USDA United States Department of Agriculture

NATURAL RESOURCES CONSERVATION SERVICE
Ohio Nutrient Management Technical Note

Assessing Nutrient Loss Risk in Ohio

Nitrogen (N) and Phosphorus (P) are often limited in soils and applications may be essential for agricultural production. However, when these nutrients are lost, unnecessary operational costs and negative water quality impacts could result. Loss to surface water under certain conditions may result in excessive algae growth or "bloom," and produce toxins that can harm human health, animals, aquatic ecosystems, and the economy. N and P can require additional conservation practices and/or BMPs to reduce the loss risk. As part of the Ohio Nutrient Management Standard (590) the N and P risk assessment processes are to be used to evaluate loss risk and ensure sufficient conservation measures are in the conservation plan to mitigate this loss risk. This document provides the detailed procedures for nutrient loss risk assessment in Ohio.

Ohio Nitrogen (N) Risk Assessment

Nitrogen is essential for plant function. For non-legume crops farmers often need to provide large quantities of plant available nitrogen to crops, while minimizing N loss to the environment. Large amounts of plant available N can be lost to the atmosphere (gaseous losses) or with water draining out of the soil profile (leaching). All nitrogen losses (gaseous loss and leaching) affect farmer profitability but this document will evaluate the potential for leaching loss.

The Ohio Nitrogen Leaching Index (NLI) assesses the sites potential risk of N leaching out of the root zone and being transported to surface water or leaching to the groundwater. This index is a tool to help conservation planners, landowners/land users and others evaluate the potential risk of N leaching from a specific site and assist in management decisions to reduce this risk.

The Nitrogen Leaching Index classifies soils as a high, medium, or low nitrogen leaching potential with relative index ratings from 0-10+ based on potential to leach. The leaching potential is rated as high (NLI>10), medium (NLI 3-10), or low (NLI<3) by combining the soil's hydrologic soil grouping (A, B, C, or D), the county's annual rainfall, and the county's seasonal rainfall (Oct. 1 to March 1).

Understanding Soil Hydrologic Groupings

- Group A. Soils having a high infiltration rate (low runoff potential). These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

- Group B. Soils having a moderate infiltration rate. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

- Group C. Soils having a slow infiltration rate. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

- Group D. Soils having a very slow infiltration rate (high runoff potential). These consist chiefly of clays that have a high shrink-swell potential, soils that have a high-water table, soils that have a clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

- Certain wet soils are placed in Group D based solely on the presence of a water table 24 inches from the surface, even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. **For the purpose of the Nitrogen Leaching Index (NLI) soils that have been systematically subsurface drained (tiled) are rated high leaching potential regardless of the soil hydrologic group.**

Nitrogen Leaching Index Procedure

1. Determine the soils hydrological soil grouping for the dominant soils in the Conservation Management Unit (CMU) (Grouping found in Section II of the FOTG or Web Soil Survey). Dominant soils are the soil type with the highest risk of loss that occupies at least 33% of the field.

2. Refer to Table 1 - Ohio (By County) Nitrogen Leaching Index (NLI) for Soils by Hydrologic Groups (A, B, C, D) for the respective county to determine the soils relative NLI.
   a. Soils with a rating of 0-2 have a low potential to leach nitrates below the root zone.
   b. Soils with a rating of 3-10 have a medium potential to leach nitrates below the root zone.
   c. Soils with a rating of greater than 10 have a high potential to leach nitrates below the root zone.
   i. All soils with systematic subsurface drains (tile) are rated high potential. A field is considered subsurface drained if 1/3 or more of the field is subsurface drained.

3. Implement appropriate conservation measures listed in the Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat, and Alfalfa (Bulletin 974), AgBMPs Ohio State University Extension and/or FOTG to mitigate leaching risk.

