2018

City of Kamloops
Drinking Water Annual Report

Canada's Tournament Capital

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1.0 INTRODUCTION

This report was prepared in compliance with the requirements under the British Columbia Drinking Water Protection Act (DWPA) and the City of Kamloops Operating Permit. This document includes an overview of the water treatment and distribution systems, a summary of the total water consumption, the 2018 water quality analysis, and a recap of water utility projects and related operations. This report has been provided to Interior Health and posted on the City's website.

2.0 KAMLOOPS WATER SYSTEM

The City's drinking water system consists of a single treatment plant, which feeds an extensive distribution system that supplies water to users throughout the community. The City's treatment plant, the Kamloops Centre for Water Quality (KCWQ), is an ultra-filtration membrane treatment facility that chlorinates the finished water to ensure the water's safety throughout the distribution system. The Environmental Operators Certification Program (EOCP) has certified the City of Kamloops water treatment and distribution systems at Level IV, which is the highest classification in BC. These complex systems require highly trained and certified staff to operate and maintain our top quality drinking water treatment and distribution.

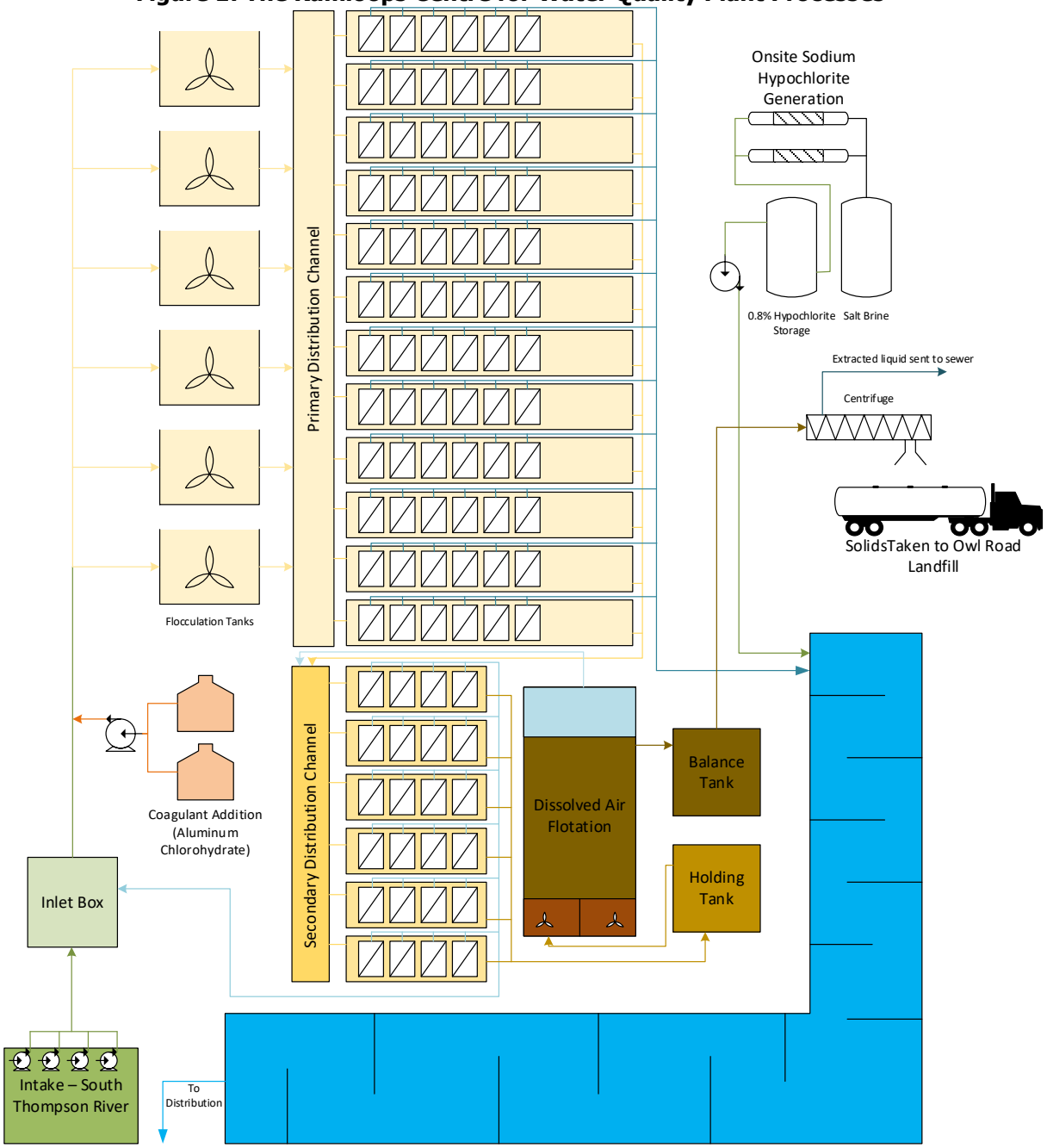
2.1 Kamloops Centre for Water Quality (KCWQ)

The KCWQ treats water from the South Thompson River and supplies most of the city's population. KCWQ is a SUEZ ZeeWeed 500D ultra-filtration membrane water treatment facility that is capable of producing 160 million L per day (MLD). Leaders in Environmental and Energy Design (LEED) have given the building a "Gold" rating.

Of the water taken into the facility, 99.99% is processed and distributed as drinking water. The solids separated through the filtering process are taken the City's Owl Road Resource Recovery Centre, where they are used as clean cover.

A layout of the KCWQ and its filtering process can be seen in Figure 1.

Figure 1: The Kamloops Centre for Water Quality Plant Processes



2.1.1 KCWQ Production Totals

There has been a continued decrease in water use since the introduction of universal water meters, and 2018 marked a new all time low. Figure 2 shows the monthly total water consumption over the past 10 years.

Figure 2: Monthly Total Production for the Past 10 Years

Month	Total Production (m^3)										Year to Year Comparison		
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average	Minimum	Maximum
January	1,102,050	1,041,252	1,028,342	1,004,683	997,845	998,516	998,859	999,352	936,100	916,086	1,002,309	916,086	1,102,050
February	965,800	882,146	920,659	912,473	870,821	903,897	875,057	876,222	823,798	809,346	884,022	809,346	965,800
March	1,079,800	1,111,459	1,112,117	1,000,423	1,013,585	1,001,555	1,001,061	991,862	893,219	912,847	1,011,793	893,219	1,112,117
April	1,484,942	1,537,427	1,254,472	1,338,717	1,256,169	1,155,441	1,377,097	1,519,266	982,158	1,029,452	1,293,514	982,158	1,537,427
May	2,418,702	2,126,552	1,970,344	2,338,361	2,228,929	1,736,305	2,405,924	2,089,764	1,576,441	2,226,009	2,111,733	1,576,441	2,418,702
June	3,342,126	2,232,802	2,446,945	2,008,220	2,128,609	2,435,774	2,633,979	2,317,143	2,596,685	2,318,204	2,446,049	2,008,220	3,342,126
July	3,742,487	3,408,915	2,902,192	2,895,880	3,424,556	3,187,312	2,922,031	2,421,451	3,322,818	2,675,200	3,090,284	2,421,451	3,742,487
August	3,596,436	3,007,564	3,430,008	3,257,773	3,133,474	2,746,427	2,659,919	2,740,741	2,867,866	2,445,042	2,988,525	2,445,042	3,596,436
September	2,404,774	1,700,291	2,629,657	2,366,983	2,036,171	1,836,736	1,737,829	1,618,868	2,046,575	1,470,836	1,984,872	1,470,836	2,629,657
October	1,320,321	1,281,721	1,301,444	1,383,194	1,254,593	1,237,151	1,147,270	1,096,279	1,128,010	1,026,683	1,217,667	1,026,683	1,383,194
November	1,056,127	1,031,241	991,751	999,703	1,114,296	996,238	976,284	958,048	899,987	905,669	992,935	899,987	1,114,296
December	1,049,221	1,037,506	1,003,279	1,011,471	1,005,151	1,006,889	989,458	978,535	919,666	920,749	992,193	919,666	1,049,221
Total	23,562,785	20,398,876	20,991,210	20,517,881	20,464,199	19,242,241	19,724,769	18,607,531	18,993,324	17,656,123	20,015,894	17,656,123	23,562,785
Daily Peak	143,509	132,697	127,032	117,905	124,608	121,608	106,999	99,564	117,078	106,218	119,722	99,564	143,509
Peak Date	30-Jul	29-Jul	06-Jul	08-Aug	25-Jul	16-Jul	28-Jun	19-Aug	03-Jul	18-Jul			
Daily Low	20,180	20,379	29,180	29,794	29,094	28,771	28,603	29,330	15,394	26,455	25,718	15,394	29,794

These monthly numbers are shown in Figure 3. Total consumption for 2018 was the lowest annual total in the history of the KCWQ and was nearly 2.5 billion L off the 10-year average.

