PREFACE

This report documents water quality trends and exceedences of objectives, effluent releases, and control measures for the Red River basin for the 2010 Water Year (October 01, 2010 through September 30, 2011). In addition, this report describes the activities of the International Red River Board during the reporting period October 01, 2011 to September 30, 2012 and identifies several current and future water quality and water quantity issues in the basin.

The units of measure presented in this report are those of the respective agencies contributing to this report.

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1.0 SUMMARY

1.01 Water Quantity and Water Quality

Water Quantity

During the spring of 2011, the Red River floods resulted from above average soil moisture at freeze-up in 2010 combined with above average snow cover in the United States and Manitoba portions of the Red River Basin. Favourable weather conditions in springtime reduced the potential for major flooding that had been initially expected in earlier flood potential projections.

In Manitoba, the Red River flows were higher than the upper decile range from October 2010 to early March 2011, reflecting high soil moisture conditions and ground water storage in the basin. The flows were between the median and the upper decile range between mid-March to early April 2011.

Active snowmelt began in earnest from late March 2011. The Red River crested at Emerson, Manitoba on April 24 at a flow of about 83,000 cfs. This was slightly less than the peak in 2009. The 2011 peak at Emerson was the fifth largest in the past 100 years and the eleventh largest since 1800, with a return period of approximately once every 23 years.

There was an ice-induced crest on the Red River at James Avenue on April 7 at 20.78 feet (6.33 metres). There was an open water peak (the peak unaffected by ice) in the afternoon of April 9 at a water level of 20.69 feet (6.30 metres). After April 9, the use of the Red River Floodway lowered water levels on the Red River in the City of Winnipeg. There was a second, smaller peak at James Avenue on May 6, caused by flows from the US side of the Red River combined with the Assiniboine River, reaching 19.61 feet (5.97 metres). Record flows on the Assiniboine River contributed significantly to the large natural flows at James Avenue in Winnipeg.

Red River Floodway Operations - On April 9th 2011, Red River Floodway operations were initiated shortly after ice had released upstream of the inlet control structure and floodway channel inlet area. Rules for operating the Red River Floodway are outlined in Environment Act License #2691 and state how the floodway gates are to be used under normal, major and extreme water flows. Operation of the Floodway, the Portage Diversion and Shellmouth Dam lowered water levels on the Red River at James Avenue during peak natural flow by 3.53 m (11.6 ft).

The peak natural flow at Winnipeg was calculated as 116,000 cfs during the May 6th peak, which would have resulted in an estimated natural peak James Avenue level of 9.5 m (31.2 ft), 0.27 m (0.9 ft) higher than the 1950 peak level. Overall, in the spring of 2011, 2.6 million acre-feet of water was diverted around the City of Winnipeg in the Floodway channel, with a peak flow of 36,700 cfs. This was the fifth highest peak floodway flow and was only exceeded during the floods of 2009, 1997, 1996, and 1979. The peak recorded level at the floodway entrance (recorded at Water Survey of Canada gauging station) was 764.09 ft in the early morning of May 1st.

The use of the floodway in 2011, along with other flood control infrastructure, contributed to preventing flooding in Winnipeg with an estimated value of $3.7 billion. In total, since the inception of the floodway and in combination with other flood control infrastructure, the estimated value is approximately $36 billion.

Pre- Flood Preparations and Flood Impacts - The Manitoba government worked closely with municipalities to plan for potential spring flooding and provided a $1 million fund to help them with early preparation activities for 2011. This included measures such as cleaning ditches, steaming culverts and building temporary dikes.

The Manitoba government set up the Red River Operation Technical Working Group with technical staff from the Provincial Government departments of Water Stewardship and Infrastructure and Transportation, and the City of Winnipeg. The Working Group set up formal communications between the Province and City about the operation of the Red River Floodway. The Working Group communicated about actions to be taken under extreme or emergency conditions. The group met four times in early 2011: January 13, February 4, March 4 and March 29. Manitoba Water Stewardship staff met with a committee of reeves and mayors from the Red River Valley in early February and March 2011.

The Ice Jam Mitigation program used seven cutting units that scored the river ice between the Selkirk Bridge and Lake Winnipeg. The ice was weakened by scoring in 16.4-foot (5.0-metre) grids over approximately two thirds of the river's width. The three Amphibex machines broke a path down the center of the river channel to help move ice to Lake Winnipeg. One live webcam was installed at the Red River Floodway to provide real time visualization and monitoring of water level conditions.

From mid-April to mid-May 2011, the PTH 75 was closed south of Morris to St. Jean Baptiste due to high floodwaters, resulting in route detours. Drivers were advised to respect all road closures and to be cautious driving in any areas of the flood plain.

In the US portion of the Red River Basin, wet conditions from the preceding two years persisted into 2011 culminating in record flow volumes on the Red River and a third consecutive year with significant spring flooding. Winter flows were in the 90th percentile or higher for the main stem Red River. The major risk factors for a significant spring runoff event, high soil moisture, high snow water, and elevated base streamflows, were present early in the winter season. The winter snowpack was above average for much of the basin and at record levels in some areas including the upper Devils Lake and Sheyenne River Basins.

The spring runoff in 2011 was delayed compared to the last five years as cooler temperatures persisted into late March. The Red River at Fargo crested on April 9 with a discharge of 27,200 cfs, the third highest peak in 110 years. The Red River at Grand Forks crested on Apr. 14 with a peak discharge of 87,500 cfs, the second highest recorded peak discharge in 129 years of record. Flows in the upper Devils Lake Basin and Sheyenne River Basins exceeded the peak of record flows of 2009. Flows into Devils Lake resulted in a new daily peak elevation of 1454.30 on June 27. All gaging stations on the upper Sheyenne River (above Lake Ashtabula) recorded a peak of record discharge except for the Sheyenne River at Harvey. The Sheyenne River at Warwick (60 years of record) crested on April 11, at 8,200 cfs, well over the previous peak of record discharge of 4,930 cfs. The Sheyenne River at Cooperstown (66 years of record) crested on April 14 at 8,460 cfs, exceeding the previous peak of record set in 1950. Peak flows on the lower Sheyenne River approached or exceeded peaks of record due to record high releases from Baldhill Dam. The Sheyenne River below Baldhill Dam recorded a peak of 7,060 cfs on April 13 compared to 6,200 cfs in 2009. The Sheyenne River at Lisbon (54 years of record) recorded the 2nd highest peak of record of 8,280 cfs on April 20. The slow recession of the spring peaks, along with summer rainfall, contributed to record annual flow volumes at some stations. The Red River at Grand Forks passed 10.3 million acre-ft between October 2010 and September 2011 and, the same period in 1997 produced 7.29 million ac-ft. Beginning in August 2011 the basin entered a period of reduced precipitation and above average temperatures causing peak and annual flows that are generally at or below normal and that are significantly below the historic levels of the last three years. Flows in the main stem Red River are at the 50th percentile or lower.

Water Quality

Some exceedences of the International Joint Commission (IJC) water quality objectives were observed at the international boundary during the 2010 water year. Dissolved oxygen generally remained well above the objective level of 5.0 mg/L. Exceedences of the International Joint Commission (IJC) water quality objectives, and concentrations approaching the objective level for total dissolved solids (TDS) were observed at the international boundary during the 2010 water year. The TDS objective of 500 mg/L was exceeded several times in the 2010 water year. The highest observed value of 684 mg/L was recorded in June 2011. The chloride objective (100 mg/L) was not exceeded. However, the sulphate objective of 250 mg/L was exceeded on four occasions during the water year. The fecal coliform and the *Escherichia coli* objective (200 colonies/ 100 mL) were exceeded once in 2011.

1.02 International Red River Board Activities

As noted in the Preface, this report also describes the activities of the International Red River Board (IRRB) for the period October 01, 2011 - September 30, 2012 which succeeds the 2011water year. The key activities are highlighted below.

In 2010, the IRRB revised its 3-year work plan to reflect the status of its activities, and to affirm consistency with the International Watersheds Initiative and the IJC Directive to the IRRB. The work plan priorities include a continued effort to expand the existing scientific knowledge of aquatic ecosystem dynamics and current conditions. The activities encompass assessment of fish and macro-invertebrate communities, distribution and abundance of exotic species, as well as plant community structures and trends. Key IRRB activities also include - development and implementation of apportionment/flow targets at the International Boundary; completion of the final year of the three-year Pathogen/Parasite Sampling Program; continuation of the development of Comprehensive Flood Mitigation Strategy (CFMS) as per the terms of reference of the Committee on Hydrology; LiDAR mapping and hydraulic modeling of the Lower Pembina River Basin, setting nutrient objectives for the Red River at the International Boundary, and formation of the Water Quality Committee (WQC).

The IRRB held its seventh bi-annual meeting on January 26-27, 2012 to address select issues in the basin, and the eighth bi-annual meeting on August 29-30, 2012 for a more complete review of its responsibilities, activities, and accomplishments. The meetings addressed water quality monitoring and compliance with IJC objectives and established alert levels; and IRRB work plan priorities. The latter included actions to develop and implement water quantity apportionment procedures, prioritized flood mitigation plans, and biological monitoring and nutrient management strategies for the basin. The Board also requested the development of a draft *White Paper* on Devils Lake for discussion to make recommendations to the IJC to resolve outstanding issues related to water quantity/flooding, water quality, biota transfer, and nutrients. Various scenarios, including a potential natural spill from Devils Lake into the Sheyenne River are being examined by the Board.

Completion of a three-year sampling program for parasites and pathogens as a result of multi-agency negotiations led by the White House Council on Environmental Quality (CEQ) was a significant IRRB undertaking during the reporting period. The objective of the sampling program, which was initiated in September 2006, was to determine the presence and prevalence of fish parasites and pathogens in resident fish from Devils Lake, the Sheyenne River, Red River, and Lake Winnipeg, and to address the risks associated with transfer of such biota from the Devils Lake outlet to aquatic ecosystems downstream. A further objective is to use the comprehensive fish survey to support the overall framework for biological monitoring in the Red River basin as identified in the IRRB work plan.

The three year pathogens and parasites sampling program was completed in 2008. Both Canadian and US analyses of fish samples collected over the three year period (2006-2008) have been analysed. The Final Synthesis Report was completed by the end of June 2011. The study examined a total of 7 species and 1616 fish were collected from Devils Lake; and 21 species and 4272fish from 6 other locations in the Red River Basin including the Red River Delta and Lake Winnipeg in Canada. The Aquatic Ecosystems Committee (AEC) conducted a workshop on April 12-13, 2011 in Bismarck, ND with a team of experts who reviewed the fish parasite, pathogen, and histopathology data collected from 2006 to 2008. The team discussed the issues and what these data meant and made recommendations for a basin-wide monitoring in the basin, not just Devils Lake.

After the workshop, the team of eight fish experts from Canada and the U.S. conducted a qualitative risk assessment and discussed the risks downstream.

The following were questions addressed by the qualitative risk assessment:

- Mechanisms for transport from Devils Lake to other aquatic ecosystems in the Red River basin and Lake Winnipeg,
- What are the known environmental factors to trigger a disease outbreak for the identified pathogens and parasites,
- If pathogens and parasites were transferred elsewhere in the basin, what are the risks and their likelihood of causing disease,
- What is the North American distribution of these pathogens and parasites, and what is their relative abundance? and,
- Does the current mitigation measure (rock/gravel filter) reduce the impact of potential transfer of pathogens and parasites?

Summary of the Pathogens and Parasites Study

Three bacteria, one parasite, and several lesions were identified from fish in Devils Lake that were not identified elsewhere in the basin. The fish pathologists concluded that the fish parasites and pathogens in Devils Lake could be transferred from the Lake through the gravel and rock filter currently in place, by birds (often the intermediate or final parasite host), and by unintentional and intentional transfer by people (or their boats). The parasites and bacteria found in Devils Lake were generally widely distributed throughout much of North America. All were opportunistic pathogens that could adversely affect fish health only if fish health was compromised for other reasons. None were foreign parasite or pathogen species. For these reasons, all experts concluded that the risk to downstream fish and fisheries was low from the parasites and pathogens found in Devils Lake, and the potential for causing disease was negligible.

Recommendations:

The investigation undertaken in 2006, 2007, and 2008 is a significant effort to isolate and identify pathogens and parasites in a watershed that is shared by North Dakota and Manitoba. Based on the data collected, the risk assessment indicates that, at present, there is limited risk to downstream fish species or communities from the organisms found in Devils Lake. However, the U.S. and Canada fish health experts provided the following recommendations that would help to ensure that risk of certain pathogens and invasive species entering the Red River basin is reduced and would monitor for the presence of invasive species in the basin.

1. Adopt a proactive model and precautionary approach to prevent and monitor transfer of invasive species and certain fish pathogens into the Hudson Bay Basin. To effectively prevent transfer of invasive species and non – endemic fish pathogens into the Hudson Bay Basin, provincial, state, and federal agencies should adopt a general model with the following key components:
A) enact legislation and develop policies to prevent transfer of foreign species and fish pathogens into the Hudson Bay basin,
B) maintain active enforcement of invasive species policies and legislation, and fish disease prevention and control policies and legislation.
C) monitor selected organisms and pathogens in aquatic ecosystems at a few biophysically unique locations to assess the effectiveness of legislation, enforcement, and remedial actions to prevent the introduction and spread of invasive species into the Hudson Bay Basin, and to provide a feedback loop for adaptive fish disease control and invasive species management programs.

2. Use the data generated in the present study to conduct a risk assessment to fish in the Red River Basin from the parasites and pathogens found throughout the Red River Basin, including Lake Winnipeg. Innovative risk analysis methods and techniques such as computer modeling should be used.

3. A fish parasites and pathogens monitoring program should be established based on selected and restrictive criteria. A workshop could be held to develop protocols, methods, and short- and long-term monitoring goals. This focused monitoring program should use multiple approaches and methods, and could include the following key components:
A) one sampling location in Canada and one sampling location in the USA;
B) fish parasites and pathogens should be assessed every three years at these two sites;
C) field and laboratory methods for Canada and the USA should be standardized. Methods should be standardized to ensure that data are comparable and compatible and costs for monitoring are kept at reasonable levels;
D) based on expert input, monitoring should be targeted to specific species of concern and problematic parasites, bacteria or virus;

E) fish species should be selected that are more susceptible than others to disease producing organisms. Ongoing targeted surveillance should be coordinated with the National Aquatic Animal Health Program (NAAHPs) that is in the process of being implemented in Canada and the USA.

4. State and provincial agencies should continue to maintain and to improve surveillance procedures to prevent transfer of organisms into the Hudson Bay Basin.

5. The science literature and other information should be regularly reviewed by the International Red River Board and member agencies to identify those organisms that are extending their range toward the Hudson Bay Basin possibly because of climate change, biological factors, or anthropogenic activities. The likelihood of these organisms moving into the basin should be modeled, and a risk assessment should be undertaken as part of this process to provide decision makers with information that could be used to prevent invasive species from entering the Basin, or could be used to develop invasive species management strategy should an invasive species become established.

6. Implement a project to determine route of transfer, rate of spread, and distribution of the Asian tapeworm (*Bothriocephalus acheilognathi*) in the Hudson Bay Basin. These population characteristics of the Asian tapeworm could be used as a model to study invasion pathways of foreign species into the watershed (AEC Qualitative Risk Assessment Report, October 2011). For more details, please go to http://www.ijc.org/conseil_board/red_river/irrb_pub.php?language=english#other and click on Devils Lake – Red River Basin Fish Parasite and Pathogen Project, Qualitative Risk Assessment.

1.03 International Red River Board Three-Year Work Plan (2010-2012)

A three-year work plan was approved by Board and its committee members at its September 2009 meeting held in Gimli, Manitoba. Priorities include:

- Report Water Quality Objectives,
- Completion of the Parasite/Pathogen Sampling Program,
- Comprehensive Flood Mitigation Strategy,
- Water Quantity Apportionment,
- Lower Pembina Flooding,
- Enhanced Bio Assessment,
- Nutrient Objectives, and
- IWI funded Projects.

The next three-year work plan is currently being revised by the Board and its committee members for the period October 1, 2012 to October 1, 2015.

2.0 INTRODUCTION

In April 2000, the International Joint Commission (IJC) formally merged its International Red River Pollution Board and International Souris-Red Rivers Engineering Board consolidating the water quality and water quantity responsibilities of the former boards, to form the International Red River Board (IRRB). This consolidation formalized the already emerging cooperative efforts of the former boards toward an integrated approach to transboundary water issues in the basin. Further, in its November 2000 report *Living with the Red*, the IJC recommended that the governments assign certain flood-related tasks to the IJC for implementation by its IRRB. In June 2001, Canada and the United States formally approved a new expanded directive for the IRRB. The directive is included in Appendix A.

In April 2003, the IJC requested further discussion with the IRRB on how to achieve a more ecosystem approach and a capacity to respond to the range of environmental and water-related challenges of the 21st century. In April 2004, the IJC adopted guiding principles aimed at broadening the partnership efforts of its international boards with other watershed entities for a more inclusive approach. The IJC refers to this effort as the International Watersheds Initiative. The various water management organizations in the Red River Basin appear receptive to the Initiative while at the same time recognizing the independent, impartial and objective role of the IJC and its boards in providing advice to governments. In June 2005, the IJC recommended that the governments of Canada and the United States confirm their support for the Initiative. The Red River basin is one of three pilot watersheds recommended by the IJC for implementation of the Initiative and for funding support.

In brief, the IRRB is responsible for assisting the IJC in avoiding and resolving transboundary disputes regarding the waters and aquatic ecosystems of the Red River and its tributaries and aquifers. This is accomplished through the application of best available science and knowledge of the aquatic ecosystems of the basin and an awareness of the needs, expectations and capabilities of residents of the basin. The geographic scope of the Board's mandate is the Red River basin, excluding the Assiniboine and Souris Rivers. The mandate presently includes the Poplar and Big Muddy River basins, previously the responsibility of the International Souris-Red Rivers Engineering Board. The Red River Basin is illustrated in Figure 1.

This report is the thirteenth IRRB annual progress report to the IJC.

