Report on 2019 Water Quality Monitoring

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Executive Summary

Although Governor Evers declared 2019 as the Year of Clean Drinking Water, Madison Water Utility focuses on the delivery of clean, safe drinking water every day. However, that declaration combined with the detection of unregulated PFAS chemicals in multiple Madison wells led to heightened attention on the local drinking water supply. Nevertheless, 2019 marked another year of full compliance with all federal and state health-based drinking water standards.

To ensure drinking water safety, the utility collected nearly four thousand routine water samples; each was tested for coliform bacteria, which was not found in any sample. In addition, each well was tested at least once for a broad suite of both naturally occurring and man-made chemicals. Chloride, nitrate, sodium, and tetrachloroethylene results indicate human influence on ground and drinking water quality.

Despite the absence of regulatory standards, the utility tested each well for PFAS and strontium, and repeated tests for 1,4-dioxane and hexavalent chromium where these unregulated chemicals previously tested above a threshold level. Revised Water Quality Monitoring and Treatment Policies, adopted by the Water Utility Board in early 2019, provide guidance for this extra testing.

Elevated levels of chloride, iron and manganese can affect the taste or appearance of tap water. The utility's long-range Capital Improvement Plan includes treatment at some wells to reduce the level of these nuisance contaminants. Board-approved treatment policies and the Water Quality Watch List serve as important planning tools for Madison Water Utility as it evaluates long-term infrastructure and water treatment needs.

Introduction

The City of Madison drinking water system consists of 23 wells, 33 water storage tanks, and 900 miles of interconnected water distribution pipes. The water utility pumps groundwater out of a deep sandstone aquifer. Wells are 500-1200 feet deep and deliver water to localized regions of the city. The water distribution system is subdivided into ten pressure districts, based primarily on topography. The largest zone is split in two at the Yahara River, with zones 6E and 6W having seven and eight wells, respectively. Some zones do not contain any wells and are supplied water via a pump station.

The groundwater source of Madison's drinking water contributes to its quality. Soil filters out organic matter, particulates, and microbes such as bacteria, algae and protozoa as the water from rainfall, snowmelt, and runoff infiltrate soil to replenish the aquifer. However, the physical and chemical properties of water allow it to dissolve minerals from the underlying rock or to pick up man-made contaminants left behind from normal use, spills, or improper disposal as water moves from the surface down to the saturated zone. The application of agricultural chemicals, including nitrate and pesticides, and road salt can negatively affect groundwater and drinking water quality.

Other threats to groundwater include active or closed landfills, leaky storage tanks, and the use of PFAS-containing firefighting foam.

Madison drinking water contains significant amounts of hardness minerals and other dissolved solids. Consequently, area businesses and homeowners generally depend on water softening to prevent scale buildup on pipes and to promote longer life for water-using appliances. Naturally occurring trace metals are also present, to varying degrees, in Madison's water supply.

Madison Water Utility routinely collects and tests water samples for bacteria and chemicals that reasonably may be expected to be present in drinking water. Samples are taken at Water Utility facilities – wells, storage tanks, and pump stations – and locations within the distribution system (see Table 1 & Figure A-1). The frequency of monitoring varies by contaminant (see Table 2). Monitoring complies with the federal Safe Drinking Water Act, as enforced by the Department of Natural Resources (DNR). Additional testing follows the Water Utility Board-approved monitoring policies and enables staff to track trends to understand changes in distribution system and source water quality.

Table 1. Distribution sample locations tested twice weekly for coliform bacteria.

WEST SIDE SAMPLE LOCATIONS **Sampled Monday & Wednesday**	**EAST SIDE SAMPLE LOCATIONS** **Sampled Tuesday & Thursday**
Booster Station 128 (128)	Booster Station 213 (213)
Hawks Landing Golf Course (HLG)[1]	Dane County Airport (TRUAX)
High Service Reservoir (HSR)	East High School (EAST)
Hill Farms Steam Plant (HF)	East Madison Community Center (EMCC)
Jefferson Middle School (JMS)	Fire Station 5 (FS5)
Leopold School (LS)	Glendale School (GS)
Lincoln School (LN)	Isthmus Engineering (IEM)*
Midvale School (MS)	Lindbergh School (LBS)
Orchard Ridge School (ORS)	Maple Bluff Village Hall (MB)
Shorewood Hills Fire Dept (SH)	Mendota School (MDS)
Thoreau School (THS)	Reservoir 229 (229)*
Tower 120 (120)	Schenk School (SS)
Tower 126 (126)	Streets Department – East (ESD)
Tower 228 (228)	Tower 225 (225)
West High School (WEST)	Tower 315 (315)

[1] Tested seasonally (April through October) when course is actively maintained

* Tested quarterly for disinfection by-products (DBP) – trihalomethanes and haloacetic acids

Table 2. Frequency and locations of routine water quality monitoring.

Test Frequency	Contaminants Tested	Test Location
Daily	Chlorine, Fluoride	Wells
Twice Weekly	Coliform Bacteria, Chlorine	Distribution Sites
Monthly	Iron, Manganese	Some Wells
Quarterly	Coliform Bacteria (Raw Water) Iron, Manganese Volatile Organic Compounds	Wells Distribution Sites Some Wells
Annually	Inorganic Compounds, Nitrate Volatile Organic Compounds	Wells Wells
Less Than Annually	Radionuclides Synthetic Organic Compounds Unregulated Contaminants	Wells Wells Wells & Distribution Sites

Microbiological Testing – Coliform Bacteria

Coliform bacteria are an indicator of water safety; tests showing presence of the bacteria indicate that water may not be safe for human consumption. Most coliforms are harmless soil organisms that do not make people sick. However, some types of fecal coliforms, including *E. coli*, grow in the guts of animals and can cause nausea, diarrhea, or intestinal cramps. Coliform bacteria may also indicate the presence of other harmful bacteria or viruses that are not as easily detected. Samples are collected twice weekly from distribution locations (see Table 1) that represent each pressure zone and are tested for coliform bacteria. The absence of coliform bacteria indicates that the water is safe for consumptive use including for cooking and drinking.

Based on the population it serves, Madison Water Utility is required to collect a minimum of 150 distribution system water samples each month and have them tested for coliform bacteria. In a typical month, the utility collects over 250 water samples for bacteriological analysis, of which over 200 samples are from the distribution system (see Table 3). In addition, on a quarterly basis (once per three month period), the water utility must collect an untreated, non-chlorinated raw water sample from each operating well immediately after water is pumped from the ground, and test these source water samples for coliform bacteria.

Of 2,909 routine distribution samples collected in 2019, none tested positive for coliform bacteria. Maintaining an appropriate chlorine level keeps the distribution system free of coliforms and helps to ensure the safety of Madison drinking water.

Table 3. Monthly number of total coliform samples collected in 2019.

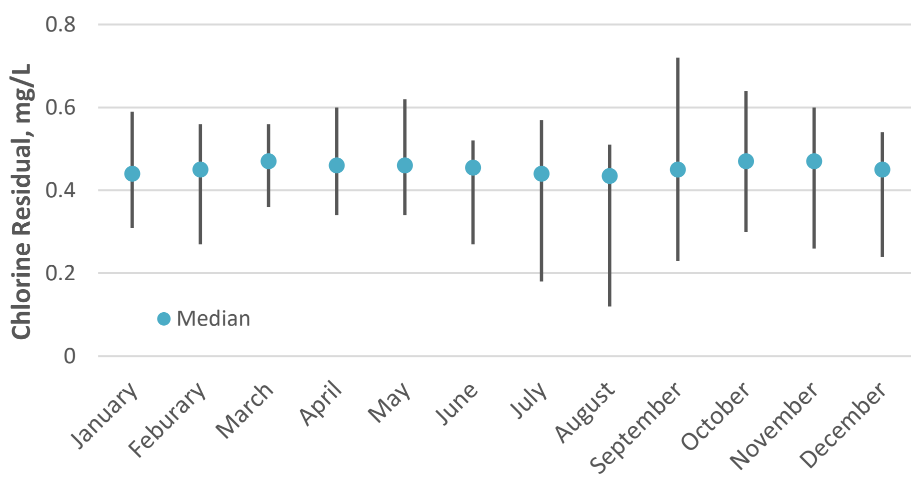
Month	Distribution	Wells	Raw Water	Total	Year to Date
January	231	73	19	323	323
February	236	63	0	299	622
March	222	58	0	280	902
April	250	65	19	334	1236
May	249	67	0	316	1552
June	231	56	1	288	1840
July	278	79	21	378	2218
August	245	58	0	303	2521
September	249	73	1	323	2844
October	262	73	20	355	3199
November	220	61	0	281	3480
December	236	42	0	278	3758

Chemical Treatment – Chlorine

Madison tap water comes from a high-quality aquifer that requires minimal treatment; however, chlorine is added to further reduce the risk from microbial contamination both at the source and in the distribution system. To achieve a minimum chlorine residual of 0.1 mg/L everywhere in the distribution system, the water utility must maintain a minimum chlorine level of 0.3 mg/L as the water leaves the pump house. Automated on-line chlorine analyzers continuously measure and report the chlorine level from each well and pump station and relay that information to the 24-hour pump operator. Water supply staff also perform daily chlorine checks to confirm the accuracy of the chlorine readings and to ensure the equipment is operating properly.

Figure 1 shows the range of chlorine results at the entry point to the distribution system for water tested at the time of coliform bacteria sampling. Each month the median value fell within the standard operating range of 0.20 to 0.55 mg/L free chlorine.

Figure 1. Monthly Range of Chlorine Samples at Entry Points.



A chlorine measurement is taken every time a coliform bacteria sample is collected. Nearly 3000 chlorine readings were made at routine distribution locations. Table 4 shows summary statistics of the test results at each of these 30 sampling locations. Typical values fall within the range of 0.2 to 0.4 mg/L of chlorine. The actual reading depends on the source water quality, proximity to the source well, water age, water temperature, service line size and length, and the water use at the specific location. For example, low chlorine residuals at Thoreau School (THS) and East Madison Community Center (EMCC) occur during school breaks when occupancy by students and staff is limited. Low residuals at Tower 315 reflect older water and the greater distance from the typical source, particularly during warm summer months, now that Well 15 is off-line due to PFAS. Few test results fell below the target level of 0.1 mg/L chlorine in the distribution system.

Table 4. Summary statistics for 2019 chlorine measurements, measured in mg/L, at routine distribution sample locations.

Location	Samples	# <0.1	Minimum	Mean	Maximum
West	102	1	< 0.1	0.36	0.48
HSR	103	0	0.23	0.35	0.47
SH	103	0	0.17	0.42	0.61
HF	103	2	< 0.1	0.38	0.65
JMS	102	0	0.18	0.35	0.46
128	102	1	< 0.1	0.36	0.49
228	35	0	0.25	0.30	0.35
HLG	46	3	< 0.1	0.21	0.41
126	101	0	0.28	0.43	0.56
120	102	0	0.40	0.47	0.54
ORS	104	0	0.31	0.43	0.52
MS	102	0	0.14	0.37	0.46
THS	102	8	< 0.1	0.27	0.42
LS	101	0	0.16	0.37	0.48
LN	102	0	0.12	0.39	0.59
East	101	0	0.15	0.33	0.47
MB	102	2	< 0.1	0.22	0.40
213	102	0	0.15	0.29	0.44
MDS	102	0	0.20	0.38	0.58
LBS	100	0	0.19	0.40	0.50
Truax	102	0	0.19	0.35	0.44
EMCC	96	13	< 0.1	0.20	0.46
ESD	100	0	0.29	0.41	0.56
315	100	11	< 0.1	0.21	0.34
229	102	0	0.20	0.29	0.37
225	99	0	0.25	0.34	0.44
SS	102	0	0.27	0.41	0.52
FS5	102	0	0.18	0.34	0.44
GS	102	0	0.19	0.36	0.50
IEM	102	0	0.13	0.37	0.51

Chemical Treatment – Fluoride

Fluoride is added to Madison tap water to improve dental health and reduce tooth decay. Water is tested daily at each well to achieve the target level of 0.7 mg/L fluoride. In 2019, the system-wide average concentration of 6,752 samples was 0.71 mg/L. Table 5 shows the number of tests and the typical range of fluoride for all Madison wells.