Figure 3: Graphical Representation of the KCWQ 10 Year Monthly Water Consumption

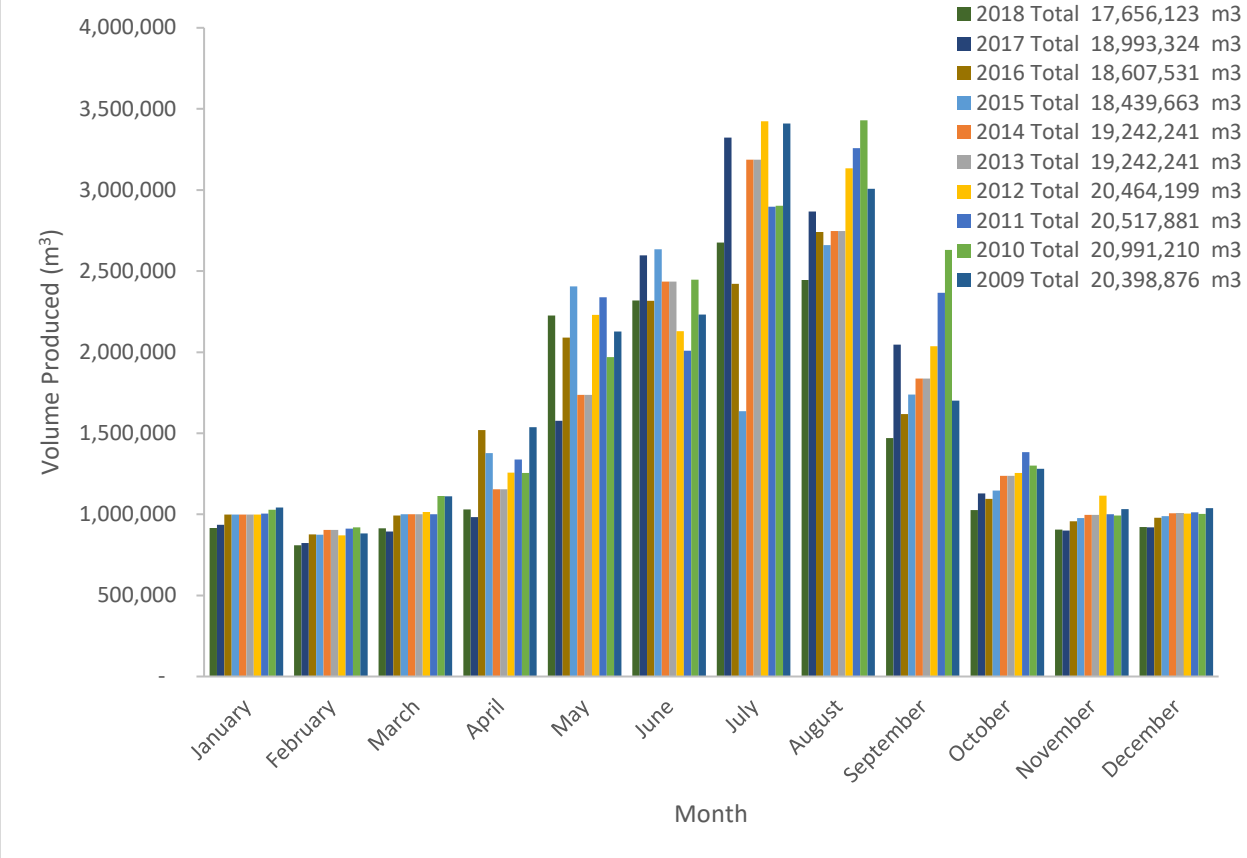
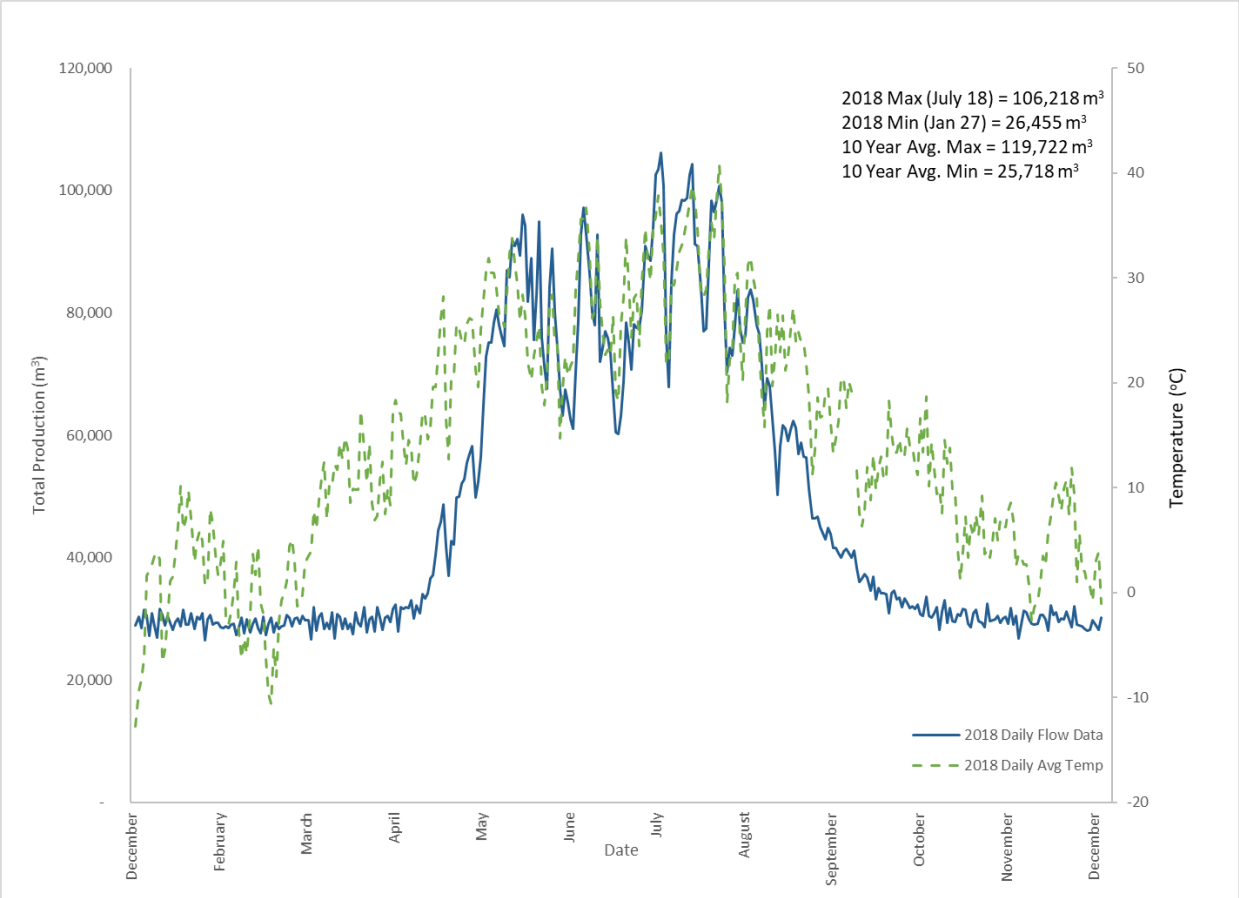


Figure 4 shows the daily water consumption for 2018 with an overlay of the maximum daily temperature. The daily peak for 2018 was 106.2 million L, which happened on July 18. This was the second lowest summer maximum peak since the plant was built. The KCWQ can achieve a maximum daily flow of 160 million L, which allows room for population growth well into the future.