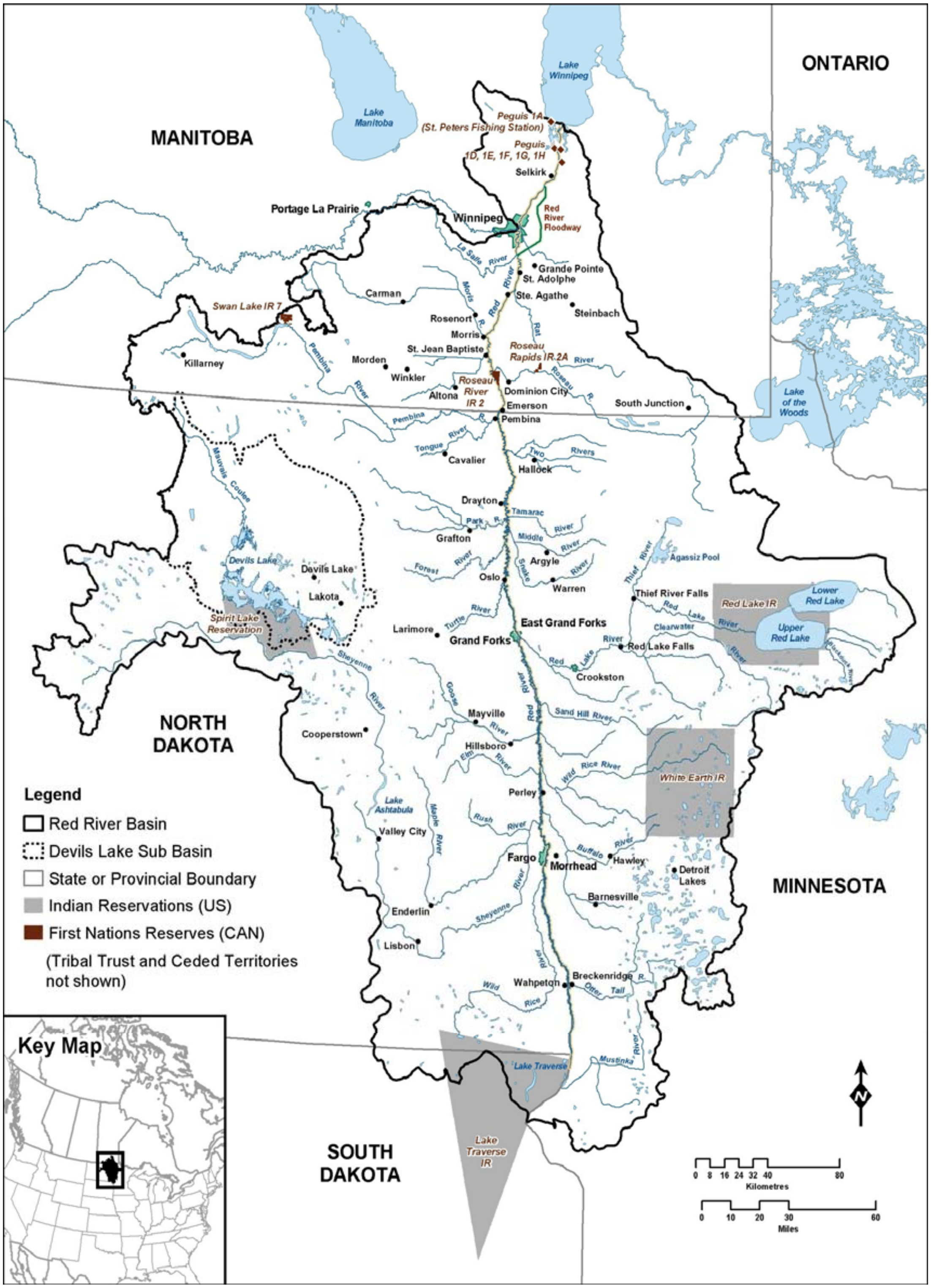

Figure 1 Red River and its Tributaries

3.0 INTERNATIONAL RED RIVER BOARD MEMBERSHIP

In its 1997 report *The IJC and the 21st Century*, the IJC proposed comprehensive international watershed boards as an improved mechanism for avoiding and resolving transboundary disputes. The intent was to broaden the scope of information upon which decisions relating to water and air are being made.

Through the continued integration of its water quality and water quantity responsibilities, and through efforts to increase stakeholder involvement, many of the goals of a comprehensive watersheds approach are being achieved by the International Red River Board. To facilitate these objectives, Board membership has been expanded to include non-government participation.

Colonel Michael Price, U.S. Army Corps of Engineers; and Mike Renouf, Environment Canada, are the current Co-Chairs of the Board, respectively. Scott Jutila, US Army Corps of Engineers; and Girma Sahlu, Environment Canada, provide secretarial and technical support to the Board.

United States

Col. Michael Price – U.S. Chair
District Engineer, St. Paul District
U.S. Army Corps of Engineers

Jim Ziegler
Detroit Lakes Office
Minnesota Pollution Control Agency

Dennis Fewless
Director, Division of Water Quality
North Dakota Department of Health

Randy Gjestvang
Red River Water Resources Engineer
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Megan Estep
U.S Fish & Wildlife Service
Denver, Colorado

Bert Garcia
Ecosystems Protection Program Director
Office of Ecosystems, Protection & Remediation
U.S. EPA Region 8

Daniel Wilkens
Administrator
Sand Hill River Watershed District, Minnesota
(Red River Basin Commission)

Gregg Wiche
Director, North Dakota
U.S. Geological Survey, Water Science Center

Vacant

Scott Jutila - U.S. Secretary
U.S. Army Corps of Engineers
U.S. Co-Secretary

Canada

Mike Renouf – Canadian Chair
Executive Director, Transboundary Waters Unit
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Nicole Armstrong
Director, Water Science & Management Branch
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Red River Basin Commission

Brian Parker
Director, Fisheries Branch
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Vacant (EC)

Dr. Patricia Ramlal
Manager, Environmental Science Division
Fisheries & Oceans Canada

Girma Sahlu - Canadian Secretary
Senior Engineering Advisor
Transboundary Waters Unit
Environment Canada

4.0 INTERNATIONAL RED RIVER BOARD ACTIVITIES

During the reporting period October 01, 2010 - September 30, 2011, the International Red River Board met with the IJC at the fall and spring semi-annual meetings at which Board priorities, activities and funding requirements were discussed. The Commissioners were apprised of basin developments and their potential transboundary implications.

4.01 Interim and Annual Board Meetings

The IRRB held its seventh bi-annual meeting January 26-27, 2012 to address select issues in the basin, and the eighth bi-annual meeting August 28-29, 2012 for a more complete review of its responsibilities, activities, and accomplishments. The meetings addressed water quality monitoring and compliance with IJC objectives and established alert levels, and IRRB work plan priorities. The latter included actions to develop and implement water quantity apportionment procedures, prioritized flood mitigation plans, and biological monitoring and nutrient management strategies for the basin.

Except for half-day executive sessions during the January and August bi-annual meeting, both meetings were open to the public in a spirit of information sharing and collaboration. This was undertaken in recognition that there are many local, regional, state/provincial, federal and natural resource management entities operating in the basin with which connective links would be mutually beneficial. In addition to inviting presentations from interested groups, the public audience was invited to share its views. The Board initiated the first evening and expanded public session on August 28, 2012 in Detroit Lakes, MN to provide an overview of its activities and to engage the public in more detailed dialogue.

4.02 IJC International Watersheds Initiative (IWI)

In 2004, the IJC adopted guiding principles aimed at broadening the partnership efforts of its international boards with other watershed entities for a more inclusive approach. The IJC refers to this effort as the 'International Watersheds Initiative'. The aim of the Initiative is to enhance the capabilities of existing IJC international boards while at the same time, strengthening cooperation among the various local entities. Building this capability includes[1]:

- employing a broader, systemic perspective of the watershed;
- expanding outreach and cooperation among organizations with local water-related interests and responsibilities;
- promoting the development of a common vision for the watershed;
- developing a better hydrologic understanding of the water-related resources; and
- creating the conditions for the resolution of specific watershed-related issues.

In 2011, the IJC funded a number of projects that were undertaken by the International Red River Board (IRRB) and its various committees. IRRB acknowledges and thanks the IJC for its continued financial support for initiatives carried out by the Board and its committees in the Red River Basin.

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1 *A Discussion Paper on the International Watersheds Initiative: Second Report to the governments of Canada and the United States under the Reference of November 19, 1998 with respect to International Watershed Boards, June 2005.*

There are many government, non-government, academic, private; and other entities with resource management responsibilities and interests in the Red River basin. Many have expressed support for a watershed approach. The present IRRB membership and Committee structures provide a linkage to key segments of this community with potential to expand the linkages as integrative approaches evolve.

In its June 2005 report to the governments of Canada and the United States[1], the IJC recommended that the governments confirm their support for the Initiative and that funds be made available commensurate with board work plans. The Red River watershed is one of five pilot watersheds recommended by the IJC for implementation of the Initiative and for funding support.

4.03 Improving the Information Base to Address Transboundary Issues

The IRRB monitors water quality at the international boundary; maintains awareness of development activities basin-wide; provides a forum for the identification and resolution of water-related transboundary issues; recommends strategies for water quality, water quantity, and ecosystem health objectives, and; monitors flood preparedness and mitigation activities.

To effectively address this mandate a focused effort through the application of best available science and knowledge of the hydrology and aquatic ecosystems of the basin is required. Hence, in 2001 the Board established two committees, a Committee on Hydrology (COH) and the Aquatic Ecosystem Committee (AEC) under which access to expertise could be consolidated with the capacity to undertake specific investigations and tasks. Specific activities assigned to the committees include establishing natural flow and water usage databases, evaluating current water quality monitoring and reporting protocols, developing biological monitoring strategies, and developing recommendations on an inter-jurisdictional drainage policy for the basin. These efforts are characterized by strengthened coordination with key water-oriented organizations in the watershed; and improved partnerships to develop a knowledge base and a shared understanding of water issues. Most frequently, the interests, objectives, and activities of the Committees intersect. Cross-membership also contributes to an integration of effort.

The Committee on Hydrology (COH) was re-established in 2006-2007 with a broader agency representation and new members.

4.03-1 Water Quality Monitoring at the International Boundary and Red River Basin

During the reporting period, Environment Canada continued to provide water quality monitoring at the international boundary, and provided reports on the status of compliance with established IJC water quality objectives. This was augmented with reports on the presence of pesticides, herbicides and other chemical constituents for which alert levels have been established (see reports summarized in Chapter 5).

IRRB Member agencies also reported on the status of water quality surveillance and water pollution control in their respective portions of the basin. The scope of this work and its significant contribution to the information base is described in Chapters 6 and 7.

In September 2011, Environment Canada announced its plans to the reduce the water quality sampling program for the Red River at Emerson. The Board sent a letter to the IJC expressing its concern about the reduction to the water quality sampling program. At the Board meeting held on August 30, 2012 in Detroit Lakes, MN, Environment Canada re-assured the Board its commitment to hire more staff and to re-instate the water quality sampling program on the Red River at the International Boundary.

4.03-2 Water Quality and Ecosystem Health

In 2003, the AEC prepared a conceptual framework to monitor the long-term aquatic ecosystem health of the watershed and an action plan outlining specific activities and resource requirements. The framework and action plan were endorsed by the Board and form the basis of the IRRB work plan. The overarching aquatic ecosystem health goal for the watershed, as articulated by the AEC, is to "assure that water resources of the Red River of the North basin support and maintain a balanced community of organisms with species composition, diversity and functional organization comparable to the natural habitats within the basin without regard to political boundaries".

Devils Lake Outlet Enhanced Monitoring

In early 2005, the North Dakota Devils Lake state outlet was completed and operation of the outlet was imminent. Operation of the outlet connects a closed basin in North Dakota, which is also part of the Hudson Bay drainage system, with the additional potential of transferring fish parasites and pathogens into the Hudson Bay watershed to the detriment of fish populations, especially to commercial and sport fish populations in the Red River and in Lake Winnipeg.

Given the transboundary implications of outlet operations and concerns to Manitoba and Canada regarding potential transfer of foreign organisms, multi-lateral negotiations were launched involving diplomatic levels, federal, state and provincial authorities, and the White House Council on Environmental Quality (CEQ). The negotiations resulted in the installation of a temporary gravel filter at the outlet to act as a barrier against the transfer of fish and some plants into the Red River system. The negotiations also resulted in a three-year sampling program to address issues related to the transfer of invasive species.

In summary, the objectives of the sampling program are to: determine the presence and prevalence of fish parasites and pathogens in resident fish from Devils Lake, the Sheyenne River, Red River, and Lake Winnipeg, and; to address the risks associated with transfer of such parasites and pathogens from the Devils Lake outlet to downstream aquatic ecosystems. A further objective is to use the comprehensive fish survey data to support the overall framework for biological monitoring in the Red River basin as identified in the IRRB work plan.

The three-year program comprising 7 sampling sites and 13 target fish species was initiated in September 2006. A report on the 2006 data collection was to provide the basis for any necessary refinement of the program for the following 2 years. Further, the results of the 3-year sampling program would be used to establish a focused long-term monitoring program for fish parasites and pathogens in the Red River basin, including select tributaries to the Red River and Lake Winnipeg.

The project plan assigns technical and financial responsibility to Canada for the collection and analysis of the biological data in the Canadian portion of the basin, and to the United States for like work carried out in the United States. Consistent methods, as confirmed in a workshop of experts in August 2006, are being applied to both streams of work. The project is being coordinated and managed by the Canadian and United States Co-Chairs of the AEC, with implementation and technical management of the project assigned to Fisheries & Oceans Canada and U.S. Fish & Wildlife Service. The project design allows for peer review of the interpretive reports. The three year sampling was completed in 2008.

The results from the 2006 -2008 Pathogen Survey of Devils Lake, the Red and Sheyenne Rivers indicate statistical confidence on six species from Devils Lake. There was no detection of viral agents, which was very significant. Some of the bacterial findings were not unusual for this type of aquatic environment; and the results were repeatable from previous years. The initial sampling results were presented to governments via a conference call on March 10, 2009 (see also Section 1.02 of this report). The final report of the Pathogens and Parasite Study was presented to the IJC at fall 2011 appearance in Ottawa, Canada. Another presentation was also made to the general public at the winter Red River Basin Commission Conference on January 26, 2012 by the Co-Chairs of IRRB. For more information, please go to http://www.ijc.org/conseil_board/red_river/en/irrb_home_accueil.htm, "*publications/other reports*". The Board is currently planning to develop Phase II of the Pathogens and Parasites Study and to explore the possibility of conducting a basin-wide study in the Red River Basin.

4.03-3 Water Quality Committee - Nutrient Management Strategy for the Red River Watershed

Excessive nutrients such as phosphorus and nitrogen are one of the greatest water quality issues facing the international Red River watershed and Lake Winnipeg. While all jurisdictions within the watershed have various regulatory frameworks, plans and approaches in place to reduce the contribution of nutrients to water, the development of an enhanced, coordinated, and systematic strategy is desirable.

The development of a basin-wide plan for the management of nutrients within the shared international Red River watershed was agreed to as part of the 2012 Four-Party discussions between the federal governments of the United States and Canada, the State government of North Dakota, and the Provincial government of Manitoba. For additional background, please see http://www.gov.mb.ca/chc/press/top/2010/10/2010-10-08-135100-9904.html and http://www.gov.mb.ca/chc/press/top/2010/11/2010-11-22-163100-10229.html. All jurisdictions involved in the Four-Party discussions agreed that South Dakota and Minnesota should be engaged in the development of a nutrient management plan.

The Red River Basin Commission also recognized the need to improve basin-wide cooperation and collaboration on water quality management, in particular with respect to nutrients. Through the support of the Red River Basin Commission, North Dakota, Minnesota, and Manitoba worked in 2009 and 2010 to develop a draft "Conceptual Water Quality Management Plan for the Red River Basin". While the draft conceptual plan was not finalized, the major concepts including the mission, guiding principles, and some of the main objectives are relevant to the development of a nutrient management strategy for the Red River.

In September 2011, Minnesota, North Dakota and Manitoba along with the Red River Basin Commission presented a draft approach for developing a nutrient management strategy to the International Red River Board. The proposed approach includes six components for developing the nutrient management strategy (see Appendix E). The Board endorsed the proposed approach at the September 2011 meeting and established the Water Quality Committee to develop the nutrient management strategy. The Water Quality Committee is co-chaired by Minnesota and Manitoba and includes membership from the State of North Dakota, Environment Canada, Agriculture and Agri-Food Canada, the US Environmental Protection Agency, the U.S. Geological Survey, and the Red River Basin Commission.

The Water Quality Committee has made considerable progress towards completing Component Two (Develop a Shared Understanding of Jurisdictions' Nutrient Regulatory Frameworks and Identify Current Nutrient Reduction Actions, Activities and Plans for the Red River Watershed) of the Nutrient Management Strategy. In particular, a matrix of actions and activities underway or proposed to reduce nutrient loads has been completed. The Committee has reviewed the activities in the matrix to identify which component of the strategy each activity addresses. The matrix will be updated periodically as agencies initiate new actions and activities that could reduce nutrient loads. The Committee has also compiled information on the different jurisdictions' regulatory framework. The framework has recently been updated with information from the Minnesota Department of Agriculture and a table of contents has been added.

The Committee has also developed a detailed work plan and timelines for Component Three (Recommend and Implement Nutrient Load Allocation and/or Water Quality Targets for Nutrients) of the nutrient management strategy (attachment three). Component Three includes significant pieces of work including:

- Developing nutrient load allocations and/or water quality targets for nutrients along the Red River including at the international boundary and at sub watershed discharge points in the Red River watershed;
- Identifying high priority areas for implementing nutrient reduction measures;
- Identifying nutrient reduction actions and activities for the Red River watershed that could assist in achieving nutrient load allocations and/or water quality targets for nutrients; and
- Developing a common set of indicators for measuring progress.

Finally, the committee has initiated an International Watersheds Initiative Project to review methods for developing water quality targets. The project proposal has been approved and the committee has developed a scope of work. Work on the project will begin as soon as the contract is completed, with a goal to start by October 1, 2012. The work should be completed by January 31, 2013.

4.03-4 Water Quantity Apportionment

As indicated by the historic streamflow records, water supply in the Red River basin is highly variable seasonally, annually, and over longer time periods. Recent forecasts of water demand based on population and economic growth projections further test the adequacy and reliability of these supplies. Scientific opinion with respect to climate change provides added caution regarding future hydrologic trends and the prospect of greater instability in water supply in the region.

The factors noted above and projected increases in water use causing larger departures from the natural regime to occur, prompt action to set flow targets at the international boundary. The IRRB considers it prudent to consider establishment of such targets before they are needed. In July 2006, the Committee on Hydrology (COH) was asked to prepare a detailed proposal to establish the 'process' for undertaking development and implementation of apportionment procedures. The proposal is to identify the project elements, participating agencies, related capacity issues, and timelines.

At the January 2008 meeting, the Board approved the Committee on Hydrology's plan for the development and implementation of flow apportionment procedure for the Red River. The Committee noted the establishment of a process for the development and implementation of water quantity apportionment requires an understanding of the natural flow regime on the Red River. Any acceptance of an apportionment procedure will require agreement on the method of computing the natural flow in the Red River Basin and understanding water uses in the Basin. The development of a flow apportionment procedure is likely to be a multi-year process and will require involvement of many partners. Major issues will be differences in water laws between the jurisdictions and consideration of instream flows. To support the development of a flow apportionment procedure three reports have been prepared under the IJC International Watershed Initiative.

The first report, Dr. Rob de Loe's, University of Guelph, reviewed apportionment governance procedures relevant to the Red River basin, and recommended an appropriate model. Dr. de Loe's completed report titled, "Sharing the Waters of the Red River Basin: A Review of options for Transboundary Water Governance" was approved by the IRRB at the September 2009 meeting.

