedar Improvement District.

Jump Creek dam and log boom

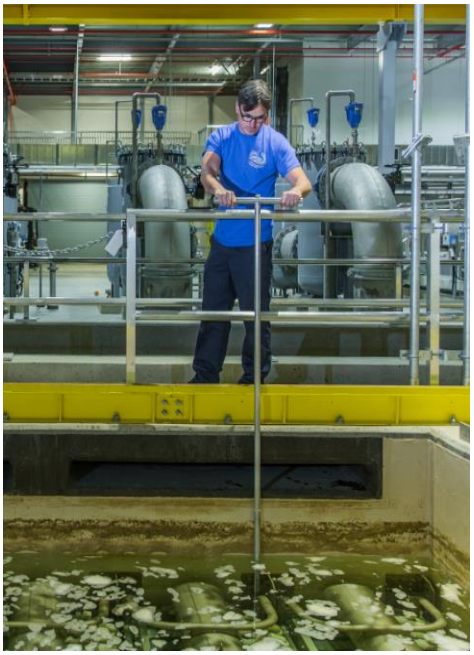
The South Fork Dam impounds approximately 2,000 ML (million litres) of water and Jump Creek Dam impounds approximately 17,000 ML of live storage.

The reservoir catchment area is approximately 230 km^2. The land within the watershed is owned by Mosaic Forest Management, and the lakes created by the two dams are held under water licenses by the City.

The watershed is co-managed by the City and Mosaic Forest Management. Jointly many policies and regulations have been put into place to protect the water quality.

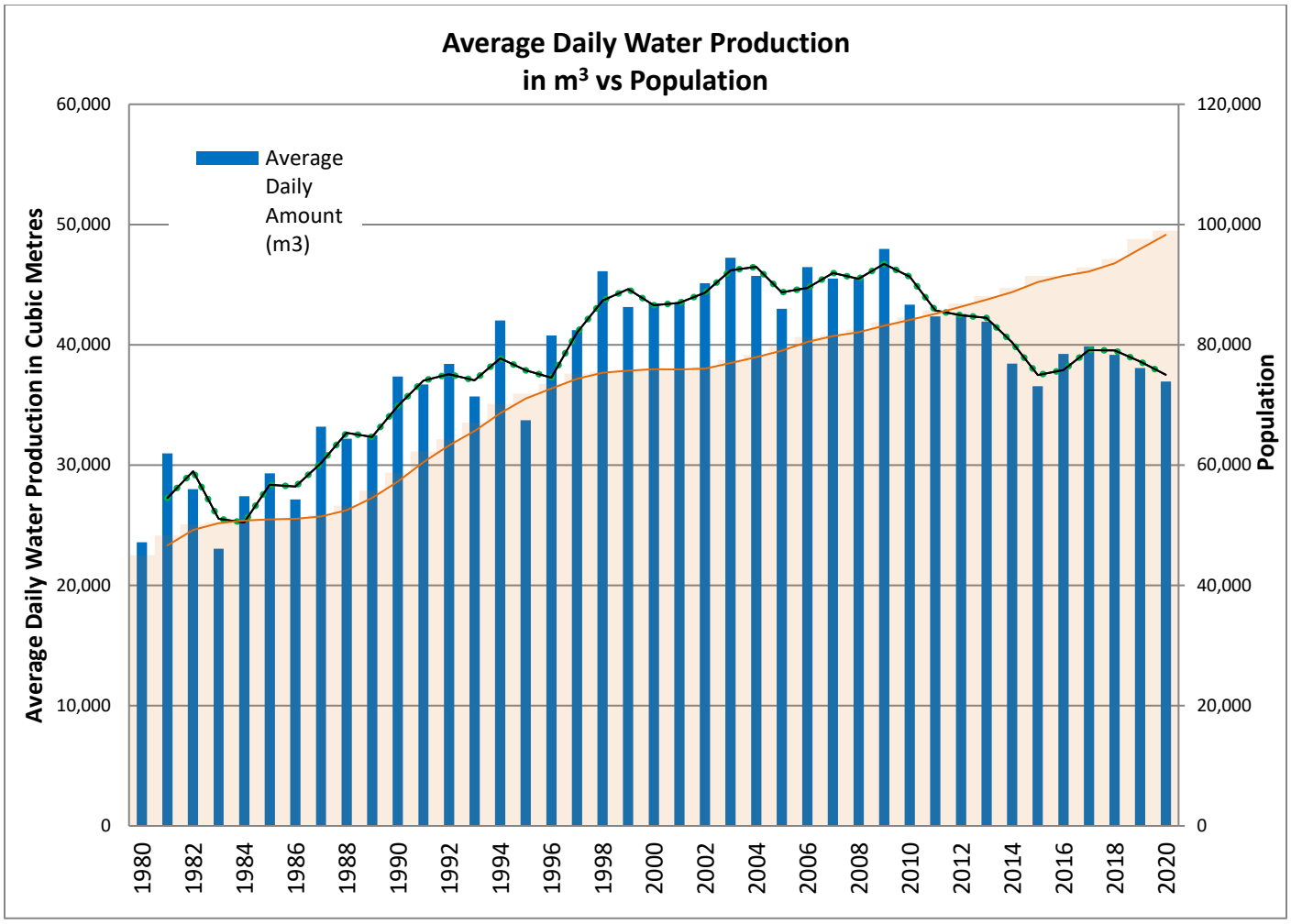
Watershed access is restricted to valid permit holders who have passed a water quality screening program.

The raw water is transported to the South Fork Water Treatment Plant (where the water is treated) via two parallel pipelines that start out as 750 mm (30") and 1200 mm (48") diameter from South Fork Dam and travel approximately 20 kilometres to the city boundary. The treatment plant has the ability to supply peak day flows of 116 ML per day.

