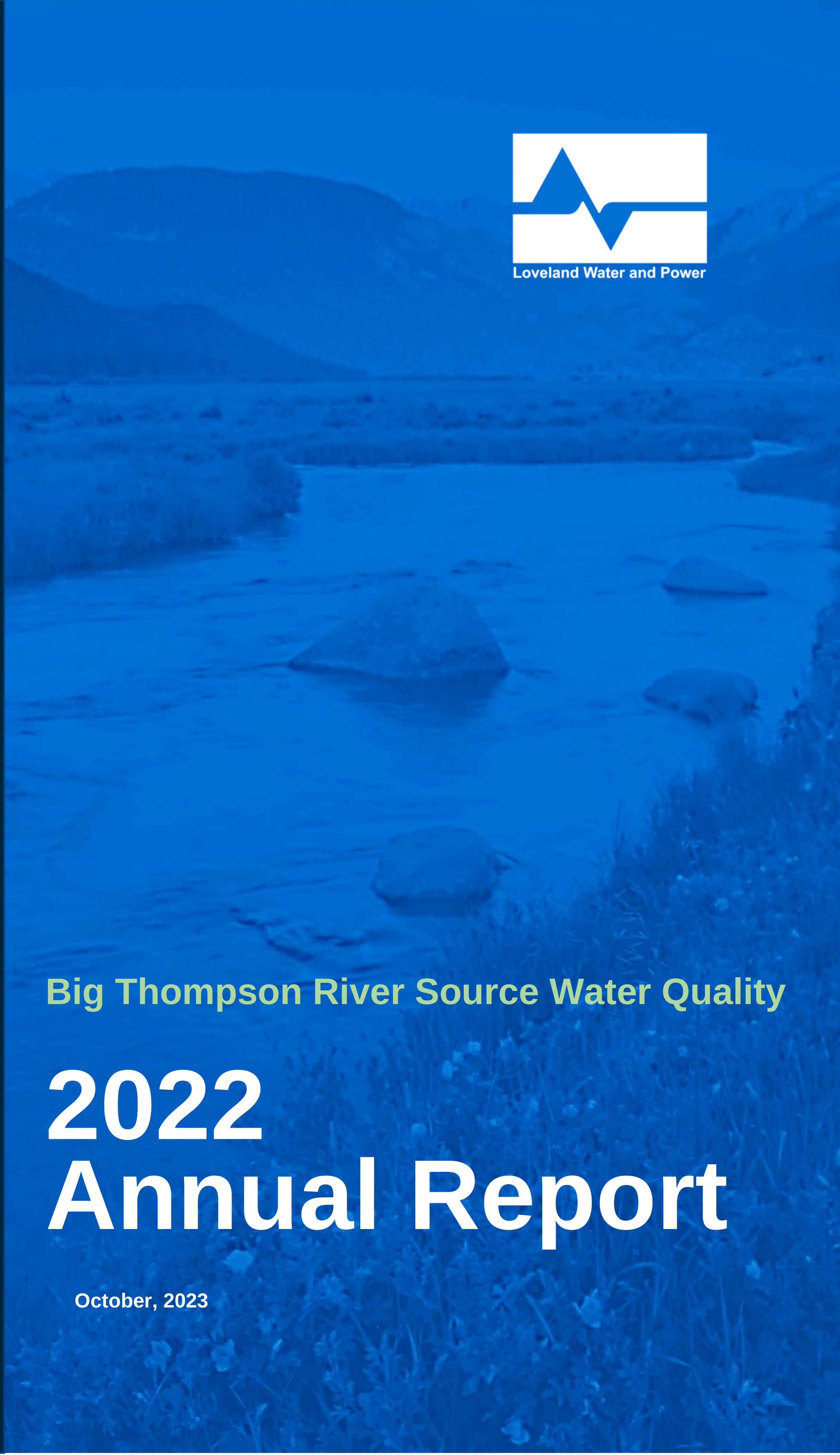
Loveland Water and Power



Loveland Water and Power

Big Thompson River Source Water Quality

2022 Annual Report

October, 2023

Contents

Common Acronyms

BTWF	Big Thompson Watershed Forum
CFS	Cubic Feet per Second
CPF	Cameron Peak Fire
CSWMP	Cooperative Source Water Monitoring Program
DO	Dissolved Oxygen
LWP	Loveland Water and Power
mg/L	Milligrams per liter (parts per million)
$CaCO_3$	Calcium carbonate
NTU	Nephelometric Turbidity Unit
North Fork	North Fork of the Big Thompson River
SU	Standard Units
SWMP	Source Water Monitoring Program
TOC	Total Organic Carbon
ug/L	Micrograms per liter (parts per billion)
uS/cm	Microsiemens per centimeter
USGS	United States Geological Survey

Executive Summary

The Big Thompson River is the primary source of drinking water for the City of Loveland, CO and its water quality continues to be generally good. Some parameters suggested better water quality in 2022 compared to recent years while others, primarily those associated with negative effects of the Cameron Peak Fire, indicated somewhat worse water quality. While there were some negative water quality impacts from the CPF, Loveland Water and Power (LWP) staff were able to utilize drinking water sources and treatment to effectively manage these effects. Significant long-term trends suggest continued water quality improvements, particularly with regard to declining dissolved copper and nutrients. However, increasing chloride and total dissolved solid concentrations at a number of locations, while not currently at levels of particular concern, are notable.

In 2022, the cooperative source water monitoring program (CSWMP) between Loveland Water and Power (LWP) and the United States Geological Survey (USGS) collected samples that provided information on 54 different water quality parameters, representing a variety of different aspects of water quality, from nine locations within the Big Thompson River watershed. Sampling occurred from February through November. Sampling has occurred at these locations for more than 20 years. This long time series and relatively broad range of parameters provides a good understanding of the state of water quality as well as changes over time.

Water quality continued to be affected by the CPF particularly during the summer monsoon season and in the most severely burned portion of the watershed surrounding the North Fork of the Big Thompson River (North Fork). Water quality parameters including dissolved manganese, turbidity, and inorganic nitrogen were all elevated, particularly in the North Fork during spring runoff and summer monsoon and these elevated values continued downstream below the confluence with the mainstem. These increases are similar to those measured in 2021, suggesting that while there may be some indications of fire recovery, water quality effects of the fire continue and are likely to be apparent for several more years.

There were several parameters that were somewhat better in terms of water quality than the previous ten-year period and some that were somewhat worse. Improvements in 2022 included: 1) relatively low concentrations of copper across sites, 2) low nitrate + nitrite concentrations at all sites except in the North Fork, and 3) low orthophosphate concentrations, particularly at the site below the LWP Water Reclamation Facility discharge. These improvements were also apparent in 2021, which is a positive indication of improving water quality. Water quality also declined in 2022 with regard to some parameters at some locations including, 1) reduced dissolved oxygen levels downstream of the LWP Water Reclamation Facility, 2) continued high turbidity in the North Fork, 3) lower pH at the sites near the Loveland Water Reclamation Facility (both above and below), 4) elevated *E. coli* concentrations at all sites, and 4) elevated dissolved manganese concentrations in the North Fork and downstream of its confluence with the mainstem. While not necessarily considered positive or negative in its own right, alkalinity levels were somewhat elevated at all sampling locations.

A number of water quality parameters demonstrated significant positive or negative trends at particular sites or portions of the river over the past decade. Similar to 2021, dissolved copper concentrations decreased significantly across all sites. These declines could be in part due to the fact that tree mortality associated with bark and pine beetles has decreased in the past decade (Fayram et al. 2019). Nutrients also declined significantly in some portions of the watershed. Inorganic nitrogen declined significantly at several sites including all sites in the lower portion of the watershed. Orthophosphate declined significantly at sites both above and below the LWP Water Reclamation Facility but more substantially at the site below. LWP installed a biological nutrient removal system in 2018. pH values have declined in several sites on the mainstem of the Big Thompson River. The cause of this decline is unknown. Finally, dissolved sodium, chloride, and total dissolved solids have increased significantly in several sites in the lower portion of the Big Thompson River Canyon. These increases are potentially caused by sodium and chloride products used to improve driving conditions in the winter months.

Introduction

The purpose of the Loveland Water and Power (LWP) Source Water Monitoring Program (SWMP) is to collect, analyze, and interpret water quality data that are of interest with regard to drinking water, wastewater, recreation, and aquatic ecosystems. These data are used to identify and quantify current issues, document management successes, evaluate regulatory compliance and the appropriateness of current water quality standards, and identify issues that may present themselves in the future.

One central component of the SWMP is the cooperative source water monitoring that occurs in partnership with the United States Geological Survey (CSWMP). The United States Geological Survey (USGS) is recognized as one of the world leaders in water quality data collection, analysis, and data storage. USGS has participated in data collection efforts in the Big Thompson River for over 20 years and its database includes a wide range of water quality parameters. Sites were previously sampled as a result of a cooperative agreement between the Big Thompson Watershed Forum (BTWF) and the USGS. Loveland Water and Power was a substantial contributor to the BTWF. The BTWF ceased data collection efforts in 2020. LWP, recognizing the importance of this dataset and its continuity, assumed the partnership role with the USGS in 2021. This partnership assured the continuation of important water quality data collection and allowed the efforts to better reflect the needs of LWP. The USGS collects and analyzes a subset of water quality samples as requested by LWP Water Quality Laboratory Staff. Resulting data are statistically analyzed and summarized as appropriate to address water quality questions and issues of interest to LWP.

Historic USGS water quality data in the Big Thompson River are substantial in breadth and depth. For over 20 years, more than 40 parameters have been collected on a monthly basis from 9-15 core sites within the watershed. The fact that these data are standardized, easily available (https://www.waterqualitydata.us/), have a long time series, and include a large number of parameters, provides opportunities to quantitatively evaluate long term trends (e.g. Stets et al. 2020, Stevens 2003), investigate potential causes of changes in water quality (e.g. Fayram et al. 2019, Voelz et al. 2005), be included in broad-scale investigations that may be of local utility (Kaushal et al. 2018, Spahr et al. 2010), and characterize changes to water quality in response to management actions or natural events (e.g. Mast et al. 2016). The diversity of parameters sampled increases the likelihood that long-term historical data will exist to examine the status of various river segments with regard to new or changing regulations or circumstances. The ready access of current and historic data means that more people will be examining and utilizing Big Thompson River Watershed information. The greater the exposure, the higher the likelihood that analyses relevant to LWP and the watershed as a whole will take place.

Scope

Data, summary statistics, and results presented are those collected and analyzed by USGS staff at the direction of LWP (and previously BTWF) over the past 10 years. While the 10-year time period is an arbitrary length of time, it is long enough for significant trends to emerge, or begin to emerge, and also short enough to adequately reflect current ambient conditions. The annual sampling frequency of these data is 10 months/year (February-November) as this follows the historical data collection schedule. This frequency is also sufficient to capture seasonal events and is representative of annual conditions in general (Giardullo 2006). The objective of this annual report is to summarize CSWMP data collected in 2022, compare sample results to established water quality standards and comparable data collected over the past 10 years, and to quantify any significant temporal trends in water quality parameters which may exist. Results can aid in identifying emerging water quality issues, which can in turn be used to begin developing appropriate water treatment and watershed management activities.

Sampling Locations

The CSWMP includes nine core sites located from the headwaters of the Big Thompson River in Rocky Mountain National Park to the plains portion of the watershed past the City of Loveland (Figure 1, Table 1). Cumulatively, these sites provide an opportunity to understand the condition of the watershed as a whole. In addition, each sampling location has site specific characteristics of interest. For example, downstream or upstream of the LWP wastewater discharge.

Table 1. USGS Cooperative Surface Water Monitoring Program location descriptions.

Site	USGS Site Name	Water Body	Description	Latitude	Longitude
M10	402114105350101	Big Thompson River	Downstream of Moraine Park USGS Benchmark Site	40 21’ 14’’	105 35’ 01’’
M30	402245105302300	Big Thompson River	Downstream of Estes Park Sanitation District Outlet	40 22' 45"	105 30' 23"
M50	402249105282000	Big Thompson River	Downstream of Upper Thompson Sanitation District Outlet	40 22' 49"	105 28' 20"
M60	402554105202100	Big Thompson River	Upstream of the confluence with the North Fork Big Thompson River	40 25' 54"	105 20' 21"
M70	06736700	Big Thompson River	Upstream of Dille Tunnel diversion	40 24' 54"	105 15' 00"
M90	40253310512430	Big Thompson River	Upstream of Loveland drinking water intake	40 25' 33"	105 12' 43"
M130	06741510	Big Thompson River	Upstream of Loveland Water Reclamation Facility outlet	40 22' 43"	105 03' 38"
M140	06741520	Big Thompson River	Downstream of Loveland Water Reclamation Facility outlet	40 23' 00"	105 01' 45"
T10	06736000	North Fork Big Thompson River	Upstream of the confluence with the Big Thompson River	40 26' 00"	105 20' 18"

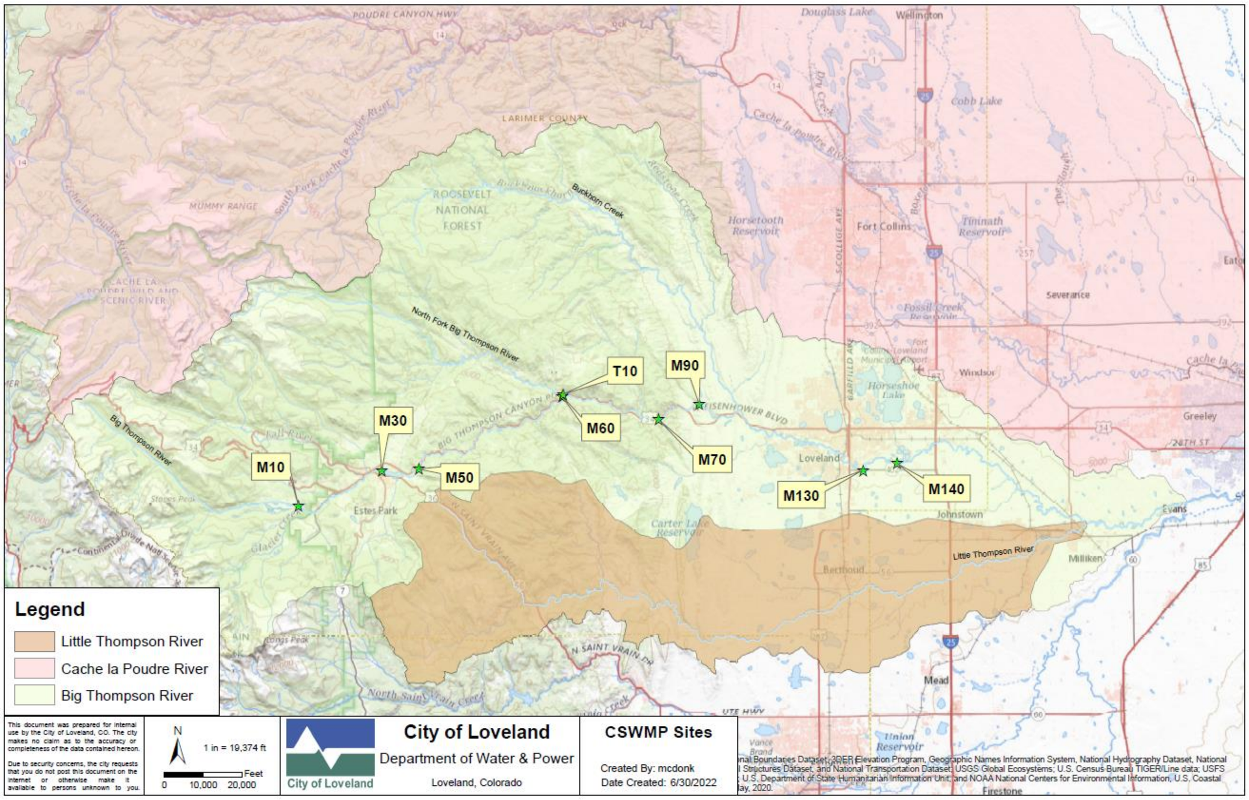


Figure 1. USGS Cooperative Surface Water Monitoring Program locations.

The sampling locations included in this report are those that have a long history of data collection as well as a specific rationale for inclusion. However, the USGS has historically collected water quality information at 37 sites within the Big Thompson Watershed and the eastern slope portion of the Colorado-Big Thompson Project. Data collected from some of the discontinued sites were collected for a specific short-term purpose and others were discontinued due to budgetary and/or logistic constraints.

Cameron Peak Fire

The Cameron Peak Fire (CPF) occurred between August 13th, 2020 and December 2nd, 2020 and burned 208,913 acres, of which 65,275 acres (31%) was in the Big Thompson River Watershed (Figure 2). In total 10% of the watershed above the LWP drinking water intake was burned. Wildfires can have negative impacts on a wide array of water quality parameters and some of these parameters are of particular interest to water providers as they can negatively impact the drinking water supply. In addition, these effects were still apparent in 2022 and may continue to be apparent for five years or more (Rust et al. 2018). The impact of the fire was large enough to result in negative water quality impacts but was small enough that the LWP Water Treatment Plant was able to successfully treat the water and continue to provide safe and clean drinking water. However, additional costs were incurred.

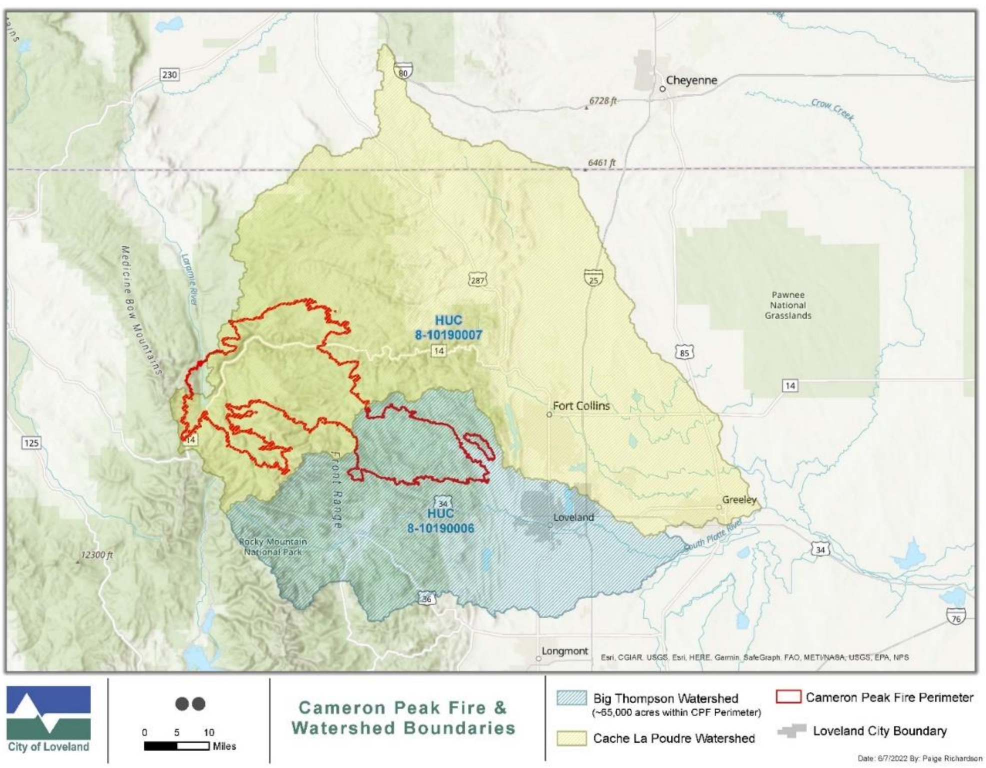


Figure 2. Cameron Peak Fire perimeter in the context of the Cache la Poudre and Big Thompson River Watersheds

The Black Creek/Miller Fork area was identified as an “Area of Greatest Concern” as well as being identified as “suitable for treatment” (i.e. moderate slope, high to moderate soil burn severity, and not bare ground) in Cameron Peak Fire Risk Assessment (Larimer County 2021). Flooding in Black Creek/Miller Fork overtopped many culverts and washed-out roads in several locations. To help mitigate these effects, LWP partnered with the City of Greeley and the Big Thompson River Coalition in 2021 to provide mulch to cover 754 acres of the most severely burned portion of this area. In 2022, similar efforts occurred, with assistance from the United States Forest Service, to provide mulch to a similar area of appropriate burned locations.

The staff at LWP Water Treatment Plant were able to continue to provide water that meets and exceeds all relevant standards despite wildfire effects. The fact that water quality effects of the CPF were visible but also manageable provided the opportunity to prepare for likely effects of the next wildfire which may be more severe. LWP has partnered with USGS Research staff to utilize long term data from stations in the most severely burned areas to develop models that are intended to quantify the magnitude of changes in various water quality parameters that can be attributed to wildfire. With these models, which are expected to be available in early 2024, LWP can better prepare to respond to inevitable fire activity within the Big Thompson River Watershed.