Table 1: Ohio (By County) Nitrogen Leaching Index (NLI) for Soils by Hydrologic Groups (A, B, C, D). *All soils with systematic subsurface drains (tile) are rated high potential regardless of the NLI listed below. A field is considered subsurface drained if 1/3 or more of the field is subsurface drained.*

County	A	B	C	D	County	A	B	C	D
Adams	15	10	6	4	Licking	15	8	6	4
Allen	10	6	4	2	Logan	15	8	4	4
Ashland	15	8	4	4	Lorain	15	8	4	2
Ashtabula	15	10	4	4	Lucas	10	6	4	2
Athens	15	10	6	4	Madison	15	8	6	4
Auglaize	10	8	4	2	Mahoning	15	8	4	4
Belmont	15	10	6	4	Marion	15	8	4	4
Brown	15	10	6	4	Medina	15	8	4	4
Butler	15	10	6	4	Meigs	15	10	6	4
Carroll	15	8	4	4	Mercer	10	8	4	2
Champaign	15	8	4	4	Miami	15	8	4	4
Clark	15	8	6	4	Monroe	15	10	6	4
Clermont	15	10	6	4	Montgomery	15	10	6	4
Clinton	15	10	6	4	Morgan	15	8	6	4
Columbiana	15	8	4	4	Morrow	15	8	4	4
Coshocton	15	8	4	4	Muskingum	15	8	6	4
Crawford	15	8	4	2	Noble	15	8	6	4
Cuyahoga	15	8	4	4	Ottawa	10	6	4	2
Darke	15	8	4	4	Paulding	10	6	4	2
Defiance	10	6	4	2	Perry	15	8	6	4
Delaware	15	8	4	4	Pickaway	15	8	6	4
Erie	10	8	4	2	Pike	15	10	6	4
Fairfield	15	8	6	4	Portage	15	8	4	4
Fayette	15	10	6	4	Preble	15	10	6	4
Franklin	15	8	6	4	Putnam	10	6	4	2
Fulton	10	6	4	2	Richland	15	8	4	4
Gallia	15	10	6	4	Ross	15	10	6	4
Geauga	15	10	4	4	Sandusky	10	6	4	2
Greene	15	10	6	4	Scioto	15	10	6	4
Guernsey	15	8	6	4	Seneca	10	6	4	2
Hamilton	15	10	6	4	Shelby	15	8	4	4
Hancock	10	6	4	2	Stark	15	8	4	4
Hardin	10	8	4	2	Summit	15	8	4	4
Harrison	15	8	6	4	Trumbull	15	8	4	4
Henry	10	6	4	2	Tuscarawas	15	8	4	4
Highland	15	10	6	4	Union	15	8	4	4
Hocking	15	10	6	4	Van Wert	10	6	4	2
Holmes	15	8	4	4	Vinton	15	10	6	4
Huron	10	8	4	2	Warren	15	10	6	4
Jackson	15	10	6	4	Washington	15	10	6	4
Jefferson	15	8	6	4	Wayne	15	8	4	4
Knox	15	8	4	4	Williams	10	6	4	2
Lake	15	10	4	4	Wood	10	6	4	2
Lawrence	15	10	6	4	Wyandot	10	8	4	2

Ohio Phosphorus (P) Risk Assessment

Phosphorus (P) is essential for plant growth and found in every living plant cell. It is involved in several key plant functions. Most soil types in Ohio require the addition of supplemental P (fertilizer and/or manures) to maintain soil test P levels within a sufficiency range. Evaluating risk of P loss will help conservation planners and landowners/land users ensure needed conservation measures are in place to minimize P loss risk.

The Ohio Phosphorus (P) Risk Assessment process is based on classing fields by soil test P, implementing higher levels of conservation with higher soil test P levels, and implementing strategies that will drawdown soil test P if the soil test P is greater than the Tri State Guide maintenance limit. It will help conservation planners and landowners/land users evaluate the risk of P leaving the field. The results of this course evaluation of P loss risk must be implemented with an on-site assessment of the site-specific transport factors to refine a set of conservation practices to protect the resources. When the on-site assessment indicates higher risk of transport, additional practices and/or conservation measures must be planned to mitigate this risk. Additional practices such as buffers, setbacks, Drainage Water Management (554), Phosphorus Removal Systems (782), Saturated Buffers (604), Cover Crops (340), crop residue practices (329 or 345), Amending Soil Properties with Gypsum Products (333) and/or other conservation practices, should be considered alone or in combination to reduce P loss impacts.

