Rock County Rural Water DWSMA Groundwater Protection Rule Summary

Groundwater, Nitrogen Fertilizer Management, and Nitrogen Loading Analysis

Updated: 9-27-2024

Introduction

This document summarizes the Minnesota Department of Agriculture's (MDA) current understanding of the Rock County Rural Water System Drinking Water Supply Management Area (DWSMA: Figure 1), 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.

DWSMA and Public Well Nitrate-Nitrogen Data

The DWSMA boundary defined by the Minnesota Department of Health (MDH) for the Rock County Rural Water public wells includes 3,697 acres. The MDH defines the groundwater below this DWSMA as high vulnerability. Of the 3,697 acres in the DWSMA, 3,119 acres meet the definition of cropland in the Groundwater Protection Rule (GPR). The GPR applies to the 3,119 acres of cropland within this DWSMA.

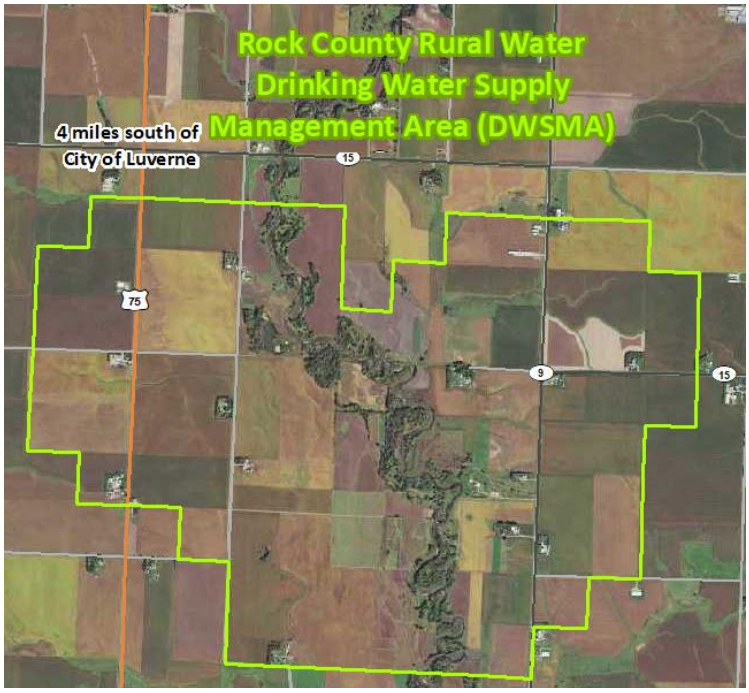

Figure 1. Rock County Rural Water Drinking Supply Management Area map.

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 six of the Rock County Rural Water's public wells within the past ten years (Figure 2). There are six additional public wells in Rock County Rural Water where nitrate levels have not exceeded 5.4 mg/L within the past ten years. See Table 1 for specific well information.

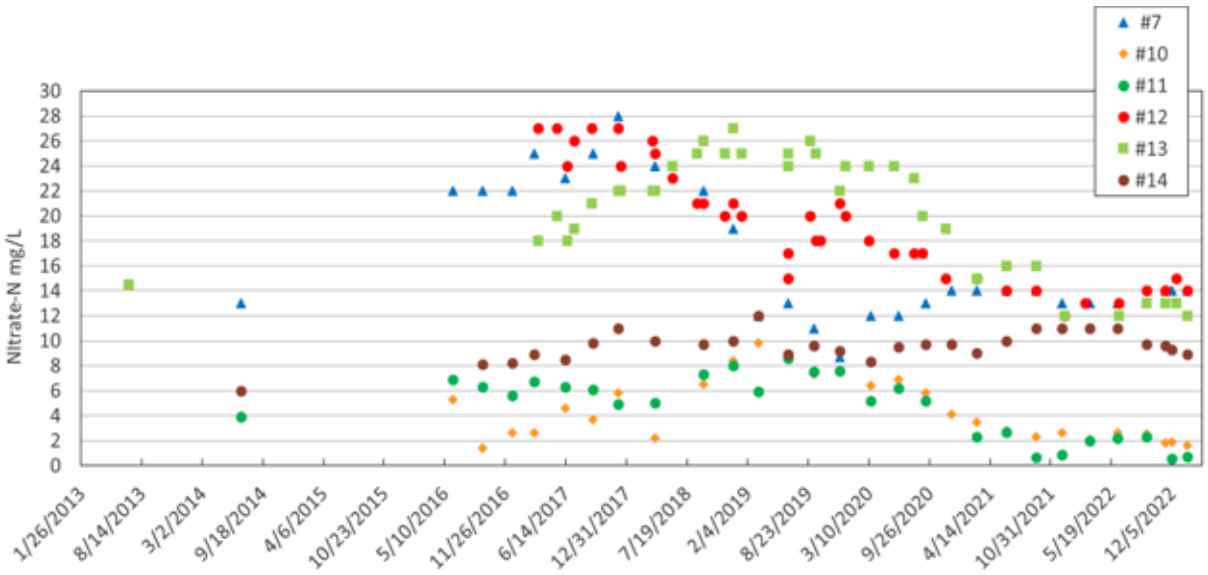

Figure 2. Rock County Rural Water Nitrate Data for six public wells (July 2013-February 2024).

