DRAFT Tennessee Phosphorus Risk Index
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The major environmental threat posed by phosphorus from agricultural sources is runoff from fields close to, or connected to, surface waters such as streams, rivers and lakes. Phosphorus can be in both a water soluble or insoluble form. Water-soluble phosphorus is the most biologically reactive form of phosphorus and thus most likely to cause short-term water quality problems, such as algal blooms. Control of water-soluble phosphorus from fields and sites adjacent or connected to surface water is more difficult than controlling the more insoluble forms that are usually associated with phosphorus carried on soil or organic particles.

There are many factors and site conditions that are important in determining the potential of phosphorus reaching nearby water in the runoff from agricultural fields. Phosphorus movement from a field to an adjacent water body will depend on both **transport** and **source** factors. The Index will not predict the quantity of phosphorus that will leave a particular site or field, but it will identify fields where there is a risk of phosphorus movement into nearby surface waters.

The Tennessee Phosphorus Risk Index is a field assessment management tool designed for use on a **field-by-field** basis. If necessary, larger fields covering areas that include a range of topographic features can be divided and assessed as several sub-fields. Depending on the results of the P index, sub-fields may have to be managed differently.

The Index is comprised of eight "factors" that are each assigned a score. Four of the factors are "**transport**" factors and four are "**source**" factors. The sum of all the transport factors is multiplied by the sum of all the source factors to produce a **Phosphorus Risk Index Rating (Table 1)**.

NOTE: The *Before Value* in the Index represents the *current* site conditions/managements and the *After Value* represents *planned* conditions/managements.

Completing Part A of the TN Phosphorus Index Rating Sheet

Runoff Class

The runoff class is an assessment of the rainfall runoff potential from a field based on certain site conditions. The runoff curve number is determined by the function of the soil type (hydrologic group), land use, and cover. Hydrologic soil groups are categorized based on estimates of runoff potential. All the major soil types found in Tennessee are classified to one of four hydrologic soil groups:

i. Group A: Well drained soils with a high infiltration rate and thus a lower potential for runoff.
ii. Group B: Moderately well-drained soils with a moderate infiltration rate and thus a moderate potential for runoff.

iii. Group C: Somewhat poorly drained soils with a slow infiltration rate and thus a higher potential for runoff.

iv. Group D: Poorly drained soils with a very slow infiltration rate and thus a relatively high potential for runoff.

Step 1: Identify Dominant Soil Map Unit

The soil survey is available through the Web Soil Survey at

http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Identify the dominant soil map unit in the field and determine the corresponding hydrologic group (A, B, C or D).

Step 2: Determine the runoff curve number of the field.

Three factors are used to determine the runoff curve number: cover type, land use (treatment) and the soil hydrological group. Use Table 2 to determine the runoff curve number (CN).

Step 3: Determine the runoff class of the field.

The final step is to estimate the average slope of the field and determine the runoff class from Table 3.

Estimated Soil Erosion Using RUSLE2

RUSLE2 is a tool used to estimate the potential sheet and rill erosion from a particular field. The official NRCS version of RUSLE2 can be found at the following website:

http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm

Use the soil loss estimates from RUSLE2 to fill in the appropriate box ("Before or After Value") in Part A of the Phosphorus Risk Index.

Permanent Vegetative Buffer Width

Permanent vegetative buffers are strips of vegetation between the field and adjacent surface water conveyances such as streams, rivers, ditches, channels etc. These permanent buffers act as physical barriers to intercept runoff from fields, slow down erosion, and encourage sedimentation and nutrient uptake in order to reduce the pollutant loading to surface waters.

For the purposes of the phosphorus risk index, surface water conveyance includes any permanent, continuous, physical conduit for transporting surface water. Surface water conveyances include permanent streams, defined waterways, and ditches that only flow intermittently during the course of the year.

Filter strips, field borders, contour buffer strips, and riparian forest buffers are all examples of vegetative buffers. Permanent vegetative buffers must be installed, constructed, and maintained in accordance with applicable NRCS Conservation Practice Standard.

Non-Application Width from Surface Water Conveyance

The non-application width from surface water conveyance is the distance from the edge of the cropped area to the nearest surface water conveyance where no manure or poultry litter is applied.

Part A: Total Site Value:
With all the information for Part A of the index completed, sum up the scores to obtain a final figure for the transport factors.

Completing Part B of the TN Phosphorus Index Rating Sheet

Soil Test Phosphorus

Current soil test (less than one year old) from either the University of Tennessee E xtension Soil, Plant and Pest Center at:

http://soilplantandpest.utk.edu/

Or an approved certified soil testing laboratory shall be utilized. For approved certified soil testing laboratories, refer to the North American Proficiency Testing Program (PAP) at:

http://www.naptprogram.org/pap/labs

If using a certified soil testing laboratory from the approved PAP list, the laboratory must utilize the Mehlich 1 or Mehlich 3 soil extractant. If requested, some certified soil testing laboratories will conduct a soil phosphorus test using the Mehlich 1 (double acid) soil extractant. The University of Tennessee estimates the plant available phosphorus in each soil sample using a Mehlich 1 (double acid) soil extractant.

