Overview of the Nitrogen Fertilizer Management Plan

The intent of the Nitrogen Fertilizer Management Plan is to prevent, evaluate and mitigate nonpoint source pollution from nitrogen fertilizer in groundwater. The Plan must include components promoting prevention and developing appropriate responses to the detection of nitrogen fertilizer in groundwater. The strategies in the NFMP are based on voluntary BMPs, intended to engage local communities in protecting groundwater from nitrate contamination.

Best Management Practices (BMPs) for nitrogen fertilizer are tools to manage nitrogen efficiently, profitably and with a minimum practicable environmental loss. The BMPs are built on a four part foundation that takes into account the nitrogen rate, application timing, source of nitrogen, and placement of the application. If one of the above is not followed, the effectiveness of the system will be compromised, and there will be agronomic and or environmental consequences. Minnesota has officially recognized state-wide and regional nitrogen fertilizer BMPs.

The general approach to addressing nitrate in groundwater in Minnesota is to: 1) promote nitrogen fertilizer BMPs to protect groundwater with greater efforts in vulnerable areas to prevent groundwater problems from occurring (ongoing); 2) monitor private wells on a township scale over a 10 year period or use existing monitoring data to identify areas with nitrate concerns; 3) conduct a detailed assessment of water quality in these areas to determine the severity and priority of the problem; and, 4) conduct mitigation actions in high priority areas using a phased approach starting with voluntary actions and progressing to regulatory actions if necessary.

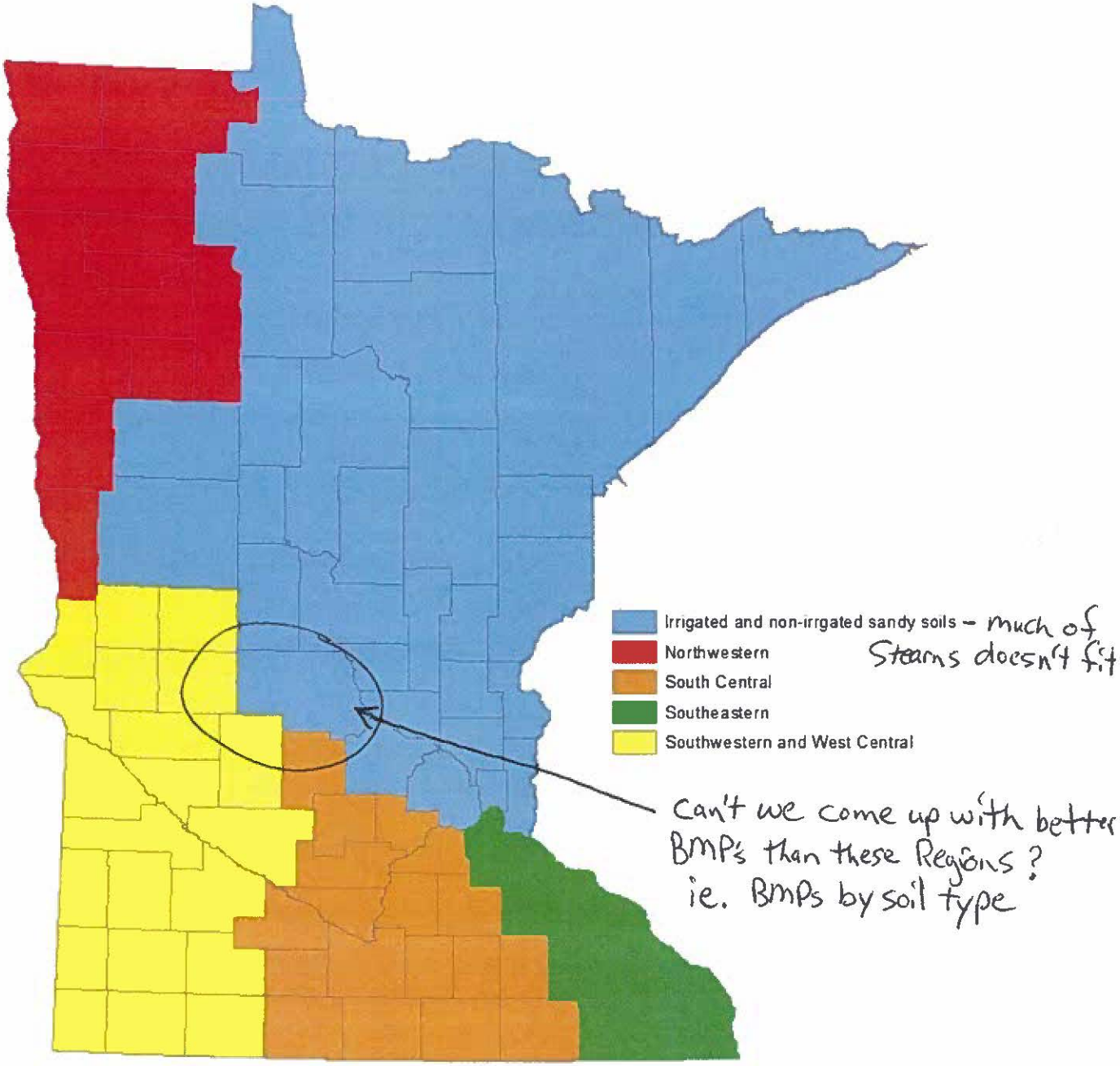
The key to success is to engage target groups who are involved in crop production and the use of nitrogen fertilizers. In addition to farmers, target groups of specific interest are the Certified Crop Advisors (CCAs), fertilizer retailers, professional crop advisors and their organizations that provide information on planning and guidance to farmers and producers. Activities outlined in this plan are targeted to areas of the state that are most vulnerable or sensitive to groundwater contamination.

