



m e m o

DATE: 09/21/2026

FROM: Minnesota Department of Health, Source Water Protection Unit

SUBJECT: Assessing potential water quality changes due to increased pumping in area around Elko New Market

Executive Summary

Minnesota Department of Natural Resources (DNR) received a request from Elko New Market (the City) to increase permitted water use. DNR required Elko New Market to run a pumping test to identify water level impacts. During and after the pumping test, DNR received complaints from many private well owners about water quality changes. As a result, DNR required the City to collect water quality samples at 20 wells within two miles of City wells. The City collected water quality samples during periods of both normal and elevated pumping rates.

DNR did not specify the lab method for sample analysis. December 2024 samples used an analytical method not approved for analysis of drinking water. A sampling round was added in July 2025 and used a drinking water method. The City collected samples in November 2025 during elevated pumping and December 2025 during normal pumping rates. The lab analyzed the November samples using both the non-drinking water and drinking water analytical methods. Data from November 2025 show significant differences in results measured by the two different methods.

Concentrations of arsenic, iron, and manganese in the samples indicate the aquifer geochemistry exhibits reducing conditions. Reducing conditions can make some minerals more soluble in water. Arsenic and iron data show no measurable difference between samples collected during elevated and normal pumping. Manganese data indicates higher concentrations in almost every well during elevated pumping compared to normal pumping. Data quality concerns make it difficult to determine if these differences are significant and whether these are caused by changes in aquifer conditions or by errors in the data.

Furthermore, data quality issues limit the number of samples that could be assessed, and do not permit a direct comparison of results taken before and after pumping rates increased, which is important in determining whether pumping changes could impact water quality in the aquifers. Finally, because no data was collected prior to the initial pumping test, water quality changes due to increased pumping cannot be fully assessed. Overall, the available data is not sufficient to evaluate whether increased pumping by the City could have caused the original water quality complaints. Recommendations for future study can be found at the end of this report.

Background

Elko New Market (the City) requested an increase in water use from the Minnesota Department of Natural Resources (DNR) in November 2022. As part of the evaluation, DNR required the City to conduct an aquifer test to assess potential impacts to surface water features and domestic wells. The aquifer test was conducted during November and December 2023. The test included groundwater level monitoring at wells in the Quaternary sand, Prairie du Chien, Jordan, Tunnel City and Wonewoc aquifers. Water quality was not sampled before or during the pumping test.

During and after the pumping test DNR received about 45 complaints about water discoloration and odor, some of which affected home water treatment systems and fixtures. As a result of the complaints, DNR required the City to implement a Water Quality Response Plan. The Water Quality Response Plan requires the City to conduct water quality sampling prior to increasing its pumping rate and during both high and low pumping rate conditions.

Description of work completed by the City

To fulfill the Water Quality Response Plan, the City sampled 18 private wells completed in both Quaternary and bedrock aquifers between December 2024 and April 2025 (Table 1). These samples were analyzed for arsenic, calcium, iron, magnesium, manganese, potassium, and sodium using EPA Method 6010D (part of the SW-846 compendium), which is intended for use in analyzing samples associated with solid waste (U.S. Environmental Protection Agency, 2025) and is not an EPA-approved drinking water method (U.S. Environmental Protection Agency, 2024). They were also analyzed for alkalinity, residual chlorine, chloride, nitrate, and sulfate using EPA Methods SM2320B, 300.0, 353.2, and 300.0, respectively. At 20 µg/L, laboratory reporting limits for arsenic using method 6010D were twice the maximum contaminant level (MCL) for arsenic in drinking water, rendering the data unusable from a public health perspective (all results were non-detects). To achieve appropriate laboratory reporting limits for arsenic in drinking water, the wells were resampled in summer 2025 and analyzed for arsenic using EPA Method 200.7, which is an approved drinking water method.

In November 2025, the City increased pumping to one million gallons per day (gpd) and sampled 19 private wells, including the 18 wells sampled previously and one additional well. The City then resumed a normal winter rate of pumping and in December 2025 sampled 16 of the 19 wells that had been sampled in November. Samples collected in November 2025 were analyzed using both EPA 6010D and EPA 200.7 to facilitate method comparison. Samples collected in December 2025 were analyzed using only method 200.7.

Samples were collected before and after well purging, except the summer 2025 sampling event when only post-purge were collected. Pre-purge samples were analyzed for iron and manganese only, whereas post-purge samples were analyzed for the full suite of chemicals (Table 1).

Table 1. Summary of City-led sampling events and parameters.

Sampling event	Number of wells	Pumping rate (gpd)	Relative pumping rate	Purge condition	Analytical method*	Analytes
December 2024	14	191,000 - 214,000	Normal	Pre-purge	6010D	Iron, manganese
December 2024	14	191,000 - 214,000	Normal	Post-purge	6010D	Arsenic, iron, magnesium, manganese, potassium, sodium, alkalinity, residual chlorine, chloride, nitrate, sulfate
April 2025	4	Unknown	Normal	Pre-purge	6010D	Iron, manganese
April 2025	4	Unknown	Normal	Post-purge	6010D	Arsenic, iron, magnesium, manganese, potassium, sodium, alkalinity, residual chlorine, chloride, nitrate, sulfate
July 2025	18	Unknown	Normal	Post-purge	200.7	Arsenic
November 2025	19	≥ 1,000,000	Elevated	Pre-purge	200.7	Iron, manganese
November 2025	19	≥ 1,000,000	Elevated	Post-purge	6010D, 200.7	Arsenic, iron, magnesium, manganese, potassium, sodium, alkalinity, residual chlorine, chloride, nitrate, sulfate
December 2025	16	333,000 - 567,000	Normal	Pre-purge	200.7	Iron, manganese
December 2025	16	333,000 - 567,000	Normal	Post-purge	200.7	Arsenic, iron, magnesium, manganese, potassium, sodium, alkalinity, residual chlorine, chloride, nitrate, sulfate

*This refers to the method used to analyze arsenic, iron, magnesium, manganese, potassium, and sodium.

In addition to parameters analyzed by the lab, the City also collected field water quality parameters during each sample. These parameters include temperature, specific conductivity, pH, dissolved oxygen (DO), and oxidation-reduction potential (ORP).

Data quality and limitations

In accordance with standard practices for collecting groundwater samples, MDH only used the data from samples collected after well purging and did not use the pre-purge data. Additionally, it was discovered after completion of sampling that samples for one well, 614931, were collected from a softened tap rather than untreated groundwater. Data from this well were removed from the dataset, leaving results for 18 wells in the November 2025 dataset and 15 wells in the December 2025 dataset. Comparisons between November 2025 and December 2025 data only utilize the 15 wells sampled during both events.

Analytical method differences

Prior to completing data analysis, MDH compared the results produced by method 6010D and method 200.7 for the same post-purge samples collected in November 2025. Differences between the two methods were evaluated for iron and manganese, two of the parameters of particular concern for this study. Note that arsenic was not analyzed with 6010D for the November sampling event due to the elevated reporting limits. MDH found that the percent difference between concentrations measured by each method ranged from 0.2% to 34% for iron and 0.3% to 68% for manganese (Table 2). The median differences were 6.7% and 2.8%, respectively, and the mean differences were 8.6% and 6.4%, respectively. Given these differences and the inappropriate application of method 6010D to drinking water samples, MDH only evaluated data collected using method 200.7.

We note that the results analyzed by Method 200.7 were produced by a different lab than the results produced by Method 6010D; the primary lab subcontracted out the 200.7 analyses, and those analyses were conducted on different dates than the 6010D analyses. Detailed quality control information is not available from the subcontractor lab, but there are no data qualifiers noted for the two samples with the highest discrepancies (Table 2).

Table 2. Differences in measured concentrations of iron and manganese using methods 6010D and 200.7 for November 2025 post-purge samples.

Unique well number	Fe by 6010D (µg/L)	Fe by 200.7 (µg/L)	Fe difference (µg/L)	Fe difference (%)	Mn by 6010D (µg/L)	Mn by 200.7 (µg/L)	Mn difference (µg/L)	Mn difference (%)
207187	2,840	2,990	-150	-5.3%	74.2	74	0	0.3%
207187 (dup)	2,690	2,940	-250	-9.3%	71.4	75	-4	-5.0%
212365	1,930	2,100	-170	-8.8%	63.2	67	-4	-6.0%
212376	375	393	-18	-4.8%	340	356	-16	-4.7%
212377	2,090	2,260	-170	-8.1%	37	36	1	2.7%

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Unique well number	Fe by 6010D (µg/L)	Fe by 200.7 (µg/L)	Fe difference (µg/L)	Fe difference (%)	Mn by 6010D (µg/L)	Mn by 200.7 (µg/L)	Mn difference (µg/L)	Mn difference (%)
212385	939	1,010	-71	-7.6%	270	281	-11	-4.1%
215724	1,400	1,470	-70	-5.0%	108	109	-1	-0.9%
420001	2,340	1,540	800	34.2%	64.9	109	-44	-68.0%
427498	1,430	1,530	-100	-7.0%	75.6	77	-1	-1.9%
436425	1,580	1,680	-100	-6.3%	31.1	31	0	0.3%
474636	1,520	1,620	-100	-6.6%	30.1	28	2	7.0%
502130	1,490	1,600	-110	-7.4%	110	112	-2	-1.8%
523542	1,820	1,800	20	1.1%	85.9	82	4	4.5%
534693	2,000	2,490	-490	-24.5%	108	111	-3	-2.8%
560352	1,870	1,980	-110	-5.9%	52.6	53	0	-0.8%
634488	3,430	3,660	-230	-6.7%	89.2	90	-1	-0.9%
657925	4,220	3,890	330	7.8%	311	325	-14	-4.5%
658117	1,080	1,150	-70	-6.5%	55.8	55	1	1.4%
822835	856	854	2	0.2%	468	450	18	3.8%

Duplicate differences

Lab reports were not provided as part of the City's data submittal, but each sampling effort required a duplicate sample to be collected at one site. Duplicates were collected at Well ID 207187 in November and Well ID 657925 in December. The percentage differences for iron in the sample and its duplicate are 1.7% and 60.1% in November and December, respectively. The percentage differences for manganese in the sample and its duplicate are 1.4% and 6.9% in November and December, respectively.

Study design

Water quality samples were not taken before the initial pumping test in November and December 2023, so no data is available representing baseline groundwater conditions. Samples were collected in December 2024 during normal pumping; however, it is not known whether water quality remained the same following the initial test in 2023. Furthermore, due to the analytical limitations of data collected in December 2024 and April 2025, MDH could only evaluate data from two out of three sampling events: data collected during elevated pumping in November 2025 and data collected during normal pumping in December 2025. For both these reasons, a drinking water chemistry comparison from before elevated pumping and during/after elevated pumping is not available.

Notably, City well pumping rates in December 2025 are higher than the pumping rates in December 2024 (333,000-567,000 gpd vs. 191,000-214,000 gpd). Though the December 2025

pumping rates are described as normal, they are up to 3 times higher than they were during the previous winter sampling, creating different baseline conditions compared to the 2024 samples. Throughout this memo, MDH draws comparisons between December 2025 and November 2025 results as representative of normal versus elevated pumping conditions. However, the December 2025 data should not be viewed as equivalent in utility to the December 2024 data (*before* the second round of elevated pumping); rather, it should be interpreted as representing conditions *following* a period of elevated pumping.

