PFAS and Other Contaminants in 97 Private Drinking Water Wells in Dakota County, Minnesota, 2018 to 2022

Prepared and written by Vanessa Demuth, P.G., Dakota County Environmental Specialist

April 2023

Contents

Executive Summary

Per- and polyfluoroalkyl substances, also known as PFAS, PFCs, 3M, or forever chemicals, were introduced in the 1940s for their ability to repel oils, stains, grease, heat, and water in products such as stain-resistant carpet and fabrics (Scotchgard™), nonstick cookware (Teflon™), coatings on some food packaging, fire-fighting foam, and other applications. PFAS are referred to as "forever chemicals" because they are stable compounds, resistant to degradation, and found in soil, surface water, groundwater, air, precipitation, humans, and animals. PFAS compounds can accumulate in the human body and have a variety of negative health effects. According to the US Environmental Protection Agency (EPA) website (US EPA 3/16/22), current peer-reviewed scientific studies have shown that exposure to certain levels of PFAS may lead to:

- Reproductive effects such as decreased fertility or increased high blood pressure in pregnant women.
- Developmental effects or delays in children, including low birth weight, accelerated puberty, bone variations, or behavioral changes.
- Increased risk of some cancers, including prostate, kidney, and testicular cancers.
- Reduced ability of the body's immune system to fight infections, including reduced vaccine response.
- Interference with the body's natural hormones.
- Increased cholesterol levels and/or risk of obesity.

Sampling of private drinking water wells in Dakota County has found PFAS in 79 (81 percent) of the wells, but none over current Minnesota Department of Health (MDH) guidance values (MDH 12/23/22). On March 14, 2023, the EPA proposed "… public water systems to monitor for six PFAS chemicals, notify the public if the levels of these PFAS exceed the proposed regulatory standards, and take action to reduce the level of PFAS in the water supply." (US EPA 3/14/23). When applying the EPA proposed Maximum Contaminant Levels (MCLs) for public water supply wells to the County private well results; seven (7 percent) of the private wells tested for PFOA, the main compound in Teflon™, exceed. Three (3 percent) of the wells exceed the proposed MCL for PFOS, the key ingredient in Scotchgard™. Two of these wells exceed for both PFOA and PFOS. PFOA and PFOS were the most widely used and are the most studied PFAS and in recent years have been replaced with other chemicals. The EPA proposed using the Hazard Index calculation for the combined results for: PFBS, PFHxS, GenX and PFNA. Neither GenX nor PFNA were detected. Three wells (3 percent) exceed the value of 1 when the proposed combined Hazard Index calculation for PFBS and PFHxS was performed. Two of the wells exceed for the proposed PFOA MCL and one exceeds for proposed PFOS MCL. (Note: This report refers to individual PFAS compounds by their common acronyms, such as PFOA or PFOS. The full chemical names of PFAS compounds are included in the Acronyms and Abbreviations Section.)

In 2018 and 2019, a total of 62 private drinking water wells in Dakota County were sampled for PFAS as part of the Dakota County Ambient Groundwater Quality Study (Ambient Study). The Ambient Study recommended the evaluation of land application of sewage sludge and other biosolids on County groundwater quality. A private lab was contracted to collect samples from 25 private drinking water wells in 2020, and County staff collected samples from 10 additional wells in 2022, downgradient from known biosolid application sites. The 2020-2022 samples were analyzed for PFAS, nitrate-nitrogen (nitrate), chloride, sulfate, manganese, and an additional nine heavy metals that biosolids are analyzed for.

The PFAS results from 97 wells are summarized below. Two wells were sampled twice in different years and the results were averaged.

- Up to 32 different PFAS were analyzed and 10 different PFAS were detected
- Three wells had eight different PFAS detected
- PFBA was the most detected PFAS, found in 79 wells (81 percent)
- The concentrations of PFBA, PFPeA, and PFHxS in wells were significantly correlated to the distance to a known biosolid application site; the closer the distance to a site, the more likely a well sample is to have PFBA, PFPeA, and PFHxS detected
- Eight (8 percent) wells exceed the EPA draft MCLs
    - Seven wells exceed the proposed MCL for PFOA of 0.4 ng/L (nanograms per liter, equivalent to parts per trillion)
    - Three wells exceed the proposed MCL for PFOS of 0.4 ng/L
    - 2 of the 8 wells exceed the proposed MCL for both PFOA and PFOS
- Three wells exceed the proposed combined Hazard Index calculation for PFBS and PFHxS
- None of the 10 PFAS detected are above the current MDH drinking water guidance values

The nitrate results are summarized below. Two wells were sampled twice in different years and the results were averaged.

- 58 (60 percent) of the 97 wells had nitrate detected above the laboratory reporting level of 0.05 milligrams per liter (mg/L)
- 33 (34 percent) of the 97 wells exceeded the drinking water guideline of 10 mg/L
- 30.5 mg/L was the highest nitrate concentration found in a well
- Nitrate was significantly correlated to the distance to a known biosolid application site: the closer to a biosolid application site, the more likely a well sample is to have nitrate detected
- Nitrate in wells was significantly, positively correlated to the levels of six of the most detected PFAS compounds in the well: the higher the nitrate levels the higher the PFAS levels

Levels of PFBA, PFOA, and nitrate were significantly different in the unconsolidated sediment and Prairie du Chien aquifers than in the Jordan aquifer. Related, the levels of PFBA, PFOA, and nitrate in shallow and medium depth wells were significantly different than in deeper wells. Levels of contaminants in general were lower in deep, Jordan aquifer wells.

Based on the private well sampling results, County staff have the following recommendations:

1. All private well owners in the County near known detections of PFAS or known biosolid application sites should treat their drinking and cooking water with a system that has been found to be effective at reducing PFAS in water. These systems include under-sink dual-stage carbon filters, two carbon filters (faucet-mounted, in-line or pitcher), or reverse osmosis systems. Look for products certified to NSF/ANSI 53 (for filters) or NSF/ANSI 58 (reverse osmosis).
2. The Minnesota Pollution Control Agency (MPCA) has announced a new blueprint to address PFAS. The report can be found on their website at https://www.pca.state.mn.us/air-water-land-climate/minnesotas-pfas-blueprint. The MPCA should sample drinking water wells near identified sources of PFAS in the County; downgradient from biosolid application sites and downgradient from the

Dakhue Closed Landfill located in Hampton Township. Data on the Dakhue Closed Landfill can be found in the Evaluation of Emerging Contaminant Data at Solid Waste Facilities report prepared for the MPCA at [https://www.pca.state.mn.us/sites/default/files/Evaluation-of-Emerging-Contaminant-Data-at-Solid-Waste-Facilities_02132020.pdf (state.mn.us)](https://www.pca.state.mn.us/sites/default/files/Evaluation-of-Emerging-Contaminant-Data-at-Solid-Waste-Facilities_02132020.pdf)

3. The MPCA should evaluate whether WWTP biosolids, a source of PFAS and nitrate, should be prohibited from land application in the Minnesota Department of Agriculture (MDA) designated Vulnerable Groundwater Areas where the fall application of nitrogen fertilizer is restricted (Figure 11). Land application of biosolids occurs in the fall after harvest.
4. Metropolitan Council Environmental Service (MCES) should implement source control and treatment for PFAS at the SKB Landfill to reduce the PFAS load to the Empire wastewater treatment plant (WWTP) where the current treatment process does not reduce the PFAS that ends up in biosolids applied to fields in Dakota County.

Acronyms and Abbreviations

mg/L	Milligrams per liter, equivalent to parts per million
µg/L	Micrograms per liter, equivalent to parts per billion
ng/L	Nanograms per liter, equivalent to parts per trillion
Ambient Study	Dakota County Ambient Groundwater Quality Study
DNR	Minnesota Department of Natural Resources
EPA	Environmental Protection Agency
FOSA	Perfluorooctane sulfonamide
GenX	Hexafluoropropylene oxide dimer acid (HFPO-DA)
MCL	Maximum Contaminant Level
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
PFBA	Perfluorobutanoate
PFBS	Perfluorobutane sulfonate
PFCs	Perfluorochemicals
PFAS	Per- and Polyfluoroalkyl Substances
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoate
PFHxS	Perfluorohexane sulfonate
PFOA	Perfluorooctanoate
PFOS	Perfluorooctane Sulfonate
PFPeA	Perfluoropentanoic Acid
PFPeS	Perfluoropentane sulfonic acid
WWTP	Wastewater treatment plant

Background

The County's project to evaluate PFAS in private drinking water wells, especially related to biosolids land application sites, is aligned with the Groundwater Plan. The 2020-2030 Dakota County Groundwater Plan includes Strategies 1C, "Prevent pollution by minimizing wastewater impacts on groundwater quality" and 1D, "Monitor groundwater quality to develop, implement, and evaluate strategies for reducing groundwater contamination in the county."

Per- and Polyfluoroalkyl Substances (PFAS)

Per- and polyfluoroalkyl substances, also known as PFAS, PFCs, "3M," or forever chemicals, were introduced in the 1940s for their ability to repel oils, stains, grease, heat, and water in products such as stain-resistant carpet and fabrics (Scotchgard™), nonstick cookware (Teflon™), coatings on some food packaging, fire-fighting foam, and other applications. Over 9,000 different PFAS have been manufactured. 3M has produced PFAS since the 1950s at the 3M Chemolite Plant in Cottage Grove, Minnesota, located north across the Mississippi River from the City of Hastings in Dakota County.

PFAS are referred to as "forever chemicals" because they are stable compounds, resistant to breakdown, and found in soil, surface water, groundwater, air, precipitation, humans, and animals. Scientific studies have found that compounds can accumulate in the human body and have a variety of negative health effects, according to the US Environmental Protection Agency (EPA) (US EPA 3/16/22).

Potential sources of PFAS in Dakota County's surface and groundwater resources are:

- Regulated and unregulated solid waste facilities such as landfills and dumps
- Wastewater Treatment Plant (WWTP) effluent and sewage sludge (biosolids) applied to agricultural field
- Household and consumer products including medications, personal care products, cleansers, and laundry rinse water discharged into septic systems or municipal wastewater
- Commercial and industrial products and waste streams
- Large scale compost sites
- Aerial deposition down-wind from 3M Chemolite Plant in Cottage Grove
- Aqueous firefighting foam

Ambient Groundwater Quality Study

In 2018 and 2019, a total of 62 private drinking water wells in Dakota County were sampled for PFAS as part of the Ambient Study (Demuth, V. September 2020). Eight different PFAS chemicals were detected; PFBA was the most frequently detected compound, found in 79 percent of the tested wells. The Minnesota Department of Health (MDH) established drinking water guidelines for 5 of the 8 PFAS chemicals detected, and none of the well results exceeded the MDH Guidance Values (MDH 12/23/22). More wells had detections with PFBA, and higher concentrations in the wells, in the northeast and east areas of the County. The Ambient Study report recommended the evaluation of land application of sewage sludge and other biosolids on County groundwater quality.

Dakota County Private Well Sampling for PFAS

Samples were collected from 25 private drinking water wells in 2020, and 10 additional wells in 2022. Well locations selected were in close proximity and downgradient from known biosolid application sites (based on information supplied by the Metropolitan Council Environmental Services. Weck Laboratories, Inc. analyzed the samples for PFAS, and Minnesota Valley Testing Laboratory (MVTL) analyzed the samples for nitrate, chloride, sulfate, manganese, and a list of heavy metals that Metropolitan Council Environmental Services (MCES) tests biosolids. Each participating well owner gave permission in advance for their well to be tested and received copies of their well results, along with an explanation and recommendations for water treatment options, if warranted.

Statistical Methods

Nonparametric statistical analysis was performed by County staff on the data to determine significance; this is to determine if the level of a contaminant in a well water sample is not likely due to chance. The result obtained is a probability value (p), which is the probability of observing a difference in the data if no difference exists. In this report, a p of 0.05 or less is considered significant, which means the probability that this result would occur by chance is less than 5 percent of the time.

PFAS Summary

PFAS Results

The PFAS results from 97 wells are summarized below. Two wells were sampled twice in different years and the results were averaged. Currently, the EPA has proposed MCLs for PFOA and PFOS and a combined Hazard Index calculation for four PFAS (PFBS, PFHxS, GenX and PFNA).

Summary of PFAS results:

- Up to 32 different PFAS were analyzed and 10 different PFAS were detected
- Three wells had eight different PFAS detected
- PFBA was the most detected PFAS, found in 79 wells (81 percent)
- Eight (8 percent) wells exceed the EPA draft MCLs
  - Seven wells exceed the proposed MCL for PFOA of 0.4 ng/L (nanograms per liter, equivalent to parts per trillion)
  - Three wells exceed the proposed MCL for PFOS of 0.4 ng/L
  - 2 of the 8 wells exceed the proposed MCL for both PFOA and PFOS
- Three wells exceed the proposed combined Hazard Index calculation for PFBS and PFHxS; PFNA and GenX were not detected.
- None of the 10 PFAS detected are above the current Minnesota Department of Health (MDH) drinking water guidance values (MDH 12/23/22)

The PFAS detections are summarized in Table 1. All PFAS results are presented in Appendix B Table 1.

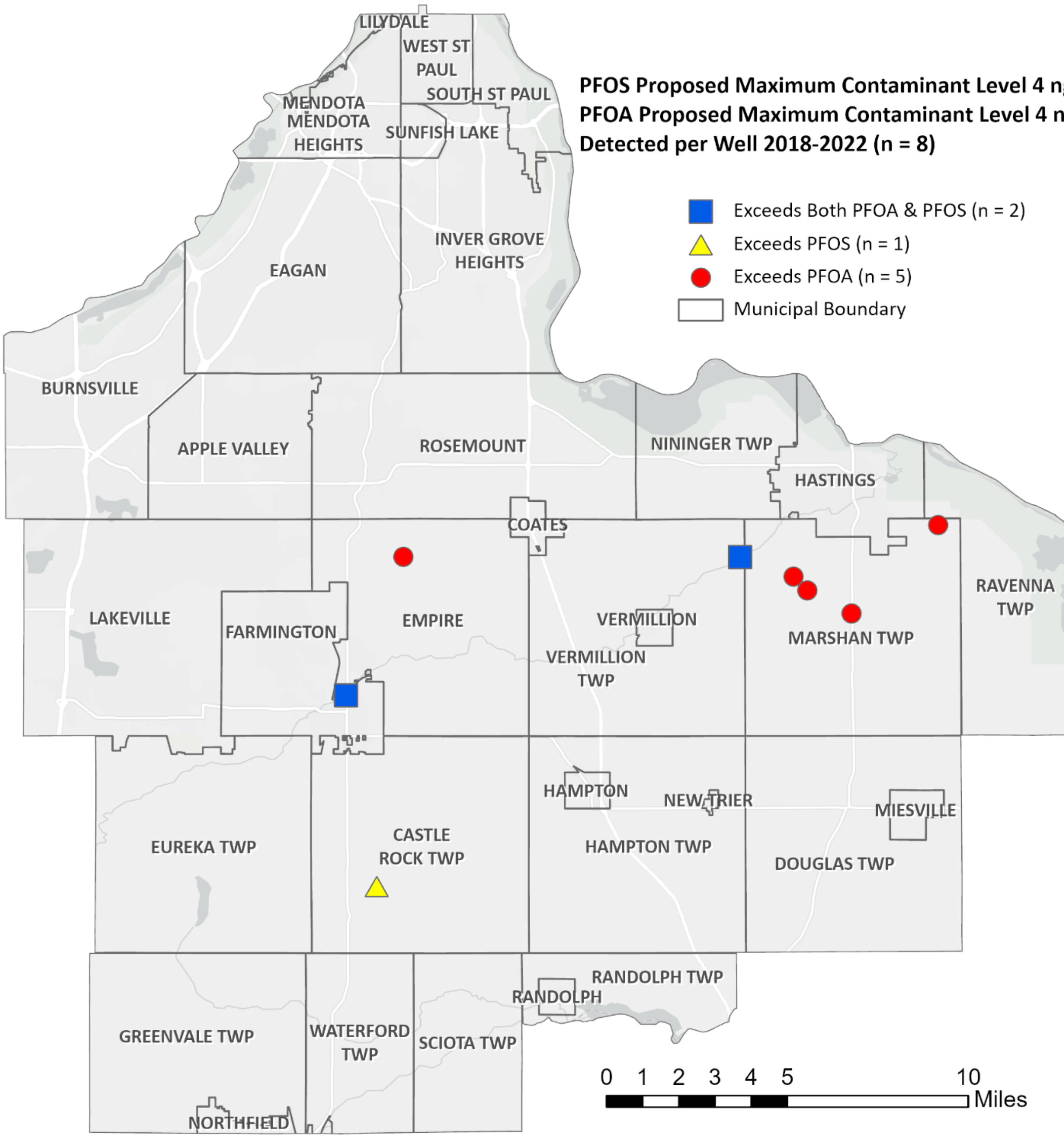
Table 1: Summary of PFAS Detections, 2018-2022

PFAS Detected	# of Drinking Water Wells Sampled	# of Wells with Detections	Minimum (ng/L)	Median (ng/L)	Maximum (ng/L)	MDH Drinking Water Guidance Value (ng/L)
PFBA (Perfluorobutanoate)	97	79	< 1.0	47	410	7000
PFPeA (Perfluoropentanoic Acid)	97	43	< 1.0	< 1.0	96	None Established
PFOA (Perfluorooctanoate)	97	27	< 1.0	< 1.0	20	35*
PFHxS (Perfluorohexane sulfonate)	97	25	< 1.0	< 1.0	21	47
PFHxA (Perfluorohexanoate)	97	24	< 2.0	< 2.0	78	200
PFBS (Perfluorobutane sulfonate)	97	17	< 1.0	< 1.0	21	100
PFHpA (Perfluoroheptanoic acid)	97	12	< 4.0	< 4.0	41	None Established
PFOS (Perfluorooctane Sulfonate)	97	6	< 2.0	< 2.0	4.7	15**
PFPeS (Perfluoropentane sulfonic acid)	52^	5	< 1.0	< 1.0	9.5	None Established
FOSA (Perfluorooctane sulfonamide)	52^	3	< 1.0	< 1.0	1.3	None Established

* EPA Proposed Maximum Contaminant Level for PFOA 4.0 ng/L announced 3/14/23
** EPA Proposed Maximum Contaminant Level for PFOS 4.0 ng/L announced 3/14/23
^There are 52 samples instead of 97 for PFPeS and FOSA because the list of analytes in the 2018 sample event was shorter than in subsequent years.

Seven private wells tested for PFOA, the main compound in Teflon™, exceed the EPA proposed MCL and three of the wells exceed the proposed MCL for PFOS, the key ingredient in Scotchgard™; two of these wells exceed for both PFOA and PFOS. PFOA and PFOS were the most widely used and are the most studied of PFAS. In recent years PFOA and PFOS have been replaced with other chemicals. The 2023 proposed MCLs consider new science and lifetime exposure that could result in negative health effects from levels close to zero. The known wells that exceed the proposed MCLs are depicted in Figure 1.