The susceptibility of a particular site or region to groundwater contamination is referred to as the "sensitivity" of the region. Several environmental factors determine the sensitivity of an area including the physical and chemical properties of the soil and geologic materials, and climatic effects.

MDA will conduct private drinking water well sampling in vulnerable areas with significant row crop agriculture, generally using the township as the primary geographic boundary in order to evaluate current nitrate conditions. These efforts will be conducted on a cooperative basis with the assistance of local government units and other agencies that can provide field support for the area. Based on the results of one round of sampling, MDA will determine the appropriate mitigation response. Enhanced monitoring on the township scale is a key component of the revised NFMP.

seems like a limited timeframe to develop a mitigation response. Will other data help support this decision?

Figure 15. Minnesota Nitrogen BMP Regions



Minnesota N rate BMPs for corn are based on a grouped economic approach that determines N rates by applying economics to large sets of N response data. This is due to the fact that there is a very weak relationship between economic optimum N rate (EONR) and corn yield in the North-Central region of the United States. Prior to 2006, N rates were based on yield goal, but a group of researchers in the North-Central region showed that the relationship between the price of N fertilizer and the price of corn was

actually a better predictor of the EONR than yield goals. The concepts and rationale for this approach to N recommendation development can be found on the Iowa State Extension website. Nitrogen BMPs that pertain to timing, placement and source of N fertilizer are addressed in each specific regional BMP and, are supported by empirical agronomic research data from that area of Minnesota.

Table 1. N Timing and Source Recommendations for Corn by Region

	Minnesota Recommended Application Timing for Corn		
BMP Region	Fall*	Spring Preplant	Split or Sidedress
Southeast	Not Recommended	Highly Recommended: AA or Urea Acceptable with Risks: Preplant with UAN or ESN	Highly Recommended: AA, Urea, or UAN
Stearns South Central	Acceptable with Risks: AA or Urea with N-Serve Not Recommended: Fall Application of Urea or UAN	Highly Recommended: AA or Urea Acceptable with Risks: Preplant with UAN or ESN	Highly Recommended: Split Applications of AA, Urea, or UAN
Stearns Coarse-Textured Soils	Not Recommended	Acceptable with Risk: AA or Urea with N-Serve, Single Sidedress w/o N-Serve, or Single Preplant with ESN	Highly Recommended: Use Split Applications, N-Serve with early Sidedress
Southwest/West Central	Recommended: Fall Application of AA or Urea Acceptable with Risk: Fall ESN or N-Serve with Agrotain ? Not Recommended: Fall UAN	Recommended: Urea, AA, or UAN	Recommended: Sidedress Prior to V7 Growth Stage
Northwest	Recommended: Fall Application of AA or Urea Acceptable with Risk: Fall ESN or N-Serve with Agrotain Not Recommended: Fall UAN	Recommended: Urea, AA, or UAN	Recommended: Sidedress Prior to V7 Growth Stage

Agrotain protects N sources from volitization. No groundwater benefit.

*Only after six inch soil temperatures fall below 50 °F

Note: AA=Anhydrous Ammonia, ESN=Environmentally Smart Nitrogen, UAN=Urea Ammonium Nitrate Solution

In Table 1 we can see how the sources and timing interact across the state. Practices that may work well in southwestern Minnesota may not be appropriate for southeastern Minnesota. BMP N rate recommendations for N rate do not change across regions except for in the coarse-textured sands. Incorporation of N fertilizer by tillage, irrigation, or rainfall is always a recommended BMP.

