Internal Monitoring Report

Policy #: O-2B Water Quality **Date**: November 27, 2018

Policy Language:

Madison Water Utility consumers will receive high quality water that meets or is better than all primary and secondary drinking water standards, including their public notification requirements, and complies with board-adopted water quality goals, incorporated by attachment.

The Madison Water Utility recognizes that drinking water standards are subject to revision and that new compounds of concern will be determined. This dynamic is a result of health studies being conducted by health organizations and government agencies on the state, national and international level. The technology to quantify compounds at increasingly minute levels is constantly improving.

The Madison Water Utility shall maintain and promulgate a Watch List of compounds of concern by unit well of compounds that are increasing and may approach the primary and secondary drinking water standards. The Watch List shall identify which wells require action.

CEO's interpretation and its justification:

Few things are more vital to a community than the availability of high quality drinking water. It promotes public health, public safety, and the economic interests of our community. To that end, the water utility will consistently deliver water that meets the primary, health-based drinking water standards, the secondary (aesthetic) standards, and the additional policy goals established by the Board.

Water Utility Board Procedural Guideline GUIDE 8 – Executive Summary of Water Quality Treatment Policies – establishes monitoring requirements and the utility's approach for responding to increasing contaminant levels. Generally, the policy establishes two thresholds – one when a contaminant exceeds 50% of a maximum contaminant level (MCL), secondary MCL, or other numerical guideline, and two when it surpasses 80% of this mark.

The first triggers increased monitoring and an investigation into treatment alternatives, operational changes, or other actions to reduce contaminant levels while the second leads to implementation of a mitigation strategy.

The policy applies to any contaminant, regulated or not, that is capable of impairing the health, safety, or aesthetic quality of drinking water. Utility staff will remain vigilant in following developments related to currently unregulated and emerging contaminants like pharmaceuticals, endocrine disruptors, chromium(VI), 1,4 dioxane, and perfluorinated compounds that may pose challenges in the future.

The utility will use multiple communication methods to adequately inform consumers of the safety and quality of their drinking water including the federally-required Consumer Confidence Report (CCR), the water utility website, e-mail distribution lists, neighborhood listservs, citizen meetings, and through direct staff contact in the field and office.

Data directly addressing the CEO'S interpretation:

Contaminants with a primary MCL, Action Level or Enforcement Standard

Coliform Bacteria - Between April and September, 1913 water samples were collected from routine monitoring points in the system including the entry point at the well houses (439 samples). None of the samples tested positive for coliform bacteria. Forty-two raw water samples were collected during this period. All were found to be free of coliform bacteria.

Inorganic Compounds – Twenty-two wells were tested in the monitoring period for a suite of water quality parameters (conductivity, alkalinity, hardness) and inorganic chemicals. None of the following contaminants was found at any well – arsenic, beryllium, cadmium, mercury, and nitrite. Except for barium and nitrate, detections of other contaminants were at low levels, often just above the level of detection. Antimony was detected at three wells. **Table 1** summarizes the range of results for the regulated inorganic chemicals while complete results follow as an attachment.

Table 1. Summary of Regulated Inorganic Chemical Detections

Parameter	MCL	Detections	Minimum	Median	Maximum
Antimony	6	3	<0.24	<0.24	1.1
Arsenic	10	0	<0.43	<0.43	<0.43
Barium	2000	22	6.5	18	61
Beryllium	4	0	<0.04	<0.04	<0.04
Cadmium	5	0	<0.11	<0.11	<0.11
Chromium	100	21	<0.58	2.2	4.3
Mercury	2	0	<0.02	<0.02	<0.02
Nickel	100	21	<0.5	1.6	2.7
Nitrate	10	14	<0.1	0.8	4.0
Nitrite	1	0	<0.01	<0.01	<0.01
Selenium	50	8	0.6	<1.7	2.0
Thallium	2	7	<0.1	<0.1	0.3

Note: The units are µg/L except for nitrate and nitrite, which are measured in mg/L

Volatile Organic Compounds – Since January, thirty-eight samples have been collected from twenty-two wells and tested for VOCs. **Table 2** shows the maximum detections at each well in which at least one VOC other than a disinfection by-product was found.

The most frequently detected VOC is tetrachloroethylene (PCE); it is found at five wells ranging from 0.45 to 2.1 µg/L. The maximum contaminant level (MCL) for PCE is 5 µg/L. The detections of ethyl benzene, toluene, and xylene at Well 9 and Well 31 likely results from painting activities at those well facilities.

Wells with previous VOC detections are sampled once a quarter while all other wells are tested once annually. Complete VOC test results follow as an attachment.

Table 2. Summary of Maximum VOC Detections, January to September

Well #		#6	#8	#9	#11	#14	#17	#18	#27	#31
Number of Samples		3	3	3	3	3	1	3	2	2
VOC Contaminant	**MCL (ug/L)**	**Test Result (ug/L)**								
1,2 Dichloroethane	Zero	<0.25	<0.25	<0.25	<0.25	<0.25	**0.1**	<0.25	<0.25	<0.25
1,2 Dichloroethylene, cis	70	<0.3	**0.2**	**0.2**	**0.4**	<0.3	<0.1	<0.3	**0.1**	<0.3
Ethyl benzene	700	<0.3	<0.3	**0.7**	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Tetrachloroethylene (PCE)	Zero	**0.99**	<0.3	**2.1**	**0.6**	**0.45**	<0.3	**1.8**	<0.3	<0.3
Toluene	1000	<0.22	<0.22	**0.1**	<0.22	<0.22	<0.1	<0.22	<0.22	**0.2**
1,1,1 Trichloroethane	200	<0.32	<0.32	**0.1**	<0.32	<0.32	<0.1	**0.1**	<0.1	<0.32
Trichloroethylene (TCE)	Zero	<0.3	<0.3	<0.3	**0.3**	**0.2**	<0.2	**0.3**	<0.3	<0.3
Trichlorofluoromethane	--	<0.3	<0.3	<0.3	**0.63**	<0.3	<0.2	<0.3	<0.3	<0.3
Xylene	10,000	<0.68	<0.68	**4.5**	<0.68	<0.68	<0.1	<0.68	<0.68	**0.3**

Radium - In accordance with GUIDE 8, seven wells are tested quarterly for radium because previous tests found combined radium (radium 226 + 228) is greater than 2.5 pCi/L, or one-half the MCL. Compliance with the MCL is based on the running annual average of quarterly samples rather than a single result. Results for samples collected during the monitoring period are presented in **Table 3**. Radium concentrations appear stable at each of these seven wells. The Technical Advisory Committee has recommended reducing testing to annually for each well except Well 19 and Well 27.

Table 3. Combined Radium (226+228) Results measured in pCi/L

	May 2018	Aug 2018	Annual Average of Quarterly Samples
Well 7	2.3	2.2	**2.3**
Well 8	Inactive	3.0	**3.0**
Well 19	4.9	4.6	**4.2**
Well 24	2.5	2.5	**2.4**
Well 27	Inactive	4.7*	**4.6**
Well 28	3.0*	2.9	**2.9**
Well 30	2.9	3.6	**2.9**

*Average of two sample results

Contaminants with a secondary MCL

Iron and Manganese - Monthly samples are collected from wells where iron and manganese are elevated. During this monitoring period, both samples from Well 8 exceeded the secondary MCL for iron [0.3 mg/L]. Test results are shown in **Tables 4 and 5**. Filters at Well 7, Well 29, and Well 31 show satisfactory iron and manganese reductions.

