North Dakota Nutrient Reduction Strategy for Surface Waters

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Final
May 2021

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Executive Summary

Nutrients, such as nitrogen (N) and phosphorus (P), are natural parts of aquatic ecosystems that support the growth of algae and aquatic plants, which provide food and habitat for fish, shellfish and smaller organisms that live in water. However, when too much N and P enter the environment, the water can become polluted affecting the aquatic ecosystem, recreation and drinking water supplies. Nutrient pollution is considered one of the nation's leading causes of water quality degradation.

Nutrients originate from a variety of sources including nonpoint sources, such as agriculture and urban runoff, and point sources, such as municipal and industrial wastewater discharges. Once these nutrients enter our rivers and streams through runoff, they may be transported far downstream where they may impact other rivers, streams, lakes, and reservoirs both in and outside the State, and internationally. In addition to direct nutrient contributions as the result of runoff, nutrients may enter our groundwater through infiltration where they can contaminate our public and private drinking water supplies.

In North Dakota, the leading sources of nutrients include nonpoint sources such as erosion and runoff from cropland, runoff from animal feeding operations, hydrologic modification (e.g., historic wetland drainage and stream channelization), failing septic systems, industrial and municipal point sources, and storm water runoff. Other sources of nutrients include poorly managed pastures and rangeland, riparian grazing, and tile drainage.

To address the serious environmental, human health, and water quality issues caused by excessive nutrients in our waters, the North Dakota Department of Environmental Quality (NDDEQ) has developed this Nutrient Reduction Strategy (strategy) for North Dakota to serve as a blueprint for local, state and federal agencies, cities, counties, and the public to address excessive nutrient runoff and loading to our rivers, streams, lakes, reservoirs, and wetlands. The goal of the strategy is to help the State prioritize watersheds and best management practices (BMPs) to achieve cost effective solutions to reduce the delivery of nutrients to the State's lakes, reservoirs, rivers, streams, and wetlands.

The NDDEQ recognizes that implementation of the strategy is primarily voluntary and thus will require sustained public interest and support. To ensure public support, the NDDEQ initiated a consensus-based stakeholder process to develop the strategy and its core components. The process for developing the strategy was initiated by the formation of a Planning Team in November 2012. The NDDEQ invited individuals representing a variety of stakeholder sectors to serve as advisors on a 35-member Planning Team. The purpose of the Planning Team was to assist the NDDEQ in identifying the core components of the strategy and in outlining a process for developing the strategy. Key to developing the strategy was the establishment of five workgroups established around what the Planning Team identified as the core components of a nutrient reduction strategy. The core components were 1) prioritization and targeting, 2) nutrient criteria development, 3) nutrient reduction strategies for point sources, 4) nutrient reduction strategies for nonpoint sources, and 5) accounting and verification measures and reporting. The five core components deemed necessary for accomplishing the strategy's goal of targeting and prioritizing watersheds and best management practices (BMPs) to achieve cost effective solutions to reduce the delivery of nutrients to the State's lakes, reservoirs, rivers, streams, and wetlands.

While each component of the strategy is described in detail, implementation of this strategy will need to be accomplished through an integrated nutrient reduction delivery process. Key to this integrated process will be implementation of the core components through a watershed approach using the principles of adaptive management, effective communication with the public and partners, and maintenance of transparency and accountability through effective performance measures and reporting.

The NDDEQ recognizes the successful implementation of the strategy will best be achieved on a watershed scale. This will promote a more coordinated effort for the collection and sharing of data and information, increased availability of technical and financial resources, and more focused and effective nutrient management activities.

One example for implementation of the strategy is the Basin Water Quality Management Template (Basin Template). The Basin Template is organized around five major river basins in the State including the Red River Basin, James River Basin, Souris River Basin, Upper Missouri River Basin (including Lake Sakakawea), and Lower Missouri River Basin including Lake Oahe (Appendix E).

A key to the successful implementation of the nutrient reduction strategy or any other water quality or watershed management plan is the adaptive management process. Adaptive management, also known as adaptive resource management (ARM), is a systematic approach for improving resource (or in this case water quality improvement and nutrient reduction) management policies and practices by learning from management outcomes. ARM acknowledges uncertainty about how natural resource systems function and how they respond to management actions. ARM is designed to improve the understanding of how a resource system works to achieve management objectives. ARM also makes use of management interventions and follow-up monitoring to promote understanding and improve subsequent decision making. In the context of the implementation of the nutrient reduction strategy, ARM consists of the development, implementation, and evaluation of a watershed-scale plan. If a desired outcome is not accomplished, then the plan will be modified or changed.

Public education and outreach are essential to the successful implementation of the nutrient reduction strategy. Education and outreach will be required at multiple spatial scales, including the state scale, basin scale and watershed or local scale. At the state scale, education and outreach will need to focus on communicating the water quality problems associated with nutrient pollution, and the primary purposes of the nutrient reduction strategy in terms of its guiding principles, goals, and objectives.

Reporting the progress of nutrient reduction at the State, basin and watershed scale is an important component of the strategy and is critical to the successful implementation of the strategy. Effective communication between the agencies and organizations involved in nutrient reduction activities and the public is essential to maintaining transparency and ensuring credibility. Communicating successes to the appropriate audiences in the form of a clear, concise, and understandable message will help engage stakeholders and build confidence in the programs, projects, and activities that will be implemented through the strategy.

I. Background on Nutrient Pollution

Nutrients, such as nitrogen (N) and phosphorus (P), are natural parts of aquatic ecosystems that support the growth of algae and aquatic plants, which provide food and habitat for fish, shellfish, and smaller organisms that live in water. However, when too much N and P enter the environment, water can become polluted affecting the aquatic ecosystem, recreation, and drinking water supplies. Nutrient pollution is considered one of the nation's leading causes of water quality degradation.

Many of North Dakota's waterbodies are affected by nutrient pollution. It is estimated that 69% of perennial streams in the State are impaired due to excessive P and 57% due to excessive N (NDDEQ, 2015a). Furthermore, more than 24% of the State's lakes and reservoirs are listed as impaired for fishing and water-based recreation due to excessive nutrients (NDDEQ, 2015b). In addition, a growing number of lakes and reservoirs in the State are experiencing harmful blue-green algae (i.e., cyanobacteria) blooms caused by excessive N and P loadings. Of concern are recent reports of blue-green algae blooms in parts of Lake Sakakawea. These blue-green algae blooms can produce harmful toxins, referred to as cyanotoxins, in the water which can pose a risk to human health in drinking water supplies and by primary contact recreational activities such as swimming, skiing, and boating.

Nutrients originate from a variety of sources including nonpoint sources, such as agriculture and urban runoff, and point sources, such as municipal and industrial wastewater discharges. Once these nutrients enter our rivers and streams, they may be transported far downstream where they may impact other rivers, streams, lakes, and reservoirs both in and outside the State, and internationally. In addition to direct nutrient contributions as the result of runoff, nutrients may enter our groundwater through infiltration where they can contaminate our public and private drinking water supplies.

In North Dakota, the leading sources of nutrients include industrial and municipal point sources, storm water runoff, and nonpoint sources such as failing septic systems, erosion and runoff from cropland, runoff from animal feeding operations, and hydrologic modification (e.g., historic wetland drainage and stream channelization). Other sources of nutrients include poorly managed pastures and rangeland, riparian grazing, and tile drainage.

North Dakota is not alone in facing nutrient related water quality problems. To some degree, every state is facing problems with nutrient enrichment caused by excessive N and P loading. For example, in 2015 Montana adopted numeric nutrient criteria for its rivers and streams, including the Yellowstone River, and is now working with its many point source dischargers in the implementation of effluent limits to address these criteria. To the east, Minnesota finalized its nutrient reduction strategy in September 2014 and has begun implementing many of its recommendations, including supporting the development of a nutrient management plan for the Red River basin. In Manitoba, nutrient reduction efforts were formally announced in 2003 through the Lake Winnipeg Action Plan and are currently being updated as new nutrient targets are developed for Lake Winnipeg and its tributaries including the Red River.

II. Strategy Goal and Rationale

To address the serious environmental, human health, and water quality issues caused by excessive nutrients in our waters, the NDDEQ has developed this Nutrient Reduction Strategy (strategy) for North Dakota to serve as a blueprint for local, state and federal agencies, cities, counties, and the public to address excessive nutrient runoff and loading to our rivers, streams, lakes, reservoirs, and wetlands. The goal of the strategy is to help the State prioritize watersheds and best management practices (BMPs) to achieve cost effective solutions to reduce the delivery of nutrients to the State's lakes, reservoirs, rivers, streams, and wetlands.

This strategy is also supported by the U.S. Environmental Protection Agency (EPA). In the EPA's March 16, 2011 memo (Stoner, 2011), "Working Effectively in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions," the EPA stated they have begun to work collaboratively with states and stakeholders to help them develop effective statewide strategies for reducing nutrient loadings while they continue developing numeric criteria for these pollutants. This memo calls upon states to identify and prioritize watersheds where N and P loadings are significant and to set loading reduction goals based on best available information. This strategy, when implemented, will achieve these objectives.

The strategy will function as a blueprint and starting point for a multi-year, multi-faceted effort to reduce nutrient pollution in North Dakota's surface waters. The strategy will also provide clear and meaningful guidance for the development of nutrient criteria for North Dakota's surface waters. Furthermore, the strategy will be flexible in nature, allow for adaptive management (see Section IV.B.3 for details), and accommodate revisions and updates as needed. The development of the strategy is driven by the following guiding principles:

- It must be technically, and scientifically supported.
- It can be implemented within State and local laws.
- The implementation must be equitable.
- It must include measures to safeguard public health.
- It must minimize economic impacts.

While it is the goal of the strategy to reduce the delivery of nutrients to the State's water resources by encouraging the wise use and proper management of nutrients, it is not the goal of this strategy to eliminate the use of fertilizers on crops grown in the State. This strategy recognizes that nutrients, principally N and P, are necessary and critical to grow the food we need for world population. This strategy also recognizes that nutrients are a diminishing resource. One that requires new and innovative strategies to properly use, conserve, and reclaim them, whether it is from a farm field, a feedlot, or a wastewater treatment plant.

Finally, this strategy was developed with the understanding that North Dakota is not "starting from scratch" and that there are currently many programs, projects, and activities in place that result in nutrient reductions. For example, the NDDEQ's Section 319 Nonpoint Source Pollution Management Program continues to support 15 to 20 watershed projects annually in the State.

Each of these watershed projects has the goal of reducing the delivery of nonpoint source pollutants, including nutrients, to surface water resources in the state. The watershed project goals are generally accomplished by 1) promoting voluntary adoption of specific BMPs, 2) providing financial and technical assistance to implement BMPs, 3) disseminating information on the project and solutions to identified NPS pollution impacts, and 4) evaluating progress toward meeting NPS pollutant reduction goals.

Local sponsors utilize numerous funding sources including Section 319 funds, USDA cost-share, North Dakota Outdoor Heritage funds, and local contributions to support their watershed restoration efforts. Funds allocated to a watershed project will typically be used to employ staff, cost-share BMPs, conduct information and education (I&E) events, and monitor trends in water quality, land use, and/or the aquatic community. Watershed projects are generally implemented as five-year projects but can be extended for five or more years depending on progress, size of the watershed, and extent of beneficial use impairments associated with NPS pollution.

To effectively reduce or eliminate the transport of NPS pollutants, including nutrients, to surface and/or groundwater resources, various “source control” measures are implemented within the watershed projects. These source control measures or BMPs are designed to 1) prevent pollutants from leaving a specific area, 2) reduce/eliminate the introduction of pollutants, 3) protect sensitive areas, and/or 4) prevent interaction between precipitation and pollutants. Specific BMPs supported by the NPS Program and the associated Section 319 cost share policies are described the “North Dakota Nonpoint Source Pollution Management Program Cost Share Guidelines for Nonpoint Source Pollution Control Best Management Practices” (https://deq.nd.gov/WQ/3_Watershed_Mgmt/1_NPS_Mgmt/NPS.aspx). Within each watershed project, the type of BMPs implemented will be dependent on several factors. Those include the NPS pollutants being addressed, the specific sources and causes of NPS pollution, the delivery mechanism(s) of the pollutant of concern, and the feasibility and affordability of the prescribed BMPs.

While much has been done, and continues to be done, to reduce the delivery of nutrients to the State’s surface waters, this does not mean that the job is complete. An area of emphasis in this strategy is to identify areas where there are gaps in programs or projects needed to address nutrient runoff. Another area of emphasis is recognizing the need to better coordinate programs, projects, and activities. There are many agencies and organizations in the State that are focused on the enhancement of the State’s natural resources and the promotion of sustainable land management. This strategy recognizes that nutrient reduction must be part of a coordinated and comprehensive approach involving all local, state, federal agencies, academic institutions, and private organizations in the State. More importantly, the nutrient reduction strategy must engage and involve private landowners and non-governmental organizations (NGOs) representing individuals actively managing natural resources throughout the State.

III. Strategy Development Process

The NDDEQ recognizes that implementation of the strategy is primarily voluntary and thus will require sustained public interest and support. To ensure public support, the NDDEQ initiated a consensus-based stakeholder process to develop the strategy and its core components. The process for developing the strategy was initiated by the formation of a Planning Team in November 2012. The NDDEQ invited individuals representing a variety of stakeholder sectors to serve as advisors on a 35-member Planning Team. Members of the Planning Team with their sector affiliation are provided in Appendix A. The purpose of the Planning Team was to assist the NDDEQ in identifying the core components of the strategy and in outlining a process for developing the strategy. Key to developing the strategy was the establishment of five workgroups established around what the Planning Team identified as the core components of a nutrient reduction strategy. The core components were 1) prioritization and targeting, 2) nutrient criteria develop, 3) nutrient reduction strategies for point sources, 4) nutrient reduction strategies for nonpoint sources, and 5) accounting and verification measures and reporting.

Following two preparatory Planning Team meetings (November 20, 2012 and April 11, 2013) and recognizing that the successful implementation of the strategy will require broad public understanding and support, the NDDEQ convened a stakeholder meeting on December 19, 2013. In addition to gaining additional input and comment on the strategy development process, the stakeholder meeting served as an opportunity to organize each of the five workgroups, including two technical workgroups (prioritization and nutrient criteria), two source reduction workgroups (point and nonpoint sources), and one workgroup that will develop strategies for measuring progress and reporting results to the public.

The workgroup Prioritization Workgroup is charged with developing strategy recommendations for the prioritization and targeting core component. The Criteria Workgroup was directed to provide recommendations to the NDDEQ for the development of nutrient criteria in the State. The two source category workgroups included the Industrial and Municipal Point Source Workgroup and Agriculture and Nonpoint Source Workgroup. The purpose of these two source category workgroups were to identify cost-effective source reduction strategies (i.e., programs, projects, practices) which, when implemented, will result in the reduction of nutrient runoff and loading to our surface waters. The fifth workgroup was the Education and Outreach Workgroup. This workgroup was established to address processes and measures for accountability and reporting progress by recommending indicators to assess progress in meeting the strategy's goals as the strategy is implemented. This workgroup was also asked to provide recommendations on education and communication actions to inform agencies, policy makers, and the public about the strategy and its elements how to effectively engage federal, state, and local governments, communities, and the public in programs and projects designed to implement the strategy. The Education and Outreach Workgroup will also be directed to identify indicators of progress that can be monitored and used to measure and report progress by the NDDEQ as the strategy is implemented.

(Once completed additional language will be added describing the final public review and comment process, including the final stakeholder meeting).

IV. Strategy Framework and Core Components

The North Dakota Nutrient Reduction Strategy has been organized around four core components 1) criteria development, 2) setting reduction targets, 3) identifying reduction priorities, and 4) implementing reduction strategies. These core components are deemed necessary for accomplishing the strategy's goal of achieving cost effective solutions to reduce the delivery of nutrients to the State's lakes, reservoirs, rivers, streams, and wetlands. Each component of the strategy is described in detail in the following sections. The purpose of this strategy to describe how each component is part of an integrated nutrient reduction framework. Key to this integrated framework will be implementation of the core components through a watershed approach using the principles of adaptive management, effective communication of strategy goals to agencies, organizations, public and maintenance of transparency and accountability through effective performance measures and reporting.

A. Strategy Components

1. Nutrient Criteria Development

What are water quality standards?

Under the Federal Clean Water Act (CWA) states are responsible for establishing water quality standards. Water quality standards are state regulations that specify designated beneficial uses for the State's rivers, streams, lakes, and reservoirs. Beneficial uses are defined in the water quality standards as drinking water, recreation, fish, and other aquatic organisms (i.e., aquatic life), agriculture (e.g., irrigation and livestock watering), and industrial uses (e.g., process water, wash water, cooling). These uses are then protected through narrative criteria, numeric criteria, and anti-degradation policies and procedures.

Narrative criteria are statements about what should not be in water and are often referred to as "free from" water quality standards as waters should be "free from" anything that is introduced into the water by manmade sources that could cause harm to the beneficial uses of that water. An example of a specific narrative standard in the water quality standards is "free from floating debris, oil, scum, and other floating materials attributable to municipal, industrial, or other discharges or agricultural practices in sufficient amounts to be unsightly or deleterious."

Numeric criteria are expressed as a specific concentration of a pollutant that cannot be exceeded, or the specific level of a water quality parameter that must be maintained. Examples of the former are nitrate as N that should not exceed 10 mg/L and sulfate that should not exceed 250 mg/L. An example of the later is dissolved oxygen that should not be less than 5 mg/L.

The State's waters, water quality standards are also used to assess the current condition of the State's waters. This is accomplished by comparing water quality monitoring data to the numeric standards found in the water quality standards. Depending on the beneficial use the standard is intended to protect, the use is determined to be fully supporting if the monitoring data do not exceed the standard and impaired if the data exceed the standard.

Water quality standards are also used to set restoration targets in total maximum daily loads (TMDLs) for waterbodies where beneficial uses are impaired. In this case, load allocations necessary to meet the water quality standards are calculated for both point sources and nonpoint sources.

What are numeric nutrient criteria and how are they developed?

Because Nitrogen (N) and Phosphorus (P) are necessary elements for all organisms, the effects that these nutrients have in the aquatic environment are inherently different from the effects of other pollutants. Most substances for which numeric criteria are established have known toxic effects to people and/or aquatic organisms. Further, these effects and the acute or chronic endpoints (i.e., concentration) that causes these effects, have been established through toxicological studies in the laboratory under controlled conditions.

Unlike the numeric criteria derived for most substances or pollutants listed in the State water quality standards, N and P are essential nutrients for plants and animals. There are even examples where waterbodies are intentionally fertilized to enhance their productivity (e.g., commercial fish farms) (Suplee et al. 2008). When excessive nutrient enrichment (i.e., eutrophication) causes an undesirable or detrimental effect resulting in an impairment to the waterbody's designated use(s), then N and P control become necessary and nutrient criteria are warranted. Establishing the linkage between the concentration or loading of N and/or P and its undesirable environmental effect is the key to nutrient criteria development.

Traditionally, nitrogen control and reduction are considered an important component of reducing eutrophication. However, recent research has indicated that decreasing phosphorus inputs is a key factor in reducing eutrophication (Schindler et al. 2008). While the department is aware of the relationship between nitrogen, phosphorus, and eutrophication, the intent of the strategy is to reduce both nitrogen and phosphorus.

To assist the states in developing nutrient criteria, the EPA has published a series of peer-reviewed technical guidance documents for a variety of waterbody types (e.g., rivers and streams, lakes and reservoirs, estuarine and coastal waters, and wetlands). These documents describe three methods for deriving numeric nutrient criteria based on a statistical analysis of previously collected data. The three approaches are 1) the reference condition approach, 2) mechanistic modeling, and 3) stressor-response analysis (USEPA 2010).

The **reference condition approach** derives nutrient criteria from N and P data collected from reference waterbodies representing a particular class or waterbody type (e.g., shallow lake, reservoir, perennial stream). Reference waterbodies are generally selected based on land use in the waterbody's watershed and/or adjacent riparian buffer area and is considered to represent a least disturbed and/or minimally disturbed condition within a region.

Since these reference condition waterbodies are assumed to represent natural conditions, free from most anthropogenic influences, then the nutrient concentrations and/or loadings observed from samples collected from these waterbodies are assumed to represent appropriate values upon which numeric nutrient criteria can be based. The challenge in using the reference condition approach when developing nutrient criteria is the ability to define and identify reference waterbodies and the availability of sufficient data necessary to characterize the distributions of different nutrient variables (USEPA 2010).

The NDDEQ currently uses the reference condition approach to select sites for biological indicator development and in development of condition thresholds for N and P that can be used to assess lakes, streams, and wetlands on a state or regional scale using probabilistic sampling designs.

The **mechanistic modeling approach** represents ecological systems using equations that represent ecological processes and parameters for these equations that can be calibrated empirically from site-specific data. These models are then used to predict changes in the system as they relate to changes in N and P concentrations or loadings. An example of the mechanistic modeling approach would be the development of a calibrated BATHTUB trophic response model for a lake or reservoir which would be used to predict the N and P load necessary to meet a prescribed chlorophyll-a target. The NDDEQ frequently uses this approach when developing nutrient targets in TMDL analysis.

The third approach to developing numeric nutrient criteria using empirical data is the **stressor-response modeling approach**. The stressor-response modeling approach is used when data are available to estimate the relationship between N and P concentrations and a response measure (e.g., biological index score) that is directly related to a waterbody's designated use (e.g., aquatic life). Once the relationship is established through a statistical regression model or other statistical relationship, then numeric criteria can be derived that are determined to be protective of the designated use.

There are generally four steps involved when using the stressor-response approach (USEPA 2010). First is the development of a conceptual model which describes the theoretical relationships between nutrient sources, changes in nutrient concentrations and loading, ecological effects, and impacts to beneficial uses. Second, variables are selected for analysis that represent the stressor (i.e., nutrients) and the response (i.e., ecological effect). Following the collection of both stressor and response variable data, the third step is data analysis to estimate stress-response relationships depicted on the conceptual model. Finally, when the stressor-response relationship is significant and directly linked to attainment of the beneficial use, nutrient criteria are developed.

What is North Dakota's approach to nutrient criteria development?

The NDDEQ's approach to developing numeric nutrient criteria for its rivers, streams, lakes and reservoirs and the approach endorsed by the Nutrient Criteria Workgroup is to follow the approach described in the North Dakota Nutrient Criteria Development Plan (Appendix B). The North Dakota Nutrient Criteria Development Plan (Plan) was developed in 2007 in response to a January 9, 2001 Federal Register notice and November 14, 2001 memorandum by Geoffrey Grubbs (Grubbs, 2001) which recommended that states and authorized tribes develop a nutrient criteria development plan to outline their process for how and when they intend to adopt numeric nutrient criteria into their water quality standards.

While states and tribes were not required to develop a plan, the EPA strongly encouraged them to do so. In these plans, the EPA expected states and tribes to describe a systematic approach for numeric nutrient criteria development with milestones for completion. The EPA also recommended that plans should describe their strategy for deriving quantitative endpoints, identify data required to develop the quantitative endpoints, identify any data gaps, and specify how data gaps will be filled. With regards to strategies for deriving quantitative endpoints, the EPA recommended three approaches for deriving numeric nutrient endpoints or criteria:

1. Adopt the EPA's recommended nutrient criteria based on data aggregated at the Level III ecoregion scale (either as a range of nutrient concentrations or as a single value with the range).
2. Combine the EPA recommendations for nutrient criteria based on the Level III ecoregion with a state's own databases to develop their own statistic-based criteria.
3. Use an EPA accepted stressor-response methodology or some other scientifically defensible method for developing nutrient criteria.

In developing its Plan, the NDDEQ relies on option three which is to develop numeric nutrient criteria based on methods that describe relationships between nutrients (stressor) and their effect on aquatic ecosystems (response). Further, the State's Plan is driven by four fundamental considerations. These considerations are that the nutrient criteria should be:

1. Protective of the State's water resources and their designated beneficial use.
2. Tailored to the unique physiographic characteristics and water resources of the State.
3. Technically and scientifically supported.
4. Based upon conceptual models that reflect cause (stressor) – effect (response) relationships founded on excess nutrient concentrations and that reflect the reasons for resource impairment (e.g., excessive algae in a lake) and the loss of beneficial uses.

In terms of setting priorities for numeric nutrient criteria development, the Plan recommends developing criteria for large reservoirs and deep natural lakes first, followed by shallow natural lakes and small reservoirs, perennial wadable rivers and streams, perennial non-wadable (large) rivers and streams, and intermittent/ephemeral streams. In setting these priorities it should be recognized that developing criteria for any one of these waterbody types will likely require the collection of additional water quality and biological data. Additionally, that these priorities may be revised based upon the availability of existing data and TMDL development activities.

In reviewing the Plan, the Nutrient Criteria Workgroup recommended the NDDEQ prioritize nutrient criteria development for Lake Sakakawea as it is a significant public water supply in the State and an important recreation lake. The Nutrient Criteria Workgroup also recommended the NDDEQ prioritize the Red River for numeric nutrient criteria development. The Red River was determined to be a priority due to its importance as a public water supply, its interstate significance as a border water with Minnesota and its international significance with Manitoba and its role in the restoration of Lake Winnipeg.

Establishing Narrative Nutrient Criteria First

As a precursor to the development of numeric nutrient criteria, a narrative nutrient criteria was adopted into the State's water quality standards during the 2017 triennial review period. As recommended by the Nutrient Criteria Workgroup, the narrative nutrient criteria language adopted in the State water quality standards is as follows:

> *"Free from nutrients attributable to municipal, industrial, or other discharges or agricultural practices, in concentrations or loadings which will cause accelerated eutrophication resulting in the objectionable growth of aquatic vegetation or algae or other impairments to the extent that it threatens public health or welfare or impairs present or future beneficial uses."*

Since it is likely that the development of numeric criteria for the State's water resources will take a significant amount of time, the adoption of narrative criteria into the State's water quality standards is seen as intermediate step giving the NDDEQ the authority to assess the State's waters for nutrient related impairments, and for setting nutrient loading targets used in TMDLs. In the latter case, when the TMDL demonstrates that a significant share of the nutrient load is related to point sources, the narrative nutrient criteria may also serve as the regulatory basis for establishing effluent limits for point sources.

Translating Narrative Criteria to Numeric Endpoints

The State water quality standards and the narrative nutrient criteria are State regulations to protect the waters of the State. To be effective and meaningful, the narrative language needs to be translated to a numeric endpoint or threshold which can be used to assess nutrient impairments to a waterbody's beneficial uses or as a restoration goal or target in a TMDL or watershed plan.

Translating narrative nutrient criteria to a numeric threshold or target is likely a two-step process. Step one will identify a response indicator that is representative of the beneficial use impairment and its threshold for impairment. The second step would be to relate the indicator to a nutrient nitrogen (N) and phosphorus (P) concentration or load that causes the threshold to be exceeded.

An example of a 2-step process would be identifying an in-lake chlorophyll-a concentration (pollutant response) that is known to cause recreational beneficial use impairment and determining the in-lake N and P concentrations that cause that chlorophyll-a concentration to be exceeded. There may be multiple indicators affecting one or more use impairments. This will result in more than one target nutrient concentration or load. In these cases, the more sensitive use and indicator would take precedent.

It is expected that the process of translating narrative nutrient criteria to numeric thresholds and targets would be an iterative process. Thresholds and targets would be refined and updated as additional data collected through the assessment and TMDL process (Figure 1) becomes available. Through the assessment process, numeric thresholds and targets will be tested and verified through the identification of regional "reference" or "least impaired" sites and sites known to be impacted by excessive nutrient loadings.

Refinement of numeric thresholds and targets developed through the TMDL process will occur through two possible ways. One pathway would be through additional monitoring and analysis which would occur as the TMDL is developed. The second would be through implementation of the TMDL as best management practices are applied in watersheds for the nonpoint sources and/or as reductions are achieved for the point sources. Through this second pathway changes in the indicator threshold(s) and target(s) would also be monitored along with changes in nutrient concentrations and/or loadings.

Established thresholds and targets will be validated when the beneficial uses are restored by meeting the nutrient TMDL targets. In cases where beneficial uses are not restored, even when the nutrient targets are met, then additional refinement of the thresholds and/or targets would be required.

This set of narrative criteria implementation steps may occur several times before a final numeric nutrient threshold or target is judged to be scientifically defensible. When defensible the threshold or numeric criteria may be adopted into the water quality standards (Figure 2). It is likely that the process of translating narrative criteria to numeric thresholds and targets will occur regionally across the State and with a variety of waterbody types or classes. It is also likely that the iterative process of refining thresholds and targets could take many years to complete.

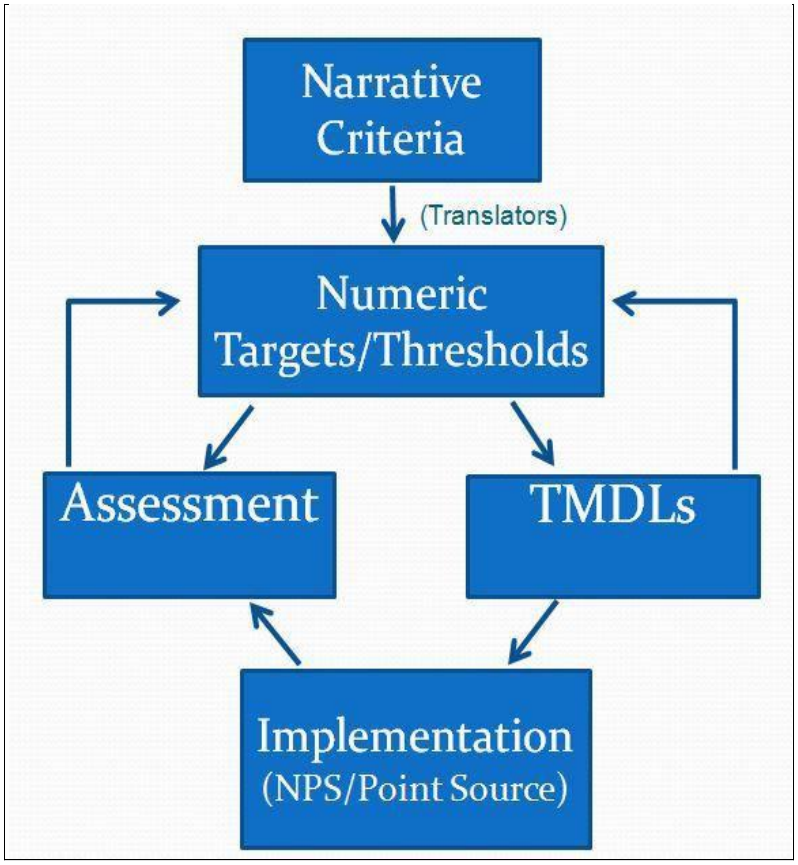

Figure 1. Narrative Nutrient Criteria Implementation Process.

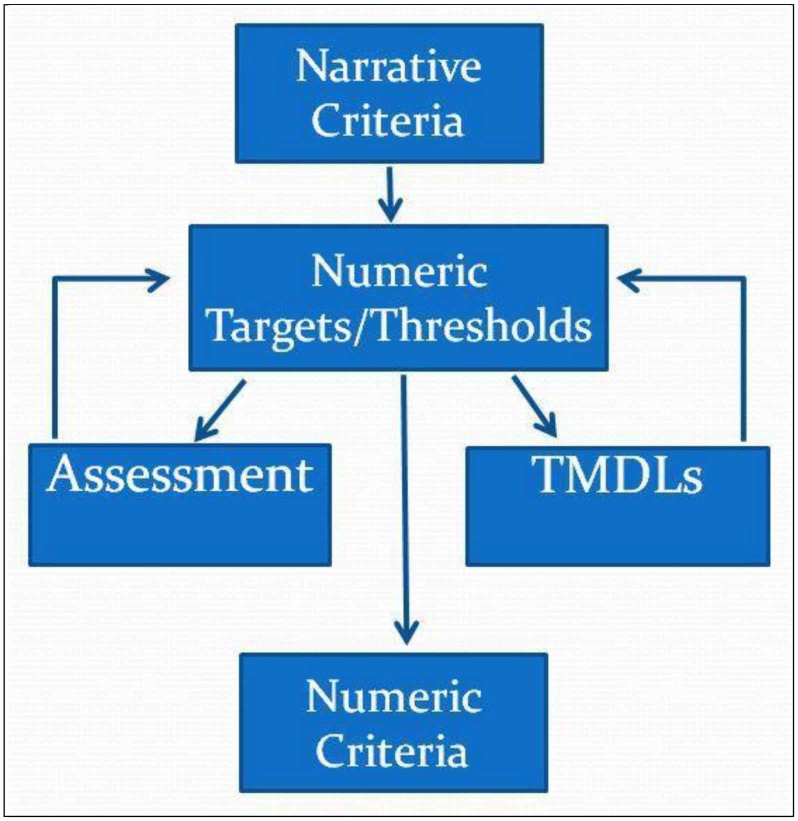

Figure 2. Numeric Criteria Development Process.

2. Setting Nutrient Reduction Targets

When completed and adopted as water quality standards, numeric nutrient criteria will be used to set nutrient reduction targets. In the interim, nutrient targets will be developed as the NDDEQ translates its narrative nutrient criteria to quantitative nutrient endpoints and thresholds (see section IV.A.1. Nutrient Criteria Development).

It will be the goal of this strategy and the NDDEQ to identify priority watersheds. Watershed that are impaired due to excessive nutrients and to set quantitative nutrient load reduction targets using the TMDL approach and the watershed planning process.

Through the TMDL approach nutrient sources are identified in the watershed and nutrient loads are allocated to the contributing point sources and nonpoint sources so that the numeric nutrient criteria (or interim thresholds or endpoints) are attained for the impaired waterbodies in the watershed. The approach normally used to develop a nutrient related TMDL for a waterbody or watershed includes the following five steps:

1. Selection of the nutrient pollutant (e.g., nitrogen, phosphorus, or both).
2. Estimation of the waterbody's assimilative capacity.
3. Estimation of existing nutrient pollution loading from all sources.
4. Predictive analysis of nutrient pollution in the waterbody, the effect of load reduction on numeric thresholds and endpoints, and the determination of total allowable nutrient load to meet the threshold or endpoint.

5. Allocation (with a margin of safely) of the allowable nutrient load among the different sources in the watershed in a manner that the nutrient reduction target or goal (i.e., water quality standards) is achieved.

Once the TMDL and/or watershed plan has been implemented through point source permit limits and/or nonpoint source control measures, the impaired waterbody should be reassessed to determine if water quality standards (or interim thresholds or endpoints) have been attained or beneficial uses are no longer threatened or impaired. The monitoring program used to gather the data for this assessment should be designed based on the nutrient target, the nutrient sources, and any nutrient related response variables. In some cases, established thresholds and endpoints will be validated when the beneficial uses are restored by meeting the nutrient TMDL targets. In cases where beneficial uses are not restored, even when the nutrient targets are met, then additional refinement of the thresholds and/or targets will be required.

3. Identifying Nutrient Reduction Priorities

Prioritization is defined as the systematic ranking in order of importance. We live in a world of limited resources - limited in terms of time, manpower, and money. Prioritization is necessary to wisely allocate our limited resources to where they can be the most efficient and effective. (i.e., best bang for the buck).

With respect to nutrient reduction and management, North Dakota does not have sufficient technical or financial resources to address all the watersheds or nutrient sources in the entire State, nor are there likely to be nutrient related problems in all watersheds in the State. For these reasons it is necessary to develop an efficient and effective method to identify and target priority watersheds within the State where nutrient related water quality problems are documented and where nutrient reductions are needed the most. Once priority watersheds are identified there is also a need to prioritize and target nonpoint source pollution best management practices (BMPs) and other conservation practices (CPs) where they will be the most effective in reducing the delivery of nutrients to waterbodies.

To accomplish this objective, the Strategy has identified several decision support tools and models to assist the NDDEQ and other stakeholders in setting nutrient reduction priorities. It should be noted that prioritization based on model output may not accurately reflect true conditions, therefore models and the output provided by models used for prioritization should be used with caution. Models can and do provide useful information, especially when used to compare and rank watershed or catchments within watersheds. It is, however, a recommendation of this Strategy that implementation of conservation practices and BMPs be based on field verification.

Watershed Prioritization

Recovery Potential Screening Tool

To assist in setting nutrient reduction priorities at the state and basin scale, the Prioritization Workgroup recommended using the Recovery Potential Screening Tool (RPS Tool). The RPS Tool is a systematic, comparative method for identifying differences among watersheds that may influence their relative likelihood to be successfully restored or protected. The RPS approach involves identifying a group of watersheds to be compared and a specific purpose for comparison (i.e., water quality question or scenario), selecting appropriate indicators in three categories (ecological, stressor, social), calculating index values for the watersheds, and applying the results in strategic basin and watershed planning and prioritization. The EPA has developed the RPS Tool to provide states and other restoration planners with a systematic, flexible tool that can help them compare watershed differences in terms of key environmental and social factors affecting prospects for restoration success.

A customized RPS Tool has been developed for North Dakota that includes indicators specific to the State (Appendix C). The North Dakota RPS Tool will serve as the primary method for prioritizing and ranking watersheds for water quality management, including nutrient reduction. It is recommended that watershed prioritization for nutrient management be done in stages with the first stage a comparison of sub-basins (HUC 8) at either the state, regional or basin scale. Following stage 1 analysis and prioritization, a stage 2 analysis will be conducted which will be a comparison and prioritization of sub-watersheds (HUC 12) within priority sub-basins. It should be noted that the examples provided in Appendix C are but one way to prioritize sub-basins and watersheds in the state. The RSP Tool allows the user to customize their prioritization by selecting their own set of ecological, stressor and social indicators and to weight the indicators.

<u>SPARROW Model</u>

It is possible to characterize and prioritize watersheds based only on N or P loading or yield. For this type of analysis and prioritization, the U.S. Geological Survey's Spatially Referenced Regressions on Watershed (SPARROW) model may be a useful tool for watershed prioritization (http://water.usgs.gov/nawqa/sparrow/). The SPARROW model is an empirically derived water quality model that allows the user to predict N and P loads, yields and flow-weighted concentrations for watersheds at varying spatial scales ranging from small catchments to large river basins and to allocate loads to major source categories in the basin or catchment. SPARROW models applicable to North Dakota include the Missouri River Basin model and the Great Lake, Ohio, Upper Mississippi, and Souris-Red-Rainey model. Recently, a new SPARROW model has been developed for the Red, Assiniboine, and Souris River basin. This SPARROW model, which includes Canada, will replace the Great Lake, Ohio, Upper Mississippi, and Souris-Red-Rainey model, at least as it applies to North Dakota.

Nutrient Source Identification and Prioritization

Once watersheds (HUC 10) or sub-watersheds (HUC 12) are identified as high priority for water quality restoration and/or nutrient reduction, it will be necessary to further prioritize and target areas (e.g., small catchments or fields) within these watersheds for BMP or CP implementation. There are currently two methods available in North Dakota which are used to prioritize and target areas for BMP implementation. One method is the PTMApp decision support tool and the other is the AnnAGNPS watershed model.

PTMApp

PTMApp (**P**rioritize, **T**arget, and **M**easure **App**lication) is an ArcGIS based decision support tool for BMP and CP planning and implementation. PTMApp was initially developed for use in the Red River basin in Minnesota by the International Water Institute in partnership with the Red River Watershed Management Board (Minnesota), the Minnesota Board of Soil and Water Resources and Houston Engineering, Inc. Recently, the application has been developed for use in the James River basin in North Dakota and work has just started to complete the application for the entire Red River basin in North Dakota. The latter will compliment a similar PTMApp project in Minnesota which is already completed.

PTMApp can be used in agricultural landscapes to 1) identify the sources and amount of sediment, N and P which may leave the landscape and enter a downstream lake or river; 2) target specific fields on the landscape (based upon NRCS design standards, landscape characteristics, land productivity and/or landowner preference) for the implementation of nonpoint source BMPs and CPs; and 3) estimate the benefits of single or multiple BMPs and CPs within a watershed where the benefits are expressed as the downstream load reduction reaching a lake or river and the estimated cost per load reduction. While currently not available, future versions of PTMApp will also allow the user to plan and allocate BMPs in a watershed based on a cost-benefit analysis. It should be noted that PTMApp uses existing soils, landuse, and slope information to predict sediment, N and P loss and does not take into account BMPs or CPs currently implemented in the watershed, therefore PTMApp should be viewed only as a tool to identify potential sources areas in a watershed.

A series of 10 steps describes the business workflow when using PTMApp for BMP and CP prioritization and targeting in watershed planning and implementation (Appendix D). For more information on PTMApp go to http://www.rrbdin.org/prioritize-target-measure-application-ptmapp.

AnnAGNPS Watershed Model

While PTMApp is recommended as the preferred tool for BMP prioritization and targeting, it is currently not available for much of the State. In these areas of the state or as a compliment to PTMApp, the **Ann**ualized **AG**ricultural **N**on**P**oint **S**ource Pollution (AnnAGNPS) watershed model is another method that has been used in North Dakota to identify areas within watersheds that are likely to be high nutrient delivery areas and where the implementation of BMPs and CPs would be beneficial. To date, this has been the primary method used by the NDDEQ's Section 319 NPS and TMDL programs to prioritize and target areas for BMP and CP implementation.

The AnnAGNPS model was developed by the USDA Agricultural Research Service and Natural Resource Conservation Service (NRCS). The AnnAGNPS model consists of a system of computer models used to predict nonpoint source pollution (NPS) loadings within agricultural watersheds. The AnnAGNPS model uses batch processing, continual-simulation, and surface runoff pollutant loading to generate an estimated daily mass balance for sediment, N and P for each cell. The reach routing component of the model moves sediment and nutrients through the watershed.

Output data is expressed through an event-based report for stream reaches and a source accounting report for land or reach components. Output parameters are selected by the user for the desired watershed source locations (specific cells, reaches) for any simulation period. Source accounting for land or reach components are calculated as a fraction of a pollutant load passing through any reach in the stream network that came from the user identified watershed source locations. Event based output data is defined as event quantities for user selected parameters at desired stream reach locations.

An example of how the AnnAGNPS model is used to prioritize and target BMP and CP implementation is the watershed depicted in Figures 3 and 4. In this watershed example "critical cells" (those with the highest nutrient loads) were determined to be cells in the watershed providing an estimated annual P yield of 0.056 lbs./acre/year or greater (Figure 3) and/or an estimated annual N yield of 6.79 lbs./acre/year (Figure 4). In this example, these critical cells were determined to be priority areas for BMP and CP implementation.

4. Implementation Strategies for Nutrient Reduction

Implementation strategies are opportunities that may exist or become available for nutrient reduction within watersheds or statewide. The implementation strategies described for each nutrient source category are actions or activities that can result in incremental progress toward nutrient reduction goals. It should be noted that voluntary support and participation will be a key factor in ensuring that these strategies are effective in reducing overall nutrient loading to the State's rivers, streams, lakes, and reservoirs.

Another key to implementation is adaptive management. The adaptive management approach assumes knowledge will be gained through the implementation and observation of nutrient reduction strategies. Through adaptive management, strategies will be evaluated on a watershed-by-watershed basis to determine what works and what does not. Strategies will also be evaluated to determine which can feasibly be implemented through regulatory processes, and which practices can be implemented through "grass-roots" participation and support.

Following the establishment of nutrient load reduction targets/thresholds for priority waterbodies, the implementation of source reduction strategies will be necessary for all significant nutrient sources in the waterbody's watershed. The following describes possible nutrient reduction strategies which can be implemented for various categories of nutrient sources to North Dakota's surface waters.

While not all available nutrient reduction opportunities will be realized in every watershed, it should be the goal to implement nutrient reduction practices for all identified sources in a watershed to the maximum extent possible.

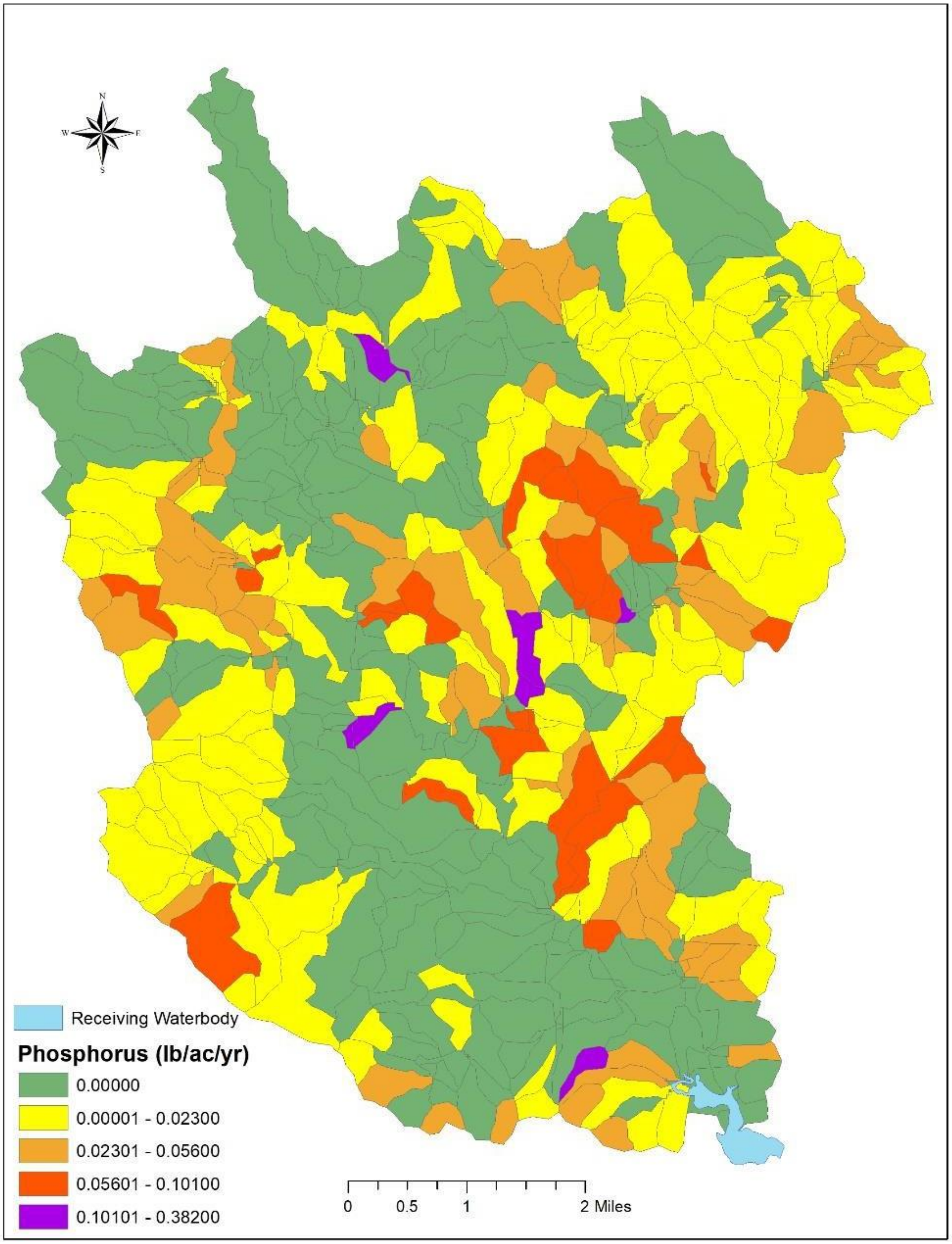

Figure 3. AnnAGNPS Modeled Phosphorus Yields in an Example Watershed.