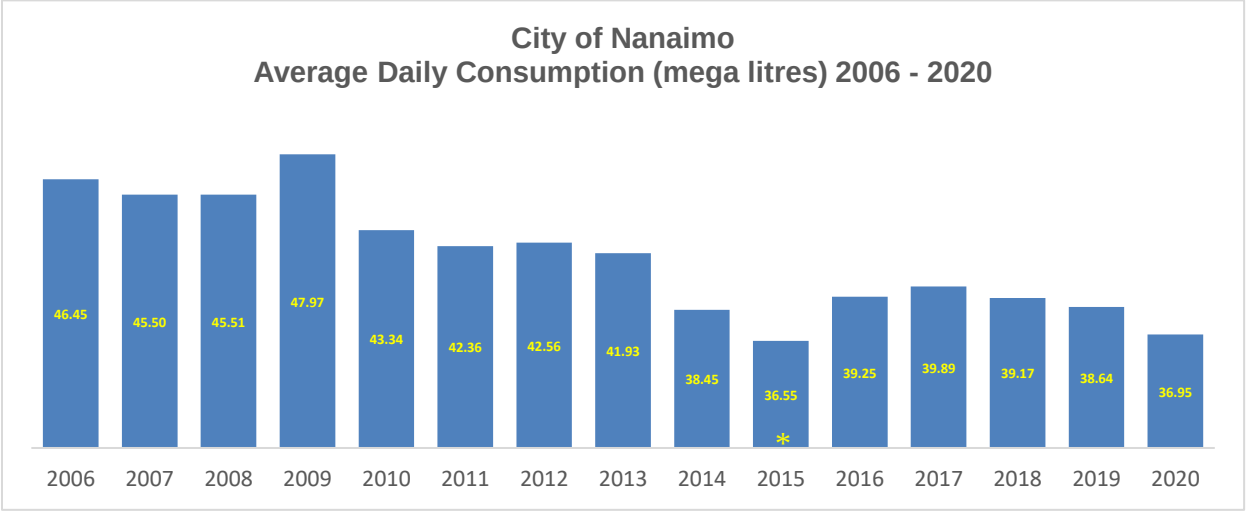


South Fork Water Treatment Plant – primary membranes

The water is then distributed through approximately 30 kilometres of secondary supply pipelines to 9 balancing tanks located throughout the City. These tanks collectively contain approximately 50 ML of *treated storage* and act to maintain system pressures during peak hour flows and to provide water for emergency fire flows. The City used up to 68 million litres per day during peak summer flows in 2020. Peak hour flows can exceed the daily average flows by two times and are supplied from the tanks. Average daily flow to the City in 2020 was 37.0 ML/day, and this annual average daily flow fell slightly (-2.7%) compared to the previous year.



In the summer months (from 1st June to 30th September inclusive between 2006 and 2020) the City enforced Stage 1 water restrictions. These restrictions allowed residents to irrigate their lawns every second day. However due to warm dry summer weather and virtually no snowpack during the winter months spanning 2014/2015 on 15th June, 2015 the water restrictions in the City were raised to Stage 3 which led to enhanced conservation measures resulting the lowest recorded annual average daily flow.



*additional water restrictions in the summer of 2015

Approximately 75% of the water reaches the customer by gravity. The City also operates several pump stations that are used to supply water to higher elevations in the City or boost pressures during peak flows. The pump stations and tanks also act to give the system a safety factor for fighting fires and redundancy for possible system failures.

The distribution of water from the tanks to the consumers is provided by the City of Nanaimo (and South West Extension Water District) through approximately 634 kilometres of supply and distribution watermains serving a population of approximately 98.957.

The water system facilities are monitored on a 24-hour basis. Abnormal conditions are reported to Public Works electronically and immediate action is taken to correct the condition.

3. REGULATORY REQUIREMENTS

The Province through Island Health (formerly Vancouver Island Health Authority VIHA) is the regulatory agency for water suppliers. The Drinking Water Protection Act is the legislation governing safe drinking water in the province. This legislation requires that the water supplier monitors the drinking water source and distribution system to ensure compliance with the *Drinking Water Protection Regulation* and report all results to VIHA.

As a condition of its Operating Permit, the City is required to meet the following standards:

1. All water supply systems in the Island Health jurisdiction that use *surface water* will ensure a minimum level of treatment and disinfection so the following criteria are met:
    - *i.* 4-log reduction (99.99%) removal/ inactivation of viruses and bacteria
    - *ii.* 3-log reduction (99.9%) removal/ inactivation of giardia lamblia cysts and cryptosporidium oocysts
    - iii. 2 log reduction (99%) removal/ inactivation of viruses
    - *iv.* 1 NTU turbidity (maximum) in finished water

2. The ultrafiltration primary membranes shall operate to achieve a turbidity level of less than or equal to 0.1 NTU in at least 99% of the measurements per operational filter period.

3. The ultrafiltration secondary membranes and ultra violet disinfection system shall operate to achieve a turbidity level of less than or equal to 0.1 NTU in at least 99% of the measurements per operational filter period.

4. The chlorine disinfection system shall ensure the 4-log reduction (99.99%) inactivation of viruses.

5. The finished potable water produced shall meet or be lower than the concentration limits listed in the Canadian Dinking Water Regulations. There shall be no detectable Escherichia coli bacteria per 100 mL and no detectable total coliform bacteria per 100 mL.

The South Fork Water Treatment Plant met and exceeded these requirements during 2020.

Water Quality Standards for Potable Water

Parameter	Standard
Fecal Coliform Bacteria	No detectable fecal coliform bacteria per 100 ml
Escherichia Coli	No detectable Escherichia Coli per 100 ml
Total Coliform Bacteria	At least 90% of samples have no detectable total coliform bacteria per 100 ml and no sample has more than 10 total coliform bacteria per 100 ml

source: Drinking Water Protection Regulation (amended B.C. Reg. 87/2011)

The City of Nanaimo water operations staff currently take water samples at fixed locations throughout the water distribution network at the following sampling frequencies.

Water Sample Frequency	Number of Samples Taken
Weekly	15
Bi-Weekly	8
Monthly	9

The City also compares its water to Health Canada's *Guidelines for Canadian Drinking Water Quality*.

4. WATER QUALITY MONITORING

Water sampling and testing is carried out regularly; at the source, at the South Fork Water Treatment Plant and throughout the water supply and distribution piping system to ensure the drinking water remains safe and meets legislated drinking water requirements.

The *Guidelines for Canadian Drinking Water Quality* are based on current, published scientific research related to health effects, aesthetic effects, and operational considerations. Health-based guidelines are established on the basis of comprehensive review of the known health effects associated with each contaminant, on exposure levels and on the availability of treatment and analytical techniques. Operational considerations are factored in when the presence of a substance may interfere with or impair a treatment process or technology (e.g. turbidity interfering with chlorination) or adversely affect drinking water infrastructure (e.g. corrosion in pipes).

The Guidelines are specific to contaminants that meet all of the following criteria:

1. Exposure to the contaminant could lead to adverse health effects;
2. The contaminant is frequently detected or could be expected to be found in a large number of drinking water supplies throughout Canada; and
3. The contaminant is detected, or could be expected to be detected, at a level that is of possible health significance.

In general the highest priority guidelines are those dealing with microbiological contaminants such as *bacteria*, *protozoa* and *viruses*. Any measures taken to reduce concentrations of chemical contaminants should not compromise the effectiveness of *disinfection*.