Table 4. Monthly Iron Test Results, in mg/L

Source	Apr	May	Jun	Jul	Aug	Sep
Well 7 - filtered	<0.01	<0.01	<0.01	<0.01	0.05	0.07
Well 8	n/s	n/s	n/s	n/s	**0.54**	**0.52**
Well 17	n/s	0.11	0.13	0.12	0.12	0.12
Well 19	0.21	0.20	0.21	0.20	0.20	0.21
Well 24	0.18	0.19	0.22	0.20	0.21	0.22
Well 26 – deep well	<0.01	<0.01	n/s	n/s	0.09	<0.02
Well 27	n/s	n/s	0.11	0.14	0.14	0.11
Well 28	0.17	0.17	0.17	0.18	0.16	0.19
Well 29 - filtered	0.01	<0.01	<0.01	<0.01	<0.01	<0.02
Well 30	0.20	0.20	0.21	0.20	0.19	0.20
Well 31	n/s	n/s	n/s	n/s	<0.01	<0.01

Table 5. Monthly Manganese Test Results, in μg/L

Source	Apr	May	Jun	Jul	Aug	Sep
Well 7 - filtered	<1.2	<3.9	<3.9	<3.9	<0.7	3.2
Well 8	n/s	n/s	n/s	n/s	45	46
Well 17	n/s	32	33	28	29	28
Well 19	47	44	45	36	43	45
Well 24	31	30	28	26	29	30
Well 26 – deep well	<1.2	<3.9	n/s	n/s	2.2	<1.0
Well 27	n/s	n/s	33	34	33	31
Well 28	22	22	22	20	21	25
Well 29 - filtered	<1.2	<3.9	<3.9	<3.9	<3.9	3.0
Well 30	<1.2	14	14	13	13	14
Well 31	n/s	n/s	n/s	n/s	<3.9	<0.2

Iron and manganese monitoring also occurs in the distribution system at all coliform sample locations. Test results, summarized in the **Table 6**, show iron and manganese infrequently exceed the established benchmarks and over 95% of the samples are below one half the policy goals.

Table 6. Summary of iron and manganese levels in the distribution system.

Manganese, µg/L

	Apr - Sep	2018
Policy Goal	**50**	**50**
Median	1.5	1.2
Average	4.6	4.0
95th Percentile	***21***	***20***
Maximum	100	100
Number of Samples	170	254
>50 µg/L	1	1

Iron, mg/L

	Apr - Sep	2018
Policy Goal	**0.3**	**0.3**
Median	<0.02	<0.02
Average	0.03	0.03
95th Percentile	***0.14***	***0.11***
Maximum	0.42	0.42
Number of Samples	170	254
>0.3 mg/L	1	1

Chloride - Chloride levels have been steadily rising at a number of wells, especially those that are not cased through the Eau Claire shale layer. The increase has been attributed to road salt use on roadways and parking lots. Annual testing shows chloride exceeding 100 mg/L at two Madison wells (#14 and #23) and chloride between 50 and 100 mg/L at five other wells. Monthly chloride monitoring continues at Well 14. Six samples were collected between April and September; the chloride level has been stable at 140 mg/L, compared to the secondary MCL – 250 mg/L.

Previous work identified the storm sewer outlet into Lake Mendota at Spring Harbor as a potential source of chloride contamination to Well 14. Last December, two temporary monitoring wells were installed in Spring Harbor Park to investigate this potential source. Sampling will continue through June 2019. Monthly test results are summarized in **Table 7**.

Table 7. Chloride and sodium levels at Well 14 and two monitoring wells located in Spring Harbor Park (MW-1 and MW-2)

	MW-1 (North)		MW-2 (South)		Well 14	
	Chloride, mg/L	Sodium, mg/L	Chloride, mg/L	Sodium, mg/L	Chloride, mg/L	Sodium, mg/L
Jan 2018	150	51	180	69	145	49
Feb 2018	160	57	200	91	137	50
Mar 2018	200	68	170	75	140	52
Apr 2018	160	66	180	72	140	50
May 2018	100	42	180	80	140	52
Jun 2018	180	67	200	91	140	53
Jul 2018	220	90	190	76	140	52
Aug 2018	67	60	180	80	140	55
Sep 2018	150	78	160	78	140	57

An alternatives evaluation, previously planned for 2018, was delayed until 2019. This study will identify and compare treatment options, including their costs, to mitigate increasing chloride and sodium levels at Well 14.

Finally, water utility staff continue to work with regional partners to help raise awareness on the issue of chloride contamination of the lakes and our groundwater and drinking water resources. The partnership helped develop and implement a Winter Salt Certification program emphasizing training, equipment calibration, and record keeping. Outreach efforts promote the training workshops that are a prerequisite to individual or organization-level certification.

Unregulated and Emerging Contaminants

Sodium - In accordance with GUIDE 8, monthly sodium testing continued at Well 14. Six samples were collected between April and September with samples measuring between 50 and 57 mg/L; sodium continues to rise in water pumped from the well. US EPA recommends that drinking water not exceed 20 mg/L to protect high-risk populations including individuals on severe sodium-restricted diets. Eight Madison wells produce water with sodium above 20 mg/L: five in the 20-25 mg/L range, one between 25 and 30 mg/L, and the remaining two (#14, #23) above 30 mg/L sodium.

1,4-Dioxane – Six wells (#9, #11, #14, #15, #17, and #18) in which dioxane was previously found were tested again this year. The results ranged from <0.07 to 0.31 µg/L. The highest level was found at Well 11 while dioxane was not detected at Well 17 during this testing period. The reference level of 0.35 µg/L corresponds to US EPA's 10^{-6} lifetime cancer risk level.

Dioxane often co-occurs with other chlorinated solvents. It is not readily removed from water like volatile organic compounds. Air stripping is mostly ineffective at removing dioxane.

Perfluorinated Compounds – A group of six perfluorinated compounds were monitored twice in 2015 at all Madison wells as part of the UCMR3 [Unregulated Contaminants Monitoring Regulation – Cycle 3] process. None of the PFCs were detected at any Madison well. In 2016, US EPA issued a health advisory for PFOA and PFOS establishing 70 ng/L as the combined concentration of PFOA and PFOS above which drinking water systems should perform additional monitoring and take action to lower the levels of PFOA and PFOS.

Beginning in 2017, the utility tested some wells using methods that are more sensitive, with detection limits in the single-digit part per trillion range. Five wells were tested based on their proximity to landfills or the airport, places where PFCs can be found. PFCs were detected at low levels at two wells: Wells 15 and 16. Regular testing has continued at Well 15 with the number of PFCs measured increasing to twelve. **Table 8** shows the PFCs test results for Well 15.

Perfluorinated compounds are manufactured chemicals used in industrial and consumer applications. They are responsible for the non-stick, stain-resistant and flame-retardant properties of cookware, clothing, fabrics, food packaging, and fire-fighting foams. Once in the environment, these chemicals are very stable and slow to degrade due to the strong carbon-fluoride bonds that make them resistant to degradation. Conventional drinking water treatment is mostly ineffective at removing or destroying these widespread and persistent chemicals. However, studies show that adsorptive media including activated carbon and ion exchange resins are two promising technologies for removing PFCs from drinking water.

PFOA and PFOS were the most commonly manufactured and widely used PFCs. Since chemical manufacturers no longer produce PFOA and PFOS in the United States, other fluoridated compounds with similar non-stick and stain-repellant properties have replaced them. Health risks associated with these substitute compounds is currently unknown.

Table 8. Perfluorinated compounds results – Well 15.

Perfluorinated Compounds	Length	3/10/15	9/15/15	8/01/17	12/04/17	3/19/18
perfluorobutanesulfonic acid (PFBS)	C4	<90	<90	**2.4**	**2.1 - 2.3**	**2.4**
perfluorohexanesulfonic acid (PFHxS)	C6	<30	<30	**19**	**19 - 20**	**20**
perfluorooctanesulfonic acid (PFOS)	C8	<40	<40	**5.4**	**4.8 - 5.0**	**4.4**
perfluorohexanoic acid (PFHxA)	C6	--	--	--	--	**5.2**
perfluoroheptanoic acid (PFHpA)	C7	<10	<10	**2.2***	<2.0	<2.0
perfluorooctanoic acid (PFOA)	C8	<20	<20	**4.9**	**4.9 - 5.0**	**4.7**
perfluorononanoic acid (PFNA)	C9	<20	<20	<2.0	<2.0	<2.0
Perfluorodecanoic acid (PFDA)	C10	--	--	--	--	<2.0
Perfluoroundecanoic acid (PFUnA)	C11	--	--	--	--	<2.0
Perfluorododecanoic acid (PFDoA)	C12	--	--	--	--	<2.0
Perfluorotridecanoic acid (PFTrDA)	C13	--	--	--	--	<2.0
Perfluorotetradecanoic acid (PFTeDA)	C14	--	--	--	--	<2.0
Combined PFOA + PFOS		ND	ND	10	9.7 - 10	9.1
Total PFC Concentration		ND	ND	34	31 - 32	37

Notes: Units in ng/L or part per trillion
ND – not detected
* – found in raw water

Chromium-6 – All Madison wells were tested in 2018 for chromium-6, also known as hexavalent chromium. Nine wells had non-detectable levels of the natural contaminant while three wells tested above 1 µg/L. Similar to previous testing, the highest level (1.8 µg/L) was found at Wells 6 and 14. There is no regulatory standard for chromium-6, instead regulators have established a limit of 100 µg/L for total chromium. Complete test results are reported on the **Annual Inorganics Analysis** attachment.