Each BMP area of Minnesota has specific risks, BMPs, acceptable practices, and practices that are not recommended. In addition to the practices listed above, a short summary of each region is listed below:

BMP REGION: NORTHWESTERN MINNESOTA

Physical Features and Cropping Systems: This region of the state is characterized by soils that have a medium to fine texture which were formed from loess, glacial till, or lacustrine deposits. The large majority of the soils have moderate to poor internal drainage and tile has been installed to improve production. Because of the flatness of the region, water often has to be pumped from the field and flooding is also common in areas within this region. This region also has a shorter growing season than other regions in Minnesota. Average annual precipitation in the region is often below 25 inches in many areas. Wheat is the dominant crop although corn, soybean and potatoes are also grown in the region. Corn and sugar beets grown in NW Minnesota should use the N BMPs for Southwest and West-Central MN.

Groundwater Concerns and Localized Problematic Areas: Due to the medium to fine textured soils found in this region coupled with lower annual precipitation, groundwater resources are generally adequately protected. There are very limited documented areas of nitrate contaminated hotspots in this region. Areas of concerns would the coarse-textured soils found along the beach ridges of the Red River Valley. Contaminated wells due to spring flooding are a significant problem.

Recommended BMPs for small grain production in NW Minnesota include an initial N rate based on expected yield, adjust N rate according to fall 2 foot deep soil nitrate test results and legume credits, accounting for N in ammoniated phosphorus fertilizers, incorporating or banding any fall applied urea, apply AA or urea after soil temperatures are below 50° F, incorporating N fertilizer, and taking credit for N contained in previous sugar beet crop tops.

Practices that are acceptable with a higher degree of risk are applying up to 40 lbs of liquid N to foliage at boot stage or later and banding urea with or near the seed at planting.

Practices that are not recommended include fall applications of any N fertilizers containing nitrate, not incorporating spring or fall applied urea (high soil pH exacerbates urea N loss to volatilization), shallow applications of AA, foliar applications of greater than 40 lb N at boot stage or later, applying ammoniated phosphorus or any N fertilizers to frozen ground (due to risk of runoff), and fall applications of N (regardless of source) to sandy soils.

BMP REGION: COARSE-TEXTURED SOILS IN MINNESOTA – to general to fit Stearns into this region

Physical Features and Cropping Systems: Sandy soils dominate the landscape in the central and east-central regions of the state. These coarse-textured soils are also scattered throughout the remainder of the state. Groundwater is often located 30 feet or less below many of these sandy soils. Average annual precipitation in the region is often below 25 inches in western area while in the eastern areas 30 inches or more is common. Corn, soybean, edible beans, wheat, potatoes and some vegetables are grown in the region. Irrigation is common on the sandy soils in this region. BMPs for the coarse-textured soils in Minnesota are aimed specifically at irrigated and dry land corn and edible beans. Nitrogen rate recommendations take into account the productivity of the soil, which in most cases is a function of

Nitrogen rates are also a major concern and component of good N management, and are probably the first part that comes to mind for most producers when N management is discussed. Table 3 presents the range of N rate recommendations for corn, and the average N rates for a region. For corn following corn acres, the N rates fell squarely within the range of acceptable N rates. The N rates that were used for corn following soybeans tended to be toward the higher end of the range, and for South Central Minnesota rates were actually outside of the acceptable range. This is partly due to the largest percentage of N rates in the South Central region being from 140-154 lb/acre.

Table 3. Minnesota N BMPs and Mean N Rates from 2010 N Use on Corn Survey

	Acceptable Range of N Rates for N Fertilizer on Corn (Lb/Acre)		Mean N Rate Reported by Minnesota Corn Farmer (Lb/Acre)	
BMP Region	Corn Following Corn	Corn Following Soybeans	Corn Following Corn	Corn Following Soybeans
Southeast	100-180	70-140	143	138
South Central	100-180	70-140	160	145
Irrigated Coarse-Textured Soils	100-180	70-140	146	151
Coarse-Textured Soils	100-180	70-140	128	137
Southwest/West Central	100-180	70-140	145	138
Northwest	100-180	70-140	NA	126

Interview: The ability for state agencies and Extension to document producer adoption rates of voluntary BMPs is a critical component of the 1989 Minnesota Groundwater Protection Act. MDA has developed a diagnostic tool called FArm Nutrient Management Assessment Process (FANMAP) to get a clear understanding of existing farm practices regarding agricultural inputs such as fertilizers, manures and pesticides. Although it is labor intensive, it provides a useful and accurate method of compiling data on BMP adoption.

a tool to use for other projects

Results have been used to design focused water quality educational programs. Data collected in the program's infancy can be used as a baseline to assist in determining if voluntary BMPs are being adopted. Over the years, hundreds of farmers have volunteered two to four hours of their time to share information

about their farming operations. The complete compendium of FANMAP surveys is available at the MDA website.