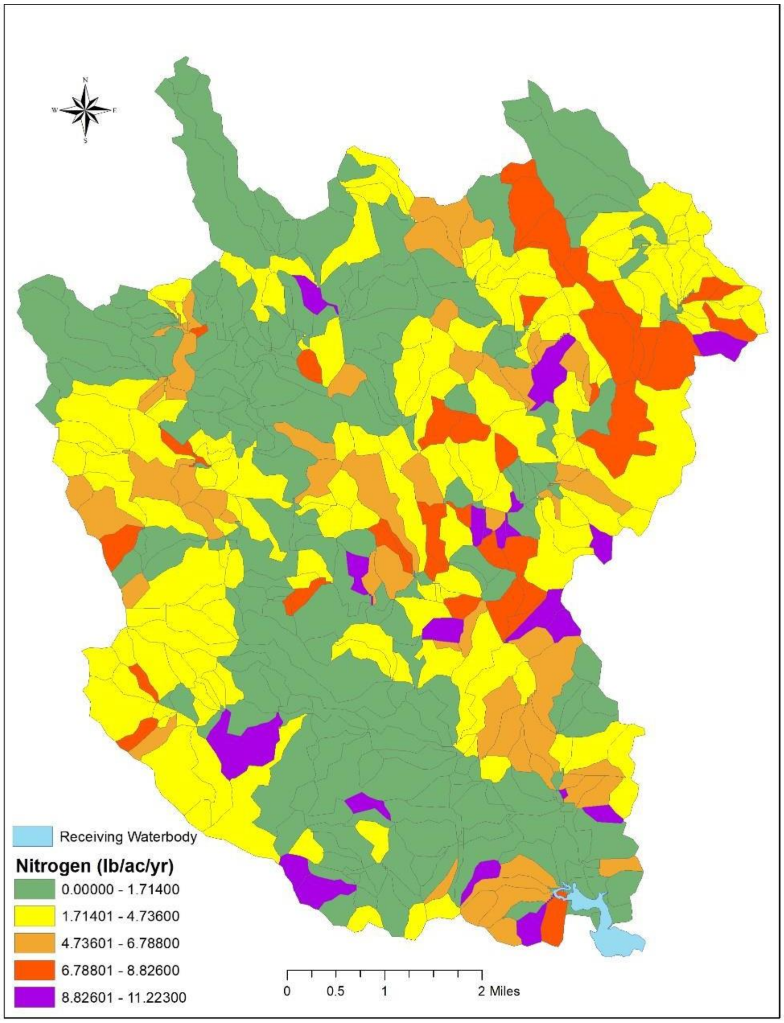

Figure 4. AnnAGNPS Modeled Nitrogen Yields in an Example Watershed.

Municipal and Industrial Point Sources

The North Dakota Pollution Discharge Elimination System (NDPDES) permit program is administered by the NDDEQ. NDPDES permits are required to control and regulate discharges from the following:

- Municipal wastewater treatment facilities
- Industrial facilities
- Storm water through industrial, construction, or municipal separate storm sewer systems (MS4)
- Concentrated animal feeding operations (CAFO) permits and animal feeding operations (AFO)
- Temporary discharge permits for activities such as hydrostatic testing of pipes, tanks or similar vessels, disinfection of potable water lines, construction dewatering, and the treatment of gasoline or diesel contaminated groundwater

There are currently 3,807 permitted dischargers within the State. The breakdown of permits is listed in Table 1. Two-hundred-eighty-eight (288) active permits are issued to publicly owned treatment works (POTWs). While some facilities serve thousands of people, 95% of the POTWs are small. This fact has significant strategic planning importance for implementing nutrient controls for POTWs.

To address nutrient reduction from municipal and industrial point sources, the NDDEQ has categorized all active NDPDES permits into two categories. The first category, Category I, is made up of all major municipal and industrial point sources. Major permitted municipal POTWs are those with populations of approximately 5,000 people or greater while major industrial facilities are those that are identified as major facilities by the EPA Regional Administrator working in conjunction with the NDDEQ. For purposes of this strategy all minor industrial facilities are also included in Category I as well as some minor municipal point source dischargers. The minor municipal point source discharges included in Category I are POTWs that have mechanical treatment.

The second category, Category II, is made up of all remaining minor municipal point source dischargers. Most of these utilize lagoon systems for wastewater treatment and are more difficult to retrofit for biological nutrient removal than the processes employed by major POTWs and those minor facilities with mechanical treatment. While most lagoon systems are believed to already achieve significant N and P reduction, data to substantiate this claim are limited. It is therefore an action item in this strategy to monitor nutrient concentrations in the discharges from these systems to quantify how efficient these types of treatment systems are in reducing nutrient loading to our surface waters (see Section V).

Table 1. Number of Active NDPDES Permits as of September 20, 2016

Type of Permit	Total Number of Permits
INDIVIDUAL PERMIT	
Major Municipal	14
Major Industrial	10
Minor Municipal	16
Minor Industrial	58
GENERAL PERMIT	
Minor Municipal	258
Minor Industrial	63
Temporary Discharge	82
Stormwater-Construction	2265
Stormwater-Industrial	438
Stormwater-MS4	18
STATE PERMIT	
AFO	513
CAFO	72
TOTAL	**3807**

Due to the high cost in relation to the amount of nutrient reduction that could be achieved by minor POTWs, this strategy's primary focus as it relates to municipal and industrial point sources will be on Category I facilities. The emphasis on Category II facilities will be on monitoring, inspections, optimization, and treatment upgrades. The latter will be done on an as needed basis. With the large number of minor dischargers with lagoon systems, the NDDEQ will also continue to support research into new and improved treatment technologies for lagoon systems which will result in additional nutrient treatment and reduction.

Strategy for Category I NDPDES Facilities

As a first step in implementing the nutrient reduction strategy for Category I NDPDES facilities, all applicable permits will be renewed to include an effluent monitoring provision for nutrients and language related to meeting the narrative nutrient criteria which is included in the State's water quality standards (see section IV.A.1. Nutrient Criteria Development). As recommended by the Nutrient Criteria Workgroup, the narrative nutrient criteria language included in the State water quality standards is as follows:

> *"Free from nutrients attributable to municipal, industrial, or other discharges or agricultural practices, in concentrations or loadings which will cause accelerated eutrophication resulting in the objectionable growth of aquatic vegetation or algae or other impairments to the extent that it threatens public health or welfare or impairs present or future beneficial uses."*

Although continually evolving, many nutrient removal technologies for wastewater treatment are already proven and well established. Thus, nutrient removal for many of North Dakota's larger wastewater treatment facilities (e.g., mechanical plants) is technologically feasible and will be evaluated for financial feasibility. If necessary, Category I facilities may need to construct or modify its treatment facilities or modify plant operations to achieve needed reductions in the amounts (i.e., concentration and/or loading) of N and P discharged to the receiving stream. These reductions would be in proportion to the discharger's contribution to the waterbody and other nutrient sources (point and nonpoint) which may be contributing. The evaluation process to determine whether this would be necessary is outlined in Figure 5.

As stated earlier, the first step with Category I facilities is to implement monthly monitoring for total N and total P in effluents from these sources. These nutrient data will be collected during the 5-year permit cycle and evaluated as they become available to help determine the impact the facility has on the receiving water body as defined by the narrative nutrient criteria. If the data indicates that the effluent is not causing a negative impact on an impaired receiving stream, then the facility will continue with effluent monitoring. If the data shows that there is a negative impact on an impaired receiving water body, then the NDDEQ will implement upstream and downstream monitoring to study the specific impact that the facility is having on the water body. These data, in addition to ambient monitoring data, will be used to help determine if there is a need to develop a TMDL for the water body. If a TMDL is needed, then the WMP will develop a TMDL which will include a load allocation (LA) for nonpoint sources, a waste load allocation (WLA) for point sources, and a margin of safety (MOS). The TMDL will be based on a numeric

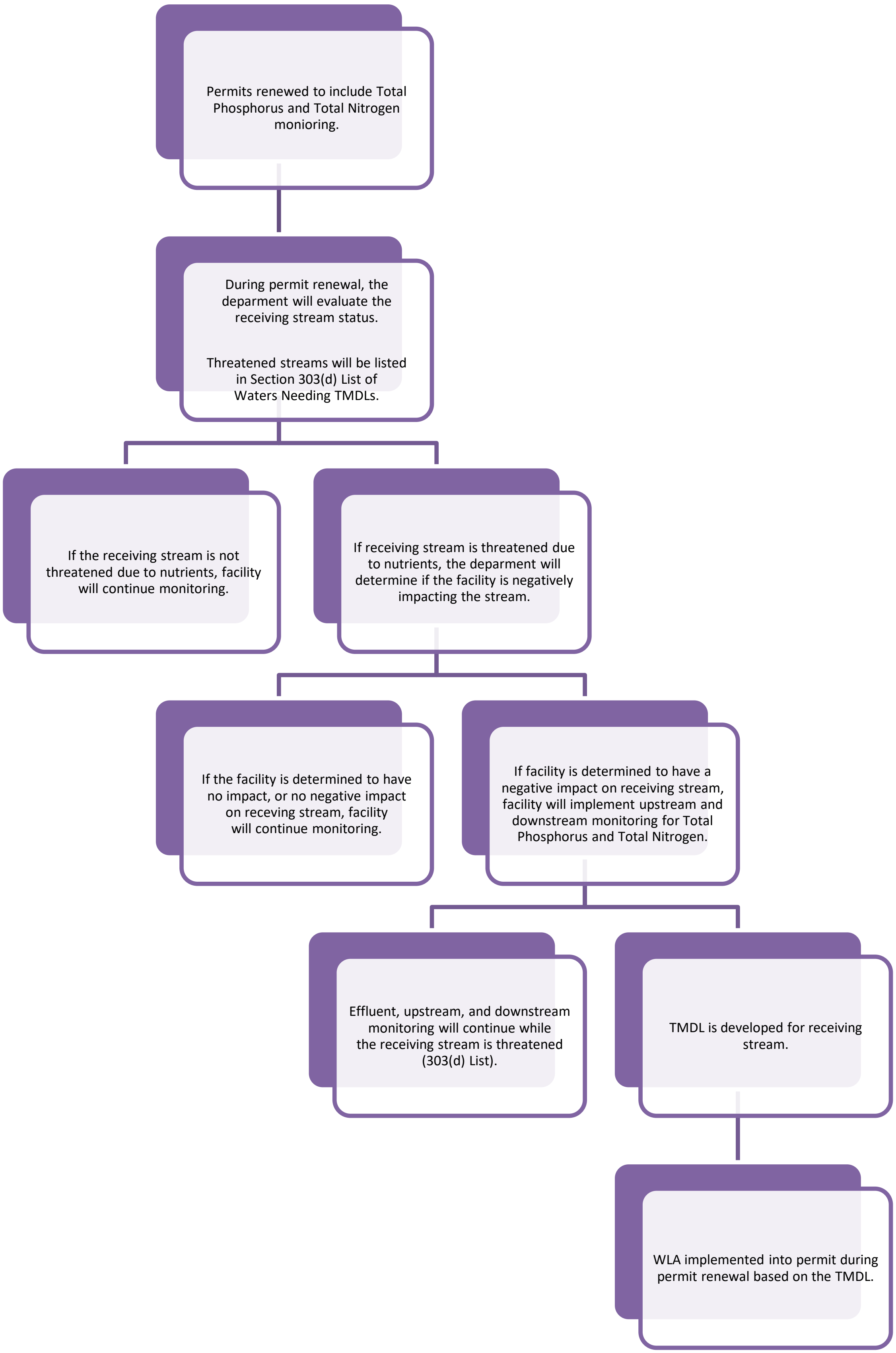

Figure 5. Nutrient Reduction Strategy Implementation Flow Chart for Category I

NDPDES Facilities

target/threshold that will be developed by the NDDEQ's WMP as a means of translating the narrative numeric criteria. This numeric threshold and the WLA which will be developed as part of the TMDL will provide the regulatory basis for the development of a numeric limit to be implemented into the permit.

An important component of any TMDL is public input and comment. As the TMDL is developed, the WMP will seek review and comment from the public as well as from any affected point source discharger(s). This input will be in the form of stakeholder meetings where input will be requested on the nutrient target, technical approaches and models used in the TMDL, load allocations and waste load allocations, and implementation strategies to meet the TMDL target.

Once the TMDL is completed, the WMP is also required to seek formal public comment through a 30-day public notice. This formal public notice affords the public and any affected parties an additional opportunity to provide comment on elements of the TMDL including the nutrient targets that were selected and the load allocations and waste load allocations developed based on the targets.

Once the TMDL is finalized, the department will incorporate the WLA assigned to a facility into the facility's permit during the renewal cycle. If necessary, facilities may need to modify existing plant operations, or construct modifications to their treatment facilities to meet the WLA. In this case, the department would work with the facility to develop a compliance schedule.

Storm Water Point Sources

Due to the intermittent nature of such discharges and their presumed small contribution to the overall statewide nutrient load, this strategy does not address specific storm water reduction targets. While no specific nutrient reductions have been targeted for municipal or industrial storm water discharges, it is anticipated that implementation of MS4 (municipal separate storm sewer system) permits and industrial storm water permits will result in some nutrient reduction. MS4 is defined as a conveyance or system of conveyances, including municipal streets, curbs, gutters, or storm drains, which are owned or operated by a state, city, town, county, district, association, or other public body having jurisdiction over disposal of storm water or other wastes, are designed or used for, collecting or conveying storm water, and which are not a combined sewer and not part of a POTW. The MS4 permit requires regulated communities to implement a public education program to distribute educational materials to the community or conduct equivalent outreach activities about the impact of storm water discharges on waterbodies. This includes steps that the public can take to reduce pollutants in storm water runoff, including nutrients, for each audience. The MS4 permit also requires regulated communities to develop ordinances to prevent illegal dumping or discharges of pollutants to surface waters. Additionally, permittees are required to develop and implement a training component for operation and maintenance programs, such as park and open space maintenance, with the goal of preventing or reducing pollutants in runoff. This includes written procedures for park and golf course maintenance, and fertilizer application.

While the contribution of nutrients from stormwater sources may be small at the statewide scale, their contributions may be relatively large at the smaller watershed scale. Once identified these nutrient sources should be factored into the watershed planning/TMDL effort for the waterbody. The department understands there is a lack of research related to urban stormwater runoff and encourages more research into the impacts of urban stormwater to better find ways to reduce nutrient contributions.

Animal Feeding Operations (AFOs)/Confined Animal Feeding Operations (CAFOs)

AFO's are facilities where animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period and crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the facility. AFOs in North Dakota are regulated by the NDDEQ for environmental performance. The amount of regulation varies by the type and number of livestock in the AFO. For example, an AFO consisting of 1,000 or more cattle is defined as a large CAFO, whereas an AFO with between 300 and 999 cattle is defined as a medium AFO. Based on state regulations the large CAFO is required to have a NDPDES permit, while the medium AFO is only required to have a permit if the facility is within a ¼ mile of surface water or the facility is determined by the NDDEQ to be impacting waters of the state. AFO's that meet the CAFO criteria based on animal numbers are also required to submit a nutrient management plan (plan) which is reviewed by the NDDEQ. The plan describes how the livestock manure generated by the CAFO will be handled and applied to agricultural land, including what equipment will be used in the process. The plan also includes field maps, field soils maps, field soil test results, crop rotations, and yield goals. Inspections are conducted annually by the NDDEQ to determine compliance with the nutrient management plan. AFOs also submit a nutrient management plan but are not inspected as frequently as CAFOs.

All AFO's that are required to have a permit also have water quality setback requirements. Setbacks are required from streams, lakes, designated wetlands, and drinking water wells. Livestock barns or manure storage structures cannot be located in a 100-year flood plain. These operations must retain all manure between periods of land application. AFO's with dry or bedded manure also have regulations governing the stockpiling of dry manure.

Private Sewage Disposal Systems

North Dakota is primarily a rural state with a large, but unknown number of septic systems. In addition, the age and condition of the majority of these systems is largely unknown. While the impact of septic systems on nutrient loading may be considered minimal on a statewide scale, inadequate or failing septic systems may be a significant nutrient source at a watershed scale or to a specific lake or reservoir. Therefore, this strategy recommends inventorying and assessing the potential for septic system contributions in priority watersheds and lakes. This strategy recognizes that most of the State's efforts to address septic systems will consist of upgrading failing systems through routine inspections by local district health units. The strategy also recognizes that funding for septic system upgrades may be available through approved Section 319 NPS watershed restoration projects (see Section IV.B.2. Water Quality and Watershed Support Programs, Nonpoint Source Pollution Control Program).

Agricultural Nonpoint Sources

Nitrogen and Phosphorus are two of the most common nonpoint source (NPS) pollutants affecting the water quality and beneficial uses of North Dakota's waterbodies. These nutrients are associated with both urban and agricultural sources, with agricultural sources being present, to some degree, in all the watersheds across the State. Within the agricultural industry, N and P are necessary inputs that play a critical role in ensuring robust and consistent forage and crop production. However, these agricultural "inputs" can and do become pollutants when applied incorrectly and then are delivered to nearby waterbodies by way of surface water runoff, subsurface drainage, and wind action on exposed soils. The displaced nutrients from agricultural sources such as croplands and concentrated livestock feeding areas are often the primary drivers behind hypereutrophic conditions (e.g., algal blooms) that impact the aquatic life and recreational uses of surface water resources.

To minimize the water quality impacts of nutrients associated with agricultural production, this strategy will focus on the development and implementation of voluntary initiatives and programs that increase nutrient use efficiencies, improve soil health, disrupt transport mechanisms, improve nutrient management on land with surface and/or subsurface drainage systems, and restore assimilative capabilities of waterbodies. Increased support for research and demonstration projects to evaluate the efficiencies of nutrient management practices as well as the impacts of nutrients in an aquatic environment will also be used to provide direction for nutrient management programs. To achieve these objectives, coordination with state and federal agencies, universities, commodity groups, and nongovernmental organizations will be necessary to provide adequate technical and financial resources to agricultural producers interested in improving nutrient management on their land.

To effectively reduce or eliminate the movement of N and P from agricultural fields, various control measures will be implemented within the watersheds of impaired waterbodies. These control measures are defined as beneficial management practices (BMPs) which are designed to 1) prevent pollutants from leaving a specific area, 2) reduce/eliminate the introduction of pollutant, 3) protect sensitive areas, or 4) prevent the interaction between precipitation and pollutants. BMPs that restore the assimilative functions of degraded waterbodies are also part of the strategy's measures for reducing nutrient impacts. Common examples of BMPs that will be promoted and implemented through the strategy include reduced tillage practices, planned grazing management systems (including exclusion fencing of riparian areas and deferred rotations), diverse crop rotations, grassed waterways, precision nutrient management, stream channel restoration, cover crops, riparian vegetative buffers, converting marginal cropland to permanent cover, restoration of drained wetlands, and livestock manure containment facilities.

While most BMPs recognized by the strategy can effectively minimize nutrient impacts as stand- alone practices, those benefits can be enhanced by implementing the nutrient management practices as part of a larger comprehensive management system that addresses all resources. This "systems approach" will be promoted and utilized, to the extent possible, at the watershed level as well as the farm level. By emphasizing the use of BMPs that consider the interaction and connectedness of all resources within a system, the overall effectiveness of the strategy will, in turn, be strengthened. This process will involve many different practices including those practices that improve soil health, control water movement in the field, manage water exiting fields, filter runoff waters, and restore assimilative functions. The foundation for this “systems approach” will be soil health management (Figure 6). Through the implementation of practices designed to improve soil health on agricultural lands, the nutrient and water cycles will be improved leading to more efficient nutrient use, reduced inputs, and reduced runoff due to increased infiltration and water holding capacity in the fields. Additional complimentary practices that improve nutrient assimilation and impede or prevent the transport of nutrients within or outside agricultural fields will also be needed to complete a comprehensive nutrient management system.

Implementation of the strategy and, more specifically, management of nonpoint source nutrients associated with agricultural production can only be accomplished through a coordinated statewide effort. This coordinated effort must involve landowners, commodity groups, nongovernmental organizations, academia, wildlife and conservation groups, public health organizations, and local, state, and federal agencies involved in resource management and/or agricultural production. Agencies and organizations currently involved in the management and delivery of NPS technical and financial assistance in North Dakota are shown in Table 2, but more involvement is needed by other organizations in the state, including agricultural commodity groups, public health agencies, and conservation and wildlife groups. At the center of these efforts are the landowners and individuals or entities directly involved in land management and agricultural production. As programs addressing agricultural nutrient sources unfold, input and participation from all the strategy’s partners and the agricultural community at large must be maintained to ensure actions initiated are effective, economical, feasible, and most importantly, accepted by agricultural producers.

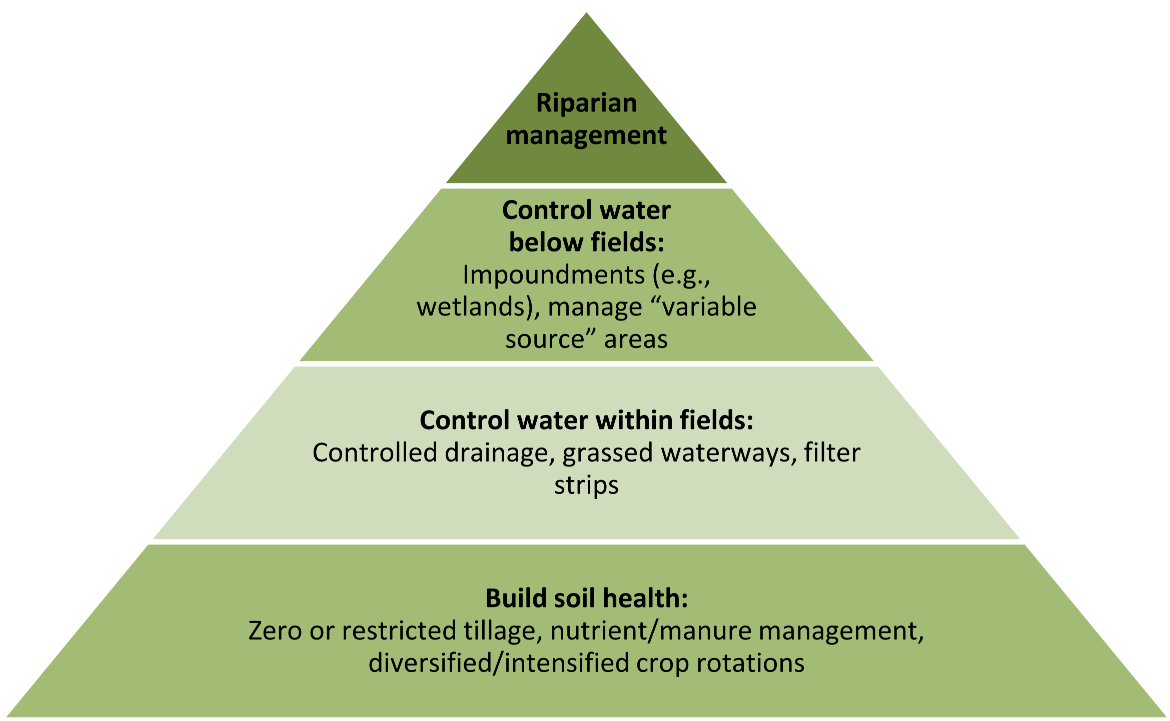

Figure 6. Conceptual Model of Conservation Practices and Best Management Practices Implementation with Soil Health as the Foundation (Tomer et al. 2013).

Table 2. NPS Partner Organizations and their Role in the Delivery of the Strategy.

Agency or Organization	Organization Type	Assistance Type **		Partner Role in Strategy Delivery		
	Federal, NGO* or State/Local	TA	FA	Strategy Planning Meetings	BMP Cost Share	Nutrient Planning Assistance
Natural Resource Conservation Service	Federal	X	X	X	X	X
US Geological Survey	Federal	X		X		
US Farm Services Agency	Federal		X	X	X	
US Fish & Wildlife Service	Federal	X	X		X	
US Environmental Protection Agency	Federal	X	X	X	X	
US Army Corps of Engineers	Federal	X				
ND Association of Soil Conservation Districts	NGO	X		X		
ND Stockmen's Association	NGO	X	X	X	X	X
ND Corn Growers Association	NGO	X		X		
Red River Basin Commission	NGO	X		X		
ND Soybean Growers Association	NGO	X		X		
ND Soybean Council	NGO	X		X		
Ducks Unlimited	NGO	X	X		X	
ND Grazing Lands Coalition	NGO	X				X
Grain Growers Association	NGO	X		X		
ND Certified Crop Advisors Board	NGO	X				X
Local Soil Conservation Districts	State/Local	X	X		X	X
Water Resource Boards (county-level)	State/Local	X	X			
ND Department of Agriculture	State/Local	X	X	X	X	X
ND Game & Fish Department	State/Local	X	X	X		
NDSU Extension Service (State-level)	State/Local	X		X		X
ND State Water Commission	State/Local	X	X	X		
ND Forest Service	State/Local	X				
ND Industrial Commission	State/Local		X		X	
Universities (NDSU, UND, VCSU)	State/Local	X	X			X

*NGO – Nongovernmental Organization
**TA – Technical Assistance; FA – Financial Assistance

The current and future ND Nonpoint Source Pollution Management Program Plans (NPS Plans) will inform this strategy with regarding to actions needed to reduce nutrient impacts to beneficial uses of the surface water resources in the state. Although there will be differences between the NPS Plans, nutrient management will likely continue to be a priority issue. The nutrient management actions to be taken under these future plans will also be similar and equally committed to achieving the goals of the Nutrient Reduction Strategy. Planned actions for the current and future NPS Plans include:

Cropland Management:

1. Support local and statewide educational programs that promote the benefits and adoption of cover crops, no till systems, diverse rotations, and other soil health management practices
2. Deliver technical and financial assistance to producers to develop comprehensive nutrient management plans that balance nutrient inputs with agronomic needs and reduce or eliminate nutrient inputs on unproductive cropland by implementing alternative uses that protect water quality in these areas
3. Promote and support the adoption of precision nutrient management practices that improve nutrient use efficiencies

4. Support field and watershed scale research or demonstration projects that evaluate the fate and transport of agricultural nutrients and/or the effectiveness of nutrient management practices and systems at reducing in-stream or in-lake nutrient concentrations

Livestock Management

1. Within NPS watershed projects, deliver technical and financial assistance to develop planned grazing systems that improve management on the uplands and riparian areas.
2. Support voluntary statewide and local programs that deliver financial and technical assistance to reduce or prevent runoff from concentrated livestock feeding areas.
3. Disseminate information of practices that improve manure utilization and reduce extended stockpiling of manure in areas that contribute runoff to nearby waterbodies.
4. Provide financial and technical assistance to develop and implement management plans for crop-aftermath grazing and winterfeeding areas to prevent accumulations of excess manure and bedding.

Subsurface and Surface Drainage Management

1. Promote nutrient management practices that minimize nutrient concentrations in subsurface and surface drain discharge waters.
2. Disseminate information on drainage management systems that improve control of tile drain discharge amounts and timing.
3. Support research and demonstration projects to evaluate effectiveness of in-field management practices as well as discharge treatment systems (e.g., bioreactors, vegetative strips, wetlands) for reducing nutrient loss on cropland.

Riparian Area Management

1. Restore the function of degraded riparian areas by supporting watershed-based projects focused on stabilizing eroding banks; improving grazing practices; preventing encroachment and reestablishing riparian buffers.
2. Support projects or programs that increase the availability of technical expertise for evaluating riparian conditions and developing restoration/management plans.
3. Through strategy partners and local NPS projects disseminate information to increase public understanding and awareness of riparian functions and the management measures needed to maintain those functions.

Coordination/Delivery

1. Coordinate with agricultural commodity groups, state natural resource agencies, and NGOs to gain input on the best approaches for increasing adoption of nutrient management practices.
2. Evaluate options for pooling financial resources or dedicating funds to address nutrient management on agricultural lands in priority watersheds.
3. Support continued development and management of the Prioritize, Target and Measure Application (PTMApp) to prioritize and implement field and watershed scale nutrient management projects in the James and Red River basins.

4. Coordinate with NDSU Extension and the State Soil Conservation Committee to develop and deliver conservation planning assistance to soil conservation districts to strengthen their capacity to address local natural resource priorities.
5. Work with NPS Program partners to evaluate options to better coordinate delivery of the various conservation funding sources in the state.

B. Strategy Implementation

The NDDEQ recognizes the successful implementation of the strategy will best be achieved on a watershed scale. This will promote a more coordinated effort for the collection and sharing of data and information, increased availability of technical and financial resources, and more focused and effective nutrient management activities.

1. Basin Water Quality Management Template

The Basin Water Quality Management Template (Basin Template) provided in Appendix D provides one example of a watershed-scale process that can be used to implement the strategy. This Basin Template is organized around the five major river basins in the State (Figure 7). This basin management concept can also be scaled down to focus on smaller watersheds to accommodate local interests and management needs. The five-major basins are:

1. Red River Basin
2. James River Basin
3. Souris River Basin
4. Upper Missouri River Basin (including Lake Sakakawea)
5. Lower Missouri River Basin (including Lake Oahe)

It is important to recognize that small catchments are nested within watersheds, which are nested within river basins. It is at the catchment level that nutrient reductions and water quality improvements will collectively provide cumulative benefits for receiving rivers and streams and downstream lakes and reservoirs.

As detailed in the Basin Template, a Basin Stakeholder Advisory Group (BSAG) is formed to undertake a locally led process that identifies and addresses water quality assessment, prioritization, restoration, and protection activities within a basin. Stakeholders will be recruited from local organizations and agencies (e.g., city councils, county commissions, townships, soil conservation districts, water resource boards, parks boards). The BSAG is also responsible for establishing a Basin Technical Advisory Group (BTAG)) to provide input during development and implementation of the Basin Plan.

Staff from the WMP and members of a BTAG will provide the necessary assistance to ensure the success of the BSAG in developing a comprehensive Basin Plan. The Basin Plan will formulate integrated, comprehensive nutrient reduction strategies and an implementation plan. The Basin Plan will be the key document used by the BSAG and its partners to:

1. Describe resource conditions in the basin
2. Identify water quality management priorities
3. Identify information and education priorities
4. Schedule implementation of priority projects,
5. Estimate financial needs for a 5-year project implementation period
6. Conduct a basin assessment to evaluate progress/success and adjust goals/priorities

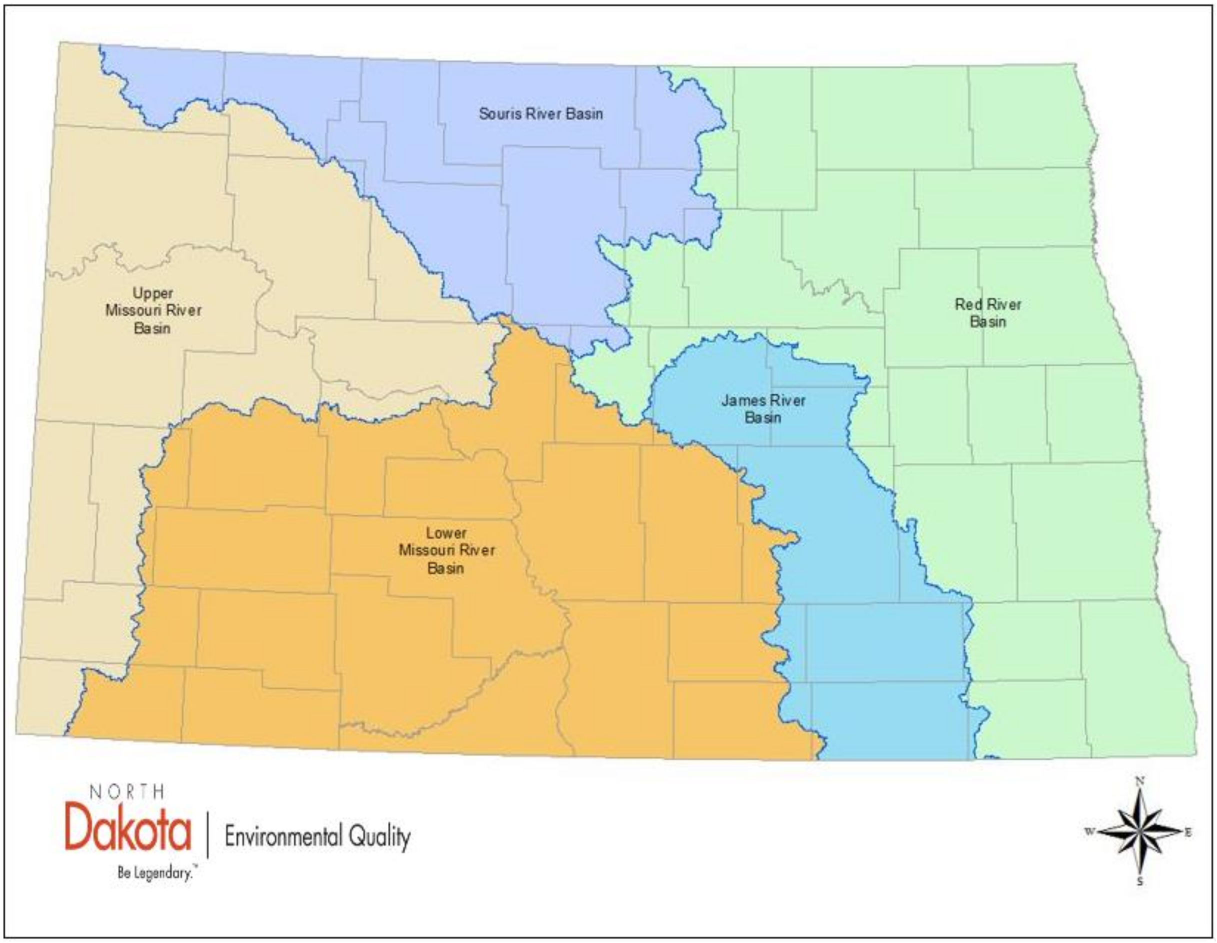

Figure 7. Major River Basins in North Dakota.

2. Water Quality and Watershed Management Support Programs

The NDDEQ Division of Water Quality administers water quality and watershed management programs that will be critical to the development and implementation of each basin plan and to nutrient reduction projects which are included in these plans. The following is a brief description of some of these programs.

Water Quality Standards Program

State water quality standards are State regulations (i.e., North Dakota Administrative Code) that describe the policy of the State which is to protect, maintain, and improve the quality of water for use as public and private water supplies; for propagation of wildlife, fish, and aquatic life; and for domestic, agricultural, industrial, recreational, and other legitimate beneficial uses.

The State classifies its surface water resources into four categories based on assigned designated beneficial uses. Class I, IA, II, and III waters are all assigned the aquatic life, recreation, municipal drinking water, industrial, and agricultural uses. What distinguishes the differences between the classes is the level of treatment needed for municipal drinking water. The assignment of a waterbody into a particular classification is also based on the water quality at the time the first standards were promulgated, which was 1967; existing uses at that time; hydrology of the waterbody; and natural background factors affecting water quality.

Water quality standards also identify specific numeric criteria for chemical, biological, and physical parameters. The specific numeric standard assigned to each parameter ensures protection of the beneficial uses assigned for each class of waters provided in the standards. The water quality standards also contain general conditions, termed “narrative standards,” applicable to all waters of the State. These general conditions contain provisions not specifically addressed in numeric criteria and add an extra level of protection for water quality.

The NDDEQ has also developed a narrative biological goal to restore all surface waters to a condition like that of sites or waterbodies determined to be regional reference sites. The goal is non-regulatory; however, it may be used in combination with other information in determining whether aquatic life uses are attained. The State is also in the process of developing “biological criteria.” These criteria will define ecological conditions in State waters and set goals for their attainment.

In addition to numeric and narrative standards and the beneficial uses they protect; a third element of water quality standards is antidegradation. The fundamental concept of antidegradation is the protection of waterbodies which currently have better water quality than applicable standards. Antidegradation policies and procedures are in place to maintain high quality water resources and prevent them from being degraded to the level of water quality standards.

State water quality standards have established three categories or tiers of antidegradation protection. Category 1 is a very high level of protection and automatically applies to all Class I and IA rivers and streams, all Class 1, 2, and 3 lakes and reservoirs, and wetlands that are functioning at their optimal level. Category 1 may also apply to some Class II and III rivers and streams, but only if it can be demonstrated that there is remaining pollutant assimilative capacity, and both aquatic life and recreation uses are currently being supported. Category 2 antidegradation protection applies to Class 4 and 5 lakes and reservoirs and to Class II and III rivers and streams not meeting the criteria for Category 1. Category 3 is the highest level of protection and is reserved for Outstanding State Resource Waters.

Waterbodies may only be designated Category 3 after they have been determined to have exceptional value for present and future potential for public water supplies, propagation of fish or aquatic biota, wildlife, recreation, agriculture, industry, or other legitimate beneficial uses.

The U.S. EPA requires the NDDEQ to review and update, as necessary, the State water quality standards based on new information and the EPA guidance a minimum of every three years. This process is termed the "triennial review."

Monitoring and Assessment Programs

North Dakota's surface water quality monitoring program is detailed in a report entitled *North Dakota's Water Quality Monitoring Strategy for Surface Waters: 2008-2019* (NDDEQ, 2014). This document describes the NDDEQ's strategy to monitor and assess its surface water resources, including rivers and streams, lakes and reservoirs, and wetlands.

The NDDEQ's water quality monitoring goal for surface waters is ***"to develop and implement monitoring and assessment programs that will provide representative data of sufficient spatial coverage and of known precision and accuracy that will permit the assessment, restoration, and protection of the quality of all the State's waters."*** In support of this goal and the water quality goals of the State, the NDDEQ has established 10 monitoring and assessment objectives. The following objectives have been established to meet the goals of this strategy. They are:

- Provide data to develop, review, and revise water quality standards.
- Assess water quality status and trends.
- Determine beneficial use support status.
- Identify impaired waters.
- Identify causes and sources of water quality impairments.
- Provide support for the implementation of new water management programs and for the modification of existing programs.
- Identify and characterize existing and emerging problems.
- Evaluate program effectiveness.
- Respond to complaints and emergencies.
- Identify and characterize reference conditions.

Monitoring Programs, Projects, and Studies

To meet the goals and objectives outlined above, the NDDEQ has taken an approach which integrates several monitoring designs, both spatially and temporally. Monitoring programs include fixed station sites, stratified random sites, rotating basin designs, statewide networks, chemical parameters, and biological attributes. In some cases, NDDEQ staff members conduct the monitoring, while in other instances monitoring activities are contracted to other agencies such as soil conservation districts, the US Geological Survey (USGS) or private consultants. Table 3 provides a summary of the current monitoring programs, projects, and activities that are implemented by the NDDEQ's WMP.

Table 3. Summary of Monitoring Programs and Objectives.

Monitoring Program	Monitoring Objective(s)
Ambient Water Quality Monitoring Network for Rivers and Streams	1. To provide data for trend analysis, general water quality characterization, and pollutant loading calculations. 2. To support the assessment of beneficial use attainment for Section 305(b) reporting and Section 303(d) listing. 3. To develop nutrient criteria. 4. To identify water quality problems. 5. To evaluate the effectiveness of pollution control and abatement programs (e.g., NDPDES and Section 319).
Biological Monitoring Program for Rivers and Streams	1. To assess aquatic life use attainment for Section 305(b) reporting and Section 303(d) listing purposes. 2. To develop nutrient criteria. 3. To identify water quality problems. 4. To evaluate the effectiveness of pollution control and abatement programs (e.g., NDPDES and Section 319).
Ecoregion Reference Station Network	1. To develop biological indicators using fish, macroinvertebrates, and/or periphyton and to use those indicators in biological condition assessment for the State's rivers and streams at varying spatial scales. 2. To develop/refine nutrient criteria for rivers and streams. 3. Refine existing sediment reference yields for rivers and streams.
Lake Water Quality Assessment Program	1. To describe the general physical and chemical condition of the State's lakes and reservoirs, including trophic status. 2. To assess beneficial use attainment for Section 305(b) reporting and Section 303(d) listing. 3. To develop nutrient criteria. 4. To identify water quality problems. 5. To evaluate the effectiveness of pollution control and pollution abatement programs (e.g., NDPDES, Section 319). 6. To refine fishery classifications described in the State water quality standards.
Missouri River Mainstem Monitoring Program	1. To provide data for trend analysis, general chemical characterization, and pollutant loading calculations. 2. To assess beneficial use attainment for Section 305(b) reporting and Section 303(d) listing. 3. To develop nutrient criteria. 4. To develop biological indicators for the mainstem Missouri River using fish, macroinvertebrates, and/or periphyton and to use those indicators in biological condition assessment of the Missouri River. 5. To identify water quality problems.

Table 3 (cont). Summary of Monitoring Program and Objectives.

Monitoring Program	Monitoring Objective(s)
Fish Tissue Contaminant Surveillance Program	1. To protect human health by monitoring and assessing the levels of commonly found toxic compounds in fish from the State's lakes, reservoirs and rivers. 2. To use these data to develop and issue fish consumption advisories. 3. To assess fish consumption use attainment for Section 305(b) reporting and Section 303(d) listing. 4. To identify water quality problems due to contaminants. 5. To monitor and assess human exposure of contaminated fish.
Wetland Monitoring and Assessment Program	1. To develop biological indicators and assessment methodologies for wetlands and to use those indicators and methods to monitor and assess wetland condition at varying spatial scales. 2. To refine and apply wetland assessment methods to evaluate the effectiveness of wetland mitigation and restoration programs and projects. 3. To support the development of water quality standards for wetlands.
Total Maximum Daily Load Development (TMDL) Program	1. To assess the State's rivers, streams, lakes, and reservoirs and to provide a list of waterbodies that are impaired. 2. To develop TMDLs for waterbodies on the State's Section 303(d) list that, when implemented, will restore the waterbody's impaired beneficial uses. 3. To develop scientifically defensible water quality targets that can be used in water quality assessment, the development of TMDLs, and in the development of nutrient criteria.
Nonpoint Source Pollution (NPS) Management Program	1. To assess waterbodies with little or no water quality assessment information by identifying beneficial use impairments or threats to the waterbody and to determine the extent to which those threats or impairments are due to NPS pollution. 2. To evaluate the effectiveness of implemented BMPs in meeting the NPS pollutant reduction goals specified in NPS implementation projects.
Support Projects and Special Studies	1. To provide data or information to either answer a specific question or to provide program support.
Complaint Investigation	1. To determine whether or not an environmental or public health threat exists and the need for corrective action where problems are found.
Fish Kill Investigations	1. To determine the extent of the fish kill and the possible cause(s) of the fish kill.

Total Maximum Daily Load Program

A Total Maximum Daily Load (TMDL) is a pollution budget and includes a calculation of the maximum amount of a pollutant that can occur in a waterbody which is necessary to meet water quality standards. A TMDL serves as a planning tool and potential starting point for restoration or protection activities with the goal of attaining or maintaining water quality standards. In North Dakota, the NDDEQ's WMP is responsible for the development, implementation, and delivery of the TMDL Program. There are two components to the TMDL Program, both which are required under Section 303(d) of the Clean Water Act and its accompanying regulations (CFR Part 130 Section 7).

Part one of the program requires each state to identify individual waterbodies (i.e., rivers, streams, lakes, and reservoirs) which are considered water quality limited (not meeting water quality standards) and which require load allocations, waste load allocations, and TMDLs. This list of impaired waters is prepared and submitted to the EPA every two years in the form of the "Integrated Section 305(b) Water Quality Assessment Report and the Section 303(d) List of Impaired Waters Needing Total Maximum Daily Loads (TMDLs)" (aka the Integrated Report).

After developing a list of impaired waters needing TMDLs, the second part of the program involves prioritizing waters on the TMDL list and then developing TMDLs for those priority waters. To accomplish the TMDL Program's goal of systematically prioritizing and reporting on priority watersheds or waters for restoration and protection and to facilitate State strategic planning to achieve water quality protection and improvement, the WMP has developed a "North Dakota Total Maximum Daily Load Prioritization Strategy" (NDDEQ, 2016). This TMDL Prioritization Strategy describes a two-phased approach for prioritizing impaired waters for TMDL development and watershed planning. Specifically, the TMDL prioritization strategy will be used to identify:

- A list of priority waters targeted for TMDL development or alternative approaches in the next two years (near term)
- A list of priority waters scheduled for likely TMDL development or alternative approaches through 2022 (long term)

The responsibility for TMDL or alternative plan development for the State's priority TMDL listed waterbodies lies primarily with the WMP. To facilitate the development of TMDLs, the NDDEQ created three regional offices located in Fargo, Bismarck, and Towner, N.D. The focus of the regional TMDL/Watershed Liaison staff is to work with local stakeholders in the development of TMDL water quality assessments, TMDLs, and alternative plans based on the Section 303(d) list of impaired waters. Technical support for TMDL development projects and overall program coordination is provided by WMP staff located in Bismarck.

Typically, TMDL development projects involve monitoring and assessment activities which will:

- Quantify the amount of a pollutant (e.g., nutrients) that the impaired water can assimilate and still meet water quality standards.
- Identify all sources of the pollutant contributing to the water quality impairment or threat.
- Calculate the pollutant loading entering the waterbody from each source.
- Calculate the reduction needed in the pollutant load from each source necessary for attainment of water quality standards.

The goals, objectives, tasks, and procedures associated with each TMDL development project are described in project-specific Quality Assurance Project Plans.

Point Source Control Program

As described in Section IV.A.4. Implementation Strategies for Nutrient Reduction-Municipal and Industrial Point Sources, the NDDEQ regulates all releases of wastewater from point sources into waters of the State. Point source pollution is defined simply as pollution coming from a specific source, like the end of a pipe.

Within the NDDEQ, the regulation of all point source discharges is the responsibility of the Division of Water Quality's North Dakota Pollutant Discharge Elimination System (NDPDES) Program. The NDPDES program requires all point source dischargers (municipal and industrial) to obtain a permit. NDPDES permits outline technology-based and/or water quality-based limits for pollutants required by the Clean Water Act based on the facility type or category and for other pollutants determined to have a reasonable potential to exceed water quality standards based on the permit application. The NDPDES permit also requires monitoring and reporting for those pollutants listed in the permit to ensure the facility's discharge does not exceed water quality standards.

Since 1992, permits have been required for stormwater discharges associated with construction and industrial facilities. Permitting stormwater discharges from industrial sites, construction sites, and larger municipalities has become a major portion of the NDPDES program. The NDDEQ has issued four separate general permits for stormwater discharges. The general permits outline requirements for stormwater discharges from construction activities, industrial activities, mining operations, and municipal separate storm sewer systems (MS4's).

Nonpoint Source Pollution (NPS) Control Program

All lakes, rivers, and streams assessed within the State are impacted to some degree by NPS pollution. Generally, most water quality impacts to lakes, rivers, and streams are associated with agricultural activities in their watersheds. The exception would be watersheds with larger cities. There, NPS pollution impacts are also related to urban activities. Groundwater impacts can result from the improper use of agricultural chemicals, leaking underground petroleum storage tanks, and pipelines, wastewater impoundments, oil and gas exploration activities, septic systems, and improperly located and maintained solid waste disposal sites.