Although the water quality effects of the CPF on the Big Thompson River are still apparent, their magnitude may be dissipating somewhat. As such, LWP has begun to transition to efforts focused on reducing the likelihood and severity of the next wildfire. The City of Loveland only owns a very small amount of land in the Big Thompson River Watershed, therefore partnering with organizations that own land or have the ability to manage land use on private property is an important mechanism for Loveland to protect the water resources upon which it relys on. In addition to broad partnerships with important organizations such as the United States Forest Service, LWP is providing direct support to organizations such as the Big Thompson Watershed Coalition and the Larimer Conservation District to obtain grants and actively manage forests in the Big Thompson River Watershed.

Methods

Parameter Summaries

Each year, at least 49 different water quality parameters (Table 2) are quantified from water samples collected at nine sites in 10 months of the year. Data associated with additional parameters and/or months are collected due to regulatory requirements or site-specific conditions (e.g. dissolved selenium). The months of December and January have historically been excluded from sampling efforts due to difficult field conditions and the fact that water quality parameters are generally stable during the winter months.

Additional focus is placed on a subset of 16 parameters are either commonly used to characterize water quality or are of potential concern regarding water quality standards. These parameters include flow, water temperature, specific conductance, dissolved oxygen, pH, alkalinity, total organic carbon, hardness, sulfate, turbidity, dissolved copper, dissolved manganese, dissolved selenium, nitrate + nitrite, orthophosphate, and *E. coli*. Specifically, the relative spread of data for each parameter at each site sampled between 2012 and 2022 is presented with box plots. The box plots also provide a reference point for the relative value of data collected in 2022.

A number of aquatic life use and drinking water standards apply to the principal parameters examined (Tables 3 and 4) and 2022 data were compared to these standards to provide a relative indication of the degree to which they are being met at the sampling locations. These standards are meant to be protective of aquatic ecosystems and human health. Water quality standards are used to provide context for the purpose of evaluating water quality status within and/or between sites. These comparisons are not meant to substitute for a formal surface water quality regulatory assessment under the federal Clean Water Act.

Table 2. Name, associated laboratory, analysis method, and detection limits of parameters included in 2022 sampling efforts.

Parameter	Detection Level	Laboratory	USGS Method
Barometric Pressure	n/a	USGS Field Staff	BAROM
Instantaneous Flow	n/a	USGS Field Staff	QSCMM
Oxygen, Dissolved	n/a	USGS Field Staff	LUMIN
pH	n/a	USGS Field Staff	PROBE
Specific Conductance	n/a	USGS Field Staff	SC001
Stream Width	n/a	USGS Field Staff	-
Temperature, Water	n/a	USGS Field Staff	THM01
Acidity (H+)	n/a	NWQL	ALGOR
Alkalinity	4 mg/L	NWQL	TT040
Aluminum, Total	3 ug/L	NWQL	PLM77
Ammonia and Ammonium, Dissolved	0.2 mg/L	NWQL	SHC02
Arsenic, Dissolved	0.1 ug/L	NWQL	PLM10
Calcium, Dissolved	0.02 mg/L	NWQL	PLA11
Carbon Dioxide	n/a	NWQL	ALGOR
Chloride, Dissolved	0.02 mg/L	NWQL	ICO02
Chlorophyll a	0.1 ug/L	NWQL	50
Chromium, Total	0.5 ug/L	NWQL	PLM77
Copper, Dissolved	0.4 ug/L	NWQL	PLM10
Copper, Total	0.4 ug/L	NWQL	PLM77
E. coli	1 CFU/100 mL	LWQL	Colilert© Quantitray
Fluoride, Dissolved[#]	0.01 mg/L	NWQL	IC003
Hardness, Ca, Mg	n/a	NWQL	ALGOR
Hardness, Non-carbonate	n/a	NWQL	ALGOR
Inorganic Nitrogen, Dissolved	0.01 mg/L	NWQL	RED02
Iron, Dissolved	5 ug/L	NWQL	PLA11
Kjeldahl Nitrogen, Total	0.07 mg/L	NWQL	KJ008
Lead, Dissolved	0.02 ug/l	NWQL	PLM43
Magnesium, Dissolved	0.01 mg/L	NWQL	PLA11
Manganese, Dissolved	0.4 ug/L	NWQL	PLM43
Manganese, Total	0.4 ug/l	NWQL	PLM78
Nickel, Dissolved	0.2 ug/l	NWQL	PLM10
Nitrate, Dissolved, (as N)	n/a	NWQL	ALGOR
Nitrite, Dissolved (as N)	0.001 mg/L	NWQL	DZ001
Nitrite, Dissolved (as NO2)	n/a	NWQL	ALGOR
Nitrogen, Mixed Forms (NH3, NH4, NO2, NO3), Total	n/a	NWQL	ALGOR
Organic Carbon, Total	0.7 mg/L	LWQL	COM89
Organic Nitrogen, Total	n/a	NWQL	ALGOR
Orthophosphate, Dissolved (as P)	0.004 mg?L	NWQL	PHM01
Pheophytin a	0.1 ug/L	NWQL	50
Phosphorus, Dissolved (as P)	0.003 mg/L	NWQL	CL020
Phosphorus, Total (as P)	0.003 mg/L	NWQL	CL021
Potassium, Dissolved	0.3 mg/L	NWQL	PLO03
Selenium, Dissolved*	0.05 ug/L	NWQL	PLM10
Silica, Dissolved	0.05 mg/L	NWQL	PLA11
Silver, Dissolved	1 ug/L	NWQL	PLM43
Sodium Adsorption Ratio	n/a	NWQL	ALGOR
Sodium, Dissolved	0.4 mg/L	NWQL	PLA11
Sodium, Percent Total Cations	n/a	NWQL	ALGOR
Sulfate, Dissolved	0.02 mg/L	NWQL	ICO02
Total Dissolved Solids	20 mg/L	NWQL	ROE10
Turbidity	2 NTU	NWQL	TS098

Temporal Trends

All 49 water quality parameters were analyzed for temporal trends over the past decade using a non-parametric seasonal Mann-Kendall trend test. Parameter values below detection limits were set to half of the detection limit or were omitted if detection limit values were not available. The non-parametric nature of this test indicates that data do not need to be normally distributed and that the effect of outliers is minimized, both of which are generally advantageous when analyzing water quality data. The primary disadvantages to this test are that the power to detect a trend is somewhat lower than for parametric tests (Mozejko 2012) and that a significant trend can include a somewhat misleading slope of zero. While a slope of zero intuitively implies lack of a trend, the Mann-Kendall test measures the direction of increases or decreases over time, not the magnitude. Therefore, it is possible that a large enough proportion of the samples are increasing (or decreasing) over time to provide a significant result, but the offsetting magnitudes of increases and decreases may result in a slope of zero. For example, if a parameter were to increase each year by a small amount (e.g., 1 unit) for 10 years and then decrease by a large amount (e.g. 10 units) in the next year, the number of increases would be 10 and the number of decreases would be 1, providing evidence of a significant upward trend. However, the resulting slope based on the magnitude of the increases and decreases would be approximately flat or zero.

An additional consideration in interpreting statistical results is the relationship between the large number of tests and the alpha level. The alpha level considered to be significant is $p = 0.05$ which suggests that one out of every twenty tests will appear to have a significant trend simply due to chance rather than an actual trend. Therefore, it is important to examine patterns or causative relationships that may be present in statistical test results. For example, if a decline in a particular parameter is significant across all sites or neighboring sites, it is more likely to be a valid trend than if it exists in isolation. To be included in the analysis for temporal trend, parameters needed to be sampled both in 2022 and in at least two other years in the previous 10-year period.

Table 3. Metal standards according to Colorado Regulations 31 and 38 (WQCC 2020a, WQCC 2020b). All standards listed are in dissolved form and in units of ug/L.

		Parameter						
Segment	Site	Copper (acute)[1]	Copper (chronic)[1]	Selenium (acute)	Selenium (chronic)	Manganese (acute)[1]	Manganese (chronic)[1]	Manganese (domestic water supply - chronic)
COSPBT01_B	M10	$e^{(0.9422*\ln(hardness)-1.7408)}$	$e^{(0.8545*\ln(hardness)-1.7428)}$	18.4	4.6	$e^{(0.3331*\ln(hardness)+6.4676)}$	$e^{(0.3331*\ln(hardness)+5.8743)}$	50
COSPBT02_C	M30	$e^{(0.9422*\ln(hardness)-1.7408)}$	$e^{(0.8545*\ln(hardness)-1.7428)}$	18.4	4.6	$e^{(0.3331*\ln(hardness)+6.4676)}$	$e^{(0.3331*\ln(hardness)+5.8743)}$	50
COSPBT02_A	M50	11	7.5	18.4	4.6	$e^{(0.3331*\ln(hardness)+6.4676)}$	$e^{(0.3331*\ln(hardness)+5.8743)}$	50
COSPBT02_A	M60	11	7.5	18.4	4.6	$e^{(0.3331*\ln(hardness)+6.4676)}$	$e^{(0.3331*\ln(hardness)+5.8743)}$	50
COSPBT02_F	M70	11	7.5	18.4	4.6	$e^{(0.3331*\ln(hardness)+6.4676)}$	$e^{(0.3331*\ln(hardness)+5.8743)}$	50
COSPBT02_D	M90	11	7.5	18.4	4.6	$e^{(0.3331*\ln(hardness)+6.4676)}$	$e^{(0.3331*\ln(hardness)+5.8743)}$	50
COSPBT03_B	M130	$e^{(0.9422*\ln(hardness)-1.7408)}$	$e^{(0.8545*\ln(hardness)-1.7428)}$	18.4	4.6	$e^{(0.3331*\ln(hardness)+6.4676)}$	$e^{(0.3331*\ln(hardness)+5.8743)}$	50
COSPBT04c	M140	$e^{(0.9422*\ln(hardness)-1.7408)}$	$e^{(0.8545*\ln(hardness)-1.7428)}$	18.4	4.6	$e^{(0.3331*\ln(hardness)+6.4676)}$	$e^{(0.3331*\ln(hardness)+5.8743)}$	50
COSPBT02	T10	11	7.5	18.4	4.6	$e^{(0.3331*\ln(hardness)+6.4676)}$	$e^{(0.3331*\ln(hardness)+5.8743)}$	50

1. Maximum hardness value for acute and chronic standard calculations is 400

Table 4. Water quality standards according to 31 and 38 (WQCC 2020a, WQCC 2020b).

		Parameter									Clean Water Act 303(d)	
Segment	Site	Nitrate + Nitrate (domestic water supply - acute)	Sulfate (domestic water supply - chronic)	Dissolved Oxygen	pH (lower limit)	pH (upper limit)	Temperature (upper limit - acute)	Temperature (upper limit - chronic)	Temperature (upper limit - acute)	Temperature (upper limit - chronic)	Impairment	Priority
COSPBT01_B	M10	10	250	6	6.5	9	21.7 [1]	17 [1]	13 [2]	9 [2]	As, Cu, Hg, Zn	H, H, H, H
COSPBT02_C	M30	10	250	5	6.5	9	21.7 [1]	17 [1]	13 [2]	9 [2]	Macro, As, Cu, NO_3, Hg	H, L, M, H, H
COSPBT02_A	M50	10	250	5	6.5	9	21.7 [1]	17 [1]	13 [2]	9 [2]	As, Cu, Hg	L, H, H
COSPBT02_A	M60	10	250	5	6.5	9	21.7 [1]	17 [1]	13 [2]	9 [2]	As, Cu, Hg	L, H, H
COSPBT02_F	M70	10	250	5	6.5	9	21.7 [1]	17 [1]	13 [2]	9 [2]	As, Temp, Hg, Fe, Cu	L, H, H, H, H
COSPBT02_D	M90	10	250	5	6.5	9	21.7 [1]	17 [1]	13 [2]	9 [2]	As, Cu	L, M
COSPBT03_B	M130	10	250	5	6.5	9	29.0 [3]	24.2 [3]	24.6 [4]	12.1 [4]	As, Hg, Mn, Se	L, M, L , L
COSPBT04c	M140	100	-	5	6.5	9	29.0 [3]	24.2 [3]	24.6 [4]	12.1 [4]	-	-
COSPBT02	T10	10	250	5	6.5	9	21.7 [1]	17 [1]	13 [2]	9 [2]	As, Hg, Mn, Se	L, H

1:June-September
2: October-May
3: March-November
4: December-February

Parameter Descriptions and Results

General Parameters

Flow

Flow represents the volume of water passing by a given site measured in cubic feet per second (cfs). Flow was measured at all nine stations. Flow rate data presented are median values and as such do not address important components of flow such as seasonal dynamics. The data do however, capture between site differences due to water diversions and tributary inputs as well as the relative flow compared to previous years. (e.g., North Fork Big Thompson River confluence between M60 and M70 and LWP diversion below M90).

Flows ranged from 4.5 cfs at site M130 in April to 812 cfs at site M30 in June. Flows were approximately average when compared to the previous 10-year time period although sites lower in the watershed had somewhat lower flows than experienced historically (Figure 4). Interestingly, the low flow documented in the river in 2022 was very low in the watershed (just above the Water Reclamation Facility Outfall). This flow was even lower than any recorded at our headwater site (M10) in Rocky Mountain National Park. This circumstance demonstrates both the influence of diversions that occur on the mainstem Big Thompson River, but also the potential positive effect of the Water Reclamation Facility Outfall. The water returned to the river from the outfall increased the flow in the Big Thompson River from 4.5 cfs measured above the outfall to 11 cfs measured below the outfall in April. Since water returned to the river must meet substantially protective environmental standards, it will be of comparable water quality to the river and increased flows may benefit the aquatic communities in this portion of the river.

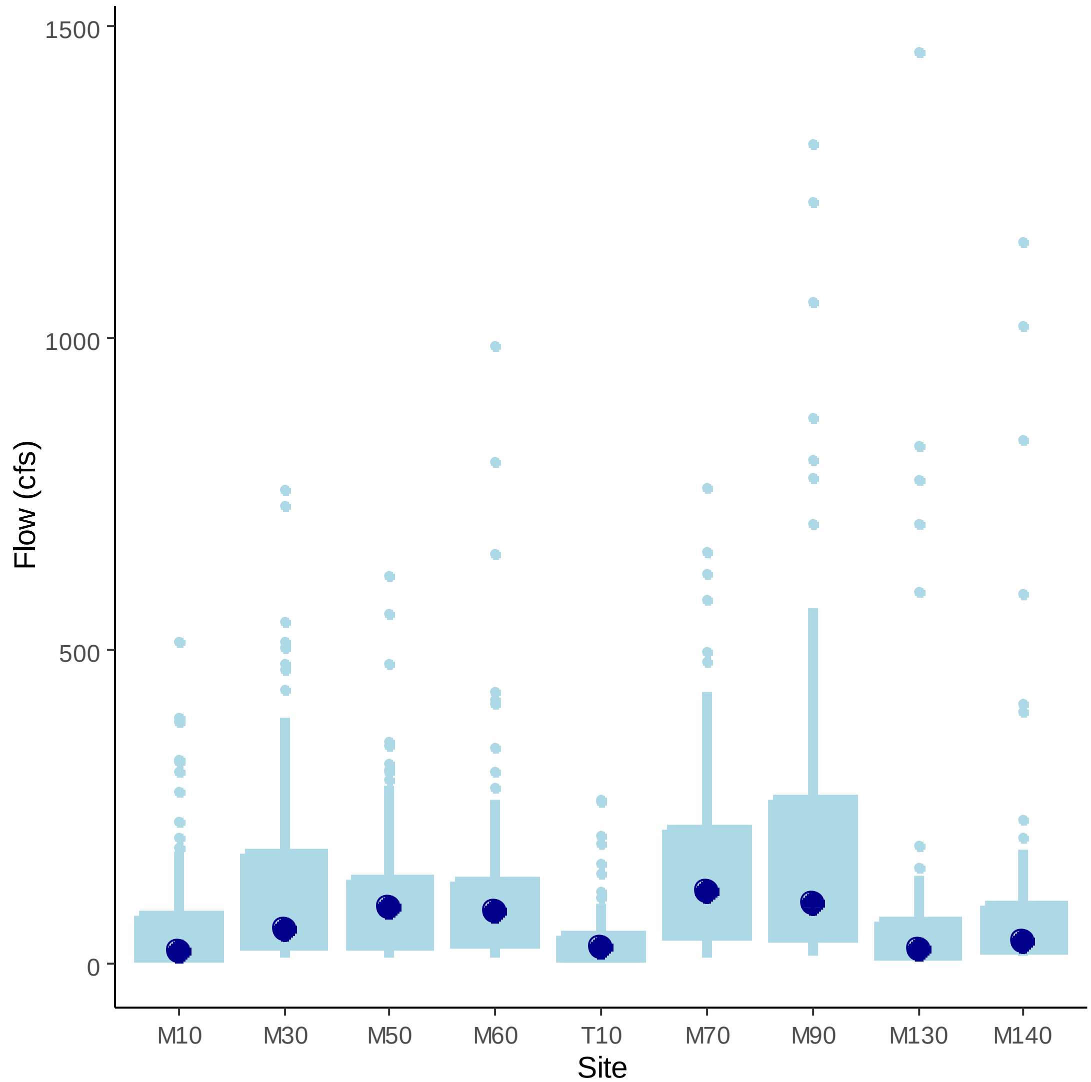


Figure 4. Box plot of flow data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Water temperature

Water temperature affects both aquatic organisms and drinking water treatment processes. Aquatic organisms have preferred and lethal temperatures. These temperatures vary widely and species with similar temperature tolerances are often associated with one another. Some organisms require relatively cold water to survive, particularly during spawning and other stressful time periods. Elevated water temperatures can cause reduced reproduction, growth, or mortality. Conversely, water temperatures can be too low for optimal growth and survival of some species, particularly those found in the lower reaches of the Big Thompson River. As such, temperature standards are based on species groups with similar thermal tolerances. Segments of the Big Thompson River are classified as Coldwater I, Coldwater II, or Warmwater II. In addition, temperature is of interest to water treatment operators because the temperature of the water influences the speed at which chemical reactions used to treat drinking water take place. Chemical reactions generally take longer to complete in colder water.

Temperatures ranged from an expected 0ºC at a number of sites in the winter months to a high of 19.1ºC at site M130 in August. While there were no recorded instances where the acute temperature standards were exceeded but chronic standards were exceeded 6 times in 2022 (Table 4). However, in general, temperatures were lower than they were in 2021. There was an average decrease in river water temperature between M130 and M140 of 0.3 ºC during the summer months (July-September). This reduction took place because the water returned to the river via outfall from the LWP Water Reclamation Facility is generally colder than ambient river temperatures during this time period.

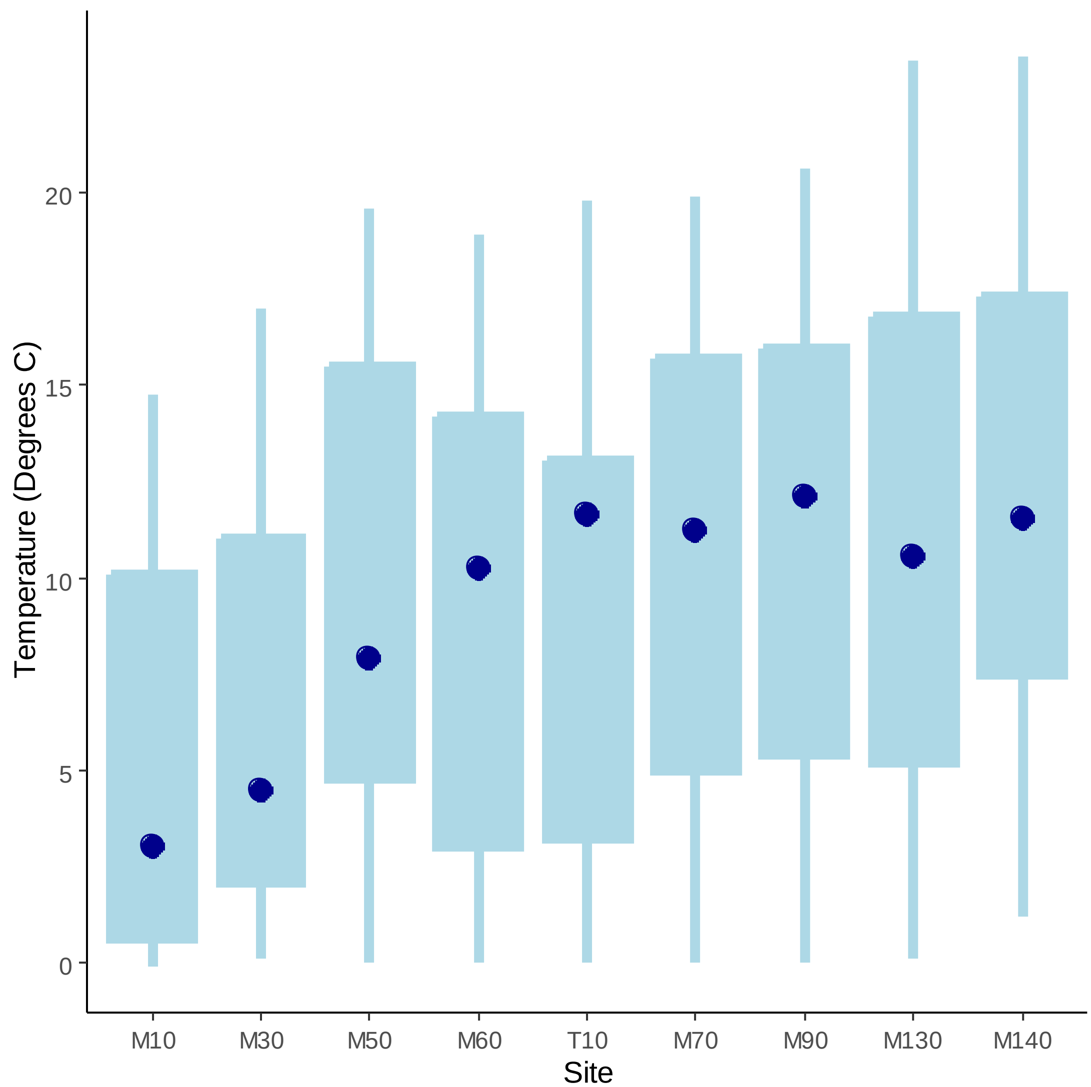


Figure 5. Box plot of temperature data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Specific conductance

Specific conductance is a measure of how well water conducts electricity. Specific conductance increases with increasing concentrations of ions that are dissolved in water such as chloride, sulfate, nitrate, phosphate, sodium, magnesium, calcium, potassium. and iron. Although specific conductance itself does not directly impact water quality, it is easily measured and indicates general seasonal and spatial differences in water quality. Specific conductance may also indicate whether an issue may exist that merits more detailed investigation. In 2022, specific conductance ranged from 16 µS/cm to 1,370 µS/cm at sites M10 in July and M130 in April respectively.