FUTURE BMPS AND REFINEMENT OF EXISTING BMPS

As science and technology rapidly evolve, agriculture has often been on the cutting edge with continual changes in practices. Therefore it is important that the recommended BMPs also stay current with evolving agricultural technology and actual changes in practices on the farm. Some current examples of agricultural practices or new technology that need revision or development of formal state BMPs include the following.

- Optical reflectance of crop canopy to evaluate in-season N stress from active sensors and remote sensing is widely viewed in the academic world as the next frontier in N management. The current challenge is to demonstrate that these tools can do a better job of quantifying N stress and addressing variability than our current N rate BMPs due to spatial and temporal variability. MDA has currently proposed using Clean Water Fund research dollars to evaluate the efficacy of these tools.
- Research is currently being conducted to update the BMP recommendations for corn grown on irrigated sands, and is expected to be completed in 2015. An outcome of this study will also be emphasizing the role that irrigation water management will play in reducing the impact of N fertilizer on groundwater in irrigated sands.
- It is also acknowledged that in some irrigated, coarse-textured areas of Minnesota nitrogen BMPs alone may not be enough to reverse the effects of groundwater contaminated by nitrate. Resources may be allocated to evaluate the feasibility of transitioning to alternative cropping systems that have lower N inputs, greater water use efficiency, and or the ability to assimilate N more efficiently.

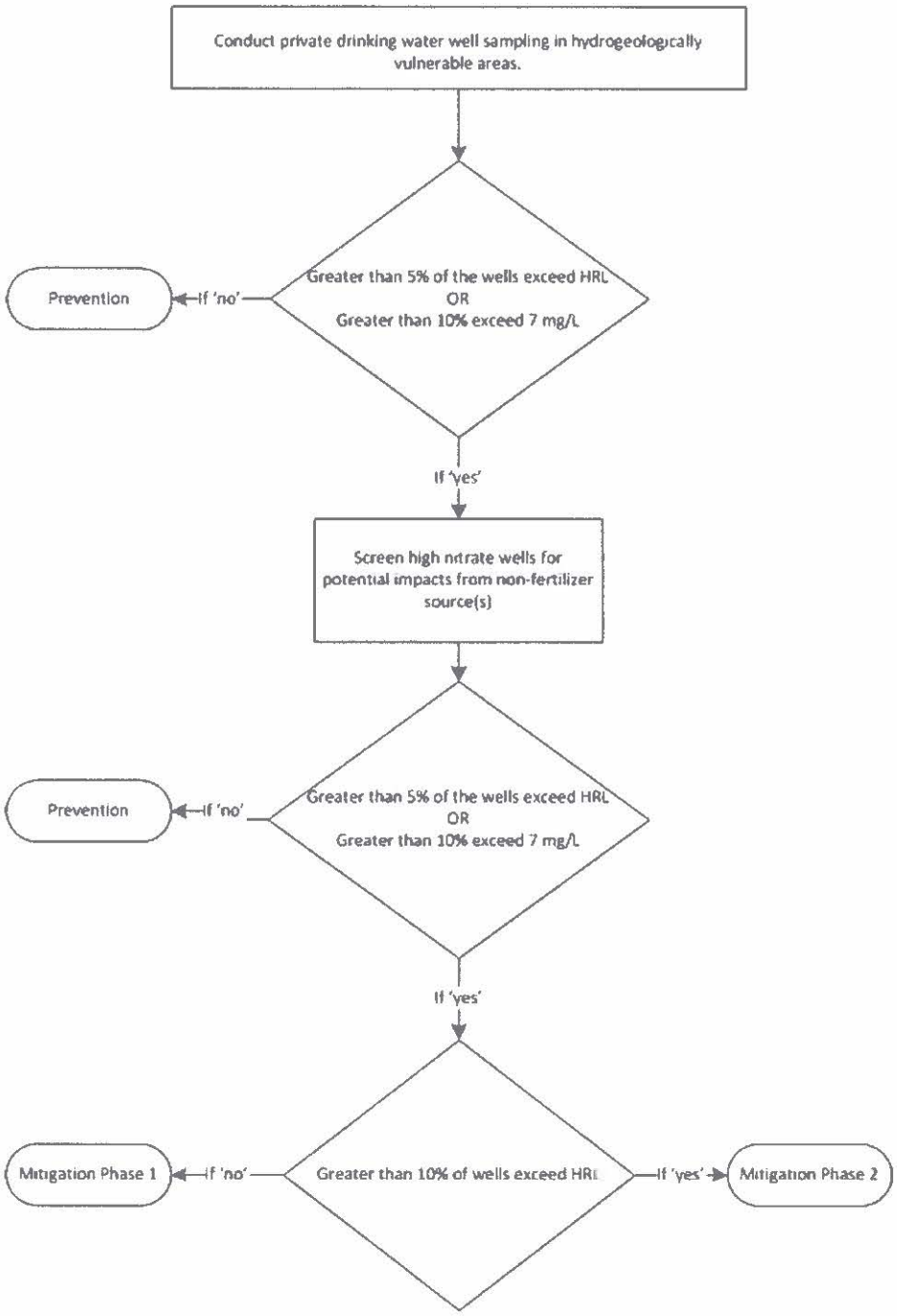
Not sure where to address, but most leaching occurs during spring rain events before crops are planted. How will this plan account for weather variability?