State and local efforts to address nonpoint source pollution impacts to the beneficial uses of North Dakota's water resources are primarily accomplished through the NPS Pollution Management Program (NPS Program). The NPS Program is a voluntary program, largely dependent on the formation of partnerships and coordination with local, state, and federal resource managers. The mission for the NPS Program is to implement a voluntary, incentive-based program that restores and protects the chemical, physical, and biological integrity of waters where beneficial uses are threatened or impaired due to nonpoint sources of pollution.

The goals for the NPS Management Program have evolved over time as projects are completed and updated management plans are developed every five years. The current NPS Pollution Management Program Plan (Management Plan) is posted on the NDDEQ website: [NPS Home (nd.gov)](). Detailed information on current NPS Program goals, priorities, and delivery are provided in the Management Plan. Despite some differences in delivery methods, the basic goals of all the Management Plans have continued to focus on watershed assessment, implementation of corrective measures, and public education.

Annually, the NPS Program uses Section 319 funding to support approximately 30-35 NPS projects throughout the State. While the size, target audience, and structure of the projects can vary significantly, they all share the same basic objectives of increasing public awareness of NPS pollution issues and solutions, reducing/preventing the delivery of NPS pollutants to waters of the State, and evaluating the benefits of the project. Projects supported by the NPS Program will generally fall under one of four different categories that describe the basic focus of the project.

These project categories are: 1) development phase projects, 2) watershed projects, 3) support projects, and 4) information and education (I&E) projects. A brief description of the project categories being implemented under the NPS Program are as follows:

> Development Phase Projects: Development phase projects are the first step in determining NPS pollution management needs and solutions. The watershed scale assessment projects under this category are generally initiated by local groups or organizations in response to an observed water quality problem and/or other information on water quality conditions in a specific waterbody (e.g,. water quality assessment reports, TMDL list). Information and data collected through the development phase watershed assessment projects is typically used to: 1) determine the extent of beneficial use impairments associated with NPS pollution, 2) identify sources and causes of NPS pollution, 3) establish watershed-specific NPS pollutant load reduction targets, 4) identify feasible solutions to achieve NPS pollutant load reduction goals, and 5) develop a Total Maximum Daily Load (TMDL), when applicable. In addition to the watershed assessments, the development phase projects also may include projects focused on the development of watershed assessment tools or the evaluation of new or emerging NPS pollutant sources and causes. The development phase projects are generally one to two years in length.
>
> Watershed Projects: Watershed projects are the most comprehensive and long-term projects implemented through the NPS Program. These projects are designed to address documented NPS pollution impacts identified through previous development/assessment phase projects or TMDL reports. The primary goal of the watershed projects is to restore

or protect waterbodies where the beneficial uses are impaired or threatened due to NPS pollution. This watershed project goal is generally accomplished by 1) promoting voluntary adoption of specific BMPs, 2) providing financial and technical assistance to implement BMPs, 3) disseminating information on the project and solutions to identified NPS pollution impacts, and 4) evaluating progress toward meeting NPS pollutant reduction goals. Local sponsors will utilize any available funding including Section 319 funds, USDA cost-share, North Dakota Outdoor Heritage funds, and local contributions to support their watershed restoration efforts. Funds allocated to a watershed project will typically be used to employ staff, cost-share BMPs, conduct I&E events, and monitor trends in the aquatic community, water quality and/or land use. Watershed projects, which are generally initiated as five-year projects, can be extended another five or more years depending on progress, size of the watershed, extent of beneficial use impairments associated with NPS pollution, and availability of funding.

Support Projects: These are projects that support BMP implementation within other NPS project areas or address a specific NPS pollutant source. Support projects can be statewide in scope or targeted toward specific NPS projects, geographic areas, or priority watersheds. Generally, support projects deliver a specific specialized service or provide financial and/or technical assistance to implement a specific type of BMP. Services provided by these projects may include the development of construction designs and/or planning and financial assistance to implement BMPs such as livestock manure management systems, wetland and stream restorations, and riparian buffers. Most support projects will be five or more years in length.

Information and Education Projects: The fourth type of NPS project is the information and education (I&E) project. As the name implies, projects in this category are those that are designed to educate the public on various NPS pollution issues. Educational projects can vary greatly in size, focus and target audience and be delivered statewide or locally. Some projects may only use demonstrations or workshops to reach the target audience while others combine several educational offerings to deliver a NPS pollution management message. The I&E projects can be one to three years in length, with the option to extend the project an additional three years.

Delivery of the NPS Program is being accomplished through five objectives addressing 1) Waterbody Prioritization, 2) Resource Assessment, 3) Project Assistance, 4) Coordination, and 5) Public Education. Each objective has specific tasks, planned outputs, and milestones that describe the major actions to be completed during the Management Plan period. These objectives are presented as individual sections of the Management Plan and are as follows:

- Waterbody Prioritization - Provide direction for the delivery of financial and technical assistance to assess, restore or protect waterbodies impaired or threatened by NPS pollution.

- Resource Assessment - Document beneficial use and water quality conditions of priority waterbodies and/or watersheds and identify the sources and causes of beneficial use impairments.

- Project Assistance - Coordinate with local partners to secure sufficient financial and technical resources to support the development and implementation of priority watershed assessments, educational programs, and watershed restoration or protection projects.

- Coordination - Maintain and expand partnerships at the state and local levels to diversify input for project development and implementation as well as to increase opportunities for securing and coordinating resources to efficiently address identified NPS pollution impacts.

- Public Out-Reach and Education - Strengthen support for and participation in NPS pollution management projects by increasing public awareness and understanding of NPS pollution impacts and the solutions for restoring and protecting those water resources impaired or threatened by NPS pollution.

3. Adaptive Management

A key to the successful implementation of the nutrient reduction strategy, Section 319 Project Implementation Plans, or other watershed-based planning efforts, is the adaptive management process. Adaptive management, also known as adaptive resource management (ARM), is a systematic approach for improving resource (or in this case water quality improvement and nutrient reduction) management policies and practices by learning from management outcomes.

The adaptive resource management process (ARM) acknowledges uncertainty about how natural resource systems function and how they respond to management actions. ARM is designed to improve the understanding of how a resource system works, to achieve management objectives. ARM also makes use of management interventions and follow-up monitoring to promote understanding and improve subsequent decision making. In the context of nutrient reduction planning at the watershed scale, ARM consists of the development, implementation, and periodic evaluation of the watershed plan to maintain effectiveness. If a desired outcome is not accomplished, then the plan will be modified or changed.

4. Education and Outreach

Public education and outreach are important core components to the successful development and implementation of the Nutrient Reduction Strategy.

In terms of the nutrient reduction strategy, education and outreach will be required at multiple spatial scales, including the state scale and watershed or local scale. At the state scale, education and outreach will need to focus on communicating the water quality impairments associated with nutrient pollution as well as the primary purpose of the nutrient reduction strategy, its guiding principles, and its goals and objectives.

At the watershed scale, education and outreach will be used to inform the public and policy makers at the state and county level of the nutrient impairments, management priorities, and strategies for addressing priority nutrient impacts to beneficial uses. It is expected local stakeholders in the watershed will be responsible for identifying and implementing educational activities pertinent to their watershed issues. With assistance from the WMP, these local education strategies will address the following objectives:

1. Identify and analyze the target audience:
   a) Collect relevant watershed and community assessment information.
   b) Analyze and evaluate information, identify and address data gaps.
   c) Assess, prioritize, and analyze key concerns and issues.

2. Create the message:
   a) Develop management objectives and strategies for implementation.
   b) Package the message.
   c) Distribute the message.

3. Evaluate the outreach campaign:
   a) Adapt selected management actions.

5. Reporting and Accountability

Reporting the progress of nutrient reduction at the State, basin, and watershed scale is an important component of the strategy and is critical to the successful implementation of the strategy. Effective communication among the agencies and organizations involved in nutrient reduction activities and the public is essential to maintaining transparency and ensuring credibility. Communicating successes to the appropriate audiences in the form of a clear, concise, and understandable message will help engage stakeholders and build confidence in the programs, projects, and activities that will be implemented through the strategy.

Reporting can take many forms including websites, presentations, meetings, and traditional reports. Some of the NDDEQ reports on nutrient reduction progress include the biennial Integrated Section 305(b) Water Quality Assessment Report and Section 303(d) List of Impaired Waters Needing TMDLs (aka the Integrated Report), the Section 319 Nonpoint Source Program annual report, and annual reports required under the State/EPA Performance Partnership Agreement. In addition to the reports required by federal rule and/or law, the NDDEQ will develop a new set of reporting indicators and measures specific to nutrient reduction. These new measures will be used to inform agencies, organizations, and the public of progress being made to reduce the contribution of nutrients to our surface waters and in improvements in water quality. Potential new nutrient reduction reporting strategies include:

- Convene a workshop to identify indicators, measures, and/or endpoints that can be used to report on progress in meeting nutrient reduction goals at the state, basin, and watershed scale.
- Hold an annual nutrient reduction forum or summit which will highlight nutrient reduction successes and failures, lessons learned, and goals for the future.
- Prepare an annual report specific to nutrient reduction in the State.

V. Recommended Actions to Support Nutrient Reduction Strategy Implementation

The following are specific actions that are suggested to reduce the delivery of nutrients to surface waters from each of the source categories. Many of these actions were suggested at two stakeholder meetings, one held in Fargo on May 1, 2018, and the other held in Mandan on May 3, 2018. The following actions are in addition to the general source category actions and strategies. In addition to the specific nutrient reduction actions recommended for each source category, recommendations for specific education and outreach and indicators and measures are also provided for each source category.

Stormwater and Point Sources

Specific Implementation Actions/Strategies

- Improve stormwater management by conducting training to MS4 systems in the form of "pond schools."

- Predictability – life cycle treatment, if x than y, multi-permit

- Define point source – beet piles
  - Operational
  - Structural

- Prioritize phosphorus for nutrient reduction.

- Consider trading and credits, especially in the Red River basin.

- Treatment credit – drinking water

- Credit for taking septics/small systems

- Pond optimization
  - Small municipal

- Research stormwater (urban)

- Source control
  - Pretreatment
  - Cooling water, etc.

- Monitoring
  - Intake
  - DMR
  - In-stream

- Housekeeping BMPs

Education and Outreach Actions/Strategies

- Have individual "pond school" in the Red River Valley.
- Common outreach materials for cities
- Watershed based agreement for predictability
- Discussion with Minnesota
- Acreage/land use
- LEC
- "Bad Actors"

Indicators and Measures

- Discharge monitoring
- Reasonable utility rates/cost
- Stay out of court.
- Monitoring
- Accountability/responsibility

Private Sewage Disposal Systems

Specific Implementation Actions/Strategies

- Survey at the township level – rural areas
- Actions
    - Inspection of system upon sale
    - Learn observe surrounding areas
    - Statewide consistent approach to rules, permitting, training, installers, etc.
- Determine scope of the issue
    - How many systems
    - Size of system
    - Age of system
    - Sized according to soil test/type
- Consistent approach

- Review systems on homes that are “x” age.

- Limit where septic systems can be installed (soils are a limiting factor).

- Education and public outreach
  - Real estate agents
  - Developers
  - Social media

- Finding bad actors when it comes to installation
  - Education and permitting/licensing

<u>Education and Outreach Actions/Strategies</u>

- Work with township officers/board to survey septic systems to assess system – need to know how many systems.
  - Explain why it is important
  - Statewide township officers meeting
  - Develop document for township to use
    - Simple 5 questions

- Work with counties on where they are at with septic ordnances.
  - First step to consistent approach

- Contact surrounding states to see what codes they have and what education is available.

- Use available programs (319) to set sailing systems.

- Realtor training

- Publications
  - “Maintaining Your septic system”- Farm & Ranch Guide (explain why and the $ savings)
  - Inserts in proper tax statements
  - Developers- handout zoning-NRCS soil info
  - Handouts for septic pumpers to give to customers
- Meeting with public health units
  - Posting of each county’s ordinances on state DoH website

<u>Indicators and Measures</u>

- Percentage of townships complete percentage of surveys

- Percentage of counties that have a septic code

- Made contact with MT, SD and MN

- Inventory state systems to determine scope.
  - Follow up after “x” amount of time of outreach.

- Target township level.

- Determine level of pumping.
    - Pumper records

- DNA testing to identify problems

AFOs/CAFOs

<u>Specific Implementation Actions/Strategies</u>

- Livestock pollution reduction program – NDDA
    - Runoff control
        - Small facilities
        - Location (zoning)

- ND Stockman's Environmental Services
    - Setbacks
        - Water and people
    - Precision application for waste from Animal Feeding Operations
        - Lack of monitoring (N&P Control) and volume/acreage

- Soil Tests – Application rates

- Producers need to ensure manure is handled
    - In accordance with application rates

- Unpermitted AFO's need more energy in education and outreach.

- Over application

- Enforce laws in place

- Local level township (start)
    - Landowner

- Filter strips

- More public input

- Fines (enforce fines for pollution)

- Maintaining compliance

- NDSU Extension
    - Traveling program

- Education for public on what is going on.
    - "Farm to Plate" for urban and rural public (all ages)
    - Facilitate education success stories

- Education for producers on the importance of soil tests to manure tests for proper land application to ensure over application is prevented.

- Analysis of manure for chemical composition.

- More education and outreach for NMP's.

- Small → Large need to incorporate the above actions.

- Producers-education-look at using facilities that have been successful.

- Social media outreach.
    - Twitter
    - Facebook
    - Develop App for DEQ
    - NDSU Extension- NMP education
    - Financial Assistance/technical
        - Dept. Ag
        - NRCS
        - Stockmen's

Education and Outreach Actions/Strategies

- Soil test/precision application/manure analysis.
    - Over application

- Set backs.

- All communication starting at local level (bottom-up).

- Enforce laws.
    - Livestock pollution reduction program/stockman's
        - Voluntary
- Memorable marketing.

- Sellable.

- Face to Face/ food & coffee.

- Are AFO & CAFOs over sold on the impacts to water quality.

Indicators and Measures

- Amount of enforcement actions.

- Annual basis

- BMP's on the ground

- Permitted= Do report & accountable

- Non-permitted

Agricultural Nonpoint Sources

<u>Specific Implementation Actions/Strategies</u>

- Education – Success stories
  - Current states
  - BMP – what they are
  - Economic of BMP

- BMP Demonstrations (working farms)
  - What works – Where/When/How

- Coordinate measures with
  - CCA, local producers
  - CEU's for CCA's
  - Extension
  - Banks etc.

- Educate insurance companies/policies.

- Apply nutrients to max yield using extension recommendations – reduces over application.

- Recognition of different soil capabilities

- Messaging on small HUCS.
  - Locals know specifics better, more effective, small/closer groups easier to coordinate/motivate/interest people into reduction strategies

- Has to be based on science
- Must include economist as well

- Peak flow reduction

- Follow up with results and data to respective agency
  - Who's tracking
  - What is the impact/benefit
  - Tell everyone, not just local

  Example: Easements for soil retention – is it working/how much

- Celebrate success.

- Erosion control/cover crops
- Seasonal water retention
- Limiting red tape and bureaucracy
- Communication is key
- System of discovery farms to help spread ideas and information relevant to local landowners
- Education
- Identify potential risk areas
    - Current states inventory
- Identify BMP/systems that are known to work
- Identify additional research needs
- Solicit impact from stakeholders
- "Helping" structure for success
    - Technical (one stop)
    - Financial resources
    - Farmer to farmer testimony
    - Common message
- Solution based on science
- Matching economics and timeliness with opportunities and assistance

<u>Education and Outreach Actions/Strategies</u>

- Economies for BMP
    - Acquire form scale economic data
    - Inform through partnerships
- Coordinate messages (common messaging).
- BMP demonstration
- Monthly press release of successes (consistently).
- Social media/newspaper (old and new).
- Field Day

- Get young people engaged to show profit.

- Need someone in charge
  - Social media director
  - Make sure things are "findable" and follow up
  - Learn best/most read newspapers

- Make sure <u>positives</u> are included as well as negative.
  - Positive actions/projects/things that improve

- Highlight results of demos – broad scope.

- Peers telling peers how things work – include funding

- Piggyback on other meetings (Thursday afternoon).

- Make sure science is not over their heads.

- Start with compliments/recognition of what has been done.

- All social media

- Technical assistance training (common message)

- Public service messaging
  - Rural & urban

- Commodity group publications

- Maximize face to face contacts

- Turn around assistance team- (structure for success)

- Demonstration projects (water quality champions)

<u>Indicators and Measures</u>

- Use farm management instruction.
  - Information sharing process

- Standard marking material
  - Track all outreach efforts.

- Field day attendance, trends, money on BMP

- Alternate survey

- Water Quality data shows position trend (edge of field).

- Increase participation in government programs.

- Monthly press releases on success

- Establish regional number values and show relationships.

- PSA's before/after farm reports
    - Farm
    - Former success stories
    - Thank you's

- Make values/information understandable.
    - Don't need chemistry to understand
    - "Spotlight" index (fire damage)
    - Report/Index/Updated – better leverage/field level
        - Numbers into something understandable

- Presentations of results/status at commodity farm shows

- Results published in local county newspapers

- Awards and words

- Farmer Speakers
    - Speakers bureau

- Publish success.

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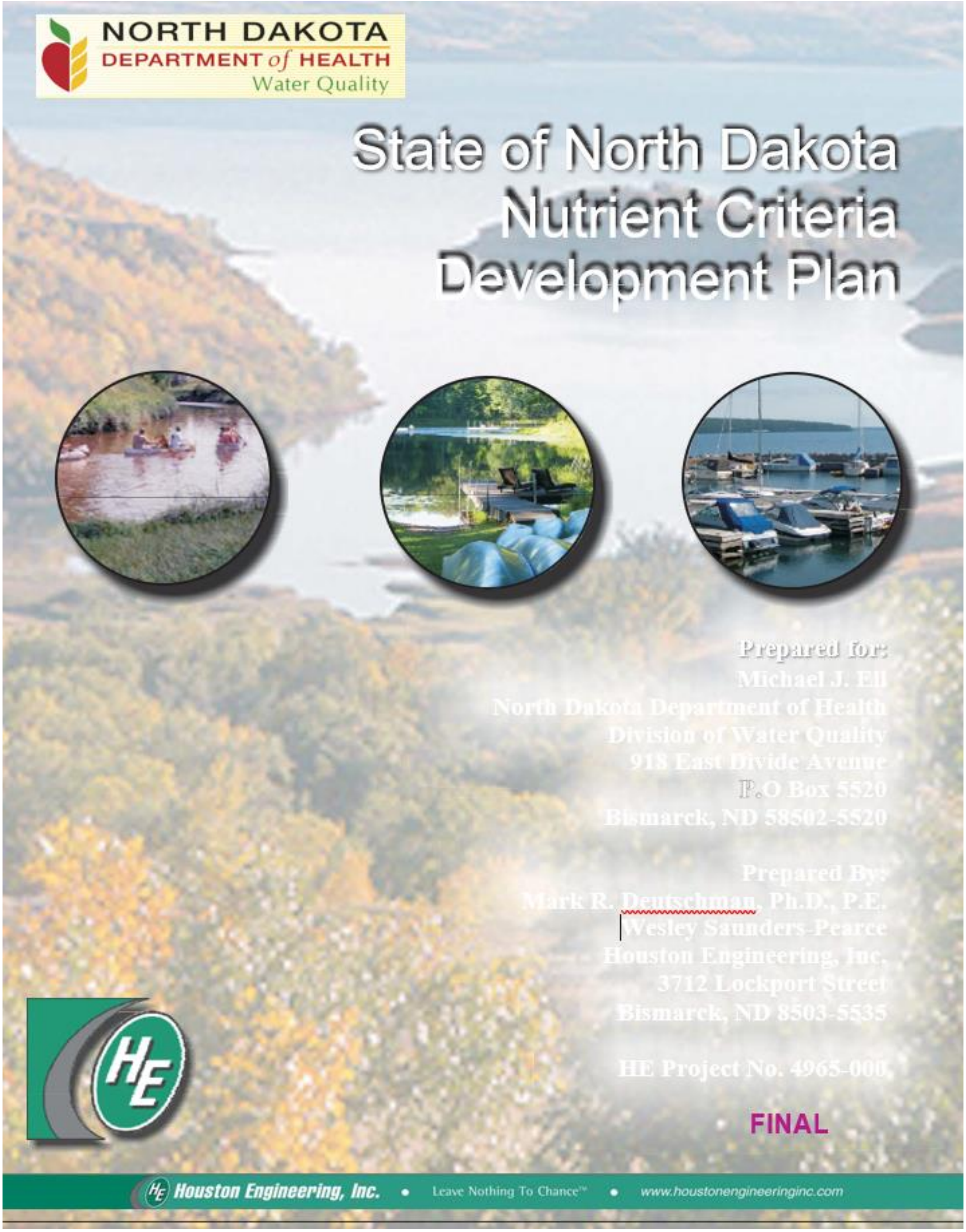
Appendix A
North Dakota Nutrient Reduction Strategy
Planning Team Members

Sector/Agency/Organization	Agency/Organization Contact
Agriculture Sector	
ND Stockmen's Association	Julie Ellingson Scott Ressler
ND Assoc. of Soil Conservation Districts	James Cart Brian Johnston
ND Farmers Union	Wes Niederman
ND Farm Bureau	Jeffrey Missling Eric Aasmundstad
Municipalities/Local Government	
Public Utilities, City of Bismarck	Keith Demke
ND League of Cities	Jerry Hjelmstad Connie Sprynczynatyk
ND Association of Counties	Terry Traynor
ND Tribes, Standing Rock Sioux Tribe	Everett Iron Eyes Ronni Chase Alone Larissa Wolf Necklace
Industry	
Tesoro Refinery/ND Water Pollution Board	Randy Binegar
American Crystal Sugar	Craig Maetzold
ND Lignite Energy Council	Sandi Tabor
ND Petroleum Council	Kari Cutting
Regulatory/Agency	
ND Dept of Agriculture	Doug Goehring
ND State Water Commission	Mike Noone
ND Game and Fish Dept	Scott Elstad
US Fish and Wildlife Service	Jessica Johnson
Environmental	
ND Wildlife Federation	Mike McEnroe
Dakota Resource Council	Don Morrison Leo Walker, alternate
Sierra Club-Dakotah Chapter	Wayde Schafer
Exofficio Members	
USGS	Joel Galloway
NRCS	Mary Podoll Ted Alme
US EPA Region 8	Al Basile Eric Steinhaus

NDSU Extension	Dave Franzen
ND Dept of Environmental Quality	Dave Glatt Karl Rockeman Mike Ell Aaron Larsen Peter Wax Greg Sandness

Appendix B
North Dakota Nutrient Criteria Development Plan



NORTH DAKOTA
DEPARTMENT of HEALTH
Water Quality

State of North Dakota Nutrient Criteria Development Plan

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FINAL

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1 Introduction

1.1 Impetus for Developing Nutrient Criteria

Nutrients such as phosphorus and nitrogen are essential components used during normal biological processes within plants and animals. Nitrogen and phosphorus are naturally occurring substances, an important component of the molecular backbone of cells, and essential to sustaining life. Within surface waters, nutrients exist in a variety of forms. Nutrients may be in either particulate or dissolved phases, associated with living or senescent tissues (i.e., organic) or associated with abiotic (inorganic) material such as the soil matrix.

Elevated levels of phosphorus and nitrogen within the environment resulting from human activity can cause real (or perceived) concerns for surface water quality. These concerns become manifested when a lake, reservoir, wetland or stream fails to meet its intended societal use (i.e., beneficial use) because excess nutrients cause too much algae and/or vegetation growth (or some other consequence) resulting in an "impaired" condition. The enrichment of lakes, reservoirs, rivers and wetlands with excess nutrients is consistently one of the top causes of water resource impairment within the United States (EPA 2000).

In 1998, the U.S. Environmental Protection Agency (EPA) published the *National Strategy for the Development of Regional Nutrient Criteria* (i.e., the National Strategy). The genesis for the National Strategy stems from a foundation of technical work completed at the state, regional, and national level to assess the existing data on nutrient problems and the extent of currently available tools to assess and address nutrient enrichment (EPA 1998). This work culminated in a Clean Water Action Plan (CWAP) published in the Federal Register in March 1998, which includes the development of water quality nutrient criteria as a key component.

The National Strategy describes the approach recommended by the EPA when developing nutrient criteria and in working with States and Tribes to adopt nutrient criteria for implementation through numeric water quality standards. The intent of the National Strategy is to establish numeric water quality criteria for nutrients, implemented as standards, which curtails water quality problems stemming from excessive nutrients in the environment. The intent is to restore and protect the Nation's water resources.

1.2 The Federal Approach to Nutrient Criteria

The EPA's *National Strategy for the Development of Nutrient Criteria* involves a two-phased approach. During Phase I, the EPA developed nutrient water quality criteria (i.e., recommended concentrations) for phosphorus, nitrogen, and other parameters for use by states as a fundamental tool to begin developing state-specific nutrient criteria. The recommended EPA criteria are based upon a statistical analysis of previously collected water quality monitoring data. The recommended values for the criteria correspond to specific percentiles of the statistical distribution (see Section 3.2.1 for additional discussion) for water quality data within aggregations of Level III ecoregions.

During the second phase, each state is expected to adopt nutrient criteria for water quality to protect the beneficial uses of a state's waters.

States and Tribes were afforded flexibility in selecting an approach for developing nutrient criteria with implementation as numeric standards. The EPA provided three possible approaches from which States or Tribes could choose regarding criteria development:

1. Adopt the EPA nutrient water quality criteria based on aggregated Level III ecoregions (either the established range or a single value within the range);
2. Combine the EPA recommendations for nutrient criteria with their own databases to develop their own statistically-based criteria; or
3. Use the EPA methodology (or some other accepted approach) for defining criteria or, alternatively, construct a scientifically defensible method for developing nutrient water quality criteria.

The need for the State of North Dakota is to develop technically defensible nutrient criteria for surface waters, protective of the resource and consistent with federal guidance.

1.3 Scope of this Nutrient Criteria Development Plan

The EPA's *National Strategy for the Development of Nutrient Criteria* recognized four major water body types:

1. Streams and rivers;
2. Lakes and reservoirs;
3. Estuaries and coastal marine waters; and
4. Wetlands.

The EPA developed technical nutrient criteria guidance manuals for the first three water body types, to provide guidance and assist the States and Tribes with the development of nutrient criteria. As of August 2006, some publications (Wetland Modules) are available for monitoring and assessing wetlands, but the complete guidance manual remains unavailable.

This plan describes the anticipated conceptual approach for developing nutrient water quality criteria by the State of North Dakota. The plan specifically focuses on lotic systems (i.e., small to large wadeable and non-wadeable streams and rivers) and lentic systems (i.e., lakes and reservoirs). The plan currently excludes wetlands, although the issues discussed and recommended methods are potentially applicable to wetland systems.

For lotic and lentic systems, the plan:

1. Defines a recommended approach for developing nutrient criteria;
2. Identifies the data needed to develop the nutrient criteria; and
3. Where possible, identifies key issues, milestones and decisions.

While the scope of the plan is intended to provide clear and meaningful guidance for the development of nutrient criteria within North Dakota, resolving certain ambiguities or unknowns associated with the amount and quality of data necessary to develop the criteria is beyond the scope of this plan. This plan represents a road map for use by the

State of North Dakota to navigate through the complex issues related to developing nutrient criteria appropriate for (and protective of) its surface water resources. A complete analysis of the data needed to develop the criteria, the analysis and development of the criteria and criteria implementation as water quality standards is expected to occur subsequent to the completion of this report. As recognized by the EPA, the report does not represent a binding commitment and modification of the plan will likely be needed as new information becomes available or unanticipated issues arise (Grubbs 2001). This plan is consistent with the content for a nutrient criteria plan as required by the EPA.

1.4 Nutrient Criteria Development Philosophy

The development of nutrient criteria by the State of North Dakota is driven by three fundamental considerations. These considerations are that the criteria developed should be:

1. Protective of the State's water resources and their designated beneficial uses;
2. Tailored to the unique physiographic characteristics and water resources of this northern plain (prairie) state;
3. Technically and scientifically defensible; and
4. Based upon conceptual ecosystem models that reflect cause (stressor) – effect (response) relationships founded on excess nutrient concentrations and that reflect the reasons for resource impairment (e.g. excessive algae in a lake) and the loss of beneficial uses.

These considerations guide the recommended approach presented by the plan.

2 Data Available to Develop Nutrient Criteria

2.1 Overview

A broad array of literature and water quality data were reviewed and assessed while preparing the nutrient criteria development plan for North Dakota. The literature reviewed included reports and information specific to North Dakota (see Section 2.5), other states which have or are developing nutrient criteria development plans, and the EPA national guidance material. North Dakota surface water monitoring data, obtained from the NDDH, the United States Geological Survey (USGS) and from the EPA, were reviewed and summarized. The objective for the literature and data review was to understand potential options (including benefits and limitations) for North Dakota in establishing an approach for developing nutrient criteria. A thorough statistical analysis of the data to develop the criteria is expected during the implementation of this plan. The analysis presented in this plan is primarily intended to understand the limitations of the available data and the need for collecting additional data when developing criteria.

2.2 Section 305(b) Assessment Data

2.2.1 Overview

Section 305(b) of the Clean Water Act requires states to develop a comprehensive biennial report on the quality of state waters. North Dakota is characterized by four Level III ecoregions and five major basins (**Map 1**), which ultimately drain to Canada and South Dakota. A narrative summary of Level III ecoregions is found in **Appendix A** and a summary description of major basins is found in **Appendix B**. The basins and associated surface waters are shown in **Maps 1 and 2**. To help manage surface waters the State recognizes five hydrologic basins as:

1. Red River (including Devils Lake and the Upper and Lower Red River Subbasins);
2. Souris River;
3. Upper Missouri River (Lake Sakakawea);
4. Lower Missouri River (Lake Oahe); and the
5. James River.

For the 305(b) assessment effort, the NDDH evaluates data collected on most of the publicly managed lakes and reservoirs. However, the many lotic (flowing) systems means that only a relatively small portion of streams and rivers can be feasibly assessed through the collection and analysis of water quality samples (i.e., monitoring). While an estimated 2.5 million acres of wetlands are present in North Dakota, these lentic systems are currently not assessed by the state, although a monitoring and assessment program is under development.

2.2.2 Lakes and Reservoirs

The NDDH currently recognizes 224 lakes and reservoirs for water quality assessment purposes. Of this total, there are 134 reservoirs and 90 natural lakes (**Table 1**). Two reservoirs (Lake Sakakawea and Lake Oahe) located on the mainstem of the Missouri River comprise 67 percent of the state's combined lake and reservoir surface area. Seventy-three (73) percent of the total area comprised by the 90 natural lakes in North Dakota is attributed to Devils Lake. Natural lakes, with the exception of Devils Lake, tend to be under represented in the State relative to the total surface area of lakes and reservoirs.

2.2.3 Streams and Rivers

The NDDH evaluated over 10,000 miles of streams and rivers for water quality assessment purposes. There are 54,427 miles of streams and rivers in the state, of which only 10 percent are considered perennial (**Table 2**). North Dakota shares perennial systems with South Dakota and Minnesota, including the Bois de Sioux River and the Red River of the North, respectively. Together these border rivers total 427 miles in shared length, which is almost 8 percent of North Dakota's total perennial system length. The perennial and ephemeral (intermittent) streams and rivers in North Dakota are distributed somewhat unevenly across the state with more ephemeral streams in the west.

2.3 Section 303(d) Impairments

Section 303(d) of the Clean Water Act requires states to develop a list of waters which, through the assessment processes, are identified as not meeting beneficial uses established by the State. Impaired waters identified in 2006 are shown in **Map 3** and summarized in **Tables 3 and 4**. Four beneficial uses (aquatic life, recreation, drinking water, and fish consumption) were assessed for purposes of Section 305(b) reporting and Section 303(d) lists. Water bodies can be water quality limited and therefore placed on the Section 303(d) list due to a variety of pollutants from sources including point sources, nonpoint sources, or both.

The NDDH uses a suite of indicators to assess beneficial use attainment and impairment, and to determine causes and sources of stressors affecting water quality. The NDDH uses a tiered approach that combines core indicators selected for each beneficial use and water resource type combination, plus supplemental indicators selected according to site-specific or project-specific considerations. Core and supplemental indicators[1] for each water resource type include physical, chemical, habitat, biological, and landscape variables and metrics. While there are a number of lakes and reservoirs listed on the Section 303(d) list for eutrophication / nutrient enrichment, there are no river and stream segments currently listed on the Section 303(d) list because of excess nutrients. Some water bodies may also be listed because of the manifestation of excess nutrients like low dissolved oxygen concentrations.

[1] The terms core indicator and supplemental indicator are used by the NDDH for assessing impairment of a water body. These indicators may also be considered "response variables" or "affect variables" as used in this plan, which are the manifestation of excess nutrients.

2.4 Available Water Quality Data

2.4.1 NDDH Water Quality Monitoring

The NDDH has a ten year strategy drafted for monitoring the water quality of surface waters. This strategy builds on the foundation laid by previous monitoring efforts within the state. The NDDH establishes four categories of monitoring efforts:

1. Condition monitoring;
2. Problem investigation monitoring;
3. Effectiveness monitoring; and
4. Special studies monitoring.

These categories help distinguish between the various purposes of the monitoring programs and projects necessary to meet the goals and objectives of the NDDH ten year strategy.

In 1991, the NDDH initiated the Lake Water Quality Assessment (LWQA) Project. Since that time, the NDDH has completed sampling and analysis for 111 lakes and reservoirs in the state. Lentic sampling sites are shown in **Map 4** and summarized for select parameters applicable to developing nutrient criteria in **Table 5**. The results from the LWQA Project have been prepared in a functional atlas-type format. Each lake report discusses the general description of the water body, general water quality characteristics, plant and phytoplankton diversity, trophic status, and watershed condition. Beginning in 1997, the LWQA Project activities were integrated into the NDDH's rotating basin monitoring strategy. In addition to its inclusion in the annual LWQA Project, Devils Lake and Lake Sakakawea have received special attention.

The NDDH first conducted state-wide biological monitoring of its streams and rivers from 1993 through 2000 using a rotating basin approach with intensive targeted chemical sampling sites. Lotic water quality sampling sites are shown in **Map 5** and summarized by select parameters in **Table 6**. The rotating basin monitoring program was discontinued in 2001 while the NDDH focused its resources in support of sampling for the EPA's Environmental Monitoring and Assessment Program (EMAP) Western Pilot Project (see Section 2.4.3). Some biological monitoring data (i.e., macroivertebrate and fish abundance) has also been collected by the NDDH (**Map 6**).

Table 6 shows limited available chlorophyll-a data, with the exception of Level III ecoregion 48, for rivers and stream. Considerable total phosphorus and total nitrogen data are available across all Level III ecoregions for rivers and stream. Considerable total phosphorus, total nitrogen and chlorophyll-a data are available across all Level III ecoregions for lakes and reservoirs.

2.4.2 National Water Information System

The USGS collects and analyzes chemical, physical, and biological properties of water, sediment and tissue samples from across the Nation. These data are accessible through the USGS National Water Information System (NWIS). There are a total of 1,302 sites within lentic or lotic systems which have been sampled by the USGS in North Dakota. Existing sampling sites on lentic and lotic systems are shown in **Maps 4 and 5,** respectively. Select parameters of interest are summarized in **Tables 7 and 8**. Within the last ten years, roughly 46 lentic sites and 105 lotic sites have been sampled for nutrients. However, one water body may be associated with several sample sites, such as Lake Sakakawea or Devils Lake. Although the USGS dataset shows considerable data across all Level III ecoregions for total phosphorus and total nitrogen, limited chlorophyll-a data are available for lakes and reservoirs or streams and rivers. Chlorophyll-a data are available for Devils Lake, the Chain of Lakes in the Devils Lake basin, Lake Darling, select locations on the Souris River and select locations within the Missouri River system.

2.4.3 EMAP Western Pilot Project

The EPA's Environmental Monitoring and Assessment Program (EMAP) Western Pilot Project is intended to help establish reference conditions for wadeable streams. The primary goal of the EMAP Western Pilot Project is to generate state and regional scale assessments of the biological condition of wadable perennial rivers and streams in the western United States and to identify stressors associated with the degradation of these resources. In 1999, EMAP embarked on a multi-year effort to demonstrate the application of core monitoring and assessment tools across a large geographical area of the western United States. The EMAP-West project includes the twelve conterminous states in EPA Regions 8, 9, and 10. The surface water component of EMAP-West has developed a set of indicators of ecological condition and environmental stressors. These include:

1. Biological assemblages (fish, macroinvertebrates, and algae);
2. Ambient water chemistry (nutrients, acid/base status, etc.);
3. Fish tissue contaminants (mercury, metals, PCB congeners, persistent organics);
4. Physical habitat (sedimentation, in-stream / riparian habitat structure, etc.); and
5. Watershed characteristics.

Within North Dakota between 2001 and 2004, a total of 113 samples were collected characterizing wadeable streams. Sampling sites are shown in **Map 5** and summarized by select parameter in **Tables 9 through 11**. Sites were chosen by EMAP staff in consultation with State staff, based on a random (i.e., probabilistic) site-selection process. However in some instances, duplicate sampling efforts were performed on one date at a single station (i.e. reach-wide versus targeted riffle sampling).

Table 9 shows that during the EMAP Western Pilot Project no chlorophyll-a or periphyton data were collected within lotic systems. Water quality data were primarily collected for lotic systems within Level III ecoregions 43 and 48, and excluded regions 42 and 46. Reference sites were primarily located in ecoregions 43 and 48 (see **Table 11**). These data are expected to be useful in obtaining a general sense of total phosphorus and total nitrogen concentrations at reference sites within two ecoregions, but of limited value in establishing the cause – effect relationship or establishing ecological endpoints except within ecoregions 43 and 48. A suite of biological indicators were collected along with the chemical water quality data.

2.4.4 Sheyenne River Pilot Study

The NDDH commissioned a pilot study, funded by the EPA (Zheng et al., 2004) to evaluate the development of potential nutrient criteria for wadeable streams within the Northern Glaciated Plains ecoregion (46). Ecoregion 46 includes the Sheyenne River and its' tributaries. The pilot study evaluated a suite of stream metrics as well as land use factors. Fourteen sites were selected as targeted reference sites within the area contributing runoff to the Sheyenne River. Two additional sites were selected outside of the Sheyenne River watershed as reference sites. Sampling occurred over a two-year (2001-2002) period. Recommended nutrient criteria were developed during this pilot study for total nitrogen, nitrate-nitrite nitrogen, total phosphorus, and soluble phosphorus. The nitrogen criterion developed during the pilot was similar to those recommended by the EPA using a statistical approach for the aggregate ecoregions. The pilot study recommended a criterion for total phosphorus considerable greater than that recommended by the EPA. The pilot study recommended an approach to developing nutrient criteria which consisted of combining information from reference sites with effects-based relationships of macroinvertebrate response.

Several lessons were learned from the completion of the pilot study. Identifying conditions considered as "reference" proved challenging, because of the considerable anthropogenic disturbance within the watershed. Nitrogen rather than phosphorus may be the nutrient limiting primary productivity. Measuring periphyton biomass proved challenging, and generally periphyton and diatom assemblages did not show a pattern of change in response to nutrient concentrations or other environmental variables. Duplicate periphyton samples tended to show low similarity (i.e., poor precision), suggesting challenges with the sampling method. Macroinvertebrate assemblages were associated with environmental variables, primarily the number of EPT taxa.

2.4.5 Statistical Analysis of Existing Data

The EPA Region 8 contracted with Dr. Pete Richards from Heidelberg College to apply the EPA's recommended statistical approach to the state's water resources. The effort resulted in the determination of potential draft nutrient criteria for Level III ecoregions within North Dakota, based on currently available data **(Table 12).** Based upon the statistical analysis, agreement between the potential criteria as derived by the EPA and Dr. Richards varies. The primary limitation with the analysis is the lack of a cause-effect relationship.

2.5 Literature Review

2.5.1 Overview

A diverse assemblage of literature relating to nutrient criteria development was compiled and reviewed (**Table 13**). The literature reflected federal technical guidance documents, fact sheets, and other information, as well as nutrient criteria plans from many states. Nutrient criteria plans from 14 states were screened to identify those with relevance to North Dakota.

2.5.2 Documents Relevant to North Dakota

There is potential value to North Dakota from building upon existing nutrient criteria plans. Most notably, it allows the state to understand the rationale for developing criteria and utilize a proven, successful strategy. It allows the state to select the most salient pieces of each plan to develop its own tailored approach to developing nutrient criteria. Nutrient criteria plans from 14 states were screened to identify those which were deemed as having particular relevance to North Dakota.

The documents from six states seemed especially applicable to North Dakota. Key components of the six nutrient criteria plans are summarized in **Tables 14 and 15**. Several factors were generally considered when assessing the relevance of a state's nutrient criteria plan to North Dakota, including similar water resources, geographic proximity, scientific rigor of the plan, and ability (based on staff and financial resources) to implement the plan. The following state plans were identified as relevant to North Dakota:

1. California;
2. Colorado;
3. Florida;
4. Minnesota;
5. Montana; and
6. Utah.

The content and detail contained in each plan varies considerably. The key components of some plans were difficult to clearly and concisely summarize in categorical form. In large part, this is due to the open-ended nature of the narrative found within several plans. While this affords a certain level of flexibility, it also reduces the utility of the nutrient criteria development plan itself. However, given that caveat, the approaches proposed for North Dakota generally align with those of other relevant states.

Based upon the literature review, several items seemed relevant to developing nutrient criteria within North Dakota:

1. Omernick Level III or IV ecoregions represent a good spatial scale for developing nutrient criteria for streams and rivers;
2. Nutrient criteria should be seasonal, reflective of the temporal response of the resource;
3. The application of the EPA's recommended approach of the 25^{th} percentile for the monitoring data "population" can result in unduly restrictive criteria;
4. Using a 75^{th} percentile concentration for sites identified as "reference" is preferred over the 25^{th} percentile for the monitoring data "population" recommended by the EPA;

5. Nutrient concentrations established using regional stressor – response[2] field studies tend to fall within a narrow band around the 85th percentile value using reference site data;
6. The selection of nutrient criteria based on a statistical approach (including the EPA's recommended approach) is best supported by ground-truthed field data used to develop a site specific stressor – response relationship;
7. The nutrient criteria should ideally include some expression of uncertainty (e.g. confidence interval) which reflects the inherent variability of natural systems, both in terms of the stressor – response relationship and the beneficial use impairment;
8. Common sense should be applied when using a statistical approach (i.e., consideration given to censoring techniques, sample size, correlation among causal variables, the type of statistical distribution);
9. Many states prefer the use of a reference approach, either to establish the form of the stressor – response relationship or for applying a statistical approach. However, identifying "reference" for large river systems can be challenging;
10. Identifying the limiting causative factor(s) for some systems can be a challenge;
11. Spatially varying nutrient criteria on large lakes and reservoirs may be necessary to be protective and represent the naturally occurring longitudinal change in water quality;
12. Criteria are intended to be regionally protective. Site-specific data developed through the completion of a total maximum daily load study may still be needed to protect a specific water body; and
13. Few states have actually implemented their criteria – so additional lessons can be learned.

The intent is to incorporate the relevant lessons learned from the literature review into the North Dakota nutrient criteria development process.

[2] The terms "stressor – response" and "cause – effect" are used interchangeably, to mean the change in a water body in response to excess nutrients.

Proposed Nutrient Criteria Development Strategy

3.1 Nutrient Criteria Development Template and Concepts

This section presents a proposed strategy for developing nutrient criteria for the State of North Dakota. The ability to implement this strategy will be largely based upon the availability of good quality surface water quality monitoring data to identify and verify reference sites and statistically defensible stressor – response relationships. Therefore, the approach should be considered "preliminary" with revisions necessary as more detailed information becomes available. The intent is to provide sufficient detail within this plan to generally identify the anticipated criteria development approaches for lotic (i.e., rivers and streams) and lentic (i.e., lakes and reservoirs) systems sufficient to secure additional funding. This funding is needed to conduct the studies to develop the data to establish nutrient criteria.

3.1.1 Spatial (Geographic) Scale for Criteria Development

Nutrient criteria may be developed on a site specific basis (i.e., individually for each water body) or across some larger geographic area (e.g. region or state). The advantages of developing the nutrient criteria across some larger geographic area are that 1) a lesser level of effort may be required to develop the criteria, because criteria are not developed individually for each water body using site specific data, and 2) there is greater consistency of the criteria when it is applied across a larger area. The disadvantage is that the criteria may be over or under protective of the resource's beneficial uses, because they are generalized.

Two alternative spatial scales, ecoregions and major surface water hydrologic basin, have been considered for criteria development. *It is the recommendation of this plan to use a nested approach of Level III ecoregions (**Map 1**) further subdivided by major surface water hydrologic basins (**Map 2**) for nutrient criteria development.* The intent is a geographic scale which separates large river systems like the Missouri River, which are influenced considerably by conditions beyond the State's border. Using major surface water basins as the primary spatial scale rather than ecoregions may have an advantage. This will be evaluated further once statistical analysis of the data begins. Large reservoirs are expected to behave differently than most water features within their ecoregion. The water quality of large rivers and the mainstem reservoirs (Lake Sakakawea and Lake Oahe) is influenced considerably by the large amount of drainage area beyond the North Dakota border. Additionally, there are numerous perennial lotic systems which flow through more than one ecoregion.

Using ecoregions alone, rather than a nested approach should be considered if the nested approach proves difficult. Previous statistical analysis of North Dakota stream and lake data by Dr. Richards did not conclusively indicate significant differences in potential nutrient criteria among all ecoregions. Statistically significant differences between some ecoregions were determined for select parameters (e.g. total phosphorus and total nitrogen). In part this analysis was hindered by an inadequate spatial distribution in data collection. A nested approach may prove cumbersome and difficult to apply, simply due to the number of criteria that would need to be developed and the amount of data required. The nested approach also implies that significant differences would exist in water quality among ecoregions within a hydrologic basin. An advantage of the nested approach is that criteria and data can always be aggregated using a larger spatial scale. Some initial work will be necessary to select the "best" spatial scale.

3.1.2 Temporal Scale for Criteria Development

Nutrient criteria should ideally be developed in a manner, which reflects the timing (when during the year) and duration (how long) of the beneficial use impairment. The timing and duration of the beneficial use impairment may differ from the timing and duration of the factors leading to the impairment. For example, the timing and duration of an algal bloom in a lake or reservoir during the growing season may be caused by an episodic pulse in nutrient load in the spring. Nutrient criteria need to include a temporal component (i.e., the time of year they apply and any duration or recurrence or averaging period) associated with the criteria.