Unregulated Contaminants Monitoring Regulation, Cycle 4 [UCMR4] – Madison Water Utility completed in July and September the initial round of sampling in support of this US EPA requirement. Every five years the EPA promulgates a list of up to thirty currently unregulated contaminants for sampling to determine the nationwide occurrence of these biological or chemical contaminants in drinking water. This occurrence data, combined with human toxicology information, helps federal regulators determine whether a drinking water regulation is warranted to reduce the public health risk associated with exposure to contaminants in drinking water.

The fourth cycle of UCMR requires Madison to test each well twice for seventeen chemical contaminants that include metals, pesticides, semi-volatiles, and alcohols. Manganese was found in 18 of 22 wells tested while the following three chemicals were found at low levels in one well each: o-toluidine, 2-methoxyethanol, and 1-butanol. Re-sampling will take place to confirm the presence of these three contaminants.

The regulation also requires testing for a broader range of disinfection by-products (DBP) that can form following the chlorination process. Similar to current testing by the utility, these tests show very low levels of DBPs since the precursors to DBP formation are mostly absent or found in very small amounts.

A second round of sampling will be repeated in January and March for the seventeen chemical contaminants and the disinfection by-products.

Water Quality Watch List

The Water Quality Watch List has been updated with current test results for inorganic, organic, radiological, and unregulated contaminants. Some changes were made to the list since the last reporting period. In addition to updated test results, the list updates the action plans for some wells to reflect the proposed 2019 Capital Budget and Capital Improvement Plan (2020-2024). In several cases, capital improvement projects, including the installation of iron and manganese filtration, have been delayed.

Water Quality Technical Advisory Committee

This committee met twice since the last monitoring report. In July, the committee heard a presentation by UW doctoral student Madeleine Matthews on the effects of geochemical conditions on radium release to the aquifer. The talk highlighted the influence of low oxygen, ionic strength, and dissolved iron/manganese on radium levels in the aquifer. An update on PFAS occurrence at Truax and Well 15, and groundwater modeling work to determine if Truax could be a potential source of PFAS to Well 15 also was presented. The remainder of the meeting was devoted to reviewing preliminary recommendations for updates to the Water Quality Monitoring & Treatment Policies.

This group also met in early October to continue the discussions on PFAS in groundwater and proposed changes to the Water Quality Monitoring & Treatment Policies. Recommended changes to the board policies will be presented for review and feedback from the board before returning to the committee for final revisions. The meeting notes from both meetings are attached for review.

One final noteworthy change to the committee is that, during 2019, the committee will hold evening meetings rather than during the workday. The next meeting is scheduled for Monday, January 7 from 5:00 to 6:30. Future dates include April 15, July 15, and October 14.

Annual Water Quality Report – Consumer Confidence Report

The 2017 consumer confidence report (CCR) was released in early May. Over 130,000 postcards were printed and mailed using the US Postal Service "Every Door Direct" saturation mailing lists. The postcards contained a direct link (URL) to the report and encouraged customers to view the report to learn more about their drinking water. The report and information in the notice was also translated into Spanish to reach our Spanish-speaking customers. Copies of the report, in English and in Spanish, were delivered to all local public library branches and many community and neighborhood centers located throughout the City. A notice also appeared on the monthly municipal services bill. Finally, an announcement was posted to our social media platforms to encourage readership of this important report.

This year additional language was added on lead and how customers can further reduce lead exposure risk in drinking water, particularly from household plumbing that may still contain lead. Also, a new section was added to describe perfluorinated compounds and what our recent testing has found. The report layout and format were similar to previous years; however, the color scheme changed slightly. Instead of a blue background with green highlights, we requested that the graphic designer reverse the color scheme.

Attachments:

Water Quality Watch List
Water Quality Technical Advisory Committee Notes – July 24, 2018
Water Quality Technical Advisory Committee Notes – October 9, 2018
Annual Inorganics Analysis, including Chromium-6
Volatile Organic Compounds (VOC) Test Results

MADISON WATER UTILITY
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	0.2	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, #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, #27	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 2014 through 2018 % Detected in at least one sample collected from 2014 through 2018

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
Perfluorinated Compounds: PFOA, PFOS, PFHxS, PFBS, PFHpA, PFHxA	0.04	µg/L	0.07^	n/a	n/a	#15, #16	none	Annual 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 2014 through 2018 % Detected in at least one sample collected from 2014 through 2018 ~ 10^{-6} Cancer Risk Level ^ PFOA + PFOS

Radionuclides (2018)

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, #31	Quarterly Monitoring	NR 809.50
Gross beta	13	pCi/L	zero	10	50	All Except Well #14	#19, #28		NR 809.50
Combined Radium	4.9	pCi/L	zero	2.5	5	All Wells	#8, #19, #24 #27, #28, #30, #31	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)

MADISON WATER UTILITY
WATER QUALITY WATCH LIST

Inorganics - Regulated

Substance	Maximum*	Units	MCLG	PAL	MCL	Detects Below PAL	Watch List	Action Plan	Reference
Antimony	1.1	µg/l	6	1.2	6	#6, #13, #24	none		NR 140.10
Barium	61	µg/l	2000	400	2000	All Wells	none		NR 809.11
Chromium, Total	4.3	µg/l	100	10	100	All Except Well #31	none		NR 809.11
Nickel	2.7	µg/l	100	20	100	All Except Well #31	none		NR 809.11
Nitrogen-Nitrate	4.0	mg/l	10	2	10	#9, #12, #16, #18, #20, #25, #27, #29	#6, #11, #13, #14, #15, #26	Annual Monitoring	NR 809.11
Selenium	2.0	µg/l	50	10	50	#9, #11, #13, #14 #15, #16, #25, #29	none		NR 809.11
Thallium	0.3	µg/l	0.5	0.4	2	#11, #15, #16, #17, #19, #27, #28	none		NR 809.11

* Based on 2018 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	140	mg/l	n/a	125	250	#6, #9, #11, #13, #15, #16, #17, #26, #27	#14	GW Investigation; Mitigation (2028)	NR 809.70
Chromium, Hexavalent	1.8	µg/l	n/a	1	n/a	#9, #11, #12, #15, #16, #18, #20, #25, #26, #29	#6, #13, #14	Annual Monitoring	n/a
Iron	0.54	mg/l	n/a	0.15	0.3	All Except Wells #9, #14, #16, #20, #31	#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	45	µg/l	n/a	25	50	All Wells	#8, #17, #19, #24, #27		NR 809.70
Sodium	51	mg/l	n/a	20	n/a	All Wells	#6, #9, #11, #14, #15, #16	Annual Monitoring	EPA DWEL
Sulfate	114	mg/l	n/a	125	250	All Wells	none		NR 809.70
Zinc	12	µg/l	n/a	2500	5000	All Except #31	none		NR 809.70

* Based on 2018 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)

Water Quality Technical Advisory Committee

Meeting Notes
Olin Avenue Conference Room
July 24, 2018 – 1:00 p.m.

Attending: Jocelyn Hemming; Sharon Long; Janet Battista; Greg Harrington; Henry Anderson; Joe DeMorett; Al Larson; Joseph Grande

Absent: Gary Krinke; Amy Barrilleaux; Tom Heikkinen

Presenters: Matt Ginder-Vogel, UW Madison; Madeleine Matthews, UW Madison Doctoral Student

Guests: Two members of the public

1. Agenda Repair/Announcements

- The Wisconsin Section of AWWA will hold its annual Research Needs Picnic on August 22
- Starting in 2019, committee meetings to occur on Monday evenings from 5 to 6:30 p.m. Joe to provide members a proposed schedule to confirm availability. Currently, the first Monday of each quarter, with the exception of January, appears to work for everyone.

