MODULE #2 - SENSITIVE FEATURES

- **WHAT ARE THE RESOURCE CONCERNS?**
- **WHY DO WE DEVELOP NUTRIENT MANAGEMENT PLANS AND SENSITIVE FEATURE SETBACK MAPS?**
- **WHAT MAKES A FEATURE SENSITIVE FOR NUTRIENT MANAGEMENT?**

- **Estimated Reading Time: 15 Minutes**
- **Lance Smith – MN State Rangeland Management Specialist**

CRITERIA

Criteria for determining if a Feature is Sensitive for Nutrient Management.

Receiving Waterbody-Must have a waterbody (feature) to receive the pollutant.

- Surface Water
- Ground Water

Pollutant-Must have a nutrient available to act as a pollutant.

- Nitrogen
- Phosphorus
- Potassium

Delivery-Must be able to deliver the pollutant to the waterbody.

- Availability
- Detachment
- Transport (Factors)
    - Influence to Surface Water
    - Influence to Ground Water

Applicable to all land uses where these criteria are present.

RECEIVING WATERBODY

- Resource Concern-Impacts of Nutrients on *Surface* Water
- Impaired waters are those waters that no longer support one or more of the designated uses such as drinking, recreation, or fisheries.
- One of the most common impairments of surface waters is accelerated *eutrophication* (nutrient enrichment) caused by excess nutrient inputs, especially phosphorus and nitrogen.
- Eutrophication of waterbodies occurs naturally over time. Human activities in a watershed can lead to increased sediment and nutrient delivery to a waterbody greatly accelerating this process.

- Perhaps the most serious adverse impact of eutrophication results from the explosive growth of nuisance algae that commonly occurs. These algae can produce chemicals that are harmful to other organisms, including livestock and humans.
- In freshwater ecosystems, blooms of blue-green algae (now called cyanobacteria) are a common symptom of eutrophication. These blooms can contribute to a wide range of water quality related problems including: fish kills, foul odor, unpalatable tastes in drinking water, impaired recreational and aesthetic values, livestock kills and serious health risks to humans.
- Furthermore, when eutrophic waters are processed in water treatment facilities, the high organic load may react with chlorine to form carcinogens known as trihalomethanes.




- Resource Concern-Impacts of Nutrients on *Ground* Water
- Nutrients that leach to ground water have the potential to increase the nutrient concentration.
- Typically, elevated nitrate concentrations are of greatest concern because of the adverse impact to drinking water quality creating a serious health risk to humans.
- High levels of nitrate in drinking water can cause a potentially fatal blood disorder called blue baby syndrome (*methemoglobanemia*). This illness occurs in children less than 6 months old. Extreme cases can result in death.
- Increased cost to municipal water treatment facilities.

POLLUTANT

- There are many, out of place, items that may be considered pollutants. Plastics, Pesticides, Heavy Metals, Smells, Noise, Etc.
- For Nutrient Management Planning a pollutant will be defined as a "<u>*nutrient*</u> out of place".
- The same criteria, planning process and documentation is required for Pest Management Planning to address a "<u>*pesticide*</u> out of place".
- Nutrient Management Plans address this "<u>*nutrient*</u> out of place" concern. This presentation will focus on the 3 primary nutrients.

Nitrogen ***Phosphorus*** ***Potassium***

NITROGEN

- Nitrogen is usually the most limiting nutrient in crop production systems. Under favorable conditions, increases in nitrogen generally leads to higher nitrogen and protein content of the plant as well as greater crop yield.
- Nitrate nitrogen (NO3--N) is an important plant nutrient, but it is not essential for animal nutrition.
- Nitrate nitrogen is very mobile in the soil. Since it is negatively charged and thus does not bind to the negatively charged clay surfaces, it is subject to leaching.

- Leaching occurs when precipitation or irrigation supplies water in excess of soil storage capacity. Once the nitrate is transported below the root-zone there is no opportunity for plant uptake and less opportunity for chemical/biological transformation. Continued leaching can move the nitrate to the ground water.
- Public health drinking water standard (US EPA) for nitrate nitrogen is 10 mg/L (10 ppm).
- The critical nitrate nitrogen concentration in livestock drinking water supplies is 40 mg/L.
- High levels of nitrate in livestock feed can also lead to animal health problems. Concentrations greater than 40 mg/L in livestock drinking water supplies can lead to reduced feed consumption and reproductive problems.

- Certain conditions, such as drought and over application, can cause a buildup of nitrate levels in the soil, which can lead to uptake in excess of plant requirement.
- Forage plants accumulate nitrates at varying rates. Plant uptake of nitrate increases rapidly in high nitrate soils with the first rains following a long drought. High nitrate accumulations have been reported in sudan grass, sorghum-sudan, pearl millet, corn, wheat, and oats. Weeds, too, can accumulate nitrates. Examples of high nitrate accumulators are pigweed, smartweed, ragweed, lambsquarter, goldenrod, nightshade, bindweed, canada thistle, and nettle.