Table 5. Summary of 2019 fluoride results, measured in mg/L, at each Madison well.

Well	Number of Samples	5th Percentile	50th Percentile	95th Percentile
6	291	0.58	0.69	0.79
7	347	0.53	0.66	0.81
8	174	0.67	0.77	0.84
9	365	0.59	0.80	0.90
11	358	0.52	0.71	0.80
12	340	0.61	0.78	0.89
13	336	0.67	0.77	0.86
14	356	0.54	0.65	0.76
15	56	0.61	0.75	0.86
16	361	0.59	0.69	0.79
17	156	0.57	0.67	0.77
18	358	0.61	0.72	0.83
19	289	0.60	0.72	0.83
20	361	0.58	0.67	0.79
24	332	0.63	0.75	0.87
25	364	0.57	0.69	0.78
26	364	0.52	0.67	0.77
27	145	0.64	0.75	0.84
28	348	0.57	0.71	0.80
29	327	0.56	0.70	0.80
30	364	0.60	0.71	0.82
31	360	0.57	0.70	0.79
Total	6752	0.57	0.70	0.84

Note: the 5th percentile corresponds to the level at which 5% of the samples collected were below this value and 95% were above it; the 50th percentile equals the median or middle value

Chemical Testing

Inorganics – Inorganic compounds are rather simple chemicals. They can be described as mineral in nature and usually exist as ions – substances with a positive or negative charge – when dissolved in water. Familiar examples include calcium, chloride, sodium, iron, magnesium, manganese, nitrate, sulfate, and zinc. Many inorganics are naturally occurring minerals that are dissolved from the rock

Table 6. Summary of 2019 annual inorganic test results after any chemical treatment.

PARAMETER	UNITS	MCL	MINIMUM	MEDIAN	MAXIMUM
Alkalinity, $CaCO_3$	mg/l	--	273	315	365
Aluminum	µg/l	SMCL: 50	< 1.6	< 1.6	3.6
Antimony	µg/l	6	< 0.5	< 0.5	< 0.5
Arsenic	µg/l	10	< 0.5	< 0.5	0.6
Barium	µg/l	2000	7.3	19	61
Beryllium	µg/l	4	< 0.1	< 0.1	< 0.1
Cadmium	µg/l	5	< 0.5	< 0.5	< 0.5
Calcium	mg/l	--	53	65	100
Chloride	mg/l	SMCL: 250	< 2.0	21	170
Chromium, Total	µg/l	100	< 0.9	< 0.9	2.1
Conductivity	umhos / cm	--	467	655	1200
Copper	µg/l	1300	0.6	3.3	20
Fluoride	mg/l	4	0.6	0.7	0.8
Hardness, $CaCO_3$	mg/l	--	259	319	454
Iron	mg/l	SMCL: 0.3	< 0.01	0.02	0.54
Lead	µg/l	15	< 0.1	0.1	1.0
Magnesium	mg/l	--	31	39	50
Manganese	µg/l	SMCL: 50	< 1.1	2.8	49
Mercury	µg/l	2	< 0.03	< 0.03	< 0.03
Nickel	µg/l	100	1.0	3.6	5.3
Nitrogen - Nitrate	mg/l	10	< 0.1	0.8	3.8
Nitrogen - Nitrite	mg/l	1	< 0.01	< 0.01	< 0.02
pH (Lab)	standard unit	--	7.3	7.6	8.1
Selenium	µg/l	50	< 1.5	< 1.5	3.1
Silver	µg/l	SMCL: 100	< 0.1	< 0.1	< 0.1
Sodium	mg/l	--	2.1	7.3	52
Strontium	µg/l	--	48	77	100
Sulfate	mg/l	SMCL: 250	5.7	21	43
Thallium	µg/l	2	< 0.1	< 0.1	0.3
Total Solids	mg/l		122	328	684
Zinc	µg/l	SMCL: 5000	1.1	4.7	21

Shaded boxes correspond to regulated contaminants
MCL – Maximum Contaminant Level (health-based)
SMCL – Secondary Maximum Contaminant Level
< Means contaminant was not detected at this level

1 mg/l = 1 part per million (ppm)
1 µg/L = 1 part per billion (ppb)
1 mg/l = 1000 µg/L

which makes up the aquifer. However, some of these substances may be introduced to surface and ground water by human activities; nitrate (a component of fertilizer) and sodium chloride (road salt) are two examples. The utility annually tests all of the wells for thirty different inorganic substances including those previously named as well as arsenic, barium, cadmium, chromium, lead, mercury, selenium, and thallium.

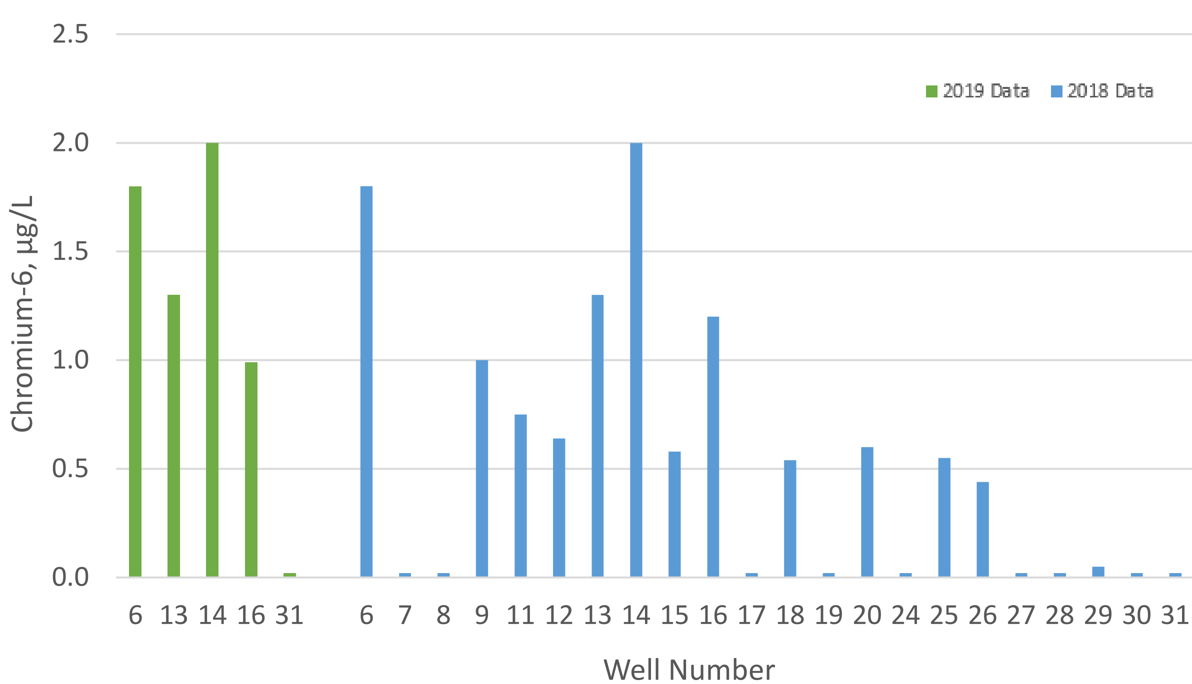
Table 6 summarizes the annual inorganic test results for well samples collected in 2019. With few exceptions, notably nitrate, the regulated inorganic contaminants (shaded in Table 6) that were detected are found at levels near the detection limit, generally < 1 µg/L [or part per billion], and well below the maximum contaminant level (MCL). The ranges of results are similar to those observed in previous years. Complete test results for all wells can be found in the appendix.

Chromium – Chromium is a metallic element naturally found in rocks, soil, plants, and animals including humans. It is used in many products and processes including stainless steel, textile dyes, wood preservation, leather tanning, and anti-corrosion coatings.

Hexavalent chromium, also called chromium (VI) or chrome-6, is the more harmful form of chromium. It can occur naturally but may also enter drinking water supplies from historic spills or industrial emissions. The current understanding about hexavalent chromium is that it commonly occurs in the upper bedrock aquifer – Tunnel City and Wonewoc formations. Water chemistry in the lower bedrock (Mt. Simon) aquifer appears not to favor chromium release into groundwater.

Figure 2 shows the 2018 and 2019 hexavalent chromium results for all Madison wells. All wells were tested in 2018 and any well with hexavalent chromium above 1 µg/L was retested in 2019, in accordance with the Water Quality Monitoring Policies. The highest levels of chrome-6 are found at Wells 6, 13, 14, and 16 where chrome-6 levels range between 1 and 2 µg/L. Wells that draw water only from the Mt Simon formation (Wells 7, 8, 19, 24, 27, 28, 29, and 30) do not have significant amounts (<0.1 µg/L) of hexavalent chromium.

Figure 2. Chromium-6 levels at Madison wells – 2018 & 2019 data.



Iron and Manganese – Accumulation and later re-suspension of iron and manganese sediment in water mains is the primary cause of discolored water at the consumer tap. Iron release from corroding cast iron pipes can also contribute to red, orange or brown colored water. Periodic flushing of hydrants helps to remove the accumulated sediment; however, the groundwater source of Madison drinking water continually introduces new iron and manganese into the distribution system. Revisions to the Water Quality Monitoring and Treatment Policies establish lower thresholds for implementation of wellhead treatment to reduce iron and manganese levels.

US EPA established secondary standards for iron and manganese as guidelines to protect against discolored water. These standards are 0.3 mg/L for iron and 50 μg/L for manganese although iron or manganese levels above 0.1 mg/L and 20 μg/L, respectively, also can contribute to customer complaints about colored water. Madison collects monthly samples at wells with iron or manganese levels consistently above these lower threshold limits. Six wells produce water with iron ranging from 0.10 to 0.25 mg/L; one – Well 8 – exceeds the secondary standard, see Table 7. Six wells have manganese levels above 20 μg/L; Well 8 and Well 19 occasionally exceed the secondary standard. Aesthetic concerns including the staining of laundry and plumbing fixtures or unpleasant tastes can occur if the secondary standard is exceeded. Complete iron and manganese test results are in the appendix.

Table 7. Summary statistics for wells with higher levels of iron and manganese.

Well	Number of Samples	Manganese (μg/L)		Iron (mg/L)	
		Average	Maximum	Average	Maximum
8*	6	48	49	0.54	0.58
17*	5	30	33	0.11	0.12
19	12	44	54	0.20	0.23
24	12	27	32	0.19	0.21
27*	6	32	34	0.12	0.16
28	12	22	23	0.17	0.19
30	12	14	14	0.20	0.22

* Seasonal well that typically operates during a period between April and September

Iron and manganese filtration was added to Wells 7, 29, and 31 to remove these nuisance contaminants and reduce incidences of colored water at customer taps. Table 8 compares the treated and untreated water quality at these three wells. Removal efficiencies above 80% are routine with iron and manganese frequently reduced to below the detection limit.

Table 8. Summary of treated and untreated water quality at wells with filters.