The City's *finished potable water* quality sampling and testing program has been set up in conjunction with VIHA. The program samples water quality at reservoirs, tanks, low, medium and high flow watermains, dead end watermains and various pressure zones.

Collected water samples are uniquely identified and sent to Provincially approved laboratories for testing. Test results are uploaded by the lab into WaterTrax (a water quality data management system) which provides the City with comprehensive access to all the test results and incorporates a notification alert system to supply the City with information if a sample failure is detected and exceeds the stipulated standards.

At the South Fork Water Treatment Plant multiple tests are carried out by certified water treatment operators on a daily basis (as per the Canadian Drinking Water Regulations) of the treated potable water and a summary of these results can be found in Appendix A of this report.

In addition, at each sample location in the water supply and distribution system a pocket chlorimeter is used by staff to determine the *free chlorine* residual which is an indicator of the effectiveness of disinfection in the distribution system. When indicators of adverse samples are found, corrective action is taken and Island Health is notified when necessary.

5. WATER QUALITY RESULTS

According to the Guidelines for Canadian Drinking Water Quality parameters are either health-based and listed as *Maximum Acceptable Concentrations (MAC)*, based on aesthetic considerations and listed as *Aesthetic Objectives (AO)* or established based on operational considerations and listed as *Operational Guidance Values (OG)*.

Appendix A summarizes results of the City's water quality testing and monitoring program results for 2020. Results in the tables that are preceded with '< ' means results are below detectable limits.

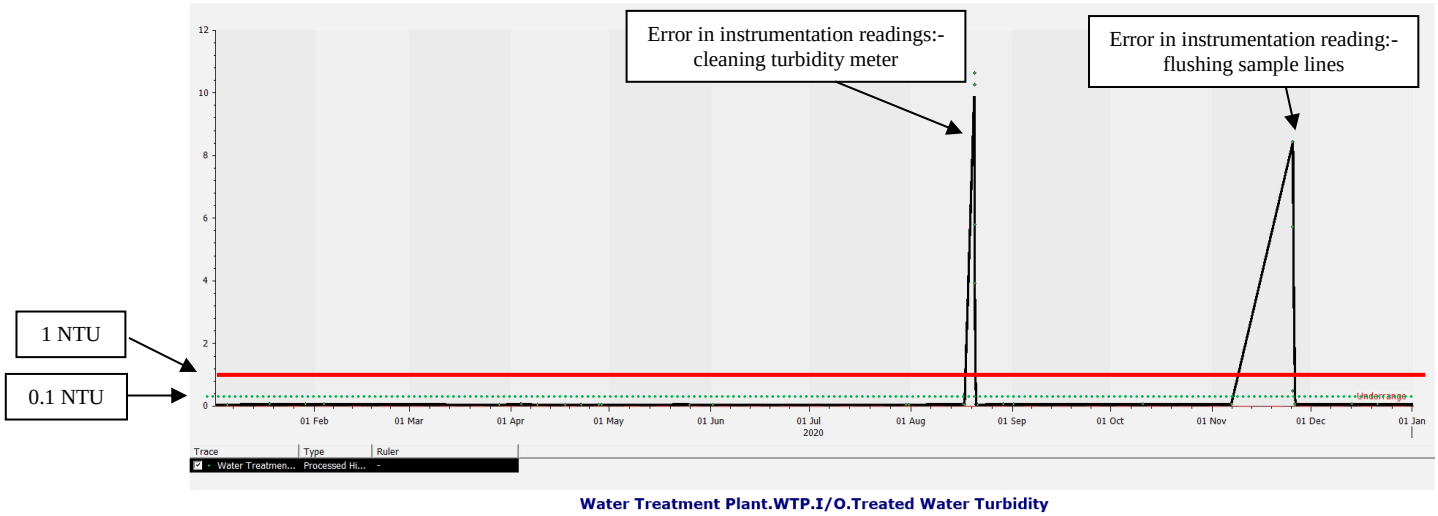
Turbidity

The City's water *turbidity* is continuously measured in the water system. The following graph 1 illustrates turbidity of the treated potable water leaving the South Fork Water Treatment Plant (SFWTP) before reaching any customers

As a condition of its VIHA Operating Permit, the City is required to meet the following standard:

- A turbidity level less than or equal to 0.1 NTU in at least 99% of **treated water** measurements per operational filter period per month.

Graph 1 – potable water turbidity at the SFWTP



Operating Permit standard 0.1 NTU for <u>treated</u> potable water

Operating Permit maximum acceptable concentration 1 NTU for <u>treated</u> potable water

6. WATER QUALITY CONCERNS

Occasionally the City of Nanaimo receives concerns from the public regarding the quality of their drinking water. During the course of 2020, the City received 14 such enquiries and the most common issue of concern related to water colour and taste. Every individual enquiry was investigated by the City's water supply and distribution operations staff and the appropriate action was taken to resolve the appropriate water quality issue. The majority of concerns were resolved following additional flushing of the distribution main lines. In some instances it was necessary to adjust air valves and replace broken water appurtenances. All of the 14 concerns received by the City in 2020 were rectified within 24 hours of the City being notified. Despite these water quality concerns being noted, at no time is the general health of the public put at risk.

Typical examples of water quality concerns (most notably dirty water) arise as a result of the following;

- water mains flushing
- fire fighting
- water main breaks
- local construction in the area (i.e. watermain tie-ins by developers)
- a build up of algae in reservoirs in the summer months during warm weather
- reservoir turnover in early autumn when season rain commences

7. WATER TREATMENT PLANT

The South Fork Water Treatment Plant has been operational and producing clear clean drinking water since December 2015. The SFWTP has a capacity of 116 million litres per day.

South Fork Water Treatment Plant treats raw water using the following process: coarse screening, fine screening, flocculation and chemical mixing (if required), ultra membrane filtration, ultra violet irradiation (secondary membranes only) and chlorine injection.

Appendix B highlights the water treatment process and contains photographs of each stage of the process from source to tap.

8. ENERGY RECOVERY FACILITY & RESERVOIR #1

The City recently constructed the Energy Recovery Facility (ERF) and an enclosed 14 million litre concrete drinking water storage tank. This facility provides storage for treated drinking water for just over 30% of the City residents covering an area from downtown to Neck Point in north Nanaimo.

As the storage tank fills up with potable water (by gravity from the SFWTP) to replenish water consumed by residents on a daily basis, turbines located in the ERF generate power that in turn is sold back to BC Hydro on a monthly basis. In 2020 the City generated 699 megawatt hours of electricity, that is the equivalent of supplying power to approximately 58 homes for one year.