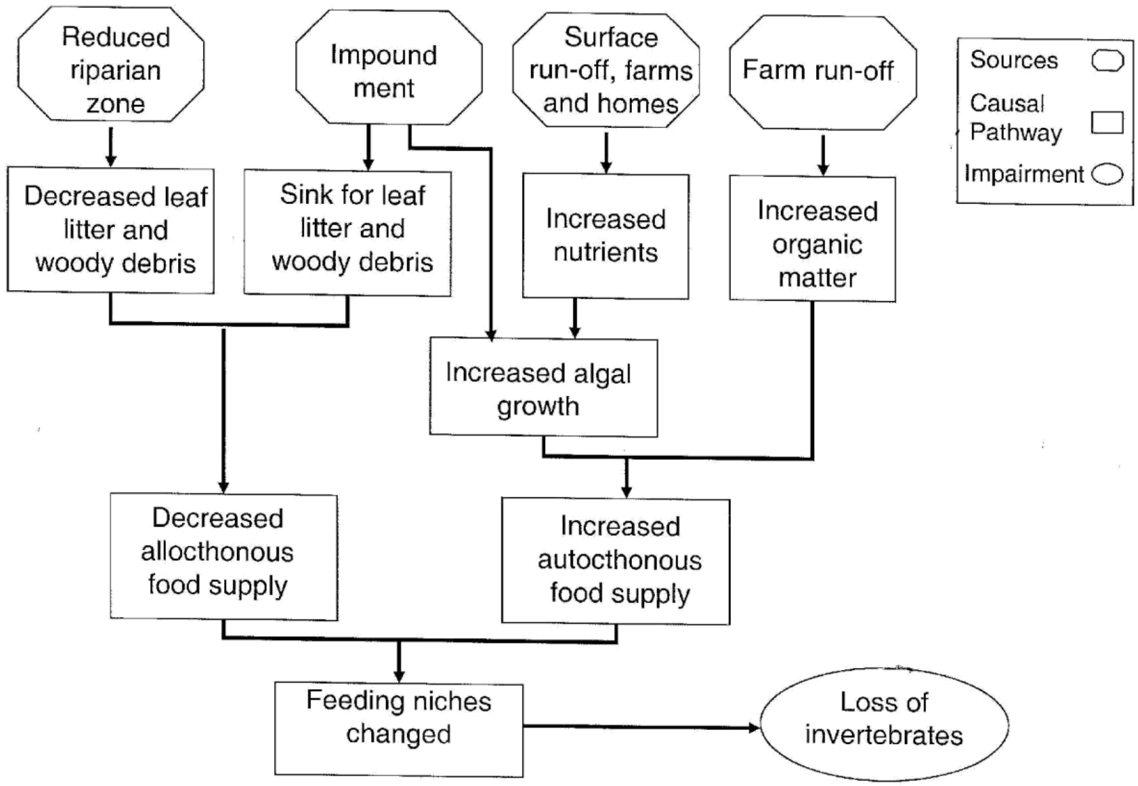
3.1.3 Stressor – Response Relationship

The process and methods used to develop nutrient criteria are ideally based upon a known and quantifiable stressor – response relationship. The stressor(s) "causes" the manifestation of the response or an "effect." The response or effect is some condition which fully or partially prevents the intended beneficial use(s) of the aquatic resource. The anticipated stressor-response relationships for lotic and lentic systems are discussed within Section 3.2. The preference is to establish criteria as an expression of the stressor variable where exceedance of some threshold results in an undesirable condition for the response variable.

Expectations are that conceptual ecological models (e.g., Causal Analysis / Diagnosis Information System or CADDIS; existing ecosystem water quality models) will provide the theoretical foundation for the stressor – response relationships. Example models are presented in the specific sections pertaining to lotic and lentic systems. Conceptual models will assist not only with identifying the stressor – response relationship, but also to reasonably ensure the proper stressor variables and metrics are identified and measured which best describe the system's response to nutrient enrichment.

Figure 1 shows an example conceptual model for a lotic system from CADDIS. There are several additional sources for conceptual models that can be used for lotic systems. Some of these conceptual models include commonly used receiving water quality models such as QUAL2K, CEQUALW2 and WASP. Prior to selecting specific stressor – response variables for developing the nutrient criteria for lentic systems, a conceptual model using currently available information will be finalized. Ideally, this conceptual model will recognize the uniqueness of the prairie aquatic ecosystem.

Figure 1. Example Conceptual Model for the Response of a Lotic System to Excess Nutrients (from CADDIS).



3.1.4 Water Body Classification

3.1.4.1 Classification System

The biological response to excess nutrients varies depending upon the physical and hydrologic characteristics of a water body. The actual metrics used to quantify the physical and hydrologic characteristics can vary. However, the metrics often involve an expression of light penetration, flow regime, and abiotic factors such as habitat, salinity, or acidity. Classifying water bodies is intended to enable the development of nutrient criteria which best reflects the likely response of water bodies which are similar in nature.

For the purpose of developing nutrient criteria, a process is needed to classify water bodies with regard to their landscape setting and the resulting physical and chemical characteristics within each geographic area. Based upon preliminary considerations, the following water body classification system is recommended:

Reservoirs and Lakes (Lentic Systems)

- a. Reservoir
    - i. Large River Reservoirs (e.g., Lake Sakakawea, Lake Oahe, Jamestown Reservoir, Lake Ashtabula)
    - ii. Small and Medium River Reservoirs (e.g., Sweet Briar Dam, McDowell Dam, Crown Butte Reservoir)
- b. Natural Lakes
    - i. Shallow Lakes (e.g., Lake Haskins, Green Lake, Powers Lake)
    - ii. Non-shallow Lakes (e.g., Devils Lake)
- c. Wetlands[4]

2. Rivers and Streams (Lotic Systems)
    - a. Perennial
        - i. Wadeable
        - ii. Non-wadeable (i.e., large)
    - b. Intermittent / Ephemeral

The recommended approach for classifying lentic water bodies includes using mean depth (derived from surface area and volume), maximum depth, fetch, open water area, overflow rate, and hydraulic residence time. The availability of some of these characteristics for lakes managed by the North Dakota Game and Fish is shown in **Map 7**. Hydraulic residence time and overflow rate may be derived using surrogates such as mean annual runoff volume derived from contributing drainage area. Two other important metrics, which may be considered or developed in the event the proposed

[4] Wetland nutrient criteria are not included in the scope of this Plan.

metrics are insufficient to classify lentic systems, are the mixing characteristics (e.g., polymictic versus dimictic) and dominant stable state (vis-a-vis clear macrophyte dominated state for shallow lake systems).

The recommended approach for classifying lotic water bodies includes the metrics of flow regime (likely frequency and magnitude of discharge) and drainage area at the watershed mouth. The National Hydrography Dataset (NHD) is anticipated to be the primary tool for the initial classification of lotic systems. A careful evaluation of the decision process used to define a stream within the NHD as perennial or intermittent is needed to ensure the distinctions between lotic systems (perennial and intermittent) are appropriate and suitable for nutrient criteria development within North Dakota. An alternative classification metric, which proved to be useful in Montana, is stream order.

The ability to develop nutrient criteria using the preliminary water body classification system depends upon the amount of water quality data available for the parameters of interest. Subsequent analysis of sample size by geographic area and water resource type is needed.

3.1.4.2 Definitions

The following preliminary definitions are presented for the purpose of classifying water bodies and determining the amount of water quality data available by water body type. These definitions may be modified or adjusted during the implementation of this plan.

Lentic Systems - Lentic systems are generally considered as standing water systems. This concept is quite broad, encompassing bodies of standing water with widely differing spatial (size) and temporal (seasonal) characteristics. In natural systems, there are no clear boundaries between standing water systems - only gradients. The categories and labels used to describe features such as wetlands, ponds, and lakes are somewhat arbitrary, often informal, and are primarily constructed to help manage the standing water systems. For this plan, a lentic system will include a lake, reservoir or wetland.

Lake - The State of North Dakota does not have a definition of a lake within the Century Code[6]. For the purpose of this plan, the following criteria are used to distinguish a lake system from other lentic systems:

1. Surface area of 10 acres (4 hectares) or more;
2. A maximum depth which is not less than 3.3 feet (1 meter); and
3. A minimum non-vegetated, contiguous open water area of 1,000 m^2 or more.

The standing water forming a lake is not artificially created or increased in depth by obstructing a watercourse through the use of a dam or other man-made obstruction.

Shallow Lake - A shallow lake is a natural lake, characterized by standing water, where light penetrates to the bottom sediments to potentially support rooted plant growth throughout the water body. The lack of consistent thermal stratification during

[6] The Century Code is the codification of all general and permanent law enacted since statehood.

the summer and the tendency to exhibit alternative turbid and clear stable states are also common characteristics of this class of water.

Non-shallow Lake - A non-shallow lake is characterized by both a shallow shoreline area that may potentially support rooted plant growth and a deeper portion where sunlight does not penetrate to the bottom. These water bodies frequently stratify into distinct thermal layers during the summer.

Reservoir - Reservoirs are artificial (man-made) lentic systems. At a minimum, reservoirs must meet the first three conditions defined for a lake system. In addition, the following criteria are used to distinguish reservoirs from other lentic systems:

1. Existence of a control structure to actively regulate water levels and discharge; and
2. Generally shorter hydraulic residence time (generally less than 1 year) because of a larger drainage area to surface area ratio compared to a lake.

Wetland – A lentic system that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

Lotic systems – Lotic systems are generally flowing water systems. More specifically, they can be characterized by the presence of a unidirectional gravity induced current. As with lentic systems, there is substantial variability in the types of lotic systems. For this plan, a lotic system will include wadeable and non-wadeable streams or rivers.

Wadeable Stream or River - A wadeable stream or river is a lotic system which can generally be traversed on foot and exhibits a depth such that it can be “sampled” without the use of a boat during summer base flow conditions. These lotic systems can be further classified according to the temporal nature of their flow regime as either perennial or intermittent.

Non-Wadeable Stream or River - A non-wadeable stream or river is a lotic system which cannot be traversed on foot and exhibits a depth such that “sampling” can only be conducted with the use of a boat during summer base flow conditions. These lotic systems are typically perennial.

Perennial Stream or River - These systems are generally considered those which have flowing water throughout most of the year during the open water season (generally > 90% of the time) during a typical year. These systems may periodically have no observable flow, but this generally occurs only during extreme drought. The stream bed seasonally intersects the water table. Groundwater is typically the source of base flow and runoff from rainfall is a supplemental source of water for stream flow. Perennial streams and rivers are generally 3rd order or greater.

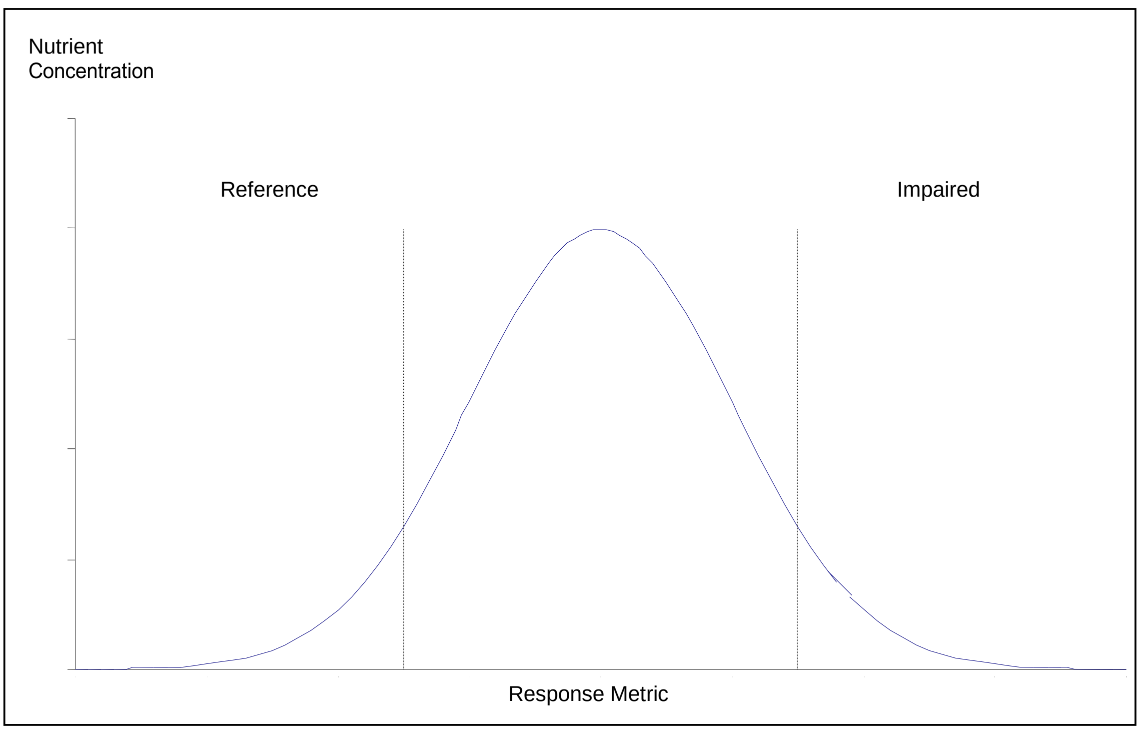
Intermittent Stream or River - These systems are generally considered those which only periodically have flowing water during the open water season, during most years. These systems may not convey water at all, unless under periods of extremely high precipitation. The stream bed seasonally intersects the water table. Runoff from rainfall is a supplemental source of water for stream flow. These streams and rivers may be 2nd, 3rd or 4th order.

Ephemeral stream: An ephemeral stream has flowing water only for a short duration during spring runoff or after precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from spring runoff or rainfall is the primary source of water for stream flow. An ephemeral stream is generally 1st or 2nd order.

3.1.5 Criteria Variability and Beneficial Use Impairment

The purpose for developing regional nutrient criteria is to broadly protect water bodies from the enrichment of nutrients due to human effects, thereby protecting designated beneficial uses (e.g., recreation, drinking water supply, aquatic life). Nutrient concentrations within a water body fluctuate across some range in response to naturally occurring factors such as varying loads resulting from a range of precipitation and runoff conditions. The biological response will mirror this natural fluctuation. It is expected that water bodies in "ecological balance" can experience a range of nutrient concentrations (either daily, seasonally or annually), while still supporting beneficial uses. The regional nutrient criterion must also either implicitly or explicitly incorporate an acceptable range of concentrations bounding that criterion. This concept is graphically shown in **Figure 2**. Conceptually **Figure 2** illustrates that opposing ends of a

Figure 2 – Conceptual Distribution of Chemical Concentrations within Water Bodies across a Geographic Area and the Relationship Between a Nutrient Criterion, and Reference and Impaired Conditions.*



*Represents the concentration "population" from all measured sites. Adapted from Figure 9 in EPA 2000.

response metric frequency distribution are the reference water bodies (low nutrient enrichment) and impaired water bodies (high enrichment).

Finding locations which represent reference conditions can be challenging. Most of the state's land cover is altered and affected by human influence. Caution is needed to properly define and characterize reference, if this approach is used to establish nutrient criteria (see Section 3.1.6 for the definition of reference).

A nutrient criterion is not intended to represent a single threshold from which beneficial use impairment can be determined. A criterion is a regionally-derived value based upon the classification of several or many similar water bodies. The process to ascertain beneficial use impairment is procedurally more rigorous in North Dakota. A common thread is that some of the stressor variables are the same as the core and supplemental indicators, which the State uses in beneficial use determination.

The nutrient criteria, once established, are based on regional information intended to establish maximum acceptable nutrient levels for water bodies of different types across the State. The NDDH uses additional factors to list specific waters as impaired and place them on the Section 303(d) list of impaired waters needing TMDLs. For those water bodies which are impaired by nutrients, a specific total maximum daily load study (TMDL) must be performed to determine how a water body can be improved (i.e., nutrient levels reduced) to meet its beneficial uses. It should be recognized that there may be the need on a site specific basis (i.e., TMDL where the regional criteria are not sufficient, either too restrictive or not restrictive enough) to establish site specific criteria. In these cases, the site specific criteria will be adopted into the State's water quality standards prior to TMDL implementation.

It is recommended that there also be a process to evaluate and define a translator mechanism during the nutrient criteria development process. This translator mechanism would allow established nutrient criteria to be adjusted in order to address impaired water bodies. The translator mechanism would essentially be a method or process allowing the "conversion" from the numeric criteria developed for a region to a site specific criteria or goal.

3.1.6 Reference Condition Definitions

A wide range of definitions have been used to describe reference condition. Ideally, a location selected to represent reference conditions reflects pristine conditions, devoid of any human influence. The following definitions are applicable to developing nutrient criteria:

> ***Pristine*** - The biological condition exhibited by an aquatic resource in absence of human disturbance, as characterized by the types and abundance of species. The biological condition prior to Euro-American settlement is generally assumed to be "pristine".
>
> ***Minimally Impacted Conditions*** - The biological condition exhibited by an aquatic resource in the presence of minimal human disturbance, as characterized by the types and abundance of species. The biological condition following Euro-American

settlement is generally assumed to be impacted. An analysis of the condition of the landscape within the contributing drainage area is typically characterized by minimal agricultural and urban influences. It is generally assumed that these conditions do not actually occur in North Dakota.

Least Impacted Condition - The biological condition exhibited by an aquatic resource characterized by the least amount of human disturbance available in a region for a water body class, as characterized by the types and abundance of species. The definition of least impacted conditions has the same meaning as "regional reference site" as defined within 2.b.(6) of 33-16-02.1-08 General Water Quality Standards of North Dakota Century Code. The biological condition following Euro-American settlement is generally assumed to be impacted. An analysis of the condition of the landscape within the contributing drainage area is typically characterized by the smallest amount of agricultural and urban influences. The least impacted condition may or may not be the minimally impacted condition.

Regional reference sites (2.b.(6) of 33-16-02.1-08 General Water Quality Standards of North Dakota Century Code) means sites or water bodies which are determined by the department to be representative of sites or water bodies of similar type (e.g., hydrology and ecoregion) and are least impacted with respect to habitat, water quality, watershed land use, and riparian and biological condition. Regional reference sites are used to describe regional reference condition.

Using the least impacted reference condition to establish the nutrient criteria is recommended.

Efforts are ongoing within the State to establish a suite of candidate reference sites and/or reaches, which can be used for multiple purposes, including the development of biological criteria, suspended and beded sediment (SABS) criteria, and **nutrient criteria**. The EMAP Western Pilot Project effort identified 21 reference sites within a single Level III ecoregion for North Dakota (see **Table 11**). Further identification of reference sites are expected as part of a planned biological monitoring effort for the Red River of the North Basin, catalyzed by the International Red River Board (IRRB) (Fritz 2004). Recommended definitions of reference conditions as developed for the IRRB are similar to those described above. The NDDH anticipates establishing a reference site network, with one of the purposes being the development of nutrient criteria. Important data to be collected at the reference sites include nutrient concentrations and cause-affect relationships for nutrient response.

3.2 Recommended Approaches for Nutrient Criteria Development

The preliminary recommendations are based upon the current understanding of data availability, the desired philosophy of the NDDH, and the need for a method tied to the biological response of the resource to excess nutrients. The approach ultimately selected and implemented may be different from that recommended, as additional information and data are collected and analyzed. The approach ultimately selected must result in nutrient criteria which are technically and scientifically defensible, can be reasonably implemented within state law and rule, and are acceptable to society. *Preliminary* *recommended approaches are provided for lotic and lentic systems separately, because of their differing response to excess nutrients.*

3.2.1 The "EPA Approach"

As stated in Section 1.2, the EPA outlines three approaches from which States could develop their nutrient criteria. The first two approaches are based on descriptive statistics defining the 75th percentile concentration for reference sites, or the 25th percentile concentration of non-reference sites, to identify the numeric criterion for a parameter. Regionally recommended nutrient criteria by the EPA are summarized in **Table 12**, along with criteria based on previous North Dakota analyses. *The use of statistical methods and the selection of percentile concentrations as an approach for determining nutrient criteria are not recommended for North Dakota, without some linkage to the stressor-response relationship*. Noteworthy drawbacks to a purely statistical based method include:

- Percentiles of data do not consider the environmental context of a resource. For instance, this method would apply the same numeric criterion to all perennial streams, regardless of size (e.g., Missouri River versus the Maple River);
- The "arbitrary" choice of a percentile rank may in fact establish a numeric criterion lower than the least impacted or minimally impacted conditions; and
- Use of a statistically based approach is not tied to the stressor-response relationship, and does not address the ability of a percentile-derived criterion to protect beneficial uses.

While the EPA technical guidance manuals provide excellent information, they do not specifically relate the recommended approach to the beneficial use. These uses vary from state to state. As noted in Section 2.3, North Dakota recognizes four beneficial uses for water bodies. *This plan for developing criteria is based upon establishing nutrient criteria protecting the most "stringent" beneficial use, which in most cases will be aquatic life. The recommended approaches assume that criteria developed to be protective aquatic life are also protective of all other beneficial uses (e.g., drinking water supply, recreation).*

3.2.2 Proposed Approach for Lentic Systems

3.2.2.1 Conceptual Model

Figure 3 presents a conceptual ecological model showing the response of lentic systems to excess nutrient concentrations. This model suggests potential causative ecological endpoints (i.e., response variables) include the frequency and severity of algal blooms, the concentrations of chlorophyll-a and chlorophyll-b, some measure of water clarity, dissolved oxygen concentrations and Trophic Status Index (TSI) score. The conceptual model further suggests that the applicable causative variables are those that limit primary production.

3.2.2.2 Ecological Endpoints (Response Variables)

The response variables are generally those variables measured in the environment that are used to determine whether a resource is impaired because of excess nutrients. During the process of developing nutrient criteria, the response variables will be used to develop the "cause – affect" relationship that forms the technical basis for the criteria.

Several ecological endpoints are used by the NDDH in assessing impairment and the attainment of beneficial uses for aquatic life. The ecological endpoints are also our response "targets" for the nutrient criteria. Characteristics of the fish community (primarily the types and abundances of species) and the algal community (primarily characterized by the types and abundances of phytoplankton and the amount of chlorophyll) are often used as ecological endpoints.

An increase in the frequency and severity of algal blooms is a typical response to excess nutrients in lakes and reservoirs. Algal biomass, expressed as the concentration of the pigment chlorophyll-a, is a common variable used to assess the response of lakes and reservoirs to excess nutrients. Algae in the water column reduce water clarity and the penetration of light. Secchi disk transparency, an indicator of water clarity, is an excellent physical response variable.

Using the concentrations of chlorophyll-a and chlorophyll-b, and water clarity expressed as Secchi disk transparency, as the response variables for nutrient enrichment is recommended. An additional recommendation is that the frequency and severity of algal blooms be evaluated as a potential response variable. This requires operationally defining an "algal bloom." The definition of a bloom likely varies geographically, depending upon user perception.

Because the fish community is dependent upon suitable physical and chemical conditions for survival, we further recommend that dissolved oxygen be considered as a response variable. The amount of dissolved oxygen available to support a diverse assemblage of fish species generally declines as the severity of nutrient enrichment increases.

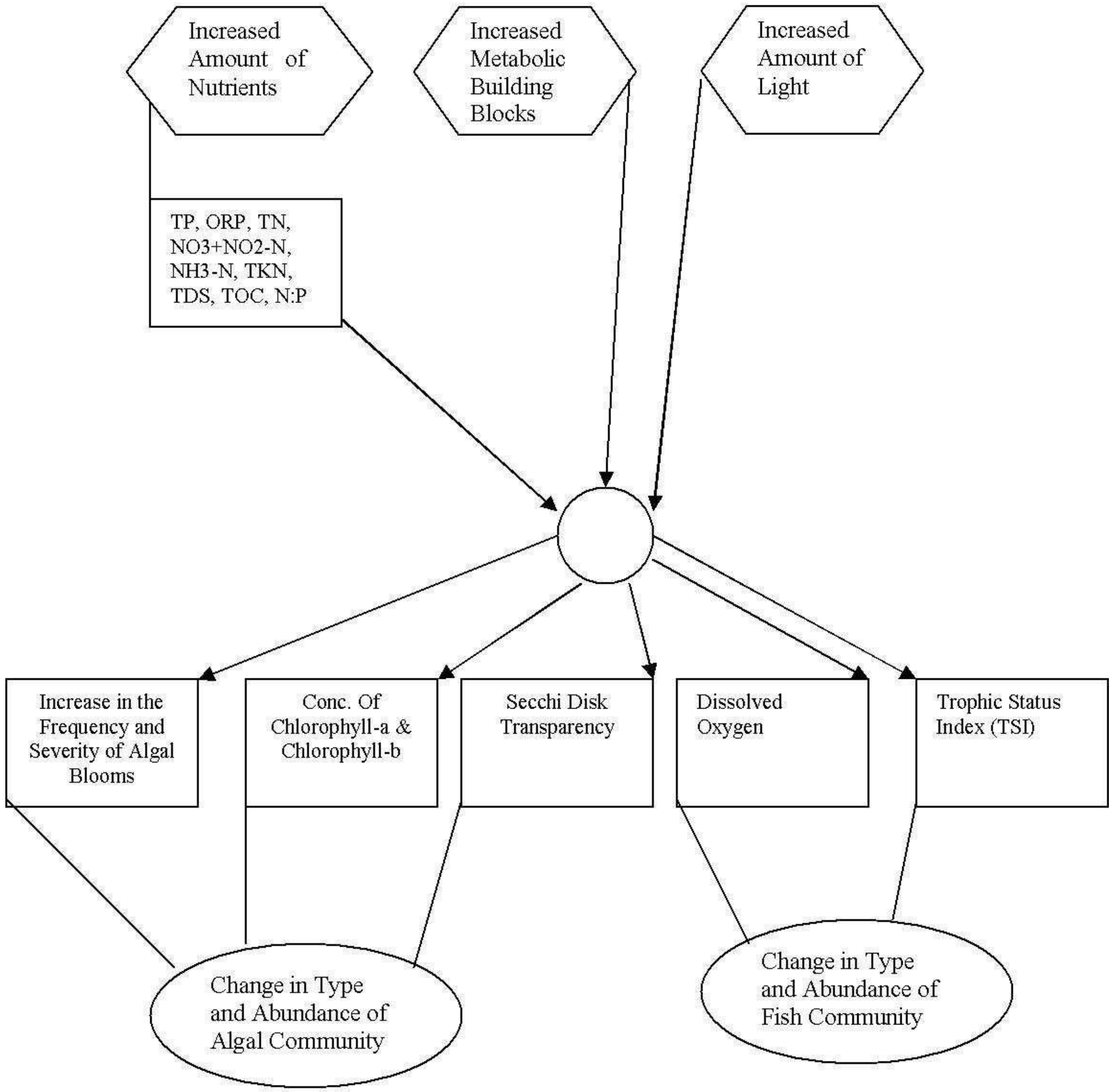
3.2.2.3 Causative Variables as Nutrient Criteria

Nutrient enrichment is principally responsible for: 1) changes in basic food webs including altered algal communities and causing harmful or nuisance algal blooms, which can lead to the loss of an economically important fishery and overall aquatic biodiversity; 2) loss of native submerged aquatic plant habitats that are important to fish and other biota; and 3) anoxia leading to fish kills and/or degraded benthic (bottom) habitats that affect shellfish and other biota.

The key in developing nutrient criteria is to understand the specific factors that biologically limit algal production. Those variables measured in the environment, which are indicative of excess nutrients, and that drive the ecological response are potential causative variables that can serve as criteria.

Lentic systems are known to respond to 1) increasing concentrations of various nutrients including nitrogen and phosphorus; 2) increasing concentrations of metabolic building blocks, including various forms of carbon (e.g., CO_2) and silica; and 3) light needed for photosynthesis. The mathematical form of the response may be linear or nonlinear.

Figure 3 – Conceptual Ecological Model for the Response of a Lentic System to increased Nutrient Concentrations (from CADDIS).



An initial evaluation of the following causative variables as potential nutrient criterion is recommended:

- Total phosphorus
- Orthophosphate or dissolved phosphorus
- Total nitrogen
- Nitrate plus nitrite nitrogen
- Nitrogen to phosphorus ratio
- Ammonia nitrogen
- Total Kjeldhal nitrogen
- Total organic carbon
- Dissolved organic carbon
- Total dissolved solids

The use of an indicator like the Trophic Status Index (TSI), which combines several trophic characteristics, should also be considered. Statistical analysis of the response and causative variables will be used to select the final parameters. Those parameters which have the strongest predictive relationship with the ecological endpoints will be the most useful to establish as criteria. Confounding factors such as salinity concentrations should be incorporated into the analysis to determine if modifications to the lentic system classification method are needed.

Expectations are that a detailed analysis of the various forms of nitrogen is not needed. Rather, the response to total nitrogen or inorganic nitrogen may be sufficient to describe the response of the ecological system.

3.2.2.4 Temporal Scale

Use of the open water season is recommended as the temporal scale for the development of nutrient criteria in lentic systems. The specific temporal scale over which nutrient criteria are applied should be confirmed during the course of nutrient criteria development. Potential options for the temporal scale include the growing season (April 1 – October 31), summer season (roughly June 1 – September 1), or recreational season (May 1 – September 30).

3.2.2.5 Spatial Scale

Use of the average water column concentration taken in the deepest (often middle) portion of a lake or reservoir is recommended as the spatial scale for the nutrient criteria. An alternative approach is expressing the criteria as a value representative of the surface mixed layer. Horizontal variation in larger lakes and reservoirs is also likely. Therefore, for larger lakes and reservoirs the nutrient criteria may need to be established longitudinally or for specific embayments.

3.2.2.6 Recommended Criteria Development Method

One important guiding principle is that the nutrient criteria should ideally be based on a definable cause – effect relationship. *The recommended approach for developing nutrient criteria for lakes and reservoirs is based on establishing regionally defensible cause (i.e., load) – effect (i.e., eutrophication response) relationships*. These relationships should incorporate the important causative and response variables and ideally incorporate the frequency and duration of the conditions causing beneficial use impairment (e.g., algal bloom frequency and duration). The approach requires establishing a threshold defining an "algal bloom" correlated to the impairment in aquatic life (or another beneficial use such as recreation).

Figure 4 presents the recommended method for developing the nutrient criteria for lakes and reservoirs. Expectations are that the method would be applied using appropriate spatial and temporal scales. The approach is based upon developing and applying regional eutrophication load-response models, tied to dissolved oxygen levels and the impact to aquatic life. The approach depends upon the ability of the NDDH to establish eco-region appropriate lake and reservoir trophic goals. These goals may be established based upon reference conditions, or the desired trophic state using best professional judgment. The approach essentially consists of using models to "back-calculate" regional nutrient loads based upon the established goals. The regional model will need to be applied on a geographically representative sample of lakes and reservoirs to establish the regional load. The regional load will then require translation into concentration or yield for some distance upstream, while considering the appropriate runoff conditions (e.g., average runoff year). The recommended criteria developed using this technique needs to be compared to the method developed for lotic systems, with the most stringent applied.

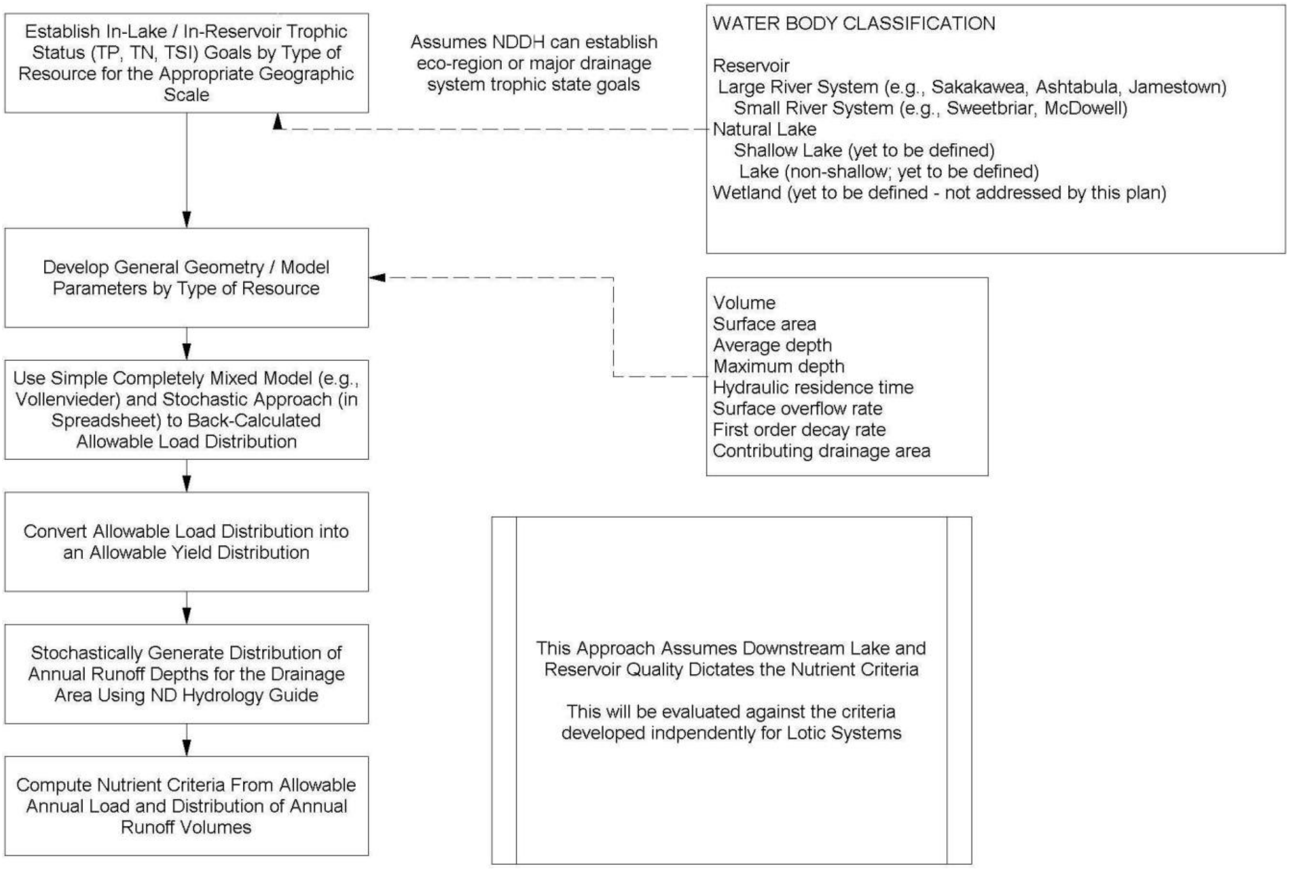
An alternative method may be used if the ability to establish goals using the desired trophic state or data limitations prohibits the use of the recommended method. The alternative approach is the use of descriptive statistics for the concentrations of the causal variables correlated to the response condition leading to beneficial use impairment. This approach is more fully described in Section 3.2.3.6 and is the recommended approach for lotic systems.

3.2.2.7 Data Gaps and Potential Issues

A significant issue for North Dakota is the lack of monitoring data relating to lakes which reflects reference conditions. The EPA is undertaking a National Lake Survey utilizing a probabilistic site selection approach, so it is possible that this gap may be addressed through pending efforts. However, four groups of lentic systems are proposed for North Dakota's nutrient criteria, so any data reflecting expected condition may only apply to certain types of lentic systems (e.g., shallow lake).

Another data gap is the lack of a Trophic Status Index (TSI) model specific to the state. Carlson's TSI model is currently utilized by the NDDH to assess eutrophication in lentic systems. A major drawback to using Carlson's TSI is that it was developed for lakes that are primarily phosphorus limited. Because most North Dakota lakes and reservoirs have an abundance of phosphorus, this model should be modified or otherwise adapted for conditions in North Dakota to provide a tool to establish causative variable criteria from endpoints such as Secchi depth transparency.

Figure 4. Potential Process to Establish Nutrient Criteria for Lakes and Reservoirs.



An additional challenge is how to convert a regionally defined load into nutrient concentrations in the streams and rivers entering the lake or reservoir and how to modify the concentrations moving upstream in the drainage area. Much of the available data is more than 5 years old, and therefore has been subject to varying and changing data collection and analytical techniques. While the National Lakes Survey will assess lakes statewide, only a single measurement will be collected from each lake. Additional funding could be used to sample the National Lakes Survey lakes additional times, sufficient to develop cause – affect relationships.

Table 16 shows the availability of paired nutrient concentration data (i.e., causual variable) and differing potential response variables, by monitoring effort / program and ecoregion for lentic and lotic systems. Considerable paired total phosphorus, total nitrogen and chlorophyll-a data are available within the NDDH database for lentic systems, with the exception of Level III ecoregion 48. No chlorophyll-a data are available within the remaining datasets for lentic systems. The NDDH data should initially be used to evaluate potential cause – affect relationships. Further analysis of the data is needed to determine sample sizes by water body type.

3.2.3 Proposed Approach for Lotic Systems

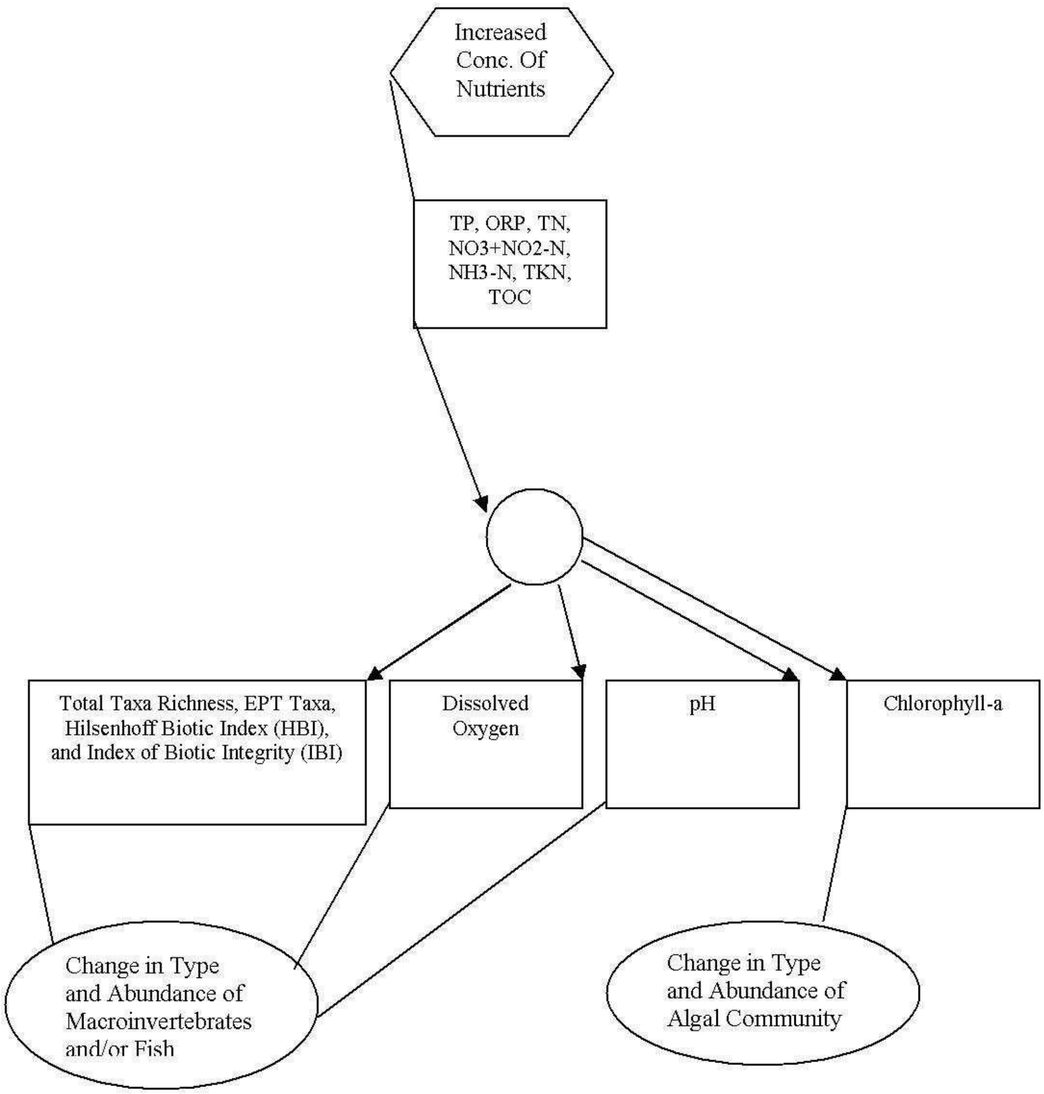
3.2.3.1 Conceptual Model

Figure 5 presents a conceptual ecological model showing the response of lotic systems to excess nutrient concentrations. This model suggests potential ecological endpoints (i.e., response variables) include the frequency and severity of algal blooms, the concentrations of chlorophyll-a, and various metrics associated with the aquatic community (e.g., fish, macroinvertebrates, periphyton). The conceptual model further suggests that the applicable causative variables are those that limit primary production.

3.2.3.2 Ecological Endpoints (Response Variables)

Several ecological indicators are used by the NDDH in assessing whether a stream or river attains the beneficial use for aquatic life. The ecological endpoints are also our response “targets” for the nutrient criteria. These ecological endpoints include the macroinvertbrate assemblage, the types and abundance of fish, the algae and diatom assemblages and plant biomass as characterized by macrophyte density and algal biomass (epiphyton, periphyton, phytoplankton). The pigment chlorophyll-a is typically used to quantify algal biomass. Excess nutrients, through biological processes, can also affect the magnitude of and daily variation in the amount of dissolved oxygen.

Figure 5 – Conceptual Ecological Model for the Response of a Lotic System to Increased Nutrient Concentrations (from CADDIS)..



Provided light (or some other physical or chemical characteristic) does not limit primary productivity, an excess of nutrients within perennial rivers and streams leads to an increase in the biomass of epiphytic algae. The increase in epiphytic algae is generally less in turbid lotic systems than in those with less turbidity. Understanding the response to excess nutrients within intermittent streams is less clear and therefore, will be more challenging.

Ecological endpoints typically include some characteristic of the ecological community, population distribution or dynamic, or the abundance and distribution of specific organisms. For example, the EPT (*Ephemeroptera* + *Plecoptera* + *Trichoptera*) taxa richness metric is one common characteristic of the macroinvertebrate community used to assess whether a stream or river is meeting its beneficial uses. The EPT characteristic or "metric" is simple, known to be stable at reference sites or reaches, and can be used to effectively evaluate changes in water quality. The EPT taxa metric proved useful on the Sheyenne River in earlier work completed by the NDDH (Zheng et al., 2005).

Macroinvertebrate sampling in wadable streams within North Dakota is extensive. The NDDH performs macroinvertebrate sampling through 1) pilot projects such as through the EMAP Western Pilot Project; 2) on the Sheyenne River to characterize macroinvertebrate structure; 3) a rotating basin bioassessment program approach to monitoring which is now being applied within the Red River Basin; and 4) Section 319 Nonpoint Source Pollution watershed assessment projects. While there are substantial efforts to characterize ecological endpoints, the variability within the available data presently makes it uncertain as to which metric will best reflect the response of a stream to human impacts and changes in nutrients.

Various macroinvertebrate endpoints or metrics are recommended as the response variables for excess nutrients within rivers and streams (based upon a conceptual model). These metrics may include total taxa richness, EPT taxa, the Hilsenhoff Biotic Index (HBI), and the Index of Biotic Integrity (IBI). Algal biomass, the concentration of dissolved oxygen, and pH may also be evaluated as potential response variables. The use of macroinvertebrate endpoints is consistent with the Sheyenne River pilot study.

3.2.3.3 Causative Variables as Nutrient Criteria

As noted in Section 3.2.2.2, many efforts have been implemented to collect data on response variables. Similarly, data for numerous causative variables, including nutrients, have been collected over time. Cursory evaluations EMAP West Pilot project data and Sheyenne River Nutrient Pilot project data suggest that both total phosphorus and total nitrogen, respectively, can be related to changes in macroinvertebrate composition.

Lotic systems are known to respond to increasing concentrations of various nutrients including nitrogen, phosphorus; the metabolic building block carbon (e.g., CO_2); and light. The nature of the response may be linear or nonlinear.

An initial evaluation of the following causative variables as potential nutrient criterion is recommended:

- Total phosphorus
- Orthophosphate or dissolved phosphorus
- Total nitrogen
- Nitrate plus nitrite nitrogen
- Ammonia nitrogen
- Total Kjeldhal nitrogen
- Dissolved organic carbon
- Total organic carbon

Statistical analysis of the response and causative variables based upon the conceptual model will be used to select the final parameters. Those parameters which have the strongest predictive relationship with the ecological endpoints will be the most useful to establish as criteria. Expectations are that a detailed analysis of the various forms of nitrogen is unneeded. Rather, the response to total nitrogen or inorganic nitrogen is sufficient to describe the response of the ecological system.

3.2.3.4 Temporal Scale

Defining the temporal scale for the nutrient criteria can help guide future data collection efforts. There are several options for defining the temporal scale for lotic system nutrient criteria, including daily, weekly, monthly, seasonal, and annual (load based). The temporal scale will depend in large part on whether the lotic system is perennial or intermittent. The magnitude of nutrient concentrations during base flow will differ inherently from those occurring storm or event flows. When determining the temporal scale of the nutrient criteria, the frequency of in-stream concentrations and the duration over which the concentrations occur should be considered.

The nutrient criteria may need to consider a weekly or even shorter temporal scale if dissolved oxygen or pH is used as the response variable(s). Excess nutrients can lead to increased epiphytic algae and an increase in the amplitude of the diel variation in dissolved oxygen. Low dissolved oxygen during the early morning in some streams and rivers can lead to aquatic life impairment.

3.2.3.5 Spatial Scale

Expectations are that the nutrient criteria will be developed by Level III ecoregion and major drainage basin and separately for perennial and intermittent streams and rivers. Further separation of the large non-wadable river systems like the Missouri River and Red River from other non-wadeable perennial streams is likely. Nutrient criteria for the Missouri River will likely be developed in cooperation with upstream and downstream states (e.g., Montana, South Dakota, Iowa, Kansas, Nebraska, Missouri), while criteria for the Red River will likely involve a collaborative effort with Minnesota and the province of Manitoba.

3.2.3.6 Recommended Criteria Development Method

The use of a reference approach to establish the nutrient criteria for lentic systems is recommended. The recommended approach consists of:

1. Refining the conceptual model **(Figure 5**) for each lotic system of interest (i.e., intermittent and perennial wadeable and non-wadeable streams) to reasonably ensure the identification of the stressor and response variables, as well as the causative mechanism for the response to excess nutrients and the ecological endpoints;
2. Using existing or newly collected biological data (e.g., fish population characteristics, macroinvertebrate abundance / diversity, periphyton abundance / diversity) to test / validate the ecological endpoints described by the conceptual model. Use the reference sites to establish the desired conditions for the ecological endpoints;
3. Subdivide the resource according to the appropriate water body classification for lotic systems;
4. Use landscape scale features to identify candidate reference sites[7] or reaches, stratified by Level III ecoregion and major drainage basin, which represent least impacted conditions and the nutrient condition gradient. Previous work completed in the Sheyenne River Basin suggests that less than 60% of the upstream land use in agriculture is necessary to define a site or reach as "reference." Additional analysis will be needed to confirm this early conclusion;
5. Evaluate the ability to use various surrogate response variables across the nutrient gradient, for the ecological endpoints of interest (e.g., relate pH and dissolved oxygen dynamics to the ecological response endpoints);
6. Use existing or newly collected chemical concentration data, specifically for the causative variables (as discussed in Section 3.2.3.3), and evaluate potential statistically significant relationships between the causative variable (stressor) and the various fish, macroinvertebrate, and periphyton ecological endpoints (i.e., response variables);
7. Determine the ecological endpoint(s) which best supports criteria development; and
8. Establish nutrient criteria for causative variables based on thresholds established for the ecological endpoints;

Two additional steps may be completed, should the recommended approach prove challenging:

9. Compute descriptive statistics (including the 85th percentile values) for the causative variables at various temporal scales. In the absence of statistically significant relationships between the causative and response variables, anecdotally identify the relationship between the descriptive statistics for the

[7] The reference approach takes into account a range of disturbances defined as least impacted and, therefore, a range in the stressor-response relationship.

causative and response variables. Use this anecdotal information to establish the nutrient criteria. Work completed by the Department of Environmental Quality in Montana has shown the 85^{th} percentile to be correlated to reference conditions when using biological metrics.