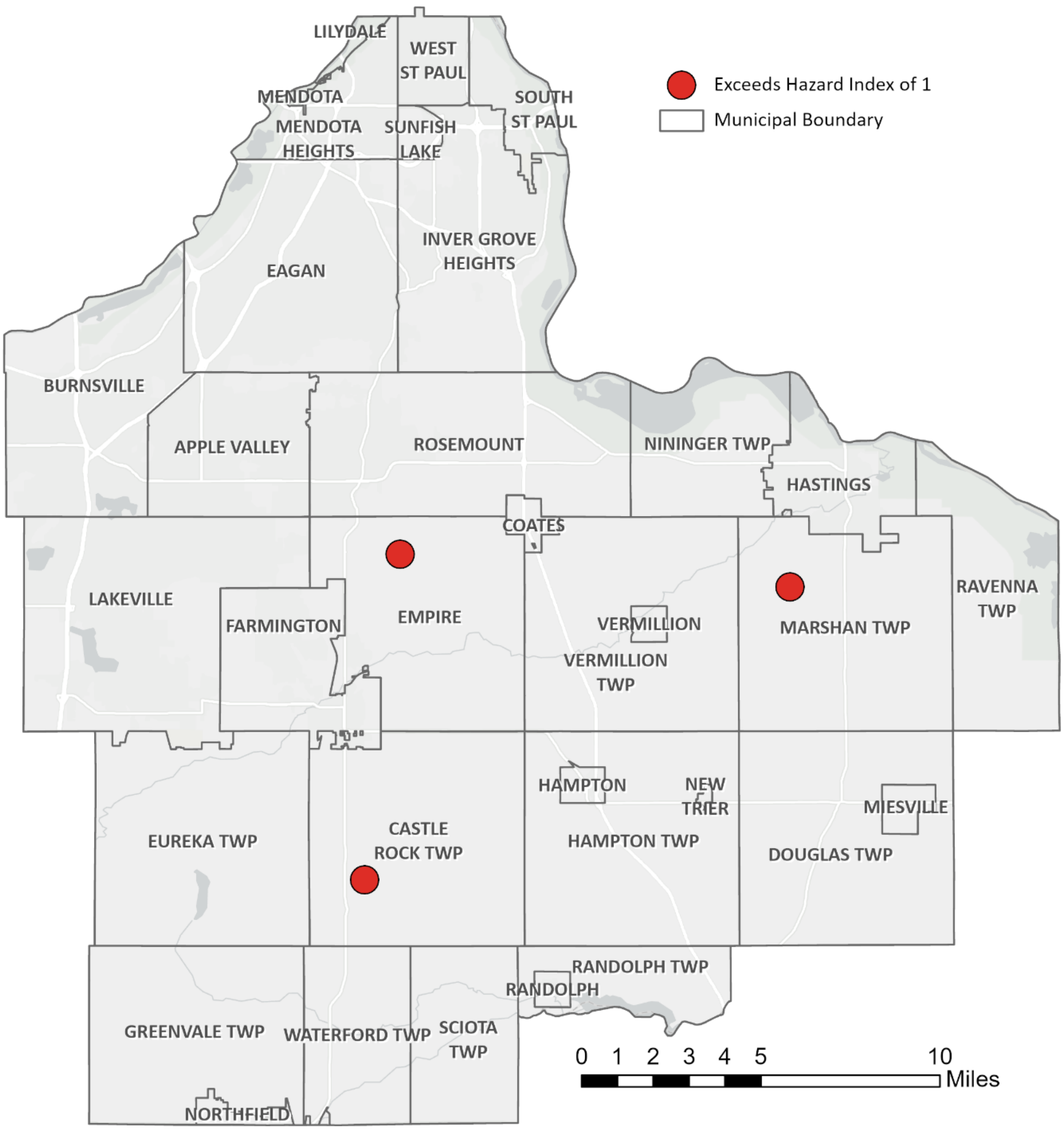
Figure 1. Location of Wells that Exceed the Proposed MCL for PFOS and PFOA



Source: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources

The three wells, depicted in Figure 2, exceed the combined Hazard Index calculation the EPA has proposed for the combined results for PFBS, PFHxS, GenX and PFNA; neither GenX nor PFNA were detected. Two of the three wells exceed PFOA of 4 ng/L, one exceeds 4 ng/L for PFOS.

Figure 2. Location of Wells that Exceed the Proposed Combined Hazard Index calculation for PFBS and PFHxS



Source: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources

PFAS and Biosolid Land Application Sites

Applications to land and agricultural fields in the County have been occurring for more than 150 years, beginning with the spreading of livestock manure. Sludge from both industrial and municipal wastewater treatment plants (WWTPs) located inside and outside of the County have been applied to land in the County for over 70 years. None of the treatment technologies at these WWTPs reduce or destroy PFAS. There is no complete set of records regarding the amount, type, and location of materials that have historically been applied to the land surface. Biosolids are solids generated by the wastewater treatment process and that are treated to produce a product called biosolids. Sludge or biosolids are not required to be tested for PFAS in Minnesota; other states are beginning to require this.

Figure 3 shows known locations of land application of biosolids that has occurred in the County. Many more biosolid application sites are suspected than included in Figure 3; however, documentation of other sites was not available at the time of this report's publication. The "Metro WWTP Biosolid Application Sites" on the map are where material from the Metro WWTP (former Pig's Eye WWTP located in St. Paul, Minnesota), operated by the Metropolitan Council Environmental Services (MCES), was applied. This treatment plant receives leachate from the Pine Bend Landfill, located in Dakota County, where the 3M Chemolite Cottage Grove Plant disposes of their WWTP pond sludges. "The PFCs in the Pine Bend Landfill leachate represent about 10 percent of the total PFC mass load to the MCES wastewater treatment plant." (Oliaei et al., 2005, p.45).

The "Other WWTP Biosolid Application Sites" on the map are mostly sites where biosolids from the MCES Empire Plant, located in Empire Township, were applied. The EPA requires MCES, as a condition of their permit, to discharge from eight WWTPs, a local limits evaluation every five years to "determine if the present local limits are adequate for the protection of the plants, their processes, sludge handling and discharges." (Rogacki et al., 1/28/2020). The SKB Landfill located in Rosemount is a known industrial PFAS discharger to the Empire WWTP. The 2020, sampling for 13 PFAS by MCES found that, "SKB was a significant source of PFAS loadings to Empire." (Smith et al., 10/13/2021 p. 8). The SKB Landfill represents about 1 percent of the influent to the plant and found to represent: 51 percent of PFOS, 88 percent of PFOA, 67 percent of PFBA, 81 percent of PFBS and 65 percent of PFHxS.

There are currently no limits set by the Minnesota Pollution Control Agency (MPCA) for PFAS in WWTP effluent that is discharged. The Empire and Hastings WWTPs discharge to the Mississippi River, the Seneca WWTP in Eagan discharges to the Minnesota River. The Hampton WWTP discharges the effluent into a ditch that connects to the South Branch of the Vermillion River. The Hampton WWTP produces very little biosolids, none have been land applied in the last 15 years (email correspondence with Mr. Bienfang with Bolton and Menk, Hampton's engineering firm). The City of Vermillion's WWTP discharges to the Vermillion River. In addition, there are no EPA approved laboratory methods for testing for PFAS in WWTP effluent or sludge/biosolids. The MCES published a factsheet regarding PFAS in biosolids, see Appendix C.

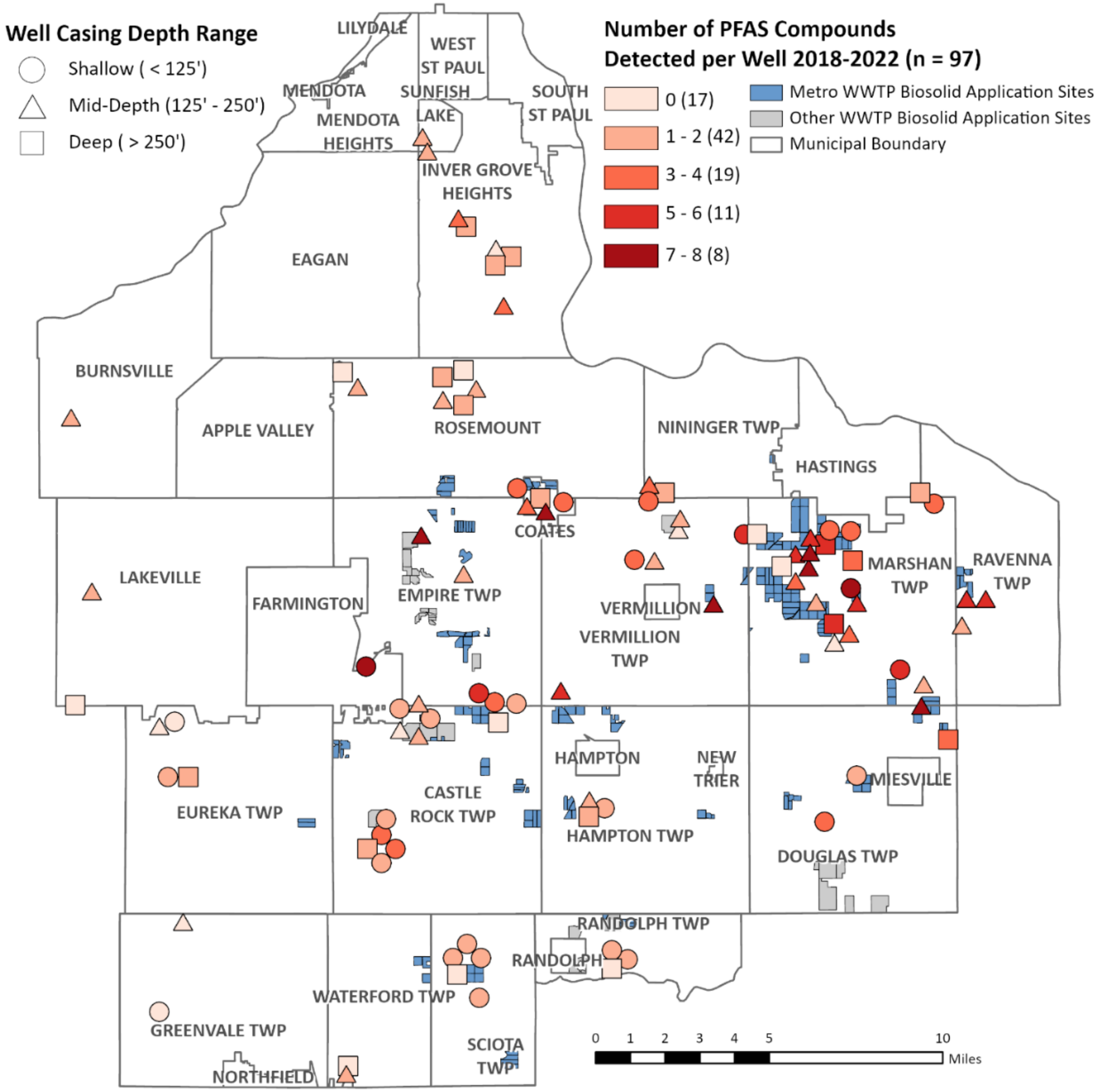
All wells in the study had well casing that was composed of either plastic or steel. Well casing is the pipe that extends from the ground surface into an aquifer. The wells sampled were put into one of three well casing depth categories (the same categories used in the Ambient Study) as summarized in Table 2.

Table 2: Well Casing Depth Categories

Well Casing Category	Depth Range in Feet Below Ground Surface	Number of Wells per Category
Shallow	Less than 125 feet	32
Medium	Between 125 and 250 feet	41
Deep	Deeper than 250 feet	24

Construction well records could not be located for all wells that were sampled because they were drilled before 1975 (after which regulations required that records be submitted to the State of Minnesota). The aquifer and the depth of the well casing for wells without a construction record were estimated for this study based on the age of the well, the underlying geology, and the construction of neighboring wells. Figure 3 depicts the wells in the study by casing depth category and the number of PFAS compounds detected.

Figure 3: Number of PFAS Compounds Detected by Well Casing Depth Category & Known Biosolid Application Sites



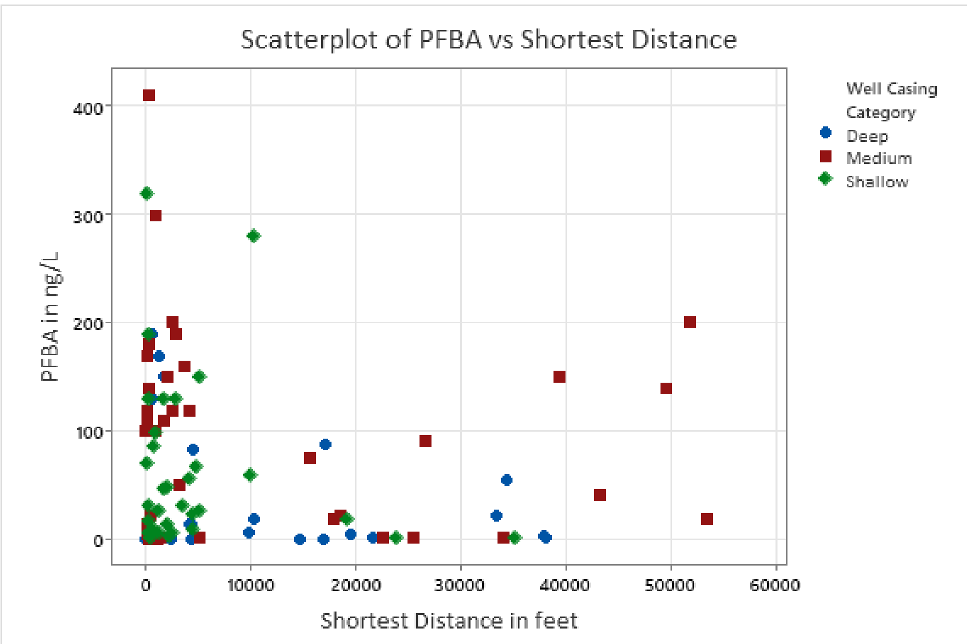
Sources: , Dakota County Environmental Resources

All PFAS results, plus nitrate, were compared to the shortest distance from a well to a known and mapped biosolid application site depicted in Figure 3. The correlations between the distance to a known biosolid application site and the concentrations of PFBA, PFPeA, PFHxS, and nitrate in the well were found to be significant ($p<0.05$, Kendall). PFBA, PFPeA and PFHxS levels are highest in wells closest to known biosolid application sites. The PFBA results by casing depth category versus shortest distance to known biosolid application sites are depicted in Figure 4. Wells far from biosolid application sites have PFBA, the most commonly detected PFAS and are located in non-agricultural areas of the County. Nitrate is discussed in more detail below.

Table 3: Summary of Significance of Contaminant Concentration to Shortest Distance to a Known Biosolid Application Site ($p < 0.05$, Kendall)

Nitrate	PFBA	PFPeA	PFOA	PFHxS	PFHxA	PFBS	PFHpA	PFOS	PFPeS	FOSA
Significant	Significant	Significant	Not	Significant	Not	Not	Not	Not	Not	Not

Figure 4: Scatterplot of PFBA Concentration vs Distance to Known Biosolid Application Site



A buffer of 500, 1,000 and 5,000 feet was placed around all the known and mapped biosolid application sites depicted in Figure 3. The PFBA, PFOA, and nitrate results were compared using the Mann-Whitney non-parametric test to see if the median contaminant levels in the wells within the buffer had statistically significant differences from the median levels in the wells outside of the buffer. PFBA and nitrate were analyzed because they were two of the most detected parameters and PFOA was analyzed because there are samples that exceeded the proposed MCLs. The PFBA results are summarized in Table 4, PFOA is summarized in Table 5 and the nitrate results are summarized in Table 6, in the nitrate results section.

Table 4: Statistical Significance of PFBA in well compared to distance from a biosolid application site ($p < 0.05$, Mann-Whitney)

Parameter PFBA	Less than 500 feet to a known biosolid application	Less than 1000 feet to a known biosolid application	Less than 5000 feet to a known biosolid application
over 500 feet to known biosolid application	Not Significant	--	--
over 1000 feet to known biosolid application	--	Significant	--
over 5000 feet to known biosolid application	--	--	Significant

Table 5: Statistical Significance of PFOA in a well compared to distance from a biosolid application site ($p < 0.05$, Mann-Whitney)

Parameter PFOA	Less than 500 feet to a known biosolid application	Less than 1000 feet to a known biosolid application	Less than 5000 feet to a known biosolid application
over 500 feet to known biosolid application	Significant	--	--
over 1000 feet to known biosolid application	--	Significant	--
over 5000 feet to known biosolid application	--	--	Significant

Maps of all 10 PFAS detected are in Appendix A.

Well owners who want to treat their drinking water to reduce PFAS can install a point of use system such as, an under-sink dual-stage carbon filters, two carbon filters (faucet-mounted, in-line or pitcher), or reverse osmosis systems. Look for products certified to NSF/ANSI 53 (for filters) or NSF/ANSI 58 (reverse osmosis).

Nitrate Summary

Nitrate Results

Synthetic nitrogen fertilizers are applied to agricultural fields to replenish nutrients in the soil, the nitrogen converts to nitrate, which is highly mobile in soil and can readily leach into groundwater. Other sources of nitrate can be septic systems, manure, feedlots, land application of municipal WWTP biosolids, and turf fertilizer. In Dakota County, agricultural nitrogen fertilizers are the suspected predominant source of elevated nitrate in groundwater. Concentrations of nitrate are higher in the drinking water aquifers where the predominant land use is row crop agriculture and replicated studies by Dakota County and the Minnesota

Department of Agriculture (MDA) have found consistent correlations between nitrate concentrations in groundwater and the presence of herbicides that are used for row crops. However, every private well that was sampled did have a septic system, which is a source of nitrate, in use, on the property. The nitrate results summarized in Table 6 and are depicted in Figure 5. Appendix B Table 2 contains all the nitrate results by well. Reverse osmosis systems and anion exchange are two water treatment options to reduce nitrate. A reverse osmosis system that meets NSF/ANSI 58 standard is recommended.

Summary of nitrate results:

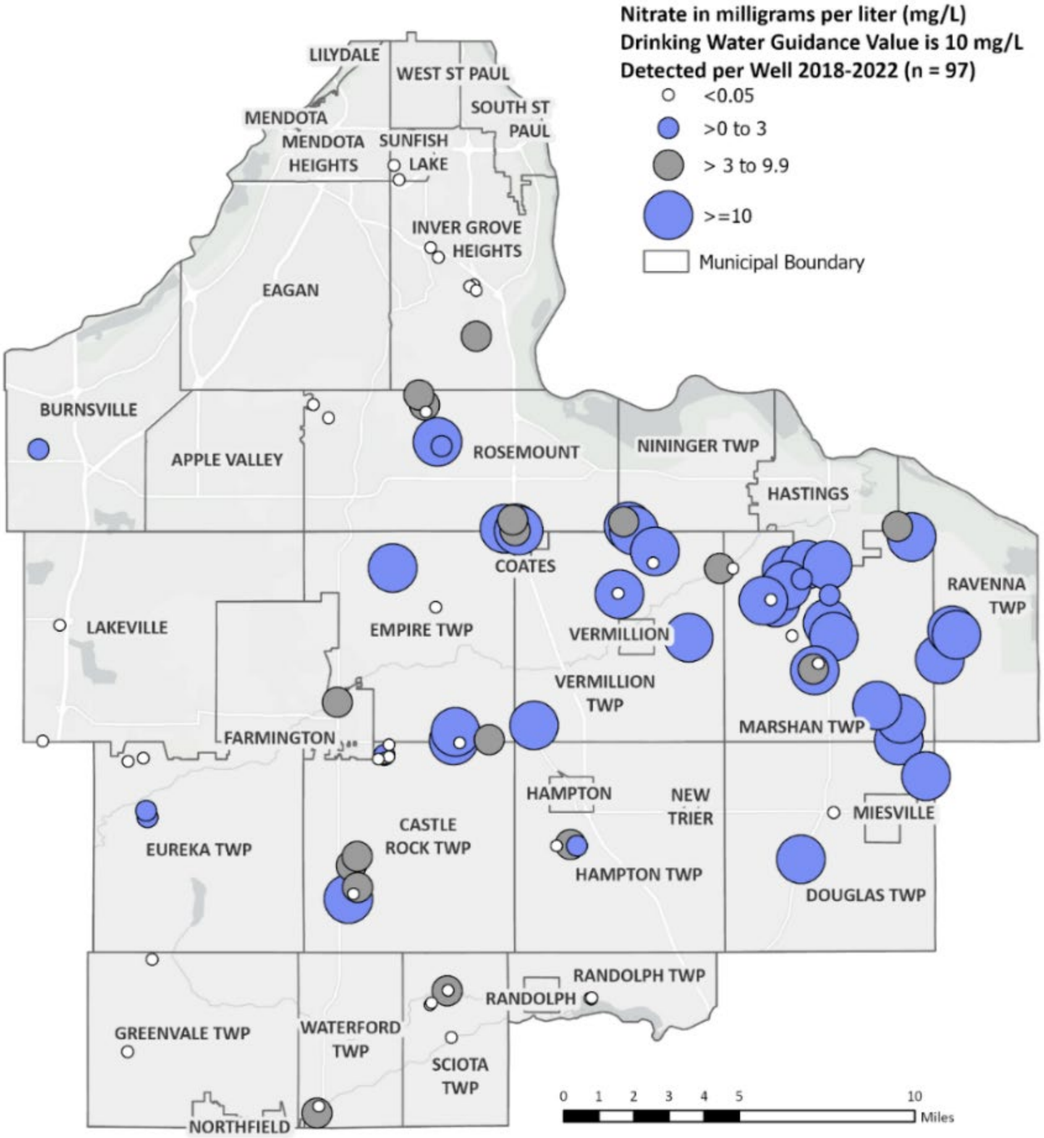
- 58 (60 percent) of the 97 wells had nitrate detected above the laboratory reporting level of 0.05 milligrams per liter (mg/L)
- 33 (34 percent) of the 97 wells exceeded the drinking water guideline of 10 mg/L
- 30.5 mg/L was the highest nitrate concentration detected in a well

Table 6: Nitrate Results Summary

Parameter	# of Drinking Water Wells Sampled	# of Wells with Detections	Minimum (mg/L)	Median (mg/L)	Maximum (mg/L)	MDH Drinking Water Guidance Value (mg/L)
Nitrate	97	58	< 0.05	3.9	30.5	10

As evident on the map below, the highest nitrate results are in the rural/agricultural areas of the County.

