RED RIVER BASIN COMMISSION'S

Water Quality Strategic Plan

For the Red River Basin

Final Report to the State of Minnesota Pursuant to Session Laws for Bill HF 2052

Red River of the North Water Quality Strategic Plan

MANITOBA
Municipalities
Bill Howatt
Laurie Hunt
Charles Posthumus
Gavin van der Linde
Cities
Jeff Browaty
John Buffie
Water Co-op
Greg Archibald
Environmental
Dimple Roy
Provincial
Eugene Kozera
Nicole Armstrong
Leloni Scott
At-large
Kurtiss Krasnesky

FIRST NATIONS/ TRIBAL
Gabriela Jimenez

MINNESOTA
Counties
Gary Kiesow
Stephanie Miranowski
Cities
Curt Johannsen
Del Rae Williams
Brian Holmer
Watersheds
John Finney
Daniel Wilkens
State
John Linc Stine
Tom Landwehr
John Jaschke
Dave Frederickson
At-large
Morrie Lanning

SOUTH DAKOTA
At-large
Gene Bartz

NORTH DAKOTA
Counties
Mary Scherling
Hetty Walker
Cities
Al Grasser
Dave Piepkorn
Watersheds
Dan Jacobson
Ben Varnson
State
Dave Glatt
Garland Erbele
Terry Steinwand
Doug Goehring
Environmental
Carmen MIller
At-large
Jake Gust

EX OFFICIO
Federal Elected:
Rep. Cramer - Lisa Gibbins
Sen. Heitkamp – Matthew Lephon
Sen. Hoeven – Jessica Lee
Sen. Klobuchar – Andy Martin
Rep. Peterson – Allison Myhre
Sen. Round
Sen. Smith
Sen. Thune – Judy Vrchota
M.P. James Bezan
ND Sen. Larry Luick

Federal Agencies:
Judy DesHarnais
Greg Gust
Dale Hutchison
John Oosterveen

Water Quality Strategic Plan (WQSP) Committees

WQSP Steering Committee

North Dakota	Minnesota	Manitoba
Mike Ell	**Jim Zielger**	**Nicole Armstrong**
ND Department of Health	MN Pollution Control Agency	Manitoba Sustainable Development

WQSP Project Advisory Committee

Andy Bradshaw – City of Moorhead, MN

Xinjua Jia – North Dakota State University

Bob Zimmerman – City of Moorhead, MN

Levi Otis – Ellingson Companies

Paul Mathison – ND Ag Coalition

Henry VanOffielen – MN Board of Water & Soil Resources

Riley Maanum – MN Farm Bureau

Jim Courneya – MN Pollution Control Agency

Chuck Fritz – International Water Institute

Al Grasser – City of Grand Forks, ND

Elaine Page – Manitoba Sustainable Development

Ted Alme – Natural Resources Conservation Service

Mitch Timmerman – MB Agriculture

Heidi Peterson – International Plant Nutrition Institute

Jim Ziegler – MN Pollution Control Agency

Mike Ell – ND Department of Health

Keith Weston – Red River Retention Authority

Zach Herrmann – Houston Engineering

Warren Formo – MN Agricultural Water Resource Center

Rochelle Nustad – US Geological Survey

Iris Griffin – Environment & Climate Change Canada

Jason Vanroadboeys – Water Quality, Agri Canada

Sharyn Reedyk – Agri Canada

Ted Preister – Red River Basin Commission

Barbara Olive – Red River Basin Commission consultant

Lance Yohe – Red River Basin Commission consultant

Red River Basin Commission
Water Quality Strategic Plan (WQSP)

Executive Summary

Map A-1
GENERAL LOCATION MAP
Red River of the North Basin
Red River Basin Long Term Flood Solutions

The Setting

The Red River basin is an international, multi-jurisdictional watershed of 45,000 square miles, with 80 percent of the basin lying in the United State and 20 percent in Manitoba, Canada. Eighteen Minnesota counties and 22 North Dakota counties lie wholly or partially in the basin. The economic impact of the basin, from both urban-generated activity and a vibrant agricultural economy, is significant. This basin is home to more than half a million people, and serves as a jobs, education and medical hub, in addition to a world-renowned agricultural producer.

Need for Action

River system stressors such as lower levels of dissolved oxygen and impacts to biological systems are becoming more evident in the Red River Basin. Impacts from some of these stressors, new monitoring information, and data from models all indicate that this basin has been experiencing increasingly higher levels of sediment and nutrients: Nitrogen and Phosphorus (N & P) in the basin surface waters. Impacts are now visually evident in Lake Winnipeg and other basin lakes as blue-green algal blooms, and they appear to be increasing yearly. Sediment which is almost always an issue in prairie river systems is impacting the Red River system from increased stream bank, stream bed and field erosion and basin-wide land use practices. Both are contributing sediment and nutrients: N and P to the Red River Basin waterways and lakes.

Impetus

The Red River Basin Commission (RRBC), as an international basin-wide organization, is uniquely qualified to develop a comprehensive, proactive plan that helps understand water quality issues and ways of addressing them throughout the watershed. The brought together its partners in an organized effort to further commitment to shared land and water stewardship goals in the basin, including the goal of water quality.

Our Findings

During the last two years under the WQSP project, information was developed and compiled which will provide basin managers with key tools to assist each jurisdiction in fostering conditions that lead to measurable improvements in Water Quality throughout the basin.

The RRBC first developed basin assumptions so that water managers and decision makers could begin the work starting with the same premises. Consolidation of a wide variety of data

and policy helped to establish the current state of the Basin and informed the discussion of a way forward for the wide variety of stakeholders.

Outline of Recommendations

The WQSP contains specific recommendations for action for local, state and federal officials on the following topics:

- Basin Connector Strategy
    - The cornerstone of the strategy must be predicated on cross boundary engagement, there are two organizations that play a crucial role in this communication, The International Joint Commission's International Red River Board and the Red River Basin Commission. Both organizations must be empowered to continue working in their niche to facilitate improvements basin wide.
- Basin Cornerstone Strategy
    - This report also represents the most up to date "State of the Basin". In addition to the RRBC maintaining a State of the Basin Report as a living document that has grown out of the report. The collection of monitoring data will inform future updates of the State of the Basin.
- Basin Building Block Strategy
    - Individual steps tailored to each jurisdiction, have been defined that will be able to help measure progress from the Mainstem to the Tributary level.
- Basin Data and Tools Strategy
    - There are some identified gaps or improvements that can be made to Data management and Tools for use in the Basin. These will facilitate the development of load allocations and indicators throughout the basin.
- Pilot projects and Stakeholder Engagement
    - The complexity of improving water quality on the Red River demands a broad array of techniques to move forward. Pilot projects across the Basin and at a variety of scales, from field to sub-watershed are proposed. The various projects will inform stakeholders on secondary and tertiary impact of those projects before they are exported to other stakeholders for implementation. That stakeholder engagement and information sharing are the core of the RRBCs ongoing efforts in water quality.

This document represents only the initial version of the WQSP. It is intended that this document is updated frequently as progress is made or new information is presented. Look for an updated State of the Basin annually at the RRRBC Conference in January and subsequently published amendments to the plan.

From the Executive Director

The topic of water quality is vastly complex when it involves one small rural stream. Scaled up to the multi-jurisdictional, multi-use, international discussion that is the Red River of the North; it may not even be possible to establish a quantifiable Strategic Plan. Rather, there may be a way forward for greater communication between the many interested parties and agreement on an outcome and general timetable as opposed to hard quotas and processes.

The single most challenging aspect of the discussion is that each jurisdiction approaches water from an entirely different perspective, which leads to dramatically different outlooks on how to address water management.

> Minnesota - maintain fishable & swimmable waters…. not pass nutrient problems downstream
>
> North Dakota - maintain or improve… the quality of the waters…. protect existing uses
>
> South Dakota - protect beneficial uses… and antidegradation policy that protects existing uses
>
> Manitoba - reduce excess nutrients in Lake Winnipeg…. not cause undue economic hardship

These are only the state and provincial perspective whereas the Federal level perspectives are different for both countries and even the International Joint Commission had challenges in finding language that is acceptable to all parties.

The most broadly agreed-to water quality challenge is excessive nutrient concentrations and thus Phosphorus and Nitrogen are used as the primary vehicle for the conversation.

This report attempts to outline the current state of efforts to prioritize the water quality of the river by Minnesota, North Dakota and Manitoba while recognizing the substantially different priorities of each of those jurisdictions. It also strives to outline how the Red River Basin Commission is seeking to bridge the gaps between regulations in the different jurisdictions and find common ground that will create more positive water quality outcomes for each of the varied stakeholders.

This cooperative approach is lined out in much more detail in the recommendations section of the document and will form the basis for future engagement activities throughout he basin.

Ted Preister
Executive Director, Red River Basin Commission

Acronyms

- AGNPS –Agricultural Non-Point Source Pollution Model
- AEC – Aquatic Ecosystem Committee (IRRB)
- ALUS – Alternative Land Use Services
- BMPs – Best Management Practice
- CLMT + CSMP – Citizens Lake/Stream Monitoring program (MN)
- COH – Committee on Hydrology
- CPs – Conservation Practices
- CWA – Clean Water Act
- CWMP – Comprehensive Water Management Plan
- DNR – MN Department of Natural Resources
- DO – Dissolved Oxygen
- ECCC – Environment & Climate Change Canada
- EPA – Environmental Protection Agency (US)
- EQB – Environmental Quality Board (MN)
- EQIP –Environmental Quality Incentives Program (USDA/NRCS)
- GIS – Geographical Information System
- HSPF – Hydrological Simulation Program – Fortran
- HUC – Hydrologic Unit Code
- IBI – Index of Biological Integrity
- IJC – International Joint Commission
- IRRB – International Red River Board
- IWM – Intensive Monitoring (MN)
- LGU – Local Governmental Unit
- LTFS – Long Term Flood Solutions
- MB – Manitoba
- MDNR – Minnesota Department of Natural Resources
- MDSD – Manitoba Department of Sustainable Development
- MN -- Minnesota
- MPCA –Minnesota Pollution Control Agency
- N – Nitrogen
- ND – North Dakota
- NDDoH – North Dakota Department of Health
- NGO – Non-Government Organization
- NITG –Nutrient Innovations Task Group (EPA)
- NPDES – National Pollutant Discharge Elimination System (EPA)
- NPS – Nonpoint source
- NRCS – Natural Resources Conservation Service (USDA)
- NRFP – *Natural Resources Framework Plan*
- NRS – Nutrient Reduction Strategy
- P – Phosphorus
- PTMApp – Prioritize Target and Measure Application
- RPS –Recovery Potential Screening
- RRB – Red River Basin
- RRBC – Red River Basin Commission
- RRRA – Red River Retention Authority

- SD – South Dakota
- SDDENR – South Dakota Department of Environment & Natural Resources
- SPARROW – Spatially Referenced Regressions on Watershed
- SWAGs – Surface Water Assessment Grants (MN)
- SWCD – Soil and Water Conservation District
- SWLA – Statewide Lakes Assessment (SD)
- SWQMP – Surface Water Quality Management Program (ND)
- TIC – The International Coalition
- TDS – Total dissolved solids
- TMDL – Total Maximum Daily Load
- TN – Total Nitrogen
- TS -- Total Phosphorus
- TSS – Total Suspended Solids
- US – United States
- USACE – United State Army Corps of Engineers
- USDA – United States Department of Agriculture
- USGS – United State Geological Survey
- WD – Watershed District
- WPLMN – Watershed Pollutant Load Monitoring Network (MN)
- WQ – Water Quality
- WQS – Water Quality Standard
- WQSP – Water Quality Strategic Plan
- WRAPS – Watershed Restoration and Protection Strategy (MN)

Reference Terminology

Conditions that contribute to stressors such as high sediment and nutrient levels can result from natural features of the landscape, human activities, or both.

Following are a number of terms that are keys to understanding and discussing the problems of sediment and stressor nutrients in the Red River basin:

Stressor -- the element that directly impacts the health of aquatic life. Sediment and excess nutrients are stressors.

Source – the factor or activity that causes or supports the stressor, impacting ecological, social and/or economic benefits.

Point Source – a specific, identifiable source of a pollutant, typically requiring a permit. Point sources are often associated with municipalities (e.g., waste water processing, storm water discharge, industrial discharge) but exist in rural areas as well (e.g., confined animal feeding operations or some processing facilities).

Nonpoint Source—a source of a pollutant contributed from the wider landscape typically from rainfall or snowmelt moving across the land. In the Red River basin, nonpoint sources are generally attributed to agricultural runoff, though smaller amounts of nonpoint runoff come from urban centers in the forms of runoff from roadways and lawns/parks.

Eutrophication –the state of a body of water in which an increase in mineral and organic nutrients has reduced the dissolved oxygen, producing an environment that favors plant over animal life.

High Flows—refers to river levels at high stages. High flows carry greater amounts of sediment and stressor nutrients and are most typically the condition in spring months.

Low Flows- refers to river levels at low stages. Low flows tend to increase concentrations of nutrients by lowering the dilution factor (typically the condition in late summer, early fall).

Hydrologic Unit Code (HUC) – a code assigned by the USGS for each US watershed, organized in a nested hierarchy by size.

Concentration – the measured amount of a particular nutrient or pollutant in water at a particular place and time. Typically calculated as a percentage and expressed as milligrams per liter (mg/L).

Load – the amount of a substance that a river or lake can carry at one time while still meeting its designated uses.

Internal loading – an instance where the source of the stressor comes from internal rather than external source(s), as, e.g., when a rise in water temperature rather than nutrient pollutants cause eutrophication.

TMDL – standards set by states for their waters under the CWA (US). The standards describe the amount or "total maximum daily load" of a pollutant a waterbody can receive and/or hold and still meet its designated uses. TMDL reports describing strategies to restore an impaired water need to be developed for waterbodies that do not meet one or more of its uses.

Target –A level of nitrogen or phosphorus in an inflow developed to determine loading reductions required to reverse trends and track progress. Typically determined by a research model. Often expressed as mg/L.

Objective – The amount or degree of change required to reverse, restore or preserve the concentration of nitrogen and phosphorus—and the ratio between the two—in a water body. Expressed numerically or via narrative.

Numeric criteria –a limit expressed numerically of the concentration or load allowed in one or more water bodies or types of water bodies.

Narrative criteria –a narrative description of element(s) allowed or not allowed in one or more water bodies or types of water.

Reaches – river segments.
Total phosphorus (Total P or TP) – Total amount of phosphates in a water stream, both suspended and dissolved.

Total nitrogen (Total N or TN) – Total amount of nitrates in a water stream, both suspended and dissolved.

Total Dissolved Solids (TDS) – Measured amount of solids that pass through a 0.45 micrometer filter (includes phosphates and nitrates). When too high, dissolved solids reduce water clarity, decrease photosynthesis, and/or combine with toxic compounds to raise water temperature.

Total Suspended Solids (TSS) – Measured amount of solids suspended in water of a variety of materials including silt and industrial waste. Impacts light penetration and productivity, recreation value, habitat quality. Can cause increases in water temperature and fish kills.

Total Solids (TS) – Measured amount of solids suspended or dissolved in a water stream.
Anoxic – marked and caused by inadequate oxygenation.

Chlorophyll a – along with chlorophyll b, the element that makes up the green coloring of plants necessary for photosynthesis.

Cyanobacteria – an algal plant whose blooms have potential to produce potent algal toxins that may pose health risks to humans and other animals

Macrophyte – member of the macroscopic plant life in a body of water.

Phytoplankton – minute floating aquatic plants. Used to measure changes in total algal abundance and diversity.

Overview of Red River Basin

The Red River basin is an international, multi-jurisdictional watershed of approximately 45,000 square miles, with approximately 80% of the basin lying in the US and 20% in Manitoba, Canada. Eighteen Minnesota counties and 22 North Dakota counties lie wholly or partially in the basin. The basin's assets, both urban-generated wealth and a vibrant agricultural economy, have long been recognized.[1] Today this basin is home to more than half a million people[2] and is a jobs, education and medical hub, in addition to a world-renowned agricultural area.

We will use three watershed based geographical reference points, the Red River mainstem, tributaries that flow directly to the Red River and those remaining tributaries that flow into larger tributaries to establish a process for sharing information, receiving feedback and implementing actions. This approach will provide a way to measure progress and demonstrate the benefits of working at all three of these scales.

Introduction

Need for Water Quality Strategic Plan

Several decades of observation and monitoring of sediment and excess nutrients in the Red River of the North's lakes and rivers reveal an alarming trend upward of sediment and excess nutrients in the basin's waters. The Red River Basin is not alone in this regard—the US Environmental Protection Agency (EPA) views excess nutrients are "one of America's most widespread and challenging environmental problems." The set of circumstances for the basin, however, its natural features together with settlement and land use, add up to a problem of particular significance for the basin's waterways, whether for the recreational and commercial industries of lakes or for clean water supply for its cities.

The high levels of excess nutrients and sediments in Red River waters have been taken under study by federal and state/provincial jurisdictions, together with supporting agencies and NGOs. And jurisdictions at several levels have begun taking steps to respond to the growing loads and concentrations of phosphates and nitrates in the basin's waterways. While these attempts by individual jurisdictions are laudatory, they are for the most part partial and isolated responses to an issue of a magnitude that demands coordinated, whole basin, multi-stakeholder effort.

Supporting Legislation and Partners

As a step towards coordinated effort in the basin to reduce harmful impacts to its water resources, the State of Minnesota funded the Water Quality Strategic Plan (WQSP), whose goals are to overview frameworks in place for regulating nutrients at state/provincial, federal, and international levels and to identify areas of agreement among leadership and stakeholders in order to find strategic ways towards shared objectives and targets for reducing sediment and excess nutrients in the basin's lakes and rivers.

The funding for WQSP was allocated to the Minnesota Pollution Control Agency (MPCA), which directed the funding to the Red River Basin Commission (RRBC) for purposes of reaching out to jurisdictions and other stakeholders to determine best roads ahead for carrying out coordinated responses to the excess nutrients impacting the Red River basin's water resources.
In addition, the state of North Dakota and province of Manitoba have provided direct guidance and input into the WQSP throughout the process.

WQ Sediment and Excess Nutrients Report

The report that follows is intended as a summary of current status of and response to excess sediment and nutrients in Red River basin waters.

Part I overviews sources and impacts of stressor nutrients in the Red River basin, together with the challenges of reserving trends.
Part II summarizes the frameworks currently in place at federal, state/province, and international levels to address stressor nutrients in the basin's lakes and rivers,
Part III looks at progress being made through monitoring basin waters, together with snapshots of recent modeling programs, both ways to increase understanding and direct strategic responses.
Part IV provides conclusions and recommendations, with the goal of reducing stressor nutrients through coordinated efforts and shared objectives.

CONTENTS

Prefatory Materials:

Part I: PROBLEM IDENTIFICATION & CHALLENGES

Part II: RESPONSES BY JURISDICTIONS: FEDERAL, STATE/PROVINCIAL, INTERNATIONAL

Part III: DATA-DRIVEN MONITORING & NUTRIENT MODELING

Part IV: MOVING AHEAD WITH INTEGRATED ACTION: CONCLUSIONS AND RECOMMENDATIONS

Part 1: PROBLEM IDENTIFICATION & CHALLENGES

1

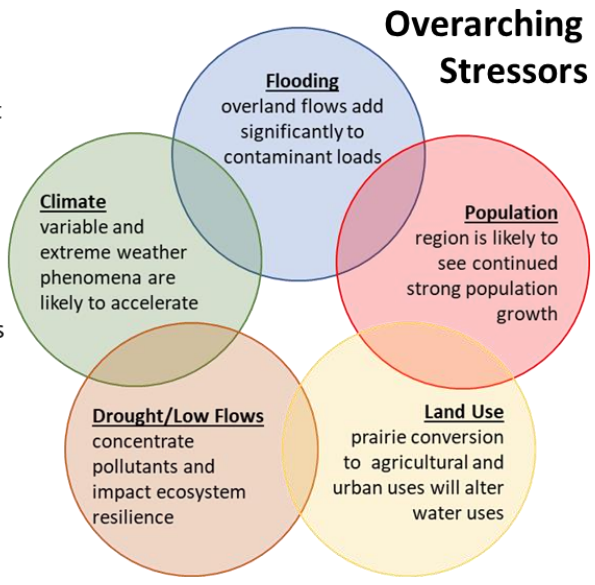
Sources of Sediment and Nutrient Stressors in Red River Basin Waters

The Red River Basin of the North (hereafter referred to as Red River Basin) has long been recognized as an area of considerable size and consequence. Flowing from the confluence of the Bois de Sioux and Otter Tail Rivers near Wahpeton, North Dakota, all the way to Lake Winnipeg in Manitoba, Canada, the basin drains 81,894 square miles (212,105 square km) of glacial plain. In the late 1990s, the Red River watershed was chosen by the US Department of Interior to be part of a nation-wide study of major rivers. Beyond its role as an example of a northern tier basin, the study cited the following about the Red River Basin (RRB):

- The basin represents an important hydrologic region where water is a valuable resource for the region's economy.
- The quality of the Red River is of international concern.
- The basin represents an economically valuable agricultural area.

Born from its history as a glacial lake, Lake Agassiz, which formed at the southern edge of the Laurentide Ice Sheet and remained in existence from approximately 11,500 to 7,500 years before the present, the Red River watershed includes natural resources of significant value, including tillable lands, forests, native prairies and waterways in the form of lakes, wetlands, and rivers. Today, these natural resources, particularly the Basin's waters, are under threat from accelerated sediments and nutrients, a result of both given natural factors and anthropic activity.

Each of the **Overarching Stressors** in the diagram have impacts on water quality. They each influence how point and non-point sources contribute to challenges. **Non-point sources** are often attributed to agricultural runoff, however, there are dozens of them in urban centers like salt from roadways in winter and lawn/park fertilizer run-off. Similarly **Point Sources** are usually associated with urban centers but exist in rural areas as well i.e. septic systems and some processing facilities.



Sources of Sediment

Why should high sedimentation of rivers and lakes be a source of concern? First, sediment in its own right is a stressor. By shading the transmission of light through water, high sedimentation decreases primary productivity and sources of food. Sediments also directly affect respiration of fish and the general viability of aquatic life. But even more important is the contribution of sediments to excess nutrients by acting as a transporter of nutrients through waterways.

If sediments by themselves, or as transporters of nutrients, are a problem for rivers in general, that problem is greater than average for RRB waters. The basin's topography and soil types, along with factors stemming from land use, together contribute to high sedimentation of the basin's waters. Add climate trends, and the degree of the problem heightens even further. Following is a closer look at major sources for high levels of sediment in RRB waterways:

Flooding

Sediments are typically associated with variable flows and flooding. Given the relatively steep escarpments on the east and west of the main stem Red, the RRB has its share and more of proneness to flooding.[3] Adding to the basin's above-average incidence of flooding are the main stem's northern direction of flow. During spring melts, the northward flowing river regularly encounters ice jams, producing overland break outs. The basin's exceptionally flat central plain, with a slope of 0.2 to 1.0 foot per mile, together with its young river channels, result in frequent use by flood waters of this 50-60-mile-wide area at the basin's center. Individual tributaries face regular flooding as well, particularly at their characteristic upward turns to the north as they enter the main stem Red.