10. In the absence of a definable relationship, use the 85^{th} percentile concentration for the reference condition.

3.2.3.7 Data Gaps and Potential Issues

A potential issue relates to situations when lotic systems discharge into lentic systems. The criteria set forth to protect the beneficial uses in a particular river or stream reach may not necessarily also be protective for conditions in downstream resources (i.e., a lake or reservoir). The role of a translator mechanism as discussed in Section 3.1.5.1 is important in this context. This would potentially allow for adjustments (i.e. more stringent) to nutrient criteria in lentic systems such that it would "agree" with the criteria established for lotic systems, thus protecting the beneficial uses in both systems.

A second substantive issue is the availability of fish, macroinvertebrate and periphyton data needed to develop the various response variable metrics. These data need to be specific to reference sites or reaches and across nutrient gradients within the geographic region of interest. Based upon a cursory review of the available macroinvertebrate data, additional data will need to be collected for reference reaches.

Large non-wadeable river systems (e.g., the Missouri River, and lower Red River) present unique technical challenges requiring a set of causative variables which may be different than for smaller wadeable perennial systems. Large river system ecology can differ considerably from smaller systems. These challenges include how reference conditions are defined, sampling challenges and a generally greater importance of allocthanous than autocthanous energy inputs. The need to collaborate with other state, provincial, and federal agencies will also be a challenge.

Table 12 shows the availability of paired nutrient concentration data (i.e., causual variable) and differing potential response variables, by monitoring effort / program and ecoregion for lotic and lentic systems. Little paired total phosphorus, total nitrogen and chlorophyll-a data are available within the NDDH database for lotic systems. Samples sizes exceeding 30 are available for select ecoregions within the western EMAP database. Further analysis of the data is needed to determine sample sizes by water body type.

Implementation Priorities and Administrative Issues

4.1 Priority for Developing Nutrient Criteria

Developing nutrient criteria is expected to require a considerable level of effort both in terms of staff and financial resources. Due to limited staff and financial resources, the NDDH will need to develop nutrient criteria sequentially by water body type and geographic region. The priority for developing nutrient criteria has been established by the NDDH based on several considerations, including recreational importance, intensity of use as a fishery, regional or state-wide prominence, TMDL need, and/or quantity and quality of existing data for criteria development. *The following priority will be used for developing nutrient criteria within the State of North Dakota:*

1. Large reservoirs and deep natural lakes;
2. Shallow natural lakes, small reservoirs;
3. Perennial wadeable rivers and streams;
4. Perennial non-wadeable (large) rivers and streams;
5. Intermittent/ephemeral streams; and
6. Wetlands.

Developing nutrient criteria for most types of water bodies will likely require the collection of additional water quality and biological data. The priority may be revised based upon the availability of existing water quality data and TMDL development activities. Those water bodies with a greater amount of water quality data have also been given preference.

4.2 Data Needs

Many of the data needs have previously been identified within this criteria development plan. The most critical of these data needs include:

1. Geospatial landscape scale data sufficient to identify and select reference sites and reaches as well as impacted or disturbed sites (i.e., sites across the nutrient gradient);
2. Geometric and morphometric data for classifying water resources;
3. Hydrologic and runoff data to assist with classifying wadeable streams as intermittent or perennial and for the recommended lentic system approach. Discharge and runoff data should ideally be paired with the causative and response variables;
4. Sufficient data for the causative variables to be representative of the populations at reference sites and reaches; and
5. Sufficient data for the response variables to be representative of the populations at reference sites and reaches. These data should be “paired’ with the causative variables.

A general rule of thumb is a sample size of 30 for establishing a statistical representation of the population. Therefore, a minimum of two to three years of effort is expected to obtain the minimum data needs for each waterbody type and geographic strata.

4.3 Administrative Requirements

North Dakota Century Code lacks many of the definitions needed to establish nutrient criteria. Preliminary definitions presented here and in subsequent documents will be refined for use in the promulgation of a final rule. There is no known obstacle to implementation of nutrient criteria through the North Dakota Century Code. As an initial step in the nutrient criteria development process, the state should consider establishing a narrative nutrient or eutrophication standard.

4.4 Schedule and Milestones

The schedule and completion of milestones is completely dependent upon sufficient staff and funding. The NDDH currently lacks sufficient staff and financial resources to implement all of the steps presented. Assuming that additional staffing and financial resources are available, an eight year process to completely develop and implement nutrient criteria seems plausible as follows.

Time Period	Milestone Activity
Year 1	• Develop conceptual models for each lentic water body type identified in Section 3.2.2.1. • Complete review and analysis of existing surface water quality monitoring data for lentic systems at the recommended spatial and temporal scales. • Modify current monitoring program design for lentic systems to fill data gaps and needs for criteria development. • Complete an evaluation of known lentic reference sites. • Complete additional Geographic Information System analysis to identify potential range of reference sites and other locations for lentic systems across the nutrient concentration and/or trophic status gradient. • Evaluate priorities recommended in this plan for criteria development and methods to reduce fiscal impact (e.g., implement by geographic region). • Develop detailed budget for developing the nutrient criteria for lentic systems.

Year 2	• Initiate data collection for priority one water bodies (large reservoirs and deep natural lakes) within all ecoregion / major drainage basin strata. • Develop conceptual models for each lotic water body type identified in Section 3.2.3.1. • Complete review and analysis of existing surface water quality monitoring data for lotic systems at the recommended spatial and temporal scales. • Modify current monitoring program design for lotic systems to fill data gaps and needs for criteria development. • Complete an evaluation of known lotic reference sites. • Complete additional Geographic Information System analysis to identify potential range of reference sites and other locations for lotic systems across the nutrient concentration gradient. • Evaluate priorities recommended in this plan for criteria development and methods to reduce fiscal impact (e.g., implement by geographic region). • Develop detailed budget for developing the nutrient criteria for lotic systems.
Year 3	• Complete data collection for priority one water bodies (large reservoirs and deep natural lakes). • Initiate data collection for priority two water bodies (shallow natural lakes, small reservoirs) within all ecoregion / major drainage basin strata. • Test the methods recommended by this plan for priority one water bodies. • Refine the methods and recommendations for developing nutrient criteria for priority one water bodies based upon data analysis and lessons learned. • Apply the refined method to compute draft criteria for priority one water bodies.
Year 4	• Complete data collection for priority two water bodies (shallow natural lakes, small reservoirs) within all ecoregion / major drainage basin strata. • Initiate data collection for priority three water bodies (perennial wadeable rivers and streams). • Test the methods recommended by this plan for priority two water bodies. • Refine the methods and recommendations for developing nutrient criteria for priority two water bodies based upon data analysis and lessons learned.

- Apply the refined method to compute draft criteria for priority two water bodies.

Year 5

- Complete data collection for priority three water bodies (perennial wadeable rivers and streams).
- Initiate data collection for priority four water bodies (perennial non-wadeable (large) rivers and stream) within all ecoregion / major drainage basin strata.
- Test the methods recommended by this plan for priority three water bodies.
- Refine the methods and recommendations for developing criteria based upon lessons learned for priority three water bodies.
- Apply the revised method to compute draft criteria for priority three water bodies.

Year 6

- Complete data collection for priority four water bodies (perennial non-wadeable (large) rivers and streams).
- Initiate data collection for priority five water bodies (intermittent/ephemeral streams).
- Test the methods recommended by this plan for priority four water bodies.
- Refine the methods and recommendations for developing criteria based upon lessons learned for priority four water bodies.
- Apply the revised method to compute draft criteria for priority four water bodies.
- Develop conceptual models for wetlands water body types.
- Complete review and analysis of existing surface water quality monitoring data for wetland systems at the recommended spatial and temporal scales.
- Modify current monitoring program design for wetland systems to fill data gaps and needs for criteria development.
- Complete an evaluation of known wetland reference sites.
- Complete additional Geographic Information System analysis to identify potential range of reference sites and other locations for wetland systems across the nutrient concentration gradient.
- Evaluate priorities recommended in this plan for criteria development and methods to reduce fiscal impact (e.g., implement by geographic region).
- Develop detailed budget for developing the nutrient criteria for wetland systems.

Year 7

- Complete data collection for priority five water bodies (intermittent/ephemeral streams).
- Initiate data collection for priority six water bodies (wetlands).
- Test the methods recommended by this plan for priority five water bodies.
- Refine the methods and recommendations for developing criteria based upon lessons learned for priority four water bodies.
- Apply the revised method to compute draft criteria for priority four water bodies.

Year 8

- Complete the data collection for priority six water bodies (wetlands).
- Test the methods recommended by this plan for priority six water bodies.
- Refine the methods and recommendations for developing criteria based upon lessons learned for priority five water bodies.
- Apply the revised method to compute draft criteria for priority five water bodies.

Year 9

- Implement criteria within North Dakota Century Code

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APPENDIX A
LEVEL III ECOREGIONS OF NORTH DAKOTA

The concept of defining or grouping broad landscapes based on environmental factors has been studied in North America for almost 45 years. However, the first national compilations of ecological classifications were proposed in the mid-1980's (CEC 1997). Ecoregions are broad geographic areas of similar land form, soil type, climate, flora and faunal communities. As such, rivers and lakes within ecoregions tend to show comparable traits.

There are four levels of detail in the ecoregion classification scheme, ranging from the continental scale (Level I) to a near-local scale (Level 4). Level III ecoregions characterize landscapes at a regional scale and are most appropriate for this plan. There are four Level III ecoregions within North Dakota (**Map 1**). The following descriptions are taken from the publication *Ecological Regions of North America* by the Commission for Environmental Cooperation (1997).

Northwestern Glaciated Plains, Ecoregion 42

This glaciated plains region comprises a transition between the generally more level, moister, more agricultural regions to the east and the generally more irregular, dryer regions to the southwest. The southern boundary roughly coincides with the limits of continental glaciation. Pocking this ecological region is a moderately high concentration of semi-permanent and seasonal wetlands, locally referred to as Prairie Potholes.

Northwestern Great Plains, Ecoregion 43

This ecological region encompasses the Missouri Plateau section of the Great Plains. It is a semiarid rolling plain of shale and sandstone punctuated by occasional buttes. Native grasslands, largely replaced on level ground by spring wheat and alfalfa, persist in rangeland areas on broken topography. Agriculture is constricted by erratic precipitation and limited opportunities for irrigation.

Northern Glaciated Plains, Ecoregion 46

This ecological region is characterized by a flat to gently rolling landscape composed of glacial till. The subhumid conditions foster transitional grassland containing tallgrass and shortgrass prairie. In its northern parts, mixed forests of aspen, lodgepole pine, and white spruce become prevalent. High concentrations of temporary and seasonal wetlands create favorable conditions for waterfowl nesting and migration. Though the till soils are very fertile, agricultural success is subject to annual climatic fluctuations.

Lake Agassiz Plain, Ecoregion 48

Glacial Lake Agassiz was the last in a series of proglacial lakes to fill the Red River valley in the three million years since the beginning of the Pleistocene. Thick beds of lake sediments on top of glacial till create the extremely flat floor of this region known as the Lake Agassiz Plain. The historic tallgrass prairie has been replaced by intensive row crop agriculture. The preferred crops in the northern half of the region are potatoes, beans, and wheat; soybeans and corn predominate in the south.

APPENDIX B
MAJOR DRAINAGE BASIN DESCRIPTIONS

There are five major hydrologic basins recognized by the State of North Dakota (**Map 2)**, where the Lower and Upper Red River Subbasins have been grouped into one major unit. Descriptions of these basins were excerpted from *Synopsis of Ground-water and Surface-water Resources of North Dakota* by Winter et al. (1984). In this report, the Lake Sakakawea and Lake Oahe Subbasins of the Missouri River have been grouped into one description for the Missouri River Mainstem Basin.

Red River (including Devils Lake) (includes Upper and Lower Red River Subbasins)

The Red River basin is a part of the Hudson Bay drainage system. Of the total drainage area, 20,820 square miles are located in North Dakota. This includes 3,800 square miles of the closed Devils Lake basin. The Ottertail and Bois de Sioux Rivers combine at Wahpeton, ND and Breckenridge, MN to form the Red River. The river flows northward for 394 miles to the United States-Canadian boundary. The Red River follows a meandering course through the broad, very flat bed of glacial Lake Agassiz. About one-half of the basins consist of the extremely flat lake plain, while the other half consists of an upland area with greater local relief. The principal tributaries are the Wild Rice, Sheyenne, Goose, and Pembina Rivers.

Souris River

The Souris River originates in southeastern Saskatchewan, Canada, flows southeasterly to enter North Dakota west of Sherwood, forms a loop in North Dakota, re-enters Canada near Westhope, and then flows to the Red River via the Assiniboine River in Canada. The topography in North Dakota varies from hilly moraines in the southwest part of the basin to gently rolling moraines and a flat glacial lake plain in the northeast part of the basin. The total drainage area in North Dakota is 9,130 square miles. Large areas within the overall basin have a poorly defined drainage pattern and are noncontributing to the streamflow. Major tributaries are the Des Lacs, Wintering, and Deep Rivers, and Willow and Boundary Creeks.

Missouri River Mainstem (includes Upper Missouri River (Lake Sakakawea) and Lower Missouri River (Lake Oahe) Subbasins)

The Missouri River mainstem drainage area within North Dakota consists of about 48 percent of the State. About 32,800 square miles of drainage area contribute to the Missouri River mainstem in North Dakota. The major tributaries are the Yellowstone, Little Missouri, Knife, Heart, and Cannonball Rivers, which drain the area to the west and south of the Missouri River. Most of the rivers in this western region flow through badland areas, which produce rapid and excessive runoff. Smaller tributaries, generally occupying large valleys of glacial origin, drain the area to the east and north. Tributaries in the eastern area originate in the lake wetlands area of the Coteau du Missouri where drainage is poorly integrated. Of the original 390 miles of river in the State, only the 90-mile reach between Garrison Dam and the upstream end of Lake Oahe near Bismarck, has not been inundated.

James River

The James River originates in Wells County in central North Dakota and follows a meandering course east and south for 260 miles to the state border. Near it headwaters, the channel is poorly defined, consisting of a series of small ponds or sloughs. The drainage area within North Dakota is 5,480 square miles, of which about 3,300 square miles is considered noncontributing. Relief through the basin is extremely slight, consisting of low hills, scattered lakes, and low bluffs along the river.

Appendix C
Summary Report: Recovery Potential Screening of North Dakota Watersheds in Support of Nutrient Management

Summary Report:
Recovery Potential Screening of North Dakota Watersheds in Support of Nutrient Management

INTRODUCTION

The US Environmental Protection Agency's (EPA's) Total Maximum Daily Loads (TMDL) Program, in cooperation with state water quality programs, released a long-term TMDL Vision document in December 2013. Part of the TMDL Vision involves increasing states' identification of priority watersheds for restoration and protection efforts over a several-year time frame, and better linkage of TMDLs to these priorities. Previously, a 2011 Office of Water policy memorandum on nutrients had also recommended systematic watershed analysis, comparison and priority setting to obtain better results. The EPA's TMDL program has provided watershed data, comparative assessment tools and state technical assistance for the past ten years through the Recovery Potential Screening (RPS) approach and tools (see Attachment 1). In support of state requests for assistance in nutrient-related prioritization, the TMDL program has partnered with several states, including North Dakota, to jointly carry out RPS assessments and develop results to help states consider their watershed nutrient management options systematically with consistent data. These RPS assessments were designed to address primary nutrient-related issues identified by each state using state-specific indicators and data relevant for watershed comparison. This report summarizes the North Dakota project approach and findings, and identifies multiple additional products (e.g., RPS Tools and data files) that were developed along with this overview document.

Background

Recovery Potential Screening (RPS) is a systematic, comparative method for identifying differences among watersheds that may influence their relative likelihood to be successfully restored or protected. The RPS approach involves identifying a group of watersheds to be compared and a specific purpose for comparison, selecting appropriate indicators in three categories (Ecological, Stressor, Social), calculating index values for the watersheds, and applying the results in strategic planning and prioritization. The EPA developed the RPS to provide states and other restoration planners with a systematic, flexible tool that could help them compare watershed differences in terms of key environmental and social factors affecting prospects for restoration success. As such, RPS provides water programs with an easy to use screening and comparison tool that is user-customizable for the geographic area of interest and a variety of specific comparison and prioritization purposes. The RPS Tool is a custom-coded Excel spreadsheet that performs all RPS calculations and generates RPS outputs (rank-ordered index tables, graphs and maps). It was developed several years ago to help users calculate Ecological, Stressor, Social, and Recovery Potential Integrated index scores for comparing up to thousands of watersheds in a desktop environment using widely available and familiar software. The EPA developed the RPS Tools with embedded indicator data for each of the conterminous states and other selected geographic areas of interest.

North Dakota Department of Environmental Quality (NDDEQ) requested assistance from the EPA in 2014 to further the state's efforts in prioritizing watersheds for nutrient management restoration and protection efforts. An RPS assessment project was jointly undertaken by the EPA's TMDL program, Tetra Tech (EPA contractor), and NDDEQ. Two hundred forty-nine (249) base, ecological, stressor, and social indicators were measured at the HUC12 scale and 72 indicators were measured at the HUC8 scale using a combination of national and state datasets. These indicators are compiled in a North Dakota statewide RPS tool (Excel file). The HUC12 watersheds were obtained from the USGS Watershed Boundary Dataset (WBD) in 2014 and include recent State-specific modifications to the HUC12 watersheds. Previously developed national indicators data were area-weighted where appropriate and to match the newer North Dakota WBD HUC12 watersheds in the Tool. The mapping features in the Tool were also updated to reflect the newer WBD HUC12 watersheds. The assessment findings and figures in this document were generated by the North Dakota RPS Tool.

APPROACH

As a starting point, each RPS nutrient project was designed to apply recommendations from the EPA Office of Water 2011 nutrient policy memorandum, which reads in part:

> *Prioritize watersheds on a statewide basis for nitrogen and phosphorus loading reductions*
>
> *A. Use best available information to estimate Nitrogen (N) and Phosphorus (P) loadings delivered to rivers, streams, lakes, reservoirs, etc. in all major watersheds across the state on a Hydrologic Unit Code (HUC) 8 watershed scale or smaller watershed (or a comparable basis.)*
>
> *B. Identify major watersheds that individually or collectively account for a substantial portion of loads (e .g. 80 percent) delivered from urban and/or agriculture sources to waters in a state or directly delivered to multi-jurisdictional waters.*
>
> *C. Within each major watershed that has been identified as accounting for the substantial portion of the load, identify targeted/priority sub-watersheds on a HUC 12 or similar scale to implement targeted N and P load reduction activities. Prioritization of sub-watersheds should reflect an evaluation of receiving water problems, public and private drinking water supply impacts, N and P loadings, opportunity to address high-risk N and P problems, or other related factors.*

The two-stage approach implicit in the text above fits well with the RPS Tool, which easily supports comparing HUC8s in an initial targeting stage and then focuses on screening and comparing HUC12s in a second, implementation-oriented stage, as illustrated in Figure 1. All of the RPS nutrient projects utilize the same general two stage approach (HUC8 or similar larger-scale unit in Stage 1, HUC12 in Stage2), while encouraging state-specific customization of the approach in identifying stage 1 scenarios, establishing state approaches for priority watershed identification, and selection and weighting of the most nutrient-relevant indicators for use in both stages. In this project, the data sources and indicators compiled in the RPS tool, the selections of indicators, choice of demonstration watersheds, and weighting of indicators in the nutrient-related screening runs all took place collaboratively among NDDEQ, the EPA and its contractor. Nevertheless, this technical project's findings and outputs are not meant to represent
decisions or policies of NDDEQ, the EPA, or any other entity.

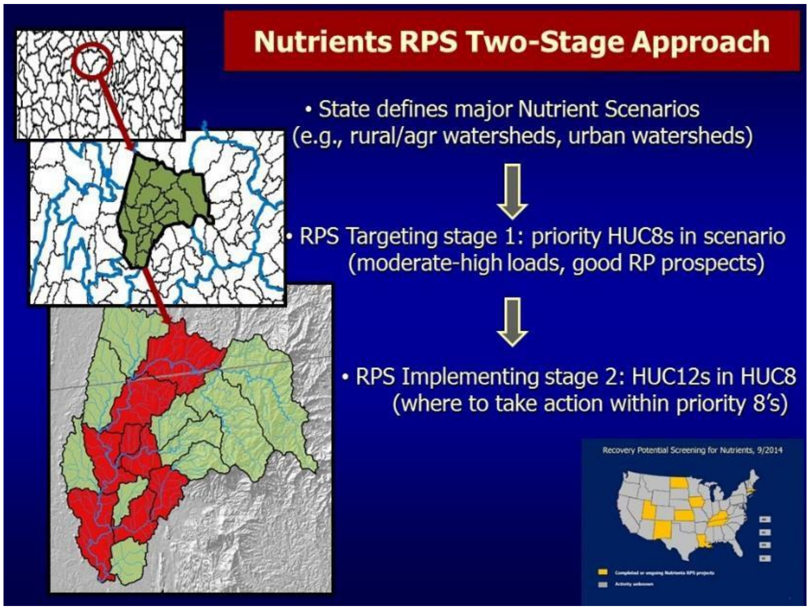


Figure 1. Two-stage conceptual approach utilized in RPS projects for supporting state nutrient management

Stage 1

Identifying Nutrient Scenarios. The RPS Tool is most effective in comparing groups of watersheds that have something in common, such as generally similar landscapes, nutrient sources, impacts and possible management options; for this reason, Stage 1 begins by engaging the state in defining specific types or groups of watersheds with something in common regarding their primary nutrient management challenges. The term "scenario" is used here to describe these sets of shared characteristics that provide a basis for groups of similar watersheds to be compared and contrasted with one another. Nutrient management challenges in any given state can be complex and involve multiple scenarios.

Breaking down a large group of watersheds statewide into smaller, more similar groups and focusing on scenarios most relevant to each group enables a narrower focus on nutrient issues and possible solutions.

For North Dakota, two Stage 1 scenarios of interest were initially selected during a series of conference calls between the EPA, NDDEQ, and Tetra Tech. The state is divided into eastern and western regions based on predominant land cover (Figure 2 and Table 1). The eastern part of the state which includes the Red River/Lake Winnipeg drainage basin is primarily row crop agriculture, and there is interest in nutrient reduction and restoration. The western part of the state is primarily small grains and rangeland and is in need of nutrient management as land disturbance and population increase due to rapidly expanding oil and gas extraction, which results in new wastewater and stormwater sources. Those HUC8 that are at least 15 percent within North Dakota were included in the Stage 1 analyses.

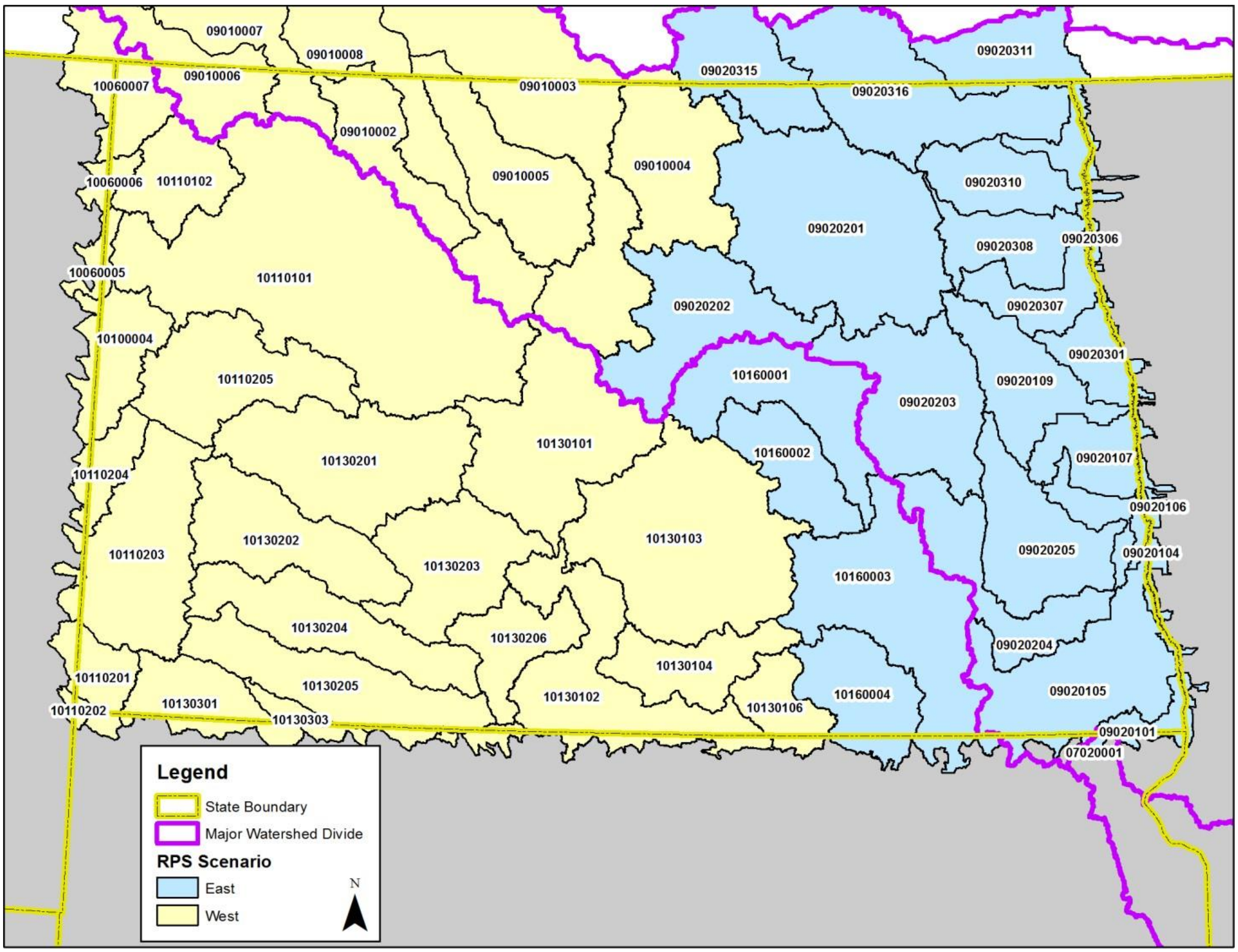


Figure 2. North Dakota HUCs. Scenario 1A ranks blue HUC8s; scenario 1B ranks yellow HUC8s. Note that HUC8 boundaries are clipped to HUC12 boundaries along the state line.

Table 1. North Dakota HUC8s included in analysis

Scenario 1A HUC8s (Eastern)	Scenario 1B HUC8s (Western)
09020101	09010002
09020104	09010003
09020105	09010004
09020107	09010005
09020109	09010006
09020201	09010008
09020202	10060007
09020203	10110101
09020204	10110102
09020205	10110203
09020301	10110204
09020307	10110205
09020308	10130101
09020310	10130102
09020311	10130103
09020315	10130104
09020316	10130106
10160001	10130201
10160002	10130202
10160003	10130203
10160004	10130204
	10130205
	10130206
	10130301

Scenario 1A - Eastern North Dakota HUC8s: Cropland and Drainage Pressures

Scenario 1A screens and compares those HUC8s that are dominated by row crop agriculture in the eastern portion of the state. These HUC8s are often served by tile drainage and ditching and are typically subject to intense tillage practices and fertilizer application. They also often have nutrient-related impairments (Figure 3). Key sources of nutrients in these watersheds include fertilizer application, runoff and erosion from fields and in nearby streams. In addition, expanded urban and human sources such as stormwater and wastewater can be important sources and are represented by population growth. These watersheds may include point sources and other significant non-point sources such as septic systems and feedlots. The purpose of this scenario is to identify those HUC8s where restoration efforts could be focused. Stressor indicators and those social indicators which represent potential for readiness to implement are weighed more heavily.

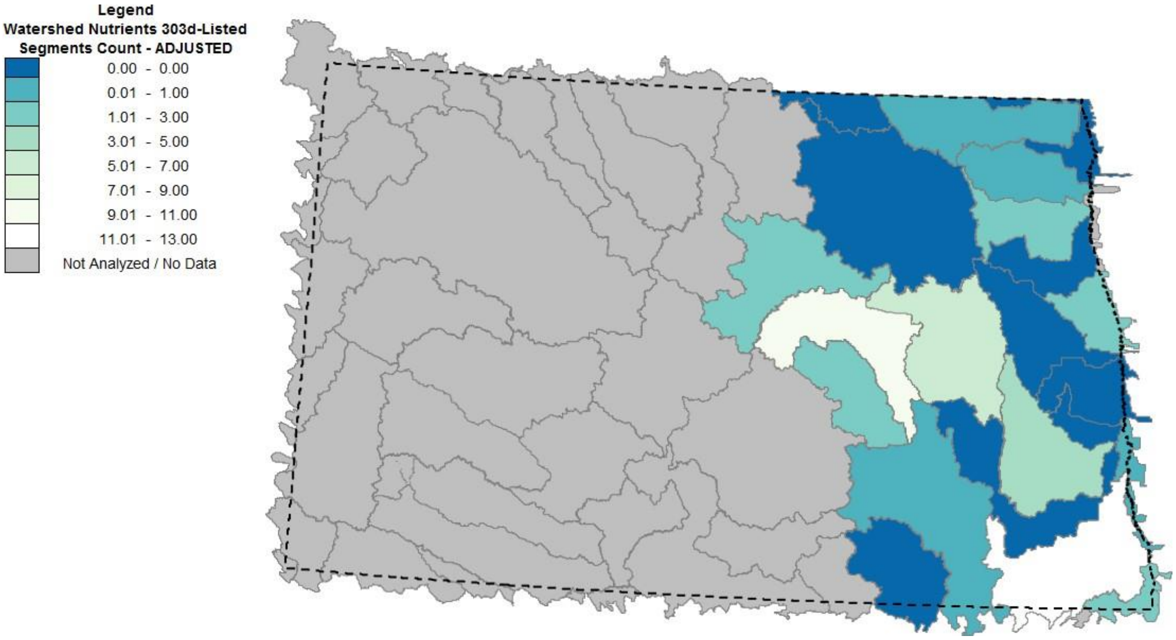


Figure 3. Number of reported nutrient impairments in eastern North Dakota

Scenario 1B - Western North Dakota HUC8s: Rangeland and Energy Production Pressures

Scenario 1B is used to identify HUC8s that are dominated by rural, non-row crop land uses in the western part of the state. These HUC8s are predominately rangeland (grassland and herbaceous land cover) and often include animal agriculture activities. In this part of North Dakota, oil and gas production has been leading to significant increases in population and land disturbance. Pathways for pollutants can include watershed and stream channel erosion, feedlot runoff, and manure management activities. In addition, population growth and wastewater loading associated with development are stressors. The purpose of this scenario is to identify HUC8s with threats that could result in additional nutrient loading and impairments beyond those already reported (Figure 4) and compare differences among these watersheds in terms of several factors that influence restorability. Ecological indicators and those stressor indicators which represent threats are weighed more heavily.

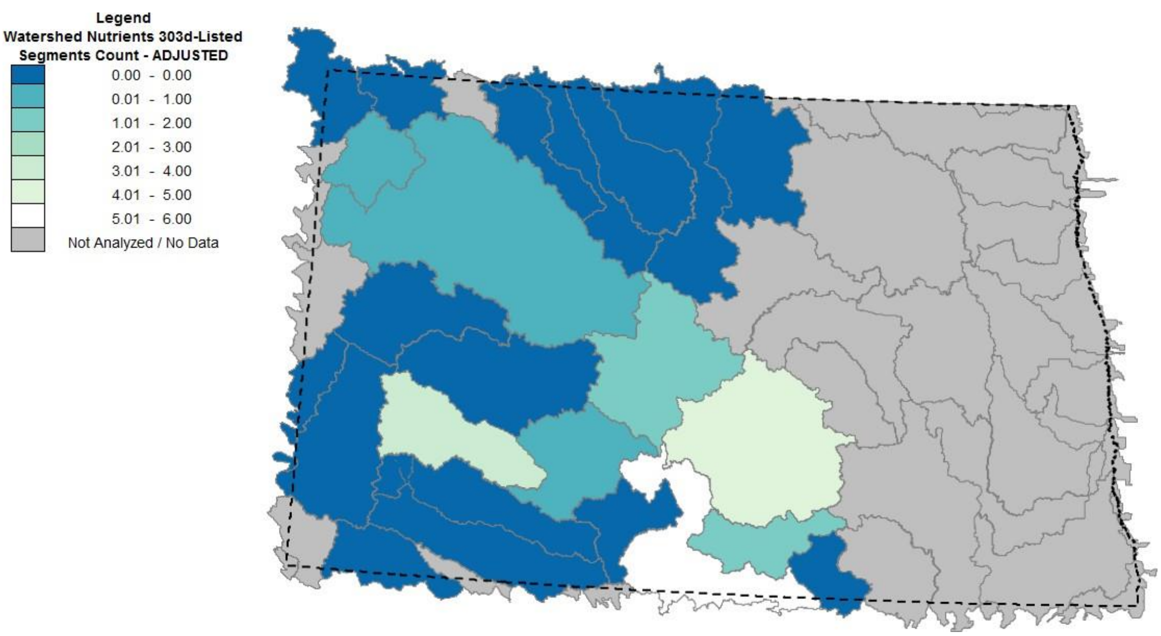


Figure 4. Number of reported nutrient impairments in western North Dakota

Selection of Stage 1 indicators. Watersheds within each scenario are compared to one another with scenario-specific indicator selections since each scenario differs in nutrient source types and exposure pathways. Indicators for Stage 1 need only to be sufficient for generally comparing watersheds across the state, identifying which watersheds to include in each scenario, and revealing major differences in condition and estimated nutrient loading magnitude as a state selects its first watersheds to assess within each scenario. Using the RPS Tool, two different (scenario-specific) selections of recovery potential indicators (see indicator lists in Table 2 and definitions in Attachment 2) were used to screen North Dakota HUC8s.

*Table 2. Stage 1 RPS indicator selections and weights for screening and comparing HUC8s for two North Dakota scenarios. See Attachment 2 for indicator definitions. Those indicators with a * are derived from state-specific datasets.*

Stage 1 Eastern North Dakota - Cropland and Drainage Pressures HUC8 Ranking – Scenario 1A					
Ecological Indicators	**wt**	**Stressor Indicators**	**wt**	**Social Indicators**	**wt**
% natural cover (2011) in watershed*	1	% corn, soybeans or sugar beet in watershed*	2	Count of segments with TMDLs in watershed	2
% natural cover (2011) in riparian zone*	1	% grassland to row crop transition in watershed*	2	% GAP status 1, 2, and 3 in watershed	1
National Fish Habitat Partnership Habitat Condition Index	1	Average TN load (kg/yr) SPARROW (2002) to watershed*	2	% drinking water source protection area*	1
% wetlands (2011 and NWI) in riparian zone*	1	Average TP load (kg/yr) SPARROW (2002) to watershed*	2	% watershed conservation activity in watershed*	2
		% population increase within watershed*	2	% CRP activities in watershed*	2
		Count of drain tile outlets/area in watershed*	2		
		Watershed nutrients 303d-listed segments count	1		
Stage 1 Western North Dakota - Rangeland and Energy Production Pressures HUC8 Ranking – Scenario 1B					
Ecological Indicators	**wt**	**Stressor Indicators**	**wt**	**Social Indicators**	**wt**
% natural cover (2011) in watershed*	1	% in pasture/hay (2011) in watershed*	1	Count of segments with TMDLs in watershed	1
% natural cover (2011) in riparian zone*	1	Average TN load (kg/yr) SPARROW (2002) to watershed*	1	% GAP status 1, 2, and 3 in watershed	1
National Fish Habitat Partnership Habitat Condition Index	2	Average TP load (kg/yr) SPARROW (2002) to watershed*	1	% drinking water source protection area*	1
% wetlands (2011 and NWI) in riparian zone*	1	Count of oil and gas wells/area in watershed*	2	% conservation activity in watershed*	2
		% population increase within watershed*	2	% CRP activities in watershed*	2
		Watershed nutrients 303d-listed segments count	1		

Interpreting the Screening Results

Several products are generated through the screening runs for each scenario. Each watershed (HUC8 or HUC12 scale) in a scenario screening run receives ecological, stressor, and social index scores and ranks. There is also an aggregate Recovery Potential Index (RPI) score and rank for each watershed. Each of these four index values have a possible range from 0 to 100. The ecological, stressor and social indices are each calculated by summing weight-adjusted, normalized indicator values, dividing by the total weight, and multiplying by 100. RPI Scores are calculated as: [Ecological Index +

Social Index + (100 - Stressor Index)] / 3. Note that all scores represent a relative gradient of values only across the watersheds being screened, and do not by themselves define thresholds of condition (e.g., impaired/unimpaired) or restorability.

A higher score implies a watershed may be better suited than others for restoration in the case of the ecological and social indices and the overall RPI. A higher stressor index score implies lower relative recovery potential. Conversely, in the case of rank order, all four indices (ecological, stressor, social and RPI) are rank ordered so that a smaller number (e.g., #1 ranked) implies higher relative recovery potential.

Maps illustrating the watersheds in the screening run are generated by the RPS Tool. The map can be customized to display values for each of the watersheds based on any index or single indicator, and map images can be saved and downloaded. The RPI score is the default map display and provides a commonly used parameter to illustrate the spatial relationship among the watersheds and their general ranking in the screening run.

Bubble plots are also produced for each screening run. These provide a visual tool for comparing the distribution of ecological, stressor and social indices across all watersheds in the screening run, and individual watersheds can be color coded and labeled for specific display purposes. The Y and X axes represent the Ecological and Stressor Index scores respectively and the size of the symbol indicates each watershed's social score. The bubble plot's extra axes position watersheds relative to the median stressor and ecological scores for every screening run. These axes split the plots into four quadrants. For example, watersheds in the upper left quadrant have high ecological scores and low stressor scores. Users may also reset these axes to represent statewide median values or user-defined values, providing more reference context to the relative value gradient of the screened watersheds. Like the map, bubble plot images can be saved and downloaded for later use in documents and presentations. Whereas there is no absolute rule dictating what the actual recovery potential of a watershed is based on these plots, theoretical considerations can be made about the relative position of HUC8s within these plots that may help guide discussion.

For additional information on using the RPS Tool and any of these product formats please see the RPS Tool User Manual and other user support resources online.

STAGE 1 RESULTS

Scenario 1A – Eastern North Dakota HUC8 Screening - Cropland and Drainage Pressures

This scenario compares HUC8s throughout the eastern region of the State to help identify a smaller number of HUC8s that could be focused on for nutrient management and restoration efforts where row crop agriculture is a predominant land cover. A copy of the RPS Tool populated with this scenario's screening results is among project deliverables (see tool files list in Attachment 4).

RPI scores for scenario 1A are displayed in map form in Figure 5 showing the relative geographic distribution of the scenario. RPI scores are a composite of scores for the Ecological, Stressor, and Social Indices for each HUC8, and as such the RPI provides a generalized starting point for comparing watersheds. Overall, the eastern and particularly east-central part of this region includes among the lowest scoring HUCs, while the highest scoring HUC8s tend to be in the western or west-central parts of the region (labeled on Figure 5). These results include all HUC8s in the region, and thus several considerations can be applied to focus on fewer HUC8s of greater interest for nutrient management and restoration. Primarily, HUC8s of interest would likely have evidence of nutrient impairments and significant nutrient loading estimates but would also have some ecological or social attributes associated with being better prospects for successful restoration. All but eight of the HUC8s within this scenario have nutrient impairments.

Of the top ten scoring HUC8s, four have estimated nutrient loads that are near or greater than the region's median 1) Western Wild Rice, 2) Lower Sheyenne, 3) Turtle, and 4) Forest. In addition, Upper Sheyenne, Middle Sheyenne, Upper James, Elm, and Western Wild Rice have many more nutrient-related impairments than the other HUC8s in this scenario. All of the top ranking HUC8s exhibit high levels of conservation activities or CRP activities in their watersheds. Many of these HUC8s, depending on the state's priorities, could be important areas for statewide prioritization and restoration efforts.

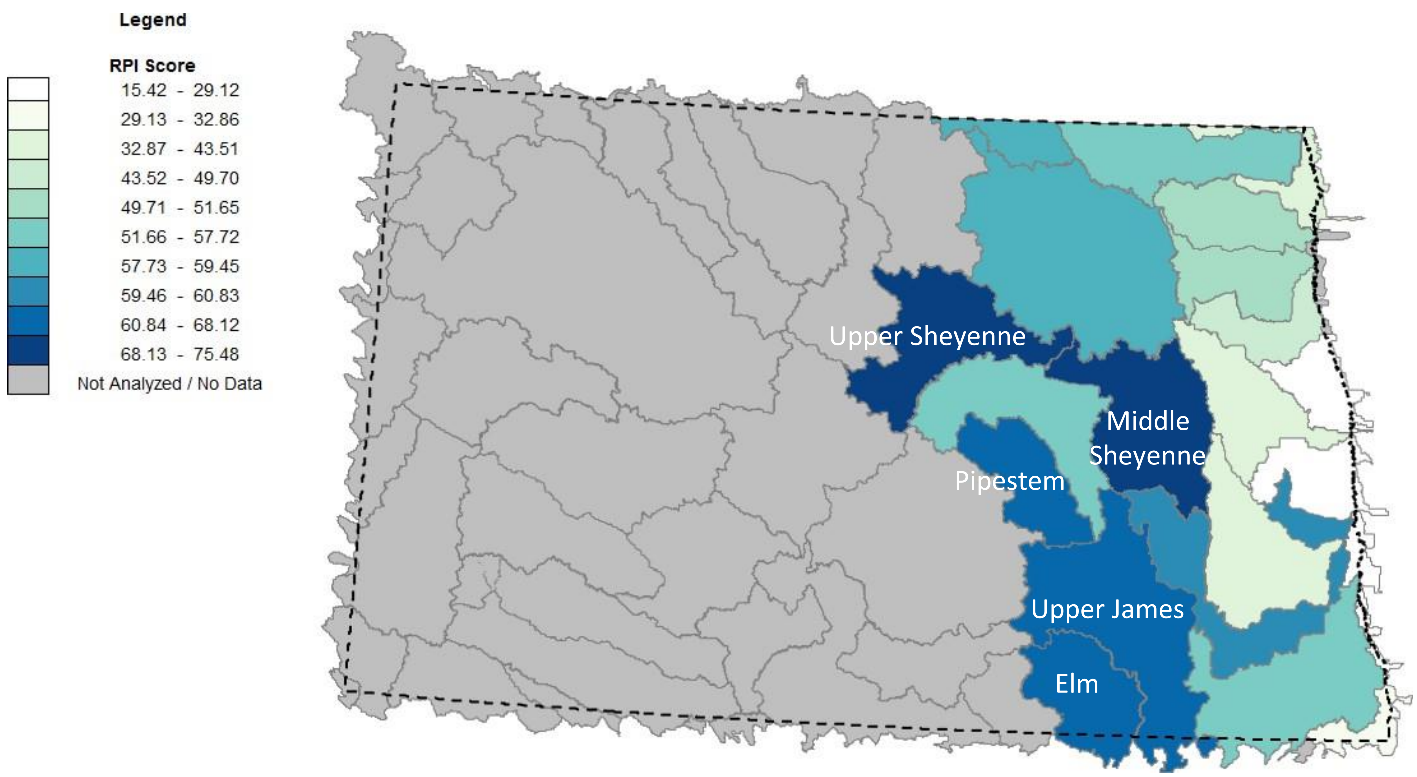


Figure 5. Scenario 1A watershed ranking by RPI score (highest ranked watersheds darkest with labels)

The bubble plot in Figure 6 displays the relative value differences among HUC8s in Ecological, Stressor and Social Index scores by each bubble's size and position on the graph, also showing how these compare to region-wide medians (the horizontal and vertical median lines). The bubble plot highlights HUC8s in orange that have estimated phosphorus or nitrogen yields that are greater than the regions' median yields. Note that Upper Pembina River, Middle Red, Turtle, Elm-Marsh, and Lower Sheyenne HUC8s have higher than average estimated nutrient loads but no identified nutrient impairments. These HUC8s could be candidates for further monitoring and assessment. In the upper right quadrant, the Western Wild Rice displays the highest social score and an above median ecological score, with an elevated stressor score; this might suggest elevated risks of impairment coupled with positive signals about the ecological and social context for restoration opportunities.

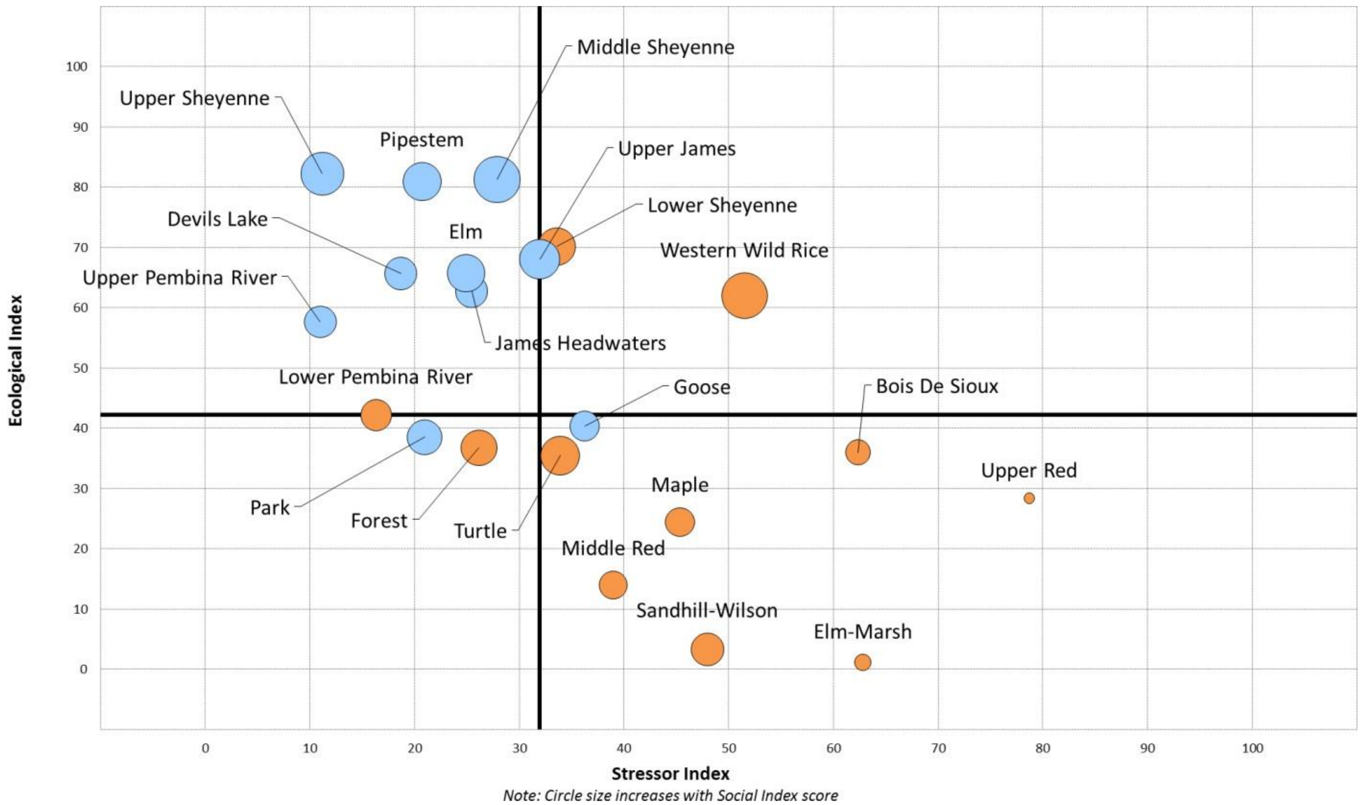


Figure 6. Bubble plot for all scenario 1A HUC8s. Orange bubbles represent HUC8s that have estimated phosphorus or nitrogen yields greater than the region's median. Axes are set to median Ecological Index and Stressor Index scores.