2. Review of Meeting Notes

- The April 26th meeting notes were approved with the following change: The next meeting will take place on October 9 at the Operations Center, 110 S. Paterson Street, in the 2nd floor conference room.

3. Radium Research Presentation

Madeleine Matthews, UW-Madison Doctoral Student, presented radium research titled "The effect of geochemical conditions on radium in the Cambrian-Ordovician aquifer". Radium is not currently an issue in Madison wells but the research is helpful in understanding the relationship between radium and the local geology. Ingested radium can accumulate in bone tissue, which can lead to osteosarcoma and other bone disease. Anoxic (low oxygen) conditions, increasing ionic strength, and dissolved iron/manganese are associated with higher radium levels. Parent isotopes (uranium/thorium) are present in Eau Claire aquitard and potentially on coatings in sandstone. Future work to examine radium occurrence in C-O aquifer statewide to determine potential solid-phase sources.

4. PFAS/Well 15 Modeling Update

Perfluorinated compounds (PFC), including PFOA and PFOS, have been found at Well 15; the highest level of combined PFC was 37 ng/L (parts per trillion) compared to the 70 ng/L lifetime health advisory for PFOA+PFOS. Due to uncertainty of potential health effects, some states have introduced health guidelines more protective than the current EPA health guidelines. Dr. Anderson added that there is limited human health data and most studies involve short-term animal studies that often only focus on PFOA & PFOS.

Dane County Regional Airport, WI Air National Guard (WI ANG), two former burn pits, and a former landfill are possible sources of the PFC/PFAS contamination. The mixture of chemicals detected suggests a fire-fighting foam origin. Preliminary groundwater modeling shows that WI ANG is in the capture zone for Well 15 and the travel time to Well 15 is consistent with historic use of PFAS-containing fire-fighting foams at the base/airport.

Staff correspondence with Madison Fire Department confirmed limited storage of foam concentrate at firehouses and that wash water for truck and equipment cleaning is diverted to the sanitary sewer. Joe reached out to the manufacturer to determine chemical formulation of foam product, which is labeled environmentally friendly, and whether there are PFAS-free alternatives.

Current technologies for treating drinking water are limited in their ability to remove PFC due to the extremely strong carbon–fluorine bond and waste generation that would need to be addressed. Treatment options include activated carbon and ion exchange with specialized resin or reverse osmosis.

The utility plans to continue monitoring for PFC/PFAS at Well 15 and 16 (September) and work with responsible parties to investigate potential PFAS sources including two former burn pits at the airport.

Committee was encouraged to view Water Research Foundation webcast, *Per- and Polyfluoroalkyl Substances (PFAS) in Water: Background, Treatment and Utility Perspective*, which is available from the WRF website.

5. Water Quality Monitoring & Treatment Policies Discussion

Previously, the committee was asked to provide feedback on six proposed revisions to Water Quality Monitoring & Treatment Policies. Below is that feedback:

A. Testing Requirements

Recommendation #1 - Radium

1. Monitoring recommendations should be well-specific rather than applied to system as a whole
2. A more conservative approach should focus on operational condition or change (seasonal start up, period of highest pumping, etc.) rather than sampling at a specific time of the year
3. Change would reduce monitoring to annually for seven wells currently monitored on a quarterly basis

Recommendation #2 – 1,4-Dioxane

Recommended approval as written

Recommendation #3 – PFAS (per- and polyfluoroalkyl substances)

1. Replace "reporting of at least twelve…" with "analyze for the presence of twelve…."
2. Add "minimum" before reporting levels.

Recommendation #4 – New or Emerging Contaminant

1. Liked flexibility of allowing for monitoring of new contaminants
2. Requested guidelines or boundaries for the selection of new contaminants for monitoring; offered to bring revised recommendation to next meeting

B. Iron and Manganese Standards for Treatment

Recommendation #5 – Uniform Iron and Manganese Standards

1. Include the values of the iron and manganese SMCL in the narrative.
2. Recommended adding a time component for implementation of treatment and using asset management tools to rank order of implementation for these and other capital improvement projects.
3. Sharon offered to wordsmith proposed recommendation language.

C. Water Quality Treatment Goals – Deferred to the next meeting due to lack of time.

6. Future Agenda Items

- MWU Master Plan & Capital Improvement Plan
- Annexations – Town of Madison; Town of Blooming Grove
- Private Well Program Policies

7. Adjournment

The next meeting will be on Tuesday, October 9 from 1 p.m. to 2:30 p.m. at the Operations Center, 110 S. Paterson Street, in the 2nd floor conference room.

Water Quality Technical Advisory Committee – DRAFT

Meeting Notes
Paterson Street Conference Room
October 9, 2018 – 1:00 p.m.

Attending: Henry Anderson; Janet Battista; Greg Harrington; Jocelyn Hemming; Gary Krinke; Sharon Long; Ald. David Ahrens; Amy Barrilleaux; Joe DeMorett; Tom Heikkinen; Al Larson; Joseph Grande

Guests: One member of the public

1. Agenda Repair/Announcements/Administration

- Starting in January, committee meetings will occur on Monday evenings from 5 to 6:30 p.m. Dates for 2019 meetings include January 7, April 15, July 15, and October 14.

2. Review of Meeting Notes

- The July 24 meeting notes were approved as presented.

3. PFAS Update

The committee was updated on a meeting between Water Utility and WI Air National Guard staff regarding PFAS contamination at Truax Field and the use and handling of PFAS-containing firefighting foams at Truax. The Guard provides emergency response to civilian, commercial, and military aircraft incidents at the Dane County Airport. Legacy AFFF (aqueous film forming form which contains C8-based PFAS) completely removed from the base by December 2016. Building 414 has a C6-based AFFF automatic fire suppression system and four fire trucks carry combined 260 gallons of C6-based AFFF concentrate. An equivalent volume of AFFF, which is required by FAA, is stored in a single-walled overhead storage tank located above a trench drain. Training activities no longer use actual product; accidental releases treated as hazardous waste spill that requires Hazmat handling and reporting.

Wisconsin DNR has asked that City, County, and WI Air National Guard to investigate two burn pits on airport property for potential PFAS contamination. WI Air National Guard to take lead with scope of work likely ready by January 2019 and bid solicitation later in the spring. No further activity on PFAS releases to soil and groundwater.

The committee also briefly discussed the preliminary ATSDR report – *Toxicological Profile for Perfluoroalkyls, Draft for Public Comment* – including guidelines/standards proposed or approved by states that go beyond the Health Advisory issued by US EPA. The committee noted that the Health Advisory Level is not an enforcement standard and that the ATSDR assessment assists federal, state, and local agencies to investigate and prioritize Superfund and other waste sites to determine whether there is a potential health concern.

The committee recommended that the utility stay the course and continue to monitor water quality at Well 15, follow the investigation and remediation efforts at Truax, and remain engaged in PFAS-related activities that are occurring at the national level.

4. Water Quality Monitoring & Treatment Policies Discussion

The committee continued its discussion on recommended changes to the Water Utility's water quality monitoring and treatment policies. Notably, the committee recommended that the proposed changes below be incorporated into the policies and be presented in draft form to the Water Utility Board. Feedback from the board to be included in the final revisions from the committee.

A. Testing Requirements

Recommendations #1, #3 and #4

Recommend approval as written

Recommendation #2 – 1,4-Dioxane

Add, “or there is a reasonable likelihood of it being detected”, to account for possible concerns at other wells, for example, when there is a new detection of a chlorinated solvent.

B. Iron and Manganese Standards for Treatment

Recommendation #5 – Uniform Iron and Manganese Standards

1. The committee noted that the justification for filtration is readily available in AWWA manuals.
2. Recommend stating a target date for complete implementation, rather than an undefined aspiration, with treatment for “high priority” wells by 2030.
3. Equity can be a factor in identifying the “high priority” wells.
4. Timeline for implementation will depend on competing projects (as determined by the Master Plan and Asset Management Program), the water utility’s ability to pay for these improvements, and what is an acceptable price of water (i.e. affordability).

C. Water Quality Treatment Goals – Recommendation #6

The committee recommended adding a more detailed justification to the preamble, clearly stating that these goals are non-enforceable, and clarifying that the goals are to be applied to the individual wells where treatment is added and not to the water system as a whole.

Carcinogenic Volatile Organic Compounds (cVOC): Strike the phrase after the semicolon; it is redundant.

Radium: Add a Best Available Technology (BAT) such as the addition of HMO.

Iron and Manganese: Increase the treatment target to 0.02 mg/L manganese to coincide with the Treatment Standard identified in Recommendation #5, even though reductions to <0.01 mg/L are readily achievable.

Primary Contaminants (not cVOC or Radium): Change “below the public health goal” to “down to the public health goal” recognizing that reductions below zero are not achievable and advances in laboratory analytical procedures are likely to produce lower detection limits over time.

Secondary Contaminants (not Iron or Manganese): Recommend approval as written

Unregulated Contaminants: Add “if a decision has been made to treat” and “with an established federal health reference level”.

5. Future Agenda Items

- MWU Master Plan & Capital Improvement Plan
- Annexations – Town of Madison; Town of Blooming Grove
- Private Well Program Policies

6. Adjournment

The next meeting will be on Monday, January 7 from 5 p.m. to 6:30 p.m. at the Water Utility, 119 E Olin Ave.

Annual Inorganics Analysis - 2018

PARAMETER	UNITS	MCL	Well 6	Well 7	Well 8	Well 9	Well 11	Well 12	Well 13	Well 14	Well 15	Well 16	Well 17	Well 18	Well 19	Well 20	Well 24	Well 25	Well 26	Well 27	Well 28	Well 29	Well 30	Well 31	PARAMETER
	Sample Date		*7/10/18*	*7/10/18*	*8/14/18*	*7/10/18*	*7/10/18*	*7/10/18*	*7/10/18*	*7/10/18*	*7/10/18*	*7/10/18*	*8/14/18*	*7/10/18*	*7/10/18*	*7/10/18*	*7/10/18*	*7/10/18*	*8/14/18*	*8/14/18*	*7/10/18*	*7/10/18*	*7/10/18*	*7/10/18*	*Sample Date*
Alkalinity ($CaCO_3$)	mg/L	--	346	336	308	340	349	283	326	353	317	293	275	285	288	275	276	325	294	318	279	317	271	340	**Alkalinity ($CaCO_3$)**
Aluminum	µg/L	--	2.5	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	6.5	<1.7	<1.7	<1.7	<1.7	<1.7	1.7	<1.7	3.3	2.3	<1.7	<1.7	<1.7	<1.7	<5.0	**Aluminum**
Antimony	µg/L	6	0.59	<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	1.1	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.13	**Antimony**
Arsenic	µg/L	10	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.50	**Arsenic**
Barium	µg/L	2000	26	34	33	29	19	14	34	61	9.5	17	21	15	17	10	13	7.5	22	26	14	50	16	6.5	**Barium**
Beryllium	µg/L	4	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.13	**Beryllium**
Cadmium	µg/L	5	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.10	**Cadmium**
Calcium	mg/L	--	88	73	66	80	84	60	76	99	80	70	62	62	63	56	56	60	66	75	62	70	56	61	**Calcium**
Chloride	mg/L	--	76	<6.0	<6.0	51	61	<6.0	44	140	53	49	34	<6.0	<6.0	<6.0	<6.0	<6.0	27	38	<6.0	<6.0	<6.0	<2.5	**Chloride**
Chromium, Total	µg/L	100	4.3	2.2	1.6	3.2	3.2	2.6	3.3	4.0	2.4	2.5	1.7	2.3	2.0	2.2	1.8	2.8	2.0	1.2	1.7	2.1	1.7	<0.58	**Chromium, Total**
Chromium, Hexavalent	µg/L	--	1.8*	<0.02#	<0.02*	0.85#	0.75#	0.64#	1.3#	1.8#	0.58#	0.85#	<0.02*	0.54#	<0.02#	0.60#	<0.02#	0.55#	0.44#	<0.02*	<0.02#	0.05#	<0.02#	<0.02*	**Chromium, Hexavalent**
Conductivity	µmhos / cm	--	943	702	633	848	895	544	818	1170	851	746	659	599	563	522	543	603	626	739	552	624	546	615	**Conductivity**
Copper	µg/L	1300	9.6	2.6	3.4	18	640	4.9	9.7	9.7	17	7.8	2.8	2.6	11	12	3.3	40	3.1	4.9	1.3	3.5	3.0	42	**Copper**
Fluoride	mg/L	4	0.78	0.84	0.82	0.82	0.85	0.86	0.86	0.72	0.83	0.87	1.13	0.80	0.82	0.87	0.87	0.82	0.71	0.77	0.80	0.83	0.83	n/s	**Fluoride**
Hardness ($CaCO_3$)	mg/L	--	410	359	323	388	416	286	368	457	384	331	311	300	290	276	278	317	306	346	293	323	273	350	**Hardness ($CaCO_3$)**
Iron	mg/L	--	0.01	0.02	0.54	<0.01	0.01	0.01	0.02	<0.01	0.01	<0.01	0.12	0.01	0.20	<0.01	0.20	0.06	0.01	0.14	0.18	0.01	0.20	<0.02	**Iron**
Lead	µg/L	15	<0.09	<0.09	<0.09	0.09	0.25	<0.09	0.20	<0.09	<0.09	<0.09	<0.09	0.09	0.32	0.13	0.14	<0.09	<0.09	<0.09	0.15	<0.09	<0.09	<0.10	**Lead**
Magnesium	mg/L	--	47	43	38	46	50	33	43	51	45	38	38	35	33	34	34	41	35	39	33	36	32	47	**Magnesium**
Manganese	µg/L	--	0.3	1.1	45	0.6	7.7	3.2	1.6	0.3	2.4	12	29	1.7	36	0.9	26	3.3	4.8	33	20	0.6	13	3.1	**Manganese**
Mercury	µg/L	2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.03	**Mercury**
Nickel	µg/L	100	1.9	1.6	1.1	1.6	2.7	1.8	1.6	1.9	1.7	2.7	1.0	1.3	1.6	1.4	1.1	1.8	1.4	2.7	1.7	1.5	1.0	<0.50	**Nickel**
Nitrogen-Nitrate	mg/L	10	3.36	<0.10	<0.10	1.72	2.57	0.91	4.04	3.39	2.66	1.87	<0.10	0.71	<0.10	0.40	<0.10	0.84	2.87	0.33	<0.10	1.46	<0.10	<0.05	**Nitrogen-Nitrate**
Nitrogen-Nitrite	mg/L	1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	**Nitrogen-Nitrite**
pH (Lab)	s.u.	--	7.4	7.5	7.2	7.2	7.2	8.0	7.3	7.9	7.9	7.3	7.1	7.4	7.6	7.6	8.1	7.4	7.3	7.9	7.6	7.3	7.4	7.5	**pH (Lab)**
Selenium	µg/L	50	<1.7	<1.7	<1.7	1.2#	0.8#	<1.7	2.0#	1.3#	1.5#	0.6#	<1.7	<1.7	<1.7	<1.7	<1.7	1.7#	<1.7	<1.7	<1.7	1.3#	<1.7	<2.0	**Selenium**
Silver	µg/L	--	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.13	**Silver**
Sodium	mg/L	--	28	7.4	9.6	21	24	2.5	19	51	23	21	15	6.2	4.5	2.3	5.3	3.3	11	17	2.4	3.7	3.9	3.3	**Sodium**
Strontium	µg/L	--	142	125	70	95	103	63	81	84	80	61	80	86	91	53	72	64	56	91	50	77	103	73	**Strontium**
Sulfate	mg/L	--	33	38	22	26	32	11	23	30	52	21	39	20	9.4	9.8	16	7.4	19	114	26	12	23	7.8	**Sulfate**
Thallium	µg/L	2	<0.10	<0.10	<0.10	<0.10	0.15	<0.10	<0.10	<0.10	0.14	0.27	0.11	<0.10	0.11	<0.10	<0.10	<0.10	<0.10	0.18	0.10	<0.10	<0.10	<0.10	**Thallium**
Total Solids	mg/L	--	460	396	278	430	458	262	438	604	446	360	328	266	288	248	264	286	308	348	262	244	258	320	**Total Solids**
Zinc	µg/L	--	3.1	2.0	5.0	3.7	12	7.9	3.1	2.8	1.6	7.3	9.9	2.2	3.0	5.8	2.9	1.7	1.4	4.7	7.4	2.7	3.6	<5.0	**Zinc**

MCL - Maximum Contaminant Level

*tested August 9, 2018

tested March 19, 2018

Volatile Organic Compound (VOC) Test Results - November 2018

Volatile Organic Compounds	Units	MCL	MCLG	6/1/17	6/4/16	6/7/17	7/4/17	8/1/16	8/8/9	8/9/11	9/3/13	9/4/17	9/7/17	11/1/16	11/4/17	11/7/17	12/1/16	13/7/17	14/1/16	14/4/16	14/7/17	15/1/16	15/4/17	15/7/17	16/4/16	17/7/17	18/1/16	18/4/16	18/7/17	19/4/16	20/4/16	24/4/17	25/4/17	26/4/16	27/7/17	27/9/11	28/4/16	29/4/17	30/4/16	31/7/17	31/9/11	Volatile Organic Compounds
Benzene	ppb	5	zero	<0.23	<0.1	<0.1	<0.5	<0.23	<0.1	<0.23	<0.23	<0.1	<0.1	<0.23	<0.1	<0.1	<0.23	<0.1	<0.23	<0.1	<0.1	<0.23	<0.1	<0.1	<0.5	<0.1	<0.23	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.23	<0.5	<0.5	<0.5	<0.1	<0.23	Benzene
Bromobenzene	ppb	--	--	<0.26	<0.1	<0.1	<0.5	<0.26	<0.1	<0.26	<0.26	<0.1	<0.1	<0.26	<0.1	<0.1	<0.26	<0.1	<0.26	<0.1	<0.1	<0.26	<0.1	<0.1	<0.5	<0.1	<0.26	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.26	<0.5	<0.5	<0.5	<0.1	<0.26	Bromobenzene
Bromodichloromethane*	ppb	80	zero	**0.27**	**0.2**	**0.2**	**1.5**	**1.3**	**0.2**	**0.45**	**0.68**	**0.6**	**0.7**	<0.23	**0.2**	**0.1**	<0.23	**0.1**	<0.23	**0.2**	**0.2**	<0.23	**0.3**	**0.3**	<0.5	**0.8**	<0.23	**0.3**	**0.2**	**2.2**	<0.5	**1.3**	<0.5	<0.5	**0.3**	<0.23	<0.5	**0.6**	<0.5	**0.5**	<0.23	**Bromodichloromethane***
Bromoform*	ppb	80	zero	<0.21	**0.3**	**0.3**	<0.5	<0.21	<0.1	<0.21	<0.21	**0.6**	**0.6**	<0.21	**0.3**	**0.2**	<0.21	**0.2**	<0.21	**0.4**	**0.4**	<0.21	**0.6**	**0.6**	<0.5	**0.3**	<0.21	**0.2**	**0.2**	<0.5	<0.5	<0.5	<0.5	<0.5	**0.3**	<0.21	<0.5	<0.5	<0.5	**0.1**	<0.21	**Bromoform***
Bromomethane	ppb	--	--	<0.37	<0.4	<0.4	<0.5	<0.37	<0.4	<0.37	<0.37	<0.4	<0.4	<0.37	<0.4	<0.4	<0.37	<0.4	<0.37	<0.4	<0.4	<0.37	<0.4	<0.4	<0.5	<0.4	<0.37	<0.4	<0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.4	<0.37	<0.5	<0.5	<0.5	<0.4	<0.37	Bromomethane
Carbon Tetrachloride	ppb	5	zero	<0.22	<0.2	<0.2	<0.5	<0.22	<0.2	<0.22	<0.22	<0.2	<0.2	<0.22	<0.2	<0.2	<0.22	<0.2	<0.22	<0.2	<0.2	<0.22	<0.2	<0.2	<0.5	<0.2	<0.22	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.22	<0.5	<0.5	<0.5	<0.2	<0.22	Carbon Tetrachloride
Chloroethane	ppb	--	--	<1.5	<0.4	<0.4	<0.5	<1.5	<0.4	<1.5	<1.5	<0.4	<0.4	<1.5	<0.4	<0.4	<1.5	<0.4	<1.5	<0.4	<0.4	<1.5	<0.4	<0.4	<0.5	<0.4	<1.5	<0.4	<0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.4	<1.5	<0.5	<0.5	<0.5	<0.4	<1.5	Chloroethane
Chloroform*	ppb	80	--	<0.25	**0.1**	**0.1**	**1.0**	**1.5**	**0.3**	**0.73**	**0.28**	**0.2**	**0.3**	<0.25	**0.1**	<0.1	<0.25	**0.1**	<0.25	**0.1**	<0.1	<0.25	**0.1**	**0.1**	<0.5	**0.6**	<0.25	**0.1**	<0.1	**2.6**	<0.5	**0.8**	<0.5	<0.5	**0.2**	<0.25	<0.5	<0.5	<0.5	**0.4**	<0.25	**Chloroform***
Chloromethane (Methyl Chloride)	ppb	--	--	<0.23	<0.3	<0.3	<0.5	<0.23	<0.3	<0.23	<0.23	<0.3	<0.3	<0.23	<0.3	<0.3	<0.23	<0.3	<0.23	<0.3	<0.3	<0.23	<0.3	<0.3	<0.5	<0.3	<0.23	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.3	<0.23	<0.5	<0.5	<0.5	<0.3	<0.23	Chloromethane (Methyl Chloride)
o-Chlorotoluene	ppb	--	--	<0.23	<0.1	<0.1	<0.5	<0.23	<0.1	<0.23	<0.23	<0.1	<0.1	<0.23	<0.1	<0.1	<0.23	<0.1	<0.23	<0.1	<0.1	<0.23	<0.1	<0.1	<0.5	<0.1	<0.23	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.23	<0.5	<0.5	<0.5	<0.1	<0.23	o-Chlorotoluene
p-Chlorotoluene	ppb	--	--	<0.20	<0.1	<0.1	<0.5	<0.20	<0.1	<0.20	<0.20	<0.1	<0.1	<0.20	<0.1	<0.1	<0.20	<0.1	<0.20	<0.1	<0.1	<0.20	<0.1	<0.1	<0.5	<0.1	<0.20	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.20	<0.5	<0.5	<0.5	<0.1	<0.20	p-Chlorotoluene
Dibromochloromethane*	ppb	80	60	**0.42**	**0.3**	**0.3**	**1.6**	**0.96**	**0.1**	**0.25**	**0.93**	**1.0**	**1.1**	<0.17	**0.3**	**0.3**	<0.17	**0.3**	<0.17	**0.3**	**0.4**	<0.17	**0.6**	**0.3**	<0.5	**0.7**	<0.17	**0.3**	**0.3**	**1.2**	<0.5	**1.5**	<0.5	<0.5	**0.5**	<0.17	<0.5	<0.5	<0.5	**0.5**	<0.17	**Dibromochloromethane***
Dibromomethane	ppb	--	--	<0.26	<0.1	<0.1	<0.5	<0.26	<0.1	<0.26	<0.26	<0.1	<0.1	<0.26	<0.1	<0.1	<0.26	<0.1	<0.26	<0.1	<0.1	<0.26	<0.1	<0.1	<0.5	<0.1	<0.26	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.26	<0.5	<0.5	<0.5	<0.1	<0.26	Dibromomethane
m-Dichlorobenzene (1,3)	ppb	--	--	<0.25	<0.1	<0.1	<0.5	<0.25	<0.1	<0.25	<0.25	<0.1	<0.1	<0.25	<0.1	<0.1	<0.25	<0.1	<0.25	<0.1	<0.1	<0.25	<0.1	<0.1	<0.5	<0.1	<0.25	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.25	<0.5	<0.5	<0.5	<0.1	<0.25	m-Dichlorobenzene (1,3)
o-Dichlorobenzene (1,2)	ppb	600	600	<0.25	<0.1	<0.1	<0.5	<0.25	<0.1	<0.25	<0.25	<0.1	<0.1	<0.25	<0.1	<0.1	<0.25	<0.1	<0.25	<0.1	<0.1	<0.25	<0.1	<0.1	<0.5	<0.1	<0.25	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.25	<0.5	<0.5	<0.5	<0.1	<0.25	o-Dichlorobenzene (1,2)
p-Dichlorobenzene (1,4)	ppb	75	75	<0.28	<0.1	<0.1	<0.5	<0.28	<0.1	<0.28	<0.28	<0.1	<0.1	<0.28	<0.1	<0.1	<0.28	<0.1	<0.28	<0.1	<0.1	<0.28	<0.1	<0.1	<0.5	<0.1	<0.28	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.28	<0.5	<0.5	<0.5	<0.1	<0.28	p-Dichlorobenzene (1,4)
Dichlorodifluoromethane	ppb	--	--	<0.22	<0.3	<0.3	<0.5	<0.22	<0.3	<0.22	<0.22	<0.3	<0.3	<0.22	<0.3	<0.3	<0.22	<0.3	<0.22	<0.3	<0.3	<0.22	<0.3	<0.3	<0.5	<0.3	<0.22	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.3	<0.22	<0.5	<0.5	<0.5	<0.3	<0.22	Dichlorodifluoromethane
1,1-Dichloroethane	ppb	--	--	<0.31	<0.2	<0.2	<0.5	<0.31	<0.2	<0.31	<0.31	<0.2	<0.2	<0.31	<0.2	<0.2	<0.31	<0.2	<0.31	<0.2	<0.2	<0.31	<0.2	<0.2	<0.5	<0.2	<0.31	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.31	<0.5	<0.5	<0.5	<0.2	<0.31	1,1-Dichloroethane
1,2-Dichloroethane	ppb	5	zero	<0.25	<0.1	<0.1	<0.5	<0.25	<0.1	<0.25	<0.25	<0.1	<0.1	<0.25	<0.1	<0.1	<0.25	<0.1	<0.25	<0.1	<0.1	<0.25	<0.1	<0.1	<0.5	**0.1**	<0.25	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.25	<0.5	<0.5	<0.5	<0.1	<0.25	**1,2-Dichloroethane**
1,1-Dichloroethylene	ppb	7	7	<0.25	<0.2	<0.2	<0.5	<0.25	<0.2	<0.25	<0.25	<0.2	<0.2	<0.25	<0.2	<0.2	<0.25	<0.2	<0.25	<0.2	<0.2	<0.25	<0.2	<0.2	<0.5	<0.2	<0.25	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.25	<0.5	<0.5	<0.5	<0.2	<0.25	1,1-Dichloroethylene
1,2-Dichloroethylene (cis)	ppb	70	70	<0.30	<0.1	<0.1	<0.5	<0.30	**0.2**	<0.30	<0.30	**0.2**	**0.1**	<0.30	**0.4**	**0.4**	<0.30	<0.1	<0.30	<0.1	<0.1	<0.30	<0.1	<0.1	<0.5	<0.1	<0.30	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	**0.1**	<0.30	<0.5	<0.5	<0.5	<0.1	<0.30	**1,2-Dichloroethylene (cis)**
1,2-Dichloroethylene (trans)	ppb	100	100	<0.47	<0.5	<0.5	<0.5	<0.47	<0.5	<0.47	<0.47	<0.5	<0.5	<0.47	<0.5	<0.5	<0.47	<0.5	<0.47	<0.5	<0.5	<0.47	<0.5	<0.5	<0.5	<0.5	<0.47	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.47	<0.5	<0.5	<0.5	<0.5	<0.47	1,2-Dichloroethylene (trans)
Dichloromethane	ppb	5	zero	<0.22	<0.3	<0.3	<0.5	<0.22	<0.3	<0.22	<0.22	<0.3	<0.3	<0.22	<0.3	<0.3	<0.22	<0.3	<0.22	<0.3	<0.3	<0.22	<0.3	<0.3	<0.5	<0.3	<0.22	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.3	<0.22	<0.5	<0.5	<0.5	<0.3	<0.22	Dichloromethane
1,2-Dichloropropane	ppb	5	zero	<0.23	<0.1	<0.1	<0.5	<0.23	<0.1	<0.23	<0.23	<0.1	<0.1	<0.23	<0.1	<0.1	<0.23	<0.1	<0.23	<0.1	<0.1	<0.23	<0.1	<0.1	<0.5	<0.1	<0.23	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.23	<0.5	<0.5	<0.5	<0.1	<0.23	1,2-Dichloropropane
1,3-Dichloropropane	ppb	--	--	<0.25	<0.1	<0.1	<0.5	<0.25	<0.1	<0.25	<0.25	<0.1	<0.1	<0.25	<0.1	<0.1	<0.25	<0.1	<0.25	<0.1	<0.1	<0.25	<0.1	<0.1	<0.5	<0.1	<0.25	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.25	<0.5	<0.5	<0.5	<0.1	<0.25	1,3-Dichloropropane
2,2-Dichloropropane	ppb	--	--	<0.15	<0.2	<0.2	<0.5	<0.15	<0.2	<0.15	<0.15	<0.2	<0.2	<0.15	<0.2	<0.2	<0.15	<0.2	<0.15	<0.2	<0.2	<0.15	<0.2	<0.2	<0.5	<0.2	<0.15	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.15	<0.5	<0.5	<0.5	<0.2	<0.15	2,2-Dichloropropane
1,1-Dichloropropene	ppb	--	--	<0.32	<0.3	<0.3	<0.5	<0.32	<0.3	<0.32	<0.32	<0.3	<0.3	<0.32	<0.3	<0.3	<0.32	<0.3	<0.32	<0.3	<0.3	<0.32	<0.3	<0.3	<0.5	<0.3	<0.32	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.3	<0.32	<0.5	<0.5	<0.5	<0.3	<0.32	1,1-Dichloropropene
1,3-Dichloropropene	ppb	--	--	<0.39	<0.5	<0.5	<0.5	<0.39	<0.5	<0.39	<0.39	<0.5	<0.5	<0.39	<0.5	<0.5	<0.39	<0.5	<0.39	<0.5	<0.5	<0.39	<0.5	<0.5	<0.5	<0.5	<0.39	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.39	<0.5	<0.5	<0.5	<0.5	<0.39	1,3-Dichloropropene
Ethylbenzene	ppb	700	700	<0.22	<0.3	<0.3	<0.5	<0.22	<0.3	<0.22	**0.54**	**0.5**	**0.7**	<0.22	<0.3	<0.3	<0.22	<0.3	<0.22	<0.3	<0.3	<0.22	<0.3	<0.3	<0.5	<0.3	<0.22	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.3	<0.22	<0.5	<0.5	<0.5	<0.3	<0.22	**Ethylbenzene**
Hexachlorobutadiene	ppb	--	--	<0.24	<0.1	<0.1	<0.5	<0.24	<0.1	<0.24	<0.24	<0.1	<0.1	<0.24	<0.1	<0.1	<0.24	<0.1	<0.24	<0.1	<0.1	<0.24	<0.1	<0.1	<0.5	<0.1	<0.24	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.24	<0.5	<0.5	<0.5	<0.1	<0.24	Hexachlorobutadiene
Isopropylbenzene	ppb	--	--	<0.22	<0.1	<0.1	<0.5	<0.22	<0.1	<0.22	<0.22	<0.1	<0.1	<0.22	<0.1	<0.1	<0.22	<0.1	<0.22	<0.1	<0.1	<0.22	<0.1	<0.1	<0.5	<0.1	<0.22	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.22	<0.5	<0.5	<0.5	<0.1	<0.22	Isopropylbenzene
p-Isopropyltoluene	ppb	--	--	<0.22	<0.1	<0.1	<0.5	<0.22	<0.1	<0.22	<0.22	<0.1	<0.1	<0.22	<0.1	<0.1	<0.22	<0.1	<0.22	<0.1	<0.1	<0.22	<0.1	<0.1	<0.5	<0.1	<0.22	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.22	<0.5	<0.5	<0.5	<0.1	<0.22	p-Isopropyltoluene
Methyl t-butyl ether	ppb	--	--	<0.29	<0.2	<0.2	<0.5	<0.29	<0.2	<0.29	<0.29	<0.2	<0.2	<0.29	<0.2	<0.2	<0.29	<0.2	<0.29	<0.2	<0.2	<0.29	<0.2	<0.2	<0.5	<0.2	<0.29	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.29	<0.5	<0.5	<0.5	<0.2	<0.29	Methyl t-butyl ether
Monochlorobenzene	ppb	100	100	<0.24	<0.1	<0.1	<0.5	<0.24	<0.1	<0.24	<0.24	<0.1	<0.1	<0.24	<0.1	<0.1	<0.24	<0.1	<0.24	<0.1	<0.1	<0.24	<0.1	<0.1	<0.5	<0.1	<0.24	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.24	<0.5	<0.5	<0.5	<0.1	<0.24	Monochlorobenzene
Naphthalene	ppb	--	--	<0.23	<0.3	<0.3	<0.5	<0.23	<0.3	<0.23	<0.23	<0.3	<0.3	<0.23	<0.3	<0.3	<0.23	<0.3	<0.23	<0.3	<0.3	<0.23	<0.3	<0.3	<0.5	<0.3	<0.23	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.3	<0.23	<0.5	<0.5	<0.5	<0.3	<0.23	Naphthalene
Styrene	ppb	100	100	<0.21	<0.2	<0.2	<0.5	<0.21	<0.2	<0.21	<0.21	<0.2	<0.2	<0.21	<0.2	<0.2	<0.21	<0.2	<0.21	<0.2	<0.2	<0.21	<0.2	<0.2	<0.5	<0.2	<0.21	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.21	<0.5	<0.5	<0.5	<0.2	<0.21	Styrene
1,1,1,2-Tetrachloroethane	ppb	--	--	<0.21	<0.2	<0.2	<0.5	<0.21	<0.2	<0.21	<0.21	<0.2	<0.2	<0.21	<0.2	<0.2	<0.21	<0.2	<0.21	<0.2	<0.2	<0.21	<0.2	<0.2	<0.5	<0.2	<0.21	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.21	<0.5	<0.5	<0.5	<0.2	<0.21	1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane	ppb	--	--	<0.20	<0.1	<0.1	<0.5	<0.20	<0.1	<0.20	<0.20	<0.1	<0.1	<0.20	<0.1	<0.1	<0.20	<0.1	<0.20	<0.1	<0.1	<0.20	<0.1	<0.1	<0.5	<0.1	<0.20	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.20	<0.5	<0.5	<0.5	<0.1	<0.20	1,1,2,2-Tetrachloroethane
Tetrachloroethylene	ppb	5	zero	**0.99**	**0.9**	**0.9**	<0.5	<0.28	<0.3	<0.28	**2.1**	**1.7**	**1.3**	**0.59**	**0.6**	**0.4**	<0.28	<0.3	**0.45**	**0.4**	**0.3**	<0.28	<0.3	<0.3	<0.5	<0.3	**1.8**	**1.3**	**1.3**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.3	<0.28	<0.5	<0.5	<0.5	<0.3	<0.28	**Tetrachloroethylene**
Toluene	ppb	1000	1000	<0.22	<0.1	<0.1	<0.5	<0.22	<0.1	<0.22	<0.22	**0.1**	<0.1	<0.22	<0.1	<0.1	<0.22	<0.1	<0.22	<0.1	<0.1	<0.22	<0.1	<0.1	<0.5	<0.1	<0.22	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.22	<0.5	<0.5	<0.5	**0.2**	<0.22	**Toluene**
1,2,4-Trichlorobenzene	ppb	70	70	<0.25	<0.3	<0.3	<0.5	<0.25	<0.3	<0.25	<0.25	<0.3	<0.3	<0.25	<0.3	<0.3	<0.25	<0.3	<0.25	<0.3	<0.3	<0.25	<0.3	<0.3	<0.5	<0.3	<0.25	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.3	<0.25	<0.5	<0.5	<0.5	<0.3	<0.25	1,2,4-Trichlorobenzene
1,1,1-Trichloroethane	ppb	200	200	<0.32	<0.1	<0.1	<0.5	<0.32	<0.1	<0.32	<0.32	**0.1**	<0.1	<0.32	<0.1	<0.1	<0.32	<0.1	<0.32	<0.1	<0.1	<0.32	<0.1	<0.1	<0.5	<0.1	<0.32	**0.1**	**0.1**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.32	<0.5	<0.5	<0.5	<0.1	<0.32	**1,1,1-Trichloroethane**
1,1,2-Trichloroethane	ppb	5	3	<0.27	<0.1	<0.1	<0.5	<0.27	<0.1	<0.27	<0.27	<0.1	<0.1	<0.27	<0.1	<0.1	<0.27	<0.1	<0.27	<0.1	<0.1	<0.27	<0.1	<0.1	<0.5	<0.1	<0.27	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.27	<0.5	<0.5	<0.5	<0.1	<0.27	1,1,2-Trichloroethane
Trichloroethylene	ppb	5	zero	<0.30	<0.2	<0.2	<0.5	<0.30	<0.2	<0.30	<0.30	<0.2	<0.2	<0.30	**0.3**	**0.3**	<0.30	<0.2	<0.30	**0.2**	<0.2	<0.30	<0.2	<0.2	<0.5	<0.2	<0.30	**0.2**	**0.3**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.30	<0.5	<0.5	<0.5	<0.2	<0.30	**Trichloroethylene**
Trichlorofluoromethane	ppb	--	--	<0.30	<0.2	<0.2	<0.5	<0.30	<0.2	<0.30	<0.30	<0.2	<0.2	**0.63**	**0.6**	**0.5**	<0.30	<0.2	<0.30	<0.2	<0.2	<0.30	<0.2	<0.2	<0.5	<0.2	<0.30	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.30	<0.5	<0.5	<0.5	<0.2	<0.30	**Trichlorofluoromethane**
1,2,3-Trichloropropane	ppb	--	--	<0.30	<0.1	<0.1	<0.5	<0.30	<0.1	<0.30	<0.30	<0.1	<0.1	<0.30	<0.1	<0.1	<0.30	<0.1	<0.30	<0.1	<0.1	<0.30	<0.1	<0.1	<0.5	<0.1	<0.30	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.30	<0.5	<0.5	<0.5	<0.1	<0.30	1,2,3-Trichloropropane
Trichlortrifluoroethane	ppb	--	--	<0.34	<0.2	<0.2	<0.5	<0.34	<0.2	<0.34	<0.34	<0.2	<0.2	<0.34	<0.2	<0.2	<0.34	<0.2	<0.34	<0.2	<0.2	<0.34	<0.2	<0.2	<0.5	<0.2	<0.34	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.34	<0.5	<0.5	<0.5	<0.2	<0.34	Trichlortrifluoroethane
1,2,4-Trimethylbenzene	ppb	--	--	<0.21	<0.1	<0.1	<0.5	<0.21	<0.1	<0.21	<0.21	<0.1	<0.1	<0.21	<0.1	<0.1	<0.21	<0.1	<0.21	<0.1	<0.1	<0.21	<0.1	<0.1	<0.5	<0.1	<0.21	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.21	<0.5	<0.5	<0.5	<0.1	<0.21	1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene	ppb	--	--	<0.22	<0.1	<0.1	<0.5	<0.22	<0.1	<0.22	<0.22	<0.1	<0.1	<0.22	<0.1	<0.1	<0.22	<0.1	<0.22	<0.1	<0.1	<0.22	<0.1	<0.1	<0.5	<0.1	<0.22	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.22	<0.5	<0.5	<0.5	<0.1	<0.22	1,3,5-Trimethylbenzene
Vinyl Chloride	ppb	0.2	zero	<0.20	<0.2	<0.2	<0.5	<0.20	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.2	<0.2	<0.20	<0.2	<0.20	<0.2	<0.2	<0.20	<0.2	<0.2	<0.5	<0.2	<0.20	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.20	<0.5	<0.5	<0.5	<0.2	<0.20	Vinyl Chloride
Xylene, Total	ppb	10000	10000	<0.68	<0.1	<0.1	<0.5	<0.68	<0.1	<0.68	**3.7**	**3.0**	**4.5**	<0.68	<0.1	<0.1	<0.68	<0.1	<0.68	<0.1	<0.1	<0.68	<0.1	<0.1	<0.5	<0.1	<0.68	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.68	<0.5	<0.5	<0.5	**0.3**	<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

Maximum Contaminant Level Goal (MCLG) - the level below which there is no known or expected risk to health

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