St. Peter DWSMA Groundwater Protection Rule Summary

Groundwater, Nitrogen Fertilizer Management, and Nitrogen Loading Analysis

Introduction

This document summarizes the Minnesota Department of Agriculture's (MDA) current understanding of the St. Peter Drinking Water Supply Management Area (DWSMA) (Figure 1), public well nitrate-nitrogen levels, predominant land use, and nitrogen fertilizer management information. Also included is a summary of the MDA's estimate of nitrate-nitrogen loss from cropland leaching within the DWSMA. This summary provides the detail that the MDA used to determine whether the proposed list of nitrogen fertilizer best management practices (BMPs) and Alternative Management Tools (AMTs) will be protective of groundwater.

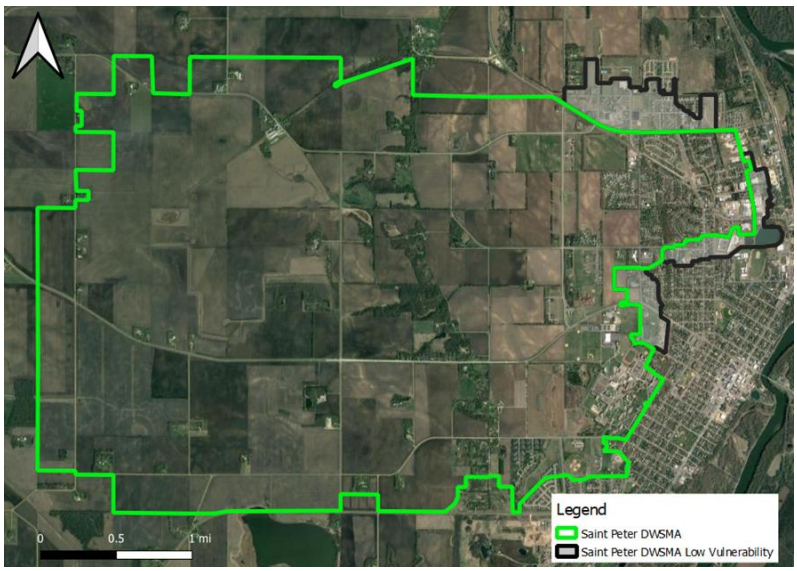

Figure 1. *St. Peter Drinking Water Supply Management Area.*

DWSMA and Public Well Nitrate-Nitrogen Data

The DWSMA boundary for the City of St. Peter's public wells, as defined by the Minnesota Department of Health (MDH), covers 7,355 acres, of which 7,029 are designated as highly vulnerable to groundwater contamination (green outlined area in Figure 1). This suggests that water, and contaminants such as nitrate-nitrogen, may travel from the land surface to the City's aquifer within a time span of months to a few years. Figure 2 demonstrates that some of the highly vulnerable area of the DWSMA is vulnerable due to surface water (highlighted in blue), while some is due to groundwater (highlighted in red). In the highly vulnerable surface water area, a system of subsurface drainage, streams, and ditches allow for water and contaminants to quickly move laterally toward the eastern portion of the DWSMA, where it can