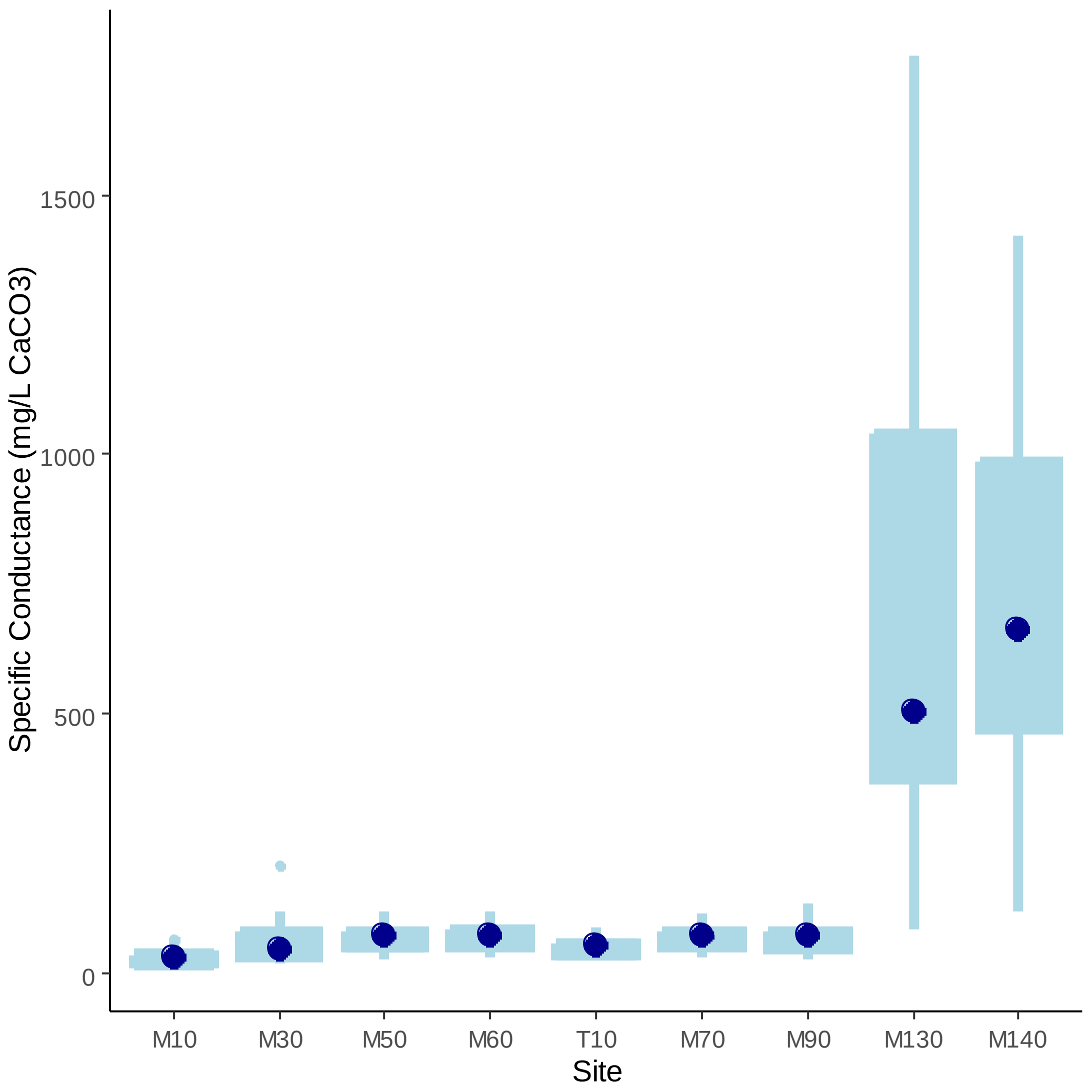


Figure 6. Box plot of specific conductance data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Dissolved Oxygen

Dissolved oxygen levels are important to aquatic life and drinking water facilities and are affected by a number of factors such as temperature, altitude, turbulence, and biological activity. Turbulent cold water at a low altitude can have higher levels of dissolved oxygen than still warm water at a higher altitude.

Biological activity (particularly photosynthesis) can increase dissolved oxygen during the day as photosynthesis occurs and can decrease dissolved oxygen levels at night when respiration dominates. Often biological activity has no net effect on dissolved oxygen levels, but it can increase the daily range of values with wider ranges being associated with greater biological activity. Virtually all aquatic organisms require dissolved oxygen to survive with the necessary concentration differing by species. For example, many fish species in the upper portion of the Big Thompson River have evolved to live in cold water streams and require higher concentrations of dissolved oxygen (e.g., cutthroat trout *Oncorhynchus clarki*) than those that evolved to persist in the lower warm water portion of the river (e.g., plains killifish *Fundulus zebinus*). Aquatic organisms can experience mortality if dissolved oxygen levels drop below their threshold level for even a short time. Although some life stages require higher levels of dissolved oxygen, a minimum threshold to support most aquatic life is 6 mg/L. In addition, dissolved oxygen levels regulate the degree to which some elements (like manganese) remain in solution. Relatively high dissolved oxygen levels allow these elements to precipitate out of the water column and make drinking water treatment easier.

Dissolved oxygen levels ranged from a high of 12.2 mg/L at site M30 in February to a low of 6.9 mg/L at site M140 in August. There were no recorded instances of dissolved oxygen levels declining below aquatic life use standards in 2022. Although dissolved oxygen levels at M140 are somewhat low, they are considerably above levels necessary for aquatic life use. In addition, levels at M140 are similar to those at M130, suggesting that the Water Reclamation Facility outfall is having only a minor, if any, effect on dissolved oxygen levels in the mainstem.

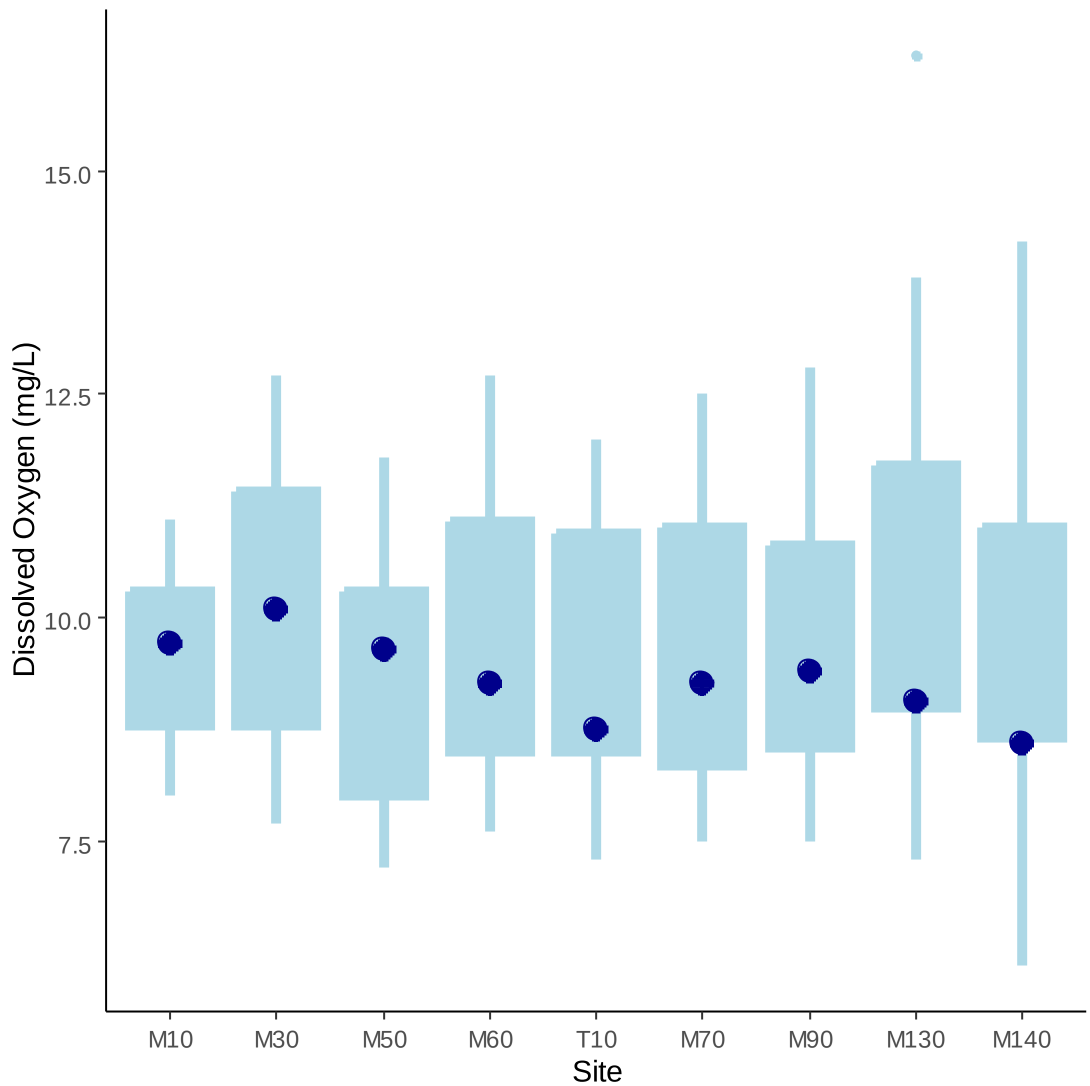


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Figure 7. Box plot of dissolved oxygen data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

pH

The pH of water is a measurement of the degree to which it is acidic or basic. The number represents the concentration of hydrogen ions on a log scale and ranges from 0 to 14 SU with acidic conditions resulting in lower values and basic conditions resulting in higher values. The relative acidity of water can affect both water treatment and aquatic life. Relatively high (> 9 SU) and low (< 6.5 SU) can cause the aquatic environment to be inhospitable for many aquatic organisms. Water treatment processes, particularly flocculation, depend in part on the pH of the water. Flocculation is a process by which a coagulant is added to the water to cause bonding between water impurities which then are more prone to settling and are easier to separate. Low pH levels can impede the flocculation process while high pH can cause flocculated particles to re-disperse before settling.

Measured pH values ranged from a high of 8.2 SU at site M50 in October to a low of 6.5 SU at site M10 in February. There were no recorded instances when water samples were either above or below water quality standards at any site. However, the relatively acidic conditions at site M10 in February were of note.

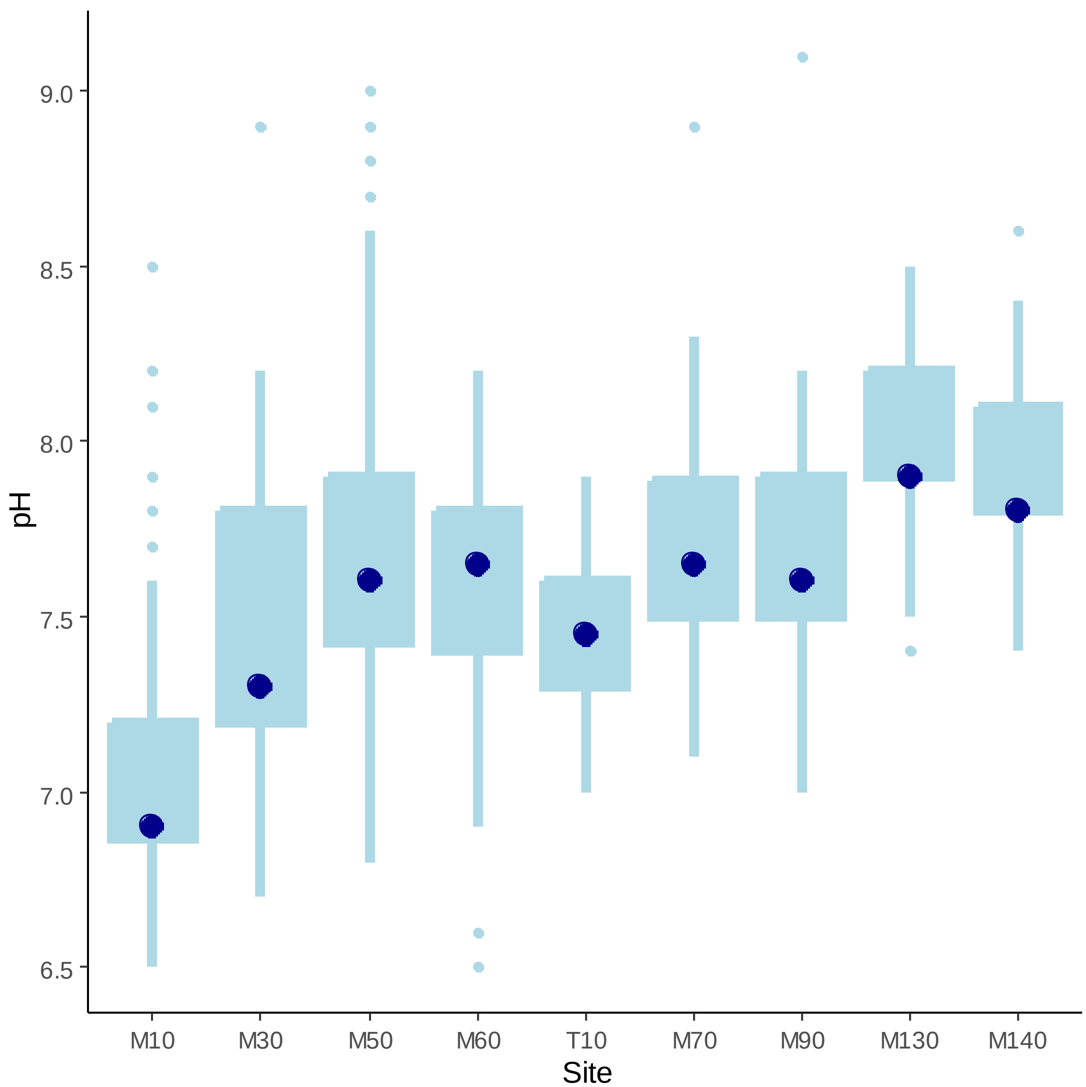

Figure 8. Box plot of pH data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Alkalinity

Alkalinity is a measure of the degree to which water can resist acidic changes in pH (or buffer changes in pH). This buffering capacity is measured by of the amount of carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) anions in the water and is described in terms of mg/L $CaCO_3$. These anions buffer changes in pH by absorbing hydrogen ions when the water is acid and releasing them when it is basic. Higher alkalinity means higher amounts of acid will need to be added to the water before a change in pH occurs.

Alkalinity levels affect aquatic ecosystems and water treatment. Water treatment plants often use flocculation techniques to purify water and these techniques are generally optimized by altering the pH (Naceradska et al. 2019). High alkalinity makes this pH adjustment more difficult. Conversely, aquatic ecosystems can benefit from elevated alkalinity because water with a pH lower than approximately 6.5 can have negative effects on aquatic life.

An error at the National Water Quality Laboratory caused a number of samples to be discarded prior to taking alkalinity measurements in 2022. June, July, August, October and November alkalinity measures were unavailable for all sites. Alkalinity measures for other months were unavailable for some or all of the sites. In general, alkalinity values were only available for the months of February, March, April, May, and September. This abbreviated data set was used to evaluate ranges, maximum values, minimum values, and historic trends. Elevated alkalinity causes pH levels of 6.5 or lower to be less likely. In 2022, alkalinity ranged from 8.1 mg/L $\mathrm{CaCO_3}$ at site M10 i n February to 187 mg/L $\mathrm{CaCO_3}$ at site M130 in April.

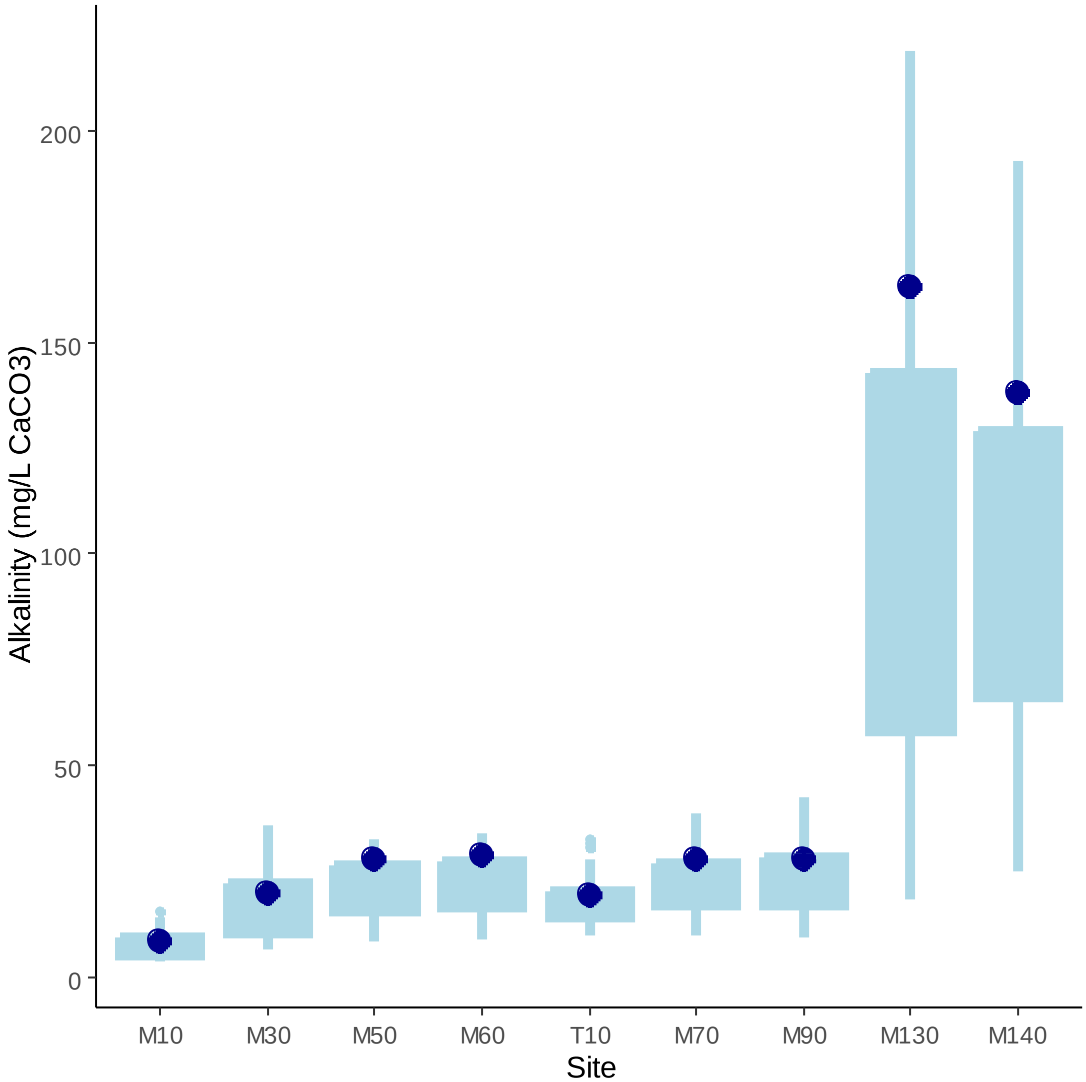

Figure 9. Box plot of alkalinity data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Total organic carbon

Total organic carbon (TOC) is a measure of the amount of dissolved and particulate organic matter in a water sample. Organic carbon compounds are the result of the decomposition of organic matter such as algae, terrestrial plants, animal waste, detritus, and organic soils. The higher the carbon or organic content of a water body, the more oxygen is consumed as microorganisms break down the organic matter. Although TOC is not a direct human health hazard, the dissolved portion of the TOC can react with chemicals (chlorine and others) used for drinking water disinfection to form disinfection byproducts that are regulated as potential carcinogens. As such, TOC levels are of concern to drinking water treatment facilities.