Maps of Ecological and Stressor Index scores for scenario 1A are displayed in Figure 7 and Figure 8. The Ecological Index map shows that high Ecological Index scores are found in the central part of the state. Low Stressor Index scores are found along the boundary with Canada, due in part to a predominance of wheat and other small grains. Additional indicators or different screenings may be warranted in these HUC8s to better understand their recovery potential in light of more specific exposure settings than were considered in this general scenario analysis.

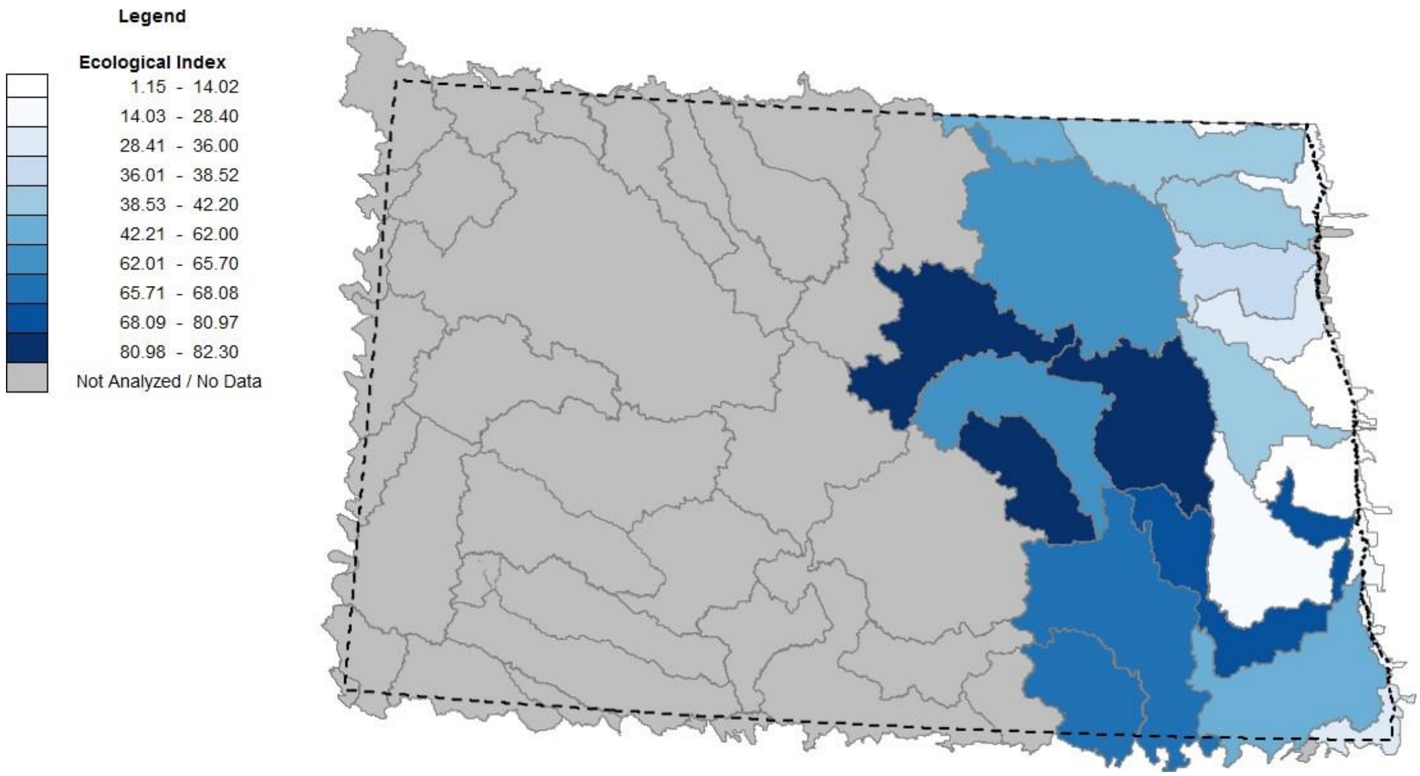


Figure 7. Ecological ranking (darker blue implies better for restoration)

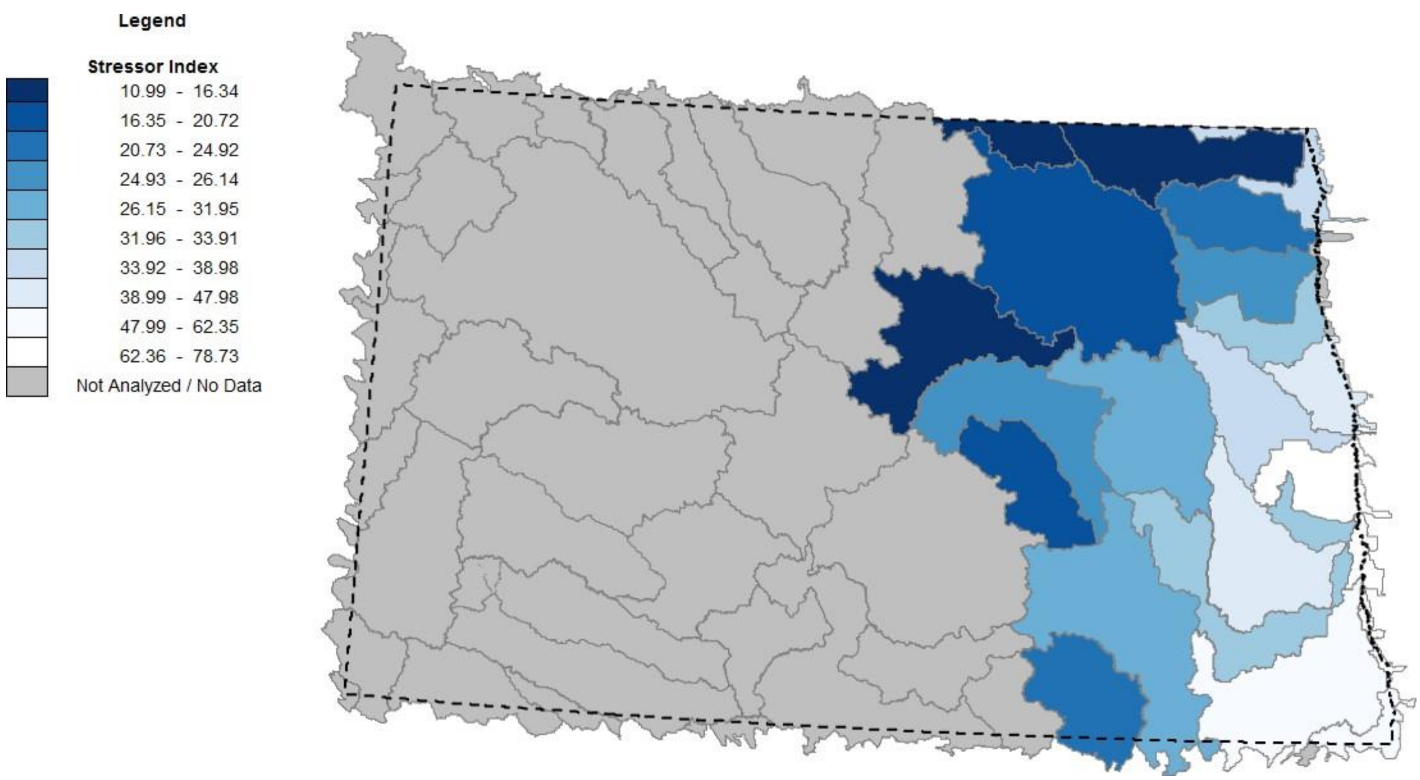


Figure 8. Stressor ranking (darker blue implies better for restoration)

Table 3 contains Ecological, Stressor, Social, and RPI scores for the scenario 1A HUC8s, in order of descending RPI score and color-coded by quartile per RPI score. This tabular format is another option for presentation of Stage 1 results that can be used to compare and contrast HUC8s. In interpreting this table, preferred HUC8s for nutrient management do not necessarily have to be those with the highest RPI scores but instead could consider one or more of the component index scores (e.g., the watersheds in the top ecological, stressor, or social quartile, or various combinations). For example, Middle Sheyenne and Upper James rank in the top 5 overall for RPI, but also have much higher (worse) Stressor Index scores indicating potentially threatened HUC8s.

*Table 3. Index and RPI scores for scenario 1A. HUC8s are ordered by RPI score. Cells are shaded (darker is better) according to rank (black = 76 - 100th percentile; dark gray = 51-75th percentile; light gray = 26-50th percentile; white = 0-25th percentile). **BOLD** indicates HUC8s that have estimated phosphorus or nitrogen yields greater than the region's median.*

Watershed ID	Watershed Name	Ecological Rank	Stressor Rank	Social Rank	RPI Rank
09020202	Upper Sheyenne	1	2	3	1
09020203	Middle Sheyenne	2	10	1	2
10160002	Pipestem	3	5	6	3
10160003	Upper James	5	11	4	4
10160004	Elm	6	7	8	5
09020204	**Lower Sheyenne**	4	12	7	6
09020201	Devils Lake	7	4	12	7
09020315	**Upper Pembina River**	10	1	14	8
09020105	**Western Wild Rice**	9	18	2	9
10160001	James Headwaters	8	8	13	10
09020316	Lower Pembina River	11	3	15	11
09020310	Park	13	6	10	12
09020308	**Forest**	14	9	9	13
09020307	**Turtle**	16	13	5	14
09020109	Goose	12	14	16	15
09020205	**Maple**	18	16	17	16
09020311	**Middle Red**	19	15	18	17
09020101	**Bois De Sioux**	15	19	19	18
09020301	**Sandhill-Wilson**	20	17	11	19
09020104	**Upper Red**	17	21	21	20
09020107	**Elm-Marsh**	21	20	20	21

Scenario 1B - Western North Dakota HUC8 Screening - Rangeland and Energy Production Pressures

This scenario identifies HUC8s that could be the focus of nutrient management efforts in the western part of North Dakota, where rangeland is a predominant land use and there are increasing pressures on water quality from development of oil and gas resources and related population growth. In contrast to scenario 1A's focus on largely existing nutrients impairments and restoration challenges, scenario 1B compares HUC8s based on a combination of their current nutrients issues and emerging future nutrient sources. A HUC in this scenario may be of high interest even if it has little current nutrient impairment, if expected future sources of nutrient loading are substantial. A copy of the RPS Tool populated with this scenario's screening results is among project deliverables.

RPI scores for scenario 1B are displayed in map form in Figure 9 and Table 4, showing the relative geographic distribution of the scenario. RPI scores are a composite of scores for the Ecological, Stressor, and Social Indices.

Integrating these three indices makes the RPI score frequently useful as an overall comparison metric, but it is capable of masking the importance of each of the component index scores, such as when two extreme scores in the same HUC cancel each other out. Thus, it is always important to examine all the indices to determine the HUC8s of high interest for the purpose at hand. For reasons discussed below, the RPI score is often not the preferred index to identify candidate HUC8s and the individual RPS indices are more useful; however, the RPI provides a useful starting point for comparison.

In this scenario, top RPI scores generally involve HUCs with fairly low stressor indices and either a high ecological or social index score. Top RPI scoring HUC8s in this scenario include Lower Cannonball (10130206), Willow (09010004), and West Missouri Coteau (10130106). All of the top ranked HUC8s have nutrient impairments or fairly high nutrient yields, however, and thus may be of high interest for nutrients management. In addition to these HUC8s, some of this scenario's HUC8s with high Ecological index scores also have some of the largest population increases (8-9%) that may indicate emerging (rather than existing) nutrient issues, most notably Middle Little Missouri (10110203) and Lower Little Missouri (10110205). Based on their high ecological scores accompanied by evidence of high emerging threats, these HUCs could be of high interest for nutrients management proactive strategies. Based only on RPI score, however, these HUCs would appear to be 'middle of the pack' and of no particular interest.

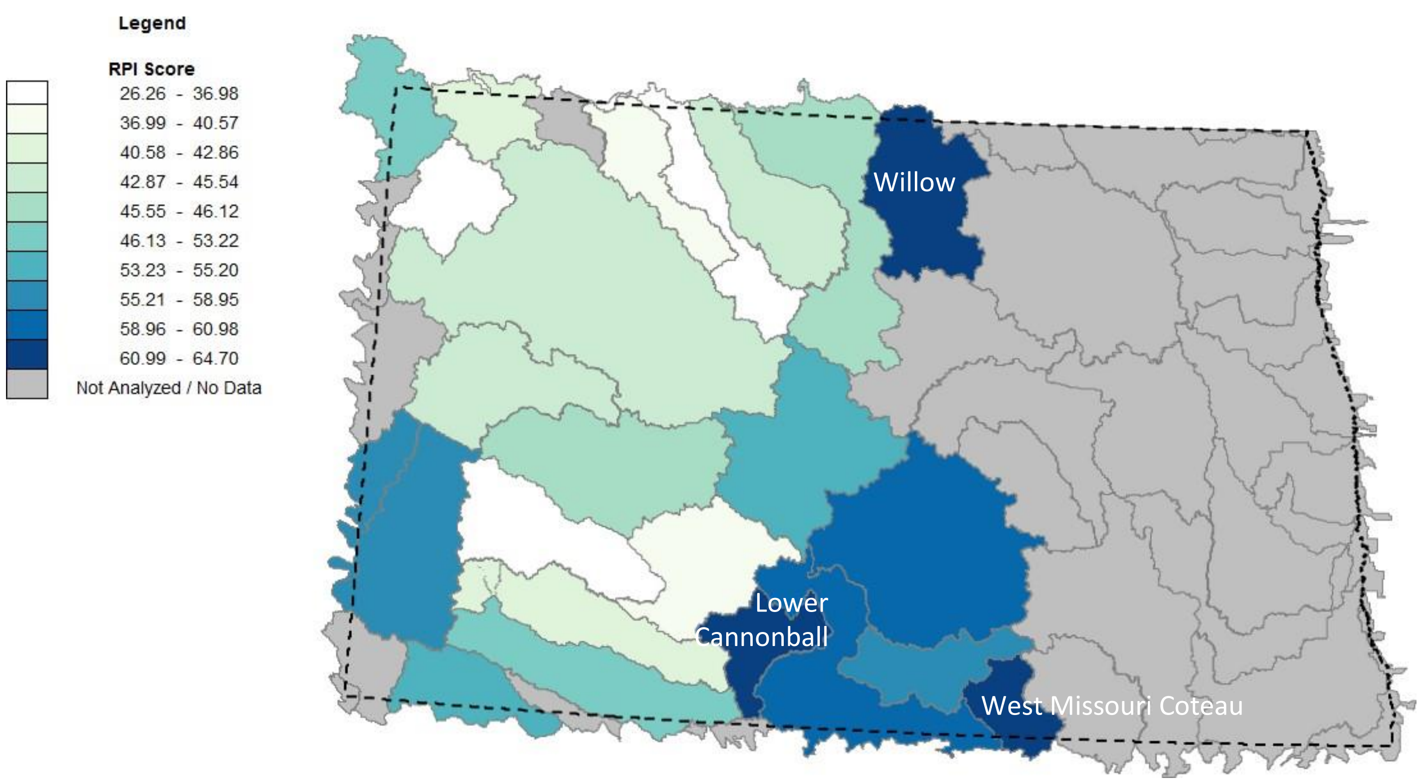


Figure 9. Scenario 1B RPI scores

Table 4 contains Ecological, Stressor, Social, and RPI scores for scenario 1B, in order of descending RPI score and color-coded by quartile per RPI score. This tabular format is another option for presentation of Stage 1 results that can be used to compare and identify HUC8s for scenario 1B nutrient management efforts. Lower Cannonball and Upper Lake Oahe rank high ecologically and have lower levels of stressors, but have lower Social Index scores. These watersheds may benefit from additional education and outreach, specifically related to conservation activities. Middle Little Missouri and Lower Little Missouri rank highest for Ecological Index, but also have very high increases in population. These two HUC8s currently have no nutrient impairments and have fairly low nutrient loads potentially indicating HUC8s that are in need of protection rather than restoration.

Table 4. Index and RPI scores for scenario 1B. HUC8s are ordered by RPI score. Cells are shaded (darker is better) according to rank (black = 76 - 100th percentile; dark gray = 51-75th percentile; light gray = 26-50th percentile; white = 0-25th percentile). ***BOLD*** *indicates HUC8s that have higher existing nutrient loads and italics represent HUC8s that have higher Ecological Index scores and high levels of emerging threats (based on population growth).*

Watershed ID	Watershed Name	Ecological Rank	Stressor Rank	Social Rank	RPI Rank
10130206	**Lower Cannonball**	4	1	10	1
09010004	**Willow**	5	8	4	2
10130106	**West Missouri Coteau**	10	2	5	3
10130102	Upper Lake Oahe	3	5	15	4
10130103	**Apple**	6	7	8	5
10130104	**Beaver**	13	6	2	6
10110203	***Middle Little Missouri***	2	16	13	7
10110204	Beaver	7	10	11	8
10130301	North Fork Grand	19	3	6	9
10130101	**Painted Woods-Square Butte**	12	9	7	10
10130205	Cedar	20	11	1	11
10060007	Brush Lake Closed Basin	22	4	14	12
09010003	**Lower Souris**	8	23	9	13
10130201	Knife	11	13	18	14
10110205	*Lower Little Missouri*	1	24	24	15
09010005	**Deep**	18	17	12	16
10110101	Lake Sakakawea	9	20	16	17
10130204	**Upper Cannonball**	23	15	3	18
09010006	**Long Creek**	16	14	19	19
10130203	**Lower Heart**	14	12	23	20
09010002	**Des Lacs**	17	21	17	21
09010008	**Moose Mountain Creek-Souris River**	15	19	20	22
10130202	**Upper Heart**	21	22	21	23
10110102	Little Muddy	24	18	22	24

The bubble plot for scenario 1B (Figure 10) reflects the relative value differences among HUC8s in Ecological, Stressor and Social Index scores by each bubble's size and position on the graph, also showing how these compare to scenario-wide medians (the horizontal and vertical median lines). For this scenario, HUC8s are widely distributed in each of the bubble plot quadrants. This figure highlights those HUC8s that may be of higher interest for nutrient management, either by combination of a high RPI score and higher nutrient loads (in green), or a combination of high ecological score and high emerging stressors related to projected population growth (in orange).

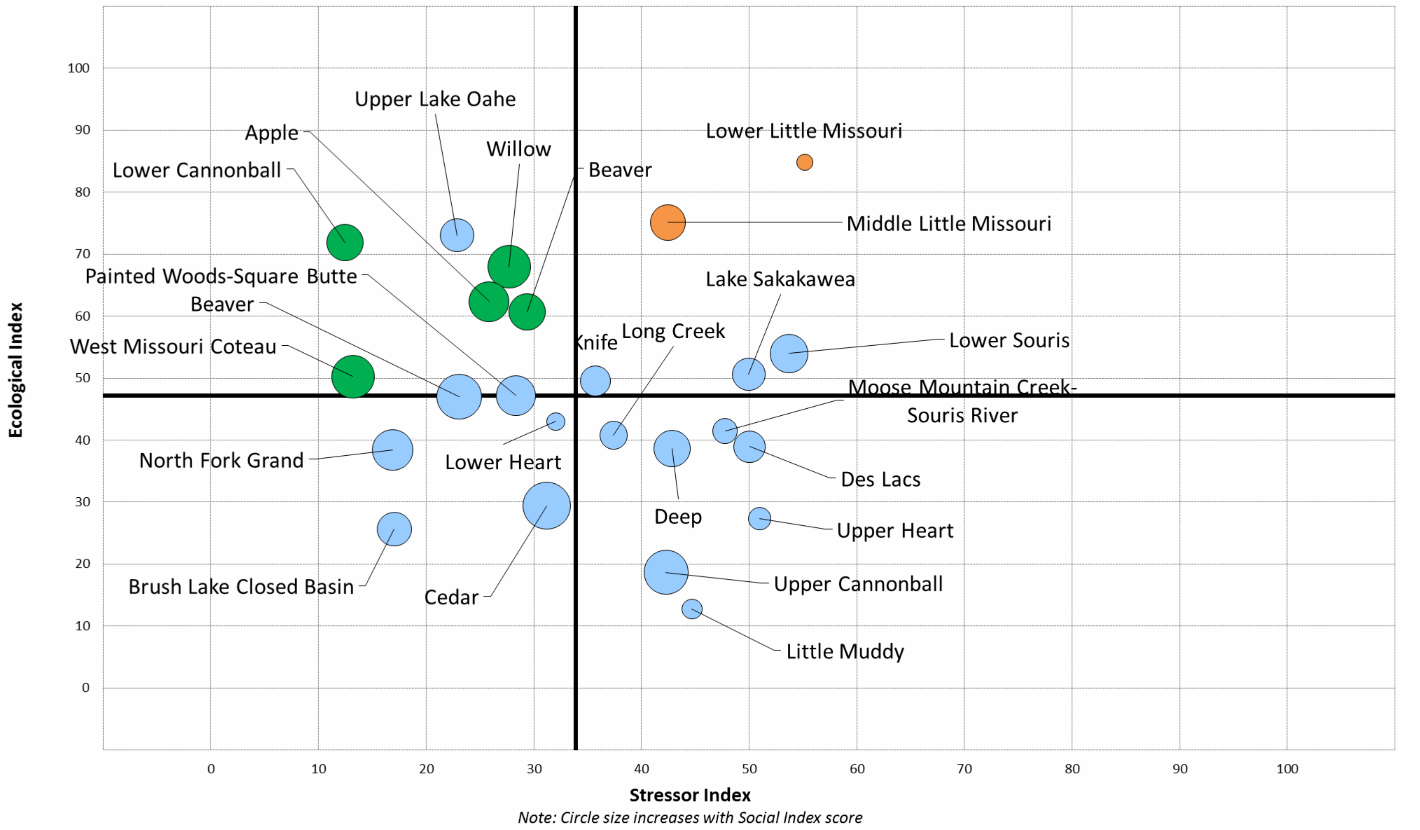


Figure 10. Bubble plot for all 1B HUC8s based on RPI score derived from scenario 1B indicators. Green bubbles represent high overall scoring HUC8s with higher existing nutrient loads. Orange bubbles represent HUC8s that have higher Ecological Index scores and emerging threats (based on population growth). Axes are set to median Ecological Index and Stressor Index scores.

Maps of Ecological and Stressor Index scores for scenario 1B are displayed in Figure 11 and Figure 12. There is no apparent geographic pattern to the Ecological Index, but the highest (worst) Stressor Index scores cluster close to the western state boundary. It is unusual to see that two of the highest-scoring HUCs ecologically (darkest blue in Figure 11) are also among the most stressed (white in Figure 12) based on the indicator choices used (Middle and Lower Little Missouri); most often, highly stressed HUCs also display low ecological scores. Both of these watersheds have high population increases, and Middle Little Missouri has an existing wastewater discharger, contributing to the higher stressor scores. This might imply that these high-ranking areas may have good ecological structure but be under emerging threats from relatively new stressors captured in the choice of stressor indicators.

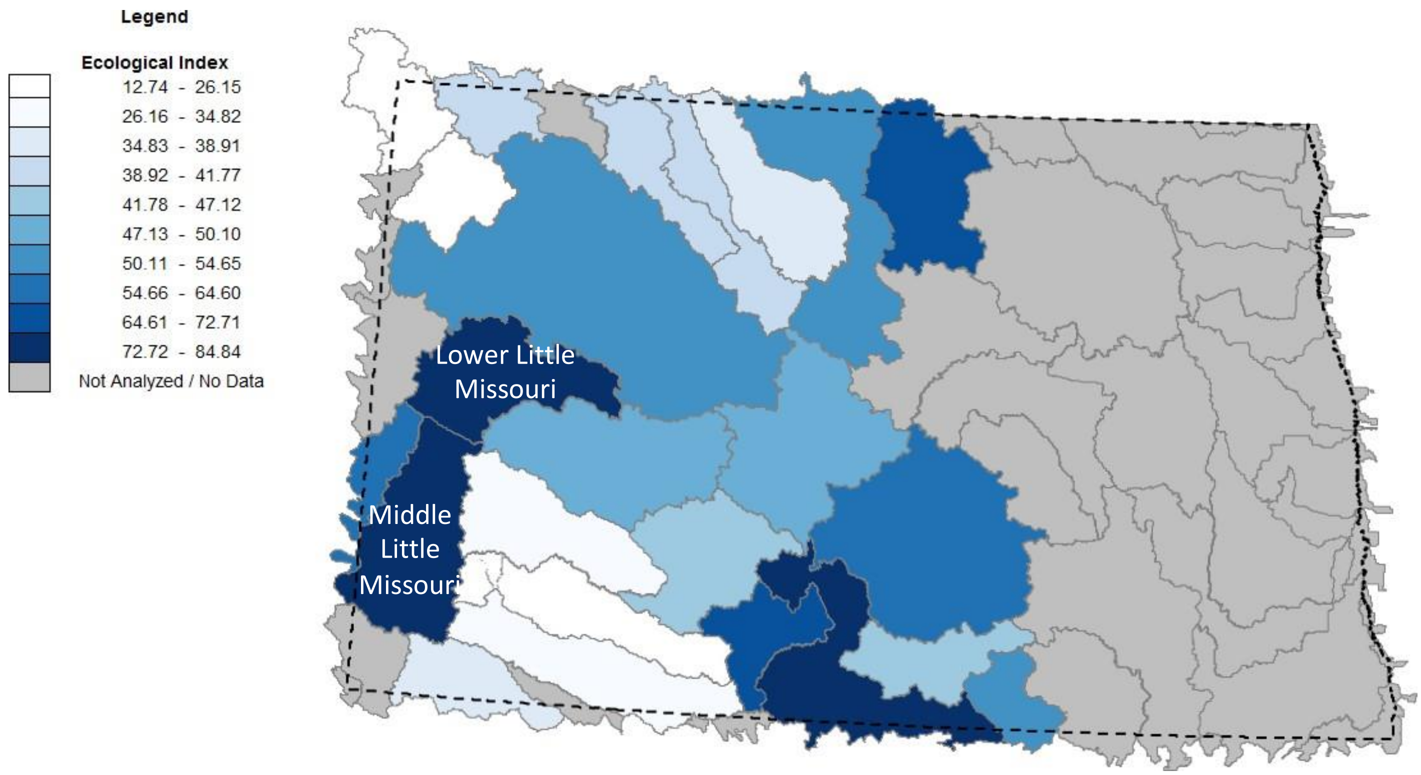


Figure 11. Scenario 1B Ecological Index (darker blue implies better for restoration)

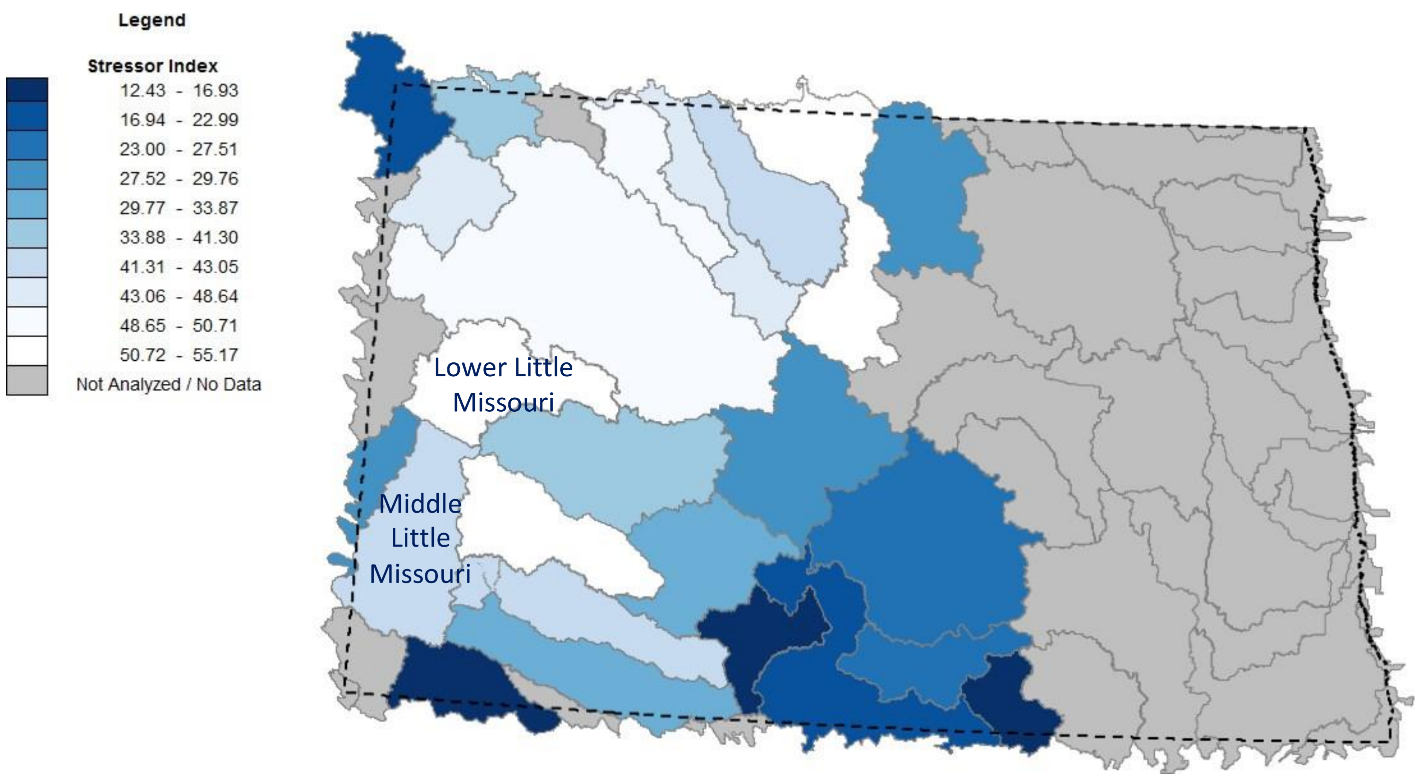


Figure 12. Scenario 1B Stressor Index (darker blue implies better for restoration)

A particular indicator of high interest can also be used to evaluate HUC8s, in this case percent population increase could be used to determine those HUC8s with higher levels of emerging threat (Figure 13). Population increases in the western part of North Dakota are attributed in part to oil and gas development but are associated with expected increases in nutrient loading. Increased population may result in stress on aquatic and natural resources in the form of wastewater discharges and land development. HUC8s with higher levels of population increase may be good candidates for nutrient management strategies emphasizing pollution prevention rather than restoration in this scenario, especially where their ecological index scores imply existing structure and function may still be relatively intact. In Figure 13, some of the same high-scoring HUCs for ecological index also show top levels of population growth.

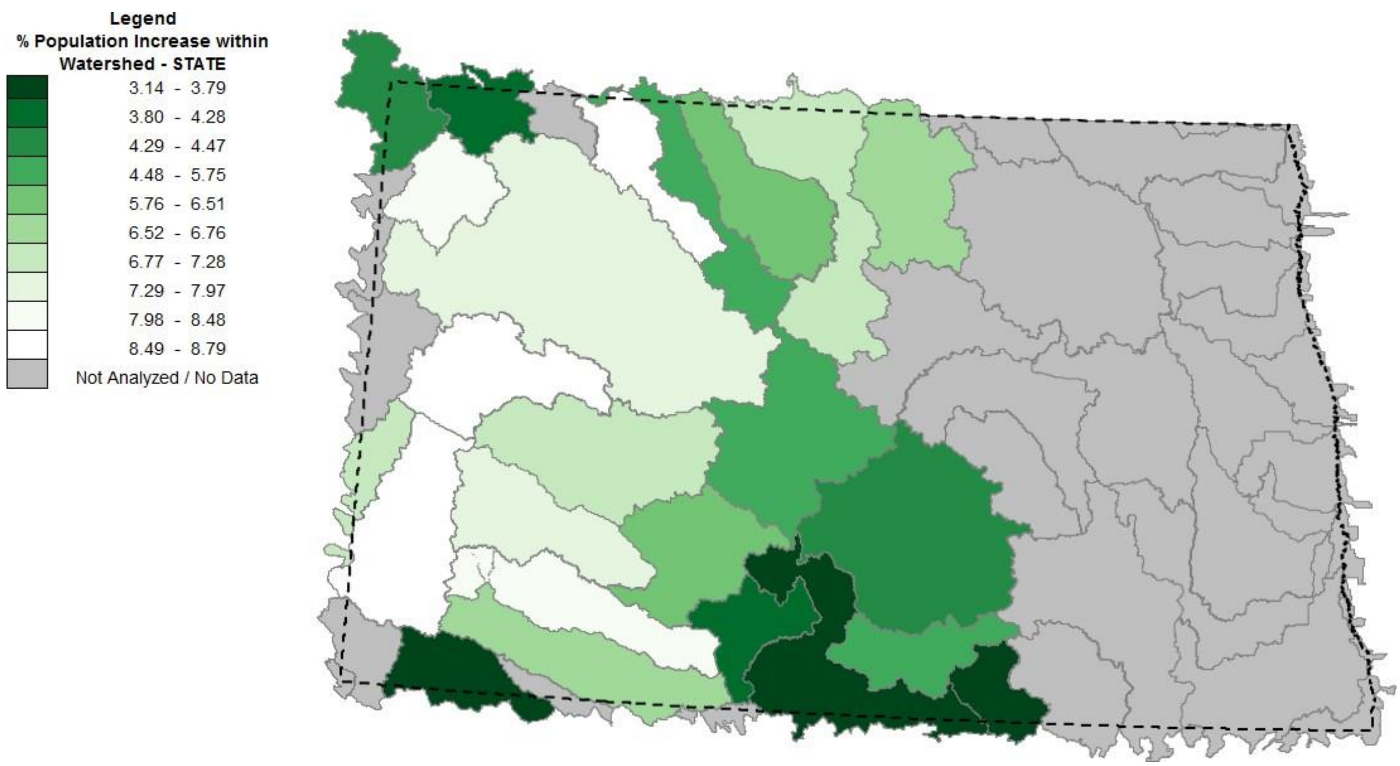


Figure 13. Population increase within HUC8s

STAGE 2 RESULTS

Typically, several Stage 1 HUC8s in each scenario are selected by the state as an initial 'focus group' in which to demonstrate the RPS assessment approach at the smaller HUC12 scale. Identifying a demonstration group may target early adopters or high-interest watersheds, but is not meant to assign priority or preclude a state's assessment of their remaining watersheds over time. Selections can be based on a Stage 1 screening, expert opinion, or a combination of both. The Stage 1 approach allows inclusion of specific watersheds that did not fully meet scenario criteria if a compelling reason existed for their inclusion (e.g., significant progress in planning or addressing nutrient issues typical of the scenario). Ideally, Stage 1 indicators, criteria and expert judgment combine to identify watersheds that not only have loading issues, but also show traits relevant to better restorability. For North Dakota, a Stage 2 demonstration is provided for a HUC8 in each of the two scenarios, including Park River - 09020310 (scenario 1A) and the Lake Sakakawea - 10110101(scenario 1B).

Stage 2 screening is performed on HUC8s individually and compares the HUC12s within a single HUC8 to each other. The more extensive array of indicators available at HUC12 scale enables more specific targeting of indicators relevant to implementing nutrient management activities. Stage 2 screenings were completed on two demonstration HUC8s 1) Park

Lake and 2) Sakakawea. These constitute one demonstration HUC8 for each Stage 1 scenario. Screenings are included in this document to serve as an example of Stage 2 methods and results. As with the Stage 1 screenings, a separate copy of the RPS tool for each of the demonstration HUC8s has been archived for delivery to NDDEQ with other products (see Attachment 4).

Park (09020301)

The Park River HUC8 is tributary to the Red River and Lake Winnipeg in eastern North Dakota. Typical of the Eastern 1A scenario from stage 1, the HUC8 is primarily comprised of agricultural land uses (e.g., sugar beets, small grains, potatoes, corn). It is located along the escarpment that borders historical glacial Lake Agassiz and extends onto the flatter, fine-grained lake bed which ultimately discharges to the Red River. The lower portion of the HUC8 is typically artificially drained by ditches or drain tile. The upper part of the HUC8 has coarser soils and some remaining wetland areas.

Nutrient reduction is a priority in this HUC8 as well as providing flood mitigation as part of larger efforts in the Red River Basin. Key questions to be addressed by the Stage 2 analysis include:

1) Which HUC12s have the greatest potential for multiple benefits including both flood mitigation and nutrient reduction? These HUC12s will have characteristics that increase the likelihood of nutrient loading and larger areas of potentially restorable wetlands. They may also have existing nutrient TMDLs, high nutrient yields, and high scoring social indices.
2) Which HUC12s are under-assessed with the greatest potential for nutrient issues and which HUC12s should be priorities for assessment and potentially TMDL development (based on watershed characteristics)?

The Park HUC8 includes 25 HUC12s. Different indicators were used to address each of the Stage 2 questions; these are presented below and defined in Attachment 3.

Which HUC12s have the greatest potential to provide multiple benefits including both flood mitigation and nutrient reduction?

Indicators selected to represent potential for providing multiple benefits in the Park HUC8 are provided in Table 5. Flood mitigation opportunities are represented by *% wetlands in the riparian zone* and the *% restorable wetlands* in the watershed. In the Red River basin, these low lying areas that have been traditionally drained could be used for flood water storage. As additional information becomes available in the Basin on potential flood storage areas, new indicators can be added to the analysis. From a water quality perspective, phosphorous loading is particularly important for downstream receiving waters (Red River and Lake Winnipeg) as well as for the Park River. Identifying areas where phosphorus loads are highest and land covers are primarily cultivated crops (as an additional indicator of high nutrient loads) can help focus implementation activities where the most nutrient reductions can be made.

*Table 5.Park HUC8, Stage 2 indicators to address questions regarding multiple benefits. See Attachment 3 for indicator definitions. Those indicators with a * are derived from state-specific datasets.*

Park (09020301) - Multiple Benefits		
Ecological Indicators	**Stressor Indicators**	**Social Indicators**
% natural cover (2011) in watershed*	% cultivated crops (2011) in watershed*	Count of segments with TMDLs in watershed
% natural cover (2011) in riparian zone*	% grassland to row crop transition in watershed*	% drinking water source protection area in watershed*
National Fish Habitat Partnership Habitat Condition Index*	Count of drains/area in watershed*	% CRP activities in watershed*
% wetlands (2011 and NWI) in riparian zone*	Average TN load (kg/yr) SPARROW (2002) to watershed*	% potentially restorable wetlands
	Average TP load (kg/yr) SPARROW (2002) to watershed*	% conservation activity in watershed*
	% urban (2006) in watershed	

Table 6 summarizes selected indicators that can be used to identify HUC12s that have a higher proportion of agricultural lands, high phosphorus yields, and higher levels of restorable wetlands. HUC12s that rank high for all three indicators could be selected as better candidates to provide multiple benefits (both water quality and water quantify) from flood mitigation projects (e.g., City of Grafton-Park River HUC12). In addition, the table includes the Social Index scores that could be further used to select candidate HUC12s, the higher Social Index scores can represent those areas that are already doing important conservation work and therefore may be ready for additional implementation. For example, those HUC12s that have high (upper quartile) *% cultivated crops* and high (upper quartile) *% restorable wetlands* such as the Willow Creek HUC12s, Salt Lake, Saint John's Church, and Lower North Branch Park River could be good candidates for flood mitigation projects. Of these, HUC12s with lower ranked social scores (e.g., Middle and Lower Willow Creek) could be good candidate for additional outreach and education.

Table 6. Park HUC8, select indicators color-coded in quartiles according to normalized indicator or index scores (dark blue = 76 -100th percentile; medium blue = 51-75th percentile; light blue = 26-50th percentile; white = 0-25th percentile).

HUC12 ID	**HUC12 Name**	**% in Cultivated Crops (2011) in Watershed - STATE**	**Average TP Load (kg/yr) SPARROW (2002) to Watershed - STATE**	**% Potentially Restorable Wetlands - STATE**	**Social Index Score**
090203100101	Upper North Branch Park River	83.80	21.60	65.00	15.98
090203100102	Middle North Branch Park River	61.59	21.24	55.00	19.34
090203100103	Upper Cart Creek	58.51	20.79	46.00	31.48
090203100104	Middle Cart Creek	58.08	20.35	60.00	29
090203100105	Lower Cart Creek	84.69	20.36	82.00	24.6
090203100106	Saint John's Church	93.90	21.57	92.00	29.8
090203100107	Lower North Branch Park River	88.82	33.59	85.00	30.24
090203100201	Headwaters Middle Branch Park River	58.93	34.90	41.00	20.92
090203100202	Upper Middle Branch Park River	56.59	32.93	46.00	19.38
090203100203	Middle Middle Branch Park River	63.94	28.23	68.00	27.14
090203100204	Lower Middle Branch Park River	75.87	34.25	72.00	30.8
090203100301	Headwaters South Branch Park River	87.14	35.33	56.00	21.2
090203100302	Upper South Branch Park River	66.60	35.85	44.00	21.9
090203100303	Middle South Branch Park River	45.85	36.58	44.00	27.74
090203100304	Fairdale Slough	39.77	42.65	33.00	33.38

HUC12 ID	HUC12 Name	% in Cultivated Crops (2011) in Watershed - STATE	Average TP Load (kg/yr) SPARROW (2002) to Watershed - STATE	% Potentially Restorable Wetlands - STATE	Social Index Score
090203100305	Lower South Branch Park River	55.32	42.78	32.00	65.18
090203100306	090203100306	72.24	36.36	61.00	33.16
090203100307	Outlet South Branch Park River	72.20	42.53	57.00	29.96
090203100401	Upper Willow Creek	77.71	22.94	76.00	38.66
090203100402	Middle Willow Creek	91.86	22.59	91.00	20.36
090203100403	Lower Willow Creek	93.82	27.89	93.00	23
090203100404	Salt Lake	88.63	25.94	92.00	25.16
090203100501	City of Grafton-Park River	86.79	44.01	85.00	32.18
090203100502	Horseshoe Coulee-Park River	90.34	46.74	84.00	17.16
090203100503	Dipple Drain-Park River	87.32	96.15	90.00	19.88

Which HUC12s are under-assessed with the greatest potential for nutrient issues and which HUC12s should be priorities for assessment and potentially TMDL development (based on watershed characteristics)?

Indicators used to address this question are provided in Table 7. These indicators are identical to Table 5 with the exception of the social indicators. Social indicators now include the extent of assessment and monitoring activities. In the Park HUC8, there are no streams that have been assessed for nutrients, however lakes and reservoirs have been assessed in many areas (Figure 14). The following HUC12 information is also extracted from the Tool dataset:

- Three out of 25 HUC12s have monitoring sites (Lower South Branch Park River, Outlet South Branch Park River, and City of Grafton-Park River)
- Two HUC12s include impaired waters (Dipple Drain-Park River and Lower South Branch Park River)
- A TMDL has been completed in Lower South Branch Park River.

*Table 7. Park HUC8, Stage 2 indicators to address questions regarding assessment and TMDL development. See Attachment 3 for indicator definitions. Those indicators with a * are derived from state-specific datasets.*

Park (09020301) - Assessment		
Ecological Indicators	**Stressor Indicators**	**Social Indicators**
% natural cover (2011) in watershed*	% cultivated crops (2011) in watershed*	Count of segments with TMDLs in watershed
% natural cover (2011) in riparian zone*	% grassland to row crop transition in watershed*	# of monitoring sites*
National Fish Habitat Partnership Habitat Condition Index*	Count of drains/area in watershed*	% watershed streamlength assessed
% wetlands (2011 and NWI) in riparian zone*	Average TN load (kg/yr) SPARROW (2002) to watershed*	% watershed waterbody area assessed
	Average TP load (kg/yr) SPARROW (2002) to watershed*	
	% urban (2006) in watershed	

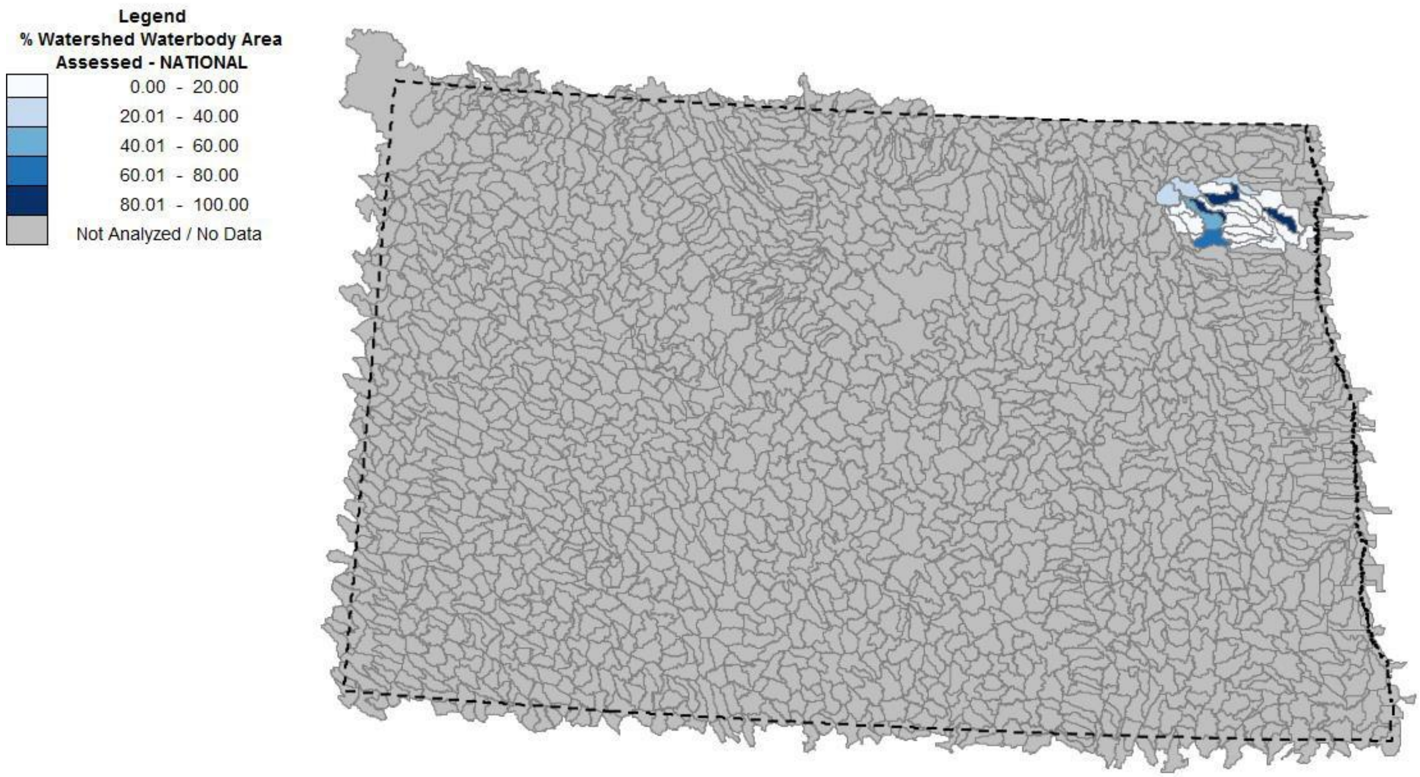


Figure 14. Percent of lake/reservoir area that has been assessed, Park HUC8.