Figure 4: KCWQ Daily Water Flows for 2018 With Daily Average Temperature Overlay



2.2 Water Conservation

In 2018, KCWQ saw the lowest total production since its opening. While total water was lower than the previous record in 2016, the peak daily demand was second lowest to 2016. The total usage was nearly 2.5 billion L below the 10-year average. Overall, spring usage was up from the previous year, but the large decline in summer use led to an overall decrease in annual production. Irrigation demands continue to be the largest factor in our water demands, and methods to address this challenge are being considered as the next phase of water conservation. The difference between an average day use in winter compared to the maximum day use during the irrigation season is known as the "peaking factor". Kamloops continues to have one of the highest peaking factors in Canada.

2.3 Distribution and Storage System Overview

According to AECOM, Kamloops has the most complex water distribution system in Canada. The water distribution system consists of over 630.6 km of water mains, 45 booster stations, 46 reservoirs, 2,366 fire hydrants, and a total of 24,983 connections. The City also maintains a potable water supply for the Tournament Capital Ranch by using trucks to deliver water to a storage tank and distribution system that supplies the area. The following sections provide further detail of the distribution system along with summaries of projects and events within the 2018 calendar year.

2.3.1 Booster Stations and Reservoirs

In 2018, Utility Services Division staff and a specialized diving contractor worked on cleaning the Southwest #2 Booster Station reservoir. Approximately 50% was cleaned, and the remainder of the cleaning will be completed in 2019. The diving contractor also completed a visual inspection of the Southwest #3 Booster Station reservoir.

Other projects included initiating a vegetation management plan to clear vegetation from high voltage compounds to conform to BC Hydro regulations and installing a pressure-reducing at the Prior Road Booster Station to allow City staff to backfeed water from the Batchelor reservoirs into the Westsyde zone.

2.3.2 Distribution System

The water distribution system is very extensive and is one of the most challenging systems in Canada, due to our area's unique topography. The material of the water main distribution system is quite varied, as illustrated in Figure 5. Asset management of the distribution system consists of actively replacing water lines that have reached the end of their functional life or have deteriorated earlier than predicted.

Figure 5: Water Main Material Summary

Material	Length (km)	% of Total Pipe	% Change from Last Year
AC (asbestos cement)	178.148	28.25	-0.48
CI (cast iron)	36.582	5.80	-1.13
Cu (copper)	0.905	0.14	-2.21
DI (ductile iron)	103.74	16.45	1.19
GI (galvanized iron)	0.276	0.04	0.00
HYP (high pressure concrete)	17.321	2.75	-0.99
PLY (polyethylene)	1.662	0.26	7.52
PVC (polyvinyl chloride)	281.12	44.58	2.96
STL (steel)	10.898	1.73	1.36
Total	**630.6 km**	**100%**	**-**

2.4 Source Protection

In 2014, a source protection plan for Kamloops was developed. This plan included recommendations to help mitigate risks to the water source within an area of direct impact to the South Thompson River Intake. Included in this document were Risk Management Actions, which included building of the now-completed North Thompson Emergency Water Intake. The secondary intake provides resiliency in the event of a major contamination of the City's primary water source; the South Thompson River.

2.5 Cross Connection Program

The City's Cross Connection Control Plan (CCCP) has focused on premise isolation for industrial, commercial, and institutional (ICI) properties. A review of the programs in communities that are similar in size to Kamloops indicates that they have also focused on premise isolation for the same group of customers to begin the program.

To date, the City's CCCP has focused on including appropriate cross connection measures for new ICI installations. If cross connection control is required, it is made a condition of the Building Permit or Development Permit. A "Backflow Prevention Assembly Testing Report" submitted to the Utility Services Division indicating that the cross connection control device is operating satisfactorily is required before occupancy of the property is granted.

Monitoring requirements include annual testing by a certified cross connection control device tester. If this test is failed, repairs and recertification or replacement will be required to maintain the safety of the City's water distribution system. The City currently monitors all inventory of roughly 1,300 cross connection control devices (premise isolation and internal protection). We continue to assess ICI properties for cross connection control risks and to determine if control devices are required.

3.0 ENVIRONMENTAL OPERATORS CERTIFICATION PROGRAM (EOCP)

All four components of the City's utilities system (Water Treatment, Water Distribution/Storage, Wastewater Collection, and Wastewater Treatment) are classified at the highest level (Level IV) through the Environmental Operators Certification Program (EOCP). This classification requires highly trained staff to operate and maintain all components.

The City currently has 49 staff certified in Water Treatment and Water Distribution/Storage. Staff certification ranges from Level I to Level IV, which makes our system compliant with the legislation for trained operators.

4.0 2018 HIGHLIGHTS, FUTURE PROJECTS, AND SERVICE REQUEST SUMMARIES

The following sections of this report provide an overview of the projects and initiatives undertaken throughout the water treatment and distribution system in 2018.

4.1 KCWQ Highlights, Projects, and Challenges

A major power outage in 2017 highlighted many electrical improvements and redundancies that could be made to make our system more robust. Extensive efforts were put toward this project in 2018. In addition to the electrical redundancy and upgrade project, improvements were made to the solids handling system including upgrades to our pumps and mixers. The following are some of the major projects that were undertaken at KCWQ in 2018:

- Dissolved Air Flotation (DAF) upgrades, including:
  - new programmable logic controllers (PLCs)
  - two 10 hp feed pumps along with new variable frequency drives (VFD) for supplying water to the DAF and bringing in operational redundancy
  - new VFDs to control the mixing and scrapers within the DAF unit itself
- centrifuge upgrades
  - new mixer in the 'balance' tank (which takes the waste from the DAF unit), including a new VFD for operational and energy efficiency
  - new PLC
- upgrades to the power feed into the plant for operational redundancy during emergencies
- design and construction of a KCWQ bypass system to allow us to provide raw water to our distribution pumps in the event of a failure of the treatment centre

4.2 Pumping Facility Upgrades

New PLCs and electrical upgrades at the Low Lift Pumping Station that feeds the water from the South Thompson River to KCWQ. Electrical upgrades were also undertaken at High Lift Pumping Station which pumps treated water to all sectors of our distribution system.

Pumping stations throughout the distribution system had electrical, communication and PLC upgrades. This included upgrading many stations to radio communication which has saved significant operating cost.

4.3 Distribution Highlights

In 2018, the following water capital work was done as part of local road projects:

- River Street – replaced 200 m of 150 mm AC water main with 200 mm PVC water main, including new service connections and valves
- Sherbrooke Avenue – replaced 163 m of 150 mm AC water main with 157 m of 200 mm PVC water main and 6 m of 150 mm PVC water main, including new service connections and valves
- Wallace Place – replaced 70 m of 50 mm poly water main with 100 mm PVC water main, including all new service connections and valves

Water capital works on other road projects included:

- River Road - replaced 150 m of 150 mm AC and 30 m of 200 mm AC water main with 180 m of 200 mm PVC, including new service connections and valves
- Singh Street - replaced 20 m of 250 mm AC with 20 m of 250 mm PVC water main, including valves and fittings

4.4 The North Thompson Emergency Water Intake (NTEWI)

The NTEWI was constructed to provide the city with a secondary water source in the event of a major contamination of the city's primary supply from the South Thompson River. This project leverages Kamloops' unique opportunity of having two separate water sources available within city limits and provides a redundancy that few other communities have. The project was constructed after receiving a $6 million grant.

Construction of the NTEWI was completed in 2018 and commissioned in November. The system will only be activated in the event of a major contamination of the South Thompson River. Once activated, water will be pumped from the North Thompson River at Yates Road to the North Kamloops reservoir. Then the water will be gravity fed to the River Street pump station, where it will be distributed throughout the system. The water distributed during a NTEWI activation will be non-potable water for indoor-only use and for fire protection.

4.5 Requests for Service

There were a total of 3,199 requests for service in 2018 related to water treatment and distribution. Figure 6 illustrates the category of those calls.

Figure 6: Service Requests in Water Treatment and Distribution

Request Categories Related to Utilities/ Water	Number of Requests 2017	2018
Booster Stations	5	7
Cross Connection Control	28	42
Frozen Services	17	0
General	82	65
Hydrants	66	68
Irrigation On/Off	34	24
No Water	104	47
Reservoirs	6	3
Service Boxes	120	100
Service Location	122	138
Turn Service On/Off	654	675
Water Filling Station	30	33
Water Leak	334	293
Water Meters	1859	1586
Water Pressure	76	58
Water Quality	89	59
Water Restrictions	4	1
Totals	3,630	3,199

5.0 WATER QUALITY SAMPLING AND ANALYSIS

Water quality samples are taken daily and extensively analysed to confirm compliance with applicable requirements. Daily samples are taken from our raw water source, from the treated water exiting KCWQ and from one rotating location within the distribution system. Weekly bacteriological samples are also taken from 23 locations throughout our distribution system. Water quality samples are taken from the potable water source at the Tournament Capital Ranch during seasonal operation.