Field data quality

Sampling procedures required the City to purge wells and monitor field parameters to ensure the parameters stabilize by the time of sampling, which ensures the pumped water is from the aquifer and not water that had been stagnant in the well. The field parameters monitored and recorded on the field sheets include dissolved oxygen, pH, oxidation-reduction (redox) potential, and conductivity. Field data can be useful when interpreting lab results.

Dissolved oxygen values can provide insight into redox reactions. This is particularly helpful when analyzing arsenic, iron, and manganese as all can be impacted by changes in dissolved oxygen. In general, dissolved oxygen was lowest in November 2025 and highest in December 2024. However, some of the December 2024 values are above the dissolved oxygen saturation limit (YSI, a Xylem Brand, 2019) and many of the November and December 2025 values had no dissolved oxygen (Figure 1). Neither of these results represent possible values for groundwater, indicating potential issues with the meter or sampling methodology. MDH notes that for other data quality reasons, the December 2024 data have not been used for the remainder of the analysis in this memo.

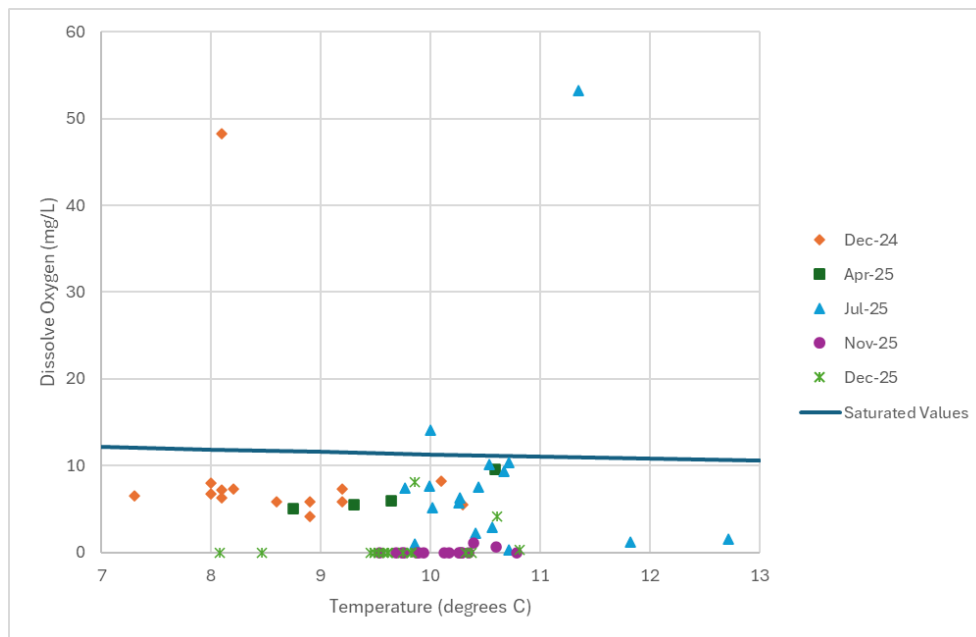


Figure 1. Dissolved oxygen vs. temperature values plotted with maximum dissolved oxygen in water at specific temperatures.

Changes in pH can impact the solubility of metals in water and are taken and recorded at the time of sampling. In general, pH was the lowest in November 2025 and highest in December 2024, similar to dissolved oxygen. Wells with the largest changes in pH between November 2025 and December 2025 sampling had six percent or less change for arsenic, iron, and manganese concentrations. Field data shared by Dakota County from nearby sampling efforts indicate that pH values are generally greater than seven. Most sampling events have less than five percent of samples with pH less than seven. All pH values for November and December 2025 are less than seven, which is inconsistent with past data for the region.

General Water Chemistry

The major cation and anion chemical constituents were plotted using Piper diagrams to visually represent groundwater chemistry. The data were separated both by collection period and by aquifer to determine if there were differences in groundwater during various pumping scenarios. Figures 2 and 3 show the bedrock and Quaternary groundwater types over time. There is minimal change in water chemistry between normal pumping and elevated pumping.

Charge balance errors were calculated for the major cations and anions in each sample to ensure neutrality. From November and December 2025, 29 out of 33 samples fall under 5% error, which is generally considered the acceptable error when evaluating general groundwater chemistry. The maximum calculated charge balance error was 13.8%.

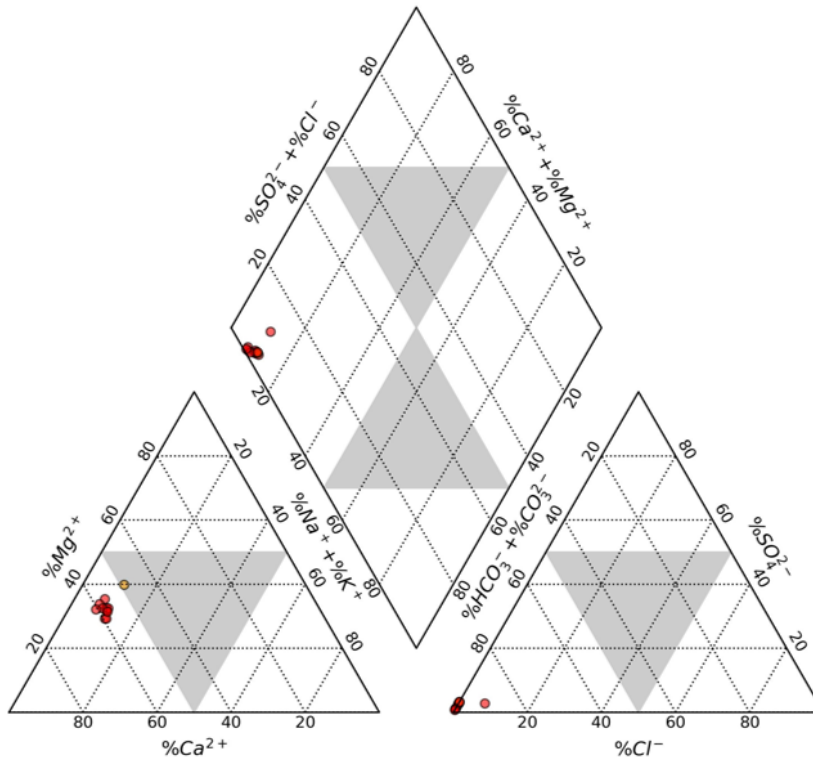
Water Quality Indicators

Arsenic, iron, and manganese are naturally occurring in groundwater in Minnesota. Changes in water levels can change oxygen levels. The changes in oxygen levels can change concentrations of these elements in water.

Arsenic

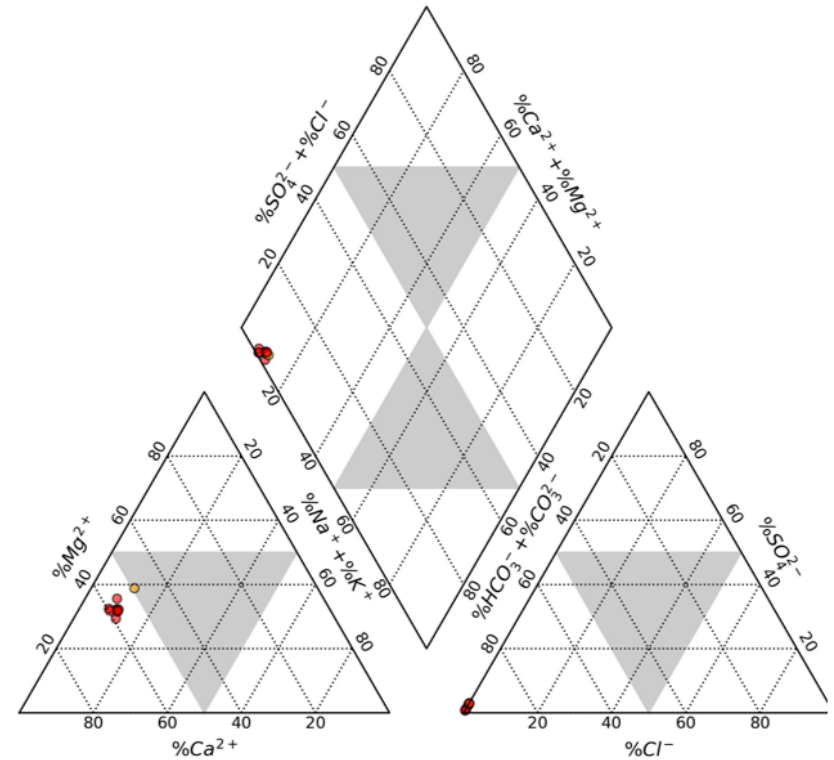
Occurrence and exposure

Arsenic occurs naturally in rocks and sediment and can dissolve into groundwater (Minnesota Department of Health, 2021). It exists in two oxidation states: As^{+3} and As^{+5} . Under reducing conditions, As^{+3} is favored, whereas under oxic conditions, the As^{+5} form is more prevalent. However, both forms can coexist in varying amounts under either condition. For removal, As^{+3} must first undergo oxidation to the less soluble As^{+5} form before it is able to adsorb freely to a solid surface and undergo precipitation (Shankar, Shankar, & Shikha, 2014). In areas with large amounts of confining clay and small sand pockets it is common to see higher instances of naturally occurring arsenic in water from wells screened just below the clay unit (National Institute of Environmental Health Sciences (NIEHS), 2020) (Erickson, Yager, Kauffman, & Wilson, 2019).



November 2025

(elevated pumping)