The basin's soil types also contribute to flooding proneness. The soils in the center plain area of the RRB, where flooding most typically occurs, are of two types, sandy loam and clay. Both are heavy soils and as such have lower infiltration than the more mixed soils of the upland areas of the basin. The low infiltration capacity of the lake plain's soils contributes to rapid runoff rates of waters, heightening the sedimentation of the waters.

Soils

The RRB's heavier soils contribute directly to the high sedimentation of the basin's surface waters. The heavy soils have fine particles which require significantly more time than courser particles to settle out of the water flow even at low flow rates. The result is turbid waters, particularly in the main stem Red River, whose dominant natural feature is the movement of suspended fine material that remains in the flow for considerable time.

RRB soils also tend to have poor river bank strength, resulting in numerous bank failures in its rivers and streams. Bank slides most typically occur following flood conditions, when water elevations are reduced to levels below those of the recent past. The slides open up areas without protective vegetation, subjecting the bare soil to erosion with the next high flow.

Seasons and Climate

[3]See *Long Term Flood Solutions– for the Red River Basin* (LTFS, 2011).

The dramatic differences among the four seasons in the RRB heighten chances for spring flooding. Winters allow for the buildup of snow and freezing of surface waters. Spring temperatures melt the ice and snow, causing high flows of waters into the basin's rivers and streams, and, depending on the degree of frozen buildup, modest to severe flooding of the basin's flat plain lands follows. At times, high river levels from spring melts can last into the summer, overlapping with early summer thunderstorms. Multiple floods in one season on the Red River or one of its tributaries has occurred.

Although flooding is a dominant challenge for the basin, sedimentation of water ways occurs as well during periods of dry conditions and drought, with their accompanying winds. According to climate analyses, the latter conditions may intensify in the years ahead. A regional meta-analysis completed by the US Corps of Engineers (USACE) in 2015-17 concludes that the RRB can expect temperatures to trend upward. Precipitation is also expected to increase but will tend to occur in larger rain events, leaving more dry days and periods.[4]

Settlement

Settlement has contributed to the turbidity of RRB waters. The basin's rural population peaked in the early 1900s when most of the basin was occupied by small farms and closely placed small towns. Since that time, farms and towns have become cities and even urban centers, and the population has migrated from rural to urban settings. Roads have become streets and large areas of land are covered with impermeable surfaces, resulting in larger and faster run offs and other hydrologic alterations. If one adds to these hydrologic changes the potential suggested by climate scientists for more frequent and intense rain events, the chances for fast runoffs and resulting movement of soils into waterways is further heightened.

These hydrologic changes typically affect the main stem directly. Given the use by early settlers of waterways as transportation corridors, settlements were often located on the main stem Red, where many grew into cities. Today the Red River's largest population centers are located on the banks of the Red River, putting stress on riverbanks and contributing to velocity of runoffs.

Land use

Prior to European settlement, the RRB was part of the prairie ecosystem, with open expanses to the west with nutrient rich wetlands, conifer forests and lakes to the east, and, in between, an exceptionally fertile plain where a semi-sedentary culture of native people lived in villages supported by agriculture crops of maize and beans.

European settlers began moving into the area by the late 1550s, pursuing trapping and logging. By the late 1800s, European settlement became more pervasive as settlers became attracted to the rich soils of the central basin. As agricultural settlement progressed, settlers cleared trees to the east and drained wetlands to the west to expand crop lands. This encroachment of crop lands into the basin's wetlands has been going on since the beginning of drainage in the late 1800s and the wholesale conversion of basin lands to crop production that followed in the aftermath. Today cultivated cropland covers 58% of the basin's land area, with the remainder in noncultivated cropland (3%), CRP (6%), range and pastureland (9%), forest land (12%), other

[4] *Comprehensive Watershed Management Plan,* p. 15

rural land (4%), water (3%), rural transport (2%), urban built-up (1%), and federal land (2%).[5] Much of the converted land is prone to erosion by both wind and water. Although the mid-plain soil types are generally heavy, these heavier soils are composed of fine particles, making them readily erodible.[6]

Accelerating the movement of soils on the basin's plain area has been the development of surface drainage, first begun in the late 1800s. These extensive human-made ditches and outlets typically lack buffering areas, making them susceptible in particular to water erosion, which is estimated to cause two-thirds of agricultural land erosion.[7] Aggressive tilling, together with the practice of leaving cultivated land clear for part or all of a year, have opened vast areas to the whims of wind and water. Soil scientist Abby Wick estimates topsoil losses of up to 15 inches in the region in the last 50 years.[8]

Sources of Excess Nutrients

Nitrates and phosphates are indispensable nutrients for plant growth. Nitrates create the deep green protein leaves in plants that allow them to absorb carbon dioxide from the atmosphere and grow. It is only when excessive nitrates (N) and phosphates (P) miscarry into susceptible environments that they become stressors.

N and P have a variety of sources. They can be found anywhere from cleaning products in homes to the deposition into the air from industrial pollution. Primary sources of excess nutrients in the RRB include the following:

Municipal Waste Treatment

A critical part of the infrastructure for towns and cities are their sewage treatment plants and lagoons, including discharge and land application of bio-solids. As such, cities can be both source of, and sufferer from, excess nutrients in their water systems. Currently, numerous towns and cities in the basin are monitoring and attempting to address water supplies with rising N levels.

Although waste systems in small towns and rural areas may not at first seem like a problem, numbers add up. In 2016, the International Red River Board (IRRB) identified 344 point sources in the RRB, 31 in the southern headwaters area, 990 in the midsection, and 223 in the northern third, mouth zone. In some cases, small towns experiencing population loss, together with some older farmsteads, may not have the means to repair and update septic or sewage systems.

In other instances, the basin has several fast-growing urban centers. Since 2000, Winnipeg has grown from 670,000 to 727,500, Fargo-Moorhead from approximately 100,000 to 163,000, and Grand Forks-East Grand Forks from 60,000 to 66,000. Together, the two largest, Winnipeg and Fargo-Moorhead, have grown since 2000 from under 800,000 to over 1,500,000 inhabitants. In addition, industrial demand is on the rise in these and other basin cities.

---

[5] USDA/NRCS, 2012 National Resources Inventory, US Portion of the RRB.

[6] Soil erosion has been a problem for earlier decades as well. A North Dakota Soil Scientist recently estimated soil losses during the first 60-75 years of intensive agriculture to be up to multiple feet in some areas.

[7] *The International Coalition, Land and Water Guide: Red River Basin*, p.35.

[8] *Successful Farming* 115 (November 2017), p. 46.

Although it has proven difficult to determine exact levels of nutrients deposited into streams, studies have found evidence of increased N and P concentrations at sites along the Red River, including sites associated with urban areas.

Data shows that during periods of low flow such as late summer, when agricultural runoff is low and temperatures warm, municipal and industrial wastewaters can become significant contributors to nutrient loading of waters.

Fertilizers - and Sediment

The largest and most direct source of nutrients in the Red River's waters is in their function as fertilizers applied to the basin's vast crop production lands, as well as their more incidental use in residential and recreational applications.

Using inorganic fertilizers has not always been the case in basin agriculture. Although commercial crop production began in the 1880s, it was not until the 1940s and 1950s that P fertilization began, slowly at first. In the first 60-75 years of commercial crop production in the basin, little benefit was seen in fertilizer application due to the basin's rich soils. But that changed after many feet of topsoil were lost to winds and waters, and row crops gradually became the rule. Given the yields possible and expected in today's agriculture, fertilization remains necessary, and, with the exception of organically produced crops, almost universally practiced. Rates of local crop fertilization today are slightly below the all-time high of several years ago but remain historically high.

If fertilizing practices have led to high concentrations of N and P in field run-off, heavy tillage has largely supplied the sediments that transport these nutrients. In particular, P bonds itself to sediment particles, which carry it into the basin's rivers and lakes.

Subsurface drainage offers some solutions but can add to the problem as well. Tiled drainage has the advantage of reducing concentrations of sediment, P and pesticides in agriculture runoff waters by shifting the pathway for excess precipitation from surface to subsurface flow. However, tile drainage waters are more likely to bypass riparian buffer strips and other areas where contaminant loads in surface runoff are trapped and filtered. Subsurface drainage also carries greater loads of N than surface runoff.[9]

Climate

Much of the variation in water quality in the RRB is seasonal. Under winter's cold temperatures, ice-covered surface waters tend to have less dissolved oxygen (DO), lower concentrations of suspended sediment, and higher concentrations of nutrients than during other seasons. Spring brings melting snow and ice along with a corresponding increase in DO. Melting also brings flooded fields and high flows into rivers, along with corresponding increases in suspended sediment and nutrient concentrations, typically delivered to streams. Soil preparation and the application of chemicals relative to the occurrence of precipitation accounts for some of the variability in the amount of contaminants that reach rivers and streams. Summer brings warm temperatures, thunderstorms, and generally declining water levels in rivers. Periodic rainstorms increase suspended sediment in surface waters, along with nutrients applied to agricultural

[9] *Red River Basin Comprehensive Watershed Management Plan* (2017): C-9.

fields in spring and summer picked up by the flow. By fall, stream flows typically approach the annual minimum, which corresponds to reduced suspended sediment and lower nutrient concentrations in the basin's waters.

Predicted overarching changes in weather patterns such as heightened precipitation events, more periods of drought, and higher temperatures, will likely increase the challenge of addressing sediments and nutrient pollution in the basin's streams and rivers. More intensity in precipitation events will increase sediment and nutrient runoff. Periods of drought will lower river levels, decreasing water flows necessary for accommodating nutrient loading from point source urban areas. Both increased agricultural runoff on the one hand and low flows and drought conditions on the other set up conditions for increased erosion, by water or wind, and for increased sedimentation of the basin's rivers and lakes. And, important to note, rises in overall temperatures will lead to increased internal loading of plant life in the basin's waters, thus accelerating damage from excess nutrients and adding to the challenge of addressing nutrient stressors on the basin's rivers and lakes.

Costs

Sedimentation and excess nutrients in the RRB's waters come at a cost. Behind sedimentation lies soil erosion. As noted in *Long Term Flood Solutions* (LTFS), while most often not factored into reports as an economic loss, agricultural acres affected by erosion may see yield losses for years following the erosion. Erosion brings increased operating costs, including that for additional fertilizer applied in an attempt to regain productivity on eroded acres. Costs of erosion also show up in the regular practice of cleaning out legal drains and in instances of mass erosion on small streams. These costs do not include the inestimable losses to erosion: permanent displacement of topsoil and degradation of water quality in the basin's streams, lakes and rivers. As concluded in *LTFS*, the combination of excess nutrients and sediment in the basin's rivers and lakes has the potential to cause loss along the full reaches of the basin's water systems, including the basin's mouth, the massive and prized Lake Winnipeg.

2

Growing Awareness of Nutrient Challenges to Water Resources

Problems with the health of RRB water resources are not new. Visual signs at the basin's mouth, Lake Winnipeg, were obvious enough by 1960 to cause Environment Canada (hereafter referred to as ECCC, Environment and Climate Change Canada) to begin an international border monitoring program at Emerson, Manitoba. In the US, the main stem Red was identified at times by both Minnesota and North Dakota as not meeting water quality standards. By the 1970s, more attention began to be given to the biological and chemical makeup of the basin's waters, and 1980 and beyond saw a series of early studies that explored growing issues with impairment, including recognition of and concern with levels of nutrients in the basin's rivers and lakes.

Sediment and Nutrient Impairments: Early Studies

The following key studies can help trace the history of a growing awareness of the threat of sediment and nutrient pollution to the basin's water resources.

Souris-Red-Rainy River Basins Comprehensive Study (1972)

The Souris-Red-Rainy River Basins Commission was established in 1967 under provisions of the Water Resources Planning Act. The Commission was authorized to study and plan on a joint Federal-State basis for purposes of optimum development of the Region's water and related land resources. The study defined its goals as providing long-range projections of economic development; translation of such projections into demands for water and related land resource uses; hydrologic projections of water availability, both as to quantity and quality; and projections of related land resource availability. Considerations were to be given to 1) the timely development and management of resources, 2) the preservation of resources to insure they will be available for their best use as needed, and 3) the well-being of all the people.
Issues of excess sediments and nutrients are both briefly noted in the study. Soil erosion via wind and water is included in a list of "long recognized problems," and sources of sediment are identified as sheet, water and wind erosion, with streambed and bank erosion contributing small amounts. Solutions offered for the latter include grade and riverbank stabilization and land conservation practices.

Pollution of streams and lake eutrophication are listed among those problem recognized "only recently" as being serious, with the most extensive problems of eutrophication in the Detroit Lakes and Boundary Waters Canoe areas. Algae blooms are described as a particularly "serious menace" to the lakes and streams of the Boundary Waters, with at least 10,000 acres having limited recreational use due to the accelerated algae. Causes of these instances of eutrophication, together with other instances of water pollution, are attributed in the study primarily to point sources such as municipalities in need of expansion of waste water treatment.

St. Paul District Corps of Engineers, *Red River of the North Basin-wide Reconnaissance Study* (1980)

The USACE detailed overview study of 1980 concludes that the RRB's water quality impairments are a result of both natural and human factors. The uneven stream flows and regular flood events characteristic of basin streams and rivers were seen as cause for prevalent erosion and resulting high sedimentation of the basin's waters, with this natural factor worsened by land use practices brought about by European settlement of the region.

In the study, a number of signs of pollution in basin rivers and lakes are given brief mention. These include, along with other impairments, growing amounts of the nutrients phosphorus (P) and nitrogen (N).

The International Coalition for Land/Water Stewardship in the Red River Basin, *Land and Water Guide: Red River Basin* (1989)

This local study by The International Coalition for Land/Water Stewardship (TIC), with the assistance of the Tri-College University Center for Environmental Studies and a private company, Meta-Dynamics, took a bold step forward by identifying N and suspended solids (sediment + P) as the primary quality problem for RRB waters, and nonpoint sources as the major cause. The study lists impacts of excess nutrients on water quality and associated uses and recommends a variety of practices for reducing erosion, including, among other, crop residue management, cover crops, perennial grass barriers and buffer strips.

US Geological Survey, *Water Quality in the Red River of the North Basin: Minnesota, North Dakota, and South Dakota (1992-95)*

By the 1990s, studies began supplying more detailed analyses of the state of RRB waters. While the USACE's *Reconnaissance Study* had considered erosion largely a problem for farmers for whom it would mean delayed planting and topsoil loss, the US Geological Survey (USGS) concerns itself with propensities of specific soil types for eroding, along with a number of other variables associated with erosion, including landscape characteristics, seasons, land use and stream flow.

The USGS study also supplies more detailed information about pollutant elements in the basin's waters, including nutrient residues. One of the study's goals is to assess the safety of basin waters for human consumption. While the study does not find major issues with drinking water safety at the time, it does note that nutrient levels have risen and concludes with some certainty that human activity "has increased the concentration and load of nutrients potentially degrading stream quality and increasing eutrophication of lakes and reservoirs."

Tores, L.H. et al, *Nutrients, Suspended Sediment, and Pesticides in Streams in the Red River of the North Basin, Minnesota, North Dakota, and South Dakota* (1993-95)

A second 1990s study, prepared as part of the USGS National Water-Quality Assessment Program, divides the basin into three areas—Drift Prairie (west), Lake Plain (center), and Lake-Washed Till Plain (northeast)—in order to identify more specifically the variability of sources impairing the basin's waters. The analysis of potential contaminants attempts to take into account seasonable and streamflow variabilities.

Elements measured include, among others, suspended sediment and nutrients. The nutrients N and P are described as "potentially important contaminants in water" due to their ability to fertilize naturally occurring aquatic plant life, resulting in large fluctuations in dissolved oxygen and the shading of bottom-lying aquatic plants by the excessive growth of algal growth. The levels of both P and N in this study, although not pointed out as alarming, are shown to be twice historical levels.

Of the three forms of P measured in the study, a dissolved form, orthophosphate, is described as "readily available for uptake by aquatic plants." The amount of orthophosphate was found to be variable by area of the basin, with considerably higher concentrations in streams draining the Drift Prairie area followed closely by concentrations in the main stem. The amount of orthophosphate was also found to increase as one moves downstream.

Measured Impacts: Lake Winnipeg

Already by the 1960s, visual signs of the impact of sediments and excess nutrients on RRB waters were beginning to emerge, particularly in Lake Winnipeg, the mouth of the RRB watershed. Algae, including toxic blue-green varieties, were showing up more frequently in the lake and growing to greater magnitude. Concern over this change in aquatic life spawned monitoring and study, along with initiatives by Manitoba citizens and government to protect this prized water body.[10]

Monitoring and studies have worked to identify the amount of excess nutrients in Lake Winnipeg's two large basins. A 2011 study showed a significant increase in total P concentrations in Lake Winnipeg between the early 1990s (0.015 mg/L) to and the time of the study (more than 0.1 mg/L)[11] While nutrient concentrations have gone down slightly since 2011, reductions have come nowhere near the early 1990s levels.

The most recent report on nutrients levels in Lake Winnipeg's south and north basins looks at annual mean concentrations of P and N in the time period 1999 to 2016. Total P in the south basin shows no apparent increasing or decreasing trends during this time. P has been quite stable in the north basin over the same period, although concentrations appear to be slightly lower in recent years. Generally, high total P concentrations in the south basin corresponded with high river flows and Total P loading to the lake (e.g., in 2005, 2009 and 2011). However, this does not appear to be the case for the north basin, likely because some of the loads from the Red River are attenuated in the south basin of the lake before reaching the north basin (see Figure 1). Annual average Total P concentrations are positively correlated with Total P loading to the lake. However, the relationship was much weaker in the south basin, which highlights the complexity of other processes affecting nutrient dynamics in the south basin (e.g., sedimentation and wind-induced resuspension).

Lake Winnipeg is also rich in total N, with higher concentrations in the lake's south basin (0.860 mg/L) as compared to the north basin (0.610 mg/L). Inter-annual variability in nitrogen may be driven by a number of factors in Lake Winnipeg, including N fixation and denitrification processes, N loading from tributary rivers, internal loading and wind-induced resuspension.

[10]Information in this section is derived from a report written for the Water Quality Strategic Plan by Elaine Page, Manitoba Sustainable Development.

[11]Bunting et al. Cited in above report.

From 1999 to 2016, there have been no clear trends in Total N in the south basin of the lake although N concentrations since 2012 appear slightly lower as compared to earlier years with exception of 2002. Total N in the north basin generally has followed a similar pattern over the same period, and, similar to N in the south basin, concentrations appear to be slightly lower in recent years.

Monitoring and studies have also explored the degree of impacts on aquatic life by accelerated nutrients, with the general conclusion that excessive concentrations of the plant nutrients P and N in the basin's surface waters can contribute to more frequent and intense algal blooms. Another dimension of the study of excess nutrients in Lake Winnipeg has been the use of objectives and targets to reverse trends and track progress in water quality. Bunting et al. recommends that total P concentrations be reduced back to 1990s levels of 0.05 mg/L to reduce the frequency and severity of toxic cyanobacteria blooms in Lake Winnipeg.[12] A total N objective of 0.75 mg/L was subsequently established in 2016 for the north and south basins of Lake Winnipeg based on the range of historical P to N ratios (P:N) and intended to preserve or restore the important ratio between P and N in the lake.

P and N targets for Lake Winnipeg and the rivers that flow into the lake have been developed to determine loading reductions required from rivers flowing into the lake. ECCC designed a water quality model for Lake Winnipeg, which Manitoba used to predict how Lake Winnipeg would respond to changes in P and N concentrations in four main rivers flowing into the lake: Dauphin, Red, Winnipeg and Saskatchewan. Nutrient targets representing the total load of nutrients carried by the river over a one year period were developed for each of the four rivers, based on both the nutrient concentration and the streamflow from each river. Data collected (nutrient concentrations and flows) between 1994 and 2014 from the flows of each of the four rivers flowing into Lake Winnipeg show that significant reductions in Total P and Total N are needed in the Red River, with the other three main tributary loads falling closer to the targets (Table 1).

Table 1. Total phosphorus (TP) and nitrogen (TN) loading targets and average loads for rivers that flow into Lake Winnipeg (1994 to 2014).

Tributary	**TP Load Target (t/yr)**	**TP Load (t/yr)**	**TN Load Target (t/yr)**	**TN Load (t/yr)**
Red River (at Selkirk)	2,800	4,731	19,050	32,337
Saskatchewan (at Grand Rapids	340	419	10,400	11,211
Winnipeg Rover (at Pine Falls)	1,050	1,040	19.450	22,543
Small tributaries	660	388	14,680	10,024
Lake Winnipeg Total	4,850	6,558	63,580	75,840

Addressing Nutrient Impairments: Current Challenges

Addressing the problem of nutrient-laden RRB waterways will require work on a number of fronts. The degree of the physical condition by itself speaks to the extent of the problem:

[12] Cited in above.

- From 1978 – 1999, the total P concentration at the US/Canada border increased by 28.8%.[13]
- The Red River watershed contributes 10 to 15% of the water flow into Lake Winnipeg but 60% of the P load and 31% of the N load.[14]
- Today, Red River basin waters at the US/Canada border exceed objectives for total dissolved solids by an average of approximately 76%. (P concentrations are directly related to total suspended solids in rivers.)[15]

The extent of the problem is also apparent in suggestions of what it will take to return Lake Winnipeg to a previous condition. The USACE, St. Paul District, estimates that returning Red River waters to the condition that existed in 1990 will require a 50% reduction from current average annual loads of nutrients.[16] To this point, solutions have not kept pace with increasing levels of nutrients in the basin's waterways. As an example, in 2012, an analysis by the Minnesota Department of Natural Resources (MDNR) showed the RRB to have a significantly low percentage of streams with perennial vegetation buffers.

Addressing excess nutrients in the basin's rivers and lakes is made challenging by a number of factors characteristic of basin agriculture. First is the vast amount of basin land in intense crop production and the shift from primarily grain to primarily row crops. Second are agricultural practices that are highly dependent on inorganic fertilizers to achieve necessary production levels. Third are the numerous individual stakeholders involved in management and decision making, many of whom do not have experience or education in best management practices (BMPs).

The multijurisdictional makeup of the basin adds additional complexities that require factoring in. Both objectives for addressing the problem of excess nutrients and approaches to those objectives may be impacted by the framework for water quality management of each state or province. For instance, Minnesota addresses nutrient reduction as part of a comprehensive water quality framework, North Dakota has developed a response as a separate water quality program, and Manitoba's focus has been on a dominant water body, Lake Winnipeg. Economic differences and differences in federal perspectives can further exacerbate variability in regulation and in the tools employed to seek solutions, a number of which are still in stages of development and application.

[13] IRRB Water Quality Committee and International Water Institute, *Red River Water Quality Conditions*

[14] Page, Elaine, Manitoba Sustainable Development, Presentation to RRBC, Sept 7, 2017.

[15] ECCC and IRRB, *Water Quality: Red River at the International Boundary*, Presented on Aug 30, 2017.