The Energy Recovery Facility and the Reservoir #1 drinking water storage tank (in the background)

Turbines inside the Energy Recovery Facility

9. WATER CONSUMPTION STATISTICS

The following summarizes City water consumption data for 2020.

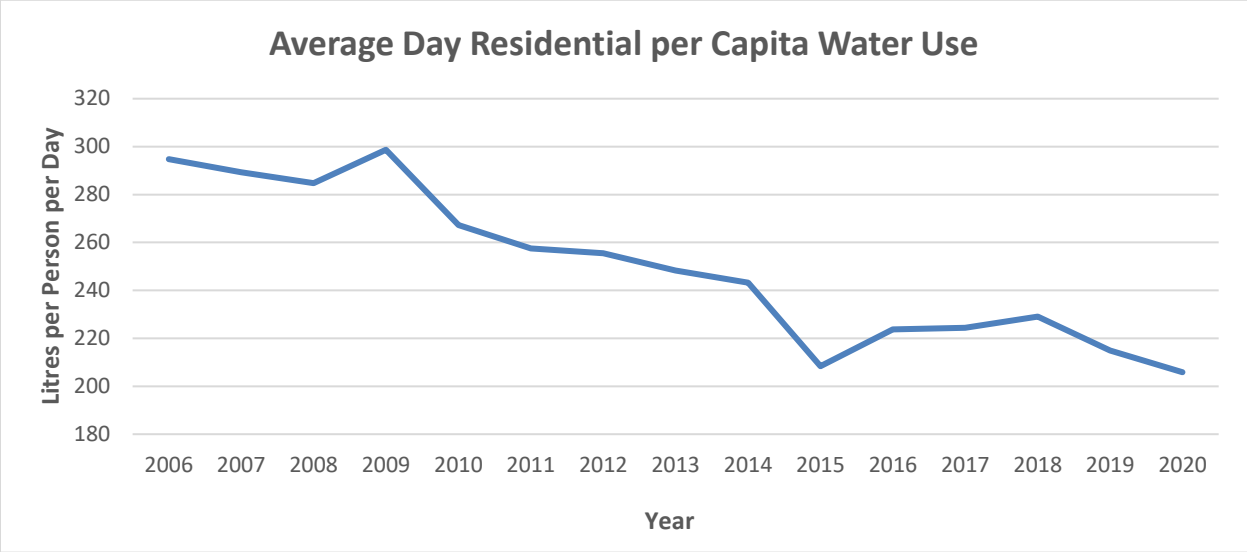
Total volume delivered: 13,524 million litres (ML)
Population served: 98,957 (BC government statistics 2020)
Average consumption (all uses *): 373 litres/person/day (Canadian average 510 litres/person/day
Average residential only consumption: 206 litres/person/day
(Canadian average 251 litres/ person/day in 2011 for properties that utilize water metres)
Average daily amount: 36.95 million litres / day
Summer peak day demand: 67.960 million litres on July 30, or 687 litres/person/day
(All uses * includes residential, commercial, industrial and institutional water demands.)
Winter minimum day demand: 26.644 million litres on January 31, or 269 litres/person/day

The City's inaugural water audit was completed in 2012, and a second follow up water audit was carried out in 2017. In the period between the two audits, there were significant changes to the City's water treatment, water supply and distribution systems. These water system upgrades together with conscientious water conservation by residents and businesses over the five year period have resulted in positive changes in almost every aspect of the water audit. (see table 1 - conservation progress below).

The City last updated its Water Conservation Strategy in 2014, which detailed initiatives that would reduce water consumption and promote water efficient practices. The Water Conservation Strategy identified a target of 10% reduction in per capita water use per decade. In addition, the City participates in *Team WaterSmart* (teamwatersmart.ca) education programs in partnership with the Regional District of Nanaimo to promote water conservation and more efficient water use. More recently the Regional District and the City of Nanaimo unified their water restriction stages and dates of implementation to promote region wide water conservation awareness. Typically watering restriction start on 1st May and end on 30th September. However the 'stage' of watering restrictions in the RDN and the City may differ at any given time as the available drinking water storage capacity of each municipality's watersheds and water sources are different.

Table 1 – Conservation Progress

Statistic	Water Audit		2020
	2012	2017	
Annual Production	15,575,392 m^3	13,775,700 m^3	13,524,2942 m^3
Population (census data)	84,741	91,506	98,957
Revenue (billed from water generated)	72.00%	78.30%	N/A
Electricity Generated & Sold to BC Hydro	0 MWh	880 MWh	699 MWh
Infrastructure Leakage Index	1.54	1.13	N/A
Real Losses (leakage)	9.83%	8.27%	N/A
Apparent Losses (unauthorized consumption, meter inaccuracies & data handling errors)	438 ML	302 ML	N/A
Bulk Water Sales	84 ML	123 ML	39.42 ML
Length of Watermains	615 km	636 km	647 km
Number of Water Meters	24,276	26,119	27,004
Residential Use (single family)	4,830 ML	4,258 ML	N/A
Residential Use (multi family)	3,050 ML	3,176 ML	N/A
Indoor Use	198 L/person/day	182 L/person/day	182 L/person/day
Average Day per Capita Residential Use	251 L/person/day	222 L/person/day	206 L/person/day



10. MAINTENANCE AND FLUSHING PROGRAM

Regular inspections, maintenance and water quality testing is performed weekly by certified water operators (as per the Canadian Drinking Water Regulations) to ensure optimal operation of the City's water system.

The City performs systematic flushing of the entire water supply and distribution piping system in the spring of each year. Flushing is a process of sending a rapid flow of water through the water pipes to clean them. This helps to maintain water quality by removing sediments and stagnant stale water from low points in the pipe network and at watermain dead ends. Flushing takes place in spring when the watershed lakes are full from winter rains and there typically is some snowpack on the surrounding mountains.

Flushing activities may cause a temporary discoloration of your water in your home. While the discoloration is unpleasant, it is not harmful. If this happens wait thirty to sixty minutes, then turn on your cold water taps and let them run for ten to fifteen minutes.

11. CROSS CONNECTION CONTROL

In the interest of maintaining safe drinking water, the City of Nanaimo has implemented a Cross Connection Control Program. The purpose of this program (adopted on March 19, 2018) is to ensure that non-potable water cannot be introduced into the City of Nanaimo water supply system due to a backflow situation.

The Cross Connection Control Coordinator performs assessments on existing facilities to determine whether there is a potential for contaminated water to flow back into the water distribution system. Backflow prevention devices are installed to stop this possible contamination.

Backflow Prevention devices are documented and tracked to ensure they are receiving annual testing. This annual testing must be carried out by a certified Cross Connection Control Backflow Assembly Tester.