The 2022 TOC levels ranged from a high value of 11.7 mg/L in May at site M10 to a low value of 1.9 mg/L in February also at site M10.

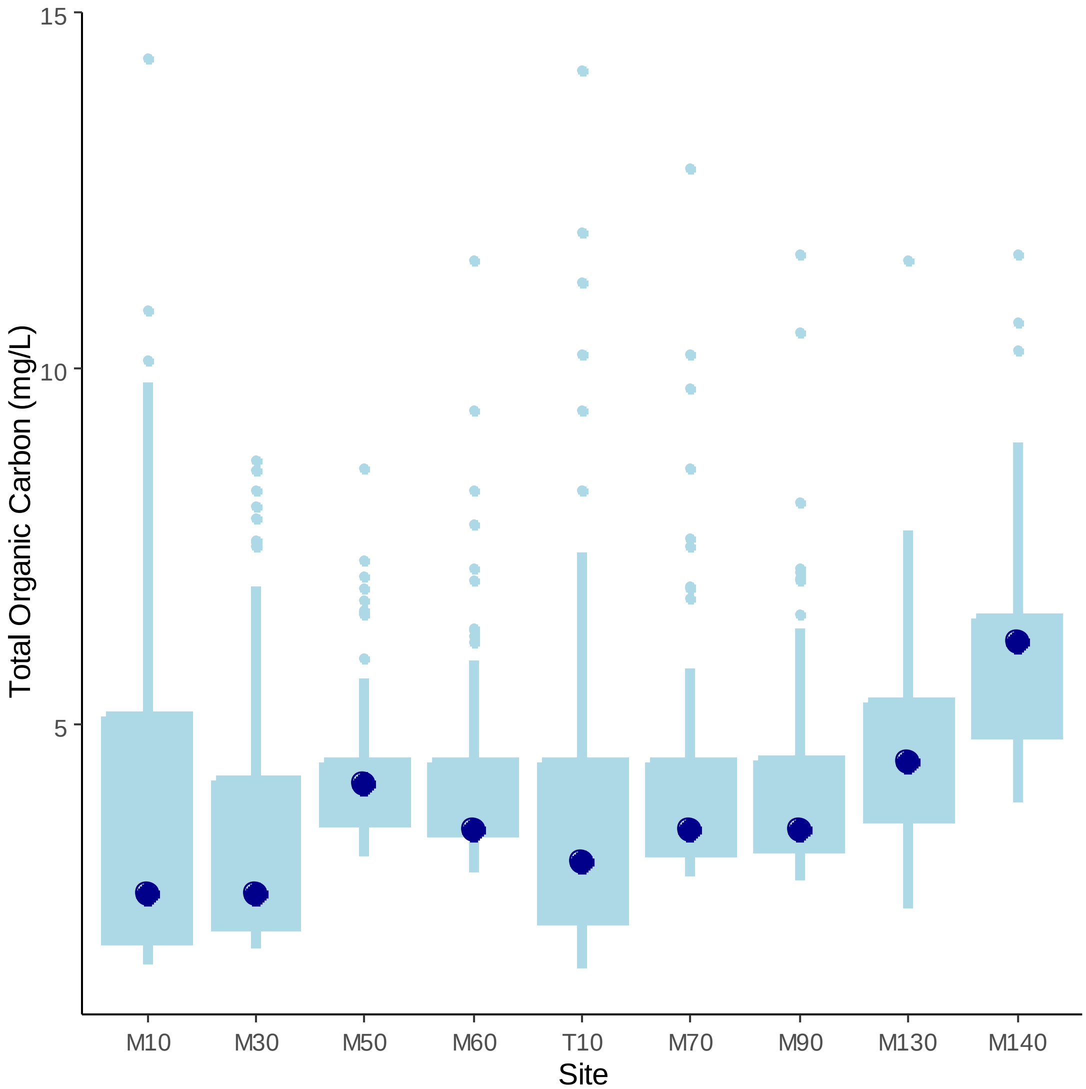

Figure 10. Box plot of total organic carbon data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Hardness

Hardness is a measure of the concentration of metal ions, primarily calcium and magnesium but also other metals such as iron, measured as mg/L of $CaCO_3$. The presence of elevated hardness reduces the toxicity of dissolved metals such as copper (Chakoumakos et al. 1979) and manganese (Stubblefield et al. 1997) at a given concentration by reducing the ability of these metal to bind to the gills of aquatic organisms. Therefore, even low levels of dissolved metals in water with low hardness can be an issue of concern. In 2022, hardness values ranged from 5.325 mg/L $CaCO_3$ at site M10 in July to 625 mg/L $CaCO_3$ at site M130 in June.

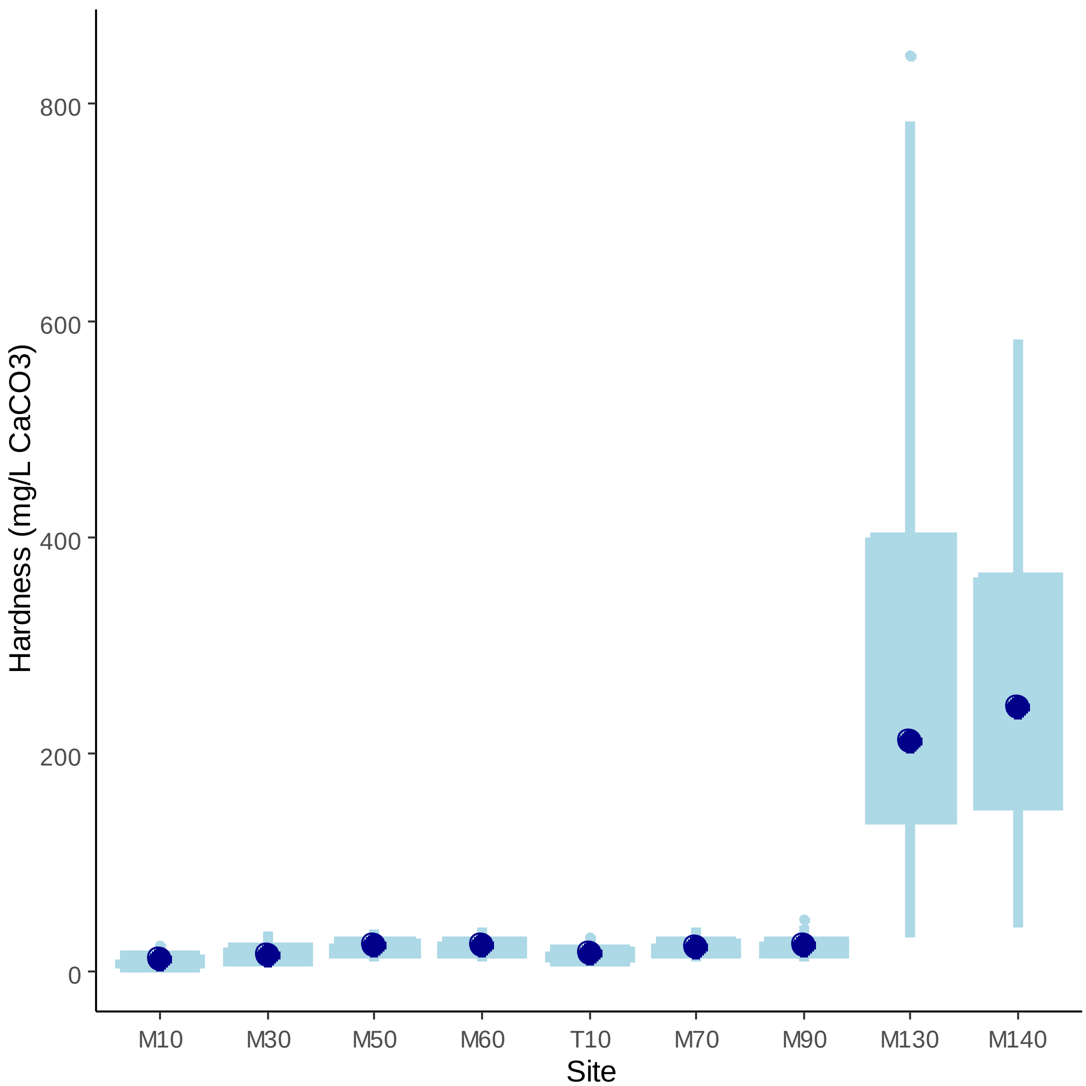

Figure 11. Box plot of hardness data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Sulfate

Sulfate is a common ion which is naturally occurring and is the primary form that sulfur takes in oxygenated waters such as the Big Thompson River. Sulfate is of interest due to taste and gastrointestinal issues that elevated levels may cause in drinking water. A treated drinking water secondary maximum contaminant standard of 250 mg/L (non-enforceable guidance level for aesthetic quality) has been adopted for sulfate. Sources of sulfate include the decay of organic matter, acid mine drainage, industrial effluent, runoff from fertilized agricultural lands, atmospheric deposition, and wastewater treatment plant effluent. Sulfate can be present in surface and ground waters at elevated concentrations due to interactions with soluble evaporite minerals such as gypsum in sedimentary bedrock. Pierre Shale, a source of selenium within the lower portion of the watershed, is also a source of sulfate.

Sulfate values ranged from 1.3 mg/L to 491 mg/L at sites M10 in July and M130 in April respectively. There were eight occasions when the drinking water standard of 250 mg/L was exceeded. The exceedances occurred in the months of February-May and November at sites M130 and M140. Although the values at M140 (below the Wastewater Reclamation Facility outfall) were above the drinking water standard in the spring, the values during this time period were lower at M140 than they were at M130 (above the Wastewater Reclamation Facility outfall) in each of the months with elevated sulfate levels. These results suggest that the WRF outfall acts to dilute sulfate levels in the Big Thompson River, at least during time periods with elevated sulfate levels in the river.

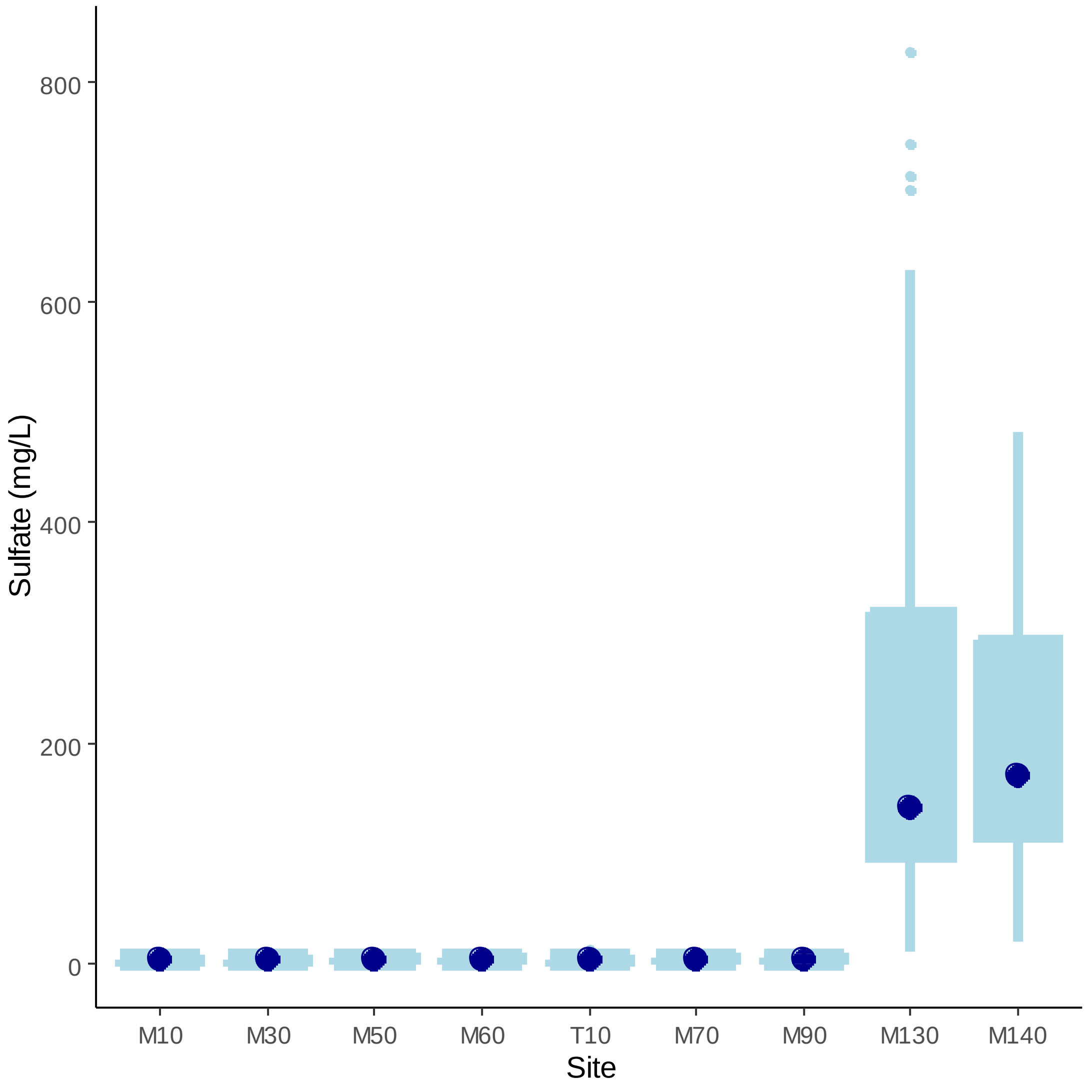

Figure 12. Box plot of sulfate data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Turbidity

Turbidity is essentially a measure of water clarity. Water with higher turbidity levels is less clear because it contains a higher number of suspended particles. Elevated turbidity has negative impacts on municipal water treatment plants and aquatic communities. High turbidity generally means there is increased sediment present in the water. Accommodating sediment is a challenge to drinking water utilities. Turbidity levels can also be positively associated with TOC levels which in turn require additional water treatment. LWP alters the location of their water collection when turbidity levels rise above 100 NTU. Elevated turbidity can have direct negative effects on aquatic organisms in addition to indirect effects such as increasing the levels of some dissolved metals. Elevated turbidity and suspended sediment can negatively affect macroinvertebrate and fish densities and can also negatively affect macroinvertebrate species richness. Effects of elevated turbidity become more severe with longer exposure.

Turbidity ranged from a low of 1 NTU at a number of sites and months (primarily during the low flow period (October-April) to a high of 1020 NTU at site M130 in August. Although 0.25 inches of rain fell in approximately 30 minutes in the North Fork watershed the day before M130 was sampled, stations further upstream but still downstream of the confluence of the North Fork with the mainstem Big Thompson, had somewhat elevated turbidities (e.g. 37 NTU at site M90) but not enough to expect that this storm was the cause of the extremely high turbidities at sites M130 and M140. Given the high flows resulting from this storm, it is likely that a portion of the bank gave way and temporarily caused very high turbidities at these two sites. Turbidity levels were near historical median values in 2022 except site T10, which experienced somewhat elevated turbidity levels associated with the continued effects of the CPF.

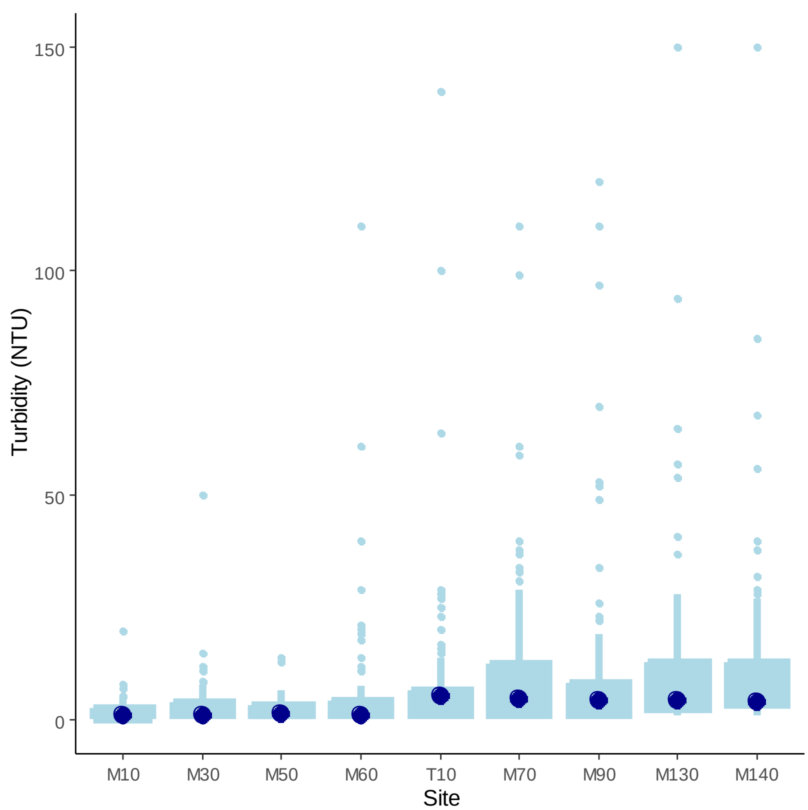

Figure 13. Box plot of turbidity data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value. There are nine individual data points above 150 NTU that do not appear in the figure.

Metals

Copper

Dissolved copper is of interest primarily due to its potential effects on aquatic life. While copper is an essential nutrient at low concentrations, it can be toxic at higher levels. Acute effects include mortality and chronic effects can lead to reduced survival, growth, and reproduction of aquatic organisms. Copper toxicity is determined in part by the hardness of the water. Toxicity to aquatic organisms is lower when hardness is higher because dissolved copper is less bioavailable when hardness is high.

Dissolved copper values ranged from 0.2 ug/L at site M130 during winter-early spring months to 1.9 ug/L at site M10 in May. Although the dissolved copper levels in 2022 were relatively low compared to historical values, there was one recorded instance of an exceedance of the acute hardness based dissolved copper standard at site M10 in June and eight instances of exceedances of the chronic standard at site M10 and other sites. The instances of exceedance of the chronic standard included site M10: May-July, M30: May-June, August, M50: July, and M60: June. Copper levels in the upper portion of the watershed are fairly low but are of concern because hardness values are also low enough to cause dissolved copper to be very bioavailable.

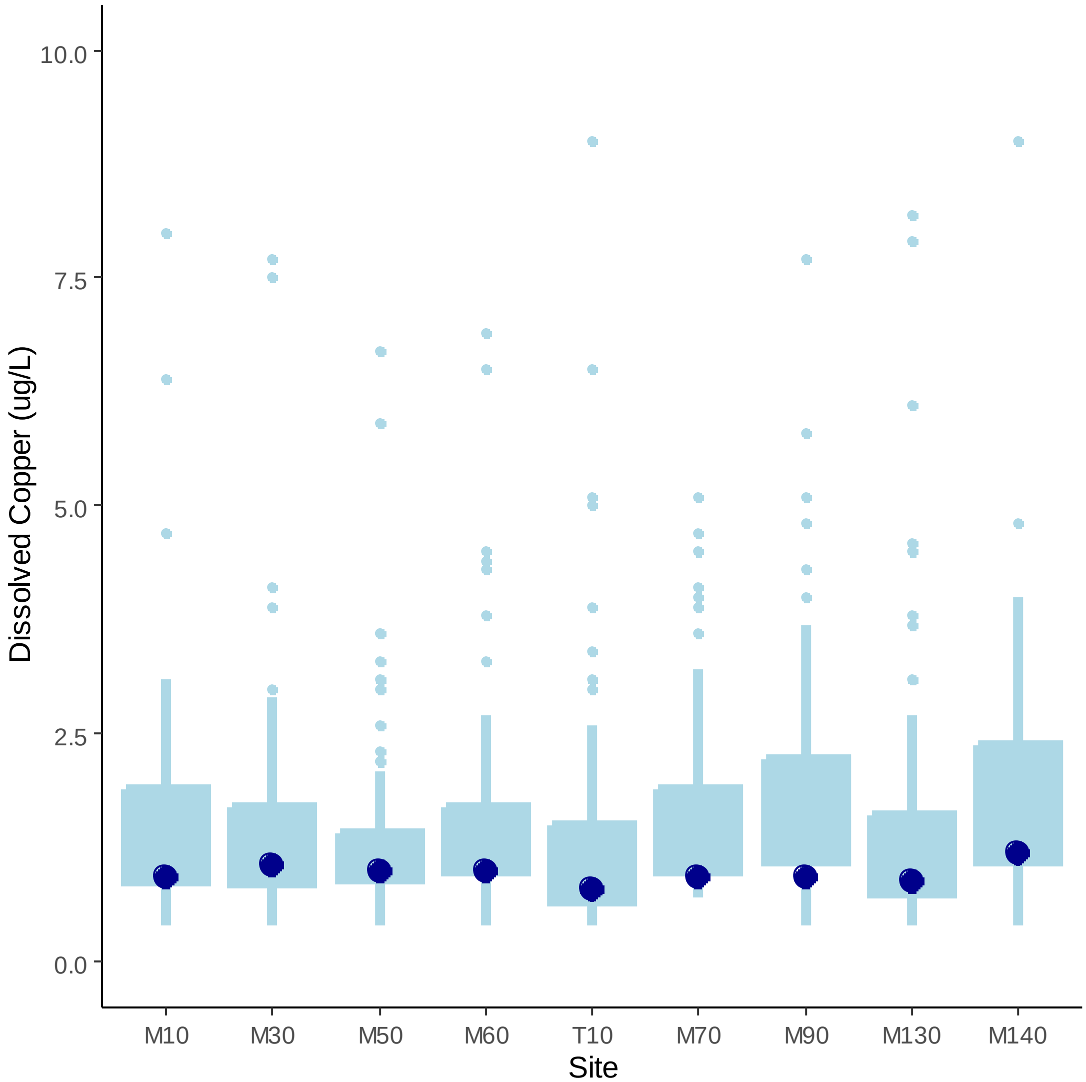

Figure 14. Box plot of dissolved copper data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Manganese

Dissolved manganese is only a health concern in drinking water at very high levels (>300 ug/L) but a secondary standard of 50 ug/L exists due to the ability of dissolved manganese to produce reddish/black/brown stains on laundry, plumbing, sinks, and showers. In addition, drinking water with dissolved manganese levels greater than 50 ug/L can have a metallic taste. Aquatic organisms can be negatively affected by particularly elevated dissolved manganese levels that are based on the hardness of the water and are much higher than the secondary drinking water standard.

