Perham DWSMA Groundwater Protection Rule Summary

Groundwater, Nitrogen Fertilizer Management, and Nitrogen Loading Analysis

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Introduction

This document summarizes the Minnesota Department of Agriculture's (MDA) current understanding of the Perham Drinking Water Supply Management Area (DWSMA), public well nitrate-nitrogen levels, and nitrogen management information. Also included is a summary of the MDA's analysis of nitrogen loss below cropland within this DWSMA. This summary provides the detail the MDA considered to determine whether the proposed list of nitrogen fertilizer best management practices (BMPs) and Alternative Management Tools (AMTs) will be protective of groundwater.

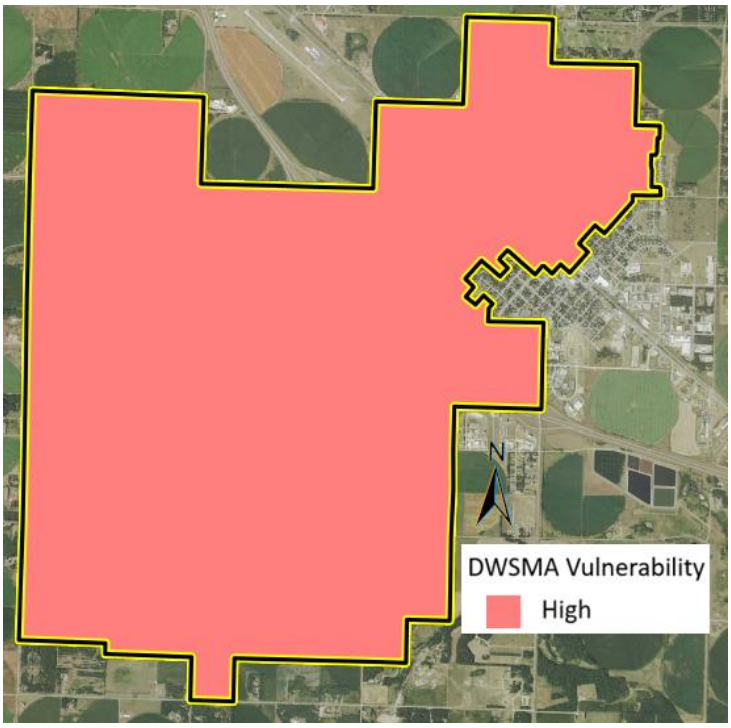

Figure 1. Perham DWSMA Vulnerability Designated by the MDH.

DWSMA and Public Well Nitrate-Nitrogen Data

The DWSMA boundary defined by the Minnesota Department of Health (MDH) for the Perham public wells includes 5869 acres. The MDH defines the groundwater below this DWSMA as highly vulnerable (Figure 1). Of the 5869 acres in the DWSMA, 3385 acres meet the definition of cropland in the Groundwater Protection Rule (GPR). The GPR applies to the 3385 acres of cropland within this DWSMA.

The MDA relies on the water quality data provided by the MDH to evaluate nitrate-nitrogen levels in the public water supply. Nitrate-nitrogen levels have exceeded 8 mg/L in two of Perham's public wells within the past ten years (Figure 2). There are three additional public wells in Perham where nitrate levels have not exceeded 5.4 mg/L within the past ten years. See Table 1 for specific well information.

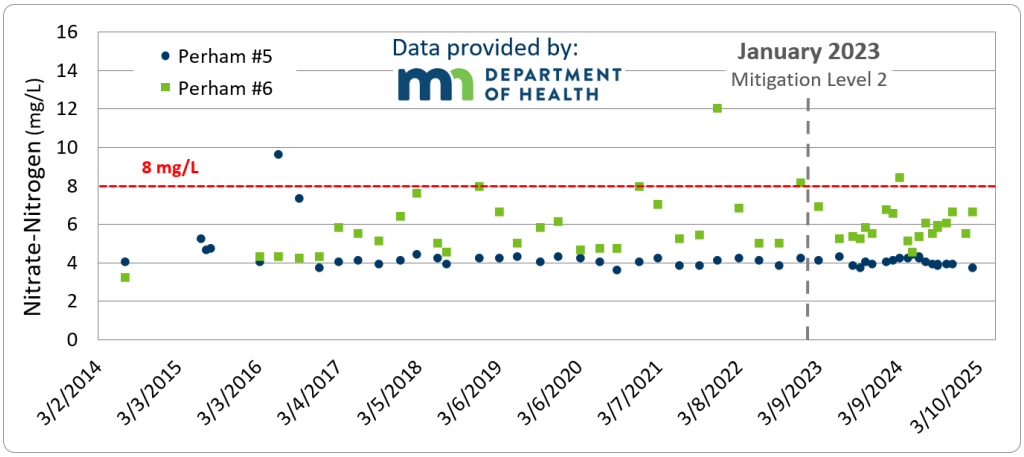

Figure 2. Perham nitrate data from July 2014 to February 2025.