PHOSPHORUS

- Phosphorus is an essential nutrient for plant growth. Plants take up phosphorus in the orthophosphate forms ($H_2PO_4^-$ and HPO_4^{-2}).
- Although the total amount of phosphorus in the soil is large, the quantity of plant-available phosphorus in the soil solution as orthophosphate is small.
- The major loss of phosphorus from land surfaces is through the process of surface runoff and erosion. Most of the phosphorus is lost in only one or two storms or runoff events.

- Approximately 90 percent of phosphorus load are carried in the sediment. Generally, phosphorus lost in runoff amounts to less than 5 percent of that applied to agricultural land. From a crop production standpoint, this amount is considered to be insignificant, however, even this seemingly small amount can lead to degradation in water quality due to eutrophication. Phosphorus applied to the surface, either as manure or commercial fertilizer, is subject to loss/transport in runoff. Soluble phosphorus, though only 10 percent of the total runoff P from cropland, is highly bioavailable and can contribute significantly to eutrophication even at the low levels.
- In soils that are not tilled, such as hay land, pastureland and no-tillage, the ratio of sediment-bound P to soluble P is reversed. In these soils 90 percent of the total runoff P is in the soluble form.
- Cattle and other ruminants convert plants and grains phosphorus into dietary phosphorus that are important in their metabolism.

- Monogastric animals (non-ruminants) like poultry and swine have a more difficult time breaking down the phosphorus contained in the plant material for dietary purposes, therefore both poultry manure and swine manure have a high concentration of P.
- Phosphorus is tied up as phytic acid, which is almost impossible for poultry and swine to metabolize. Addition of the enzyme phytase to the feed helps in the conversion of phytate to dietary P. Sufficient supplements of dietary P are added to the feed to ensure a balance diet. Much of this dietary and plant P is passed through the digestion system.
- Manure is a significant source of phosphorus regardless of the animal source, and if mismanaged can create water quality and other resource problems.

POTASSIUM

- Potassium is utilized in relative large quantities by plants.
- Potassium plays an important role in plant hardiness and disease tolerance.
- The effects of high potassium levels in soil and long-term sustainability are poorly understood. Recent research suggest that excessive levels of soil potassium may have a negative effect on sustainability. However, little data is available and critical levels have not been established.
- There are no known deleterious effects of potassium in fresh or saline waters except to increase the salt content and electric conductivity.

- The potassium ion (K+) regulates the water status in plants. It also works in the ion transport system across cell membranes and activates many plant enzymes. Potassium is a cation (K+) that is held on the soil cation exchange sites.
- Excess potassium in the soil can lead to conditions of grass tetany in livestock.
- Grass tetany is a serious disorder, that can cause death in lactating ruminant animals, caused by low magnesium content in forage, especially grasses.
- When high levels of potassium are present in the soil solution, plants will take up the potassium at the expense of magnesium, leading to luxury consumption of potassium and an imbalance of potassium and magnesium in the plant. Lactating ruminants that eat this forage do not get enough magnesium in their diet.

- The concern comes from using high rates of manure and other organic material on forages. This situation is more common when forages receive organic material high in nitrogen and potassium early in the growing season.
- Although legumes are better balanced with magnesium, pastures with a mixture of grasses and legumes may still have problems early in the season when legumes are typically growing much slower than grasses.
- Early season application of organic material to forages should be avoided until the slower-growing legume has an opportunity to flourish. Grazing can be delayed until the legumes provide a good balance in the pasture with the grasses.
- High magnesium supplements can be provided to livestock in the spring to combat this imbalance.

DELIVERY

- The impact of nutrients on water quality is ultimately dependent on pollutant delivery.
- These are the 3 required components to complete the delivery process.
- ***Availability*** is the presence of a nutrient in quantities and forms capable of being moved off-site.
- ***Detachment*** is the mobilization of nutrients allowing them to become available for transport.
  - Examples of detachment are wind blown suspended particles, nutrients dissolving in water or soil particles detached by raindrop impact.
- ***Transport*** is the physical movement of a nutrient or nutrient source (i.e. animal waste) from one place to another.

Availability

Detachment

Transport

Transport (Factors)

- Factors that influence transport of nutrients to *surface* water:
  - Distance to waterbody
  - Slope
  - Direction of flow
  - Surface roughness
  - Surface cover
  - Soil texture
  - Soil permeability

- Factors that influence transport of nutrients to *ground* water:
  - Soil organic matter
  - Soil texture
  - Soil permeability
  - Subsurface geology
  - Depth to water

WHAT MAKES A FEATURE SENSITIVE FOR NUTRIENT MANAGEMENT?