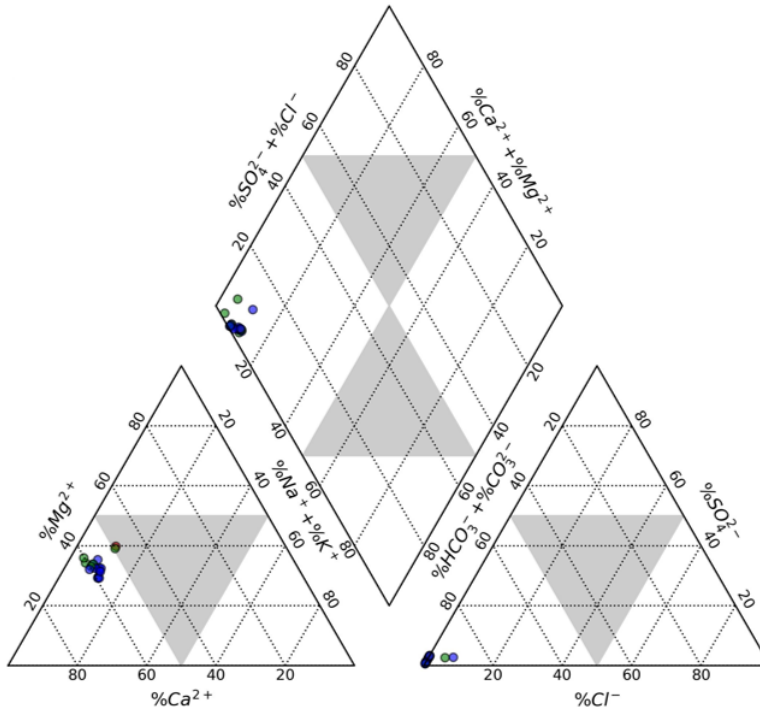


December 2025

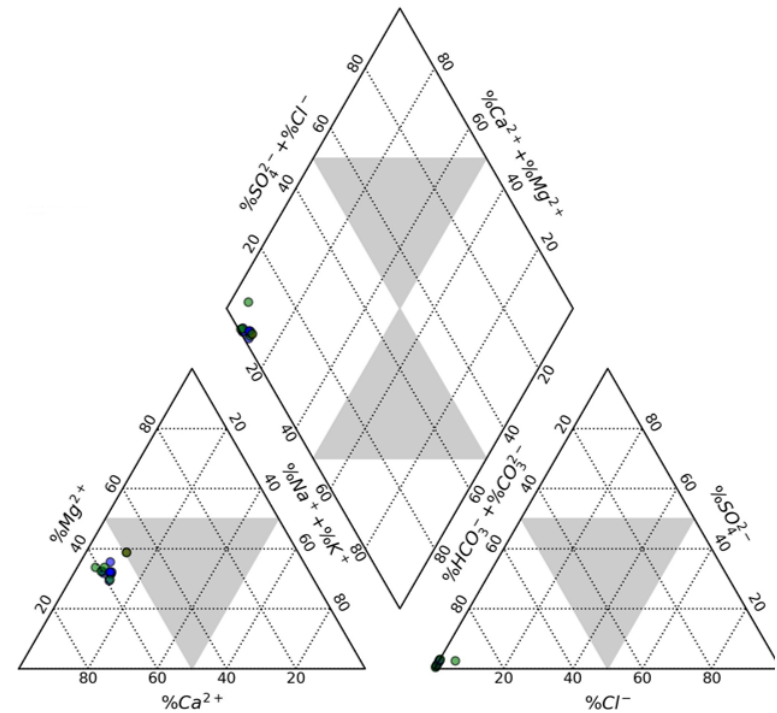
(normal winter pumping)

Figure 2. Bedrock water chemistry Piper diagrams.

ASSESSING POTENTIAL WATER QUALITY CHANGES AROUND ELKO NEW MARKET



November 2025
(elevated pumping)



December 2025
(normal winter pumping)

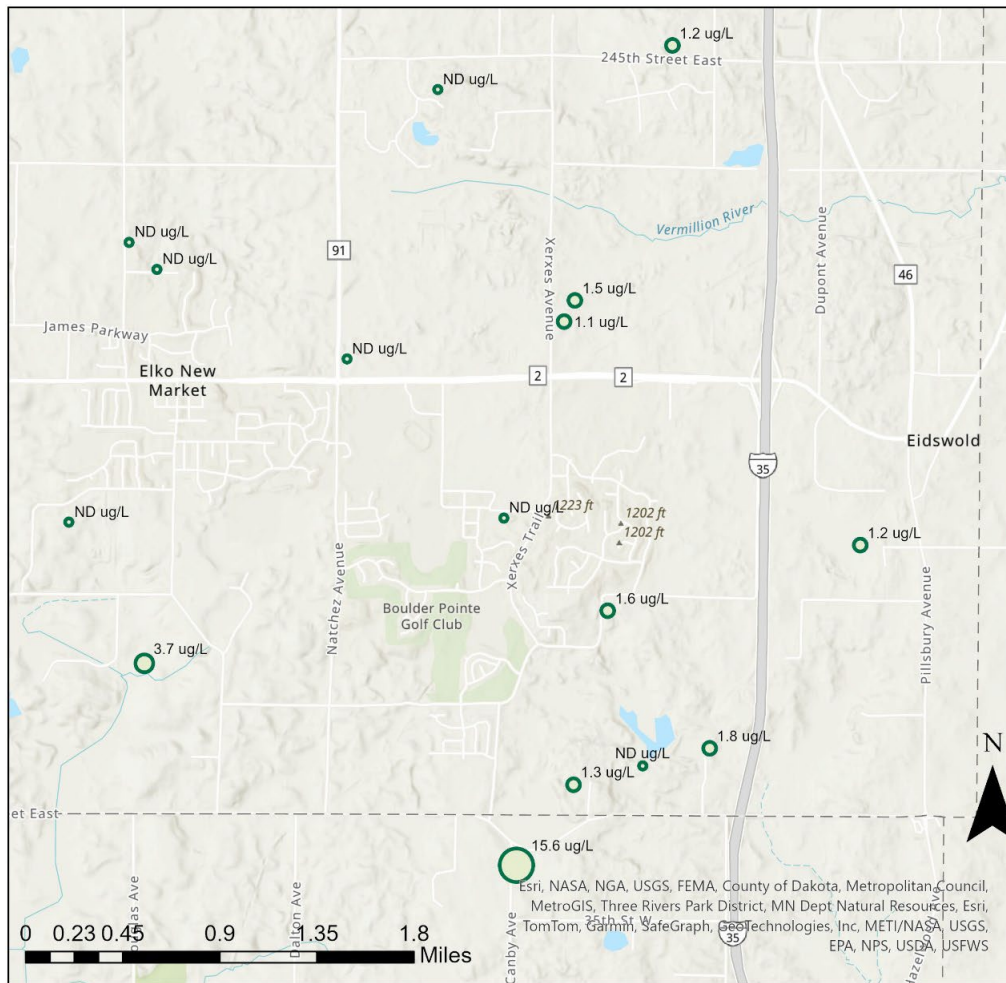
Figure 3. Quaternary water chemistry Piper diagrams.

The US Environmental Protection Agency (EPA) established a maximum contaminant level (MCL) for arsenic of 10 µg/L (United States Environmental Protection Agency, 2018). Drinking water with low levels of arsenic over a long time is associated with diabetes and increased risk of cancers of the bladder, lungs, liver, and other organs. Contact with arsenic can also contribute to cardiovascular and respiratory disease, reduced intelligence in children, and skin problems, such as lesions, discoloration, and the development of corns.

Findings

In November and December 2025, arsenic was detected in nine of 18 wells, with one well showing concentrations above the MCL during both events. There were arsenic detections in both the Quaternary and Bedrock aquifers. There does not appear to be any pattern in concentrations based on aquifer or spatial distribution (Figures 4 and 5). For the 15 wells sampled in both November 2025 (elevated pumping) and December 2025 (normal pumping), differences in arsenic concentrations were generally less than 1 µg/L or 10% (Figure 6a-b). The maximum percent difference was a 21% lower concentration in arsenic during high pumping compared to normal pumping in one well completed in the Prairie du Chien aquifer (Figure 6b). In all but one well with detectable arsenic, arsenic concentrations were lower during the period of elevated pumping compared to the period of normal pumping. Each of the six wells with a non-detect result for arsenic showed non-detects during both sampling events. Additionally, the single well with concentrations exceeding the MCL showed exceedances during both normal and high pumping (Figure 7).

Aggregate arsenic concentrations during the November and December 2025 sampling events were compared for both wells in the Prairie du Chien and Quaternary aquifers using a two-sided Wilcoxon rank sum test, which is a nonparametric test of differences in distribution between two groups of data (Ford, 2023). P-values for both aquifers were greater than 0.05, indicating that there is no statistically significant difference between concentrations in the two groups (Figure 8). Note that one well, 657925, is completed in the Jordan aquifer rather than the Prairie du Chien and was not included in this analysis.



Legend

November 2025

Arsenic (ug/L)

- Non-detect
- ≤ 2
- > 2 ≤ 5
- > 5 ≤ 10
- > 10

Arsenic concentration

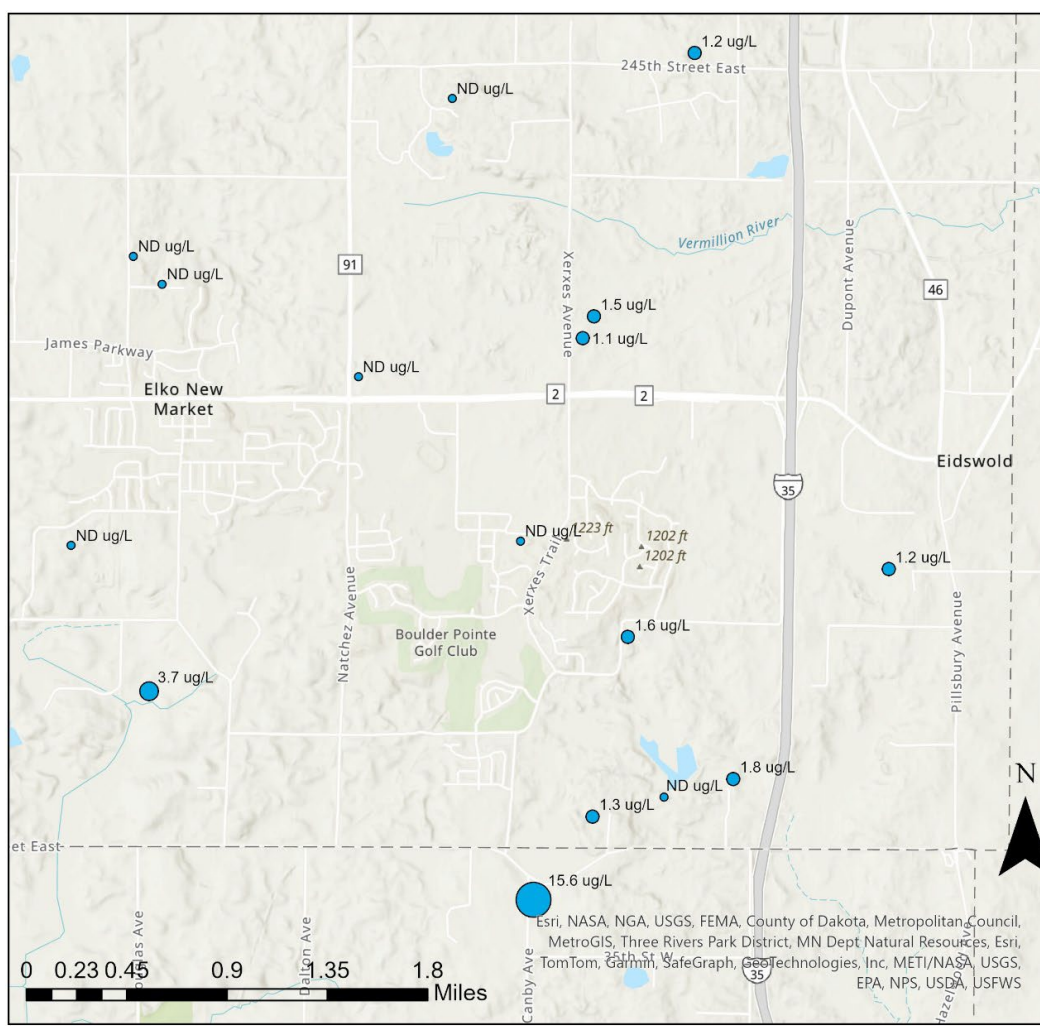
November 2025

Note: ND = Non-detect



Figure 4. Arsenic concentration in November 2025.

ASSESSING POTENTIAL WATER QUALITY CHANGES AROUND ELKO NEW MARKET



Legend

December 2025

Arsenic

- Non-detect
- $>0 \leq 2$
- $>2 \leq 5$
- $>5 \leq 10$
- >10

Arsenic concentration December 2025

Note: ND = Non-detect



Figure 5. Arsenic concentrations in December 2025.