All wells except for well #15 are shallow wells in an unconfined aquifer that are vulnerable to groundwater contamination. The shallow wells range in a depth from 23-37 ft. Rock County Rural Water does not have a nitrate treatment plant and they currently blend water from wells with lower nitrate levels and water from the Lewis and Clark Regional Water System. The wells with higher nitrate levels are needed as the lower nitrate wells do not supply enough water quantity to the system.

Table 1. Rock County Rural Water System public well information.

Well Name	Use/Status	Casing Diameter (in)	Casing Depth (ft)	Water Level	Well Depth (ft)	Date Constructed	Aquifer	Well Vulnerability
Well 1	Emergency backup	12	15	12.4	23	9/29/1978	QWTA	Vulnerable
Well 2	Primary	12	22	16	32	6/18/1977	QWTA	Vulnerable
Well 6	Primary	12	23	14	29	9/26/1978	QWTA	Vulnerable
Well 7	Primary	12	27	16	34	12/11/1996	QWTA	Vulnerable
Well 8	Primary	12	22	18	28	6/14/1999	QWTA	Vulnerable
Well 9	Primary	12	25	18	31	6/7/1999	QWTA	Vulnerable
Well 10	Primary	12	23	19	31	6/11/1999	QWTA	Vulnerable
Well 11	Primary	12	25	19	34	10/3/2002	QWTA	Vulnerable
Well 14	Primary	12	28.6	16	37	5/9/2007	QWTA	Vulnerable
Well 12	Primary	12	19	12.5	29	9/11/2012	QWTA	Vulnerable
Well 13	Primary	12	24	12.5	32	7/2/2013	QWTA	Vulnerable
Well 15	Primary	12	290	70	353	6/1/2023	Dakota	Not Vulnerable

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 well exceeding the criteria for mitigation level designation (Minnesota Statute 1573.0040, Subp. 3, C). In the Rock County Rural Water 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 2020 (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 Rock County Rural Water designated at Level 2, the MDA works with a local advisory team (LAT) including local farmers, agronomists, and others to get input on agricultural practices that can reduce nitrate levels in groundwater.

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 excludes 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, https://nass.usda.gov/Research_and_Science/Cropland/Release/index.php) in the Rock County Rural Water DWSMA shows that the land use here is predominately cropland. Data illustrated in Figure 3 and Figure 4 is from the Feb 2022 data release.

During this time, there has been an increase in cropland converted to land conservation. Land conversation is reference to the conversion of cropland to perennial cover or cropland management protective of groundwater through some form of government cost share program. In 2019 there were 421 cropland acres planted in perennial cover (including land conservation, hay, pasture, and alfalfa). By 2022, there has been a 40% increase (up to 1,050 acres) in the cropland planted into perennial cover. The following maps illustrate these changes.