TECHNICAL ADVISORY COMMITTEE FOR BMP DEVELOPMENT

One of outcomes of the NFMP revision will be the development of a technical advisory team that will serve several functions. The first role will be in assisting local advisory groups in establishing prioritized BMPs, based on the best available science and reasonable considerations for local conditions and cropping systems, for nitrate impacted areas. Prioritization of site specific BMPs will play an important role in making sure that targeted and impacted groundwater areas respond positively, both environmentally and agronomically. This committee will also assist MDA in prioritizing the development and revision of BMPs that relate to the use of N fertilizer.

Assessment Process. Prevention activities commensurate with the hydrogeologic sensitivity of the area and should continue regardless of any mitigation effort.

Figure 19. NFMP Preliminary Assessment Process



← will mitigation be at the twp level?

CHAPTER 9: MITIGATION

MITIGATION GOAL, STRATEGY AND IMPLEMENTATION

MITIGATION GOAL

The goal of mitigation is to minimize the source of pollution to the greatest extent practicable and, at a minimum, to reduce nitrate contamination to below the HRL so the groundwater is not restricted for human consumption.

MITIGATION STRATEGY

The mitigation strategy is based on the prevention strategy, but implemented over a defined area and at a higher level of effort and intensity. Mitigation will be accomplished by: 1) intensifying and targeting education and outreach (preventative) efforts; 2) refining existing BMPs; developing incentives or regulatory options; 3) considering the cost versus benefit and technical feasibility of mitigation measures; and, if necessary, 4) exercising regulatory authority by the adoption of water resource protection requirements.

PRIORITIZING MITIGATION EFFORTS

Mitigation activities require significant staff resources to implement and MDA will need to prioritize its work load. Protecting groundwater from exceeding the Health Risk Limit (HRL) is identified as a high priority in the Groundwater Protection Act, therefore MDA will prioritize its mitigation efforts, including decision making for potential regulatory actions, based on a phased approach with the highest priority generally allocated to those areas with the highest concentrations in wells relative to the HRL and with the greatest numbers of wells exceeding the HRL. In addition, a higher priority will be given to areas where local government units and the local agricultural community demonstrate a willingness and capacity to participate and provide support, as well as the estimated likelihood that successful implementation of mitigation activities will cause the groundwater nitrate concentrations to decrease in a reasonable amount of time based on the characteristics of the site. MDA will place an especially high priority on responses in Source Water Protection Areas, in consultation with the MDH.

← highest pri should be bas on the resoure not volunta participat especially under mitig

MITIGATION IMPLEMENTATION

Phase Determination Criteria

The determination of the phase level is primarily based on groundwater nitrate concentrations and adoption of BMPs. It is important to recognize that there is significant variability in nitrate concentrations over time and distance as a result of the complexity and uniqueness of each site. Therefore, concentration and adoption data should not be used as the only evidence in making a phase determination. Additional

secondary information such as trend data and other local factors should be considered, which must be used by local decision makers and MDA staff with appropriate caution and good judgment. It is envisioned that decision makers can and should deviate from this guidance if deemed appropriate based on site specific conditions and circumstances.

The NFMP mitigation mode is comprised of four implementation phases (Table 9). The phases represent an escalating level of implementation effort. The phases under the voluntary mitigation mode include Phase 1 and Phase 2.

- Phase 1 is considered when 5% of the wells have nitrate levels greater than the HRL or 10% or more of the wells have groundwater concentrations greater than 7 mg/L.
- Phase 2 is considered when 10% of the wells have nitrate levels greater than the HRL and, the BMPs are being adopted or the response effort is initially promoting BMP adoption.