The use of nutrient loss risk tools such as The Ohio State University On-Field Ohio or Nutrient Tracking Tool (NTT) can be used to refine nutrient management alternatives for the application methods, timing, transport, and other conservation treatment needed to meet the P Risk Assessment criteria (Table 2). The information provided by these nutrient loss tools will be useful to compare various nutrient management strategies being considered to meet the criteria listed in Table 2. The additional conservation practices and conservation measures needed to meet the P Risk Assessment criteria (Table 2) must be included in the nutrient management/conservation plan.

Phosphorus (P) Risk Assessment Procedure

1. Determine P risk assessment class based on the current Soil Test P (STP) for each Conservation Management Unit (CMU). A CMU is defined as a field or area of a field that will be managed similarly – for example with the same crop, tillage system, and the same rate, timing, source and placement of nutrients. A current soil test is one no older than 3 or 4 years (based on the crop rotation) and representing no more than 25 acres. If more than one soil sample represents the CMU (as in grid sampling) determine the class on the average STP for the CMU. For example, if a field is grid sampled and a blanket application of manure is planned, the assessment of the P loss risk shall be based on the average STP.

   With large fields or wide variation in soil test values, sampling zones should be established, and manure managed when possible on actual zonal soil test values rather than field averages. This will provide both economic and environmental benefits.

2. After an onsite assessment of the CMU, plan the needed practices and nutrient management strategies to meet the risk criteria, as listed in Table 2. This onsite evaluation must include the evaluation of runoff potential, considering the slope of the field and the surface infiltration in combination with the field's connectivity to water. Fields with high runoff risk, efficient water conductivity and a P Risk Assessment class of High or Very High indicate a need for water management practices. These water management practices could include additional setbacks and/or vegetative treatment areas, Drainage Water Management (554), Phosphorus Removal System (782), Constructed Wetland (656), Saturated Buffer (604) and other appropriate innovative practices. Implement appropriate conservation measures listed in the Ohio FOTG and/or AgBMPs Ohio State University Extension to mitigate loss risk.

3. Additional consideration must be given to water management practices when P Risk Assessment class is High or Very High when transport factors are also high. The Ohio State University On-Field Ohio or Nutrient Tracking Tool (NTT) can be used to evaluate various management and BMP alternatives. These tools can be used to compare various options but will not be used to determine risk class or allow greater application rate and/or a reduction of required criteria listed in Table 2.

4. Develop a nutrient management plan that meets the phosphorus application rate, phosphorus placement, and timing criteria for the appropriate column in table 2, based on the field Mehlich-3 soil test risk level. This plan must also include additional water management practices to mitigate high transport factors as needed.

5. All appropriate conservation practices and conservation measures to address both source and transport factors must be included in the conservation/nutrient management plan. Suitability of these conservation practices and conservation measures are all site specific.

Adaptive P Management

Soil testing provides the foundation of an adaptive nutrient management strategy providing sample depth, time of sampling, and intervals between sampling are all kept consistent. Maintaining consistency over many years enables a grower to monitor soil test trends and evaluate how management practices and nutrient management regimes are performing. This can provide critical information to further refine a fertility program, control input costs, maximize farm profitability, and meet management goals.

This soil test data plus known nutrient application rates and crop removal from 3 or more sampling periods, shall be used to monitor trends in STP to identify any corrective changes needed to application rates so goals are met. This is a long-term process and trends must be evaluated over several sampling periods.

When periodic applications are made to moderate or higher P loss risk fields, a downward trend of soil test P levels must be established. If this downward trend cannot be established, updates to the nutrient management plan must be made to reduce application rate and/or make changes to the crop rotation which result in increased P removal.