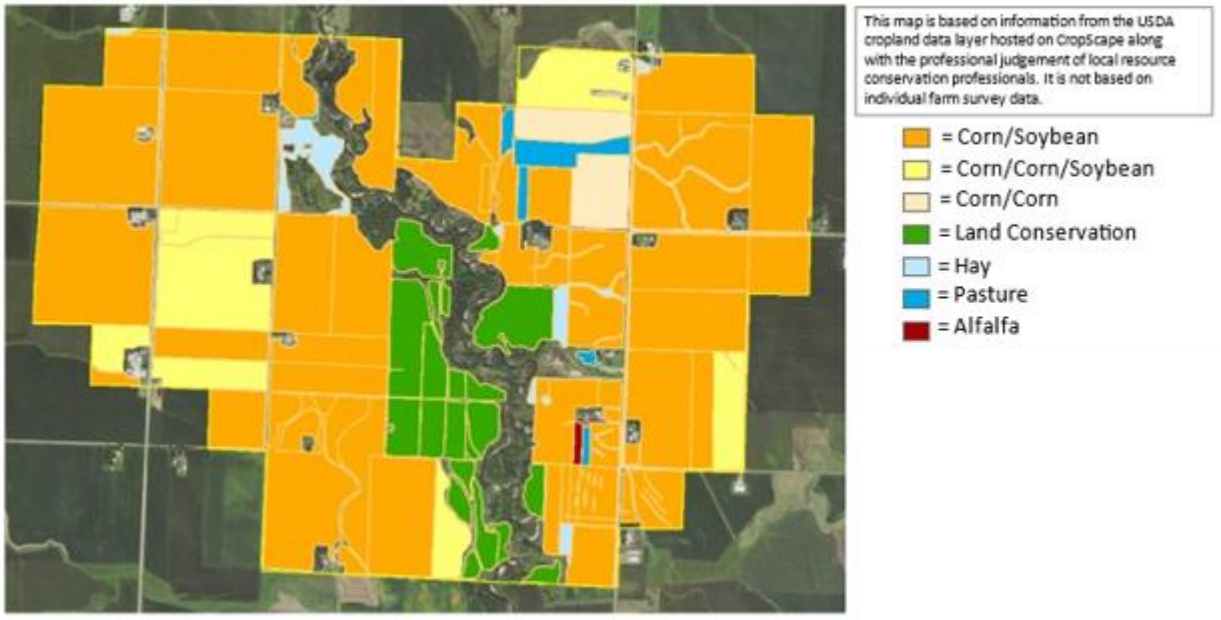

Figure 3. 2019 Rock County Rural Water DWSMA Crop Rotation Map. This map uses the crop types identified by CropScape 2012-2019. See Table 2 for more information.

Table 2. Number of acres and percentage of DWSMA cropland for each crop rotation in 2012-2019 (3118.6 total acres).

Crop Rotation	Acres	% of DWSMA Cropland
Corn/Bean	2268.3	72.7%
Corn/Corn/Bean	342.3	11.0%
Land Conservation	286.0	9.2%
Corn/Corn	87.1	2.8%
Grass Hay	81.3	2.6%
Pasture	49.3	1.6%
Alfafla	4.3	0.1%

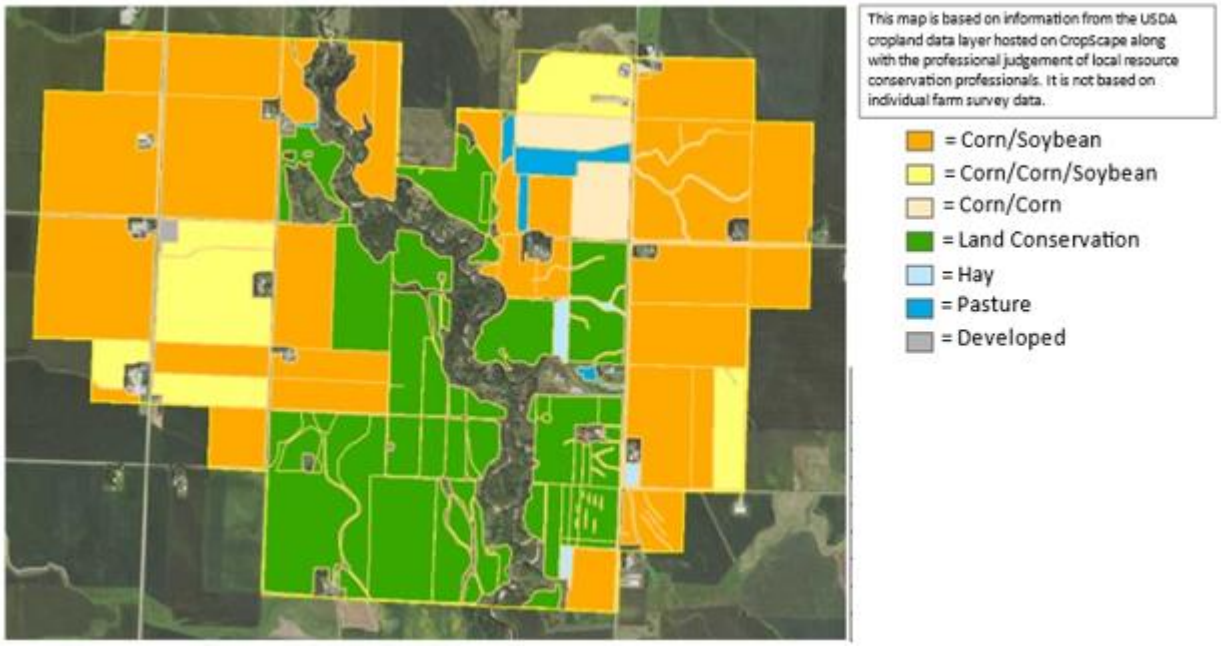

Figure 4. 2022 Rock County Rural Water DWSMA Crop Rotation Map. This map uses the crop types identified by CropScape 2020-2022. See Table 3 for more information.