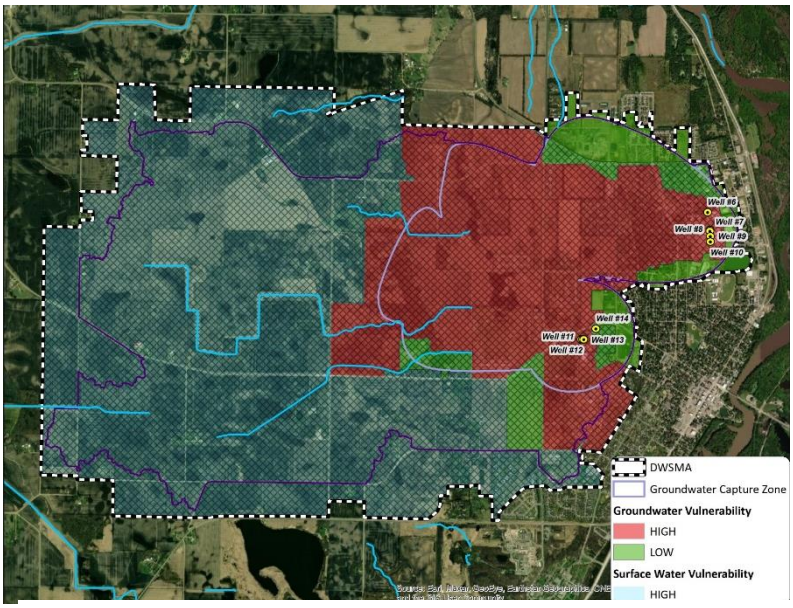

Figure 2. *St. Peter DWSMA Vulnerability Ratings*

then infiltrate. The highly vulnerable groundwater area of the DWSMA is designated as such due to sandy and gravelly soils which allow for rapid leaching to the aquifer below.

The City of St. Peter has nine primary public supply wells (Table 1). Of these, wells 6, 9, and 11 are vulnerable, and all three are drawing water from the Jordan aquifer. The MDA relies on the water quality data provided by the MDH to evaluate nitrate-nitrogen levels in the public water supply. The public well data provided for the St. Peter public well system is shown in the graph below (Figure 3). The 8 mg/L nitrate-nitrogen level illustrated in the graph is a threshold for Mitigation Level 2 designation under the Groundwater Protection Rule (Minnesota Statute 1573.0040, Subp. 7, C, 2).

Table 1. *Primary Public Supply Wells in St. Peter*

Well Name	Unique ID	Status	Aquifer	Casing Depth (feet)	Well Depth (feet)	Year Constructed	Well Vulnerability
Well 6	209906	Primary	Jordan	80	130	1972	Vulnerable
Well 7	433254	Primary	Mt. Simon	510	635	1987	Not Vulnerable
Well 8	473638	Primary	Wonewoc	362	410	1991	Not Vulnerable
Well 9	473639	Primary	Jordan	112	145	1991	Vulnerable
Well 10	473640	Primary	Tunnel City-Wonewoc	320	396	1991	Not Vulnerable
Well 11	770414	Primary	Jordan	188	233	2009	Vulnerable
Well 12	770415	Primary	Wonewoc	430	490	2009	Not Vulnerable
Well 13	770416	Primary	Mt. Simon	630	780	2009	Not Vulnerable
Well 1	770417	Primary	Mt. Simon	620	775	2009	Not Vulnerable