In 2020 a number of industrial, commercial and institutional facilities across the city were identified as requiring backflow prevention devices installed. A total of 197 on site surveys were carried out and it was found that 110 of these facilities required plumbing upgrades to conform to the cross connection control by-law.

To reduce possible cross connection contamination at fire hydrants the City constructed two water filling stations in 2020 to limit contractors hooking up to hydrants to obtain water during construction works.

12. EMERGENCY RESPONSE PLAN

The City has prepared a Water System Emergency Response Plan so an adequate supply of clean potable water can be delivered to its citizens even in the event of an emergency or disaster. Disruptions in water quality and delivery may also result from emergencies such as natural disasters or accidents. The City's goal is to minimize all adverse impacts resulting from disruptions in the water system which can only be achieved through sound emergency planning and thorough communication coordination. This also supports the City's goal of providing a safe and sustainable supply of water.

During 2020 a new emergency pump station was constructed that will help supply the City with water in the event of a major emergency.

13. STAFF CONTACTS

The following persons are responsible for the management, operation and system maintenance of the supply and distribution system. If you have any water quality questions please contact either of these staff members.

Title	Name	Telephone
Manager, Water Resources	Mike Squire	(250) 758-5222
Manager, Utilities	David Myles	
Lead Supervisor - Waterworks	Ritchie Fulla	

14. AVAILABILITY OF THE REPORT

This report may be found on the City's website at www.nanaimo.ca / Departments / Engineering/Public Works / Water Supply / Water Quality and Treatment / 2020 Water Quality Report.

If you have any questions regarding this report, please contact the staff member above.
Or e-mail: public.worksinfo@nanaimo.ca phone: (250) 758-5222
Or write to us at: City of Nanaimo, Public Works, 2020 Labieux Road, Nanaimo, V9T 6J9.

15. GLOSSARY

Alkalinity – the capacity of water to neutralize an acid or the measure of how much acid can be added to a liquid without causing a significant change in pH. Alkalinity is not the same as pH because water does not have to be strongly basic (high pH) to have high alkalinity.

Aesthetic Objective (AO) – conforming to accepted notions of good taste.

Bacteria – many different types of bacterial organisms are found in drinking water. Most municipal treated water is essentially bacteria free due to the addition of chlorine. Some forms of cyst type bacteria have a degree of immunity to chlorine due to the cocoon-like shell around the organism, such as Giardia Lamblia, and Cryptosporidium.

Canadian Drinking Water Quality Guidelines – standards established by health Canada that recommend the maximum acceptable concentrations (MAC) for physical, microbiological, chemical and radiological substances in drinking water.

Chemical Parameter – properties of water relating to the molecular composition, such as mineral or metal concentrations.

Chlorine – widely used in the disinfection of water available as a gas, a liquid in sodium hypochlorite, or as a solid in calcium hypochlorite.

Chlorine Demand – the amount of chlorine required to react with all dissolved and particulate materials and inorganic ammonia in the water to purify drinking water.

Chlorine Dosing – the quantity of chlorine added to the water expressed in milligrams per litre (mg/L), equivalent to parts per million.

Coliform Bacteria – a group of organisms primarily found in human and animal intestines and wastes, and thus widely used as an indicator organisms to show the presence of such wastes in water and the possible presence of pathogenic bacteria.

Contact Time – the time from when the chlorine is added to the water, to when the water reaches the first customers.

Contaminant – a substance that infects and degrades the quality and safety of water.

Corrosion – the deterioration of a material, specifically metals in water, caused by reactions and affected by complex interactions between pH, hardness, alkalinity and temperature of the water.

Cryptosporidium – an intestinal parasite that is found in water. If it is not properly destroyed through water treatment can cause nausea, diarrhea and abdominal pain in humans.

CT Values – the product of contact time and free chlorine concentration. It is used to calculate the percent removal of viruses and bacteria.

Disinfection by-products (DBP) – are created when the chlorine added to water reacts with naturally occurring matter in the water.

Disinfection – a process used to eliminate any harmful substance or micro-organism in water.

Domestic Use – water used by residents, in a household.

Drinking Water Protection Regulation (DWPR) – defines regulatory standards under the Provincial Water Act that must be met to ensure water is safe to drink and fit for domestic purposes.

Escherichia coli (E. Coli) – are bacteria present in the intestine and feces of warm-blooded animals. E. Coli are a member species of the fecal coliform group of indicator bacteria. Their concentrations are expressed as number of colonies per 100 mL of sample.

Fecal Coliform – a sub group of total coliform bacteria that are distinguished in laboratory tests at elevated temperatures. It is used as an indicator organism for potential waterborne disease risk.

Filtration – the process of passing water through a porous substance to remove solids in suspension, such as organics. Effectiveness is measured as a reduction of turbidity.

Finished Water – water that has passed through all the processes in a water treatment plant and is ready to be delivered to consumers.

Free Chlorine – the quantity of chlorine remaining which has not been consumed in reactions with microorganisms or organic matter. Also referred to as residual chlorine.

Giardia Lamblia – a common protozoan found in water derived from animal droppings. It can cause contagious waterbourne disease characterized by acute diarrhea. Its cyst forming nature is resistant to disinfectants such as chlorine.

Hardness – a characteristic of natural water due to the presence of dissolved calcium and magnesium.

Inactivation – to destroy or ensure the loss of the ability to cause disease.

Log Removal – indicates how effective disinfection is in eliminating protozoa. For example, 4 log removal guarantees 99.99% disinfection of pathogenic organism, 3 log removal guarantees 99.9%, and 2 log removal guarantees 99% removal.

Maximum Acceptable Concentration (MAC) – defines the upper most limit of a parameter before it can become a health concern.

NTU (Nephelometric Turbidity Units) – the standard unit of measurement for turbidity in water. It detects the amount of light that is scattered by fine suspended particles in water.

Organic – derived from plant or animal matter, as opposed to inorganic matter which is derived from rocks and minerals. Organic matter is characterized by it carbon-hydrogen structure.

Pathogen – an agent that causes disease; a living organism or virus.

pH – the expression of the acidity of a solution by the negative logarithm of the hydrogen ion concentration; pH of 1 is very acidic; pH of 14 is very basic (alkaline); pH of 7 is neutral. The neutral point of 7 indicates the presence of equal concentrations of free hydrogen and free hydroxide ions.

Physical Parameters – these are often observable properties such as colour, taste and odour.

Potable Water – water which is considered safe and fit for human consumption, culinary and domestic purposes and meets the requirements of the health authority having jurisdiction which is Island Health (formerly Vancouver Island Health Authority) in this region.