The study was based on an extensive review of two main sources of information: (1) documents and reports relating to water management in the Red River Basin, and (2) the literature of transboundary water management. Two overseas and two International Canada/US case studies were analyzed in detail, with the goal of revealing insights into real-world problems and solutions of transboundary water governance. The overseas case studies were the Orange-Senqu River Basin in southern Africa and the Murray-Darling Basin, in Australia, The two Canada/US case studies were the St. Mary-Milk Rivers and the Souris River basins. The study recommended an apportionment model and approach to transboundary water governance in the Red River Basin that includes the following major elements:

1. A prior appropriation to meet critical human and environmental needs.
2. Rules to apportion remaining natural flows between Canada and the United States based on the principle of equitable sharing.
3. Rules regarding waters that originate in the respective countries' portion of the basin but do not cross the boundary. This model represents a balanced approach that takes account of local circumstances (e.g., the role of the *Boundary Waters Treaty of 1909*, existing management relationships, climatic conditions and the nature of water uses).

The second report, by R. Halliday & Associates, entitled "Determination of Natural Flow for Apportionment of the Red River identified a process for the development and implementation of water quantity apportionment procedures. The report covered the following areas:

- Define and review various methodologies that may be used to determine natural flow.
- Discuss these methods in the context of the Red River basin and recommend a specific method or methods.
- Review the data requirements of the selected method/methods and compare the requirements to the existing databases.
- Identify key data deficiencies and indicate how these could be resolved.
- Identify potential problem areas, such as, availability of structures to deliver minimum flows, different water rights appropriation procedures between jurisdictions and information availability.
- Review specific calculation procedures pertaining to international tributaries and recommend an approach.
- Review considerations related to equitable apportionment.

The Project Depletion Method was recommended given the availability of an adequate hydrometric network and a robust system of water permits or licenses in the Basin. Information is provided on how the calculation can be accomplished and several information gaps were identified in the areas of hydrometric and meteorological networks; water allocation; water use: evaporation and apportionment.

The report notes that there are a number of matters that must be resolved before natural flow can be calculated and before an apportionment arrangement can be executed. None of them is incapable of being resolved with good will among the parties. However, as water consumption in the Red River Basin is relatively low compared to that in other apportioned basins in the interior plains, it may be preferable to explore whether an international drought contingency plan may be a productive task to pursue rather than considering a traditional apportionment agreement. As an alternative, careful consideration of minimum flow criteria for the Red River could provide additional insights. Such criteria could well be the only element of an apportionment arrangement that is really required at this time.

The development and implementation of water quantity apportionment procedures for the Red River basin requires an understanding of the aquatic ecosystem to assist in identifying instream flow requirements for the Red River. A report gathered information to support the development of instream flows entitled “Information Available for an Instream Flows Analysis of the Red River for Water Apportionment Purposes" was prepared by William G. Franzin for the Board. Information was gathered with respect to the following five major riverine areas of hydrology; geomorphology; biology; connectivity; and water quality; variables. Because of the large amount of detailed hydrological, hydraulic and modeling data at least a year’s effort would be required by a person specializing in hydraulic modelling and GIS would be required to process the data to determine the feasibility of an instream flow study with the available data. If feasible, an Instream flow study of the Red River would be lead by a Steering Committee with several Task groups and take three to five years.

4.04 Comprehensive Flood Mitigation Strategy

In its report *Living with the Red*, the IJC noted that there is no single solution to reduce, mitigate and prevent harm from future flooding, and that comprehensive, integrated, binational approaches must be pursued and implemented. The report follows with a list of recommendations to include, ” Governments immediately take steps, on a binational basis, to begin development of a comprehensive flood damage reduction plan for the Red River basin”.

In 2003, at the request of the IJC, the IRRB completed a basin-wide survey and analysis of actions taken by governments at all levels in implementing the recommendations contained in *Living with the Red*. The final survey report titled *Flood Preparedness and Mitigation in the Red River Basin* **-** *October 2003*, indicated that while considerable progress had been made in increasing preparedness for major floods and in mitigating potential harm from future floods, there was a need for continued and concerted effort to address those IJC recommendations entailing multiple objectives and inter-jurisdictional cooperation. Further to this report, the IRRB indicated that a comprehensive flood mitigation plan as proposed by the IJC in January 2003 would provide an appropriate mechanism to mobilize the multi-jurisdictional co-operation necessary to assure cohesion on flood management and long-term resiliency in the basin.

In 2005 the document titled *Comprehensive Flood Mitigation Plan* (CFMP) was prepared by the IJC in consultation with the Red River Basin Commission (RRBC) and the IRRB, and advice regarding preferred options for advancing the document to the political level was sought from senior officials in the three jurisdictions (North

Dakota, Minnesota, and Manitoba). The proposed CFMP is intended to build on the Memorandum of Understanding for Flood and Drought Mitigation on the Red River that was signed by the governors of North Dakota, Minnesota and South Dakota and the Premier of Manitoba in April 2004. Further, the Plan recognizes current efforts led by the RRBC to develop a Natural Resources Framework Plan (NRFP). The CFMP would contribute to and become an integral part of the NRFP.

Support for the CFMP was discussed further at the IRRB annual meeting in July 2006. It was concluded that while members do not all have the same interpretation of the priorities for flood mitigation in the basin or on follow-up approach, the components under a CFMP, or Flood Mitigation Strategy as the suggested name-change, need to be determined. Integral to this task is a [current] documentation of the accomplishments and the positive benefits that have accrued to the basin and communities. The latter represents an important communications document reflecting the actions and achievement of many agencies, including the IJC and IRRB. This undertaking would also provide insight into how the IRRB and others might support or influence continued preparedness and mitigation activities in the basin.

As agreed at the 2006 annual meeting, the IRRB Co-Chairs prepared a Terms-of-Reference for the Committee on Hydrology Committee (COH) to develop a detailed project proposal that outlines the scope of work required to document the flood mitigation accomplishments to date and to identify the remaining mitigation priorities for the basin. The individual and collective capacity of participating agencies, and options to engage Committee members, IRRB members, and/or independent consultants, to complete the task is to be explored.

The IRRB Co-Chairs reviewed the March 2007 letter they had sent to the COH regarding the IRRB's role in identifying priority flood mitigation activities for the basin. In their letter, the Co-Chairs asked the COH to continue providing a current inventory of improvements and deficiencies based on agency knowledge. The same letter was also discussed with the IJC Commissioners at the April 2007 meeting. Based on the discussion, the Commissioners clarified their position on the Comprehensive Flood Mitigation Strategy (CFMS), previously known as the Comprehensive Flood Mitigation Plan (CFMP), and it was agreed that the IRRB should continue with the development of the CFMS as per the terms of reference provided to the COH. The Co-Chairs have indicated that based on the discussion with the IJC, they would amend their direction to the COH.

Since the 1997 Red River Flood there has been a legacy of accomplishments in the areas of cooperation between jurisdictions, improvements in predictive tools, public involvement and changes in legislation and development of data dissemination tools. However, there are still challenges in improving the predictive tools, maintaining and improving databases, data collection and data dissemination, maintaining flood protection infrastructure and continued review of flood protection policy and legislation.

Based on these accomplishments and challenges the Board felt it was time to update the IJC report "Living with the Red". The COH was instructed to develop a project proposal under the IWI initiative for the publication of a document entitled "How Are We Living with The Red?" In 2008, the IJC approved funding for this project and the COH contracted Halliday & Associates to assess flood preparedness, mitigation and to identify gaps and tasks yet to be undertaken. The intent of the document is to inform the public of accomplishments and challenges regarding flood mitigation in the basin and to supplement IRRB information available via the IJC International Red River web page. The completed project was presented to the Board at its meeting on September 16, 2009 in Gimli, Manitoba.

The study found much has been accomplished, yet some unresolved issues remain. While the communities of the Red River basin are unquestionably more flood resilient than in 1997, it will still take considerable effort to achieve the level of integration and cohesion on flood management that the IJC envisaged. Adoption of binational measures, however, will still be needed before the long-term resiliency of the basin can be assured. Some of the key achievements can be summarized under headings of policy, legislation and institutions; preparedness; mitigation; and environment as follows:

Policies, Legislation and Institutions

- Improvements in policy and legislation have been made in all jurisdictions.
- In 2008 Canada introduced its first national mitigation strategy. That strategy includes a number of priority actions, including an avenue for federal contributions to mitigation measures.
- Changes in data policies by the Canadian federal government and by the Manitoba government have led to much improved access to data.
- Manitoba has introduced a new designated flood area regulation. The associated elevation and inspection requirements for new structures will reduce future flood damages.
- Activities of the United States Army Corps of Engineers are aimed at a more integrated basin-wide consideration of mitigation projects.
- Both North Dakota and Minnesota have implemented new state building codes that include flood-proofing measures.
- Key institutional developments include the formation of the IJC's International Red River Basin Board, the Red River Basin Commission and the International Water Institute.

Preparedness

- All communities in the basin now have up-to date emergency response plans.
- Significant improvements have been made to flood forecasting in both Canada and the United States.

Mitigation

- Many structural measures aimed at protecting both rural and urban floodplain residents have been completed or are at advanced stages of development.
- Major levees such as those for Grand Forks and East Grand Forks are essentially complete.
- The increased capacity of the Red River Floodway at Winnipeg is now available although the project will not be complete until 2011.
- Flood protection measures for many other communities, large and small, are in place and thousands of rural residences have been moved, raised or diked.
- Several agencies are collaborating with the Red River Basin Commission and the International Water Institute on the development of complex hydraulic models for the basin.

Environment

- Measures have been introduced to avoid contamination of wells and to remove hazardous chemicals from the floodplain, or improve the storage facilities for chemicals.
- Programs are underway aimed at establishing riparian conservation reserves and developing a greenway on the Red River.

There are some causes for concern nonetheless. The less successful recommendations are those that involve multiple agencies and, perhaps, multiple objectives. These sorts of tasks could be deemed to be more difficult and could naturally be expected to take longer. It may be that public expectations for structural measures supercede all other post-flood pressures and that those expectations need to be met before proceeding with "softer" projects. As well, some structural measures in the upper basin have been delayed by other priorities and because of permitting issues.

4.05 Invasive Species – Zebra Mussels

Zebra mussels, a nonnative invasive species, were discovered in the Red River basin for the first time in September 2009. The mussels were found in Pelican Lake in Otter Tail County, Minnesota, which is on the Otter Tail River. Native to Eastern Europe and Western Russia, zebra mussels were first discovered in the Great Lakes in 1988. They entered the Upper Mississippi River system from Lake Michigan via the Illinois River (Chicago Sanitary and Shipping Canal) and spread upriver into Minnesota and Wisconsin via recreation and commercial boat traffic. Heavy infestations can kill native mussels, impact fish populations, interfere with recreation, and increase costs for industry, including power and water supply facilities.

Zebra mussels are adapted to lentic (lakes/reservoir) habitat. They can survive in riverine habitat, but they require an upstream source of healthy zebra mussel populations to continually supply free floating larvae – typically from an upstream reservoir or lake. Zebra mussels are typically spread overland from infected lakes via transient recreational boat traffic and transfers of boat docks or lifts. It is probable that there is an established and reproducing population in Pelican Lake, as evidenced by small and large individuals observed. Based on previous experience on the Upper Mississippi River, it is likely that zebra mussels will colonize the reservoir immediately downstream (Orwell Reservoir) and larvae likely will drift down the Otter Tail River to the Red River. However, the higher energy and flashy nature of the Red River does not provide ideal zebra mussel habitat. Eventual Zebra mussel infestation of the Red River is possible, but surviving population levels are likely to be minimal.

The confluence of the Red River and the Otter Tail River is approximately 550 river miles from Lake Winnipeg. U.S. Army Corps of Engineers experience on the Upper Mississippi River indicates that larval drift ranges from approximately 75 to 125 miles before juveniles settle and attach to hard surfaces. It is highly unlikely that larval juveniles will drift from the Otter Tail to Lake Winnipeg. Infestation of Lake Winnipeg via the Red River would require the establishment of a viable population within closer proximity (a lake or a reservoir which is non-existent at this time). Over land transport by humans from infested waters appears to be a more likely vector for zebra mussels to become established in Lake Winnipeg.

There is little that can be done to address an existing infestation of zebra mussels. Natural resource agencies in the U.S. and Canada are focused on public awareness and education aimed at preventing transportation of mussels on boats, trailers, and docks. Actions include increased signage at infested lakes, watercraft inspections, and monitoring.

Because of the potential transfer of Zebra mussels and other species of concern downstream into the Red River system, IRRB has agreed to keep the topic of Invasive Species as a standing item on its Board agenda for future discussions.

4.06 Lower Pembina River Flooding

The IRRB at their January, 2008 meeting, established the Lower Pembina River Flooding Task Team (LPRFTT). The mandate of this Task Team is to develop a science-based solution(s) to mitigate flooding in the lower Pembina River basin.

The LPRFTT has overseen the completion of an International Watersheds Initiatives (IWI) study draft report entitled "Simulation of Flood Scenarios on the Lower Pembina River Flood Plains with the Telemac2D Hydrodynamic Model", a Phase 3 study conducted by the National Research Council's (NRC) Canadian Hydraulics Centre. The two previous phases were also conducted by the Canadian Hydraulics Centre with IWI funding. This latest report will soon be finalized once the NRC hydrological component has been reviewed. Based on the results of this modelling effort, the LPRFTT has developed a Recommendations Document that will be submitted to the IRRB at its August meeting. This LPRFTT document provides comments on the Phase 3 Report, summarizes main modelling results and conclusions from the report, and suggests a path forward concerning flood mitigation within the basin. This LPRFTT Recommendations Report is part of a package that will be accompanied with the finalized Phase 3 Report, inundation maps, Phase 3 Conclusions, summary table and excerpts from the Phase 3 Report.

Early in 2010, the USACE conducted the survey of Switzer Ridge area, which experienced significant erosion during the spring of 2009. The first report (Phase 1) was completed during July 2009; model details including model description, how it was applied to the Lower Pembina River flood plains, calibration, verification, etc. were presented at the IRRB September 2009 meeting by the NRC modeller, Thierry Faure; and the report was later approved by the IRRB at its January 2010 meeting and was forwarded to the IJC. Reviewers of the first phase thought that the model fairly accurately replicated what flooding occurred during the spring of 2006.

The second study (Phase 2) was completed during June 2010, expanded the model domain geographically and included more infrastructure, such as more roads and culverts. This was accomplished by provision of additional agency infrastructure data and additional LiDAR information to the NRC. Based on consultations with a number of stakeholders, simulation scenarios such as removal of both County Road 55 and the border road dyke, and flattening of all roads; along with various flood mitigation scenarios including set-back dykes, various floodway alignments and various diversion alternatives, were simulated using the 2006 flood event. Stakeholders consulted included the Pembina River Basin Advisory Board, the Pembina County Water Resource District, the Red River Basin Commission, and the IRRB. Results of the study were presented to the IRRB September 2010 meeting by the LPRFTT. Model generated results were also presented to the Pembina River Basin Advisory Board and Pembina County Water Resource District and at the January 2011 Annual Red River Basin & Water International Summit Conference and at the June 2011 Canadian Water Resources Annual Conference.

The third phase of the study, "Simulation of Flood Scenarios on the Lower Pembina River Flood Plains with the Telemac2D Hydrodynamic Model" refined the model along various rivers and coulees to allow more accurate simulation of the flood extent along these watercourses. The model was further enhanced in some key areas in terms of inclusion of additional roads, bridges, and culverts; and the downstream boundary was moved downstream to Morris, Manitoba, to properly assess the confluence of Buffalo Creek with the Red River. Four different flood scenarios were modeled: the 1:10, 1:50 and 1:100 year return period spring floods and the 1:20 year summer flood allowing a wide range of flood severity levels to be assessed. The model used the USACE developed hydrographs (annual events) and Manitoba Water Stewardship hydrographs (summer rainfall events) at Walhalla along with local hydrographs for specific return periods. Local hydrographs for both annual events and summer rainfall events were estimated by NRC and are currently being reviewed. The model was then used to analyze the increase and decrease of flooding when comparing the existing conditions to other scenarios. The modelled scenarios included the removed the border road/dyke, all roads removed ("natural conditions"), removed ND County Road 55, and compared the existing and "natural" scenarios with hypothetical situations including a floodway, a set-back dyke, and diversions or cuts in the border road/dyke. The model provided a general estimate of acres flooded and flood duration.

Preliminary modelled results were presented by Thierry Faure at the January 2012 Annual Red River Basin & Water International Summit Conference and the IRRB January 2012 meeting. Thierry also presented modelled results to the Pembina River Basin Advisory Board at a March 26th meeting in Walhalla, North Dakota. The draft third phase report should be finalized in the next few months.

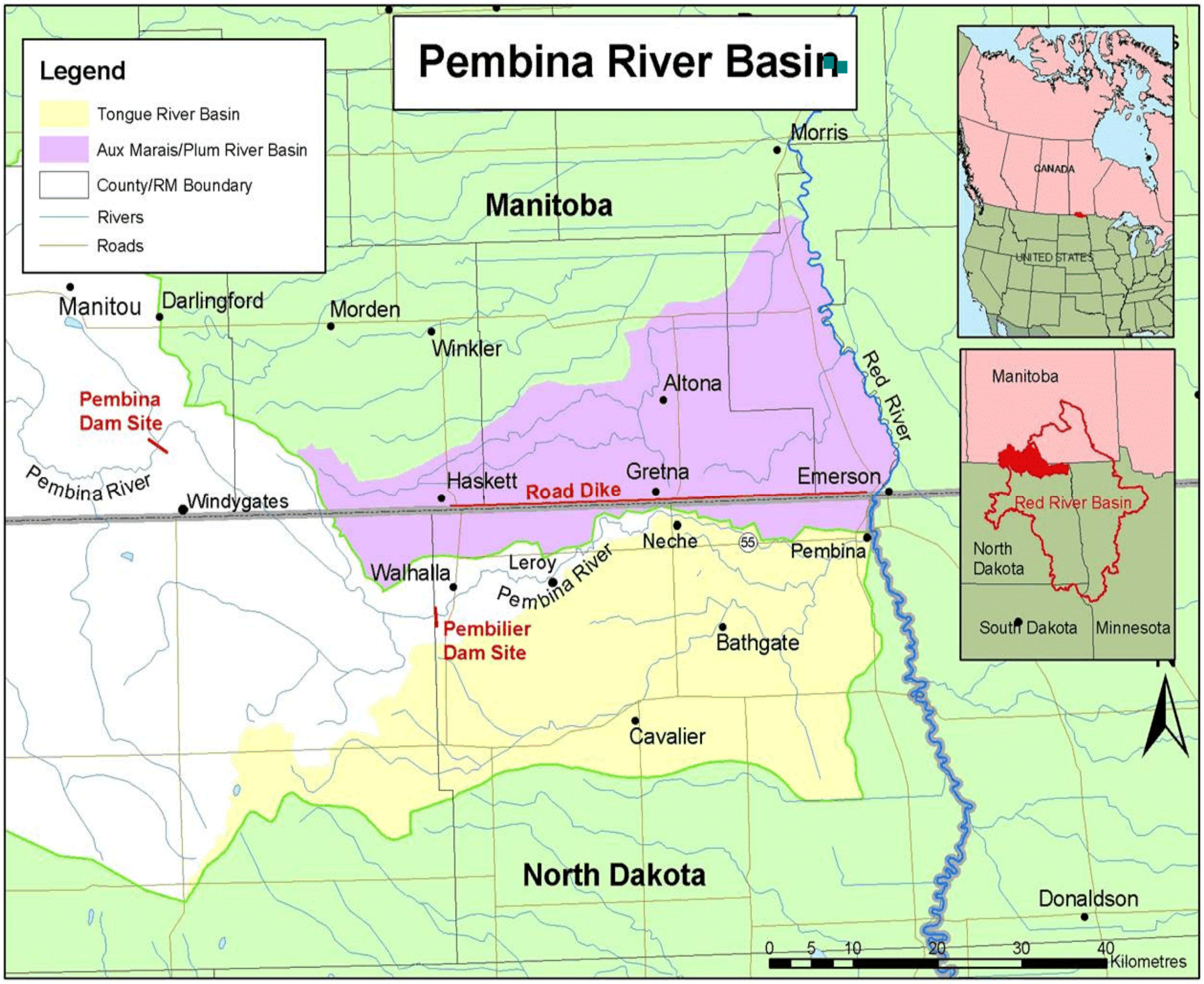

Figure 2 Pembina River Basin. The yellow and white areas comprise the Pembina River Basin.

