

Adrian DWSMA Groundwater Protection Rule Summary

Groundwater, Nitrogen Fertilizer Management, and Nitrogen Loading Analysis

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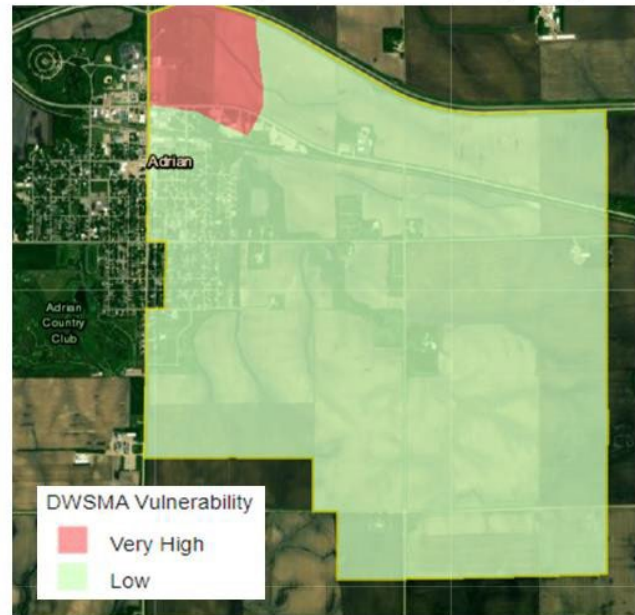
Introduction

This document summarizes the Minnesota Department of Agriculture's (MDA) current understanding of the Adrian Drinking Water Supply Management Area (DWSMA), public well nitrate-nitrogen levels, and nitrogen management information. Also included is a summary of the MDA's nitrogen loss analysis below cropland within this DWSMA. This summary provides the detail 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 city of Adrian public wells covers 1,865 acres. The groundwater below 1,757 (94%) of those acres is designated by the MDH as low vulnerability. Areas classified as low vulnerability by the MDH are not included in the mitigation area designation under the Groundwater Protection Rule (Minnesota Statute 1573.0040, Subp 3, D (2)). A total of 108 acres located nearest to the public wells are designated as highly vulnerable. The Groundwater Protection Rule applies to this highly vulnerable portion of the DWSMA.

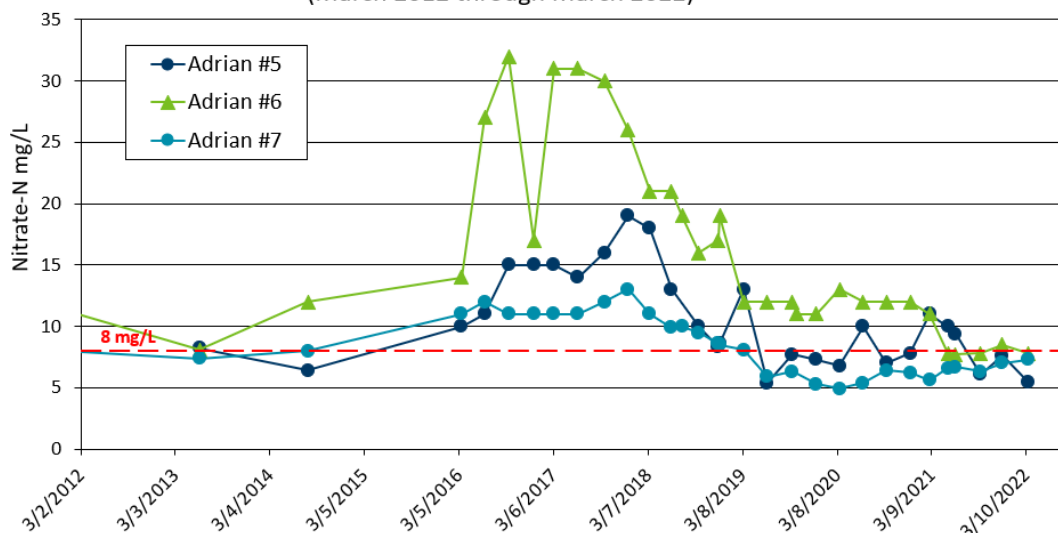
Adrian DWSMA Vulnerability Designated by the Minnesota Department of Health (MDH)



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 Adrian is shown in the graph below. Nitrate-nitrogen levels have exceeded 8 mg/L in three municipal wells within the past ten years.