[16] Red River Basin Comprehensive Watershed Management Plan Water Quality Working Group, *Water Quality: Red River of the North Watershed*, 2015, C-21.

3

The Role of Water Quality Strategic Plan (WQSP)

The Water Quality Strategic Plan (WQSP) has the goals of creating a baseline understanding of the current status, impacts, and sources of sediment and excess nutrients in the RRB and determining best strategies for moving ahead cooperatively as a basin to address the issue of nutrient-impaired basin rivers and lakes.

Foundations for WQSP

The goal for WQSP is to address water pollution in the Red River Basin by remedying and protecting the basin's rivers and lakes from impacts of excess sediment and nutrients. Since its origin, the Red River Basin Commission ((RRBC) has worked to address the basin's most difficult natural source issues and, in so doing, has developed a foundation for addressing such issues. Its Natural Resources Framework Plan (NRFP, 2005) demonstrated the power and potential of extensive outreach to stakeholders in all parts of the basin. Its LongTerm Flood Solutions for the Red River Basin (LTFS, 2011) brought stakeholders together with experts to arrive at sound, creative solutions for the basin. RRBC's support of the Comprehensive Watershed Management Plan (CWMP, 2015-2017) produced comprehensive actions plans for the basin in a variety of areas and is one of the first studies to recognize the serious challenge of excess nutrients in the basin's lakes and rivers. Brief descriptions of these efforts follow:

Natural Resources Framework Plan (NRFP)

The RRBC facilitates basin-wide initiatives for water and land resources by providing organizational structures for cooperative planning among the basin's jurisdictions. A yearly meeting brings together heads of agencies from across the basin to report on current issues and projects. An annual conference, whose location alternates among the jurisdictions, offers opportunity for in-depth consideration of basin-wide issues for board members, agencies, and the general public.

The lodestar of the RRBC's work in promoting basin-wide management of land and water is its *Natural Resources Framework Plan* (NRFP, 2005). This compilation of thirteen goals was developed with extensive stakeholder input and regional participation, using the best available data. The NRFP was disseminated basin-wide via an outreach effort that encouraged signing on to the goals by local resource boards and watersheds. RRBC working committees, each comprised of members from the major jurisdictions, conduct ongoing planning to carry out NRFP objectives.

***Long Term Flood Solutions for the Red River Basin* (LTFS)**

The landmark study, *LTFS* (2011) brought together professional and citizen water managers from all levels and reaches of the RRB to address the basin's crisis of flooding. In addition to hands on involvement from the RRBC Board of Directors, two umbrella committees were assembled (Policy, Technical) and specific issue workgroups formed to dissect major issues and identify solutions. In addition, a number of outside experts and agencies were contracted to develop information and analysis for central questions addressed in the study.

Most importantly, the study was a grass roots effort. It was launched with an extensive public engagement process, drawing over 1,000 attendees at 21 meetings throughout the US portion of the basin.

The LTFS was developed under a set of five Assumptions for Future Conditions (50-year window), assumptions that are reminders of what we can expect for the basin's future decades. The current WQSP reaffirms the five assumptions and adds one additional on soil health in order to underscore the dynamic relationships between land and water resources.

Assumptions for Future Conditions

1. **Agriculture** will continue to be the dominant land use throughout the basin. Adequate surface drainage has been and will continue to be integral to maintaining productivity of cropland. Subsurface drainage is likely to become increasingly popular.
2. **Current development** trends will continue. Major urban centers and communities will continue in their present locations, and major metropolitan areas will continue to grow. Future development will occur in compliance with floodplain management regulations.
3. **Floods** will continue into the future. Floods larger than historically experienced can be expected to occur.
4. **Flood damage reduction** will need to be implemented in the basin based primarily on the identified needs of basin residents and their willingness to provide or seek funding necessary to implement the measures that they believe are appropriate, effective, and justified. State and federal agencies will support the implementation of the various measures based on their policies, regulations, and availability of funding.
5. Flood damage is just one issue that affects the sustainability of the region. **Other key resource issues** need to be considered as this plan is developed and implemented, including droughts, water supply, water quality, recreation, and other natural resource areas.

Developed by the LTFS Policy Committee and adopted by the RRBC Board of Directors in May 2010. Item 6 added 2018.

Red River of the North - Comprehensive Watershed Management Plan (CWMP)

The Red River Basin Comprehensive Watershed Management Plan (CWMP, 2015-2017) is based on the vision, goals and objectives outlined in the NRFP, including the overarching goal of developing unified approaches to managing RRB resources. The project was a broad effort to gather data and conduct studies for that purpose. The action-based study was facilitated by the St. Paul District USACE in partnership with the North Dakota Red River Joint Water Resource District, the Minnesota Red River Watershed Management Board and the RRBC. CWMP selected for study five major resource areas identified by the NRFP: Flood Risk Management and Hydrology; Fish, Wildlife and Ecosystem Health; Water Quality; Water Supply; and Recreation, adding a sixth area on Soil Health. Study groups for each of the six areas were comprised of representatives from local, state and other federal agencies and, as far as possible, from the several jurisdictions. The study groups carried out the project, working

closely with existing RRBC working committees in order to economize efforts and ensure widespread involvement.

The Water Quality section of the CWMP final report acts as a planning document for improving water quality in the basin. It includes a comprehensive list of recommendations and actionable solutions for the basin, together with suggested timeline and responsible entity for each strategy area.

It is notable that the first two of CWMP's recommendations for improving water quality in the RRB call for unified action in addressing excess nutrients:

- Reduce both dissolved and particulate nutrient loadings to the Red River and its tributaries and Lake Winnipeg by reducing phosphorus and nitrogen concentrations and discharge.
- Reduce average and peak flows through storage and infiltration to limit downstream total solids and the transfer of nutrients, biological and chemical contaminates.

CWMP's extensive focus on soil health opens roads for addressing Water Quality.

WQSP Charge, Focus and Goals

The WQSP was funded by the State of Minnesota in 2016. The legislative charge specified the following guidance:

> Funding is granted to the RRBC for development of a water quality strategic plan for the Red River of the North, in cooperation with the International Red River Board. The plan must include, but is not limited to, consistency in water quality goals and objectives for the Red River of the North and pollution reduction allocations for both point and nonpoint sources on the Red River and for individual major watersheds tributary to the Red River. The RRBC must involve the interests of local, state, and federal government, business and industry, environmental groups, and Red River basin landowners.

The WQSP project is focusing on the major water quality issue for the RRB of excess sediment and nutrients in its waterways. Immediate objectives are: 1) to increase understanding of the problem at hand of stressor sediments and nutrients, 2) to consider how the various jurisdictions that comprise the basin (federal, states/province) have responded to the problem to this point, and 3) to identify opportunities for action by determining areas of agreement and cooperation among leadership and stakeholders.

The WQSP lays the groundwork for an organized, coordinated response to the problems of nutrient load and concentrations throughout the Red River's sub-basins in MN, ND, and SD, holding in perspective the Canadian portion of the basin.

Part II: RESPONSES BY JURISDICTIONS

4

Federal Responses

Excess nutrients in RRB lakes and rivers waters are part of a larger problem facing many areas of the US and Canada. Determining and carrying out initiatives for restoring or maintaining water quality are most often the job of states. But federal agencies in both the US and Canada can set directions and offer technical and financial support. In some cases, an agency takes specific actions, such as the US Environmental Protection Agency (EPA) issuing memos to states regarding excess nutrients in the nation's waters or ECCC taking a direct role in monitoring Red River waters for excess nutrients at the international border.

Lead US Agencies

Following are snapshot pictures of actions several lead US federal agencies have taken in response to excess nutrients in Basin waters.

EPA

The work of the EPA, the lead US agency for regulating discharges of pollutants in US waters, goes back to the 1948 Federal Water Pollution Control Act, with major revisions in 1972 (Clean Water Act), and further directions in 1977 and 1987.

Two major programs introduced with the 1972 revisions, the National Pollutant Discharge Elimination System (NPDES) and Total Maximum Daily Load (TMDL), have played active roles in monitoring and protecting the nation's waters. The NPDES delegated to most states the permitting and monitoring of point sources, such as municipal and industrial waste treatment, municipal storm water systems, large mining operations, and concentrated animal feeding operations.[17] A 2011 EPA memorandum reported that violations of NDPES nitrate limits for drinking water had doubled in an eight year period, a sign that excess nutrients have become increasingly difficult to manage.

EPA's TMDL program, which provides states a framework for monitoring their water bodies, has also done much to protect the nation's waters. The program has helped to identify primary pollutants, including excess nutrients, information that the EPA used to create a composite report in 2006 that documented waters impaired by P & N pollution in over 3 million acres of lakes, reservoirs, and ponds; 75,000 miles of rivers and streams; nearly 900 square miles of bays and estuaries; and over 70,000 acres of wetlands. The overview of waters polluted by nutrients also showed N and P to be detrimental to the overall biological conditions of streams and rivers. In comparison with other stressors, including riparian disturbance and vegetative cover, streambed sediments, instream fish habitat, salinity and acidification, the negative effects of nitrates and phosphorous on biological conditions were over double those of the other stressors.

[17] Carrying out NPDES requirements in the US portion of the RRB are the MN Pollution Control Agency, ND Department of Health, and SD Department of Environment and Natural Resources.

In the last two decades, the EPA has taken a number of steps to address the challenge of nutrient-laden rivers and lakes:

1998 EPA's National Strategy for the Development of Regional Nutrient Criteria

The *National Strategy for the Development of Regional Nutrient Criteria* was based on water quality conditions reported by states indicating that nutrients are the leading cause of impairment in lakes and coastal waters and the second leading cause of impairment in rivers and streams. Excessive nutrients were shown to result in accelerated growth of plant life and potentially harmful algal blooms, leading to oxygen declines, imbalance of aquatic species, public health threats, and a general decline in aquatic resources. The program was intended as a blueprint of federal agencies working together with states and other stakeholders to restore and protect water resources. Its three goals included:

- enhanced protection from public health threats posed by water pollution,
- more effective control of polluted runoff, and
- promotion of water quality restoration and protection on a watershed basis.

The program's action plan was to reduce nutrient over-enrichment of waters by stepping up the development of scientific information concerning the levels of nutrients that cause water quality problems and by organizing the information by waterbody types and regions. Within this framework, the EPA's plan was to work with states and tribal groups to adopt criteria (i.e., numeric concentration levels) for nutrients as part of enforceable state water quality standards under the Clean Water Act.

The National Strategy was followed up by ongoing guidance to states in the form of memoranda and progress reports, including the following:

2001 *EPA Memorandum to directors of state water programs*
This 2001 memo to states reaffirmed the importance of states adopting numeric nutrient standards and encouraged each state to develop a plan to adopt standards.

2007 *EPA Memorandum to directors of state water programs*
This 2007 memo to states reiterates EPA's expectation that states adopt numeric nutrient standards. It urges states to accelerate the pace for adoption of those standards and announced its plan to publish periodical reports of the progress by states in adopting nutrient water quality standards.

2008 *State Adoption of Numeric Nutrient Standards (1998 – 2008)*
This report on states' progress in adopting nutrient water quality standards contends that such standards "are critical for preventing the harmful effects of nitrogen and phosphorus pollution in the nation's waters and for restoring water quality from the impairments caused by this pollution."

The report acknowledges a narrative option for reporting progress and recognizes a range of tools in place to address nutrient pollution, including TMDLs, trading, economic incentives, and technology-based control approaches. The report concludes that numeric nutrient water quality standards support all other approaches and tools by providing a way to "accelerate, guide,

calibrate, and evaluate the implementation of these tools." In addition, according to the report, numeric nutrient standards:

- provide measurable, objective water quality baselines against which to measure environmental progress,
- facilitate the writing of protective NPDES permits,
- make development of water quality targets in TMDLs faster and easier,
- increase the effectiveness in evaluating success of nutrient runoff minimization programs,
- provide quantitative targets to support trading programs,
- support broader partnerships to employ BMPs, land stewardship, wetlands protection, voluntary collaboration, and urban storm water runoff control strategies, and
- identify the water quality goals being sought and thus enhance greater public participation and a more transparent process.

As demonstrated in the following table, the adoption by states of some form of numeric criteria for nutrients shows progress between 1998 and 2008 but far from uniform practice.

Adoption of numeric nutrient criteria into water quality standards	1998	2008
For one or more parameters for at least one entire waterbody type	6 states (including MN)	7 states (including MN)
For one or more parameters for selected individual waters in a waterbody type	7 states	18 states
Has not adopted numeric criteria	37 states	25 states

2009 *Report by Nutrient Innovations Task Group (NITG)*

The EPA established a Nutrient Innovations Task Group (NITG) in order to focus more intently on reducing P and N in various environments. The report of the Task Group in 2009 documents the role of nutrients in co-occurring contamination and impairment of biological conditions. It provides more details about threats to human health and, in addition, raises the specter of cost for municipal upgrades being made necessary to counter these deteriorating conditions. The NITG's overall picture of the nutrient problem suggests challenges ahead:

- The problem of excess nutrients has increased "drastically" over the last 50 years, posing significant water quality and public health concerns, whether for drinking waters or the impairment for inland and coastal estuaries.
- Given expected population growth, the problems caused by excess nutrients are expected to accelerate.
- Efforts to correct the situation are "collectively inadequate."
    - TMDLs are more effective for point than nonpoint sources.
    - Current tools are underutilized and lack coordination.
    - Specific steps are being taken but in absence of a multi-state framework.

The NITG considered a variety of tools and strategies to counter nutrient increases in the environment that can be used nationally, regionally or by state. Its recommendations include combinations of incentive-based and regulatory tools that national or state programs can use to

control nutrients from five main sources: urban storm water runoff, municipal wastewater treatment, atmospheric N deposition, agricultural livestock activities, and agricultural row crops.

2011 *Memorandum: Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions*

This EPA memo calls for faster action on the front of reducing P and N in US waters. It attempts to make room in a flexible framework for states to innovate but once again urges states to use numeric criteria. The EPA continues to offer states partnership and adds the US Department of Agriculture (USDA) and State Departments of Agriculture as "vital partners" in the effort.

2016 *Memorandum: Renewed Call to Action to Reduce Nutrient Pollution and Support for Incremental Actions to Protect Water Quality and Public Health*
This memo asks states and stakeholders yet again to "intensify their efforts" in combating nutrient pollution. The memo underscores dangers to public health and specifies assistance programs. In establishing their frameworks and strategies, states are to "work expeditiously" to:

- prioritize watersheds for nutrient load reduction;
- set challenging yet realistic load-reduction goals that improve water quality;
- reduce point and nonpoint sources of nutrient loads;
- provide for accountability and public reporting in its nutrient load reduction program; and
- continue to develop numeric nutrient criteria that clearly identify nutrient levels that are consistent with a state, tribe or territory's uses of its waters under the CWA and serve as clear guides for protecting and restoring those uses for its citizens.

US Army Corps of Engineers

The USACE has provided direct focus on the RRB through its comprehensive studies of the Basin, the *Basin-wide Reconnaissance* study of 1980 and the recent feasibility study, *CWMP,* carried out with the assistants of RRBC. As noted, the *CWMP* study is a broad effort to gather data, perform modeling, and conduct studies needed to enhance tools for managing the vast resources of the basin. Of the six natural resource areas chosen for study, three address aspect(s) of stressor sediments and excess nutrients in the basin's surface waters: water quality; fish, wildlife & ecosystem health; and soil health.

Water Quality: The CWMP's work on water quality sets up a clear directive for addressing excess nutrients. The Water Quality Working group predicts for the next several decades the worsening of eutrophication along with an increase in suspended and dissolved solids in basin waterways. Heading up the list of primary challenges to water quality are eutrophication (caused by P and N), elevated sulfate loading and increased total dissolved solids (TDS), together with elevated total suspended solids (TSS) and turbidity in most tributaries and main stem reaches.

Strategies for improving the basin's water quality are headed up by two recommendations for basin-wide nutrient strategy and standards:

1) Develop a basin-wide nutrient management strategy for the International Red River watershed.
2) Develop nutrient reduction strategies, targets, limits and/or standards.

The remaining seven strategies describe methods and tools that can forward such a basin-wide effort:

3) Prioritize and implement restoration and improvement projects.
4) Provide incentives for best management practices.
5) Pursue education, research and outreach.
6) Pursue agriculture and land use restrictions.
7) Use water quality modeling.
8) Use water quality monitoring.
9) Pursue wetland restoration.
10) Follow management plans and TMDLs.

The CWMP report also catalogues those various efforts in place to develop nutrient reduction limits and standards:

- Manitoba Nutrient Reduction Limits
- Manitoba Water Quality Standards, Objectives and Guidelines Regulation
- Onsite Wastewater Management System Regulation
- Nutrient Management Regulation
- North End Water Pollution Control Centre
- Phosphorus Reduction Act
- Minnesota Phosphorus Limit to Lakes
- Minnesota 2008-2012 Triennial Water Quality Rule Review Process
- North Dakota Non-point Source 319 Program
- Environment Canada National Wastewater Effluent Regulations
- The Lake Winnipeg Stewardship Board
- North Dakota Establishment of Nutrient Strategy Stakeholder Task Force.[18]

Fish, Wildlife and Ecosystem Health: Among CWMP's main goals for fish, wildlife and ecosystem health are reversing habitat loss and habitat degradation. The most common water quality impairments in the basin are identified as high levels of nutrients, turbidity, bacteria, and low dissolved oxygen. Among objectives for restoring habitat degradation are 1) decreasing the contaminants, nutrients, and turbidity of waterbodies in the basin; 2) restoring hydrology (e.g., controlling municipal and agricultural runoff); and 3) promoting the integration of features that provide environmental benefits in projects with other primary purposes.

Soil Health: CWMP goes beyond earlier studies in its emphasis on soil health. The *Soil Health* section of CWMP goes into some detail on soil health management, demonstrating connections between soil and water health in its summary goal/objective/strategies:

> Goal: Maintain and enhance soil health within the Red River Basin to improve the physical, chemical and biological properties and effective functioning.
> Objective: Improve soils' ability to store water, nutrients and carbon to ensure their effective availability.
>
> Strategies: 1) Reduce surface/subsurface runoff. 2) Reduce/minimize soil erosion.

[18] p. 49.

CWMP demonstrates that paths to soil health are multiple and provides a list "strategies and actions" for moving forward. The study group also demonstrates the connection between soil health and farm profitability, as well as the potential positive connections between farm productivity and environmental impacts. An overarching conclusion of the report is that "soil and water conservation are inseparably linked."

US Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)

The USDA's NRCS offers education and outreach programs, support, and tools to land owners and farm managers. It delivers a non-point modeling program, Agricultural Non-Point Source Pollution Model, which links management decisions to impacts on waters (see discussion in section on RRB Nutrient Modeling). It delivers to farmers programs legislated by the US Farm Bill. The Environmental Quality Incentives Program (EQIP) authorized in 2002 and made widely available in 2014 and after offers farm owners and managers financial and planning support to develop and carry out conservation projects on land in production. The NRCS also supplies soil surveys by state that contain detailed information on soil properties and management.

NRCS initiatives typically connect soil and water management in an effort to demonstrate the synergy between the two and the positive outcomes of a healthy relationship between soil and water to production agriculture. A recent education initiative, "Unlock the Secrets in the Soil," emphasizes how improving soil health can increase water infiltration, increase available water holding capacity, improve water quality—and increase nutrient availability to plants as intended, maintaining or increasing production.

US Geographical Survey (USGS)

The USGS maintains Hydrologic Unit Maps for U.S. waters, a standardized base for coding, locating and storing information. It also offers data, study and technical assistance to specific US river basins or hydrologic regions. In the early 1990s, it carried out and/or supported some of the first technical studies of water quality in the RRB, and in 1997 produced SPARROW, a powerful tool that integrates monitoring and modeling to help water managers determine primary areas of non-point pollution (see discussion in section on Red River Basin Nutrient Modeling).

Major recent projects include:

Red River Water-Quality Statistical Summary Story Map

This interactive map of the Red River basin is part of nation-wide mapping of rivers and streams, allowing for a comprehensive long-term look at changes in the quality of US rivers and streams over the past four decades. The mapping for the RRB includes statistics for TP,TN, specific conductance, sulfate, total dissolved solids, and total suspended solids (TSS). Data for the RRB are provided by federal and state/provincial agencies from both the US (USGS, MN Pollution Control Agency [MPCA] and ND Department of Health [NDDoH]) and Canada (ECCC and Manitoba Conservation and Water Stewardship). Summary statistics are updated annually.

Water Quality Trend Analysis

The USGS is partnering with the MPCA, SD Water Stewardship Division, NDDoH, and MB Sustainable Development to conduct a Water Quality Trend analysis for the international Red

River. The USGS developed the software program, QWTrend, for carrying out the water quality trend estimation, which will be used at approximately 40 sites, including the binational site at Emerson, MB, to collect long-term and short-term data.

The project will identify changes in water quality from 1980 – 2015 while taking streamflow into account. Constituents tracked include nutrients, TSS, total dissolved solids, sulfate, and chloride. The analysis will provide a framework for developing comprehensive strategies for reducing nutrient levels to desired targets and tracking future progress through an efficient monitoring program. As such, the study will inform efforts by the IRRB and the RRBC to address water quality concerns in the basin as well as the IJC's work in reviewing international water quality objectives.

Lead Canadian Agencies

Following are snapshot pictures of actions several lead Canadian federal agencies have taken in response to excess nutrients in Basin waters.

Environment Climate Change Canada (ECCC)

ECCC, the lead federal agency in Canada for environmental management, functions under Canada's Water Act of 1970 (revised 1985). The ECCC shares responsibility for Canadian freshwater with over 20 departments within the federal government, each with a unique responsibility for Canada's freshwaters. The ECCC works to ensure freshwater management is in national interest. To further this work, the ECCC sponsored legislation for the Federal Water Policy act (1987), which gives focus to water-related activities of all federal departments. Federal water policy is grounded in and promotes partnership among government and private sectors, including the engagement of citizens, for purposes of enhancing the quality of Canadian waters and promoting wise and efficient management of this valuable resource.

Surface water health is monitored by the ECCC's National Pollutant Release Inventory, established in 1992, whose goal is to "reduce [pollutants] now rather than manage it later." The program's report for 2016 identifies those pollutants most often released into Canadian waters as N in solutions, ammonia, and P. Between 2007 and 2016, the overall release of nutrients decreased by 28% while the release of nutrients into surface water increased by 12%.

The ECCC also reports regularly on the overall health of the country's waters. A January 2018 ECCC assembled report, *Water Quality in Canadian Rivers*, describes 75% of the monitored sites on rivers between 2014 and 2016 as "fair" to "good." "Worse" ratings were found in areas of intense agriculture, mining, or a combination of the two.

The responsibility for carrying out water-related programs is largely that of the provinces, though shared with the ECCC and other federal departments. The ECCC regularly helps provinces 1) identify impaired waters, 2) develop uniform approaches, 3) take measures to protect waters, 4) encourage research, and 5) ensure meeting of international and interprovincial water quality. It also addresses larger water issues that have complexities or implications beyond a single province. An example for the RRB is ECCC's tracking of environmental indicators for the health of Lake Winnipeg. A recent report finds "frequent" high nutrient levels in two rivers flowing into Lake Winnipeg, the Red River and Winnipeg River, and "intermittent" high levels in the Saskatchewan River. The report finds the highest levels of P and N in Lake Winnipeg in the south basin near the Red River inflow.

