MCD Report 2022-19

2022 Groundwater Quality Survey and Contaminant Trends

Study Report

MCD staff, Elli Sigmond and Alex Hackney, prepare to collect a groundwater sample

Executive Summary

To study groundwater quality trends, MCD staff collected samples during the spring and fall of 2022. Groundwater samples were collected at 12 monitoring wells installed in the buried valley aquifer system of the Great Miami River Watershed. The goal of the groundwater monitoring program, which began in 2014 is to better understand human impact on groundwater quality and identify contaminant trends. The groundwater samples were analyzed for baseline parameters including: the presence of *E. coli*; major ions; metals; and nutrients. Samples were also collected from a monitoring well with a history of trichloroethene detections and analyzed for volatile organic compounds.

The results of this study are comparable to previous studies. Low levels of anthropogenic contaminants are common in sensitive, shallow sand and gravel aquifer settings. This emphasizes the need for groundwater protection strategies to manage the quality of buried valley aquifer resources in southwest Ohio.

Introduction

Since 2014, MCD has managed a groundwater monitoring program in the Great Miami River Watershed. The purpose of the program is to provide a better understanding of the impact of human activities on groundwater quality. In 2022, MCD staff collected samples from 12 groundwater monitoring wells to survey groundwater quality in the buried valley aquifer (see Figure 1). The wells included in the study are surrounded by land uses with the potential to release contaminants into the aquifer.

Groundwater quality monitoring has been conducted by MCD staff twice per year since 2014 at monitoring wells BUT10014, BUT10016, CLA10018, and MON10016. The other eight monitoring wells have been sampled since 2015 or 2016.

The wells selected for the study are installed in unconfined sand and gravel aquifers with permeable soils at the surface. Eight of the wells (BUT10014, BUT10016, BUT10017, CLA10011, MON00022, MON10016, WAR10003, and WAR10004) are situated within 400 feet of a river or lake and a comparison of static water level measurements for those wells with nearby stream gage data suggests hydraulic interactions occur between groundwater and surface water. Seven of the wells are screened at shallow (< 50 feet) depths. Table 1 summarizes depths and screened intervals for all of the monitoring wells in this survey.

MCD equipped each monitoring well with a bladder pump installed within the screened interval of the well. The bladder pumps allow low-flow purging techniques to be used (Puls and Barcelona, 1996).

MCD staff collect groundwater samples twice each year. The samples are analyzed for *Escherichia coli (E. coli),* major ions, metals, nutrients, and in the case of monitoring well BUT10014, volatile organic compounds (VOCs). These parameters are measured every sampling event to provide a baseline for groundwater quality. Additional parameters including VOCs, semivolatile organic compounds (SVOCs), and pharmaceuticals are analyzed on a less frequent basis to provide additional data on groundwater quality.

Table 1 – Construction details for groundwater quality monitoring wells

Monitoring Well ID	Casing Diameter (in)	Well Depth (ft)	Screened Interval (ft)	Aquifer Screened	Distance to River or Lake (ft)
BUT10014	2	40	35 - 40	Sand and Gravel	120
BUT10016	2	65	60 - 65	Sand and Gravel	120
BUT10017	2	39	34 - 39	Sand and Gravel	120
CLA10011	2	60	55 - 60	Sand and Gravel	135

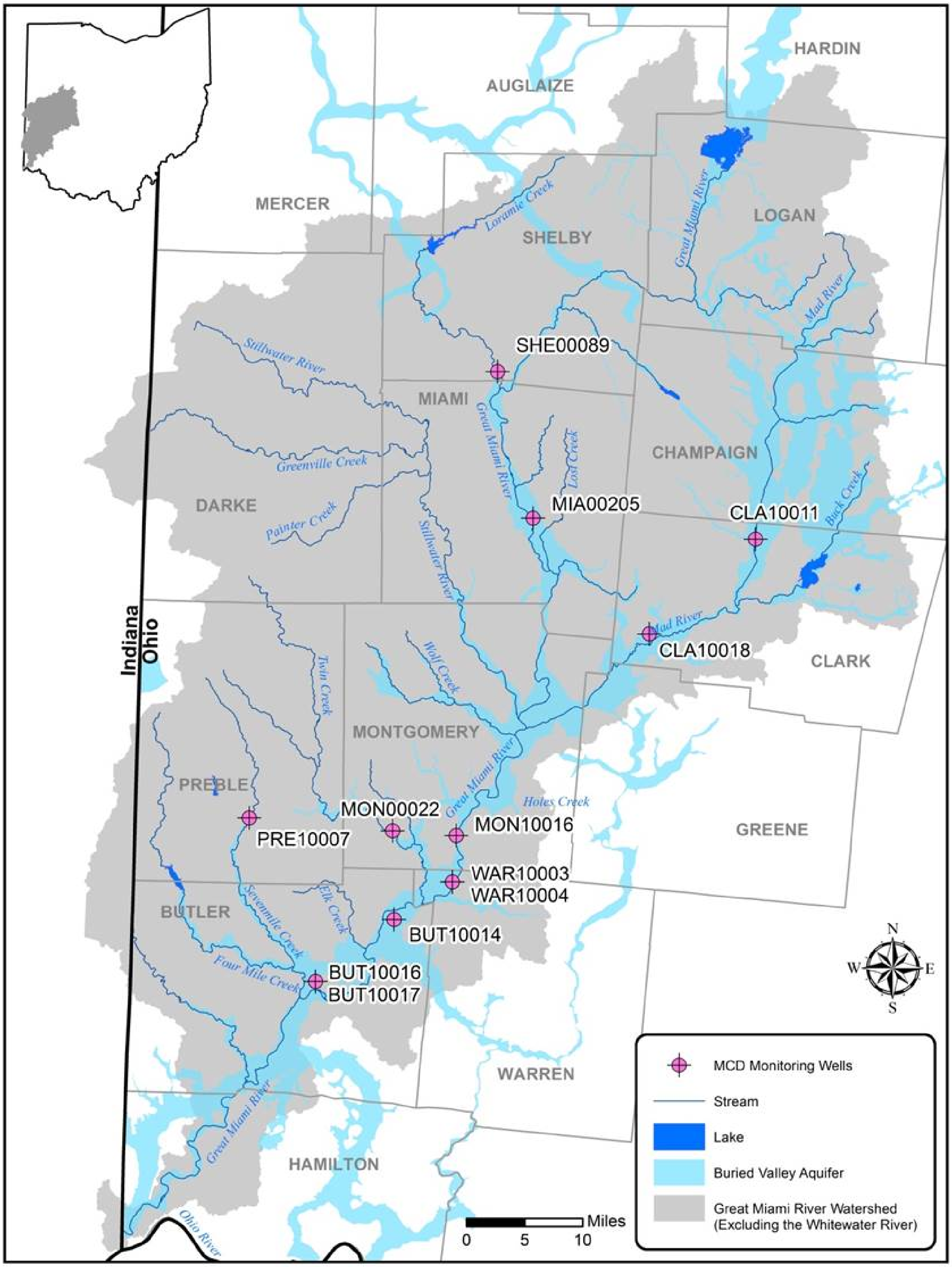
Monitoring Well ID	Casing Diameter (in)	Well Depth (ft)	Screened Interval (ft)	Aquifer Screened	Distance to River or Lake (ft)
CLA10018	2	16	11 - 16	Sand and Gravel	2,810
MIA00205	2	24	19 - 24	Sand and Gravel	1,130
MON00022	2	15	10 - 15	Sand and Gravel	110
MON10016	2	108	88 - 108	Sand and Gravel	355
PRE10007	2	60	40 - 60	Sand and Gravel	960
SHE00089	2	43	38 - 43	Sand and Gravel	600
WAR10003	2	67	62 - 67	Sand and Gravel	85
WAR10004	2	32.5	27.5 – 32.5	Sand and Gravel	90

Duplicate samples are collected from one monitoring well during each sampling event to evaluate laboratory precision. Field blanks were also collected to assess potential contamination from field conditions during sampling.

The results of this study are compared with federal drinking water standards and human health-based screening levels. Drinking water standards are generally more stringent than other water standards, so when groundwater meets drinking water standards it should be suitable for other uses.

The National Primary Drinking Water Regulations are legally enforceable standards set by the USEPA (United States Environmental Protection Agency) that apply to public water systems. Primary standards set maximum contaminant levels (MCLs) that help protect public health by limiting the contaminant concentrations in drinking water. National Secondary Drinking Water Standards are advisable guidelines addressing secondary maximum contaminant levels (SMCLs) that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. The USEPA recommends, but does not require, that public water systems incorporate secondary standards. The USEPA Office of Water also publishes non enforceable Health-Based Screening Levels (HBSLs) for some constituents which may pose potential human-health concerns but do not yet have an enforceable standard. HBSLs are used as a supplement for evaluating contaminants in drinking water in a human-health context. For the purpose of this study, all MCLs and HBSLs are referred to as human-health benchmarks and used for interpreting analytical results.

Figure 1 – Locations of monitoring wells



2022 Results

In 2022, MCD collected samples twice; once between May 16 and June 3 (spring) and once between September 26 and October 5 (fall). MCD records depths to groundwater with loggers at 11 of the 12 monitoring wells. Groundwater levels measured during the spring sampling event were higher than those measured during the fall (see Figure 2) reflecting winter and spring seasonal recharge. This is typical for shallow wells in the buried valley aquifer system.

Sampling results for 2022 are generally similar to results from previous years. Analysis of major ions (cations and anions) in groundwater samples show the dominant cation is calcium with significant quantities of magnesium and sodium also present. The average calcium concentration of groundwater samples was 95 mg/L. The dominant anion was bicarbonate with lesser amounts of chloride and sulfate. Bicarbonate content was estimated using alkalinity and pH measurements for each sample. The average bicarbonate concentration in groundwater samples was 295 mg/L. A piper diagram of major cations and anions shows the groundwater has a calcium-magnesium-bicarbonate composition (see Figure 2). Calcium-magnesium-bicarbonate groundwater tends to be present in areas where carbonate rocks comprise a significant amount of the aquifer matrix.

Groundwater samples collected at monitoring wells BUT10014, BUT10017, CLA10011, CLA10018, MIA00205, MON10016, SHE00089, WAR10003 and WAR10004 met all human-health benchmarks including MCLs and HBSLs for both sampling events (see Table 2). See Appendix A for a complete list of all analytical parameters, analytical methods, and results.

Parameters Exceeding Human-Health Benchmarks

At least one parameter occurred at a concentration exceeding human-health benchmarks in 1 of the 12 monitoring wells (BUT10016) for the spring sampling event. Concentrations of at least one parameter also exceeded human-health benchmarks in 3 of 12 monitoring wells (BUT10016, MON00022, and PRE10007) for the fall sampling event. The parameters arsenic, *E. coli*, hexavalent chromium, lithium, and manganese were detected in at least one sample at concentrations exceeding human health based benchmarks in 2022. Arsenic and *E. coli* have MCLs while hexavalent chromium, lithium, and manganese have HBSLs. Manganese also has a SMCL.

- The arsenic concentration (36.8 µg/L) in the fall groundwater sample collected from monitoring well PRE10007 exceeded the MCL of 10 µg/L, but the concentration (4.2 µg/L) measured in the spring sample fell below this level.

- *E. coli* was present at 1.0 MPN/100mL in the spring groundwater sample collected from monitoring well BUT10016. The MCL for *E. coli* is 0 MPN/100 mL. *E. coli* was not detected in any of the groundwater samples collected during the fall.

- The hexavalent chromium concentration (0.026 mg/L) in the spring groundwater sample collected from monitoring well BUT10016 exceeded the HBSL of 0.02 mg/L, but the concentration (0.014 mg/L) measured in the fall sample fell below this level. There is an

Figure 2 – Chart showing depths to groundwater measured at MCD monitoring wells. Gray areas show time intervals for the spring and fall sampling events.