City of Adrian Primary Public Well Nitrate Data (March 2012 through March 2022)

Data provided by:
m DEPARTMENT OF HEALTH



Between 2016 and 2018, the nitrate levels measured in the Adrian public wells show an increase followed by a return to levels observed before this timeframe. Well #6 is upgradient of the other wells, but has a smaller

casing diameter and deeper casing compared with well #7 (Table 1). Within the highly vulnerable portion of the Adrian DWSMA, we are not aware of any changes to the perennial cover or cropland management during this time period that would have contributed to the elevated nitrogen levels. Dry climatic conditions in the region before and during this timeframe may have limited the crop uptake of nitrogen and influenced the nitrogen levels measured in the Adrian public wells.

Table 1. City of Adrian public well information.

Local Well ID	MDH Status	Casing Diameter (in)	Casing Depth (ft)	Well Depth (ft)	Date Constructed
Well #5	Primary	12	19	26	1984
Well #6	Primary	12	31	42	1985
Well #7	Primary	18	23	42	2006

DWSMA Land Use and Potential Nitrate-Nitrogen Point Source Consideration

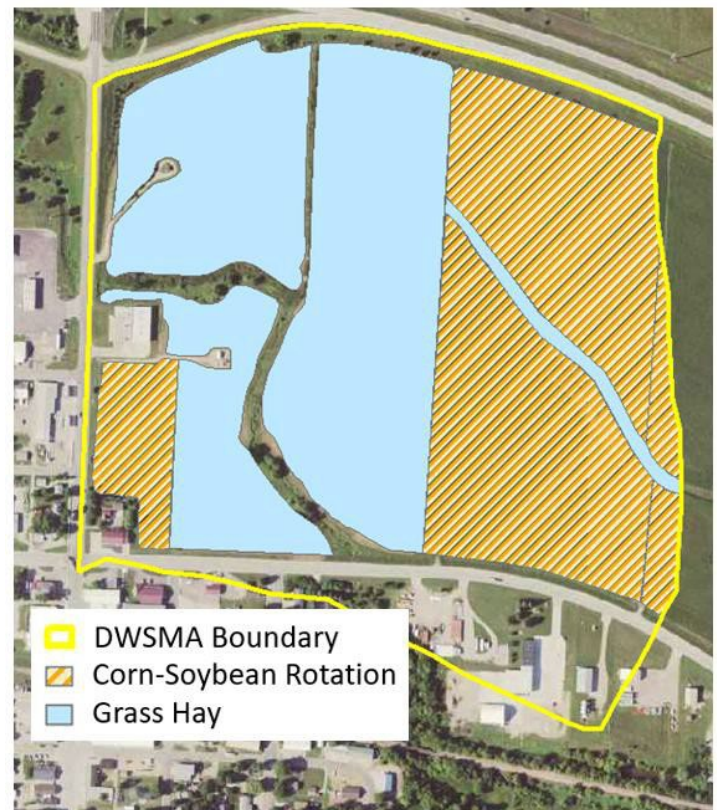
The MDA conducted a detailed review of potential contaminant sources to determine whether a point source of nitrogen could be the cause of the public well exceeding the criteria for mitigation level designation (Minnesota Statute 1573.0040, Subp. 3, C). In the Adrian DWSMA, the MDA did not identify a potential point source for nitrate-nitrogen. With nitrate levels exceeding 8.0 mg/L within the past ten years and without a point source contribution, the highly vulnerable portion of this DWSMA was designated at a 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 already have elevated nitrate. The goal is to take action to reduce nitrate in groundwater before a public well exceeds the health standard for nitrate. In Level 2 DWSMAs, the MDA works with a local advisory team (LAT) including local farmers, agronomists, and others to get input on management practices (BMPs and AMTs) 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 excluding forestland. A review of the publicly available USDA Cropland Data Layer (hosted on Crop Scape)¹ in the highly vulnerable portion of the Adrian DWSMA shows that the land use is predominately cropland. This is illustrated in the map to the right.