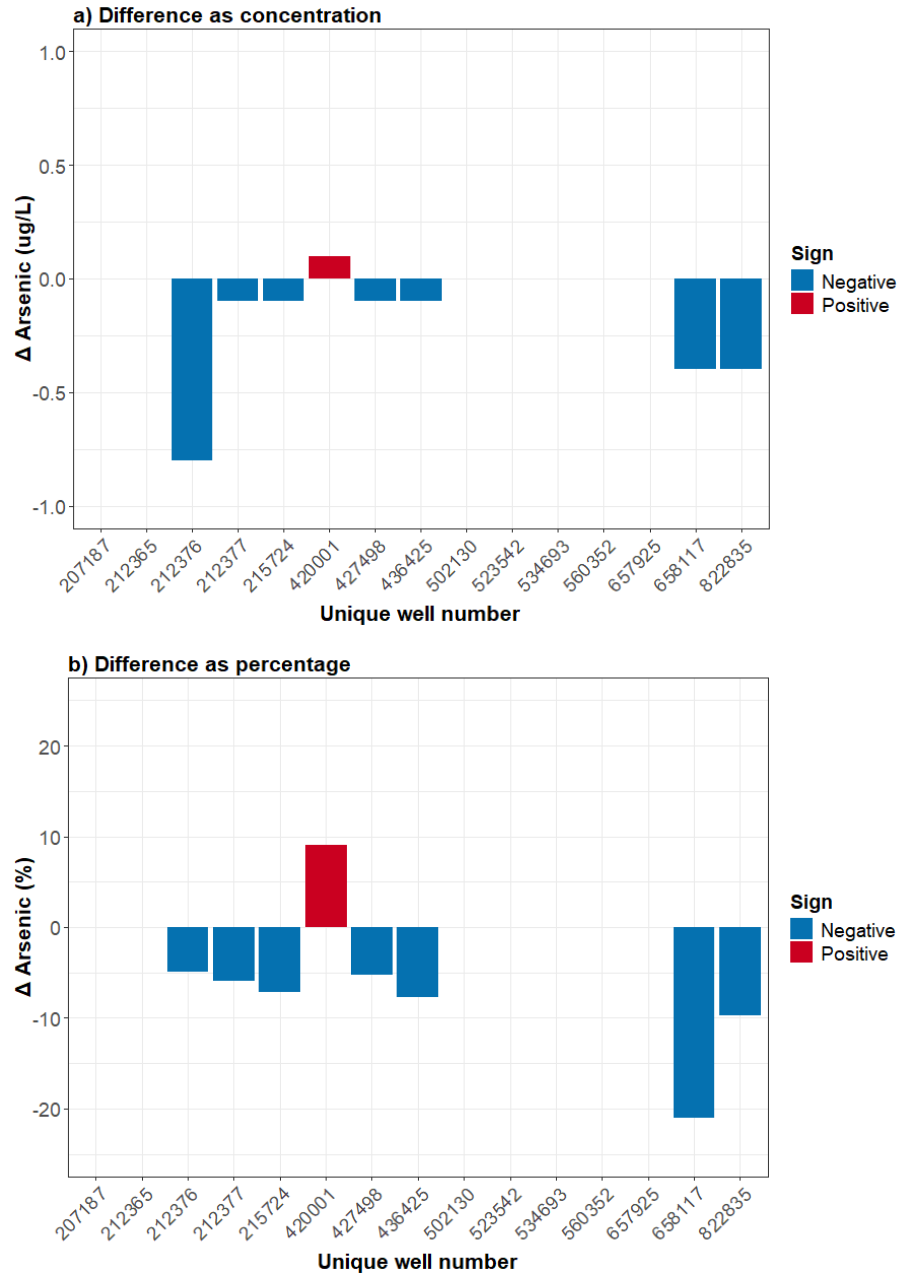


Figure 6. Difference in arsenic concentrations between normal pumping and elevated pumping conditions as a) numeric difference and b) percentage difference.

Blue bars indicate that concentrations were lower during the elevated pumping period; red bars indicate that concentrations were higher during the elevated pumping period. Missing bars indicate there was no difference between the two events.

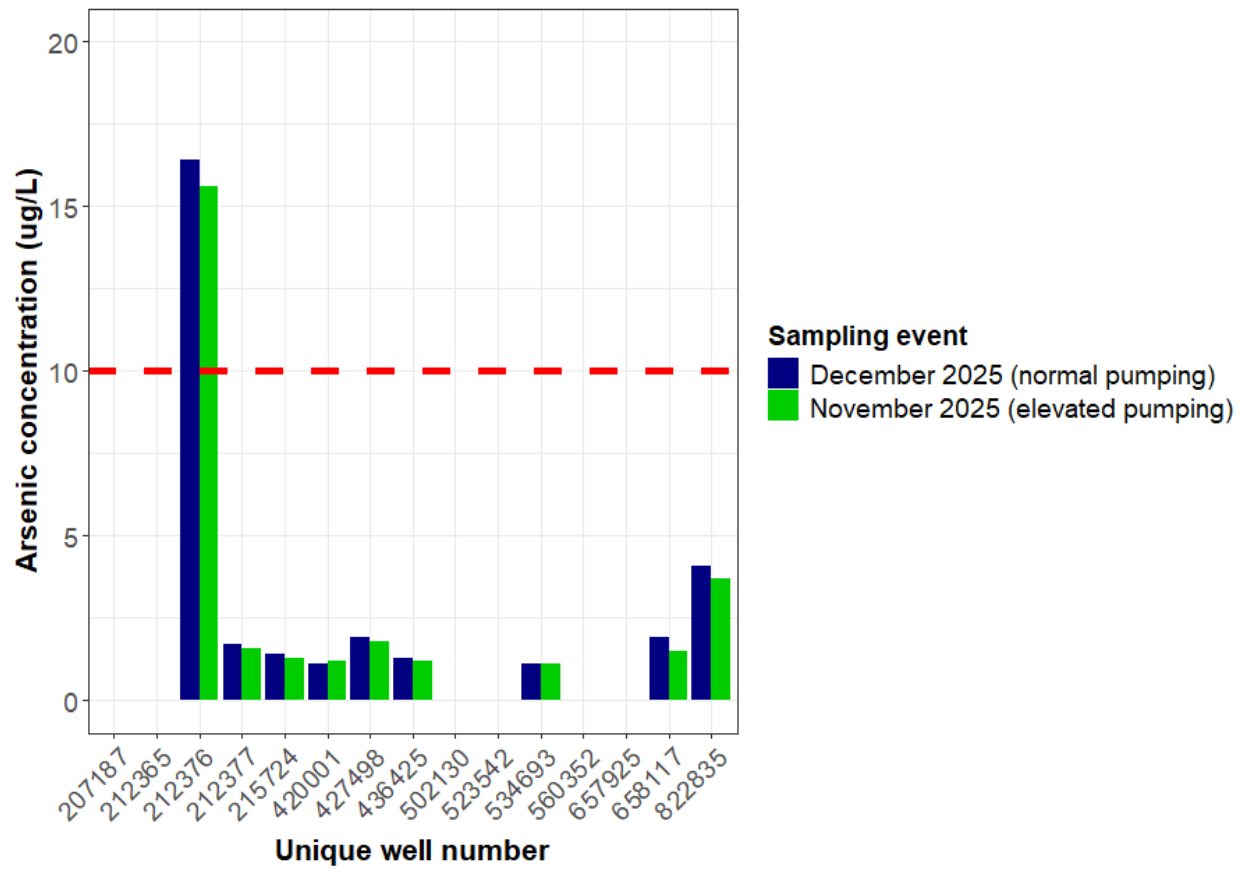


Figure 7. Arsenic concentrations in November and December 2025 relative to the MCL (dashed red line)

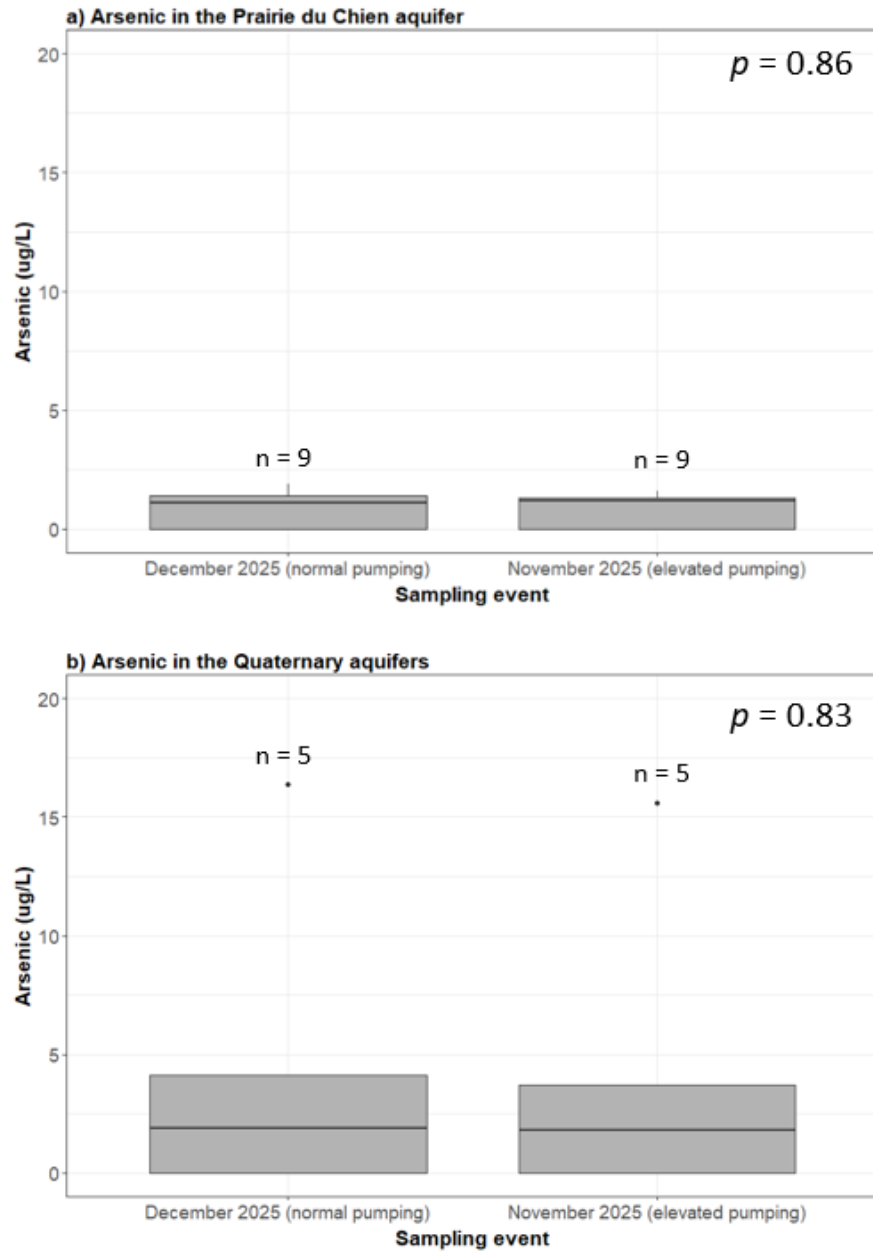


Figure 8. Aggregate arsenic concentrations measured in wells in a) the Prairie du Chien (bedrock) aquifer, and b) the Quaternary aquifers for the November and December 2025 sampling events. P-values represent results of two-sided Wilcoxon rank sum tests comparing concentrations observed during the two sampling events.