An example of shared management between federal and provincial governments is ECCC's and Manitoba Water Stewardship's (hereafter referred to as Manitoba Sustainable Development) first *State of Lake Winnipeg Report* (2011). The report was a first of its kind compilation of physical, chemical and biological information on Lake Winnipeg and its watershed, covering data and research from 1999 through 2007. ECCC and MB Sustainable Development are currently leading the production of the second State of the Lake report, along with additional federal and provincial government departments and other key partners. The final report, expected in 2018-19, will include an updated assessment of nutrients in Lake Winnipeg and updated nutrient loads to the lake for the 1999 to 2016 period.

Agriculture and Agri-Food Canada

As part of its work promoting Canada's agricultural sector, Agriculture and Agri-Food Canada provides research on the environmental sustainability of Canadian agriculture. The Agri-Environmental performance results and trends for the 30-year period 1981-2011 provide a snapshot of the health of Canadian agriculture as a whole and as compared with that of other nations. The project acts as a report card for producers, consumers and the international community, pointing out areas where further efforts are required.

An indicators list traces the changes over the 30 years for each of four areas: biodiversity, soil quality, water quality and air quality. Soil quality was found to have improved "significantly," due to improvements in land management practices such as increased adoption of reduced tillage and no-till practices and the reduction in land area under summer fallow. Water quality was not found to be at risk but showed trends towards increasing risk. Levels of N concentration were shown to have increased, with inputs outpacing outputs (off the field production). P concentrations also increased over the time period, attributed to the increase in use of mineral fertilizers and concentration of livestock operations. Levels of pesticides in waters were also shown to be higher, a result attributed to reduced tillage practices, a practice that, although among positive practices for sustainable agriculture, may necessitate more pesticide use.

Fisheries and Oceans Canada (DFO)

Canada's multi-billion dollar fishing sector is directly affected by water and aquatic health. The Fisheries Act of 1985 includes a prohibition against degrading waters with "deleterious" substances. Monitoring and research of fish populations in RRB rivers suggest impacts on numbers of species by alterations in stream flow. Monitoring and research of Lake Winnipeg aquatic life makes clear connections between excess nutrients and aquatic health. But many gaps in data and knowledge on aquatic life and fish populations remain, and the day-to-day work of protecting Canada's Lake Winnipeg continues to lie largely in the hands of the many individual farm and city managers living and working in the reaches of the basin.

5

State/Provincial Nutrient Reduction Frameworks

State Nutrient Reduction Frameworks

RRB states are under the guidance of the EPA in developing frameworks for maintaining and/or restoring water quality. The frameworks take a variety of approaches.

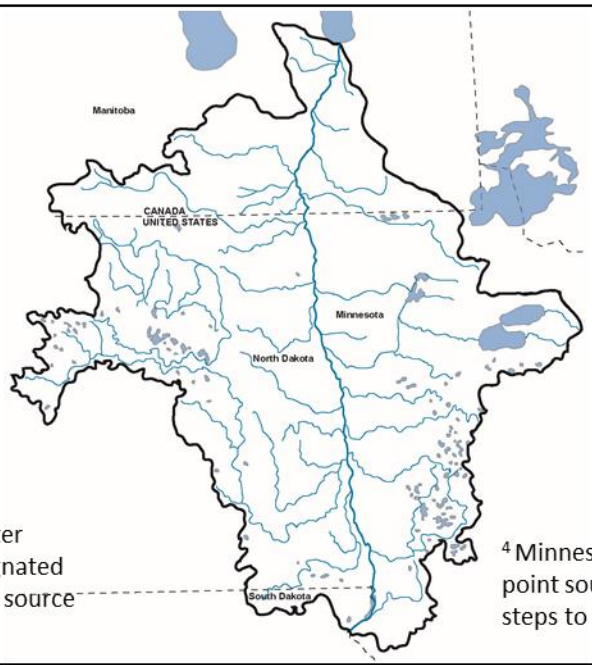
Current Standards/Regulations

ND[1]	Point	Non
P	Narative	Narative
N	Narative	Narative

[1] North Dakota is pending narrative nutrient standards, anticipated effective date of standards June 2018, primarily addresses point sources

SD[2]	Point	Non
P	Narative	Narative
N	Narative	Narative

[2] South Dakota has narrative water quality standards based on designated uses and primarily address point source discharges



MB[3]	Point	Non
P	1mg/L	Narative
N	15mg/L	Narative

[3] Manitoba has numeric standards for treatment facilities of communities over 2000 people to be met by 1 January 2016. Significant numbers of exceptions are granted based on economic constraints

MN[4]	Point	Non
P	1mg/L	Narative
N	15mg/L	Narative

[4] Minnesota has numeric standards for all point sources and has taken significant steps to reduce non-point, i.e. buffer strips.

Environmental Protection Agency (Clean Water Act 1972) approach to working with states: States are to 1) set standards for surface waters (numeric or narrative), 2) identify waterbodies that do not meet their beneficial use standard, 3) develop a total daily maximum load (TMDL) for impaired water bodies.
The IRRB is close to recommending concentration targets of 1.15 mg/L of N and .15mg/L of P at the international border. These targets are selected to maintain the ecological health of the Red River. These concentrations also meet the target goal for total load into Lake Winnipeg.
All four states/provinces have language in regulation to the effect of "best management practices should be used to minimize the impact of non point sources"

EPA Guidance

The EPA and the CWA of 1972 provide guidance that:

> *States are to 1) set standards for surface waters **(numeric or narrative)**, 2) identify waterbodies that do not meet their beneficial use standard, 3) develop a total daily maximum load (TMDL) for impaired water bodies."*

In the years since this initial guidance frequent policy adjustments and clarifications have been published through a various means. For example, a January 9, 2001 Federal Register notice and November 14, 2001 memorandum by Geoffrey Grubbs of the EPA recommended that states 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. In these plans, EPA expects states to describe a systematic approach for numeric nutrient criteria development, along with milestones for completion. The EPA recommends that a state's plans should describe its 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. EPA recommends three approaches for deriving numeric nutrient endpoints or criteria:

1. Adopt EPA's recommended nutrient criteria based on data aggregated at the Level III ecoregion scale (either as a range of 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 statistically based criteria; or
3. Use an EPA accepted stressor response methodology or some other scientifically defensible method for developing nutrient criteria.

Minnesota Processes and Progress[19]

MN's Nutrient Reduction Strategy (NRS), introduced in 2014, is driven by the environmental needs of both waters within MN and waters downstream of MN, including Lake Winnipeg, the Gulf of Mexico and Lake Superior. In-state lake standards and pending river eutrophication standards, as well as planning goals for downstream waters, have clearly defined the magnitude of needed nutrient reductions.

The overall theme of the NRS is "A Path to Progress in Achieving Healthy Waters." Fundamental elements of the NRS strategy include 1) defining progress with clear goals, building on current strategies and success, prioritizing problems and solutions, supporting local planning and implementation, and improving tracking and accountability.

Aligning with Supporting Agencies and Efforts

The NRS was able to call upon a rich array of MN entities and agencies that provide expertise in water resource issues to create a statewide strategy for reducing nutrients in MN waters. These include:

- **Metropolitan Council of Environmental Services**
- Board of Water and Soil Resources
- Department of Agriculture
- Department of Employment and Economic Development
- Department of Natural Resources
- MPCA
- University of Minnesota
- Department of Health

[19] Derived from MPCA, *Nutrient Reduction Strategy*.

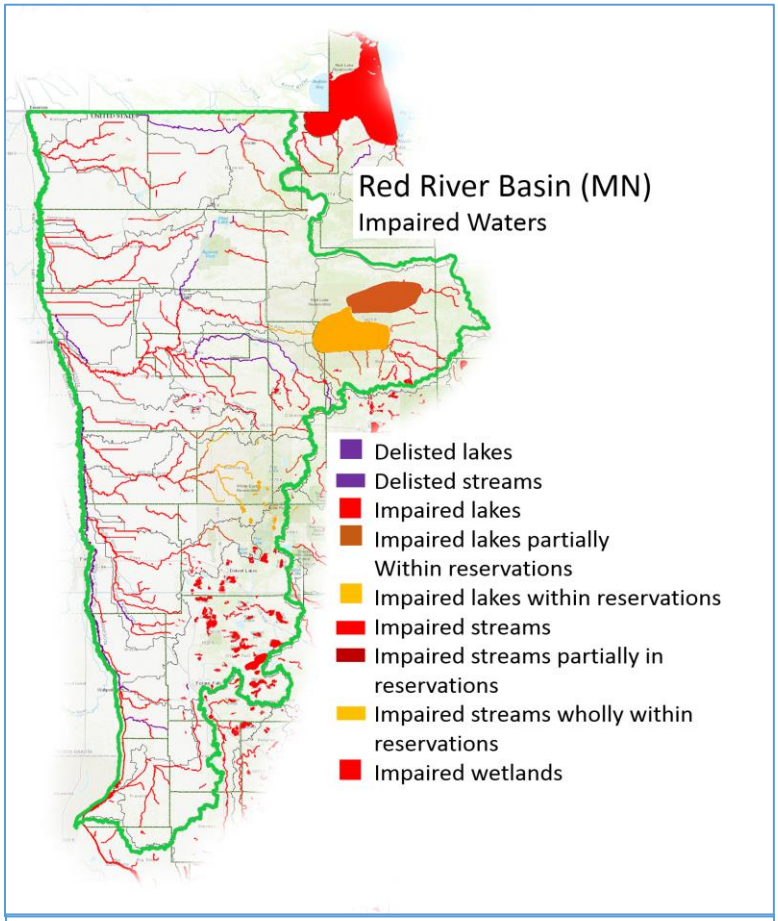
In addition, the timing of the development of NRS aligned it with a number of other significant efforts in the state that support the restoration and protection of MN waters:

1. The 2009 MN Clean Water, Land and Legacy Amendment provides additional funding for water quality protection and restoration until 2034.
2. Along with 11 other states represented on the Gulf of Mexico Hypoxia Task Force, MN committed to develop a NRS to protect in-state waters and the Gulf of Mexico.
3. Developed in 2014, the MN Water Management Framework lays out the state's approach for implementing watershed-based planning that will sustain a 10-year statewide cycle of locally-led water quality improvement plans (WRAPS).
4. In 2014 the MN Department of Agriculture updated its Nitrogen Fertilizer Management Plan for protecting groundwater from N pollution.
5. The legislature directed the MPCA to develop N standards which will eventually increase protection of MN's aquatic life from the toxic effects of high N.
6. MB, ND and MN are working together to update plans for protecting Lake Winnipeg from severe algae blooms.

Employing Goals, Milestones, Adaptive Management

The NRS comes under the umbrella of MN's Water Quality Standards (WQS) which uses numeric criteria to help clarify goals and monitor progress. Since 2008, numeric criteria for P have been applied to individual water bodies. Criteria for N are expected. For the state's major basins, including the RRB, planning goals for reducing MN's nutrient levels and contributions were developed. Goals for the RRB are a 10% reduction from 2003 in P and a 13% reduction from 2003 in N.

MN also has turbidity standards, which are planned to become TSS standards. Whether applied to individual water bodies or a major basin such as the RRB, numeric goals help the state to determine whether standards are/will be met. Intermediate data can help determine realistic benchmarks or milestones while working towards a goal. Use of milestones can also establish points in time to adapt strategies as necessary based on the rate of progress and/or on changes in factors such as land use, climate, regulatory environment, and technologies. The basic components of the NRS's adaptive management plan are as follows:



Derived from information at https://www.pca.state.mn.us/water/impaired-waters-viewer-iwav

1. Identify data and information needed to track progress toward NRS goals and milestones.
2. Create a system or approach for collecting data and information needed to track progress toward NRS goals and milestones.
3. Evaluate trends as well as relationships between actions and outcomes.
4. Adjust the NRS as necessary.

Developing Overarching Nutrient Reduction Strategies

MN's NRS acknowledges that no single solution exists for achieving the level of nutrient reductions needed to meet goals and milestones. Required reductions will take many actions and Best Management Practices (BMPs) implemented over large areas of the state. To support the needed widespread contributions, the NRS includes two overarching strategies:

- **Develop a Statewide NRS Education/Outreach Campaign**

Develop and implement a coordinated NRS outreach campaign that integrates with other efforts to promote statewide stewardship of water resources. This statewide campaign is responsible for raising general public awareness about the need to reduce nutrients in MN waters and will support BMP-specific educational activities.

- **Integrate Basin Reduction Needs with Watershed Planning Goals and Efforts**

MN has adopted a watershed approach for managing its waters, carried out by programs such as One Watershed One Plan, which emphasizes local level efforts to restore and protect water resources within a watershed, and WRAPS, which allows for prioritizing watersheds for intensive review (typically at 10-year intervals).

NRS would ensure that downstream nutrient reduction needs are addressed by cumulative local level efforts. Watershed restoration and protection strategies and accompanying comprehensive watershed management plans, such as One Watershed One Plan or WRAPS, should have the goal not only of protecting and restoring water resources within the watershed but also of contributing to nutrient reductions needed for downstream waters both within MN and those downstream of state borders.

A MN Nutrient Planning Portal was recently developed for accessing watershed nutrient-related information. It includes information on P and N conditions and trends in local waters, nutrient modeling, local water planning, and other nutrient information. This portal can be used by watersheds when developing local plans and strategies to reduce nutrient losses to local and downstream waters.

Developing Implementation Tracking

MN's NRS approaches implementation tracking in several ways. First, the NRS process itself provides early indicator information about P and N reductions that, over time, should translate to in-stream nutrient reductions. Second, the NRS uses an integrative approach that would collect and track both water quality and land management data. The latter, the NRS report explains, "is likely the largest gap in ensuring success of the NRS," since a significant proportion of BMPs are occurring outside of government assistance programs and thus not taken into account.

Third, NRS puts priority on an integrated and streamlined approach to tracking implementation of BMPs.

To support implementation, NRS contains a suite of program measures that can be used to measure progress, including various implementation activities. It also looks to and calls upon many other local, regional, statewide and national monitoring programs that can inform water quality evaluations. Just as no single restored watershed can provide the millions of adapted acres needed to reach goals, so to "no single water quality water quality metric, monitoring site, or period of monitoring will provide the needed information to evaluate environmental outcomes."

North Dakota Processes and Progress[20]

In developing the North Dakota Nutrient Reduction Strategy, the NDDoH relies on the EPA's option three: 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. Nutrient criteria 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 the State,
3) technically and scientifically defensible, and
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.

The NDDoH Nutrient Criteria Workgroup recommended that the NDDoH prioritize nutrient criteria development for Lake Sakakawea and the Red River. Lake Sakakawea is a significant public water supply in the State as well as an important recreation lake. The Red River is important as a public water supply and also has interstate significance as a border water with Minnesota and international significance with Manitoba and its role in the restoration of Lake Winnipeg.

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 NDDoH translates its narrative nutrient criteria to quantitative nutrient endpoints and thresholds. Additionally, the goal of the NDDoH is to complete the identification of priority watersheds, those watersheds which are impaired due to excessive nutrients, and to set quantitative nutrient load reduction targets using the following TMDL approach and watershed planning process:

1. selection of the nutrient pollutant (e.g., P, N or both);
2. estimation of the waterbody's assimilative capacity;
3. estimation of existing nutrient pollution loading from all sources;

[20] Derived from *North Dakota Nutrient Reduction Strategy for Surface Waters*, 2018 (draft). While the document is not fully integrated into state policy or law, it speaks to the direction in which the North Dakota Department of Health (NDDoH) is heading.

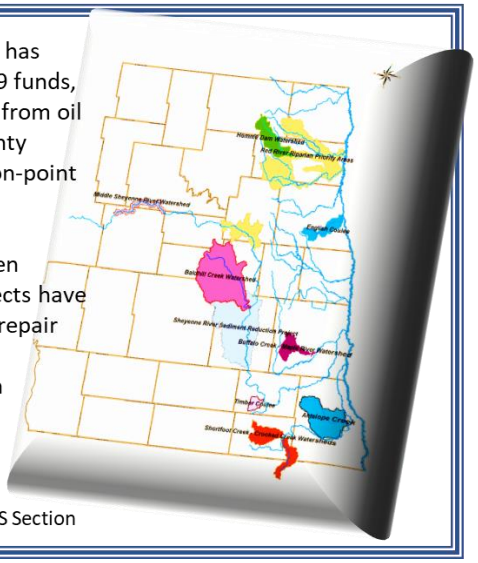
4. predictive analysis of nutrient pollution in the waterbody, the effect of load reduction on numeric thresholds and endpoints, and the determination of total allowable nutrient load to meet the threshold or endpoint; and
5. allocation of the allowable nutrient load among the different sources in the watershed in a manner that the nutrient reduction target or goal (i.e., water quality standards) is achieved.

This process must be iterative and adaptive, frequently revisiting and evaluating the standards and progress being made toward those goals. If actions are not meeting the goals it will require adjustments to the approaches.

Since 2010 the state of North Dakota has leveraged nearly $35M in Federal 319 funds, Outdoor Heritage Funds (state funds from oil tax revenues), and other state & county sources to address both point and non-point sources in the Red River Basin.

Project have been completed in eleven priority sub-watersheds. These projects have focused on education, septic system repair and agricultural best management practices(BMPs) like forested riparian buffers, grassed waterways, grazing management and erosion control.

Derived from Draft
North Dakota 2017 IRRB Annual Report-NPS Section



Identifying Nutrient Reduction Priorities

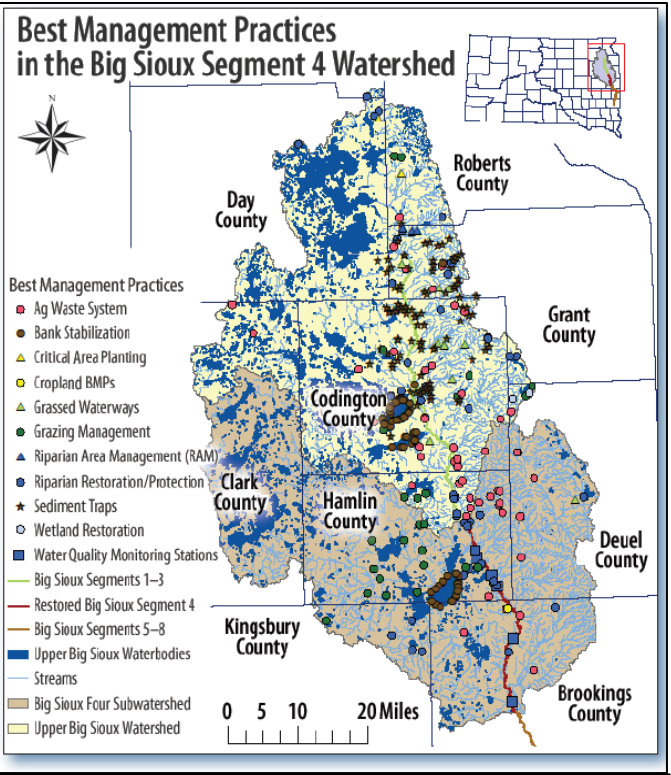
ND does not have sufficient technical or financial resources to address all the watersheds or nutrient sources in the state; therefore, it is necessary to develop an efficient and effective method to identify and target priority watersheds where nutrient reductions are needed the most. In support of this process the NDDoH uses a variety of decision support tools and models to assist in setting nutrient reduction priorities. The two most important tools currently being employed are:

Recovery Potential Screening (RPS) Tool - 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 ND that includes indicators specific to the State.

SPARROW Model - the U.S. Geological Survey's Spatially Referenced Regressions on Watershed (SPARROW) 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. A new SPARROW model has been developed for the Red and Assiniboine which includes Canada.

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.

South Dakota Processes and Progress[21]



South Dakota has worked through a detailed process to understand the status of water quality across the state and has taken steps to improve it. The Red River is only a very small part of two out of 66 counties in the state so has not been highly prioritized for action but is still monitored regularly. https://www.epa.gov/sites/production/files/2015-12/documents/sd_bigsioux_508.pdf

The CWA provides for an opportunity to more effectively restore and protect waters by using a systematic process of prioritizing TMDL development and implementing alternative approaches and protection activities. South Dakota's strategy includes the six actions discussed below.

Engagement - SD uses multiple means to engage the public and stakeholders and these will be used as part of the Vision. The Nonpoint Source (NPS) Task Force will be a primary means of getting information about the Vision to the stakeholders. The NPS Task Force is a citizen's advisory group containing approximately twenty-five agencies, organizations, and tribal representatives. It provides a forum for the exchange of information and activities about NPS related activities as well as providing recommendations for projects.

Prioritization - The prioritization process used is a subset of the TMDL prioritization of listed waters. However, changes in the impairment status and other considerations required a decrease in the numbers of priority waters. Ten lakes were removed from the list because a chlorophyll-a threshold had not been determined and the TMDLs cannot be completed without that threshold. Nine stream segments were removed because their status changed from being impaired to meeting their uses. Another three waterbodies were removed because it was determined that more data were needed before those TMDLs could be written.

Protection - This element is intended to encourage management actions that prevent impairments to waters not currently impaired. South Dakota is receptive to this concept and will consider providing technical or financial assistance to these types of projects. Requests for funding for CWA Section 319 funds will follow the same protocols as other projects requesting these funds and the "protection" activities must be identified as such.

Integration - The NRCS is the primary federal agency that interacts on NPS implementation projects. CWA Section 319 funds are often used in concert with NRCS funds to use the two funding sources more efficiently to combat NPS pollution. Multiple federal agencies have partnered with SD in various water quality assessment activities, and regional or local agencies are often project sponsors for NPS assessment or implementation projects.

[21] Derived from *South Dakota Integrated Report for Surface Water Quality Assessment*, 2018 (draft).

Alternatives - Alternative approaches that incorporate adaptive management or are tailored to specific circumstances where such approaches are better suited to implementing priority watershed or water restoration actions may be used in addition to TMDLs. Consideration will be given to projects or cases where a relatively simple or straight-forward solution can be reached without going through the TMDL development process. Requests for funding for CWA Section 319 funds will follow the same protocols as other projects requesting these funds and the "alternative" activities must be identified as such. The Information and Education Program may be useful in circumstances where public outreach and education can help to identify alternative approaches to resolving water quality issues.

Assessment - The goal of this element is to identify the extent of healthy and CWA impaired waters in a state's priority watersheds. Summarized below are several methods and data sources SD uses to assess waters:

- Fixed ambient monitoring of rivers and streams. The major rivers in the state are sampled and analyzed for a select suite of parameters.
- Data obtained from regional sources or federal agencies (e.g. the USGS or the volunteer lake monitoring program).
- Statewide Lakes Assessment (SWLA). Each year a minimum of 50 lakes are randomly selected and sampled for a suite of parameters using this statistically-based assessment.
- Intensive monitoring. Monitoring can be conducted to assess specific point or nonpoint source problems.
- Site-specific assessments. These are often used during TMDL studies if more general data methods/surveys do not provide adequate data. NPS implementation projects may also use site-specific studies to document water quality improvements due to NPS project activities.