4.07 Poplar River Basin

The Poplar River forms an international river basin shared by Saskatchewan and Montana. Although not geographically located within the Red River basin, the mandate of the IRRB includes the Poplar River, previously the responsibility of the International Souris-Red Rivers Engineering Board (ISRREB). This responsibility originates with the 1975 IJC instructions to the ISRREB to investigate equitable apportionment alternatives on the East Poplar River in consideration of the thermal power station and cooling reservoir that were being constructed by the Saskatchewan Power Corporation near Coronach, Saskatchewan. In 1976, the ISRREB recommended an apportionment formula to the IJC for the East Poplar River. Subsequently, in 1978, the IJC recommended an apportionment formula to the governments of Canada and the United States.

Environment Canada and the United States Geological Survey (USGS) have been collecting monthly water quality samples for nutrients, major ions and metals since July 1975. However, in 1977, the governments of Canada and the United States referred the issue of water quality to the IJC. The IJC Water Quality Task Force completed its report in 1981, which provided the basis for establishing flow-weighted objectives for numerous water quality parameters, including total dissolved solids (TDS) and boron. The International Air Pollution Advisory Board provided advice to the IJC regarding air pollution potential from the generating station. The Coronach Power Station began operation in 1981. Although Canada and Saskatchewan have not accepted the IJC apportionment formula and water quality objectives, both the formula and objectives have been followed by Saskatchewan throughout the intervening years.

Bilateral Monitoring Committee

The Poplar River Bilateral Monitoring Committee was established in 1980, and is composed of government representatives from Canada and the United States, Montana, and Saskatchewan, as well as one public ex-officio member from Canada and one from the United States. The Committee's main responsibility is to oversee monitoring programs designed to evaluate the potential for transboundary impacts from the generating station and its operations. The Committee's current mandate expires in 2017.

Under the Committee's purview, surface and ground water quality and quantity data, and air quality data are collected at or near the international boundary. These monitoring programs initially included a quarterly data exchange and an annual data review and report. In September 1991, the Committee agreed that the data exchange was no longer required and that an annual data review and report would suffice.

Compliance with Apportionment and Water Quality Objectives

The water quality report for boron and TDS for 2011 was derived from the daily specific conductance data collected on the East Poplar River at the international boundary. No exceedences of the water quality objectives were observed for the 2011 monitoring year.

Based on IJC recommendations, the United States was entitled to an on-demand release of 617 dam^3 (500 acre-feet) from Cookson Reservoir in 2011. A volume of 2,180 dam^3 (1,770 acre-feet) was delivered between May 1 and May 31, 2011. Daily flows during 2011 met or exceeded the minimum recommended by the IJC for most of the year.

5.0 WATER QUALITY AT THE INTERNATIONAL BOUNDARY

The water quality of the Red River at the international boundary, as reported herein, is based on continuous monitoring and instantaneous grab samples obtained during the 2010 water year (October 1, 2010 - September 30, 2011). The collected data, carefully scrutinized, are used to determine compliance with established IJC water quality objectives at the international boundary and in meeting the provisions of the Boundary Waters Treaty of 1909. Detection of exceedences of the objectives serves as a trigger mechanism for agencies to take appropriate action to prevent or to mitigate potential problems, and to minimize the potential for reoccurrence. Environment Canada carries the responsibility for providing this monitoring service for the IRRB and maintains a permanent water quality and water quantity data collection site at Emerson, Manitoba.

The five parameters for which the IJC has approved objectives are discussed below along with streamflow and *pH* characteristics for a corresponding time period.

Water quality characteristics at other locations throughout the basin are referenced in subsequent chapters of this report to provide a more complete spatial representation of water quality and aquatic ecosystem conditions in the Red River basin.

***pH* and Temperature**

During the reporting period, the observed pH and temperature values for the Red River remained within the normal range.

5.01 Water Quality Objectives

As described in Appendix B, the IJC established objectives for a limited number of water quality variables for the Red River at the international boundary. These variables are dissolved oxygen, total dissolved solids, chloride, sulphate, and fecal coliform bacteria. The IRRB is responsible for monitoring and reporting on compliance with these objectives.

Dissolved Oxygen

Dissolved oxygen generally remained well above the objective level of 5.0 mg/L.

Total Dissolved Solids and Specific Conductance

Some exceedences of the International Joint Commission (IJC) water quality objectives, and concentrations approaching the objective level for total dissolved solids (TDS) were observed at the international boundary during the 2010 water year. The TDS objective of 500 mg/L was exceeded several times in the 2010 water year. The highest observed value of 684 mg/L was recorded in June 2011.

Chloride

The chloride objective (100 mg/L) was not exceeded during the reporting period. Other monthly values ranged from a high of 51 mg/L in March 2010 to a low of 13 mg/L in April 2011.

Sulphate

The sulphate objective (250 mg/L) was exceeded on five occasions during the water year – three times in June 2011, and twice in July 2011. Other monthly values ranged from a low of 80 mg/L in April 2011 to a high of 275 mg/L in June 2011.

Bacteriological Characteristics

The bacteriological characteristics of the Red River are assessed on the basis of observed fecal coliform bacteria for which an IJC objective (200 colonies per 100 ml) has been defined. During the 2010 water year, the fecal coliform bacteria objective of 200 colonies/100 ml was exceeded once. The newly established *Escherichia coli* objective of 200 colonies per 100 ml was also exceeded once during the water year.

New *Escherichia coli* Objective - In December 2009, the IRRB requested approval from the IJC to switch its bacterial indicator from fecal coliform to *Escherichia coli* to be consistent with other participating agencies. Subsequently, the IJC recommended to the Governments of Canada and United States endorsing the Board's request. In a letter sent to the IJC in July 2010, Canada and the United States supported the recommendation from the IJC and have agreed to amend the objective. The new *Escherichia coli* objective was effective starting October 1, 2010 (beginning of new water-year).

Although some exceedences of the IJC water quality objectives, and concentrations approaching the objective level for some parameters were observed during the reporting period, no intervention or action by the IRRB or participating agencies was required.

5.02 Alert Levels

Fifteen of the suite of pesticides, herbicides and metals for which alert levels were established by the former International Red River Pollution Board (Table 1) were detected during the reporting period. Based on a total of 12 water samples, 11 pesticides and/or herbicides with a total aggregate of 92 exceedences (greater than detection concentration) were recorded during the October 1, 2010 - September 30, 2011 reporting period. The number of exceedences may be higher because some of the later samples are still missing pesticide/herbicide data. The detection levels were below the Canadian Aquatic Guidelines. Given that the Red River basin is an agriculturally dominated region, the presence of pesticides and herbicides is expected.

The IRRB recognizes that there is very little scientific information available to assess the implications of long-term exposure to low concentrations of pesticides and herbicides by aquatic organisms and humans. The IRRB continues to closely monitor trends in these concentrations and their frequency of detection with the view to updating its assessment as new scientific information becomes available.

Table 1. **Exceedences of Alert Levels, Red River at International Boundary October 1, 2010 to September 30, 2011**

Parameter	Units	Alert Level	Number of Exceedences	Exceedence Values		Canadian Aquatic Life Guidelines
				Min	Max	
pH		6-9	0			6-9
Chloride	mg/L	100	0			NG
TDS	mg/L	500	33	503.9	684.2	NG
Cadmium	ug/L	Detect	22	0.021	0.341	0.017ug/l
Manganese Total	ug/L	50	22	60.1	752	NG
Iron Total	ug/L	300	22	370	5920	300 ug/l
2,4-D	ng/L	Detect	12	16.8	153	4000 ng/l
Bromoxynil	ng/L	Detect	3	1.3	3.7	5000 ng/l
Clopyralid	ng/L	Detect	12	2.8	125	NG
Dicamba	ng/L	Detect	10	2.22	14.9	10000 ng/l
Imazamethabenz-methyl a	ng/L	Detect	0			NG
Imazamethabenz-methyl b	ng/L	Detect	0			NG
MCPA	ng/L	Detect	11	2.1	254	2600 ng/l
Mecoprop	ng/L	Detect	7	2	17	NG
Picloram	ng/L	Detect	4	17	42	29000 ng/l
Aldrin	ng/L	Detect	0			NG
g-Benzenehexachloride	ng/L	Detect	0			NG
Pentachloroanisole	ng/L	Detect				NG
Atrazine	ng/L	Detect	11	5.4	290	1800 ng/l
Desethyl Atrazine	ng/L	Detect	8	11	53	NG
Metolachlor	ng/L	Detect	9	3.2	287	7800 ng/l
P,P-DDE	ng/L	Detect	0			NG
Alpha-Endosulfan	ng/L	Detect	0			20 ng/l
Beta-Endosulfan	ng/L	Detect	0			20 ng/l
Heptachlor Epoxide	ng/L	Detect	0			10 ng/l
Metribuzin	ng/L	Detect	1		37	NG
Total PCB	ng/L	Detect	0			NG

*DL = Detection Level   NG = No Guideline Established

6.0 WATER QUALITY SURVEILLANCE PROGRAMS

As described in Chapter 5, data collected at Emerson, Manitoba, are used to determine compliance with established IJC water quality objectives at the international boundary. Chapter 6 contains basin-wide data and information contributed by IRRB member agencies to provide a more complete spatial representation of water quality and aquatic ecosystem health conditions in the Red River basin.

U.S. Water Quality Standards Program

In the United States, the statutory basis for the current Water Quality Standards (WQS) program is the Clean Water Act. Under Section 303 of this Act, the Environmental Protection Agency (EPA) issued a Water Quality Standards Regulation (40 CFR Part 131). This regulation specifies the requirements and procedures for developing, reviewing, revising, and approving WQS by the States and Tribal Nations. EPA has approved WQS programs for the States of North Dakota, South Dakota, and Minnesota. No tribal programs in the Red River basin have yet been approved.

WQS define the water quality goals for a water body or portion thereof, by designating the use or uses to be made of the water, and implementation criteria for protecting each of those uses or areas. Additionally, a WQS program must include an anti-degradation policy to protect water quality that is already better than State standards. Designated uses for water bodies may include:

- Aquatic life - protection of fish and other aquatic organisms;
- Recreation - swimming, wading, boating, and incidental contact;
- Drinking water - protection for downstream public water supply intakes;
- Miscellaneous - industrial or agricultural uses, tribal religious use, etc.

Water quality standards are designed to protect the beneficial uses associated with the standards. Based on the assessment of the water quality data and other relevant information compared to the standards for a given pollutant or water quality characteristic, the use may be:

- Fully supported
- Partially supported
- Threatened
- Not supported

6.01 Minnesota

Water Quality Surveillance

In order to effectively sample streams throughout Minnesota, the Minnesota Pollution Control Agency (MPCA) has implemented an Intensive Watershed Monitoring Approach planning to assess and manage the aquatic health of the entire major watershed through intensive biological and water chemistry sampling and supporting assessment and action.

The Intensive Watershed Monitoring Strategy determines watershed condition through intensive monitoring of the state's major watersheds, known as 8HUCs, using a classification scheme developed by USGS.

Intensive Watershed Monitoring utilizes a 'pour point' method of sampling which measures the condition of the upstream watershed in an unbiased way. The intensive approach allows assessment of the watershed for aquatic life, aquatic recreation, and aquatic consumption use support of the state's streams in each of the state's 84 major watersheds on a rotating 10 year cycle. These uses are assessed to make sure that the goals of the Clean Water Act of "fishable, swimmable" waters are being met.

Biological Sampling

The majority of the sites in the watershed design are termed biological. A single water chemistry sample is taken at each of these sites during the sampling season. Fish are sampled through electro-shocking, and invertebrates are sampled with dip nets. Sites are placed at the nearest road crossing to the end of each minor watershed throughout the larger watershed to be able to assess the watershed for biology. Sampling does not take place in a minor watershed if a lake, wetland, or larger stream is within one mile of the planned site location.

Water Chemistry Sampling

At the mouth of each minor watershed, a water chemistry site is placed. These sites are sampled for biology, along with additional water chemistry parameters. Sites are sampled ten times throughout the summer, and depending on the watershed, may be sampled for nitrates-nitrites, ammonia, dissolved oxygen, pH, conductivity, temperature, total phosphorus, Kjeldahl nitrogen, chlorides, sulfates, calcium, magnesium, total suspended solids, total volatile solids, E. coli, chlorophyll-a, pheophytin, and transparency data. E. coli data makes it possible to assess the stream for aquatic recreation, and dissolved oxygen, transparency, and suspended solids data makes it possible to assess the stream for aquatic life.

Fish Contaminants Sampling

At the pour point of each of the major watersheds, fish are collected for the analysis of contaminants (mercury and PCBs) to assess whether or not the surface water is meeting the beneficial use of aquatic consumption. Additional stream reaches within the watershed may also be sampled and analyzed, such as collecting trout for mercury testing in coldwater reaches. Mercury and PCB analysis will be conducted on fish tissue. Top carnivore species are particularly important for mercury analysis while rough fish species are important for PCB analysis. Species preferences for top carnivores are: walleye, northern pike, smallmouth bass, channel catfish, and bluegill. Species preferences for rough fish are: common carp, redhorse sucker, and white sucker. It is important to collect an appropriate age/length range of these individuals, preferably of edible size. In general as the age/length increases so do the concentrations of these contaminants. An adequate distribution of size classes is critical to characterize or assess the contamination level of these parameters.

IWM Watersheds Monitored

Intensive Watershed Monitoring was completed in the Thief River, Sandhill, Bois de Sioux, and Mustinka major watersheds in water year 2011. Intensive Watershed Monitoring was completed in the Upper Red, Buffalo and Lower Red major watersheds in water year 2010.

Watershed Pollutant Load Monitoring Network

The Watershed Pollutant Load Monitoring Network (WPLMN) is designed to measure and compare regional differences and long-term trends in water quality among Minnesota's major rivers including the Red, Rainy, St Croix, Minnesota, and Mississippi and the outlets of major tributaries (8 digit HUC scale) draining to these rivers. Since the program's inception in 2007 with an appropriation from Minnesota's Clean Water Legacy Fund, the network has adopted a multi-agency monitoring design. Site-specific stream flow data from United States Geological Survey (USGS) and Minnesota Department of Natural Resources (DNR) gaging stations is combined with water quality data collected by the Metropolitan Council Environmental Services (MCES), local monitoring organizations, and WPLMN staff to compute annual pollutant loads at river monitoring sites across Minnesota.

For the water year 2011, there were 18 sites sampled in the Red River Basin of Minnesota. Water quality measurements collected include both field and laboratory measurements.
The in-field measurements include:

- pH
- temperature
- conductivity
- dissolved oxygen
- turbidity
- transparency tube

The laboratory measurements include:

- total suspended solids (TSS)
- suspended volatile solids (SVS)
- turbidity
- dissolved orthophosphate (DOP)
- total phosphorus (TP)
- nitrate plus nitrite nitrogen (NO3 + NO2)
- total kjeldahl nitrogen (TKN)

All labs used in the program are certified by the Minnesota Department of Health. Loads and flow weighted mean concentrations are calculated annually for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), nitrate plus nitrite nitrogen (NO_3+NO_2 -N) and total Kjeldahl nitrogen (TKN).

Partners

The MPCA continues to partner with the Minnesota Department of Agriculture (MDA) for monitoring of agricultural chemicals in the Red River Basin. MDA monitors ground water and surface water for detection of agricultural chemicals.
Six surface water sites are monitored for agricultural chemicals in the Red River Basin. One site remains as a Tier 1 site, it is located at the confluence of the Red River of the North and the Sandhill River. Acetochlor, atrazine and metolachlor were not detected at greater than aquatic life standards.

Sites at the confluences of the Red River and the Snake River, Bois de Sioux River, Tamarac River, Red Lake River (Fisher), and Grand Marais Creek were also sampled and are now in the Tier 2 site category.
The Buffalo River became a Tier 3 site in 2009, after Chlorpryifos had been detected at low levels over several years. For the water year 2011 the Buffalo River remains the only Tier 3 site.

For the water year 2011, the two agencies continue their agreement to house all water quality data in a single data base, maintained by MPCA.

Water Pollution Control in the Minnesota Red River Basin

For the water year 2011, eighteen (18) Minnesota wastewater treatment facilities reported 28 spills or bypasses. The majority of these releases were during snowmelt or rain events. There were 55 permits issued and 12 enforcement actions. There are approximately 2000 registered feedlots in the Red River Basin, of varying sizes and animal types. The greatest numbers are in Otter Tail, Becker and Clay counties. Of these, 10 facilities had enforcement actions in water year 2011. For the water year 2011, 128 construction storm water permits were issued by MPCA for the 22 counties of northwestern Minnesota. These permits are required for any activity disturbing more than one acre of land.

6.02 North Dakota

Ambient Water Quality Monitoring Program

During the reporting period October 1, 2010 to September 30, 2011, the North Dakota Department of Health (department) conducted or contracted with the USGS for ambient chemical monitoring at 18 sites in the Red River Basin (Table 2).

Table 2. North Dakota Department of Health Ambient Water Quality Monitoring Sites in the Red River Basin.

Station Number	Station Description
385055	Bois de Sioux near Doran, MN[1]
380083	Red River at Brushville, MN
380031	Wild Rice River near Abercrombie[1]
385414	Red River at Fargo[1,2]
385040	Red River near Harwood
380010	Sheyenne River at Warwick[1]
380009	Sheyenne River 3 mi E of Cooperstown[1]
380153	Sheyenne River below Baldhill Dam[1]
380007	Sheyenne River at Lisbon
385001	Sheyenne River near Kindred[1]
384155	Maple River at Mapleton[1]
380156	Goose River at Hillsboro[1,2]
384156	Red River at Grand Forks[1,2]
380037	Turtle River at Manvel[2]
380039	Forest River at Minto[1,2]
380157	Park River at Grafton[1,2]
380158	Pembina River at Neche[1,2]
384157	Red River at Pembina[1,2]

[1] Site co-located with USGS flow gauging station.
[2] Site sampled by the USGS under cooperative agreement with the department.

Sites were sampled during the open-water period at six-week intervals from April through November. In addition, one sample was collected under ice in February 2011. This schedule resulted in seven samples collected at each site during the reporting period. Stations inaccessible due to flooding/road construction or sites with no flow were not sampled. Samples collected by the department were analyzed for major cations, anions, trace elements, nutrients (total and dissolved), total suspended solids (TSS) and E. coli bacteria (Table 3). In addition, field measurements for temperature, pH, dissolved oxygen and specific conductance were taken during each site visit.