Table 3. Number of acres and percentage of DWSMA cropland for each crop rotation in 2020-2022 (3118.6 total acres).

Crop Rotation	Acres	% of DWSMA Cropland
Corn/Bean	1668.2	53.5%
Land Conservation	956.6	30.7%
Corn/Corn/Bean	308.4	9.9%
Corn/Corn	87.1	2.8%
Grass Hay	47.6	1.5%
Pasture	45.8	1.5%
Developed	4.9	0.2%

Within the Rock County Rural Water DWSMA, the crops grown include corn, soybeans, grass hay, and pasture. Small grains and alfalfa have also been grown in the DWSMA in the last ten years. In 2022 there were 1,050 acres of perennial crops (alfalfa, pasture, grass hay, and land conservation) accounting for 33.7% of the total cropland area. The remaining 66.3% of cropland acres in 2022 included corn and soybean rotations.

Table 4. Rock County Rural Water DWSMA cropland history excluding soybeans.

Year	Perennial Cover (Alfalfa, Pasture, Grass Hay & Sod) Acres	Perennial Cover (Alfalfa, Pasture, Grass Hay & Sod) % of Cropland	Corn Acres	Corn % of Cropland	Small Grains Acres	Small Grains % of Cropland
2013	469	23%	1574	77%	4	0%
2014	425	21%	1598	79%	0	0%
2015	418	22%	1445	78%	0	0%
2016	384	21%	1416	79%	0	0%
2017	445	24%	1373	76%	0	0%
2018	428	23%	1374	75%	34	2%
2019	469	23%	1607	77%	0	0%
2020	748	37%	1296	63%	0	0%
2021	938	41%	1347	59%	0	0%
2022	1050	47%	1184	53%	0	0%

The MDA evaluation of BMP adoption will exclude soybean acres. During the ten years of crop history shown in Table 4 the perennial cover on cropland when soybeans are excluded has ranged between 21-47% of the cropland area.

In addition to review of cropping history, the MDA also surveyed agronomists and farmers to understand the nitrogen fertilizer management practices used in the Rock County Rural Water area. The MDA was able to obtain farming information for most of the cropland acres across the DWSMA. Having current and accurate nitrogen fertilizer management data is critical to the discussion of protective agricultural management practices (i.e. BMPs and AMTs) appropriate for this DWSMA. 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.

Farmers within this DWSMA use both commercial nitrogen and manure to fertilize corn. Table 5 is an estimate of total nitrogen applied annually including both commercial nitrogen and manure. Due to the small number of operators farming within this DWSMA, more detailed farming practice information cannot be included in this document. The state statute on Agricultural Data (Minnesota Statute 13.643 Subd. 7) protects the identities and location of producers who are cooperating with the MDA in an assessment of farm practices. If farm practice information could identify an individual, it is considered private information and cannot be shared by the MDA.

Table 5. Rock County Rural Water DWSMA Cropland Nitrogen Rates

Crop Rotation	Acres	Total Nitrogen Applied (lbs. N/acre)
Corn-Soybean	1,248	130-180
Corn-Corn	201	180-225

The MDA was not able to collect detailed nitrogen management information on all cropland acres that receive manure within this DWSMA. On these acres estimates were made based on discussion with local farmers, agronomists, and resource conservation professionals. Based on the detailed commercial nitrogen fertilizer use information the MDA was able to collect within this DWSMA; all nitrogen sources are accounted for, and nitrogen credits from previous legume crops and manure are taken. Some cropland corn acres within the DWSMA apply nitrogen fertilizer at rates above the current University of Minnesota recommendations. In addition, in-season split applications of nitrogen on corn occurs on some of the acres in this DWSMA.

DWSMA Nitrate-Nitrogen Loss Below Cropland

Using a crop and soil computer simulation model called the Soil Water and Assessment Tool (SWAT) (https://swat.tamu.edu/) the MDA has estimated the nitrogen loss below the root zone in the Rock County Rural Water DWSMA comparing the nitrogen management practices used in 2019 with the nitrogen loss below the 2022 cropland cover. From 2019 to 2022 there were 629 additional acres of perennial cover planted on cropland in this DWSMA for the purpose of protecting groundwater. The table below shows the modeled nitrogen loss below the cropland nitrogen management practices in 2019 and 2022 (Tables 6 and 7).

Table 6. Rock County Rural Water DWSMA nitrate-nitrogen loss estimates below cropland. Modeled nitrogen loss below cropland following nitrogen management practices in 2019.