[8-14-2025]

Table 1. Perham public well information.

Local Well ID	MDH Status	Casing Diameter (in)	Well Depth (ft)	Date Constructed
Well #5	Primary	12	95	1976
Well #6	Primary	12	95	1990
Well #7	Primary	12	82	1999
Well #8	Primary	12	81	2008
Well #9	Primary	12	76	2008

DWSMA Land Use and Potential Nitrate-Nitrogen Point Source Consideration

The MDA conducted a detailed review of potential contaminant sources to determine whether a point source of nitrogen could be the cause of the public wells exceeding the criteria for mitigation level designation (Minnesota Statute 1573.0040, Subp. 3, C). In the Perham DWSMA, the MDA review did not identify a point source for 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 at Mitigation Level 2 under Part 2 of the Groundwater Protection Rule in January 2024 (Minnesota Statute 1573.0040, Subp. 7, C, 2).

Part 2 of the Groundwater Protection Rule responds to DWSMAs which have elevated nitrate. The goal is to take action to reduce nitrate in groundwater before a public well exceeds the health standard for nitrate, 10 mg/L. For DWSMAs, like Perham designated at Level 2, the MDA works with a local advisory team (LAT) including local farmers, agronomists, and others to get input on BMPs and AMTs that can reduce nitrate levels in groundwater.

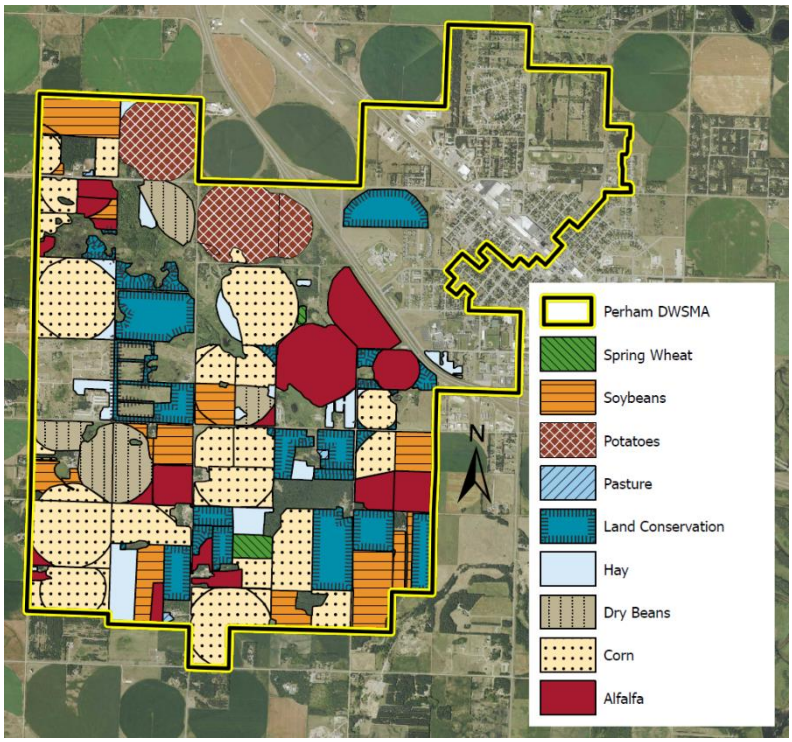

Figure 3. 2023 Cropland within the Perham DWSMA based on the USDA Cropland Data Layer. See Table 2 for more information.

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. The evaluation of BMP adoption to determine if a mitigation level change is needed excludes soybean acres (Minnesota Statute 1573.0040, Subp. 7, A).

A review of the publicly available USDA Cropland Data Layer (hosted on Crop Scape, nass.usda.gov/Research_and_Science/Cropland/Release/index.php) in the Perham DWSMA shows that the land use here is predominately cropland. Data illustrated in Figure 3 is from the February 2024 data release.

The MDA has also surveyed agronomists and farmers to understand the nitrogen fertilizer management practices used in the Perham area. The MDA was able to obtain farming information for all of the cropland acres across the DWSMA. Having current and accurate nitrogen fertilizer management data is critical to the discussion of BMPs and AMTs. With computer modeling tools, the MDA compares nitrogen leaching loss below current nitrogen fertilizer management and under management changes proposed to protect groundwater. The farming practice information collected includes crop planting, harvest, tillage, and nitrogen fertilizer use data.