Table 2: Ohio Phosphorus (P) Loss risk assessment classes and mitigation options[1].

		Lower Risk	Moderate Risk	Higher Risk	Very High Risk
Rate	Soil Test P (STP)	<50 ppm Mehlich-3	50-120 ppm Mehlich-3	120-200 ppm Mehlich-3	200+ ppm Mehlich-3
	Rate of P Application[2]	≤ P recommendation 250 lb P_2O_5/ac annual application limit	≤ P removal (annual or multiple year crop rotation) 250 lb P_2O_5/ac annual application limit	≤ 50% P removal (annual or multiple year crop rotation) [3] 125 lb P_2O_5/ac annual application limit	No P application[3]
	STP Management Strategy	Build-up and maintenance Approach: Tri-State Fertilizer Recommendations[4]	Adaptive P Management: Drawdown STP over time[4&5]	Short term P application to facilitate change[5&6]	Drawdown STP over time[5]
Placement	Minimum ground cover at time of surface application	>30% or Growing Crop/Cover Crop	>30% or Growing Crop/Cover Crop	>50% or Growing Crop/Cover Crop	>50% or Growing Crop/Cover Crop
	Incorporation[7]/sub-surface placement	Or			
		Required if the minimum ground cover is not met for surface application			
	Sensitive Area Avoidance	Follow setback and vegetative recommendations in Table 3.			
Time	Seasonality of Timing[8]		Spring surface applications are to be made only if applied to a growing crop or cover crop.		
Erosion	Sheet & Rill	< Soil Loss Tolerance			
	Concentrated flow	No active concentrated erosion			

1. Utilize FOTG, On-Field Ohio and/or the Nutrient Tracking Tool (NTT) to identify and plan other BMP's and conservation alternatives that can reduce the potential of phosphorus loss beyond the P Risk Assessment criteria basic requirements (Table 2). Additional consideration must be given to water management practices when P Risk Assessment class are High or Very High when transport factors are also high.
2. The application rate of manure cannot exceed the next crop years N requirement or the most limiting factor (Table 3 Ohio CPS 590) regardless of the P application rate. The total annual application of P at any risk level may not be greater than the lesser of recommendation/P removal rate and the listed annual application limit for the P risk class.
3. At high or very high risk, dilute wastewater or other liquid manure effluent with low P may be applied through irrigation at low annual rates; no greater than the lesser of 50% crop removal or 35 lb/ac P2O5. This allowance is only for wash water or other treated effluent and not for raw liquid manure.
4. Crops included in the rotation that have a documented STP maintenance limit greater than 50 ppm (Mehlich-3) can maintain a soil test P level greater than 50 ppm up to the STP maintenance limit. Land grant university (LGU) publications or industry practice when recognized by the LGU shall be used to document STP maintenance limit for crops not included in the current Tri-State Fertilizer Recommendations.
5. Adaptive P management system that draws down STP over time is required if P applications are made under this risk. This drawdown strategy is implemented when sample depth, time of year samples are collected and intervals between sampling are all kept consistent. If STP is not showing a downward trend over time application rates must be reduced or eliminated until the downward trend is documented in STP.
6. Manure applications made at higher P risk can only be made to facilitate a change in manure collection, handling and storage systems unless applications of dilute wastewater or other liquid manure effluent are in accordance with footnote 3. These changes in the manure handling system must be documented in the conservation plan (CNMP). After the installation of these practices no additional P applications are to be made until STP and the risk of P loss is reduced to a moderate or low risk.
7. Incorporation is defined as the use of a full width tillage implement operating at a minimum of 3-4-inch depth within 1 week or before the next predicted rainfall event whatever is less.
8. Timing of applications is subject to criteria listed in the Ohio 590 standard and applicable state laws.

Table 3: Minimum Setback Distances and Vegetative Treatment Requirements for the Application of Manure.