Crop Rotation	2019 Acres Within the DWSMA	Area Weighted Average Nitrogen Leaching (lbs. N/ac/yr)
Corn-Soybean (C-SB)- commercial N only	965	35.6
Corn-Soybean (C-SB)- acres with manure included	1303	36.8
Corn-Corn-Soybean	342	46.9
Corn-Corn (C-C)	87	Data protected
Land Conservation	286	7.9
Grass Hay	81	6.9
Pasture	49	Data protected
Alfalfa x 4, Corn	4	Data protected
Total	3,117	35.5

Table 7. Rock County Rural Water DWSMA nitrate-nitrogen loss estimates below cropland for the 2022 crop year. Modeled nitrogen loss below cropland following current nitrogen management practices.

Crop Rotation	2022 Acres Within the DWSMA	Area Weighted Average Nitrogen Leaching (lbs. N/ac/yr)
Corn-Soybean (C-SB)- commercial N only	618	35.6
Corn-Soybean (C-SB)- acres with manure included	1052	38.3
Corn-Corn-Soybean	308	46.9
Corn-Corn (C-C)	87	Data protected
Land Conservation	957	7.9
Grass Hay	48	6.9
Pasture	46	Data protected
Total	3,116	29.6

In 2019, the model estimates an area weighted average of 35.5 lbs. N/acre is lost below the rootzone of all cropland within the DWSMA (Table 6). In 2022, the area weighted average loss below the cropland rootzone is reduced to 29.6 lbs. N/acre (Table 7).

The DWSMA-wide change in average nitrogen loss below cropland between these two years (2019 and 2022) amounts to a 16.7% reduction in nitrogen leaching per year within this DWSMA. This DWSMA-wide reduction is a significant change in nitrogen leaching.

The MDA modeling also looked at nitrogen leaching reductions possible with the adoption of University of Minnesota BMPs on acres where these practices are not already adopted. The BMPs modeled included changes in corn nitrogen rate and practices that change the timing for nitrogen available to the corn grown on coarse textured soils.

The model estimates a 1.6% DWSMA-wide reduction in nitrate leaching if the nitrogen rates applied to corn did not exceed the University of Minnesota's 0.075 ratio range of application rates for nitrogen (Table 8). This would require 61% of the cropland acres with corn in the rotation to reduce the rate of nitrogen applied. For reference, the upper end of the 0.075 ratio range is currently 165 lbs. N/acre for a corn-soybean rotation and 205 lbs. N/acre

for a corn-corn rotation. This reduction is in addition to an estimated 16.7% reduction realized following the conversation of cropland into perennial cover.

Table 8. DWSMA wide nitrogen reduction with corn nitrogen rates not exceeding the range of application rates recommended in the University of Minnesota's 0.075 ratio range.

Crop Rotation	Nitrogen Loss Reduction	Practice
Cropland acres with corn in rotation	1.6%	Reducing nitrogen rates to not exceed the high end of the 0.075 ratio range.

The model also estimates that by adding split applications of nitrogen on course textured soils to acres where this nitrogen fertilizer BMP is not already adopted a 0.5% DWSMA-wide reduction in nitrogen loss on an annual basis is possible. The use of a urea/ESN blend or urea with a nitrification inhibitor at preplant results in a 0.1% and a 0.2% annual reduction in nitrogen loss respectively (Table 9). The modeling in this DWSMA indicates that these three BMPs are equivalent from a groundwater protection standpoint. As such, any one of these practices could be used interchangeably to protect groundwater in this DWSMA.

Table 9. Rock County Rural Water DWSMA modeled nitrate-nitrogen loss below nitrogen best management practices (BMPs) for coarse soils. The nitrogen loss reductions are based on the adoption of the listed BMPs on course textured soils where split application is not already adopted. ESN and use of a nitrification inhibitor at preplant are alternatives to the split application of nitrogen.

Nitrogen Best Management Practices	Additional Acres within DWSMA	Nitrogen Loss Reduction	Notes
Split apply nitrogen on all C-C and C-SB acres	342	0.5%	This would be applicable to 342 additional C-C and C-SB acres splitting nitrogen. Dealer surveys indicated that there is currently no split applications being done on course textured soils.
Urea/ESN (70/30 blend) applied at preplant on C-C and C-SB acres	123	0.1%	This would be applicable to 123 acres of course textured soils.
Nitrification inhibitor on urea applied preplant on C-C and C-SB acres)	123	0.2%	This would be applicable to 123 acres of course textured soils.