- Based on the information in the previous slides, the answer to the question above is: A combination of factors.
- We must first determine if any of the Criteria are present and what their relationship is to each other.
- **Receiving Waterbody**-There is almost always a receiving waterbody or feature. The distance from the site or relationship to the site needs to be measured to determine if the feature is relevant to the site.
    - Open tile intakes located in the crop field would be relevant feature for surface water, but the river that is 1/2 mile away may not be a relevant feature.
    - Coarse textured soils may determine that the entire field is a relevant sensitive feature for ground water.

- **Pollutant**-Are Nutrients being applied to the land? Are the Nutrients being applied in excess of crop needs? What is the form of the nutrient, commercial fertilizer or manure? These are questions we need to know to determine if nutrients are present in a quantity and form capable of being moved off-site.
  - A drainage ditch adjacent to a crop field is a sensitive feature, but, if commercial fertilizer is being applied at rates equal to or less than crop needs the feature would not require a setback distance to be mapped.
  - The same feature with cattle manure being applied, with a spreader, requires a 25’ buffer of no manure application and incorporation of manure (<24 Hours) from 25’ to 300’. Manure application rate not exceeding crop needs. These two buffers need to be applied to the map feature because of the form of nutrient being utilized. The feature is now sensitive to nutrient management.

- **Delivery**-We have covered the *availability* of nutrients under pollutants. We now need to look at the site conditions that influence *detachment* and *transport* of nutrients to a feature.
    - An open tile intake in a crop field with manure application will be a sensitive feature for nutrient management because the tile line is a direct conveyance to a waterbody.
    - Coarse textured soils with a high water table will be a sensitive feature for ground water. The correct application of nutrients for these soils is what minimizes the potential for ground water contamination.
    - A stream adjacent to a highly erodible field, due to slope, would mean the stream would be a sensitive feature. The slope of the field cannot be changed but a suite of conservation practices could be used to minimize the potential for soil erosion and subsequent nutrient transport to the stream.

WHAT CAN CONSERVATION PRACTICES INFLUENCE?

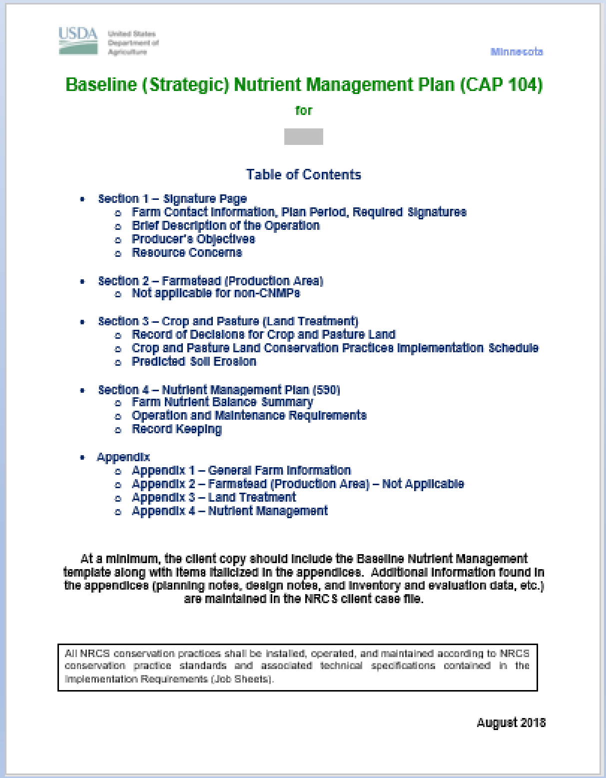
Control of most pollutants can be assessed in terms of the capability to impact one or more of the pollutant delivery processes.

Conservation Practices act on one or more of these pollutant delivery processes to prevent nutrients from moving off-site and causing adverse environmental impacts.

- ***Availability***: Nutrient Management limits the amount of nutrients applied based on crop needs, thus reducing nutrient *availability*.
- ***Detachment***: Vegetative and Management erosion control practices minimize *detachment* of soil particles and subsequent sedimentation.
- ***Transport***: A Filter Strip intercepts *transport* of sediments and nutrients to a surface waterbody.

Conservation Practices that Decrease Availability

Nutrient Management Plan



USDA United States Department of Agriculture

Minnesota

Baseline (Strategic) Nutrient Management Plan (CAP 104)

for

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At a minimum, the client copy should include the Baseline Nutrient Management template along with items italicized in the appendices. Additional information found in the appendices (planning notes, design notes, and inventory and evaluation data, etc.) are maintained in the NRCS client case file.

All NRCS conservation practices shall be installed, operated, and maintained according to NRCS conservation practice standards and associated technical specifications contained in the Implementation Requirements (Job Sheets).

August 2018

4.14 Sensitive Features & Manure Application Setback Map

Conservation Practices that Decrease Detachment

528-Prescribed Grazing

340-Cover Crop

Conservation Practices that Decrease Transport

412-Grassed Waterway

393-Filter Strip