Provincial Nutrient Reduction Framework

The following planning phases were outlined in the Nutrient Management Strategy developed in MB in 2000. Significant analysis was completed and resulted in a sweeping Nutrient Management Regulation in 2008.

Manitoba Processes and Progress

A first task in the development of a nutrient management strategy for southern MB was gathering background information on the nutrient status of waterways in the region. This task included the following:

1. Review and compare existing water quality guidelines/objectives/criteria for nutrient related variables in Manitoba and elsewhere.
2. Conduct a search of the Water Quality Management Section database for data on the nutrient related variables in samples collected from water quality monitoring stations in rivers and streams in MB.
3. Extract, summarize and interpret the data to determine levels of exceedance above existing objectives and to identify any spatial and temporal trends in the data.
4. Identify gaps in the existing database.

City of Winnipeg
Water and Waste Department

2017 RIVERS SURVEY MONITORING REPORT

Survey Date[1]:	October 5, 2017	Assiniboine River Sampling Locations				Red River Sampling Locations						
Parameter	Unit	HEADINGLY BRIDGE (R1)	WEST PERIMETER BRIDGE (R2)	ASSINIBOINE PARK FOOT BRIDGE (R3)	MAIN STREET BRIDGE (R4)	SOUTH FLOODWAY CONTROL[3] (R5)	SOUTH PERIMETER BRIDGE (R6)	FORT GARRY BRIDGE (R7)	NORWOOD BRIDGE (R8)	REDWOOD BRIDGE (R9)	NORTH PERIMETER BRIDGE (R10)	LOCKPORT BRIDGE (R11)
Temperature	°C	11.3	11.3	10.7	11.3	13.4	13.2	13.4	12.9	12.6	12.3	12.9
Dissolved Oxygen	mg/L	10.80	10.90	10.80	10.40	9.58	9.41	9.46	9.20	9.36	9.21	10.60
Oxygen Saturation	%	99	100	98	96	92	90	91	87	88	86	101
Biochemical Oxygen Demand	mg/L	3	<3	3	<3	<3	<3	<3	<3	<3	<3	<3
pH	units	8.39	8.41	8.40	8.37	7.90	7.89	7.83	7.75	7.93	7.82	7.82
Total Solids	mg/L	772	770	776	744	704	704	656	630	630	598	592
Total Suspended Solids	mg/L	95	93	99	51	140	185	110	108	114	89	62
Turbidity	n.t.u.	65	69	70	44	132	157	122	130	120	91	73
Total Organic Carbon	mg/L	12.7	12.6	12.1	11.6	13.9	13.6	13.6	13.7	12.7	11.6	11.8
Chlorophyll a	ug/L	53	57	43	41	8	8	8	7	11	11	12
Ammonia Nitrogen	mg/L N	<0.003	<0.003	<0.003	<0.003	<0.003	0.013	0.070	0.164	0.069	0.330	0.333
Nitrate Nitrogen	mg/L N	0.124	0.137	0.154	0.196	0.309	0.278	0.295	0.298	0.319	0.360	0.479
Total Nitrogen	mg/L N	0.6	0.6	0.7	0.8	1.3	1.0	1.3	1.2	1.0	1.3	1.3
Soluble Phosphorus	mg/L P	0.09	0.10	0.11	0.10	0.17	0.19	0.25	0.20	0.15	0.19	0.17
Total Phosphorus	mg/L P	0.23	0.21	0.22	0.18	0.27	0.25	0.25	0.27	0.22	0.26	0.34
Escherichia Coliform[2]	MPN/100 mL	190	280	410	260	120	180	60	70	340	250	310
Fecal Coliform[2]	MPN/100 mL	230	350	460	270	90	140	90	50	290	290	310

Weather Conditions during monitoring: Winds N/NW at 7 km/hr with 40% cloud cover and <0.1 mm of precipitation. Average air temperature during survey at 11ºC

Notes: 1) LIMS Reference No: 50924
2) Analyzed by contract laboratory.
3) Red River elevation at South Floodway Control Gates: 735.6 ft.

Report Compiled By: H.Demchenko, Compliance Reporting Technician
Approved in LIMS By: C.Diduck, Analytical Services Branch Head
Date Approved: 25-Jan-18

File No: 040-14-09-03-00

1/29/2018

Dozens of sites in Manitoba sample water regularly to maintain an understanding of nutrient sources from the various reaches of streams and rivers
http://www.winnipeg.ca/waterandwaste/sewage/monitoring/2017RiversReports.stm

The derivation of new numeric objectives for nutrient variables was one of the first challenges in the development of a nutrient management strategy for southern MN. Numeric objectives, as opposed to narrative objectives, are important in controlling eutrophication because they allow water quality managers to make informed, scientifically defensible decisions about regulating nutrient inputs to surface waters.

Approaches to deriving numeric nutrient objectives

Two approaches to deriving numeric nutrient objectives were used. These were:
(1) Regional Based Objectives and (2) Objectives Based on Receiving Waters.

Regional Based Objectives

The chemical and physical characteristics of a waterway are determined in large part by the features of its drainage basin or watershed. Topography, natural vegetation cover, land-use practices, climate, geology, and soil type can vary considerably between watersheds, and as a result, no two waterways are the same in terms of flow regime, physical characteristics, and water chemistry. The growth of algae and macrophytes is dependent in large part on the availability of P and N. However, primary productivity in streams is also influenced by light exposure, temperature, water clarity, flow regime, grazing, the presence of toxic pollutants, and micro-nutrient concentrations, all of which vary between waterways. Given the considerable variation that exists among aquatic systems, it is unrealistic that a single numeric objective for each nutrient variable could be applicable to all the rivers and streams in southern MB. It is apparent that more site-specific objectives are required.

The establishment of nutrient objectives for individual waterways was determined to be impractical. Regionally-based nutrient objectives were based on ecological units such as eco zones or ecoregions, or on drainage units such as drainage basins or watersheds. Once regional boundaries were established the process of developing nutrient objectives proceeded. Major tasks in the development of regional nutrient objectives included:

1. identifying major problems within each region and prioritizing which regions and waterways require immediate attention,
2. identifying core variables used to assess nutrient concentrations in southern MB,
3. developing focused monitoring programs to better define the relationship between nutrients and productivity to identify any temporal/spatial trends in rivers within each region,

4. identifying reference streams or reaches to represent non-impacted conditions in regions,
5. analyzing data using scientifically defensible processes; critical in establishing value for managing and regulating nutrient inputs to streams and rivers from point and non-point sources,
6. determining nutrient objectives based on the results of analysis and modeling work,
7. supporting work being conducted elsewhere in the prairies.

Objectives Based on Receiving Waters

This approach developed objectives for waterways based on the effects that stream nutrient loads have on the lakes into which they enter. Lake Winnipeg is the recipient of much of the drainage in the southern half of Manitoba. It is possible to reverse or halt this process by developing nutrient objectives for streams which enter the lake that are based on the carrying capacity of the lake itself. In doing so the water quality of the lake and possibly the water quality of waterways upstream of the lake will be protected. The major steps in the process include:

1. determine the carrying capacity of Lake Winnipeg,
2. determine the amount of external nutrient loading that is contributed by rivers and streams that flow into the lake,
3. determine the maximum acceptable nutrient concentrations for streams entering Lake Winnipeg (based both on the carrying capacity and the relative contribution of each stream),
4. develop nutrient objectives for rivers and streams entering the lake. The objectives must protect the receiving water as well as the watercourse upstream.

Approaches to Managing Point and Non-Point Sources

Approaches to managing to point and non-point sources were also explored.

Managing Nutrient Point Sources

Some jurisdictions had developed a watershed-based approach to nutrient management. The watershed approach involves identifying all the inputs to the river system within a basin or watershed, followed by the development and implementation of strategies aimed at reducing these inputs. The watershed approach is often multidisciplinary, requiring the cooperation of all stakeholders. Following are issues to consider in the control of nutrient inputs from point sources:

A. Point sources of nutrients are still being identified and information/data about nutrient from these sources is being gathered, analyzed/modeled with existing stream nutrients and flow data.
B. When non-compliance occurs, nutrient control measures are considered.
C. Streams that have multiple point sources are encouraged to coordinate their discharges to ensure that stream nutrient objectives are not exceeded and water use not compromised.
D. Point source discharges may be relocated to minimize negative impacts to the waterway and to water uses along the waterway.

Managing Nutrient Non-Point Sources

Education awareness campaigns may need to be initiated that are aimed at reducing nutrient inputs in domestic and industrial wastewater. In general, nutrient inputs to a waterway from non-point sources tend to be extremely variable, intermittent, and difficult to predict and control. Some management practices that help to control non-point source loading of nutrients to waterways include:

1. control of runoff and erosion from agricultural/urban areas through improved landscaping,
2. use of precision farming practices to limit excess chemical fertilizers and manure applied to cultivated land,
3. preservation or re-establishment of riparian vegetation along waterways,
4. restricted access of cattle and other livestock to waterways,
5. increased awareness in rural areas on the need to change or alter farming practices,
6. increased cooperation, communication, and education between government (all levels), producers, conservation groups, and other concerned parties.

Development of a Geographic Information System (GIS) for the Nutrient Management Strategy

The development of a GIS was an important component of the nutrient management strategy. Using the GIS allows water quality data to be displayed, interpreted, and modeled on a geographic scale (spatial analysis). This helps facilitate better decision making on the part of water managers and better communication of the data and management plans to regulators, elected officials, and the general public. All point sources that discharge to water (licensed or otherwise), associated data, and ambient water quality data are included in the GIS. This information was gleaned from Environment Act Licenses, client files, the Water Quality Management Section database, and historical records, and by conferring directly with Department staff in the Municipal and Industrial Approvals Section and in the regional offices.

6

International Response: IRRB/RRBC

Responding to issues that arise in the RRB is made challenging by the multi-jurisdictional make-up of the basin:

- The RRB lies in two countries, US and Canada.
- The area is home to 42 counties or parts of counties (MN, ND, MB).
- Twenty-five major sub-watersheds drain into the Red River, 4 of which cross international and/or state/provincial borders.

The IRRB was established by the International Joint Commission (IJC) to provide guidance on "the quality, levels and integrity of the waters of the Red River ecosystem," and thus to assist the IJC in resolving and preventing international disputes over water. The IRRB includes representatives from MN, ND, MB, and select federal agencies.
The RRBC is a non-profit organization of 44 members, equal members from MN, ND and MB and representatives from SD and First Nations. It works, as far as possible, across the RRB's political boundaries, led by the vision of "a RRB where residents, organizations and governments work together to achieve basin-wide commitment to comprehensive integrated watershed stewardship and management."

Coordinated Planning

The IRRB established a Water Quality Committee in 2011 to develop a nutrient management strategy for the Red River Watershed. Members of that Committee also serve on the RRBC Water Quality working group. The IRRB Water Quality Committee has recently worked through 6 components of a strategic approach outlined by the RRBC-originated study, CWMP.
In 1969, the IRRB established the Red River Pollution Board to provide surveillance of Red River water quality. In 2011, a Water Quality Committee (WQC) was established to coordinate the development and implementation of a nutrient management strategy for the Red River Watershed. The task was divided into 6 components. Those components and the status of each as stated in a 2016 report follow:

1 – Develop nutrient management study (completed),
2 – Develop a shared understanding of jurisdictions' nutrient regulatory frameworks and identify current nutrient reduction actions, activities and plans for the Red River watershed (completed, but will need regular updating, including the work of this report),
3 – Recommend and implement nutrient load allocation and/or water quality for nutrients (first report in 2013; a revised report 2016. With the final recommendation to coordinate two approaches: a) stressor-response modeling for the Red River and b) downstream nutrient targets for Lake Winnipeg),
4 -- Monitor and report on progress towards meeting water quality targets and nutrient load allocations (ongoing),

Together, the RRBC and IRRB are positioned to support the work of the Water Quality Committee, as the two cooperating entities continue to identify gaps and seek opportunities to support nutrient reduction efforts for the RRB.

Additional RRBC nutrient - reduction projects include:

- State of MN LCCMR/ENRTF for nutrient capture and water quality monitoring within North Ottawa Impoundment,
- EPA 319 funding through MPCA for nutrient load reduction monitoring from the upstream North Ottawa drainage system.
- The current WQSP funding for a basin-wide approach to seeking agreement on desired basin-wide nutrient load reductions, N and P targets, and other basin-wide outcomes that improve water quality in all parts of the basin.

Part III: DATA-DRIVEN MONITORING & MODELING

7

Monitoring of Surface Waters

Monitoring of surface waters in the RRB is a necessary step towards restoring and protecting the basin's water resources. Monitoring can occur on various reaches of the main stem Red, on one of its major sub-watersheds, and/or on the basin's and lakes. Carrying out the monitoring is typically accomplished cooperatively between federal and state agencies, with assistance from other entities.[22] Methods of collecting, maintaining, and applying data differ among jurisdictions.

Minnesota Surface Water Monitoring

MN surface water monitoring is carried out primarily through MPCA-led/funded projects and programs such as Intensive Watershed Monitoring (IWM; the majority of monitoring occurs with this program), identification of biotic stressors, Watershed Restoration and Protection Strategy (WRAPS) projects, Watershed Pollutant Load Monitoring Network (WPLMN), and Citizen Lake/Stream Monitoring Program (CLMP and CSMP). These projects and programs are state-wide, though the following descriptions are narrowly focused on the RRB. In addition, some Watershed Districts and American Indian tribal governments in the RRB have their own water quality programs that are independent of MPCA funding.

In 2008, the MPCA began using a systematic, watershed approach for monitoring and assessing the RRB's surface water. Each major watershed in the RRB includes a main river/stream and all smaller tributaries and lakes that drain into it. The MPCA's watershed approach includes intensive monitoring (IWM) to collect surface water data in each of the major watersheds. The duration of the IWM in each watershed is 2 years and the frequency every 10 years. This duration and frequency allows the MPCA to focus monitoring efforts on fewer watersheds per year,[23] which results in more robust dataset in a watershed within a shorter period of time. Not every waterbody in a watershed can be intensively sampled so the MPCA and local partners jointly decide which stream reaches and lakes are part of the IWM efforts. Many different types of surface water data are collected at various stations/locations along stream reaches and lakes that are the focus during IWM. The primary data types that are collected during the IWM are water chemistry (e.g., P, TSS, DO, bacteria, etc.), biology (e.g., fish and macroinvertebrates), and flow (e.g., volume and velocity of a stream, water level, etc.). Though MPCA employees perform the majority of the chemistry and biology data collection during IWM, Surface Water Assessment Grants (SWAGs) are also awarded to local partners to assist the MPCA with data collection. Also, the Minnesota Department of Natural Resources

[22] In MN, these include local government units (LGUs), Soil and Water Conservation Districts (SWCDs), Watershed Districts (WDs), American Indian tribal governments, MN colleges and universities, citizen volunteers, subcontractors, and others via funded programs.

[23] 3-4 on average in the RRB, about half of which are in year 1 of IWM, the rest in year 2.

(DNR) performs all of the fish and plant monitoring in RRB lakes, which may or may not occur during IWM.[24]

Collection of surface water data doesn't begin and end with the IWM, temporally or spatially. There is much data collected in the intervening 8 years and at stations/locations that are not part of the IWM. The importance of this additional data is paramount, because it provides information on surface water that may otherwise not have been captured in only two years of IWM data. Here are some examples of additional monitoring that occur regardless of the IWM schedule, though some of the monitoring may happen during the same years as the IWM:

- Some of the flow monitoring stations are owned by the United States Geological Survey (USGS) or DNR and are continuously or intermittently collecting flow and, in some instances, chemistry data.
- The International Water Institute[25] collects surface water data in the RRB from various project teams (e.g., River Watch).
- Local Government Units (LGU), Soil & Water Conservation Districts (SWCD), Watershed Districts (WD), DNR, etc. collect surface water data for various projects (e.g. DNR performs all the fish and plant monitoring in lakes).
- Identification of parameters that are stressing biological communities often requires additional monitoring (this program may be dependent on the IWM schedule because stressor identification generally begins the field season after IWM).
- WPLMN provides additional flow and chemistry monitoring (especially during high flows) in order to calculate pollutant loads.
- CLMP and CSMP allow for public volunteers to collect transparency data on waterbodies; the advanced CLMP (CLMP+) allows for additional water chemistry data to be collected on lakes as equipment allows.

Following the intensive, 2-year collection of data in a watershed, waterbodies are assessed by the MPCA using all data collected in that watershed over the previous 10 years to determine whether they meet state standards for a suite of parameters for which there are sufficient data. For example, in most RRB waterbodies, the average DO needs to be above 5 mg/L (indicating good water quality in terms of DO) in order for the standard to be met.

Though the parameters related to flow data[26] are not assessed directly, they become invaluable to the assessment process and subsequent water quality work. For example, there are situations where a result of a parameter is noticed to be an outlier during an assessment. If the flow data shows that water volume and/or level was unusually high on the day the sample was taken (indicating a recent large rain event), it may be reason enough to exclude the sample from the assessment. When assessing for biological parameters (fish and macroinvertebrates), the MPCA employs a framework called Tiered Aquatic Life Uses (TALU) to account for the fact that all river/stream reaches are not of equal value (e.g., a straight ditch isn't expected to support aquatic life to the same extent as a natural watercourse).

[24] IWM for the first 10-year cycle has been completed for all 17 major watersheds in the RRB. The second cycle is scheduled to begin in two major watersheds in the RRB in 2019.

[25] http://www.iwinst.org/

[26] Both what is collected specifically for IWM and as part WPLMN.

The following Table shows a summary of assessment results for river/stream reaches in the RRB that were assessed from 1998 to 2017.[27] Note that some of these assessment results are prior to the MPCA beginning the watershed approach to monitor and assess water quality. P and bacteria are the two parameters that have failed to meet state standards for the highest proportion of assessed reaches (54% and 46%, resp.) while chloride, pH, ammonia, BOD, and DO flux have all met standards for 100% of assessed reaches.

Number and percentage river/stream reaches in the Red River Basin assessed between 1998-2017 that meet and do not meet standards for 13 water quality parameters.

Water quality parameter	# (%) of assessed river/stream reaches that meet standards	# (%) of assessed river/stream reaches that do not meet standards
Fish IBI[b]	130 (70%)	56 (30%)
Macroinvertebrate IBI	113 (75%)	38 (25%)
Dissolved Oxygen (DO)	39 (68%)	18 (32%)
Total Suspended Solids (TSS)	72 (67%)	36 (33%)
Secchi Tube[c]	74 (77%)	22 (23%)
Chloride	114 (100%)	0 (0%)
pH	153 (100%)	0 (0%)
Ammonia	132 (100%)	0 (0%)
Phosphorus[d]	126 (46%)	148 (54%)
Chlorophyll A[d]	89 (98%)	2 (2%)
Biological Oxygen Demand (BOD)[d]	24 (100%)	0 (0%)
Dissolved Oxygen (DO) Flux[d]	5 (100%)	0 (0%)
Bacteria	71 (54%)	60 (46%)

[a] Reaches can be assessed for many other parameters than just those listed in this table.
[b] IBI= index of biological integrity.
[c] This parameter is used as a surrogate for TSS.
[D] These 4 parameters are used to assess a river/stream for eutrophication.

A comparison of the 13 parameters for all 10 basins located in MN (data not shown) shows that chloride, pH, and ammonia all have low proportions (<15%) of assessed reaches that do not meet standards, while the other 10 parameters show a very high degree of variability among all 10 basins. It is noteworthy that for the fish Index of Biological Integrity (IBI), macroinvertebrate IBI, DO, TSS, Secchi tube, P, and bacteria parameters, the RRB is, or is nearly, one of the median basins (i.e., there are always at least 2 other basins that have a higher or lower proportion of reaches that do not meet standards). The proportions of reaches that do not meet chlorophyll A, BOD, and DO flux standards are very low for the RRB compared to most other basins. The RRB never has the highest proportion of reaches that do not meet standards for any of the 13 parameters; there is always another basin with a higher proportion.

[27] Data was retrieved from MPCA's Consolidated Assessment Review Launchpad [CARL] on 6 October 2017.

The MPCA needs to be aware of and have access to the data in order to use it to assess water quality. All water chemistry data is submitted to MPCA's Environmental Quality Information System (EQuIS); biological data is entered into an MPCA internal database; assessment data is entered into MPCA's Consolidated Assessment Review Launchpad (CARL). All three of these data types (chemistry, biology, and assessment) can be accessed by citizens through MPCA's Environmental Data Access [EDA].[28] An exception is DNR's lake fish monitoring which can be accessed from DNR's LakeFinder[29] site. All flow monitoring data is submitted to DNR's/MPCA's HYDSTRA.[30] and can be accessed by citizens at DNR's Cooperative Stream Gaging[31] site.[32] Monitoring and assessing waterbodies make up the crucial foundation for further investigation into water quality that occurs in the intervening years before the next IWM and assessment cycle. Sequential work includes listing waterbodies as impaired due to not meeting standards for one or more parameter; creating or updating a computer model of the watershed; identifying stressors to the biotic communities; writing of Total Maximum Daily Loads (TMDLs) for impaired waterbodies; writing of a Watershed Restoration and Protection Strategies (WRAPS) report for impaired and unimpaired waterbodies; and implementing Best Management Practices (BMPs) by local partners that aim to improve water quality.

North Dakota Surface Water Monitoring[33]

As home to North Dakota's Division of Water Quality, the North Dakota Department of Health recognizes statewide 247 lakes and reservoirs, 54,606 miles of rivers and streams, and 2.5 million acres of wetlands as monitoring area. The NDDoH also recognizes the many partners—state, federal and local—that conduct monitoring and assessment in this large state. The report at hand, *North Dakota Water Quality Monitoring Strategy for Surface Waters*, focuses on the monitoring duties of the NDDoH.

Guiding the work of surface monitoring and assessment by the NDDoH's Division of Water Quality are six principles:

1. Integrate and coordinate use of scarce monitoring resources with other agencies and organizations.
2. Maximize use of local units of government and citizens to monitor surface water quality.
3. Schedule field studies . . . to be consistent with the DoH's rotating basin monitoring schedule.
4. Use a tiered monitoring approach consisting of rapid assessment of screening level assessments at numerous sites and intensive study at a smaller subset of pre-screened sites.
5. Generate monitoring data that are scientifically defensible and relevant to the decision-making process.
6. Manage and report water quality data in a way that is meaningful and understandable to the intended audience.

[28] https://cf.pca.state.mn.us/water/watershedweb/wdip/search_more.cfm

[29] http://www.dnr.state.mn.us/lakefind/index.html

[30] Transitioning to WISKI.

[31] http://www.dnr.state.mn.us/waters/csg/index.html

[32] The flow data from the USGS stations can be accessed from this site as well.

[33] Derived from NDDoH, Division of Water Quality, Surface Water Quality Management Program, *North Dakota Water Quality Monitoring Strategy for Surface Waters* 2008-2019.