Protozoa – any of a large group of mostly microscopic, one cell animals living chiefly in water, mainly referring to Cryptosporidium or Giardia Lamblia.

Raw Water – untreated water from wells, surface sources (i.e. lakes and rivers) or any water before it reaches a water treatment device or process.

Reservoir – a receptacle used for storing water within the water system.

Residual Chlorine – the quantity of chlorine remaining which has not been consumed in reactions with microorganisms or organic matter. Also referred to as free chlorine.

Runoff - precipitation that does not infiltrate into soil.

Surface Water – water collecting on the ground or in a stream, river, lake sea or ocean, as opposed to groundwater, which is contained in underground aquifers.

Trihalomethanes (THMs) – a single carbon compound formed in drinking water as a result of the reaction between chlorine and organic matter.

Total Chlorine – the total amount of chlorine in a solution, which includes the chlorine demand as well as the residual chlorine.

Total Coliform – an indicator group of organisms mostly of intestinal origin used to appraise the microbiological risks to drinking water.

Turbidity – the measurement of how cloudy or murky water is. Its measurement relates to the optical property of water that causes light to be scattered and absorbed in a cloudy sample rather than transmitted in a straight line. Measured in NTU (Nephelometric Turbidity Units).

Virus – the smallest form of life known to be capable of producing disease or infection, usually considered to be of large molecular size. They multiple by assembly of component fragments in living cells, rather than by cell division as do most bacteria.

16. APPENDIX A – ANALYTICAL TEST RESULTS

***There were no adverse laboratory test results for the City of Nanaimo Water Resources & Water Supply during 2020**

Analytical Test Results: (All values are reported in mg/L unless otherwise noted)

Microbiological Parameters:

Microbiological Parameters	MAC or IMAC	No. of Samples	No. of Detectable Results	No. of Adverse Results	Method	Sampling Date	Results		Comments
							Min.	Max.	
Total Coliform (counts/100ml) *	Not Detectable	1010	0	0	Membrane Filtration	Jan - Dec	<1	<1	Parameter sampled is used to test for the possible presence of fecal matter. Zero detectable test results indicates that Total Coliforms were not detected.
E. Coli (counts/100ml) *	Not Detectable	1011	0	0	Membrane Filtration	Jan - Dec	<1	<1	Parameter sampled is used to test for the possible presence of fecal matter. Zero detectable test results indicates that E.Coli was not detected.

Operational Parameters:

Operational Parameters	MAC or IMAC	Objective AO/OG	No. of Samples	Sampling Date	Results			Comments
					Min.	Max.	Avg.	
Chlorine Residual[1,2], Free (mg/L)		0.2 to 4.0	Continuous monitoring plus 1 grab sample per day	Jan - Dec	0.48	1.18	0.85	The maintenance of an adequate free chlorine residual in essential to the protection of public health. Values reported are based on the 6 daily grab samples. The regulated minimum for free chlorine residual concentration in a water distribution system is 0.2 mg/L at a pH 8.5 or less.
Chlorine Residual[1], Total (mg/L)			Continuous monitoring plus 1 grab sample per day	Jan - Dec	0.69	1.19	0.90	The maintenance of an adequate free chlorine residual in essential to the protection of public health. Values reported are based on daily grab samples.
Colour (TCU)		5	1 grab samples per day	Jan - Dec	0	10	1	Values reported are based on daily grab samples.
pH[1] (no units)		6.5 – 8.5	Continuous monitoring plus 1 grab sample per day	Jan - Dec	6.75	7.94	7.45	Values reported are based on daily grab samples.
Turbidity[1] (NTU)	1.0		Continuous monitoring plus 1 grab sample per day	Jan - Dec	0.02	0.09	0.061	Turbidity (cloudiness) of water is an indication of the presence of particles in the water. If excessive, it may interfere with proper disinfection. Values reported are based on daily grab samples.
Aluminum (mg/L)		0.2	1 grab sample per day	Jan - Dec	0.02	0.02	0.02	Aluminum levels are slightly elevated during treatment as a result of the use of ACH to help in the removal of particulates & dissolved organics.
UV Transmittance[1] (%) (UV254)			Continuous monitoring plus 1 grab sample per day	Jan - Dec	89.8	97.6	94.6	UV Transmittance is a direct indicator of dissolved organics in water. If values begin to drop, chlorine demand will increase which could result in elevated levels of disinfection by-products (DBP's).

Inorganic Parameters:

Inorganic Parameters		MAC or IMAC (mg/L)	Objective AO/OG	Required Frequency of Testing (months)	2020				Reportable Detection Limit (mg/L)	Comments
					Q1	Q2	Q3	Q4		
1.	Antimony	0.006		12	NT	ND	NT	NT	0.00002	
2.	Arsenic	0.010		12	NT	ND	NT	NT	0.0002	
3.	Barium	1.0		12	NT	0.010	NT	NT	0.00001	
4.	Boron	5.0		12	NT	ND	NT	NT	0.0002	
5.	Cadmium	0.005		12	NT	ND	NT	NT	0.000003	
6.	Chromium	0.05		12	NT	ND	NT	NT	0.0005	
7.	Mercury	0.001		12	NT	ND	NT	NT	0. 00002	
8.	Selenium	0.05		12	NT	ND	NT	NT	0.001	
9.	Uranium	0.02		12	NT	ND	NT	NT	0.000001	

Organic Parameters:

Organic Parameters		MAC or IMAC (mg/L)	Objective AO/OG	Required Frequency of Testing (months)	2020				Reportable Detection Limit (mg/L)	Comments
					Q1	Q2	Q3	Q4		
1.	Alachlor	0.005		12	NT	ND	NT	NT	0.00002	Herbicide
2.	Aldicarb			12	NT	ND	NT	NT	0.00001	Insecticide
3.	Aldrin + Dieldrin			12	NT	ND	NT	NT	0.00001	Insecticide
4.	Azinphos-methyl	0.02		12	NT	ND	NT	NT	0.00002	Insecticide
5.	Bendiocarb			12	NT	ND	NT	NT	0.00001	Insecticide
6.	Benzene	0.005		12	NT	ND	NT	NT	0.00032	An aromatic hydrocarbon present in gasoline
7.	Benzo(a)pyrene	0.00001		12	NT	ND	NT	NT	0.000004	A polycyclic aromatic hydrocarbon (PAH) that forms during the combustion of organic matter (eg. emissions from burning fossil fuels)
8.	Carbaryl	0.09		12	NT	ND	NT	NT	0.00001	Insecticide
9.	Carbofuran	0.09		12	NT	ND	NT	NT	0.00001	Insecticide
10.	Carbon Tetrachloride	0.005		12	NT	ND	NT	NT	0.00016	An organic liquid that is primarily released from man-made sources; used in industrial and agricultural process
11.	Chlorpyrifos	0.09		12	NT	ND	NT	NT	0.00002	Pesticide
12.	Diazinon	0.02		12	NT	ND	NT	NT	0.00002	Insecticide
13.	1,2-Dichlorobenzene	0.2	0.003	12	NT	ND	NT	NT	0.00041	An organic compound used in both industrial and commercial products (coolant, degreaser, solvent)
14.	1,4-Dichlorobenzene	0.005	0.001	12	NT	ND	NT	NT	0.00036	An organic compound used in both industrial and commercial products (deodorizer, fungicide, lubricant)
15.	1,2-Dichloroethane	0.005		12	NT	ND	NT	NT	0.00035	An organic chemical with many industrial and commercial applications (solvent, fumigant, ingredient in plastics etc.)
16.	1,1-Dichloroethylene (vinylidene chloride)	0.014		12	NT	ND	NT	NT	0.00033	Volatile organic compound; imported for use in the food packaging and textile industries
17.	Dichloromethane (Methylene Chloride)	0.05		12	NT	ND	NT	NT	0.00035	Volatile organic compound used in a variety of industries (electronics, textiles, pharmaceuticals, plastics etc.)