Figure 15 presents the bubble plot for all Park HUC12s color-coded by *% waterbody area assessed*. Those HUC12s that are dark green have been assessed fairly well (e.g., Salt Lake, Lower South Branch Park River, Upper Middle Branch Park, and Middle Cart Creek). HUC12s on the right half of the bubble plot have higher than average stressor scores that could be good candidates to focus monitoring and assessment activities. Outlet South Branch Park River and City of Grafton-Park River have monitoring sites established indicating that two of these HUC12s are already being evaluated; Horseshoe Coulee-Park River and Dipple Drain-Park River could be important candidates for monitoring and assessment if the intention is to identify nutrient impaired waters. Each of these four HUC12s also have high nutrient loads, density of tiles, and % cultivated cropland.

Individual stressor indicators can also potentially be used to represent overall nutrient loading such as the three examples in Figure 16 1) *average TP load, 2) % grassland to row crop conversion*, and 3) *% cultivated crops.* HUC12s that have similar indicator scores may have similar impairments. Dipple Drain-Park River stands out as a highly stressed system as compared to the other HUC12s in the Park River HUC8, however efforts may be better focused on those HUC12s in the upper right quadrant that have higher than average stressor scores but still retain higher levels of ecological structure such as 90203100306 and Middle Middle Branch Park River.

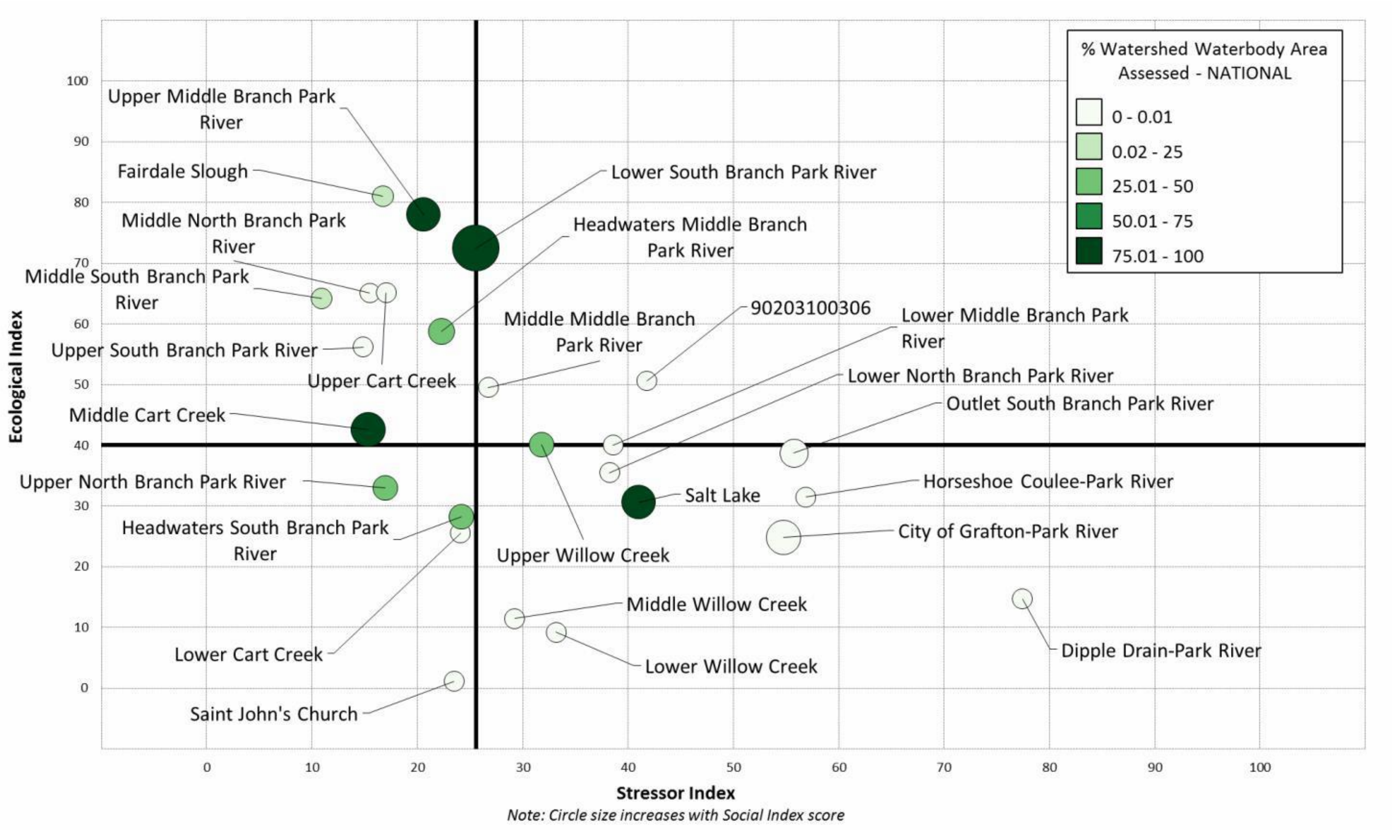


Figure 15. Park HUC8, color-coded bubble plot based on % of waterbodies assessed.

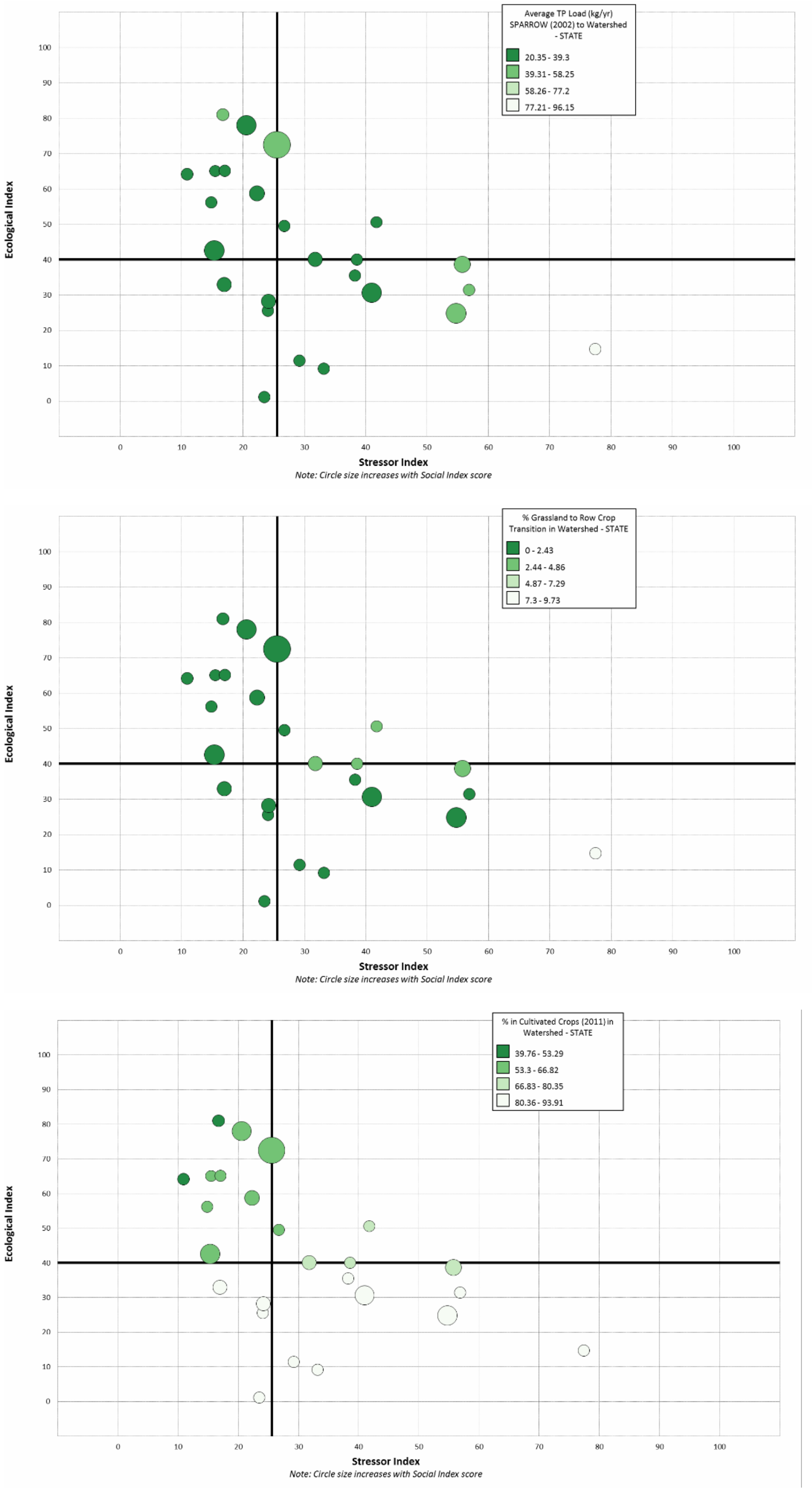


Figure 16. Single stressor indicators highlighted in three bubble plots, Park HUC8. Lightest colors are highest stressor values.

Lake Sakakawea (10110101)

Lake Sakakawea is a large reservoir located along the Missouri River in the western part of North Dakota. The lake's watershed is primarily characterized by grasslands and livestock grazing. Oil and gas production is potentially a significant stressor. This reservoir has been identified as a high priority in the state's nutrient reduction strategy. In addition, there is interest in identifying important areas for protection in this HUC8 based on vulnerability. The Lake Sakakawea HUC8 includes 181 HUC12s. Indicators used in this screening analysis are presented in Table 8 (see definitions in Attachment 3).

*Table 8. Lake Sakakawea HUC8, Stage 2 indicators. See Attachment 3 for indicator definitions. Those indicators with a * are derived from state-specific datasets.*

Lake Sakakawea (10110101)		
Ecological Indicators	**Stressor Indicators**	**Social Indicators**
% natural cover (2011) in watershed*	% in cultivated crops (2011) in watershed*	% drinking water source protection area*
% natural cover (2011) in riparian zone*	% urban change 2001-2006 in watershed	% tribal lands in HUC12
National Fish Habitat Partnership Habitat Condition Index*	Watershed mean soil erodibility	% conservation activity in watershed*
% wetlands (2011 and NWI) in riparian zone*	Count of oil and gas wells/area in watershed*	% CRP activities in watershed*
	Count of active CAFO/AFO permits/area in watershed*	Watershed segments with TMDLs count
	Count of permitted animals in watershed/area*	% restorable wetlands
	Average TP load (kg/yr) SPARROW (2002) to watershed*	
	Average TN load (kg/yr) SPARROW (2002) to watershed*	

Figure 17 presents the Lake Sakakawea results color-sorted by RPI score. As seen on the map, HUC12s with higher RPI scores are generally in the headwater areas. These HUC12s have higher Ecological Index scores and are found in the upper left quadrant of the bubble plot. Boggy Creek (-12101), Skunk Creek (-2101), and Saddle Butte Bay (-2903) have the highest overall RPI scores based on the selected indicators.

Specific questions to be addressed by this Stage 2 analysis include:

1) Which HUC12s contribute the largest nutrient loads to the reservoir? These will be HUC12s with characteristics that imply high nutrient loading such as erodible soils, land use, point sources, slope, etc.
2) Which HUC12s have the highest level of vulnerability from a nutrient standpoint? These HUC12s will have good ecological indices and higher levels of stressors.

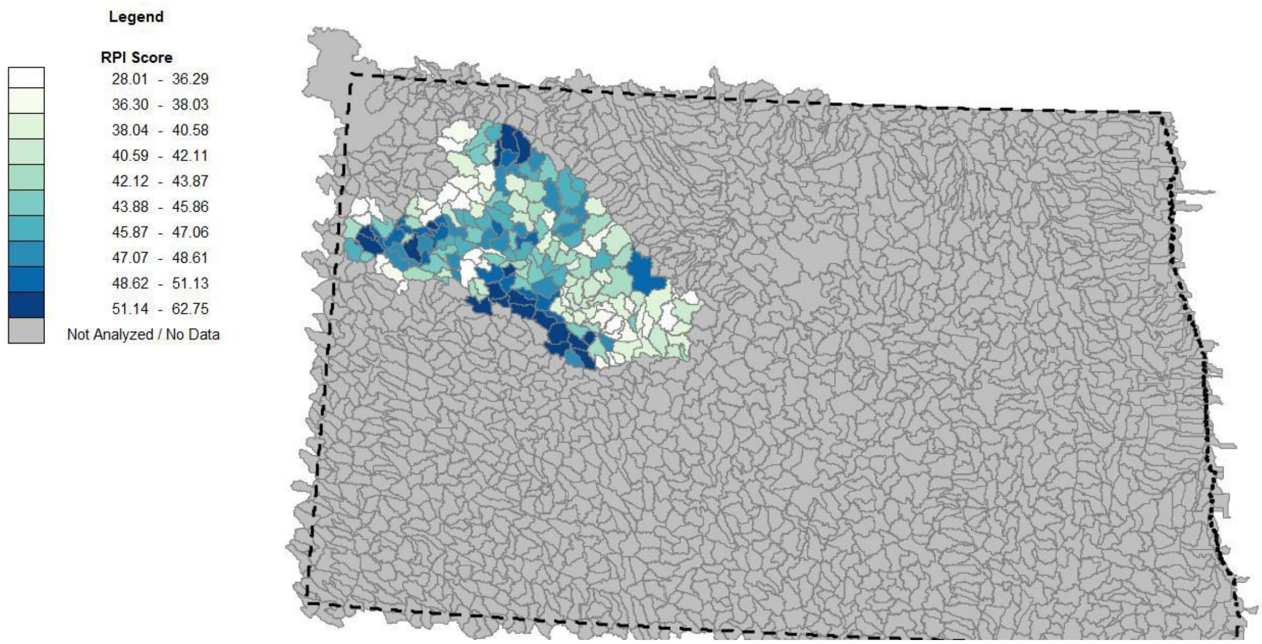


Figure 17. Lake Sakakawea RPI scores.

<u>Which HUC12s contribute the largest nutrient loads to the reservoir?</u>

Figure 18 shows bubble plots for both total phosphorus and total nitrogen loads for all HUC12s. Table 9 summarizes those HUC12s that have the highest yields (upper quartile) for both total nitrogen and total phosphorus yield. These HUC12s have the highest nutrient loading, according to the SPARROW-derived indicators. This is an example of how to use specific indicators to answer a question. Data for every indicators is provided in the Tool and can be summarized, plotted, and mapped separately.

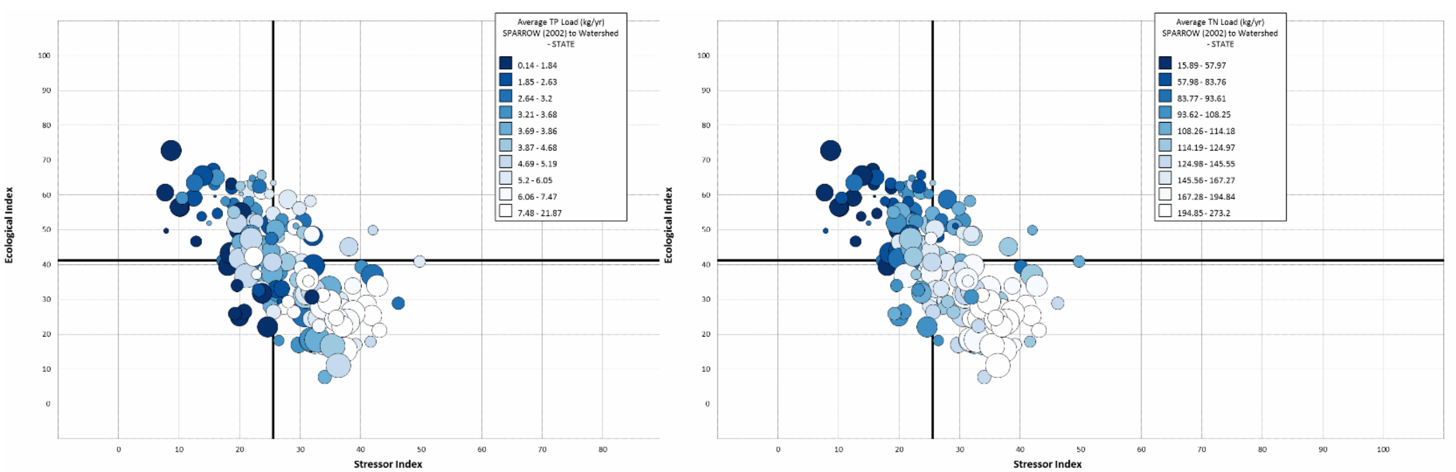


Figure 18. Nutrient loading bubble plot, total phosphorus on the left, total nitrogen on the right. Data derived from SPARROW model outputs. The highest estimated loads are the white bubbles

Table 9. HUC12s in the upper quartile for both nitrogen and phosphorus yield.

Watershed ID	Watershed Name	Average TN Load (kg/yr) SPARROW (2002) to Watershed - STATE	Average TP Load (kg/yr) SPARROW (2002) to Watershed - STATE
101101012802	Round Top Hill	240.98	5.93
101101012808	Middle Deepwater Creek	256.22	6.21
101101012401	Spring Valley Church	243.71	6.34
101101012702	Lower Crane Creek	153.95	6.45
101101011403	Beauty Valley	180.08	6.46
101101012701	Upper Crane Creek	153.98	6.48
101101011602	White Lake	167.98	6.49
101101012805	Lucky Mound Church	246.18	7.04
101101012804	Bethlehem Church	273.20	7.66
101101012803	Town of Roseglen	258.26	8.12
101101012810	Lower Deepwater Creek	191.16	8.79
101101013203	Blackwater Cemetery	230.68	9.24
101101013202	Blackwater Lake	233.77	9.27
101101013305	East Branch Douglas Creek	202.42	9.29
101101013201	Town of White Shield	231.21	9.32
101101013204	Town of Emmet	231.29	9.68
101101013306	Douglas Creek Bay	194.84	9.99
101101013004	Sixmile Creek	184.47	10.00
101101012809	101101012809	215.55	10.45
101101012801	Upper Deepwater Creek	242.46	11.09
101101011103	The Swamp	237.85	21.09
101101011101	Nelson Lake	243.20	21.86

In addition to evaluating modeled nutrient load indicators, other indicators could also provide additional information on those HUC12s with the potential for high loadings. For example, areas with a high proportion of agricultural lands may have higher nutrient loading (Figure 19 and Table 10).

HUC12s with the highest nutrient loads may be good candidates for focused nutrient reduction activities, but additional analysis can be used to further evaluate HUC12s with regard to restorability. Figure 20 provides three example bubble plots that can inform nutrient loading and restorability, depending on which sources are of interest such as roads, human use, and cultivated cropland. These three stressor indicators help to identify differences amongst the HUC12s, specifically if certain stressors are more important than others in a particular HUC12. Road density and human use were not included in the overall screening analysis, however all of the indicator data are available for summary in data tables, bubble plots or maps, regardless of whether the data were used in a screening analysis.

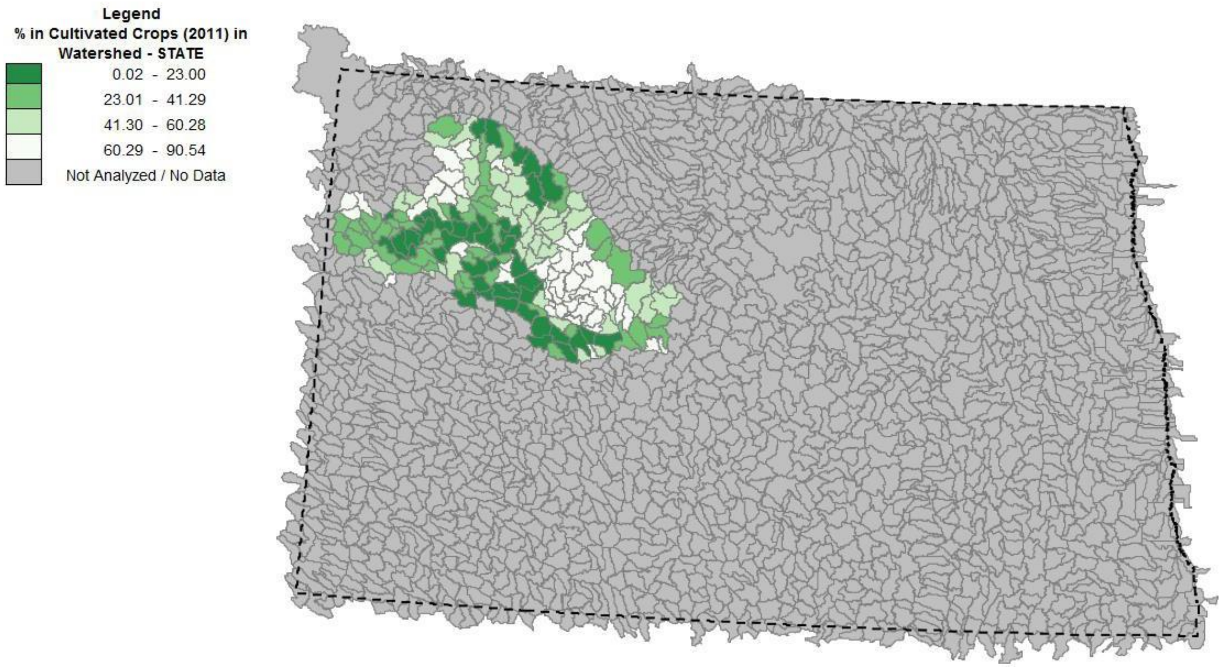


Figure 19. HUc12s color-coded by percent cultivated crops.

Table 10. HUC12s with greater than 75% cultivated crops

Watershed ID	Watershed Name	% in Cultivated Crops (2011) in Watershed
101101012808	Middle Deepwater Creek	76.17
101101010501	Arnegard Dam	76.43
101101012802	Round Top Hill	77.26
101101010202	Middle Painted Woods Creek	77.89
101101012806	Paint Hill	78.96
101101013203	Blackwater Cemetery	79.13
101101012803	Town of Roseglen	79.28
101101013702	Wolf Creek	79.32
101101012401	Spring Valley Church	79.53
101101010201	Upper Painted Woods Creek	80.26
101101010902	Upper Beaver Creek	80.41
101101011001	Upper Sand Creek	81.69
101101012801	Upper Deepwater Creek	82.18
101101013202	Blackwater Lake	82.85
101101012603	101101012603	83.95
101101012805	Lucky Mound Church	84.04
101101012604	101101012604	84.20
101101012807	101101012807	86.10
101101012504	Saint Pauls Church	87.39
101101012804	Bethlehem Church	87.70
101101010401	Upper Stony Creek	90.54

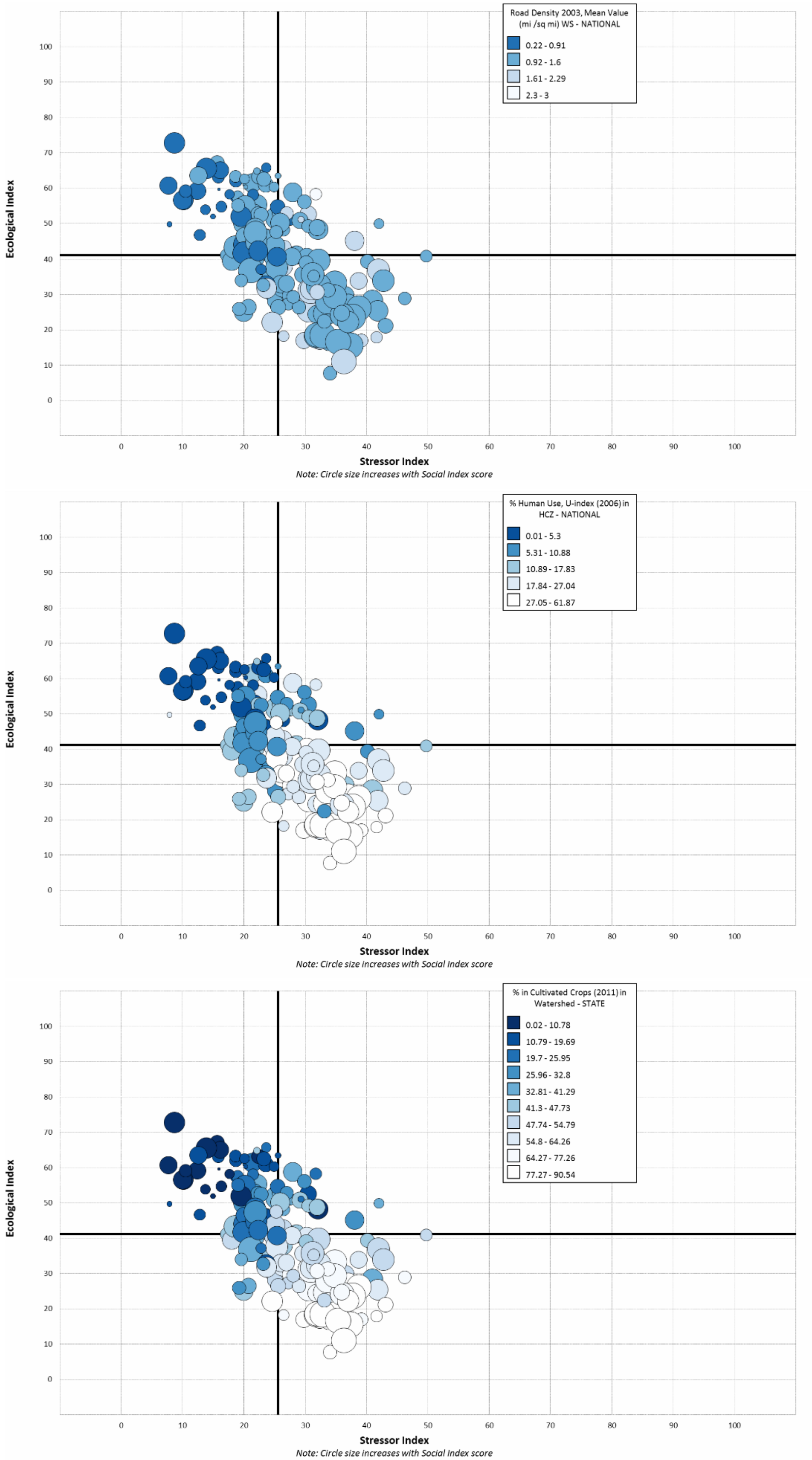


Figure 20. Indicator-specific bubble plots that can use used to further sort HUC12s. Note that indicators not included in the overall screening can also be summarized in the Tool bubble plots by adding a color gradient. The higher scores for these stressor indicators are the lighter colors.

A closer look at the modeled phosphorus loadings in Figure 21 reveals several watersheds that have high phosphorus loads with higher than average Ecological Index scores including Camp Creek, North Fork Clarks Creek, Four Bears Bay, Lower Crane Creek, and Sloulin International Airport HUC12s. Combining this information with the data from stressor-specific bubble plots in Figure 20 provides additional insight on restorability. For example, Camp Creek has the highest overall Stressor Index score and a high proportion of cultivated cropland. Four Bears Bay has a high density of roads and Sloulin International Airport has a fairly high value for human use impacts. Lower Crane Creek has the highest modeled phosphorus load with moderate levels of stressors, indicating that it is likely the cumulative effects of several stressors in this HUC12 leading to the high phosphorus loads. These HUC12s may be better candidates for nutrient reduction activities since they maintain higher levels of ecological structure and therefore may have higher potential for restoration.

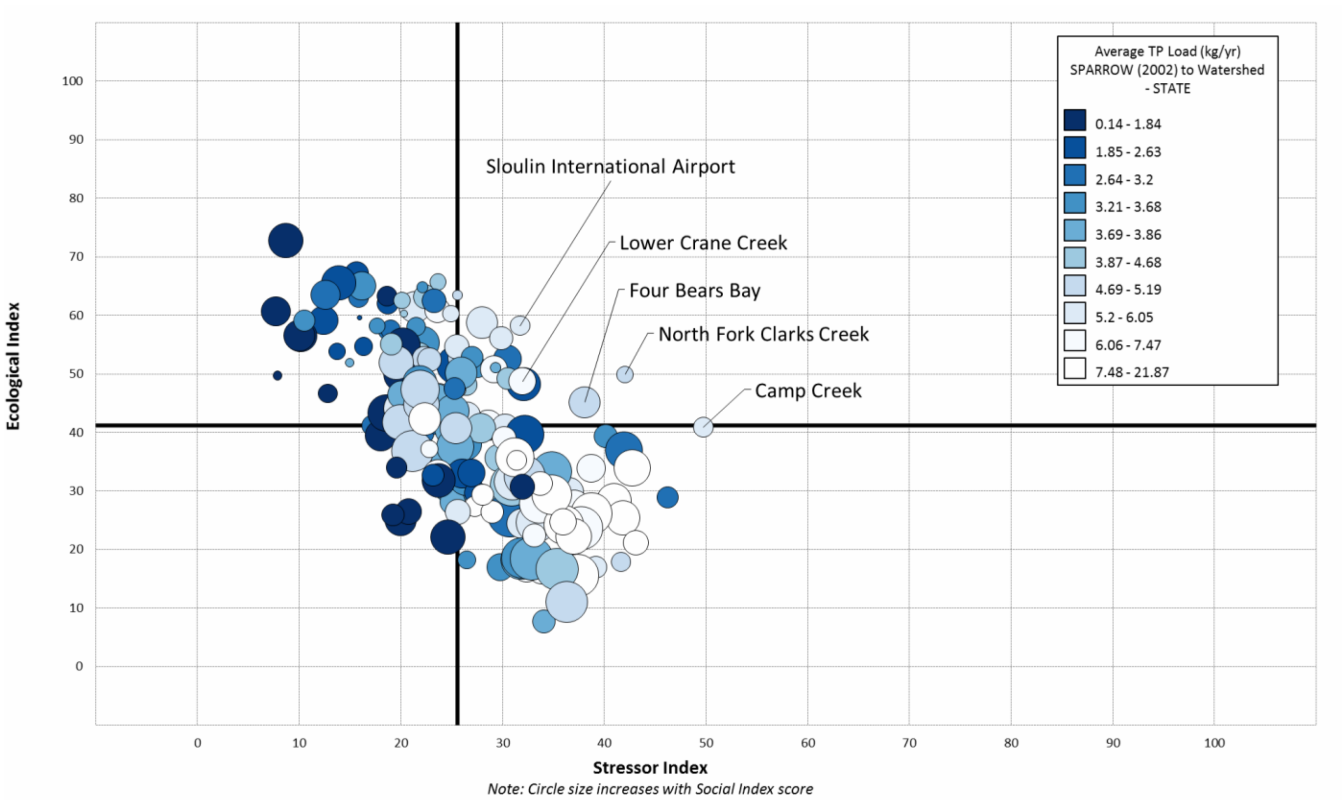


Figure 21. Lake Sakakawea bubble plot color-coded by average TP load.

<u>Which HUC12s have the highest level of vulnerability from a nutrient standpoint?</u>

HUC12s that are vulnerable to nutrient loading and associated impacts but are currently in better than average condition occur in the upper right quadrant of the bubble plot (Figure 22). These HUC12s, including Sloulin international Airport, Lower Dry Fork Creek, Lower Crane Creek, Red Lake, North Fork Clarks Creek, and Four Bears Bay have better than average Ecological Index scores but higher than average Stressor Index scores and therefore may be at higher risk for future degradation and potential new impairments.

Activities that result in human disturbance (e.g., roads, housing) can create further vulnerabilities in a watershed as relate to nutrients. Current threats provided by oil and gas exploration activities (Figure 23) further focuses potential vulnerable HUC12s (Lower Dry Fork Creek, Lower Crane Creek, North Fork Clarks Creek, and Four Bears Bay). Increasing conservation and protection activities in these watersheds could minimize or prevent future degradation.

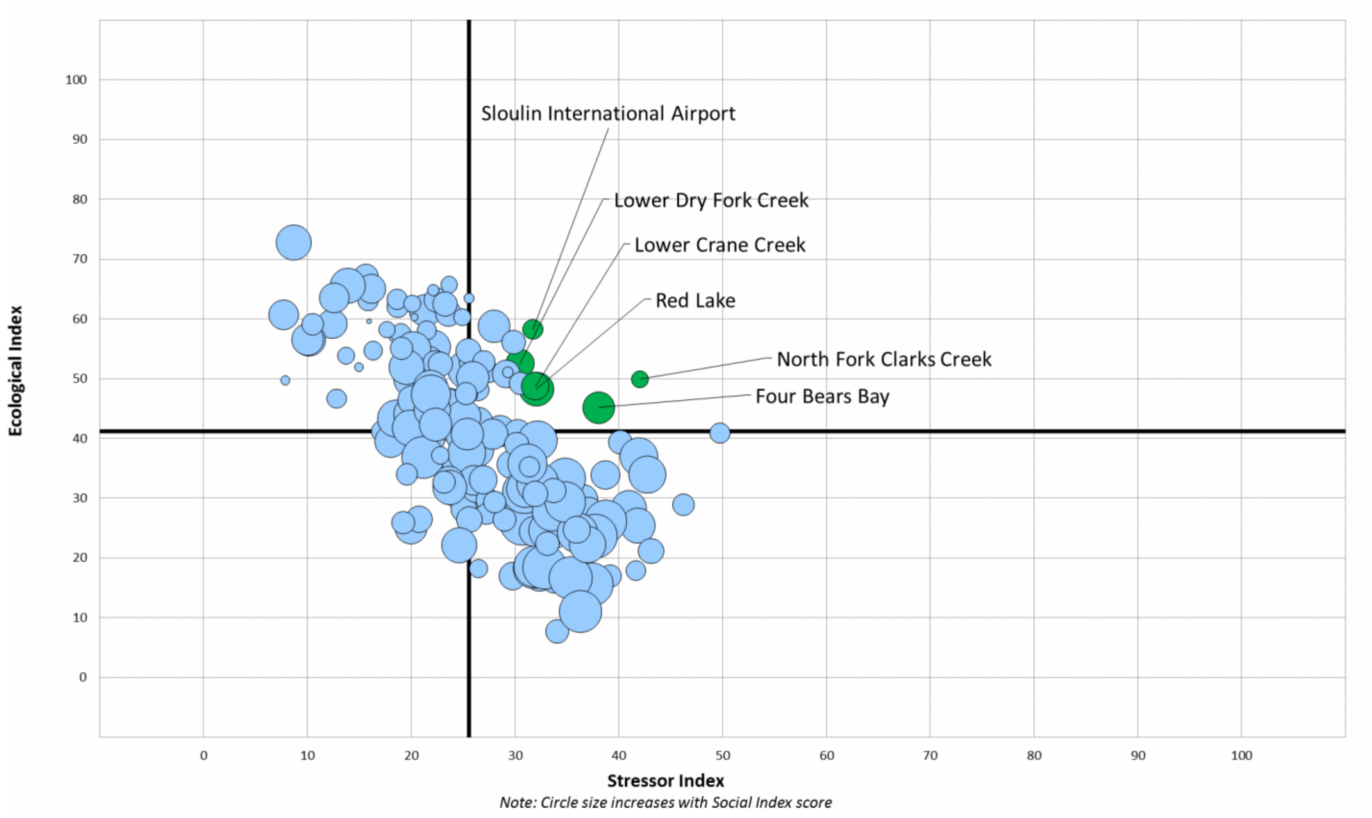


Figure 22. Examples of vulnerable HUC12s in the Lake Sakakawea HUC8.

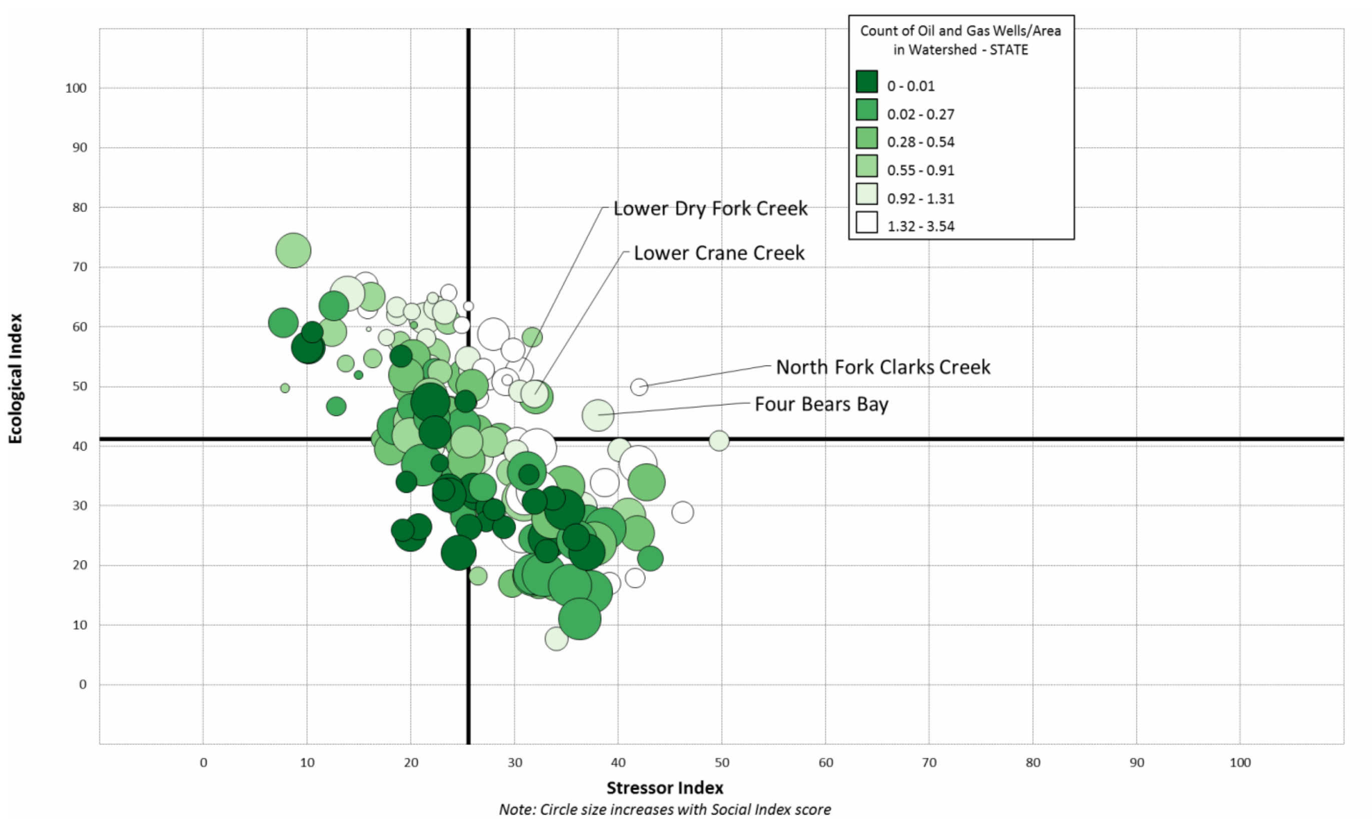


Figure 23. Oil and gas exploration threats, Lake Sakakawea.

SUMMARY AND RECOMMENDATIONS

This document summarizes the usage of Recovery Potential Screening (RPS) to compare watersheds at two scales (HUC8 and HUC12) for purposes of informing possible watershed management options and priorities for nutrient management. Utilizing georeferenced data provided primarily by NDDEQ, the EPA and additional sources, this project compiled indicators (base, ecological, stressor and social) at one or both watershed scales that were used to screen and compare watersheds in a two-stage process. In the first stage, North Dakota's HUC8s were screened with two separately developed sets of indicators selected to identify and rank watersheds according to geographic location in the state. Based on these first stage screenings and other criteria, two watersheds were selected as demonstration HUC8s for further analysis in the second stage (Lake Sakakawea and Park).

Stage two screenings were performed on each of the demonstration HUC8s that scored and compared each HUC8's component HUC12s using more detailed sets of indicators that drew from HUC12-scale metrics. Whereas the purpose of Stage 1 was to compare and recognize like groups of scenario watersheds at the larger scale, Stage 2's purpose was to examine and reveal potential opportunities for nutrient management action at the more localized HUC12 scale. As a demonstration of the RPS Tool, no priorities among HUC12s were selected in this project but numerous alternatives and analytical techniques were presented. Products include this summary report, a master RPS Tool file, and separate screening files that archived the results from the Stage 1 and Stage 2 screenings. Opportunities for NDDEQ and other users from this point forward may include:

Become adept at RPS Tool desktop use. Despite the extensive amount of data it holds and the wide variety of comparisons among watersheds that these data can support, the RPS Tool is actually a fairly simple spreadsheet tool. As novice users of Excel far outnumber GIS specialists, for many more people this tool opens the door to simple but useful forms of spatial data analysis, systematic comparisons among watersheds, and a variety of visualization tools – on their own desktops. A wider circle of users will be able to perform quick 'what-if' screenings to compare watersheds on the spur of the moment and gain insights on what may be worth a greater investment of time and effort with more technical analytical tools.

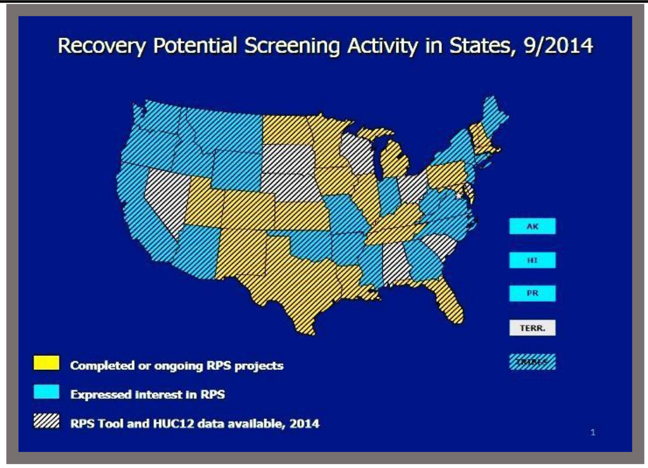
Apply the RPS Tool to other screening topics. Although this effort focused on a nutrients application of RPS, the North Dakota dataset could support numerous other screening themes and purposes that can be explored in the interest of long-term priority setting for restoration and protection. Other screening topics might include sediment, metals, pathogens, or any other prominent cause of impairment. Or in contrast, screenings might focus on a valued resource such as watersheds with coldwater fisheries, or drinking water sources, or major outdoor recreational sites. The RPS Tool might be used to develop a first-cut identification of healthy watersheds for protection, or rank likely eligibility for specific types of pollution control incentives. With both the TMDL Program and the Non-Point Source Control Program promoting watershed priority-setting, the range of opportunities is widespread.

Refine the available data and selection of indicators. Even within this nutrient application of RPS, opportunities always exist to add more relevant data or refine previous screenings as new insights are gained. The RPS Tool is structured to accept additional indicator data from a user that can then be made part of future screenings. New data needn't be statewide, and a local user may still use the tool after adding new data for a limited set of their local subwatersheds. Further, previous analyses can be refined by structured group processes to assign consensus weights to indicators, or by correlation analyses designed to narrow down indicator selections and better differentiate watersheds. For example, varying North Dakota's available HUC8 indicators and re-screening could allow for considering nutrient delivery to the Gulf of Mexico as well as comparing HUC8s based on instate effects only.

Galvanize state/local restoration and protection dialogue and partnering. RPS offers a mechanism for state-local collaboration. Rather than assume that the RPS indicators are a static dataset, or that the HUC8 screenings shouldn't be additionally adjusted or customized, further tailoring to the circumstances and data of each locale is appropriate and encouraged. Some HUC8s may host watershed groups, researchers and other sources of continued analysis and refinement of the available indicators and techniques that can be accommodated by this versatile tool. Further, if local organizations do engage with IDNR and enhance their RPS Tool copies, they may provide valuable dialogue on addressing local as well as statewide interests in watershed priority-setting and improved nutrient management.

Attachment 1

RECOVERY POTENTIAL SCREENING: SUMMARY



- Recovery Potential Screening (RPS) is a systematic, comparative method for identifying differences among watersheds that may influence their relative likelihood to be successfully restored or protected. The EPA Office of Wetlands, Oceans and Watersheds (OWOW) created RPS jointly with the EPA Office of Research and Development (ORD) in 2004 to help states and others use limited restoration resources wisely, with an easy to use tool that is customizable for any geographic area of interest and a variety of specific comparison and prioritization purposes.

- The main programmatic basis for RPS includes the TMDL Program (e.g., prioritized schedule for listed waters; where best to implement TMDLs; Integrated Reporting of Priority waters under the TMDL Vision) and the Nonpoint Source Program (e.g., annual program strategies; prioritization to aid project funding decisions; collaboration with Healthy Watersheds), but several other affiliations also exist.

- Since 2005, several hundred RPS indicators have been incrementally compiled through literature review, identifying states' indicator needs and preferences, and collaboration with others (ORD EnviroAtlas, Region 4 Watershed Index). Most have been applied in a series of statewide RPS projects. In 2009, an RPS paper was published in the refereed journal *Environmental Management*. The one-stop RPS Website hosts a library of indicators, RPS tools, case studies and step by step RPS instructions.

- As of September 2014, RPS projects and statewide databases have been either initiated or completed in 20 states (**see figure**). Approximately that many additional states have expressed interest in RPS usage, but Branch resources have not previously been able to support these requests.

- The RPS Tool is key to RPS' ease of use, widespread applicability and speed. This tool is an Excel spreadsheet that contains all watershed indicators, auto-calculates key indices, and generates rank-ordered tables, bubble plot graphics and maps that can be user-customized. Any novice Excel user can quickly become fluent in using the RPS Tool.

- Statewide RPS Tools and data have now been developed for each of the lower 48 states. These contain 207 indicators measured for every HUC12, and enable customizable desktop screening, rank ordering, graphics plotting and mapping without advanced software or training. Individual, state-specific RPS Tools were distributed to every lower 48 state and all EPA Regions in July 2014 (HI and AK in planning).

- RPS is playing/may soon play a pivotal role in each of the following:
  - Prioritizing watersheds for nutrient management (projects in 9 states)
  - Identifying state priority watersheds for TMDL Vision/Integrated Reporting 2016-2022
  - Improving state/local interactions in states with RPS projects
  - Enabling Tribes to screen and compare their watersheds for purposes similar to states
  - Helping the Healthy Watersheds program by providing a national preliminary assessment
  - Jointly (OW and EPA Region 4) creating the Watershed Index Online (WSIO) interactive tool

- Contact: Doug Norton, WB/AWPD/OWOW at norton.douglas@epa.gov or 202-566-1221.

Attachment 2: North Dakota Stage 1 HUC8 Indicator Descriptions

Green denotes ecological indicators, red are stressor indicators, and blue are social indicators. These indicators are based on data that end at the state-line, therefore watersheds were clipped to the state line and all metrics were calculated based on this area. All North Dakota-specific indicators are denoted with “STATE”.