The department enters all of its water quality results in the Surface Water Quality Management Program's Sample Identification Database (SID). Each year, data are exported to the U.S. Environmental Protection Agency's (EPA) STOrage and RETreival (STORET) database.

Table 3. North Dakota Department of Health Water Quality Variables Analyzed.

Field Measurements	Laboratory Analysis			
	General Chemistry	**Trace Elements[1]**	**Nutrients[2]**	**Biological**
Temperature	Sodium	Aluminum	Ammonia	E. coli
pH	Magnesium	Antimony	Nitrate-nitrite	
Dissolved Oxygen	Potassium	Arsenic	Total Kjeldahl Nitrogen	
Specific Conductance	Calcium	Barium	Total Nitrogen	
	Manganese	Beryllium	Total Phosphorus	
	Iron	Boron	Organic Carbon	
	Chloride	Cadmium		
	Sulfate	Chromium		
	Carbonate	Copper		
	Bicarbonate	Lead		
	Hydroxide	Nickel		
	Alkalinity	Silver		
	Hardness	Selenium		
	Total Dissolved Solids	Thallium		
	TSS	Zinc		

[1]Department samples are analyzed for total recoverable and dissolved metals. The USGS samples are analyzed only for dissolved metals.
[2]Nutrients are analyzed for both total and dissolved fractions.

6.03 Manitoba

Surface Water Quality Monitoring

Water quality continues to be monitored monthly at two sites on the Red River within Manitoba by Manitoba Conservation and Water Stewardship. These sites are located upstream and downstream of the City of Winnipeg (Floodway control structure and Selkirk, respectively) (Figure 3). Variables measured include physical, general chemistry, suspended sediment, bacteria, industrial organics, trace elements, plant nutrients, and agricultural chemicals. The City of Winnipeg normally monitors six sites on a bi-weekly basis. These sites are located upstream, within, and downstream of the City of Winnipeg. Variables monitored by the City of Winnipeg include general chemistry, plant nutrients, suspended sediment, bacteria, and chlorophyll *a*. Long-term variables monitored by Manitoba Conservation and Water Stewardship are shown in Table 4. Routine monitoring is also conducted on five tributary streams to the Red River by Manitoba Conservation and Water Stewardship (Figure 3). Samples are collected at minimum four times per year and analyzed for a wide range of variables including physical, general chemistry, suspended sediment, bacteria, industrial organics, trace elements, plant nutrients, and agricultural chemicals. In addition, benthic macroinvertebrates were collected from the Red River at Emerson and Selkirk in September 2011.

Red River – Main Stem

During this reporting period, water quality in the Manitoba reach of the Red River main stem remained relatively good and comparable to previous years. Dissolved oxygen concentrations were relatively high with an average concentration of 8.3 mg/L upstream of the City of Winnipeg and 9.2 mg/L downstream of the City of Winnipeg. The lowest value recorded of 5.5 mg/L occurred in July of 2011 upstream of the City of Winnipeg.

Densities of *Escherichia coli* bacteria downstream of the City of Winnipeg were lower than the previous reporting period. Average density downstream of the City of Winnipeg was 44 organisms / 100 mL (geomean), compared to 61 organisms / 100 mL in the previous reporting period. In comparison, the average density of *E. coli* bacteria in the upstream reach was 17 organisms / 100 mL (geomean), comparable to the previous year (21 organisms / 100 mL). Densities of *E. coli* bacteria did not exceed the Manitoba Water Quality Standards, Objectives, and Guideline for the protection of recreation of 200 organisms / 100 mL upstream of the City of Winnipeg. Meanwhile the exceedence rate of the Manitoba Water Quality Standards, Objectives, and Guidelines for the protection of recreation was 21% downstream of the City of Winnipeg as opposed to 18 per cent in the previous reporting period.

During this reporting period, seven samples were analyzed for pesticides upstream of the City of Winnipeg. Nine pesticides out of the 63 monitored were detected. Pesticides detected included AMPA, atrazine, 2, 4-D, bromoxynil, dicamba, diuron, glyphosate, thifensulfuron-me, and MCPA. 2,4-D was detected in 5 out of 7 samples in October 2010, and April, June, July and August 2011. AMPA and dicamba were detected in October 2010, and July, August, and September 2011. Atrazine was detected in June, July, and August 2011. Bromoxynil and Diuron were detected only in July 2011. Glyphosate was detected in all samples analysed for pesticides while thifensulfuron-me was only detected in September 2011. None of the pesticides detected were at concentrations that exceeded water quality guidelines (where available) for the protection of surface water used as sources of drinking water supply, habitat for aquatic life and wildlife, or livestock uses. However, concentrations of MCPA and dicamba exceeded the guidelines developed by the Canadian Council of Ministers of the Environment for protection of irrigation uses.

Nine pesticides out of the 63 monitored were detected downstream of the City of Winnipeg. A total of 13 samples were analyzed for pesticides. Chlorothanlonil was detected once in May of 2011. Thifensulfuron-me, was detected once in April and September 2011. Bromoxynil was only detected in July 2011. 2,4-D was detected in October and November 2010, and April, June, and July 2011. AMPA was detected in October 2010 and July, August, and September 2011. Dicamba was detected in October and November 2010, and April, June, and July 2011. Atrazine was found in July and August 2011. Glyphosate was detected frequently including in October and November 2010 and in April, May, June, July, August and September 2011. MCPA was detected in December 2010, and June, July, and August 2011. None of the detections of pesticides exceeded water quality guidelines (where available) for the protection of surface water used as sources of drinking water supply, habitat for aquatic life and wildlife, or livestock uses. However, the concentrations of MCPA and dicamba exceeded the guidelines developed by the Canadian Council of Ministers of the Environment for protection of irrigation uses.

Red River - Tributary Streams

During this reporting period, most water quality parameters in the tributaries to the Red River main stem remained relatively comparable to past years. Average dissolved oxygen concentrations were notably higher than the previous reporting period and ranged from 6.7 to 9.3 mg/L. Dissolved oxygen concentrations were generally above water quality objectives at the tributaries monitored in the reporting year. The Roseau River in October 2010 had the lowest dissolved oxygen concentration at 4.0 mg/L. Densities of *Escherichia coli* bacteria were within the Manitoba Water Quality Objective for the protection of recreation at all the Red River tributaries sampled in the reporting year.

Twelve pesticides were detected in samples collected from the five main tributaries to the Red River within Manitoba including 2-4-D, AMPA, atrazine, MCPA, MCPP, chlorothalonil, glyphosate, thifensulfuron methyl, tribenuron methyl, triclopyr, dicamba, and bromoxynil. 2,4-D was detected in the Boyne River (June 2011), the La Salle River (October 2010, June 2011) and the Roseau River (October 2010). Dicamba was detected in the Roseau (October 2010, April, May, June, July 2011), the Seine (June 2011), and the La Salle River (October 2010, April, June, July 2011) AMPA was detected in all tributaries except for the Rat River. AMPA was detected in the Roseau and Boyne River both in October 2010, the Seine River (October 2010, April 2012) and the La Salle River (October 2010, April, June and July 2011). Atrazine was detected once in June 2011 for the Seine River at the South Perimeter highway. Bromoxynil was detected at three tributaries, the Roseau River (July 2011), the Boyne River (June and July 2011), and La Salle River at La Salle (July 2011). Chlorothalonil was detected in one sample from the La Salle River at La Salle in June 2011. Glyphosate was regularly detected in samples from the five tributaries. MCPA was detected in the Roseau, La Salle and Boyne Rivers in June and July 2011 and once additional detection for the La Salle River at La Barrier Park in October 2010. MCPP (mecoprop) was detected only in June 2011 at the La Salle River at La Salle. Thifensulfuron-ME was also detected once during the reporting period at the La Salle River at La Salle in July 2011. Tribenuron methyl was detected twice in the La Salle River (October 2010 at La Salle, and July 2011 at La Barrier Park). Triclopyr was detected once in October 2010 at the La Salle River at La Barrier Park. Concentrations of dicamba and MCPA exceeded the guidelines developed by the Canadian Council of Ministers of the Environment for protection of irrigation uses. The concentration of chlorothalonil in the sample from the Boyne River in October 2010 was above the water quality guideline for the protection of freshwater aquatic life.

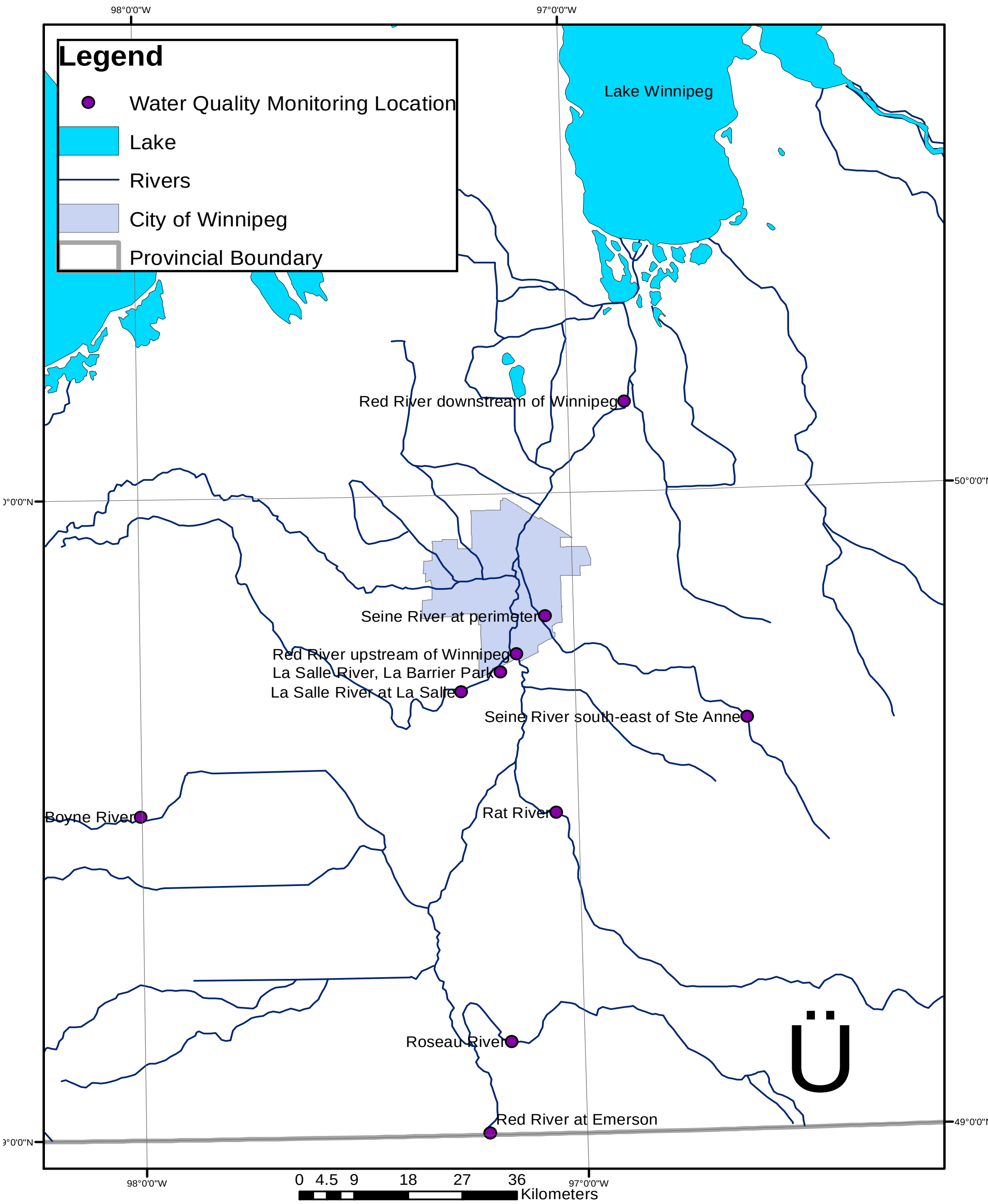

Figure 3: Location of water quality and benthic invertebrate sample sites in the Red River watershed (Manitoba).

Table 4. Routine surface water quality monitoring variables sampled by Manitoba Conservation and Water Stewardship on the Red River and tributaries within Manitoba, Canada.

Variables	Units
2,4,5-TP	ug/L
2,4-DB	ug/L
2,4-D	ug/L
ALACHLOR	ug/L
ALKALINITY CO3	mg/L
ALKALINITY OH	mg/L
ALKALINITY TOTAL CACO3	mg/L
ALKALINITY TOTAL HCO3	mg/L
ALUMINUM DISSOLVED	mg/L
ALUMINUM TOTAL	mg/L
AMMONIA DISSOLVED	mg/L
AMPA(AMINOMETHYLPHOSPHONIC ACID)	ug/L
ANTIMONY TOTAL	mg/L
ARSENIC TOTAL	mg/L
ATRAZINE DESETHYL	ug/L
ATRAZINE	ug/L
AZINPHOS METHYL	ug/L
BARIUM TOTAL	mg/L
BENOMYL	ug/L
BERYLLIUM TOTAL	mg/L
BISMUTH TOTAL	mg/L
BORON TOTAL	mg/L
BROMACIL	ug/L
BROMOXYNIL	ug/L
CADMIUM TOTAL	mg/L
CALCIUM TOTAL	mg/L
CAPTAN	ug/L
CARBOFURAN	ug/L
CARBON TOTAL INORGANIC	mg/L
CARBON TOTAL ORGANIC (TOC)	mg/L
CARBON TOTAL	mg/L
CARBOXIN (CARBATHIN)	ug/L
CESIUM TOTAL	mg/L
CHLORDANE-CIS	ug/L
CHLORDANE-TRANS	ug/L
CHLORIDE DISSOLVED	mg/L
CHLOROPHYLL A	ug/L
CHLOROTHALONIL	ug/L
CHLORPYRIFOS-ETHYL (DURSBAN)	ug/L
CHROMIUM HEXAVALENT DISSOLVED	mg/L
CHROMIUM TOTAL (CR)	mg/L
COBALT TOTAL	mg/L
COLOUR TRUE	CU
CONDUCTIVITY (AT 25C)	uS/cm
COPPER TOTAL (CU)	mg/L
CYANAZINE	ug/L
DELTAMETHRIN	ug/L
DIAZINON	ug/L
DICAMBA (BANVEL)	ug/L
DICHLOROPROP(2,4-DP)	ug/L
DICLOFOP-METHYL	ug/L
DIMETHOATE (CYGON)	ug/L

Table 4. Continued....

Variables	Units
DINOSEB	ug/L
DIURON (DCMBU)	ug/L
DIURON	ug/L
EPTAM	ug/L
ESCHERICHIA, COLI	CFU/100 mL
ETHALFLURALIN (EDGE)	ug/L
FENOXAPROP	ug/L
GAMMA-BENZENEHEXACHLORIDE (LINDANE)	ug/L
GLYPHOSATE (ROUNDUP)	ug/L
HARDNESS TOTAL CACO3	mg/L
IMAZAMETHABENZ-ME	ng/L
IMAZAMETHABENZ-METHYL	ug/L
IRON TOTAL (FE)	mg/L
LEAD TOTAL	mg/L
LITHIUM TOTAL	mg/L
MAGNESIUM TOTAL	mg/L
MALATHION	ug/L
MANGANESE TOTAL (MN)	mg/L
MCPA	ug/L
MCPP (MECOPROP)	ug/L
METASULFURON-ME	ng/L
METHOXYCHLOR (P,P'-METHOXYCHLOR)_	ug/L
METRIBUZIN	ug/L
METSULFURON-METHYL	ug/L
MOLYBDENUM TOTAL	mg/L
NICKEL TOTAL	mg/L
NITROGEN DISSOLVED NO3 & NO2	mg/L
NITROGEN TOTAL KJELDAHL (TKN)	mg/L
OXYGEN BIOCHEMICAL DEMAND	mg/L
OXYGEN DISSOLVED	mg/L
PARATHION ETHYL	ug/L
PARATHION METHYL	ug/L
PENTACHLOROPHENOL	ug/L
PHEOPHYTIN A	ug/L
PHOSPHOROUS-ACID HYDROLYZABLE	mg/L
PHOSPHOROUS-TOTAL-ORTHO	mg/L
PHOSPHORUS DISSOLVED ORTHO	mg/L
PHOSPHORUS PARTICULATE	mg/L
PHOSPHORUS TOTAL (METALS SCAN)	mg/L
PHOSPHORUS TOTAL (P)	mg/L
PHOSPHORUS TOTAL DISSOLVED	mg/L
PHOSPHORUS TOTAL INORGANIC	mg/L
pH	pH units
PICLORAM (TORDON)	ug/L
POTASSIUM TOTAL	mg/L
PROPACHLOR	ug/L
PROPANIL	ug/L
PROPOXUR	ug/L
QUIZALOFOP	ug/L
RUBIDIUM TOTAL	mg/L
SELENIUM TOTAL	mg/L
SETHOXYDIM	ug/L

Table 4. Continued....

Variables	Units
SETHOXYDIM	ug/L
SILICON TOTAL	mg/L
SILVER TOTAL	mg/L
SIMAZINE	ug/L
SODIUM TOTAL	mg/L
SULPHATE DISSOLVED	mg/L
TEBUTHIURON	ug/L
TELLURIUM TOTAL	mg/L
TERBUFOS	ug/L
THALLIUM TOTAL	mg/L
THIFENSULFURON METHYL	ug/L
THIFENSULFURON-ME	ng/L
THORIUM TOTAL	mg/L
TIN TOTAL	mg/L
TITANIUM TOTAL	mg/L
TOTAL DISSOLVED SOLIDS	mg/L @18^{0}C
TOTAL SUSPENDED SOLIDS	mg/L
TRALKOXYDIM	ug/L
TRALKOXYDIM	ug/L
TRIALLATE (AVADEXBW)	ug/L
TRIBENURON	ng/L
TRICLOPYR	ug/L
TRIFLURALIN(TREFLAN)	ug/L
TUNGSTEN TOTAL	mg/L
TURBIDITY	Ntu
URANIUM TOTAL	mg/L
VANADIUM TOTAL	mg/L
ZINC TOTAL (ZN)	mg/L
ZIRCONIUM TOTAL	mg/L

7.0 WATER POLLUTION CONTROL

7.01 Contingency Plan

In January 1981 a contingency plan was developed by the former International Red River Pollution Board. The purpose of the plan, which had been adopted by the IRRB, is to ensure that positive coordinated action is taken to minimize public health hazards and environmental damage in the event of a spill. This plan does not supersede any local or national contingency plans in existence but rather serves to coordinate these activities. The plan becomes effective wherever the discharge of a pollutant within the Red River basin has the potential to adversely impact the Red River. The plan also becomes effective at any time when exceedences of either water quality objectives or alert levels as described in Chapter 5 are observed at the international boundary. A current list of contacts and telephone numbers associated with the contingency plan is included in Appendix C.

7.02 Spills and Releases

Minnesota

For the water year 2011, eighteen (18) Minnesota wastewater treatment facilities reported 28 spills or bypasses. The majority of these releases were during snowmelt or rain events. There were 55 permits issued and 12 enforcement actions.

There are approximately 2000 registered feedlots in the Red River Basin, of varying sizes and animal types. The greatest numbers are in Otter Tail, Becker and Clay counties. Of these, 10 facilities had enforcement actions in water year 2011.

For the water year 2011, 128 construction storm water permits were issued by MPCA for the 22 counties of northwestern Minnesota. These permits are required for any activity disturbing more than one acre of land.

North Dakota

The North Dakota Pollutant Discharge Elimination System (NDPDES) program requires all permitted facilities (industrial and municipal) to report wastewater spills and by-passes. During this reporting period (October 1, 2010 through September 30, 2011), there were 26 releases reported to the department in the Red River basin in North Dakota. The releases were related to pipe break/mechanical failure and lift station problems (overflows/bypasses) due to localized flooding and excessive precipitation. The facilities followed the reporting requirements of their permit. The spills/releases were followed up by department staff and all actions were resolved. Formal enforcement was not required based on the findings of the department.

Manitoba

Three municipalities with populations greater than 1,000 discharge treated effluents directly to the Red River within Manitoba. The Town of Morris discharges for a short period of time each spring and fall, while the City of Winnipeg's South End and North End Water Pollution Control Centres and the Town of Selkirk discharge continuously. Volumes and quality of effluent have not changed significantly from previous years. In addition to the two major wastewater treatment facilities within the City of Winnipeg, discharges also occur from 21 private wastewater treatment plants, 79 combined sewer outfalls, and 90 major land drainage outfalls. Most tributary streams also receive treated wastewater effluents from nearby communities.

Manitoba Conservation and Water Stewardship tracks incidents that have the potential to impact water quality in Lake Winnipeg on the Department web site at www.manitoba.ca/lakewinnipeg. No incidents occurred within the reporting period.

7.03 Pollution Abatement and Advisories

North Dakota

Point Source Control Program

The department regulates the release of wastewater and stormwater from point sources into waters of the state through permits issued through the NDPDES Program. Permitted municipal and industrial point source dischargers must meet technology or water quality based effluent limits. In addition, all major municipal and industrial permittees must monitor their discharge for whole effluent toxicity (WET) on a regular basis.

Toxic pollutants in wastewater discharges are regulated through the industrial pretreatment program which is administered by the NDPDES Program. The cities of Grand Forks, Fargo, and West Fargo all have approved pretreatment programs within the Red River basin in North Dakota.

There are presently 152 facilities with a NDPDES Program permit in the Red River basin. Of these, there are 30 industrial wastewater permits and 122 domestic/municipal wastewater permits. A majority of the domestic/municipal wastewater permits are for small lagoon systems which typically discharge 2-3 times a year for a period of a few days to a few weeks.

Stormwater

The NDPDES Program permits stormwater discharges from industrial sites, construction sites and larger municipalities (termed MS4s). The cities of Grand Forks, Fargo, West Fargo and their urbanized area continue to implement their MS4 permits within the Red River basin in North Dakota.

A majority of the construction stormwater permitting in North Dakota is in the eastern part of the state which is part of the Red River basin. There are approximately 687 stormwater permits for construction activity and 293 industrial stormwater permits in the Red River basin in North Dakota.

Animal Feeding Operations (AFOs)

The NDPDES Program continues to regulate animal feeding operations (AFOs) in the North Dakota. All large (>1000 animal units) permitted confined animal feeding operations (CAFOs) are inspected annually; whereas medium and small AFOs are inspected on an as-needed basis. There are 220 AFOs permitted by the department in the Red River basin. Of these, there are 27 designated as large CAFOs.

Nonpoint Source Pollution Management Program

The Division of Water Quality is responsible for administering the Clean Water Act Section 319 Nonpoint Source Pollution Management Program (NPS Program) in North Dakota. Section 319 of the Clean Water Act and guidance provided by EPA defines the scope of the NPS Program, while the department administers the program with input from the North Dakota Nonpoint Source Pollution Task Force. The task force is comprised of representatives from state and federal natural resource agencies, commodity/producer groups, tribal councils and private wildlife/natural resource organizations.

Each year, federal funds are appropriated by the U.S. Congress to EPA for NPS pollution management. These Section 319 funds are then made available to individual states based on an allocation formula. In North Dakota, funds are awarded to project sponsors (e.g., soil conservation districts, water resource boards, cities, state agencies, universities, resource conservation and development councils, nonprofit organizations) to implement a variety of NPS pollution education, assessment and NPS pollution abatement projects. Approved local projects receive 60 percent federal funds with a 40 percent local match requirement.

Through the NPS Program, the department is currently cost-sharing a variety of NPS watershed assessment and NPS pollution abatement projects in the Red River basin. A map depicting the location of these projects in the Red River basin is provided in Figure 4. The following is a short summary of these projects.

- The Richland County SCD recently received Phase II funding for the Antelope Creek watershed implementation project. The primary goal of the project is to restore the recreational uses of the impaired reaches of Antelope Creek and the Wild Rice River to fully supporting status. As a secondary goal, the project will also protect and enhance the aquatic life use of Antelope Creek and the Wild Rice River through targeted implementation of best management practices (BMPs) within or immediately adjacent to the riparian corridor. These goals will be accomplished through comprehensive conservation planning, BMP implementation, and public education.

- The Barnes County SCD has recently received Phase II funding for a NPS pollution abatement project on the Sheyenne River below Baldhill Dam (Lake Ashtabula). The Barnes County Sheyenne River Watershed Phase II Project is designed to provide technical, financial and educational assistance to all agriculture producers and landowners with riparian acreage within the county. The goal of the project is to restore and maintain the recreational and aquatic uses of the Sheyenne River and its tributaries in Barnes County. Project sponsors intend to: 1) provide technical and financial assistance to producers and landowners within ½ mile of the Sheyenne River and its tributaries and to priority locations outside this corridor; 2) assist with BMPs that protect/enhance our riparian areas; 3) develop educational programs to heighten public awareness of NPS pollution impacts and solutions; and 4) develop working partnerships in the local community to benefit natural resources.

- The Ransom County SCD is in the third year of a watershed restoration and NPS pollution abatement project for Dead Colt Creek Dam. The main goal of this project is to implement the nutrient, sediment and dissolved oxygen TMDLs for Dead Colt Creek Dam which was finalized in 2006. Implementation of these TMDLs will restore the recreational and aquatic uses of Dead Colt Creek Dam. The recreational and aquatic uses can be restored by reducing the sediment/nutrient loads from 12,614 acres of targeted crop, pasture and rangeland in the watershed. These goals will be accomplished by providing financial and technical assistance for conservation planning, BMP implementation and promoting a strong informational/educational (I/E) program. The I/E program will focus on providing farmers and ranchers information on the causes and effects of NPS pollution and ways to reduce or eliminate NPS pollution.

- The Cass County SCD has recently received Section 319 funding for a watershed implementation project for the Rush River and Brewer Lake watersheds. As part of the watershed implementation project, the Cass County SCD will promote the implementation of agricultural BMPs, which will result in the improvement of the designates uses of the Rush River and Brewer Lake, including fish and other aquatic biota, and recreation, while creating measurable reductions in the concentrations of known pollutants (nitrates, phosphorus, and fecal coliform bacteria) throughout the Rush River and Brewer Lake watersheds.

- The Cass County SCD has also received Section 319 funding for the Maple River watershed implementation project. The sponsors will promote the implementation of agricultural BMPs to improve of the designated uses of the Maple River, which includes fish and other aquatic biota, and recreation, while creating measurable reductions in the concentrations of known pollutants (nitrates, phosphorus, and fecal coliform bacteria) throughout the Maple River watershed. The project will provide technical and financial support for comprehensive conservation planning, BMP implementation, monitoring and assessment, and information and education programs in the highest priority sub-watersheds in terms of NPS pollution loadings to the Maple River.

- The Red River Riparian Project has recently received Section 319 funding for its Phase IV project aimed at stream and riparian area protection and restoration in the lower Red River basin. The first goal of this program will be to provide information and education for riparian management and restoration techniques to landowners, communities, water resource districts and soil conservation districts within targeted high priority watersheds in the Upper Red River basin in North Dakota. Financial assistance will be provided to landowners at selected sites to demonstrate effective riparian forest management in order to protect and sustain proper functioning condition and long-term measurable improvements in the health of the river system. In addition, trials will be established for riparian range/forestry management, and possible recommendations will be developed to enhance natural reforestation of riparian areas; there will be an outreach effort for proper management of riparian areas within an urban setting; and there will be an inventory of riparian forest to estimate the percentage of ash and predict the possible impacts from an Emerald Ash Borer infestation. The final three years will be implementation of riparian treatments including bio-engineering and management in targeted watersheds.

- The East and West Grand Forks County SCDs recently completed a two year water quality and watershed assessment project on the lower Turtle River in Grand Forks County and Larimore Dam. Based on this assessment, the project sponsors are now implementing the Turtle River/Larimore Dam Watershed Restoration Project. The primary goal of the project is the restoration of the recreational and aquatic life uses of the Turtle River and Larimore Dam reservoir through the implementation of BMPs. For priority areas within the Turtle River watershed, the project will focus on the implementation of BMP's that will reduce concentrations and loadings of phosphorus, nitrogen, and fecal coliform bacteria. Additional BMPs will also be implemented to improve riparian conditions along the Turtle River and its tributaries. As a secondary focus, BMPs which contribute to a reduction in the levels of cadmium, selenium, chloride, and arsenic, which occur naturally, will be given special consideration.

- The Wild Rice SCD in Sargent County continues to implement its Section 319 Watershed Restoration project on the upper Wild Rice River and its tributaries. The Wild Rice SCD's primary goal, through the course of the project is to promote and implement agricultural BMPs that will reduce or prevent sediment and nutrient loadings to the Wild Rice River and its tributaries. The watershed project will provide technical and financial support for comprehensive conservation planning and BMP implementation in three of the highest priority ranked tributaries in terms of NPS pollution loadings to the upper Wild Rice River and its tributaries.

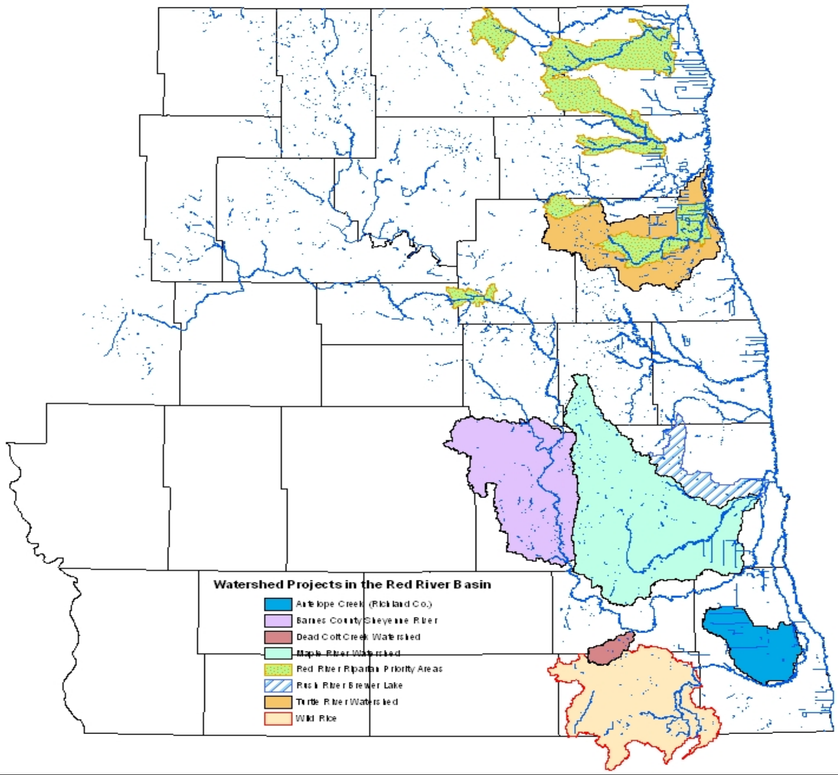

Figure 4. Watershed Restoration and Abatement Project in the Red River basin, North Dakota.

Manitoba

Treated municipal effluents discharged to tributary streams within the Red River basin in Manitoba are licensed under Manitoba's *Environment Act*. Disinfection with ultra-violet light technology has been installed and is operational at the City of Winnipeg's South and North End Water Pollution Control Centres. In August 2004, the City of Winnipeg introduced a web-based system to inform the public whenever there is likely to be a sewer overflow into the Red or Assiniboine Rivers (http://winnipeg.ca/waterandwaste/sewage/overflow/previous24.stm).

Manitoba continues to work to understand sources of nutrients to Lake Winnipeg, to monitor the impacts of excess nutrients and to reduce nutrient loading. On May 31, 2011, the Province of Manitoba released a report prepared by Dr. Peter Leavitt, Canada Research Chair in Environmental Change and Society (Department of Biology, University of Regina) and his colleagues Dr. Lynda Bunting and others on the paleolimnology of Lake Winnipeg. The report was commissioned by the province. The report (http://www.gov.mb.ca/waterstewardship/water_quality/lake_winnipeg/pdf/report_lake_wpg_paleolimnology_2011.pdf), one part of the research and monitoring underway on Lake Winnipeg through Manitoba Conservation and Water Stewardship, Environment Canada and others, is a comprehensive report that identifies the historical water quality conditions that most likely existed in the south basin of Lake Winnipeg prior to the early 1800s, how the lake has changed up to the present time, and the likely causes of those changes. Dr. Leavitt's work has indicated that a 50 % reduction in phosphorus in Lake Winnipeg is required to reverse regular algae blooms and return the lake to a pre-1990 state.

On July 4, 2011, the Province of Manitoba and the Government of Canada released the State of Lake Winnipeg report. The report, led by Manitoba Conservation and Water Stewardship and Environment Canada, is a collaborative effort by many researchers from government, universities, and non-governmental organizations and is the first comprehensive assessment of the physical, chemical, and biological characteristics of Lake Winnipeg since intensive lake monitoring began in late 1990s.

The State of Lake Winnipeg report serves as a reference to measure progress towards reducing nutrient loading, will help in the assessment of the overall health of the lake, and also provides key information to support current and future research on Lake Winnipeg. The report is available as both an extended technical report and a highlights report on the Manitoba Conservation and Water Stewardship web site at http://www.gov.mb.ca/waterstewardship/water_quality/state_lk_winnipeg_report/index.html.

In September 2010, Canada and Manitoba signed the *Canada-Manitoba Memorandum of Understanding Respecting Lake Winnipeg and the Lake Winnipeg Basin* to facilitate a cooperative and coordinated approach in efforts to understand and protect the water quality and ecological health of Lake Winnipeg and the Lake Winnipeg Basin. A Steering Committee was formed under this Memorandum of Understanding and technical-secretariat support for the Committee is provided by the Department. The Memorandum of Understanding is available on the Manitoba Conservation and Water Stewardship web site at http://www.gov.mb.ca/waterstewardship/water_quality/lake_winnipeg/index.html.

Progress to reduce the nitrogen and phosphorus load to Lake Winnipeg includes:

- *The Phosphorus Reduction Act* (*Water Protection Act* amended) came into effect on July 1, 2010. The Act restricts the phosphorus content in household automatic dishwashing detergents that can be manufactured, sold, distributed or imported into Manitoba for use in Manitoba. Under the legislation, only those automatic dishwashing detergents that contain 0.5 % phosphorus or less can be sold or distributed throughout the province. Manitoba Conservation and Water Stewardship worked with manufactures, retailers, and distributors of automatic dishwashing detergents to increase the availability of automatic dishwashing detergents with less than 0.5 % phosphorus.

- Nutrient Management Regulation

    - Work continues to implement the Nutrient Management Regulation which was enacted in March 2008. Effective January 1, 2009, within urban and built up areas (Nutrient Management Zone N5, no one shall apply a fertilizer to turf containing more than 1 per cent phosphorus by weight, expressed as P_2O_5. An exception to this restriction includes newly established turf during the year of establishment as well as the year following establishment. Phosphorus-containing fertilizers can be applied provided that the soil test phosphorus level:
        - is less than 60 ppm on land used to grow grass for sale as sod,
        - is less than 30 ppm on land used as a sports facility, or
        - is less than 18 ppm on land used neither to grow grass for sale as sod or as a sports facility

- Flowerbeds, gardens, trees and shrubs are excluded from the phosphorus restrictions. In addition, no one shall apply or allow the escape of a substance containing nitrogen or phosphorus onto a paved or other impervious surface within Nutrient Management Zone N5. Should this occur, the individual must immediately take all reasonable steps to remove the substance so that it does not drain into a storm or sewage drainage system. Manitoba Conservation and Water Stewardship worked with fertilizer retailers and the public to develop signage, brochures and ad campaigns to communicate the requirements of the regulation in urban areas.

- Also, as of January 1, 2009 under the Nutrient Management Regulation, golf courses in Manitoba are required to prepare annual Nutrient Management Plans to demonstrate how nutrients will be used on their golf courses to ensure that excess nutrients do not runoff into waterways. Manitoba Conservation and Water Stewardship developed templates for nutrient management planning for golf courses and is working to achieve compliance throughout the industry. 145 nutrient management plans were submitted in 2011/12.
- As of January 1, 2009, nutrients cannot be applied in the Nutrient Buffer Zone. The Nutrient Buffer Zone is a setback from waterways that varies in width depending on the type of waterway and if it is used as a drinking water source. Nutrient Buffer Zones apply to all nutrient applications including from livestock manure, inorganic fertilizer and municipal biosolids.

- More information on the Nutrient Management Regulation under *The Water Protection Act* is available at http://www.gov.mb.ca/waterstewardship/wqmz/index.html.

- Wastewater Treatment:
  - The Manitoba Water Quality Standards, Objectives and Guidelines were recently enshrined in a regulation under Part Two of *The Water Protection Act* (http://www.gov.mb.ca/waterstewardship/water_quality/quality/website_notice_mwqsog_2011.html). The regulation was registered on November 28th, 2011. The Manitoba Water Quality Standards now include new province-wide standards for phosphorus in wastewater effluent (1 mg/L) and where site-specific conditions warrant, nitrogen (15 mg/L). Under the new province-wide nutrient standards, a 1 mg/L phosphorus limit applies immediately for all new, expanding or modified wastewater treatment facilities. Small wastewater treatment facilities discharging more than 820 kilograms of phosphorus per year (serving less than 2,000 people or equivalent) have the option of implementing a demonstrated nutrient reduction strategy (for example, a constructed wetland, effluent irrigation, etc) or the 1 mg/L phosphorus limit. Existing wastewater treatment facilities discharging more than 820 kilograms of phosphorus per year (serving more than 2,000 people or equivalent due to industrial contributions) will be required to meet a 1 mg/L phosphorus limit by January 1, 2016. Facilities are required to submit a phosphorus compliance plan by January 1, 2013 that demonstrates the actions taken and proposed to be taken to meet the 1 mg/L phosphorus limit by January 1, 2016.

  - Nutrient removal has already been implemented at a number of wastewater treatment facilities across the province including in Brandon, Winnipeg's West End Water Pollution Control Centre, Headingley, Neepawa and Gimli. In addition, all wastewater treatment facilities in provincial parks are required to remove phosphorus to 1 mg/L.