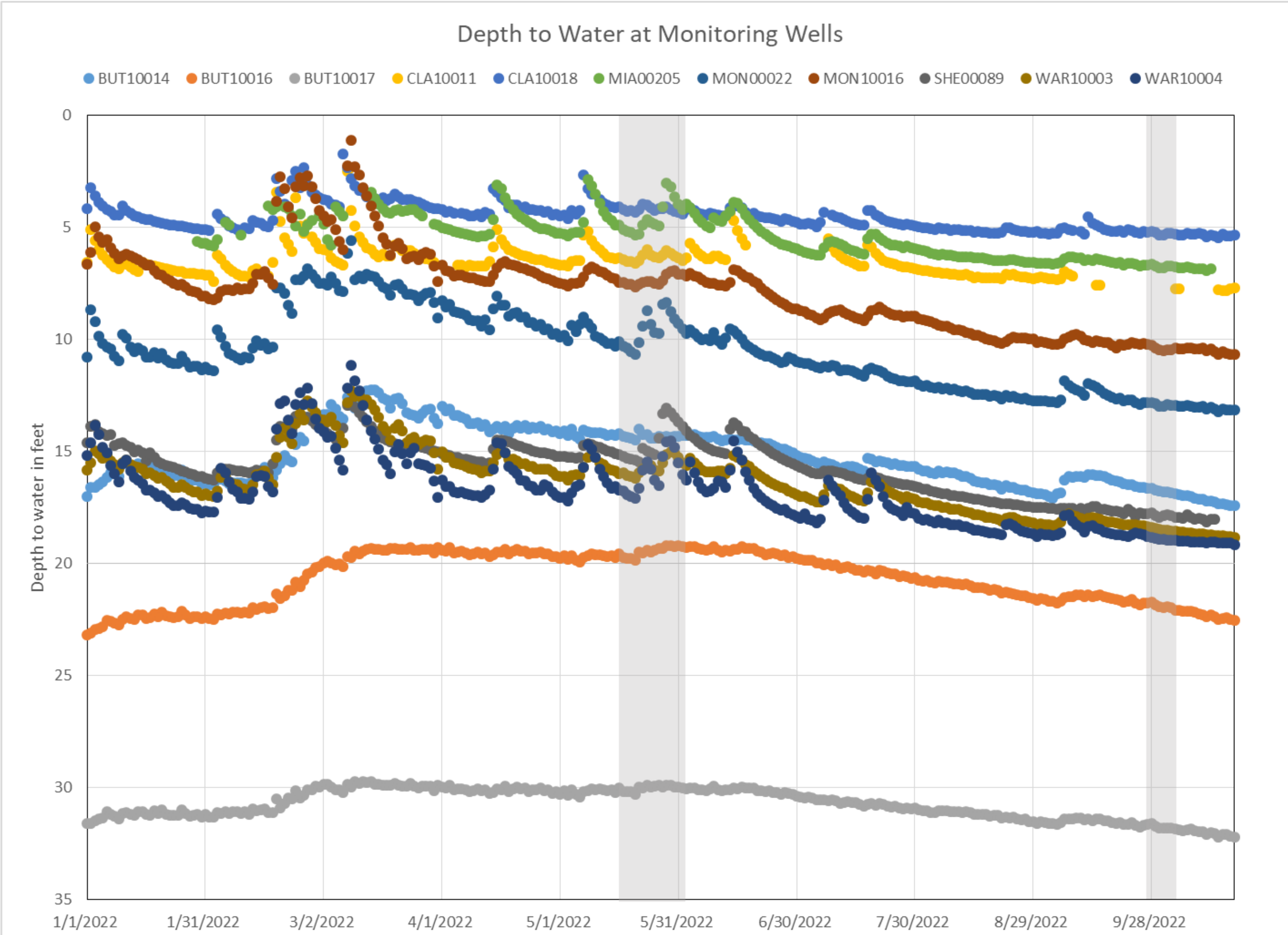


Figure 3 – Piper diagram illustrating dominant cations, anions, and water type of samples

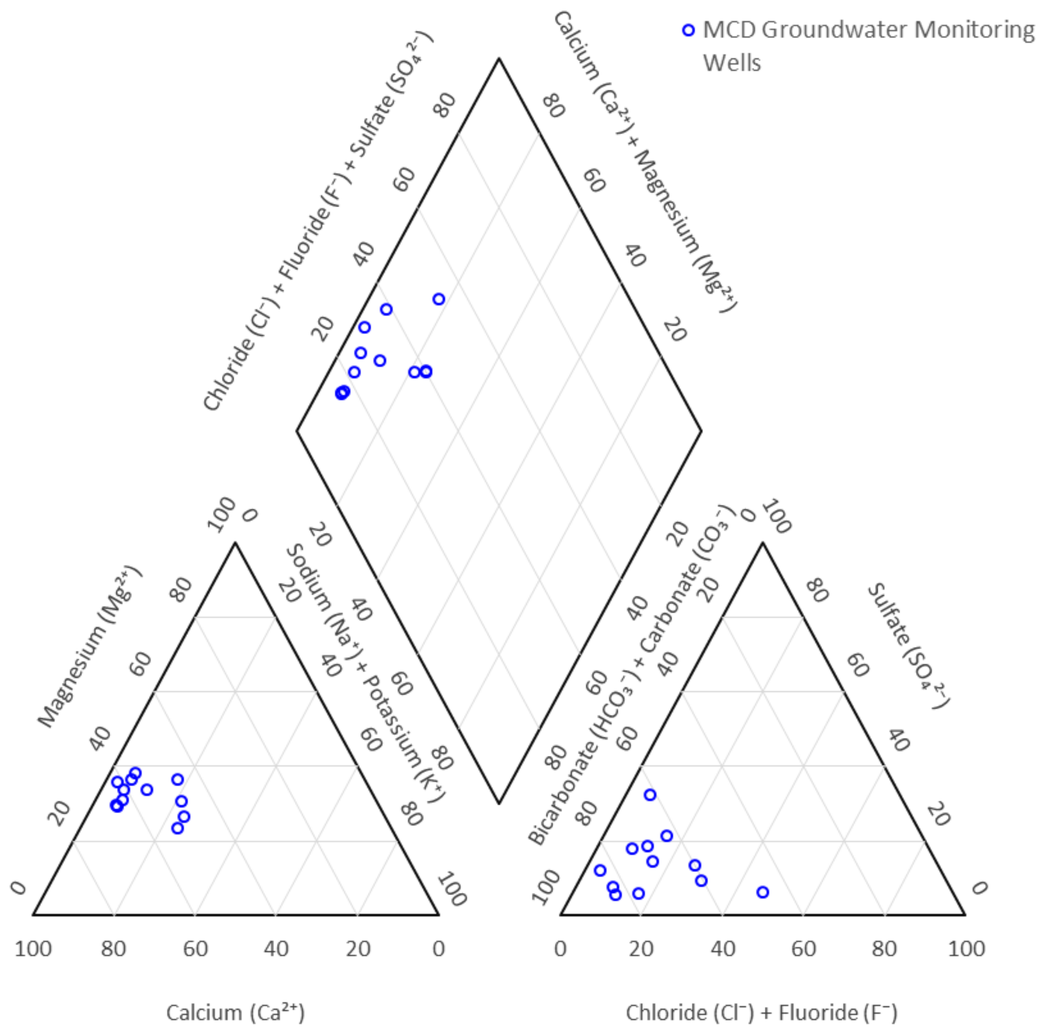


Table 2 – Summary of significant detections of constituents in groundwater

Spring 2022		**Benchmark**		**Sample Sites**					
Parameter	**Units**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Chloride	mg/L	SMCL	250	85.5					
Chromium, Hexavalent	mg/L	HBSL	0.02		**0.026**				
E. coli	MPN/100mL	MCL	0		**1.0**				
Nitrogen, Ammonia	mg/L	HBSL	0.5		0.21				
Nitrogen, Nitrate-Nitrite	mg/L	MCL	10			5.5		4.5	3.6
Sodium	mg/L	-	-	58.9					
Arsenic	µg/L	MCL	10		4.1		7.1		
Iron	mg/L	HBSL, SMCL	4, 0.03		**0.758**		**3.09**		
Lithium	µg/L	HBSL	10						
Manganese	mg/L	HBSL, SMCL	0.3, 0.05		**0.453**		**0.062**		**0.066**
Total Dissolved Solids	mg/L	SMCL	500	**700**					
Total Hardness	mg/L	-	-	431	318	333	419	356	369
Parameter	**Units**	**Type**	**Value**	**MON00022**	**MON10016**	**PRE10007**	**SHE00089**	**WAR10003**	**WAR10004**
Chloride	mg/L	SMCL	250		67.3		129	116	
Chromium, Hexavalent	mg/L	HBSL	0.02						
E. coli	MPN/100mL	MCL	10						
Nitrogen, Ammonia	mg/L	HBSL	0.5			0.15		0.24	
Nitrogen, Nitrate-Nitrite	mg/L	MCL	10						
Sodium	mg/L	-	-		49.6			51.1	
Arsenic	µg/L	MCL	10			4.2		2.2	
Iron	mg/L	HBSL, SMCL	4, 0.03		**0.316**	**2.07**		**2.17**	
Lithium	µg/L	HBSL	10			5.2			
Manganese	mg/L	HBSL, SMCL	0.3, 0.05		**0.091**		**0.279**	**0.062**	
Total Dissolved Solids	mg/L	SMCL	500	**544**	**547**			**604**	
Total Hardness	µg/L	-	-	459	303	355	372	438	267

Numbers in bold exceed a benchmark
NA – Parameter was not analyzed

Table 2 continued – Summary of significant detections of constituents in groundwater continued

Fall 2022		**Benchmark**		**Sample Sites**					
Parameter	**Units**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Chloride	mg/L	SMCL	250	87.3					
Chromium, Hexavalent	mg/L	HBSL	0.02		0.014	0.011		0.007	
E. coli	MPN/100mL	MCL	0						
Ethyl Acetate	µg/L	HBSL	6000	1.9	NA	NA	NA	NA	NA
Nitrogen, Ammonia	mg/L	HBSL	0.5						
Nitrogen, Nitrate-Nitrite	mg/L	MCL	10			8.2		9.2	9.0
Sodium	mg/L	-	-	56.2					
Arsenic	µg/L	MCL	10		7.6		9.5		
Iron	mg/L	HBSL, SMCL	4, 0.03		**0.925**		**2.91**		
Lithium	µg/L	HBSL	10						
Manganese	mg/L	HBSL, SMCL	0.3, 0.05		**0.456**		**0.061**		**0.069**
Total Dissolved Solids	mg/L	SMCL	500	**534**					
Total Hardness	mg/L	-	-	405	300	331	395	355	367
Parameter	**Units**	**Type**	**Value**	**MON00022**	**MON10016**	**PRE10007**	**SHE00089**	**WAR10003**	**WAR10004**
Chloride	mg/L	SMCL	250		75.4			42.2	126
Chromium, Hexavalent	mg/L	HBSL	0.02						
E. coli	MPN/100mL	MCL	10						
Ethyl Acetate	µg/L	HBSL	6000	NA	NA	NA	NA	NA	NA
Nitrogen, Ammonia	mg/L	HBSL	0.5					0.33	
Nitrogen, Nitrate-Nitrite	mg/L	MCL	10						
Sodium	mg/L	-	-		41.1			49.9	21.4
Arsenic	µg/L	MCL	10			**36.8**		3.0	
Iron	mg/L	HBSL, SMCL	4, 0.03		**0.306**	**11.3**		**2.06**	
Lithium	µg/L	HBSL	10	**12.5**				5.1	
Manganese	mg/L	HBSL, SMCL	0.3, 0.05		**0.075**		**0.275**	**0.061**	
Total Dissolved Solids	mg/L	SMCL	500	**700**				**582**	
Total Hardness	µg/L	-	-	606	302	354	366	418	233

Numbers in bold exceed a benchmark
NA – Parameter was not analyzed

MCL for total chromium of 0.10 mg/L which includes hexavalent chromium. None of the detections of hexavalent chromium exceeded this value.

- Lithium exceeded the HBSL of 10 µg/L in the fall (12.5 µg/L) groundwater sample collected from monitoring well MON00022. However, lithium was not detected in the groundwater sample collected from MON00022 during the spring.

- Manganese exceeded the HBSL of 0.3 mg/L in both the spring (0.453 mg/L) and fall (0.456 mg/L) groundwater samples collected from monitoring well BUT10016.

Parameters Exceeding Secondary Drinking Water Standards

At least one parameter exceeded an SMCL in samples collected from 9 of the 12 monitoring wells for both sampling events (see Table 2). Parameters present at concentrations exceeding SMCLs included iron, manganese, and total dissolved solids.

- Iron was detected at concentrations above the SMCL (0.3 mg/L) in fall and spring groundwater samples collected from monitoring wells BUT10016, CLA10011, MON10016, PRE10007, and WAR10003.

- The SMCL for Manganese is 0.05 mg/L. Measured concentrations of manganese in groundwater samples collected from monitoring wells BUT10016, CLA10011, MIA00205, MON10016, SHE00089, and WAR10003 exceeded this standard for both sampling events.

- Total dissolved solids measured in groundwater samples collected from monitoring wells BUT10014, MON00022, and WAR10003 exceeded the SMCL of 500 mg/L for both sampling events. The concentration of total dissolved solids exceeded the SMCL in the groundwater sample collected from MON10016 during the spring event but not the fall event.

Parameters Indicative of Anthropogenic Sources of Contaminants

Chemical parameters detected in recent groundwater samples at concentrations that likely reflect anthropogenic sources include ammonia, chloride, ethyl acetate, nitrate, sodium, and trichloroethene. Chloride and sodium are present in groundwater naturally, but human activities can elevate their concentration significantly above natural levels. Likewise, nitrogen primarily in the form of nitrate can be naturally present in groundwater, but anthropogenic sources of nitrogen can elevate nitrate concentrations above levels that would be present in the absence of human activities. Ethyl acetate and trichloroethene are a manufactured compounds that cannot be found in nature in the absence of anthropogenic sources. A summary of the parameters detected in at least one groundwater sample and believed to reflect anthropogenic sources of contaminants follows.