Well	Untreated Water		Filtered Water	
	Iron, mg/L	Manganese, μg/L	Iron, mg/L	Manganese, μg/L
7	0.6	29	0.06	2.9
29	0.3	58	0.05*	1.5
31	0.3	10	0.05*	0.7*

*Measured below the detection limit

In 2019, the Water Utility Board approved revisions to the Water Quality Monitoring and

Treatment Policies. One revision was to establish a uniform performance standard for the acceptable level of iron and manganese – 0.1 mg/L and 0.02 µg/L, respectively – delivered by each well. The policy language identified Well 8 and Well 19 as high priority wells and set a goal for the utility to install treatment at these wells by 2030. The policy established 2045 as a target date for implementation of treatment at the five other wells that currently exceed the performance standard, see Table 7.

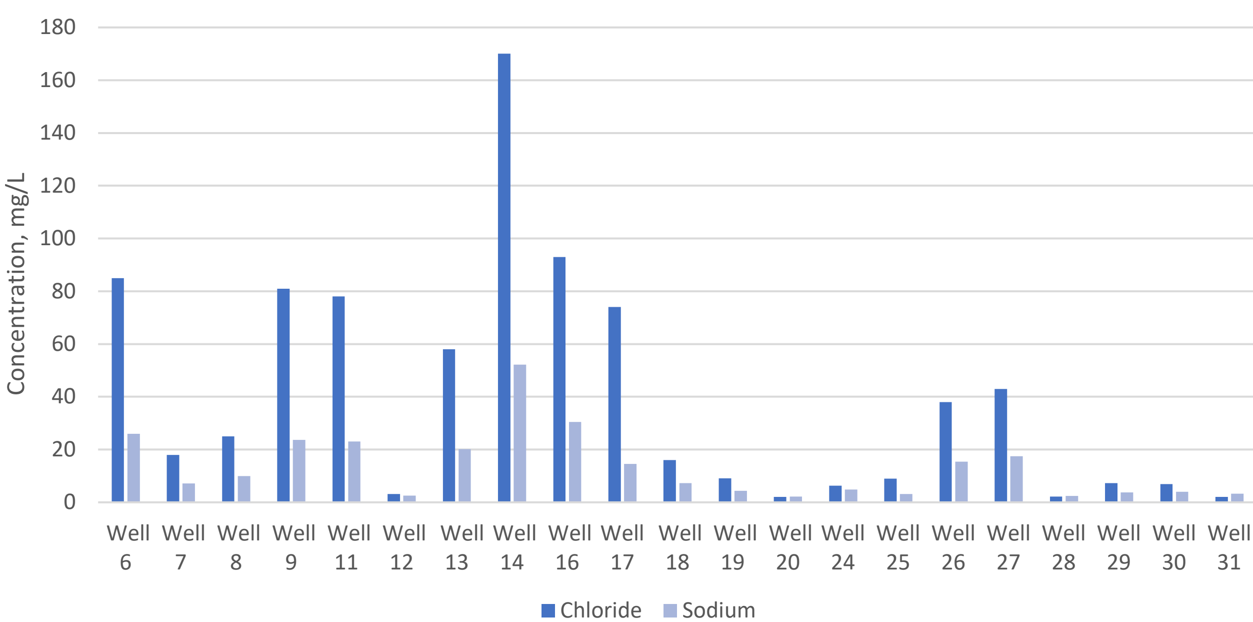
In addition to monitoring iron and manganese levels at the wells, the water utility collects quarterly samples at routine distribution sites (see Table 1). These locations correspond to the coliform bacteria sample locations and include at least one sample site in each pressure zone. Of the 118 samples collected in 2019, none exceeded the secondary standard for either iron or manganese. The average and 95th percentile levels were 0.03 and 0.13 mg/L for iron and 2.5 and 14 µg/L for manganese. Complete results are in the appendix.

Nitrate **–** Nitrate is an essential plant nutrient. Fertilizer application, barnyard runoff, and septic systems can increase the amount of nitrate in soil and groundwater. Shallow wells located adjacent to or downhill from farmland or septic fields may be more vulnerable to nitrate contamination. Municipal wells with short casing lengths can also be susceptible to contamination at the land surface.

Nitrate ranged from below detection (<0.1 mg/L) to 3.8 mg/L (see Table 6). Seven wells tested above 2 mg/L with the highest level found at Well 14. Madison's older wells with casings that do not extend through the Eau Claire shale have higher nitrate compared to more recently constructed wells. Most Madison wells constructed after 1968 have nitrate below 1 mg/L.

Sodium and Chloride **–** An elevated level of sodium and chloride in groundwater is often the result of salt use for winter deicing. Public Health Madison & Dane County has been documenting the increasing trends for these substances in Madison lakes and some wells for many years. Figure 3 shows the current sodium and chloride levels at Madison wells. Well 14, with 170 mg/L chloride and 52 mg/L sodium, has the highest levels. Six other wells have chloride over 50 mg/L and five of those wells have sodium above 20 mg/L.

Figure 3. Sodium and chloride measured at Madison municipal wells in 2019.



Two factors that influence the sodium and chloride levels at a well are length of the steel casing (well construction) and proximity to major roadways (salt routes). A well with a short casing draws proportionally more water from the upper aquifer where water quality is more impacted by surface activities including winter salt application.

There are no regulatory standards for either chemical. US EPA does recommend keeping chloride below 250 mg/L to avoid taste complaints. Sodium levels above 20 mg/L can be concerning for individuals on severe sodium-restricted diets. Health officials recommend these individuals account for sodium in drinking water when calculating their daily sodium intake.

Radionuclides – Radionuclides are unstable forms of an atom that give off radiation when they decay into more stable atoms. They may come from natural or man-made sources. Radium 226 and 228 form when uranium and thorium decay in the environment. Radium occurs naturally at low levels in almost all rock, soil, water, and plants. If higher levels of thorium or uranium are present in native rock or soil, then radium will also be present at higher levels.

Radionuclide testing in 2019 was limited to eight wells. Seven previously tested above a threshold that requires quarterly or annual testing; the eighth was a newly commissioned well with initial requirements for quarterly monitoring. Tests include combined radium (226 + 228) and other gross measures of radioactivity (alpha and beta decay). Radium is highest at Well 19 and Well 27 where combined radium at each well occasionally tests above 5 pCi/L. Compliance with the drinking water standard, however, requires that the running annual average (RAA) of quarterly samples for radium stays below 5 pCi/L. Table 9 summarizes the radionuclide results; complete test results are found in the appendix.

Table 9. Summary of 2019 radionuclide test results, measured in pCi/L.

Well	Samples	Gross Alpha	Gross Beta	Combined Radium, 226 + 228	Maximum RAA
7	1	5.3	6.1	3.3	n/a
8	2*	2.8 – 5.2	6.8 – 8.6	2.9 – 3.9	n/a
19	5*	< 2.0 – 10.1	2.6 – 7.2	4.1 – 5.9	4.8
24	1	8.8	8.0	2.1	n/a
27	5*	4.4 – 6.1	3.1 – 9.9	3.9 – 4.8	4.5
28	1	5.4	2.3	4.6	n/a
30	1	4.9	8.6	3.2	n/a
31	4	2.2 – 8.1	3.0 – 7.9	0.9 – 1.9	1.7

*Includes duplicates RAA – Running Annual Average of Quarterly Samples

Volatile Organic Compounds – Volatile organic compounds (VOC) include chemical solvents, degreasers, dry cleaning chemicals, and petroleum-based products or their derivatives. They are man-made contaminants that arise from industrial processes. They can leach into groundwater from improper storage, chemical spills, or wastewater discharge from industrial plants. Others are found in landfill leachate. At high levels, some of these substances are known or suspected carcinogens. The utility annually tests all the wells for over 50 different VOCs including carbon tetrachloride, tetrachloroethylene (PCE), trichloroethylene (TCE), and a gasoline additive, methyl t-butyl ether (MTBE). Additional monitoring is triggered when the level of any VOC exceeds a threshold, typically one tenth of the maximum contaminant level (MCL).

The most frequently encountered VOC in Madison water is PCE. In 2019, PCE was found at seven wells, see Table 10. The amount found at most wells is around 1 µg/L or lower; the average at Well 9 was 1.9 µg/L while at Well 18 it ranged from 1.5 – 3.4 µg/L. These levels compare to an MCL of 5 µg/L.

A limited number of other VOCs are found in some Madison wells. These contaminants usually are detected in only one or two wells, and are found at very low levels. Table 10 identifies the VOC, the maximum amount detected, and the well in which each was found. Complete test results are found in the appendix.

Table 10. Summary of 2019 VOC detections, measured in µg/L, at Madison wells

Volatile Organic Compound	Well(s) Present	Maximum Level Found	MCL[1]	MCLG[2]
Chloromethane	18	0.72	--	--
1,2-Dichloroethylene (cis)	11	0.39	70	70
Ethylbenzene	9	0.54	700	700
Tetrachloroethylene (PCE)	6, 7, 9, 11, 14, 18, 27	3.4	5	zero
Trichloroethylene (TCE)	18	0.42	5	zero
Trichlorofluoromethane	11	0.64	---	---
Xylene, Total	9	3.0	10000	10000

[1] Maximum Contaminant Level (MCL) – maximum amount allowed in drinking water

[2] Maximum Contaminant Level Goal (MCLG) – level below which there is no known or expected risk to human health

Disinfection By-Products – These chemical by-products form when chlorine combines with impurities in groundwater. If organic matter is present, chlorine may react with it to form a variety of trihalomethanes or haloacetic acids. Because little organic matter is present in groundwater, the level of DBPs in Madison drinking water is low. Quarterly samples are collected at Reservoir #229 and a manufacturing plant located at the end of our distribution system. Previous testing found these locations to have the highest levels of disinfection by-products. Total trihalomethane levels ranged from 2 – 13 µg/L compared to the combined MCL of 80 µg/L. Similarly, total haloacetic acid levels ranged from 0.2 – 2.6 µg/L compared to a combined MCL of 60 µg/L. Higher levels are often observed at locations with higher water age including some towers and large reservoirs and at the farthest reaches of a distribution system. Complete results are in the appendix.

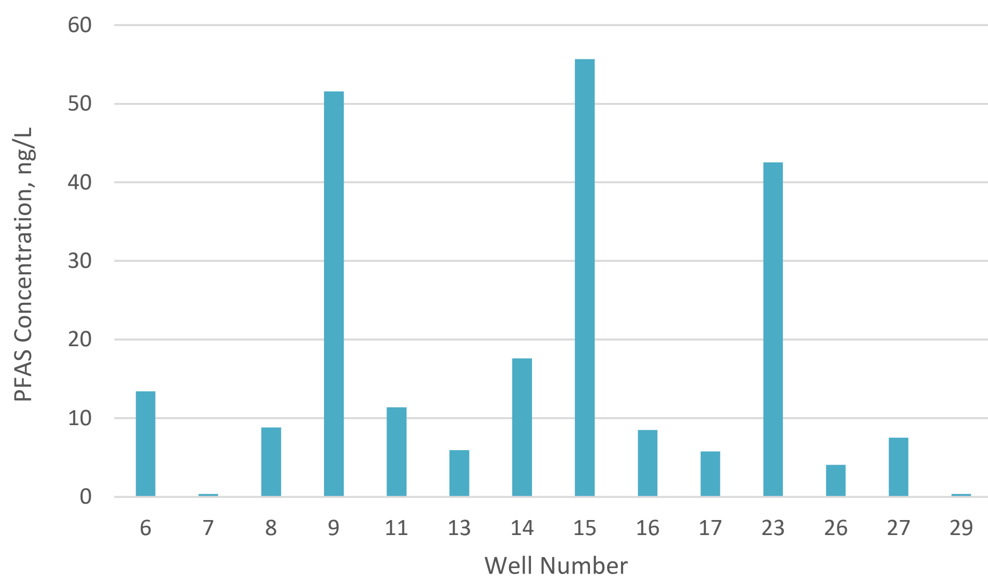
Unregulated Contaminants – Every five years the EPA identifies substances that may be present in drinking water but do not have health-based water quality standards set under the Safe Drinking Water Act. The EPA requires testing at the nation's largest water suppliers, including Madison, and at some smaller utilities. US EPA identified thirty contaminants for testing under the fourth Unregulated Contaminant Monitoring Rule (UCMR4). Madison tested for twenty of these potential chemical contaminants in 2018 and 2019. Ten cyanotoxins were included in the rule;

however, the monitoring requirement only applied to surface water systems.

