

Minnesota Agronomy Technical Note 32

Nutrient Loss Risk Assessments, Sensitive Features and Definitions for Minnesota

I. Evaluating Nitrogen Loss Potential

Potential off-field nitrogen transport will be determined on all sites using Table 1 and Figure 1 below.

- These have been modified from similar tables and figures found in the:
 - University of Minnesota publication “Nitrogen Loss Potential and Nitrogen Fertilizer Management of Minnesota Soils” - 1983
 - University of Minnesota Extension Regional Best Management Practices (BMPs) publications.
 - Minnesota Dept. of Agriculture’s (MDA) Nitrogen Best Management Practices (BMPs) webpage

Additional nitrogen application restrictions may be applicable to fields within this plan. Consult the following:

- MDA Nitrogen Fertilizer Rule (currently in draft version) for a list and/or map of applicable conditions and areas.
- Table 3: Summary Nutrient Application Restrictions in Sensitive Areas
- Table 4: Additional Commercial Nitrogen Timing and Form Guidance

Nitrogen fertilizer management options that reduce loss potential will be recommended if a client's existing practices have a rating of moderate to high.

- Consult information contained in NRCS-MN conservation practice standard 590 Nutrient Management, University of Minnesota Extension Regional BMPs publications, and MDA’s Nitrogen BMPs webpage for management options which may include:
 - changing application timing, or
 - changing the nitrogen fertilizer source, or
 - using a nitrification inhibitor where appropriate.

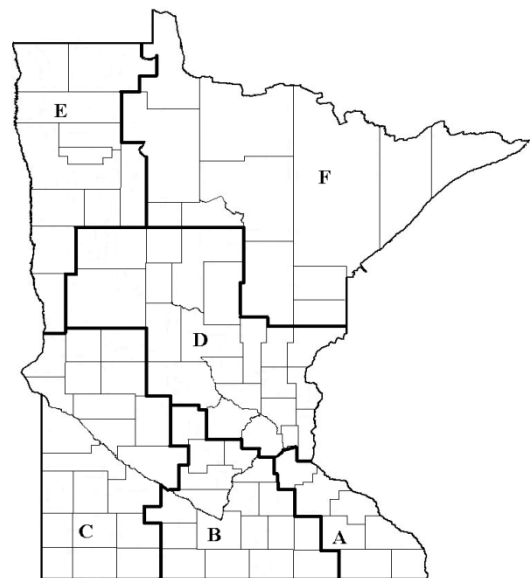
Use caution in the following areas:

- Areas with an identified nitrogen-related water quality impairment
- DWSMAs and SWPAs with medium to high vulnerability to contamination
- Areas having High or Very High pollution sensitivity of the water table or surficial aquifer as portrayed in a County Geologic Atlas, Regional Hydrogeologic Assessment, or Web Soil Survey (Aquifer Assessment).

Table 1: Long Term Annual Relative Nitrogen Loss Potential¹

Zone	Application Timing	Soil Texture ²		
		Coarse	Medium	Fine
A	Fall Spring preplant Sidedress or split	R H M	R M L	R M L
B	Fall Spring preplant Sidedress or split ³	R H M	M M L	M M L
C,D	Fall Spring preplant Sidedress or split ³	R H M	L L L	L L L
E	Fall Spring preplant Sidedress or split ³	R L L	L L L	L L L
F	Fall Spring preplant Sidedress or split ³	R M M	L L L	L L L

Figure 1. Nitrogen Loss Zones



¹ Loss Potential Rating: R-Restricted (application not allowed), H-High, M-Moderate, and L-Low

² Soil Texture: See definitions section

³ If applied after June 15, the loss rating is reduced to Low on Coarse textured soils.

- Nitrogen loss as a result of the crop not utilizing the applied nitrogen can also occur on most soils if late nitrogen applications are followed by conditions that reduce yield (i.e. below average precipitation).

II. Evaluating Phosphorus Loss Potential

Any planning land unit receiving or proposed to receive manure or other organic by-products will have the potential for off-field phosphorus transport evaluated using Table 2 below.

Planning land units located in a watershed impaired because of phosphorus (shown on MPCA's Inventory of Impaired Waters with the "pollutant or stressor" identified as "nutrient/eutrophication biological indicators") will use the University of Minnesota's Phosphorus Index on fields receiving commercial fertilizer or manure applications.