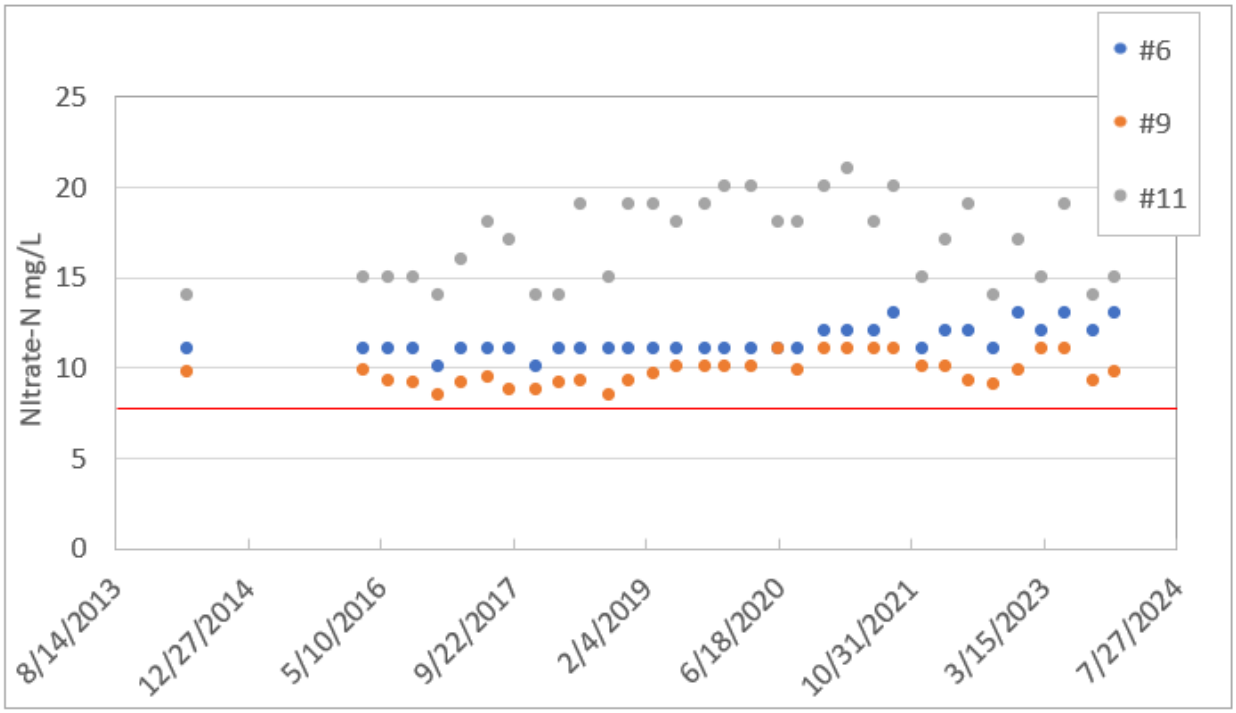

Figure 3. *St. Peter public water supply well nitrate-nitrogen levels (May 2014 through Dec 2023)*

Potential Nitrate-Nitrogen Point Source Consideration

The MDA conducted a detailed review of potential contaminant sources in the area to determine whether a point source of nitrate-nitrogen could be the cause of a public well exceeding the criteria for mitigation level designation (Minn. Stat. 1573.0040, Subp. 3, C). Based on information from this review in the St. Peter DWSMA, the MDA did not identify a potential point source of nitrate-nitrogen. With nitrate levels exceeding 8.0 mg/L within the past ten years and without a point source contribution, this DWSMA was designated as Mitigation Level 2 under the Groundwater Protection Rule on January 15, 2020 (Minn. Stat. 1573.0040, Subp. 7, C, 2).

Part 2 of the Groundwater Protection Rule responds to DWSMAs which already have elevated nitrate. The goal is to take action to reduce nitrate in groundwater in public wells that exceed or are close to exceeding the health standard for nitrate. In Level 2 DWSMAs, the MDA works with a local advisory team (LAT) including farmers, agronomists, and others to get input on agricultural practices that can reduce nitrate leaching in groundwater.

DWSMA Land Use

The Groundwater Protection Rule defines cropland as land used primarily for the production or harvest of annual or perennial field, forage, food, fiber, or energy crops including pasture but excluding forestland. However, the evaluation of BMP adoption to determine if a mitigation level change is needed will exclude soybean acres (Minnesota Statute 1573.0040, Subp. 7, A).

A review of the publicly available USDA Cropscape Cropland Data Layer in the St. Peter DWSMA shows that of the 7,029 total acres, 4,965 are cropland. An estimate of crops grown within the DWSMA from 2013 to 2022 is shown below in Table 2.

Table 2. *Crops grown in the St. Peter DWSMA from 2013-2022*

Year	Corn Acres	Corn %	Soybean Acres	Soybean %	Alfalfa Acres	Alfalfa %	Wheat Acres	Wheat %	Other Acres	Other %	Developed Acres	Developed %
2013	2978.3	59.6%	1699.7	34.0%	14.0	0.3%	96.2	1.9%	211.1	4.2%	0.0	0.0%
2014	2665.3	53.3%	2031.2	40.6%	37.2	0.7%	85.3	1.7%	180.2	3.6%	0.0	0.0%
2015	2242.3	44.9%	2433.8	48.7%	45.1	0.9%	97.9	2.0%	180.2	3.6%	0.0	0.0%
2016	3122.5	62.5%	1458.6	29.2%	49.1	1.0%	182.4	3.6%	186.6	3.7%	0.0	0.0%
2017	2182.7	43.7%	2448.6	49.0%	87.8	1.8%	30.0	0.6%	224.9	4.5%	25.4	0.5%
2018	2751.3	55.0%	1909.5	38.2%	94.6	1.9%	0.0	0.0%	218.5	4.4%	25.4	0.5%
2019	2614.1	52.3%	1944.5	38.9%	144.3	2.9%	96.1	1.9%	169.6	3.4%	30.6	0.6%
2020	2354.0	47.1%	2296.1	45.9%	144.3	2.9%	0.0	0.0%	174.2	3.5%	30.6	0.6%
2021	2420.1	48.0%	2317.3	46.0%	84.8	1.7%	0.0	0.0%	183.9	3.6%	33.7	0.7%
2022	2252.6	45.1%	2431.6	48.6%	103.2	2.1%	0.0	0.0%	178.3	3.6%	33.7	0.7%

The primary crops grown within the DWSMA are corn and soybeans, while alfalfa and wheat are also grown but on limited acreage. Most rotations are either corn/soybeans or continuous corn, with crops of all types being grown without irrigation. In Table 2 the “other” column refers to pasture, grass hay, idle ground, or fields enrolled in a conservation program.

Nitrogen Fertilizer Use Survey

In addition to reviewing cropping history, the MDA surveyed local agronomists and farmers to understand the nitrogen fertilizer management practices used in the St. Peter area. Having current and accurate nitrogen fertilizer management data is critical to the discussion of BMPs and AMTs. The farming practice information collected includes crop type, planting date, harvest date, and nitrogen fertilizer use information. This information was then used in computer models to compare nitrogen leaching loss under current management practices and under the nitrogen fertilizer BMPs proposed to protect groundwater.

In September 2021, the MDA conducted in-person, on-site interviews with fertilizer dealerships that serve farmers in the St. Peter DWSMA. Dealers were asked about timing, rates, and methods of fertilizer application. All sources of commercial nitrogen were included. The information listed below pertains to the 2021 crop year except where noted.

- Famers applied between 145 and 170 lbs. N/acre with an average of 160 lbs. for a corn following soybean rotation without manure applications.
- Farmers applied between 175 and 225 lbs. N/acre with an average of 185 lbs. for a corn following corn rotation without manure.
- Total amount of nitrogen applied on manured corn acres ranged from 190 lbs. for corn following soybeans to 220 lbs. for corn following corn.
- 54% of the corn acres received a split application of nitrogen.
    - 44% of corn acres received a split application of preplant and sidedress.
    - 10% of the corn acres received a split application of a weed and feed and a sidedress.
- All nitrogen was incorporated except for the sidedress applications.
- Nitrogen inhibitor or similar product was used on 80% of the corn acres.
- 50% percent of the farmers used a liquid starter.
- No applications of urea, UAN, or anhydrous ammonia were applied as variable rate.
- Corn yields generally averaged between 175 and 240 bushels per acre for the 2020 crop year, which was an average crop year. The lighter soils did not yield as well. Farmers generally reduced nitrogen applications by about 20 pounds on the lighter soils.

DWSMA Nitrate-Nitrogen Loss Below Cropland

Using a computer model called the Soil and Water Assessment Tool (SWAT) (https://swat.tamu.edu/), the MDA estimated the nitrogen loss below the root zone in the St. Peter DWSMA. Nitrogen management practices used in the recent past were compared with the list of proposed nitrogen fertilizer BMPs for this DWSMA, as well as AMTs. The model estimates nitrogen leaching below the crop root zone based on soil types from SSURGO soil maps, local climate data from the last ten years, current agronomic practices used in the DWSMA, and the presence of drain tile. Additional information on the modeling process can be found on the MDA's computer modeling of agricultural management practices webpage (www.mda.state.mn.us/pesticide-fertilizer/computer-modeling).

The modeling output is summarized in Table 3. Each row of the table is a change in corn nitrogen management that was modeled. For each of these potential changes, the estimated nitrogen leaching loss was compared to the leaching loss below current practices. The estimated reduction in nitrogen loss is shown by percent in the right hand column.