***UCMR4* –** Two alcohols (1-butanol and 2-methoxyethanol) were each detected at one well during the initial round of testing. The second round of testing did not show the presence of either chemical at any well. Except for manganese, bromide, and unregulated disinfection by-products in the haloacetic acid class, none of the other contaminants was found. Manganese ranged from below detection to 50 µg/L, consistent with results previously found at Madison wells. Bromide, a precursor of some haloacetic acids, was detected at six of seven wells tested. The haloacetic acids measured in the low single-digit microgram per liter (µg/L) range. Full 2018 & 2019 test results are found in the appendix.

***Per and Polyfluoroalkyl Substances (PFAS)* –** The shutdown of Well 15 over elevated levels of a wide range of PFAS raised concern about the potential presence of PFAS in other City wells and prompted additional testing. Comprehensive results have been reported elsewhere and are summarized in Figure 4. Fourteen of twenty-three wells showed the presence of at least one PFAS; nine wells were free of all PFAS tested. The highest combined PFAS levels were observed at Wells 9, 15, and 23 where total PFAS ranged from 43 to 56 ng/L. Combined PFOA + PFOS at these three wells ranged from 5 to 12 ng/L compared to the US EPA health advisory level of 70 ng/L and the proposed Wisconsin groundwater standard of 20 ng/L. The remaining wells with measurable PFAS had between <1 to 18 ng/L of total PFAS. The most commonly found PFAS include PFBA, PFHxS, PFOA, and PFOS. Eleven different PFAS have been confirmed to be present with two additional PFAS potentially present. Finally, individual PFAS rarely occur in isolation; a mixture of six or more PFAS often were found in Madison wells.

Figure 4. Combined PFAS levels in Madison wells.



***1,4-Dioxane* –** This unregulated contaminant was monitored at all Madison wells in 2015 under UCMR3. Dioxane was found at six wells at levels ranging from 0.10 to 0.43 µg/L. These six wells were retested in 2018 when five tested between <0.07 and 0.13 µg/L; the sixth well (Well 11) tested at 0.31 µg/L. Well 11 was retested in 2019 and dioxane measured 0.4 µg/L. The one-in-a-million cancer risk level for dioxane in drinking water is estimated at 0.35 µg/L.

Water Quality Monitoring and Treatment Policies

In 2019, the Water Utility Board revised the Water Quality Monitoring and Treatment Policies. The changes update the testing requirements for radium, dioxane, PFAS, and any other emerging or unregulated contaminant; establish a uniform performance standard for iron and manganese; and establish water quality treatment targets when wellhead treatment is implemented. Details about the revised policy can be found in the Water Utility Board Policy Book, which is available on our website at www.madisonwater.org. These policies guide and inform decision-making about capital improvement investments, supply utilization, and monitoring plans for the utility.

Water Quality Watch List

Water utility staff maintain a Water Quality Watch List to identify contaminants that exceed some threshold, typically the Preventative Action Limit specified in NR 140 (which is a fraction of the Maximum Contaminant Level), or show a history of increasing concentrations over time. The actions identified on the watch list include increased monitoring, a groundwater investigation, an analysis into potential treatment option alternatives, or implementation of the preferred treatment alternative. For example, the action plan calls for the installation of iron and manganese filtration at several wells and increased monitoring for chloride, dioxane, radium, sodium, and VOC at other wells. The complete watch list and accompanying action plan can be found in the appendix.

Conclusions

Madison drinking water meets all federal and state health-based drinking water standards.

Madison Water Utility collects many more bacteriological samples than are required each month for regulatory compliance. These tests rarely show the presence of coliform bacteria, reflecting the high-quality water source and effective disinfection practices.

Daily testing of treatment chemicals – chlorine and fluoride – confirms that levels are within the standard operating range. Otherwise, the chemical feed equipment is adjusted to restore levels to the normal range.

Similar to other metallic ions, chromium in groundwater is influenced by aquifer water chemistry. Naturally occurring hex chrome is the predominant form of chromium in Madison drinking water. Madison continues to annually test for chromium-6 at wells where it exceeds 1 µg/L. A significant amount of hexavalent chromium is not present in water pumped from the lower Mt. Simon aquifer.

Several wells produce water with elevated levels of iron and manganese, minerals that can discolor the water. Iron-manganese filtration is effectively removing these nuisance chemicals from the source water at Wells 7, 29, and 31, improving the quality of water delivered to our customers. Filtration is planned for several additional wells including Well 8 and Well 19.

Sodium, chloride, and nitrate concentrations in groundwater are influenced by human activities including the application of road salt (sodium chloride) and fertilizer (nitrate). Nitrate levels are stable while sodium and chloride levels are rising at several wells. Well 14 is on the water utility's Water Quality Watch List due to rising levels of both sodium and chloride.

At least one volatile organic compound was detected at seven wells. These substances come from historic spills and improper storage at current and former commercial or industrial sites. Routine monitoring tracks trends over time and provides data to determine when treatment is needed.

Testing in conjunction with UCMR4 confirmed previous manganese test results and low levels of disinfection by-products. Two contaminants each detected at one well in 2018 were not confirmed present during testing in 2019. Under this program, none of thirteen other unregulated chemicals were detected at any Madison well.

Using non-standard methods with low detection limits, multiple PFAS were detected at fourteen Madison wells. Levels of PFOA + PFOS, the most well-studied PFAS, are below the EPA health advisory level and proposed Wisconsin groundwater standard at all wells. Additional testing will take place in 2020.

The Water Utility Board revised the Water Quality Monitoring and Treatment Policies to update test requirements, establish a uniform performance standard for iron and manganese, and establish treatment targets for water quality when treatment is implemented.

Water utility staff maintain a Water Quality Watch List to identify contaminants that exceed a threshold or have an increasing trend over time and may require additional action such as wellhead treatment or a groundwater investigation. The list includes action plans for iron, manganese, radium, chloride, sodium, and tetrachloroethylene (PCE) as well as unregulated contaminants including 1,4-dioxane and PFAS.

APPENDIX

Table A-1. Annual Inorganic Test Results for Samples Collected in 2019

PARAMETER	UNITS	MCL	Well 06	Well 07	Well 08	Well 09	Well 11	Well 12	Well 13	Well 14	Well 16	Well 17	Well 18
Sample Date			6/12	6/13	8/15	6/13	6/13	6/12	6/13	6/12	6/12	6/13	6/12
Alkalinity ($CaCO_3$)	mg/l		315	339	316	354	352	285	345	337	285	295	286
Aluminum	µg/L		< 1.62	< 1.62	3.55	< 1.62	< 1.62	< 1.62	< 1.62	< 1.62	< 1.62	< 1.62	< 1.62
Antimony	µg/L	6	< 0.5	< 0.5	< 0.24	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Arsenic	µg/L	10	< 0.5	< 0.5	0.53	< 0.5	0.55	< 0.5	< 0.5	0.59	< 0.5	< 0.5	< 0.5
Barium	µg/L	2000	26	37	35	37	19	16	37	61	20	20	15
Beryllium	µg/L	4	< 0.09	< 0.09	< 0.04	< 0.09	< 0.09	<0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09
Cadmium	µg/L	5	< 0.5	< 0.5	< 0.11	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Calcium	mg/l		87	73	65	84	81	58	77	100	71	62	62
Chloride	mg/l		85	18	25	81	78	3.1	58	170	93	74	21
Chromium	µg/L	100	2.0	< 0.9	< 0.9	1.2	0.9	1.1	1.7	2.1	1.2	8.9	< 0.9
Conductivity	umhos /cm		931	689	655	853	888	530	806	1200	828	661	617
Copper	µg/L	1300	13	2.7	5.5	18	2.3	3.3	3.6	7.1	6.9	2.6	5.0
Fluoride	mg/l	4	0.62	0.56	0.84	0.64	0.60	0.75	0.76	0.60	0.71	0.64	0.67
Hardness ($CaCO_3$)	mg/l		396	355	319	392	401	274	370	454	335	314	298
Iron	mg/l		0.005	0.041	0.538	0.014	0.025	0.003	0.019	0.003	0.004	0.119	0.010
Lead	µg/L	15	< 0.10	< 0.10	0.17	0.20	0.21	< 0.10	0.21	< 0.10	< 0.10	0.15	0.20
Magnesium	mg/l		44	42	38	45	48	31	43	50	39	39	35
Manganese	µg/L		< 1.1	1.7	49	1.5	12	< 1.1	1.4	< 1.1	< 1.1	28	2.8
Mercury	µg/L	2	< 0.025	< 0.025	< 0.019	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Nickel	µg/L	100	4.9	4.0	1.0	4.4	5.0	3.3	4.6	5.3	3.7	3.6	3.4
Nitrogen-Nitrate	mg/l	10	3.3	< 0.095	< 0.089	2.2	2.5	1.7	3.7	3.8	2.8	< 0.095	1.1
Nitrogen-Nitrite	mg/l	1	< 0.012	< 0.012	< 0.015	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012
pH (Lab)	standard unit		7.7	7.5	7.8	7.3	7.5	7.6	7.4	8.0	8.0	7.4	7.8
Selenium	µg/L	50	2.96	< 1.53	< 1.66	2.26	2.67	1.61	1.66	3.06	1.85	< 1.53	< 1.53
Silver	µg/L		< 0.1	< 0.1	< 0.09	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Sodium	mg/l		26	7.2	10	24	23	2.6	20	52	31	15	7.3
Strontium	µg/L		77	92	75	77	90	54	78	88	65	80	81
Sulfate	mg/l		31	35	21	25	30	5.7	21	29	14	38	21
Thallium	µg/L	2	< 0.1	< 0.1	< 0.01	< 0.1	0.28	< 0.1	< 0.1	< 0.1	< 0.1	0.12	< 0.1
Total Solids	mg/l		508	374	388	476	510	200	392	684	454	404	266
Zinc	µg/L		3.2	5.4	9.3	2.1	5.6	15	4.3	3.2	14	21	4.7

MCL – Maximum Contaminant Level

Table A-1, continued. Annual Inorganic Test Results for Samples Collected in 2019