To consider additional opportunities for reducing nitrogen loss to groundwater the MDA modeled nitrogen management changes and Alternative Management Tools (AMTs) that go above and beyond BMPs to further reduce nitrogen loss below the crop rootzone (Table 10). If adopted the model estimates that nitrogen leaching below the rootzone within this DWSMA could be reduced by the percentages shown in Table 10. These are voluntary practices. Working with local farmers, this list will be promoted widely and funding identified to support adoption of these practices.

Table 10. Rock County Rural Water DWSMA modeled nitrate-nitrogen loss below nitrogen management changes and AMTs for all soils considered by the Rock County Rural Water LAT.

Nitrogen Management Changes and AMTs	Additional Acres within DWSMA	Nitrogen Loss Reduction	Notes
Nitrification inhibitor with urea preplant N on all soils	1119	1.9%	Using an MDA approved nitrification inhibitor across all DWSMA acres that receive preplant urea.
Nitrification Inhibitor with urea preplant N and fall hog manure on all soils	1937	4.1%	Using an MDA approved nitrification inhibitor across all DWSMA acres that receive preplant urea or liquid hog manure.
Split Application of Nitrogen on all soils	1387	1.9%	Using a split application where 1/3 N is applied in season across all soils in DWSMA
Cover crop after soybeans on 80% of the corn-soybean acres	1536	10%	Cereal Rye planted after soybean harvest. With good establishment 6 out of 10 years. Currently 7% of the DWSMA cropland acres use cover crops.

The MDA also modeled the effectiveness of alternative crop rotations to reduce nitrogen loss below cropland (Table 11). The table below compares crop rotations using average field conditions within this DWSMA (soil, weather, and topography considered). A hypothetical corn-soybean rotation with 165 lbs. N/acre urea applied at preplant was used as a baseline to compare with. The modeling results shown in this table are calculated on a per acre basis (not DWSMA-wide). While this comparison is hypothetical it does provide an estimate of the relative benefit that these rotation changes could have if adopted within this DWMSA.

Table 11. Rock County Rural Water DWSMA modeled nitrate-nitrogen loss below crop rotations considered by the LAT.

Crop Rotation	Nitrogen Loss Reduction	Notes
Corn/Soybean (165 lb N/ac applied preplant as urea)	Baseline	This baseline scenario is what the other
Corn-Soybean-Oat-Soybean	10.3%	(Corn 150lb N/ac, Oats 50lb N/ac; preplant)
Soybean-Soybean-Soybean-Soybean-Corn	22.5%	(Corn 150lb N/ac, preplant)
Alfalfa (x4)-Corn-Soybean	50.8%	Zero N for Corn
Alfalfa (x4)-Corn	74.6%	Zero N for Corn
Land Conservation	79.1%	(perennial grass, zero N, no cuttings)
Pasture	82.5%	(perennial grass, zero N, grazed)

MDA Recommended Nitrogen Fertilizer Best Management Practices for the Rock County Rural Water 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 Rock County Rural Water DWSMA webpage (www.mda.state.mn.us/rockcountyrw-dwsma).

- Apply nitrogen to dryland corn in a corn-corn rotation at or below the high end of the 0.075 nitrogen rate range in the University of Minnesota's nitrogen fertilizer application guidelines.
- Apply nitrogen to dryland corn in a corn-soybean rotation at or below the high end of the 0.075 nitrogen rate range in the University of Minnesota's nitrogen fertilizer application guidelines.
- Account for all nitrogen sources when calculating nitrogen rate.

- Take appropriate credits for previous legume crops and manure used in the crop rotation.
- Split application of nitrogen fertilizer or the use of urea/ESN blend or urea with a nitrification inhibitor at preplant on coarse textured soils.
- For all other crops grown within the DWSMA, nitrogen rates must follow the current University of Minnesota guidance applicable to that crop.
- Maintain the existing perennial cover on cropland.
- Use products delaying nitrification, approved by the MDA.
- Use products delaying plant available nitrogen, approved by the MDA.
- Split application of nitrogen on all soils.

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 Rock County Rural Water DWSMA the MDA has reviewed the cropping history, surveyed nitrogen management practices, modeled nitrogen loading estimates below existing nitrogen fertilizer management practice and alternative practices.

The cropland in perennial cover including grass hay, alfalfa, and pasture accounts for a substantial amount of cropland within this DWSMA. Since 2019, the amount of cropland acres in perennial cover has significantly increased to over 33% in the DWSMA. The modeled DWSMA wide decrease in nitrogen loss to groundwater from this perennial cover is 16.7%. Over the past ten years, the percentage of cropland in perennial cover ranged from 21-47% when soybeans are not counted in the calculation.