The overall goal for the Surface Water Quality Management Program (SWQMP) 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."

The objectives of SWQMP are to:

- provide data to establish, 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.

The NDDoH is responsible for carrying out the federal Integrated Section 305(b) Water Quality Assessment Report and Section 303(d) biennial List of Waters Needing TMDLs, including beneficial uses, narrative and numeric standards, and anti-degradation policies and procedures. The DoH also participates in international monitoring as a member of the IRRB board, which monitors RRB water quality. Other members of the IRRB board include ECCC, Manitoba Water Stewardship, EPA, USGS, US Bureau of Reclamation, and MPCA.

SWQMP's Monitoring and Assessment program carries out nine major monitoring "Programs, Projects and Studies": Ambient Water Quality Monitoring Network for Rivers and Streams, Biological Monitoring and Assessment Program for Rivers and Streams, Ecoregion Reference Station Network, Lake Water, Missouri River, Fish Tissue, Wetlands, Impaired Waters, and Non-point Source Pollution Management. Three of these programs/projects/studies are most relevant to nutrient monitoring:

<u>Ambient Water Quality Monitoring Network for Rivers and Streams</u>

Established in the 1960s, this monitoring network maintains 34 fixed station sites on 19 rivers, co-located as far as possible along with USGS flow-gauging stations. Eighteen of the stations are located in the RRB. Monitoring objectives include providing data for trend analysis, characterizing general water quality, and calculating pollutant loading. Parameters for monitoring include nutrients TN and TP, along with general chemistry, trace elements and biological markers.

<u>Biological Monitoring and Assessment Program for Rivers and Streams</u>

Biological Monitoring assesses use attainment for aquatic life by developing indicators using fish and other aquatic life. In 2005-7, the NDDoH teamed with MPCA to carry out a project in the Red River basin in order to:

1. assess the current biological condition of perennial, wadable rivers and streams in the ND and MN portions of the Red River basin;
2. assess the current status of aquatic life use attainment of the perennial, wadable streams of the ND and MN portions of the Red River basin;
3. develop and refine indices of biological integrity for the fish and macroinvertebrate communities; and
4. investigate potential stressors for impaired aquatic life uses.

Nonpoint Source Pollution Management Program Monitoring

Nonpoint Source Pollution Management approaches monitoring with consideration of variables that should be taken into account in specific instances. Its objectives are 1) to assess waterbodies with little or no water quality assessment information by identifying beneficial use impairments or threats to the waterbody and determining the extent to which those threats or impairments are due to nonpoint source pollution, and 2) to evaluate the effectiveness of implemented BMPs in meeting the nonpoint pollutant reduction goals specified in nonpoint source implementation projects. The nonpoint source pollution monitoring data provides the basis to define watershed needs, set beneficial use improvement goals, and quantify pollutant reduction goals for the water body.

A related program, described in *The North Dakota Nonpoint Source Pollution Management Program Plan* (NDDoH, 2009), contains a comprehensive list of potential nonpoint pollutants in the state. Of the many potential sources on the list, the four pollutant sources anticipated as primary are agricultural lands, degraded riparian areas, animal feeding operations and failed on-site wastewater treatment systems. Anticipated pollutants from these sources include nitrogen, phosphorus and sediment, together with E. coli bacteria.

Manitoba Surface Water Monitoring[34]

The Province of MB has maintained a long-term surface water quality monitoring program at many sites across the province since the early 1970s. The surface water quality monitoring program consists of an ambient monitoring network of 74 surface water quality sampling sites on major streams, rivers and lakes located throughout Manitoba, including the Red River (at Selkirk and further upstream at St. Norbert) and its major tributaries. The largest proportion of surface water quality sampling stations are in central and southern MB where agricultural and anthropogenic activities dominate the landscape. Water samples are typically collected on a bi-monthly, monthly or a quarterly basis and are analyzed for up to 150 water quality variables (chemical, biological and physical) at most sites throughout the year. These data are used in a variety of applications to protect surface water quality in MB through assessment of water quality trends, identification of impairments to water uses and estimation of nutrient loads. Since 1999, MB has maintained a long-term water quality monitoring program on Lake Winnipeg to assess trends in water quality and aquatic ecosystem health. The Province works collaboratively with the Lake Winnipeg Research Consortium and other agencies and researchers on Lake Winnipeg. Samples are collected during the spring, summer and fall from a network of 65 stations across the lake and analyzed for general chemistry, nutrients, metals, pesticides, phytoplankton composition, biomass and algal toxins among other parameters. Sample are typically collected from a smaller subset of sites during the winter to assess under-ice conditions.

[34] Derived from information compiled for WQSP by Elaine Page, Manitoba Sustainable Development

The importance of Lake Winnipeg to Canada is suggested by the assistance federal agencies and departments are providing in assessing and reporting on the health of the lake. ECCC assisted Manitoba Water Stewardship in compiling the 2011 *State of Lake Winnipeg Report.* The report serves, among other purposes, as a reference to measure progress towards reducing nutrient loading in Lake Winnipeg. An updated assessment of nutrients in Lake Winnipeg by ECCC and Manitoba Sustainable Development is scheduled for 2018-2019.

International Boundary Surface Water Monitoring[35]

The IRRB is responsible for surface water monitoring at the International Boundary under the direction of the IJC and with the assistance of ECCC.[36] Both continuous monitoring and instantaneous grab samples are used to monitor numerous pesticides, metals, and toxic substances that have alert levels, together with five parameters for which the IJC established objectives in the late 1960s. The collected data are used to determine compliance with these alert levels and water quality objectives at the International Boundary. Exceedances act as notices to agencies to take appropriate actions to prevent or mitigate problems.

The five parameters for which the IJC set water quality objectives include dissolved oxygen, total dissolved solids, chloride, sulphate, and Fecal coliform bacteria. Except for one alteration,[37] these water quality objectives have been used in boundary monitoring until the present.

The issue of excess nutrients relates most closely to the first two of the five parameters: DO and TDS. DO, which is critical in sustaining aquatic health, originates from the atmosphere and phytoplankton productivity and is consumed by biological activity and decay, the latter of which can be caused by accelerated nutrients. Total dissolved solids are largely composed of organic nutrients.

The most recent yearly report (17th Annual, for 2014-2015 collecting year) shows dissolved oxygen to meet the objective level (above 5.0 mg/L) throughout the reporting period. Total dissolved solids (TDS) were shown to remain at or exceed the objective of 500 mg/L for most of the reporting period.

Parameter	Objective level	Number of Samples	Number of exceedances	% exceeding	Maximum value
Dissolved oxygen	5 mg/L	42	0	0%	--
Total dissolved solids	500 mg/L	42	32	71%	773.2

Statistics from IRRB's *Water Quality Trends and Exceedances of Objectives for 2014 Water Year*

In order to improve its work of monitoring for water quality, the IRRB in 2001 established two committees in which expertise could be consolidated: Committee on Hydrology (COH) and

[35] Derived from International Red River Board, *17th Annual Progress Report,* October 2016.

[36] In addition to the IRRB's direct monitoring, Member agencies report on the status of compliance in their portion of the Basin.

[37] In 2010 E. coli replaced Fecal coliform as a water quality objective.

Aquatic Ecosystem Committee (AEC). Reestablished in 2006-2007, the COH was assigned, among other issues, the following monitoring-related investigations: establishing natural flow and water usage databases, evaluating current water quality monitoring and reporting protocols, and developing biological monitoring strategies.

In carrying out its numerous areas of research and consideration, the IRRB also has the task of maintaining awareness of activities basin-wide, while suggesting strategies for resolution of issues. In its most recent annual report, the IRRB recommends the development of a long-term monitoring plan for the basin, one that would:

- consider input from Minnesota, North Dakota, and Manitoba and as much as possible be complementary to their monitoring programs; [Note: MN, ND and SD function under the statutory basis of EPA's current Water Quality Standards (WQS). EPA has approved WQS programs for all three states: MN Watershed Approach and WRAPS, ND Ambient Water Quality Monitoring Program with 3 levels of sampling intensification.]
- include physical, chemical and biological monitoring;
- have uniform quality assurance/quality control, with sampling protocols aligned for consistency in methodology and allowing for compatibility of results for data analysis;
- be designed so that progress toward attaining nitrogen and phosphorus loading targets for Lake Winnipeg and the Red River can be evaluated.

8

Red River Basin Nutrient Modeling

Modeling can be a powerful tool. It can establish a process for testing objectively for one or more factors that leads to more understanding. Modeling can also be challenging, in circumstances where there are multiple or unlike inputs, as is the case of a large, complex river basin such as the Red River. Following are modeling efforts developed and/or used in the Red River Basin in recent years that hold promise for improving understanding of sources of excess nutrients and best strategies for protecting basin waters against these stressors.

Agricultural Non-Point Source Pollution Model (AGNPS)

Agricultural Non-Point Source Pollution Model (AGNPS) is a system of modeling components developed by the USDA's NRCS for use in agriculture management. The model evaluates the impacts of management decisions on water, sediment, and chemical loadings within a watershed system.

AGNPS input programs include 1) a GIS-assisted computer program with all the needed hydrologic and hydraulic parameters, management procedures, soils, climate, and gully information, and 2) an Input Editor to initialize, complete and/or revise the data.

Outputs include predictions of 1) water, 2) sediment by particle size class and source of erosion, and 3) chemicals – nitrogen, phosphorus, organic carbon, and pesticides. These loadings are generated for land areas (called AGNPS cells) and routed through stream systems on a daily basis. Special land use components such as feedlots, gullies, field ponds, and point sources are included. Individual feedlot potential ratings can also be derived. A related application includes more detailed science for channel hydraulics, morphology, and transport of sediments and contaminants.

Hydrological Simulation Program FORTRAN (HSPF)

The Hydrological Simulation Program - Fortran (HSPF) is a useful modeling tool across multiple pollutant sources, spatial scales, and time steps. The model uses rainfall and meteorological data and applies it across the landscape, taking into account both pervious and impervious surfaces. The model is capable of predicting flow rate, sediment load, and nutrient and pesticide concentrations. According to the EPA, the developer of the model, HSPF is "the only comprehensive watershed hydrology and water quality model that allows integrated simulation of land and soil contaminant runoff processes with instream hydraulic and sediment-chemical interactions".

The input requirements for HSPF include:

- precipitation records;
- evapotranspiration predictions; and
- air temperature, wind, solar radiation, humidity, loud cover, tillage, point sources and pesticide application.

Physical specifications may also be required.[38]

The result of the comprehensive simulation is a time history of the runoff flow rate, sediment load, and nutrient and pesticide concentrations, along with a time history of water quantity and quality at any point in a watershed. Due to its flexible design, HSPF can model systems of varying size and complexity.

The MPCA has chosen HSPF modeling as a key tool in their 10-year statewide effort to assess watershed conditions and implement watershed protection and restoration strategies for its 80 HUC-8 watersheds. HSPF model applications have been developed for all of the HUC-8 watersheds in the MN side of the Red River basin.

These HPSF models are being used for numerous MPCA functions, including TMDL calculations, development of Watershed Restoration and Protection Strategies (WRAPS), Stressor Identification (SID) work, point source effluent limit work, pollutant trading ratio calculations, and support of a variety of other MPCA watershed science studies and efforts. The HSPPF models will be updated periodically and the time series information in the models will be extended.

Prioritize Target and Measure Application (PTMApp)

Prioritize Target and Measure Application (PTMApp) is a vision built through a public, non-profit, private collaboration for a tool to support aspects of surface water quality planning, in particular nutrient management. The tool is a state-wide desktop and web application which can provide a technical bridge between the general description of the types of strategies in a local water plan and the identification of implementable on-the-ground Best Management Practices (BMPs) and Conservation Practices (CPs).

PTMApp can be used in a workshop environment by Soil and Water Conservation Districts (SWCD), watershed districts, county local water planning, agency staff, and other decision makers. Interactively and in real-time, practitioners will:

- PRIORITIZE resources and the issues impacting them,
- TARGET specific fields to place CPs and BMPs, and
- MEASURE water quality improvement by tracking the expected nutrient and sediment load reductions delivered to priority resources.

At this point, PTMApp is still under testing and has limited on-line access. Despite a number of stated limitations, the tool has the potential to help water quality practitioners build prioritized and targeted implementation scenarios, measure the cost-effectiveness of a scenario for improving water quality, and report results, including requests for financial support.

Recovery Potential Screening (RPS)

Recovery Potential Screening (RPS) is a systematic comparative method for identifying differences among watersheds that may influence their relative likelihood to be successfully

[38] Much of the input data can be assessed through EPA's BASINS system.

restored or protected. Created by the EPA in 2004, the tool is intended to assist states and others with limited resources to use these resources wisely.

The main programmatic basis for RSP includes the TMDL Program (by helping to identify where best to implement TMDLs) and the Nonpoint Source Program (by assisting with prioritizing and identifying best strategies). The RPS tool is an Excel spreadsheet containing all watershed indicators and auto-calculated key indices. The tool can generate rank-ordered tables, bubble plot graphics, and maps that can be user-customized.

Statewide RPS tools and data have been developed for each of the lower 48 states. They were distributed to states and EPA regions in July 2014. Beginning in 2017, ND will be incorporating the RPS tool into its Nonpoint Source Program to assist with prioritizing water bodies for assessment, the first of five objectives for its Nonpoint Source program.

Spatially Referenced Regressions on Watershed Attributes (SPARROW)

SPARROW is a modeling program of great interest to the Red River basin given its ability to estimate the sources of nutrients in watersheds. Instances in the Red River basin of nutrient-caused eutrophication are clear but not so the specific places or practices from which nutrients come, nor the relations among human activities, natural processes, and contaminant transport. SPARROW can estimate answers to questions regarding sources of water pollution with some confidence, helping to determine most beneficial strategies for nutrient abatement. In particular, SPARROW has the potential to make load reductions of contaminants more efficient by targeting where in the basin landscape reduction efforts would have the largest local and downstream benefits.

SPARROW's modeling program has three features:

1) a Geographic Information System (GIS) that manages data about the contaminant's sources (typically nitrogen or phosphorus), instream contaminant flux (from catchment sites), characteristics of the landscape, and the location and connectivity of a watershed's stream reach,
2) a statistical basis that provides an objective means of specifying a relation between contaminant flux (from catchment sites) and the sources and losses of the contaminant within the watershed, and
3) information derived from the stream reach network about the special relations among contaminant fluxes, sources, landscape characteristics, and stream characteristics.

Developed by USGS in 1997, the SPARROW model is in the public domain and has been used in the US and abroad to model regions as well as individual watersheds. In 2016, the first bi-national application of the SPARROW model examined the levels of phosphorus and nitrogen being delivered to Lake Winnipeg from the Red-Assiniboine River basin.

Stressor-Response Model for the Red River of the North

The IRRB has identified excess nutrients as a major problem for the Red River, based on the levels of excess nutrients in reaches of the river and its sub-watersheds and on the contribution of Red River waters to hyper-eutrophic conditions in downstream Lake Winnipeg. To address these concerns, the IRRB contracted with RESPEC to help determine an approach to

establishing nutrient targets. It was determined that the study should examine the biological stressor response of the algal community to elevated nutrients as a way to determine targets. The RESPEC modeling identified algal communities and performed multiple statistical analyses to establish a statistically and ecologically valid relationship between the biological response and the measured environmental variables. A stressor-response of algae caused by nutrients was first indicated through determining the statistical correlations between the algal community and the established nutrient gradients. A stressor-response in quantity was apparent in both phytoplankton and periphyton, although the growth of the latter was significantly repressed by total suspended solids (TSS) concentrations.

After the analysis was completed, an effective nutrient stressor-response model was developed by using a combination of periphyton, phytoplankton, water quality, together with land-use information delineated through the application of SPARROW. Using the information from these analyses, nutrient targets were determined at 0.15 milligrams per liter (mg/L) for total phosphorus and 1.15 mg/L for total nitrogen. The appropriateness of MN's existing river standard for total suspended solids of 100 mg/L was reinforced by these analyses.

Gaps remain in the Stressor-Response analysis, in particular: 1) the role of dissolved oxygen's (DO) effect on biota; 2) the collective effect of oxbows and riparian wetlands; and 3) the degree to which cyanobacteria toxins, which bloom in the river before entering Lake Winnipeg, threaten municipal water supplies. The developers of the Stressor-response model also suggest that downstream water sources be considered, specifically the loading goals of Lake Winnipeg, in order to ensure compatibility between two sets of candidate targets, which share the goal of improved ecological health for both the Red River and Lake Winnipeg.

PART IV: MOVING AHEAD WITH INTEGRATED ACTION: CONCLUSIONS AND RECOMMENDATIONS

RED RIVER BASIN (RRB) – WATER QUALITY STRATEGIC PLAN (WQSP) for SEDIMENT AND NUTRIENTS: NITROGEN (N) AND PHOSPHOROUS (P)

The Red River Basin, like many other global and North American locations has water quality challenges. Some of these water quality challenges are being addressed by government, business, industry, landowner and stakeholder actions. Other water quality challenges remain. In the Red River Basin two things stand out. First, is that successful water quality improvements must have a basin-wide element or strategy behind them. And second, one of the most pressing issues, from a public and political perspective, that requires this basin-wide approach in the Red River Basin is the reduction in loading of sediment and nutrients: nitrogen (N) and phosphorus (P).

River system stressors such as lower levels of dissolved oxygen and aquatic habitat degradation are becoming more evident in the Red River Basin. Impacts from some of these stressors, new monitoring information, and data from models all indicate that this basin has been experiencing increasingly higher levels of sediment and nutrients (N and P) in the basin's surface waters. Impacts are now visually evident in Lake Winnipeg and other basin lakes as blue-green algal blooms, and they appear to be increasing frequency, duration and magnitude yearly. Sediment which is almost always an issue in prairie river systems is impacting the Red River system from increased stream bank erosion and basin-wide land management practices. Both are contributing sediment and nutrients: N and P to the Red River Basin waterways and lakes.

The **Red River Basin Commission** (RRBC) has identified the following conclusions and recommendations as Part IV: Moving Ahead with Integrated Action in the "Red River Basin (*RRB)-Water Quality Strategic Plan (WQSP): Sediment and Nutrients: Nitrogen (N) and Phosphorous (P)"* for stakeholders and leaders in the Red River Basin to address sediment and nutrients. RRBC has developed these basin-wide recommendations for action that will have positive impacts and provide overall benefits to the basin. These basin recommendations for action are directed toward the states of Minnesota, North Dakota and South Dakota, the Province of Manitoba, and both federal governments, local governments and all stakeholders to consider as they work individually and together to address sediment and nutrients: N and P in the Red River Basin waterways and lakes.

These recommendations are included in the *"RRB-WQSP for Sediment and Nutrients: N and P"* to serve as future strategies for action and as a baseline for measuring progress toward achieving water quality improvements in the Red River Basin. These recommendations will move water quality efforts in the Red River Basin forward with all levels of government and stakeholders participating and doing their part in implementing the recommendations.

1. BASIN CONNECTOR STRATEGY

1A International Red River Board (IRRB)
1B Red River Basin Commission (RRBC)
1C Basin Wide Dialogue and Cooperation

Sediments and nutrients have been increasing at various measuring points in the basin and data so far indicates that they are generated from all corners of the Red River basin. Visual and monitored impacts are becoming more and more evident in the basin surface waters. Lake Winnipeg, as the primary downstream indicator, shows increased visible summer-time blue-green algae blooms that affect tourism, recreation and fishing. Similar excess levels of sediment and nutrients are now also measurable in the Red River, its tributaries and in lakes across the basin.

Addressing the challenges of sediment and nutrients: N and P is a task that involves everyone who lives in the basin; businesses who operate here; and local, provincial, state and federal governance structures with defined responsibilities. Challenges confront leaders regarding what action to implement, who to regulate, what reductions and target levels are appropriate and a myriad of other issues that need to be addressed. In addressing these challenges, basin leaders, governments, agencies, stakeholder groups and citizens will accomplish more, do so more equitably, and experience greater stakeholder participation if they work together toward agreed upon common goals with everyone doing their part, than if they work independently.

The most immediate need is to begin addressing the sediment and nutrients: N and P challenges from a basin-wide approach based on basin-wide strategies. The International Red River Board (IRRB) and the Red River Basin Commission (RRBC) are working collaboratively to define the parameters, challenges, conditions and goals that a basin-wide effort needs to address. Both realize that engaging stakeholders and implementing actions in a fair and consistent manner requires actions that are consistent with jurisdictional mandates, funding, rules, regulations and laws. Both also realize the importance of working together where possible and the importance of individual and jurisdictional actions that promote basin-wide improvements. To assist this basin-wide effort the IRRB and RRBC have compatible, complementary, and connected initiatives that have begun and need to continue. As this basin-wide approach unfolds, jurisdictional actions will continue, and it is hoped that the basin-wide effort will help coordinate and perhaps guide jurisdictional approaches. This will eventually result in shared basin-wide identification of high priority areas, common targets, and goals shared by all.

1A INTERNATIONAL RED RIVER BOARD (IRRB)

The International Red River Board (IRRB) has been established by the International Joint Commission (IJC) to report semi-annually to the IJC on the following parameters at the

International Boundary: Dissolved Oxygen (DO), Total Dissolved Solids (TDS), Chloride, Sulfate, and Fecal Coliform bacteria (replaced by *Escherichia Coli bacteria* in 2000).

The IRRB can also work toward a better understanding of issues at the border, if so directed and approved by IRRB/IJC workplan and processes. At this time the IRRB has such a workplan and is working toward a better understanding of sediment and nutrients: N and P through research and monitoring (typically done by member agencies) as sediment and nutrients relate to the International Boundary between the United States and Canada. These efforts by the IRRB are being led by their Water Quality (WQ) Committee and may result in recommendations to the IJC from the IRRB that the IJC can then choose to recommend to the two governments (Canada and the United States).

The IRRB membership includes representatives from Manitoba, Minnesota, North Dakota, select federal agencies and the Red River Basin Commission (RRBC). These members are each working on sediment and nutrients: N and P reduction within their jurisdictional and organizational frameworks. Through the IRRB these individual efforts are collectively linked to higher levels of government through the IJC process.

Efforts to understand the impacts and challenges of sediment and nutrients: N and P reduction on a basin scale have been the key elements of the IRRB WQ Committee workplan for about the last decade. This committee brings representatives from the IRRB membership together to dialogue, to strategize and to bring recommendations for action forward for consideration by IRRB. RRBC provides staff support to this committee as needed. The IRRB WQC scope of work includes discussion and the development of recommendations to the IRRB on a range of water quality issues. Topics include: the identification of nutrient reduction strategies and practices best suited to the Red River Basin, basin monitoring, load allocations, tributary nutrient load allocations, prioritization of areas in the basin, and the development of criteria for both determining water quality conditions and for measuring progress towards water quality goals. The WQC also reports back to the IRRB membership on the progress of their work and with recommendations.

Recommendation for Action 1A.1 IRRB: International Border Leadership

1A.1.1 The IRRB should continue to provide basin focused leadership using the International Boundary as the focal point where political interests from the province, states, and federal government can be best addressed for common agreements and paths forward that have basin implications, utilizing the IRRB and IJC processes already in place.