5.1 KCWQ Water Quality Testing

A variety of parameters are measured and monitored at KCWQ to ensure compliance with applicable water quality regulations. Figures 8, 9, and 10 summarize the results of the nightly analysis for the KCWQ. These analyses are completed by the certified operators at the KCWQ.

5.1.1 **True and Apparent Colour**

Treated water colour can be imparted in two ways: through dissolved material or suspended material. The suspended material could be trace amounts of clays, silts, or any other material that can be remain undissolved in water. The dissolved materials are typically organics such as tannins that are leached from plants, trees, or roots and result in a yellowish/brown colour. They may also be from dissolved metals like iron. Suspended material in water is much easier to treat through filtration, while dissolved material may be more difficult to remove. "Apparent colour" is a measure of all colour in water, including suspended material, while "true colour" measures only the dissolved colour. Colour in itself is not a health issue; it is simply an aesthetic component of our water.

5.1.2 **pH**

pH is a measure of the activity of the hydrogen ion in water. It represents the acidity or basicity of water. The pH scale goes from 0 to 14. Anything lower than 7 is acidic, anything higher than 7 is basic, and 7 is neutral. Drinking water is regulated to fall between a pH of 6.5 to 8.5. In Kamloops, we strive to be on the high side of that range in order to protect our pipes against corrosion.

5.1.3 **Hardness**

Hardness is primarily made up of dissolved calcium and magnesium in water. These compounds are not harmful to health, and people actually need them in their diet. At high levels, they may cause "soap scum", require more soap or detergent when cleaning things, and clog pipes and hot water tanks. Hardness is broken down into the following general categories: 0 to 60 mg/L as $CaCO_3$ is considered soft, 61 to 120 mg/L is considered moderate, 121 to 180 mg/L is considered hard, and over 180 mg/L is considered very hard.

5.1.4 **Alkalinity**

Alkalinity is a measure of the buffering capacity of water. The alkalinity will keep the pH stable if something acidic or basic is introduced to the water. The higher the alkalinity, the more stable your pH will remain. In general, this parameter has no health implications; it is strictly used as a guideline in treatment processes.

5.1.5 Conductivity and Total Dissolved Solids (TDS)

Conductivity and total dissolved solids (TDS) go hand in hand as the criteria that measure conductivity in water. Conductivity is a measure of how well a water sample conducts electricity. Water is actually an insulator and, in order to conduct electricity, water needs dissolved ions. Water's ability to conduct electricity is directly related to the amount of dissolved solids within the water. In water treatment, this measurement is used to monitor any changes in water quality.

5.1.6 Total Suspended Solids (TSS)

Total suspended solids (TSS) is a measure of all the colloidal material in water. Measuring this in our raw water gives an indication of the amount of solids that will be removed through our process. There are no guidelines related to TSS as there is another related test called turbidity, which is a quicker test for which a guideline is established.

5.1.7 Turbidity

Turbidity is a measure of the clarity of the water. It is also directly related to the colloidal material in the water. Turbidity is measured by passing a beam of light through the sample and measuring the amount of water that is refracted at a 90° angle. The units applied are called nephelometric turbidity units (NTU). *The Guidelines for Canadian Drinking Water Quality* (GCDWQ) state that drinking water should have a turbidity of less than 1 NTU. Water leaving our membrane filtration treatment plant should not have a turbidity of greater than 0.1 NTU.

5.1.8 Aluminum

Aluminum in our water is of interest as we use an aluminum-based coagulant to help in the treatment process. By monitoring the amount of aluminum in our raw and treated water, we ensure that our coagulant is not being overdosed and is not entering our drinking water at elevated levels. The GCDWQ sets the operational guideline for water treatment plants at 0.1 mg/L.

5.1.9 Free and Total Chlorine (Cl_2)

Chlorine levels are important in water treatment to ensure that water is safe all the way through the distribution system. The primary form of chlorine used in our treatment system is sodium hypochlorite. "Free chlorine" measures the amount of sodium hypochlorite in our water, while "total chlorine" measures the free chlorine plus any combined chlorine disinfectants such as chloramines. In our system, we strive to maintain a residual free chlorine level of greater than 0.2 mg/L at the end of the distribution system.

Figure 7: KCWQ Average Monthly Raw Water Analysis

Month	True Colour (PtCo Units)	Apparent Colour (PtCo Units	pH	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	TDS (mg/L)	Conductivity (µs/cm)	TSS (mg/L)	Turbidity (NTU)	Aluminium (mg/L)	Temp (°C)
January	5.8	9.4	7.8	42.2	40.4	43.2	79.5	2.1	1.8	3.4	2.1
February	4.4	15.6	7.8	42.4	40.8	45.7	79.8	4.4	2.4	ND	2.3
March	5.0	20.7	7.9	44.4	42.2	46.6	88.7	4.6	3.3	ND	4.8
April	6.3	23.8	7.9	46.6	45.2	49.6	93.7	5.2	3.8	ND	8.5
May	7.9	68.1	7.8	55.7	42.0	44.5	84.5	22.2	10.7	0.0	11.8
June	5.3	18.4	7.8	38.5	38.2	39.6	75.8	3.5	3.4	ND	13.8
July	5.7	17.9	7.8	37.5	37.6	39.4	75.0	3.1	2.5	ND	18.1
August	5.0	17.4	7.8	36.8	36.9	40.7	98.1	2.3	2.2	ND	20.6
September	5.6	14.1	7.9	38.6	38.6	42.7	81.0	1.2	1.6	ND	17.1
October	5.9	12.2	7.8	39.9	39.6	42.3	80.4	1.6	1.7	ND	11.8
November	5.3	12.9	7.8	40.1	39.9	41.2	78.3	1.2	1.6	ND	8.7
December	5.2	12.8	7.7	41.3	40.2	40.7	77.5	1.8	2.2	ND	6.1
Min	4	9	7.73	37	37	39.4	75.0	1.2	1.56	ND	2.1
Max	8	68	7.95	56	45	49.6	98.1	22.2	10.69	ND	20.6
Average	6	20	7.82	42	40	43.0	82.7	4.4	3.08	ND	10.5

Figure 8: KCWQ Average Monthly Treated Water Analysis

Month	True Colour (PtCo Units)	Apparent Colour (PtCo Units	pH	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	TDS (mg/L)	Conductivity (µs/cm)	Turbidity (NTU)	Aluminium (mg/L)	Temp (°C)	Free Cl (mg/L)	Total Cl (mg/L)
January	ND	ND	7.8	41.0	40.0	47.4	89.9	0.0	ND	4.0	1.2	1.3
February	ND	ND	7.8	40.0	40.0	46.9	91.0	0.0	ND	3.0	1.3	1.4
March	ND	ND	7.9	42.0	41.0	48.9	92.7	0.0	ND	3.6	1.3	1.3
April	ND	ND	7.9	44.0	42.0	52.2	99.0	0.0	ND	1.0	1.3	1.4
May	ND	ND	7.7	38.0	38.0	44.2	83.9	0.0	ND	10.9	1.3	1.4
June	ND	ND	7.7	38.0	37.0	44.7	81.0	0.0	ND	11.0	1.2	1.3
July	ND	ND	7.9	36.0	37.0	45.9	87.2	0.0	ND	15.7	1.1	1.3
August	ND	ND	7.8	36.0	36.0	46.0	87.4	0.0	ND	18.5	1.2	1.3
September	ND	ND	7.9	38.0	38.0	48.1	89.6	0.0	ND	16.0	1.2	1.3
October	ND	ND	7.7	35.0	38.0	44.8	89.8	0.0	ND	11.7	1.3	1.2
November	ND	ND	7.8	38.0	39.0	48.2	91.4	0.0	ND	8.4	1.4	1.5
December	ND	ND	7.7	40.0	39.0	47.2	89.7	0.0	ND	6.3	1.1	1.2
Min	ND	ND	7.67	35.0	36.0	44.2	81.0	0.010	ND	1.0	1.08	1.15
Max	ND	ND	7.93	44.0	42.0	52.2	99.0	0.012	ND	18.5	1.37	1.45
Average	ND	ND	7.79	38.8	38.8	47.0	89.4	0.011	ND	9.2	1.23	1.33