Is there a time frame for voluntary compliance? How long until regulation is the driver?

The mitigation activities become regulated in Phases 3 and 4 via rule writing. Before going to regulation, mitigation activities must first be introduced in the voluntary mode, in order to provide farmers the opportunity to implement them.

- Phase 3 is considered when 10% of the wells have nitrate levels greater than the HRL and BMPs are not being adopted.
- Phase 4 is considered when 15% or more of the wells have nitrate levels greater than the HRL and BMPs are not being adopted.

Table 9. Mitigation Phases and Criteria

Groundwater Nitrate Concentration Criteria	5% wells >HRL OR 10% wells >7mg/L	10% wells > HRL	10% wells > HRL	15% wells > HRL
BMP Adoption Criteria	None	BMPs Adopted	BMPs not Adopted	
Mitigation Type	Voluntary		Regulatory	
Phase	1	2	3	4

NOTE: The Health Risk Limit for nitrate-nitrogen in Minnesota currently is 10 mg/L.

Phase Transitions

The Groundwater Protection Act directs that a voluntary approach be implemented before considering a regulatory approach. Therefore sites which are newly entering into mitigation will begin in a voluntary mode, either Phase 1 or Phase 2. The Phase may change upwards or downwards after a period of not less than one crop rotation, which is typically three years, to allow for the adoption of BMPs, plus sufficient time to account for the lag between adoption of BMPs and improvements in water quality.

Lag time can vary tremendously from less than a year to decades depending upon a number of factors including: soils types; depth to groundwater; field practices such as tillage and their effects on leaching; and the volume, intensity and timing of precipitation. In dry years there may be virtually no nitrate leaching to groundwater while heavy precipitation after several dry years could result in a large quantity of nitrate leaching past the root zone that is completely beyond the ability of any farmer to control. The lag time should be based on a technical assessment of water travel times from the land surface to the water table using modeling, soil sampling, age dating of groundwater or other suitable methods. The estimate of lag time should be based on the best available data, with consideration provided for the actual local weather history. Nitrate leaching models may be helpful in this regard.

What tools are available other than tracking Tritium for dating? Is that realistic for this program?

MDA recognizes that there is a need to understand the relationship between land-use practices and changes in groundwater nitrate levels and to develop tools to provide useful information about the lag time between practice implementation and water quality outcomes. Therefore, MDA will utilize or develop tools such as models that can provide the information to show the link between the consequences of implementing BMPs and their effect on water quality.

MDA should help advance NTT for this purpo

Regulated Mitigation

If a regulatory option is deemed necessary, then MDA will write Water Resources Protection Requirements (WRPRs) in consideration of local advisory team recommendations. WRPRs are discussed in more detail later in this chapter.

It is intended that Phase 3 of regulation not be as burdensome as Phase 4 regulation and in particular that it continue to allow farmers significant freedom to control their agronomic practices. However Phase 3 regulations are intended to send a clear message that groundwater contamination is a significant concern in the area; it is critical to actively work with crop advisors and the local advisory team to help develop and implement reasonable and effective methods for addressing these water quality concerns. The goal of Phase 3 regulation is to ensure the widespread adoption of the BMPs and, to the extent possible, to involve stakeholders in identifying solutions that will be effective in addressing the problem. Effective solutions will include the widespread adoption of BMPs, however some cases they may require actions significantly in excess of adopting the BMPs. Therefore it is important that Phase 3 regulations be moderate and that a reasonable time be provided for implementing changes and observing improvements in water quality before proceeding to Phase 4, if required. Phase 3 regulations may also be used to prevent inappropriate practices for the area.

Mitigation Process

Based on experience developed over the last twenty years, MDA has developed an approach for responding to local areas with elevated nitrate. The mitigation process generally consists of the following activities listed in order of implementation and can generally be applied in Phases 1-4.

* How can MDA definitively state nitrate is a result of Ag activities? MDH can't say w/ certainty that Ag is the source of nitrate in the Cold Spring DWSMA. Should MDA move forward w/ regulation who, if anyone, is responsible for negating other nitrate sources in the recharge area?

1. Confirm there is a problem and understand the extent and scope of the problem by reviewing monitoring data (previously discussed in the Monitoring and Assessment Chapter).

   The primary scale for the preliminary assessment activities will be the township scale, although MDA will consider the use of existing program activities, such as wellhead protection areas or source water protection areas as defined by the MDH. MDA may consider combining geographic areas such as townships for the purpose of developing a mitigation response.