Figure 5: Map of Nitrate Results

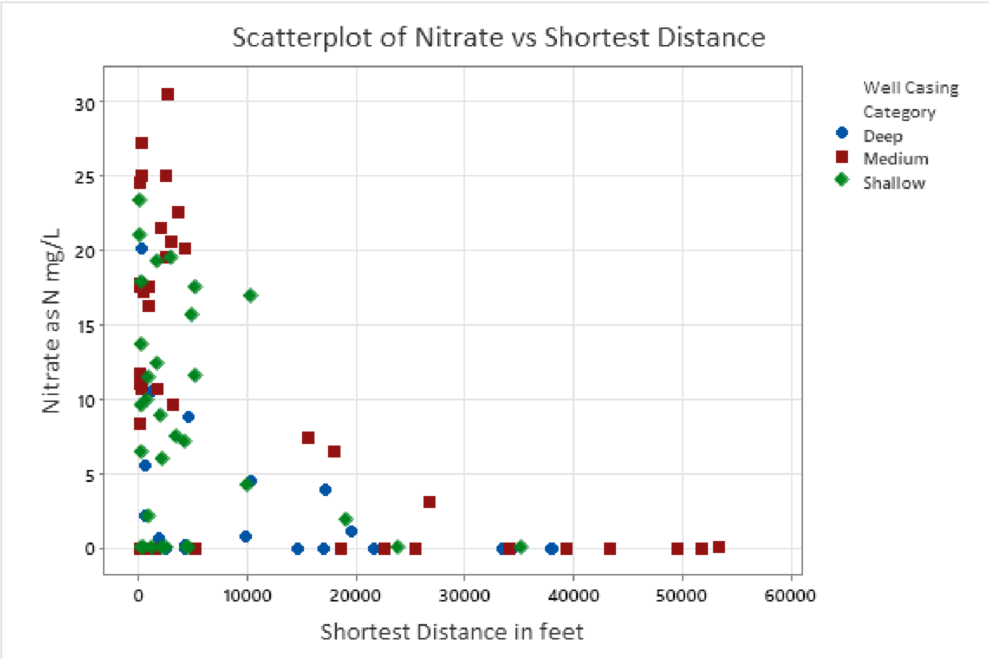


Sources: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Services

Nitrate and Biosolids Application Sites

Nitrate levels are highest in wells closest to known biosolid application sites. Nitrate results were compared to the shortest distance from a well to a known biosolid application sites mapped in Figure 3 and is significant ($p<0.05$, Kendall). The nitrate results by casing depth category versus shortest distance to known biosolid application sites are graphed in Figure 6. Wells furthest away from biosolid application sites have no nitrate and are in non-agricultural areas of the County.

Figure 6: Scatterplot of Nitrate versus Shortest Distance to Known Biosolid Application Site



Wells closer to biosolid sites have statistically significant different median nitrate levels compared to wells further from a biosolid site as summarized in Table 7 and the median nitrate levels are also higher closer versus farther.

Table 7: Statistical Significance of Nitrate in a well compared to distance from known a biosolid application site ($p < 0.05$, Mann-Whitney)

Parameter Nitrate	Less than 500 feet to a known biosolid application	Less than 1000 feet to a known biosolid application	Less than 5000 feet to a known biosolid application
over 500 feet to known biosolid application	Significant	--	--
over 1000 feet to known biosolid application	--	Significant	--
over 5000 feet to known biosolid application	--	--	Significant

Nitrate and PFAS levels were correlated to each other. Nitrate levels were compared to number of PFAS detects per well using the Kendall statistical test, and to all 10 PFAS detected are summarized in Table 8 below. Six of the most detected PFAS compounds had statistically significant (<0.05 Kendall), positive correlations with nitrate, which means as nitrate levels increases so do PFAS levels. The PFAS with the lowest number of detections, PFHpA, PFOS, PFPeS and FOSA, were not statistically significantly correlated to nitrate.

Table 8: Significance of Nitrate Levels Compared to PFAS Results ($p < 0.05$, Kendall)

	# of PFAS Detects	PFBA	PFPeA	PFOA	PFHxS	PFHxA	PFBS	PFHpA	PFOS	PFPeS	FOSA
Nitrate	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Not	Not	Not	Not

PFAS and Nitrate by Aquifer and Well Casing Depth

Levels of PFBA, PFOA, and nitrate were significantly higher in the unconsolidated sediment and Prairie du Chien aquifer than in the Jordan aquifer. Related, the levels of PFBA, PFOA, and nitrate were significantly higher in shallower wells than in deeper wells.

The water quality data were compared to the aquifer and casing depth. All wells sampled draw water from one of the three most commonly used aquifers in the County which are: (1) the unconsolidated aquifer --wells that are screened in the sand or gravel; (2) the Prairie du Chien aquifer -- wells are finished in the dolostone which is similar to limestone and is often cavernous and fractured so that contaminants can travel quickly through it; and (3) the Jordan aquifer -- these wells are typically finished below the Prairie du Chien except for where the Prairie du Chien has been removed by erosion which occurs in old stream or river valleys that have since been filled with unconsolidated sediment.

A cross-section of the typical geology in the County and a simplified path for contaminated groundwater to reach a drinking water well is illustrated in Figure 7.

Figure 7: Conceptual Cross-Section of Geology and Contaminant Path-Line

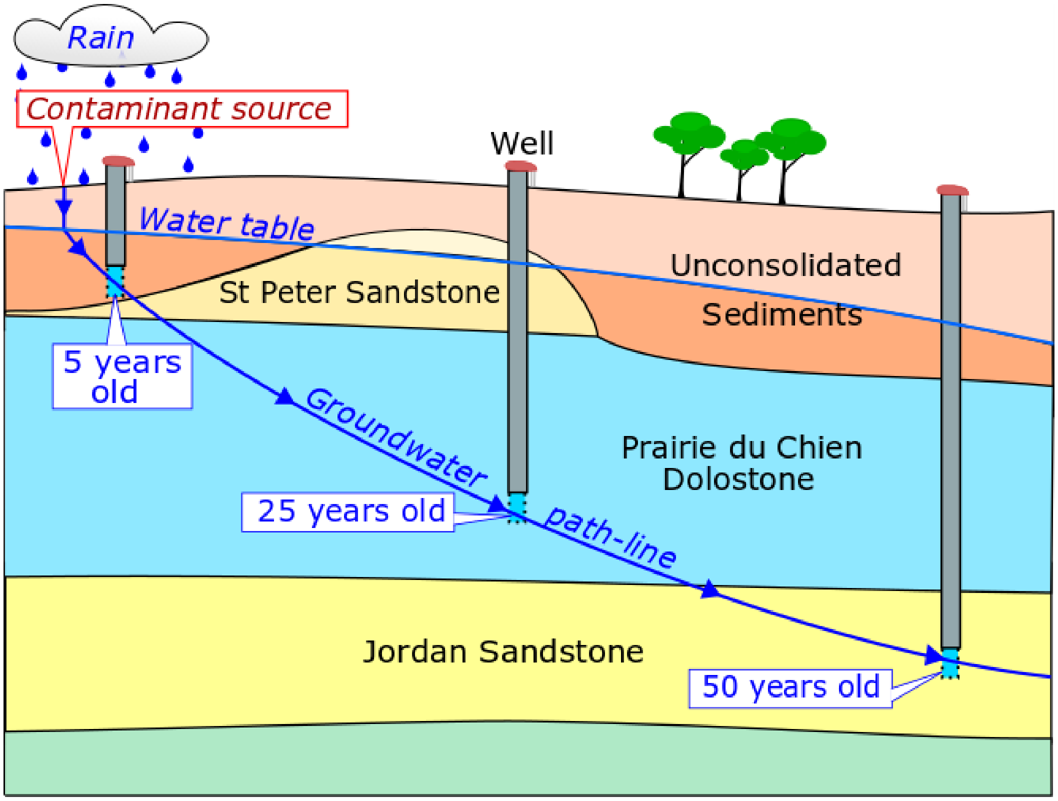


Table 9 summarizes the statistical significance or no significance of the median PFBA, PFOA, and nitrate results in the three aquifers, using the Mann-Whitney statistical test. There is no statistically significant difference in the amount of PFBA, PFOA, and nitrate in wells in the unconsolidated sediments and wells in the Prairie du Chien. This means their degree of contamination is basically the same; they are the shallowest aquifers in general and are more vulnerable to contamination than the Jordan aquifer. PFBA, PFOA, and nitrate were all found to be significantly different when comparing wells in the Unconsolidated to the Jordan and Prairie du Chien to the Jordan. In general, wells in the Jordan are deeper and the level of contamination is lower than the other two aquifers.

Table 9: Statistical Differences of PFBA, PFOA, and Nitrate Between Aquifers ($p < 0.05$, Mann-Whitney)

PFBA, PFOA & Nitrate	Unconsolidated Sediments	Prairie du Chien well	Jordan well
Unconsolidated Sediments-screened well	--	Not Significant	Significant
Prairie du Chien well	Not Significant	--	Significant
Jordan well	Significant	Significant	--

Figure 8 depicts the PFBA and nitrate concentrations by well casing depth category. There are 24 wells in the deep well casing category; statistically, the deep wells have lower nitrate and PFBA than the 41 wells in the medium well category and the 32 wells in the shallow well casing category.

Figure 8: Nitrate vs PFBA by Well Casing Depth Category ($p < 0.05$)

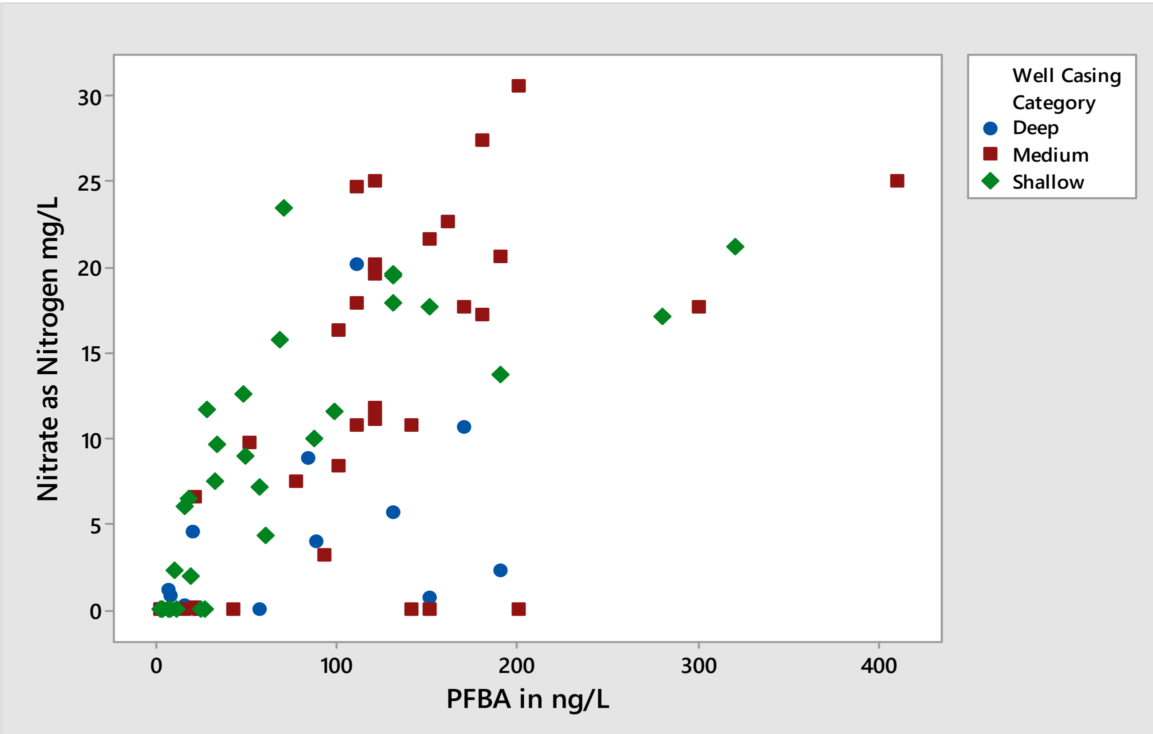


Table 10 summarizes the median PFBA, PFOA and nitrate statistical significance or no significance when compared to the casing depth category of the well. The significance determination is the same when PFBA, PFOA and nitrate was compared to aquifer in Table 9 above, this is likely due to the wells in the unconsolidated sediments and Prairie du Chien are mostly in the shallow or medium depth casing category.

Table 10: Statistical Differences of PFBA, PFOA, and Nitrate Between Well Casing Depth Categories ($p < 0.05$, Mann-Whitney)

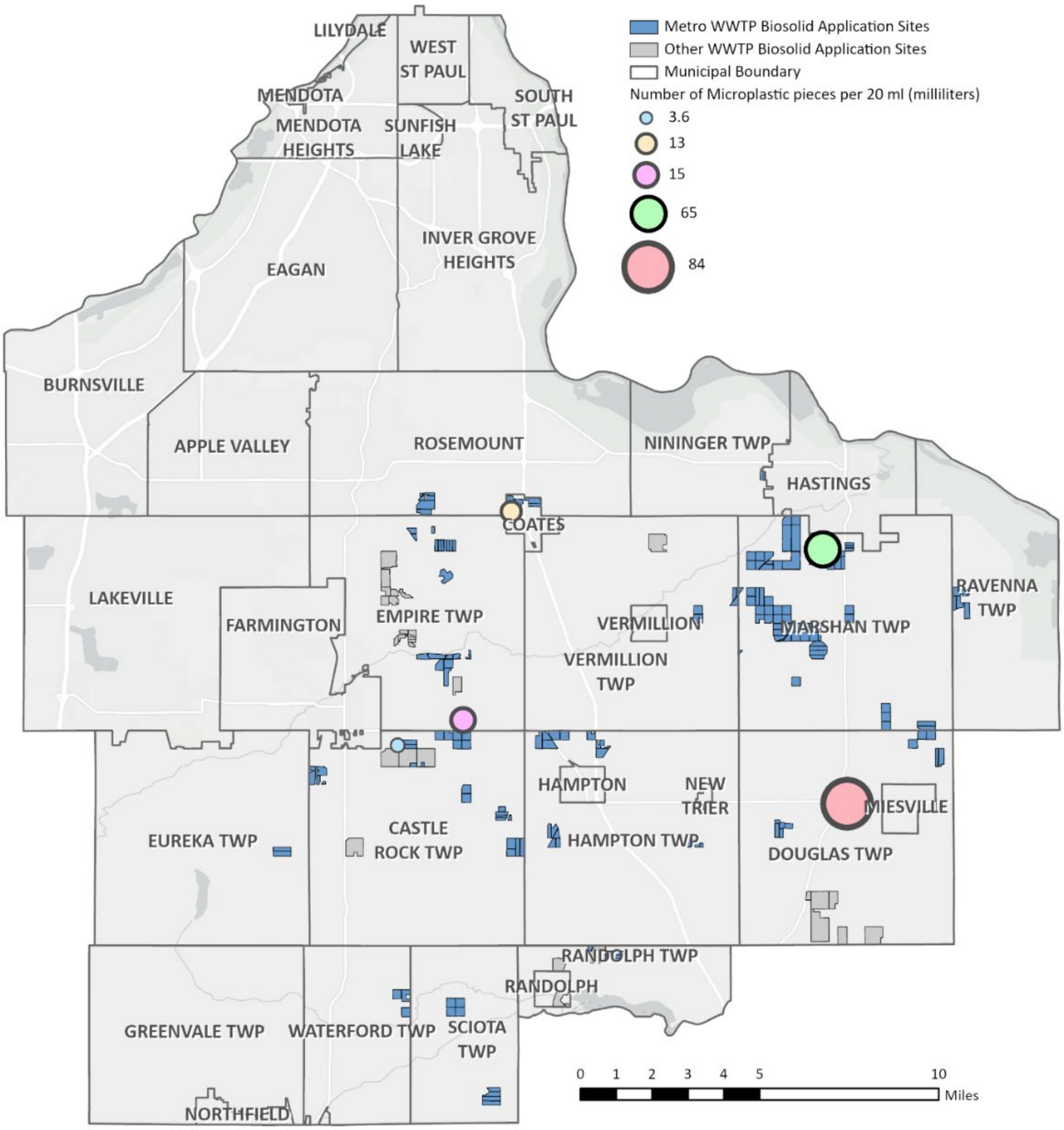
PFBA, PFOA & Nitrate	Shallow Casing Category Less than 125 feet	Medium Casing Category Between 125 to 250 feet	Deep Casing Category Greater than 250 feet
Shallow	--	Not Significant	Significant
Medium	Not Significant	--	Significant
Deep	Significant	Significant	--

Microplastic Summary

Microplastics are plastic pieces that range in size from 0.1 1 micrometers (µm) to 5 millimeters. They are the result of the breakdown or degradation of plastic use in our everyday life. Microplastics are found in our seafood, municipal/city water, bottled water, salt, beer, milk, air, and in the drinking water of County private well owners. Five of the 25 wells sampled in the 2020 sample event had water samples collected and analyzed for microplastics by Polyhedron Laboratories, Inc.

The location of the wells sampled for microplastics and the count of microplastic particles are mapped in Figure 9.

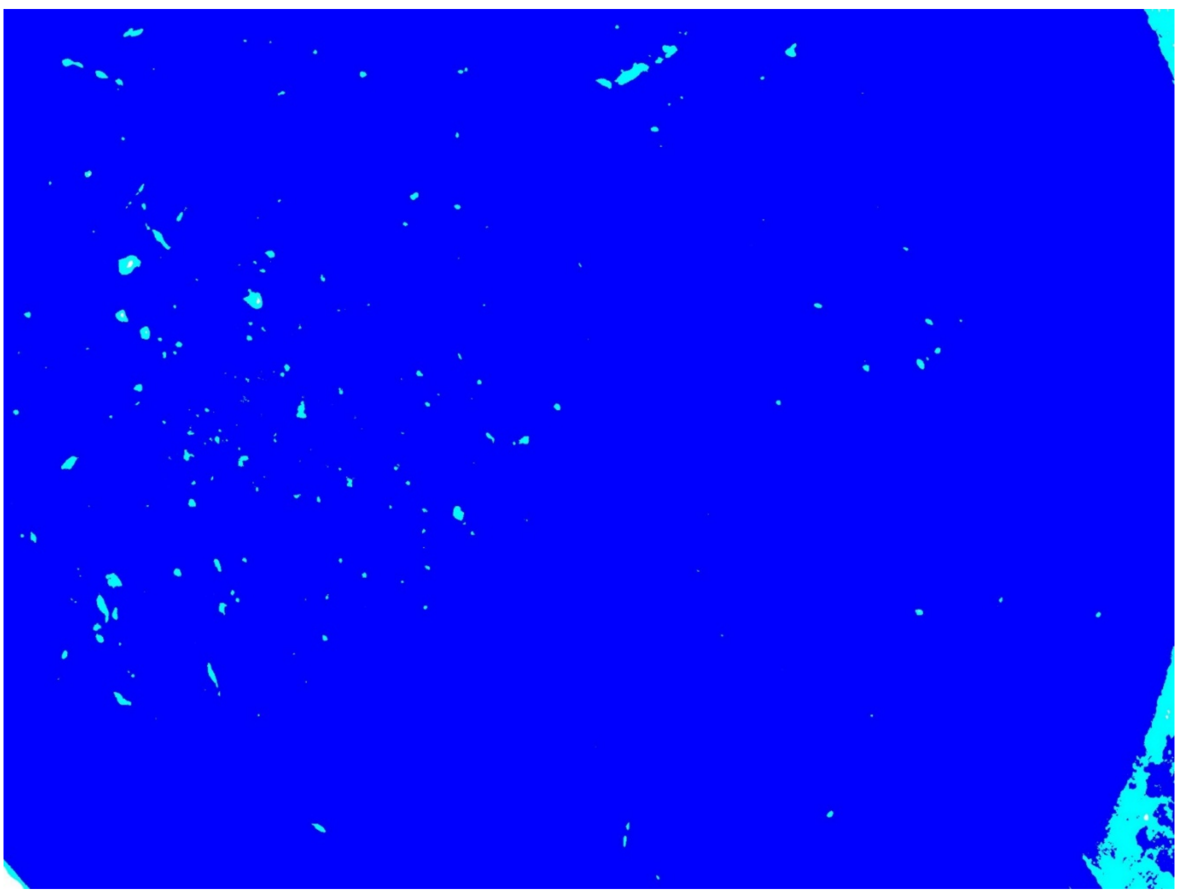
Figure 9: Number of Microplastics per 20 milliliters of Water Sample



Sources: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources

All five water samples that were tested had microplastics detected, ranging from 3 to 84 particles per water sample of 20 milliliters (approximately 4 teaspoons). Particle sizes ranged from 1.58 µm to 189.8 µm. Drinking water quality can affect health and it is suspected that microplastics in drinking water can be a potential health risk. Currently, there are no drinking water guidance values for microplastics. State and federal agencies are researching this. Determination of a health advisory for microplastics is challenging due to the diversity of type, shape, and size of the particles. Contaminants will adsorb differently to different microplastics and may behave differently within organ tissue. Irrigation crops with water containing microplastics is a concern for ingestion by livestock and humans of food contaminated with microplastics. Different water treatment devices have varied outcomes when it comes to reducing microplastics. None of the three agencies that certify water treatment devices has certified any devices for microplastic reduction. Reverse osmosis systems are widely available and consist of two carbon filters and a reverse osmosis membrane which may be the best option for well owners wanting to reduce microplastics from their water. A photographic image for each sample was provided by the lab. Figure 10 is the image from the water sample with the highest number of microplastic particles, 84 microplastics were counted by the lab in a 20 ml water sample.