The Minnesota Department of Agriculture (MDA) surveyed local agronomists and farmers to understand the nitrogen fertilizer management practices used in the Adrian area. Having current and accurate nitrogen fertilizer management data is critical to the discussion of BMPs and AMTs. With computer modeling the MDA compares nitrogen leaching loss below current management practices and under the nitrogen fertilizer BMPs proposed to protect groundwater. The farming practice information collected includes crop type, planting date, harvest date, and nitrogen fertilizer use information.

Cropland within the highly vulnerable portion of the Adrian DWSMA based on the USDA Cropland Data



¹ National Ag Statistics Service (NASS) Cropland Data Layer (Feb 2022 release). Retrieved from <https://data.nal.usda.gov/dataset/cropscape-cropland-data-layer?msckid=7095cf4ca92d11ecb2a28bbba44507d5>

Due to the small number of operators farming within this DWSMA, the farming practice information MDA collected is not included in this document. 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 farming practice information could identify an individual, it is considered private information and can be used for analysis but cannot be shared by the MDA.

Within the highly vulnerable portion of the Adrian DWSMA the crops grown in 2021 include grass hay, corn, and soybeans. The land area in a corn-soybean rotation is 38 acres and represents 44% of the cropland. The remaining 45 acres are in grass hay. The 45 acres of grass hay are adjacent to the public wells and make up 56% of the cropland area (Table 2). The grass hay land has been owned by the City of Adrian since 2020 and was purchased with a Board of Soil and Water Resources (BWSR) Wellhead Protection Partnership Program grant requiring that the land be permanently managed to protect groundwater (Minnesota Statute 103F.515, Subd. 2, paragraph (d)). Before the city took ownership of this land it was enrolled in the Conservation Reserve Program (CRP) in 2007 or 2008 and has had perennial cover in place since then.

Table 2. 2021 Adrian DWSMA Cropland Cover

2021 Cropland cover within the highly vulnerable area of the Adrian DWSMA		
Crop Type	Acres	% of Cropland
Grass Hay	45	56%
Corn/Soybeans	38	44%
Non-Cropland	25	---

The MDA has also reviewed the USDA Cropland Data Layer¹ over the past 10 years in the highly vulnerable portion of the Adrian DWSMA. During this time the perennial cover (CRP or grass hay) in place has exceeded 56% of the cropland area every year (Table 3).

The crop rotation between corn and soybeans is the reason that perennial cover varies from 56-96% within the Adrian DWSMA. When soybeans are planted and excluded from the calculation, the denominator is reduced and the percentage of perennial cover during those years is accordingly higher.

Table 3. Adrian DWSMA Crop History

Adrian DWSMA Cropland Crop History (Excluding Soybeans)				
Year	Perennial Cover (CRP/Grass Hay)		Corn	
	Acres	% of Cropland	Acres	% of Cropland
2010	45	56	36	44
2011	45	96	2	3
2012	45	56	36	44
2013	45	96	2	3
2014	45	56	36	44
2015	45	96	2	3
2016	45	56	36	44
2017	45	74	16	26
2018	45	56	36	44
2019	45	96	2	3
2020	45	56	36	44
2021	45	96	2	3

DWSMA Nitrate-Nitrogen Loss Below Cropland

Using a crop and soil simulation model called EPIC², the MDA has estimated the nitrogen loss below the root zone in the Adrian DWSMA comparing the nitrogen management practices used in the recent past with the list of proposed nitrogen fertilizer BMPs for this DWSMA. The proposed practices include a lower rate of nitrogen than currently used and a split application of this nitrogen. The table below shows the modeled nitrogen loss reduction below these two nitrogen management practices. The model estimates a 29.1% reduction in nitrogen losses below cropland if the MDA recommended BMPs are followed (Table 4).