Dissolved manganese values in 2022 ranged from 0.56 ug/L at site M60 in February to 167 ug/L at site M130 in April. There were no recorded instances of chronic or acute exceedances of hardness based aquatic life standards but there were 11 instances of exceeding the secondary drinking water standard (50 mg/L). All exceedances occurred in the lower portion of the river at sites M130 and M140 during the low flow time period.

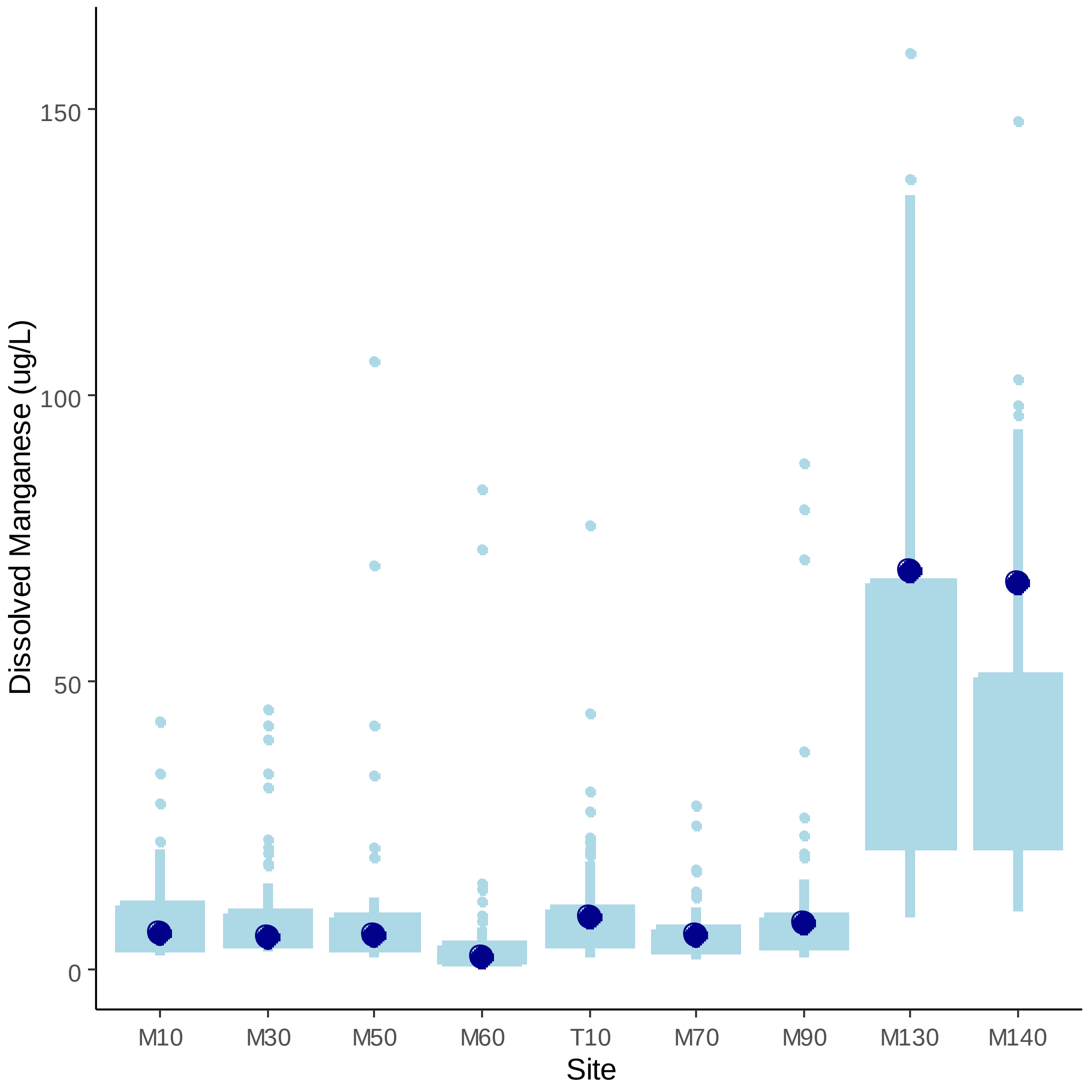

Figure 15. Box plot of flow dissolved manganese representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Selenium

Elevated selenium levels in water can negatively affect aquatic organisms and are therefore included in this report. Acute and chronic aquatic life standards of 18.4 µg/L and 4.6 µg/L, respectively, have been adopted for all stream segments in the Big Thompson Watershed. Several segments of the Big Thompson River are listed as impaired for selenium on Colorado's 303(d) List. However, selenium occurs at elevated levels primarily due to the bedrock geology of the watershed. The lower portion of the watershed, below the canyon mouth, includes a type of bedrock called Pierre Shale (Hart 1974) which is enriched in selenium.

Selenium values reflected the prevalence of Pierre Shale bedrock with concentrations near zero at site M90 and as high as 11.1 ug/L at site M130 in April. Dissolved selenium levels are generally highest during low flow periods of December-April. Values during this time period were lower at M140 than they were at M130 (above the Wastewater Reclamation Facility outfall) suggesting that the WRF outfall acts to dilute dissolved selenium levels in the Big Thompson River, at least during time periods with elevated sulfate selenium in the river.

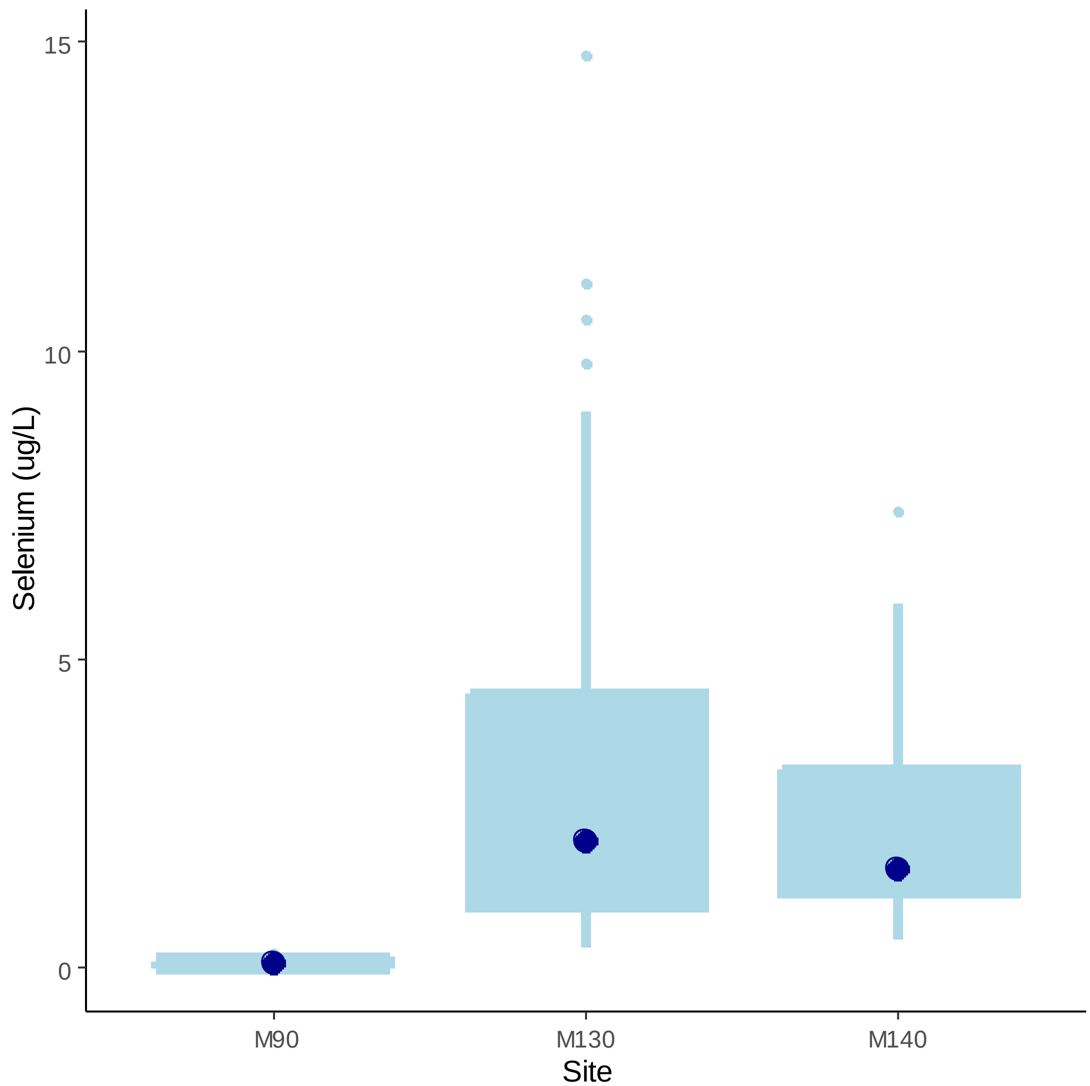

Figure 16. Box plot of dissolved selenium data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Nutrients

Nitrate + Nitrite

Nitrate and nitrite are of interest due to the role they play in aquatic plant growth and their potential effects on human health. Nitrate, along with ammonia, is a form of nitrogen that is available for immediate uptake by algae and is therefore of interest due to its role in determining the productivity of a given waterbody. At higher concentrations (e.g. >10 mg/L) nitrate can be of concern in drinking water because it can reduce the oxygen-carrying capacity of hemoglobin in humans and create a condition known as “methemoglobinemia” particularly in those under two years of age. Nitrite is also available for uptake by algae but is rarely present at substantial concentrations. Inorganic nitrogen levels ranged from 0.09 mg/L at site M130 in April to a high of 6.2 mg/L at site M140 in April.

There were no recorded instances of inorganic nitrogen levels exceeding the drinking water standard of 10 mg/L. Improvements in nitrate levels have been documented at site M140 due to the activation of a biological nutrient removal system at the WRF in 2019, although these declines are less apparent in 2022. Biological Nutrient Removal is a process in wastewater treatment designed to utilize particular microbial populations to reduce nutrients such as orthophosphate and nitrate. The process utilizes anoxic and oxic environments to encourage the nutrient reducing actions of particular bacteria. Nitrate+nitrite levels were also somewhat elevated in the North Fork (T10) in 2022, likely as a result of continuing effects of the CPF.

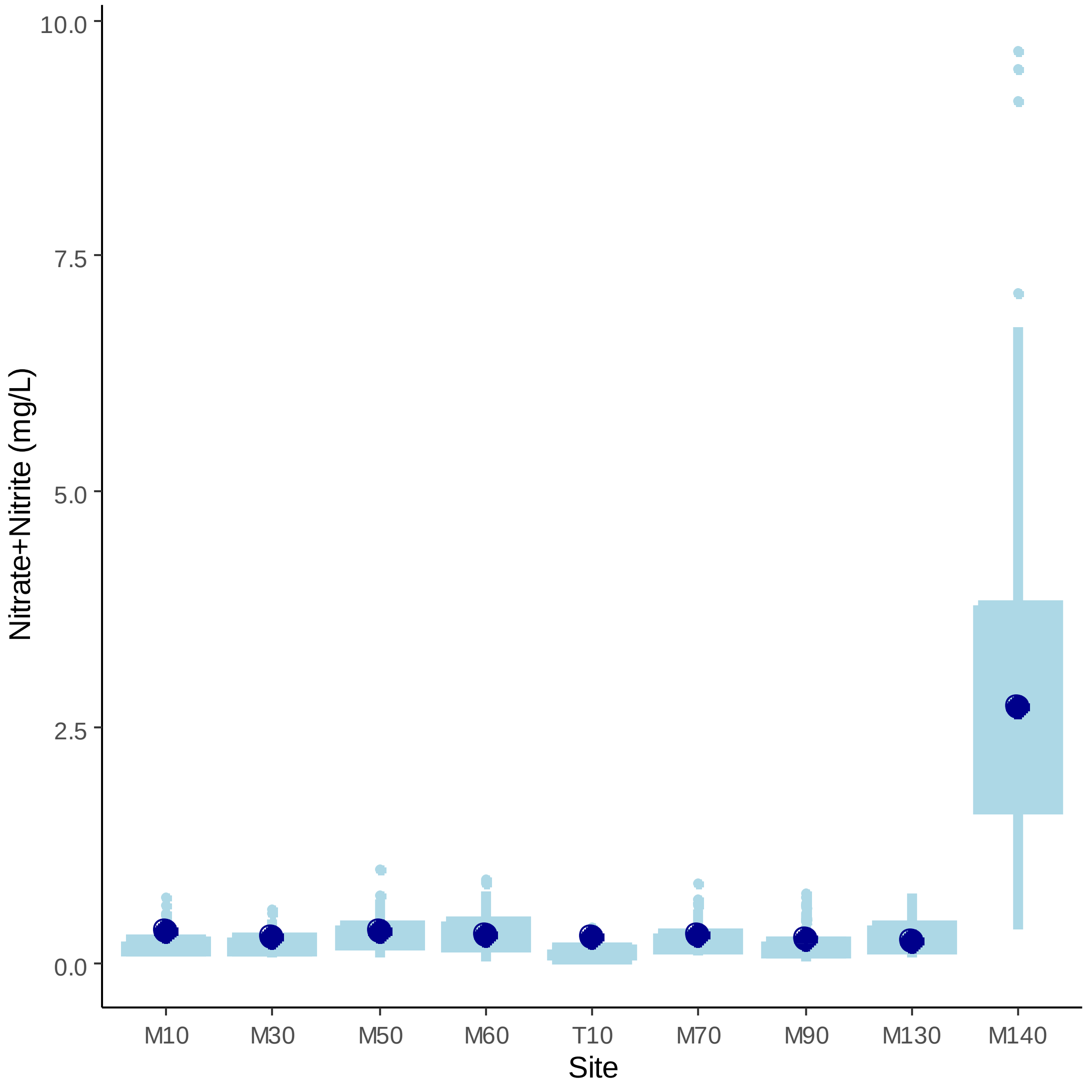

Figure 17. Box plot of nitrate + nitrite data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Orthophosphate (Ortho-P)

Orthophosphate is a dissolved form of phosphorus and is the only form that is immediately available for uptake by algae. Sources of orthophosphate include the decay of plant debris and other organic matter, the minerals that make up rocks, soils, and sediments in the watershed, wastewater treatment plant effluent, failing individual sewage disposal systems, runoff from fertilized agricultural lands and urban areas, and erosion of stream channels, dirt roads, construction sites, and other land surfaces.

Orthophosphate levels ranged from 0.002 mg/L (as P) (half of the detection limit) at several sites in several different months to a high of 0.136 at site M60 in February. Orthophosphate concentrations were dramatically lower in 2022 at site M140 than in previous years due to the installation of a Biological Nutrient Removal system at the LWP Water Reclamation Facility in 2019.

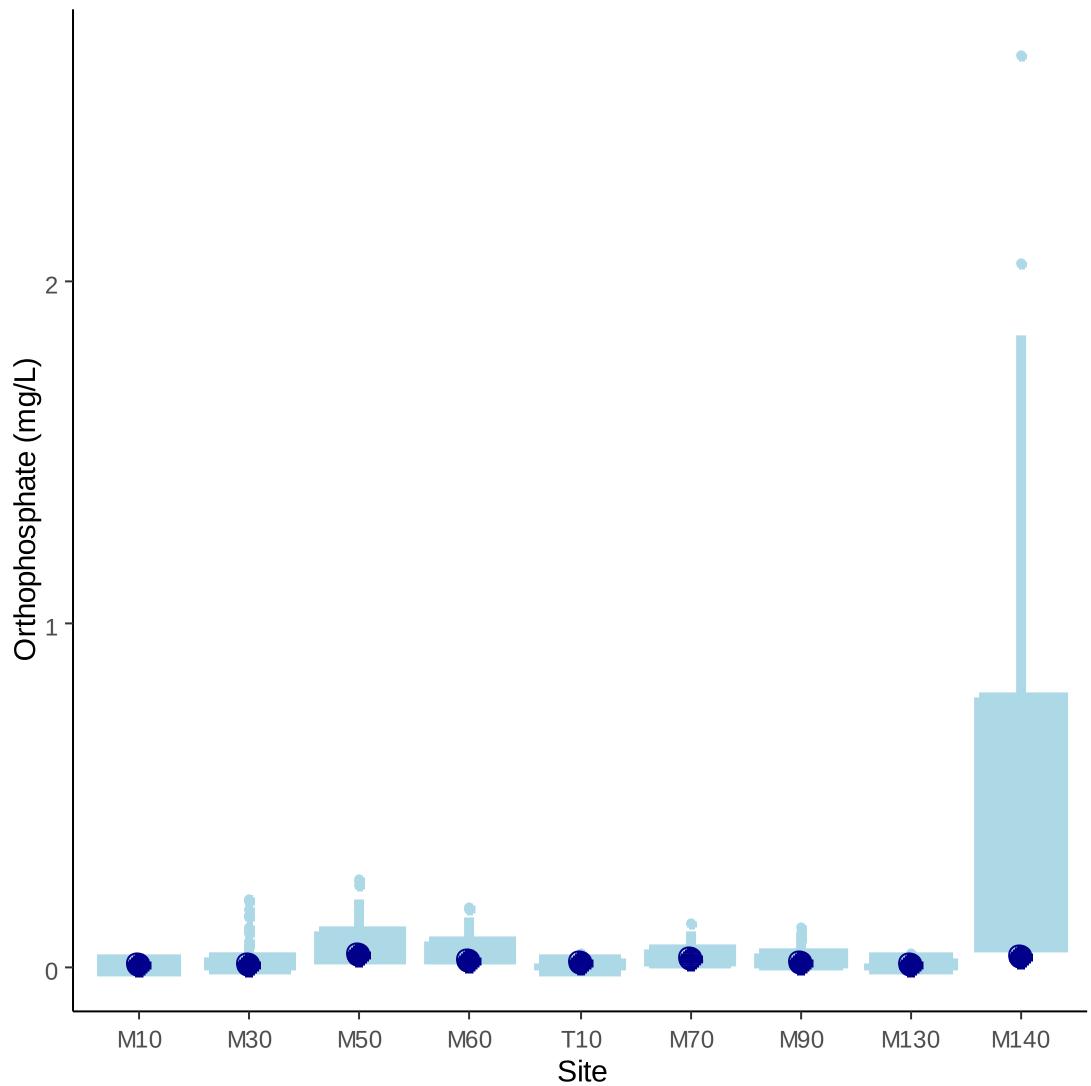

Figure 18. Box plot of orthophosphate data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Biological

E. coli

E. coli is a species of bacteria that occurs in the intestines of animals and aids in the digestion of food. *E. coli* is usually not pathogenic but is used as an indicator of the potential presence of disease-causing bacteria, protozoa and viruses. Water with elevated levels of *E. coli* may indicate a potential water consumption or contact risk for humans.

E.coli concentrations appeared to be relatively elevated in 2022 compared to historical values and ranged from 0.05 (half the detection limit of 1 CFU) to 3280 at site M130 in August. The cause of these elevated concentrations is unknown.