The MDA has reviewed the USDA Cropland Data Layer over the past 10 years in the DWSMA (Tables 2 and 3). Perennials—alfalfa, grass hay, pasture, and land conservation—are protective of groundwater and have covered an average of 30% of cropland within the DWSMA over the ten-year period. Over time, perennial acres have increased from 23% in 2014 to 36% of the cropland in 2023, primarily because of an increase in conservation and alfalfa acres.

Table 2. Perham DWSMA cropland cover based on USDA cropland data layer (acres)

Year	Soybean Acres	Corn Acres	Edible bean Acres	Potato Acres	Small Grain Acres	Alfalfa Acres	Grass Hay and Pasture Acres	Land Conservation Acres	Pea Acres
2014	763	858	508	260	219	326	247	203	0
2015	462	677	789	287	329	303	289	248	0
2016	462	1091	207	288	75	417	302	371	172
2017	260	1096	705	34	262	427	149	453	0
2018	1115	517	362	160	265	308	193	465	0
2019	636	828	343	348	183	366	187	492	0
2020	209	674	1234	0	179	347	207	533	0
2021	355	1243	162	381	142	395	171	533	0
2022	846	815	291	254	117	405	124	533	0
2023	405	1179	231	311	26	457	177	598	0

Table 3. Perham DWSMA cropland cover based on USDA cropland data layer (percent)

Year	Soybean % of Cropland	Corn % of Cropland	Edible bean % of Cropland	Potato % of Cropland	Small Grain % of Cropland	Alfalfa % of Cropland	Grass Hay and Pasture % of Cropland	Land Conservation % of Cropland	Pea % of Cropland
2014	23%	25%	15%	8%	6%	10%	7%	6%	0%
2015	14%	20%	23%	8%	10%	9%	9%	7%	0%
2016	14%	32%	6%	9%	2%	12%	9%	11%	5%
2017	8%	32%	21%	1%	8%	13%	4%	13%	0%
2018	33%	15%	11%	5%	8%	9%	6%	14%	0%
2019	19%	24%	10%	10%	5%	11%	6%	15%	0%
2020	6%	20%	36%	0%	5%	10%	6%	16%	0%
2021	11%	37%	5%	11%	4%	12%	5%	16%	0%
2022	25%	24%	9%	7%	3%	12%	4%	16%	0%
2023	12%	35%	7%	9%	1%	13%	5%	18%	0%

Within the Perham DWSMA all nitrogen sources are accounted for, and nitrogen fertilizer applications are split throughout the growing season. The timing, placement, and product BMPs recommended by the University of Minnesota for the cropping rotations and soil types present within this DWSMA are currently being used. A reduction in nitrogen fertilizer rates applied to some crops is the primary BMP change that could reduce nitrogen leaching below the crop rootzone. Additionally, there is opportunity to reduce nitrogen rates through increased crediting for nitrogen from previous legume crops. Hydrologic and geologic conditions in this area make groundwater vulnerable.

DWSMA Nitrate-Nitrogen Loss Below Cropland

The MDA and the University of Minnesota worked together utilizing crop and soil computer simulation models called the Decision Support System Agrotechnology Transfer model (DSSAT) (www.dssat.net) and the Environmental Policy Integrated Climate model (EPIC). These models estimate the nitrogen loss below the root zone in the Perham DWSMA comparing the nitrogen management practices used in the recent past with the nitrogen loss below alternative nitrogen management practices. Within the Perham DWSMA there are wide variety of crops, cropping rotations, and management practices. Model estimates of nitrogen loss were made on 54% of cropland including the crop rotations with the highest nitrogen fertilizer needs. The remaining cropland

that was not modeled includes crops with a lower risk of nitrogen loss like perennial crops, small grains, and other crops with low nitrogen needs. The table below shows the crop rotations modeled within the Perham DWSMA (Table 4).

Table 3. Perham DWSMA cropland rotations that nitrate-nitrogen loss was modeled following current nitrogen management practices.

Crop Rotation	Acres
Potato-Edible bean-Corn-Soybean (irrigated)	1142
Corn-Soybean (irrigated)	165
Corn-Corn-Edible bean (irrigated)	333
Corn-Soybean (dryland)	198

Computer modeling estimates a 4.0% reduction in annual nitrogen loss on modeled acres if irrigated corn nitrogen rates are applied at or below the high end of the 0.10 price ratio range (Table 5). Modeling also indicates that following University of Minnesota guidelines for nitrogen rates on edible beans will reduce leaching by 4.7% across modeled acres.