*ND refers to Non-Detectable Limit

Figure 9: KCWQ Average Monthly Distribution Water Analysis

Month	True Colour (PtCo Units)	Apparent Colour (PtCo Units	pH	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	TDS (mg/L)	Conductivity (µs/cm)	Turbidity (NTU)	Free Cl2 (mg/L)	Total Cl2 (mg/L)	Temp (°C)
January	ND	ND	7.9	40.5	40.1	48.7	92.3	0.1	1.1	0.9	7.6
February	ND	ND	7.9	42.0	41.1	50.2	94.7	0.1	0.9	0.9	6.0
March	ND	ND	7.9	43.0	42.4	53.4	101.0	0.1	0.8	0.9	7.5
April	ND	ND	7.9	44.9	44.0	54.5	103.2	0.1	0.8	13.4	9.9
May	ND	ND	7.9	43.8	43.0	54.5	101.4	0.1	0.8	0.9	11.8
June	ND	ND	7.8	39.5	39.3	45.5	86.4	0.2	0.9	0.9	13.1
July	ND	ND	8.0	38.5	38.1	44.2	84.0	0.2	0.8	0.8	14.7
August	ND	ND	7.5	37.0	36.5	43.2	82.1	0.1	0.7	0.8	18.8
September	ND	ND	8.1	38.2	35.4	45.8	87.2	0.1	0.6	0.7	18.1
October	ND	ND	8.0	40.2	38.8	48.6	92.1	0.1	0.5	0.6	14.3
November	ND	ND	8.0	40.8	39.8	50.1	95.2	0.1	0.5	0.5	10.7
December	ND	ND	7.9	41.8	40.7	50.2	95.2	0.1	0.6	0.7	9.6
Min	ND	ND	7.52	37	35	43.2	82.1	0.09	0.47	0.55	6.0
Max	ND	ND	8.05	45	44	54.5	103.2	0.23	1.05	13.39	18.8
Average	ND	ND	7.89	41	40	49.1	92.9	0.12	0.74	1.86	11.8

*ND refers to Non-Detectable Limit

5.2 Distribution Sampling

The City is committed to providing safe drinking water to each and every connection within its service area. The distribution system is sampled at 23 different locations weekly, with an additional weekly sample taken at the Tournament Capital Ranch from April to October. These samples are analyzed for background bacterial counts, total coliforms, and E. coli.

5.2.1 Background Bacterial Monitoring

Background bacteria monitoring is done through what is called a heterotrophic plate count (HPC). Heterotrophic bacteria are a group of bacteria that use carbon as a food source and can be found in a variety of water sources. Most bacteria found in water are actually heterotrophic. In general, these bacteria are not pathogenic, and the HPC test in itself will not tell you whether the water is safe to drink. Because of this, there is no maximum acceptable concentration (MAC), as stated in the GCDWQ. This test tells us if there are conditions within the system that bacteria can regrow or thrive in.

The City uses this test to monitor integrity and overall "health" of the distribution system. If a sample is positive for background bacteria greater than 200 counts, the system is flushed and resampled. Any positive counts of any size for background bacteria are also resampled, which is above and beyond any legislative requirements.

5.2.2 Coliform Bacterial Monitoring

Coliform bacteria represent a large group of bacteria found in water and soil, on vegetation, and in the feces of mammals. Most of these bacteria are not harmful to humans but, because of the ease of testing of this bacteria, it makes for a great indicator of contamination.

In water treatment systems, there is a zero threshold allowance for coliforms within water samples. If a sample shows positive for coliforms, the site is immediately resampled and, if coliforms are found again, a boil water advisory is put in place while working closely with the local health authority.

5.2.3 **E. Coli Bacterial Monitoring**

E. coli bacteria are a subsection of coliform bacteria. These bacteria may not be harmful to human health, but specific strains can cause serious health issues and even death in some instances. These bacteria are also found almost exclusively in the feces of mammals; therefore, they are a definite sign of contamination. Any positive counts for coliforms or E. coli result in an immediate boil water advisory, resampling, and cleaning of the affected area. The results for the 2018 distribution system can be seen in Figure 10.

In 2018, there were a total of eight positive results for background bacteria and no positive samples for coliform bacteria or E. coli. After resampling the background bacteria positive samples, all results came back negative. One high background count triggered a water main flushing and Interior Health was notified as a precaution; however, the follow-up resampling came back negative.

Figure 10: 2018 Distribution System Biological Sampling

Date	Number of Samples Taken	Samples Positive for Background Bacteria	Samples Positive for Coliforms	Samples Positive for E. Coli	Notes/ Measures Taken
2018-01-02	23	0			
2018-01-08	23	0			
2018-01-15	23	0			
2018-01-22	23	0			
2018-01-29	23	0			
2018-02-05	23	0			
2018-02-13	23	0			
2018-02-19	23	0			
2018-02-26	23	0			
2018-03-05	23	0			
2018-03-12	23	0			
2018-03-19	23	0			
2018-03-26	23	0			
2018-04-03	23	0			
2018-04-09	23	0			
2018-04-16	25	0			A second sample taken to ALS labs
2018-04-24	24	0			
2018-04-30	24	0			
2018-05-07	24	0			
2018-05-14	24	0			
2018-05-22	24	0			
2018-05-28	24	0			
2018-06-04	24	0			
2018-06-11	24	0			
2018-06-18	22	2			One sample had background of 1, Another sample had background of 1100. I.H.A. notified of the results and our flushing and re-sampling
2018-06-25	26	0			Resamples taken and all came back negative
2018-07-03	24	0			
2018-07-09	24	0			
2018-07-16	23	1			Background count of 2
2018-07-23	25	0			Resample taken, came back negative
2018-07-30	24	0			
2018-08-07	24	0			
2018-08-13	24	0			
2018-08-20	24	0			
2018-08-27	24	0			
2018-09-04	24	0			
2018-09-10	24	0			
2018-09-17	23	1			Background count of 7, lab delayed reporting, re-sample taken in Oct. came back negative.
2018-09-24	24	0			
2018-10-01	23	1			Background count of 2
2018-10-09	25	0			Resample taken, came back negative
2018-10-15	24	0			
2018-10-22	22	1			Background count 130
2018-10-29	22	2			Background count of 5 and 6
2018-11-05	25	0			Resamples came back negative
2018-11-13	23	0			
2018-11-19	23	0			
2018-11-26	24	0			
2018-12-03	23	0			
2018-12-10	23	0			
2018-12-17	23	0			
Totals	1201	8	0	0	

5.3 Quarterly Raw and Distribution Sampling

The following extensive water quality analysis results were completed by a provincially accredited lab from the source water and within the distribution system. In 2018, there were three sampling periods. The samples were taken by City staff and sent off to CARO Analytical Services in Kelowna, BC. The results of these extensive analyses can be seen in Tables 11 through 19. Glyphosate monitoring, which was added in 2017, was included again. Haloacetic acids (HAAs), which are disinfection by-products, were included in 2018 and were sampled during three different periods and four sites during each sampling process. As seen in the tables, all of our treated water quality parameters were within the Guidelines for Canadian Drinking Water Quality.