² Environmental Policy Integrated Climate (EPIC) model. <https://epicapex.tamu.edu/epic/>

A corn-corn rotation is not currently grown within the DWSMA, however MDA will list BMPs related to corn-

Table 4. Adrian DWSMA nitrate-nitrogen loss below recommended nitrogen management practices

EPIC Model Nitrogen Loading Estimates Below Cropland in the Highly Vulnerable Portion of the Adrian DWSMA		
Cropland Cover or Rotation	Current nitrogen management practices used in the DWSMA	Split apply nitrogen at a total rate within or below the 0.075 ratio range
CRP-Grassland-Pasture	Minimal	Minimal
Corn-Soybean	The baseline nitrogen loss rate estimated below current nitrogen management practices used in the DWSMA*	29.1 % reduction

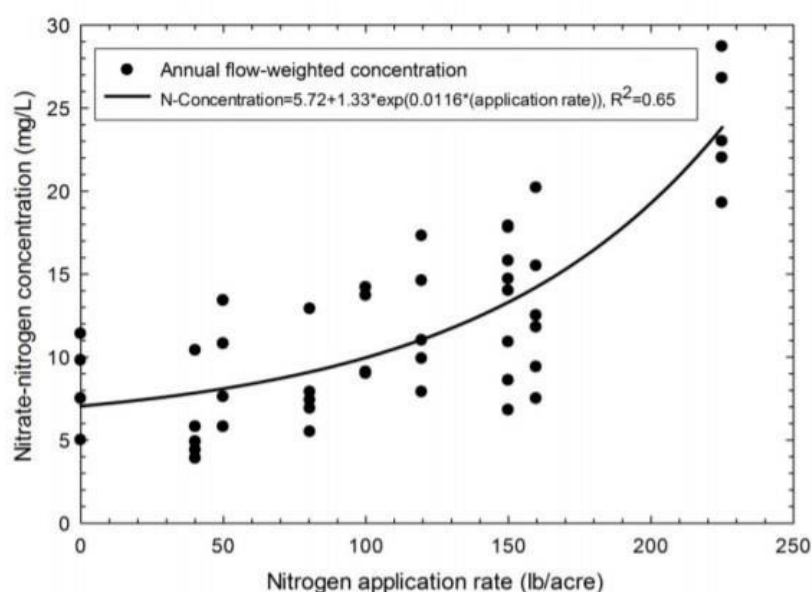
*The baseline nitrogen loss rate is not listed here due to the small number of operators farming within this DWSMA.

corn in the case that this changes. The corn-corn BMPs were compared to the current management within a corn-soybean rotation. The EPIC model estimated a 22.2% reduction in nitrogen losses below the recommended corn-corn BMPs.

Choosing the correct nitrogen rate is generally the most important factor in managing nitrogen fertilizer to protect groundwater. In addition to the DWSMA specific modeling, the MDA also looked at nitrate loss reduction estimates in published literature. The graphic³ below illustrates the annual flow weighted concentration of nitrogen lost below the crop root zone of a corn-soybean rotation through tile drainage for different fertilizer application rates.

This graphic illustrates an approximate 21% reduction in nitrogen concentration following the MDA recommended nitrogen management practices for the Adrian DWSMA. This reduction generally aligns with the 29.1% nitrogen loss reduction estimated with MDA modeling below the recommended set of BMPs and provides an additional line of evidence that the approved BMP list will reduce nitrogen loss below the cropland root zone.

If the recommended nitrogen fertilizer BMPs are adopted including a nitrogen rate reduction for corn in a corn-soybean rotation and the current perennial cover within the DWSMA is maintained both the MDA modeling and peer-reviewed literature indicates that nitrogen leaching below cropland will be reduced.