The soil analysis will report an extractable phosphorus (P) soil test value in pounds per acre which is used in Part B: Soil Test calculations. Determine if the soil analysis utilized the Mehlich 1 or 3 extract and choose the appropriate range in the Index.

Application Rate of Phosphorus

The amount and type of phosphorus that is land applied will directly influence the phosphorus content in runoff. The risk of phosphorus movement is higher where more phosphorus is applied than can be removed annually by the crop.

The application rate of phosphorus is the amount of phosphorus (lbs. P_20_5/acre) applied per crop or crop rotation/sequence. Application rates shall be based on the University of Tennessee soil test recommendations or approved crop removal rates. A soil analysis that uses a Mehlich 3 extractant will need to be compared to the appropriate ranges in the University of Tennessee guide sheet, *W229 Interpreting Mehlich 1 and Mehlich 3 Soil Test Extractant Results for P and K in Tennessee*, to get the corresponding University of Tennessee recommendation range of Low, Medium, High, or Very High. When using the Manure Management Planner (MMP) to create a nutrient budget, this will automatically be calculated when selecting the Mehlich 3 extractant option on the Soils Tests tab.

The University of Tennessee recommendations and guide sheet W229 can be found at the University of Tennessee Extension Soil, Plant and Pest center website:

http://soilplantandpest.utk.edu/

For information on crop removal rates, refer to the International Plant Nutrition Institute (IPNI) at:

https://www.ipni.net/app/calculator/home

In order to estimate the phosphorus content of animal manures or biosolids, a current analysis (less than one year old) from a certified manure analysis laboratory shall be used. All analyses should be converted to P_2O_5 from P (by multiplying P concentrations by 2.3). For approved certified manure analysis laboratories, refer to the Minnesota Department of Agriculture - Manure Analysis Proficiency (MAP) Laboratories for a list of approved lab at website:

http://www2.mda.state.mn.us/webapp/lis/maplabs.jsp

In cases where a phosphorus-based nutrient plan is required when applying manure, a low phosphorus application rate may not be practical with available equipment or economically feasible. In such cases, a one-time application of manure can occur based on a multiple-year crop uptake of P as long as the resulting application rate does not exceed the one-year nitrogen needs of the crop. In the year of the one-time application, the soil loss value for the field shall be equal to or less than the soil loss tolerance.

Application Timing

Phosphorus applications shall be timed with the optimum growth and nutrient uptake period of the crop.

Application Method

The application method considers the effect phosphorus placement has on increasing the risk for P movement.

Part B: Total Management Value:

Once all the information required to complete Part B of the index has been completed, sum up the scores to obtain a final figure for the source factors.

Finalizing TN Phosphorus Index Rating

For the field being assessed, calculated the Tennessee Phosphorus Risk Index Rating by multiplying the sum from Part A by the sum from Part B.

Multiply Part A (_____) x Part B (_____) = ______ P Loss Rating

Refer to Table 1 for the Rating and corresponding management criteria.

Draft TN Phosphorus Index*

Part A: Phosphorus loss potential due to site and transport characteristics

Transport	Phosphorus Loss Rating				Before Value	After Value
Runoff Class	(1 point)	(2 points)	(4 points)	(8 points)		
	Low	Medium	High	Very Hjgh	0	0
RUSLE2 (tons/ac/yr)	(1 point)	(4 points)	(8 points)	(16 points)		
	<5	5 - 10	10.1 - 15	>15	0	0
Permanent Vegetative Buffer Width** (ft)	(1 point)			(8 points)		
	≥35			<35	0	0
Non-Application Width from Surface Water Conveyance (ft)	(1 point)	(2 points)	(4 points)	(8 points)		
	>100	61 - 100	35 - 60	<35	0	0
				Part A: Total Site Value:	0	0

**Permanent Vegetative Buffers must be installed, constructed, and maintained in accordance with applicable NRCS Conservation Practice Standard.