Iron

Occurrence and Exposure

Some soil and rocks in Minnesota are very high in iron. As rain falls or snow melts on the land surface and water seeps through iron-bearing soil and rock. The low-to-no-oxygen environment releases iron from the soil and rock. The released iron can be dissolved into water. When oxygen is introduced to the iron rich water the iron precipitates out and is often identified by staining plumbing fixtures. Like how iron in a metal pail turns to rust when exposed to water and oxygen, iron minerals in water turn to rust and stain plumbing fixtures and laundry.

Iron in water does not usually present a health risk. Iron may present some concern if harmful bacteria have entered a well. Some harmful organisms require iron to grow. If there is iron in the water, it may be harder to get rid of harmful bacteria. Water with an iron concentration above 300 µg/L is usually considered objectionable (“nuisance levels”). Iron levels are usually below 10,000 µg/L in groundwater.

Findings

Iron concentrations range from 383 µg/L to 3,890 µg/L. There are no discernable patterns in concentrations based on aquifer or spatially (Figures 9 and 10). Differences in iron concentrations in individual wells between the high pumping event (November 2025) and normal pumping event (December 2025) range from 10 µg/L to 2,260 µg/L; as a percentage difference, the range is less than 1% to 62% (Figure 11a-b). Five wells had lower iron concentrations during the period of high pumping compared to low pumping, while 10 wells had higher iron concentrations during high pumping. Whether concentrations were higher or lower during high pumping was not dependent on aquifer.

Iron concentrations are above nuisance levels in all wells regardless of pumping rate during the time of sampling (Figure 12). Aggregate concentrations in the November and December samples are not significantly different for either the Quaternary or Prairie du Chien aquifer using a 5% significance level (Figure 13).

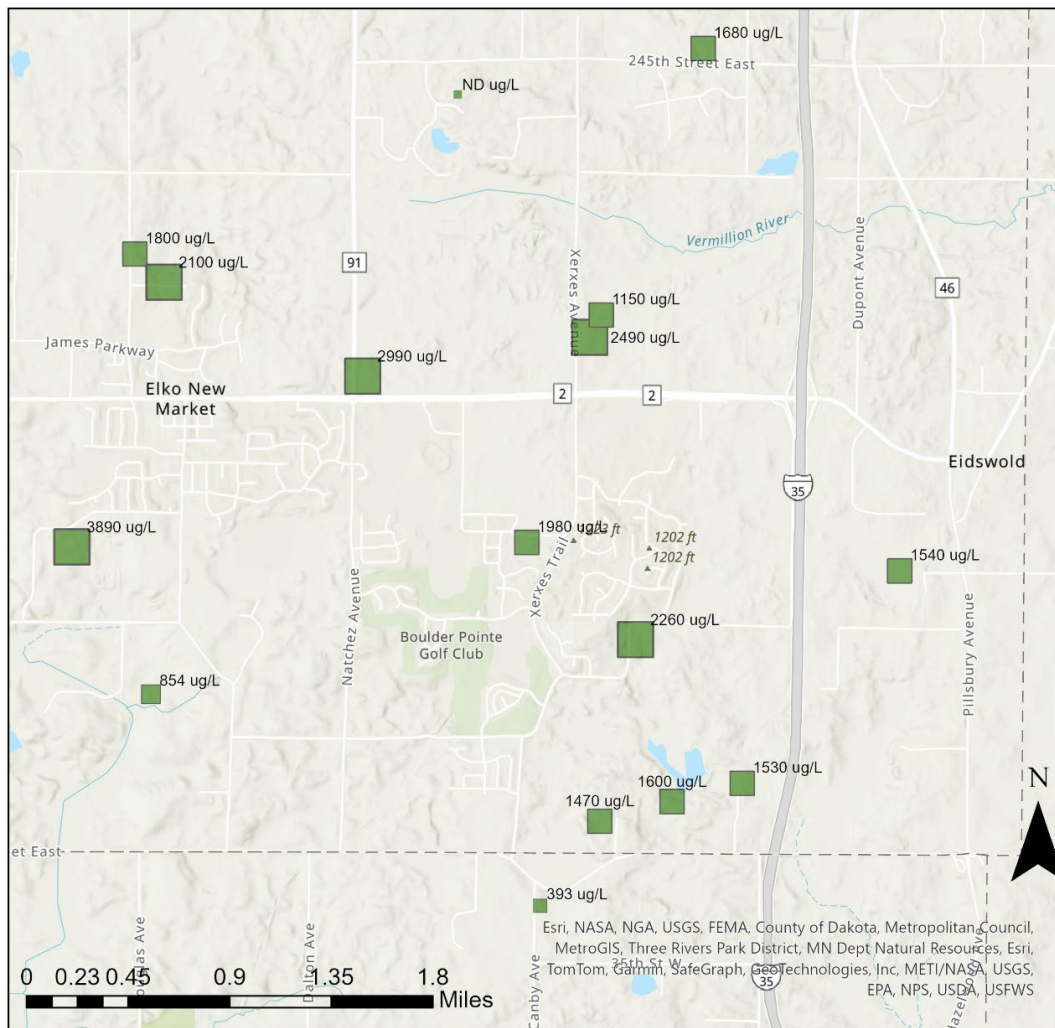
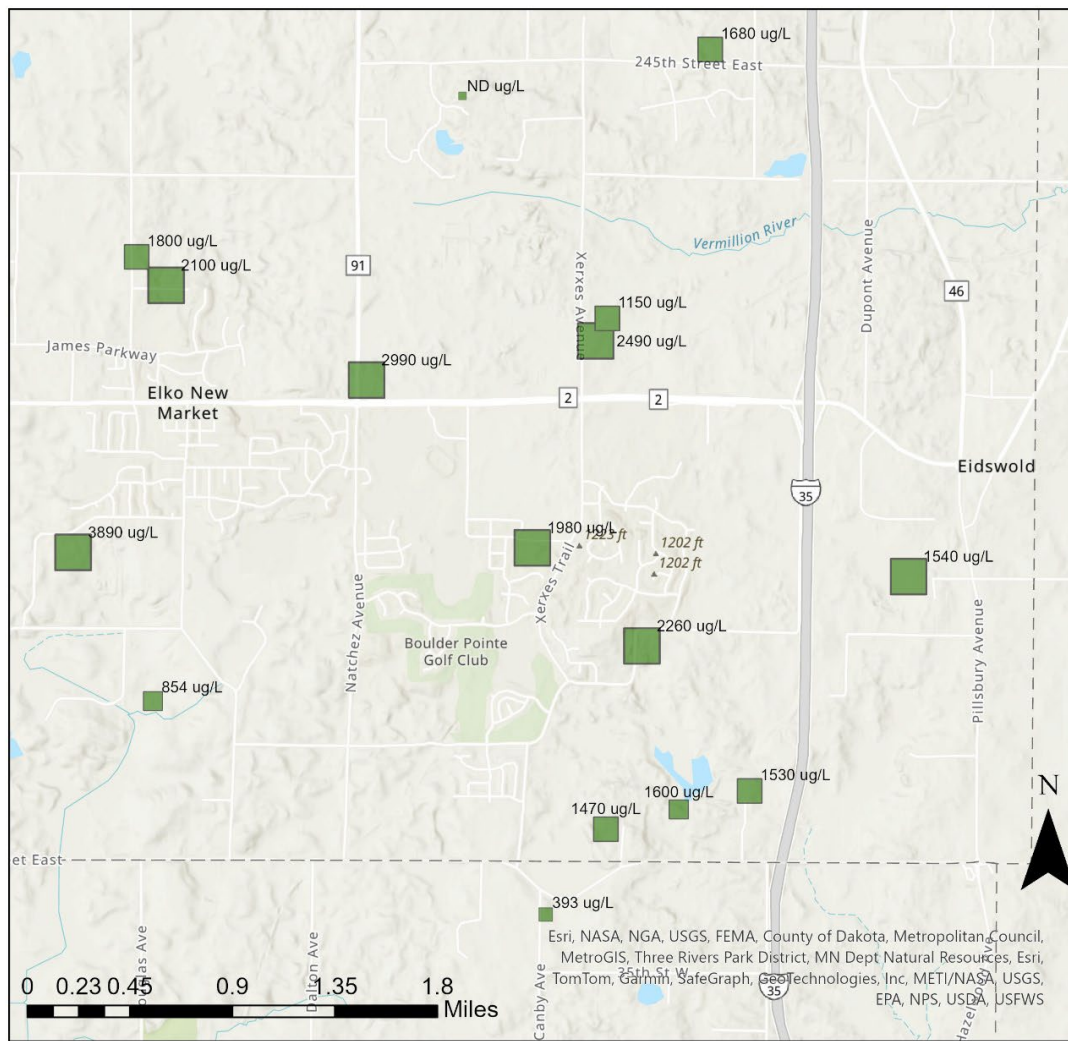


Figure 9. Iron concentrations November 2025.



Iron concentration

December 2025

Note: ND = Non-detect



Figure 10. Iron concentrations December 2025.