Chloride and Sodium
Chloride has an SMCL of 250 mg/L. There are no human health based benchmarks for sodium in drinking water. Background levels of chloride in the buried valley aquifer system typically do not exceed 50 mg/L (Spieker, 1968), and (Debrewer et al, 2000). Kunz and Sroka (2004) reported mean background concentrations of chloride ranging from 13 to 23 mg/L in shallow unconsolidated aquifers in Champaign, Clark, and Pickaway counties in Ohio. Chloride concentrations above 70 mg/L and sodium concentrations above 43 mg/L in local sand and gravel aquifers likely reflect anthropogenic sources (Kunz and Sroka, 2004; Ohio EPA, 2015). These concentrations reflect the 90th percentile for Ohio EPA groundwater data collected from sand and gravel aquifers in Ohio (Ohio EPA, 2015).

Chloride concentrations measured in groundwater samples from monitoring wells BUT10014, MON10016, WAR10003, and WAR10004 exceeded 70 mg/L in at least one sampling event in 2022 and likely reflect anthropogenic sources. Sodium concentrations in groundwater samples from monitoring wells BUT10014, MON10016, and WAR10003 exceeded 43 mg/L in one or both sampling events and also likely reflect anthropogenic sources. Anthropogenic sources of chloride and sodium include road salt applications for deicing and private and municipal wastewater from homes with water softeners.

Ethyl Acetate
Ethyl acetate is a volatile organic compound used in glues, nail polish removers, and in the decaffeination process of tea and coffee. It is used primarily as a solvent and diluent. There is no MCL for the compound. Ethyl acetate was detected at a concentration of 1.9 µg/L in the groundwater sample collected from monitoring well BUT10014 during the fall sampling event. It has not been detected previously in groundwater samples collected from this well.

Hexavalent Chromium
Chromium (Cr) is a metallic element that exists in the environment in various forms or oxidation states. The most common are trivalent, hexavalent, and metallic form. Hexavalent chromium can occur naturally, but is often associated with industrial processes. Major industrial uses of hexavalent chromium include steel production, pulp mills, metal plating, wood preservation, and production of dyes and pigments. Hexavalent chromium was detected in the spring and fall groundwater samples collected from monitoring well BUT10016 and in the fall groundwater samples collected from monitoring wells BUT10017 and CLA10018. Hexavalent chromium has not been detected in any groundwater samples from previous sampling events.

Nitrogen as Ammonia and Nitrate
Nitrogen in groundwater is found in inorganic and organic forms. Inorganic nitrogen is present as ammonia, nitrite, and nitrate. Of these three inorganic forms, nitrate is the dominant species. According to Madison and Brunett (1985), nitrate concentrations in excess of 3.0 mg/L in groundwater are often indicative of anthropogenic sources. Nitrate concentrations measured in groundwater samples during the spring and fall sampling events for monitoring wells BUT10017, CLA10018, and MIA00205 exceeded 3.0 mg/L. Common sources of nitrate in groundwater include fertilizers, domestic or municipal wastewater, and animal waste or manure applied as fertilizer. Monitoring wells CLA10018 and MIA 00205 are particularly vulnerable to sources of nitrate. Both wells are located within or adjacent to agricultural fields used for corn

and soybean production and screened at shallow depths. The MCL for nitrate nitrogen is 10 mg/L.

Ammonia nitrogen was present in groundwater samples collected from monitoring wells BUT10016, PRE10007, and WAR10003 during the spring sampling event and only from monitoring well WAR 10003 during the fall event. Common sources of ammonia in groundwater are the same as those for nitrate including fertilizers, domestic or municipal wastewater, and animal waste or manure applied as fertilizer. There is no MCL for ammonia in drinking water.

Analysis of nitrogen and oxygen isotopes measured in groundwater samples collected from BUT10017 and CLA10018 in 2017 and 2018 suggested an inorganic fertilizer source for the nitrate present in those wells (Bedaso and Ekberg, 2019).

Trichloroethene (TCE)
TCE is a volatile organic compound used primarily to remove grease from fabricated metal parts. The MCL for trichloroethene is 5 µg/L. TCE was detected in groundwater samples collected from monitoring well BUT10014 in previous years. However, in 2022 it was not detected in either the fall or spring groundwater samples collected from the well. Well BUT10014 is located at Smith Park in Middletown close to the former Aeronca Air Products site, a site which underwent environmental cleanup activities (Robinson and Richter, 2012). A TCE contaminant plume is present in the aquifer south of the site including the area in which BUT10014 is located. The City of Middletown and Ohio EPA have been tracking the extent of the TCE contamination in recent years (J. Smindak, Ohio EPA, personal communication, September 8, 2017).

Naturally Occurring Contaminants

Arsenic
Arsenic occurs naturally in regional groundwater and concentrations of arsenic are largely controlled by redox conditions. The dominant mechanism for moving arsenic into groundwater is thought to be the release of arsenic from iron oxides in the aquifer under reducing conditions (Thomas et al, 2008). The MCL for arsenic is 10 µg/L. Groundwater samples collected from monitoring wells BUT10016, CLA10011, PRE10007, and WAR10003 had detectable concentrations of arsenic for spring and fall sampling events. The concentration of arsenic measured in the fall groundwater sample collected from monitoring well PRE10007 exceeded the MCL. It should be noted groundwater samples from all of these wells had elevated levels of iron and low levels of dissolved oxygen indicating reducing conditions present in the aquifer zone in which the wells are screened.

Lithium
Lithium is a metal that occurs naturally in groundwater that comes into contact with lithium containing minerals or saline water. The HBSL for lithium is 10 µg/L. At least one groundwater sample collected from monitoring wells MON00022, PRE10007, and WAR10003 had detectable concentrations of lithium. The lithium concentration measured in the fall groundwater sample collected from monitoring well MON00022 (12.5 µg/L) exceeded the HBSL.

Nuisance Contaminants

Hardness, iron, manganese, and total dissolved solids are generally considered to be “nuisance” contaminants. These contaminants are present naturally in groundwater from the buried valley aquifer system. Their presence does not typically pose a health threat. Nevertheless, they can have adverse aesthetic impacts that cause water to appear cloudy or colored. They can also adversely impact plumbing fixtures, stain laundry, and cause taste and odor issues. At high enough concentrations manganese may pose health concerns. In 2004, U.S. EPA issued a lifetime health advisory level of 0.3mg/L for manganese in drinking water.

Hardness is a measure of the amount of dissolved calcium and magnesium in a water sample. When the hardness value exceeds 180 mg/L the water is considered to be very hard. All groundwater samples collected in 2022 had hardness values exceeding 180 mg/L. There is no SMCL for water hardness.

The SMCL for Iron is 0.3 mg/L. Iron concentrations measured in samples collected from monitoring wells BUT10016, CLA10011, MON10016, PRE10007, and WAR10003 exceeded this standard in both sampling events.

The SMCL for manganese is 0.05 mg/L. Manganese concentrations in groundwater samples collected from monitoring wells BUT10016, CLA10011, MIA00205, MON10016, SHE00089, and WAR10003 exceeded this standard during both sampling events. Manganese also has a lifetime health advisory level of 0.3 mg/L. Both groundwater samples collected from well BUT10016 in 2022 exceeded this standard.

Total dissolved solids (TDS) are comprised of inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates). TDS is the sum of cations and anions in a water sample. The SMCL for TDS is 500 mg/L. Groundwater samples collected from wells BUT10014, MON00022, MON10016, and WAR10003 exceeded this standard for at least one sampling event.

Contaminant Trends

Groundwater quality data collected during this study was analyzed for trends in contaminant concentrations. MCD selected the chemical parameters chloride, nitrate, sodium, and TCE as parameters indicative of anthropogenic sources. The parameters arsenic, iron, lithium, and manganese were selected to examine trends in naturally occurring contaminant concentrations.

Contaminants Indicative of Anthropogenic Sources

Chloride and Sodium

Chloride concentrations measured in samples collected from monitoring wells BUT10014, MON10016 and WAR10003 are consistently higher than 70 mg/L and above the concentrations measured in samples from the other monitoring wells (see figure 4). Chloride concentrations in samples show fluctuations from sampling event to sampling event. Likewise, sodium concentrations measured in the three wells (BUT10014, MON10016, and WAR10003) are consistently higher than concentrations measured at other monitoring wells (see figure 5).

Figure 4 – Chloride concentrations in monitoring wells

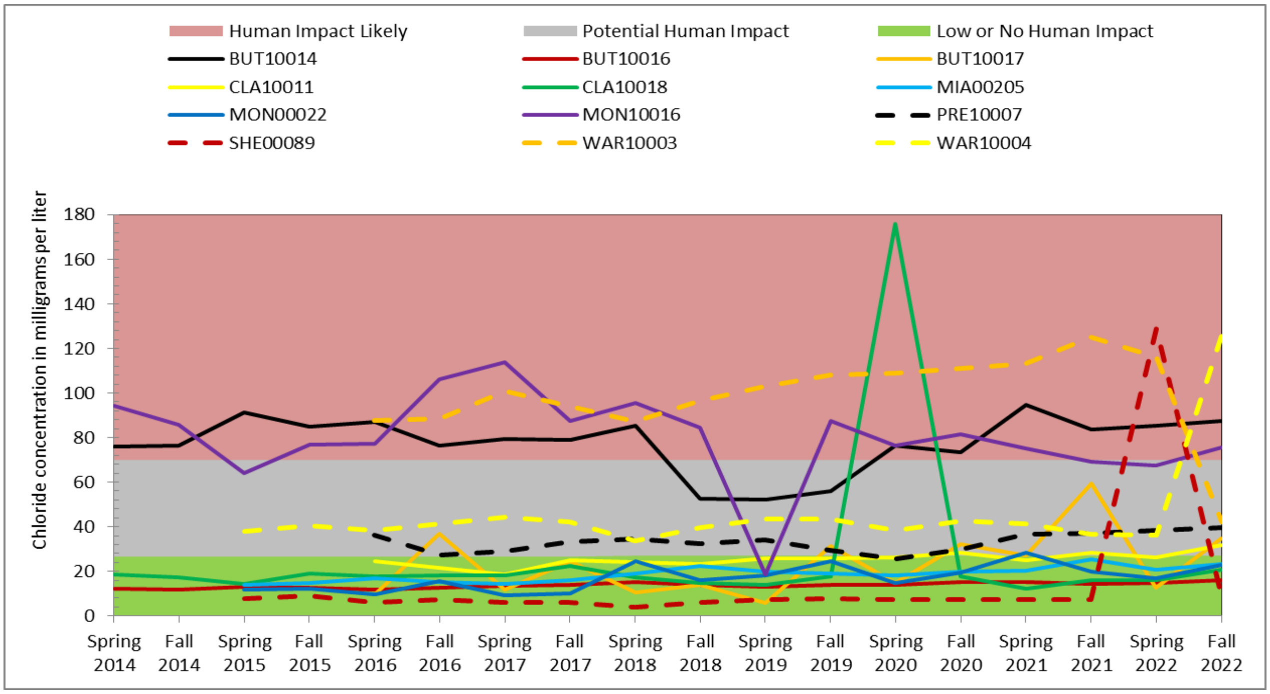


Figure 5 – Sodium concentrations in monitoring wells

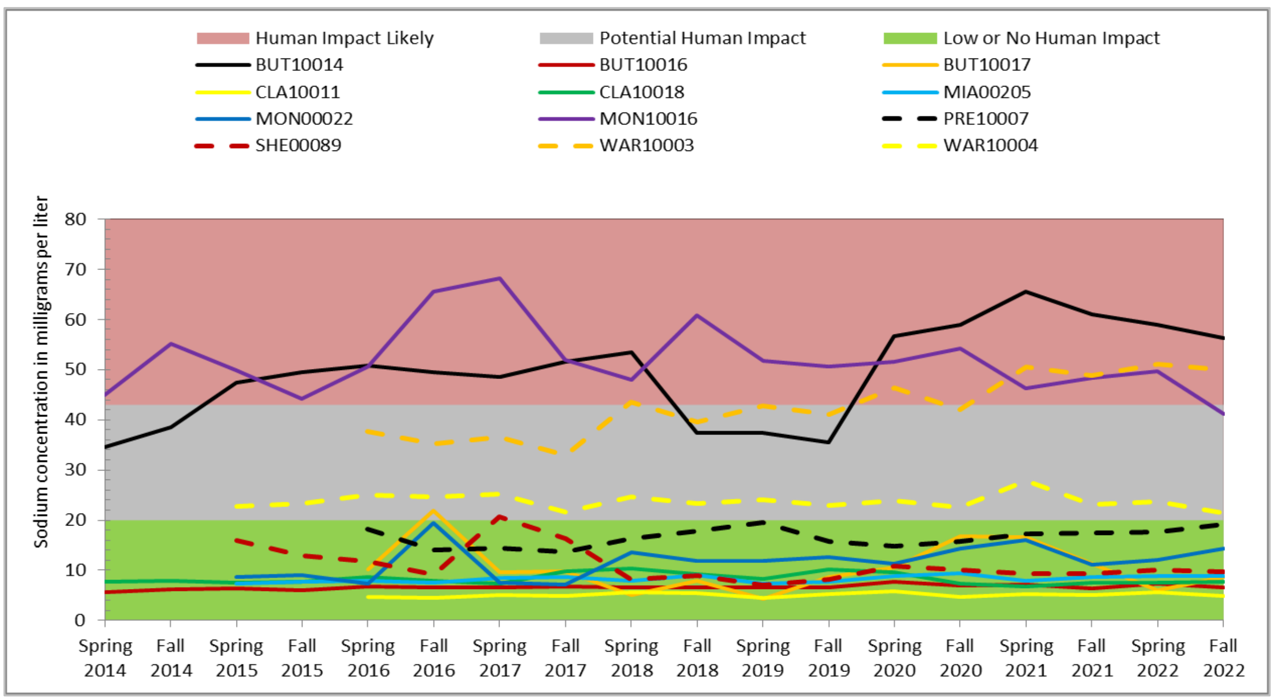


Figure 6 – Nitrate concentrations in monitoring wells

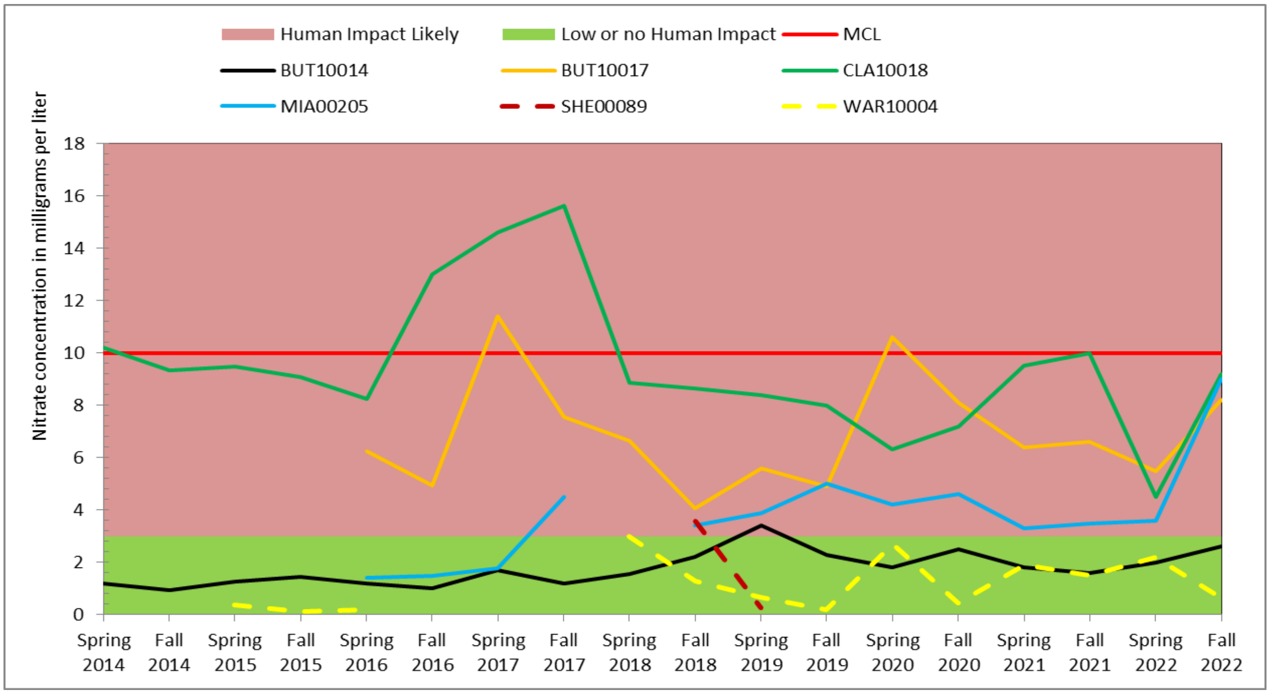
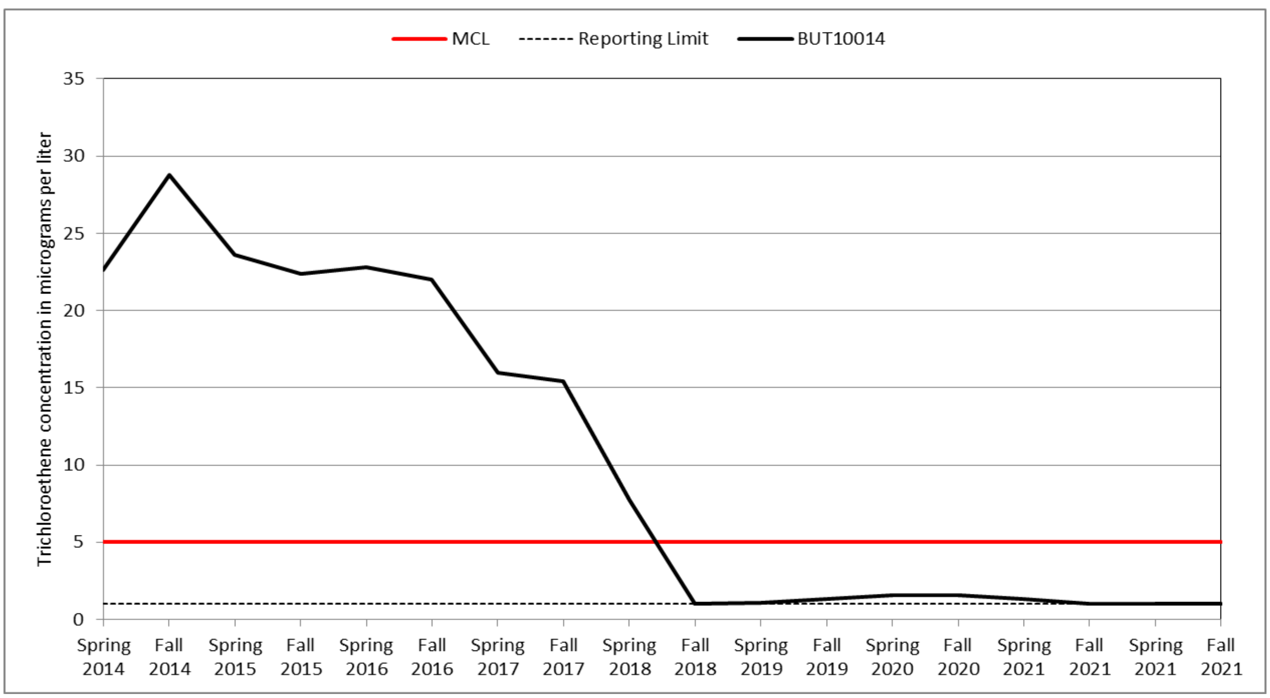


Figure 7 – TCE concentrations in monitoring well BUT10014



Sodium concentrations show similar fluctuations as chloride. Seasonal fluctuations in chloride and sodium are often more pronounced in wells with the highest concentrations of those parameters. These fluctuations may reflect infiltration of saline water from snow melt and rainfall events after seasonal applications of road salt.

Nitrate

Nitrate concentrations measured at monitoring wells BUT10017, CLA10018 and MIA00205 consistently exceed 3 mg/L and likely reflect anthropogenic sources of nitrate to the aquifer screened by those wells (see figure 6). Concentrations of nitrate in groundwater samples from monitoring wells BUT100017 and CLA10018 fluctuate from year to year. Nitrate concentrations measured in groundwater samples from monitoring well MIA00205 have been above 3 mg/L for the past nine sampling events suggesting anthropogenic sources of nitrate are impacting the aquifer at that well location.

Trichloroethene (TCE)

Since 2014, concentrations of TCE in groundwater samples from monitoring well BUT10014 have declined (see figure 7). TCE in the fall 2018 sample was below the reporting limit of 1 µg/L and also below the MCL for the first time since sampling began. Groundwater concentrations measured since fall 2018 have remained close to or below the reporting limit. TCE was not detected in any groundwater samples collected from BUT10014 in 2022.

Naturally Occurring Contaminants

Arsenic

Arsenic was detected in groundwater samples collected from monitoring wells BUT10016, CLA10011, and PRE10007 (see figure 8). The arsenic concentration (26.8 µg/L) measured during the spring sampling event from monitoring well PRE10007 exceeded the drinking water MCL of 10 µg/L. The arsenic concentration in the fall groundwater sample from PRE10007 fell sharply to 5.9 µg/L. Over all, arsenic concentrations in samples collected from PRE10007 seem to be showing significant fluctuations from sampling event to sampling event and may reflect mixing of groundwater from different aquifer zones. Arsenic concentrations measured in monitoring wells BUT10016 and CLA10011 fluctuate between 4 and 9 µg/L but show no overall upward or downward trend.

Iron

There are large fluctuations in iron concentrations measured in groundwater samples collected from monitoring well PRE10007. The large fluctuations in arsenic and iron concentrations may indicate mixing of oxic and anoxic groundwater in the vicinity of the well. Monitoring well PRE10007 is located in a municipal wellfield. MCD staff noted fluctuating dissolved oxygen levels in the well during recent sampling events as nearby production wells turned on and off. This suggests fluctuating redox conditions at the well. There does not appear to be any upward or downward trend in iron concentrations in the other monitoring wells.

Concentrations of dissolved iron greater than 0.1 mg/L in groundwater are often associated with the presence of arsenic in the glacial aquifer system of the northern United States (Thomas, 2007). When compared with previous studies, iron concentrations in groundwater samples