Figure 10: Image of the 84 Microplastics Visible in Light Blue in a 20 ml Sample



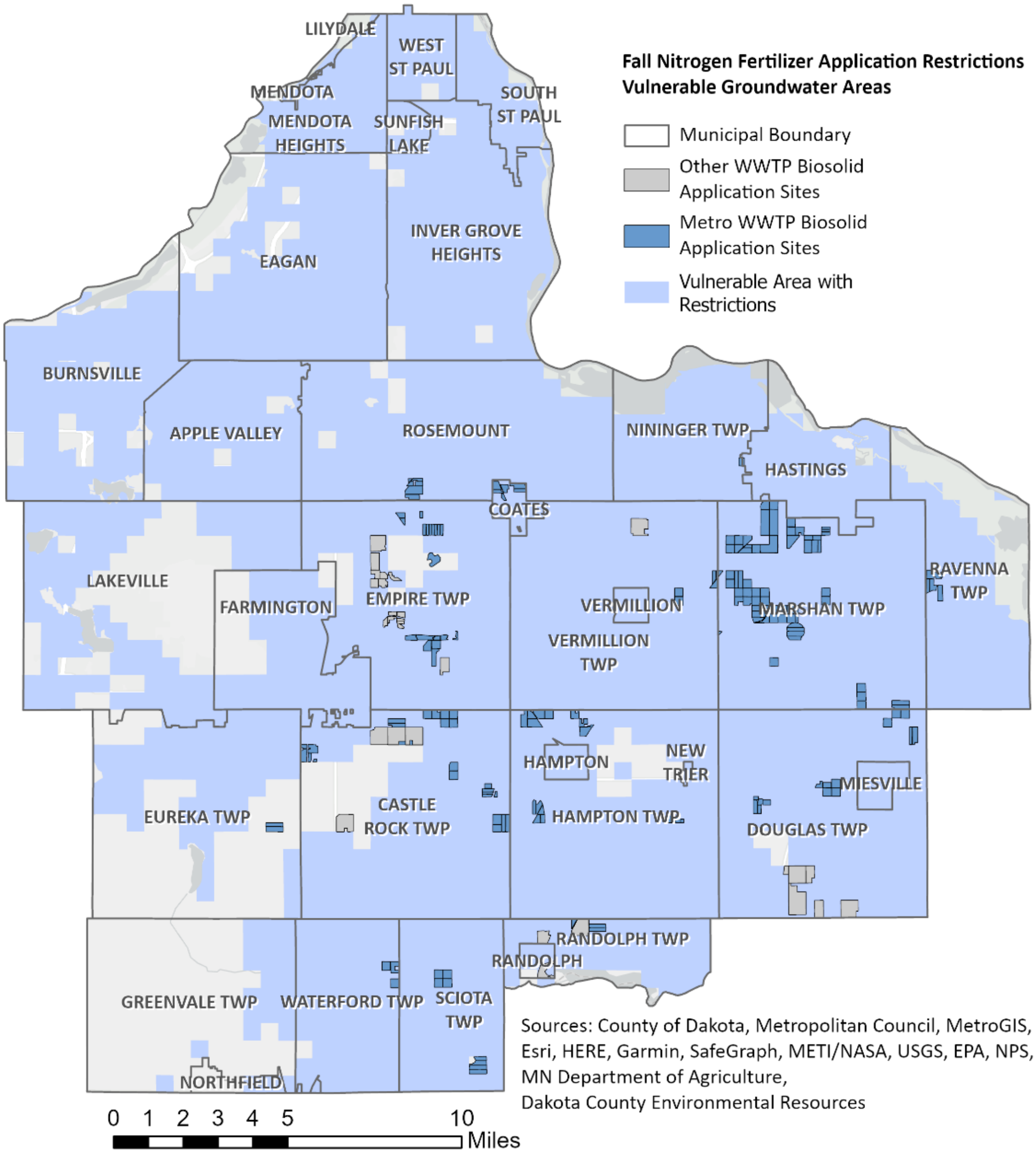
Metals Summary

MVTL analyzed the 35 samples from the 2020 and 2022 sample event for metals that biosolids are currently required to be tested: arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, zinc, with the addition of chloride, manganese, and sulfate. A shorter list of metals was analyzed in the Ambient Study wells from 1999 to 2019. Only manganese was detected above the drinking water guideline of 0.100 mg/L for infants 12 months and younger and 0.300 mg/L for everyone older than 12 months. Arsenic and lead were detected and did not exceed the drinking water guidelines, although no amount of arsenic or lead is considered safe. All the metals results are summarized in Appendix B Table 2.

Vulnerable Groundwater Areas

Most of Dakota County's groundwater is vulnerable to contaminants moving through the soil and bedrock to the groundwater. Over 90 percent of Dakota County residents use groundwater for drinking water either through private wells or municipal public water supplies. MDA has determined that a large portion of Dakota County does not have suitable soils for the application of agricultural fertilizer in the fall months of the year. The areas designated as Vulnerable Groundwater Areas by the MDA are depicted in Figure 11 meet the following criteria as explained on the MDA website (https://www.mda.state.mn.us/part-1-groundwater-protection-rule#Fall%20and%20Frozen%20Soil%20Restriction Accessed 1/31/23). Most of the known biosolid application sites are in a vulnerable area. Land application of biosolids occurs in the fall after harvest according to the Metropolitan Council Environmental Services (MCES) website (https://metrocouncil.org/Wastewater-Water/Services/Wastewater-Treatment/Land-Application-Program.aspx Accessed 12/2/2022).

Figure 11. Vulnerable Groundwater Areas where Fall Application of Fertilizer is Restricted



Sources: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, MN Department of Agriculture, Dakota County Environmental Resources

Recommendations

1. All private well owners in the County near known detections of PFAS or known biosolid application sites should treat their drinking and cooking water with a system that has been found to be effective at reducing PFAS in water. These systems include under-sink dual-stage carbon filters, two carbon filters (faucet-mounted, in-line or pitcher), or reverse osmosis systems. Look for products certified to NSF/ANSI 53 (for filters) or NSF/ANSI 58 (reverse osmosis).
2. The Minnesota Pollution Control Agency (MPCA) has announced a new blueprint to address PFAS. The report can be found on their website at https://www.pca.state.mn.us/air-water-land-climate/minnesotas-pfas-blueprint. The MPCA should sample drinking water wells near identified sources of PFAS in the County; downgradient from biosolid application sites and downgradient from the Dakhue Closed Landfill located in Hampton Township. Data on the Dakhue Closed Landfill can be found in the Evaluation of Emerging Contaminant Data at Solid Waste Facilities report prepared for the MPCA at https://www.pca.state.mn.us/sites/default/files/Evaluation-of-Emerging-Contaminant-Data-at-Solid-Waste-Facilities_02132020.pdf (state.mn.us)
3. The MPCA should evaluate whether Wastewater Treatment Plants (WWTP) biosolids, a source of PFAS and nitrate, should be prohibited from land application in the Minnesota Department of Agriculture (MDA) designated Vulnerable Groundwater Areas where the fall application of nitrogen fertilizer is restricted (Figure 10). Land application of biosolids occurs in the fall after harvest.
4. Metropolitan Council Environmental Service (MCES) should implement source control and treatment for PFAS at the SKB Landfill to reduce the PFAS load to the Empire wastewater treatment plant (WWTP) where the current treatment process does not reduce the PFAS that ends up in biosolids applied to fields in Dakota County.

References

Demuth, V., S. Scott. September 2000. Dakota County. Ambient Groundwater Quality Study 1999-2019. https://www.co.dakota.mn.us/Environment/WaterResources/WellsDrinkingWater/Pages/ambient-groundwater-quality-study.aspx.

Minnesota Department of Health (MDH). 12/23/22. “PFAS and Health”. Accessed 1/30/23. https://www.health.state.mn.us/communities/environment/hazardous/topics/pfashealth.html.

Minnesota Pollution Control Agency (MPCA). No Date. “Minnesota’s PFAS Blueprint/”. Accessed 1/30/23. Minnesota’s PFAS Blueprint | Minnesota Pollution Control Agency (state.mn.us).

Rogacki, L., G. Sprouse. 1/28/2020. Metropolitan Council Environmental Services (MCES). Information Item: Contaminants of Emerging Concern PFAS and Wastewater Treatment https://metrocouncil.org/Council-Meetings/Committees/Environment-Committee/2020/January-28,-2020/Info-Item-PFAS-Presentation.aspx.

Oliaei, F., D. Kriens, K. Kessler. 2006. Investigation of Perfluorochemical (PFC) Contamination in Minnesota Phase One Report to Senate Environment Committee. https://peer.org/wp-content/uploads/attachments/06_27_2_pfc_report.pdf.

Smith, N., T. Nelson, A. Waitros, R. Nordquist, T. Ranta, M. Michaelis. 10/13/21. Metropolitan Council Environmental Services (MCES). Local Limits Evaluation September 2021 (Resubmitted 10/13/21).

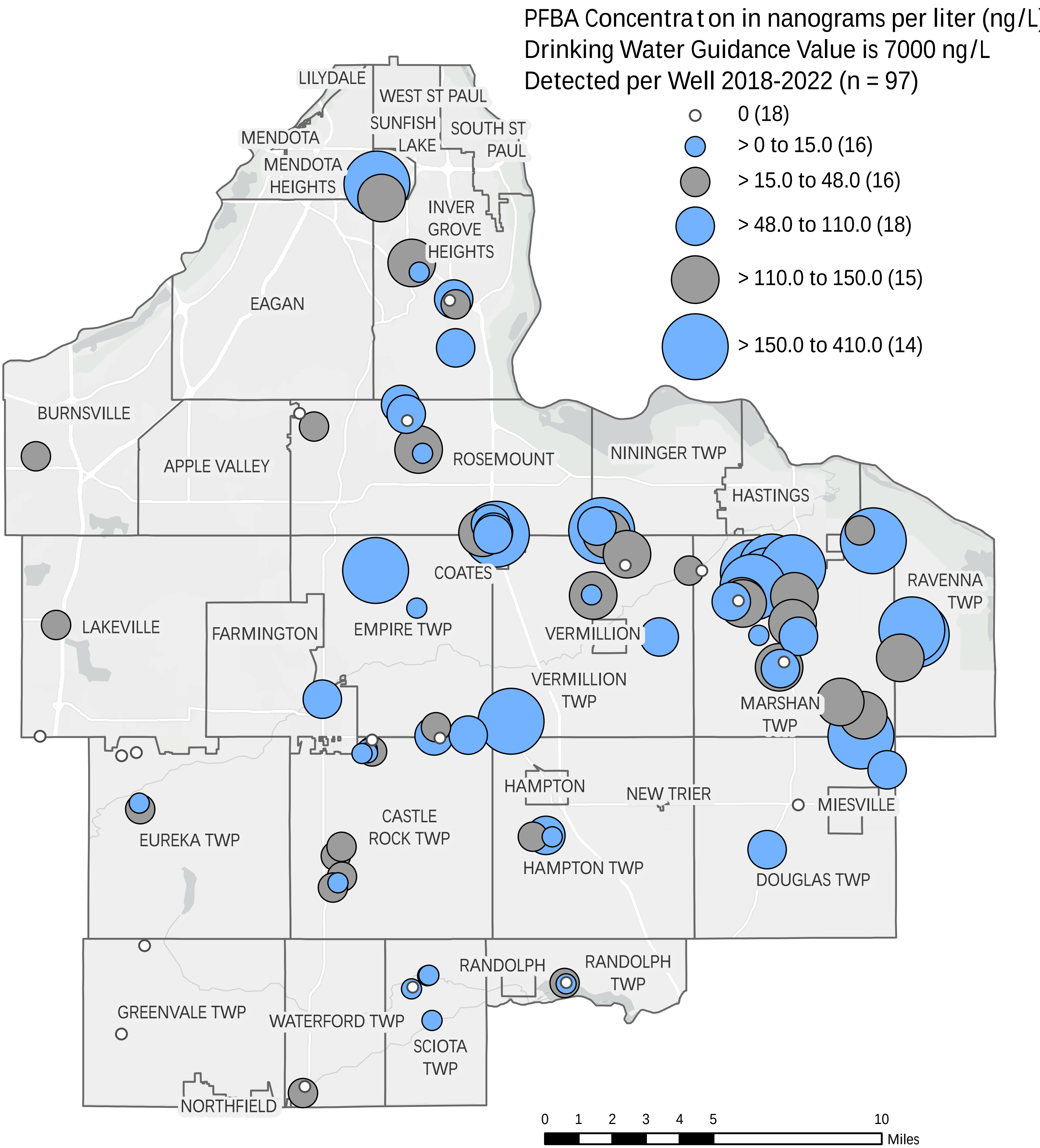
US EPA. 3/16/22. “Our Current Understanding of the Human Health and Environmental Risks of PFAS.” Accessed 1/30/23. https://www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas.

US EPA 3/17/23. “Biden-Harris Administration Proposes First-Ever National Standard to Protect Communities from PFAS in Drinking Water.” Accessed 4/17/23. https://www.epa.gov/newsreleases/biden-harris-administration-proposes-first-ever-national-standard-protect-communities.