Confirm well construction information, to the extent possible, for the purpose of evaluating minimum well construction and source separation criteria to assure that nitrate in the well are likely from a nitrogen fertilizer and agricultural non-point source (see Appendix H: MDA Private Well Sampling Analysis and Source Confirmation Guidance for details). Make site visits if necessary and if resources are available.

2. Consult with other agencies and local government unit(s) (county, soil and water conservation district, water management organization, Rural Water Authority, etc.) on their understanding of the problem, especially the use of hydrogeologic sensitivity and groundwater flow maps to understand potential source areas for targeted implementation of practices.

   Notify DNR, MDH, MGS and other groundwater-related agencies about the project. Request available technical data related to land use, hydrogeologic sensitivity, groundwater flow, etc. to determine scope and extent of the problem area and potential source areas.

   Consult with other agencies on groundwater capture zones and travel times. Conduct age dating of aquifer or other similar tests if they are relevant and available. Reevaluate the boundaries of the area of concern if necessary,

   A work plan may be developed to define expectations, tasks, responsibilities, timelines, funding needs, etc. in the process. Examples of work plans will be provided to local government units. Are LGU's expected to carry out the work plan?

3. Form local Advisory Team (Advisory Team) made up of representatives from the agricultural community (farmers, agronomists, cooperatives), representatives from local government (county, SWCD, etc.) state and federal agencies (this will vary depending upon the site) and other local interested parties. Local farmers and their crop advisors should be recruited to the greatest extent possible and are critical members for the success of the team.

   The state agency Advisory Team members must clearly articulate what the problem is and why it is a problem. The farmer Advisory Team members could exchange information about local water resource issues, their consequences, and agricultural BMPs and/or AMTs (see #8) as a solution. The Advisory Team will have the primary responsibility for recommending potential implementation strategies to MDA and should support promoting and implementing the selected activities.

   There are two options for leadership in Phases 1 and 2. One option is for MDA to administer and lead the process. The other option is for a local entity (county, SWCD, watershed management

APPENDIX A: MDA LESSONS LEARNED IN RESPONDING TO ELEVATED NITRATES IN GROUNDWATER

MDA has been working on responding to areas with elevated nitrates in groundwater for over 20 years. Most activities have been focused on responding to public water supply issues. However, our staff resources have always been severely limited, generally only a few staff to address the issue statewide. Therefore we focused our efforts on developing a process for responding to locally high nitrates, primarily through working with the MDH in source water protection areas with nitrate problems. Based on this experience, we have developed a general approach to addressing nitrate problems and have also learned a number of lessons regarding these efforts. This approach and some of the lessons learned are briefly discussed below:

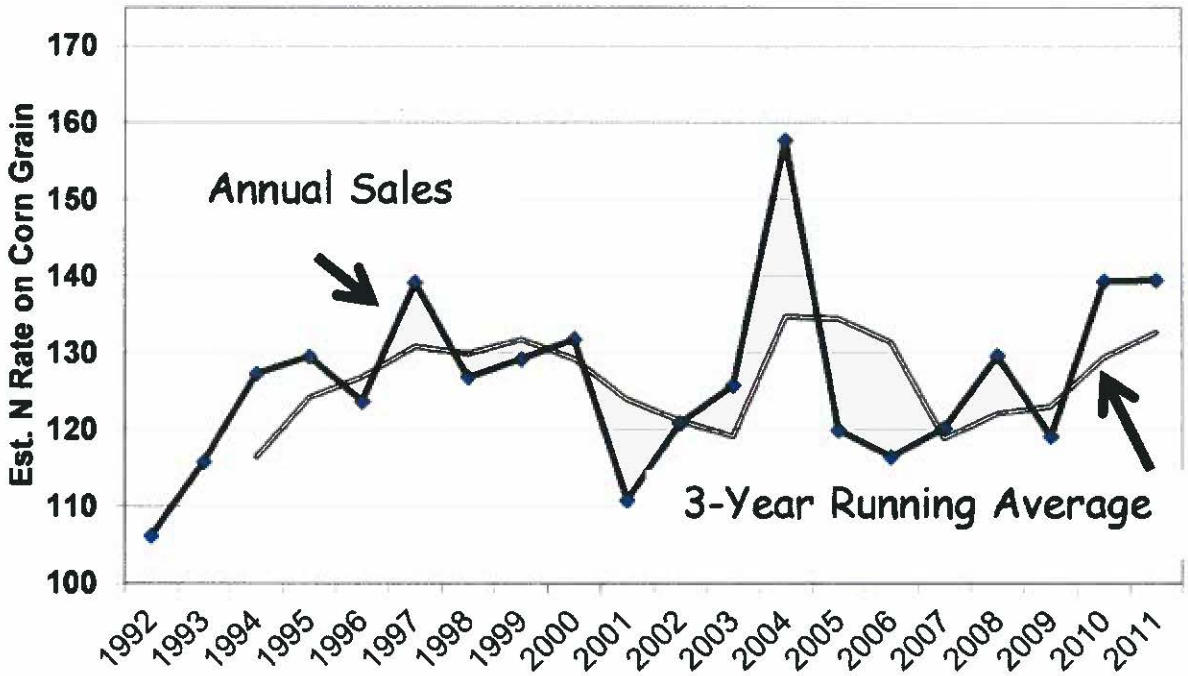
Major Steps

1. Review monitoring data to confirm there is a problem and to understand the extent and scope of the problem.
2. Consult with other agencies on their understanding of the problem, especially the use of hydrogeologic sensitivity and groundwater flow maps to understand potential source areas for targeted implementation of practices.
3. Form a local advisory team.
4. Begin a long term private well monitoring network. This is not always possible within a wellhead area because most residents will be on public water. The same may be true for rural water systems.
5. Hold a public information meeting early in the process specifically for farmers; otherwise the subsequent survey of practices may not be successful.
6. Conduct a detailed survey of agricultural practices (FArm Nutrient Management Assessment of Practices - FANMAP) and other local issues such as lawn care, golf courses, etc.
7. Review the FANMAP data and identify recommended BMPs for local soils and cropping systems.
8. Develop an educational response targeting key weaknesses (if any).
9. Work with farmers to implement recommended BMPs.
10. Use FANMAP data to support obtaining implementation and cost sharing funding if needed.
11. Foster industry and local agricultural dealership support and awareness.
12. Conduct edge of field demonstrations, such as the Red Top and Highway 90 demonstration sites. These sites were essential to opening doors to farmers and demonstrating BMPs that needed to be implemented.
13. Promote the Nutrient Management Initiative (NMI), BMP Challenge and other programs that address the economic risk for the farmers.
14. Consider alternative management practices such as alfalfa or CRP on high risk lands as early as possible in the process. ← this can be challenging w/ lack of equipment/market & lower revenue w/ CRP
15. Continue monitoring and BMP promotion.

both options are no longer funded.

from other existing surveys and university input for all crops other than grain corn. The remaining balance was then divided across all reported corn acres. Rates over time are provided in Figure 26.

Figure 26. Statewide Estimates of Nitrogen Fertilizer Rates on Grain Corn: 1992-2011 (MDA unpublished data)



Due to the fact that the relationship shown in Figure 26 is based upon sales data, there tends to be considerable year to year variability. Spikes such as shown in 2003 were probably caused by the short term occurrence of buying fertilizers on the futures market. The actual product more than likely did not get applied until 1-3 years after the recorded sale. Based upon the MDA estimates, it appears that across all corn acres the typical nitrogen fertilizer rate on corn tends to be between 120 to 140 lbs/ac. Rates also appear to be increasing very slightly (4%) over the past 20 years. Average rates between the time periods of 1992-2001 and 2002-2011 were 124 and 129 lb/ac/year, respectively.

? That seem much lower than what I have seen in Stearn

The National Ag Statistics Service (NASS) has also made estimates of fertilizer rates over the past fifty years. The nitrogen fertilizer rate estimates for corn shown Figure 27 are from the ARMS[17] survey program. NASS collected this information annually until 2003. Because of federal budget cuts, ARMS activities have become highly sporadic. It is very important to note that the sampling population used in ARMS is used primarily for economic analysis and is heavily weighted on factors such as farmer age, income and

[17] Agricultural Resource Management Survey. This survey is USDA's primary source of information of the financial condition, production practices, resource use, and economic well-being of America's farm households.

Coarse-textured Soils

Marketplace Trends Over the Past 20 Years: Irrigation development has had a profound impact on localized areas within the Central Sands and Dakota/Goodhue Counties. Statewide, irrigated acres have increased by 9% over the last decade. Some counties, such as Morrison, have shown irrigated acreage increases over 20%. wow!

Opportunities for Advancements in N Management: Nitrogen rates ranged from 112 lb/ac in Isanti County to 162 lb/ac in Chisago County. Timing indicated that 95% of N fertilizer was applied either in the spring (70%) or as a split application (25%). The area that warrants the greatest education resources in the coarse-textured soil will undoubtedly be irrigation water management. As irrigation acres continue to expand, it is imperative that growers are provided with the knowledge and tools to accurately manage water and N as they transition from low input, dry land management into highly managed irrigated crops.