1A.1.2 The RRBC will continue to work with the IRRB WQC to support the implementation of their WQ workplan to identify: nutrient reduction strategies and practices best suited to the Red River Basin, basin monitoring needs, load allocations, tributary nutrient load allocations, prioritization of areas in the basin, set of common factors, and continued

monitoring of sediment and nutrients reporting back to the IRRB membership for further action, as deemed appropriate.

1A.1.3 The IRRB continues to discuss their WQ Committee workplan recommendations and seek IRRB board action.

1A.1.3.a IRRB can determine the next step, which could include moving these recommendations forward to the IJC for their consideration and potential recommendations to governments.

1A.1.3.b IRRB members can take actions separately or jointly, as appropriate, and continue to work toward the basin-wide efforts identified in the IRRB workplan so that as a basin we move in the same direction for the same purposes.

1B RED RIVER BASIN COMMISSION (RRBC)

RRBC is a registered charity in Canada and non-profit in the United States and was first established by local leaders (particularly local mayoral leadership) in 1979. RRBC seeks to work across the political boundaries of Minnesota, North Dakota, and South Dakota in the United States and Manitoba in Canada, in the Red River Basin. RRBC has developed a Natural Resource Framework Plan (NRFP) for the basin that has 13 basin-wide goals. Goal #9 relates to water quality and this effort on sediment and nutrients: N and P reduction falls primarily under this goal. Other goals related to soil conservation, education, basin-wide approach and integration, natural resources enhancement and even recreation also have connections to this effort.

The RRBC Board 88-member delegate/alternate membership includes: local governments: cities, counties, rural municipalities, and water boards; provincial and state agencies; citizen, environmental non-governmental organizations; and tribes/First Nations. This membership comes from Minnesota, North Dakota, South Dakota, and Manitoba. In addition, all federal and state elected leaders and federal agencies are welcome and have an ex-officio role on the Board.

Working together with its membership, the RRBC seeks to promote a basin-wide approach that challenges and encourages everyone to look at, and act on, the “big picture”. “How can we all work on this together”, “what do we need from a basin-wide perspective” and “what can we do now to preserve the future for our children and grandchildren” are some of the concepts that are always on the forefront of RRBC efforts. Almost all the projects, education, and engagement activities of RRBC have relevance across political boundaries and have basin-wide significance.

Recommendation for Action 1B.1 RRBC: Basin-wide Leadership

1B.1.1 Continue to use the RRBC Basin Water Quality (WQ) Steering Committee, that represents a wide variety of stakeholders, from: cities, industry,

agriculture, and provincial and state agencies around the basin, to develop and promote basin-wide consensus and approaches to sediment and nutrients: N and P reduction.

1B.1.2 The RRBC Basin WQ Steering Committee should discuss and provide feedback to the IRRB WQ Committee and their workplan.

1B.2.a The RRBC Basin WQ Steering Committee feedback should focus first on IRRB WQ Committee efforts related to basin goals, targets, nutrient loads, prioritization, common indicators, and other nutrient reduction strategies.

1B.1.3 RRBC should continue to use *the "RRB-WQSP for Sediment and Nutrients: N & P"* to measure success and regularly update to promote basin-wide solutions.

1B.1.3.a RRBC should regularly update *the "RRB-WQSP for Sediment and Nutrients: N & P",* with input from their Basin WQ Steering Committee, input from the IRRB WQ committee, and linkages to the IRRB WQ workplan outcomes.

1B.1.3.b RRBC should use the *"RRB-WQSP for Sediment and Nutrients: N & P"*, their Basin WQ Steering Committee, input from the IRRB WQ committee, and the IRRB WQ workplan outcomes to provide annual updates as "State of the Basin WQ Reports" to the RRBC Annual Summit Conference.

1C BASIN WIDE DIALOGUE AND COOPERATION

IRRB and RRBC work together on several issues. On water quality issues, the IRRB has a WQ Committee that RRBC participates in. In addition, RRBC has two board members on the IRRB where committee recommendations are discussed and acted upon. Conversely, many of the IRRB members participate in the RRBC Basin WQ Steering Committee and have provided input and direction to the development of the *"RRB-WQSP for Sediment and Nutrients: N & P".* Together the two organizations are positioned to create basin-wide opportunities for multiple stakeholder participation in addressing sediment and nutrients: N and P reduction in the Red River Basin.

Recommendation for Action 1C.1 IRRB and RRBC Connectors

1C.1.1 The IRRB WQ Committee, representing provincial, state and federal Canada and United States government should continue to meet regularly to fulfill their 3-year workplan, assisted by RRBC.

1C.1.2 The RRBC Basin WQ Basin Steering Committee, representing basin stakeholder groups should continue to meet regularly to implement, report

on and update the *"RRB-WQSP: Sediment and Nutrients: N & P*".

1C.1.3 The IRRB WQ Committee and the RRBC Basin WQ Steering Committee should discuss and determine how to best integrate, link, and provide input to each other's efforts in the following areas: IRRB WQ workplan; RRBC "*RRB-WQSP: Sediment and Nutrients: N & P*" development, stakeholder engagement and updates; and the RRBC Annual Conference "State of the Basin WQ Report".

2. BASIN CORNERSTONE STRATEGY

2A The Border and the Basin

The cornerstone strategy for sediment and nutrient reduction in the Red River Basin is shaped by efforts at the international boundary and in the Red River Basin. The work and efforts of IRRB: WQ Committee and their WQ workplan targets the international boundary and how basin issues impact water quality. The work and efforts of RRBC: NRFP, WQ Basin Steering Committee, "RRB-WQSP for Sediment and Nutrients: N & P" and Annual Summit Conference "State of the Basin WQ Report" assist in keeping the basin picture at the forefront. As stated above there is significant member and participant crossover between the IRRB and RRBC, their respective committees, and their efforts. Jointly, the initiatives by the IRRB and RRBC are paving the way for a much clearer understanding of basin-wide sediment and nutrient issues and potential cooperative joint and complimentary individual actions that will promote basin-wide sediment and nutrient: N and P reduction solutions.

To address sediment and nutrients: N and P in the Red River Basin we have two available pathways: 1) to address the challenges, independently, inside each jurisdictional boundary, or 2) to work together from a larger perspective. Currently pathway 1) is underway. Pathway 2) is the main target of efforts by IRRB and RRBC.

RRBC is recommending that we blend the two approaches, continuing to do what can be done within each jurisdictional boundary, based on jurisdictional mandates and available funding, while at the same time continue to use the efforts of IRRB and RRBC to expand the basin-wide approaches and move toward establishing basin-wide goals and targets. This strategy will provide the cornerstone of a basin-wide effort recognizing the value of each pathway, moving ahead where we can, using joint efforts where possible, implementing common approaches where there is agreement, and promoting action and equity in efforts around the basin.

Efforts to understand the impacts and challenges of sediment and nutrients: N and P on a basin scale have been the key elements of the IRRB WQ Committee work plan for about the last decade. This committee brings representatives from the IRRB membership together to dialogue, strategize and to bring recommendations for action forward for consideration by IRRB. These recommendations may include the identification of nutrient

reduction strategies and practices best suited to the Red River Basin, basin monitoring, load allocations, tributary nutrient load allocations, prioritization of areas in the basin, and the development of criteria for both determining water quality conditions and for measuring progress towards water quality goals.

Efforts related to water quality have been part of RRBC activities since the development of their RRB-NRFP. Various projects over the years have increased awareness and understanding of water quality issues in the Red River Basin. The recent effort to focus in on sediment and nutrients: N and P reduction, has led to the establishment of their Basin WQ Steering Committee and the effort to produce this "RRB-WQSP for Sediment and Nutrients: N & P."

Coupling the efforts of the IRRB and the RRBC joins the best of two basin-wide approaches. This coupling of efforts incorporates the political and basin-wide realities of the Red River Basin. IRRB brings governments together in a political manner that is practically and visibly evident at the international boundary. Here, all the political jurisdictions are linked to working together for the common good of both countries, under the auspices of the 1909 Boundary Waters Treaty, that is upheld and implemented by the International Joint Commission (IJC) with assistance from IRRB and its regional structure. The water quality workplan in progress through the IRRB provides the key elements for this cornerstone basin-wide strategy on sediment and nutrients: N and P reduction.

The IRRB WQ workplan will be incorporated into the RRBC effort on the "*RRB-WQSP for Nutrients: N and P"* as the major recommendations for action under this cornerstone section. As the IRRB workplan unfolds and information is updated into the "*RRB-WQSP for Nutrients: N and P"* several paths of action are available. 1) IRRB will discuss the workplan outcomes and may choose to recommend elements to IJC for their consideration to determine if recommendations to higher governments is warranted. 2) Jurisdictions may decide to act on portions of the IRRB workplan outcomes either independently or jointly. And 3) RRBC can and will promote IRRB agreed upon workplan outcomes throughout the basin along with other elements of the "*RRB-WQSP for Sediment and Nutrients: N and P"* through their ongoing engagement activities.

2A. THE BORDER AND THE BASIN

Development of a watershed-based approach to managing sediment and nutrients: N and P in the Red River Basin is a long-term effort. It will take time to identify nutrient reduction strategies and practices best suited to the Red River Basin, establish full basin-wide monitoring and trend assessment, set load allocations, set tributary nutrient load allocations, prioritize areas in the basin for action and develop criteria. Much of the work related to these items is underway and listed in the IRRB WQ workplan for the next three years. Using the international boundary as the focal point we will gain data and insights into the sediment and nutrient: N and P problem in the Red River Basin that will lead to discussions and hopefully outcomes on basin-wide agreed to parameters to measure problems, act, and track successes. RRBC participates in and

supports the IRRB WQ Committee efforts on the IRRB workplan and links these efforts to RRBC efforts such as the "*RRB-WQSP for Sediment and Nutrients: N & P".*

Recommendation for Action 2A.1 Nutrient Reduction Actions and Activities: for major source categories (industrial/municipal point sources, storm water, animal feeding operations, septic systems, and NPS-primarily agricultural).

2A.1.1 Identify nutrient reduction actions and activities that could assist in achieving nutrient load allocation and/or water quality targets.
2A.1.2 Review and report on the nutrient reduction actions and activities most likely to be effective in the Red River Basin.

Recommendation for Action 2A.2 Monitoring, Data, and Communication.

2A.2.1 Develop sediment and nutrient reduction indicators, measures and/or metrics to measure progress
2A.2.2 Develop process for monitoring, data collection, analysis, storage and communication regarding results.
2A.2.3 Implement monitoring and reporting.

Recommendation for Action 2A.3 Nutrient Load Allocations: The IRRB WQC scope of work includes discussion and the development of recommendations to the IRRB on a range of water quality issues including nutrient load allocations.

2A.3.1 Obtain approval of nutrient targets from IRRB through the federal government processes, (especially under auspices of IJC)
2A.3.2 The RRBC continues to work with the IRRB WQC to facilitate implementation of nutrient load allocations necessary to meet Water Quality Target for Nutrients. Prioritize sub-watersheds for nutrient load reductions.
2A.3.3 Finalize and obtain approval of methods for measuring compliance with nutrient targets by IRRB.

Recommendation for Action 2A.4 Tributary Nutrient Load Allocations: Each jurisdiction will need to go through the exercise of tributary allocation and could seek a common approach through the WQ Committee if there was jurisdictional agreement.

2A.4.1 Use available data and water quality objectives for Lake Winnipeg to begin to develop load allocation and /or targets for tributaries.
2A.4.2 Use of Contractor or Agency resources.
2A.4.3 Complete development of load allocations for tributaries.

Recommendation for Action 2A.5 Common Set of Indicators.

2A.5.1 Review information to be used in development of a Common Set of Indicators for Measuring Progress.

2A.5.2 Begin development of a Common Set of Indicators for Measuring Progress.
2A.5.3 Complete development of a Common Set of Indicators for Measuring Progress.

Recommendation for Action 2A.6 Monitoring and Reporting.

2A.6.1 Monitor and Report on Progress towards Meeting Water Quality Targets and Nutrient Load Allocations related to the IRRB workplan.

3. BASIN BUILDING BLOCK STRATEGY:

3A Red River Basin
3B Red River Mainstem
3C Red River Tributaries
3D Red River Sub-Watersheds

The RRBC will use the work of the IRRB Water Quality Committee as the cornerstone for working toward agreement on issues in the basin related to sediment and nutrients. The RRBC Water Quality Steering Committee provides the primary mechanism to bring stakeholders together to talk together about goals, targets, loads, and other nutrient reduction strategies from a basin-wide perspective. The RRBC WQ steering committee also provides a venue to bring the RRBC-WQSP to stakeholders for their information, feedback and partnership in implementing actions to address basin sediment and nutrient reduction strategies.

We will use three watershed based geographical reference points, the Red River mainstem, tributaries that flow directly to the Red River and those remaining tributaries that flow into larger tributaries to establish a process for sharing information, receiving feedback and implementing actions. This approach will provide a way to measure progress and demonstrate the benefits of working at all three of these scales.

3A. RED RIVER BASIN

We all need to work together to reduce sediment and nutrients: N and P in the Red River basin using Lake Winnipeg as one of the litmus tests for implementing actions throughout the basin. These actions will need to occur within jurisdictions at the local level to reduce nutrients and sediment delivery within improve sub-watersheds and to the Red River. The following actions, implemented by each jurisdiction in the basin, should help address and promote the RRBC, “RRB-WQSP for Sediment and Nutrients: N and P” recommendations as well as IRRB activities related to their workplan and any recommendations that IRRB would forward to IJC for consideration. These combined

efforts will assist in the identification of high priority areas in the basin that will provide the biggest beneficial impacts for the funds that are expended.

Recommendation for Action 3A.1 Continue to monitor and track sediment and nutrients in Lake Winnipeg to determine if there is improvement in the health of Lake Winnipeg (as evidenced by decreasing the frequency, duration, and magnitude of blue-green algae blooms) that can be attributed to actions Implemented throughout the Red River basin.

Recommendation for Action 3A.2 Work together as a basin, to explore joint jurisdictional funding opportunities to implement actions based on the IRRB identified high priority sub-watersheds.

Recommendation for Action 3A.3 Identify indicators and measure that can assist in establishing high priority areas for addressing sediment and nutrient reduction.

Recommendation for Action 3A.4 Continue to update and use water quality and land use models to assist in the identification of high priority sub-watersheds, specific priority areas, and to measure progress toward basin-wide reduction goals.

3B. RED RIVER MAINSTEM

Work together to reduce the delivery of sediments and nutrients: nitrogen and phosphorous loading on Red River by using the International Boundary and other mainstem river sites as a way to integrate and compile the efforts of the jurisdictions.

Recommendation for Action 3B.1 Continue to monitor in Minnesota, North Dakota, and Manitoba at the point of entry into the Red River to assist the IRRB and jurisdictions in identification of high priority tributary sub-basins for the reduction of sediment and nutrient: nitrogen and phosphorous.

Recommendation for Action 3B.2 RRBC should educate leaders and public that the Red River has high levels of nutrients: nitrogen and phosphorous.

Recommendation for Action 3B.3 Work together, within jurisdictional boundaries, toward reducing nutrient NPS run-off to the Red River and its Tributaries.

Recommendation for Action 3B.4 Work together, within jurisdictional boundaries, toward reducing nutrient NPS and PS discharges into the Red River and its tributaries.

Recommendation for Action 3B.5 Work together, within jurisdictional boundaries, to address and reduce excess sediment originating from stream bank and bed erosion throughout the basin.

3C. RED RIVER TRIBUTARIES

Work together to reduce the delivery of sediments and nutrients: nitrogen and phosphorous to the major Red River tributaries using water quality data collected and compiled at the point where the tributary enters the Red River as a way to integrate and compile the efforts of the jurisdictions.

Recommendation for Action 3C.1 Continue to monitor all tributaries in Minnesota, North Dakota, and Manitoba at the point of entry into the Red River to assist the IRRB and jurisdictions in identification of high priority tributary sub-basins for the reduction of sediment and nutrient: nitrogen and phosphorous.

Recommendation for Action 3C.2 Conduct education on tributary nutrient loads and sources in addition to efforts on the Mainstem.

Recommendation for Action 3C.3 Continue to support the work of the jurisdictions in the United States to address impaired waters, as identified in the three states under the Clean Water Act and develop total maximum daily loads that will eventually lead to load reduction goals and strategies to achieve these goals.

Recommendation for Action 3C.4 Continue to work in Manitoba towards nutrient reduction goals for Lake Winnipeg and those that are identified in the Manitoba Water Quality Standards Objectives and Guidelines Regulation and through the Integrated Watershed Management planning process.

Recommendation for Action 3C.5 Work within all jurisdictional boundaries to address and reduce excess sediment from stream bank, stream bed and field erosion originating from the major tributaries.

3D. RED RIVER SUB-WATERSHEDS

Work together to reduce the delivery of sediments and nutrients: nitrogen and phosphorous originating from priority sub-watersheds in the Red River basin and its major tributaries using measurements at the lowest downstream point in the sub-watershed where the sediments and nutrient concentrations are usually the greatest. Address sediments and nutrients: nitrogen and phosphorous in each sub-watershed by efforts in each jurisdiction based on their modeling, prioritization efforts and available funding.

Recommendation for Action 3D.1 Identify highest priority sub-watersheds in the Red River tributaries based on monitoring and modeling efforts and then develop strategies to address the sediment and nutrients in these high priority areas, as a basin or by jurisdiction.

Recommendation for Action 3D.2 Reduce the delivery of sediment and nutrients: nitrogen and phosphorous origination from priority sub-watersheds by targeting

streambank and bed erosion and land use strategies.

Recommendation for Action 3D.3 Based on landscape and field level (or catchment scale) modeling, identify priority sediment and nutrient delivery areas in the sub-watershed and use this information to develop watershed or sub-watershed level plans and action.

Recommendation for Action 3D.4 Implement beneficial management practices deemed most appropriate for reducing the delivery of sediment and nutrients in the Red River basin in priority areas identified in Action 3D. 3 through appropriate provincial, state and federal agencies, using established jurisdictional approaches that fit their budgets and programs.

Recommendation for Action 3D.5 Continue to monitor and increase our understanding of the role of detention/retention sites in managing runoff and reducing sediment and nutrients in sub-watersheds.

3D.5.1 Continue to study sites such as North Ottawa to determine the water quality benefits related to sediment and nutrient reductions that detention/retentions sites provide by slowing and holding water as well as various benefits provided by vegetative growth.

3D.5.2 Continue to work through the Red River Retention Authority (RRRA) to maintain funding in the next U.S. federal farm bill, for detention/retention sites in the Red River Basin.

3D.5.3 Continue to work through the RRRA and local water boards in Minnesota and North Dakota to build multiple benefit detention/retention sites.

Recommendation for Action 3D.6 Work together to utilize and maximize existing funding mechanisms and investigate new programs for funding to implement beneficial management practices identified by the IRRB WQ workplan and the jurisdictions as most effective for the Red River basin.

Recommendation for Action 3D.7 Work within priority sub-watersheds to reduce sediment origination from stream bank and bed erosion.

4. BASIN DATA AND TOOLS STRATEGY

Efforts are underway in the Red River Basin to assist in the understanding of loads, yields, concentrations, trends, highest contributing areas related to sediment and nutrients: nitrogen and phosphorous from the basin perspective all the way down to the sub-watershed and field scale or individual landowner perspective. Information and strategies to address these sediment and nutrient issues in the basin range from qualitative narrative explanations to numeric standards and are formulated based on monitoring data, modeling that provides information at a basin-wide level, a watershed level, a sub-watershed level and individual farm scale level.

The narrative approach to water quality standards used by all the jurisdictions is a beginning point that identifies the water quality goal in a general way and establishes a general overall narrative nutrient standard. A narrative nutrient standard, numeric targets or threshold, is set which can be used to assess water quality problems/impairments associated with nutrients and to with a TMDL (total daily maximum load) to determine load reduction targets and strategies. Monitoring is used in both assessment and TMDL development as a means of interpreting the numeric target or threshold. As more detailed modeling and monitoring information becomes available that shows clear relationships between nutrient concentrations and loading and water quality response variables, the goal is to set numeric nutrient standards. Minnesota and Manitoba currently have some of these numeric standards and North Dakota and South Dakota are working towards their development.

Together these approaches and information are shaping the way we are working toward actions that address the issues basin-wide, at the International Border, in the Red River, in the Red River major tributaries, at the sub-watershed level, and finally at the individual landowner level (urban and rural). The data and tools we are using can be categorized into 4 areas

4A Narrative and Numeric Nutrient Standards
4B Monitoring, Modeling and Analysis
4C Report/Analysis

4A. NARRATIVE

Recommendation for Action 4A.1 Continue to develop sediment and nutrient: nitrogen and phosphorus targets and thresholds as a means of translating narrative nutrient criteria.

Recommendation for Action 4A.2 Continue to monitor and assess water quality impairments due to sediment and nutrient problems using narrative standards and numeric targets and thresholds.

4A.2.1 Continue to use biological indicators to identify streams and watersheds impacted by sediment and nutrients and to implement appropriate strategies.

Recommendation for Action 4A.3 Continue to refine and improve numeric thresholds and targets used to translate narrative standards moving toward numeric nutrient standards which will be used for assessment, TMDLs, and permitting.

Recommendation for Action 4A.4 Continue to use textual narrative in Manitoba through their Integrated Watershed Management process to address sediment and nutrients as specific targets with consideration given to efforts on the Red River the Assiniboine River and the Rainy/Lake of the Wood in context of Lake Winnipeg targets.

4A.3.1 Move toward load reductions goals in Manitoba watersheds through the Integrated Water Management Plan process.

4B. MONITORING, MODELING & ANALYSIS

Recommendation for Action 4B.1 Continue monitoring at sites that are in place and work together and within jurisdictions with all partners to expand monitoring in the basin.

Recommendation for Action 4B.2 Expand monitoring related to IRRB and jurisdictional high priority areas to list impairments and to track future successes for each tributary throughout the sub-watersheds and at other places in the basin as needed.

Recommendation for Action 4B.3 Work jointly toward real-time monitoring throughout the basin.

Recommendation for Action 4B.4 Continue to update older models with current data to show more accurately current impacts on sediment and nutrients based on changes implemented since the original data (oftentimes decades old) was inputted.

Recommendation for Action 4B.5 Continue to use the USGS WQTrends analysis modeling to increase the understanding of sediment and nutrients over time in the Red River basin.

4B.5.1 Continue building the USGS WQTrend analysis model to provide current and future WQ analysis capabilities over time at multiple basin locations to provide baseline data that can be used in future analysis of WQ trends in the basin.

4B.5.2 Seek funding to update the USGS WQTrend analysis every 5 years to show WQ trends.

4B.5.3 Link the USGS WQ Map Story, to the USGS WQTrend analysis and the annual "State of the Basin WQ Report" that RRBC (with IRRB and USGS input) will produce, showing WQ site locations and site data in the basin using 1, 5, and 10-year history of data back to 2003.

4B.5.4 Update the USGS WQ Map Story annually and link effort to the annual "State of the Basin" update of RRBC and IRRB efforts.