Table 3. *Summary of modeling results in the St. Peter DWSMA*

Modeled Changes in Nitrogen Management	% Reduction in Nitrogen Leaching Compared with Current Practices
Corn nitrogen rate limited to 0.075 ratio high end (currently 165 lbs. N/ac for C-Sb and 205 lbs. N/ac for C-C)	1%
Corn nitrogen rate limited to 0.10 ratio high end (currently 150 lbs. N/ac for C-Sb and 190 lbs. N/ac for C-C)	4%
Corn nitrogen rate limited to the 0.10 ratio MRTN (currently 140 lbs. N/ac for C-Sb and 175 lbs. N/ac for C-C)	9%
Corn nitrogen rate limited to 0.10 ratio high end + 80% of corn acres split applying nitrogen	6%
Corn nitrogen rate limited to 0.10 ratio high end + 80% of corn acres split applying nitrogen + 12.5% of corn acres including a cover crop	10%
Corn nitrogen rate limited to the 0.10 ratio MRTN + 100% of corn acres split applying nitrogen	12%
Split application of nitrogen on 100% of corn acres	5%
Split application of nitrogen on 80% of corn acres + 10% of corn acres including a cover crop	6%
Split application of nitrogen on 80% of corn acres + 18.5% of corn acres including a cover crop	10%
Split application of nitrogen on 100% of corn acres + 12.5% of corn acres including a cover crop	10%
Split application of nitrogen on 100% of corn acres + 100% of corn acres with variable rate nitrogen	13%
18% of corn acres converted to perennials (currently 4.7% of cropland is in perennial)	10%
43% of corn acres including a cover crop (currently 3.5% of corn acres include a cover crop)	10%

Choosing the correct nitrogen rate is generally the most important factor when managing nitrogen fertilizer to protect groundwater. The model estimates a 9% DWSMA-wide reduction in nitrate leaching if the nitrogen rates applied to corn did not exceed the University of Minnesota's 0.10 ratio Maximum Return to Nitrogen (MRTN) rate. Currently, the 0.10 MRTN rate for corn following corn is 175 lbs. N/acre, and 140 lbs. N/acre for corn following soybeans. According to the MDA's nitrogen fertilizer use survey, approximately 81% of corn-corn rotation acres and 100% of corn-soybean acres in the DWSMA are applying nitrogen above the 0.10 MRTN. For both corn rotations, the majority of acres in the DWSMA would need to reduce nitrogen rates by 20 lbs. or less in order to apply at the 0.10 MRTN rate.

MDA Recommended Nitrogen Fertilizer Best Management Practices for the St. Peter DWSMA

In consultation with the local advisory team that includes farmers and agronomists managing cropland within the DWSMA, the MDA has developed the following list of nitrogen fertilizer BMPs and additional practices to protect groundwater. A more detailed list of these is available on the MDA's St. Peter DWSMA webpage (www.mda.state.mn.us/stpeter-dwsma).

- Apply nitrogen to dryland corn in a corn-corn rotation at or below the 0.10 MRTN nitrogen rate in the University of Minnesota's nitrogen fertilizer application guidelines.

- Apply nitrogen to dryland corn in a corn-soybean rotation at or below the 0.10 MRTN nitrogen rate in the University of Minnesota's nitrogen fertilizer application guidelines.
- For all other crops grown within the DWSMA, follow the current University of Minnesota guidance applicable to that crop.
- Account for all nitrogen sources when calculating nitrogen rate.
- Take appropriate credits for previous legume crops and manure used in the crop rotation.
- On coarse textured soils use split applications of nitrogen fertilizer or use ESN blend with urea or use spring preplant application with a nitrification inhibitor.
- On coarse textured soils use N stabilizer on labeled crops when early side-dress is used.
- On fine textured soils use spring preplant applications of ammonia and urea or split applications of ammonia, urea, and UAN.

Conclusion

In the St. Peter DWSMA the MDA has reviewed the cropping history, surveyed nitrogen management practices and modeled nitrogen loading below existing nitrogen fertilizer management practices and alternatives.

The fertilizer dealership survey indicated that all nitrogen sources are considered and manure and legume credits counted. The published corn nitrogen fertilizer BMPs will reduce the total nitrogen rate applied on 81% of corn-corn rotation acres and 100% of the corn-soybean acres resulting in a 9% reduction in nitrogen loss within the DWSMA.

Alternative Management Tools go beyond the BMPs and modeling showed that using these practices (such as cover crops, variable rate nitrogen, or perennials) provide additional options for cropland within this DWSMA that can further reduce nitrogen loss below the crop root zone Alternative Management Tools (www.mda.state.mn.us/nitrogenamts). These options were reviewed with the LAT. Specific cropland acres have not been identified for the establishment of these nitrogen management changes, but the LAT acknowledges the additional groundwater protection that these could provide if adopted. Adoption of Alternative Management Tools are not required in a Mitigation Level 2 DWSMA but farmers are encouraged to consider these practices when appropriate or applicable to their farm. Additionally, other water management strategies in the DWSMA are being evaluated and could further reduce nitrate leaching. A technical study is underway and should be discussed by the LAT.