Appendices

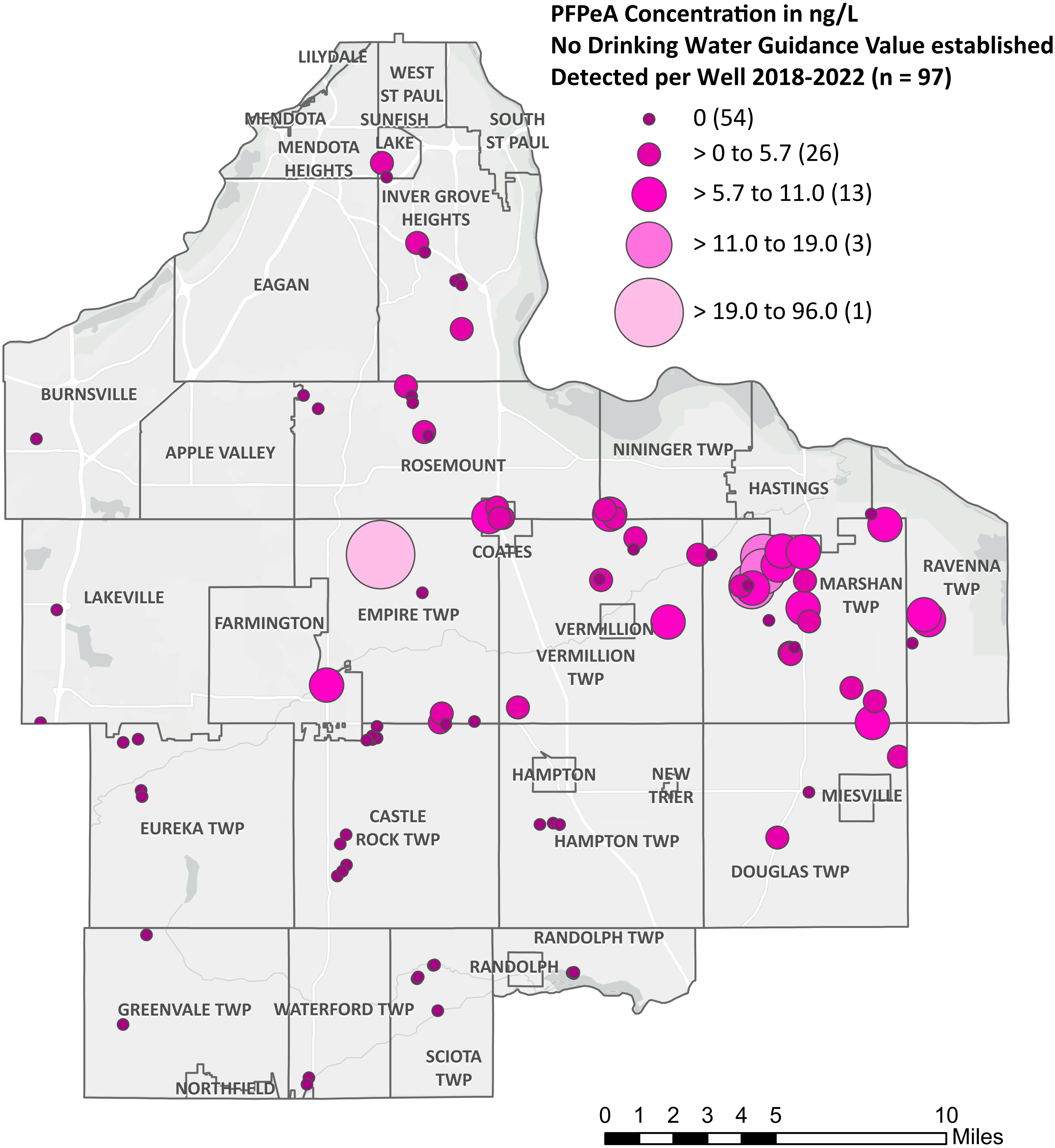
Appendix A – Maps

Map 1. PFBA in Private Drinking Water Wells in Dakota County, MN

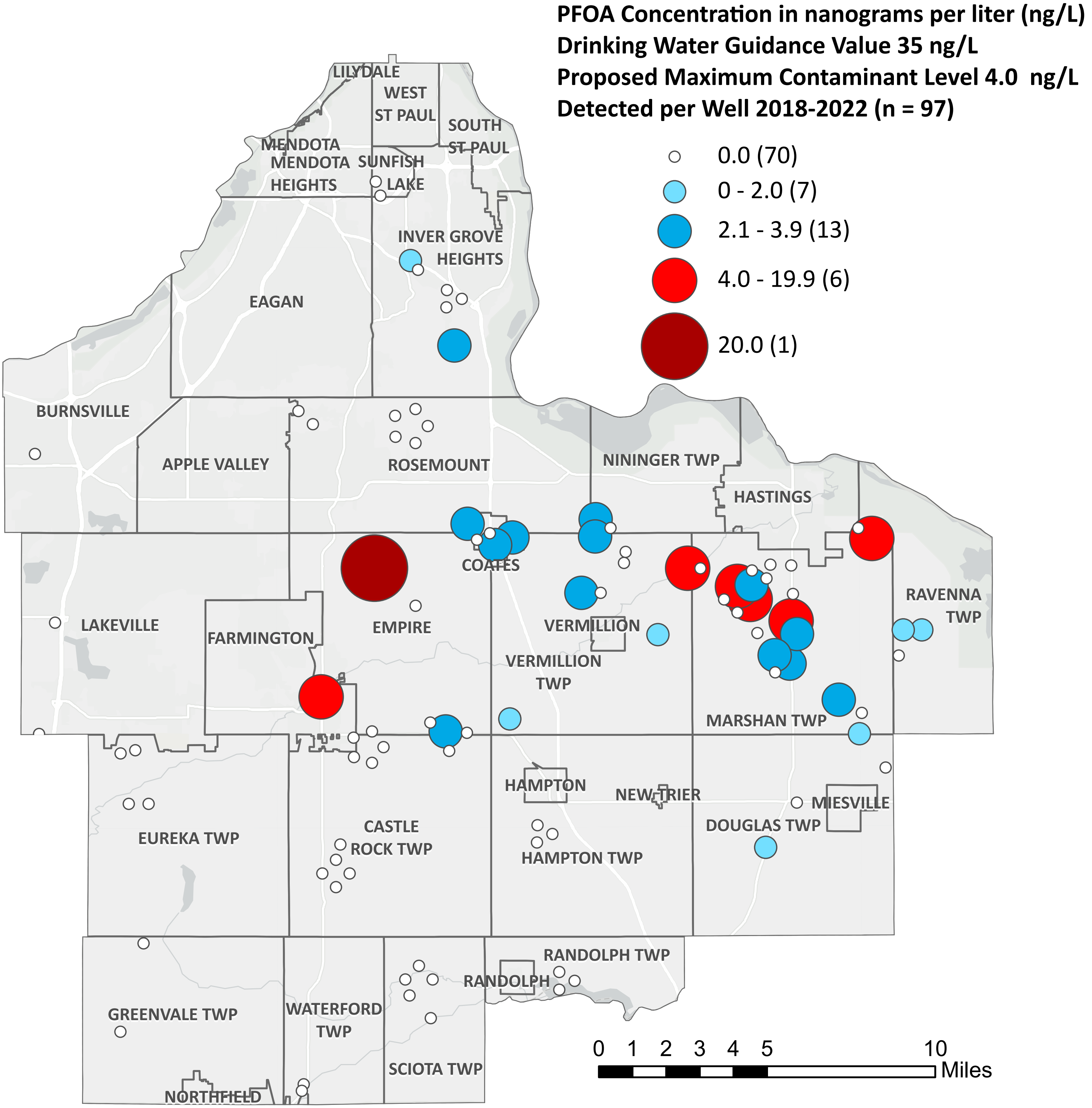


Sources: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources

Map 2. PFPeA in Private Drinking Water Wells in Dakota County, MN

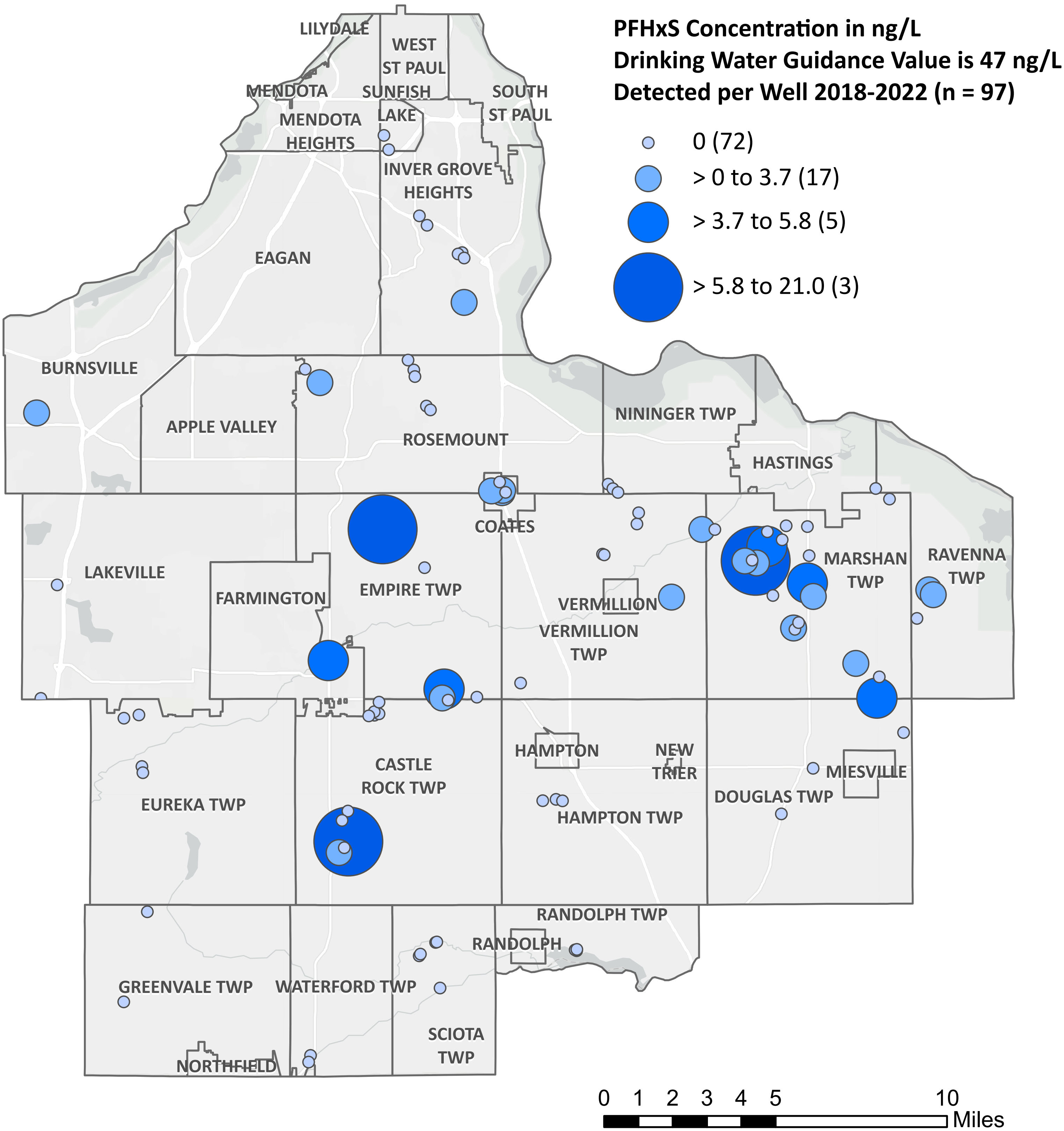


Sources: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources



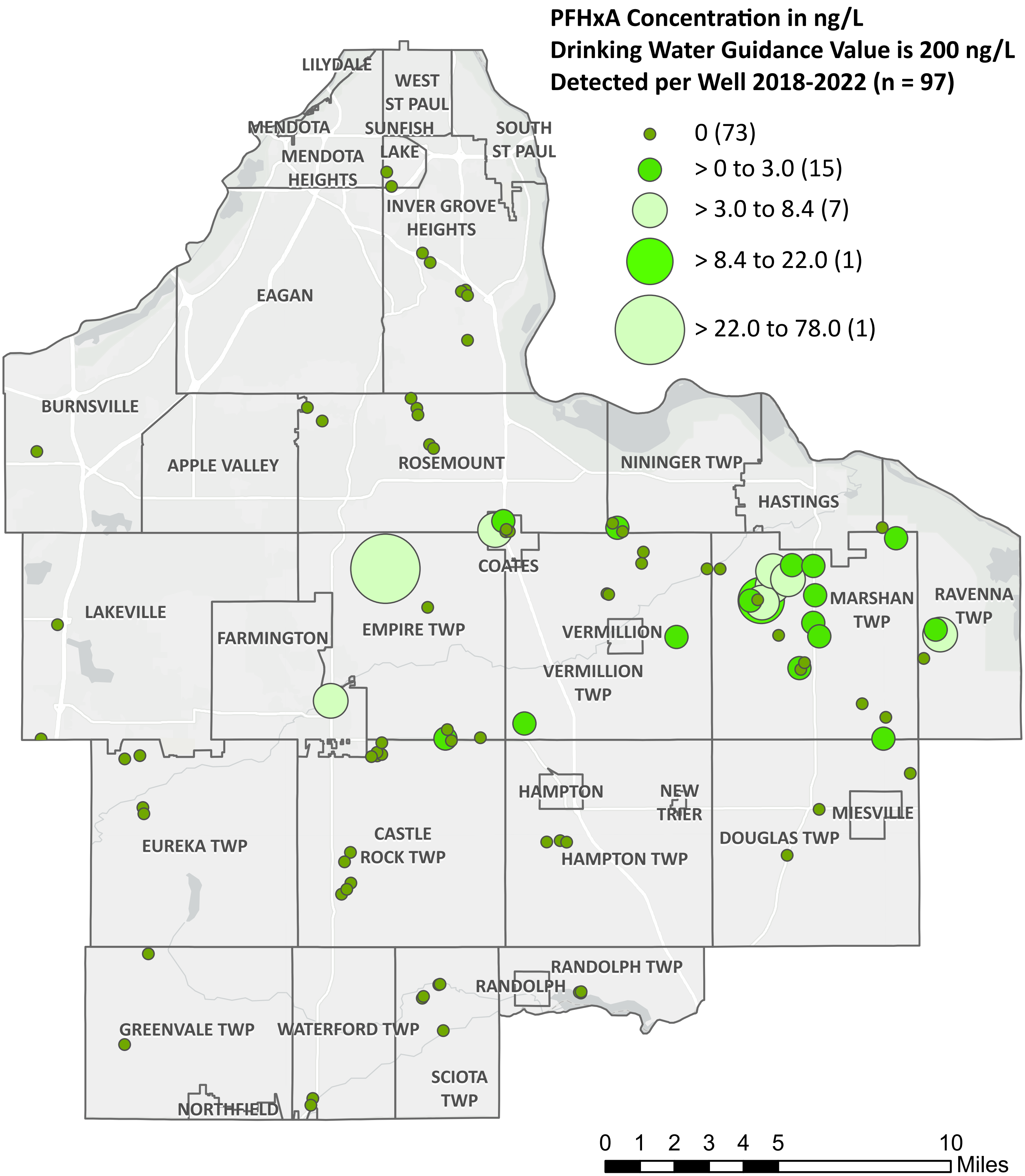
Source: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources

Map 4. PFHxS in Private Drinking Water Wells in Dakota County, MN



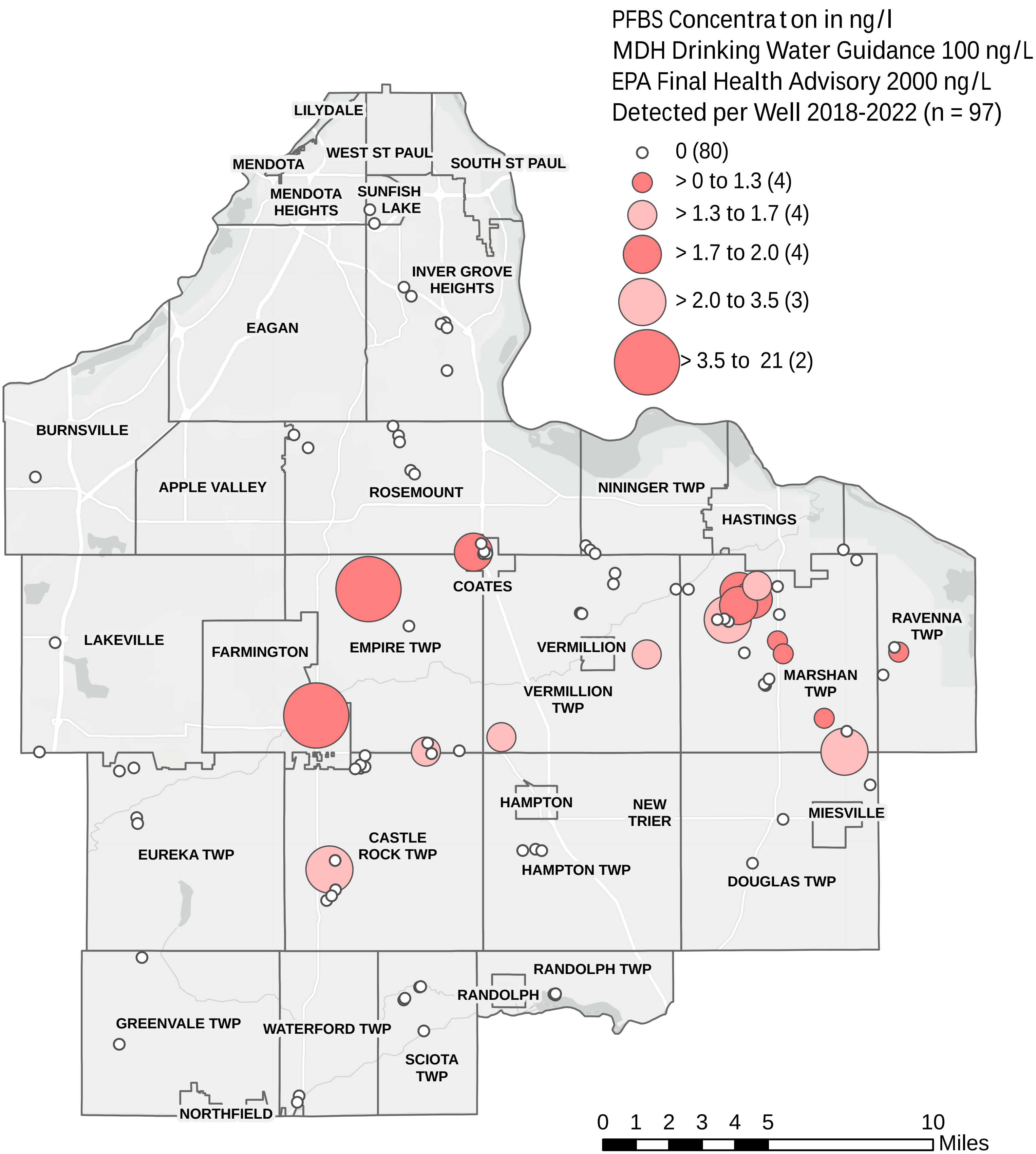
Sources: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources

Map 5. PFHxA in Private Drinking Water Wells in Dakota County, MN



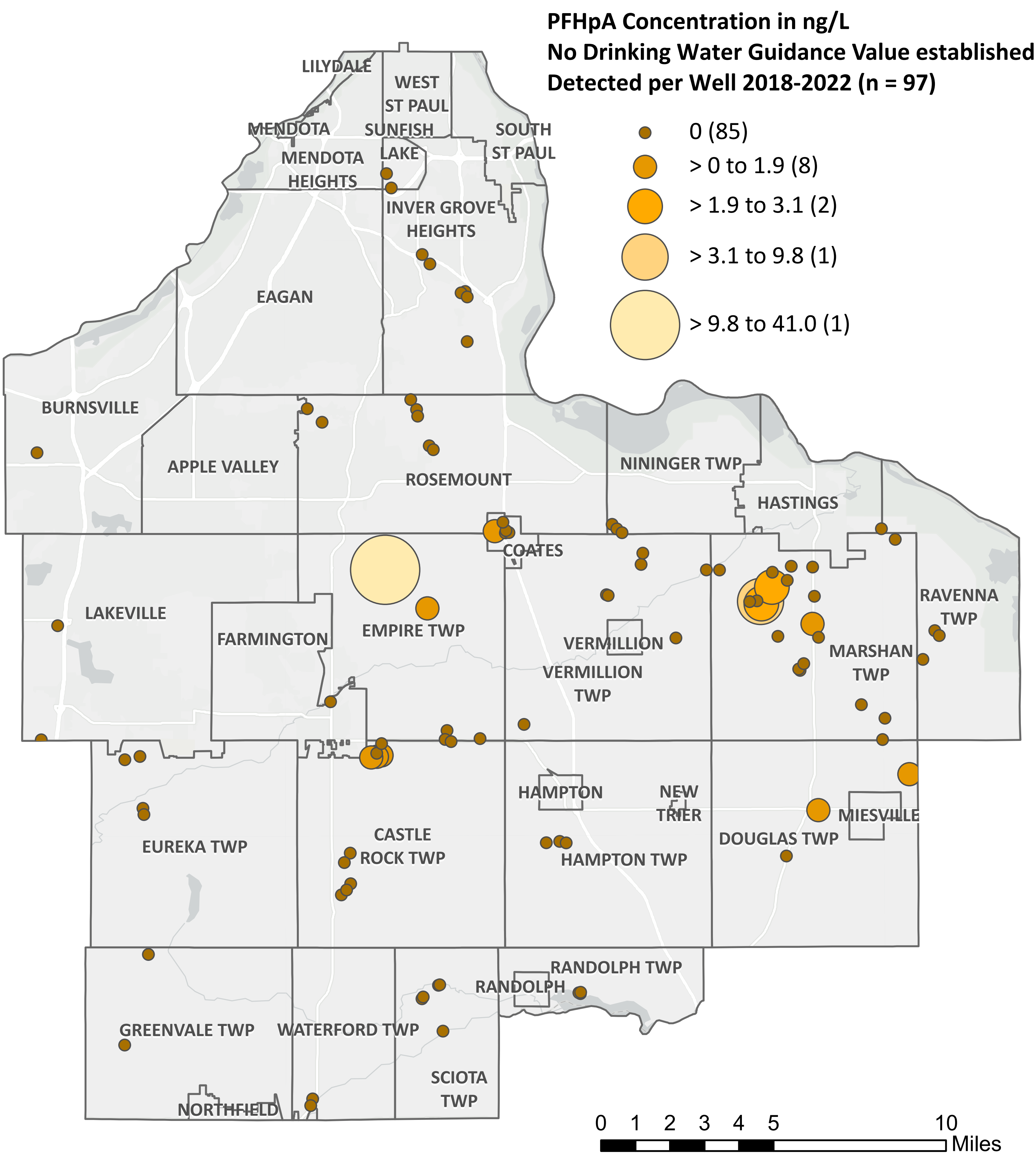
Sources: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources

Map 6. PFBS in Private Drinking Water Wells in Dakota County, MN

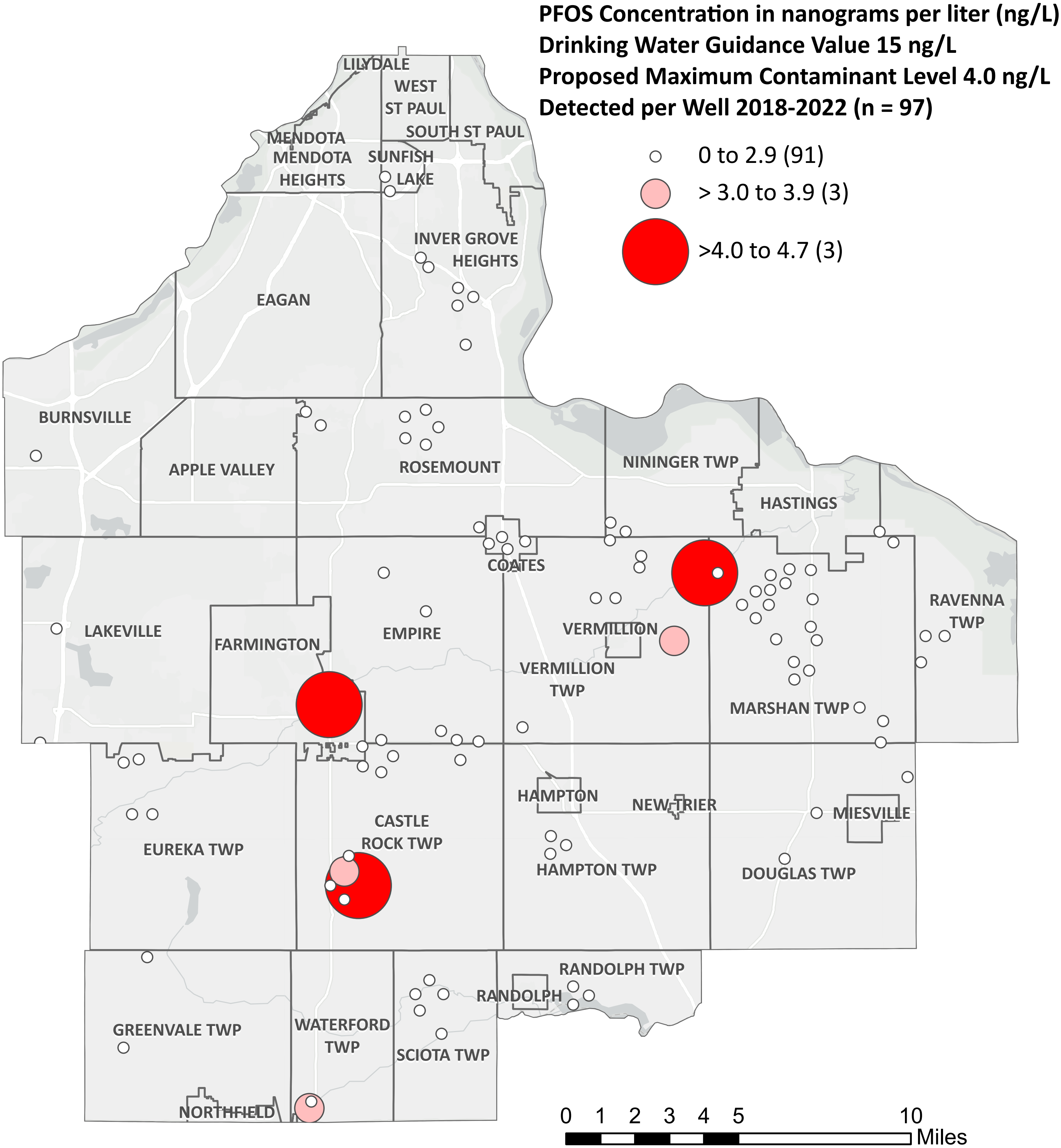


Sources: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources

Map 7. PFHpA in Private Drinking Water Wells in Dakota County, MN

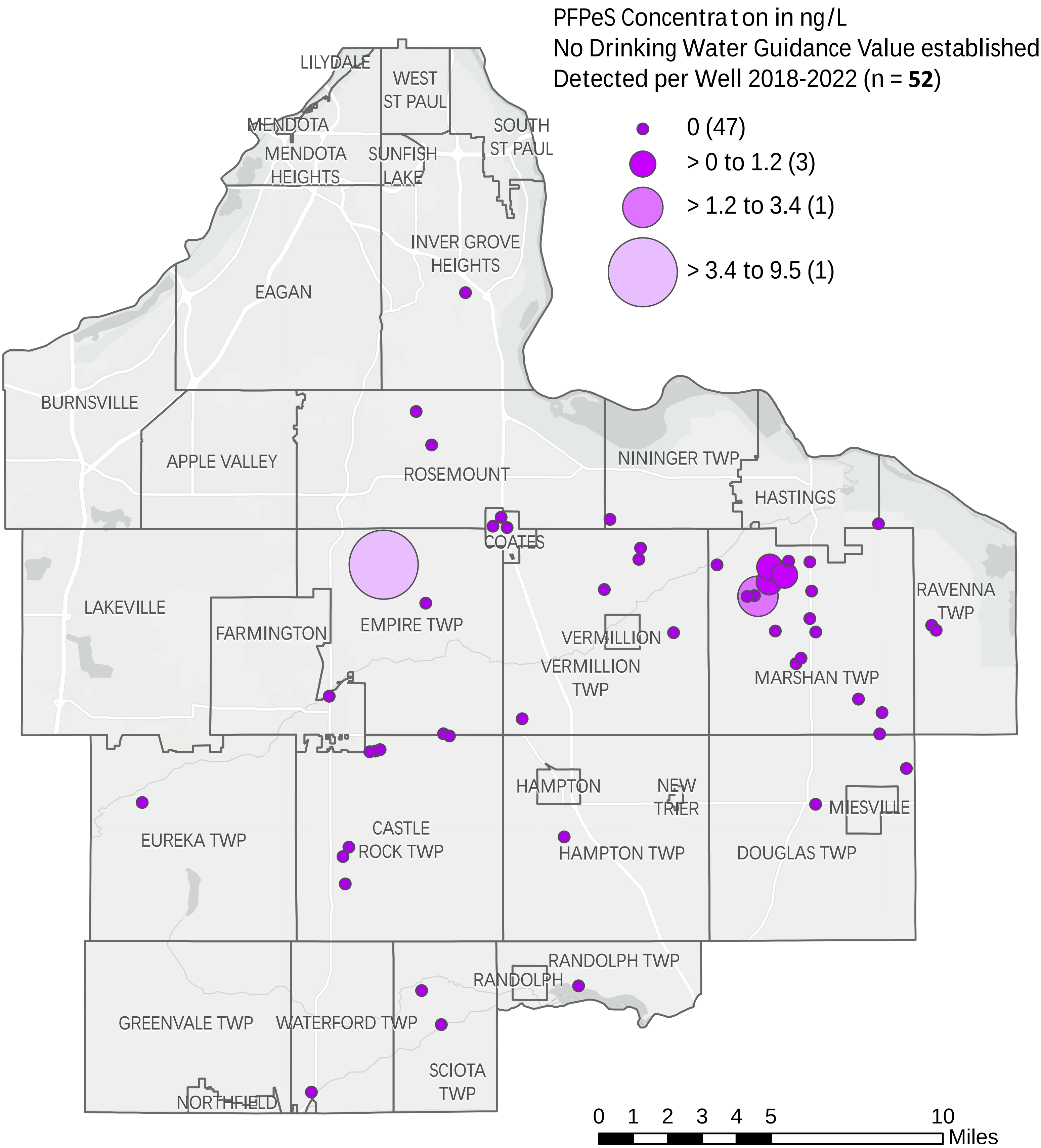


Sources: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources



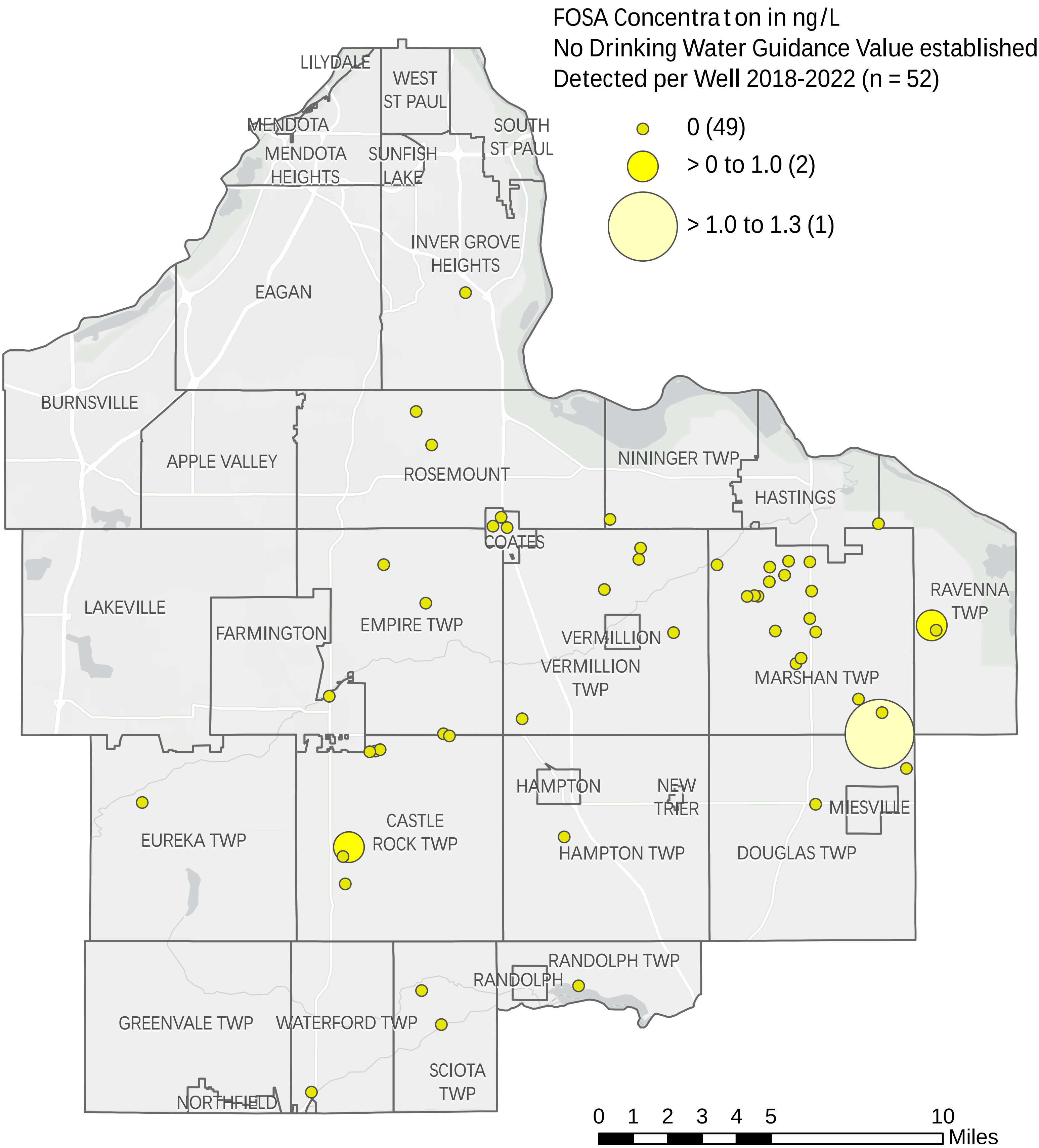
Source: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources

Map 9. PFPeS in Private Drinking Water Wells in Dakota County, MN



Sources: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources

Map 10. FOSA in Private Drinking Water Wells in Dakota County, MN



Sources: County of Dakota, Metropolitan Council, MetroGIS, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Dakota County Environmental Resources

Appendix B – Tables

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Municipality	Well Casing Category	Aquifer	Year Sampled	PFBA	PFPeA	PFOA	PFHxS	PFHxA	PFOS	PFBS	PFHpA
AGQS-01	COATES	Shallow	Opdc	2018	98	3.9	3.5	3.3	<2	<1.9	<1.8	<2
AGQS-02	EMPIRE TWP	Shallow	Opdc	2018	56	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-04	NININGER TWP	Mid	Opdc	2018	160	6.5	3.5	<1.8	2.1	<1.9	<1.7	<2
AGQS-06	MARSHAN TWP	Deep	Cjdn	2019	130	4.0	2.2	1.0	1.1	<1	<1	<1
AGQS-07	EUREKA TWP	Mid	Opdc	2018	<2	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-08	EUREKA TWP	Shallow	Opdc	2018	18	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-09	ROSEMOUNT	Mid	Opdc	2018	120	2.5	<2	<1.8	<2	<1.9	<1.7	<2
AGQS-10	INVER GROVE HEIGHTS	Mid	Opdc	2018	150	2.8	2.0	<1.8	<2	<1.9	<1.7	<2
AGQS-11	HASTINGS	Deep	Cjdn	2019	19	<1	<1	<1	<1	<1	<1	<1
AGQS-12	MARSHAN TWP	Mid	Opdc	2018	100	2.7	3.8	<1.9	<2	<1.9	<1.8	<2
AGQS-13	SUNFISH LAKE	Mid	Opdc	2018	125	<2	<2	<1.9	<2	<1.9	<1.7	<2
AGQS-14	HAMPTON	Deep	Cjdn	2019	14	<1	<1	<1	<1	<1	<1	<1
AGQS-17	ROSEMOUNT	Deep	Ucs	2018	88	2.2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-18	ROSEMOUNT	Deep	Opdc	2018	<2	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-19	INVER GROVE HEIGHTS	Deep	Ucs	2018	3.5	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-20	EMPIRE TWP	Shallow	Ucs	2018 & 2019	45	5.4	4.9	4.1	4.4	3.5	4.3	<1
AGQS-21	BURNSVILLE	Mid	Ucs	2018	20	<2	<2	2.8	<2	<1.9	<1.7	<2
AGQS-23	INVER GROVE HEIGHTS	Mid	Ucs	2018	92	4.4	2.8	1.9	<1.9	<1.9	<1.7	<1.9
AGQS-25	EUREKA TWP	Deep	Cjdn	2019	5.7	<1	<1	<1	<1	<1	<1	<1
AGQS-26	LAKEVILLE	Deep	Opdc	2018	<2	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-27	ROSEMOUNT	Mid	Ucs	2018	23	<2	<2	2.5	<2	<1.9	<1.8	<2
AGQS-28	CASTLE ROCK TWP	Deep	Cjdn	2019	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-29	CASTLE ROCK TWP	Shallow	Opdc	2018	9.2	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-30	CASTLE ROCK TWP	Shallow	Opdc	2018	27	<2	<2	3.0	<2	3.0	<1.8	<2
AGQS-31	LAKEVILLE	Mid	Ucs	2018	42	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-32	ROSEMOUNT	Mid	Opdc	2018	76	<2	<2	<1.9	<2	<1.9	<1.7	<2
AGQS-33	COATES	Deep	Cjdn	2019	170	3.7	<1	<1	<1	<1	<1	<1
AGQS-34	SCIOTA TWP	Shallow	Opdc	2018	6.6	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-35	RANDOLPH TWP	Shallow	Opdc	2018	9.9	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-36	INVER GROVE HEIGHTS	Deep	Opdc	2018	56	<2.1	<2.1	<1.9	<2.1	<2	<1.8	<2.1
AGQS-37	RANDOLPH TWP	Shallow	Ucs	2018	23	<2	<2	<1.9	<2	<1.9	<1.7	<2

Blue shaded cell are detections.
< - not detected over the laboratory reporting level
NS - not sampled
Two wells were sampled in two different years, the results were averaged

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Municipality	Well Casing Category	Aquifer	Year Sampled	PFBA	PFPeA	PFOA	PFHxS	PFHxA	PFOS	PFBS	PFHpA
AGQS-38	CASTLE ROCK TWP	Deep	Cjdn	2019	14	<1	<1	<1	<1	<1	<1	<1
AGQS-39	RANDOLPH TWP	Deep	Cjdn	2019	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-40	WATERFORD TWP	Deep	Cjdn	2019	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-41	ROSEMOUNT	Deep	Cjdn	2019	6.6	<1	<1	<1	<1	<1	<1	<1
AGQS-42	MARSHAN TWP	Mid	Opdc	2018 & 2020	104.5	4.5	<0.9	1.2	2.5	<1.9	<1.8	<2
AGQS-43	INVER GROVE HEIGHTS	Deep	Cjdn	2019	22	<1	<1	<1	<1	<1	<1	<1
AGQS-44	MARSHAN TWP	Deep	Cjdn	2019	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-45	SCIOTA TWP	Deep	Cjdn	2019	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-46	ROSEMOUNT	Deep	Cjdn	2019	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-47	SUNFISH LAKE	Mid	Ucs	2018	200	3.7	<2	<1.8	<2	<1.9	<1.7	<2
AGQS-48	CASTLE ROCK TWP	Mid	Ucs	2018	<2	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-49	NININGER TWP	Deep	Cjdn	2019	83	1.0	<1	<1	<1	<1	<1	<1
AGQS-50	GREENVALE TWP	Mid	Opdc	2018	<2	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-51	INVER GROVE HEIGHTS	Mid	Ucs	2018	<2	<2	<2	<1.8	<2	<1.9	<1.7	<2
AGQS-52	EUREKA TWP	Shallow	Ucs	2018	<2	<2	<2	<1.9	<2	<2	<1.8	<2
AGQS-54	EMPIRE TWP	Shallow	Opdc	2018	47	2.6	2.5	5.8	<2	<1.9	<1.8	<2
AGQS-55	MARSHAN TWP	Shallow	Opdc	2018	280	8.1	5.9	<1.8	2.3	<1.9	<1.7	<1.9
AGQS-56	HAMPTON TWP	Mid	Opdc	2018	51	<2	<2	<1.9	<2	<1.9	<1.7	<2
AGQS-57	DOUGLAS TWP	Shallow	Opdc	2018	67	2.9	2.0	<1.9	<2	<1.9	<1.7	<2
AGQS-59	CASTLE ROCK TWP	Shallow	Ucs	2018	31	<2	<2	12.0	<2	4.3	<1.7	<2
AGQS-61	HAMPTON TWP	Shallow	Ucs	2018	26	<2	<2	<1.9	<2	<1.9	<1.7	<2
AGQS-63	NININGER TWP	Shallow	Ucs	2018	130	5.3	2.9	<1.9	<2	<1.9	<1.7	<2
AGQS-64	SCIOTA TWP	Shallow	Ucs	2018	14	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-65	SCIOTA TWP	Shallow	Ucs	2018	2.7	<2	<2	<1.9	<2	<1.9	<1.8	<2
AGQS-66	COATES	Shallow	Ucs	2018	86	3.1	3.5	3.6	<2	<1.9	<1.8	<2
AGQS-67	WATERFORD TWP	Shallow	Opdc	2018	20	<2	<2	<1.9	<2	3.0	<1.8	<2
AGQS-78	VERMILLION TWP	Shallow	Opdc	2018	150	3.5	2.4	<1.9	<2	<1.9	<1.7	<2
AGQS-79	MARSHAN TWP	Mid	Ucs	2018	120	7.9	5.1	3.7	6.3	<1.9	<1.7	3.1
AGQS-80	VERMILLION TWP	Mid	Cjdn	2019	2.0	<1	<1	<1	<1	<1	<1	<1
AGQS-81	VERMILLION TWP	Shallow	Ucs	2018	48	3.4	5.7	2.8	<2	4.7	<1.7	<2
AGQS-82	RAVENNA TWP	Mid	Ucs	2018	103	<2	<2	<1.9	<2	<1.9	<1.7	<2

Blue shaded cell are detections.
< - not detected over the laboratory reporting level
NS - not sampled
Two wells were sampled in two different years, the results were averaged

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Municipality	Well Casing Category	Aquifer	Year Sampled	PFBA	PFPeA	PFOA	PFHxS	PFHxA	PFOS	PFBS	PFHpA
83	GREENVALE TWP	Shallow	Opdc	2018	<2	<2	<2	<1.9	<2	<1.9	<1.8	<2
84	MARSHAN TWP	Medium	Ucs	2020	120	19	<0.91	21	22	<0.91	<0.88	9.8
85	EMPIRE TWP	Shallow	Opdc	2020	70	3.1	<0.89	2.2	0.92	<0.89	<1	<0.89
86	VERMILLION TWP	Medium	Opdc	2022	120	3.5	<0.9	<0.9	<1.8	<1.8	<0.9	<3.6
87	MARSHAN TWP	Medium	Ucs	2020	410	18	<0.91	<0.91	5.8	<0.91	<1	<0.9
88	MARSHAN TWP	Medium	Opdc	2020	<2	<0.9	<0.9	<0.9	<0.9	<0.9	3.3	<0.9
89	DOUGLAS TWP	Deep	Cjdn	2020	110	2.4	<0.88	<0.88	<0.88	<0.88	1.5	1.7
90	CASTLE ROCK TWP	Shallow	Opdc	2020	6	<0.9	<0.9	<0.9	<0.9	<0.9	2	1.6
91	MARSHAN TWP	Medium	Cjdn	2020	15	<0.88	<0.88	<0.88	<0.88	<0.88	<0.9	<0.88
92	EMPIRE TWP	Medium	Opdc	2022	190	96	20	18	78	<2	21	41
93	MARSHAN TWP	Medium	Ucs	2020	180	13	2.7	4.1	8.4	<0.9	<0.88	2.8
94	MARSHAN TWP	Deep	Cjdn	2020	190	11	<1	<1	4.6	<1	<0.9	1
95	MARSHAN TWP	Deep	Cjdn	2020	<1	<1	<1	<1	<1	<1	1.8	<1
96	MARSHAN TWP	Deep	Ucs	2020	150	4.6	<0.91	0.91	1.1	<0.91	1.8	<0.91
97	EMPIRE TWP	Medium	Opdc	2020	1.6	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	1.9
98	MARSHAN TWP	Medium	Cjdn	2020	150	3.2	<0.88	<0.88	<0.88	<0.88	<1	<1
99	DOUGLAS TWP	Shallow	Cjdn	2020	<1	<1	<1	<1	<1	<1	<0.91	1.9
100	CASTLE ROCK TWP	Medium	Opdc	2020	22	<1	<1	<1	<1	<1	<0.9	1.7
101	MARSHAN TWP	Shallow	Opdc	2022	130	4	2.5	3.2	<1.8	<1.8	0.98	<3.6
102	VERMILLION TWP	Medium	Cjdn	2022	<1	<1	<1	<1	<2	<2	<1	<4
103	CASTLE ROCK TWP	Shallow	Opdc	2022	32	<0.89	<0.9	<0.89	<1.8	<1.8	3.5	<3.6
104	SCIOTA TWP	Shallow	Opdc	2022	5.5	<1	<1	<1	<2	<2	<1	<4
105	RAVENNA TWP	Medium	Ucs	2022	300	11	1.3	2.1	5	<2	1.3	<4
106	RAVENNA TWP	Medium	Ucs	2022	170	7.1	1.3	2.4	2.3	<1.8	<0.9	<3.6
107	COATES	Shallow	Ucs	2020	140	8.3	2.1	1.2	6.7	<0.9	2	0.94
108	COATES	Medium	Opdc	2020	100	3.7	<1	<1	1.6	<1	<1	<1
109	MARSHAN TWP	Medium	Opdc	2022	180	7.1	1	4.7	2.1	<2	1.5	<4
110	MARSHAN TWP	Shallow	Ucs	2020	130	7	6.8	5.7	2.5	<0.89	1.3	1.8
111	MARSHAN TWP	Shallow	Ucs	2020	190	7.9	<0.9	<0.9	2	<0.9	<0.9	<0.9
112	VERMILLION TWP	Medium	Opdc	2020	110	6.2	1.8	1.5	2.1	3.4	1.7	<0.9
113	VERMILLION TWP	Medium	Opdc	2020	200	5.7	1.9	<0.89	1.4	<0.89	1.4	<0.89

Blue shaded cell are detections.
< - not detected over the laboratory reporting level
NS - not sampled
Two wells were sampled in two different years, the results were averaged

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Municipality	Well Casing Category	Aquifer	Year Sampled	PFBA	PFPeA	PFOA	PFHxS	PFHxA	PFOS	PFBS	PFHpA
114	CASTLE ROCK TWP	Shallow	Opdc	2020	17	<1	<1	<1	<2	<2	<1	<4
115	CASTLE ROCK TWP	Medium	Opdc	2020	5.6	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	1.5
116	MARSHAN TWP	Medium	Opdc	2020	110	4.1	3.3	0.91	1.4	<0.9	0.9	<0.9
117	MARSHAN TWP	Shallow	Ucs	2020	320	11	<0.89	<0.89	3	<0.89	1.4	<0.89

Blue shaded cell are detections.