HUC8 METRIC	DESCRIPTION
% Natural Cover (2011) in Watershed - STATE	The percentage of the HUC within the state considered "Natural Cover" based on the 2011 NLCD. "Natural Cover" is considered the following NLCD codes~classes: 41~Deciduous Forest, 42~Coniferous Forest, 43~Mixed Forest, 52~Shrub/Scrub, 71~Grassland/Herbaceous, 90~Woody Wetlands, and 95~Emergent Herbaceous Wetlands.
% Natural Cover (2011) in RZ - STATE	The percentage of the Riparian Zone (RZ) in the HUC within the state considered "Natural Cover" based on the 2011 NLCD. "Natural Cover" is considered the following NLCD codes~classes: 41~Deciduous Forest, 42~Coniferous Forest, 43~Mixed Forest, 52~Shrub/Scrub, 71~Grassland/Herbaceous, 90~Woody Wetlands, and 95~Emergent Herbaceous Wetlands.
% Wetlands (2011 and NWI) in RZ - STATE	The percentage of the Riparian Zone (RZ) in the HUC within the state considered "Wetlands": NLCD codes~classes 90~Woody Wetlands and 95~Emergent Herbaceous Wetlands in the 2011 NLCD, or a wetland in US Fish and Wildlife Service’s National Wetland Inventory (NWI) state-wide data set.
NFHAP Habitat Condition Index - NATIONAL	Likelihood of suitable fish habitat, based on National Fish Habitat Action Plan Assessment
Watershed Streamlength 303d-Listed Nutrients - ADJUSTED	Length of stream features listed as impaired due to nutrient-related causes and requiring a TMDL under Section 303(d) of the Clean Water Act in HUC12 (kilometers). Calculated from the EPA Office of Water "303(d) Listed Impaired Waters" NHD-indexed dataset. Only includes length of lines meeting criteria for classification as "streams" and with "Nutrients", "Organic Enrichment/Oxygen Depletion", "Algal Growth", or "Noxious Aquatic Plants" listed as a parent cause of impairment. Criteria for stream classification include: (1) feature has NHD REACHCODE with FTYPE equal to StreamRiver, CanalDitch, or Connector; (2) feature has NHD REACHCODE with FTYPE equal to Artificial Path and FTYPE of corresponding NHDArea feature is StreamRiver; or (3) feature is custom-added to the EPA Reach Address Database and is not in the NHD (blank NHD REACHCODE).
% in Corn, Soy, Sugar Beet (2013) in Watershed - STATE	The percentage of the HUC within the state that are designated as Corn, Soybeans, or Sugar beet by the 2013 USDA National Agricultural Statistics Service (NASS), Cropland Data Layer (CDL). The areas are estimated using the following CDL codes~classes: 1~Corn, 5~Soybeans, 12~Sweet Corn, 26~Dbl Crop WinWht/Soybeans, 41~Sugar Beets, 225~Dbl Crop WinWht/Corn, and 241~Dbl Crop Corn/Soybeans.
% in Pasture/Hay (2011) in Watershed - STATE	The percentage of the HUC within the state classified as 'Pasture/Hay' (code 81) by the 2011 NLCD. See definitions above.
% Grassland to Row Crop Transition in Watershed - STATE	This indicator was derived using a grid produced by researchers at South Dakota State University who estimated the percent of grasslands in a 560-meter grid cell that has transitioned from grassland to corn/soybean in the Upper Midwest of the US. The researchers used the USDA NASS CDL data sets from 2006 to 2011 for their analysis. Using the grid provided by the University the average percent of transition within each HUC was derived using ESRI ArcMap's Spatial Analyst Zonal Stats as Table tool.

HUC8 METRIC	DESCRIPTION
% Population Increase within Watershed - STATE	The percent population increase was derived using data provided as part of the U.S. Census Bureau's American Community Survey (ACS) 5-year estimates for the period from 2009 to 2013. Different population data are provided for each census tract. The data used for the creation of this indicator were estimates of the total population, percent moved from a different county, percent moved from different state, and percent moved from abroad. The percent increase in overall population of a census tract was estimated by summing the (total x %moved from different county) + (total x %moved from different state) + (total x %moved from abroad). Next, the summed census tract-scale data was intersected with HUC boundaries and applied using an area-weighted averaging approach for each HUC.
Count of Oil and Gas Wells/Area in Watershed - STATE	The number (i.e., count) of oil and gas related wells with a "Status" of 'Active', 'Drilling', or 'Temporarily Abandoned' and a "Well Type" of 'Oil or Gas Well', or 'Salt Water Disposal'; as identified by the GIS point coverage attributes available online from the North Dakota Department of Mineral Resources--within each HUC area divided by the HUC area in square kilometers.
Count of Drains/Area in Watershed - STATE	The number (i.e., count) of drainage network outlets--as identified by the GIS point coverage (file named "Drains") available online from the North Dakota State Water Commission--within each HUC area divided by the HUC area in square kilometers.
Average TN Load (kg/yr) SPARROW (2002) to Watershed - STATE	The average estimated load of Total Nitrogen (TN) from upland areas within each HUC. The estimates of loading were derived from two USGS SPARROW 2002 model outputs (Upper Midwest/Great Lakes and Missouri River Basin models, MRB3 and MRB4, respectively). SPARROW model outputs were assigned to SPARROW model subwatersheds that were then used to create an area-weighted average loading rate (kg/km/yr) for each HUC. The area-weighted average loading rate (kg/km/yr) was multiplied by the HUC(km) to reach this indicator's values in kg/yr.
Average TP Load (kg/yr) SPARROW (2002) to Watershed - STATE	The average estimated load of Total Phosphorus (TP) from upland areas within each HUC. The estimates of loading were derived from two USGS SPARROW 2002 model outputs (Upper Midwest/Great Lakes and Missouri River Basin models, MRB3 and MRB4, respectively). SPARROW model outputs were assigned to SPARROW model subwatersheds that were then used to create an area-weighted average loading rate (kg/km/yr) for each HUC. The area-weighted average loading rate (kg/km/yr) was multiplied by the HUC(km) to reach this indicator's values in kg/yr.
Watershed Segments with TMDLs Count - ADJUSTED	The count of TMDLs in the HUC within the state (July 2014). This indicator was derived using the number of unique state-assigned water segment IDs in the EPA Office of Water "Impaired Waters with TMDLs" NHD-indexed dataset. For more information go to http://www.epa.gov/sites/production/files/2015-11/documents/rp3existplan1109.pdf. The national data was processed to assign appropriate values to the ND-specific version of HUC12s.
Percent GAP status 1, 2 and 3 WS - NATIONAL	Percent of HUC8 by total area that is in GAP analysis program's protection and conservation status categories 1, 2, and 3
% Drinking Water Source Protection Area - STATE	The percentage of source water protection area (SPA) in the watershed. This indicator was derived using data available from the State's GIS website whereby the total areas of Community and Non-Community areas designated as surface water only (i.e., excluded groundwater protection areas) were summed within each HUC and divided by the HUC area within the state.
% CRP Activities in Watershed - STATE	The percent of the HUC with Conservation Reserve Program lands as reported in 2007 (considered to be the most recently reported year of peak activity). The report of acres by HUC12 was provided by the USDA Farm Service Agency and is based on Common Land Unit data on December 29, 2014. HUC12 data were also aggregated at the HUC8 scale. For HUCs that extend outside of the state, the final area used to derive this indicator was area-weighted to only include that part within the state.

HUC8 METRIC	DESCRIPTION
% Conservation Activity in Watershed - STATE	The percent of HUC that has a NRCS practice that would benefit water quality. Data range included 1995-2015. Dataset includes 152 different NRCS practices, selected by North Dakota because they have a beneficial effect on water quality. Source data provided by USDA through a Conservation Cooperators memorandum of understanding with North Dakota. Contact Ann Fritz at North Dakota Department of Environmental Quality for further information. For HUCs that extend outside of the state, the final area used to derive this indicator was area-weighted to only include that part within the state.

Attachment 3: North Dakota Stage 2 HUC12 Indicator Descriptions

Green denotes ecological indicators, red are stressor indicators, and blue are social indicators. All North Dakota-specific indicators are denoted with "STATE".

HUC12 Metric	Description
NFHAP Habitat Condition Index - STATE	Likelihood of suitable fish habitat, based on National Fish Habitat Action Plan Assessment
% Natural Cover (2011) in Watershed - STATE	The percentage of the HUC within the state considered "Natural Cover" based on the 2011 NLCD. "Natural Cover" is considered the following NLCD codes~classes: 41~Deciduous Forest, 42~Coniferous Forest, 43~Mixed Forest, 52~Shrub/Scrub, 71~Grassland/Herbaceous, 90~Woody Wetlands, and 95~Emergent Herbaceous Wetlands.
% Natural Cover (2011) in RZ - STATE	The percentage of the Riparian Zone (RZ) in the HUC within the state considered "Natural Cover" based on the 2011 NLCD. "Natural Cover" is considered the following NLCD codes~classes: 41~Deciduous Forest, 42~Coniferous Forest, 43~Mixed Forest, 52~Shrub/Scrub, 71~Grassland/Herbaceous, 90~Woody Wetlands, and 95~Emergent Herbaceous Wetlands.
% Wetlands (2011 and NWI) in RZ - STATE	The percentage of the Riparian Zone (RZ) in the HUC within the state considered "Wetlands": NLCD codes~classes 90~Woody Wetlands and 95~Emergent Herbaceous Wetlands in the 2011 NLCD, or a wetland in US Fish and Wildlife Service's National Wetland Inventory (NWI) state-wide data set.
% in Cultivated Crops (2011) in Watershed - STATE	The percentage of the HUC within the state classified as 'Cultivated Crops' (code 82) by the 2011 NLCD. See definitions above.
% Urban (2006) in Watershed - NATIONAL	% of HUC12 with urban cover (2006 National Land Cover Dataset version 1; Land classes 21, 22, 23, 24)
% Urban Change 2001-06 WS - NATIONAL	% of HUC12 Change in urban cover (2001 2006 National Land Cover Change Dataset version 1; 21, 22, 23, 24)
% Grassland to Row Crop Transition in Watershed - STATE	This indicator was derived using a grid produced by researchers at South Dakota State University who estimated the percent of grasslands in a 560-meter grid cell that has transitioned from grassland to corn/soybean in the Upper Midwest of the US. The researchers used the USDA NASS CDL data sets from 2006 to 2011 for their analysis. Using the grid provided by the University the average percent of transition within each HUC was derived using ESRI ArcMap's Spatial Analyst Zonal Stats as Table tool.
Count of Oil and Gas Wells/Area in Watershed - STATE	The number (i.e., count) of oil and gas related wells with a "Status" of 'Active', 'Drilling', or 'Temporarily Abandoned' and a "Well Type" of 'Oil or Gas Well', or 'Salt Water Disposal'; as identified by the GIS point coverage attributes available online from the North Dakota Department of Mineral Resources--within each HUC area divided by the HUC area in square kilometers.
Count of Drains/Area in Watershed - STATE	The number (i.e., count) of drainage network outlets--as identified by the GIS point coverage (file named "Drains") available online from the North Dakota State Water Commission--within each HUC area divided by the HUC area in square kilometers.
Average TN Load (kg/yr) SPARROW (2002) to Watershed - STATE	The average estimated load of Total Nitrogen (TN) from upland areas within each HUC. The estimates of loading were derived from two USGS SPARROW 2002 model outputs (Upper Midwest/Great Lakes and Missouri River Basin models, MRB3 and MRB4, respectively). SPARROW model outputs were assigned to SPARROW model subwatersheds that were then used to create an area-weighted average loading rate (kg/km/yr) for each HUC. The area-weighted average loading rate (kg/km/yr) was multiplied by the HUC(km) to reach this indicator's values in kg/yr.

HUC12 Metric	Description
Average TP Load (kg/yr) SPARROW (2002) to Watershed - STATE	The average estimated load of Total Phosphorus (TP) from upland areas within each HUC. The estimates of loading were derived from two USGS SPARROW 2002 model outputs (Upper Midwest/Great Lakes and Missouri River Basin models, MRB3 and MRB4, respectively). SPARROW model outputs were assigned to SPARROW model subwatersheds that were then used to create an area-weighted average loading rate (kg/km/yr) for each HUC. The area-weighted average loading rate (kg/km/yr) was multiplied by the HUC(km) to reach this indicator's values in kg/yr.
Count of Active CAFO/AFO Permits/Area in Watershed - STATE	The number (i.e., count) of active, permitted Confined Animal Feeding Operations (CAFO) and Animal Feeding Operations (AFO) as described in the State's NDPDES permits program database divided by the HUC12 area in square kilometers.
Count of Permitted Animals in Watershed/Area - STATE	The number of animals from all active, permitted Confined Animal Feeding Operations (CAFO) and Animal Feeding Operations (AFO) as described in the State's NDPDES permits program database divided by the HUC12 area in square kilometers.
Watershed Mean Soil Erodibility - NATIONAL	Average soil erodibility (K) factor in HUC12. Calculated from the "STATSGO2" soil attribute dataset.
Count of Water Quality Monitoring Sites in Watershed - STATE	The number (i.e., count) of monitoring sites in the HUC that have records of Total Phosphorus (TP) or Total Nitrogen (TN) samples between 2004 and 2013 (note -- number does not include Index of Biological Integrity (IBI) sampling sites).
Watershed Streamlength Assessed - ADJUSTED	Length of stream features assessed under Section 305(b) of the Clean Water Act in HUC12 (kilometers). Represents only the most recent assessment cycle that the state has provided to the EPA as geospatial data. Calculated from the EPA Office of Water "305(b) Waters as Assessed" NHD-indexed dataset. Only includes length of lines meeting criteria for classification as "streams". These criteria include: (1) feature has NHD REACHCODE with FTYPE equal to StreamRiver, CanalDitch, or Connector; (2) feature has NHD REACHCODE with FTYPE equal to Artificial Path and FTYPE of corresponding NHDArea feature is StreamRiver; or (3) feature is custom-added to the EPA Reach Address Database and is not in the NHD (blank NHD REACHCODE).
Watershed Waterbody Area Assessed - ADJUSTED	Area of lakes, estuaries, and other areal water features assessed under Section 305(b) of the Clean Water Act in HUC12 (square kilometers). Calculated from the EPA Office of Water "305(b) Waters as Assessed" NHD-indexed dataset.
Watershed Segments with TMDLs Count - ADJUSTED	The count of TMDLs in the HUC within the state (July 2014). This indicator was derived using the number of unique state-assigned water segment IDs in the EPA Office of Water "Impaired Waters with TMDLs" NHD-indexed dataset. For more information go to http://www.epa.gov/sites/production/files/2015-11/documents/rp3existplan1109.pdf. The national data was processed to assign appropriate values to the ND-specific version of HUC12s.
Percent potentially restorable wetlands WS - NATIONAL	Estimated percent of land within each HUC12 that may be suitable for wetland restoration.
% Drinking Water Source Protection Area - STATE	The percentage of source water protection area (SPA) in the watershed. This indicator was derived using data available from the State's GIS website whereby the total areas of Community and Non-Community areas designated as surface water only (i.e., excluded groundwater protection areas) were summed within each HUC and divided by the HUC area within the state.
% CRP Activities in Watershed - STATE	The percent of the HUC with Conservation Reserve Program lands as reported in 2007 (considered to be the most recently reported year of peak activity). The report of acres by HUC12 was provided by the USDA Farm Service Agency and is based on Common Land Unit data on December 29, 2014. HUC12 data were also aggregated at the HUC8 scale. For HUCs that extend outside of the state, the final area used to derive this indicator was area-weighted to only include that part within the state.

HUC12 Metric	Description
% Conservation Activity in Watershed - STATE	The percent of HUC that has a NRCS practice that would benefit water quality. Data range included 1995-2015. Dataset includes 152 different NRCS practices, selected by North Dakota because they have a beneficial effect on water quality. Source data provided by USDA through a Conservation Cooperators memorandum of understanding with North Dakota. Contact Ann Fritz at North Dakota Department of Environmental Quality for further information. For HUCs that extend outside of the state, the final area used to derive this indicator was area-weighted to only include that part within the state.
% Tribal Lands	Percent of total area constituting Tribal lands; otherwise blank. Analysis based on PLUS2 WBD snapshot HUC12 dataset and Tribal information from http://epamap5.epa.gov/ArcGIS/rest/services/EMEF/Tribal/MapServer/4 EPA Tribal data for the conterminous US, including all lands associated with Federally-recognized tribal entities— Federally recognized Reservations, Off-Reservation Trust Lands, and Census Oklahoma Tribal Statistical Areas.

Attachment 4: North Dakota RPS Tool file names and contents

The following are RPS Tool files completed during this project and delivered to NDDEQ for statewide and HUC8 or HUC12-specific use. Except for ND RPS-Scoring-Tool-032216, all these files contain archived results for each geographic area and scenario as named.

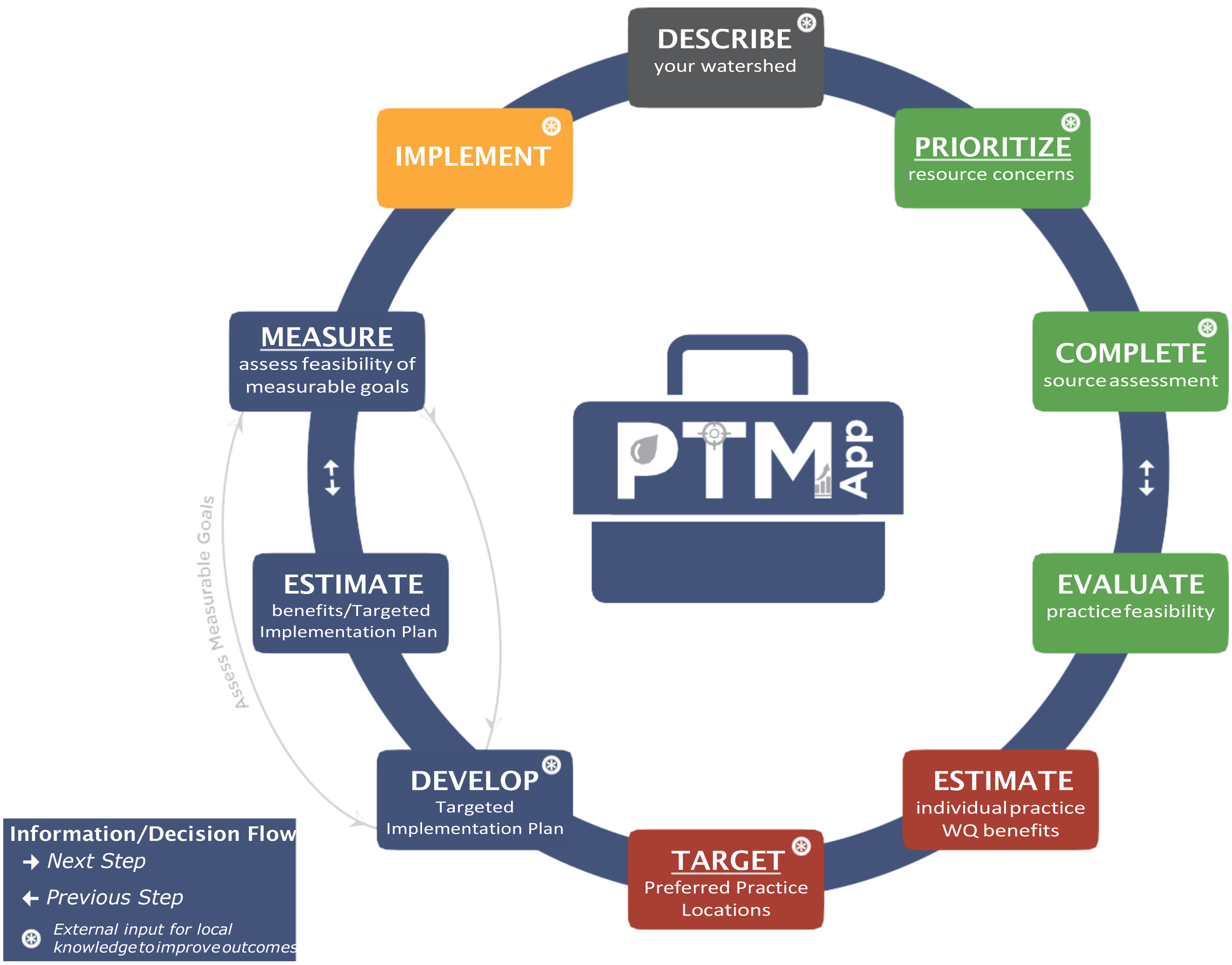
RPS Tool File Name	Content
ND RPS-Scoring-Tool-032216	ND RPS Tool with all HUC8 and HUC12 data, no screening content saved (master copy for all new screening statewide or on HUC subsets)
HUC8_SCENARIO 1A_ND RPS-Scoring-Tool-021016	ND RPS Tool with screening results for HUC8 Scenario 1A
HUC8_SCENARIO 1B_ND RPS-Scoring-Tool-021016	ND RPS Tool with screening results for HUC8 Scenario 1B
HUC12_ Park_MultBenefits_ND RPS-Scoring-Tool-032216	ND RPS Tool with Stage 2 results for HUC12 screening for Park HUC8 – Multiple Benefits
HUC12_ Park_Assess_ND RPS-Scoring-Tool-032216	ND RPS Tool with Stage 2 results for HUC12 screening for Park HUC8 - Assessment
HUC12_ Sakakawea_ND RPS-Scoring-Tool-032216	ND RPS Tool with Stage 2 results for HUC12 screening for Lake Sakakawea HUC8

Appendix D
PTMApp Products and Business Workflow

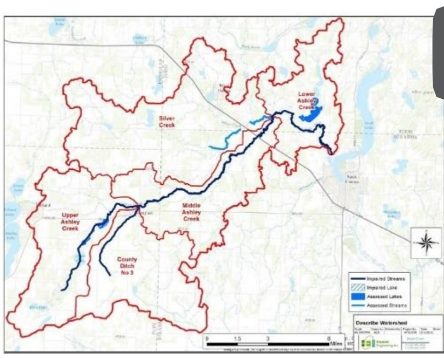
PTMApp Products and Business Workflow

The Prioritize, Target, Measure Application (PTMApp) is an innovative new tool that will help users with aspects of surface water quality planning from describing the watershed to developing implementation plans. Learn more about how you can use the application to improve every day decisions for more accurate results.

Available for free download: www.rrbdin.org/prioritize-target-measure-application-ptmapp

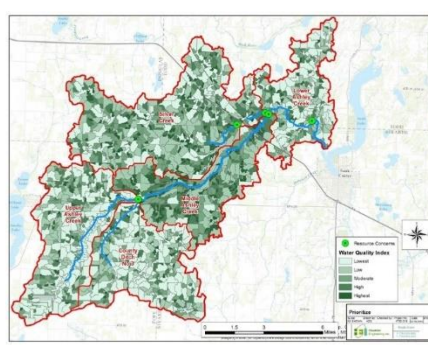


The following examples were completed as a pilot case study in the Sauk River Watershed District:



DESCRIBE
your watershed

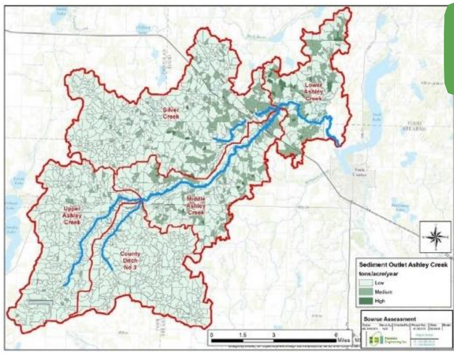
Identify and describe important resources, features, and factors associated with your watershed. PTMApp contains a pre-packaged publicly available watershed data set to the boundary of your watershed. This simplifies the process of gathering and summarizing GIS and resource data needed for your watershed. Data from PTMApp can help visualize and summarize the number of impaired waters and assessed waters in the study area.



PRIORITIZE
resource concerns

Establish the relative importance of resources within the area you manage. Lakes, streams and wetlands are frequently potential resource concerns included in prioritization processes. Use PTMApp products in conjunction with other models and Zonation to help prioritize resource concerns. PTMApp can help select resources that are a priority and locations where management actions should be taken.

Continued ▶

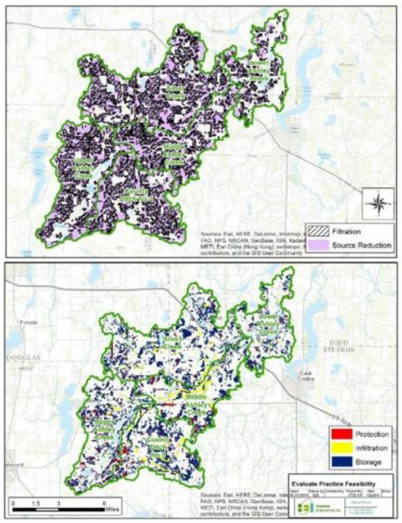


COMPLETE
source assessment

Identify the magnitude and spatial distribution of potential pollution sources across the landscape. Understand how various parts of the watershed contribute sediment, total phosphorus, and total nitrogen loads to downstream locations including impaired waters. Use PTMApp to identify the highest areas of sediment loading and show the best areas for practices.

DEVELOP
Targeted Implementation Plan

Specific locations to place practices must also be targeted based on practical and social factors. PTMApp data can incorporate additional information to refine the practices targeted. It is likely that many areas in the watershed may already have numerous Best Management Practices implemented, lack willing landowners, or have benefits beyond water quality that would impact the targeted locations for practices. PTMApp can adjust scenarios to restrict targeting to certain areas.



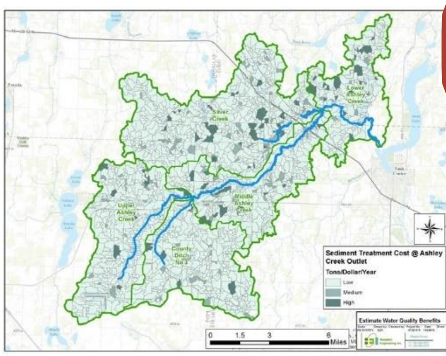
EVALUATE
practice feasibility

The feasibility of placing best management practices (BMPs) on the landscape depends on several factors: the size of contributing drainage area, land slope, and flow regime. Feasibility is often based on technical factors and excludes societal factors. PTMApp creates products to facilitate these conversations: BMP opportunities can be combined with the source assessment data to estimate the "measurable" water quality benefits for implementing the practices.

Priority Resource	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction
	Sediment, tons/year			TP, lbs/year			TN, lbs/year		
Lower Ashley Creek	559	267	292	331	130	201	6,148	2,945	3,203
Silver Creek	340	146	194	213	113	100	4,087	3,133	955
Middle Ashley Creek	308	186	122	274	115	158	4,277	2,756	1,521
Upper Silver Creek	259	117	142	200	98	102	4,100	3,141	959
County Ditch No. 3	164	158	6	182	175	6	3,514	3,470	44
Upper Ashley Creek	208	201	7	245	225	20	4,944	4,538	405

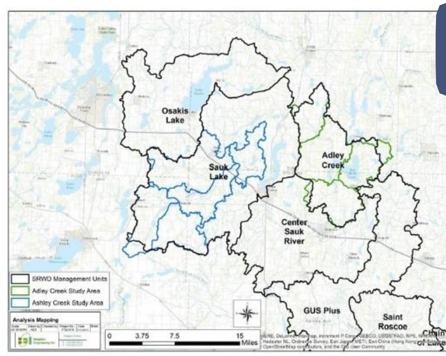
ESTIMATE
benefits/Targeted Implementation Plan

Combined benefits can be compared to a measurable goal. PTMApp can use the combined benefits of many practices to assess the effectiveness of the targeted implementation plan. Annual load reduction estimates can be calculated at each priority resource point within a study area and used to assess progress toward a measurable water quality goal. This information can be used directly within a Targeted Implementation Plan.



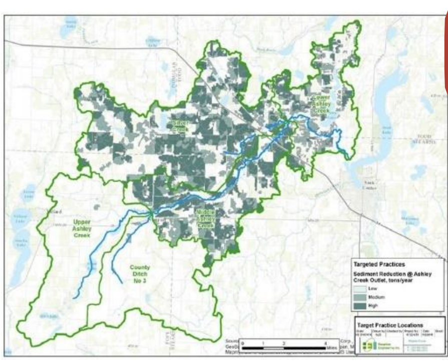
ESTIMATE
individual practice WQ benefits

Selecting specific practices to implement is based on their probable benefits, ranging from pollutants removed or the related cost. PTMApp can help estimate benefits at the location of the practice or resource. Outputs from PTMApp can show areas that provide the most bang for your buck and can help target practice locations to provide the most cost-effective ways to create measurable progress.



MEASURE
assess feasibility of measurable goals

A measurable goal may be the load reduction needed to restore a lake or river reach, or a maximum load to protect a resource. PTMApp can compare the estimated benefits of the Targeted Implementation Plan to water quality goals. Results of this analysis can show the scenarios that will provide the reductions needed to reach your planning goals.



TARGET
preferred practice locations

Once possible BMP locations are identified for feasibility, potential locations must be evaluated for their combined effectiveness. PTMApp can generate data to provide feasible locations for implementing practices that will provide measurable water quality improvements for priority resources. There are a number of factors that might influence preferred practices, including existing practices in place and landowner participation.

IMPLEMENT

By running various scenarios in PTMApp, managers can identify scenarios to implement the best, targeted solutions. PTMApp can analyze various practices and estimate the largest load reductions for specific areas within the watershed. This information helps users implement the best possible practices in the most effective locations.

Appendix E
Basin Water Quality Management Template

North Dakota Basin Water Quality Management Template 2015-2027

Final
October 2015

North Dakota Department of Environmental Quality Division of Water Quality Watershed Management Program

The North Dakota Basin Water Quality Template

The North Dakota Department of Environmental Quality (NDDEQ), Division of Water Quality's Watershed Management Program (WMP) is responsible for several water quality management programs, including monitoring and assessment, Total Maximum Daily Loads (TMDLs), Section 319 Nonpoint Source Pollution Management and nutrient management. To date, the WMP has implemented these programs and projects on a statewide basis which has led to a lack of watershed priorities and an inefficient allocation of limited resources, both technical and financial.

To improve the delivery of its water quality management programs, the WMP recognizes the need for a locally led process to identify and address water quality restoration and protection issues in the state's major river basins. In response, the WMP has developed the "North Dakota Basin Water Quality Management Template" (Basin Template).

The purpose of this Template is to serve as a comprehensive guide for water quality management planning and implementation. It is a targeted approach.

Basin Water Quality Management Template

This Basin Water Quality Management Template (Basin Template) is organized around five major river basins in the state (Figure 1). It should be noted this template is only presented as one example for implementing the nutrient reduction strategy. The template may need to be applied at different watershed scales to more effectively address nutrient management concerns in the state.

1. Red River Basin
2. James River Basin
3. Souris River Basin
4. Upper Missouri River Basin (including Lake Sakakawea)
5. Lower Missouri River Basin (including Lake Oahe)

The WMP will begin implementation of the Basin Template with the Red River Basin. The WMP is starting with the Red River Basin because this basin already has a well-established stakeholder structure (i.e., Red River Basin Commission) which will facilitate and aid in the organization of a Basin Stakeholder Advisory Group (BSAG) and with collection of existing information and data. The order in which basins will be selected for implementation of the Basin Template in subsequent years will be determined by the WMP as the Basin Template is further developed and implemented.

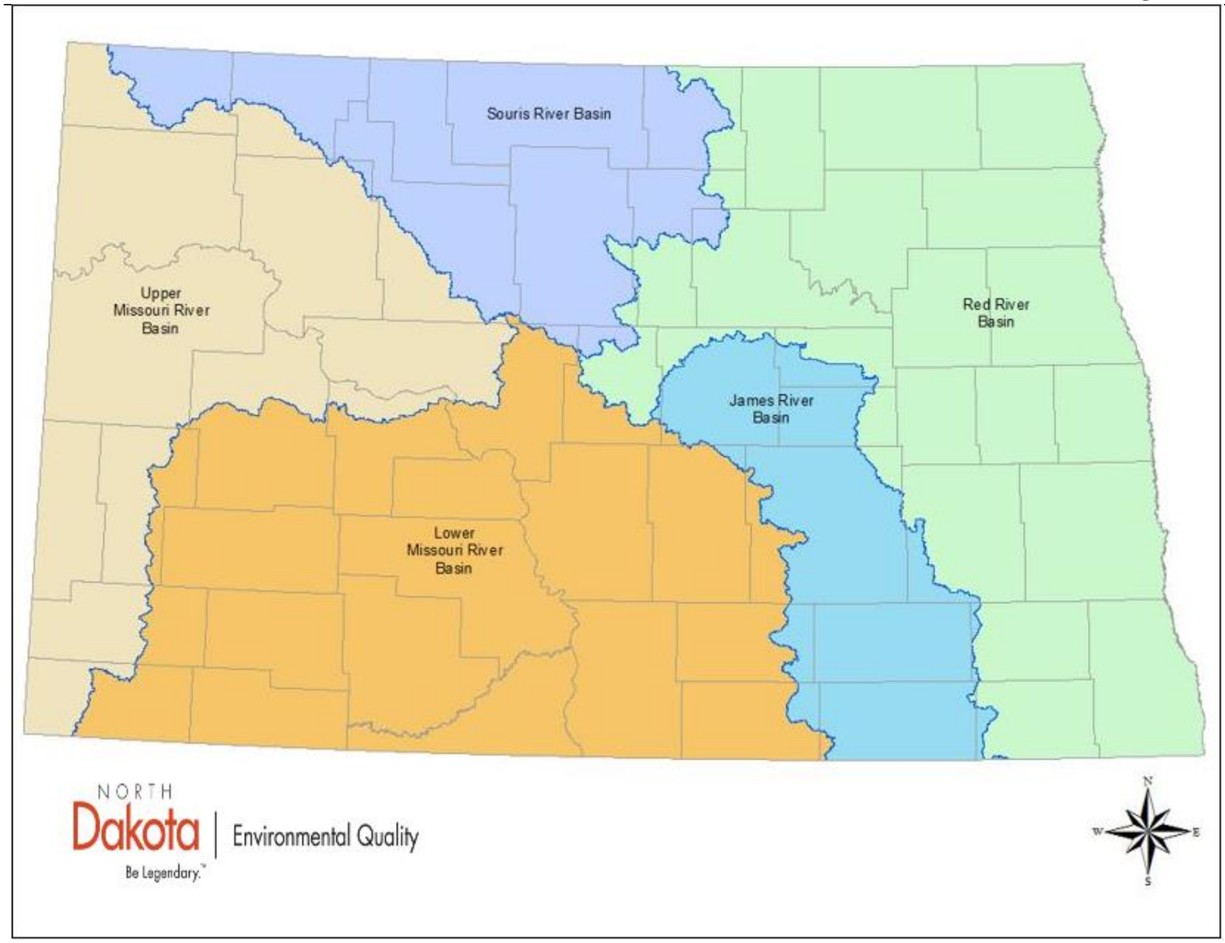


Figure 1. Major River Basins in North Dakota.

Roles and Responsibilities

The WMP is committed to providing the necessary assistance to develop a locally led process for basin water quality management. WMP staff will assist newly formed BSAGs through each step of the basin water quality management planning process. Initially, WMP staff will aid in the gathering of existing data and information, identifying data gaps and preparing a summary report which describes water quality and resource conditions in the basin, as well as, where there is a need for additional data and information (see Phase 1 Goal, Objective 2).

The first step in implementing the Basin Template in a specific basin or watershed will be the formation and organization of the Basin Stakeholder Advisory Group (BSAG). Each BSAG will be made up of local stakeholders who have a resource interest in the basin. The BSAG will provide the local leadership for developing and implementing each Basin Water Quality Management Plan (Basin Plan). Each BSAG, in cooperation with the WMP, will be responsible for overseeing the two phases of the Basin Plan. The BSAG will be responsible for the facilitation, coordination and implementation of the water quality assessment, restoration and protection, and education activities outlined by the basin plan.

The Basin Technical Advisory Groups (BTAGs) will provide expertise and technical guidance to the BSAG for the development and implementation of the basin plan. It is anticipated that members of this group will be primarily from state and federal agencies and academic representatives, including, but not limited to the NDDEQ, US Geological Survey, Natural

Resources Conservation Service, US Fish and Wildlife Service, ND State Water Commission, ND Game and Fish Department, ND Department of Agriculture, ND Forest Service and NDSU Extension.

Utilizing the data that has been gathered, the BSAGs will identify and prioritize water quality problems and issues in the basin. One method that could be used for prioritization is the Recovery Potential Screening Tool (RPST). The RPST is a watershed prioritization tool that uses several ecological, stressor, and social indicators which are selected based on the watershed management scenario or question being asked. The RPST has the advantage over other watershed prioritization methods in that it also measures the likelihood of successful management or restoration efforts in a watershed. The precise indicators selected for use in the RPST will vary based on the watershed management scenario, question, or priority interest (e.g., pathogen impairments, urban waters, heavily agricultural watersheds).

The WMP will work with the BSAG and associated BTAG in each basin to implement the RPST or other prioritization tools (e.g., PTMApp, AnnAGNPS) in each basin or watershed. Based on the results of the prioritization process, the BSAGs will set assessment, implementation,and educational priorities and develop a five-year basin or watershed plan. WMP staff will provide the necessary technical assistance to finalize the plan and assist in secure financial assistance for the implementation of the priority projects. In subsequent years, WMP staff will be committed to providing technical support in the form of identifying changes and amendments to the plan based on issues identified during plan implementation. WMP staff will also continue to provide training, and guidance for field staff, and maintain communications with the BSAGs to ensure the success of the project.

Over the long term, the BSAG's, in cooperation with the BTAGs and the WMP, will be responsible for all updates to the Basin Plans. Also, the BSAGs may choose to evolve into a more formalized structure and take a more proactive approach in implementing their Basin Plan.

Phased Basin Water Quality Management Planning and Implementation Approach

Phase one of each basin water quality management planning process will involve development of an initial Basin Plan. The phase one Basin Plan will be the key document used by the BSAG and its partners to 1) describe resource conditions in the basin, 2) identify water quality management priorities, 3) identify information and education priorities, 4) schedule implementation of priority projects, and 5) estimate financial needs for the five-year project implementation period. An outline describing the proposed elements of a Basin Plan is provided in Appendix A.

Phase two of the basin water quality management planning process will involve updating the initial Basin Plan. To coincide with the five major river basins on which this Template is organized, each phase two Basin Plan update will be completed on a five-year cycle. This five-year cycle may be adjusted if the size and number of watersheds involved in the delivery process are increased or decreased. Updates to the Basin Plans will be conducted to 1) evaluate the progress/success of implementation projects and activities, 2) measure the performance of meeting Basin Plan goals and objectives, 3) incorporate new data, 4) set new Basin Plan goals and objectives, and 5) establish schedules for new or ongoing priority projects.

Key to the implementation of the Phase 1 Basin Plans and Phase 2 Basin Plan updates will be the adaptive management process. Adaptive management, also known as adaptive resource management (ARM), is a systematic approach for improving resource (or in this case water quality) management policies and practices by learning from management outcomes. ARM acknowledges uncertainty about how natural resource systems function and how they respond to management actions. ARM is designed to improve our understanding of how a resource system works, so as to achieve management objectives. ARM also makes use of management interventions and follow-up monitoring to promote understanding and improve subsequent decision making. In the context of the Basin Template, ARM consists of the development, implementation, and evaluation of a Basin Plan. If a desired outcome is not accomplished, then the plan will be modified or changed. It is expected that this phase of the planning and implementation process will be repeated several times throughout the five-year cycle as new data becomes available and lessons are learned. Therefore, the Basin Plan will be a dynamic and living document with changes expected.

Goals, Objectives, and Tasks of the Basin Water Quality Management Template

Goals, objectives and tasks for development, implementation, and continuation of the Basin Water Quality Management Template are:

Phase 1 Goal – Develop and implement an initial Basin Water Quality Management Plan (Basin Plan) for each of the state's five major river basins.

Objective 1. Establish a Basin Stakeholder Advisory Group (BSAG) for each major river basin which will be responsible for the development and implementation of the basin plan.

Task 1. Coordinate with "core" local entities (e.g., soil conservation districts, water resource boards) to identify specific local organizations/agencies to be represented on the BSAG. BSAG membership will be limited to representatives with water management and resource interests in the basin.

Task 2. Convene an initial meeting with the full membership of the newly formed BSAG to discuss roles and responsibilities of the BSAG, establish an organizational structure, and set a schedule and milestones for developing and completing the initial Basin Plan.

Task 3. Establish a Basin Technical Advisory Group (BTAG) for each major river basin. Each BSAG will work with the WMP to identify agencies/organizations to be on the BTAG and to define the responsibilities of the BTAG in the development and implementation of the Basin Plan.

Task 4. Identify resource needs (e.g., staffing, funding) and responsibilities (project reviews, prioritization) for organizing and conducting BSAG meetings and other activities related to the development and implementation of the Basin Plan.

Objective 2. Compile existing information/data and determine information needs and data gaps.

Task 1. Identify existing reports, plans, studies, and datasets to characterize water quality and resource conditions in the basin.

Task 2. Determine data gaps and additional information that is needed to characterize water quality and resource conditions in the basin and in watersheds and sub-watersheds in the basin.

Task 3. Complete a summary report which describes water quality and resource conditions in the basin, as well as, where there is a need for additional data and information.

Objective 3. Identify priority water quality management issues, problems and concerns in the basin.

Task 1. Based on existing data and information (see Objective 2) and input from the BSAG, BTAG, and the WMP, identify and prioritize water quality management issues, problems and concerns in the basin and at the watershed (10-digit HUC) and sub-watershed (12 digit HUC) scale within each basin.

Objective 4. Establish basin water quality management program and project (e.g., monitoring and assessment, TMDL, Section 319 NPS source pollution implementation, nutrient reduction) priorities in the basin which will address priority water quality problems, issues and concerns in the basin (see Objective 3).

Task 1. Develop water quality management scenarios and/or questions which will be the basis for the development of basin prioritization.

Task 2. Using the Recovery Potential Screening Tool (RPST) or other standardized prioritization methods, establish priorities for water quality management programs, projects and activities in the basin. Note: For most water quality management scenarios and/or questions, basin priorities will be established at the watershed or sub-watershed scale.

Task 3. Identify potential roadblocks to the implementation of basin priorities.

Task 4. Identify short (1-5 years) and long term (5-10 years) basin water quality management priorities.

Objective 5. Educate and inform the public as to the basin issues that were used to develop the goals, objects and priorities described in the Basin Plan.

Task 1. Define information and education goals and objectives based on the stakeholder representation.

Task 2. Identify and analyze the target audience.

Task 3. Create and package the message.

Task 4. Distribute the message by using methods and/or focus groups as the BSAG and BTAG determines most effective (e.g. media outlets, public meetings, etc.).

Task 5. Create evaluation criteria and a schedule to determine effectiveness, update content, and make changes.

Objective 6. Develop a five-year Basin Plan.

Task 1. Using the outline provided in Appendix A to develop a five-year Basin Plan. The Basin Plan will describe the programs, projects and activities that, when implemented, will address priority water quality problems and issues in the basin. The Basin Plan should also include milestones for implementation and identify performance criteria for meeting basin goals.

Objective 7. Secure financial support and implement priority programs, projects and activities in the basin.

Task 1. Compile list of potential funding sources from federal, state, local, nonprofit, and industry organizations.

Task 2. Identify sponsors for the implementation of priority programs, projects and activities in the basin.

Task 3. Work with sponsors to secure funding for the implementation of programs, projects and activities identified in the Basin Plan.

Objective 8. Evaluate progress in meeting the Phase 1 Basin Plan goals, objectives and tasks.

Task 1. Determine the extent of implementation of priority projects.

Task 2. Complete a summary of Basin Plan implementation progress, including a description of lessons learned, financial issues, and project improvements.

Phase 2 Goal – Long Term Implementation, Support, and Revision of Basin Plan

The goal of Phase 2 is to provide ongoing updates to the Basin Plan based on ARM, the summary of Phase 1 progress (see Phase 1 Goal, Objective 8), and long-term support for assessment and implementation projects identified as priorities in the Basin Plan. This will be accomplished by making any necessary modifications to the BSAGs and/or BTAGs, revising watershed priorities, if needed, identifying additional data gaps and educational needs, and continued support of priority projects. To assure these objectives are met, basin monitoring and assessment will be conducted to evaluate the progress of the Basin Plan.

Appendix A
Basin Plan

River Basin Water Quality Management Plan Outline

A. Introduction

1) Overview of the basin, major industries, landuse, etc.

2) Identify current state or locally driven water quality monitoring activities in the basin.

3) Describe the relationship/interaction of the basin plan with the statewide Basin Template and other Programs addressing water quality.

4) Summarize the purpose/focus of the basin plan.

B. Basin Description

1) General description of the basin - landuse, industries, waterbody types, population, cities, land ownership, etc.

2) Current and state/federal/local programs focused on water quality restoration and assessment (e.g., USDA Programs, state & local monitoring programs, 319 projects)

3) Current water quality and beneficial use conditions

C. Beneficial Use Impairments and Pollution Sources and Causes

1) Identify documented beneficial use impairments (e.g., listed waterbodies, TMDLs)

2) Point Sources – Identify sources and types of point source pollution, associated beneficial use impairments, and industry in the state. Also identify known solutions.

3) Nonpoint Sources - Identify sources and types of NPS pollution; associated beneficial use impairments; and related industries in the state. Also identify known solutions.

4) Identify emerging or potential point/nonpoint source pollution sources and causes.

D. Management Plan Purpose

1) Describe the goals and objectives of the Plan.

E. Advisory Committees and Partnerships

1) Describe interaction with other state/local/federal agencies, NGO's and other entities to coordinate and/or pool financial and technical resources focused on water quality management.

2) Identify membership on the Statewide Pollution Management Task Force and describe roles and responsibilities in the review of statewide Also describe the Task Force role in the review of basin-specific plans and projects.

3) Describe potential membership on the BSAGs and BTAGs and the roles these groups play in the development and implementation of the basin-specific management plans and local projects within the basins.

F. Water Quality Management Goals and Priorities

1) Identify basin-wide pollution priorities; subwatershed priorities for assessment and restoration; healthy watersheds priorities and land management priorities.

2) Set goals for priorities and establish milestones for gauging progress toward those goals.

3) Describe process for soliciting and selecting assessment, restoration or protection projects in the basin.

G. Assessment, Restoration and Protection Initiatives

1) Identify Basin and Local Assessment Projects and Prioritization and Planning Programs. The QAPPs and budgets can be attached in the appendices of the Plan.

2) Identify Watershed Restoration and Protection projects and Basin-wide Actions and Programs. The PIPs, QAPPs and budgets can be attached in the Plan appendix.

H. Public Out-Reach and Education

1) Describe the strategy for basin and local level public out-reach.

2) Identify basin and local level public education programs for the 5-year period. The PIPs and budgets can be attached in the Plan appendix.

I. Milestones for Gauging Implementation Progress

1) Table displaying the five-year and interim milestones and outputs for local projects and basin-wide activities supported under the plan.

J. Financial and Technical Support

1) Identify financial and technical assistance available through the NDDEQ and describe the processes for soliciting assistance to support basin plans/projects.

2) Identify and describe other local, state and federal sources for financial and/or technical support for water quality improvement projects.

K. Evaluation and Reporting

1) Describe annual reporting requirements and performance measures at the basin and local levels.

2) Identify responsibilities and timelines for reporting monitoring and evaluation results to the BSAGs, NDDEQ, local residents and project partners.