Organic Parameters		MAC or IMAC (mg/L)	Objective AO/OG	Required Frequency of Testing (months)	2020				Reportable Detection Limit (mg/L)	Comments
					Q1	Q2	Q3	Q4		
18.	Diclofop-methyl	0.009		12	NT	ND	NT	NT	0.0004	Herbicide
19.	Dimethoate	0.02		12	NT	ND	NT	NT	0.00003	Insecticide
20.	Heptachlor + Heptachlor Epoxide	0.003		12	NT	ND	NT	NT	0.00001	Insecticide
21.	Lindane (Total)			12	NT	ND	NT	NT	0.00001	Pesticide
22.	Malathion	0.19		12	NT	ND	NT	NT	0.00002	Insecticide
23.	Methoxychlor			12	NT	ND	NT	NT	0.00001	Insecticide
24.	Metolachlor	0.05		12	NT	ND	NT	NT	0.00001	Herbicide
25.	Metribuzin	0.08		12	NT	ND	NT	NT	0.00002	Herbicide
26.	Parution	0.05		12	NT	ND	NT	NT	0.00002	Insecticide
27.	Pentachlorophenol	0.06		12	NT	ND	NT	NT	0.00015	An organic compound; used as a pesticide and wood preservative (manufacture and use banned since the 1980's)
28.	Phorate	0.002		12	NT	ND	NT	NT	0.00001	Insecticide
29.	Polychlorinated Biphenyls (PCB)			12	NT	ND	NT	NT	0.00004	An organic compound; used in electrical equipment and as a fire retardant (use has been banned since the 1980's)
30.	Prometryn	0.001		12	NT	ND	NT	NT	0.00003	Herbicide
31.	Terbufos	0.001		12	NT	ND	NT	NT	0.00001	Insecticide
32.	Tetrachloroethylene (perchloroethylene)	0.030		12	NT	ND	NT	NT	0.00035	An organic compound; used as a solvent in dry cleaning and metal cleaning industries
33.	Triallate			12	NT	ND	NT	NT	0.00001	Herbicide
34.	Trichloroethylene	0.05		12	NT	ND	NT	NT	0.00044	Volatile organic compound; used in metal degreasing operations and chemical manufacturing
35.	Trifluralin	0.045		12	NT	ND	NT	NT	0.00002	Herbicide
36.	Vinyl Chloride	0.002		12	NT	ND	NT	NT	0.00017	Volatile organic compound; Used in making PVC (polyvinyl chloride) plastic items

General Chemistry and Physical Parameters:

General Chemistry and Physical Parameters	MAC or IMAC (mg/L)	Objective AO/OG (mg/L)	Required Frequency of Testing (months)	2020				Reportable Detection Limit (mg/L)	Comments
				Q1	Q2	Q3	Q4		
Alkalinity (Total as $CaCO_3$)		30 – 500	12	16	17	26	14	2	
Chloride		250	12	NT	3.38	NT	NT		
Copper		1.0	12	NT	0.002	NT	NT	0.001	
Dissolved Organic Carbon (mg/L as C)		5	12	0.7	NT	1.0	0.9	0.1	
Ethylbenzene		0.0024	12	NT	ND	NT	NT		
Geosmin (ng/L)			12	NT	ND	NT	NT	3.0 ng/L	Geosmin is tested Annually. Geosmin is an Organic Compound which indicates possible offensive taste & odor in drinking water
Haloacetic Acids (2450 Northfield Rd.)		0.080	3	0.046	NT	0.025	0.037	0.0053	The standard is expressed as a running annual average of quarterly samples measured at a point reflecting the maximum residence time in the distribution system. Running annual average: 0.036mg/L
Haloacetic Acids (3600 Place Rd.)		0.080	3	0.037	NT	0.021	0.029	0.0053	The standard is expressed as a running annual average of quarterly samples measured at a point reflecting the maximum residence time in the distribution system. Running annual average: 0.029mg/L
Haloacetic Acids (34 Turnabout View)		0.080	3	0.048	NT	0.030	0.040	0.0053	The standard is expressed as a running annual average of quarterly samples measured at a point reflecting the maximum residence time in the Running annual average: 0.039mg/L
Haloacetic Acids (907 Yee Place)		0.080	3	0.029	NT	0.022	0.012	0.0053	The standard is expressed as a running annual average of quarterly samples measured at a point reflecting the maximum residence time in the distribution system. Running annual average: 0.021mg/L
Hardness (mg/L as $CaCO_3$)			12	13	NT	15	11	1	
Iron		0.30	12	NT	0.01	NT	NT		
Lead	0.005		12	NT	0.0051	NT	NT	0.00001	
Manganese		0.05	12	NT	ND	NT	NT		