- Integrated Watershed Management Planning:
    - Work on integrated watershed management planning under *The Water Protection Act* also continued and included plans in several Red River tributary watersheds: the Rat River, Cooks Creek, and Devils Creek. Integrated watershed management plans for Seine, La Salle, and Pembina Rivers and the Grassmere-Netley Creek watershed have now been completed. Integrated watershed management plans are compiled by local water planning authorities with stakeholder input and are to be implemented, monitored and updated regularly (every ten years) by these authorities. Water planning authorities are designated under *The Water Protection Act* and the development of integrated watershed management planning is guided by specifications in *the Act*. Manitoba provides financial, planning and technical assistance to the process. The integrated watershed management plans include a report on current science knowledge of the watershed environment as well as initiatives to monitor, maintain and improve environmental conditions in the watershed.

- Education:
    - Manitoba Conservation and Water Stewardship continues to provide support to the South Basin Mayors and Reeves to develop and launch a program to help consumers better identify products that have proven to be the best choice for the environment. The Lake Friendly Label (www.lakefriendly.ca) criteria are based on Environment Canada's EcoLogo criteria. EcoLogo provides assurance that the products and services bearing the logo meet stringent standards of environmental leadership. The initial phase identifies hard surface cleaners, dish detergents (including dishwasher detergents) and laundry cleaners. These cleaners are all commonly used and can impact Lake Winnipeg. Lake Friendly Products are available at retailers across the south basin of Lake Winnipeg.

8.0 BIOLOGICAL MONITORING IN THE RED RIVER BASIN

8.01 Fisheries of the Red River in Manitoba

Biological Information

A total of 67 fish species have been recorded in the Manitoba's portion of the Red River (Table 5. Presently, Bigmouth Buffalo (*Ictiobus cyprinellus)*, Chestnut Lamprey (*Ichtyomyzon unicuspis*) and Silver Chub (*Macrhboposis storeriana*) are designated as Special Concern under *The Species at Risk Act.* In 2005, Lake Sturgeon (*Acipenser fulvescens)* were recommended for listing as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This species may be listed under the Species at Risk Act in 2012/2013.

Known aquatic invasive species that have been introduced in the Manitoba portion of the Red River include the Common Carp (*Cyprinus carpio),* White Bass (*Morone chrysops),* Rainbow Smelt (*Osmerus mordax)* and Asian Carp Tapeworm (*Bothriocephalus acheilognathi).* Other recent introductions into the Manitoba portion of the Red River include Feral Gold Fish (*Carassius auratus),* Smallmouth Bass *(Micropterus dolomieu)* and Largemouth Bass *(Micropterus salmoides).*

In 2010 and 2011, zebra mussel veligers (*Dreissena polymorpha*) were confirmed from the Red River near Wahpaton, North Dakota. This follows the discovery of zebra mussels in 2009 from Pelican Lake, Minnesota. Pelican Lake forms part of the upstream chain of connected waterways within the Red River watershed and this discovery was the first occurrence of this aquatic invader in the Red River watershed. Consequently, Manitoba Water Stewardship in cooperation with Environment Canada continued to collect weekly water samples during the spring and summer of 2010 and 2011for the presence of zebra mussel veligers (larval zebra mussels) in the Red River at Emerson. No veligers have been found to date.

In 2010, a number of new initiatives were put into place by the Aquatic Invasive Species Task Group under the Canada-Manitoba Fisheries Advisory Board with the goal of establishing collaborative programs for preventing aquatic invasive species from entering Manitoba. These preventative measures were aimed at popular fishing and boating destinations including the Red River corridor. Inspections of trailered watercraft at the international border crossings of Emerson and Sprague were conducted during 2011. Navigational buoys and supporting equipment deployed in the Red River were inspected for aquatic invasive species in the fall of 2011 with none being found.

An instream flow study has been undertaken on the Assiniboine River (a major tributary of the Red River). The objective of this study is to develop appropriate instream flow recommendations to ensure healthy and sustainable aquatic ecosystem functions. A draft report on the study was submitted for review in 2008 and a final report draft is expected in 2013/14.

The Instream Flow program within Manitoba Fisheries Branch continued coordination efforts on some of its activities with a committee from Fisheries and Oceans Canada. The intention of this collaboration was to seek intellectual partnerships that could promote the development of instream flow needs assessments within Manitoba. One project coming out of this collaboration concerned the International Joint Commission which had requested instream flow work to commence on the Red River through the International Red River Board. This request sought to understand the environmental impacts of apportionment agreements for the Red River. Up until this point, work had begun on the hydrology of the system but it had not been clear how these hydrological assessments would be linked to the environmental impact of the river's changed hydrology over time. As such, the Provincial Instream Flow Biologist was consulted to explain conceptual and methodological linkages between the hydrology and the other aspects of the instream flow needs approach as a method for determining "environmental flows". Currently, work on the Red River has remained focused on understanding its hydrology, after which it is proposed that linkages to other instream flow needs aspects will commence.

Recreational Angling - Value

The Manitoba portion of the Red River has become internationally known for the high quality of angling the fishery supports. Based on Manitoba's 2005 Angler Survey, Manitobans and visitors to the province fished a total of 2.6 million days of which 10% were spent on the Red River making it the most heavily fished area in the province. It is estimated that anglers fishing the Red River contribute $15-20 million annually on goods and services directly/indirectly related to angling. In 2010, Manitoba will again be participating in a National Recreational Angling Survey. These surveys remain the only source of harvest and economic information related to recreational fishing in Canada. The 2010 survey will provide vital information on recreational fishing activities on the Red River.

The fishery attracts nonresidents to trophy walleye and channel catfish angling opportunities. Furthermore, the diverse fish species composition appeals to residents of all ages. From an angling perspective, the fishery is managed to: 1) ensure sustainability of the recreational fishery for future generations, 2) encourage angler participation and development of the recreational fishing potential of the river, and 3) maximize economic returns to angling interests who rely on the fishery for their lively hood.

The majority of angling effort occurs between the floodway gate structure at St. Norbert to the mouth of the river at Lake Winnipeg during the open water season. Angling is especially concentrated from the dam at Lockport downstream to Netley Creek and within the City of Winnipeg.

Angling in Winnipeg has become more popular with anglers over the past 10 years due to the work conducted by Winnipeg's Urban Angling Partnership (UAP - private sector and government partnership). There are a number of issues that have affected users of this fishery and the UAP has been working towards addressing as many as possible. These include, but not restricted to, water quality concerns, fish consumption (i.e., safety) and access to the fishery due to fluctuating water levels particularly in within the City of Winnipeg.

Manitoba Conservation and Water Stewardship, Fisheries Branch began collaborating with researchers from the University of Nebraska in 2011 on a series of projects to understand and improve management of the valuable Red River channel catfish fishery. Substantial effort has been expended to determine methodology for long-term indexing of the population. Demographic information is being collected to assess fecundity, and elements of the food web have been collected that will facilitate description of energy flow up to channel catfish. A tagging study will begin in August of 2012 that will help estimate population size, mortality, and estimate the physical extent of the population.

Table 5. Fish species of the Red River in Manitoba.

Common Name	Genus	Species	Presence	Common Name	Genus	Species	Presence
Banded Killifish	Fundulus	diaphanus	Rare	Largemouth Bass +	Micropterus	salmoides	Uncommon
Bigmouth Buffalo *	Ictiobus	cyprinellus	Common	Logperch	Percina	caprodes	Common
Bigmouth Shiner	Notropis	dorsalis	Unknown	Longnose Dace	Rhinichthys	cataractae	Unknown
Black Bullhead	Ameiurus	melas	Common	Longnose Sucker	Catostomus	catostomus	Common
Black Crappie	Pomoxis	nigromaculatus	Common	Mimic Shiner	Notropis	volucellus	Unknown
Blackchin Shiner	Notropis	heterodon	Unknown	Mooneye	Hiodon	tergisus	Rare
Blacknose Shiner	Notropis	heterolepis	Unknown	Ninespine Stickleback	Pungitius	pungitius	Common
Blackside Darter	Percina	maculata	Unknown	Northern Pike	Esox	lucius	Common
Bluntnose Minnow	Pimephales	notatus	Unknown	Pearl Dace	Margariscus	margarita	Unknown
Brassy Minnow	Hybognathus	hankinsoni	Unknown	Quillback	Carpiodes	cyprinus	Uncommon
Brook Stickleback	Culaea	inconstans	Common	Rainbow Smelt +	Osmerus	mordax	Uncommon
Brown Bullhead	Ameiurus	nebulosus	Common	River Darter	Percina	shumardi	Common
Burbot	Lota	Lota	Common	River Shiner	Notropis	blennius	Unknown
Central Mudminnow	Umbra	Limi	Common	Rock Bass	Ambloplites	rupestris	Common
Channel Catfish	Ictalurus	punctatus	Common	Rosyface Shiner	Notropis	rubellus	Unknown
Chestnut Lamprey *	Ichthyomyzon	castaneus	Unknown	Sand Shiner	Notropis	stramineus	Uncommon
Cisco	Coregonus	artedi	Common	Sauger	Sander	canadensis	Common
Common Carp +	Cyprinus	carpio	Common	Shorthead Redhorse	Moxostoma	macrolepidotum	Common
Common Shiner	Luxilus	cornutus	Rare	Silver Chub *	Macrhybopsis	storeriana	Common
Creek Chub	Semotilus	atromaculatus	Unknown	Silver Lamprey	Ichthyomyzon	unicuspis	Unknown
Emerald Shiner	Notropis	atherinoides	Abundant	Silver Redhorse	Moxostoma	anisurum	Common
Fathead Minnow	Pimephales	promelas	Common	Smallmouth Bass +	Micropterus	dolomieu	Unknown
Flathead Chub	Platygobio	gracilis	Unknown	Spotfin Shiner	Cyprinella	spiloptera	Unknown
Freshwater Drum	Aplodinotus	grunniens	Abundant	Spottail Shiner	Notropis	hudsonius	Common
Golden Redhorse	Moxostoma	erythrurum	Rare	Stonecat	Noturus	flavus	Unknown
Golden Shiner	Notemigonus	crysoleucas	Unknown	Tadpole Madtom	Noturus	gyrinus	Common
Goldeye	Hiodon	alosoides	Common	Troutperch	Percopsis	omiscomaycus	Common
Goldfish +	Carassius	auratus	Unknown	Walleye	Sander	vitreus	Common
Hornyhead Chub	Nocomis	biguttatus	Unknown	Western Blacknose Dace	Rhinichthys	obtusus	Unknown
Iowa Darter	Etheostoma	exile	Common	White Bass +	Morone	chrysops	Common
Johnny Darter	Etheostoma	nigrum	Common	White Crappie	Pomoxis	annularis	Unknown
Lake Chub	Couesius	plumbeus	Rare	White Sucker	Catostomus	commersoni	Common
Lake Whitefish	Coregonus	clupeaformis	Uncommon	Yellow Perch	Perca	flavescens	Common
Lake Sturgeon *	Acipenser	fulvescens	Rare				

Note: * = indicates species at risk, + = indicates introduced species

8.02 Macroinvertebrates of the Red River in Manitoba

Benthic macroinvertebrates were collected at two locations on the Red River in September 2011: Emerson and Selkirk. At each location, three transects of five ponar dredge grab samples were collected. Starting at the east bank, samples were collected at five equidistant sample sites across the width of the river. A petit ponar was purchased this season. Each ponar dredge covered an area of 0.023 m^2. Previous years the ponar dredge covered an area of 0.05 m^2. Thus the amount of sediment collected was reduced. For each transect, 0.115 m^2 of sediment was collected. The dredge samples were washed through a 500 µm Nitex nylon net. River water was used to remove organisms and sediment from the nylon net into a 500 µm mesh sieve. Samples were then sieved to remove macroinvertebrates from the sediment matrix. Remaining sediment and all organisms were then placed in labelled 500 mL glass jars with 70 % ethyl alcohol preservative. Macroinvertebrates were subsequently identified to the lowest possible taxonomic level, typically genus and species, by ALS Laboratory Group, Winnipeg, Manitoba.

In 2011 at Emerson, moving from downstream to upstream, 40 organisms were collected at Transect #1, 11 organisms at Transect #2, and 173 organisms were collected at Transect #3. To calculate organisms per square metre, the number of organisms at each transect was multiplied by a factor of 43.3. Transects #1, #2, and #3 yielded 1731, 476, and 7488 organisms/m^2, respectively (Table 6). At Emerson, the organisms in greatest abundance was order Trichoptera (Family Hydropsychidae) a relatively pollution-tolerant net spinning caddis fly larvae. Transect #2 had the lowest density of organisms (476 organisms/m^2). Transect #3 had the greatest sample diversity (12 taxa). The coordinates for all three Emerson transects are listed in Table 7.

In the Red River at Selkirk, Manitoba, 23 organisms were collected at Transect #1, 40 organisms at Transect #2, and 73 organisms at Transect #3. To calculate organisms per square metre, the number of organisms at each transect was multiplied by a factor of 43.3. Respectively, Transects #1, #2, and #3 yielded 995, 1731, and 3160 organisms/m^2 (Table 8). Trichopterans formed a larger proportion of the benthic organisms collected at Transects #2 and #3. The species of greatest abundance in Transect #1 was aquatic worms Tubificidae (order Oligochaeta). The coordinates for all three Selkirk transects are listed in Table 9.

During 2011, the greatest number of benthic invertebrate organisms were sampled at Emerson while the Selkirk location had the greatest diversity. The species dominating the six transects along the Red River was Trichoptera (Family Hydropsychidae), a relatively pollution-tolerant species.

Table 6. Summary of macroinvertebrates collected per square meter in pooled Ponar © dredge samples from three transects on the Red River at Emerson, Manitoba in September 2011.

Class	Order	Family	Genus	Species	Transect 1 Numbers / m^2	Transect 2 Numbers / m^2	Transect 3 Numbers / m^2
Annelida	Oligochaeta	Tubificidae			0	1	0
Crustacea	Ostracoda				0	1	0
Gastropoda	Basommatophor	Ancylidae	Ferrissia		0	0	1
Insecta	Coleoptera	Elmidae	Stenelmis		0	0	1
Insecta	Diptera	Ceratopogonidae			0	1	1
Insecta	Diptera	Chironomidae	Cryptochironomus		0	0	1
Insecta	Diptera	Chironomidae	Paracladopelma		0	1	0
Insecta	Diptera	Chironomidae	Polypedilum		0	0	1
Insecta	Diptera	Chironomidae	Procladius		0	1	0
Insecta	Diptera	Chironomidae	Thienemanniella		0	0	3
Insecta	Diptera	Empididae	Hemerodromia		1	0	0
Insecta	Ephemeroptera	Baetidae	Baetis		1	0	0
Insecta	Ephemeroptera	Polymitarcyidae	Ephoron		3	0	2
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche		3	0	1
Insecta	Trichoptera	Hydropsychidae	Hydropsyche		7	0	115
Insecta	Trichoptera	Hydropsychidae	Potamyia	*flava*	24	3	45
Insecta	Trichoptera	Hydropsychidae	Potamyia		0	1	0
Insecta	Trichoptera	Leptoceridae	Nectopsyche		1	0	0
Insecta	Trichoptera	Leptoceridae	Triaenodes		0	0	1
Pelecypoda	Veneroida	Pisiidae			0	2	1
Total Number of Organisms / m2					**1731**	**476**	**7488**
Total Number of Taxa					**7**	**8**	**12**

Table 7. Geographic coordinates for the three transects where benthic macroinvertebrates were sampled at Emerson, Manitoba in September 2011.

Transect	Latitude	Longitude
1	49°00'23.4"	97°13'03.2"
2	49°00'13.6"	97°13'16.2"
3	49°00'01.2"	97°13'41.8"

Table 8. Summary of macroinvertebrates collected per square meter in pooled Ponar © dredge samples from three transects on the Red River at Selkirk, Manitoba in September 2011.

Class	Order	Family	Genus	Species	Transect 1 Numbers / m^2	Transect 2 Numbers / m^2	Transect 3 Numbers / m^2
Annelida	Oligochaeta	Tubificidae			6	1	0
Crustacea	Ostracoda				0	2	0
Gastropoda	Neotaeniogloss	Hydrobiidae	*Amicola*	*limnosa*	0	0	1
Insecta	Coleoptera	Elmidae	*Stenelmis*		0	1	0
Insecta	Coleoptera	Scirtidae	*Cyphon*		1	0	0
Insecta	Diptera	Chironomidae	*Cladopelma*		0	0	1
Insecta	Diptera				0	1	0
Insecta	Ephemeroptera				1	0	0
Insecta	Ephemeroptera	Ephemeridae	*Hexagenia*		1	0	0
Insecta	Ephemeroptera	Heptageniidae	*Stenonema*		0	0	1
Insecta	Ephemeroptera	Heptageniidae			0	2	0
Insecta	Odonata	Gomphidae	*Gomphus*		0	1	0
Insecta	Trichoptera	Brachycentridae	*Brachycentrus*		3	0	0
Insecta	Trichoptera	Hydropsychidae	*Cheumatopsyche*		3	11	13
Insecta	Trichoptera	Hydropsychidae	*Hydropsyche*		0	0	2
Insecta	Trichoptera	Hydropsychidae	*Potamyia*	*flava*	2	13	47
Insecta	Trichoptera	Hydropsychidae	*Potamyia*		0	0	0
Insecta	Trichoptera	Hydropsychidae			2	2	0
Insecta	Trichoptera	Leptoceridae	*Oecetis*		0	0	1
Nematoda					1	4	0
Pelecypoda	Veneroida	Pisiidae	*Sphaerium*		0	0	2
Pelecypoda	Veneroida	Pisiidae			3	2	3
Turbellaria	Tricladida				0	0	2
Total Number of Organisms / m2 :					**995**	**1731**	**3160**
Total Number of Taxa :					**10**	**11**	**10**

Table 9. Geographic coordinates for the three transects where benthic macroinvertebrates were sampled at Selkirk, Manitoba in September 2011.

Transect	Latitude	Longitude
1	50°09'10.7"	96°51'10.2"
2	50°08'55.7"	96°51'24.8"
3	50°08'37.2"	96°51'59.7"

8.03 Escherichia coli and Algal Bloom Monitoring in Lake Winnipeg

Manitoba monitored eighteen recreational beaches within the south basin of Lake Winnipeg for levels of *Escherichia coli* during 2011 (Table 10). Sampling began in early May and continued weekly until late August. Two beaches were monitored daily to provide sufficient data in support of developing a real-time predictive model for *E. coli* levels. Bathing water, sand, and sand water near the shoreline were collected for densities of *E. coli*.

While some beaches occasionally exceeded Manitoba's recreational water quality guideline for fecal indicator bacteria, in general recreational water quality is excellent at Lake Winnipeg beaches. All beaches have a blue coloured "Clean Beaches" sign that provides information to bathers about *E. coli* and identifies precautions on how the bathing public can reduce risk of exposure to pathogens. For beaches that had *E. coli* densities above the guideline and that have a history of elevated densities, additional yellow coloured "Beach Advisory" signs were posted. Results of the DNA ribotyping from 2002 to 2007 indicated that approximately 34 per cent of *E. coli* from all samples could be attributed to shorebirds and geese, while less than 5 per cent of the samples could be attributed to human sources. Thirty seven per cent of the *E. coli* samples could not be matched to a particular animal source.