Part B: Phosphorus loss potential due to source and management characteristics

Source	Phosphorus Loss Rating				Before Value	After Value
Soil Test P Value (lbs/ac) *(Choose One)*	(1 point)	(2 points)	(4 points)	(8 points)		
Mehlich 1	0 - 30	31 - 120	121 - 300	>300	0	0
OR						
Mehlich 3	0 - 60	61 - 210	211 - 420	>420	0	0
P Application Rate (lbs P_2O_5/ac)	0.20 X _________ lbs P_2O_5/ac applied as commercial fertilizer 0.10 X _________ lbs P_2O_5/ac applied as manure, litter, or biosolids 0.05 X _________ lbs P_2O_5/ac applied as alum to poultry litter at 100 lbs per 1000 sq. ft. rate OR 0.02 X _________ lbs P_2O_5/ac applied as alum to poultry litter at 200 lbs per 1000 sq. ft. rate					
Application Timing	(1 point)	(2 points)	(4 points)	(8 points)		
	Actively growing crop or within 15 days before planting	16 to 45 days before planting	More than 45 days before planting	December, January, or dormant pastures/hay	0	0
Application Method	(1 point)	(2 points)	(4 points)	(8 points)		
	Injected	Incorporated within 5 days of application	Incorporated more than 5 days after application	Surface applied (no incorporation)	0	0
				Part B: Total Management Value:	0	0

Before Value - Multiply Total Part A x Total Part B:	0	P Loss Rating - Before
After Value - Multiply Total Part A x Total Part B:	0	P Loss Rating - After

*The index numbers and the interpretations, as well as the whole document will continue to be reviewed and evaluated, and are subject to modification as further field testing and validation of the index continues.

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Table 1: Tennessee Phosphorus Index Rating

Total Points From P Index	Generalized Interpretation of the P Index Points for the Site
<140	**LOW** potential for P movement from the field. If farming practices are maintained at the current level there is a low probability of an adverse impact to surface waters from P losses. Nitrogen-based nutrient management planning is satisfactory for this site. Soil P levels and P loss potential may increase in the future due to N-based nutrient management.
140 - 270	**MODERATE** potential for P movement from the field. The chance for adverse impact to surface waters exists. *Nutrient management plans shall be designed not to exceed UT phosphorus recommendation or phosphorus removal rate.* Soil P levels and P loss potential may increase in the future due to N-based nutrient management are implemented.
271 - 400	**HIGH** potential for P movement from the field. The chance for adverse impact to surface waters is likely unless remedial action is taken. Nutrient management planning based on the crop removal of phosphorus can be applied when the following requirements are met: **1** A soil phosphorus drawdown strategy has been implemented, **AND** **2** A site assessment of nutrients and soil loss has been conducted to determine if mitigation practices are required to protect water quality.
>400	**VERY HIGH** potential for P movement from the field. *Applications of phosphorus are prohibited.*

Table 2: Runoff curve numbers for agricultural lands[1/] *(referenced from 210-VI-NEH, July 2004 Table 9-1)*

Cover Description			CN for Hydrologic Soil Group			
Cover Type	Cover Description Treatment[2/]	Hydrologic Condition[3/]	A	B	C	D
Fallow	Bare Soil		77	86	91	94
	Crop Residue Cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row Crops	Straight Row (Sr)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured and Terraced (C & T)	Poor	66	74	80	82
		Good	62	71	78	81
	C & T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small Grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C & T	Poor	61	72	79	82
		Good	59	70	78	81
	C & T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or Broadcast Legumes or Rotation Meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C & T	Poor	63	73	80	83
		Good	51	67	76	80
Pasture, Grassland, or Range-continuous forage for grazing [4/]		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80

1/ Average runoff condition, and I_a=0.2s.

2/ Crop residue cover applies only if residue is on at least 5 percent of the surface throughout the year.

3/ Hydrologic condition is based on combinations of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, © amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good $\geq$20%), and (e) degree of surface toughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better then average infiltration and ten to decrease runoff.

For conservation tillage poor hydrologic condition, 5 to 20 percent of the surface is covered with residue (less than 750 pounds per acre for row crops or 300 pounds per acre for small grain.

For conservation tillage good hydrologic condition, more than 20 percent of the surface is covered with residue (greater than 750 pounds per acre for row crops or 300 pounds per acre for small grain.

4/ Poor: <50% ground cover or heavily grazed with no mulch.

Fair: 50 to 75% ground cover and not heavily grazed.

Good: >75% ground cover and lightly or only occasionally grazed.

Table 3: Runoff class based on site slope and curve number

Slope %	Runoff Curve Number*						
	<60	60-65	66-70	71-75	76-80	81-85	>85
<1	L	L	L	L	L	L	L
1	L	L	L	L	L	L	M
2	L	L	L	L	M	M	M
3	L	L	L	M	M	M	M
4	L	L	L	M	M	M	H
5	L	L	M	M	M	M	H
6	L	L	M	M	M	H	H
7	L	M	M	M	M	H	VH
8	L	M	M	M	M	H	VH
9	L	M	M	M	M	H	VH
10	M	M	M	M	H	H	VH
11	M	M	M	M	H	H	VH
12	M	M	M	M	H	VH	VH
13	M	M	M	M	H	VH	VH
14	M	M	M	H	H	VH	VH
15	M	M	M	H	H	VH	VH
>15	M	M	M	H	H	VH	VH

*Runoff curve numbers are found in USDA NRCS National Engineering Handbook Part 630 Hydrology, Chapter 9 Hydrologic Soil-Cover Complexes