The fertilizer dealership survey indicated that all nitrogen sources are considered, and manure and legume credits counted. The published nitrogen fertilizer BMPs will add split application on coarse soils and reduce the total nitrogen rate on 61% of corn rotation acres in the DWMSA resulting in an additional 2.1% reduction in nitrogen loss within the DWSMA.

Modeling of nitrogen loss below alternative management tools within this DWSMA illustrate options that can further reduce nitrogen loss below the crop root zone. These options were developed in consultation with the LAT. Specific cropland acres have not been identified for the establishment of these alternative management tools, but the LAT acknowledges the additional groundwater protection that this could provide if adopted. The next steps within this DWSMA are to review these practices with individual landowners and explore possible funding opportunities to establish these practices.

If the percentage of perennial cover within the DWSMA were to be reduced from its current level, additional review of the appropriate nitrogen fertilizer BMPs for this DWSMA may be needed and a new list of nitrogen fertilizer BMPs approved. Other 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 practices within the Rock County Rural Water 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 the establishment of alternative management tools. Promotion and funding to support the establishment of alternative management tools within the Rock County Rural Water DWSMA will be a priority. The MDA will continue to work with local partners and ag stakeholders to implement practices that go above and beyond the BMP list to reduce nitrogen leaching in the DWSMA.

Supplemental Data

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

Table 12. Nitrate-nitrogen levels within the six Rock County Rural Water public wells that have exceeded 8 mg/L within the past ten years.

Well Number	Collection Date	Nitrogen Test Levels in mg/L
7	7/7/2014	13
7	6/6/2016	22
7	9/13/2016	22
7	12/19/2016	22
7	3/1/2017	25
7	6/12/2017	23
7	9/12/2017	25
7	12/4/2017	28
7	4/4/2018	24
7	9/12/2018	22
7	12/18/2018	19
7	3/12/2019	12
7	6/17/2019	13
7	9/10/2019	11
7	12/4/2019	8.7
7	3/17/2020	12
7	6/17/2020	12
7	9/14/2020	13
7	12/8/2020	14
7	3/2/2021	14
7	6/8/2021	14
7	9/14/2021	14
7	12/7/2021	13
7	3/9/2022	13
7	6/8/2022	13
7	9/13/2022	13
7	11/14/2022	14
7	12/5/2022	14
7	1/25/2023	14
7	3/22/2023	15
7	4/10/2023	15
7	5/1/2023	16
7	7/10/2023	13
7	8/8/2023	12
7	9/5/2023	12
7	11/13/2023	13
7	12/5/2023	12
7	1/17/2024	13
7	2/6/2024	13
10	7/7/2014	4
10	6/6/2016	5.3
10	9/13/2016	1.4
10	12/19/2016	2.6
10	3/1/2017	2.6
10	6/12/2017	4.6
10	9/12/2017	3.7
10	12/4/2017	5.8
10	4/4/2018	2.2
10	9/12/2018	6.5
10	12/18/2018	8.4
10	3/12/2019	9.8
10	6/17/2019	8.6
10	9/10/2019	7.3
10	12/4/2019	7.5
10	3/17/2020	6.4
10	6/17/2020	6.9
10	9/14/2020	5.8
10	12/8/2020	4.1
10	3/2/2021	3.5
10	6/8/2021	2.8
10	9/14/2021	2.3
10	12/7/2021	2.6
10	3/9/2022	2.1
10	6/8/2022	2.6
10	9/13/2022	2.5
10	11/14/2022	1.8
10	12/5/2022	1.9
10	1/25/2023	1.6
10	4/10/2023	0.76

Well Number	Collection Date	Nitrogen Test Levels in mg/L
10	5/1/2023	3.7
10	6/5/2023	2.2
10	7/10/2023	1.7
10	8/8/2023	1.5
10	9/5/2023	1.8
10	11/13/2023	0.05
10	12/5/2023	0.75
10	1/17/2024	0.74
10	2/6/2024	0.91
11	7/7/2014	3.9
11	6/6/2016	6.9
11	9/13/2016	6.3
11	12/19/2016	5.6
11	3/1/2017	6.7
11	6/12/2017	6.3
11	9/12/2017	6.1
11	12/4/2017	4.9
11	4/4/2018	5
11	9/12/2018	7.3
11	12/18/2018	8
11	3/12/2019	5.9
11	6/17/2019	8.6
11	9/10/2019	7.5
11	12/4/2019	7.6
11	3/17/2020	5.2
11	6/17/2020	6.2
11	9/14/2020	5.2
11	3/2/2021	2.3
11	6/8/2021	2.7
11	9/14/2021	0.64
11	12/7/2021	0.84
11	3/9/2022	2
11	6/8/2022	2.2
11	9/13/2022	2.3
11	12/5/2022	0.53
11	1/25/2023	0.69
11	4/10/2023	1.1
11	5/1/2023	1.9
11	6/5/2023	1.9
11	7/10/2023	1.5
11	8/8/2023	1.6
11	9/5/2023	1.2
11	11/13/2023	0.72