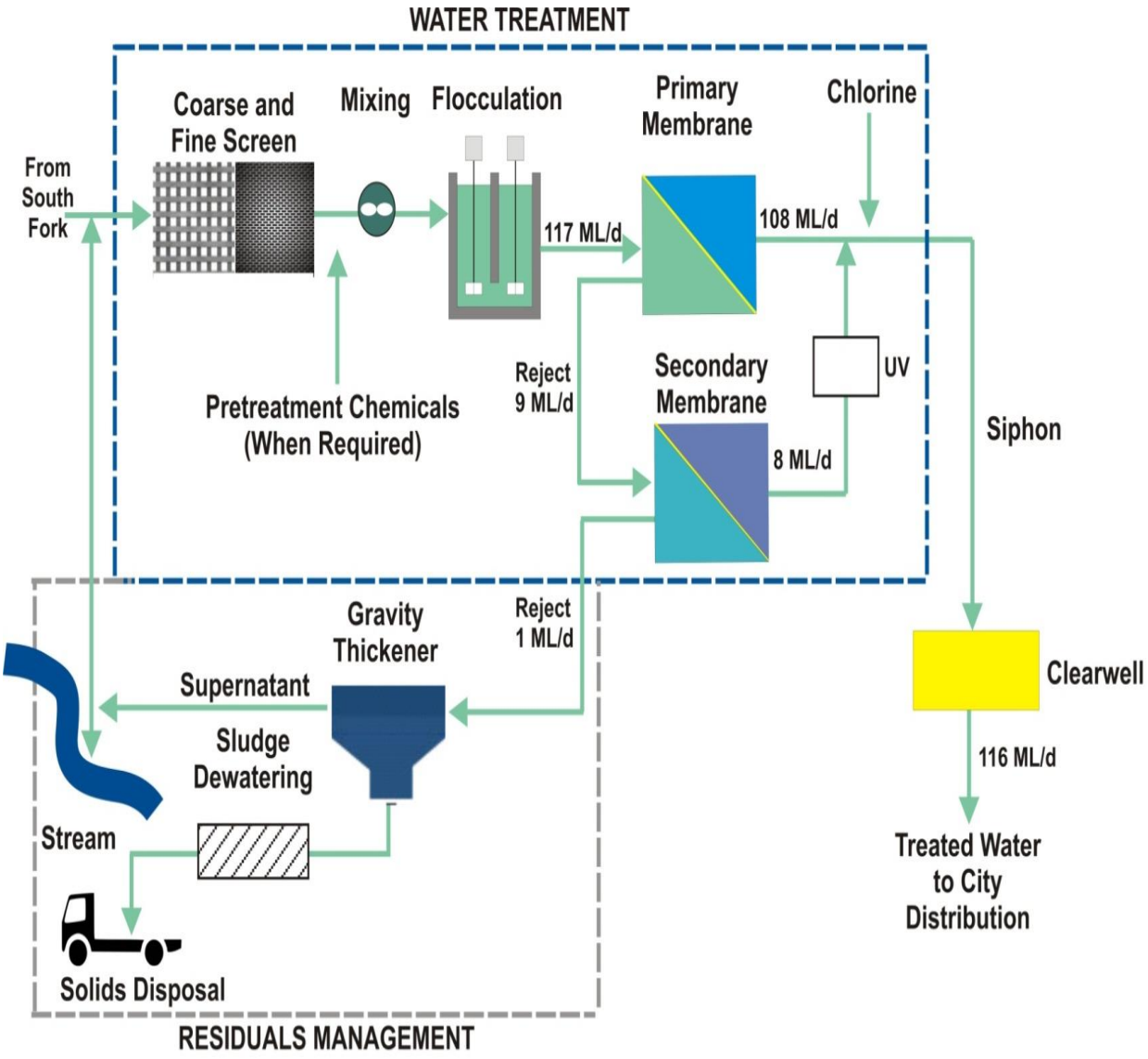
General Chemistry and Physical Parameters	MAC or IMAC (mg/L)	Objective AO/OG (mg/L)	Required Frequency of Testing (months)	2020				Reportable Detection Limit (mg/L)	Comments
				Q1	Q2	Q3	Q4		
2-Methylisoborneol (MIB) (ng/L)			12	NT	ND	NT	NT	3.0 ng/L	MIB is tested Annually. MIB is an Organic Chemical and indicator of the presence of Algae.
Nitrate	10.0		3	ND	ND	0.01	0.02	0.013	Where both nitrate and nitrite are present, the total of the two should not exceed 10 mg/L (as nitrogen)
Nitrite	1.0		3	ND	ND	ND	ND	0.005	Where both nitrate and nitrite are present, the total of the two should not exceed 10 mg/L (as nitrogen)
Sodium		20	12	NT	5.2	NT	NT	0.5	The local Medical Officer of Health must be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium-restricted diets.
Sulphate		500	12	NT	0.8	NT	NT	1	
Sulfide		0.05	12	NT	ND	NT	NT		
Toluene		0.024	12	NT	ND	NT	NT	0.0002	
Total Dissolved Solids		500	12	NT	150	NT	NT		
Trihalomethanes (2450 Northfield Rd.)	0.100		3	0.058	NT	0.050	0.064	0.00037	The standard is expressed as a running annual average of quarterly samples measured at a point reflecting the maximum residence time in the distribution system. Running annual average: 0.057mg/L
Trihalomethanes (3600 Place Rd.)	0.100		3	0.047	NT	0.063	0.046	0.00037	The standard is expressed as a running annual average of quarterly samples measured at a point reflecting the maximum residence time in the distribution system. Running annual average: 0.052mg/L
Trihalomethanes (34 Turnabout View)	0.100		3	0.045	NT	0.053	0.048	0.00037	The standard is expressed as a running annual average of quarterly samples measured at a point reflecting the maximum residence time in the distribution system. Running annual average: 0.049mg/L
Trihalomethanes (907 Yee Place)	0.100		3	0.035	NT	0.043	0.010	0.00037	The standard is expressed as a running annual average of quarterly samples measured at a point reflecting the maximum residence time in the distribution system. Running annual average: 0.029mg/L
Xylenes		0.3	12	NT	ND	NT	NT		
Zinc		5.0	12	NT	0.004	NT	NT	0.005	

Discussion of Analytical Results:

* Indicator of adverse water quality
[1] In addition to the analytical samples noted above, chlorine residual, pH, UV Transmittance, and turbidity are measured on a continuous basis at the treatment facility using on-line instrumentation.

NT – Not Tested
NR – Not Required
ND – Not Detected

17 APPENDIX B – SOUTH FORK WATER TREATMENT PROCESS



South Fork Water Treatment Plant Process (in Pictures)

Raw water collected and stored in South Fork Dam

Raw water flows (by gravity) to South Fork Water Treatment Plant

Raw water passes through coarse & fine screens

Raw water passes chemical injection points and mixing pumps

Raw water flocculation (mixing) tanks

Raw water being filtered in primary membranes

Raw (reject primary) water being filtered in secondary membranes

Secondary membranes raw water uv treatment

Primary and secondary membrane filtered water being treated at the chlorine injection point

Reject raw water centrifuge

Dewatered sludge (dirt removed from water by centrifuge) ready for disposal

Treated potable water clearwell (storage tank)