Figure 8 – Arsenic concentrations in monitoring wells

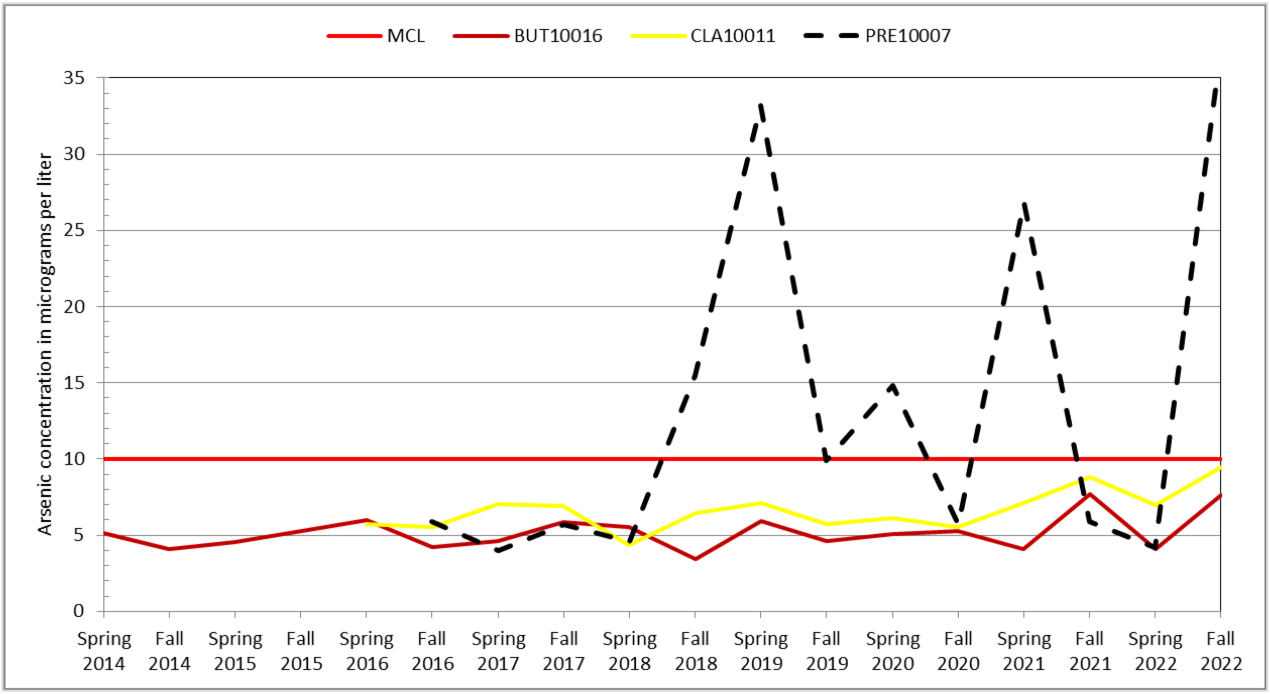


Figure 9 – Iron concentrations in monitoring wells

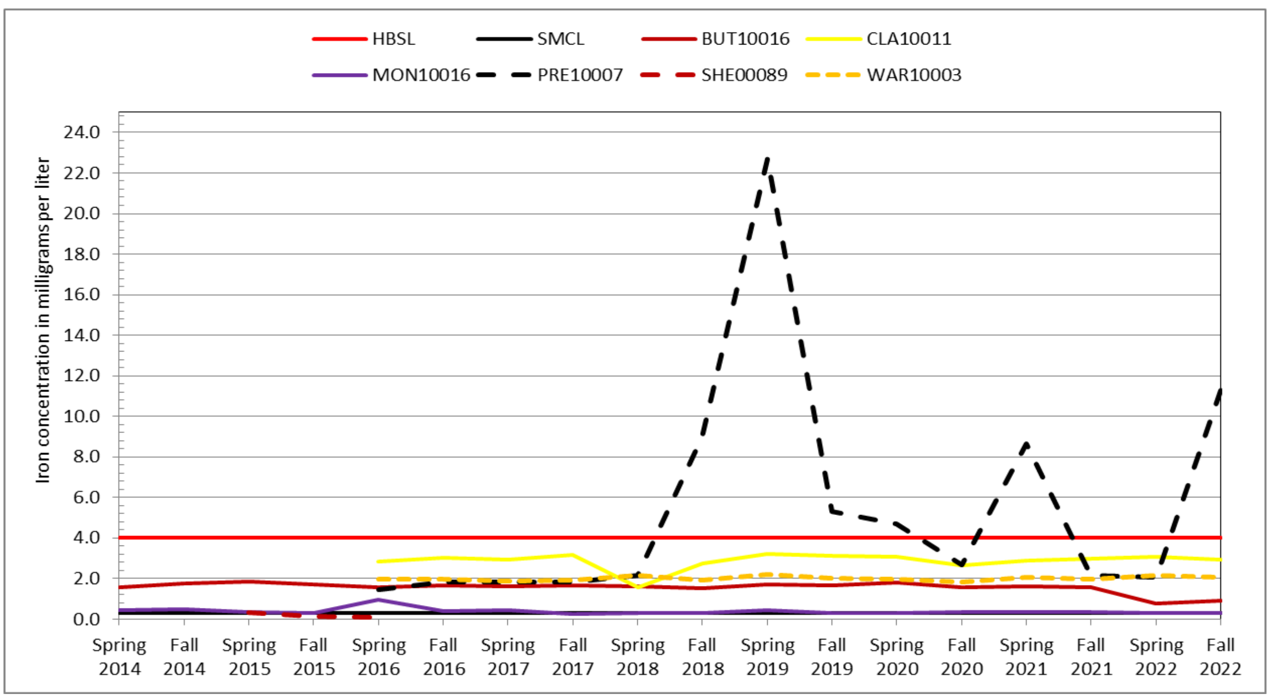


Figure 10 – Lithium concentrations in monitoring wells

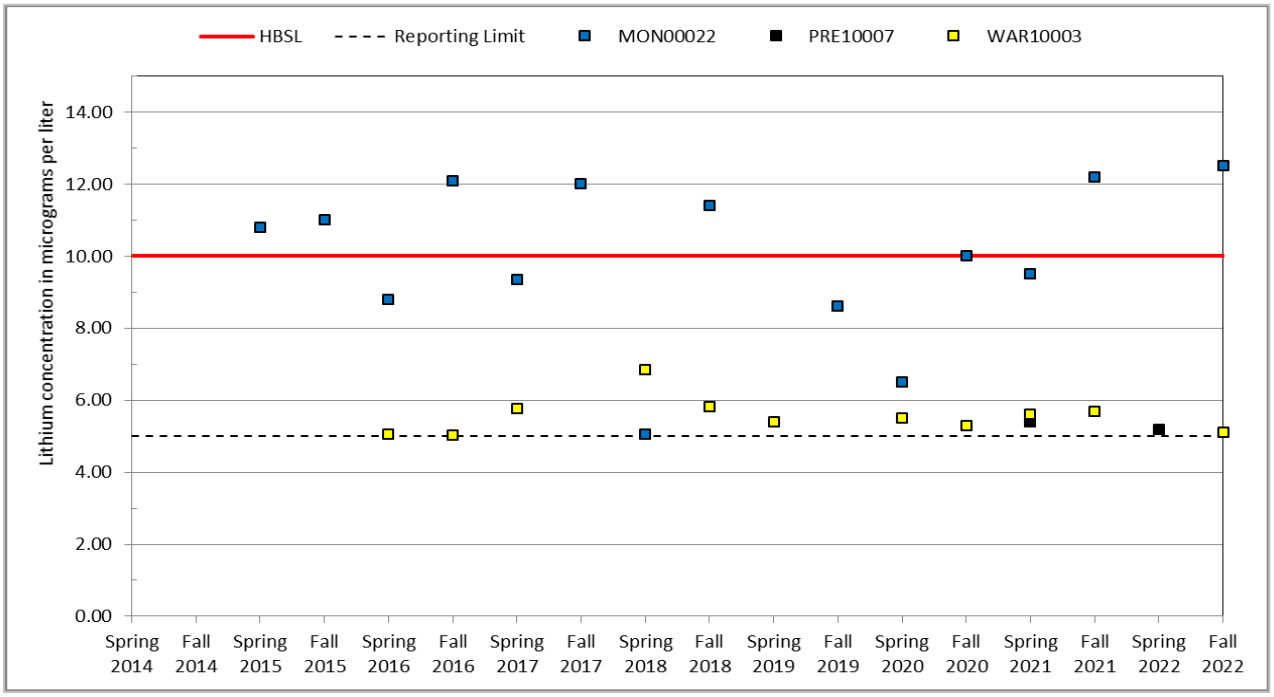
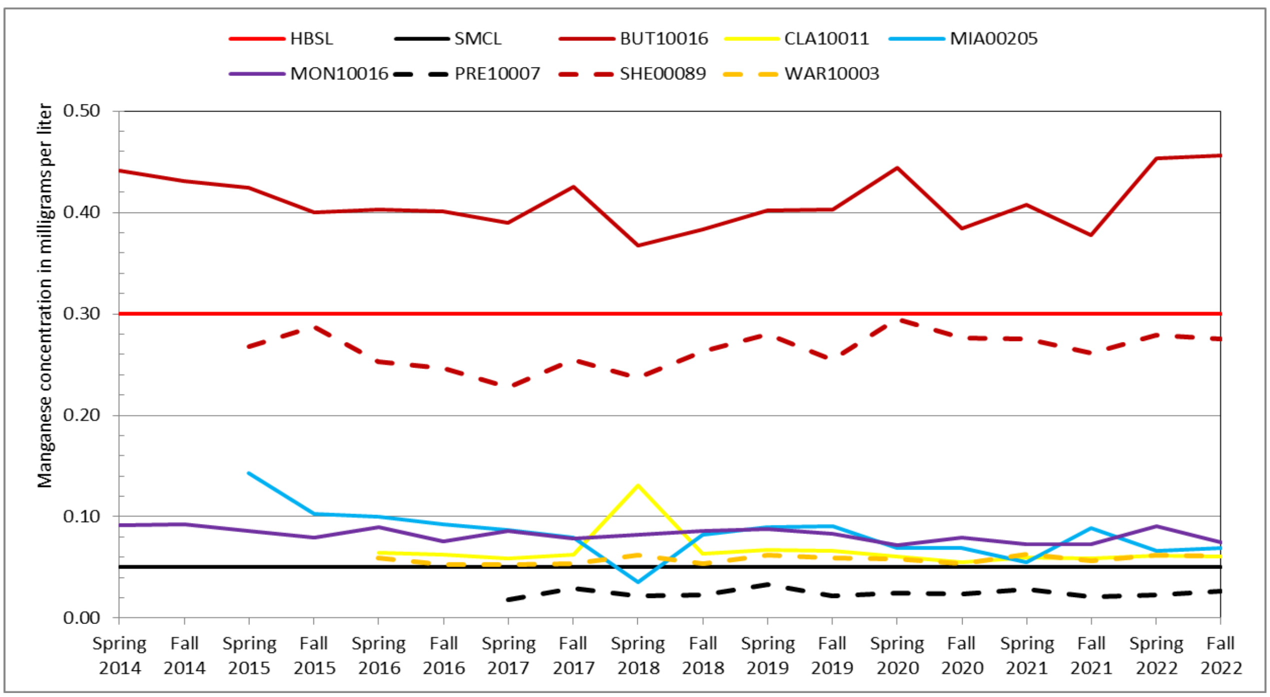


Figure 11 – Manganese concentrations in monitoring wells



collected from monitoring wells BUT10016, CLA10011, MON10016, PRE10007, and WAR10003 consistently exceed the drinking water SMCL of 0.3 mg/L (see figure 9). Groundwater samples from all five of those monitoring wells consistently have detectable concentrations of arsenic.

Lithium
Lithium is consistently detected at concentrations above the reporting limit in groundwater samples collected from monitoring wells MON00022 and WAR10003 (see figure 10). Lithium concentrations in MON00022 fluctuate above and below the HBSL of 10 µg/L but do not show any upward or downward trend. Concentrations of lithium in monitoring well WAR10003 have been fairly consistent from sampling event to sampling event and tend to range between 5 and 7 µg/L.

Manganese
Manganese concentrations in groundwater samples collected from monitoring wells BUT10016, CLA10011, MIA00205, MON10016, SHE00089, and WAR10003 consistently exceed the SMCL of 0.05 mg/L (see figure 11). Manganese concentrations measured in groundwater samples from monitoring well BUT10016 were the highest of all the monitoring wells in 2022 as well as in previous sampling events consistently exceeding the HBSL of 0.3 mg/L. There does not appear to be a strong upward or downward trend in manganese concentration for any of the monitoring wells. Manganese concentrations appear to be fairly consistent from sampling event to sampling event.

Conclusions for 2022

The sample set of the groundwater monitoring program is insufficient in size and scope to characterize in detail the health of the entire buried valley aquifer system. Yet, the results can be used to better understand which contaminants are likely to impact groundwater quality in the buried valley aquifer in southwest Ohio. Furthermore, when the 2022 results are compared with previous rounds of sampling and other studies, some themes related to groundwater quality in the aquifer begin to emerge.

Contaminants originating from anthropogenic sources such as chloride, nitrate, sodium, and VOCs are sometimes present in groundwater samples from sensitive aquifer settings such as shallow unconfined sand and gravel aquifers. This conclusion is supported by other studies which collected groundwater samples from shallow zones in the buried valley aquifer and found similar results (Ohio Environmental Protection Agency, 2015), (Rowe et al, 2004), and (Stuck, 2021a and 2021b).

Naturally occurring contaminants including arsenic and nuisance contaminants are also commonly present in groundwater samples collected from the buried valley aquifer system. Arsenic is a naturally occurring contaminant and may be present in groundwater at concentrations exceeding the MCL. Nuisance contaminants such as hardness, iron, manganese, and total dissolved solids are often present in groundwater at concentrations exceeding secondary drinking water standards and in some cases health-based screening levels. Water softening as well as iron and manganese removal may be necessary to deliver the desired water quality.

These findings emphasize the importance of managing land use over the buried valley aquifer to preserve the quality of the water. They also highlight the interconnected nature of the Great Miami River and the underlying buried valley aquifer system. Anthropogenic constituents present in rivers and streams can also be found in buried valley aquifers. Proactive groundwater protection strategies are critical to ensure the quality of groundwater in our region.

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Appendix A

Spring 2022					Benchmark		Sample Sites					
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Dissolved Oxygen	mg/L	Field Measured	—	—	—	—	5.40	0.69	9.39	2.08	8.22	1.88
pH	S.U.	Field Measured	—	—	SMCL	6.5 - 8.5	7.36	7.53	7.32	7.34	7.45	7.39
Specific Conductance	mS/cm	Field Measured	—	—	—	—	761	442	472	571	655	516
Temperature	°C	Field Measured	—	—	—	—	13.23	12.89	12.83	12.08	11.09	10.89
Chloride	mg/L	SM 4500-Cl E-11	2.0	0.22	SMCL	250	**85.5**	14.7	12.6	26.4	15.9	20.9
Fluoride	mg/L	SM 4500-F C-11	0.20	0.068	MCL	4	0.26	0.22	< 0.20	0.25	0.20	< 0.20
Nitrogen, Ammonia	mg/L	EPA 350.1	0.10	0.048	—	—	< 0.10	0.21	< 0.10	< 0.10	< 0.10	< 0.10
Nitrogen, Kjeldahl, Total	mg/L	SM 4500-Norg D-11	0.50	0.05	—	—	0.58	< 0.50	0.70	< 0.50	< 0.50	< 0.50
Nitrogen, Nitrite	mg/L	SM 4500-NO3 F-11	0.10	0.027	MCL	1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nitrogen, NO2 plus NO3	mg/L	SM 4500-NO3 F-11	0.10	0.05	MCL	10	2.0	< 0.10	**5.5**	< 0.10	**4.5**	**3.6**
Orthophosphate as P	mg/L	SM 4500-P F	0.10	0.0085	—	—	< 0.10	0.18	0.11	< 0.10	< 0.10	< 0.10
Phosphorus, Total	ug/L	EPA 6010B	100	33.8	—	—	< 100	110	< 100	< 100	< 100	< 100
Sulfate	mg/L	SM 4500-SO4 D	5.0	1	SMCL	250	44.9	49.6	15.2	63.4	16.5	44.9
Total Hardness by 2340B	ug/L	EPA 6010B	2000	460	—	—	431,000	318,000	333,000	419,000	356,000	369,000
Aluminum, Total	ug/L	EPA 6010B	100	25.9	HBSL, SMCL	6000, 200	< 100	< 100	< 100	< 100	< 100	< 100
Antimony, Total	ug/L	EPA 6020A	0.50	0.47	MCL	6	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Arsenic, Total	ug/L	EPA 6020A	2.0	0.57	MCL	10	< 2.0	4.1	< 2.0	7.0	< 2.0	< 2.0
Barium, Total	ug/L	EPA 6010B	5.0	2.7	MCL	2000	234	243	43.9	61.1	74.5	120
Beryllium, Total	ug/L	EPA 6010B	0.50	0.18	MCL	4	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Boron, Total	ug/L	EPA 6010B	200	139	HBSL	5000	< 200	< 200	< 200	< 200	< 200	< 200
Cadmium, Total	ug/L	EPA 6020A	1.0	0.62	MCL	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Calcium, Total	ug/L	EPA 6010B	500	429	—	—	118,000	83,100	89,500	105,000	84,200	102,000
Chromium, Hexavalent	mg/L	SM 3500-Cr	0.004	0.0025	HBSL	0.02	< 0.0040	**0.026**	0.0094	0.0083	0.016	0.0049
Cobalt, Total	ug/L	EPA 6010B	5.0	1.7	HBSL	2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Copper, Total	ug/L	EPA 6010B	5.0	4.6	MCL	1300	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Iron, Total	ug/L	EPA 6010B	100	79.3	HBSL, SMCL	4000, 300	< 100	**758**	< 100	**3,090**	< 100	< 100
Lead, Total	ug/L	EPA 6020A	0.50	0.4	MCL	15	< 0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Lithium, Total	ug/L	EPA 200.7	5.0	0.5	HBSL	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Magnesium, Total	ug/L	EPA 6010B	100	30.4	—	—	33,000	26,900	26,500	38,000	35,400	28,100
Manganese, Total	ug/L	EPA 6010B	5.0	2.8	HBSL, SMCL	300, 50	< 5.0	**453**	< 5.0	**62.2**	< 5.0	**66.0**
Molybdenum, Total	ug/L	EPA 6010B	10.0	4.5	HBSL	30	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Nickel, Total	ug/L	EPA 6010B	5.0	4.8	HBSL	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Potassium, Total	ug/L	EPA 6010B	1000	149	—	—	3,900	1,640	2,000	< 1000	1,890	< 1000
Silica, Total	ug/L	EPA 6010B	100	64.6	—	—	11,300	13,600	10,500	15,300	8,970	9,460
Silver, Total	ug/L	EPA 6010B	2.0	0.68	HBSL	100	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Sodium, Total	ug/L	EPA 6010B	2000	1460	—	—	**58,900**	7,380	5,980	5,600	7,580	8,880
Strontium, Total	ug/L	EPA 6010B	5.0	0.77	HBSL	4000	723	441	167	329	2,020	376
Thallium, Total	ug/L	EPA 6020A	0.50	0.22	MCL	2	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Vanadium, Total	ug/L	EPA 6010B	5.0	0.85	—	—	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Zinc, Total	ug/L	EPA 6010B	15.0	12	HBSL	2000	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0
Alkalinity, Total as CaCO3	mg/L	SM 2320B	5.0	5	—	—	324	116	116	282	278	288
BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbonaceous BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Chemical Oxygen Demand	mg/L	HACH 8000	20.0	7.1	—	—	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0
Cyanide	mg/L	EPA 335.4	0.01	0.0049	MCL	0.2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phenolics, Total Recoverable	ug/L	EPA 420.4	2.0	1	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Total Dissolved Solids	mg/L	SM 2540C	10.0	10	SMCL	500	**700**	328	326	456	364	392
Total Organic Carbon	mg/L	SM 5310C-11	1.0	0.36	—	—	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
E.coli	MPN/100mL	SM 9223B	1.0	1	MCL	0	< 1.0	**1.0**	< 1.0	NA	NA	NA

Appendix A

Spring 2022					Benchmark		Sample Sites					
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
1,1,1-Trichloroethane	ug/L	SW 8260B	1.0	0.28	MCL	200	< 1.0					
1,1,2,2-Tetrachloroethane	ug/L	SW 8260B	1.0	0.23	HBSL	0.0002	< 1.0					
1,1,2-Trichloroethane	ug/L	SW 8260B	5.0	0.34	MCL	5	< 5.0					
1,1-Dichloroethane	ug/L	SW 8260B	1.0	0.27	HBSL	1000	< 1.0					
1,1-Dichloroethene	ug/L	SW 8260B	1.0	0.22	MCL	7	< 1.0					
1,2,3-Trichlorobenzene	ug/L	SW 8260B	5.0	0.23	—	—	< 5.0					
1,2,3-Trichloropropane	ug/L	SW 8260B	5.0	0.27	HBSL	30	< 5.0					
1,2,4-Trichlorobenzene	ug/L	SW 8260B	5.0	0.21	MCL	70	< 5.0					
1,2-Dibromo-3-chloropropane	ug/L	SW 8260B	5.0	0.87	MCL	0.2	< 5.0					
1,2-Dibromoethane (EDB)	ug/L	SW 8260B	1.0	0.19	MCL	0.05	< 1.0					
1,2-Dichlorobenzene	ug/L	SW 8260B	1.0	0.57	MCL	600	< 1.0					
1,2-Dichloroethane	ug/L	SW 8260B	1.0	0.3	MCL	5	< 1.0					
1,2-Dichloropropane	ug/L	SW 8260B	1.0	0.23	MCL	5	< 1.0					
1,3-Dichlorobenzene	ug/L	SW 8260B	1.0	0.2	HBSL	600	< 1.0					
1,3-Dichloropropane	ug/L	SW 8260B	1.0	0.24	HBSL	100	< 1.0					
1,4-Dichlorobenzene	ug/L	SW 8260B	1.0	0.21	MCL	75	< 1.0					
2,2-Dichloropropane	ug/L	SW 8260B	1.0	0.26	—	—	< 1.0					
2-Butanone (MEK)	ug/L	SW 8260B	25.0	2.7	—	—	< 25.0					
2-Chlorotoluene	ug/L	SW 8260B	5.0	0.22	—	—	< 5.0					
2-Hexanone	ug/L	SW 8260B	25.0	0.078	HBSL	30	< 25.0					
4-Chlorotoluene	ug/L	SW 8260B	5.0	0.24	HBSL	100	< 5.0					
4-Methyl-2-pentanone (MIBK)	ug/L	SW 8260B	25.0	1.9	—	—	< 25.0					
Acetone	ug/L	SW 8260B	25.0	3.8	HBSL	6000	< 25.0					
Acetonitrile	ug/L	SW 8260B	25.0	2.4	—	—	< 25.0					
Benzene	ug/L	SW 8260B	1.0	0.27	MCL	5	< 1.0					
Bromobenzene	ug/L	SW 8260B	1.0	0.22	HBSL	50	< 1.0					
Bromochloromethane	ug/L	SW 8260B	5.0	0.29	HBSL	60	< 5.0					
Bromodichloromethane	ug/L	SW 8260B	1.0	0.23	MCL	80	< 1.0					
Bromoform	ug/L	SW 8260B	5.0	0.23	MCL	80	< 5.0					
Bromomethane	ug/L	SW 8260B	5.0	0.29	HHBP	140	< 5.0					
Carbon tetrachloride	ug/L	SW 8260B	1.0	0.24	MCL	5	< 1.0					
Chlorobenzene	ug/L	SW 8260B	1.0	0.26	MCL	100	< 1.0					
Chloroethane	ug/L	SW 8260B	5.0	0.26	—	—	< 5.0					
Chloroform	ug/L	SW 8260B	5.0	0.27	MCL	80	< 5.0					
Chloromethane	ug/L	SW 8260B	5.0	0.32	—	—	< 5.0					
cis-1,2-Dichloroethene	ug/L	SW 8260B	1.0	0.3	MCL	70	< 1.0					
cis-1,3-Dichloropropene	ug/L	SW 8260B	1.0	0.23	HBSL	0.3	< 1.0					
Dibromochloromethane	ug/L	SW 8260B	5.0	0.65	MCL	80	< 5.0					
Dibromomethane	ug/L	SW 8260B	5.0	0.3	—	—	< 5.0					
Dichlorodifluoromethane	ug/L	SW 8260B	5.0	0.24	HBSL	1000	< 5.0					
Ethylbenzene	ug/L	SW 8260B	1.0	0.17	MCL	700	< 1.0					
Hexachloro-1,3-butadiene	ug/L	SW 8260B	5.0	0.28	—	—	< 5.0					
m&p-Xylene	ug/L	SW 8260B	2.0	0.41	MCL	10000	< 2.0					
Methylene Chloride	ug/L	SW 8260B	5.0	0.16	MCL	5	< 5.0					
Methyl-tert-butyl ether	ug/L	SW 8260B	5.0	0.24	—	—	< 5.0					

Appendix A

Spring 2022					Benchmark		Sample Sites					
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Naphthalene	ug/L	SW 8260B	5.0	0.21	HBSL	100	< 5.0					
o-Xylene	ug/L	SW 8260B	1.0	0.22	MCL	10000	< 1.0					
p-Isopropyltoluene	ug/L	SW 8260B	5.0	0.18	—	—	< 5.0					
Styrene	ug/L	SW 8260B	1.0	0.21	MCL	100	< 1.0					
Tetrachloroethene	ug/L	SW 8260B	1.0	0.23	MCL	5	< 1.0					
Toluene	ug/L	SW 8260B	1.0	0.23	MCL	1000	< 1.0					
trans-1,2-Dichloroethene	ug/L	SW 8260B	1.0	0.22	MCL	100	< 1.0					
trans-1,3-Dichloropropene	ug/L	SW 8260B	5.0	0.2	HBSL	0.3	< 5.0					
Trichloroethene	ug/L	SW 8260B	1.0	0.3	MCL	5	< 1.0					
Trichlorofluoromethane	ug/L	SW 8260B	1.0	0.25	HBSL	2000	< 1.0					
Vinyl acetate	ug/L	SW 8260B	5.0	0.28	—	—	< 5.0					
Vinyl chloride	ug/L	SW 8260B	1.0	0.22	MCL	2	< 1.0					
Xylene (Total)	ug/L	SW 8260B	3.0	0.41	MCL	10000	< 3.0					

MCL - Maximum Contaminant Level set by USEPA
SMCL - Secondary Maximum Contaminant Level set by USEPA
AMCL - Alternative Maximum Contaminant Level set by USEPA
HBSL - Non enforceable Health Based Screening Level based on (1) latest USEPA Office of Water policies for establishing drinking water benchmarks and (2) most recent USEPA peer reviewed toxicity information
HHBP - Human Health Benchmark for Pesticides set by USEPA
— No drinking water benchmark set for the compound
[1] Duplicate sample result
Numbers in bold exceed a benchmark or indicate anthropogenic sources

Appendix A

Spring 2022					**Benchmark**		**Sample Sites**					
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**MON00022**	**MON10016**	**PRE10007**	**SHE00089**	**WAR10003**	**WAR10004**
Dissolved Oxygen	mg/L	Field Measured	—	—	—	—	3.05	3.16	0.64	3.61	2.12	2.94
pH	S.U.	Field Measured	—	—	SMCL	6.5 - 8.5	7.41	7.66	7.44	7.16	7.40	7.65
Specific Conductance	mS/cm	Field Measured	—	—	—	—	624	575	549	494	850	466
Temperature	°C	Field Measured	—	—	—	—	10.79	12.10	13.00	12.32	15.81	14.70
Chloride	mg/L	SM 4500-Cl E-11	2.0	0.22	SMCL	250	17.0	**67.3**	38.5	**129**	**116**	36.3
Fluoride	mg/L	SM 4500-F C-11	0.20	0.068	MCL	4	< 0.20	< 0.20	0.21	0.38	< 0.20	0.21
Nitrogen, Ammonia	mg/L	EPA 350.1	0.10	0.048	—	—	< 0.10	< 0.10	0.15	0.16	0.24	< 0.10
Nitrogen, Kjeldahl, Total	mg/L	SM 4500-Norg D-11	0.50	0.05	—	—	< 0.50	< 0.50	< 0.50	< 0.50	0.57	0.62
Nitrogen, Nitrite	mg/L	SM 4500-NO3 F-11	0.10	0.027	MCL	1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nitrogen, NO2 plus NO3	mg/L	SM 4500-NO3 F-11	0.10	0.05	MCL	10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	2.2
Orthophosphate as P	mg/L	SM 4500-P F	0.10	0.0085	—	—	< 0.10	< 0.10	0.53	< 0.10	< 0.10	< 0.10
Phosphorus, Total	ug/L	EPA 6010B	100	33.8	—	—	< 100	< 100	< 100	< 100	< 100	< 100
Sulfate	mg/L	SM 4500-SO4 D	5.0	1	SMCL	250	107	< 29.4	56.6	28.6	80.5	22.8
Total Hardness by 2340B	ug/L	EPA 6010B	2000	460	—	—	459,000	303,000	355,000	372,000	438,000	267,000
Aluminum, Total	ug/L	EPA 6010B	100	25.9	HBSL, SMCL	6000, 200	< 100	< 100	< 100	< 100	< 100	< 100
Antimony, Total	ug/L	EPA 6020A	0.50	0.47	MCL	6	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Arsenic, Total	ug/L	EPA 6020A	2.0	0.57	MCL	10	< 2.0	< 2.0	4.2	< 2.0	2.2	< 2.0
Barium, Total	ug/L	EPA 6010B	5.0	2.7	MCL	2000	79.3	104	256	152	217	63.6
Beryllium, Total	ug/L	EPA 6010B	0.50	0.18	MCL	4	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Boron, Total	ug/L	EPA 6010B	200	139	HBSL	5000	< 200	< 200	< 200	< 200	221	< 200
Cadmium, Total	ug/L	EPA 6020A	1.0	0.62	MCL	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Calcium, Total	ug/L	EPA 6010B	500	429	—	—	126,000	79,500	85,200	90,600	107,000	60,100
Chromium, Hexavalent	mg/L	SM 3500-Cr	0.004	0.0025	HBSL	0.02	< 0.0040	< 0.0040	**0.027**	< 0.0040	< 0.0040	< 0.0040
Cobalt, Total	ug/L	EPA 6010B	5.0	1.7	HBSL	2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Copper, Total	ug/L	EPA 6010B	5.0	4.6	MCL	1300	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Iron, Total	ug/L	EPA 6010B	100	79.3	HBSL, SMCL	4000, 300	101	**316**	**2,070**	< 100	**2,170**	< 100
Lead, Total	ug/L	EPA 6020A	0.50	0.4	MCL	15	<0.50	<0.50	< 0.50	< 0.50	< 0.50	< 0.50
Lithium, Total	ug/L	EPA 200.7	5.0	0.5	HBSL	10	< 5.0	< 5.0	5.2	< 5.0	< 5.0	< 5.0
Magnesium, Total	ug/L	EPA 6010B	100	30.4	—	—	35,100	25,400	34,600	35,400	41,700	28,400
Manganese, Total	ug/L	EPA 6010B	5.0	2.8	HBSL, SMCL	300, 50	< 5.0	**90.9**	22.7	**279**	**61.6**	< 5.0
Molybdenum, Total	ug/L	EPA 6010B	10.0	4.5	HBSL	30	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Nickel, Total	ug/L	EPA 6010B	5.0	4.8	HBSL	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Potassium, Total	ug/L	EPA 6010B	1000	149	—	—	2,940	2,590	1,930	1,250	2,870	2,550
Silica, Total	ug/L	EPA 6010B	100	64.6	—	—	6,830	9,390	11,300	11,400	14,300	8,960
Silver, Total	ug/L	EPA 6010B	2.0	0.68	HBSL	100	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Sodium, Total	ug/L	EPA 6010B	2000	1460	—	—	12,000	**49,600**	17,700	10,000	**51,100**	23,600
Strontium, Total	ug/L	EPA 6010B	5.0	0.77	HBSL	4000	379	448	840	514	1,090	431
Thallium, Total	ug/L	EPA 6020A	0.50	0.22	MCL	2	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Vanadium, Total	ug/L	EPA 6010B	5.0	0.85	—	—	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Zinc, Total	ug/L	EPA 6010B	15.0	12	HBSL	2000	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0
Alkalinity, Total as CaCO3	mg/L	SM 2320B	5.0	5	—	—	321	252	122	313	256	221
BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbonaceous BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Chemical Oxygen Demand	mg/L	HACH 8000	20.0	7.1	—	—	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0
Cyanide	mg/L	EPA 335.4	0.01	0.0049	MCL	0.2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phenolics, Total Recoverable	ug/L	EPA 420.4	2.0	1	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Total Dissolved Solids	mg/L	SM 2540C	10.0	10	SMCL	500	**544**	**547**	406	372	**604**	290
Total Organic Carbon	mg/L	SM 5310C-11	1.0	0.36	—	—	1.8	< 1.0	< 1.0	NA	< 1.0	< 1.0
E.coli	MPN/100mL	SM 9223B	1.0	1	MCL	0	< 1.0	< 1.0	< 1.0	< 1.0	<1.0	<1.0

Appendix A

Fall 2022					Benchmark		Sample Sites					
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Dissolved Oxygen	mg/L	Field Measured	—	—	—	—	4.86	0.07	8.32	0.06	5.49	0.19
pH	S.U.	Field Measured	—	—	SMCL	6.5 - 8.5	7.19	7.53	7.32	7.23	7.23	7.15
Specific Conductance	mS/cm	Field Measured	—	—	—	—	982	586	668	761	568	557
Temperature	°C	Field Measured	—	—	—	—	14.57	12.80	12.55	12.74	16.93	13.18
Chloride	mg/L	SM 4500-Cl E-11	2.0	0.22	SMCL	250	**87.3**	16.0	34.8	31.6	20.5	23.3
Fluoride	mg/L	SM 4500-F C-11	0.20	0.068	MCL	4	0.22	0.22	< 0.20	0.22	< 0.20	< 0.20
Nitrogen, Ammonia	mg/L	EPA 350.1	0.10	0.048	—	—	< 0.10	0.20	< 0.10	< 0.10	< 0.10	< 0.10
Nitrogen, Kjeldahl, Total	mg/L	SM 4500-Norg D-11	0.50	0.05	—	—	< 0.50	< 0.50	< 0.50	< 0.50	0.63	0.83
Nitrogen, Nitrite	mg/L	SM 4500-NO3 F-11	0.10	0.027	MCL	1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nitrogen, NO2 plus NO3	mg/L	SM 4500-NO3 F-11	0.10	0.05	MCL	10	2.6	< 0.10	**8.2**	< 0.10	**9.2**	**9.0**
Orthophosphate as P	mg/L	SM 4500-P F	0.10	0.0085	—	—	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phosphorus, Total	ug/L	EPA 6010B	100	33.8	—	—	< 100	113	< 100	< 100	< 100	< 100
Sulfate	mg/L	SM 4500-SO4 D	5.0	1	SMCL	250	59.1	45.3	17.1	65.9	14.4	25.9
Total Hardness by 2340B	ug/L	EPA 6010B	2000	460	—	—	405,000	300,000	331,000	395,000	355,000	367,000
Aluminum, Total	ug/L	EPA 6010B	100	25.9	HBSL, SMCL	6000, 200	< 100	< 100	< 100	< 100	< 100	< 100
Antimony, Total	ug/L	EPA 6020A	0.50	0.47	MCL	6	< 0.50	< 0.50	< 0.50	< 0.50	0.75	< 0.50
Arsenic, Total	ug/L	EPA 6020A	2.0	0.57	MCL	10	< 2.0	7.6	< 2.0	9.5	< 2.0	< 2.0
Barium, Total	ug/L	EPA 6010B	5.0	2.7	MCL	2000	234	236	46.5	58.9	87.7	130
Beryllium, Total	ug/L	EPA 6010B	0.50	0.18	MCL	4	< 0.50	< 0.50	0.67	< 0.50	< 0.50	< 0.50
Boron, Total	ug/L	EPA 6010B	200	139	HBSL	5000	< 200	< 200	< 200	< 200	< 200	< 200
Cadmium, Total	ug/L	EPA 6020A	1.0	0.62	MCL	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Calcium, Total	ug/L	EPA 6010B	500	429	—	—	112,000	77,200	88,400	99,700	84,500	101,000
Chromium, Hexavalent	mg/L	SM 3500-Cr	0.004	0.0025	HBSL	0.02	< 0.004	**0.014**	**0.011**	< 0.004	**0.007**	< 0.004
Cobalt, Total	ug/L	EPA 6010B	5.0	1.7	HBSL	2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Copper, Total	ug/L	EPA 6010B	5.0	4.6	MCL	1300	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Iron, Total	ug/L	EPA 6010B	100	79.3	HBSL, SMCL	4000, 300	< 100	**925**	< 100	**2,910**	< 100	< 100
Lead, Total	ug/L	EPA 6020A	0.50	0.4	MCL	15	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Lithium, Total	ug/L	EPA 200.7	5.0	0.5	HBSL	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Magnesium, Total	ug/L	EPA 6010B	100	30.4	—	—	30,600	26,100	26,800	35,600	35,000	27,700
Manganese, Total	ug/L	EPA 6010B	5.0	2.8	HBSL, SMCL	300, 50	< 5.0	**456**	< 5.0	**60.9**	< 5.0	**69.3**
Molybdenum, Total	ug/L	EPA 6010B	10.0	4.5	HBSL	30	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Nickel, Total	ug/L	EPA 6010B	5.0	4.8	HBSL	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Potassium, Total	ug/L	EPA 6010B	1000	149	—	—	4,550	2,600	3,280	1,420	4,890	4,270
Silica, Total	ug/L	EPA 6010B	100	64.6	—	—	11,000	12,800	9,100	13,600	10,200	9,960
Silver, Total	ug/L	EPA 6010B	2.0	0.68	HBSL	100	3.7	2.8	2.6	3.3	4.4	3.0
Sodium, Total	ug/L	EPA 6010B	2000	1460	—	—	**56,200**	6,460	8,700	4,920	7,840	8,920
Strontium, Total	ug/L	EPA 6010B	5.0	0.77	HBSL	4000	704	416	160	311	2,420	373
Thallium, Total	ug/L	EPA 6020A	0.50	0.22	MCL	2	< 0.50	< 0.50	< 0.50	< 0.50	0.61	< 0.50
Vanadium, Total	ug/L	EPA 6010B	5.0	0.85	—	—	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Zinc, Total	ug/L	EPA 6010B	15.0	12	HBSL	2000	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0
Alkalinity, Total as CaCO3	mg/L	SM 2320B	5.0	5	—	—	274	189	232	251	224	293
BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbonaceous BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Chemical Oxygen Demand	mg/L	HACH 8000	20.0	7.1	—	—	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0
Cyanide	mg/L	EPA 335.4	0.005	0.0049	MCL	0.2	< 0.005	< 0.005	< 0.005	< 0.005	0.0058	< 0.005
Phenolics, Total Recoverable	ug/L	EPA 420.4	2.0	1	—	—	5.4	3.2	3.2	3.7	< 2.0	< 2.0
Total Dissolved Solids	mg/L	SM 2540C	10.0	10	SMCL	500	**534**	260	130	392	274	378
Total Organic Carbon	mg/L	SM 5310C-11	1.0	0.36	—	—	< 1.0	< 1.0	< 1.0	1	< 1.0	< 1.0
E.coli	MPN/100mL	SM 9223B	1.0	1	MCL	0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Appendix A