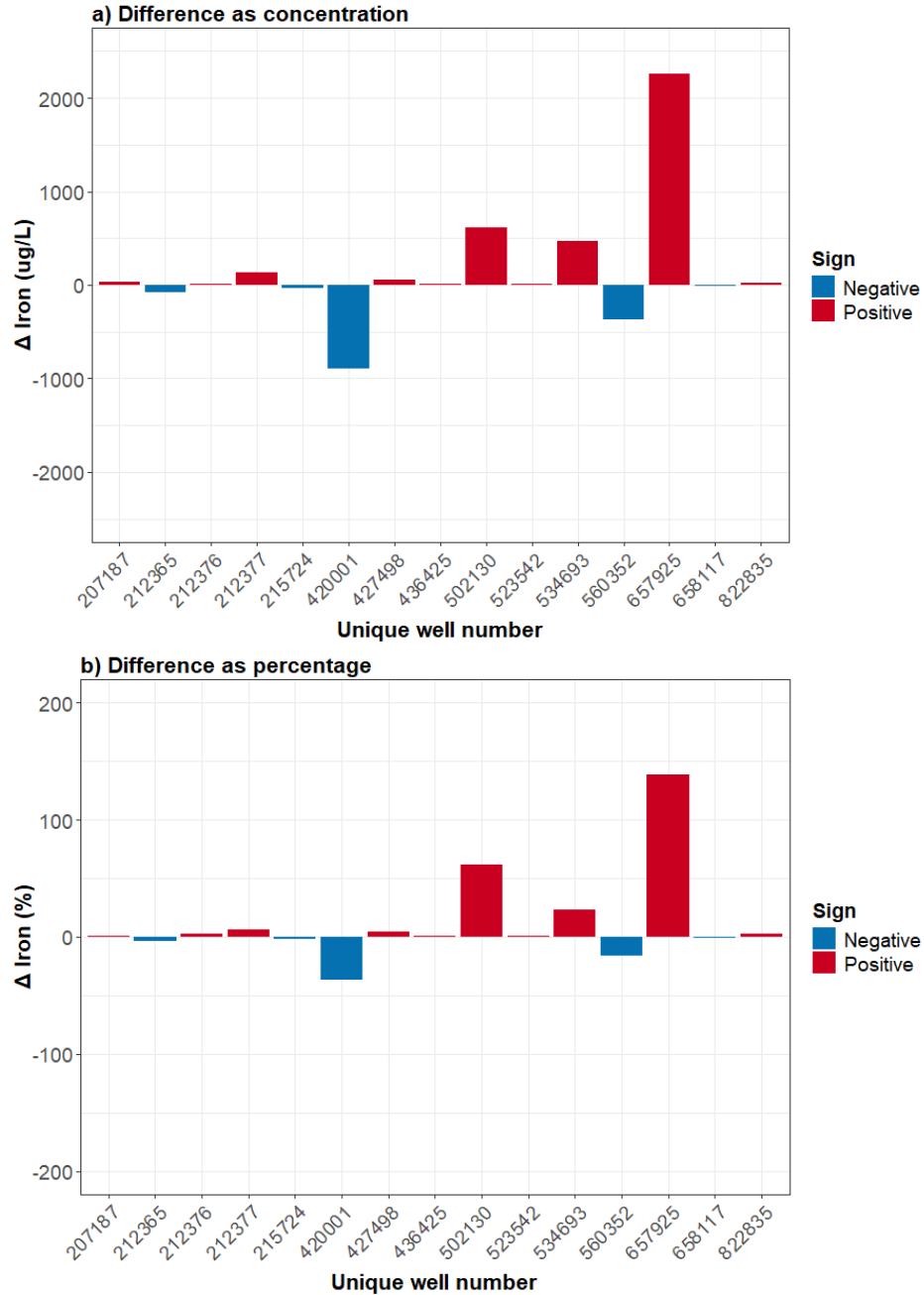


Figure 11. Difference in iron concentrations between normal pumping and elevated pumping conditions as a) numeric difference and b) percentage difference. Blue bars indicate that concentrations were lower during the elevated pumping period; red bars indicate that concentrations were higher during the elevated pumping period. Missing bars indicate there was no difference between the two events.

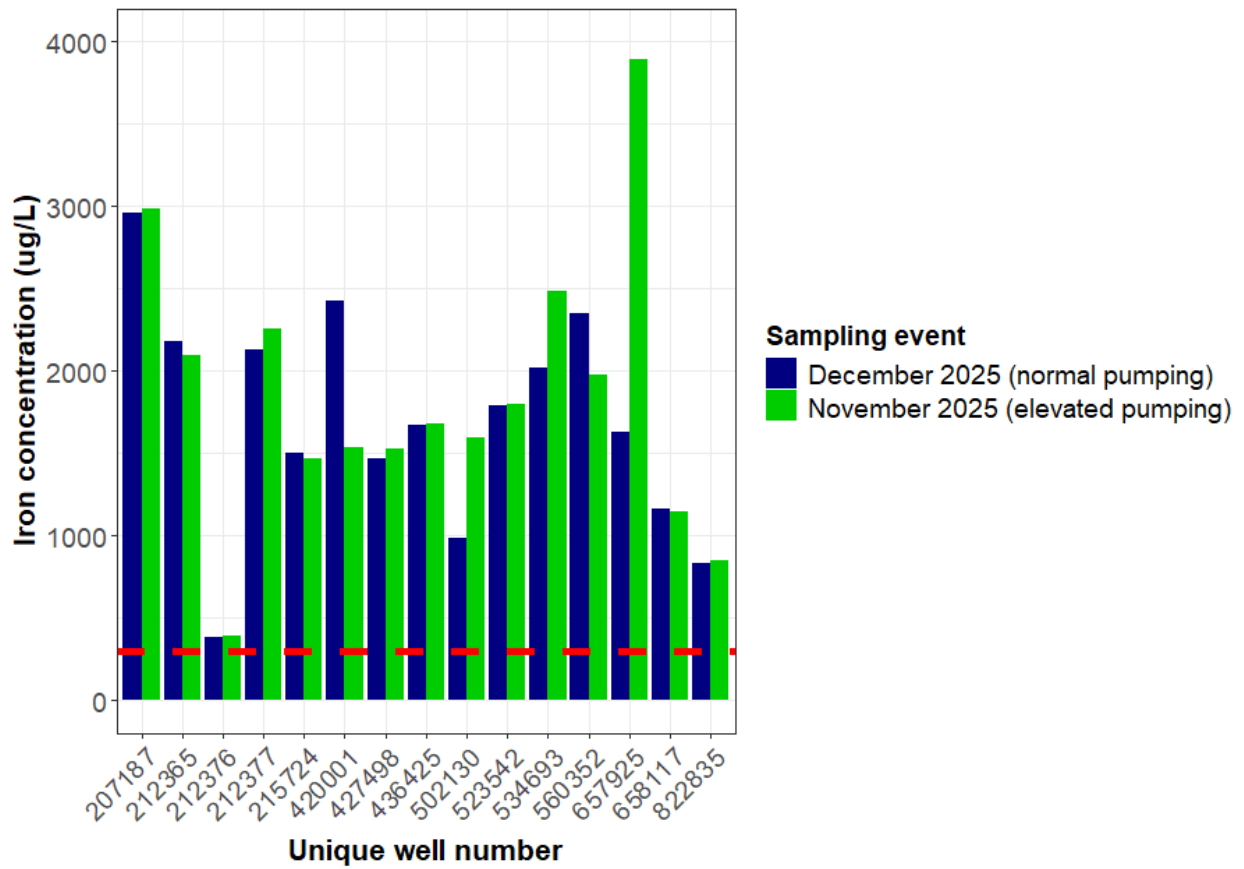


Figure 12. Iron concentrations in November and December 2025 relative to nuisance levels (red dashed line).

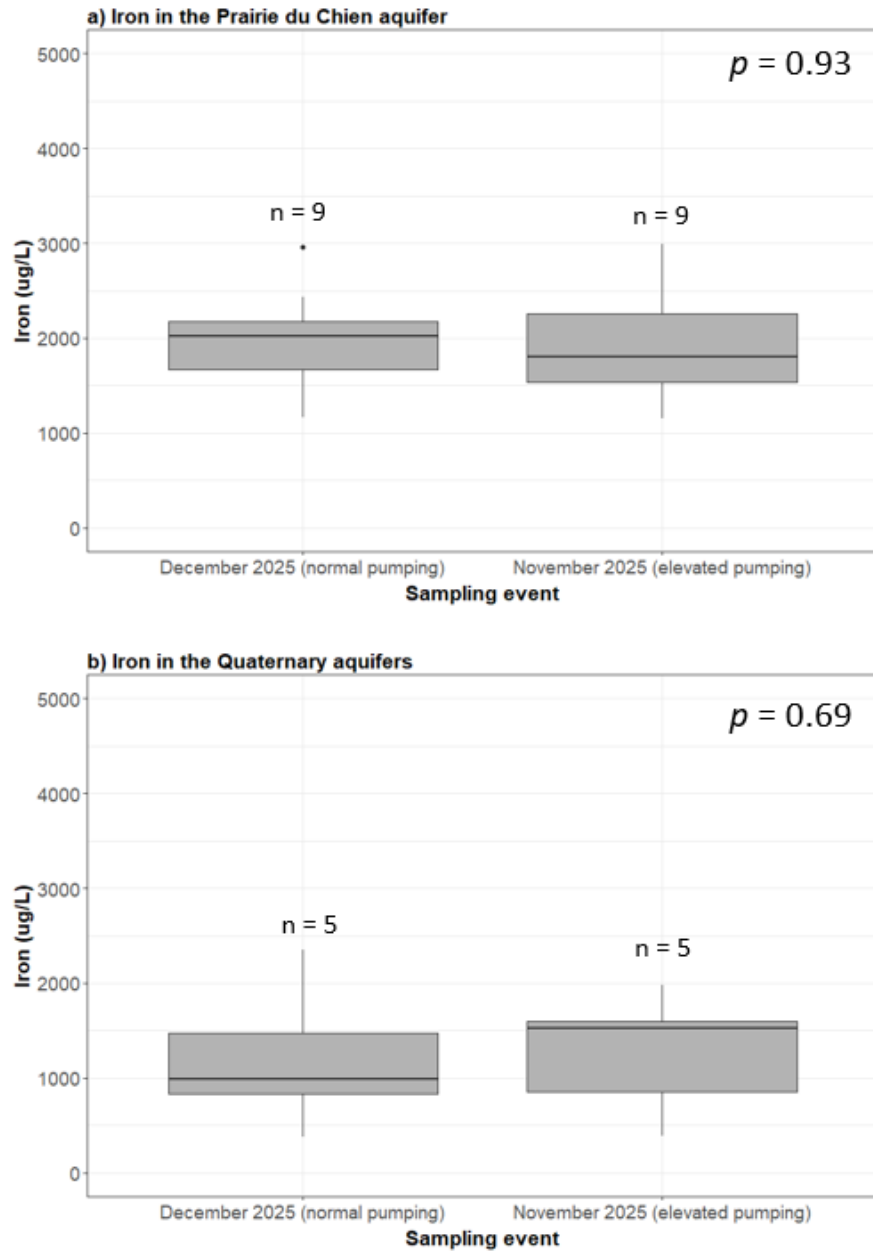


Figure 13. Aggregate iron concentrations measured in wells in a) the Prairie du Chien (bedrock) aquifer, and b) the Quaternary aquifers for the November and December 2025 sampling events. P-values represent results of two-sided Wilcoxon rank sum tests comparing concentrations observed during the two sampling events.

Manganese

Occurrence and Exposure

Manganese occurs naturally in rocks and sediment and is often found in Minnesota groundwater and surface water (Minnesota Department of Health, 2023). It exists in both solid and aqueous forms, typically co-occurring with iron. Its behavior is largely driven by oxidation and reduction chemical reactions. Under reducing conditions, manganese converts to the more soluble form Mn^{+2} . This leads to higher concentrations, often associated with deep confined aquifers isolated from the atmospheric oxygen. Interaction with atmospheric oxygen causes oxidation of manganese to the more insoluble Mn^{+3}/Mn^{+4} form. Under these conditions, precipitation occurs, and particles drop out of suspension, leaving water relatively depleted of manganese (Minnesota Groundwater Association, 2015).

In concentrations above approximately 50 $\mu\text{g/L}$, dissolved manganese can be a household nuisance. As the water reaches the surface, atmospheric oxygen can cause manganese to precipitate leading to negative aesthetic effects such as discoloration, change in odor, and/or taste. With over 60% of ambient groundwater measurements exceeding 50 $\mu\text{g/L}$ in Minnesota, it is likely that many water supplies contain nuisance levels of manganese (Minnesota Department of Health, 2012).

The guidance for safe concentrations of manganese in drinking water, as established by the Minnesota Department of Health, is 300 $\mu\text{g/L}$ for adults and children above 1 year and 100 $\mu\text{g/L}$ for infants (Minnesota Department of Health, 2023). Children and adults who drink water with excessive levels of manganese for an extended period may experience neurological effects including problems with memory, attention, and motor skills (Minnesota Department of Health, 2023). Infants are especially vulnerable to ingested manganese; their bodies absorb the metal more readily than adults or children but are unable to excrete excessive amounts (Minnesota Groundwater Association, 2015).