Table 2. Phosphorus Loss Potential and Manure Application Rates

Distance to Surface Water (feet)	Soil Test Phosphorous (STP) Levels		Sheet and Rill Erosion Tons/Acre/Yr.	Field Edge Filter Strip (See Definitions)	
	Bray P1 (ppm)	Olsen (ppm)		No	Yes
				Base Manure Application on:	
NA			> 5	High (No Application)	
< 300 Feet	≤ 21	≤ 16	≤ 5	Low (Nitrogen Needs)	
	22 – 75	17 – 60	≤ 5	Medium (P ₂ O ₅ Removal)	Low (Nitrogen Needs/P Index) ¹
	76 – 150	61 – 120	≤ 5	Medium (P ₂ O ₅ Removal)	Medium (P ₂ O ₅ Removal)
	> 150	> 120	< 2	High (No Application)	Medium (P ₂ O ₅ Removal)
			2 – 5	High (No Application)	High (No Application/P Index) ³
				Field Edge Filter Strip or Field Border (See Definitions)	
				No	Yes
> 300 Feet	≤ 75	≤ 60	≤ 5	Low (Nitrogen Needs/P-Index) ¹	
	76 -150	61 – 120	≤ 5	Medium (P ₂ O ₅ Removal/P-Index) ²	Low (Nitrogen Needs/P-Index) ¹
	> 150	> 120	< 4	Medium (P ₂ O ₅ Removal/P-Index) ²	Low (Nitrogen Needs/P-Index) ¹
			4 – 5	Medium (P ₂ O ₅ Removal/P-Index) ²	

¹ If site review indicates nitrogen based rates may be too high, run Minn. Phosphorus Index.

- Change to a P₂O₅ removal basis if current or proposed management results in a Minn. Phosphorus Index value of > 2.0

² Can apply manure at a nitrogen based rate if current or proposed management results in a Minn. Phosphorus Index value of ≤ 2.0

³ Can apply manure on a P₂O₅ removal basis if current or proposed management results in a Minn. Phosphorus Index value of ≤ 2.0

Nitrogen Needs

- For non-legumes, follow University of Minnesota nitrogen recommendations found in the most recent publication.
- For legumes, use annual crop nitrogen removal rates.

P2O5 removal

- The quantity removed in the harvested portion of a specific crop or by a crop rotation (up to 6 years).

Consult Minnesota Pollution Control Agency (MPCA) rules for specific requirements for NPDES and SDS Permits as they differ depending upon the manure application method.

Table 3: Summary Nutrient Application Restrictions in Sensitive Areas

Minnesota 7020 Feedlot Rule requirements are in blue text followed by the underlined specific management requirement.

Additional requirements for individuals participating in USDA-NRCS payment programs are in *italics*.

Consult MPCA rules for specific requirements for NPDES and SDS Permits, especially in regards to winter applications.

Environmentally Sensitive Features	Non-Winter Applications	Winter Applications (When soil is frozen, snow-covered or actively thawing)
Surface Waters - Lakes, Perennial Streams, Intermittent Streams, DNR Protected Wetlands, Drainage Ditches without Berms, <i>Bermed Drainage Ditches with Side Inlets</i>	FIELDS WITHOUT A FILTER STRIP – Within 25 Feet of surface waters - <u>Do Not Apply Manure</u> Within 300 Feet of surface waters – <u>Inject or incorporate manure within 24 hours</u> If soil test phosphorous levels exceed 21 ppm Bray P1 or 16 ppm Olsen - <u>Apply Manure at Phosphorous Removal Rates</u>	Within 300 Feet – <u>Do Not Apply Manure</u>
	FIELDS WITH A FILTER STRIP 100 Feet Wide around Lakes and Streams 50 Feet Wide around Intermittent Streams, DNR Protected Wetlands, Drainage Ditches without Berms <u>Do not apply manure on the filter strip area</u>	
	<i>Incorporate commercial fertilizer applications within a few days on fields draining to surface waters</i>	Outside of 300 feet - If soil losses >4 tons/ac./yr. - - Do not apply Solid Manure If soil losses >2 tons/ac./yr. - - Do not apply Liquid Manure
Open (Surface) Tile Intakes	Within 300 Feet – <u>Inject or incorporate manure within 24 hours</u>	Within 300 Feet – <u>Do Not Apply Manure</u>
Water Supply Wells (Active or Inactive), Mines, Quarries	Within 50 Feet - <u>Do Not Apply Manure</u>	Within 300 Feet - Do Not Apply Manure
	<i>Within 300 Feet – Inject or incorporate manure or commercial fertilizer applications within 24 hours</i>	
Sinkholes - receiving surface runoff (MPCA), and other direct conduits to ground water (NRCS)	Within 50 Feet - <u>Do Not Apply Manure</u>	Within 300 Feet - Do Not Apply Manure
	Within 300 Feet - <u>Inject or incorporate manure or commercial nitrogen applications within 24 hours</u>	
Road Ditches	<u>Do Not Apply Manure Directly Into</u>	
Fields with sheet and rill losses greater than 5 tons/acre/year	<i>Do Not Apply Manure or commercial fertilizer</i>	
Fields with uncontrolled ephemeral erosion	<i>Do Not Apply Manure or commercial fertilizer</i>	
Established Waterways, Ditches and other water conveyance systems	<i>Do Not Apply Manure Directly Into</i>	
Frequently Flooded Soils	<i>During usual peak flooding periods, Do Not Apply Manure and Incorporate commercial fertilizer within 24 hours</i>	Do Not Apply Manure
	<i>When the probability of flooding is low, Incorporate manure within 2 days</i>	
Fractured Bedrock	<i>Apply manure in a manner that maintains at least 15 inches of soil separation between applied manure and fractured bedrock</i>	
	<i>Do not Fall apply commercial N fertilizer on fields with less than 36 inches of soil covering bedrock</i>	
High Water Table Soils	<i>Apply manure in a manner that maintains at least 15 inches of soil separation between applied manure and the high water table</i>	
Coarse Textured Soils	<i>In Fall,</i> <ul style="list-style-type: none"> • <i>Avoid liquid manure applications when possible</i> • <i>Delay manure applications until daily average soil temperatures are below 50 degrees F at a 6 inch depth.</i> • <i>Do not apply commercial nitrogen fertilizer</i> 	
	<i>Use sidedress or split applications of commercial nitrogen fertilizer</i>	