These setbacks and vegetative treatment requirements were primarily established to reduce loss risk associated with pathogens. CAFO's must additionally follow the setbacks defined in the Ohio Department of Agriculture (ODA) rules regarding manure application (Ohio Administrative Code 901:10-2-14). Additional setbacks may apply to sludge that is regulated by the Ohio Environmental Protection Agency (OEPA) and septage regulated by the Ohio Department of Health.

Type of Sensitive - Setback Area	**Manure Application**	
	Surface Application	**Incorporation or Direct Injection**
Residences / Private Wells down slope from the application area.	100 ft	100 ft
Sinkholes	300 ft	100 ft
Pond or Lake	100 ft. at a minimum 35 ft of the 100 must be Vegetative Barrier[2] Or 300 ft	35ft. Vegetative Barrier
- Streams[1] - Ditches[1] - Surface Inlets	35 ft Vegetative Barrier or 35 ft with 50% residue cover at time of application or 100 ft	None
Grassed Waterway	35 ft	None
Field Surface Drains	35 ft[3]	None
Public Wells	300 ft	100 ft
Developed Springs down slope from the application area.	300 ft	300 ft
Public Surface Drinking Water Intake	300 ft	300 ft

1. All listed measurements are from top of bank.
2. Vegetative Barriers are permanent vegetation consisting of grass, grass/legume mix, trees/shrubs, or trees/shrubs and grass/legumes.
3. Setback requirement for field surface drains are only required if the criteria listed Nutrient application Timing and Placement section are not met. When this criterion is not met the applications of manure must abide by this 35 ft setback distance.

References

Culman, S., et.al. 2019. Converting between Mehlich-3, Bray P, and Ammonium Acetate Soil Test Values. ANR-75. https://ohioline.osu.edu/factsheet/anr-75 [Accessed 20 May, 2020]

Culman, S., Fulford, A., Camberato, J., Stienke, K. (2020). Tri-state fertilizer recommendations for corn, soybeans, wheat, and alfalfa. (Bulletin 974). Columbus, OH: The Ohio State University.

Duncan, E.W. K.W. King, L.A. Pease, N.R. Fausey, M.R. Williams, G.A. LaBarge, and D.R. Smith. (2017). Linking Soil Phosphorus to Dissolved Phosphorus Losses in the Midwest. Agric. Environ. Lett. 2:170004 (2017) Agric. Environ. Lett. 2:170004 doi:10.2134/ael2017.02.0004

Sundermeier, A. 2016. Manure and Compost: Nitrogen Availability in Organic Production. ANR-34. https://ohioline.osu.edu/factsheet/anr-34 [Accessed 23 June, 2020]

Texas Institute for Applied Environmental Research (TIAER) at Tarleton State University (2020). Nutrient Tracking Tool (NTT). https://ntt.tiaer.tarleton.edu/welcomes/new?locale=en

The Ohio State University (2020). AgBMPs Ohio State University Extension. https://agbmps.osu.edu/home

The Ohio State University (2020). On-Field Ohio. https://nutrientmanagement.osu.edu/field-ohio-tool

USDA, NRCS. Title 190, General Manual, (GM), Part 402, Nutrient Management. 2011. Washington, DC. NRCS eDirectives under General Manual, Title 190 (https://policy.nrcs.usda.gov/).

USDA, NRCS. Title 190, National Instruction (NI), Part 313, Nutrient Management Policy Implementation. 2017. Washington, DC. NRCS eDirectives under National Instruction, Title 190 (https://policy.nrcs.usda.gov/).

Wang, Y.T. and T.Q. Zhang, I.P. O'Halloran, C.S. Tan, Q.C. HU and D.K. Reid. (2012). Soil Tests as Risk Indicators for Leaching of Dissolved Phosphorus from Agricultural Soils in Ontario. Soil Sci. Soc. Am. J. 76:220–229 doi:10.2136/sssaj2011.0175

Warncke, D., J. Dahl, B. Zandstra (2004). Nutrient Recommendations for Vegetable Crops in Michigan. (Bulletin E2934). East Lansing, MI: Michigan State University.