Fall 2022					Benchmark		Sample Sites					
Parameter	Units	Method	PQL	MDL	Type	Value	BUT10014	BUT10016	BUT10017	CLA10011	CLA10018	MIA00205
1,1,1-Trichloroethane	ug/L	SW 8260B	1.0	0.28	MCL	200	< 1.0					
1,1,2,2-Tetrachloroethane	ug/L	SW 8260B	1.0	0.23	HBSL	0.0002	< 1.0					
1,1,2-Trichloroethane	ug/L	SW 8260B	1.0	0.34	MCL	5	< 1.0					
1,1-Dichloroethane	ug/L	SW 8260B	1.0	0.27	HBSL	1000	< 1.0					
1,1-Dichloroethene	ug/L	SW 8260B	1.0	0.22	MCL	7	< 1.0					
1,2,3-Trichlorobenzene	ug/L	SW 8260B	1.0	0.23	—	—	< 1.0					
1,2,3-Trichloropropane	ug/L	SW 8260B	1.0	0.27	HBSL	30	< 1.0					
1,2,4-Trichlorobenzene	ug/L	SW 8260B	1.0	0.21	MCL	70	< 1.0					
1,2-Dibromo-3-chloropropane	ug/L	SW 8260B	5.0	0.87	MCL	0.2	< 5.0					
1,2-Dibromoethane (EDB)	ug/L	SW 8260B	1.0	0.19	MCL	0.05	< 1.0					
1,2-Dichlorobenzene	ug/L	SW 8260B	1.0	0.57	MCL	600	< 1.0					
1,2-Dichloroethane	ug/L	SW 8260B	1.0	0.3	MCL	5	< 1.0					
1,2-Dichloropropane	ug/L	SW 8260B	1.0	0.23	MCL	5	< 1.0					
1,3-Dichlorobenzene	ug/L	SW 8260B	1.0	0.2	HBSL	600	< 1.0					
1,3-Dichloropropane	ug/L	SW 8260B	1.0	0.24	HBSL	100	< 1.0					
1,4-Dichlorobenzene	ug/L	SW 8260B	1.0	0.21	MCL	75	< 1.0					
2,2-Dichloropropane	ug/L	SW 8260B	1.0	0.26	—	—	< 1.0					
2-Butanone (MEK)	ug/L	SW 8260B	10.0	2.7	—	—	< 10.0					
2-Chlorotoluene	ug/L	SW 8260B	1.0	0.22	—	—	< 1.0					
2-Hexanone	ug/L	SW 8260B	10.0	0.078	HBSL	30	< 10.0					
4-Chlorotoluene	ug/L	SW 8260B	1.0	0.24	HBSL	100	< 1.0					
4-Methyl-2-pentanone (MIBK)	ug/L	SW 8260B	10.0	1.9	—	—	< 10.0					
Acetone	ug/L	SW 8260B	10.0	3.8	HBSL	6000	< 10.0					
Acetonitrile	ug/L	SW 8260B	10.0	2.4	—	—	< 10.0					
Benzene	ug/L	SW 8260B	1.0	0.27	MCL	5	< 1.0					
Bromobenzene	ug/L	SW 8260B	1.0	0.22	HBSL	50	< 1.0					
Bromochloromethane	ug/L	SW 8260B	1.0	0.29	HBSL	60	< 1.0					
Bromodichloromethane	ug/L	SW 8260B	1.0	0.23	MCL	80	< 1.0					
Bromoform	ug/L	SW 8260B	1.0	0.23	MCL	80	< 1.0					
Bromomethane	ug/L	SW 8260B	1.0	0.29	HHBP	140	< 1.0					
Carbon Disulfide	ug/L	SW 8260B	1.0	0.24	HBSL	600	< 1.0					
Carbon tetrachloride	ug/L	SW 8260B	1.0	0.24	MCL	5	< 1.0					
Chlorobenzene	ug/L	SW 8260B	1.0	0.26	MCL	100	< 1.0					
Chloroethane	ug/L	SW 8260B	1.0	0.26	—	—	< 1.0					
Chloroform	ug/L	SW 8260B	1.0	0.27	MCL	80	< 1.0					
Chloromethane	ug/L	SW 8260B	1.0	0.32	—	—	< 1.0					
cis-1,2-Dichloroethene	ug/L	SW 8260B	1.0	0.3	MCL	70	< 1.0					
cis-1,3-Dichloropropene	ug/L	SW 8260B	1.0	0.23	HBSL	0.3	< 1.0					
Dibromochloromethane	ug/L	SW 8260B	1.0	0.65	MCL	80	< 1.0					
Dibromomethane	ug/L	SW 8260B	1.0	0.3	—	—	< 1.0					
Dichlorodifluoromethane	ug/L	SW 8260B	1.0	0.24	HBSL	1000	< 1.0					
Ethyl Acetate	ug/L	SW 8260B	1.0	0.21	HBSL	6000	**1.9**					
Ethylbenzene	ug/L	SW 8260B	1.0	0.17	MCL	700	< 1.0					
Hexachloro-1,3-butadiene	ug/L	SW 8260B	1.0	0.28	—	—	< 1.0					
m&p-Xylene	ug/L	SW 8260B	1.0	0.41	MCL	10000	< 1.0					
Methylene Chloride	ug/L	SW 8260B	1.0	0.16	MCL	5	< 1.0					
Methyl-tert-butyl ether	ug/L	SW 8260B	1.0	0.24	—	—	< 1.0					

Appendix A

Fall 2022					Benchmark		Sample Sites					
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Methyl-tert-butyl ether	ug/L	SW 8260B	1.0	0.24	—	—	< 1.0					
Naphthalene	ug/L	SW 8260B	1.0	0.21	HBSL	100	< 1.0					
o-Xylene	ug/L	SW 8260B	1.0	0.22	MCL	10000	< 1.0					
p-Isopropyltoluene	ug/L	SW 8260B	1.0	0.18	—	—	< 1.0					
Styrene	ug/L	SW 8260B	1.0	0.21	MCL	100	< 1.0					
Tetrachloroethene	ug/L	SW 8260B	1.0	0.23	MCL	5	< 1.0					
Toluene	ug/L	SW 8260B	1.0	0.23	MCL	1000	< 1.0					
trans-1,2-Dichloroethene	ug/L	SW 8260B	1.0	0.22	MCL	100	< 1.0					
trans-1,3-Dichloropropene	ug/L	SW 8260B	1.0	0.2	HBSL	0.3	< 1.0					
Trichloroethene	ug/L	SW 8260B	1.0	0.3	MCL	5	< 1.0					
Trichlorofluoromethane	ug/L	SW 8260B	1.0	0.25	HBSL	2000	< 1.0					
Vinyl acetate	ug/L	SW 8260B	5.0	0.28	—	—	< 5.0					
Vinyl chloride	ug/L	SW 8260B	1.0	0.22	MCL	2	< 1.0					
Xylene (Total)	ug/L	SW 8260B	1.0	0.41	MCL	10000	< 1.0					

MCL - Maximum Contaminant Level set by USEPA
SMCL - Secondary Maximum Contaminant Level set by USEPA
AMCL - Alternative Maximum Contaminant Level set by USEPA
HBSL - Non enforceable Health Based Screening Level based on (1) latest USEPA Office of Water policies for establishing drinking water benchmarks and (2) most recent USEPA peer reviewed toxicity information
HHBP - Human Health Benchmark for Pesticides set by USEPA
— No drinking water benchmark set for the compound
[1] Duplicate sample result
Numbers in bold exceed a benchmark or indicate anthropogenic sources

Appendix A

Fall 2022					Benchmark		Sample Sites					
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**MON00022**	**MON10016**	**PRE10007**	**SHE00089**	**WAR10003**	**WAR10004**
Dissolved Oxygen	mg/L	Field Measured	—	—	—	—	0.22	0.03	0.31	0.31	0.05	1.21
pH	S.U.	Field Measured	—	—	SMCL	6.5 - 8.5	7.00	7.43	7.41	7.26	7.44	7.58
Specific Conductance	mS/cm	Field Measured	—	—	—	—	1,111	588	729	682	1,055	571
Temperature	°C	Field Measured	—	—	—	—	16.94	12.31	12.66	12.09	14.43	14.50
Chloride	mg/L	SM 4500-Cl E-11	2.0	0.22	SMCL	250	22.7	**75.4**	39.5	8.4	**42.2**	**126**
Fluoride	mg/L	SM 4500-F C-11	0.20	0.068	MCL	4	0.21	< 0.20	0.28	0.48	0.26	0.30
Nitrogen, Ammonia	mg/L	EPA 350.1	0.10	0.048	—	—	< 0.10	< 0.10	< 0.10	< 0.10	0.33	< 0.10
Nitrogen, Kjeldahl, Total	mg/L	SM 4500-Norg D-11	0.50	0.05	—	—	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Nitrogen, Nitrite	mg/L	SM 4500-NO3 F-11	0.10	0.027	MCL	1	< 0.10	< 0.10	< 0.10	0.10	0.10	< 0.10
Nitrogen, NO2 plus NO3	mg/L	SM 4500-NO3 F-11	0.10	0.05	MCL	10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.62
Orthophosphate as P	mg/L	SM 4500-P F	0.10	0.0085	—	—	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phosphorus, Total	ug/L	EPA 6010B	100	33.8	—	—	< 100	< 100	< 100	< 100	< 100	< 100
Sulfate	mg/L	SM 4500-SO4 D	5.0	1	SMCL	250	170	31.9	50.8	37.7	77.8	23.0
Total Hardness by 2340B	ug/L	EPA 6010B	2000	460	—	—	606,000	302,000	354,000	366,000	418,000	233,000
Aluminum, Total	ug/L	EPA 6010B	100	25.9	HBSL, SMCL	6000, 200	< 100	< 100	< 100	< 100	< 100	< 100
Antimony, Total	ug/L	EPA 6020A	0.50	0.47	MCL	6	< 0.50	0.82	< 0.50	< 0.50	< 0.50	< 0.50
Arsenic, Total	ug/L	EPA 6020A	2.0	0.57	MCL	10	< 2.0	< 2.0	**36.8**	< 2.0	3.0	< 2.0
Barium, Total	ug/L	EPA 6010B	5.0	2.7	MCL	2000	126	101	277	152	208	55.8
Beryllium, Total	ug/L	EPA 6010B	0.50	0.18	MCL	4	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Boron, Total	ug/L	EPA 6010B	200	139	HBSL	5000	< 200	< 200	< 200	< 200	226	< 200
Cadmium, Total	ug/L	EPA 6020A	1.0	0.62	MCL	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Calcium, Total	ug/L	EPA 6010B	500	429	—	—	166,000	78,800	87,700	89,500	102,000	52,300
Chromium, Hexavalent	mg/L	SM 3500-Cr	0.004	0.0025	HBSL	0.02	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Cobalt, Total	ug/L	EPA 6010B	5.0	1.7	HBSL	2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Copper, Total	ug/L	EPA 6010B	5.0	4.6	MCL	1300	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Iron, Total	ug/L	EPA 6010B	100	79.3	HBSL, SMCL	4000, 300	< 100	**306**	**11,300**	< 100	**2,060**	< 100
Lead, Total	ug/L	EPA 6020A	0.50	0.4	MCL	15	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Lithium, Total	ug/L	EPA 200.7	5.0	0.5	HBSL	10	**12.5**	< 5.0	< 5.0	< 5.0	5.1	< 5.0
Magnesium, Total	ug/L	EPA 6010B	100	30.4	—	—	46,500	25,600	32,800	34,600	39,500	25,000
Manganese, Total	ug/L	EPA 6010B	5.0	2.8	HBSL, SMCL	300, 50	22.8	**75.2**	26.8	**275**	**60.5**	< 5.0
Molybdenum, Total	ug/L	EPA 6010B	10.0	4.5	HBSL	30	< 10.0	< 10.0	< 10.0	12.4	< 10.0	< 10.0
Nickel, Total	ug/L	EPA 6010B	5.0	4.8	HBSL	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Potassium, Total	ug/L	EPA 6010B	1000	149	—	—	5,220	4,510	2,670	1,840	3,190	2,480
Silica, Total	ug/L	EPA 6010B	100	64.6	—	—	9,080	8,840	12,100	10,600	12,400	7,490
Silver, Total	ug/L	EPA 6010B	2.0	0.68	HBSL	100	5.6	3.6	4.1	4.7	4.80	2.9
Sodium, Total	ug/L	EPA 6010B	2000	1460	—	—	14,400	**41,100**	19,200	9,830	**49,900**	21,400
Strontium, Total	ug/L	EPA 6010B	5.0	0.77	HBSL	4000	553	581	913	484	1,070	382
Thallium, Total	ug/L	EPA 6020A	0.50	0.22	MCL	2	< 0.50	0.77	< 0.50	< 0.50	< 0.50	< 0.50
Vanadium, Total	ug/L	EPA 6010B	5.0	0.85	—	—	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Zinc, Total	ug/L	EPA 6010B	15.0	12	HBSL	2000	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0
Alkalinity, Total as CaCO3	mg/L	SM 2320B	5.0	5	—	—	332	208	247	270	235	174
BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbonaceous BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Chemical Oxygen Demand	mg/L	HACH 8000	20.0	7.1	—	—	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0
Cyanide	mg/L	EPA 335.4	0.005	0.0049	MCL	0.2	< 0.005	0.0058	< 0.005	< 0.005	< 0.005	< 0.005
Phenolics, Total Recoverable	ug/L	EPA 420.4	2.0	1	—	—	5.9	< 2.0	5.8	< 2.0	3.1	< 2.0
Total Dissolved Solids	mg/L	SM 2540C	10.0	10	SMCL	500	**700**	290	406	400	**582**	246
Total Organic Carbon	mg/L	SM 5310C-11	1.0	0.36	—	—	1.1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
E.coli	MPN/100mL	SM 9223B	1.0	1	MCL	0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

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