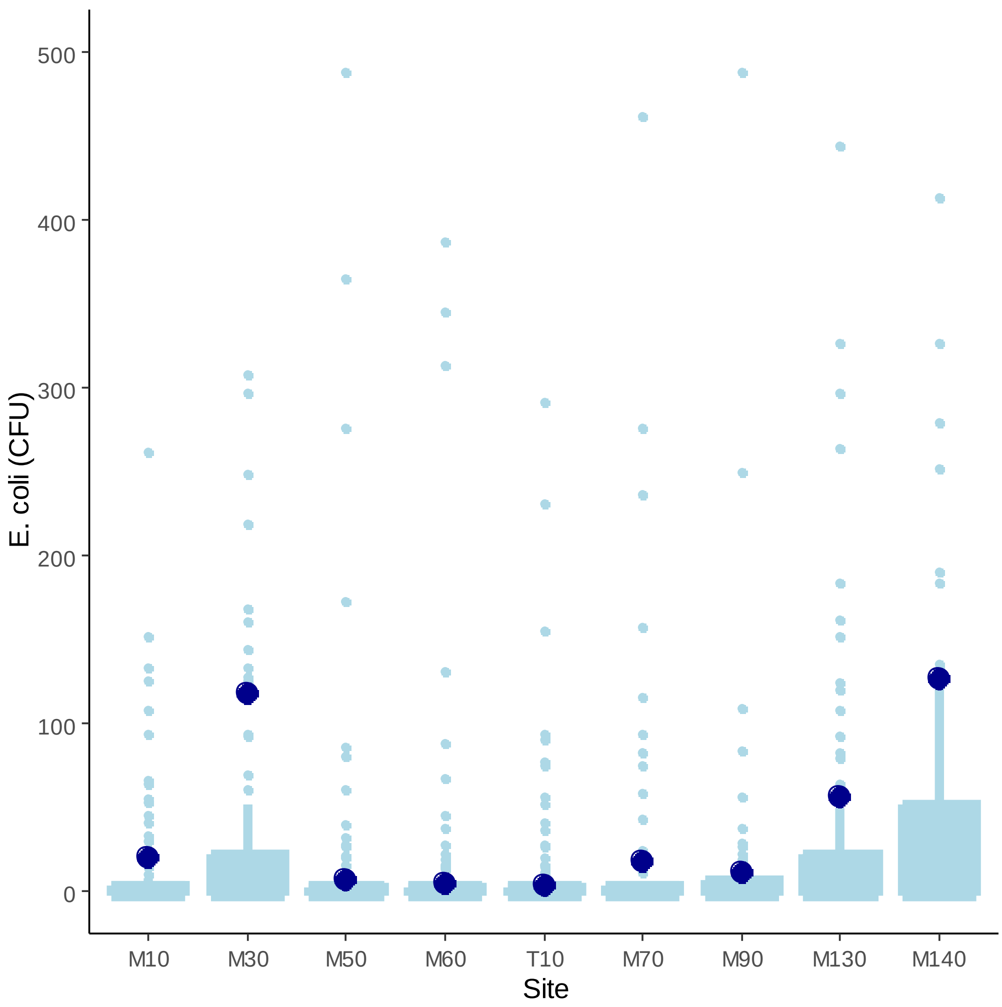

Figure 19. Box plot of *E. coli* data representing the 2012-2021 time period for each sampling location. Box represents 25th and 75th percentiles and blue circle represents 2022 median value.

Temporal Trends

Significant temporal trends over the previous 10-year period were detected for a number of parameters at each sampling location. However, given a p-value of 0.05 and more than 40 parameters examined at each site, one would expect one or two significant results at each site simply due to chance rather than any real increase or decrease over time. Consistent results among sites (or groups of sites) or additional site-specific information is useful in increasing confidence in significant trend results.

There were significant declines in orthophosphate concentrations at sites in the lower portion of the river (M130 and M140) with a greater decrease at site M140 (-0.04 mg/L/year) than at site M130 (-0.0003 mg/L/year). These results suggest that conditions are improving with regard to orthophosphate concentrations in the lower river in general with reductions due to the Biological Nutrient Removal system being substantially greater than baseline reductions. This decline in orthophosphate can generally be viewed as a positive result for the river because it indicates that the impacts of cultural eutrophication (such as through wastewater discharges) are being successfully addressed. The decline in orthophosphate below water reclamation facility discharges was also noted by Hawley and Rodriquez-Jeangros (2021) over a longer time-period.

Dissolved copper concentrations declined significantly across all sites. The overall average decline in dissolved copper concentration was 0.103 ug/L/year. Sites in the upper watershed had a smaller decline than those in the lower watershed. The decline in dissolved copper was also documented for several of these sites over a 15-year period ending in 2021 by Hawley, C. & Rodriquez-Jeangros (2021). This result also matches with the suggestion that somewhat lower tree mortality caused by bark beetles in recent years (USDA 2019) would result in decreased dissolved copper in the Big Thompson River. Tree mortality caused by bark beetles may result in copper, which had been taken up and stored by trees, being released into surface water upon their death (Fayram et al. 2019).

Water has become more acidic at a number of sites (M30, M50, and M140). The declines were relatively modest (declines of -0.019 to -0.033 SU/year). Because the trend was observed at several sites and was negative in each case, the trend is more likely to be valid. However, the cause of these declines is unknown.

Several sites demonstrated significant increases in chloride and sodium. Sites in the lower portion of the Big Thompson River Canyon (M70, M130, and M140) as well as the site on the North Fork of the Big Thompson River (T10) showed a significant increase in dissolved chloride. There was also a significant increase in dissolved sodium at the two lower sites (M70 and M90) as well as at site M10 and the North Fork Big Thompson River site (T10). Taken together, these results suggest that the increases may be due to the use of sodium chloride (or perhaps magnesium chloride) as a de-icing agent on area roads during the winter. Given the proximity of Highway 34 to the mainstem and Highway 43 to the North Fork, this mechanism seems reasonable. The increase in dissolved sodium concentration at these sites over the last decade is 0.051 mg/L/year or approximately 0.74 mg/L overall. Similarly, Kaushal et al. (2018) documented a mainstem wide increase in sodium concentration in the Big Thompson River in recent decades. There were also significant increases in total dissolved solids at several of the same sites (M10, M70, M90, M130, and T10). This result is consistent with the significant increases in dissolved chloride and dissolved sodium as both elements are included in the measurement of total dissolved solids.

Acknowledgements

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Appendix A.

Number of samples, Mann-Kendall trend test results, maximum value, minimum value, median value, and range of years represented for each water quality parameter at each sampling location. Yellow highlights represent significant ($p < 0.05$) trend.

	M10						
Parameter	**Slope**	**p value**	**Maximum**	**Minimum**	**Median**	**Date Range**	**Count**
Acidity, (H+) (mg/L)	0.000	0.516	0.0005	0.00001	0.000095	2012-2022	104
Alkalinity, Dissolved (mg/L)	-0.010	0.777	15.5	3.566667	7.366667	2012-2022	112
Ammonia and ammonium, Dissolved (mg/L)	0.001	0.001	0.02	0.005	0.01	2012-2022	55
Ammonia as NH_4 (mg/L)	0.000	0.917	0.03	0.0065	0.0065	2012-2022	105
Arsenic, Dissolved (mg/L)	0.000	0.489	0.21	0.02	0.11	2012-2022	73
Barometric pressure (mm/Hg)	0.000	0.817	577	556	569.5	2012-2022	110
Cadmium, Dissolved (mg/L)			-	-	-	-	-
Calcium, Dissolved (mg/L)	0.010	0.313	6.075	1.335	2.496667	2012-2022	116
Carbon dioxide, Total (mg/L)	0.057	0.102	5.5	0.1	1.3	2012-2022	96
Chloride, Dissolved (mg/L)	0.000	0.977	1.295	0.095	0.325	2012-2022	116
Copper, Dissolved (mg/L)	-0.086	<0.001	8	0.56	1.4	2012-2022	109
E. coli (cells/100 mL)	0.000	0.013	613	0.5	0.5	2012-2022	99
Hardness, Ca, Mg (mg/L $CaCO_3$)	0.045	0.218	22.75	4.595	9.065833	2012-2022	116
Iron, Dissolved (mg/L)	0.040	0.955	312	49.4	86.8	2012-2022	111
Kjeldahl nitrogen, Total (mg/L)	0.000	0.583	0.44	0.035	0.13	2012-2022	106
Lead, Dissolved (mg/L)	0.001	0.143	0.097	0.01	0.036	2012-2022	67
Magnesium, Dissolved (mg/L)	0.005	0.089	1.845	0.30425	0.682333	2012-2022	116
Manganese, Dissolved (mg/L)	-0.156	0.044	43.3	2.3	5.715	2012-2022	110
Nickel, Dissolved (mg/L)	0.020	<0.001	1.9	0.1	0.3	2012-2022	81
Nitrate + Nitrite, Dissolved (mg/L)	0.003	0.109	0.96	0.07	0.183333	2012-2022	120
Nitrate, Dissolved (mg/L)	0.003	0.505	0.958	0.0625	0.189625	2012-2022	80
Nitrite, Dissolved (mg/L)	0.000	0.520	0.006	0.0005	0.001	2013,2016-2022	22
Nitrogen, mixed forms (NH3), (NH4), organic, (NO2) and (NO3), Dissolved (mg/L)	0.003	0.285	1.22	0.13	0.29	2012-2022	120
Nitrogen, mixed forms (NH_3), (NH_4), organic, (NO_2) and (NO_3),Total (mg/L)	0.003	0.261	1.3	0.135	0.291667	2012-2022	120
Organic carbon, Total (mg/L)	0.022	0.245	14.36667	1.6	2.57	2012-2022	110
Organic Nitrogen, Total (mg/L)	-0.001	0.239	0.65	0.025	0.07	2012-2020,2022	100
Orthophosphate, Dissolved as P (mg/L)	0.000	0.076	0.006	0.002	0.002	2012-2022	112
Orthophosphate, Dissolved as $P0_4$ (mg/L)	0.000	0.066	0.018	0.006	0.006	2012-2022	106
Oxygen, Dissolved (%)	-0.017	0.239	11.1	8	9.7	2012-2022	110
Oxygen, Dissolved (mg/L)	0.000	0.296	113	91	101.75	2012-2022	110
pH (SU)	0.000	0.492	8.5	6.5	7	2012-2022	104
Phosphorus, Dissolved (mg/L)	0.003	<0.001	0.013	0.0015	0.005	2012-2022	82
Phosphorus, Total (mg/L)	0.000	0.200	0.0495	0.002	0.008	2012-2022	113
Potassium, Dissolved (mg/L)	-	-	-	-	-	-	-
RBP Stream width (ft)	-0.500	<0.001	41	12.4	30	2012-2022	110
Selenium, Dissolved (mg/L)	-	-	-	-	-	-	-
Silver, Dissolved (mg/L)	0.004	<0.001	0.5	0.0025	0.01	2012-2014,2022	38
Sodium adsorption ratio [(Na)/(sq root of 1/2 Ca + Mg)]	0.001	0.009	0.34	0.135	0.21	2012-2022	116
Sodium, Dissolved (mg/L)	0.013	0.016	3.33	0.685	1.55375	2012-2022	116
Sodium, total cations (%)	0.000	0.183	29	19	26	2012-2022	116
Specific conductance (µS/cm)	0.083	0.279	62.5	13.33333	27	2012-2022	118
Stream flow (cfs)	0.060	0.954	513	1.6	22.75	2012-2022	110
Sulfate, Dissolved (mg/L)	0.005	0.576	10.2	1.015	2.729167	2012-2022	116
Temperature, water (°C)	-0.018	0.234	14.75	-0.1	5.083333	2012-2022	120
Total Coliform (cells/100 mL)	0.000	0.014	1733	0.5	0.5	2012-2022	99
Total dissolved solids, Dissolved, Dried 180 (mg/L)	0.666	<0.001	56	10	26	2012-2022	110
Total dissolved solids, Dissolved, Filtered (mg/L)	0.125	0.089	39	9.5	19.33333	2012-2022	112
Turbidity (NTU)	0.000	0.568	19.85	1	1	2012-2022	110
Zinc, Dissolved (mg/L)	-	-	-	-	-	-	-

Parameter	Slope	p value	Maximum	Minimum	Median	Date Range	Count
				M30			
Acidity, (H+) (mg/L)	0.000	0.015	0.0005	0.00001	0.00004	2012-2022	109
Alkalinity, Dissolved (mg/L)	-0.200	0.022	36	6.7	14.8	2012-2022	104
Ammonia and ammonium, Dissolved (mg/L)	0.002	0.001	0.73	0.005	0.025	2012-2022	85
Ammonia as NH_4 (mg/L)	0.000	0.298	0.938	0.0065	0.016	2012-2022	111
Arsenic, Dissolved (mg/L)	0.003	0.076	1.1	0.04	0.1	2012-2022	74
Barometric pressure (mm/Hg)	-0.125	0.105	588	568	580	2012-2022	111
Cadmium, Dissolved (mg/L)	-	-	-	-	-	-	38
Calcium, Dissolved (mg/L)	0.009	0.734	9.85	1.74	3.89	2012-2022	110
Carbon dioxide, Total (mg/L)	0.041	0.064	4.3	0.1	1.1	2012-2022	102
Chloride, Dissolved (mg/L)	0.003	0.887	42.4	0.53	2.995	2012-2022	110
Copper, Dissolved (mg/L)	-0.075	<0.001	7.7	0.4	1.2	2012-2022	108
E. coli (cfu)	0.000	0.007	690	0.5	0.5	2012-2022	100
Hardness, Ca, Mg (mg/L $CaCO_3$)	0.029	0.712	36.1	6.25	14.3	2012-2022	110
Iron, Dissolved (mg/L)	-2.000	0.074	372	47.4	110.5	2012-2022	110
Kjeldahl nitrogen, Total (mg/L)	0.003	0.348	0.95	0.11	0.22	2012-2022	110
Lead, Dissolved (mg/L)	0.001	0.161	0.189	0.01	0.038	2012-2022	83
Magnesium, Dissolved (mg/L)	0.030	0.515	2.8	0.462	1.11	2012-2022	110
Manganese, Dissolved (mg/L)	-0.117	0.095	45.1	2.93	6.88	2012-2022	110
Nickel, Dissolved (mg/L)	0.010	0.043	1.6	0.1	0.285	2012-2022	82
Nitrate + Nitrite, Dissolved (mg/L)	0.025	0.278	0.57	0.06	0.2	2012-2022	111
Nitrate, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrite, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH3), (NH4), organic, (NO2) and (NO3), Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH_3), (NH_4), organic, (NO_2) and (NO_3),Total (mg/L)	0.008	0.078	1.3	0.22	0.425	2012-2022	110
Organic carbon, Total (mg/L)	0.075	0.427	9.2	1.83	2.645	2012-2022	110
Organic Nitrogen, Total (mg/L)	0.000	0.797	0.39	0.045	0.135	2012-2022	110
Orthophosphate, Dissolved as P (mg/L)	0.000	0.490	0.195	0.002	0.00825	2012-2022	110
Orthophosphate, Dissolved as $P0_4$ (mg/L)	-0.001	0.008	0.598	0.006	0.025	2012-2022	109
Oxygen, Dissolved (%)	0.025	0.122	12.7	7.7	9.75	2012-2022	111
Oxygen, Dissolved (mg/L)	-0.167	0.021	126	98	105	2012-2022	111
pH (SU)	-0.027	0.003	8.9	6.6	7.4	2012-2022	109
Phosphorus, Dissolved (mg/L)	0.000	0.088	0.239	0.0045	0.012	2012-2022	111
Phosphorus, Total (mg/L)	0.000	0.590	0.259	0.009	0.028	2012-2022	111
Potassium, Dissolved (mg/L)	0.013	<0.001	1.22	0.29	0.62	2012-2022	109
RBP Stream width (ft)	-0.394	0.379	124	17	50	2012-2022	111
Selenium, Dissolved (mg/L)	-	-	-	-	-	-	-
Silver, Dissolved (mg/L)	0.004	<0.001	0.5	0.0025	0.01	2012-2014,2022	38
Sodium adsorption ratio [(Na)/(sq root of 1/2 Ca + Mg)]	0.002	0.229	2.35	0.18	0.37	2012-2022	110
Sodium, Dissolved (mg/L)	0.012	0.497	28.3	1.12	3.19	2012-2022	110
Sodium, total cations (%)	0.000	0.929	68	24	31	2012-2022	109
Specific conductance (µS/cm)	0.000	0.753	208	19.5	48	2012-2022	111
Stream flow (cfs)	-0.600	0.438	812	8.4	58.5	2012-2022	110
Sulfate, Dissolved (mg/L)	-0.016	0.213	7.32	1.29	2.72	2012-2022	110
Temperature, water (°C)	-0.266	<0.001	17	0	6.35	2012-2022	111
Total Coliform	0.000	0.005	4840	0.5	0.5	2012-2022	100
Total dissolved solids, Dissolved, Dried 180 (mg/L)	0.533	0.042	117	10	38	2012-2022	110
Total dissolved solids, Dissolved, Filtered (mg/L)	0.183	0.346	104	6	26.5	2012-2022	104
Turbidity (NTU)	0.000	0.804	50	1	2.05	2012-2022	110
Zinc, Dissolved (mg/L)	0.033	0.594	11.9	0.7	2.8	2012-2022	71

Parameter	Slope	p value	Maximum	Minimum	Median	Date Range	Count
				M50			
Acidity, (H+) (mg/L)	0.000	0.688	0.0005	0.00001	0.00003	2012-2022	108
Alkalinity, Dissolved (mg/L)	-0.050	0.691	32.6	8.4	22.8	2012-2022	104
Ammonia and ammonium, Dissolved (mg/L)	-0.003	0.081	0.47	0.005	0.04	2012-2022	96
Ammonia as NH_4 (mg/L)	-0.004	0.007	0.611	0.0065	0.03925	2012-2022	107
Arsenic, Dissolved (mg/L)	-0.001	0.097	1	0.1	0.16	2012-2022	110
Barometric pressure (mm/Hg)	0.000	0.545	590	568	583	2012-2022	111
Cadmium, Dissolved (mg/L)	-	-	-	-	-	-	38
Calcium, Dissolved (mg/L)	0.023	0.321	10.6	2.24	6.35	2012-2022	110
Carbon dioxide, Total (mg/L)	0.031	0.175	6.4	0.05	0.95	2012-2022	102
Chloride, Dissolved (mg/L)	-0.012	0.821	10.7	0.71	2.975	2012-2022	110
Copper, Dissolved (mg/L)	-0.088	<0.001	28.3	0.4	1.1	2012-2022	108
E. col i (cells/100 mL)	0.000	0.001	613	0	0.5	2012-2022	102
Hardness, Ca, Mg (mg/L $CaCO_3$)	0.060	0.379	38.5	7.95	21.65	2012-2022	110
Iron, Dissolved (mg/L)	-1.333	0.203	1080	26.8	66.2	2012-2022	110
Kjeldahl nitrogen, Total (mg/L)	-0.010	0.004	1.3	0.16	0.28	2012-2022	111
Lead, Dissolved (mg/L)	0.000	0.091	0.529	0.01	0.039	2012-2022	78
Magnesium, Dissolved (mg/L)	0.005	0.533	2.93	0.551	1.38	2012-2022	110
Manganese, Dissolved (mg/L)	-0.285	0.051	106	1.9	6.09	2012-2022	110
Nickel, Dissolved (mg/L)	0.000	0.791	1.6	0.045	0.275	2012-2022	88
Nitrate + Nitrite, Dissolved (mg/L)	-0.007	0.094	0.99	0.06	0.26	2012-2022	111
Nitrate, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrite, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH3), (NH4), organic, (NO2) and (NO3), Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH_3), (NH_4), organic, (NO_2) and (NO_3),Total (mg/L)	-0.017	0.006	1.6	0.23	0.55	2012-2022	111
Organic carbon, Total (mg/L)	-0.014	0.444	8.6	3.1	4.08	2012-2022	110
Organic Nitrogen, Total (mg/L)	-0.008	0.016	1	0.09	0.235	2012-2022	107
Orthophosphate, Dissolved as P (mg/L)	0.000	0.931	0.256	0.002	0.0505	2012-2022	110
Orthophosphate, Dissolved as $P0_4$ (mg/L)	0.002	0.749	0.784	0.006	0.1565	2012-2022	109
Oxygen, Dissolved (%)	0.025	0.103	11.8	7.2	9.3	2012-2022	111
Oxygen, Dissolved (mg/L)	0.000	0.954	120	87	105	2012-2022	111
pH (SU)	-0.033	0.008	9	6.7	7.6	2012-2022	109
Phosphorus, Dissolved (mg/L)	0.000	0.713	0.277	0.007	0.059	2012-2022	111
Phosphorus, Total (mg/L)	0.001	0.733	0.347	0.021	0.072	2012-2022	111
Potassium, Dissolved (mg/L)	0.007	0.195	6.39	0.42	0.85	2012-2022	109
RBP Stream width (ft)	0.250	0.410	85	19	44	2012-2022	111
Selenium, Dissolved (mg/L)	-	-	-	-	-	-	
Silver, Dissolved (mg/L)	0.004	0.000	0.5	0.0025	0.01	2012-2014,2022	38
Sodium adsorption ratio [(Na)/(sq root of 1/2 Ca + Mg)]	0.006	0.012	0.59	0.19	0.34	2012-2022	110
Sodium, Dissolved (mg/L)	0.053	0.113	7.07	1.42	3.605	2012-2022	110
Sodium, total cations (%)	0.333	0.001	35	19	27	2012-2022	109
Specific conductance (µS/cm)	0.000	1.000	117	25	62	2012-2022	111
Stream flow (cfs)	0.422	0.650	621	9.6	80	2012-2022	111
Sulfate, Dissolved (mg/L)	0.002	0.865	5.85	1.56	3.49	2012-2022	110
Temperature, water (°C)	-0.146	0.025	19.6	0	8.7	2012-2022	111
Total Coliform (cells/100 mL)	0.000	0.018	2648	0.5	0.5	2012-2022	102
Total dissolved solids, Dissolved, Dried 180 (mg/L)	0.633	0.211	78	10	46	2012-2022	110
Total dissolved solids, Dissolved, Filtered (mg/L)	0.250	0.122	59	7	34.5	2012-2022	104
Turbidity (NTU)	0.000	0.009	14	1	2.2	2012-2022	110
Zinc, Dissolved (mg/L)	0.189	0.001	7.5	0.7	2.6	2012-2022	73

Parameter	Slope	p value	M60 Maximum	Minimum	Median	Date Range	Count
Acidity, (H+) (mg/L)	0.000	0.553	0.00031	0.00001	0.00002	2012-2022	105
Alkalinity, Dissolved (mg/L)	-0.058	0.811	33.9	8.8	22.9	2012-2022	99
Ammonia and ammonium, Dissolved (mg/L)	0.000	0.171	0.24	0.005	0.01	2012-2022	67
Ammonia as NH_4 (mg/L)	0.000	0.442	0.306	0.0065	0.013	2012-2022	104
Arsenic, Dissolved (mg/L)	-0.003	0.015	0.28	0.05	0.165	2012-2022	108
Barometric pressure (mm/Hg)	-0.125	0.272	617	591	609	2012-2022	108
Cadmium, Dissolved (mg/L)	-	-	-	-	-	-	-
Calcium, Dissolved (mg/L)	0.029	0.659	11.1	2.47	6.65	2012-2022	109
Carbon dioxide, Total (mg/L)	0.000	0.574	11	0.3	1	2012-2022	99
Chloride, Dissolved (mg/L)	0.064	0.206	10.9	0.89	3.34	2012-2022	109
Copper, Dissolved (mg/L)	-0.069	<0.001	14.1	0.4	1.2	2012-2022	108
E. col i (cells/100 mL)	0.000	0.004	1300	0	0.5	2012-2022	98
Hardness, Ca, Mg (mg/L $CaCO_3$)	0.117	0.480	40.5	8.66	22.5	2012-2022	109
Iron, Dissolved (mg/L)	-1.362	0.078	487	15.7	52	2012-2022	109
Kjeldahl nitrogen, Total (mg/L)	-0.004	0.234	0.56	0.15	0.255	2012-2022	108
Lead, Dissolved (mg/L)	0.000	0.649	0.206	0.01	0.04	2012-2022	85
Magnesium, Dissolved (mg/L)	0.010	0.185	3.07	0.606	1.43	2012-2022	109
Manganese, Dissolved (mg/L)	-0.090	0.040	83.7	0.56	2.17	2012-2022	109
Nickel, Dissolved (mg/L)	0.007	0.067	0.94	0.045	0.27	2012-2022	90
Nitrate + Nitrite, Dissolved (mg/L)	-0.015	0.011	0.93	0.02	0.28	2012-2022	109
Nitrate, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrite, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH3), (NH4), organic, (NO2) and (NO3), Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH_3), (NH_4), organic, (NO_2) and (NO_3),Total (mg/L)	-0.023	0.001	1.3	0.23	0.555	2012-2022	108
Organic carbon, Total (mg/L)	-0.010	0.409	11.5	2.9	3.8	2012-2022	109
Organic Nitrogen, Total (mg/L)	-0.005	0.201	0.53	0.075	0.175	2012-2022	103
Orthophosphate, Dissolved as P (mg/L)	0.000	0.791	0.17	0.002	0.039	2012-2022	109
Orthophosphate, Dissolved as $P0_4$ (mg/L)	0.001	0.791	0.52	0.006	0.12	2012-2022	109
Oxygen, Dissolved (%)	-0.050	0.003	12.7	7.6	9.5	2012-2022	108
Oxygen, Dissolved (mg/L)	0.000	0.823	110	98	102	2012-2022	107
pH (SU)	0.000	0.848	8.2	6.5	7.6	2012-2022	105
Phosphorus, Dissolved (mg/L)	0.001	0.021	0.188	0.007	0.048	2012-2022	109
Phosphorus, Total (mg/L)	0.001	0.315	0.627	0.027	0.077	2012-2022	109
Potassium, Dissolved (mg/L)	0.008	0.409	1.4	0.34	0.86	2012-2022	109
RBP Stream width (ft)	-0.667	0.058	58	12.3	38	2012-2022	109
Selenium, Dissolved (mg/L)							
Silver, Dissolved (mg/L)	0.004	<0.001	0.5	0.0025	0.01	2012-2015,2022	39
Sodium adsorption ratio [(Na)/(sq root of 1/2 Ca + Mg)]	0.005	0.021	0.61	0.22	0.36	2012-2022	109
Sodium, Dissolved (mg/L)	0.078	0.052	8.1	1.59	3.93	2012-2022	109
Sodium, total cations (%)	0.250	0.007	34	19	27	2012-2022	109
Specific conductance (µS/cm)	1.000	0.082	118	28	66	2012-2022	109
Stream flow (cfs)	1.500	0.203	987	10	76	2012-2022	107
Sulfate, Dissolved (mg/L)	0.024	0.393	6.44	1.63	3.55	2012-2022	109
Temperature, water (°C)	0.140	0.050	18.9	0	8.5	2012-2022	109
Total Coliform (cells/100 mL)	0.000	0.002	9680	0.5	0.5	2012-2022	98
Total dissolved solids, Dissolved, Dried 180 (mg/L)	1.142	0.019	90	10	44	2012-2022	109
Total dissolved solids, Dissolved, Filtered (mg/L)	0.375	0.122	67	15	36	2012-2022	103
Turbidity (NTU)	0.000	0.103	470	1	2.3	2012-2022	109
Zinc, Dissolved (mg/L)							

	M70						
Parameter	**Slope**	**p value**	**Maximum**	**Minimum**	**Median**	**Date Range**	**Count**
Acidity, (H+) (mg/L)	0.000	0.137	0.0005	0.00001	0.00002	2012-2022	108
Alkalinity, Dissolved (mg/L)	0.029	0.838	38.6	9.7	22.2	2012-2022	98
Ammonia and ammonium, Dissolved (mg/L)	0.001	0.001	0.23	0.005	0.01	2012-2022	67
Ammonia as NH_4 (mg/L)	0.000	0.917	0.29	0.0065	0.013	2012-2022	99
Arsenic, Dissolved (mg/L)	-0.001	0.189	0.28	0.11	0.16	2012-2022	106
Barometric pressure (mm/Hg)	-0.125	0.463	635	606	623	2012-2022	108
Cadmium, Dissolved (mg/L)	-	-	-	-	-	-	-
Calcium, Dissolved (mg/L)	0.019	0.641	11.4	2.68	6.38	2012-2022	108
Carbon dioxide, Total (mg/L)	-0.025	0.049	2.7	0.05	0.8	2012-2022	102
Chloride, Dissolved (mg/L)	0.106	0.011	8.22	0.95	3.055	2012-2022	108
Copper, Dissolved (mg/L)	-0.100	<0.001	15.3	0.59	1.3	2012-2022	106
E. col i (cells/100 mL)	0.000	0.009	461	0	0.5	2012-2022	103
Hardness, Ca, Mg (mg/L $CaCO_3$)	0.107	0.561	39.8	9.33	21.6	2012-2022	108
Iron, Dissolved (mg/L)	-1.980	0.071	418	22.2	59.45	2012-2022	108
Kjeldahl nitrogen, Total (mg/L)	0.000	0.884	0.59	0.13	0.255	2012-2022	108
Lead, Dissolved (mg/L)	0.000	0.790	0.444	0.0125	0.0405	2012-2022	88
Magnesium, Dissolved (mg/L)	0.008	0.294	2.83	0.639	1.39	2012-2022	108
Manganese, Dissolved (mg/L)	-0.043	0.485	28.6	1.69	4.61	2012-2022	108
Nickel, Dissolved (mg/L)	0.016	0.003	0.97	0.045	0.27	2012-2022	91
Nitrate + Nitrite, Dissolved (mg/L)	-0.008	0.024	0.85	0.07	0.22	2012-2022	107
Nitrate, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrite, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH3), (NH4), organic, (NO2) and (NO3), Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH_3), (NH_4), organic, (NO_2) and (NO_3),Total (mg/L)	-0.008	0.145	1.3	0.15	0.4875	2012-2022	108
Organic carbon, Total (mg/L)	-0.020	0.281	12.8	2.86	3.495	2012-2022	108
Organic Nitrogen, Total (mg/L)	-0.003	0.367	0.58	0.065	0.165	2012-2022	99
Orthophosphate, Dissolved as P (mg/L)	0.000	0.484	0.126	0.002	0.029	2012-2022	108
Orthophosphate, Dissolved as $P0_4$ (mg/L)	-0.001	0.485	0.386	0.006	0.088	2012-2022	108
Oxygen, Dissolved (%)	0.000	0.611	12.5	7.5	9.45	2012-2022	107
Oxygen, Dissolved (mg/L)	0.000	0.454	114	97	103	2012-2022	107
pH (SU)	0.013	0.074	8.9	7.1	7.7	2012-2022	108
Phosphorus, Dissolved (mg/L)	0.000	0.907	0.146	0.007	0.036	2012-2022	108
Phosphorus, Total (mg/L)	0.001	0.367	0.3225	0.024	0.0695	2012-2022	108
Potassium, Dissolved (mg/L)	0.007	0.129	1.48	0.43	0.875	2012-2022	108
RBP Stream width (ft)	1.110	0.007	126	15	51.5	2012-2022	108
Selenium, Dissolved (mg/L)	-	-	-	-	-	-	-
Silver, Dissolved (mg/L)	-	-	-	-	-	-	-
Sodium adsorption ratio [(Na)/(sq root of 1/2 Ca + Mg)]	0.007	<0.001	0.58	0.23	0.37	2012-2022	108
Sodium, Dissolved (mg/L)	0.078	0.006	7.25	1.75	3.87	2012-2022	108
Sodium, total cations (%)	0.333	<0.001	34	20	28	2012-2022	108
Specific conductance (µS/cm)	0.867	0.058	115	28.5	63.5	2012-2022	108
Stream flow (cfs)	0.667	0.516	761	8.3	91	2012-2022	107
Sulfate, Dissolved (mg/L)	0.048	0.122	8.59	1.66	3.39	2012-2022	108
Temperature, water (^oC)	-0.100	0.075	19.9	0	9.9	2012-2022	108
Total Coliform (cells/100 mL)	0.000	0.009	3972	0.5	0.5	2012-2022	103
Total dissolved solids, Dissolved, Dried 180 (mg/L)	0.667	0.044	86	10	45.5	2012-2022	108
Total dissolved solids, Dissolved, Filtered (mg/L)	0.600	0.019	64	16	34.5	2012-2022	102
Turbidity (NTU)	0.000	0.881	210	1	3.45	2012-2022	108
Zinc, Dissolved (mg/L)	-	-	-	-	-	-	-

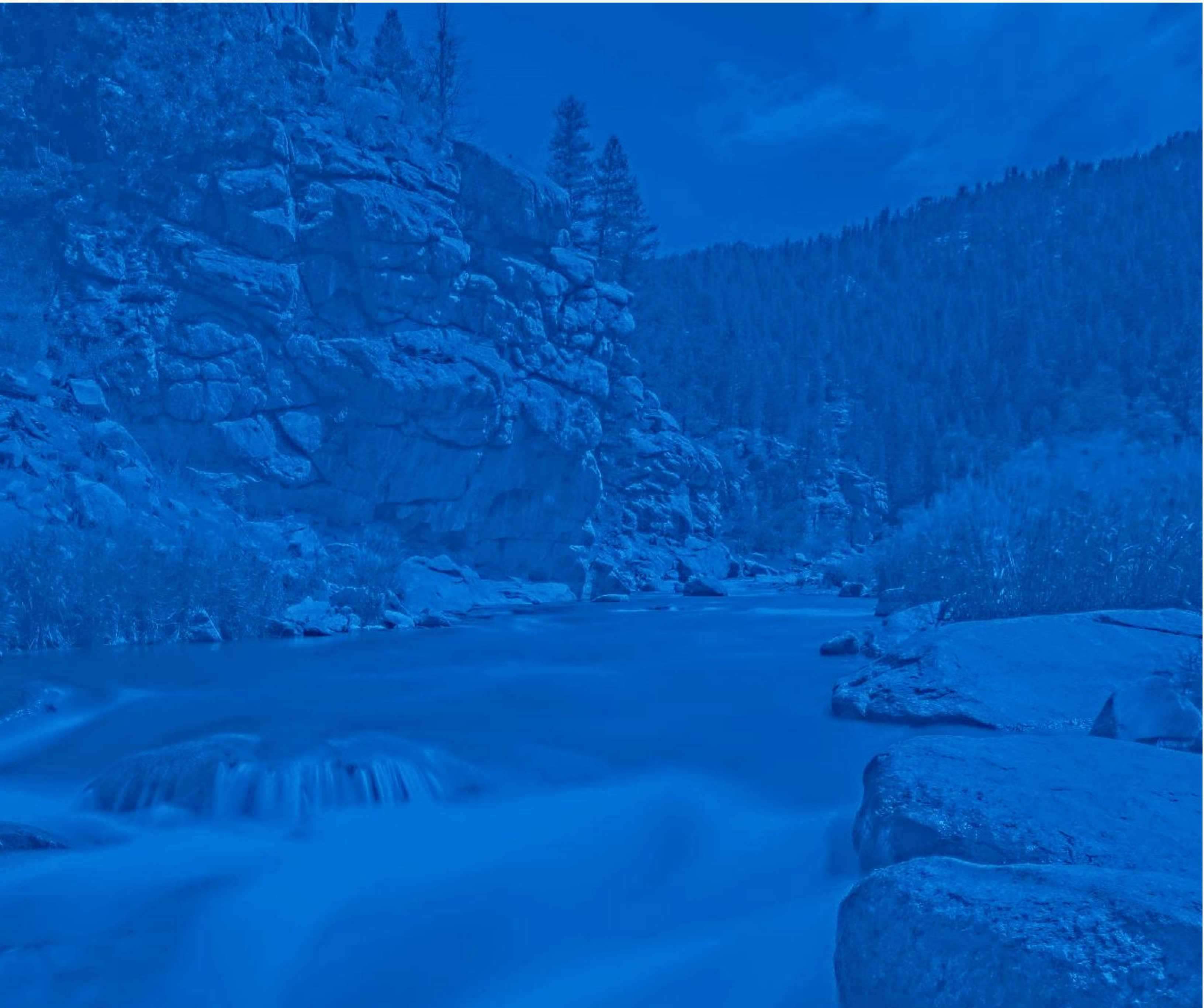
Parameter	Slope	p value	Maximum	M90 Minimum	Median	Date Range	Count
Acidity, (H+) (mg/L)	0.000	0.446	0.0005	0.00001	0.00002	2012-2022	107
Alkalinity, Dissolved (mg/L)	0.045	0.576	42.2	9.4	23	2012-2022	105
Ammonia and ammonium, Dissolved (mg/L)	0.000	0.086	0.11	0.005	0.01	2012-2022	78
Ammonia as NH_4 (mg/L)	0.000	0.762	0.142	0.0065	0.014	2012-2022	105
Arsenic, Dissolved (mg/L)	-0.001	0.205	0.33	0.1	0.17	2012-2022	106
Barometric pressure (mm/Hg)	-0.125	0.223	640	606	629	2012-2022	109
Cadmium, Dissolved (mg/L)	-	-	-	-	-	-	-
Calcium, Dissolved (mg/L)	0.045	0.207	13.8	2.51	6.535	2012-2022	110
Carbon dioxide, Total (mg/L)	0.012	0.342	3	0.05	0.85	2012-2022	102
Chloride, Dissolved (mg/L)	0.088	0.004	11.7	0.78	2.98	2012-2022	110
Copper, Dissolved (mg/L)	-0.123	<0.001	7.7	0.66	1.4	2012-2022	109
E. col i (cells/100 mL)	0.000	0.037	488	0.5	0.5	2012-2022	104
Hardness, Ca, Mg (mg/L $CaCO_3$)	0.200	0.126	47.8	8.73	22	2012-2022	110
Iron, Dissolved (mg/L)	-1.368	0.094	4670	24.3	64.65	2012-2022	110
Kjeldahl nitrogen, Total (mg/L)	-0.004	0.193	0.94	0.14	0.255	2012-2022	110
Lead, Dissolved (mg/L)	-0.001	0.443	3.12	0.0125	0.041	2012-2022	92
Magnesium, Dissolved (mg/L)	0.015	0.073	3.3	0.596	1.385	2012-2022	110
Manganese, Dissolved (mg/L)	0.078	0.618	88.1	1.76	6.19	2012-2022	110
Nickel, Dissolved (mg/L)	0.010	0.018	2.6	0.045	0.27	2012-2022	90
Nitrate + Nitrite, Dissolved (mg/L)	-0.005	0.033	0.73	0.01	0.18	2012-2022	110
Nitrate, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrite, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH3), (NH4), organic, (NO2) and (NO3), Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH_3), (NH_4), organic, (NO_2) and (NO_3),Total (mg/L)	-0.012	0.027	1.4	0.18	0.435	2012-2022	110
Organic carbon, Total (mg/L)	-0.010	0.617	11.6	2.8	3.515	2012-2022	110
Organic Nitrogen, Total (mg/L)	-0.004	0.126	0.92	0.075	0.19	2012-2022	105
Orthophosphate, Dissolved as P (mg/L)	0.000	0.459	0.116	0.002	0.019	2012-2022	107
Orthophosphate, Dissolved as $P0_4$ (mg/L)	-0.001	0.363	0.354	0.006	0.059	2012-2022	110
Oxygen, Dissolved (%)	-0.025	0.183	12.8	7.5	9.5	2012-2022	109
Oxygen, Dissolved (mg/L)	-0.166	0.015	127	98	104	2012-2022	107
pH (SU)	0.000	0.287	9.1	7	7.7	2012-2022	107
Phosphorus, Dissolved (mg/L)	-0.003	0.479	0.135	0.006	0.025	2012-2022	110
Phosphorus, Total (mg/L)	0.000	0.723	0.922	0.02	0.054	2012-2022	110
Potassium, Dissolved (mg/L)	0.005	0.393	2.8	0.33	0.83	2012-2022	110
RBP Stream width (ft)	0.620	0.195	86	14.2	50	2012-2022	110
Selenium, Dissolved (mg/L)	0.000	0.063	0.21	0.025	0.07	2012-2022	110
Silver, Dissolved (mg/L)	-	-	-	-	-	-	-
Sodium adsorption ratio [(Na)/(sq root of 1/2 Ca + Mg)]	0.005	<0.001	0.6	0.2	0.335	2012-2022	110
Sodium, Dissolved (mg/L)	0.070	<0.001	7.55	1.5	3.56	2012-2022	110
Sodium, total cations (%)	0.330	<0.001	35	20	26	2012-2022	110
Specific conductance (µS/cm)	1.268	0.003	132	27	65	2012-2022	110
Stream flow (cfs)	-1.000	0.597	1310	11	123.5	2012-2022	110
Sulfate, Dissolved (mg/L)	0.061	0.019	8.71	1.56	3.37	2012-2022	110
Temperature, water (℃)	0.007	0.657	20.6	0	11.15	2012-2022	108
Total Coliform (cells/100 mL)	0.000	0.004	2937	0.5	0.5	2012-2022	104
Total dissolved solids, Dissolved, Dried 180 (mg/L)	1.000	0.010	121	10	42.5	2012-2022	110
Total dissolved solids, Dissolved, Filtered (mg/L)	0.666	0.009	70	14	35	2012-2022	105
Turbidity (NTU)	-0.027	0.267	560	1	3.8	2012-2022	110
Zinc, Dissolved (mg/L)	-	-	-	-	-	-	-