PARAMETER	UNITS	MCL		Well 19	Well 20	Well 24	Well 25	Well 26	Well 27	Well 28	Well 29	Well 30	Well 31
Sample Date				6/12	6/12	6/13	6/13	6/12	8/16	6/12	6/13	6/12	6/12
Alkalinity ($CaCO_3$)	mg/l			281	297	286	337	314	316	273	335	275	365
Aluminum	µg/L			< 1.62	< 1.62	< 1.62	< 1.62	< 1.62	< 1.68	< 1.62	< 1.62	< 1.62	< 1.62
Antimony	µg/L	6		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.24	< 0.5	< 0.5	< 0.5	< 0.5
Arsenic	µg/L	10		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.43	< 0.5	< 0.5	0.56	< 0.5
Barium	µg/L	2000		17	9.7	12	7.3	19	26	14	50	16	18
Beryllium	µg/L	4		< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.04	< 0.09	< 0.09	< 0.09	< 0.09
Cadmium	µg/L	5		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.11	< 0.5	< 0.5	< 0.5	< 0.5
Calcium	mg/l			62	53	54	59	65	74	61	69	56	60
Chloride	mg/l			9.1	< 2.0	6.3	9.0	38	43	2.2	7.3	6.9	2.1
Chromium	µg/L	100		< 0.9	1.0	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9
Conductivity	umhos /cm			559	507	467	584	675	749	546	613	534	631
Copper	µg/L	1300		9.3	1.9	1.7	0.6	2.5	4.2	1.4	2.7	1.5	20
Fluoride	mg/l	4		0.71	0.68	0.76	0.69	0.64	0.83	0.72	0.74	0.67	0.72
Hardness ($CaCO_3$)	mg/l			282	259	268	311	307	345	281	320	270	325
Iron	mg/l			0.198	0.003	0.156	0.052	0.027	0.143	0.171	0.015	0.194	0.006
Lead	µg/L	15		0.98	0.11	< 0.10	< 0.10	0.12	0.10	0.21	< 0.10	< 0.10	< 0.10
Magnesium	mg/l			31	31	32	40	35	39	31	36	32	43
Manganese	µg/L			37	< 1.1	17	2.9	4.2	32	21	1.6	13	< 1.1
Mercury	µg/L	2		< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	<0.019	< 0.025	< 0.025	< 0.025	< 0.025
Nickel	µg/L	100		3.4	2.8	2.7	2.9	4.3	2.5	3.7	3.8	3.0	3.3
Nitrogen-Nitrate	mg/l	10		< 0.095	0.39	< 0.095	0.76	2.4	0.24	< 0.095	1.3	< 0.095	< 0.095
Nitrogen-Nitrite	mg/l	1		< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	< 0.015	< 0.012	< 0.012	< 0.012	< 0.012
pH (Lab)	standard unit			8.1	7.6	7.6	7.7	7.5	7.4	7.8	7.4	7.7	7.9
Selenium	µg/L	50		< 1.53	< 1.53	< 1.53	< 1.53	< 1.53	< 1.66	< 1.53	< 1.53	< 1.53	< 1.53
Silver	µg/L			< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	<0.09	< 0.1	< 0.1	< 0.1	< 0.1
Sodium	mg/l			4.4	2.1	4.8	3.2	15	18	2.4	3.8	4.0	3.3
Strontium	µg/L			88	52	69	62	58	92	48	75	100	71
Sulfate	mg/l			9.7	9.5	15	6.7	16	43	25	12	23	7.3
Thallium	µg/L	2		0.12	< 0.1	< 0.1	< 0.1	< 0.1	0.15	< 0.1	< 0.1	< 0.1	< 0.1
Total Solids	mg/l			328	122	258	288	258	364	208	316	246	280
Zinc	µg/L			3.1	2.6	6.5	2.5	13	4.6	8.6	4.4	5.7	1.1

MCL - Maximum Contaminant Level

Table A-2. Monthly Well Samples – Manganese Levels (µg/L)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Well 6	n/s	n/s	n/s	n/s	n/s	<1.1	n/s	n/s	n/s	n/s	n/s	<2.0
Well 7	16	n/s	1.5	1.4	1.1	<0.7	<0.7	<0.7	1.2	<0.7	n/s	n/s
Well 8	n/s	n/s	n/s	n/s	n/s	n/s	49	49	47	48	49	48
Well 9	n/s	n/s	n/s	n/s	n/s	1.5	n/s	n/s	n/s	n/s	n/s	6.2
Well 11	n/s	n/s	n/s	n/s	n/s	12	n/s	n/s	n/s	n/s	n/s	2.8
Well 12	n/s	n/s	n/s	n/s	n/s	<1.1	n/s	n/s	n/s	n/s	n/s	<2.0
Well 13	n/s	n/s	n/s	n/s	n/s	1.4	n/s	n/s	n/s	n/s	n/s	2.1
Well 14	n/s	n/s	n/s	n/s	n/s	<1.1	n/s	n/s	n/s	n/s	n/s	<2.0
Well 16	n/s	n/s	n/s	n/s	n/s	<1.1	n/s	n/s	n/s	n/s	n/s	<2.0
Well 17	n/s	n/s	n/s	n/s	33	29	30	30	29	n/s	n/s	n/s
Well 18	n/s	n/s	n/s	n/s	n/s	2.8	n/s	n/s	n/s	n/s	n/s	3.2
Well 19	50	54	46	46	39	37	40	41	37	46	42	47
Well 20	n/s	n/s	n/s	n/s	n/s	<1.1	n/s	n/s	n/s	n/s	n/s	<2.0
Well 24	30	32	28	30	24	17	28	28	26	29	28	22
Well 25	n/s	n/s	n/s	n/s	n/s	2.9	n/s	n/s	n/s	n/s	n/s	2.6
Well 26	<3.9	8.4	<3.9	<3.9	<3.9	12	14	24	18	<3.9	<3.9	11
Well 27	n/s	n/s	n/s	n/s	n/s	34	32	32	31	33	n/s	33
Well 28	21	22	22	21	21	21	22	22	21	23	22	22
Well 29	<0.7	n/s	<0.7	<0.7	<0.7	<0.7	4.6	0.8	3.2	<0.7	n/s	n/s
Well 30	14	14	14	13	13	13	14	14	13	14	13	13
Well 31	<0.7	n/s	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	n/s	n/s

Table A-3. Monthly Well Samples – Iron Levels (mg/L)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Well 6	n/s	n/s	n/s	n/s	n/s	0.005	n/s	n/s	n/s	n/s	n/s	<0.007
Well 7	0.140	n/s	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052	n/s	n/s
Well 8	n/s	n/s	n/s	n/s	n/s	n/s	0.54	0.54	0.51	0.56	0.58	0.53
Well 9	n/s	n/s	n/s	n/s	n/s	0.014	n/s	n/s	n/s	n/s	n/s	0.010
Well 11	n/s	n/s	n/s	n/s	n/s	0.025	n/s	n/s	n/s	n/s	n/s	<0.007
Well 12	n/s	n/s	n/s	n/s	n/s	0.003	n/s	n/s	n/s	n/s	n/s	<0.007
Well 13	n/s	n/s	n/s	n/s	n/s	0.019	n/s	n/s	n/s	n/s	n/s	0.017
Well 14	n/s	n/s	n/s	n/s	n/s	0.003	n/s	n/s	n/s	n/s	n/s	<0.007
Well 16	n/s	n/s	n/s	n/s	n/s	0.004	n/s	n/s	n/s	n/s	n/s	<0.007
Well 17	n/s	n/s	n/s	n/s	0.094	0.114	0.113	0.119	0.117	n/s	n/s	n/s
Well 18	n/s	n/s	n/s	n/s	n/s	0.010	n/s	n/s	n/s	n/s	n/s	<0.007
Well 19	0.199	0.228	0.204	0.198	0.187	0.198	0.191	0.196	0.180	0.223	0.215	0.21
Well 20	n/s	n/s	n/s	n/s	n/s	0.003	n/s	n/s	n/s	n/s	n/s	<0.007
Well 24	0.203	0.211	0.192	0.188	0.174	0.156	0.211	0.201	0.197	0.212	0.212	0.15
Well 25	n/s	n/s	n/s	n/s	n/s	0.052	n/s	n/s	n/s	n/s	n/s	0.035
Well 26	0.005	0.005	0.005	0.007	0.009	<0.004	0.007	0.005	0.006	0.005	0.010	<0.007
Well 27	n/s	n/s	n/s	n/s	n/s	0.093	0.104	0.143	0.132	0.161	n/s	0.11
Well 28	0.162	0.181	0.172	0.165	0.166	0.171	0.171	0.177	0.167	0.193	0.184	0.17
Well 29	<0.052	n/s	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052	n/s	n/s
Well 30	0.199	0.208	0.197	0.188	0.181	0.194	0.190	0.196	0.184	0.217	0.205	0.19
Well 31	<0.052	n/s	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052	n/s	n/s

Table A-4. Monthly Distribution Samples – Manganese Levels (µg/L)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave	95th
WEST	2.0	n/s	n/s	0.2	n/s	n/s	0.5	n/s	n/s	0.5	n/s	n/s	0.8	1.8
HSR	2.1	n/s	n/s	0.3	n/s	n/s	1.7	n/s	n/s	0.5	n/s	n/s	1.2	2.0
SH	<0.2	n/s	n/s	<0.2	n/s	n/s	<0.2	n/s	n/s	0.2	n/s	n/s	0.2	0.2
HF	0.6	n/s	n/s	0.5	n/s	n/s	0.5	n/s	n/s	0.8	n/s	n/s	0.6	0.7
JMS	1.6	n/s	n/s	1.5	n/s	n/s	1.3	n/s	n/s	1.7	n/s	n/s	1.5	1.7
128	13	n/s	n/s	19	n/s	n/s	20	n/s	n/s	18	n/s	n/s	18	20
228	n/s	n/s	n/s	16	n/s	n/s	14	n/s	n/s	22	n/s	n/s	17	21
HLG	n/s	n/s	n/s	n/s	n/s	<3.9	0.7	n/s	n/s	1.0	n/s	n/s	1.8	3.6
126	1.5	n/s	n/s	3.4	n/s	n/s	4.2	n/s	n/s	7.6	n/s	n/s	4.2	7.1
120	1.0	n/s	n/s	1.0	n/s	n/s	0.9	n/s	n/s	1.2	n/s	n/s	1.0	1.2
ORS	<0.2	n/s	n/s	<0.2	n/s	n/s	<0.2	n/s	n/s	1.0	n/s	n/s	0.4	0.9
MS	<0.2	n/s	n/s	<0.2	n/s	n/s	1.2	n/s	n/s	0.4	n/s	n/s	0.5	1.1
THS	0.6	n/s	n/s	<0.2	n/s	n/s	0.6	n/s	n/s	1.7	n/s	n/s	0.7	1.5
LS	<0.2	n/s	n/s	<0.2	n/s	n/s	<0.2	n/s	n/s	0.5	n/s	n/s	0.2	0.4
LN	17	n/s	n/s	4.2	n/s	n/s	2.7	n/s	n/s	3.0	n/s	n/s	6.7	15
IEM	<0.2	n/s	n/s	0.3	n/s	n/s	0.3	n/s	n/s	0.4	n/s	n/s	0.3	0.4
EAST	0.3	n/s	n/s	0.7	n/s	n/s	0.6	n/s	n/s	5.2	n/s	n/s	1.7	4.5
MB	0.2	n/s	n/s	0.4	n/s	n/s	0.9	n/s	n/s	7.5	n/s	n/s	2.3	6.5
213	0.8	n/s	n/s	1.7	n/s	n/s	0.7	n/s	n/s	1.1	n/s	n/s	1.1	1.6
MDS	0.7	n/s	n/s	1.2	n/s	n/s	0.8	n/s	n/s	1.2	n/s	n/s	1.0	1.2
LBS	1.4	n/s	n/s	1.3	n/s	n/s	1.0	n/s	n/s	1.6	n/s	n/s	1.3	1.6
TRUAX	0.3	n/s	n/s	0.4	n/s	n/s	0.5	n/s	n/s	1.0	n/s	n/s	0.5	0.9
EMCC	0.6	n/s	n/s	1.0	n/s	n/s	2.6	n/s	n/s	5.2	n/s	n/s	2.3	4.8
ESD	1.6	n/s	n/s	0.2	n/s	n/s	0.5	n/s	n/s	1.6	n/s	n/s	1.0	1.6
315	0.9	n/s	n/s	1.5	n/s	n/s	2.3	n/s	n/s	5.2	n/s	n/s	2.5	4.8
229	0.8	n/s	n/s	2.2	n/s	n/s	0.7	n/s	n/s	1.6	n/s	n/s	1.3	2.1
SS	1.0	n/s	n/s	3.2	n/s	n/s	2.7	n/s	n/s	4.7	n/s	n/s	2.9	4.5
FS-5	0.9	n/s	n/s	2.3	n/s	n/s	1.3	n/s	n/s	4.0	n/s	n/s	2.1	3.7
225	1.8	n/s	n/s	2.1	n/s	n/s	1.7	n/s	n/s	1.9	n/s	n/s	1.9	2.1
GS	1.6	n/s	n/s	0.2	n/s	n/s	0.2	n/s	n/s	0.9	n/s	n/s	0.7	1.5
Ave	1.9	n/s	n/s	2.3	n/s	<3.9	2.2	n/s	n/s	3.4	n/s	n/s		
Max	17	n/s	n/s	19	n/s	<3.9	20	n/s	n/s	22	n/s	n/s		