Figure 11: CARO Anions Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (May 4, 2018)	Harrington Booster (May 4, 2018)	Raw (July 30, 2018)	Southwest #3 Booster Station (July 30, 2018)	Raw (Oct 11, 2018)	Memorial Booster Station (Oct 11, 2018)	Raw (Dec 17, 2018)	Southeast #1 Booster Station (Dec 17, 2018)
Bromide	mg/L	0.1	N/A	<0.10		<0.10		<0.10		<0.10	
Chloride	mg/L	0.1	AO<=250	2.09	5.41	0.5	0.51	0.75	5.35	0.7	4.99
Fluoride	mg/L	0.1	MAC=1.5		<0.10		<0.10		<0.10		<0.10
Nitrate as N	mg/L	0.01	MAC=10	0.042	<0.010	<0.010	<0.010	0.023	0.046	0.038	0.038
Nitrite as N	mg/L	0.01	MAC=1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phosphate, Ortho as P	mg/L	0.01	N/A		<0.0050		<0.0050		<0.0100		<0.0050
Sulfate	mg/L	1	AO<=500	6.8	7.5	5	5.1	6.7	6.8	6.8	6.8
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective								

Figure 12: CARO General Parameters Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (May 4, 2018)	Harrington Booster (May 4, 2018)	Raw (July 30, 2018)	Southwest #3 Booster Station (July 30, 2018)	Raw (Oct 11, 2018)	Memorial Booster Station (Oct 11, 2018)	Raw (Dec 17, 2018)	Southeast #1 Booster Station (Dec 17, 2018)
Colour, True	CU	5	AO<=15	9.6	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	6.3
Alkalinity, Total (as CaCO3)	mg/L	2	N/A	46.1	49.3	34.2	32.9	36.7	38.6	38.6	39.2
Alkalinity, Phenolphthalein (as CaCO3)	mg/L	2	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity, Bicarbonate (as CaCO3)	mg/L	2	N/A	46.1	49.3	34.2	32.9	36.7	38.6	38.6	39.2
Alkalinity, Carbonate (as CaCO3)	mg/L	2	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity, Hydroxide (as CaCO3)	mg/L	2	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia, Total (as N)	mg/L	0.02	N/A	<0.020		0.048		0.05			0.029
BOD, 5-day	mg/L	2	N/A	<5.5		<5.0		10.7			<6.8
Carbon, Total Organic	mg/L	0.5	N/A	3.75	2.99	2.27	1.95	2.28	2.21	2.21	1.81
Carbon, Dissolved Organic	mg/L	0.5	N/A	2.89		1.73		2.22			1.58
Cyanide, Total	mg/L	0.002	MAC=0.2		<0.0050		<0.0020		<0.0020	<0.0020	
Nitrogen, Total Kjeldahl	mg/L	0.05	N/A	17.6	6.26	0.111	<0.050	0.134	0.12	0.12	<0.050
Oil & Grease, Total	mg/L	2	N/A		<2.0		<2.0		<2.0	<2.0	
Phenolics, Total	mg/L	0.002	N/A		<0.10		<0.10		<0.10	<0.10	
Solids, Total Dissolved	mg/L	10	AO<=500	77	72	51	56	70	64	64	63
Sulfide, Total	mg/L	0.05	AO<=0.05		<0.020		<0.020		<0.020	<0.020	
Turbidity	NTU	0.1	OG<0.1	7.04	<0.10	1.79	1.02	0.82	0.12	0.12	1.42
Conductivity (EC)	uS/cm	2	N/A	110	131	79.5	93.8	95.2	112	112	89
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective								

Figure 13: CARO Calculated Parameters

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (May 4, 2018)	Harrington Booster (May 4, 2018)	Raw (July 30, 2018)	Southwest #3 Booster Station (July 30, 2018)	Raw (Oct 11, 2018)	Memorial Booster Station (Oct 11, 2018)	Raw (Dec 17, 2018)	Southeast #1 Booster Station (Dec 17, 2018)
Hardness, Total (Total as CaCO3)	mg/L	0.5	N/A	46.1	47.5	29.8	30	39.8	39.5	36.2	36
Nitrate+Nitrite as N	mg/L	0.02	N/A	0.0418	<0.0200	<0.0200	<0.0200	0.0227	0.0464	0.0381	0.0375
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective								

Figure 14: CARO Dissolved Metals Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (May 4, 2018)	Harrington Booster (May 4, 2018)	Raw (July 30, 2018)	Southwest #3 Booster Station (July 30, 2018)	Raw (Oct 11, 2018)	Memorial Booster Station (Oct 11, 2018)	Raw (Dec 17, 2018)	Southeast #1 Booster Station (Dec 17, 2018)
Aluminum, dissolved	mg/L	0.005	N/A	0.0076	0.0063	0.0108	0.0145	0.0053	0.0062	<0.0050	<0.0050
Antimony, dissolved	mg/L	0.0001	N/A	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Arsenic, dissolved	mg/L	0.0005	N/A	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Barium, dissolved	mg/L	0.005	N/A	0.0103	0.0106	0.009	0.0088	0.0098	0.0097	0.0101	0.0098
Beryllium, dissolved	mg/L	0.0001	N/A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth, dissolved	mg/L	0.0001	N/A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Boron, dissolved	mg/L	0.004	N/A	<0.0050	<0.0050	0.0111	0.0081	0.0064	0.0072	<0.0050	<0.0050
Cadmium, dissolved	mg/L	0.00001	N/A	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000011
Calcium, dissolved	mg/L	0.2	N/A	13.6	14.3	9.34	9.42	12.3	12.2	11.1	11.1
Chromium, dissolved	mg/L	0.0005	N/A	<0.00050	<0.00050	0.00053	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt, dissolved	mg/L	0.00005	N/A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper, dissolved	mg/L	0.0002	N/A	0.00191	0.00147	0.00128	0.00276	0.0012	0.00283	0.00107	0.00217
Iron, dissolved	mg/L	0.01	N/A	<0.010	<0.010	0.016	<0.010	<0.010	<0.010	<0.010	<0.010
Lead, dissolved	mg/L	0.0001	N/A	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Lithium, dissolved	mg/L	0.0001	N/A	0.00085	0.00088	0.00063	0.00064	0.0007	0.00069	0.00054	0.00054
Magnesium, dissolved	mg/L	0.01	N/A	2.91	2.84	1.56	1.58	2.19	2.17	2.05	2.03
Manganese, dissolved	mg/L	0.0002	N/A	0.00035	0.00033	0.00062	0.00049	0.00035	0.00038	<0.00020	0.0006
Mercury, dissolved	mg/L	0.00001	N/A	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum, dissolved	mg/L	0.0001	N/A	0.00067	0.00072	0.0011	0.00062	0.0009	0.00066	0.00072	0.00073
Nickel, dissolved	mg/L	0.0002	N/A	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040
Phosphorus, dissolved	mg/L	0.02	N/A	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium, dissolved	mg/L	0.02	N/A	0.98	1.01	0.64	0.65	0.86	0.86	0.75	0.76
Selenium, dissolved	mg/L	0.0005	N/A	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon, dissolved	mg/L	0.5	N/A	3.2	3.2	2.7	2.7	2.7	2.7	3.3	3.3
Silver, dissolved	mg/L	0.00005	N/A	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Sodium, dissolved	mg/L	0.02	N/A	2.44	5.65	1.21	3.5	1.87	4.99	1.62	4.22
Strontium, dissolved	mg/L	0.001	N/A	0.0918	0.0932	0.0702	0.0699	0.0761	0.075	0.0789	0.0798
Sulfur, dissolved	mg/L	1	N/A	<3.0	3.2	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Tellurium, dissolved	mg/L	0.0002	N/A	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium, dissolved	mg/L	0.00002	N/A	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Thorium, dissolved	mg/L	0.0001	N/A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin, dissolved	mg/L	0.0002	N/A	<0.00020	<0.00020	<0.00020	<0.00020	0.00029	0.00058	<0.00020	<0.00020
Titanium, dissolved	mg/L	0.005	N/A	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tungsten, dissolved	mg/L	0.001	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium, dissolved	mg/L	0.00002	N/A	0.000398	0.000215	0.00027	0.000098	0.000303	0.0001	0.000344	0.000076
Vanadium, dissolved	mg/L	0.001	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Zinc, dissolved	mg/L	0.004	N/A	<0.0040	0.0043	<0.0040	0.0072	<0.0040	<0.0040	<0.0040	<0.0040
Zirconium, dissolved	mg/L	0.0001	N/A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective								