< - not detected over the laboratory reporting level

NS - not sampled

Two wells were sampled in two different years, the results were averaged

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	FOSA	PFPeS	PFDA	PFDoA	PFDS	PFNA	PFTeDA	PFTrDA	PFUnA	11Cl-PF3OUdS	4:2 FTS	6:2 FTS	8:2 FTS
AGQS-01	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-02	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-04	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-06	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-07	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-08	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-09	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-10	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-11	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-12	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-13	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-14	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-17	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-18	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-19	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-20	NS	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-21	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-23	NS	NS	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	NS	NS	NS	NS
AGQS-25	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-26	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-27	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-28	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-29	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-30	NS	NS	<2	<2	<2	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-31	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-32	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-33	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-34	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-35	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-36	NS	NS	<2.1	<2.1	<2	<2.1	<2.1	<2.1	<2.1	NS	NS	NS	NS
AGQS-37	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS

Blue shaded cell are detections.
< - not detected over the laboratory reporting level
NS - not sampled
Two wells were sampled in two different years, the results were averaged

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	FOSA	PFPeS	PFDA	PFDoA	PFDS	PFNA	PFTeDA	PFTrDA	PFUnA	11Cl-PF3OUdS	4:2 FTS	6:2 FTS	8:2 FTS
AGQS-38	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-39	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-40	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-41	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-42	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-43	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-44	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-45	<1000	NS	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-46	<1000	<1	<1	<1000	<1000	<1	<1	<1	<1	<1000	<1	<1	<1
AGQS-47	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-48	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-49	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-50	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-51	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-52	NS	NS	<2	<2	<2	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-54	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-55	NS	NS	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	NS	NS	NS	NS
AGQS-56	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-57	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-59	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-61	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-63	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-64	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-65	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-66	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-67	NS	NS	<2	<2	<2	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-78	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-79	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-80	<1000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
AGQS-81	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
AGQS-82	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS

Blue shaded cell are detections.
< - not detected over the laboratory reporting level
NS - not sampled
Two wells were sampled in two different years, the results were averaged

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	FOSA	PFPeS	PFDA	PFDoA	PFDS	PFNA	PFTeDA	PFTrDA	PFUnA	11Cl-PF3OUdS	4:2 FTS	6:2 FTS	8:2 FTS
83	NS	NS	<2	<2	<1.9	<2	<2	<2	<2	NS	NS	NS	NS
84	<0.88	3.4	<0.88	<0.88	<0.88	<0.91	<0.91	<0.91	<0.91	<0.91	<0.88	<0.88	<0.88
85	<1	0.89	<1	<1	<1	<0.89	<0.89	<0.89	<0.89	<0.89	<1	<1	<1
86	<0.91	<0.91	<0.91	<0.91	<0.91	<0.91	<1.8	<0.91	<0.91	<1.8	<0.91	<0.91	<0.91
87	<1	1.1	<1	<1	<1	<0.91	<0.91	<0.91	<0.91	<0.91	<1	<1	<1
88	<0.91	0.9	<0.91	<0.91	<0.91	<0.9	<0.9	<0.9	<0.9	<0.9	<0.91	<0.91	<0.91
89	<0.89	0.88	<0.89	<0.89	<0.89	<0.88	<0.88	<0.88	<0.88	<0.88	<0.89	<0.89	<0.89
90	<0.91	0.9	<0.91	<0.91	<0.91	<0.9	<0.9	<0.9	<0.9	<0.9	<0.91	<0.91	<0.91
91	<0.9	0.88	<0.9	<0.9	<0.9	<0.88	<0.88	<0.88	<0.88	<0.88	<0.9	<0.9	<0.9
92	<1	9.5	<1	<1	<1	<1	<2	<1	<1	<2	<1	<1	<1
93	<0.88	1.2	<0.88	<0.88	<0.88	<0.9	<0.9	<0.9	<0.9	<0.9	<0.88	<0.88	<0.88
94	<0.9	1	<0.9	<0.9	<0.9	<1	<1	<1	<1	<1	<0.9	<0.9	<0.9
95	<0.9	1	<0.9	<0.9	<0.9	<1	<1	<1	<1	<1	<0.9	<0.9	<0.9
96	<1	0.91	<1	<1	<1	<0.91	<0.91	<0.91	<0.91	<0.91	<1	<1	<1
97	<0.9	0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
98	<1	0.88	<1	<1	<1	<0.88	<0.88	<0.88	<0.88	<0.88	<1	<1	<1
99	<0.91	1	<0.91	<0.91	<0.91	<1	<1	<1	<1	<1	<0.91	<0.91	<0.91
100	<0.9	1	<0.9	<0.9	<0.9	<1	<1	<1	<1	<1	<0.9	<0.9	<0.9
101	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<1.8	<0.9	<0.9	<1.8	<0.9	<0.9	<0.9
102	<1	<1	<1	<1	<1	<1	<2	<1	<1	<2	<1	<1	<1
103	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<1.8	<0.89	<0.89	<1.8	<0.89	<0.89	<0.89
104	<1	<1	<1	<1	<1	<1	<2	<1	<1	<2	<1	<1	<1
105	<1	<1	<1	<1	<1	<1	<2	<1	<1	<2	<1	<1	<1
106	1	<0.91	<0.91	<0.91	<0.91	<0.91	<1.8	<0.91	<0.91	<1.8	<0.91	<0.91	<0.91
107	<0.9	0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
108	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
109	1.3	<1	<1	<1	<1	<1	<2	<1	<1	<2	<1	<1	<1
110	<0.89	0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89
111	<0.9	0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
112	<0.9	0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
113	<0.89	0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89

Blue shaded cell are detections.
< - not detected over the laboratory reporting level
NS - not sampled
Two wells were sampled in two different years, the results were averaged

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	FOSA	PFPeS	PFDA	PFDoA	PFDS	PFNA	PFTeDA	PFTrDA	PFUnA	11Cl-PF3OUdS	4:2 FTS	6:2 FTS	8:2 FTS
114	1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<1	<1
115	<0.88	0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88
116	<0.9	0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
117	<0.89	0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89

Blue shaded cell are detections.
< - not detected over the laboratory reporting level
NS - not sampled
Two wells were sampled in two different years, the results were averaged

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	ADONA	EtFOSA	EtFOSAA	EtFOSE	HFPO-DA	MeFOSA	MeFOSAA	MeFOSE	PFHpS	PFNS	9Cl-PF3ONS	# of Detections	
AGQS-01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	4	
AGQS-02	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-04	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	4	
AGQS-06	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	5	
AGQS-07	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0	
AGQS-08	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-09	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2	
AGQS-10	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	3	
AGQS-11	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	1	
AGQS-12	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	3	
AGQS-13	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-14	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	1	
AGQS-17	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2	
AGQS-18	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0	
AGQS-19	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-20	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	7	
AGQS-21	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2	
AGQS-23	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	4	
AGQS-25	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	1	
AGQS-26	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0	
AGQS-27	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2	
AGQS-28	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	0	
AGQS-29	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-30	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	3	
AGQS-31	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-32	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-33	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	2	
AGQS-34	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-35	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-36	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-37	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	

Blue shaded cell are detections.
< - not detected over the laboratory reporting level
NS - not sampled
Two wells were sampled in two different years, the results were averaged

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	ADONA	EtFOSA	EtFOSAA	EtFOSE	HFPO-DA	MeFOSA	MeFOSAA	MeFOSE	PFHpS	PFNS	9Cl-PF3ONS	# of Detections	
AGQS-38	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	1	
AGQS-39	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	0	
AGQS-40	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	0	
AGQS-41	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	1	
AGQS-42	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	3	
AGQS-43	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	1	
AGQS-44	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	0	
AGQS-45	<1	<1000	<1	<1000	<1	<1000	<1	<1000	NS	NS	<1	0	
AGQS-46	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	0	
AGQS-47	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2	
AGQS-48	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0	
AGQS-49	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	2	
AGQS-50	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0	
AGQS-51	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0	
AGQS-52	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0	
AGQS-54	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	4	
AGQS-55	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	4	
AGQS-56	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-57	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	3	
AGQS-59	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	3	
AGQS-61	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-63	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	3	
AGQS-64	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-65	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	
AGQS-66	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	4	
AGQS-67	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2	
AGQS-78	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	3	
AGQS-79	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	6	
AGQS-80	<1	<1000	<1	<1000	<1	<1000	<1	<1000	<1	<1	<1	1	
AGQS-81	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	5	
AGQS-82	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1	

Blue shaded cell are detections.
< - not detected over the laboratory reporting level
NS - not sampled
Two wells were sampled in two different years, the results were averaged

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	ADONA	EtFOSA	EtFOSAA	EtFOSE	HFPO-DA	MeFOSA	MeFOSAA	MeFOSE	PFHpS	PFNS	9Cl-PF3ONS	# of Detections	
83	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0	
84	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.91	<0.91	<0.88	5	
85	<1	<1	<1	<1	<1	<1	<1	<1	<0.89	<0.89	<1	4	
86	<0.91	<1.8	<1.8	<0.91	<0.91	<1.8	<0.91	<1.8	<0.91	<0.91	<0.91	2	
87	<1	<1	<1	<1	<1	<1	<1	<1	<0.91	<0.91	<1	3	
88	<0.91	<0.91	<0.91	<0.91	<0.91	<0.91	<0.91	<0.91	<0.9	<0.9	<0.91	1	
89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.88	<0.88	<0.89	4	
90	<0.91	<0.91	<0.91	<0.91	<0.91	<0.91	<0.91	<0.91	<0.9	<0.9	<0.91	3	
91	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.88	<0.88	<0.9	1	
92	<1	<2	<2	<1	<1	<2	<1	<2	<1	<1	<1	8	
93	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.9	<0.9	<0.88	7	
94	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<1	<1	<0.9	4	
95	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<1	<1	<0.9	1	
96	<1	<1	<1	<1	<1	<1	<1	<1	<0.91	<0.91	<1	4	
97	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	2	
98	<1	<1	<1	<1	<1	<1	<1	<1	<0.88	<0.88	<1	2	
99	<0.91	<0.91	<0.91	<0.91	<0.91	<0.91	<0.91	<0.91	<1	<1	<0.91	1	
100	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<1	<1	<0.9	2	
101	<0.9	<1.8	<1.8	<0.9	<0.9	<1.8	<0.9	<1.8	<0.9	<0.9	<0.9	5	
102	<1	<2	<2	<1	<1	<2	<1	<2	<1	<1	<1	0	
103	<0.89	<1.8	<1.8	<0.89	<0.89	<1.8	<0.89	<1.8	<0.89	<0.89	<0.89	2	
104	<1	<2	<2	<1	<1	<2	<1	<2	<1	<1	<1	1	
105	<1	<2	<2	<1	<1	<2	<1	<2	<1	<1	<1	6	
106	<0.91	<1.8	<1.8	<0.91	<0.91	<1.8	<0.91	<1.8	<0.91	<0.91	<0.91	6	
107	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	6	
108	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3	
109	<1	<2	<2	<1	<1	<2	<1	<2	<1	<1	<1	7	
110	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	7	
111	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	3	
112	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	7	
113	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	5	

Blue shaded cell are detections.
< - not detected over the laboratory reporting level
NS - not sampled
Two wells were sampled in two different years, the results were averaged

Appendix B. Table 1. Summary of all PFAS results in ng/L from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	ADONA	EtFOSA	EtFOSAA	EtFOSE	HFPO-DA	MeFOSA	MeFOSAA	MeFOSE	PFHpS	PFNS	9Cl-PF3ONS	# of Detections	
114	<1	<2	<2	<1	<1	<2	<1	<2	<1	<1	<1	2	
115	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	<0.88	2	
116	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	6	
117	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89	4	

Blue shaded cell are detections.
< - not detected over the laboratory reporting level
NS - not sampled
Two wells were sampled in two different years, the results were averaged

Appendix B. Table 2. Summary of all metals results from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Municipality	Well Casing Category	Aquifer	Arsenic ug/L	Cadmium mg/L	Chloride mg/L	Copper mg/L	Lead ug/L	Manganese mg/L	Mercury ug/L
AGQS-01	COATES	Shallow	Opdc	0.0	NS	76.3	NS	NS	0.034	NS
AGQS-02	EMPIRE TWP	Shallow	Opdc	0.3	NS	76.1	NS	NS	0.004	NS
AGQS-04	NININGER TWP	Mid	Opdc	0.0	NS	37.6	NS	NS	0.006	NS
AGQS-06	MARSHAN TWP	Deep	Cjdn	0.3	NS	12.5	NS	NS	0.039	NS
AGQS-07	EUREKA TWP	Mid	Opdc	0.0	NS	2.7	NS	NS	0.093	NS
AGQS-08	EUREKA TWP	Shallow	Opdc	0.3	NS	12.5	NS	NS	0.023	NS
AGQS-09	ROSEMOUNT	Mid	Opdc	0.0	NS	15.9	NS	NS	0.014	NS
AGQS-10	INVER GROVE HEIGHTS	Mid	Opdc	0.5	NS	125.8	NS	NS	0.609	NS
AGQS-11	HASTINGS	Deep	Cjdn	0.0	NS	0.3	NS	NS	0.005	NS
AGQS-12	MARSHAN TWP	Mid	Opdc	0.0	NS	15.2	NS	NS	0.001	NS
AGQS-13	SUNFISH LAKE	Mid	Opdc	1.2	NS	14.0	NS	NS	0.233	NS
AGQS-14	HAMPTON	Deep	Cjdn	0.5	NS	1.7	NS	NS	0.044	NS
AGQS-17	ROSEMOUNT	Deep	Ucs	0.0	NS	32.8	NS	NS	0.007	NS
AGQS-18	ROSEMOUNT	Deep	Opdc	0.0	NS	0.3	NS	NS	0.118	NS
AGQS-19	INVER GROVE HEIGHTS	Deep	Ucs	7.0	NS	2.6	NS	NS	0.736	NS
AGQS-20	EMPIRE TWP	Shallow	Ucs	0.8	NS	84.3	NS	NS	0.006	NS
AGQS-21	BURNSVILLE	Mid	Ucs	0.0	NS	31.5	NS	NS	0.017	NS
AGQS-23	INVER GROVE HEIGHTS	Mid	Ucs	0.0	NS	12.8	NS	NS	0.004	NS
AGQS-25	EUREKA TWP	Deep	Cjdn	0.3	NS	10.2	NS	NS	0.055	NS
AGQS-26	LAKEVILLE	Deep	Opdc	0.5	NS	0.3	NS	NS	0.030	NS
AGQS-27	ROSEMOUNT	Mid	Ucs	0.0	NS	11.5	NS	NS	0.384	NS
AGQS-28	CASTLE ROCK TWP	Deep	Cjdn	0.0	NS	0.1	NS	NS	0.044	NS
AGQS-29	CASTLE ROCK TWP	Shallow	Opdc	0.6	NS	2.4	NS	NS	0.067	NS
AGQS-30	CASTLE ROCK TWP	Shallow	Opdc	0.0	NS	18.0	NS	NS	0.004	NS
AGQS-31	LAKEVILLE	Mid	Ucs	1.0	NS	101.8	NS	NS	0.208	NS
AGQS-32	ROSEMOUNT	Mid	Opdc	0.0	NS	13.7	NS	NS	0.003	NS
AGQS-33	COATES	Deep	Cjdn	0.0	NS	16.6	NS	NS	0.004	NS
AGQS-34	SCIOTA TWP	Shallow	Opdc	0.4	NS	2.1	NS	NS	0.064	NS
AGQS-35	RANDOLPH TWP	Shallow	Opdc	0.3	NS	3.8	NS	NS	0.030	NS
AGQS-36	INVER GROVE HEIGHTS	Deep	Opdc	5.9	NS	7.1	NS	NS	0.656	NS
AGQS-37	RANDOLPH TWP	Shallow	Ucs	0.0	NS	10.3	NS	NS	0.219	NS

NS - not sampled ug/L = micrograms per liter mg/L = milligrams per liter
Manganese results that exceed the drinking water guidance of 0.100 mg/L are shaded in blue.
Nitrate results that exceed the drinking water guidance of 10 mg/L are shaded in blue.

Appendix B. Table 2. Summary of all metals results from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Municipality	Well Casing Category	Aquifer	Arsenic ug/L	Cadmium mg/L	Chloride mg/L	Copper mg/L	Lead ug/L	Manganese mg/L	Mercury ug/L
AGQS-38	CASTLE ROCK TWP	Deep	Cjdn	0.5	NS	2.8	NS	NS	0.101	NS
AGQS-39	RANDOLPH TWP	Deep	Cjdn	0.0	NS	0.3	NS	NS	0.024	NS
AGQS-40	WATERFORD TWP	Deep	Cjdn	0.0	NS	0.2	NS	NS	0.067	NS
AGQS-41	ROSEMOUNT	Deep	Cjdn	0.0	NS	1.1	NS	NS	0.006	NS
AGQS-42	MARSHAN TWP	Mid	Opdc	0.0	NS	10.9	NS	NS	0.004	NS
AGQS-43	INVER GROVE HEIGHTS	Deep	Cjdn	1.6	NS	2.6	NS	NS	0.557	NS
AGQS-44	MARSHAN TWP	Deep	Cjdn	<0.5	NS	0.1	NS	NS	0.027	NS
AGQS-45	SCIOTA TWP	Deep	Cjdn	<0.5	NS	0.2	NS	NS	0.053	NS
AGQS-46	ROSEMOUNT	Deep	Cjdn	<0.5	NS	0.4	NS	NS	0.239	NS
AGQS-47	SUNFISH LAKE	Mid	Ucs	2.9	NS	18.2	NS	NS	0.178	NS
AGQS-48	CASTLE ROCK TWP	Mid	Ucs	0.3	NS	0.4	NS	NS	0.049	NS
AGQS-49	NININGER TWP	Deep	Cjdn	<0.5	NS	7.2	NS	NS	0.003	NS
AGQS-50	GREENVALE TWP	Mid	Opdc	3.4	NS	0.3	NS	NS	0.024	NS
AGQS-51	INVER GROVE HEIGHTS	Mid	Ucs	1.4	NS	0.5	NS	NS	0.741	NS
AGQS-52	EUREKA TWP	Shallow	Ucs	<0.5	NS	5.3	NS	NS	0.355	NS
AGQS-54	EMPIRE TWP	Shallow	Opdc	<0.5	NS	11.3	NS	NS	0.001	NS
AGQS-55	MARSHAN TWP	Shallow	Opdc	<0.5	NS	19.8	NS	NS	0.004	NS
AGQS-56	HAMPTON TWP	Mid	Opdc	<0.5	NS	13.2	NS	NS	0.003	NS
AGQS-57	DOUGLAS TWP	Shallow	Opdc	<0.5	NS	22.2	NS	NS	0.004	NS
AGQS-59	CASTLE ROCK TWP	Shallow	Ucs	<0.5	NS	28.8	NS	NS	0.008	NS
AGQS-61	HAMPTON TWP	Shallow	Ucs	<0.5	NS	8.0	NS	NS	0.031	NS
AGQS-63	NININGER TWP	Shallow	Ucs	<0.5	NS	17.9	NS	NS	0.003	NS
AGQS-64	SCIOTA TWP	Shallow	Ucs	0.6	NS	24.2	NS	NS	0.423	NS
AGQS-65	SCIOTA TWP	Shallow	Ucs	<0.5	NS	3.5	NS	NS	0.120	NS
AGQS-66	COATES	Shallow	Ucs	2.7	NS	213.0	NS	NS	0.004	NS
AGQS-67	WATERFORD TWP	Shallow	Opdc	<0.5	NS	67.4	NS	NS	0.009	NS
AGQS-78	VERMILLION TWP	Shallow	Opdc	<0.5	NS	23.8	NS	NS	0.007	NS
AGQS-79	MARSHAN TWP	Mid	Ucs	0.3	NS	15.5	NS	NS	0.003	NS
AGQS-80	VERMILLION TWP	Mid	Cjdn	<0.5	NS	0.5	NS	NS	0.060	NS
AGQS-81	VERMILLION TWP	Shallow	Ucs	0.2	NS	33.7	NS	NS	0.010	NS
AGQS-82	RAVENNA TWP	Mid	Ucs	<0.5	NS	16.4	NS	NS	<0.005	NS

NS - not sampled ug/L = micrograms per liter mg/L = milligrams per liter
Manganese results that exceed the drinking water guidance of 0.100 mg/L are shaded in blue.
Nitrate results that exceed the drinking water guidance of 10 mg/L are shaded in blue.