Based on the understanding and information provided above, the MDA believes that the recommended nitrogen fertilizer BMPs within the St. Peter DWSMA are appropriate and that the continued use of these practices over the long-term will prevent nitrate-nitrogen loss below cropland from increasing. Additionally, modeling of nitrogen loss below cropland indicates that further reductions are possible with additional changes to nitrogen management. Promotion and funding to support the establishment of alternative practices within the St. Peter DWSMA will be a priority. The MDA will continue to work with local partners and ag stakeholders to implement both the nitrogen fertilizer BMPs and alternative nitrogen management tools to reduce nitrogen leaching in the DWSMA.

Supplemental Data

The following table is supplemental information for the "St. Peter DWSMA Groundwater Protection Rule Summary". The data included below is presented as a graph (Figure 3) in the summary document.

Table 4. Nitrate-nitrogen levels within the three St. Peter public water supply wells that have exceeded 8 mg/L within the past ten years.

Well Number	Collection Date	Nitrogen Test Levels in mg/L
11	5/14/2014	14
11	3/9/2016	15
11	6/13/2016	15
11	9/14/2016	15
11	12/13/2016	14
11	3/13/2017	16
11	6/23/2017	18
11	9/11/2017	17
11	12/18/2017	14
11	3/19/2018	14
11	6/6/2018	19
11	9/18/2018	15
11	12/5/2018	19
11	3/8/2019	19
11	6/5/2019	18
11	9/17/2019	19
11	12/3/2019	20
11	3/10/2020	20
11	6/17/2020	18
11	9/1/2020	18
11	12/14/2020	20
11	3/10/2021	21
11	6/15/2021	18
11	8/30/2021	20
11	12/14/2021	15
11	3/15/2022	17
11	6/7/2022	19
11	9/12/2022	14
11	12/13/2022	17
11	3/8/2023	15
11	6/7/2023	19
11	9/18/2023	14
11	12/12/2023	15
6	5/14/2014	11
6	3/9/2016	11
6	6/13/2016	11
6	9/14/2016	11
6	12/13/2016	10
6	3/13/2017	11
6	6/23/2017	11
6	9/11/2017	11
6	12/18/2017	10
6	3/19/2018	11
6	6/6/2018	11
6	9/18/2018	11
6	12/5/2018	11
6	3/8/2019	11
6	6/5/2019	11
6	9/17/2019	11
6	12/3/2019	11
6	3/10/2020	11
6	6/17/2020	11
6	9/1/2020	11
6	12/14/2020	12
6	3/10/2021	12
6	6/15/2021	12
6	8/30/2021	13
6	12/14/2021	11
6	3/15/2022	12
6	6/7/2022	12
6	9/12/2022	11
6	12/13/2022	13
6	3/8/2023	12
6	6/7/2023	13
6	9/18/2023	12
6	12/12/2023	13
9	5/14/2014	9.7
9	3/9/2016	9.8
9	6/13/2016	9.3
9	9/14/2016	9.2
9	12/13/2016	8.5
9	3/13/2017	9.2
9	6/23/2017	9.4
9	9/11/2017	8.8
9	12/18/2017	8.8
9	3/19/2018	9.2
9	6/6/2018	9.3
9	9/18/2018	8.5
9	12/5/2018	9.3
9	3/8/2019	9.6
9	6/5/2019	10
9	9/17/2019	10
9	12/3/2019	10
9	3/10/2020	10

Well Number	Collection Date	Nitrogen Test Levels in mg/L
9	6/17/2020	11
9	9/1/2020	9.8
9	12/14/2020	11
9	3/10/2021	11
9	6/15/2021	11
9	8/30/2021	11
9	12/14/2021	10
9	3/15/2022	10
9	6/7/2022	9.3
9	9/12/2022	9.1
9	12/13/2022	9.8
9	3/8/2023	11
9	6/7/2023	11
9	9/18/2023	9.3
9	12/12/2023	9.7