Findings

Manganese concentrations ranged from 29 to 450 $\mu\text{g/L}$ across both sampling events. There are no discernable patterns in manganese concentration by aquifer or spatially (Figures 14 and 15). However, manganese concentrations in all but one well were higher during the period of elevated pumping compared to the period of normal pumping (Figure 16). The percentage difference was less than 10% in most wells, with one well showing a 79% difference between the two sampling events. Well ID 420001 is located to the east of the pumping center (Figures 14 and 15), and the manganese concentration measured by EPA Method 200.7 was 109 $\mu\text{g/L}$ in November 2025 (high pumping) compared to 61 $\mu\text{g/L}$ in December 2025 (normal pumping). It is unclear why this well may have experienced such a large change based on geology or location. Importantly, the sample collected from this well in November 2025 showed significantly different measured concentrations when analyzed with EPA Method 6010D (64.9 $\mu\text{g/L}$) versus EPA Method 200.7 (109 $\mu\text{g/L}$), representing a 68% error (Table 2). If the concentration measured by method 6010D were to be used, the difference between the November and

December concentrations would be negligible. Based on the information available to MDH at the time of this memo, the cause of the large discrepancy in manganese concentrations between the two methods is unclear, and the results for this well should be viewed as suspect.

Five wells had manganese concentrations exceeding the HRL for infants younger than one year (100 µg/L) in at least one sample, and three wells had concentrations exceeding the HRL for people older than one year (300 µg/L) in at least one sample (Figure 17). Well 657925 had a manganese concentration lower than the 300 µg/L threshold (279 µg/L) during normal pumping and a concentration higher than that threshold during elevated pumping (325 µg/L), a 16% difference between the two events. Notably, a duplicate sample was collected for this well during the period of normal pumping. The duplicate concentration was 299 µg/L, which is almost at the higher HRL and would represent a smaller difference from November sampling, at 9%. Well 420001 had a manganese concentration lower than the infant HRL (61 µg/L) during normal pumping and a concentration above the infant HRL (109 µg/L) during elevated pumping. However, as previously noted, the manganese data for this well is suspicious, and reliable conclusions about differences in health risk during higher pumping cannot be drawn.

Aggregate manganese concentrations during November (elevated pumping) and December (normal pumping) were compared against each other in wells in the Prairie du Chien and the Quaternary aquifers (Figure 18). Using two-sided Wilcoxon rank sum tests, there are no significant differences in concentrations between the two sampling events for either aquifer, using a 5% significance level.

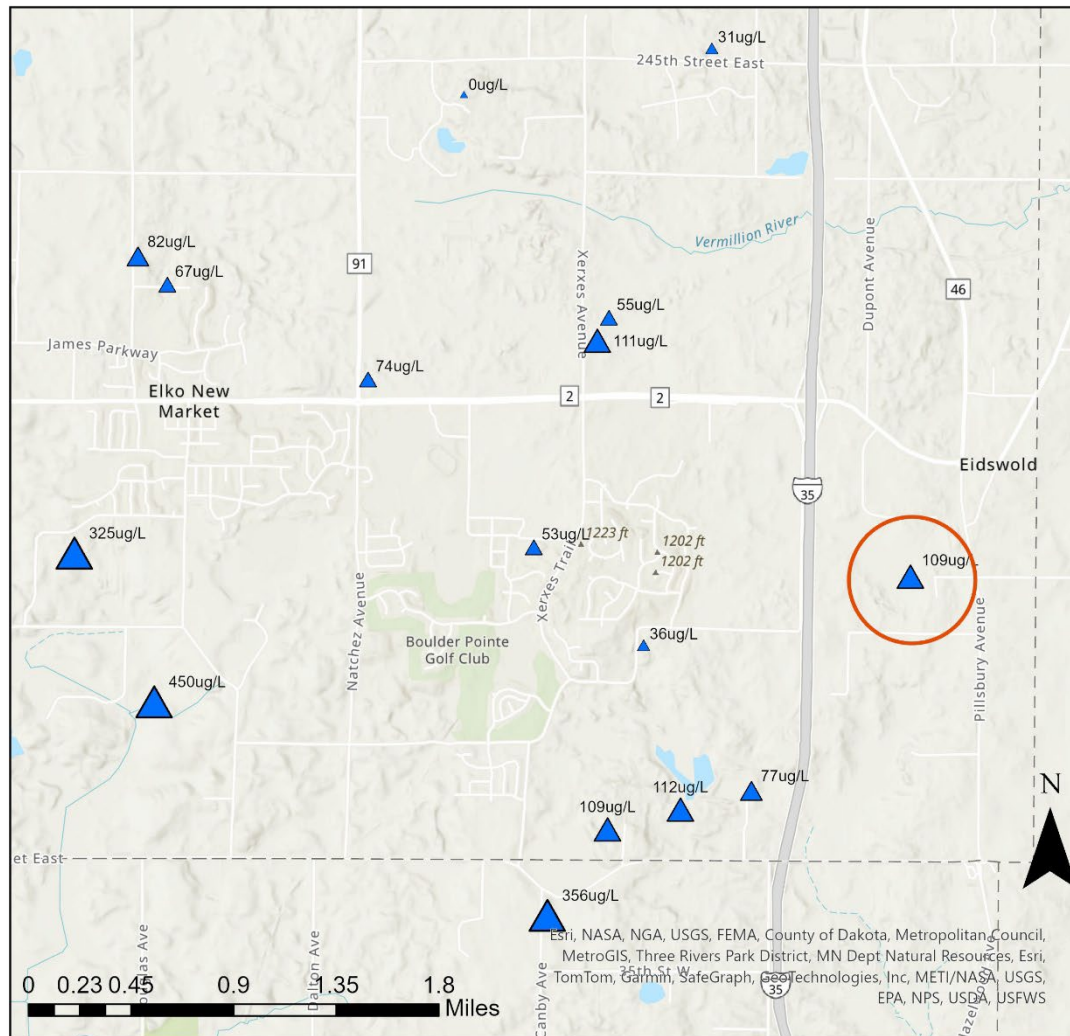
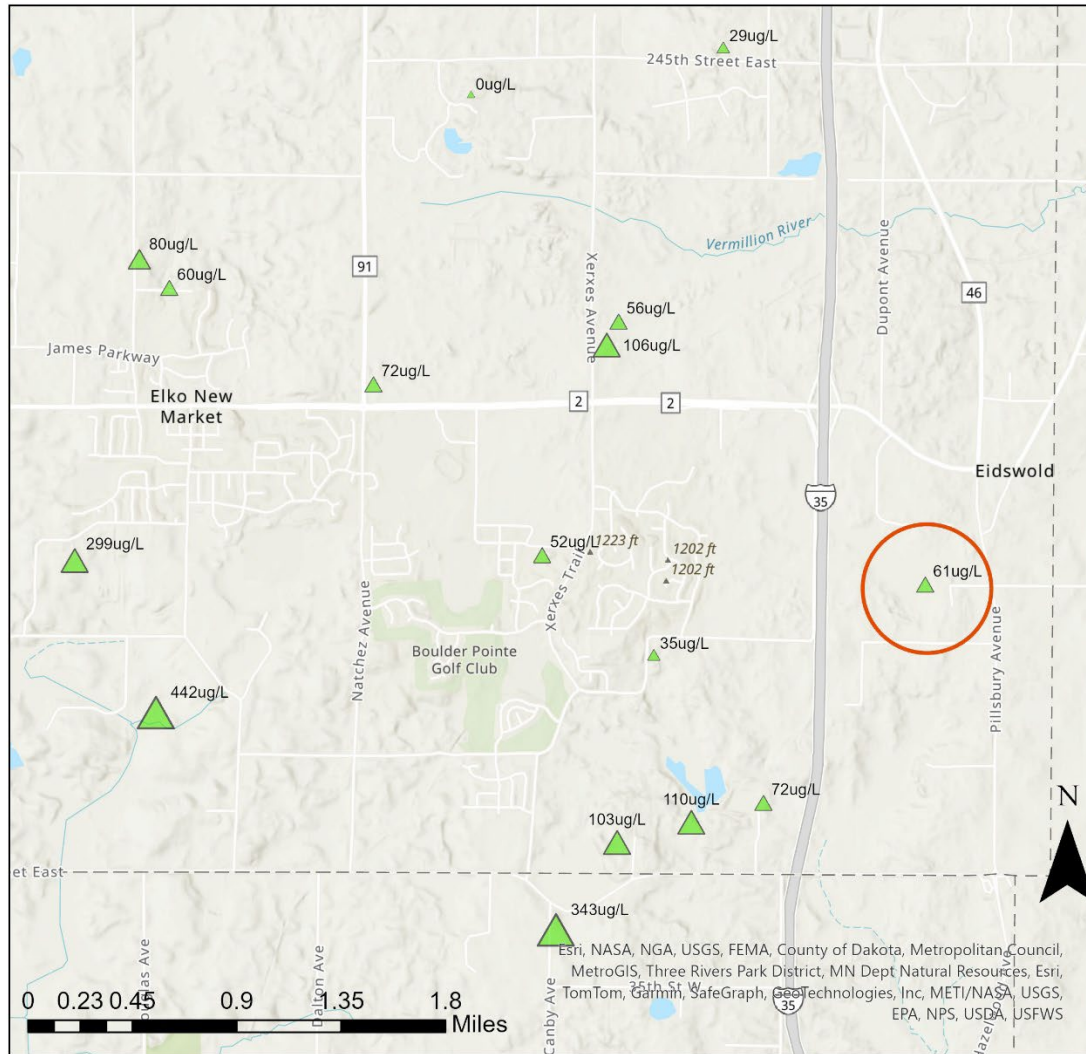


Figure 14. Manganese concentrations November 2025.



Manganese concentration
December 2025
Note: ND = Non-detect
Circled well is Well ID 420001



Figure 15. Manganese concentrations December 2025.