Table A-5. Monthly Distribution Samples – Iron Levels (mg/L)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave	95th
WEST	0.010	n/s	n/s	0.018	n/s	n/s	0.010	n/s	n/s	<0.005	n/s	n/s	0.011	0.017
HSR	0.011	n/s	n/s	0.019	n/s	n/s	0.034	n/s	n/s	0.007	n/s	n/s	0.018	0.032
SH	0.010	n/s	n/s	0.024	n/s	n/s	0.015	n/s	n/s	<0.005	n/s	n/s	0.014	0.023
HF	0.006	n/s	n/s	0.020	n/s	n/s	0.014	n/s	n/s	<0.005	n/s	n/s	0.011	0.019
JMS	0.014	n/s	n/s	0.026	n/s	n/s	0.016	n/s	n/s	0.012	n/s	n/s	0.017	0.025
128	0.13	n/s	n/s	0.17	n/s	n/s	0.18	n/s	n/s	0.15	n/s	n/s	0.16	0.18
228	n/s	n/s	n/s	0.16	n/s	n/s	0.15	n/s	n/s	0.18	n/s	n/s	0.16	0.18
HLG	n/s	n/s	n/s	n/s	n/s	0.010	0.014	n/s	n/s	<0.005	n/s	n/s	0.010	0.014
126	0.010	n/s	n/s	0.024	n/s	n/s	0.021	n/s	n/s	0.011	n/s	n/s	0.016	0.024
120	<0.005	n/s	n/s	0.018	n/s	n/s	0.005	n/s	n/s	<0.005	n/s	n/s	0.008	0.016
ORS	<0.005	n/s	n/s	0.011	n/s	n/s	<0.005	n/s	n/s	<0.005	n/s	n/s	0.007	0.010
MS	<0.005	n/s	n/s	0.011	n/s	n/s	0.026	n/s	n/s	<0.005	n/s	n/s	0.012	0.024
THS	0.011	n/s	n/s	0.012	n/s	n/s	0.015	n/s	n/s	<0.005	n/s	n/s	0.011	0.015
LS	<0.005	n/s	n/s	0.011	n/s	n/s	0.007	n/s	n/s	<0.005	n/s	n/s	0.007	0.010
LN	0.053	n/s	n/s	0.018	n/s	n/s	0.014	n/s	n/s	0.024	n/s	n/s	0.027	0.049
IEM	0.020	n/s	n/s	0.041	n/s	n/s	0.025	n/s	n/s	<0.005	n/s	n/s	0.023	0.039
EAST	0.007	n/s	n/s	0.024	n/s	n/s	0.013	n/s	n/s	0.067	n/s	n/s	0.028	0.061
MB	0.008	n/s	n/s	0.026	n/s	n/s	0.024	n/s	n/s	0.089	n/s	n/s	0.037	0.080
213	0.014	n/s	n/s	0.034	n/s	n/s	0.012	n/s	n/s	0.009	n/s	n/s	0.017	0.031
MDS	0.012	n/s	n/s	0.035	n/s	n/s	0.012	n/s	n/s	0.010	n/s	n/s	0.017	0.032
LBS	0.011	n/s	n/s	0.030	n/s	n/s	0.011	n/s	n/s	0.012	n/s	n/s	0.016	0.027
TRUAX	0.007	n/s	n/s	0.021	n/s	n/s	0.018	n/s	n/s	0.007	n/s	n/s	0.013	0.021
EMCC	0.005	n/s	n/s	0.024	n/s	n/s	0.056	n/s	n/s	0.053	n/s	n/s	0.035	0.056
ESD	<0.005	n/s	n/s	0.014	n/s	n/s	0.020	n/s	n/s	0.008	n/s	n/s	0.012	0.019
315	<0.005	n/s	n/s	0.021	n/s	n/s	0.033	n/s	n/s	0.046	n/s	n/s	0.026	0.044
229	<0.005	n/s	n/s	0.019	n/s	n/s	0.018	n/s	n/s	0.012	n/s	n/s	0.014	0.019
SS	<0.005	n/s	n/s	0.021	n/s	n/s	0.019	n/s	n/s	0.013	n/s	n/s	0.015	0.021
FS-5	<0.005	n/s	n/s	0.023	n/s	n/s	0.017	n/s	n/s	0.012	n/s	n/s	0.014	0.022
225	0.024	n/s	n/s	0.048	n/s	n/s	0.042	n/s	n/s	0.024	n/s	n/s	0.035	0.047
GS	0.010	n/s	n/s	0.019	n/s	n/s	0.018	n/s	n/s	<0.005	n/s	n/s	0.013	0.019
Ave	0.015	n/s	n/s	0.032	n/s	0.010	0.029	n/s	n/s	0.027	n/s	n/s		
Max	0.13	n/s	n/s	0.17	n/s	0.010	0.18	n/s	n/s	0.18	n/s	n/s		

Table A-6. Radionuclide test results – 2019.

Sample Point	Sample Date	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Radium-226 (pCi/L)	Radium-228 (pCi/L)	Combined Radium (226 + 228)	Uranium (ug/L)
MCL		15	50	5*	5*	5	30
Well #7	8/27	5.3	6.1	1.4	1.9	3.3	ns
Well #8	8/27	2.8	8.6	1.9	2.0	3.9	ns
	8/27	5.2	6.8	2.0	0.92	2.9	ns
Well #19	3/12	10.1	7.2	2.2	1.9	4.1	ns
	5/20	*1.1*	4.7	2.1	2.8	4.9	0.95
	8/28	8.9	4.4	1.9	4.0	5.9	ns
	11/20	5.8	3.4	2.1	2.0	4.1	ns
	11/20	3.6	2.6	2.1	2.4	4.5	ns
Well #24	3/12	8.8	8.0	1.4	0.72	2.12	ns
Well #27	6/24	4.9	5.0	2.1	2.2	4.3	ns
	6/24	6.1	3.1	1.6	2.4	4.0	ns
	8/28	6.0	9.9	2.2	2.6	4.8	ns
	12/2	4.4	4.4	2.0	1.9	3.9	ns
	12/2	6.0	3.6	2.1	2.2	4.3	ns
Well #28	11/20	5.4	2.3	1.8	2.8	4.6	ns
Well #30	8/28	4.9	8.6	1.4	1.8	3.2	ns
Well #31	3/12	8.1	6.7	0.75	0.32	1.07	0.33
	5/20	*1.8*	3.0	0.87	*0.06*	0.93	0.34
	8/28	2.2	7.9	0.83	1.1	1.93	0.37
	8/28	2.6	4.2	0.55	1.0	1.51	0.37

* MCL for combined radium (226+228) is 5 pCi/L
MCL – Maximum Contaminant Level
Note: Italicized results are below the method reporting level; ns = not sampled

Table A-7. UCMR4 test results – Manganese and Bromide.

Sample Year	Manganese, ug/L 2018	Manganese, ug/L 2019	Bromide, ug/L 2018	Bromide, ug/L 2019	Sample Year
Well 06	0.512	0.923	n/s	n/s	Well 06
Well 07	< 0.4	0.631	36.9	34.4	Well 07
Well 08	50.2	46.6	n/s	n/s	Well 08
Well 09	< 0.4	< 0.4	44.3	56.2	Well 09
Well 11	6.04	2.33	56.3	59.7	Well 11
Well 12	0.466	0.924	n/s	n/s	Well 12
Well 13	2.57	1.55	29	39.4	Well 13
Well 14	< 0.4	< 0.4	n/s	n/s	Well 14
Well 15	3.20	3.16	55.1	58.1	Well 15
Well 16	< 0.4	2.89	n/s	n/s	Well 16
Well 17	30.4	29.2	n/s	n/s	Well 17
Well 18	11.1	14.4	n/s	n/s	Well 18
Well 19	45.2	39.2	n/s	n/s	Well 19
Well 20	1.00	1.24	n/s	n/s	Well 20
Well 24	28.1	28	n/s	n/s	Well 24
Well 25	4.36	3.05	n/s	n/s	Well 25
Well 26	15.7	4.42	n/s	n/s	Well 26
Well 27	34.3	31.1	n/s	n/s	Well 27
Well 28	22.1	21.9	n/s	n/s	Well 28
Well 29	1.89	0.425	< 20	21.9	Well 29
Well 30	14.1	14.2	n/s	n/s	Well 30
Well 31	4.11	0.421	< 20	< 20	Well 31

n/s - not sampled

Table A-8. Summary of UCMR4 test results.

Monitoring Period 1: July - December 2018

Unregulated Contaminant	Detection Limit	Facilities Tested	Number of Detections	Locations With Detections	Results
Germanium	0.3	All Wells	0	none	n/a
Manganese	0.4	All Wells	18	All except #7, #9, #14, and #16	See Table A-7
alpha-Hexachlorocyclohexane	0.01	All Wells	0	None	n/a
Chlorpyrifos	0.03	All Wells	0	None	n/a
Dimethipin	0.2	All Wells	0	None	n/a
Ethoprop	0.03	All Wells	0	None	n/a
Oxyfluorfen	0.05	All Wells	0	None	n/a
Profenofos	0.3	All Wells	0	None	n/a
Tebuconazole	0.2	All Wells	0	None	n/a
Permethrin, cis & trans	0.04	All Wells	0	None	n/a
Tribufos	0.07	All Wells	0	None	n/a
Butylated hydroxyanisole	0.03	All Wells	0	None	n/a
o-Toluidine	0.007	All Wells	0	None	n/a
Quinoline	0.02	All Wells	0	None	n/a
1-Butanol	2.0	All Wells	1	Well 28	8.04
2-Methoxyethanol	0.4	All Wells	1	Well 26	0.537
2-Propen-1-ol	0.5	All Wells	0	None	n/a
HAA5	varies	IEM, 229	2	IEM, 229	See Table A-9
HAA6	varies	IEM, 229	2	IEM, 229	See Table A-9
HAA9	varies	IEM, 229	2	IEM, 229	See Table A-9
Total Organic Carbon (TOC)	1000	#7, #9, #11, #13, #15, #29, #31	0	none	n/a
Bromide	20	#7, #9, #11, #13, #15, #29, #31	5 of 7	#7, #9, #11, #13, #15	See Table A-7

* All measurements reported in µg/L or parts per billion (ppb)

Table A-8, continued. Summary of UCMR4 test results.