Table 5. Perham DWSMA modeled nitrate-nitrogen loss below nitrogen best management practices (BMPs). The nitrogen loss reductions are based on the adoption of the listed BMP.

Nitrogen Fertilizer Best Management Practice	Acres Within the DWSMA	Nitrogen Loss Reduction
Apply nitrogen at or below the high end of the 0.10 price ratio range for irrigated corn (current rates listed below) 195 lb. N/ac for C-SB, 205 lb. N/ac for C-EB, 225 lb. N/ac for C-C or C-P	1654	4.0%
Apply nitrogen to edible beans according to University of Minnesota guidelines Current guidance is up to 120 lb. N/acre depending on yield goal, previous crop, and soil organic matter level.	1550	4.7%

In addition to modeling the benefit of BMPs, the MDA used modeling to estimate the nitrogen loss reductions below additional practices that go above and beyond BMPs to further reduce nitrogen loss below the root zone. Producers within the Perham DWSMA have voluntarily adopted a new crop variety with lower nitrogen demand to support the protection of the Perham community water supply. The model estimates that nitrogen leaching across the modeled acres is reduced by 8.1% with this new variety in the rotation (Table 6).

Table 6. MDA modeled nitrogen loss reductions below additional practices voluntarily adopted in the Perham DWSMA to support the protection of this drinking water source.

Additional Practices	Acres Within the DWSMA	Nitrogen Loss Reduction
New crop variety with lower nitrogen demand	991	8.1%

Another additional practice modeled in this DWMSA is deficit irrigation water scheduling. Deficit irrigation water scheduling is managing irrigation water use to keep soil water levels in a deficit, less than the holding capacity of the soil. Modeling indicates that limiting irrigation water to 75% of the holding capacity of the soil can reduce the amount of nitrogen lost below that cropland. The nitrogen loss reductions were estimated at 7.7% if the practice was adopted on 65% of the modeled cropland in the DWSMA (Table 7).

Table 7. Nitrogen loss reductions below additional practices modeled in the Perham DWSMA.

Additional Practices	Nitrogen Loss Reduction	Notes
Deficit irrigation water scheduling	7.7%	The deficit irrigation schedule simulated in the model limited irrigation water application at a given time to 75% of the soil water-holding capacity.

MDA Recommended Nitrogen Fertilizer Best Management Practices for the Perham 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 BMPs to protect groundwater. A more detailed list of these BMPs is available on the MDA's Perham DWSMA webpage (www.mda.state.mn.us/perham-dwsma).

- Apply nitrogen to irrigated corn at or below the high end of the 0.10 price ratio range in the University of Minnesota's nitrogen fertilizer application guidelines.
- Apply nitrogen to dryland corn at or below the 0.125 MRTN in the University of Minnesota's nitrogen fertilizer application guidelines.
- Apply nitrogen to edible beans following the University of Minnesota guidance based on yield goal, previous crop and soil organic matter (currently up to 120 lbs. N/ac)
- Account for all nitrogen sources when calculating nitrogen rate.
- Take appropriate credits for previous legume crops and manure used in the crop rotation.
- Split applications of nitrogen fertilizer.
- Use a nitrogen rate for potatoes based on variety, harvest date, and realistic yield goals.
- For all other crops grown within the DWSMA, follow the current University of Minnesota guidance applicable to that crop.
- Limit the rate of starter nitrogen applied to potatoes.
- Plant a fall cover following potatoes whenever possible.

The MDA will conduct an evaluation in this Level 2 DWSMA to determine whether these nitrogen fertilizer BMPs have been implemented on 80% of the cropland, excluding soybeans. The evaluation will occur no sooner than three growing seasons after the BMP list is published.

Conclusion

In the Perham DWSMA the MDA has reviewed the cropping history, surveyed nitrogen management practices, modeled nitrogen loading estimates below previous nitrogen fertilizer management practices and below BMPs and additional practices adopted to protect the community drinking water supply.

The current University of Minnesota nitrogen fertilizer BMPs are being followed during most years in the crop rotation. All nitrogen sources are considered and nitrogen applications are split during the growing season. Additional crediting of nitrogen following previous legume crops and changes to nitrogen rate are University of Minnesota BMPs that can further reduce nitrogen leaching.

Modeling of nitrogen loss below the published BMPs and additional practices estimates a 16.8% reduction in nitrogen loss below cropland. This reduction is from a combination of nitrogen rates applied to irrigated corn at or below the high end of the 0.10 price ratio, nitrogen rates applied to edible beans according to University of Minnesota's nitrogen fertilizer application guidelines (not exceeding 120 lbs. N/acre), and the primary crop variety changes made within the DWSMA.

If cropland management changes occur within the DWSMA, additional review of the appropriate nitrogen fertilizer BMPs may be needed and a new list of nitrogen fertilizer BMPs approved. Examples that could cause

such a change include, but are not limited to, changes in the cropping rotation, changes to the MDH groundwater vulnerability designations, and changes to the MDH approved DWSMA boundary.

Based on the understanding and information provided above, the MDA believes that the recommended nitrogen management BMPs within the Perham DWSMA are appropriate and that the continued use of these practices along with the primary crop variety changes made over the long-term will reduce nitrate-nitrogen loss below cropland. Promotion and outreach to support the continued implementation of these practices within the Perham DWSMA will be a priority.

Supplemental Data

The following table is supplemental information for the “Perham DWSMA Groundwater Protection Rule Summary”. The data included below is presented as a graph (Figure 2) in the summary document.

Table 7. Nitrate-nitrogen levels within the Perham public wells that exceeded 8 mg/L within the past ten years.

Well Number	Collection Date	Nitrogen Test Levels in mg/L
5	7/9/2014	4.0
5	3/15/2016	4.0
5	6/7/2016	9.6
5	9/12/2016	7.3
5	12/12/2016	3.7
5	3/13/2017	4.0
5	6/5/2017	4.1
5	9/11/2017	3.9
5	12/19/2017	4.1
5	3/5/2018	4.4
5	6/6/2018	4.2
5	7/16/2018	3.9
5	12/12/2018	4.2
5	3/12/2019	4.2
5	6/5/2019	4.3
5	9/16/2019	4.0
5	12/10/2019	4.3
5	3/18/2020	4.2
5	6/16/2020	4.0
5	9/2/2020	3.6
5	12/15/2020	4.0
5	3/8/2021	4.2
5	6/15/2021	3.8
5	9/13/2021	3.8
5	12/6/2021	4.1
5	3/15/2022	4.2
5	6/13/2022	4.1
5	9/12/2022	3.8
5	12/19/2022	4.2
5	3/14/2023	4.1
5	6/14/2023	4.3
5	8/15/2023	3.8
5	9/19/2023	3.7
5	10/11/2023	4.0
5	11/15/2023	3.9
5	1/17/2024	4.0
5	2/14/2024	4.1
5	3/19/2024	4.2
5	4/24/2024	4.2
5	5/15/2024	4.4
5	6/12/2024	4.3
5	6/12/2024	4.2
5	7/17/2024	4.0
5	8/4/2024	3.9
5	9/9/2024	3.8
5	9/9/2024	3.9
5	10/16/2024	3.9
5	11/14/2024	3.9
5	2/12/2025	3.7
6	7/9/2014	3.2
6	3/15/2016	4.3
6	6/7/2016	4.3
6	9/12/2016	4.2
6	12/12/2016	4.3
6	3/13/2017	5.8
6	6/5/2017	5.5
6	9/11/2017	5.1
6	12/19/2017	6.4
6	3/5/2018	7.6
6	6/6/2018	5.0
6	7/16/2018	4.5
6	12/12/2018	7.9
6	3/12/2019	6.6
6	6/5/2019	5.0
6	9/16/2019	5.8
6	12/10/2019	6.1
6	3/18/2020	4.6
6	6/16/2020	4.7
6	9/2/2020	4.7
6	12/15/2020	7.9
6	3/8/2021	7.0
6	6/15/2021	5.2

DEPARTMENT OF AGRICULTURE

Well Number	Collection Date	Nitrogen Test Levels in mg/L
6	9/13/2021	5.4
6	12/6/2021	12.0
6	3/15/2022	6.8
6	6/13/2022	5.0
6	9/12/2022	5.0
6	12/19/2022	8.1
6	3/14/2023	6.9
6	6/14/2023	5.2
6	8/15/2023	5.3
6	9/19/2023	5.2
6	10/11/2023	5.8
6	11/15/2023	5.5
6	1/17/2024	6.7
6	2/14/2024	6.5
6	3/19/2024	8.4
6	4/24/2024	5.1
6	5/15/2024	4.5
6	6/12/2024	5.3
6	6/12/2024	5.3
6	7/17/2024	6.0
6	8/14/2024	5.5
6	9/9/2024	5.8
6	9/9/2024	5.9
6	10/16/2024	6.0
6	11/14/2024	6.6
6	1/15/2025	5.5
6	2/122025	6.6