Appendix B. Table 2. Summary of all metals results from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Municipality	Well Casing Category	Aquifer	Arsenic ug/L	Cadmium mg/L	Chloride mg/L	Copper mg/L	Lead ug/L	Manganese mg/L	Mercury ug/L
83	GREENVALE TWP	Shallow	Opdc	<0.5	NS	< 3	NS	NS	0.454	NS
84	MARSHAN TWP	Medium	Ucs	< 0.5	< 0.005	20	< 0.005	0.87	0.024	< 0.005
85	EMPIRE TWP	Shallow	Opdc	< 0.5	< 0.005	23.2	< 0.005	< 0.5	< 0.005	< 0.01
86	VERMILLION TWP	Medium	Opdc	< 0.5	< 0.005	11.4	< 0.005	< 0.5	< 0.005	< 0.005
87	MARSHAN TWP	Medium	Ucs	< 0.5	< 0.005	27.6	0.006	< 0.5	< 0.005	< 0.005
88	MARSHAN TWP	Medium	Opdc	< 0.5	< 0.005	< 3	< 0.005	< 0.5	0.038	< 0.005
89	DOUGLAS TWP	Deep	Cjdn	< 0.5	< 0.005	21.3	0.009	< 0.5	< 0.005	< 0.01
90	CASTLE ROCK TWP	Shallow	Opdc	1.25	< 0.005	< 3	< 0.005	< 0.5	0.049	< 0.01
91	MARSHAN TWP	Medium	Cjdn	1.91	< 0.005	4	< 0.005	< 0.5	0.010	< 0.005
92	EMPIRE TWP	Medium	Opdc	< 0.5	< 0.005	15.9	< 0.005	0.52	< 0.005	< 0.005
93	MARSHAN TWP	Medium	Ucs	< 0.5	< 0.005	19.8	< 0.005	< 0.5	< 0.005	< 0.005
94	MARSHAN TWP	Deep	Cjdn	1.04	< 0.005	13.6	0.018	0.69	0.171	< 0.005
95	MARSHAN TWP	Deep	Cjdn	< 0.5	< 0.005	< 3	< 0.005	< 0.5	0.055	< 0.01
96	MARSHAN TWP	Deep	Ucs	< 0.5	< 0.005	13.7	< 0.005	< 0.5	0.085	< 0.005
97	EMPIRE TWP	Medium	Opdc	< 0.5	< 0.005	< 3	< 0.005	< 0.5	< 0.005	< 0.01
98	MARSHAN TWP	Medium	Cjdn	< 0.5	< 0.005	26.8	0.009	< 0.5	< 0.005	< 0.01
99	DOUGLAS TWP	Shallow	Cjdn	< 0.5	< 0.005	< 3	< 0.005	< 0.5	0.019	< 0.01
100	CASTLE ROCK TWP	Medium	Opdc	0.95	< 0.005	5.7	0.033	< 0.5	0.026	< 0.01
101	MARSHAN TWP	Shallow	Opdc	< 0.5	< 0.005	23.9	0.005	0.99	< 0.005	< 0.005
102	VERMILLION TWP	Medium	Cjdn	1.1	< 0.005	< 3	< 0.005	< 0.5	0.035	< 0.005
103	CASTLE ROCK TWP	Shallow	Opdc	< 0.5	< 0.005	35.5	0.014	< 0.5	< 0.005	< 0.005
104	SCIOTA TWP	Shallow	Opdc	0.77	< 0.005	12.8	< 0.005	< 0.5	0.055	< 0.005
105	RAVENNA TWP	Medium	Ucs	0.63	< 0.005	19.3	< 0.005	< 0.5	< 0.005	< 0.005
106	RAVENNA TWP	Medium	Ucs	< 0.5	< 0.005	21	0.006	< 0.5	< 0.005	< 0.005
107	COATES	Shallow	Ucs	< 0.5	< 0.005	35.8	< 0.005	0.52	< 0.005	< 0.01
108	COATES	Medium	Opdc	< 0.5	< 0.005	16	0.018	0.95	< 0.005	< 0.01
109	MARSHAN TWP	Medium	Opdc	< 0.5	< 0.005	43	0.007	< 0.5	< 0.005	< 0.005
110	MARSHAN TWP	Shallow	Ucs	< 0.5	< 0.005	20.1	0.01	0.98	< 0.005	< 0.005
111	MARSHAN TWP	Shallow	Ucs	0.64	< 0.005	14.4	< 0.005	< 0.5	< 0.005	< 0.005
112	VERMILLION TWP	Medium	Opdc	< 0.5	< 0.005	30.4	< 0.005	< 0.5	< 0.005	< 0.005
113	VERMILLION TWP	Medium	Opdc	< 0.5	< 0.005	65.1	0.011	< 0.5	< 0.005	< 0.01

NS - not sampled ug/L = micrograms per liter mg/L = milligrams per liter
Manganese results that exceed the drinking water guidance of 0.100 mg/L are shaded in blue.
Nitrate results that exceed the drinking water guidance of 10 mg/L are shaded in blue.

Appendix B. Table 2. Summary of all metals results from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Municipality	Well Casing Category	Aquifer	Arsenic ug/L	Cadmium mg/L	Chloride mg/L	Copper mg/L	Lead ug/L	Manganese mg/L	Mercury ug/L
114	CASTLE ROCK TWP	Shallow	Opdc	< 0.5	< 0.005	17.9	< 0.005	< 0.5	< 0.005	< 0.005
115	CASTLE ROCK TWP	Medium	Opdc	0.8	< 0.005	4	< 0.005	< 0.5	0.050	< 0.01
116	MARSHAN TWP	Medium	Opdc	< 0.5	< 0.005	19.9	< 0.005	< 0.5	< 0.005	< 0.01
117	MARSHAN TWP	Shallow	Ucs	0.55	< 0.005	25.3	0.014	1.5	< 0.005	< 0.005

NS - not sampled ug/L = micrograms per liter mg/L = milligrams per liter
Manganese results that exceed the drinking water guidance of 0.100 mg/L are shaded in blue.
Nitrate results that exceed the drinking water guidance of 10 mg/L are shaded in blue.

Appendix B. Table 2. Summary of all metals results from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Molybdenum mg/L	Nickel mg/L	Nitrite mg/L as N	Nitrate mg/L as N	Nitrate+Nitrite mg/L as N	Selenium ug/L	Sulfate mg/L	Zinc mg/L
AGQS-01	NS	NS	<0.02	10.0	NS	NS	26.0	NS
AGQS-02	NS	NS	0.002	4.9	NS	NS	30.1	NS
AGQS-04	NS	NS	0.002	23.2	NS	NS	28.0	NS
AGQS-06	NS	NS	0.142	5.7	NS	NS	63.7	NS
AGQS-07	NS	NS	<0.002	0.2	NS	NS	19.2	NS
AGQS-08	NS	NS	0.002	2.8	NS	NS	31.1	NS
AGQS-09	NS	NS	<0.002	9.1	NS	NS	27.1	NS
AGQS-10	NS	NS	<0.002	0.2	NS	NS	43.4	NS
AGQS-11	NS	NS	<0.002	4.2	NS	NS	10.4	NS
AGQS-12	NS	NS	<0.002	14.9	NS	NS	24.3	NS
AGQS-13	NS	NS	0.002	0.2	NS	NS	22.9	NS
AGQS-14	NS	NS	<0.002	0.2	NS	NS	28.5	NS
AGQS-17	NS	NS	<0.002	4.8	NS	NS	32.0	NS
AGQS-18	NS	NS	<0.002	<0.25	NS	NS	14.0	NS
AGQS-19	NS	NS	0.022	0.2	NS	NS	22.3	NS
AGQS-20	NS	NS	0.045	3.7	NS	NS	33.5	NS
AGQS-21	NS	NS	<0.002	0.7	NS	NS	31.8	NS
AGQS-23	NS	NS	0.023	2.6	NS	NS	30.0	NS
AGQS-25	NS	NS	0.077	3.7	NS	NS	37.1	NS
AGQS-26	NS	NS	<0.002	<0.25	NS	NS	5.9	NS
AGQS-27	NS	NS	<0.002	<0.25	NS	NS	37.1	NS
AGQS-28	NS	NS	0.003	<0.25	NS	NS	26.1	NS
AGQS-29	NS	NS	0.002	<0.25	NS	NS	27.8	NS
AGQS-30	NS	NS	0.005	10.7	NS	NS	20.1	NS
AGQS-31	NS	NS	0.005	0.2	NS	NS	7.5	NS
AGQS-32	NS	NS	<0.002	7.8	NS	NS	31.2	NS
AGQS-33	NS	NS	<0.002	8.6	NS	NS	27.4	NS
AGQS-34	NS	NS	<0.002	<0.25	NS	NS	28.9	NS
AGQS-35	NS	NS	<0.002	<0.25	NS	NS	39.5	NS
AGQS-36	NS	NS	<0.002	<0.25	NS	NS	22.9	NS
AGQS-37	NS	NS	<0.002	<0.25	NS	NS	49.0	NS

NS - not sampled ug/L = micrograms per liter mg/L = milligrams per liter
Manganese results that exceed the drinking water guidance of 0.100 mg/L are shaded in blue.
Nitrate results that exceed the drinking water guidance of 10 mg/L are shaded in blue.

Appendix B. Table 2. Summary of all metals results from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Molybdenum mg/L	Nickel mg/L	Nitrite mg/L as N	Nitrate mg/L as N	Nitrate+Nitrite mg/L as N	Selenium ug/L	Sulfate mg/L	Zinc mg/L
AGQS-38	NS	NS	0.002	<0.25	NS	NS	34.3	NS
AGQS-39	NS	NS	<0.002	<0.25	NS	NS	20.4	NS
AGQS-40	NS	NS	0.002	<0.25	NS	NS	17.0	NS
AGQS-41	NS	NS	<0.002	<0.25	NS	NS	20.8	NS
AGQS-42	NS	NS	<0.002	10.1	NS	NS	27.5	NS
AGQS-43	NS	NS	0.002	<0.25	NS	NS	20.0	NS
AGQS-44	NS	NS	0.003	<0.25	NS	NS	17.2	NS
AGQS-45	NS	NS	<0.002	<0.25	NS	NS	18.0	NS
AGQS-46	NS	NS	0.002	<0.25	NS	NS	16.3	NS
AGQS-47	NS	NS	<0.002	<0.25	NS	NS	39.0	NS
AGQS-48	NS	NS	<0.002	<0.25	NS	NS	29.5	NS
AGQS-49	NS	NS	0.001	6.3	NS	NS	24.3	NS
AGQS-50	NS	NS	0.002	<0.25	NS	NS	8.3	NS
AGQS-51	NS	NS	<0.002	<0.25	NS	NS	16.0	NS
AGQS-52	NS	NS	0.005	0.1	NS	NS	40.3	NS
AGQS-54	NS	NS	<0.002	11.6	NS	NS	38.1	NS
AGQS-55	NS	NS	<0.002	14.2	NS	NS	22.7	NS
AGQS-56	NS	NS	<0.002	9.6	NS	NS	17.8	NS
AGQS-57	NS	NS	<0.002	16.3	NS	NS	24.1	NS
AGQS-59	NS	NS	<0.002	8.2	NS	NS	16.0	NS
AGQS-61	NS	NS	<0.002	0.3	NS	NS	45.4	NS
AGQS-63	NS	NS	<0.002	18.9	NS	NS	23.0	NS
AGQS-64	NS	NS	0.069	3.9	NS	NS	41.6	NS
AGQS-65	NS	NS	<0.002	<0.25	NS	NS	21.9	NS
AGQS-66	NS	NS	<0.002	11.8	NS	NS	27.2	NS
AGQS-67	NS	NS	<0.002	6.8	NS	NS	31.4	NS
AGQS-78	NS	NS	<0.002	18.0	NS	NS	27.4	NS
AGQS-79	NS	NS	0.003	17.8	NS	NS	33.5	NS
AGQS-80	NS	NS	<0.002	<0.25	NS	NS	22.4	NS
AGQS-81	NS	NS	<0.002	8.8	NS	NS	29.0	NS
AGQS-82	NS	NS	<0.002	19.4	NS	NS	16.8	NS

NS - not sampled ug/L = micrograms per liter mg/L = milligrams per liter
Manganese results that exceed the drinking water guidance of 0.100 mg/L are shaded in blue.
Nitrate results that exceed the drinking water guidance of 10 mg/L are shaded in blue.

Appendix B. Table 2. Summary of all metals results from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Molybdenum mg/L	Nickel mg/L	Nitrite mg/L as N	Nitrate mg/L as N	Nitrate+Nitrite mg/L as N	Selenium ug/L	Sulfate mg/L	Zinc mg/L
83	NS	NS	NS	< 0.05	NS	NS	10.2	NS
84	< 0.015	< 0.01	NS	NS	25	0.88	39.2	0.091
85	< 0.015	< 0.01	NS	NS	23.4	< 1	24.1	< 0.01
86	< 0.015	< 0.01	< 0.005	11.8	11.8	0.84	20.5	< 0.01
87	< 0.015	< 0.01	NS	NS	25	0.99	27.7	0.012
88	< 0.015	< 0.01	NS	NS	< 0.05	< 0.5	17	0.088
89	< 0.015	< 0.01	NS	NS	20.1	< 1	12.7	0.106
90	< 0.015	< 0.01	NS	NS	< 0.05	< 1	28.8	< 0.01
91	0.023	< 0.01	NS	NS	< 0.05	< 0.5	40.5	0.016
92	< 0.015	< 0.01	< 0.005	20.6	20.6	0.86	39.3	0.247
93	< 0.015	< 0.01	NS	NS	17.2	0.59	24.7	< 0.01
94	< 0.015	0.015	NS	NS	2.19	< 0.5	116	0.148
95	< 0.015	< 0.01	NS	NS	< 0.05	< 1	12.5	0.054
96	< 0.015	< 0.01	NS	NS	0.68	< 0.5	99.7	0.03
97	< 0.015	< 0.01	NS	NS	< 0.05	< 1	16.7	< 0.01
98	< 0.015	< 0.01	NS	NS	21.6	< 1	19.8	0.164
99	< 0.015	< 0.01	NS	NS	< 0.05	< 1	24.9	0.19
100	< 0.015	< 0.01	NS	NS	< 0.05	< 1	35.5	0.21
101	< 0.015	< 0.01	< 0.005	19.4	19.4	< 0.5	17.1	1.02
102	< 0.015	< 0.01	< 0.005	< 0.05	< 0.05	< 0.5	13.8	0.022
103	< 0.015	< 0.01	< 0.005	9.6	9.61	0.94	31.1	0.134
104	< 0.015	< 0.01	< 0.005	< 0.05	< 0.05	< 0.5	82.8	< 0.01
105	< 0.015	< 0.01	< 0.005	17.6	17.6	< 0.5	23.7	0.21
106	< 0.015	< 0.01	< 0.005	17.6	17.6	0.61	27.1	0.075
107	< 0.015	< 0.01	NS	NS	10.7	< 1	19.6	0.025
108	< 0.015	0.026	NS	NS	8.39	0.7	18.1	0.035
109	< 0.015	< 0.01	< 0.005	27.3	27.3	< 0.5	33.2	0.253
110	< 0.015	< 0.01	NS	NS	17.9	< 1	25.8	0.096
111	< 0.015	< 0.01	NS	NS	13.7	< 0.5	17.5	0.191
112	< 0.015	< 0.01	NS	NS	24.6	< 1	21.7	0.043
113	< 0.015	< 0.01	NS	NS	30.5	< 1	42.9	0.026

NS - not sampled ug/L = micrograms per liter mg/L = milligrams per liter
Manganese results that exceed the drinking water guidance of 0.100 mg/L are shaded in blue.
Nitrate results that exceed the drinking water guidance of 10 mg/L are shaded in blue.

Appendix B. Table 2. Summary of all metals results from 97 private drinking water wells located in Dakota County and sampled between 2018 to 2022

Well Number	Molybdenum mg/L	Nickel mg/L	Nitrite mg/L as N	Nitrate mg/L as N	Nitrate+Nitrite mg/L as N	Selenium ug/L	Sulfate mg/L	Zinc mg/L
114	< 0.015	< 0.01	< 0.005	6.4	6.42	1.16	30.6	0.144
115	< 0.015	< 0.01	NS	NS	< 0.05	< 1	36.1	< 0.01
116	< 0.015	< 0.01	NS	NS	17.8	< 1	20.7	< 0.01
117	< 0.015	< 0.01	NS	NS	21.1	0.77	35.7	0.071

NS - not sampled ug/L = micrograms per liter mg/L = milligrams per liter
Manganese results that exceed the drinking water guidance of 0.100 mg/L are shaded in blue.
Nitrate results that exceed the drinking water guidance of 10 mg/L are shaded in blue.

Appendix C – MCES Factsheet

PFAS Fact Sheet

About PFAS

- PFAS chemicals have been produced since the 1940s and are found in everyday products.
- Common uses of PFAS include: nonstick cookware, stain and water resistant carpets and fabrics, coatings on some food packaging (especially microwave popcorn bags and fast-food wrappers), components of fire-fighting foam, and some dental flosses. Because of this, PFAS are also present in our bodies, our environment, and biosolids.
- Wastewater treatment plants recover valuable resources from wastewater such as carbon, nitrogen, and phosphorus and need to be protected. Wastewater treatment plants are not sources of PFAS. The PFAS entering a wastewater treatment plant pass through the plant. The most effective way to reduce the amount of PFAS in our wastewater and our environment is to reduce the source of PFAS (source reduction).

DEFINITIONS

PFAS: Per- and polyfluoroalkyl substances (PFAS) are a large group of man-made chemicals that are resistant to heat, water, and oil.

PFOS: Perfluorooctane sulfonate is a specific substance in the large group of man-made chemicals.

WWTP: Wastewater Treatment Plant

What MCES is doing now to help address PFAS

We know:

PFAS impacts all water sectors. It's a problem for all of us.

PFAS management is challenging, expensive, and pushes the limits of available technology.

We need to work together to reduce PFAS.

We commit to:

Resources
Studying the issue to understand the full impacts of how PFAS affects our systems and customers and will work towards solutions.

Partnership
MCES will continue to collaborate with stakeholders and advocacy groups to gather information and develop solutions.

Sharing knowledge
MCES will draw on past experiences solving costly, complex water quality challenges.

MCES PFAS Data

- MCES began sampling for PFAS in Empire Wastewater Treatment Plant's effluent in 2020. That information is available publicly here: pca.state.mn.us/data/wastewater-data-browser
- You can find data for all of our facilities here. For the Empire WWTP select: **Met Council – Empire WWTP (MN0045845).**

For more information, contact: Terry Gilchrist
Environmental Health and Safety, Environmental Analyst• Terese.Gilchrist@metc.state.mn.us • 651.602.1193

METROPOLITAN COUNCIL ENVIRONMENTAL SERVICES

PFAS Fact Sheet

How MCES is using proven methods to reduce pollutants at the source for PFAS

- MCES has a history of partnering with communities, watersheds, and industries to successfully achieve source reduction and will continue to do so as the region works together to address the PFAS issue.
- MCES is aware of the PFAS issues facing the region and has been working with industrial customers to identify sources of PFAS in the regional wastewater system and as possible, reduce PFAS at the source.
- To date, MCES has worked with its industrial customers to:

Our work continues

2007-2014
Reduce PFOS coming into the Metropolitan WWTP by working with the source to identify and require changes at the facility that would reduce PFOS discharge to the regional wastewater system.

2010
Surveyed all Industrial Permit holders to identify PFAS-containing products in use. This effort allowed MCES to identify sources of PFAS and also resulted in a reduction of PFAS discharged to the regional wastewater system as companies chose to stop using PFAS containing products once identified.

October 2020
MCES conducted monitoring in the Empire WWTP collection system to identify industrial customers discharging PFAS compounds to the regional wastewater system. MCES will work with industrial customers to reduce the amount of PFAS being discharged.

What you can do to protect the environment

COOKWARE

- Don't use non-stick cookware.
- Cook with cast iron, stainless steel, ceramic, stoneware, and glass.

FOOD PACKAGING

- Cut back on fast food and carryout – PFAS is used in the cardboard containers and paper wrappers.
- Make popcorn on the stove or with an air popper instead of microwave popcorn in PFAS treated bags.

PERSONAL CARE PRODUCTS

- PFAS has been found in products ranging from eyeliner to dental floss.
- Search Skin Deep **ewg.org/skindeep** from the Environmental Working Group to find information on products you use.

STAIN-RESISTANT AND WATERPROOF FABRICS

- Avoid buying items that are labeled "stain-resistant", "water-resistant", or "water proof".
- Carpet and rugs are a major source of exposure for infants and toddlers.

WATER

- Visit the Minnesota Department of Health website **health.state.mn.us** to learn about PFAS and drinking water.
- Wash skin that has come into contact with PFAS-containing foam with soap and water.

To learn more visit: metrocouncil.org/landapp

Environmental Protection Agency (EPA)
epa.gov/chemical-research/research-and-polyfluoroalkyl-substances-pfas

Minnesota Department of Health (MDH)
health.state.mn.us/communities/environment/hazardous/topics/pfcs.html

Water Environment Federation (WEF)
wef.org/pfas

Minnesota Pollution Control Agency (MPCA)
pca.state.mn.us/waste/pfas-pollution

For more information, contact: Terry Gilchrist
Environmental Health and Safety, Environmental Analyst• Terese.Gilchrist@metc.state.mn.us • 651.602.1193