Table 4. Additional Commercial Fertilizer Timing and Form Guidance

See Minnesota Department of Agriculture's Nitrogen Fertilizer Rules (currently in draft version) which include additional conditions and specific areas where nitrogen application restrictions apply.

Fall Nitrogen Applications for Spring Seeded Crops	
All Sites	<ul style="list-style-type: none"> - Do not apply UAN or any other commercial fertilizer containing nitrate-nitrogen - Delay applications of other N forms until soil temperatures have stabilized below 50 degrees F at a 6 inch depth where allowed
Minnesota Department of Agriculture Vulnerable Groundwater Areas	<ul style="list-style-type: none"> - Do not apply any Nitrogen (N) fertilizer including MAP or DAP
Coarse Textured Soils	<ul style="list-style-type: none"> - Do not apply any Nitrogen (N) fertilizer including MAP or DAP
Southeastern Minnesota	<ul style="list-style-type: none"> - Do not apply any Nitrogen (N) fertilizer including MAP or DAP
South Central Minnesota	<ul style="list-style-type: none"> - Acceptable forms <ul style="list-style-type: none"> • Anhydrous ammonia (AA) with a nitrification inhibitor • Incorporated polymer coated urea recognized by the University of Minnesota
Southwestern, West Central and Northwestern Minnesota	<ul style="list-style-type: none"> - Acceptable forms <ul style="list-style-type: none"> • Anhydrous ammonia (AA) placed at a 4 inch depth. A nitrification inhibitor is encourage but not required. • Incorporated polymer coated urea recognized by the University of Minnesota • Urea incorporated to a depth of at least 3 inches within 3 days
Winter Applications	
All Sites	<ul style="list-style-type: none"> - Do not apply any nitrogen and phosphorus fertilizers including DAP and MAP on soils that are frozen, snow-covered or actively thawing
Spring Pre-Plant N or Sidedress N Applications	
All Sites	<ul style="list-style-type: none"> • Incorporate Spring broadcast applications of Urea and UAN solutions to a depth of 3 inches • If incorporation after 3 days is anticipated, use a urease inhibitor with the Urea and UAN solutions according to label requirements
Coarse Textured Soils	<ul style="list-style-type: none"> • Use a nitrogen stabilizer according to label instructions for nitrogen applied up to the 4 leaf corn stage when greater than 40 pounds of nitrogen are applied (excludes polymer coated urea) • Organic operations are exempt unless the nitrification inhibitor is approved for organic use
Irrigated Crops	<ul style="list-style-type: none"> • Limit pre-plant applications to 40 pounds of nitrogen or less • Use sidedress or split applications of commercial nitrogen fertilizer (non-organic or approved organic) for the remaining nitrogen requirement

DEFINITIONS

These terms are used in the MN Nutrient Management (590) Conservation Practice Standard and in this technical note. Definitions are written to provide context for these terms in the standard.

Commercial Fertilizers

- Products with a guaranteed analysis displayed in accordance with Minnesota's Fertilizer Soil Amendment and Plant Amendment Law (Minnesota Statue 18C).

Crop Nutrient Removal Rates

- Removal rates for purposes of this standard are the quantity of N, P₂O₅ or K₂O taken up by a specific crop or crop rotation and removed in the harvested portion of that crop. Some databases express removal as elemental P and K and must be converted to P₂O₅ or K₂O.