³ P.A. Lawlor, M.J. Helmers, J.L. Baker, S.W. Melvon, D.W. Lemke. Transactions of the ASABE. 51(1): 83-94, (doi: 10.13031/2013.24229) @2008

MDA Recommended Nitrogen Fertilizer Best Management Practices for the Adrian DWSMA

In consultation with the local advisory team that includes both the farmers operating cropland within the highly vulnerable portion of the Adrian DWSMA and City of Adrian leadership, the MDA has developed the following list of practices to protect groundwater. A more detailed list of these BMPs is available at www.mda.state.mn.us/adrian-dwsma.

- Maintain the existing perennial cover.
- Apply nitrogen to corn in a corn-soybean rotation within or below the 0.075 ratio range in the University of Minnesota's nitrogen fertilizer application guidelines for dryland corn.
- Apply nitrogen to corn in a corn-corn rotation at or below the 0.075 MRTN in the University of Minnesota's nitrogen fertilizer application guidelines for dryland corn.
- Account for all nitrogen sources when calculating nitrogen rate.
- Take appropriate credits for legume and manure used in the rotation.
- Split applications of nitrogen fertilizer.
- For all other crops grown within the DWSMA, nitrogen rates must follow the current University of Minnesota guidance applicable to that crop.

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 BMPs are published.

Conclusion

In the highly vulnerable portion of the Adrian DWSMA the MDA has reviewed the cropping history, surveyed nitrogen management practices, considered related estimates in published literature, and modeled nitrogen loading estimates below cropland.

The land in perennial cover nearby the city wells is owned by the City of Adrian and conditions of the grant funding used to acquire this property require that it is permanently managed to protect groundwater from nitrogen contamination. This perennial cover accounts for more than 56% of the cropland area in the highly vulnerable portion of Adrian's DWSMA.

Modeling of nitrogen loss below cropland estimates a 29.1% reduction in nitrogen loss by following the MDA recommended Nitrogen Fertilizer Best Management Practices and maintaining the amount of perennial cover currently in place.

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 recommended nitrogen fertilizer BMPs. 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 fertilizer BMPs within the highly vulnerable portion of the Adrian DWSMA are appropriate and that over time nitrate-nitrogen loss below the cropland rootzone will be reduced following these practices.

In accordance with the Americans with Disabilities Act, this information is available in alternative forms of communication upon request by calling 651-201-6000. TTY users can call the Minnesota Relay Service at 711. The MDA is an equal opportunity employer and provider.

Addendum: Updated Corn Nitrogen Fertilizer Rate Guidance

Added 5/15/25

This addendum explains changes to University of Minnesota nitrogen fertilizer rates for corn. Other text in the document has not been edited and reflects the University of Minnesota guidance available at the time this summary was published in May 2023.

In April 2025 the University of Minnesota (UMN) nitrogen rate recommendations for dryland corn were updated. The updated UMN corn nitrogen rate guidance is based on the latest research available in Minnesota. To align with the current guidance, the corn nitrogen rates included in the BMP list published for this DWSMA were updated. The tables below are adapted from the UMN rate guidance released in April 2025 and reflect the new rate guidance to which the BMPs published in this DWSMA will refer.

Guidelines for use of nitrogen fertilizer for corn grown following soybeans when supplemental irrigation is not used.

N Price/Crop Value Ratio	Maximum Return to Nitrogen	Acceptable Range
0.075	155	145-170
0.100	150	135-160
0.125	140	130-155
0.150	135	125-145

Guidelines for use of nitrogen fertilizer for corn grown following corn when supplemental irrigation is not used.

N Price/Crop Value Ratio	Maximum Return to Nitrogen	Acceptable Range
0.075	200	180-220
0.100	185	170-200
0.125	175	160-190
0.150	165	150-175

Adoption of the BMPs can be evaluated no sooner than three growing seasons after the DWSMA BMP list is published. For the Adrian DWSMA, the evaluation could occur as soon as 2026. Following that evaluation, the BMP list for the Adrian DWSMA may be adjusted considering water quality information, input from the LAT and any new Nitrogen Fertilizer BMP updates from the University of Minnesota.