	M130						
Parameter	**Slope**	**p value**	**Maximum**	**Minimum**	**Median**	**Date Range**	**Count**
Acidity, (H+) (mg/L)	0.000	0.937	0.0005	0.00001	0.00001	2012-2022	129
Alkalinity, Dissolved (mg/L)	0.610	0.007	219	18.5	89.2	2012-2022	105
Ammonia and ammonium, Dissolved (mg/L)	0.000	0.228	0.08	0.005	0.01	2012-2022	93
Ammonia as NH_4 (mg/L)	0.000	0.707	0.103	0.0065	0.016	2012-2022	121
Arsenic, Dissolved (mg/L)	0.003	0.508	1.3	0.15	0.33	2012-2022	109
Barometric pressure (mm/Hg)	-0.134	0.317	651	626	637	2012-2022	129
Cadmium, Dissolved (mg/L)	-	-	-	-	-	-	-
Calcium, Dissolved (mg/L)	0.500	0.444	188	8.24	55.95	2012-2022	110
Carbon dioxide, Total (mg/L)	0.031	0.097	6.2	0.5	1.6	2012-2022	105
Chloride, Dissolved (mg/L)	0.509	0.002	97.5	2.34	12.7	2012-2022	110
Copper, Dissolved (mg/L)	-0.156	<0.001	10.6	0.4	1.1	2012-2022	105
E. coli (cells/100 mL)	0.000	0.050	24196	0.5	0.5	2012-2022	104
Hardness, Ca, Mg (mg/L $CaCO_3$)	2.650	0.428	846	30	220	2012-2022	110
Iron, Dissolved (mg/L)	-1.200	0.049	902	6.5	30.9	2012-2022	104
Kjeldahl nitrogen, Total (mg/L)	-0.004	0.185	5.2	0.14	0.29	2012-2022	128
Lead, Dissolved (mg/L)	0.001	0.214	3.78	0.01	0.03	2012-2022	84
Magnesium, Dissolved (mg/L)	0.233	0.533	91.6	2.28	19.2	2012-2022	110
Manganese, Dissolved (mg/L)	1.325	0.034	167	8.93	38.35	2012-2022	110
Nickel, Dissolved (mg/L)	-0.020	0.021	2.1	0.27	0.76	2012-2022	109
Nitrate + Nitrite, Dissolved (mg/L)	-0.013	<0.001	0.73	0.05	0.25	2012-2022	129
Nitrate, Dissolved (mg/L)	-0.016	0.001	0.72	0.051	0.238	2014-2022	105
Nitrite, Dissolved (mg/L)	0.000	0.875	0.009	0.001	0.003	2014-2022	105
Nitrogen, mixed forms (NH3), (NH4), organic, (NO2) and (NO3), Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH_3), (NH_4), organic, (NO_2) and (NO_3),Total (mg/L)	-0.019	0.001	5.4	0.2	0.58	2012-2022	129
Organic carbon, Total (mg/L)	-0.013	0.167	11.6	2.4	4.28	2012-2022	110
Organic Nitrogen, Total (mg/L)	-0.005	0.261	2.6	0.035	0.22	2012-2022	121
Orthophosphate, Dissolved as P (mg/L)	0.000	0.012	0.037	0.002	0.006	2012-2022	129
Orthophosphate, Dissolved as PO_4 (mg/L)	-0.001	0.008	0.113	0.006	0.021	2012-2022	122
Oxygen, Dissolved (%)	-0.250	0.172	16.3	7.3	10.35	2012-2022	128
Oxygen, Dissolved (mg/L)	-0.333	0.289	200	84	107	2012-2022	128
pH (SU)	0.000	0.538	8.5	7.4	8	2012-2022	129
Phosphorus, Dissolved (mg/L)	0.000	0.006	0.112	0.003	0.01	2012-2022	123
Phosphorus, Total (mg/L)	-0.001	0.018	1.88	0.004	0.032	2012-2022	129
Potassium, Dissolved (mg/L)	0.006	0.610	4.36	0.64	1.805	2012-2022	110
RBP Stream width (ft)	-0.250	0.453	63	12	27	2012-2022	129
Selenium, Dissolved (mg/L)	-0.020	0.295	14.8	0.25	1.9	2012-2022	85
Silver, Dissolved (mg/L)	0.008	<0.001	2.5	0.0025	0.01	2012-2015, 2018-2022	60
Sodium adsorption ratio [(Na)/(sq root of 1/2 Ca + Mg)]	0.003	0.570	1.77	0.3	0.605	2012-2022	110
Sodium, Dissolved (mg/L)	0.200	0.380	115	3.83	20.75	2012-2022	110
Sodium, total cations (%)	0.000	0.163	28	13	17.5	2012-2022	110
Specific conductance (µS/cm)	7.344	0.240	1770	82	526	2012-2022	129
Stream flow (cfs)	-0.500	0.262	1460	1.5	35	2012-2022	129
Sulfate, Dissolved (mg/L)	1.600	0.444	828	9.99	155	2012-2022	110
Temperature, water (°C)	0.000	0.894	23.4	0.1	12	2012-2022	129
Total Coliform (cells/100 mL)	0.000	0.021	24200	0.5	0.5	2012-2022	104
Total dissolved solids, Dissolved, Dried 180 (mg/L)	3.000	0.428	1380	55	334.5	2012-2022	110
Total dissolved solids, Dissolved, Filtered (mg/L)	3.816	0.013	1380	42	322	2012-2022	105
Turbidity (NTU)	0.000	0.620	1020	1	5.25	2012-2022	110
Zinc, Dissolved (mg/L)	-	-	-	-	-	-	-

				M140			
Parameter	**Slope**	**p value**	**Maximum**	**Minimum**	**Median**	**Date Range**	**Count**
Acidity, (H+) (mg/L)	0.000	0.124	0.0005	0.00001	0.00001	2012-2022	129
Alkalinity, Dissolved (mg/L)	1.000	0.134	193	24.8	95.3	2012-2022	105
Ammonia and ammonium, Dissolved (mg/L)	0.003	<0.001	5.97	0.005	0.03	2012-2022	126
Ammonia as NH_4 (mg/L)	0.004	<0.001	7.69	0.0065	0.035	2012-2022	128
Arsenic, Dissolved (mg/L)	0.003	0.221	1	0.125	0.37	2012-2022	110
Barometric pressure (mm/Hg)	-0.063	0.291	651	627	638.5	2012-2022	129
Cadmium, Dissolved (mg/L)	0.002	0.044	0.075	0.008	0.03	2012-2022	60
Calcium, Dissolved (mg/L)	1.025	0.029	134	11.2	59.55	2012-2022	110
Carbon dioxide, Total (mg/L)	0.100	<0.001	6.8	0.5	2	2012-2022	105
Chloride, Dissolved (mg/L)	0.616	0.017	89.8	3.62	21.35	2012-2022	110
Copper, Dissolved (mg/L)	-0.130	<0.001	16.2	0.6	1.6	2012-2022	108
E. col i (cells/100 mL)	0.000	0.034	24196	0.500	0.500	2012-2022	104
Hardness, Ca, Mg (mg/L $CaCO_3$)	4.450	0.066	583	40.6	235.5	2012-2022	110
Iron, Dissolved (mg/L)	-0.090	0.843	584	8.7	36.95	2012-2022	110
Kjeldahl nitrogen, Total (mg/L)	0.011	0.081	7.3	0.31	0.64	2012-2022	129
Lead, Dissolved (mg/L)	-0.006	<0.001	0.536	0.029	0.094	2012-2022	109
Magnesium, Dissolved (mg/L)	0.473	0.089	60.2	3.08	23.3	2012-2022	110
Manganese, Dissolved (mg/L)	2.010	<0.001	148	10.1	31.95	2012-2022	110
Nickel, Dissolved (mg/L)	-0.005	0.216	2	0.39	0.91	2012-2022	110
Nitrate + Nitrite, Dissolved (mg/L)	-0.085	0.048	9.68	0.354	2.36	2012-2022	129
Nitrate, Dissolved (mg/L)	-0.111	0.159	9.63	0.35	2.32	2013-2022	107
Nitrite, Dissolved (mg/L)	0.006	<0.001	1.1	0.002	0.019	2013-2022	107
Nitrogen, mixed forms (NH3), (NH4), organic, (NO2) and (NO3), Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH_3), (NH_4), organic, (NO_2) and (NO_3),Total (mg/L)	-0.006	0.851	11	0.77	3.2	2012-2022	129
Organic carbon, Total (mg/L)	-0.015	0.497	11.6	3.88	5.5075	2012-2022	110
Organic Nitrogen, Total (mg/L)	0.002	0.004	5	0.165	0.59	2012-2022	128
Orthophosphate, Dissolved as P (mg/L)	-0.040	<0.001	2.66	0.012	0.277	2012-2022	129
Orthophosphate, Dissolved as $P0_4$ (mg/L)	-0.123	<0.001	8.15	0.036	0.8515	2012-2022	129
Oxygen, Dissolved (%)	-0.133	0.001	14.2	6.1	9.5	2012-2022	128
Oxygen, Dissolved (mg/L)	-1.714	0.002	146	66	107.5	2012-2022	128
pH (SU)	-0.019	0.005	8.6	7.4	7.9	2012-2022	129
Phosphorus, Dissolved (mg/L)	-0.043	<0.001	2.97	0.021	0.3235	2012-2022	129
Phosphorus, Total (mg/L)	-0.040	<0.001	3.14	0.049	0.42	2012-2022	129
Potassium, Dissolved (mg/L)	-0.015	0.671	10.6	0.92	3.315	2012-2022	110
RBP Stream width (ft)	-1.891	<0.001	63.5	20	39	2012-2022	129
Selenium, Dissolved (mg/L)	0.007	0.841	7.4	0.3	2.1	2012-2022	85
Silver, Dissolved (mg/L)	0.015	<0.001	2.5	0.0025	0.01	2012-2022	50
Sodium adsorption ratio [(Na)/(sq root of 1/2 Ca + Mg)]	0.002	0.821	2.04	0.37	0.96	2012-2022	110
Sodium, Dissolved (mg/L)	0.308	0.553	104	5.64	33.15	2012-2022	110
Sodium, total cations (%)	0.000	0.180	35	18	24	2012-2022	110
Specific conductance (µS/cm)	13.291	0.167	1420	118	641	2012-2022	129
Stream flow (cfs)	-2.292	<0.001	1155.5	11	51	2012-2022	129
Sulfate, Dissolved (mg/L)	3.063	0.235	482	20.2	176	2012-2022	110
Temperature, water (°C)	0.023	0.915	23.55	1	12.9	2012-2022	129
Total Coliform (cells/100 mL)	0.000	0.021	24200	0.500	0.500	2012-2022	104
Total dissolved solids, Dissolved, Dried 180 (mg/L)	4.000	0.141	1040	79	405	2012-2022	110
Total dissolved solids, Dissolved, Filtered (mg/L)	4.485	0.157	987	63	390	2012-2022	105
Turbidity (NTU)	0.033	0.569	480	1	6.05	2012-2022	110
Zinc, Dissolved (mg/L)	-0.186	0.528	40	1	8.1	2012-2022	105

Parameter	Slope	p value	Maximum	Minimum	T10 Median	Date Range	Count
Acidity, (H+) (mg/L)	0.000	0.744	0.0001	0.00001	0.00003	2012-2022	105
Alkalinity, Dissolved (mg/L)	-0.088	0.746	32.6	9.7	17.55	2012-2022	104
Ammonia and ammonium, Dissolved (mg/L)	0.000	0.054	0.02	0.005	0.0075	2012-2015, 2017, 2019-2022	46
Ammonia as NH_4 (mg/L)	0.000	0.833	0.03	0.0065	0.0065	2012-2022	100
Arsenic, Dissolved (mg/L)	0.004	0.055	0.32	0.05	0.12	2012-2022	89
Barometric pressure (mm/Hg)	-0.167	0.143	618	592	608.5	2012-2022	110
Cadmium, Dissolved (mg/L)	-	-	-	-	-	-	-
Calcium, Dissolved (mg/L)	0.036	0.167	9.02	2.44	4.5	2012-2022	110
Carbon dioxide, Total (mg/L)	0.000	0.509	3	0.4	1.1	2012-2022	99
Chloride, Dissolved (mg/L)	0.100	<0.001	6.19	0.48	1.51	2012-2022	110
Copper, Dissolved (mg/L)	-0.100	<0.001	20.3	0.4	1	2012-2022	105
E. col i (cells/100 mL)	0.000	0.065	687	0.5	0.5	2012-2022	99
Hardness, Ca, Mg (mg/L $CaCO_3$)	0.158	0.251	31	8.36	15.65	2012-2022	110
Iron, Dissolved (mg/L)	-3.268	0.017	439	35.9	83.95	2012-2022	110
Kjeldahl nitrogen, Total (mg/L)	0.000	0.655	3	0.07	0.17	2012-2022	109
Lead, Dissolved (mg/L)	0.005	0.030	0.704	0.01	0.044	2012-2022	79
Magnesium, Dissolved (mg/L)	0.013	0.218	2.28	0.529	1.055	2012-2022	110
Manganese, Dissolved (mg/L)	-0.404	<0.001	77.5	2.07	6.35	2012-2022	110
Nickel, Dissolved (mg/L)	0.030	0.160	0.72	0.045	0.27	2012-2022	78
Nitrate + Nitrite, Dissolved (mg/L)	0.000	0.739	0.87	0.02	0.1	2012-2022	109
Nitrate, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrite, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH3), (NH4), organic, (NO2) and (NO3), Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrogen, mixed forms (NH_3), (NH_4), organic, (NO_2) and (NO_3),Total (mg/L)	-0.001	0.790	3.1	0.06	0.28	2012-2022	110
Organic carbon, Total (mg/L)	-0.017	0.746	14.2	1.55	2.875	2012-2022	110
Organic Nitrogen, Total (mg/L)	-0.004	0.008	3	0.03	0.085	2012-2022	100
Orthophosphate, Dissolved as P (mg/L)	0.000	0.636	0.038	0.002	0.006	2012-2022	109
Orthophosphate, Dissolved as $P0_4$ (mg/L)	0.000	0.108	0.117	0.006	0.018	2012-2022	106
Oxygen, Dissolved (%)	-0.100	<0.001	12	7.3	9.5	2012-2022	109
Oxygen, Dissolved (mg/L)	0.000	0.142	106	98	102	2012-2022	109
pH (SU)	0.000	1.000	7.9	7	7.5	2012-2022	105
Phosphorus, Dissolved (mg/L)	0.000	0.271	0.044	0.003	0.008	2012-2022	107
Phosphorus, Total (mg/L)	0.000	0.836	2.24	0.006	0.019	2012-2022	110
Potassium, Dissolved (mg/L)	0.012	0.088	1.42	0.37	0.66	2012-2022	110
RBP Stream width (ft)	-0.100	0.425	66	8.75	22.8	2012-2022	110
Selenium, Dissolved (mg/L)	-	-	-	-	-	-	-
Silver, Dissolved (mg/L)	0.004	<0.001	0.5	0.0025	0.01	2012-2014, 2016, 2022	39
Sodium adsorption ratio [(Na)/(sq root of 1/2 Ca + Mg)]	0.003	0.001	0.51	0.25	0.33	2012-2022	110
Sodium, Dissolved (mg/L)	0.045	0.002	5.25	1.71	3.02	2012-2022	110
Sodium, total cations (%)	0.134	0.188	36	21	29	2012-2022	110
Specific conductance (µS/cm)	0.750	0.087	87	27	45.5	2012-2022	110
Stream flow (cfs)	0.000	0.722	262	2.8	19	2012-2022	110
Sulfate, Dissolved (mg/L)	0.010	0.617	12.9	1.38	2.645	2012-2022	110
Temperature, water (°C)	0.347	0.004	19.8	0	8.35	2012-2022	110
Total Coliform (cells/100 mL)	0.000	0.021	3227	0.5	0.5	2012-2022	100
Total dissolved solids, Dissolved, Dried 180 (mg/L)	1.127	0.025	78	10	37.5	2012-2022	110
Total dissolved solids, Dissolved, Filtered (mg/L)	0.464	0.038	58	14	25	2012-2022	104
Turbidity (NTU)	0.000	0.755	1060	1	2.75	2012-2022	110
Zinc, Dissolved (mg/L)	-	-	-	-	-	-	-

Parameter	Slope	p value	Maximum	Minimum	T10 Median	Date Range	Count
RBP Stream width (ft)	-0.100	0.425	66	8.75	22.8	2012-2022	110
Temperature, water (℃)	0.347	0.004	19.8	0	8.35	2012-2022	110
Barometric pressure (mm/Hg)	-0.167	0.143	618	592	608.5	2012-2022	110
Stream flow (cfs)	0.000	0.722	262	2.8	19	2012-2022	110
Specific conductance (µS/cm)	0.750	0.087	87	27	45.5	2012-2022	110
Acidity, (H+) (mg/L)	0.000	0.744	0.0001	0.00001	0.00003	2012-2022	105
Oxygen, Dissolved (%)	-0.100	<0.001	12	7.3	9.5	2012-2022	109
Oxygen, Dissolved (mg/L)	0.000	0.142	106	98	102	2012-2022	109
pH (SU)	0.000	1.000	7.9	7	7.5	2012-2022	105
Carbon dioxide, Total (mg/L)	0.000	0.509	3	0.4	1.1	2012-2022	99
Nitrogen, mixed forms (NH_3), (NH_4), organic, (NO_2) and (NO_3),Total (mg/L)	-0.001	0.790	3.1	0.06	0.28	2012-2022	110
Organic Nitrogen, Total (mg/L)	-0.004	0.008	3	0.03	0.085	2012-2022	100
Ammonia and ammonium, Dissolved (mg/L)	0.000	0.054	0.02	0.005	0.0075	2012-2015, 2017, 2019-2022	46
Nitrite, Dissolved (mg/L)	-	-	-	-	-	-	-
Nitrate, Dissolved (mg/L)	-	-	-	-	-	-	-
Kjeldahl nitrogen, Total (mg/L)	0.000	0.655	3	0.07	0.17	2012-2022	109
Nitrate + Nitrite, Dissolved (mg/L)	0.000	0.739	0.87	0.02	0.1	2012-2022	109
Orthophosphate, Dissolved as $P0_4$ (mg/L)	0.000	0.108	0.117	0.006	0.018	2012-2022	106
Phosphorus, Total (mg/L)	0.000	0.836	2.24	0.006	0.019	2012-2022	110
Phosphorus, Dissolved (mg/L)	0.000	0.271	0.044	0.003	0.008	2012-2022	107
Orthophosphate, Dissolved as P (mg/L)	0.000	0.636	0.038	0.002	0.006	2012-2022	109
Organic carbon, Total (mg/L)	-0.017	0.746	14.2	1.55	2.875	2012-2022	110
Hardness, Ca, Mg (mg/L $CaCO_3$)	0.158	0.251	31	8.36	15.65	2012-2022	110
Calcium, Dissolved (mg/L)	0.036	0.167	9.02	2.44	4.5	2012-2022	110
Magnesium, Dissolved (mg/L)	0.013	0.218	2.28	0.529	1.055	2012-2022	110
Sodium, Dissolved (mg/L)	0.045	0.002	5.25	1.71	3.02	2012-2022	110
Sodium adsorption ratio [(Na)/(sq root of 1/2 Ca + Mg)]	0.003	0.001	0.51	0.25	0.33	2012-2022	110
Sodium, total cations (%)	0.134	0.188	36	21	29	2012-2022	110
Potassium, Dissolved (mg/L)	0.012	0.088	1.42	0.37	0.66	2012-2022	110
Chloride, Dissolved (mg/L)	0.100	<0.001	6.19	0.48	1.51	2012-2022	110
Sulfate, Dissolved (mg/L)	0.010	0.617	12.9	1.38	2.645	2012-2022	110
Arsenic, Dissolved (mg/L)	0.004	0.055	0.32	0.05	0.12	2012-2022	89
Cadmium, Dissolved (mg/L)	-	-	-	-	-	-	-
Copper, Dissolved (mg/L)	-0.100	<0.001	20.3	0.4	1	2012-2022	105
Iron, Dissolved (mg/L)	-3.268	0.017	439	35.9	83.95	2012-2022	110
Lead, Dissolved (mg/L)	0.005	0.030	0.704	0.01	0.044	2012-2022	79
Manganese, Dissolved (mg/L)	-0.404	<0.001	77.5	2.07	6.35	2012-2022	110
Nickel, Dissolved (mg/L)	0.030	0.160	0.72	0.045	0.27	2012-2022	78
Silver, Dissolved (mg/L)	0.004	<0.001	0.5	0.0025	0.01	2012-2014, 2016, 2022	39
Zinc, Dissolved (mg/L)	-	-	-	-	-	-	-
Selenium, Dissolved (mg/L)	-	-	-	-	-	-	-
Alkalinity, Dissolved (mg/L)	-0.088	0.746	32.6	9.7	17.55	2012-2022	104
Nitrogen, mixed forms (NH3), (NH4), organic, (NO2) and (NO3), Dissolved (mg/L)	-	-	-	-	-	-	-
Turbidity (NTU)	0.000	0.755	1060	1	2.75	2012-2022	110
Total dissolved solids, Dissolved, Dried 180 (mg/L)	1.127	0.025	78	10	37.5	2012-2022	110
Total dissolved solids, Dissolved, Filtered (mg/L)	0.464	0.038	58	14	25	2012-2022	104
Ammonia as NH_4 (mg/L)	0.000	0.833	0.03	0.0065	0.0065	2012-2022	100
E. col i (cells/100 mL)	0.000	0.065	687	0.5	0.5	2012-2022	99
Total Coliform (cells/100 mL)	0.000	0.021	3227	0.5	0.5	2012-2022	100



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