Fall Applications

- Applications made after August 31st. (MDA Nitrogen Fertilizer Rules – currently in draft version)

Field Borders

- A strip of permanent vegetation established at the edge or around the perimeter of a field.
- Design border widths to comply with all applicable State and local regulations regarding manure and chemical application setbacks.
- As a minimum, locate field borders along the edge(s) of the field where runoff enters or leaves the field. The minimum width for this purpose shall be 30 feet and have a vegetation stem density/retardance of moderate to high (e.g. equivalent to a good stand of wheat).

Filter Strips

- For purposes of this standard these are strips of ungrazed, unmanured permanent perennial plant species with growth patterns conducive to retarding runoff flow velocities. Establishment shall be consistent with the most current version of USDA-NRCS-MN Conservation Practice Standard 393 Filter Strip and with applicable state rules.
 - Vegetative buffer widths for manure applications [Minnesota Rules, Chapter 7020, Animal Feedlots, 7020.2225 LAND APPLICATION OF MANURE, Subp. 6., B., (1)]
 - (1) Lakes and Perennial Streams - 100 Feet
 - (2) Unbermed Ditches, Public Water Wetlands, Intermittent Streams - 50 Feet

Incorporation

- Refers to manure applications that result in 100% of the applied manure covered by soil following application for manure crediting and runoff consideration purposes.

Intermittent Streams

- All watercourses identified as intermittent streams on United States Geological Survey quadrangle maps (Minnesota Rules, Chapter 7020, Animal Feedlots, 7020.0300 DEFINITIONS, Subp. 13A.).

Karst Areas

- A type of geology that is formed from the dissolution of limestone, dolomite, or gypsum and that is characterized by closed depressions or sinkholes, and underground drainage through conduits enlarged by dissolution." (Minnesota Rules 7035.0300, subp. 51.)

MnDNR Protected Wetlands

- Includes all wetlands or other surface water features identified on MnDNR protected waters and wetlands inventory maps. Protected Water Inventory Maps are available in local SWCD and NRCS offices or can be obtained on-line at:
http://www.dnr.state.mn.us/waters/watermgmt_section/pwi/maps.html

Soil Textures

- For purpose of this standard, texture applies to the surface soil texture and/or the subsoil texture within three feet of the surface.
- **Fine Textured Soils**
 - Includes clay, clay loam, silty clay, silty clay loam, sandy clay loam and sandy clays
- **Medium Textured Soils**
 - Includes silts, silt loams and loams
- **Coarse Textured Soils**
 - Includes sand, loamy sand, loamy coarse sand, fine sand, loamy fine sand, loamy very fine sand, coarse sand, very fine sand, and any of the above listed textures with gravelly or very gravelly modifiers.
 - The percent of coarse textured soils contained within a planning unit necessary to make the whole unit susceptible to leaching will vary by site, contiguous nature of the map unit and planner and producer objectives. However, the entire planning unit will be considered susceptible to leaching if at least 33% coarse textured soils are present either in the surface soil or subsoil as defined above.

Solid Manure

- Animal wastes that have 15% or more solids at the time of land application and can be stacked at a 3:1 vertical to horizontal ratio. (Minnesota Rules, Chapter 7020, Animal Feedlots, 7020.2125 MANURE STOCKPILING SITES, Subp. 1, B.)

Surface Waters

- For purposes of this standard includes:
 - Protected waters and protected wetlands as identified on MN DNR protected waters and wetlands maps including:
 - lakes, ponds and flowages; public water wetlands,
 - perennial streams, rivers and creeks, intermittent streams identified on USGS quadrangle maps excluding segments of intermittent streams which are grassed waterways,
 - off-field drainage ditches identified on USGS quadrangle maps excluding drainage ditches with berms
- Also defined in the Minnesota Rules, Chapter 7020, Animal Feedlots, 7020.0300 DEFINITIONS, Subp. 23. Special Protection Areas.

Vulnerable Groundwater Areas

- As defined by MDA Nitrogen Fertilizer Rules (currently in draft version), land with –
 - NRCS soil mapping units with a weighted average saturated hydraulic conductivity (Ksat) greater than or equal to 10 micrometers per second
 - Ksat – ability of a saturated soil to transmit water. Based on soil characteristics including structure, consistence, porosity and texture.
 - Karst or bedrock at or near the surface as identified in the MN DNR Pollution Sensitivity of Near-Surface Materials Report

Web Soil Survey (WSS)

- NRCS website dedicated to providing soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS). In addition to soil maps, this website also assists planners with the identification of sensitive soil features along with aquifer assessments.
- <https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm>