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NUTRIENT MANAGEMENT

INTRODUCTION

This Technical Note has been developed in order to provide guidance for nutrient management planning in addition to NRCS Field Office Technical Guide (FOTG) Standard 590. A Comprehensive Nutrient Management Plan (CNMP) is different from a 590 plan and additional documentation is required. More information on CNMPs can be found in the NRCS National Planning Procedures Handbook, Subpart F, Part 600.75 and this fact sheet: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_019284.pdf.

NRCS, Field Office Technical Guide (FOTG), Section IV, Conservation Practice Technical Standard 590, Nutrient Management, provides specific criteria for nutrient management planners (see section IV). It identifies the necessary components of a nutrient management plan (see section VI), and lists operation and maintenance requirements of the practice (see section VII). Federal, state, and local laws may provide additional requirements and guidance. The Wisconsin Conservation Planning Technical Note WI-1 is the companion document to NRCS FOTG Standard 590 and provides additional guidance and references for plan development.

This technical note is updated periodically. To find the most current information for developing nutrient management plans, use Snap Plus nutrient management software from developed by the UW Madison, Soil Science Department and available free of charge. (http://www.snapplus.wisc.edu/) This nutrient management planning tool will allow nutrient management planners to use the most current application rate guidelines found in UWEX Publication A2809 and the most current manure book values for estimating manure production and nutrient availability. Soil restriction map units are listed in Appendix 1 of this technical note and will be changing As county soil surveys are updated. Soil restriction map units are continuously updated so this Tech Note may not be current. The most recent soil restriction units are available in SnapPlus.

This technical note provides detailed guidance on the following:

The appendices below are in a separate document.

PART I
MINIMUM REQUIREMENTS FOR A NUTRIENT MANAGEMENT PLAN

The landowner/producer (person required to have the plan developed, or receiving the cost share monies) is responsible for annually updating the plan and keeping records of all the components of the nutrient management plan for a minimum of four years. A nutrient management plan shall be developed according to the criteria defined in the NRCS FOTG Standard 590, Nutrient Management and include the following:

A. Plan Narrative summarizing the implementation and operation of the nutrient management plan as it pertains to the entire farm unit. Details shall include:

   1. An overview of the operation including typical crops grown and the sources of nutrients other than fertilizer applied to the land.
   2. A summary of Phosphorus reduction strategies, as appropriate.
   3. An explanation for any fields that are out of compliance with the standard and the schedule for bringing them into compliance.

B. Aerial photographs and/or maps of the farm containing:

   1. Boundaries, identification numbers, and acreage for all crop fields, pastures, and nutrient management units. Provide consistent field identification in the nutrient management plan, soil test record, and conservation plan.
   2. Soil series and soil series boundaries.
   3. Location and identification of spreading restrictions as identified in FOTG 590 Standard Criteria IV.A.2. and IV.A.3.a. Each map shall have a legend defining map symbols. The 590 spreading restriction maps can be downloaded from http://www.manureadvisorysystem.wi.gov/.

C. Field-specific (or nutrient management unit specific) documentation of:

   1. Planned crop rotation including the previous crop and crop to be grown this year.
   2. Projected yield goals for each crop based on previous yields.
   3. Dominant critical soil map unit for soil erosion calculations (most erosive soil map unit comprising greater than 10% of field area) and the predominant soil map unit to obtain nutrient application rates.
   4. Previous year's actual and current year's proposed nutrient and soil amendment application rates including the form, rate, and timing for:
      a. Commercial fertilizers
      b. Manure (If you are collecting and applying livestock manure, complete Part IV, Step 1 below.)
      c. Other organic byproducts
      d. Credits for Legume Nitrogen
      e. Soil Amendments (e.g., lime)
   5. Soil test information per Criteria IV.A.1.e.
   6. Where P (all sources) is applied in excess of crop need, the credits for surplus P must be tracked and subsequent nutrient applications shall be adjusted using FOTG 590 Criteria IV.A.1.g. and IV.C.
   7. The current NRCS soil loss estimates for sheet and rill or wind, or equivalent should be included.
   8. Document current year's actual crop yield and nutrient application rates including form, timing, and application method. Changes to nutrient applications that are not consistent with the plan should be documented in the plan. Include the reasons why the changes were made and revise the P budget in #6 above as necessary. The plan for the production year is not considered complete until all actual nutrient application rates are documented.
   9. For Nitrogen Restricted Soils see Appendix 1. For certified soil testing laboratories see Part VI of this document. For Nutrient Management for Wisconsin Cranberry Production see Appendix 2.

10. Pastures must be included in the nutrient management plan. Further information regarding state rules and exceptions associated with nutrient management planning for pastures can be found at:

    - http://datcp.wi.gov/uploads/Environment/pdf/ATCP50GuidanceNutrientManagementOnPastures.pdf
    - UWEX Soil Fertility Guidelines for Pastures in Wisconsin - http://learningstore.uwex.edu/Assets/pdfs/A4034.pdf

PART II
REQUIREMENTS FOR A WINTER SPREADING PLAN

The Winter Spreading Plan shall be consistent with the WI NRCS 590 Nutrient Management practice standard.

A. Winter Spreading Plan Implementation Maps:

   These maps should be simplified for use in the field by farmer or manure hauler and contain the following:

   1. Field boundaries, identification numbers, and acreage.
   2. Field access locations.
   3. Location of stacking areas (See NRCS FOTG Standard 313 or Table 1 in "Additional Considerations").
   4. Planned mitigation practices by field as defined by Criteria IV.A.2.d.
   5. Identification of fields or portions of fields not spreadable due to access limitations or nutrient management prohibitions.

B. Documentation records:

   The landowner/producer (person responsible for the land application of manure) shall review the winter spreading plan annually prior to winter application of manure, and keep records of all the components of the winter spreading plan for a minimum of four years. Utilize data forms, spreading logs, GPS data, or photos to document implementation activities.

ADDITIONAL CONSIDERATIONS AND RESOURCES FOR WINTER SPREADING

A. Assessment of Seasonal or Annual Field Conditions at Time of Manure Application:

   The following factors are used to select fields or portions of those fields with the lowest risk for runoff at the time of winter manure application:

   1. Previous crop and condition/amount of residue cover
   2. Cover crops (type/condition)
   3. Surface roughness (primary/secondary tillage practices completed prior to manure spreading)
   4. Field rutting or surface compaction (presence)
   5. Previous manure application (timing/rate)
   6. Other in-field considerations identified by the planner

B. Assessment of Forecasted Weather Characteristics and Snow Conditions at Time of Manure Application:

   Consider the following conditions before winter manure application.

   1. Snow depth (< 6 inches, <12 inches, >12 inches or more)
   2. Snow characteristics (powder, compacted) and uniformity of cover
   3. Presence of ice (soil surface, crust on snow etc.)
   4. Frost depth and uniformity
   5. Predicted air temperature (5-day forecast)
   6. Predicted precipitation (5-day forecast)
   7. Month of application (sun intensity– angle and duration i.e. mid-winter vs. early/late winter)

C. Winter Manure Spreading Research Findings – UW Discovery Farms Publications:
Runoff Lessons: Frozen and Snow Covered Ground
Considerations for Early Winter Applications of Manure (Nov 2013)
Considerations for Mid-Late Winter Manure Applications (Jan 2014)

D. Table 1. NRCS FOTG Conservation Practice Standard 313, Waste Storage Facility Table 10 Temporary, Unconfined Stacks of Manure and Derivatives Outside the Animal Production Area

1. Waste Consistencies [Note 1]		
	> 32% Solids	16% to 32% Solids [Note 2]
2. Size & Stacking Period		
Stacking Period	8 months	8 months
Maximum Volume/Stack	≤ 40,000 cu ft.	≤ 15,000 cu ft.
Maximum Number of Stacks/40 acres [Note 3]	–	2
Frequency of Stacking Site Use	1 year out of 2	1 year out of 3
3. Hydrologic Soil Groups		
	B or C	B or C
4. Subsurface Separation Distance		
Subsurface Saturation	≥ 3 ft.	≥ 3 ft.
Bedrock	≥ 3 ft.	≥ 5 ft.
5. Surface Separation Distance		
Wells [Note 4]	≥ 250 ft.	≥ 250 ft.
Lakes	≥ 1,000 ft.	≥ 1,000 ft.
Sinkholes, or other Karst Features	≥ 1,000 ft.	≥ 1,000 ft.
Quarries	≥ 1,000 ft.	≥ 1,000 ft.
Streams	≥ 300 ft.	≥ 500 ft.
Wetlands and Surface Inlets	≥ 300 ft.	≥ 500 ft.
Areas of Concentrated Flow	≥ 100 ft.	≥ 300 ft.
Land Slope Down Gradient of Stack	≤ 6%	≤ 3%
Floodplain	≥ 100 ft.	≥ 300 ft.
Tile lines	≥ 40 ft.	≥ 40 ft.

[Note 1] Refer to AWMFH, Figure 9-1 for consistency values and Chapter 4 for % solids, for specific livestock types.

[Note 2] 16% to 32% solids represents waste at near saturation conditions where additions of free water from runoff, rain, or snow-melt can result in liquid flow conditions.

[Note 3] The separation distance between stacks shall be at least 100 feet.

[Note 4] Community water system wells may require larger separation distances (see NR 812).

PART III
ENHANCED NUTRIENT MANAGEMENT PLANNING

The practices listed in this section are recommendations that will enhance nutrient management planning and provide additional water quality benefit. The rate, timing, and placement of nutrients are important considerations that may affect water quality.

A. General

1. Nutrients should be applied as near to the time of crop use as possible.
2. Minimize manure applications on frozen or snow-covered soils.

3. Apply nutrients to the least environmentally sensitive areas first at rates needed to supply the crop N requirements or the anticipated crop removal of P and/or K. Criteria to consider include: hydraulic loading rate of the soil profile, soil permeability, infiltration capacity, slope, distance to surface water features, erodibility, accessibility, present crop, potential fate of runoff, infiltration, and presence of conservation practices.

4. Apply manure to crops which can use all of its nutrients, including nitrogen, whenever possible. Grasses such as corn are best. Applying manure to a forage legume crop adds substantial cropland available for spreading throughout summer months and provides a good utilization of all nutrients. Manure applied to forages may stimulate grass production and weed growth resulting lower forage protein and tend to reduce the alfalfa stand. The following recommendations are suggested in "Applying Manure to Alfalfa," North Central Regional Research Report 346.

    a. Pre-plant manure applications generally can have a positive effect on seedling-year alfalfa dry matter production where weeds are adequately controlled. This response may also be carried over into the full production years. Although manure may increase certain seedling-year weed problems, these usually do not persist past first cutting. Repeated manure applications at high rates may increase forage potassium to unacceptably high levels.

    b. Topdressing manure to established alfalfa is somewhat more risky. While benefits can be obtained, especially on low-testing soils or on legume-grass mixtures, problems from compaction, salt burn and stand suffocation can occur. Alfalfa can be a major sink for recycling nitrogen and other nutrients; however, topdress applications, especially to frozen soils, may result in large nutrient runoff losses. Various management practices, including using low rates on the poorest stands immediately after cutting, will help reduce the agronomic and environmental risks associated with following this strategy.

    c. Applying at the end of the alfalfa rotation may leave more nitrogen than the following crop can use. This can lead to large, unacceptable environmental risks from nitrate leaching. A producer who takes this approach must consider the nitrogen contributed from both the legume and the manure. Removing all of the alfalfa top growth before application and limiting manure rates by taking into account the alfalfa nitrogen credit is essential.

B. Nitrogen

1. Nitrogen management practices to improve nitrogen use efficiency are summarized in UWEX Publication A3340, "Corn Fertilization" (1998).

    a. Use the appropriate nitrogen rate for the production conditions.

    b. Make proper adjustments for high corn residue cover.

    c. Fully credit nitrogen that may be available from organic sources such as manure legumes and soil organic matter.

    d. Use soil nitrate tests when appropriate to help identify the optimum N rate.

    e. Avoid fall applications of N fertilizers.

    f. Use sidedress N applications or delay N applications to coincide with the crop N demand, especially on coarse-textured soils where nitrate leaching is likely.

    g. Use a nitrification inhibitor with ammonium forms of nitrogen where the risk of N loss through leaching or denitrification is high.

    h. Control ammonia losses from urea containing fertilizers by incorporating or injecting these materials within 72 hours, by using urease inhibitor, or by selecting a non-urea material for surface applications.

    i. Control ammonia losses from dairy farms by removing excess protein from the cow's diet. Incorporate manure in the field being aware of the potential for increased erosion and P losses. Cover manure storage structures or use organic matter in bedding to form a crust cover. Consider diverting urine away from feces.

2. Reference list of articles related to nitrification inhibitors, urease inhibitors, and slow release fertilizers.

   Extension Publications and Conference Proceedings

   Franzen, D.W. 2013. Nitrification Inhibitor Claims – Are They Real? Proc. Wisconsin Crop Management Conference. 52:124-137. http://www.soils.wisc.edu/extension/wcmc/2013/pap/Franzen_inhibitor.pdf

   Franzen, D.W. 2013. Volatilization Losses from Urea. Proc. Wisconsin Crop Management Conference. 52:139-155. http://www.soils.wisc.edu/extension/wcmc/2013/pap/Franzen_urea.pdf

   Franzen. D.W. 2011. Nitrogen Extenders and Additives for Field Crops. North Dakota State University Extension Publication SF-1581. http://www.ag.ndsu.edu/pubs/plantsci/soilfert/sf1581.pdf

   Goos, R.J. 2011. Nitrogen Fertilizer Additives Which Ones Work? Proc. North Central Extension-Industry Soil Fertility Conference. 27:5-15. http://extension.agron.iastate.edu/nce/ncepdfs/2011/ncsfc%202011%20goos%20p5.pdf

   Goos, R.J. 1987. Ammonium Thiosulfate as a Urease Inhibitor: A Suggested Mechanism. Proc. North Central Extension-Industry Soil Fertility Conference. 3:103-105. http://extension.agron.iastate.edu/nce/ncepdfs/1987/ammoniumthiosulfate.pdf

   Laboski, C. 2006. Does it pay to use nitrification and urease inhibitor? Proc. Wisconsin Crop Management Conference. 45:44-50.

3. When concerned with the rate and placement of nitrogen, consider these points in addition to those found in Section V. Considerations of NRCS FOTG, Standard 590, Nutrient Management:

   a. Unused or residual nitrate may be leached from the soil and impact groundwater and surface waters. In years of normal fertilizer application and unexpected low yields, excess nutrients, including nitrate, may accumulate in the soil. Pre-plant soil nitrate tests can be used to measure carryover nitrogen and adjust nitrogen applications (see UWEX Pub A2809, “Nutrient application guidelines for field, vegetable, and fruit crops in Wisconsin,” 2012). Additional options for reducing the amount of nitrogen subject to leaching include:

      (1) Growing a winter cover crop to use carryover nitrogen.
      (2) Growing legume crops (when managed without supplemental N inputs) to “scavenge” N remaining in the profile.
      (3) Growing high N demanding crops such as corn and forage grasses.

   b. Nitrification inhibitors used with ammonium or ammonium-forming N fertilizers can improve N efficiency and limit loss of fertilizer N on soils where the potential for nitrate loss through leaching or denitrification is high.

   c. Use the Wisconsin NRCS recognized Nitrogen Leaching Index to evaluate N pathway loss via leaching, solution runoff, reactive N emissions and for planning N reduction alternatives located on the Wisconsin NRCS website under Nutrient Management: http://www.nrcs.usda.gov/wps.portal/nrcs/main/wi/technical/cp/.

4. First year annual N removal by legumes and companion crops

   Legume crop maximum N applications:

   Most legume crops can fix sufficient N from the air to ensure adequate growth without applying additional N to the soil; therefore recommended N fertilization rates for most legume crops are zero. However, legumes will use available N in the soil in preference to fixing their own. Thus, manure N applied to legume crops is considered to have a low risk of loss through leaching if it does not exceed the crop N removal rate or is no more than 205 lb of available N per acre.

Table 2. First-year available manure N application rates allowed for legume and legume plus companion crops*

Crop	Yield range	Manure available N allowed (lb/acre)
Alfalfa; alfalfa/brome; red clover; or trefoil, birdsfoot, seeding or established †	< 1.5 ton/a	50
	1.5 – 2.5 ton/a	100
	2.6 – 3.5 ton/a	155
	> 3.5 ton/a	205
Barley for grain underseeded with alfalfa, alfalfa/brome, or red clover seeding ‡	All yield levels, bu/a	150
Dry beans	10-20 cwt/a	75
	21-30 cwt/a	125
	31-40 cwt/a	175
Oats for grain underseeded with alfalfa, alfalfa/brome, or red clover seeding ‡	All yield levels, bu/a	140
All pastures §	0.5-1.9 ton/a	55
	2 -3 ton/a	115
	3.1 - 4.0 ton/a	160
	4.1 - 5.0 ton/a	205
Small grain silage underseeded with alfalfa	2 - 3.5 ton/a	170
Small grain & legume silage	2 - 3.5 ton/a	70
Small grain & legume silage underseeded with alfalfa	2 - 3.5 ton/a	170
Soybean	15-25 bu/a	75
	26-35 bu/a	115
	36-45 bu/a	155
	> 45 bu/a	195

**Some legume crops such as peas and snap beans are not included in this table because N removal in the harvested portions of the crop is similar to their N fertilizer recommendation.*

†To minimize the potential for stand injury, single applications should not exceed 5,000 gal/acre for liquid or 10 ton/acre for solid maures.

‡ Nitrogen allowed is the recommended rate for the grain crop plus removal in the forage crop. This rate may be too high for successful management of the grain crop.

§ Nitrogen allowed is the total available N deposited by grazing animals plus manure applied mechanically.

***Note:** As per the FOTG 590 Standard, commercial N should not be applied to legume crops that do not have an N requirement unless it is an unavoidable ingredient of a fertilizer needed to provide other required nutrients.*

Non-leguminous crops maximum N application rates:

If commercial N fertilizer is applied in any amount: Total N applications, including N in starter, should not exceed the UW recommended rate for the crop. For non-legume crops other than corn or wheat, there is only one N rate recommended for a given crop or, in the case of potatoes, crop and yield range combination.

If only organic sources are applied: The 590 Standard recognizes that there will always be some uncertainty in estimating manure N availability because of variability in manure nutrient contents, uneven application rates, and weather. When organic sources of nutrients are used to meet 100% of the N requirement: 1) an additional 20 lb N/a of may be applied as commercial starter fertilizer

for corn; 2) no additional commercial N should be applied to wheat beyond the top end of the MRTN range at a wheat: N price ratio of 0.050; and 3) up to 20% more N than recommended may be applied to crops other than corn or wheat.

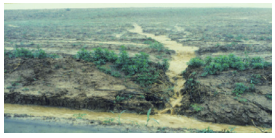
C. Phosphorus

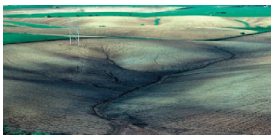
1. Phosphorus losses are usually greatest on sites with high erosion.

Definitions of types of erosion:

- **Sheet erosion**, sometimes referred to as inter-rill erosion, is the detachment of soil particles by raindrop impact and the removal of thin layers of soil from the land surface by the action of rainfall and runoff.

- **Rill erosion** is the formation of small, generally parallel channels formed by runoff water and usually do not re-occur in the same place on the landscape from one storm event to the next, season to season or from one year to the next.





- **Ephemeral erosion** means erosion which forms rills that may converge to form shallow channels. These shallow channels can easily be filled with soil by typical tillage operations and usually re-formed in the same general location by subsequent runoff events.

- **Classical gullies or classic gullies** are concentrated flow channels formed when rills converge to form well defined permanent incised drainage ways that cannot be crossed by ordinary farming operations.

2. When applying nutrients on non-frozen ground, consider the following:

   a. Use runoff and erosion control practices such as spring tillage, maintaining high levels of crop residue on the soil surface, contour farming, and utilization of vegetated riparian buffers.

   b. Limit corn starter P applications on row crops to 20 pound P2O5 per acre, to the extent possible, eliminate all non-starter P applications.

   c. Whenever possible, apply manure on fields with lower P soil tests.

   d. Where possible, develop a means to move nutrients off the farm to areas with less environmental hazard.

3. Consider following National Research Council dietary P recommendations to lower P levels in rations and avoid high levels of P in manure.

4. To limit high-risk manure applications to frozen or snow-covered soil, complete a Winter Spreading Plan (Part II) and implement the following additional management practices:

   a. Temporary stacking of manure, manure storage, manure trading, and additional rental land for manure spreading.

   b. Where supplemental feeding of P in current rations is above National Research Council recommended levels, a feed management strategy will be discussed with the producer and their animal health and feed supply professionals with the goal of reducing supplemental feeding of P and reducing manure P losses.

D. Subsurface Drainage

1. Vertical fractures in fine textured soils can be a pathway for nutrients and manure to reach groundwater. Where cracks are identified, consider tillage to break up cracks and macropores before application. See UWEX Publication "Preferential Flow of Manure in Tile Drainage" at www.extension.org/animal_manure_management.
2. Evaluate the need to modify field operations to reduce the risk of large nutrient losses based on current field conditions or forecasted weather events.
3. Resources

    - Michigan State University: http://animalagteam.msu.edu/animalagteam/tile_drains
    - University of Wisconsin Discovery Farms: http://www.uwdiscoveryfarms.org/OurResearch/AgriculturalTileDrainage.aspx
    - University of Minnesota Extenstion: http://www.extension.umn.edu/agriculture/water/publications/
    - University of Wisconsin NPM Program Emergency Response resources
        - http://datcp.wi.gov/uploads/Farms/pdf/NMTrainingIEmerResponsePlan.pdf
        - http://datcp.wi.gov/uploads/Farms/pdf/NMTrainingIEmerResponseContax.pdf

E. Other Considerations

1. Use appropriate pH management to keep the soil pH in the proper range for optimum crop production. Soil pH affects the availability of almost all of the essential elements. See UWEX Pub. A2809.
2. Good soil tilth should be maintained because it encourages infiltration, reduces runoff, and enhances crop vigor. This is especially important when the objective is to protect surface water.

    a. Organic matter additions promote good soil tilth.
    b. Equipment travel on saturated soils should be avoided to reduce soil compaction and rutting.
3. The hydraulic loading rate of the upper horizons should be considered. If the loading rate is low, or if there is a horizon that prohibits downward movement of liquid (i.e., hard pan or a clay horizon), it is important not to apply more liquid manure than the soil can absorb.

PART IV
DETERMINING MANURE NUTRIENT CREDITS

Proper crediting of manure nutrients can lower commercial fertilizer needs and reduce the potential for surface and groundwater pollution. Manures contain significant amounts of the major plant nutrients (N, P and K) and many other essential nutrients. Only a portion of the nutrients from field-spread manure is available in the first year. The rest becomes available over time as the nutrients are released from the organic fraction. Calculating the fertilizer value of manure involves three steps:

1) Estimate quantity of on-farm manure production;
2) Estimate available - nutrients;
3) Estimate the manure nutrient credit and application rates

An example of how to estimate the quantity of on-farm manure production is provided below. Chapter 9 Nutrient credits in UWEX Pub A2809 describes manure nutrient availability and the process for estimating manure nutrient credits including example calculations. Manure nutrient content can vary significantly from the average values provided in UWEX Pub A2809. Therefore, sampling manure and analyzing for nutrient composition is encouraged as a means to more accurately assess manure nutrients. UWEX Publication A3769 Recommended Methods of Manure Analysis provides guidance on how to collect and handle manure samples.

Estimate Quantity of On-Farm Manure Production

Manure production can be estimated by utilizing the information provided in Table 3. Manure production can vary considerably between production systems. Other manure production estimates are acceptable. Estimates of the

percent of the total manure production that is actually collected may also aid in the planning process. The planner may explain the manure production/collection system in the narrative section as described in Part 1.

Manure storage size may provide a better quantity estimate:

- What is the manure storage facility size?
- Multiply storage facility size by the number of times emptied/year. This equals the total annual manure collection.

SnapPlus offers a Manure Production Estimator or a Grazing Application Estimator and is available for free at http://snapplus.wisc.edu/.

Table 3. Manure Quantity Estimation for Crop Production

Version January 16, 2003

Animal	Size lbs.	Daily Manure Production To Apply						Annual Manure Production To Apply					
		Solid		Liquid									
		Lbs/day	ft3/day	MWPS ft3/ day x WI dairy & beef dilu-tion factor	ft³/day & WI dilution	MWPS gal./ day x WI dairy & beef dilution factor	gal./day & WI dilution	Number of Head	x Daily Total **Tons or Gal.**	x 365 Day Total	x % Collected	= Total Collected **Tons or Gal.**
Dairy												
Calf	150	13	0.200	.21*1.8=	0.37	1.53*1.8=	2.8					
Calf	250	21	0.320	.33*1.8=	0.60	2.47*1.8=	4.5					
Heifer	750	65	1.000	1.03*1.8=	1.85	7.70*1.8=	13.8					
Lact. Cows	1000	106	1.700	1.71*1.8=	3.07	12.7*1.8=	23.0					
	1400	148	2.400	2.38*1.8=	4.28	17.7*1.8=	32.0					
Dry Cows	1000	82	1.300	1.30*1.8=	2.35	9.7*1.8=	18.0					
	1400	115	1.820	1.82*1.8=	3.33	13.6*1.8=	25.0					
Beef												
Calf	450	26	0.420	.415*3.2=	1.3	3.1*3.2=	9.9					
High Forage	750	62	1.000	1.00*3.2=	3.2	7.5*3.2=	24.0					
High Forage	1100	92	1.400	1.48*3.2=	4.8	11*3.2=	35.0					
High Energy	750	54	0.870	.87*3.2=	2.7	6.5*3.2=	20.8					
High Energy	1100	80	1.260	1.27*3.2=	4.1	9.5*3.2=	30.5					
Beef Cow	1000	63	1.000	1.00*3.2=	3.2	7.5*3.2=	24.0					
Swine												
Nursery Pig	25	2.7	0.040	0.04		0.3						
Grow-Finish Pig	150	9.5	0.150	0.17		1.2						
Gestating Sow	275	7.5	0.120	0.14		1						
Sow & Litter	375	22.5	0.360	0.42		3						
Boar	350	7.2	0.120	0.14		1						
Poultry / Other												
Layers	4	0.26	0.004	0.004		0.03						
Broilers	2	0.18	0.003	0.003		0.02						
Turkeys	20	0.9	0.014	0.015		0.11						
Duck	6	0.33	0.005	0.006		0.04						
Sheep	100	4	0.060	0.055		0.4						
Horse	1000	50	0.800	0.827		5.98						

Source: Midwest Plan Service publication number MWPS-18 "Manure Characteristics" Section 1, copyright 2000. Solid volumes are as excreted. The liquid dairy and beef values are computed from the MWPS daily production and have approximately equal nutrient values annually as solid manure. MWPS liquid dairy and beef factors are multiplied by 1.8 and 3.2 respectively. Dilution on your operation may be substantially different. **Use manure analysis and manure storage volumes** to determine manure production whenever possible.

Manure quantities are likely to be more accurate estimated from storage size:

What is the manure storage pit size? _____ gallons or tons?

Multiply pit size x Number of times emptied/year _____ = Total annual manure collection

PART V
DNR CONTACT INFORMATION AND RESOURCES FOR NUTRIENT MANAGEMENT

DNR Service Center Locations by Region - The State of Wisconsin is divided into five regional areas. They include Northern Region, Northeast Region, West Central Region, South Central Region, and Southeast Region. The DNR Central Office is located in Madison.

Contacts

CAFO - AG Runoff Management Staff (by DNR office and county)
http://dnr.wi.gov/topic/AgBusiness/CAFO/Contacts.html

Agricultural Nonpoint Source Specialists (by DNR office and county)
http://dnr.wi.gov/topic/Nonpoint/NPScontacts.html

Drinking and Groundwater Staff (link in lower left corner) by county
http://dnr.wi.gov/topic/drinkingwater/

Resources

Reporting Concerns regarding Agricultural Operations
http://dnr.wi.gov/topic/Nonpoint/dischargesComplaints.html

Manure Spills Response Planning and Prevention
http://dnr.wi.gov/topic/agbusiness/manurespills.html

Nonpoint Source Pollution
http://dnr.wi.gov/topic/nonpoint/

CAFO's and Nutrient Management
http://dnr.wi.gov/topic/AgBusiness/CAFO/NutrientManagementPlan.html

Agricultural TMDL's
http://dnr.wi.gov/topic/tmdls/npstmdls.html

Impaired Waters
http://dnr.wi.gov/topic/impairedwaters/

PART VI
CERTIFIED SOIL TEST LABORATORIES

The following laboratories have been approved as of the publication date of this document:

UW Soil & Forage Laboratory
8396 Yellowstone Drive
Marshfield, WI 54449
Ph: (715) 387-2523

Rock River Laboratory
710 Commerce Drive
P. O. Box 169
Watertown, WI 53094
Ph: (920) 261-0446

Dairyland Laboratories
217 E. Main Street
Arcadia, WI 54612
Ph: (608) 323-2123

Agsource Soil & Forage Laboratory
106 N. Cecil Street
Bonduel, WI 54107
Ph: (715) 758-2178

A&L Great Lakes Laboratories
3505 Conestoga Drive
Fort Wayne, IN 46808
Ph: (260) 483-4759

APPENDIX 2. NUTRIENT MANAGEMENT FOR WISCONSIN CRANBERRY PRODUCTION

This appendix to the Wisconsin Conservation Planning Technical Note WI-1 (WI CP-TN-1) has been developed in order to provide guidance for nutrient management planning on cranberry production systems. A cranberry nutrient management plan that meets the criteria included in this appendix should satisfy the requirements of the Wisconsin NRCS Nutrient Management Conservation Practice Technical Standard (WI NRCS CPS, Nutrient Management (Code 590)) and the technical note. Reference is made to particular sections of the 590 standard and the technical note, where special attention may be needed.

The guidance and instructions included in this appendix are in addition to those found in the 590 standard. Implementation of a plan developed based upon the guidance included in this document must be in accordance with the 590 standard. Federal, state, and local laws may provide additional requirements.

This appendix provides detailed guidance on the following:

Section I: Criteria Unique to Cranberry Nutrient Management Planning

Section II: Cranberry Nutrient Management Tables

Section III: Cranberry Nutrient Management Plan

Section I: Criteria Unique to Cranberry Nutrient Management Planning

A. General

1. Cranberry nutrient management planning shall be based on plant tissue analysis. Plant tissue analysis shall be performed annually, on each individual nutrient management unit, in accordance with Cranberry Tissue Testing for Producing Beds in North America (Extension publication EM-8610). Tissue analysis should be performed by a reputable laboratory—preferably one that participates in the North American Proficiency Testing Program. A minimum of one sample shall be collected per management unit per year. In addition, a total of at least one sample per 5 acres of cranberry beds, within each nutrient management unit, shall be collected every 4 years. (For example, on a 25-acre nutrient management unit, collect at least one tissue sample every year and a total of at least 5 samples over a 4-year period.) Refer to EM- 8610 and "How to Take a Cranberry Tissue Sample," (Teryl R. Roper, Professor and Extension Fruit Crops Specialist, UW- Madison, 2006) for further guidance.

2. Soil fertility analysis should also be considered in cranberry nutrient management planning. Soil samples must be analyzed by an approved Wisconsin laboratory. (Refer to Appendix 2 of this technical note for contact information.) Consider collecting a total of at least one composite sample per 5 acres of producing cranberry beds, within each nutrient management unit, every 4 years. Refer to Sampling Soils for Testing (UW-Extension publication A2100) and "How to Take a Cranberry Soil Sample," (Teryl R. Roper, Professor and Extension Fruit Crops Specialist, UW-Madison, 2006) for further guidance.

3. Additional considerations in cranberry nutrient management planning should include monitoring and observation of plant vigor and appearance, production history, and grower experience, in addition to the considerations described in the Extension publications referenced in this document.

4. Ensure that application equipment is properly calibrated.

5. Applications of nutrient and soil amendments should not be made when soil temperatures are low (<50 deg. F) or fields are saturated with water.

6. Applications of nutrient and soil amendments should be rescheduled when predicted weather conditions are likely to transport these amendments to non-target areas (i.e. precipitation events, planned irrigation events, frost protection events, etc.). The nutrient management plan shall document mitigation practices to be implemented when rescheduling is not possible.

7. An analysis of the water chemistry of irrigation and/or flood water should be considered when the conservation planning resource assessment has identified that water chemistry may significantly

influence nutrient management by altering soil acidity and/or resulting in the application of significant quantities of plant nutrients.

8. Efforts should be made to limit the detachment and transport of vegetation and soil materials (i.e. material that is removed or disturbed in the processes of bed renovation/construction or managed "floods"), which may result in the deposition of these materials into surface waters.

B. Soil Acidity

1. Maintain soil pH at or below 6.0, where practical. The "target pH" is 5.6 for mineral soils and 5.4 for organic soils, as identified in Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin (UWEX publication A2809). Note circumstances where the difference between the actual soil pH and the target pH is greater than 0.5, and describe procedures utilized to adjust pH, if such efforts are made.

2. Annual sulfur applications should not exceed 500 lbs elemental S per acre.

3. Individual sulfur applications should not exceed 150 lbs elemental S per acre.

C. Nitrogen (for producing beds)

1. Nitrogen management strategies shall be in accordance with Nitrogen for Bearing Cranberries in North America (Extension publication EM-8741). Note: Hybrid varieties, such as Stevens and Pilgrim, may benefit from tissue-N concentrations up to 1.3% (2006 Wisconsin Cranberry School Proceedings, Teryl Roper, UW-Extension).

2. Ammonium or urea forms of nitrogen fertilizer should be used.

3. Individual nitrogen applications should not exceed 20 lbs/ac.

4. Identify and implement water quality mitigation practices for beds where soil pH is greater than 5.5 and 70 lbs or more of nitrogen fertilizer are applied per acre per year.

5. Annual applications of fertilizer containing N should be made using a minimum of three passes, unless total planned applications for the season do not exceed 20 lbs N per acre.

6. Applications of fertilizer containing N should be timed to coincide with peak crop demand (active growth).

D. Phosphorous (for producing beds)

1. Phosphorous management strategies shall be in accordance with Phosphorous for Bearing Cranberries in North America (UW- Extension publication, Nov. 2004).

2. Annual phosphorous applications shall not exceed 20 lbs actual P per acre (~45 lbs P2 O5 per acre), unless the need for additional annual P is documented by plant tissue analysis or other considerations as outlined in Phosphorous for Bearing Cranberries in North America.

3. Develop a fertilizer reduction strategy where planned, annual applications of phosphorous fertilizer exceed 20 lbs actual P per acre (~45 lbs P2 O5 per acre), on producing beds; tissue analysis demonstrates that nutrient concentrations are within or exceed recommended levels; and no deficiency of phosphorous has been demonstrated through soil fertility analysis. Cranberry tissue nutrient content guidelines for producing beds and soil test interpretation categories for phosphorous are summarized in Section II of this appendix.

4. Applications of fertilizer containing P should be timed to coincide with peak crop demand (hook to fruit set). Multiple, lighter applications of fertilizer containing P are preferred over fewer, heavier applications.

E. Potassium (for producing beds)

1. The goal of potassium fertility management should be to maintain plant tissue concentrations within the recommended range (refer to EM-8610 or Section II).

2. Large doses of potassium fertilizer have the potential to disrupt the balance of available cations (positively-charged ions) in the soil. Because of this, individual applications of fertilizer containing potassium should not exceed ~62 lbs actual K per acre (75 lbs K20 per acre).

3. Multiple, lighter applications of fertilizer containing K are preferred over fewer, heavier applications.

F. New Plantings

1. Nutrient management strategies for new plantings shall be based upon soil fertility analysis and consideration of soil characteristics. Collect soil samples for analysis at a rate of one composite sample per 5 acres of cranberry beds after the beds have been prepared for planting. Refer to UWEX publication A2809, or Section II of this Appendix, for fertilizer application guidelines based on soil test results.

2. Annual applications of nitrogen should not exceed 150 lbs/ac.

3. Individual applications of fertilizer should not exceed 15 lbs N per acre.

4. If fertilizers containing phosphorous and/or potassium are to be applied after the plants have become established, consider alternating fertilizer applications between nitrogen-only products [i.e. urea or ammonium sulfate (21-0-0)] and complete, N-P-K blends [i.e. 13-13-13, 10-10-30, or similar products].

5. Pre-plant applications of fertilizer containing phosphorous and/or potassium should be incorporated into the soil. Applications must be based upon soil test results and UW-Extension guidelines (see A2809 or Section II of this Appendix).

6. Frequent, lighter applications of fertilizers are preferred on new plantings over fewer, heavier applications.

SECTION II: CRANBERRY NUTRIENT MANAGEMENT TABLES

Table 1: Soil test interpretation categories for phosphorous (P) and potassium (K) for *common cranberry soils

Nutrient	Very Low	Low	Optimum	High	Very High	Excessively High
P (ppm)	<18	18-25	26-37	38-55	>55	
K (ppm)	<50	50-80	81-120	121-160	161-220	>220

*These categories apply to Subsoil Group E [Sandy, coarse-textured soils (sands and loamy sands)] and Subsoil Group O [Organic soils (mucks and peats)], as defined in Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin (UWEX publication A2809). Refer to A2809 if the dominant soil type does not meet either of these descriptions.

Table 2: Phosphorous and potassium fertilizer application rate guidelines [from UWEX publication A2809]

Fertilizer Component	Very Low	Low	Optimum	High	Very High	Excessively High
P2 O5 (lbs/ac)	†200	†125	NA	NA	--	NA
K2 O (lbs/ac)	†250	†200	NA	NA	NA	NA

†These rates are only applicable prior to cranberry bed establishment. Incorporate all P2 O5 and K2 O before planting. For established cranberry beds, use tissue testing to guide fertilizer application rates.

Table 3: Cranberry tissue nutrient content guidelines for producing beds

Nutrient	Normal Concentration (%)	Nutrient	Normal Concentration (ppm)
Nitrogen (N)	0.90 – ‡1.10	Boron (B)	15 – 60
Phosphorous (P)	0.10 – 0.20	Iron (Fe)	>20
Potassium (K)	0.40 – 0.75	Manganese (Mn)	>10
Calcium (Ca)	0.30 – 0.80	Zinc (Zn)	15 – 30
Magnesium (Mg)	0.15 – 0.25	Copper (Cu)	4 – 10
Sulfur (S)	0.08 – 0.25		

‡Hybrid varieties, such as Stevens and Pilgrim, may benefit from tissue-N concentrations of up to 1.30%.

SECTION III: CRANBERRY NUTRIENT MANAGEMENT PLAN OUTLINE AND OPTIONAL FORMS

A cranberry nutrient management plan shall be developed according to the 590 standard, as well as the criteria included in this technical note. The following outline should be used as a guide in the development of a cranberry nutrient management plan. The attached forms may be useful tools when developing a plan. These forms are not required. [Bracketed references to individual forms are included, for guidance, within this outline.] Note: Completing the optional forms may satisfy some of the items listed below. However, use of the optional forms will not preclude the need to develop a plan narrative, as some items will require further explanation.

Consider organizing the plan around nutrient management units. *Nutrient management units are groups of fields or beds that are managed similarly. A single management unit may include a group of beds with similar soil conditions, production status (new plantings, plantings of similar age, fresh-fruit beds, non-producing beds, etc.), or other considerations, which allow the unit to be managed as a whole.*

A cranberry nutrient management plan should satisfy the requirements of the 590 standard by satisfying the following items, as well as the criteria outlined in Section I of this appendix:

I. Plan Narrative:

The purpose of the narrative is to provide an overview of the operation and describe the nutrient management strategies for the growing season, including descriptions of how the plan will be implemented and why the proposed strategies were selected. The narrative should provide an overview of the operation, identify the nutrient management units on the marsh, explain past practices and results, explain how current strategies have been developed or refined, and discuss potential factors that may cause deviation from the intended strategies.

The narrative should explain how the nutrient management plan will be implemented, with an explanation of how nutrient management decisions will be made.

A. Identify nutrient management units and include the following information:

[Management Unit Identification Worksheet]

1. Current production status.
2. A general description of the soil, including subsoil characteristics and soil characteristics within the rooting zone. Explain bed construction/renovation and management histories, including sanding practices. Focus on those characteristics and past activities that may influence nutrient management.

B. Summarize records of nutrient and soil amendment applications, tissue and soil fertility test results, and crop yields from previous years. If available, records from the most recent four years should be summarized in the narrative and either included with the plan or referenced if available in another format or easily accessible location. Include the following details per individual management unit:

[5-Year Nutrient Management Summary per Management Unit]

1. Applications of commercial fertilizers, organic byproducts (i.e. fish waste), and soil amendments (i.e. elemental sulfur), including the form, rate, and timing.

2. Plant tissue analysis results.

3. Soil fertility analysis results.

4. Historic crop yields.

C. Planned nutrient and soil amendment applications, including the rate, form, and timing. In addition, identify anticipated or expected yields per management unit. These should be based on historical production records, crop conditions, crop varieties grown, and grower experience.

[Planned Nutrient Management Practices worksheet]

[Fertilizer Decision-Making Checklist]

II. Aerial photographs and/or maps of the farm containing:

A. Boundaries, identification numbers, and acreage for all beds and nutrient management units. The Wisconsin DNR has a free, internet mapping program, which may be used to generate marsh maps based on aerial photography or topographic maps: http://maps.dnr.state.wi.us.

B. A soil map. NRCS has a free, internet mapping program, which may be used to generate soil maps: http://websoilsurvey.nrcs.usda.gov.

C. Locate and identify features that require additional protection. These may include groundwater risk areas (i.e. abandoned wells), surface water risk areas (i.e. water conveyance ditches, reservoirs, streams or lakes, wetlands, etc.), or other sensitive areas. Delineate boundaries for nutrient application restriction areas. Consider depicting routes of surface water flow, reservoirs, and key surface water control points (i.e. water control structures or bulkheads), which allow for the storage or recovery of discharges from beds. Include a legend of map symbols.

III. Documentation of nutrient management activities:

Document the following within-season activities per individual nutrient management unit:

A. Actual nutrient and soil amendment applications, including the rate, form, and timing.

[Actual Nutrient Management Practices worksheet]

B. Monitoring efforts (i.e. measurements of crop potential, upright growth, soil temperatures, precipitation, etc.) and observations (i.e. plant vigor and appearance, weather events and climatic conditions, etc.) made in support of nutrient management decisions. Nutrient management activities that are inconsistent with the plan narrative should be documented.

[Annual Nutrient Management Observation Checklist]

Cranberry Nutrient Management Optional Forms are included on the following pages

Marsh: _____ Plan Year:_____

NUTRIENT MANAGEMENT PLAN

Landowner:

Address:

Contact Person: _____ Title:_____

Telephone No.: _____ Email:_____

County: _____ Township:_____

Legal Description:

Nutrient Management Plan Acceptance

I/we have reviewed and do accept the attached plan. I/we agree to implement this plan, for the crop year identified in the plan. I/we agree that implementation of this plan shall be in accordance with the NRCS Conservation Practice Standard 590, Nutrient Management. I/we recognize that this is a management plan that should be reviewed and updated annually, with the help of a qualified technical specialist.

Signed: _____ Date: _____

Developed by: _____ Date: _____

Approved by: _____ Date: _____

Planner's/Review's Qualifications: _____

Marsh: _____ Plan Year:_____

Plan Narrative Supplemental Worksheet

Describe how fertilizers and soil amendments are applied:

_____

_____

_____

Discuss the weather/climatic considerations that go into deciding when/if to make a fertilizer application. [In which situations will applications be cancelled or rescheduled?]

_____

_____

_____

Discuss the monitoring and observations of plant vigor and appearance that go into deciding when/if to make a fertilizer or soil amendment application.

_____

_____

_____

Describe how and when fertilizer/soil amendment application equipment is calibrated:

_____

_____

_____

Are you planning to renovate beds this season? ☐ Yes ☐ No

If so – and if that process will include the removal and relocation of vegetation and/or soil materials – please explain how those materials will be utilized or disposed of:

_____

_____

_____

Marsh: _____ Plan Year:_____

Management Unit Identification Worksheet

Management Unit Name: Total Acres:

[Include one worksheet per management unit. Alternatively, attach "Exhibit A" or similar maps to your plan, with management units delineated, and describe the individual units in your plan narrative.]

Bed ID	Acres	*Variety	Production Status†	Year Planted	Bed ID	Acres	*Variety	Production Status†	Year Planted

*Use abbreviations such as *BL* for Ben Lear, *ST* for Stevens, *SE* for Searles, etc., as appropriate.

†Use words such as *fresh*, *process*, *out*, and *new* for fresh fruit, processed fruit, beds out of production, and new plantings.

Describe the soil conditions within the management unit (including history of, and plans for, sanding and bed renovations):

_____

_____

_____

_____

_____

_____

Marsh: _____ Plan Year:_____

5-Year Nutrient Management Summary per Management Unit

Management Unit: _____

Total Acres: _____

Recommendations		Units		Year x-4	Year x-3	Year x-2	Year x-1	This Yr. (x)	5-Year Averages
Yield		bbl/ac	MAX						
			AVG						
			MIN						
N Fertilizer Applications		lbs N/ac	MAX						
			AVG						
N Tissue Concentration	*1.10 to 0.90	%	MAX						
			AVG						
			MIN						
P Fertilizer Applications	≤45	lbs P2O5/ac	MAX						
			AVG						
	≤20	lbs P/ac	MAX						
			AVG						
P Tissue Concentration	0.20 to 0.10	%	MAX						
			AVG						
			MIN						
P Soil Test [DATCP-certified lab]	37 Optimum Range 26	ppm	MAX						
			AVG						
			MIN						
K Fertilizer Applications		lbs K2O/ac	MAX						
			AVG						
		lbs K/ac	MAX						
			AVG						
K Tissue Concentration	0.75 to 0.40	%	MAX						
			AVG						
			MIN						
K Soil Test [DATCP-certified lab]	120 Optimum Range 81	ppm	MAX						
			AVG						
			MIN						
Soil Acidity	≤6.0	pH	MAX						
			AVG						
			MIN						
Elemental S Applications	≤500	lbs/ac	MAX						
			AVG						

* Hybrid varieties, such as Stevens and Pilgrim, may benefit from tissue-N concentrations of up to 1.3%

Marsh: _____ Plan Year: _____

Planned Nutrient Management Practices

Management Unit: _____ Yield Goal (bbl/ac): _____

Average of Prior-Year Yields (bbl/ac): No. of Years Included in Avg. Yield (3-5 recommended):

Approximate Timing	Product (i.e. 9-20-19)	Rate (lbs/ac)	Nitrogen (lbs/ac)	P2O5 (lbs/ac)	K2O (lbs/ac)	Sulfur (lbs/ac)	Other____ (lbs/ac)	Other____ (lbs/ac)
	Totals (N-P2O5-K2O):							
	Totals (Actual N-P-K):							
Most recent Maximums, Averages, and Minimums for beds included within this management unit:	MAX Tissue (%):							
	AVG Tissue (%):							
	MIN Tissue (%):							
	MAX Soil (ppm):	OM%:				pH:		
	AVG Soil (ppm):	OM%:				pH:		
	MIN Soil (ppm):	OM%:				pH:		

Describe planned variations within this unit (i.e. sanded beds, new plantings, low-yielding beds, frost/pest damage, etc.):

_____

_____

If required, describe phosphorous fertilizer reduction strategy: _____

_____

_____

Describe soil/tissue testing strategy: _____

_____

_____

Page ___ of ___

Marsh: _____ Plan Year: _____

Actual Nutrient Management Practices

Management Unit: _____

Method of Application: A = Air, BG = Boom/granular; BL = Boom/liquid; S = Sprinkler

Date	Product (i.e. 9-20-19)	Rate (lbs/ac)	Beds Applied To	^ Method	N (lbs/ac)	P_2O_5 (lbs/ac)	K_2O (lbs/ac)	Sulfur (lbs/ac)	Other____ (lbs/ac)	Other____ (lbs/ac)
				Totals (N-P2O5-K2O):						
				Totals (Actual N-P-K):						

Notes & observations (including deviations from original plan):

_____

_____

_____

_____

_____

_____

Page ___ of ___

Marsh: _____ Plan Year: _____

Annual Nutrient Management Observation Checklist

Use one form per management unit per year.

Management Unit: _____ Plan Year: _____

	Date of Observation	Notes
Are you producing a crop this year?		
General condition of the management unit		
Vine stresses: Winter injury? Mechanical damage? *Phytophthora* root rot?		
Frost damage?		
Sanded? Pruned? Mowed? (When?)		
Insect infestations affecting yield?		
Date of 55 °F soil temperature		
Upright length (vegetative and flowering uprights)	June	
Runners present?		
Upright density		
Leaf color		Green Pale green Off color
Crop potential - flowers and density of flowering uprights		Excellent Good Fair Poor None
Additional observations		

Marsh: _____ Plan Year: _____

Fertilizer Decision-Making Checklist – N rate

Use one form per management unit per year. Recommendations are listed below each question.

Management Unit: _____Plan Year: _____

	Yes/No	Notes/Action Taken
Crop produced? (use less)		
Bog renovated? Soil test organic matter <1%? (use more)		
Rate adjusted for variety?		
Is subsoil peat? (use less)		
Is bog built on mineral soil? (use more in small increments)		
Is organic matter in soil test >3% (use less in spring)		
Was bog sanded this year? (use less in spring)		
Was bog pruned or mowed? (less if pruned, more if mowed)		
Was previous crop abnormal? (less if light, more if heavy)		
Was tissue test N abnormal? (less if >1.1%, more if <0.75%)		
Is upright length abnormal? (less if >4" or many runners, more if <2" above flowers)		
Is stand density adequate? (less if rank, more if thin)		
Is bloom adequate? Frost? (less if limited, more if heavy)		
Has insect or disease damage limited crop potential? (use less)		
Are vines yellowed? (check for other issues; use more)		
Base nitrogen fertilizer rate (list planned minimum or range)	lbs/ac	Notes:

Page ___ of ___

Marsh: _____ Plan Year: _____

Fertilizer Decision-Making Checklist – P Rate

Use one form per management unit per year.

Management Unit: _____ Plan Year:

	yes/no	Recommendation	Action/ rate used
Tissue test P >0.1%?		If yes - use N-P-K with 1:2 ratio; 20 lb/a P If no - go to next line	
Is tissue test <0.1%? Is soil test (Bray) >20 ppm?		If yes - use a foliar P pre-bloom (2-4 lb/a P) If no - go to next line	
Is tissue test <0.1%? Is soil test (Bray) <20 ppm?		If yes - use N-P-K with 1:3 or greater ratio	
Is soil test (Bray) >80 ppm?		If yes - avoid high P fertilizers, 1:1 ratio is recommended	

APPENDIX 3. GUIDELINES FOR ADAPTIVE NUTRIENT MANAGEMENT

The goal of adaptive management is to enable growers to use on-farm data to refine nutrient management strategies to adapt to conditions on their farm. Adaptive management in the context of this standard can be used to 1) document the need for and amount of rescue N applications after excessive rainfall; 2) adjust P and K application rates when documented crop yield levels are greater than ranges provided in UWEX Pub. A2809; or 3) refine any nutrient application rate (primarily N) or management strategy using on-farm research data.

G. Evaluating and documenting nitrogen loss from excessive rainfall

Section IV.A.1.i. of the standard allows for supplemental in-season N when N deficiency from excessive rainfall has been documented on each field. Evaluation and documentation of this field situation is not necessarily simple because of the complexity of estimating N loss, determining crop N deficiency, and assessing physiological damage to the crop from water logged soil conditions. Information which should be considered when estimating N loss from excessive rainfall includes: date, rate, and form of N application; amount of time elapsed between prior N application and excessive rainfall; rainfall amount; duration of rainfall event(s); soil water holding capacity; soil aeration/saturation; amount of time the soil was saturated; soil temperature; and appearance of the crop. A few methods that may be considered when evaluating and documenting the need for supplemental N include:

- Laboski, C. 2014. Potential for N loss following heavy rainfall. Wisconsin Crop Manager Newsletter. http://ipcm.wisc.edu/blog/2014/06/potential-for-nitrogen-loss-following-heavy-rainfalls-2/
- Schmitt, M.A., G.W. Randall, J.A. Lamb, & G.W. Rehm. 2005. The University of Minnesota Supplemental Fertilizer Nitrogen Worksheet. 43(3). http://www.joe.org/joe/2005june/tt4.php
- Soil nitrate tests have not been calibrated for this purpose. However, experienced agronomists may be able to use soil nitrate tests, especially if soil is sampled at 0-1' and 1-2', along with professional judgment to determine if supplemental N may be needed.
- Plant analysis (tissue testing) may also be used. Keep in mind that hybrids vary in what might be considered a sufficient N concentration and plant analysis is best used when samples are collected from both good and bad areas of a field to compare results.
- Chlorophyll meters (e.g. SPAD meters), crop canopy reflectance sensors (e.g. GreenSeeker, OptRx, etc.), or aerial images (regular photography and/or NDVI images) may be used to document N deficiency. Many of these technologies have not been calibrated for Wisconsin. Establishment of high N reference strips early in the growing season is helpful to compare greenness of the crop.
- Nitrogen management models (eg. Adapt-N, Climate Fieldview Pro, Encirca, N Index, etc.) may also be used. Use with caution: none of these models has been adequately, independently validated for use in Wisconsin.

At least one of the above methods must be used to document N loss from excessive rainfall. Two methods of evaluation and documentation are required if more than 46 lbs./acre is applied as a rescue N application.

H. Adjusting phosphorus and potassium application rates

For crops with documented yield levels (See section V.A.1.b of the standard) greater than or less than yield levels provided in A2809, P and K application rates may be adjusted by following the text in Chapter 7 of UWEX Pub. A2809 paying close attention to the section titled "Phosphorus and potassium application rate guidelines". If soil test levels are low or very low determine an appropriate build rate to be added to the rate at optimum by reviewing table 7.4 for the crop of concern. For example, for corn, soybean, wheat, and alfalfa, 30 lbs P_2O_5/acre is added to the rate at optimum soil test levels to arrive at the rate for low testing soils. For very low testing soils, 40 lbs P_2O_5/acre is added to the rate at optimum.

I. Refining nutrient management through on-farm research

On-farm research can be used to validate the need for nutrient application rates greater than those outlined in UWEX Pub. A2809 or management practices which may vary from this standard.

For a general background and details on conducting on-farm research see the following:

- Glewen, K., and J. Rees. 2013. Grower's Guide to On-Farm Research. University of Nebraska. http://viewer.zmags.com/publication/4efd82ad#/4efd82ad/14
- Lauer, J.G. 2013. On-Farm Testing. University of Wisconsin-Madison, Department of Agronomy. http://corn.agronomy.wisc.edu/Management/L016.aspx
- Nielsen, R.L. A Practical Guide to On-Farm Research. 2010. Purdue University, Department of Agronomy Corny News Network. https://www.agry.purdue.edu/ext/corn/news/timeless/onfarmresearch.pdf
- NRCS Agronomy Technical Note No. 6 Adaptive Nutrient Management, September 2011.

Specific experimental design, data analysis, data collection and documentation criteria required is provided below.

Experimental design

1. Follow the guidance in Lauer, 2013; Nielsen, 2010; or University of Nebraska, 2013 for laying out plots and accounting for field variability.
    a. Plots can be small plots or field strips.
2. When documenting that a different rate of nutrients is more appropriate for farm conditions, a field trial must contain the following:
    a. At least five (5) nutrient application rates including a zero rate where the nutrient of concern is not applied or is applied in starter fertilizer at rates not to exceed 20 lbs N/a, 10 lbs P2O5/a, or 10 lbs K2O/a.
        (1) The total amount of nutrient applied (starter + preplant + sidedress + late season + fertigation) is recorded as the nutrient application rate.
    b. Each treatment must be replicated at least three (3) times in the same field.
    c. Treatments should be randomly placed within each replicate.
    d. The study should be collected on at least one (1) field each year.
        (1) Field conditions should be similar for comparison purposes. This includes at a minimum tillage, previous crop, and fertilizer/manure application history.
    e. The study should be conducted a minimum of three (3) years.
3. When comparing two or more practices (e.g. source of N fertilizer) not including rate, NRCS Agronomy Technical Note No. 6 Adaptive Nutrient Management, September 2011 suggests five (5) replications at a minimum when two practices are compared and four (4) replications at a minimum when three (3) or more practices are compared.

Data analysis

Data must be statistically analyzed before conclusion can be drawn. When evaluating nutrient application rates, use the Crop Nutrient Response Tool (http://nane.ipni.net/article/NANE-3068) developed by the International Plant Nutrition Institute (IPNI) to calculate the economic optimum nutrient rate. For a comparison of practices, analysis on variance (ANOVA) with Fisher's least significant difference (LSD) is an appropriate statistical analysis. Excel can compute an ANOVA, but not a LSD. Alternatively AgStats (http://pnwsteep.wsu.edu/agstatsweb/) is an online tool that can be used.

Data collection and documentation

Data collected for each on-farm trial will vary based on the objective of the trial. This data can include some or all of the following:

1. Yield, moisture, test weight.
2. Routine soil test levels.
3. Pre-plant profile nitrate test (PPNT), pre-sidedress nitrate test (PSNT), soil nitrate testing at other times.
4. Plant analysis.
5. Manure analysis – required if manure is an objective of the trial.

For all trials document the following site criteria:

1. Year study was conducted.
2. Town and county.
3. Latitude and longitude of field.
4. Soil map unit(s) in the field.
5. Previous crop history for the past five years.
6. All nutrients applied for the past five years including source, rate, time, and placement.
7. Hybrid/variety, relative maturity, planting date, seeding rate, row spacing.
8. Tillage and time of tillage.
9. Percentage of surface residue coverage at planting.
10. Is the field tile drained?
11. Is the field irrigated? If so, N content of irrigation water and amount irrigated in season.
12. Weekly precipitation and general commentary about weather with regard to precipitation and temperature during the growing season.
13. Observations on weed, insect, and disease pressure.

Example on-farm trial protocol

An example of an on-farm N rate trial protocol and data collection spreadsheet can be found at http://www.npketc.info/?page_id=289.