Figure 15: CARO Total Recoverable Metals Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (May 4, 2018)	Harrington Booster (May 4, 2018)	Raw (July 30, 2018)	Southwest #3 Booster Station (July 30, 2018)	Raw (Oct 11, 2018)	Memorial Booster Station (Oct 11, 2018)	Raw (Dec 17, 2018)	Southeast #1 Booster Station (Dec 17, 2018)
Aluminum, total	mg/L	0.005	OG<0.1	0.161	0.0081	0.0679	0.0203	0.0266	0.0078	0.0297	0.0065
Antimony, total	mg/L	0.0002	MAC=0.006	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Arsenic, total	mg/L	0.0005	MAC=0.01	<0.00050	0.00055	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Barium, total	mg/L	0.005	MAC=1	0.0136	0.0115	0.0096	0.0094	0.0107	0.0099	0.0111	0.0103
Beryllium, total	mg/L	0.0001	N/A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth, total	mg/L	0.0001	N/A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Boron, total	mg/L	0.005	MAC=5	0.0073	0.009	0.0094	0.0082	0.0051	0.0097	0.0077	0.0091
Cadmium, total	mg/L	0.00001	MAC=0.005	0.000015	0.000011	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Calcium, total	mg/L	0.2	None Required	14.6	15.5	11.2	11.1	12.3	12.4	12.9	12.9
Chromium, total	mg/L	0.0005	MAC=0.05	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt, total	mg/L	0.0001	N/A	0.00015	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper, total	mg/L	0.0004	AO<=1	0.00334	0.00325	0.00239	0.00232	0.00173	0.00348	0.00176	0.00387
Iron, total	mg/L	0.01	AO<=0.3	0.246	0.012	0.036	<0.010	0.05	<0.010	0.052	0.016
Lead, total	mg/L	0.0002	MAC=0.01	<0.00020	0.00023	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Lithium, total	mg/L	0.0001	N/A	0.00103	0.00093	0.00071	0.00067	0.00081	0.00078	0.00066	0.00064
Magnesium, total	mg/L	0.01	None Required	3.1	3.06	1.76	1.77	2.25	2.26	2.28	2.22
Manganese, total	mg/L	0.0002	AO<=0.05	0.0117	0.00117	0.00247	0.00144	0.00463	0.00058	0.00488	0.00121
Mercury, total	mg/L	0.00001	MAC=0.001	<0.000010	<0.000010	<0.000010	<0.000010	<0.0050	<0.000010	<0.000010	<0.000010
Molybdenum, total	mg/L	0.0001	N/A	0.00069	0.00077	0.00063	0.00061	0.00063	0.00063	0.00069	0.00073
Nickel, total	mg/L	0.0004	N/A	0.00088	<0.00040	0.00085	<0.00040	<0.00040	<0.00040	0.00076	<0.00040
Phosphorus, total	mg/L	0.05	N/A	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium, total	mg/L	0.1	N/A	1.05	1.08	0.75	0.76	0.88	0.89	0.83	0.81
Selenium, total	mg/L	0.0005	MAC=0.05	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon, total	mg/L	1	N/A	3.9	3.6	2.9	2.8	3.1	3.1	3.5	3.4
Silver, total	mg/L	0.00005	None Required	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Sodium, total	mg/L	0.1	AO<=200	2.48	5.96	1.48	4.16	1.86	5.14	1.8	4.66
Strontium, total	mg/L	0.001	N/A	0.0982	0.102	0.0691	0.0696	0.0769	0.0772	0.0838	0.0847
Sulfur, total	mg/L	3	N/A	<3.0	<3.0	<3.0	<3.0	<3.0	3	<3.0	<3.0
Tellurium, total	mg/L	0.0005	N/A	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium, total	mg/L	0.00002	N/A	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Thorium, total	mg/L	0.0001	N/A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin, total	mg/L	0.0002	N/A	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium, total	mg/L	0.005	N/A	0.0073	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tungsten, total	mg/L	0.001	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium, total	mg/L	0.00002	MAC=0.02	0.000452	0.000242	0.000303	0.000101	0.000327	0.000103	0.000363	0.00008
Vanadium, total	mg/L	0.001	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Zinc, total	mg/L	0.004	AO<=5	0.0068	0.0093	<0.0040	0.0045	<0.0040	<0.0040	<0.0040	0.0044
Zirconium, total	mg/L	0.0001	N/A	0.00014	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010

MAC = Maximum Acceptable Concentration AO = Aesthetic objective

Figure 16: CARO Pesticides, Herbicides and Fungicides Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (May 4, 2018)	Harrington Booster (May 4, 2018)	Raw (July 30, 2018)	Southwest #3 Booster Station (July 30, 2018)	Raw (Oct 11, 2018)	Memorial Booster Station (Oct 11, 2018)	Raw (Dec 17, 2018)	Southeast #1 Booster Station (Dec 17, 2018)
Glyphosate	mg/L	0.05	MAC=0.28		<0.050				<0.050		<0.050
Alachlor	ug/L	0.1	N/A		<0.100				<0.100		<0.100
Aldrin	ug/L	0.006	N/A		<0.006				<0.006		<0.006
Atrazine	ug/L	0.1	N/A		<0.100				<0.100		<0.100
Azinphos-methyl	ug/L	0.2	MAC=20		<0.200				<0.200		<0.200
alpha-BHC	ug/L	0.01	N/A		<0.010				<0.010		<0.010
beta-BHC	ug/L	0.05	N/A		<0.050				<0.050		<0.050
delta-BHC	ug/L	0.05	N/A		<0.050				<0.050		<0.050
gamma-BHC (Lindane)	ug/L	0.05	N/A		<0.050				<0.050		<0.050
Bromacil	ug/L	0.1	N/A		<0.100				<0.100		<0.100
Captan	ug/L	0.1	N/A		<0.100				<0.100		<0.100
alpha-Chlordane	ug/L	0.05	N/A		<0.050				<0.050		<0.050
gamma-Chlordane	ug/L	0.05	N/A		<0.050				<0.050		<0.050
Chlordane (cis + trans)	ug/L	0.05	N/A		<0.050				<0.050		<0.050
Chlorothalonil	ug/L	0.05	N/A		<0.050				<0.050		<0.050
Chlorpyrifos	ug/L	0.01	MAC=90		<0.010				<0.010		<0.010
Cyanazine	ug/L	0.1	N/A		<0.100				<0.100		<0.100
p,p-DDD	ug/L	0.01	N/A		<0.010				<0.010		<0.010
p,p-DDE	ug/L	0.01	N/A		<0.010				<0.010		<0.010
p,p-DDT	ug/L	0.01	N/A		<0.010				<0.010		<0.010
Diazinon	ug/L	0.02	MAC=20		<0.020				<0.020		<0.020
Dichlorvos	ug/L	0.1	N/A		<0.100				<0.100		<0.100
Dieldrin	ug/L	0.01	N/A		<0.010				<0.010		<0.010
Dimethoate	ug/L	0.2	MAC=20		<0.200				<0.200		<0.200
Disulfoton	ug/L	0.1	N/A		<0.100				<0.100		<0.100
Endosulfan I	ug/L	0.01	N/A		<0.010				<0.010		<0.010
Endosulfan II	ug/L	0.01	N/A		<0.010				<0.010		<0.010
Endosulfan sulfate	ug/L	0.05	N/A		<0.050				<0.050		<0.050
Endrin	ug/L	0.02	N/A		<0.020				<0.020		<0.020
Endrin aldehyde	ug/L	0.02	N/A		<0.020				<0.020		<0.020
Endrin ketone	ug/L	0.02	N/A		<0.020				<0.020		<0.020
Fenchlorphos (Ronnel)	ug/L	0.1	N/A		<0.100				<0.100		<0.100
Heptachlor	ug/L	0.01	N/A		<0.010				<0.010		<0.010
Heptachlor epoxide	ug/L	0.01	N/A		<0.010				<0.010		<0.010
Malathion	ug/L	0.1	MAC=190		<0.100				<0.100		<0.100
Methyl parathion	ug/L	0.1	N/A		<0.100				<0.100		<0.100
Metolachlor	ug/L	0.1	MAC=50		<0.100				<0.100		<0.100
Metribuzin	ug/L	0.2	MAC=80		<0.200				<0.200		<0.200
Parathion	ug/L	0.1	N/A		<0.100				<0.100		<0.100
Pentachloronitrobenzene	ug/L	0.1	N/A		<0.100				<0.100		<0.100
cis-Permethrin	ug/L	0.01	N/A		<0.010				<0.010		<0.010
trans-Permethrin	ug/L	0.01	N/A		<0.010				<0.010		<0.010
Phorate	ug/L	0.1	MAC=2		<0.100				<0.100		<0.100
Simazine	ug/L	0.2	MAC=10		<0.200				<0.200		<0.200
Sulfotep	ug/L	0.1	N/A		<0.100				<0.100		<0.100
Terbufos	ug/L	0.1	MAC=1		<0.100				<0.100		<0.100
Triallate	ug/L	0.1	N/A		<0.100				<0.100		<0.100
Trifluralin	ug/L	0.2	MAC=45		<0.200				<0.200		<0.200

