Colorado Phosphorus Index Risk Assessment
(Version 1.0)

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The Colorado Phosphorus Index is a field assessment tool that may be used to rank the relative potential for the movement of phosphorus off-site. It is intended to provide planners, producers, and consultants a way to identify fields where the risk of phosphorus movement may be high.

The Colorado Phosphorus Index is patterned after the index proposed by Lemunyon and Gilbert (1993), and has been modified for use in Colorado. The modifications are based on the equivalent of 38 site years of runoff phosphorus concentration data collected in the Arkansas, South Platte, and Uncompahgre River Basins of Colorado during the 1998 and 1999 growing seasons.

The Colorado Phosphorus Index is not intended to be used for determining whether or not land users are operating within legal guidelines for water quality that have been established by local, state, or federal agencies. Rather, it may be used to develop planning alternatives for the landuser to minimize the potential for phosphorus movement from the field.

A Preliminary Phosphorus Risk Screening Tool is provided below to make an initial determination as to whether or not a Phosphorus Index Risk Assessment needs to be completed for an individual field and cropping rotation.

Preliminary Phosphorus Risk Screening Tool

Will animal manures or other organic nutrients be applied to this field?

NO → **A Colorado Phosphorus Index Risk Assessment is not needed for this field.**

YES ↓

Is soil test P greater than:
10 ppm AB-DTPA; 30 ppm Bray P1; 30 ppm Mehlich 3, or; 20 ppm Olsen?

NO → **A Colorado Phosphorus Index Risk Assessment is not needed for this field. Base organic nutrient application rates on crop nitrogen requirements.**

YES ↓

Can runoff or irrigation tailwater reach a surface water body? (continuous or intermittent stream, irrigation ditch, lake, or wetland, etc.)

NO → **A Colorado Phosphorus Index Risk Assessment is not needed for this field. Base organic nutrient application rates on crop nitrogen requirements.**

YES ↓

Complete a Colorado Phosphorus Index Risk Assessment for this field.

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Procedures for Making an Assessment

The Colorado Phosphorus Index consists of four site and management Risk Factors that can affect the potential for the movement of phosphorus off-site. In order to complete an assessment, the relative risk associated with each of these four Factors must be rated. The rating scale goes from Low (1), to Medium (2), to High (3), to Very High (4). Instructions for rating each Risk Factor are provided below. The rating process will require a field-specific knowledge of soils and slopes, soil test phosphorus levels, crop rotation and yield history, phosphorus application history, and phosphorus application methods. Once the Risk Factors are rated, add the values together and compare the sum with the Phosphorus Index Risk Interpretations to determine the relative potential for the movement of phosphorus off-site. Implementation of certain Best Management Practices may also be considered in order to mitigate or decrease the relative risk potential.

Colorado Phosphorus Index Risk Factors

Factor 1. Runoff Class – Runoff Class is based on field slope and the least permeable soil layer in the top three feet of the soil profile. Permeability classes for specific soils can be found in the Soil Survey for your area. Contact your local Natural Resources Conservation Service Field Office for soils information. Soil permeability class and field slope must be determined first, and then the runoff class can be determined from Table 1.

Table 1. Runoff Class Risk

	Soil Permeability Class				
	Very Rapid (> 20.0 in/hr) (>141.14 μm/sec)	Rapid and Moderately Rapid (2.0-20.0 in/hr) (14.11-141.14 μm/sec)	Moderate and Moderately Slow (0.2-2.0 in/hr) (1.41-14.11 μm/sec)	Slow (0.06-0.2 in/hr) (0.42-1.41 μm/sec)	Very Slow (< 0.06 in/hr) (< 0.42 μm/sec)
Slope %	Runoff Class				
Depressions	Negligible	Negligible	Negligible	Negligible	Negligible
0-1 %	Negligible	Negligible	Negligible	Low	Low
1-5 %	Negligible	Very Low	Low	Medium	High
5-10 %	Very Low	Low	Medium	High	Very High
10-20 %	Very Low	Low	Medium	High	Very High
> 20 %	Low	Medium	High	Very High	Very High

Factor 2. Soil Test Phosphorus – Bray P1 soil tests are used for low pH soils. Olsen or AB-DTPA soil tests are used for soils with a pH greater than 7.0 that contain calcium carbonate. Mehlich 3 soil tests have been used for both low and high pH soils. Phosphorus soil test samples should be taken from the top 2 to 3 inches for continuous no-till cropland, hayland and pastures, and from the top 8 to 12 inches for tilled cropland.

Table 2. Soil Test Phosphorus Risk

Soil Test	Low (1)	Medium (2)	High (3)	Very High (4)
AB-DTPA	< 10 ppm	10-20 ppm	21-40 ppm	> 40 ppm
Bray P1	< 30 ppm	30-60 ppm	61-120 ppm	> 120 ppm
Mehlich 3	< 30 ppm	30-100 ppm	100-200 ppm	> 200 ppm
Olsen	< 20 ppm	20-40 ppm	41-80 ppm	> 80 ppm

Factor 3. Phosphorus Application Rate – The Phosphorus Application Rate is the amount of phosphorus (P_2O_5) annually applied (or average annual application rate calculated for the current rotation) to the field in pounds per acre from both inorganic and organic sources. The pounds per acre of phosphorus annually applied from organic sources is derived from tons or gallons per acre applied and the nutrient content can be estimated from manure tests or book values. See Table 3b for examples of acceptable book values.

Table 3a. Phosphorus Application Rate Risk

Phosphorus Application Rate					
	None (0)	Low (1)	Medium (2)	High (3)	Very High (4)
Rate (lb. P_2O_5 /ac.)	None Applied	< 30	30-90	91-150	> 150

Table 3b. Approximate Nutrient Composition of Selected Types of Manure at Time of Application[1]

Type of Manure	Moisture Content %	Total N	NH_4-N	P_2O_5	K_2O
		pounds per ton			
Swine	82	10	6	9	8
Beef	32	23	7	24	41
Dairy Cattle	46	13	5	16	34
Sheep	31	29	5	26	38
Chicken w/o litter	55	33	26	48	34
Turkey w/o litter	78	27	17	20	17
Horse w/o	22	19	4	14	36

[1] These values are derived from the USDA, SCS, Agricultural Waste Management Field Handbook (1992), and modified with data collected from Colorado feeding operations when possible. Nutrient composition of manure will vary with age, breed, feed rations, and manure handling practices.

Factor 4. Phosphorus Application Method – The manner in which phosphorus is applied to the soil and the amount of time it is exposed on the soil surface impacts potential phosphorus losses. Incorporation implies that the phosphorus is incorporated into the soil a minimum of two inches. The categories of increasing severity, Low to Very High, depict the longer surface exposure time between phosphorus application, incorporation, and crop utilization.

Table 4. Phosphorus Application Method Risk

Phosphorus Application Method					
	None (0)	Low (1)	Medium (2)	High (3)	Very High (4)
Application Method	None Applied	Injected or Subsurface Applied	Spring Applied and Incorporated within 2 weeks	Fall/Winter Applied and Incorporated within 2 weeks	Surface Applied with No Incorporation, or Fall/Winter Applied with Spring Incorporation

Factor 5. Best Management Practice (BMP) Implementation Credits – Specific BMPs may be implemented to decrease the relative potential for off-site P movement. To take a BMP credit, subtract one point from the gross score for each of the following BMPs implemented on-site.

- **Cover or Green Manure Crops** may be planted after harvest or crop failure to decrease erosion potential and use excess nutrients applied to the field.
- **Filter Strips** may be planted on the down gradient side of the field to decrease the potential to transport phosphorus off-site.
- **Polyacrylamide**, or PAM, may be used with flood irrigated systems to decrease irrigation-induced erosion and the potential to transport phosphorus off-site.
- **Contour Buffer Strips** of permanent vegetation may be planted on the contour and alternated with wider cultivated strips to slow runoff and trap sediment.

References

Davis, J.G. and R.M. Waskom. 1999. A risk-based approach to phosphorus management on manured and non-manured soils. Proc. of the Western Nutrient Management Conf. Salt Lake City. March 4-5, 1999.

Waskom, R.M., and J.G. Davis. 1999. Best management practices for manure utilization, Colo. State Univ. Coop. Ext. Bulletin 569A, Fort Collins, CO.

Lemunyon, J.L., and R.G. Gilbert. 1993. Concept and need for a phosphorus assessment tool. J. Prod. Agric., Vol.6, no. 4. 483-486.

USDA, Soil Conservation Service. 1992. Agricultural Waste Management Field Handbook.

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Factor	**None (0)**	**Low (1)**	**Medium (2)**	**High (3)**	**Very High (4)**	**Score**
1. Runoff Class (See Table 1)	Negligible	Very Low or Low	Medium	High	Very High	
2. Soil Test P (See Table 2)	Not Applicable	Low	Medium	High	Very High	
3. P Application Rate (Annually applied or rotational average lbs. P_2O_5 per acre per year, all sources)	None Applied	< 30	30-90	91-150	> 150	
4. P Application Method (Use highest applicable risk category for multiple P applications)	None Applied	Injected or Subsurface Application Deeper Than 2 inches	Spring Applied and Incorporated within 2 weeks	Fall/Winter Applied and Incorporated within 2 weeks	Surface Applied with No Incorporation, or Fall/Winter Applied with Spring Incorporation	
Gross Score (sum of Factors 1 through 4)						
5. BMP Implementation Credits	Subtract one point for each of the following BMPs implemented on this site: Cover or Green Manure Crops; Filter Strips; Polyacrylamides to decrease Irrigation-Induced Erosion, or; Contour Buffer Strips.					
Net Score (sum of Factors 1 through 4 less Factor 5, BMP Implementation Credits)						

Score	Phosphorus Index Risk Interpretations
< 8	This field has a **LOW** potential for off-site P movement if management is maintained at the current level. Organic nutrient application rates may be calculated according to crop nitrogen requirements.
8 to 11	This field has a **MEDIUM** potential for off-site P movement and some management changes may need to be made to support continued long term organic nutrient applications. Organic nutrient application rates may be calculated according to crop nitrogen requirements.
12 to 15	This field has a **HIGH** potential for off-site P movement and management changes should be implemented to decrease risk. Organic nutrient application rates should be calculated according to crop phosphorus requirements.
16	This field has a **VERY HIGH** potential for off-site P movement and management changes are needed to decrease risk. Organic nutrients should not be applied to this field.