Monitoring Period 2: February - August 2019

Unregulated Contaminant	Detection Limit	Facilities Tested	Detections	Locations	Results
Germanium	0.3	All Wells	0	none	n/a
Manganese	0.4	All Wells	20	All except #9 and #14	See table A-7
alpha-Hexachlorocyclohexane	0.01	All Wells	0	None	n/a
Chlorpyrifos	0.03	All Wells	0	None	n/a
Dimethipin	0.2	All Wells	0	None	n/a
Ethoprop	0.03	All Wells	0	None	n/a
Oxyfluorfen	0.05	All Wells	0	None	n/a
Profenofos	0.3	All Wells	0	None	n/a
Tebuconazole	0.2	All Wells	0	None	n/a
Permethrin, cis & trans	0.04	All Wells	0	None	n/a
Tribufos	0.07	All Wells	0	None	n/a
Butylated hydroxyanisole	0.03	All Wells	0	None	n/a
o-Toluidine	0.007	All Wells	0	None	n/a
Quinoline	0.02	All Wells	0	None	n/a
1-Butanol	2.0	All Wells	0	None	n/a
2-Methoxyethanol	0.4	All Wells	0	None	n/a
2-Propen-1-ol	0.5	All Wells	0	None	n/a
HAA5	varies	IEM, 229	1	229	See table A-9
HAA6	varies	IEM, 229	1	229	See table A-9
HAA9	varies	IEM, 229	1	229	See table A-9
Total Organic Carbon (TOC)	1000	#7, #9, #11, #13, #15, #29, #31	0	none	n/a
Bromide	20	#7, #9, #11, #13, #15, #29, #31	6 of 7	#7, #9, #11, #13, #15, #29	See table A-7

* All measurements reported in µg/L or parts per billion (ppb)

Table A-9. UCMR4 test results – Haloacetic Acid (HAA) Group.

Haloacetic Acids/Groups	Detection Limit	Results by Location & Year			
		IEM		229	
		2018	2019	2018	2019
Bromochloroacetic acid^	0.3	0.658	ND	0.629	0.912
Bromodichloroacetic acid^	0.5	0.665	ND	0.665	0.586
Chlorodibromoacetic acid^	0.3	ND	ND	0.374	0.446
Dibromoacetic acid*^	0.3	0.702	ND	0.446	0.367
Dichloroacetic acid*	0.2	0.359	ND	0.466	0.944
Monobromoacetic acid*^	0.3	ND	ND	ND	ND
Monochloroacetic acid*	2	ND	ND	ND	ND
Tribromoacetic acid^	2	ND	ND	ND	ND
Trichloroacetic acid*	0.5	ND	ND	0.628	0.558
HAA5 Group*		1.061	0	1.54	1.869
HAA6Br Group^		2.025	0	2.114	2.311
HAA9 Group		2.384	0	3.208	3.813

All measurements reported in µg/L or parts per billion (ppb)

ND - not detected (below the detection limit)

Samples collected 7/17/2018 and 2/21/2019

Table A-10. Test Results for Disinfection By-Products, in µg/L, at Distribution System Locations.

Compound	MCL	IEM	IEM	IEM	IEM	229	229	229	229
		1/16	4/16	7/16	10/15	1/16	4/16	7/16	10/15
Bromodichloromethane	--	0.89	0.58	0.77	1.4	2.6	2.2	4.7	2.8
Bromoform	--	0.28	<0.21	<0.21	<0.21	0.41	0.36	0.57	0.59
Chloroform	--	0.84	0.67	0.57	1.5	2.5	1.9	4.6	2.2
Dibromochloromethane	--	0.85	0.35	0.53	0.76	2.0	1.7	3.5	2.4
Total Trihalomethanes	**80***	**2.9**	**1.6**	**1.9**	**3.7**	**7.5**	**6.2**	**13.4**	**8.0**
Dibromoacetic Acid	--	0.23	<0.21	<0.21	0.24	0.60	0.59	0.65	0.86
Dichloroacetic Acid	--	0.62	0.48	0.23	0.84	1.4	1.1	1.2	1.0
Monobromoacetic Acid	--	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13
Monochloroacetic Acid	--	<0.93	<0.93	<0.93	<0.93	<0.93	<0.93	<0.93	<0.93
Trichloroacetic Acid	--	<0.22	<0.22	<0.22	0.23	0.51	0.58	0.72	0.48
Total Haloacetic Acid	**60***	**0.85**	**0.48**	**0.23**	**1.31**	**2.5**	**2.3**	**2.6**	**2.3**

KEY:

Sample locations: IEM = Isthmus Engineering & Manufacturing; 229 = Reservoir 229

MCL = maximum contaminant level, the highest level that is allowed in drinking water

* MCL for Total Trihalomethanes and Total Haloacetic Acids are cumulative; levels of individual trihalomethanes or haloacetic acids must not add up to more than the collective MCL

Table A-11. Water Quality Watch List

Organics - Regulated

Contaminant	Maximum*	Units	MCLG	PAL	MCL	Detects Below PAL%	Watch List	Action Plan	Reference
Atrazine	0.03	µg/L	3	0.3	3	#29	none		NR 809.20
1,2-Dichloroethane	0.1	µg/L	zero	0.5	5	#17	none		NR 809.24
1,2-Dichloroethylene (cis)	0.6	µg/L	70	7	70	#8, #9, #11, #27	none		NR 809.24
Ethylbenzene	0.7	µg/L	700	140	700	#9	none		NR 809.24
Tetrachloroethylene [PCE]	3.5	µg/L	zero	0.5	5	#27	#6, #7, #9, #11, #14, #18	Quarterly Monitoring	NR 809.24
Toluene	0.2	µg/L	1000	160	1000	#9, #31	none		NR 809.24
1,1,1-Trichloroethane	0.3	µg/L	200	40	200	#9, #18	none		NR 809.24
Trichloroethylene [TCE]	0.4	µg/L	zero	0.5	5	#11, #14, #18	none		NR 809.24
Xylene, Total	4.5	µg/L	10000	400	10000	#9, #31	none		NR 809.24

* Maximum detection observed at any Madison well from 2015 through 2019

% Detected in at least one sample collected from 2015 through 2019

Organics - Unregulated

Contaminant	Maximum*	Units	HAL	PAL	ES	Detects Below PAL%	Watch List	Action Plan	Reference
1,1-Dichloroethane	0.08	µg/L	n/a	85	850	#9	none		NR 140.10
1,4-Dioxane	0.43	µg/L	0.35~	0.3	3	#9, #14, #15, #17, #18	#11	Semi-Annual Monitoring	NR 140.10
Metolachlor	0.01	µg/L	n/a	10	100	#14	none		NR 140.10
PFAS: PFOA, PFOS, PFHxS, PFHxA, PFBS, PFBA, PFHpA, PFHpS, PFPeA, PFPeS, FOSA, N-Et FOSA, 6:2 FTSA	0.06	µg/L	0.07^	n/a	n/a	#6, #7, #8, #9, #11, #13, #14, #16, #17, #23, #26, #27, #29	#15	Monthly Monitoring	US EPA
Trichlorofluoromethane	1.1	µg/L	n/a	698	3490	#11	none		NR 140.10

* Maximum detection observed at any Madison well from 2015 through 2019 % Detected in at least one sample collected from 2015 through 2019 ~ 10^{-6} Cancer Risk Level ^ PFOA + PFOS

Radionuclides (2018 & 2019)

Contaminant	Maximum	Units	MCLG	Watch	MCL	Wells with Detects	Watch List	Action Plan	Reference
Gross alpha	12	pCi/L	zero	5	15	All Except Well #14	#7, #8, #19, #24 #27, #28, #30	Annual or Quarterly Monitoring	NR 809.50
Gross beta	13	pCi/L	zero	10	50	All Except Well #14	#19, #28		NR 809.50
Combined Radium	5.9	pCi/L	zero	2.5	5	All Wells	#7, #8, #19, #24 #27, #28, #30	Annual or Quarterly Monitoring	NR 809.50

ES - Enforcement Standard (NR 140 - Groundwater Quality) **HAL** - Health Advisory Level **MCL** - Maximum Contaminant Level Legal Limit **MCLG** - MCL Goal (Public Health Goal) **PAL** - Preventive Action Limit (NR 140 - Groundwater Quality)

Table A-11, continued. Water Quality Watch List

Inorganics - Regulated

Substance	Maximum*	Units	MCLG	PAL	MCL	Detects Below PAL	Watch List	Action Plan	Reference
Arsenic	0.6	µg/l	zero	1	10	#8, #11, #14, #30	none		NR 809.11
Barium	61	µg/l	2000	400	2000	All Wells	none		NR 809.11
Chromium, Total	14	µg/l	100	10	100	All Wells	none		NR 809.11
Nickel	5.3	µg/l	100	20	100	All Wells	none		NR 809.11
Nitrogen-Nitrate	4.8	mg/l	10	2	10	#12, #18, #20, #25, #27, #29	#6, #9, #11, #13, #14, #16, #23, #26	Annual Monitoring	NR 809.11
Selenium	3.1	µg/l	50	10	50	#6, #9, #11, #12, #13, #14, #16	none		NR 809.11
Thallium	0.3	µg/l	0.5	0.4	2	#11, #17, #19, #27	none		NR 809.11

* Based on 2019 annual test data

Inorganics - Unregulated

Substance	Maximum*	Units	MCLG	Watch	SMCL	Wells with Detects	Watch List	Action Plan	Reference
Aluminum	6.5	µg/l	n/a	50	200	#6, #14, #20, #25, #26	none		NR 809.70
Chloride	170	mg/l	n/a	125	250	#6, #8, #9, #11, #13, #16, #17, #18, #26, #27	#14	GW Investigation; Mitigation (2028)	NR 809.70
Iron	0.54	mg/l	n/a	0.15	0.3	All Wells	#8, #19, #24, #28 #30	Install Filtration: Well #8 (2032) Well #19 (2025) Well #24 (2030) Well #28 (2026) Well #30 (2027)	NR 809.70
Manganese	49	µg/l	n/a	25	50	All Except Wells #6, #12, #14, #16, #20, #31	#8, #17, #19, #24, #27, #28		NR 809.70
Sodium	52	mg/l	n/a	20	n/a	All Wells	#6, #9, #11, #13, #14, #16	Annual Monitoring	EPA DWEL
Sulfate	43	mg/l	n/a	125	250	All Wells	none		NR 809.70
Zinc	21	µg/l	n/a	2500	5000	All Wells	none		NR 809.70

* Based on 2019 annual test data

DWEL - Drinking Water Equivalency Level **MCL** - Maximum Contaminant Level (Legal Limit) **MCLG** - MCL Goal Public Health Goal **PAL** - Preventive Action Limit (NR 140 - Groundwater Quality) **SMCL** - Secondary MCL (Aesthetic Guideline)