MAC = Maximum Acceptable Concentration AO = Aesthetic objective

Figure 17: CARO Polycyclic Aromatic Hydrocarbon (PAH) Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (May 4, 2018)	Harrington Booster (May 4, 2018)	Harrington Booster Retest (May 29, 2018)	Raw (July 30, 2018)	Southwest #3 Booster Station (July 30, 2018)	Raw (Oct 11, 2018)	Memorial Booster Station (Oct 11, 2018)	Raw (Dec 17, 2018)	Southeast #1 Booster Station (Dec 17, 2018)
Acenaphthene	ug/L	0.05	N/A		<0.050	<0.050		<0.050		<0.050		<0.050
Acenaphthylene	ug/L	0.2	N/A		<0.200	<0.200		<0.200		<0.200		<0.200
Acridine	ug/L	0.05	N/A		<0.050	<0.050		<0.050		<0.050		<0.050
Anthracene	ug/L	0.01	N/A		<0.010	<0.010		<0.010		<0.010		<0.010
Benz(a)anthracene	ug/L	0.01	N/A		<0.010	<0.010		<0.010		<0.010		<0.010
Benzo(a)pyrene	ug/L	0.01	MAC=0.04		<0.010	<0.010		<0.010		<0.010		<0.010
Benzo(b+j)fluoranthene	ug/L	0.05	N/A		<0.050	<0.050		<0.050		<0.050		<0.050
Benzo(g,h,i)perylene	ug/L	0.05	N/A		<0.050	<0.050		<0.050		<0.050		<0.050
Benzo(k)fluoranthene	ug/L	0.05	N/A		<0.050	<0.050		<0.050		<0.050		<0.050
2-Chloronaphthalene	ug/L	0.1	N/A		<0.100	<0.100		<0.100		<0.100		<0.100
Chrysene	ug/L	0.05	N/A		<0.050	<0.050		<0.050		<0.050		<0.050
Dibenz(a,h)anthracene	ug/L	0.01	N/A		0.012	<0.010		<0.010		<0.010		<0.010
Fluoranthene	ug/L	0.03	N/A		<0.030	<0.030		<0.030		<0.030		<0.030
Fluorene	ug/L	0.05	N/A		<0.050	<0.050		<0.050		<0.050		<0.050
Indeno(1,2,3-cd)pyrene	ug/L	0.05	N/A		<0.050	<0.050		<0.050		<0.050		<0.050
Naphthalene	ug/L	0.2	N/A		<0.100	<0.100		<0.100		<0.100		<0.100
1-Methylnaphthalene	ug/L	0.1	N/A		<0.100	<0.100		<0.100		<0.100		<0.100
2-Methylnaphthalene	ug/L	0.1	N/A		<0.200	<0.200		<0.200		<0.200		<0.200
Phenanthrene	ug/L	0.1	N/A		<0.100	<0.100		<0.100		<0.100		<0.100
Pyrene	ug/L	0.02	N/A		<0.020	<0.020		<0.020		<0.020		<0.020
Quinoline	ug/L	0.05	N/A		<0.050	<0.050		<0.050		<0.050		<0.050

MAC = Maximum Acceptable Concentration AO = Aesthetic objective

Figure 18: CARO Volatile Organic Compounds (VOC) Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (May 4, 2018)	Harrington Booster (May 4, 2018)	Raw (July 30, 2018)	Southwest #3 Booster Station (July 30, 2018)	Raw (Oct 11, 2018)	Memorial Booster Station (Oct 11, 2018)	Raw (Dec 17, 2018)	Southeast #1 Booster Station (Dec 17, 2018)
Benzene	ug/L	0.5	MAC=5		<0.5		<0.5		<0.5		<0.5
Bromodichloromethane	ug/L	1	N/A		2.9		<1.0		4.4		4
Bromoform	ug/L	1	N/A		<1.0		<1.0		9.5		7.1
Carbon tetrachloride	ug/L	0.5	MAC=2		<0.5		<0.5		<0.5		<0.5
Chlorobenzene	ug/L	1	AO<=30		<1.0		<1.0		<1.0		<1.0
Chloroethane	ug/L	2	N/A		<2.0		<2.0		<2.0		<2.0
Chloroform	ug/L	1	N/A		75.6		38		34.7		37.5
Dibromochloromethane	ug/L	1	N/A		<1.0		<1.0		3.5		2.6
1,2-Dibromoethane	ug/L	0.3	N/A		<0.3		<0.3		<0.3		<0.3
Dibromomethane	ug/L	1	N/A		<1.0		<1.0		<1.0		<1.0
1,2-Dichlorobenzene	ug/L	0.5	AO<=3		<0.5		<0.5		<0.5		<0.5
1,3-Dichlorobenzene	ug/L	1	N/A		<1.0		<1.0		<1.0		<1.0
1,4-Dichlorobenzene	ug/L	1	AO<=1		<1.0		<1.0		<1.0		<1.0
1,1-Dichloroethane	ug/L	1	N/A		<1.0		<1.0		<1.0		<1.0
1,2-Dichloroethane	ug/L	1	MAC=5		<1.0		<1.0		<1.0		<1.0
1,1-Dichloroethylene	ug/L	1	MAC=14		<1.0		<1.0		<1.0		<1.0
cis-1,2-Dichloroethylene	ug/L	1	N/A		<1.0		<1.0		<1.0		<1.0
trans-1,2-Dichloroethylene	ug/L	1	N/A		<1.0		<1.0		<1.0		<1.0
Dichloromethane	ug/L	3	MAC=50		<3.0		<3.0		<3.0		<3.0
1,2-Dichloropropane	ug/L	1	N/A		<1.0		<1.0		<1.0		<1.0
3-Dichloropropene (cis + trar	ug/L	1	N/A		<1.0		<1.0		<1.0		<1.0
Ethylbenzene	ug/L	1	AO<=1.6		<1.0		<1.0		<1.0		<1.0
Methyl tert-butyl ether	ug/L	1	AO<=15		<1.0		<1.0		<1.0		<1.0
Styrene	ug/L	1	N/A		<1.0		<1.0		<1.0		<1.0
1,1,2,2-Tetrachloroethane	ug/L	0.5	N/A		<0.5		<0.5		<0.5		<0.5
Tetrachloroethylene	ug/L	1	MAC=10		<1.0		<1.0		<1.0		<1.0
Toluene	ug/L	1	AO<=24		<1.0		<1.0		<1.0		<1.0
1,1,1-Trichloroethane	ug/L	1	N/A		<1.0		<1.0		<1.0		<1.0
1,1,2-Trichloroethane	ug/L	1	N/A		<1.0		<1.0		<1.0		<1.0
Trichloroethylene	ug/L	1	MAC=5		<1.0		<1.0		<1.0		<1.0
Trichlorofluoromethane	ug/L	1	N/A		<1.0		<1.0		<1.0		<1.0
Vinyl chloride	ug/L	1	MAC=2		<1.0		<1.0		<1.0		<1.0
Xylenes (total)	ug/L	2	AO<=20		<2.0		<2.0		<2.0		<2.0

MAC = Maximum Acceptable Concentration AO = Aesthetic objective

Figure 19: CARO Haloacetic Acid Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	May-18				Aug-18				Nov-18			
Sampling Sites				Knutsford Hills Booster	Campbell Cr Booster	C.R.E.D.S.	Noble Creek Domestic Booster	Simms Rd. Booster	Super Save Gas - CC	Fortune Dr. Petro Can	Noble Creek Domestic Booster	Lac Le Jeune Resevoir	Knutsford Hills Booster	Super Save Gas - CC	Noble Creek Domestic
Monochloroacetic Acid	mg/L	0.002	N/A	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	0.0048	< 0.0020	< 0.0020	< 0.0020
Monobromoacetic Acid	mg/L	0.002	N/A	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Dichloroacetic Acid	mg/L	0.002	N/A	0.0326	0.0304	0.0288	0.0258	0.029	0.0051	0.0197	0.0127	0.0033	0.0142	0.004	0.0079
Trichloroacetic Acid	mg/L	0.002	N/A	0.0332	0.0329	0.0335	0.0314	0.0276	0.0298	0.0197	0.0301	0.0274	0.0305	0.0288	0.03
Dibromoacetic Acid	mg/L	0.002	N/A	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Total Haloacetic Acids (HAA5)	mg/L	0.020	MAC = 0.08	0.0658	0.0633	0.0623	0.0572	0.0566	0.0349	0.0394	0.0428	0.0355	0.0447	0.0328	0.0378

MAC = Maximum Acceptable Concentration AO = Aesthetic objective