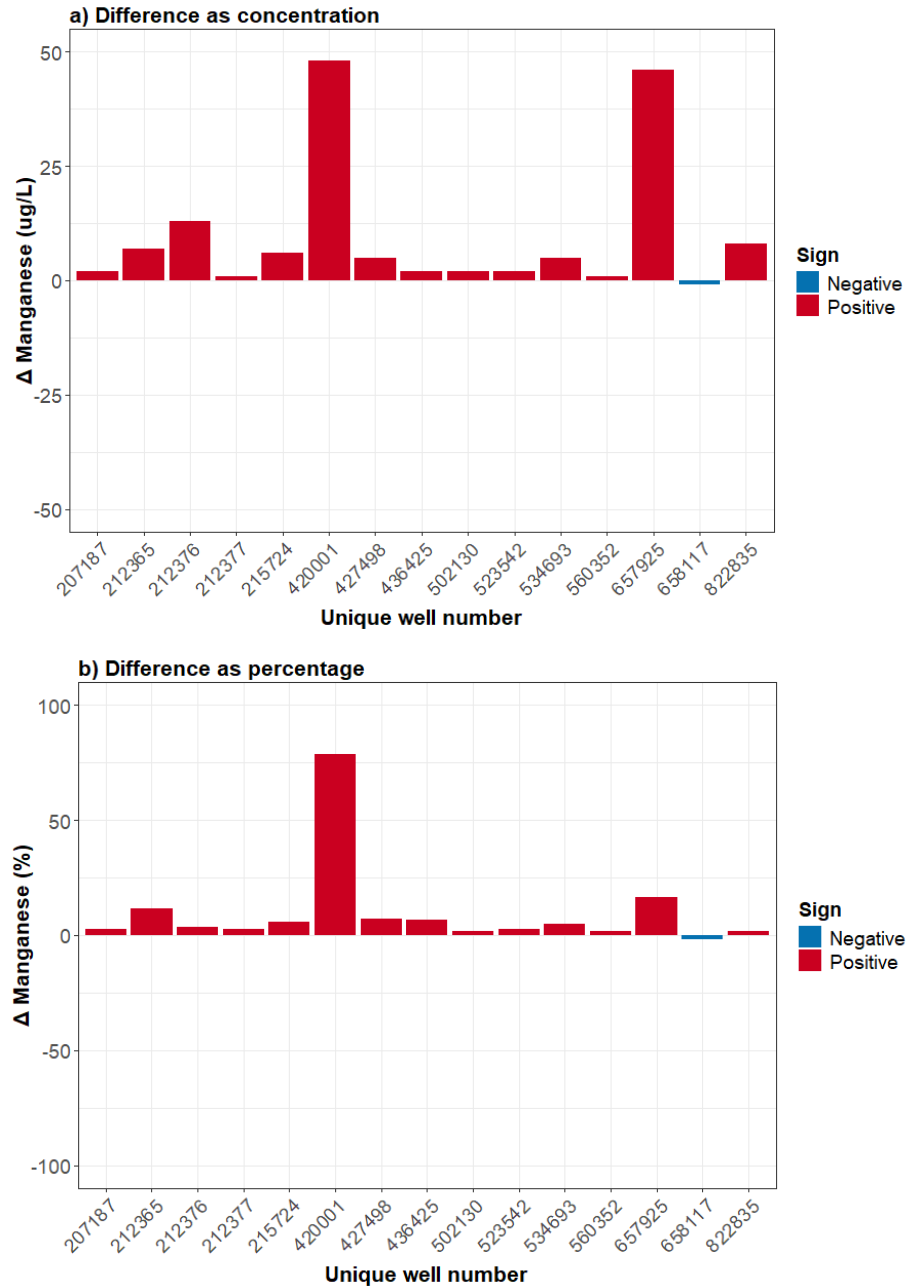


Figure 16. Difference in manganese concentrations between normal pumping and elevated pumping conditions as a) numeric difference and b) percentage difference. Blue bars indicate that concentrations were lower during the elevated pumping period; red bars indicate that concentrations were higher during the elevated pumping period. Missing bars indicate there was no difference between the two events.

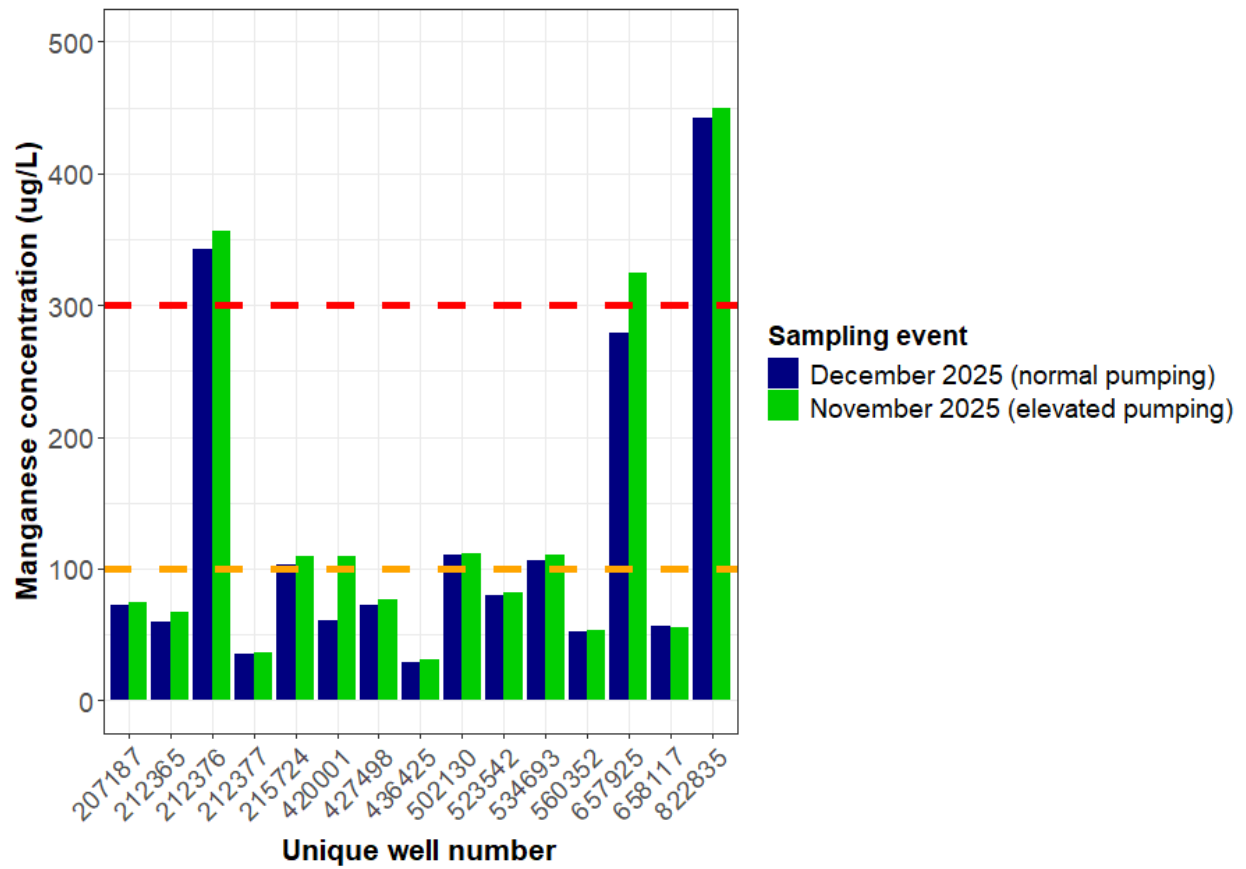


Figure 17. Manganese concentrations in November and December 2025 relative to MDH health risk limits (HRLs). The orange dashed line represents the HRL for infants under 1 year of age; the red dashed line represents the HRL for everyone older than 1.

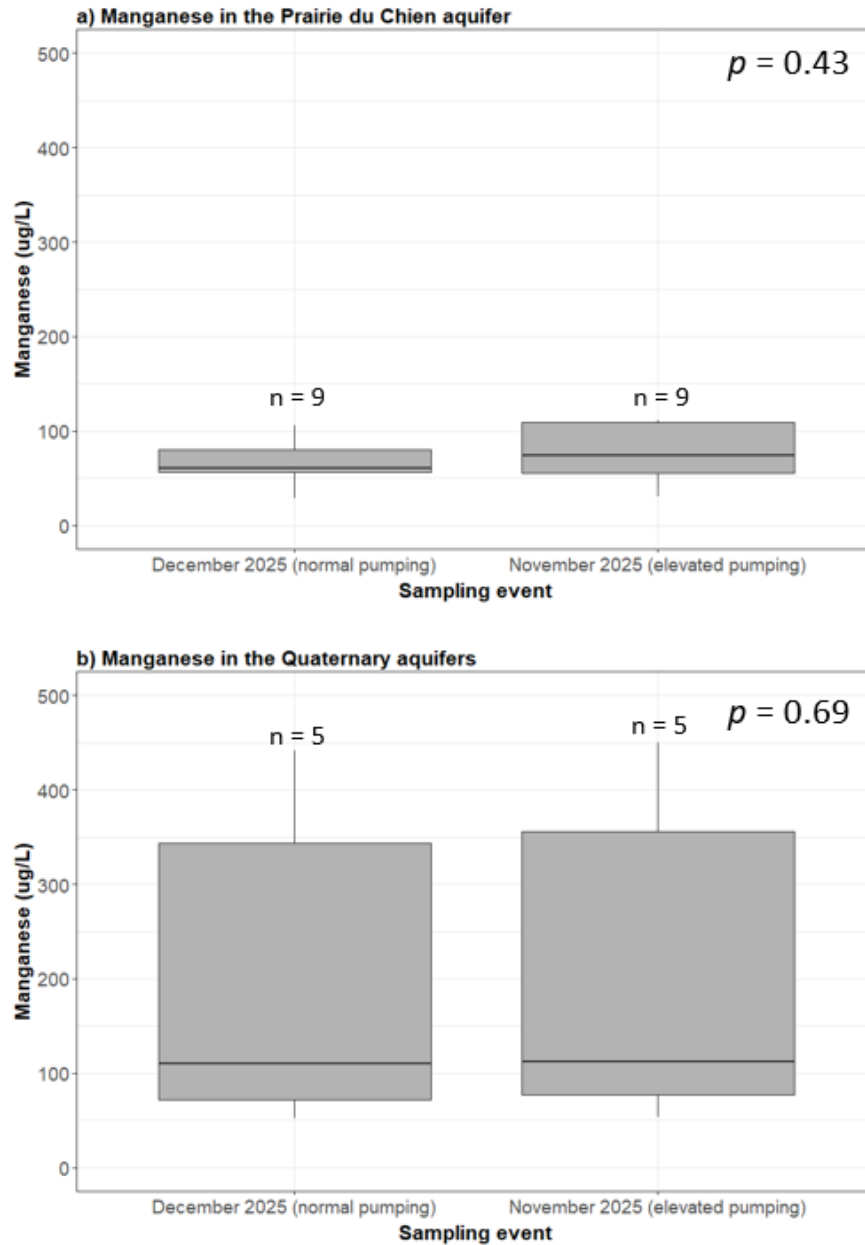


Figure 18. Aggregate manganese concentrations measured in wells in a) the Prairie du Chien (bedrock) aquifer, and b) the Quaternary aquifers for the November and December 2025 sampling events. P-values represent results of two-sided Wilcoxon rank sum tests comparing concentrations observed during the two sampling events.

Conclusions

Using the data provided, there are no significant differences in general chemistry, arsenic, iron, and manganese concentrations in private wells sampled during elevated pumping compared to the following period of normal pumping. Manganese concentrations in almost all wells were higher during elevated pumping than during normal pumping, but the results for the wells with the largest differences are unreliable due to lab method and field replicate discrepancies. Results for the three chemical constituents with health or nuisance guidance values available do not indicate that there are differences in public health exposure risk between water sampled during high pumping compared to normal pumping.

Data from the first sampling event, a period of normal pumping preceding the increased pumping rate, could not be used for this analysis due to incorrect lab method selection and discrepancies between the methods used to generate different rounds of sampling data. Therefore, a comparison of groundwater chemistry prior to pumping increase and after pumping increase is not possible. Additionally, samples collected during elevated and normal pumping are only available for 15 wells, compared to a target of at least 20. Overall, the data available do not allow MDH to confidently assess whether an increase in pumping rates could have contributed to water chemistry changes during the 2023 aquifer test.

Recommendations

MDH recommends the following practices to increase confidence in data when assessing water quality in private wells:

- Samples should be analyzed using EPA Method 200.7 or another method approved for use with the Safe Drinking Water Act.
- At least one field replicate should be taken for each day of sampling.
- Field sheets and lab reports should be shared with the DNR when sampling results are shared.
- Field meters should be calibrated and noted on field sheets.
- If field meter sensors are showing readings out of expected range, they should be checked to ensure readings are correct and noted on field sheets.
- Baseline water quality samples should be collected prior to pumping tests wherever possible.
- Initial target well sample size should be sufficient to account for scenarios in which some wells cannot be sampled during all sampling rounds, to ensure a final dataset large enough for statistical analysis.

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