Table A-12. Volatile Organic Compound (VOC) Test Results - 2019

Volatile Organic Compounds	Units	MCL	MCLG	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	11	11	11	11	12	13	14	14	14	14	15	16	17	18	18	18	18	19	20	24	25	26	27	28	29	30	31	31	31	Volatile Organic Compounds
	Sample Date			3/11	4/16	7/15	10/14	1/16	4/16	7/18	10/15	7/16	8/27	9/27	10/15	1/16	4/16	7/16	10/15	1/16	4/16	7/18	10/15	4/16	1/16	3/11	4/16	7/15	10/14	1/16	4/16	7/16	3/11	4/16	7/15	10/14	4/16	4/16	4/16	4/16	4/16	7/15	4/16	4/16	4/16	3/11	4/16	7/15	
Benzene	ppb	5	zero	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.19	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	Benzene
Bromobenzene	ppb	--	--	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.20	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	Bromobenzene
Bromodichloromethane*	ppb	80	zero	<0.23	<0.23	<0.23	**0.29**	**1.9**	**1.1**	**1.5**	**1.9**	**0.71**	**0.39**	**0.41**	**0.40**	**0.69**	**0.55**	**1.0**	**1.1**	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	**1.2**	<0.23	<0.23	<0.23	<0.23	**1.6**	<0.23	**1.1**	<0.23	**0.27**	<0.23	<0.23	**0.39**	<0.23	<0.23	<0.23	**0.26**	**Bromodichloromethane***
Bromoform*	ppb	80	zero	<0.21	<0.21	**0.24**	**0.39**	**0.40**	**0.26**	**0.29**	**0.39**	<0.21	<0.13	<0.21	<0.21	**0.49**	**0.58**	**0.85**	**0.77**	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	**0.23**	**0.40**	**0.21**	**0.21**	<0.21	**0.34**	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	**Bromoform***
Bromomethane	ppb	--	--	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.12	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	Bromomethane
Carbon Tetrachloride	ppb	5	zero	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.19	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	Carbon Tetrachloride
Chloroethane	ppb	--	--	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.4	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	Chloroethane
Chloroform*	ppb	80	--	<0.25	<0.25	<0.25	<0.25	**1.6**	**0.94**	**1.2**	**1.5**	**0.91**	**0.43**	**0.49**	**0.57**	**0.31**	<0.25	**0.45**	**0.38**	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	**0.79**	<0.25	<0.25	<0.25	<0.25	**2.4**	<0.25	**0.84**	<0.25	<0.25	<0.25	<0.25	**0.39**	<0.25	<0.25	**0.38**	<0.25	**Chloroform***
Chloromethane	ppb	--	--	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.15	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	**0.72**	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	**Chloromethane**
o-Chlorotoluene	ppb	--	--	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.19	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	o-Chlorotoluene
p-Chlorotoluene	ppb	--	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.18	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	p-Chlorotoluene
Dibromochloromethane*	ppb	80	60	<0.17	<0.17	**0.34**	**0.55**	**1.9**	**1.1**	**1.2**	**1.8**	**0.55**	<0.20	<0.17	**0.21**	**0.94**	**1.0**	**1.7**	**1.5**	<0.17	<0.17	**0.25**	**0.27**	<0.17	<0.17	**0.19**	**0.22**	**0.31**	**0.23**	**0.18**	<0.17	**1.2**	<0.17	**0.24**	**0.19**	**0.26**	**0.85**	<0.17	**1.1**	<0.17	**0.43**	**0.18**	<0.17	**0.37**	<0.17	<0.17	**0.19**	**0.27**	**Dibromochloromethane***
Dibromomethane	ppb	--	--	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.16	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	Dibromomethane
m-Dichlorobenzene (1,3)	ppb	--	--	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.18	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	m-Dichlorobenzene (1,3)
o-Dichlorobenzene (1,2)	ppb	600	600	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.18	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	o-Dichlorobenzene (1,2)
p-Dichlorobenzene (1,4)	ppb	75	75	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.16	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	p-Dichlorobenzene (1,4)
Dichlorodifluoromethane	ppb	--	--	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.16	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	Dichlorodifluoromethane
1,1-Dichloroethane	ppb	--	--	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.18	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	1,1-Dichloroethane
1,2-Dichloroethane	ppb	5	zero	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.17	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	1,2-Dichloroethane
1,1-Dichloroethylene	ppb	7	7	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.21	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	1,1-Dichloroethylene
1,2-Dichloroethylene (cis)	ppb	70	70	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.20	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	**0.38**	**0.31**	**0.39**	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	**1,2-Dichloroethylene (cis)**
1,2-Dichloroethylene (trans)	ppb	100	100	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.16	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	1,2-Dichloroethylene (trans)
Dichloromethane	ppb	5	zero	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.12	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	Dichloromethane
1,2-Dichloropropane	ppb	5	zero	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.18	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	1,2-Dichloropropane
1,3-Dichloropropane	ppb	--	--	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.17	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	1,3-Dichloropropane
2,2-Dichloropropane	ppb	--	--	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.11	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	2,2-Dichloropropane
1,1-Dichloropropene	ppb	--	--	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.19	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	1,1-Dichloropropene
1,3-Dichloropropene	ppb	--	--	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.38	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	1,3-Dichloropropene
Ethylbenzene	ppb	700	700	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.18	<0.22	<0.22	<0.22	<0.22	**0.54**	**0.27**	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	**Ethylbenzene**
Hexachlorobutadiene	ppb	--	--	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	Hexachlorobutadiene
Isopropylbenzene	ppb	--	--	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.19	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	Isopropylbenzene
p-Isopropyltoluene	ppb	--	--	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.16	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	p-Isopropyltoluene
Methyl t-butyl ether	ppb	--	--	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.19	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	Methyl t-butyl ether
Monochlorobenzene	ppb	100	100	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.20	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	Monochlorobenzene
Naphthalene	ppb	--	--	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.19	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	Naphthalene
Styrene	ppb	100	100	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.17	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	Styrene
1,1,1,2-Tetrachloroethane	ppb	--	--	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.17	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane	ppb	--	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.11	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	1,1,2,2-Tetrachloroethane
Tetrachloroethylene	ppb	5	zero	**1.2**	**1.2**	**1.5**	**0.97**	**0.45**	**0.47**	**0.73**	**0.64**	<0.28	<0.19	<0.28	<0.28	**2.0**	**1.7**	**2.2**	**1.8**	**0.62**	**0.53**	**0.75**	**0.61**	<0.28	<0.28	**0.41**	**0.35**	**0.48**	**0.37**	<0.28	<0.28	<0.28	**1.5**	**1.9**	**2.1**	**3.4**	<0.28	<0.28	<0.28	<0.28	<0.28	**0.34**	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	**Tetrachloroethylene**
Toluene	ppb	1000	1000	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.21	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	Toluene
1,2,4-Trichlorobenzene	ppb	70	70	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.16	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	1,2,4-Trichlorobenzene
1,1,1-Trichloroethane	ppb	200	200	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.18	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	1,1,1-Trichloroethane
1,1,2-Trichloroethane	ppb	5	3	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.15	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	1,1,2-Trichloroethane
Trichloroethylene	ppb	5	zero	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.18	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	**0.42**	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	**Trichloroethylene**
Trichlorofluoromethane	ppb	--	--	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.20	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	**0.56**	<0.30	<0.30	**0.64**	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	**Trichlorofluoromethane**
1,2,3-Trichloropropane	ppb	--	--	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.18	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	1,2,3-Trichloropropane
Trichlortrifluoroethane	ppb	--	--	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.16	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	Trichlortrifluoroethane
1,2,4-Trimethylbenzene	ppb	--	--	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.19	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene	ppb	--	--	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.18	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	1,3,5-Trimethylbenzene
Vinyl Chloride	ppb	0.2	zero	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.17	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	Vinyl Chloride
Xylene, Total	ppb	10000	10000	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.48	<0.68	<0.68	<0.68	**1.1**	**3.0**	**1.6**	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	**Xylene, Total**

* Disinfection By-Products - 80 parts per billion (ppb) is the Maximum Contaminant Level (MCL) for the combined concentrations of these four substances

MCLG - Maximum Contaminant Level Goal, a public health goal

NOTE: Numbers preceded by a < symbol indicate the substance was not detected; for example, <0.15 means the substance was not found at the 0.15 ppb detection level

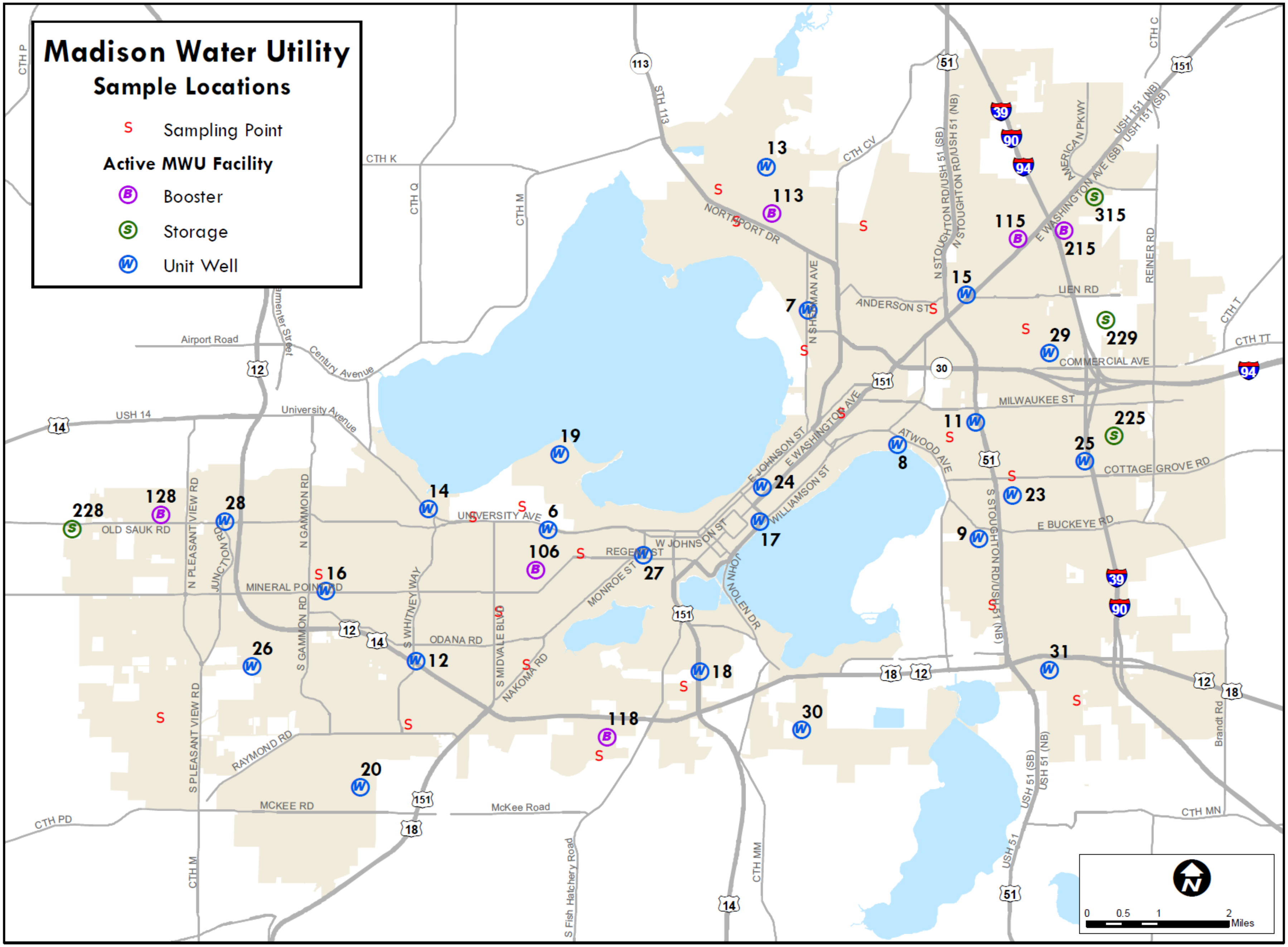


Figure A-1. Water quality monitoring locations – wells, reservoirs, water towers, and distribution sites.