Recommendation for Action 4B.6 Continue to use and update the USGS SPARROW model to clarify the basin picture, to help identify high priority areas in the basin, and to assist with recommendations through IRRB at the International Border.

4B.6.1 Continue to update the SPARROW model with data from 2010-2017 that also includes the data harmonization information across the international boundary and use the new model to assist the IRRB and jurisdictions in their efforts to implement their workplans for sediment and nutrients on the Red River and for the Red River basin.

4B.6.2 Summarize work underway to identify high priority areas (geographical, social, economic) including links to SPARROW project.
4B.6.3 Report to IRRB on high priority areas for implementing nutrient reduction measures.
4B.6.4 Link identification of priority areas with actions and activities.
4B.6.5 Actions and activities that are most likely to be effective in the Red River Basin will be identified for specific high priority areas.

Recommendation for Action 4B.7 Continue to finish the Hydrologic Simulation Program Fortran (HSPF) modeling in the Minnesota portion of the Red River basin that provides sediment and nutrient results at a very small sub-watershed level (dozens of sub-watersheds in an 8 unit HUC watersheds).

4B.7.1 Use the numeric generated results from the HSPF modeling to identify the sediment and nutrient contributing "hot spot" small watersheds to prioritize areas for action.

4B.7.2 Include all HSPF modeling results and the stressor identifications in the Minnesota PCA WRAP report and distribute to all relevant state and local governmental structures and other groups and interested stakeholders.

4B.7.3 Develop strategy to get the modeling results and other relevant information to all local governmental units, groups and interested stakeholders through appropriate engagement activities: workshops, conferences, meetings, and tours.

Recommendation for Action 4B.8 Manitoba should assess the decision support modelling tools that have been completed and that are currently under development with respect to nutrient management on the landscape (e.g., PTMApp and SWAT).

It is recommended that Manitoba select appropriate modelling approaches and expand modelling across watersheds to target best management practices (BMP) in 'hotspot' areas to work towards meeting the nutrient loading targets.

Recommendation for Action 4B.9

4B.9.1 Consider adoption of PTMApp in all U.S. jurisdictions as PTMApp is developed and available for local users, for watershed districts, water resource districts, soil and water conservation districts and soil conservation districts.
4B.9.2 Continue to seek funding in the jurisdictions to create a hydro- conditioned digital elevation model (h3DEM) needed as input for PTMApp:
4B.9.3 Continue to seek funding in Minnesota, to enable use of similar application (PTMApp or HSPF if capabilities are similar) for the Sandhill River, Red Lake River, Middle River, Tamarac River, Snake River and Two Rivers

watershed.

4B.9.4 Continue to build PTMApp in North Dakota, with funding already in place to do the entire North Dakota portion of the Red River basin.

4B.9.5 Continue to build PTMApp in South Dakota, with funding already in place for the sub-watersheds in South Dakota through the Boise de Sioux Watershed in Minnesota and Wild Rice River, in North Dakota projects respectively.

Recommendation 4B.10 Develop a training and outreach strategy to reach individual landowners and local governments such as water boards, soil and water boards, soil conservation boards, and conservation districts on the use of and results from landscape and field level models for local and farm level planning and implementation of actions to reduce sediment and nutrients.

4B.10.1 The training should illustrate how local farm scale modeling can be used to develop larger sub-watershed and watershed strategies to reduce sediment and nutrients.

4D. REPORT/ANALYSIS

Recommendation for Action 4D.1 An economic analysis related to WQ benefits gained verses costs of implementation of all PS and NPS strategies should be done (or updated) to include current data related to fiscal, social and environmental values.

5. BASIN PILOT PROJECTS STRATEGY

Pilot projects will demonstrate approaches that have the potential to reduce sediment and nutrients: nitrogen and phosphorus impacts in the basin. Pilot projects offer voluntary verses regulatory solutions to the sediment and nutrient problems in the basin.

There are traditional and emerging approaches that need to be analyzed, understood, and promoted that have the potential to assist in actual sediment and nutrient load reductions or in offsetting the cumulative impacts of nutrients. Some of these projects are related to fiscal issues, some to water management systems in place, and some are related to individual activities on the land. The implementation and benefits of these activities can be better understood by a pilot project to demonstrate their viability, process and benefits. The following pilot projects are recommended.

5A Nutrient Credit Trading
5B: Drainage Connectivity
5C: Seeding/Cover Crop Strategies
5D: Storm Water Runoff
5E: Rural Septic Fields

5A. PILOT PROJECT: NUTRIENT TRADING CREDITS

Recommendation for Action 5A.1 Create two Nutrient Credit Trading Pilot Projects for the Minnesota portion of the Red River basin in 2018-2019.

5A.1.1. RRBC will seek funding from Minnesota to create a Nutrient Credit Trading Steering Committee to guide and assist in the development of a Nutrient Credit Trading strategy/report that will work for the Red River basin (and Minnesota) related to sediment and nutrients: nitrogen and phosphorus.

5A.1.2 RRBC will seek funding from Minnesota to develop two Nutrient Credit Trading Pilot Projects in the Minnesota portion of the Red River basin, based on the Nutrient Trading Credit strategy/report one in the north with a focus on Thief River Falls and the other in the south with a focus on Moorhead.

5A.1.3 RRBC will share the Nutrient Credit Trading strategy/report and pilot project activities with neighboring jurisdictions in the Red River basin, for their input during each step with the goal of seeking their buy-in regarding implementation actions and expansion to a basin-wide effort.

5A.1.4 RRBC will seek funds from Minnesota to jump start a Nutrient Credit Trading financial pool, that neighboring Red River basin jurisdictions will be asked to join that will enable basin-wide Nutrient Credit Trading.

5A.1.4.1 The Nutrient Credit Trading pool of funds will be managed and used by the RRBC board of directors (representing a large balanced cross-section of basin stakeholders) for basin-wide trading and will be self-sustaining with growth strategies.

5A.1.5 Encourage engagement by Manitoba, North Dakota and South Dakota from the beginning in this pilot project for their input and hold workshops and meetings as needed to develop a basin-wide strategy.

5B. PILOT PROJECT: DRAINAGE WATER MANAGEMENT

Recommendation for Action 5B.1 Drainage Water Management (DWM) Projects to illustrate future options for more comprehensive water management efforts in the basin should be pursued and supported by local, provincial, state and federal governments.

Recommendation for Action 5B.2 Two Pilot Projects on Comprehensive Drainage Management (CDM) should be pursued: 1) in the Buffalo-Red Watershed District in Minnesota and one in North Dakota by the Cass County Joint Water Resource Board.

Recommendation for Action 5B.3 Develop a Pilot Project on CDM focusing on the

relationship between retentions sites and drainage (surface/tile) in the lower 1/3 of the Buffalo-Red Watershed.

5B.3.1 Create a partnership between the Buffalo-Red Watershed District (as lead), RRBC, EERC, NRCS and Ellingson Drainage, to explore all funding options to create a Pilot Project: Drainage Water Management in the lower 1/3 of the watershed closest to the Red River that explores the effects and optimal management of DWM on water quality and nutrient reduction.

Recommendation for Action 5B.4 Develop a DWM Pilot Project focusing on tile-surface drainage interface on a larger scale in North Dakota through the Cass County Joint Water Resource District.

5B.4.1 Create a partnership between the Cass County Joint Watershed District (as lead), RRBC, NDSU, NRSC, RRRA, Ellingson Drainage and others, to explore all funding options to create this pilot project in an east/west manner in a contiguous sub-watershed to better understand the interface of tile and surface drainage on a larger scale.

5B.4.2 Seek NRCS and CCJWRD funding to scope the project in July-September of 2018.

5B.4.3 Identify all elements of a project that could be included such as: culvert sizing, precipitation monitoring, water quality monitoring, flow monitoring, modeling of information, cover crop strategies, surface drain systems, tile drain strategies and controls and whatever else would assist in total water management strategies to reduce impacts from flooding, sediments and nutrients, while maintaining economic viability for landowners and seek funding to implement as many practices as possible.

5C. PILOT PROJECT: SEEDING AND COVER CROPS

Recommendation for Action 5C.1 RRBC should explore stakeholder education opportunities working with NDSU and Amity to promote the new seeding and cover crop strategies for corn row crop under development at NDSU**.**

Recommendation for Action 5C.2 These cover crop strategies should be considered for incorporation into the Pilot Project for Drainage Connectivity in the North Dakota pilot project.

5D. PILOT PROJECT: STORM WATER RUNNOFF

Recommendation for Action 5D.1 Groups like: River Keepers, Save the Seine, Native Prairie Solutions, Ducks Unlimited, and RRBC in the major urban areas: Breckenridge/Wahpeton, Fargo/Moorhead, East Grand Forks/Grand Forks, Morris, Winnipeg, Selkirk on the Red River and other urban communities on the tributaries should

work together to develop pilot projects for education and information on the impacts of urban storm water runoff particularly related to sediment and nutrients to educate the public and local leaders on the problem and remedies.

5E. PILOT PROJECT: RURAL SEPTIC FIELDS

Recommendation for Action 5E.1 Jurisdictions and RRBC should work together through the IRRB and RRBC Water Quality Committees to develop a pilot projects to link to workshops and tours to illustrate the challenges of addressing rural septic fields and their potential impacts on nitrogen and phosphorus. Ensure tours are conducted in partnership with appropriate agencies in the various jurisdictions.

6. BASIN COMMUNICATION STRATEGY:

One of the best ways to promote a change in behavior and progress toward basin wide goals that improve the condition of our water and land resources, is to enhance communication throughout the basin, which will accomplish two basic purposes. First, to gather feedback from stakeholders related to regulations and/or proposed regulations. And second, so that stakeholders can learn about alternative techniques or emerging concepts.

First, we need to create two-way communication so that there is buy-in at the local levels for actions that have the potential to reduce sediment and nutrients. This two-way communication also creates the opportunity to promote the adoption of approaches that are voluntary and emerge because everyone sees the problems and together are willing to work toward common goals—each doing their part knowing that others are also contributing.

Second, learning about what the needs are, what needs to be done, who is doing what, and what is working gives stakeholders in the basin the opportunity to voluntarily implement actions based on successes in other places. Learning about what works and why, can encourage stakeholders to voluntarily adopt similar practices, especially if the economic advantages are clearly understood. This approach moves away from regulation and promotes a good will effort by all stakeholders to get involved and do their part. If economic benefits can be illustrated implementation is even more attractive. This basin wide communication strategy can be accomplished best by utilizing, focusing, and expanding efforts that are already in place or are under development. They fall into three major areas.

6A: Stakeholder Engagement
- 6A.1: RRBC Activities
- 6A.2: Partnership Activities
- 6A.3: RRBC Basin Conference

6B: Plans
6C: Updates

6A. BASIN STAKEHOLDER ENGAGEMENT

Recommendation for Action - RRBC Activities: 6A.1 RRBC has groups in place that meet regularly to learn, discuss, plan and work together on Red River basin issues. These groups provide excellent forums to create the two-way dialogue to gather feedback and buy-in and to create opportunities for stakeholders to learn and adopt successful actions others are doing.

6A.1.1 Minnesota 15 County Joint Powers Board is composed of County Commissioners from the 15 Minnesota Counties that border the Red River and meets quarterly.

6A.1.2 South Valley Initiative is composed of stakeholders (citizens and local leaders) from Minnesota, North Dakota and South Dakota at the southern end of the Red River basin around the Lake Traverse area and meets 2-3 times a year.

6A.1.3 Roseau River International Watershed is composed of local leaders and stakeholders from Minnesota and Manitoba in the Roseau River area and meets 2-3 times a year.

6A.1.4 Pembina River Basin Advisory Board is composed of local leaders, citizens, farmers and other stakeholder from Manitoba and North Dakota in the Pembina River area and meets 2-3 times a year.

6A.1.5 RRBC North Chapter includes local and provincial leaders on the north side of Winnipeg and meets 10 times a year with a large annual 100+ dinner gathering.

6A.1.6 RRBC South Chapter includes local and provincial leaders on the south side of Winnipeg and meets 10 times a year with a large annual 100+ dinner gathering.

6A.1.7 RRBC Board: is represented by 88 Directors and Alternates board members composed of state, provincial, local, tribal/first nation, organization, and citizens and meet 5 times a year with one meeting for federal agency discussions and either 1-2 other meeting in conjunction with tours.

Recommendation for Action - Partnership Activities: 6A.2 RRBC partners with and links to other groups, agencies, and outreach engagement efforts around the basin, through presentations, discussion and dialogue to create the needed two-way communication and leaning opportunities. This is accomplished by workshops, conferences, and meetings.

6A.2.1 RRBC will assist with North Dakota Agriculture and Department of Health (Department of Environmental Quality after transition is complete) workshops for landowners in the basin.

6A.2.2 RRBC will participate and present at Minnesota farmer summer meetings

through MN Farm Bureau.

6A.2.3 RRBC will partner with Manitoba Agriculture and Sustainable Development to plan and execute engagement meetings with landowners on sediment and nutrients and promote the Manitoba ecological goods and services program called GROW.

6A.2.4 RRBC will link to South Dakota DENR and Agriculture to connect to local landowners in the southern portion of the basin.

6A.2.5 RRBC will partner with other groups to hold meetings for provincial and state legislators in the basin on progress toward the RRB- WQSP for Sediment and Nutrients: Nitrogen and Phosphorus recommendations.

6A.2.6 Work through the RRRA to create funding opportunities in the next U.S Federal farm bill for farmer programs that pay for sediment and nutrient reduction opportunities.

6A.2.7 RRBC will continue to explore other opportunities with commodity and farm groups, business and industry groups, and any other group or agency planning on doing outreach to stakeholders and assist as needed.

6A.2.8 Participate in the ND DOH state nutrient stakeholder meeting in May 2018.

6A.2.9 Create opportunities for engagement, dialogue and communication of information with Soil and Water Conservation Districts in MN, Soil Conservation Districts in ND and SD, Conservation Districts in MB, Water Resource Districts in ND and Watershed Districts in MN at the local level.

Recommendation for Action - RRBC Basin Conference: 6A.3 RRBC has an annual summit conference that bring together 400 – 500+ leaders, citizens, agencies and other stakeholders from around the basin to learn, keep informed, dialogue, and build relationships to promote cooperation.

.

6A.3.1 Keynotes, Presentations and Panels to promote updates and information on sediment and nutrients, a basin approach, standards, goals, targets, and progress being made in the Red River Basin.

6A.3.2 Provide annual progress updates “State of the Basin: RRB-WQSP for Sediment and Nutrients: Nitrogen and Phosphorus recommendations.

6A.3.3 Continue to educate on topics such as: role of climate. BMP’s for cold weather areas, drainage: tile/surface, new cover crop planting techniques, nutrient trading, pilot projects in the basin and other relevant and current topics.

6B. PLANS

Recommendation 6B.1 RRBC will link RRB-WQSP for Sediment and Nutrients: Nitrogen and Phosphorus to related basin-wide plans and jurisdictional water quality plans and strategies to update and maintain continuity with activities around the basin so that the RRB-WQSP for Sediment and Nutrients: Nitrogen and Phosphorus remains relevant as a basin-wide guide and tracking document for successes.

6B.1.1 Basin plans. RRBC will link the RRB-WQSP for Sediment and Nutrients: Nitrogen and Phosphorus to the following basin plans.

6B.1.1.1 RRBC: When the Natural Resources Framework Plan (NRFP) is updated include the RRB-WQSP relevant information.

6B.1.1.2 USACE: When the Comprehensive Watershed Management Plan (CWMP) is updated include the RRB-WQSP relevant information.

6B.1.1.3 RRBC: When the Long -Term Flood Solutions (LTFS) is updated included the RRB-WQSP relevant information.

6B.1.1.4 IRRB: Continually connect the IRRB Water Quality Committee plan and the RRB-WQSP: Sediment and Nutrients: N& P.

6B.1.2 Provincial and State plans and strategies. RRBC will continually link the RRB- WQSP for Sediment and Nutrients: Nitrogen and Phosphorus with Manitoba, Minnesota, North Dakota, and South Dakota water quality plans and efforts, especially as it relates to sediment and nutrients.

6B.1.2.1 Link and update the RRB-WQSP for Sediments and Nutrients: N & P with the Manitoba Water Quality Standards Objectives and Guidelines and the Integrated Watershed Management planning process.

6B.1.2.2 Link and update the RRB-WQSP for Sediments and Nutrients: N & P with the Minnesota Discovery Farms data and Minnesota WRAP's reports.

6B.1.2.3 Link and update the RRB-WQSP for Sediments and Nutrients: N & P with the North Dakota Nutrient Reduction Strategy Plan.

6B.1.2.4 Link and updates the RRB-WQSP for Sediments and Nutrients: N & P with the South Dakota activities through DENR, since they have no nutrient plan, but do biological monitoring and other strategies to identify problems and strategies.

6C. UPDATES

RRBC will provide a basin annual progress report on efforts in the basin to address the sediment and nutrient issues, using the WQSP format.

Recommendations for Action: 6A.1

The RRBC shall produce an annual progress report called the: "The State of the Basin: WQSP for Sediment and Nutrients: Nitrogen and Phosphorus".

6A.1.1 RRBC will produce the annual progress report for their annual summit conference and will show progress in relation to the RRB-WQSP Sediment and Nutrients: Nitrogen and Phosphorus.

6A.1.2 RRBC will produce the annual progress report for their annual summit conference and will show progress in relation to the IRRB WQ work plan.

6A.1.3 Connect the RRB-WQSP and IRRB WQ Work Plan updates with the USGS

WQ Story Map.

6A.1.4 Include a summation of the Environment Canada annual data gathering at the International Boundary with the annual “State of the Basin” report.

6A.1.3 Together RRBC, IRRB and USGS will develop a strategy to track progress that is consistent with the RRB-WQSP, the IRRB WQ Work Plan and USGS Story Map to show progress of lack of progress on sediment and nutrients in the basin.

6A.1.4 Connect all efforts to the USGS WQ Trend Analysis updates as required.

Recommendation for Action: 6A.2
The RRBC shall in 10 years work with others to seek funding and participation to update the RRB-WQSP for Sediment and Nutrients: Nitrogen and Phosphorus.

6A.2.1 In the future the RRB-WQSP for Sediment and Nutrients: N & P should be updated, cognizant of climate change impacts, that are currently being projected as a major factor in all water management, to determine if there are impacts and what they are in relation to WQ in the basin.

7. BASIN INDIVIDUAL STAKEHOLDER STRATEGIES

Individuals, agencies, organizations, and groups throughout the basin are continually experimenting with and implementing new techniques to help reduce sediment and nutrients in the basin. Efforts that are successful need to be shared with others, so they can learn about the results and consider implementing them as well. This approach offers a method to bring about the desired results without regulation. It also brings others on board with successes so that fiscal components can help drive the desired actions, to bring about results that are being implemented throughout the basin---so that everyone can participate in actions to address the problems. This will be accomplished by targeted workshops and tours.

7A Targeted Workshops
7B Tours

7A. TARGETED WORKSHOPS

Targeted workshops by RRBC and others will be utilized to help spread the word on successful activities that reduce nutrients that are based on the RRB-WQSP for Sediment and Nutrients: Nitrogen and Phosphorus recommendations and the work of IRRB, RRBC, jurisdictional agencies, universities, and business.

Recommendation for Action 7A.1 A workshop focused on BMP’s for Cold Weather will be held in the fall of 2018 led by IRRB will be held for key stakeholders, with assistance by RRBC and other partners.

Recommendation for Action 7A.2 Drainage workshops related to Tile/Surface will be held for specific audiences and leaders on a regular basis as new information in learned and is ready to share.

7A.2.1 Include in these workshops updated information from the Minnesota Discovery Farms efforts as well as new information from Manitoba, North Dakota and South Dakota.

Recommendation for Action 7A.3 Workshops for local leaders, state elected leaders, Minnesota state agencies, on Nutrient Trading will be held as the pilot project is developed to guide the details and locations of the Red River basin Minnesota pilot project and to inform stakeholders of the process and successes of the approach.

7A.5.1 Manitoba, North Dakota and South Dakota workshop will follow the Minnesota model at the appropriate time.

Recommendation for Action 7A.4 Workshops on the Pilot Projects for Drainage Water Management Connectivity will be held for local leaders (water boards, county commissions, etc.) if the pilot projects get funded and when results are ready.

Recommendation for Action 7A.5 Workshops on the Pilot Project for Seeding and Cover for corn Crops illustrating new techniques for farmers and producers will provide information currently in progress by NDSU and Amity.

Recommendation for Action 7A.6 Workshops on the Storm Water Runoff Pilot Project will be held in urban areas to educate urban landowners.

Recommendation for Action 7A.7 Workshops on the Rural Septic Pilot Project will be held in rural areas to educate rural landowners on the problem and programs to help address the issue.

7B. TOURS

Recommendation for Action 7B.1 Tours, as appropriate for local leaders, state elected leaders, Minnesota state agencies, on Nutrient Trading Pilot Project will be held related to the details, locations, process, and strategy of the Red River basin Minnesota pilot project.

Recommendation for Action 7B.2 Drainage tours related to Tile/Surface will be held for basin stakeholders and leaders on a regular basis as new information in learned and is ready to share.

7B.2.1 Tours for the Drainage Connectivity Pilot Projects will be held if the pilot projects receive funding and when results are ready.

7B.2.2 Tours will also link to Minnesota Discovery Farms and other research

being conducted at the field scale level in Manitoba, North Dakota, and South Dakota by agencies, research institutions and business.

Recommendation for Action 7B.3 Tours for farmers and producers will provide information on New Cover Crop Planting Technique Pilot Project for corn, in progress by NDSU and Amity.

Recommendation for Action 7B.4 Tours for urban stakeholders on the Storm Water Runoff Pilot Projects will be held.

Recommendation for Action 7B.5 Tours for rural stakeholder on the Rural Septic Field Pilot Project will held.

8. RESOURCES TO IMPLEMENT

Resources to implement the RRBC recommendations in the "RRB-WQSP for Sediment and Nutrients: N and P" depends on many factors. One key factor is the level of reductions that governments determine are appropriate to try and achieve. This factor is influenced by many sub-factors, such as: where, when, costs to implement of reduction strategies, budgets, and regulations. Many other factors are also at play. It will take time. It will cost millions of dollars if we continue on the current path and more if we change the path to include lower reduction targets and shortened timelines. If this is done, funding from multiple sources will increase the potential for success.

There are short-term funding needs related mostly to better understanding the sediment and nutrient: N and P problem. These costs will be incurred over the next three years at the IRRB, federal and provincial/state levels and will to some extent continue into the future as decisions to implement actions are made, as improvements to our understanding occur, and as new questions emerge that need to be addressed. Implementation of strategies to reduce sediment and nutrients are much longer-term and include: improvements to urban water treatment facilities, land use practices, changes that address non-point sources of pollution, rural septic fields, urban stormwater practices, and many others.

The annual updates on basin WQ through the RRBC Annual Summit Conference "State of the Basin on WQ Report" will be one avenue to highlight needed funds for actions that are needed in the near future, all the while measuring progress and successes in achieving the above recommendations.