Well Number	Collection Date	Nitrogen Test Levels in mg/L
11	12/5/2023	0.71
11	1/17/2024	0.35
11	2/6/2024	0.2
11	5/9/2007	10.5
11	7/7/2014	6
11	9/13/2016	8.1
12	3/14/2017	27
12	5/15/2017	27
12	6/19/2017	24
12	7/12/2017	26
12	9/7/2017	27
12	12/4/2017	27
12	12/12/2017	24
12	3/27/2018	26
12	4/4/2018	25
12	5/31/2018	23
12	8/20/2018	21
12	9/12/2018	21
12	11/20/2018	20
12	12/18/2018	21
12	1/16/2019	20
12	6/17/2019	15
12	6/18/2019	17
12	8/29/2019	20
12	9/18/2019	18
12	10/3/2019	18
12	12/4/2019	21
12	12/24/2019	20
12	3/9/2020	18
12	6/1/2020	17
12	8/6/2020	17
12	9/2/2020	17
12	11/18/2020	15
12	3/2/2021	15
12	6/8/2021	14
12	9/14/2021	14
12	12/15/2021	12
12	2/22/2022	13
12	6/14/2022	13
12	9/13/2022	14
12	11/14/2022	14
12	12/20/2022	15
12	1/25/2023	14

Well Number	Collection Date	Nitrogen Test Levels in mg/L
12	3/22/2023	15
12	4/10/2023	14
12	5/1/2023	13
12	5/3/2023	13
12	6/5/2023	14
12	7/10/2023	12
12	8/1/2023	14
12	8/8/2023	14
12	9/5/2023	13
12	11/13/2023	14
12	11/14/2023	14
12	1/17/2024	14
12	2/6/2024	14
13	7/2/2013	14.5
13	3/14/2017	18
13	5/15/2017	20
13	6/19/2017	18
13	7/12/2017	19
13	9/7/2017	21
13	12/4/2017	22
13	12/12/2017	22
13	3/27/2018	22
13	4/4/2018	22
13	5/31/2018	24
13	8/20/2018	25
13	9/12/2018	26
13	11/20/2018	25
13	12/18/2018	27
13	1/16/2019	25
13	6/17/2019	24
13	6/18/2019	25
13	8/29/2019	26
13	9/18/2019	25
13	12/4/2019	22
13	12/24/2019	24
13	3/9/2020	24
13	6/1/2020	24
13	8/6/2020	23
13	9/2/2020	20
13	11/18/2020	19
13	3/2/2021	15
13	6/8/2021	16
13	9/14/2021	16

Well Number	Collection Date	Nitrogen Test Levels in mg/L
13	12/15/2021	12
13	6/14/2022	12
13	9/13/2022	13
13	11/14/2022	13
13	12/20/2022	13
13	1/25/2023	12
13	3/22/2023	13
13	4/10/2023	12
13	5/1/2023	12
13	5/3/2023	12
13	6/5/2023	13
13	7/10/2023	12
13	8/1/2023	13
13	8/8/2023	13
13	9/5/2023	12
13	11/13/2023	13
13	11/14/2023	12
13	12/5/2023	12
13	1/17/2024	12
13	2/6/2024	12
14	12/19/2016	8.2
14	3/1/2017	8.9
14	6/12/2017	8.5
14	9/12/2017	9.8
14	12/4/2017	11
14	4/4/2018	10
14	9/12/2018	9.7
14	12/18/2018	10
14	3/12/2019	12
14	6/17/2019	8.9
14	9/10/2019	9.6
14	12/4/2019	9.2
14	3/17/2020	8.3
14	6/17/2020	9.5
14	9/14/2020	9.7
14	12/8/2020	9.7
14	3/2/2021	9
14	6/8/2021	10
14	9/14/2021	11
14	12/7/2021	11
14	3/9/2022	11
14	6/8/2022	11
14	9/13/2022	9.7

Well Number	Collection Date	Nitrogen Test Levels in mg/L
14	11/14/2022	9.6
14	12/5/2022	9.3
14	1/25/2023	8.9
14	3/22/2023	9.2
14	4/10/2023	9.9
14	5/1/2023	9.7
14	6/5/2023	9.3
14	7/10/2023	8.7
14	8/8/2023	8.8
14	9/5/2023	8.2
14	11/13/2023	9.3
14	12/5/2023	9.4
14	1/17/2024	7.6