As part of the 2011 beach monitoring program, Manitoba Conservation and Water Stewardship continued to monitor beaches on Lake Winnipeg for the presence of algal blooms. While there were a few algal blooms reported from a number of Manitoba waterbodies in 2011, these were not as extensive as the previous reporting year. On Lake Winnipeg, Victoria Beach at the Red Cross Dock, and Albert Beach were posted with the first level of algae advisory indicating the number of blue-green algae cells exceeded the Manitoba recreational water quality objective of 100,000 cells per mL. The first level of algae advisory lets bathers know that algae blooms have been observed at the beach and provides some additional advice regarding avoiding contact with the water when algae blooms are present. The second level of advisory or algae toxin advisory is posted when the concentration of microcystin exceeds the Manitoba recreational water quality objective of 20 ug/L. The advisory indicates that drinking, swimming or other contact with the water is not recommended. No beaches on Lake Winnipeg were posted with the second level of algae advisory in 2011.

Table 10. Recreational beaches in Lake Winnipeg south basin monitored in 2011.

Locations	*E. coli* in bathing water	Sand and Sand water Samples
Victoria Beach (2 sites)	Weekly	
Hillside Beach	Weekly	
Albert Beach	Weekly	
Lester Beach	Weekly	
East Grand Beach	Weekly	
West Grand Beach	Daily	Daily
Patricia Beach	Weekly	
Gull Harbour	Weekly	
Black Point	Weekly	
Grindstone Beach	Weekly	
Sandy Bar Beach	Weekly	
Hnasau Park Beach	Weekly	
Spruce Sands Beach	Weekly	
Gimli Beach	Daily	Daily
Sandy Hook Beach	Weekly	
Winnipeg Beach	Weekly	
Matlock Beach	Weekly	

8.04 ECOLOGICAL ASSESSMENT OF PERENNIAL, WADEABLE STREAMS IN THE RED RIVER BASIN OF NORTH DAKOTA

The following is a brief summary of the results from the Red River Basin in North Dakota Perennial, Wadeable Streams Ecological Assessment Project. For the complete report the reader is referred to the final report entitled "An Ecological Assessment of Perennial, Wadeable Streams in the Red River Basin-North Dakota" (NDDoH, 2012) which is available on the NDDoH website at www.ndhealth.gov.

Background and Goals

The North Dakota Department of Health (NDDoH) has long recognized the natural, economic and recreational value of the many rivers and streams within the Red River basin. The protection, maintenance and restoration of water quality and the beneficial uses of these waterbodies has long been a top priority. This led to the development of the Red River Bioassessment project with the intent of providing an ecological assessment of the Red River basin in North Dakota. The perennial, wadeable rivers and streams of the Red River basin in North Dakota were the primary focus of this bioassessment project. This project differs from past efforts by incorporating random site selection and a more intense physical habitat investigation and provides an integrated (physical, chemical and biological) assessment of the perennial, wadeable streams within the region.

Several variables within the Red River basin have led to potentially significant water quality impairments. Major impacts to surface water quality arise from non-point source (NPS) pollutants from agricultural practices as well as urban development. Primary pollutants are nutrients and sediment originating from agricultural lands. Cropland erosion on unprotected fields, especially during the winter, entrains sediment in the snowpack, which runs off during the spring melt. Rainfall or heavy snow events early in the spring can cause cropland erosion, ultimately transporting sediment to perennial surface waters within the watershed which can have a significant effect on aquatic life such as fish and macroinvertebrates.

The primary goals of the Red River Bioassessment Project were to: 1) assess, using the biological, physical and chemical data, the current biological condition of perennial, wadeable rivers and streams of the Red River basin in North Dakota; 2) assess the current status of aquatic life use attainment of the perennial, wadeable streams of the Red River basin in North Dakota; and 3) investigate potential stressors to impaired aquatic life use within the Red River basin. A secondary objective of the project, and one that was necessary in order to complete the assessment described in this report, was to develop and refine multi-metric IBIs for fish and macroinvertebrate communities in both the Northern Glaciated Plains (macroinvertebrates) and Lake Agassiz Plain (fish and macroinvertebrates) ecoregions.

Extent of Resource

The data used to select random, or probability, sampling sites for the Red River Bioassessment Project in North Dakota are based on the perennial stream network located in EPA's River Reach File, known as RF3. According to the RF3 data file, the total length of perennial rivers and streams in the Red River basin of North Dakota is estimated to be 4855.97 km. A majority (2633.95 km or 54%) of this was found to be non-target (non-wadeable, non-perennial or non-target in some other fashion (wetland, reservoir, etc). A summary of target and non-target stream length is provided in Figure 5.

The remaining "target stream length" (2222.02 km or 46%) represents the portion of the Red River basin in North Dakota that met our criteria (perennial, wadeable streams) for inclusion in this assessment. A small portion of stream length (100.21 km or 5%) was not accessible due to landowner denial. Another small portion (56.23 km or 3%) of the target stream length was not accessible due to physical barriers (inaccessible locations) that prevented sampling. The remaining 2065.58 km (43% of the original RF3 perennial data frame and 93% of the targeted stream length) comprised the assessed length of stream for this ecological assessment. Results of this assessment cannot be applied, or inferred, to the remainder (non-target) of the perennial streams that did not meet our criteria and could not be assessed for condition at this time.

The Lake Agassiz Plain ecoregion of North Dakota has an estimated 2815.58 km of perennial stream. Of this, 1101.23 km, (39%) was assessed for condition, while 1557.90 km (55%) was determined to be non-target (Figure 1). The remaining 156.45 (6%) was either inaccessible due to a physical barrier or sampling personnel were denied landowner permission.

The Northern Glaciated Plains ecoregion of North Dakota has an estimated 2040.39 km of perennial stream in the Red River basin. Of this, 964.35 km, (47%) was assessed for ecological condition while 1076.05 km (53%) was evaluated as being non-target (Figure 5). In this ecoregion there were no physical barriers that prevented sampling crews from accessing sites nor were there any landowner denials.

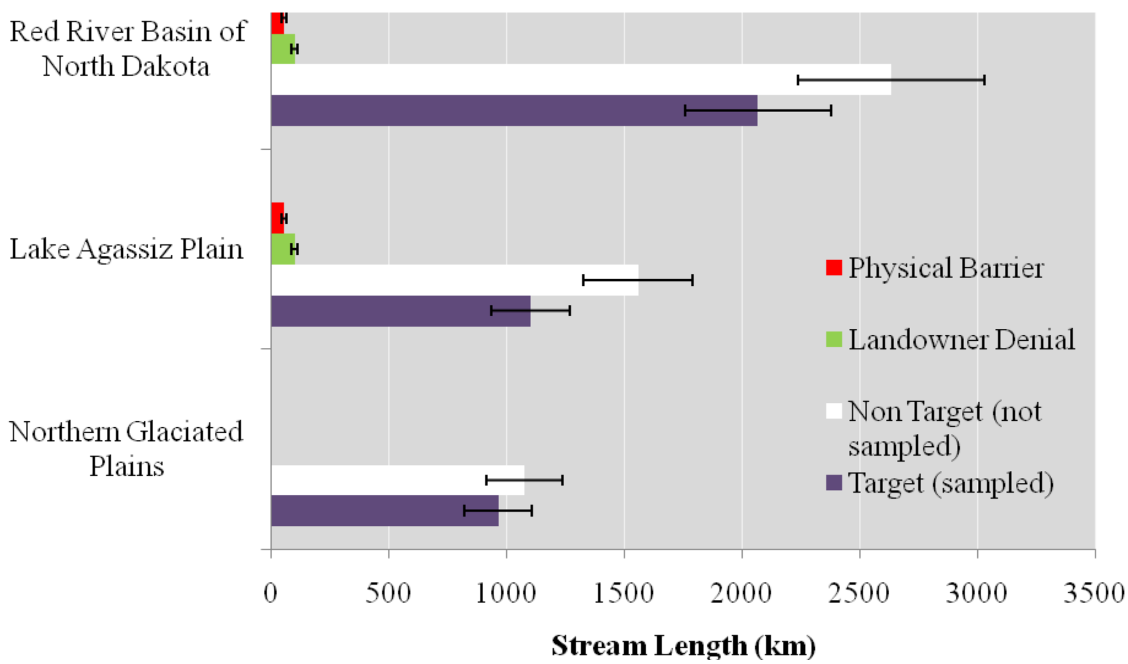

Figure 5. Stream Length Estimates for the Red River Basin in North Dakota Including Target and Non-Target Estimates.

Methods

The following is a brief description of the study design and methods employed as part of this study. For a more complete explanation of the site selection process and methods, the reader is referred to the Quality Assurance Project Plan (QAPP) for the Red River Bioassessment Project (NDDoH 2007).

Sample Site Selection

In order to assess the overall biological condition of the wadeable, perennial rivers and streams in the Red River basin in North Dakota with known precision and accuracy, a probabilistic sampling design was employed for this study. The probabilistic sampling design involved the selection of 25 randomly selected sites within each ecoregion, for a total sample size of 50. In the Lake Agassiz Plain (48) ecoregion, fish were also sampled as an additional biological indicator of water quality. Results were analyzed using Analyze-It 2012 software.

Water Quality

In-situ field measurements for dissolved oxygen (DO), temperature, specific conductance and pH were taken at the middle transect of each sampling reach using an YSI handheld meter. A water quality sample was also collected during each visit and analyzed for major cations/anions, trace metals, nutrients (total nitrogen, total and dissolved phosphorus, nitrate-nitrite, and ammonia), and total suspended solids.

Physical Habitat

Physical habitat measurements were also taken with each site visit. Cross-sectional measurements were taken at each of the 11 transects within the sampling reach. Physical habitat measurements include bank measurements (i.e., wetted and bankfull width, etc) and channel measurements (i.e., water depth and substrate type) (Table 19). A visual habitat assessment based on the Rapid Bioassessment Protocol (RBP) described by Barbour et al (1999) was completed for each site.

Benthic Macroinvertebrates

Benthic macroinvertebrate samples were collected using two methods. Stream sites located in the Lake Agassiz Plain ecoregion were sampled using the proportional sampling method described by Barbour et al. (1999). With this method, 20 individual D-frame jab samples are collected among each of the dominant habitat types present within the sample reach. The 20 individual jab samples are then composited into one sample and submitted to the laboratory for processing.

In the Northern Glaciated Plains ecoregion, macroinvertebrate samples were collected using the transect method employed by the Environmental Monitoring and Assessment Program Western Pilot study (EMAP – West) (Peck et al. 2005). With this method, benthic macroinvertebrate D-frame jab samples were collected at each of the 11 transects.

Fish

As mentioned previously, fish samples were only collected at sites located in the Lake Agassiz Plain ecoregion. At each site the entire reach was sampled using a long-line electrofishing unit. Beginning at the downstream end of the reach and proceeding in an upstream direction, an effort was made to include all available habitat types in order to collect a representative sample of the entire reach. Enumeration included separating the individuals collected into species, measuring the largest and smallest of each species, and taking a batch weight of each species to account for total biomass.

Setting Expectations for Impairment

Due to the difficulty of estimating historical conditions for most biological indicators, the Department has adopted the "least-disturbed" condition as the operational definition of reference condition. "Least-disturbed condition" is found in conjunction with the best available physical, chemical and biological habitat conditions for a given area or region (e.g., ecoregion) given the current state of the landscape. "Reference" or "least-disturbed" condition is described by evaluating data collected at sites selected based on a set of explicit criteria defining what is "best" or "least-disturbed" by human activities. These criteria vary from ecoregion to ecoregion in the state and are developed iteratively with the goal of identifying a set of sites which are influenced the least by human activities.

Once a set of "reference sites" are selected for a given ecoregion in the state, they are sampled using the methods described earlier. The range of conditions (e.g., habitat variables, chemical concentrations, or IBI scores) found at these "reference sites" describes a distribution of values, and extremes of this distribution are used to set thresholds in order to separate sites that are in relatively good condition from those that are clearly not. One common approach, and the one used by the Department, is to examine the range or statistical distribution of IBI scores for a set of reference sites within an ecoregion, and to use the 5th or 10th percentile of this distribution to separate the "most disturbed" (i.e., poor biological condition) sites from "moderately disturbed" (i.e., fair biological condition) sites. Similarly, the 25th or 50th percentile of the distribution is used to distinguish between "moderately disturbed" sites and those in "least-disturbed" condition. The IBI scoring thresholds for each biological condition class and use support category are provided in Tables 11-13. Biological condition scores were then translated into aquatic life use attainment categories by assigning the good biological condition class as fully supporting aquatic life use and the poor biological condition class as not supporting aquatic life use (Table 11-13).

Table 11. Scoring Thresholds by Biological Condition Class and Aquatic Life Use Support Category for the Lake Agassiz Plain Ecoregion Macroinvertebrate IBI.

IBI Score	Biological Condition Class	Aquatic Life Use Support
100-72	Least Disturbed	Fully Supporting
71-60	Moderately Disturbed	Fully Supporting, but Threatened
59-0	Most Disturbed	Not Supporting

Table 12. Scoring Thresholds by Biological Condition Class and Aquatic Life Use Support Category for the Northern Glaciated Plain Ecoregion Macroinvertebrate IBI.

IBI Score	Biological Condition Class	Aquatic Life Use Support
100-71	Least Disturbed	Fully Supporting
70-59	Moderately Disturbed	Fully Supporting, but Threatened
58-0	Most Disturbed	Not Supporting

Table 13. Scoring Thresholds by Biological Condition Class and Aquatic Life Use Support Category for the Lake Agassiz Plain Ecoregion Fish IBI.

IBI Score	Biological Condition Class	Aquatic Life Use Support
100-63	Least Disturbed	Fully Supporting
62-47	Moderately Disturbed	Fully Supporting, but Threatened
46-0	Most Disturbed	Not Supporting

Ecological Condition

Macroinvertebrate Assessment

Overall condition class estimates for the entire Red River Basin in North Dakota are represented in Figure 6. Of the estimated 4855.97 perennial stream kilometers, 1792.78 km (37%) were assessed for this project. Overall, 594.98 km (33%) are "least disturbed"; 359.14 km (20%) are "moderately disturbed" while 838.66 km (47%) are "most disturbed" with regards to the macroinvertebrate indicator.

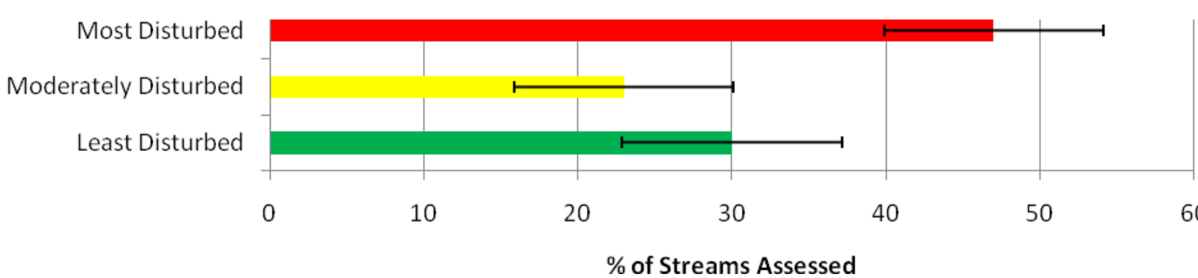

Figure 6. Overall Condition Class Estimates for the Red River Basin in North Dakota With Regard to the Macroinvertebrate Indicator.

Fish Assessment

Fish were sampled in the Lake Agassiz Plain only. Previous biological monitoring efforts achieved poor results with the fish indicator in the Northern Glaciated Plains ecoregion due to depauperate fish communities throughout the region. Therefore, the fish assessment was not included in the Northern Glaciated Plains. Of the 2815.58 perennial stream kilometers present in the Lake Agassiz Plain ecoregion, 755.73km (27%), were assessed using the fish indicator. Of these, 297.63 km (39%) are considered "least disturbed" while 178.41km (24%) are "moderately disturbed" and 279.69 km (37%) are considered to be in "most disturbed" condition (Figure 7).

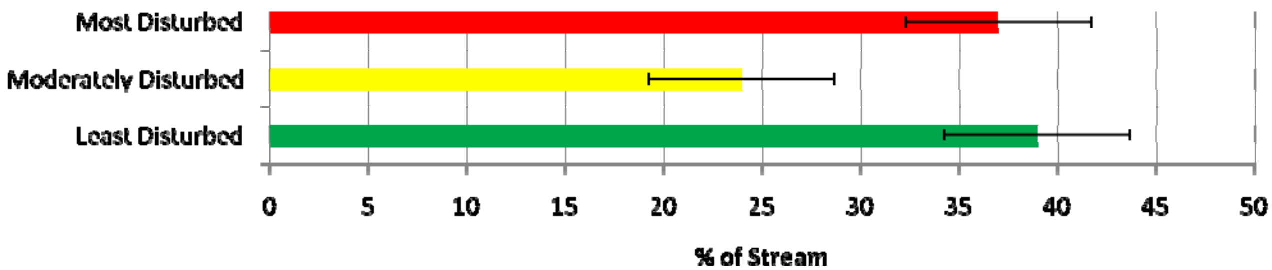

Figure 7. Condition Class Estimates for the Lake Agassiz Plain Ecoregion of North Dakota with Regard to the Fish Indicator

Stressor Condition

Chemical Stressors

Previous studies have shown that three chemical stressors are of particular importance in the region (Johnson et al. 2009), total nitrogen, total phosphorus and specific conductance. Based on the statistical distribution of reference site data for each ecoregion, thresholds were drawn using the 75th percentile and above as "most disturbed" and the 25th percentile and below as "least disturbed" (Tables 14 and 15). Values falling between are considered "moderately disturbed".

It is estimated that 4855.97 km of perennial streams and rivers are present in the entire basin. Of these, 2548.52 (52%) were assessed for chemical stressors in the Lake Agassiz Plain and Northern Glaciated Plains. Results from both ecoregions are combined and presented in Figure 4 for a complete assessment of the Red River basin as a whole.

Table 14. Threshold Values Used to Determine Condition Class for Three Chemical Stressors in the Lake Agassiz Plain Ecoregion.

Chemical Stressor	Most Disturbed	Moderately Disturbed	Least Disturbed
Total Nitrogen	>1230 µg/L	1230 - 883 µg/L	<883 µg/L
Total Phosphorus	>261 µg/L	261 - 148 µg/L	<148 µg/L
Specific Conductance	>1432 µmho/cm	1432 - 911 µmho/cm	<911 µmho/cm

Table 15. Threshold Values Used to Determine Condition Class for Three Chemical Stressors in the Northern Glaciated Plains Ecoregion.

Chemical Stressor	Most Disturbed	Moderately Disturbed	Least Disturbed
Total Nitrogen	>1047 µg/L	1047 - 581 µg/L	<581 µg/L
Total Phosphorus	>215 µg/L	215 - 115 µg/L	<115 µg/L
Specific Conductance	>1044 µmho/cm	1044 - 991 µmho/cm	<991 µmho/cm

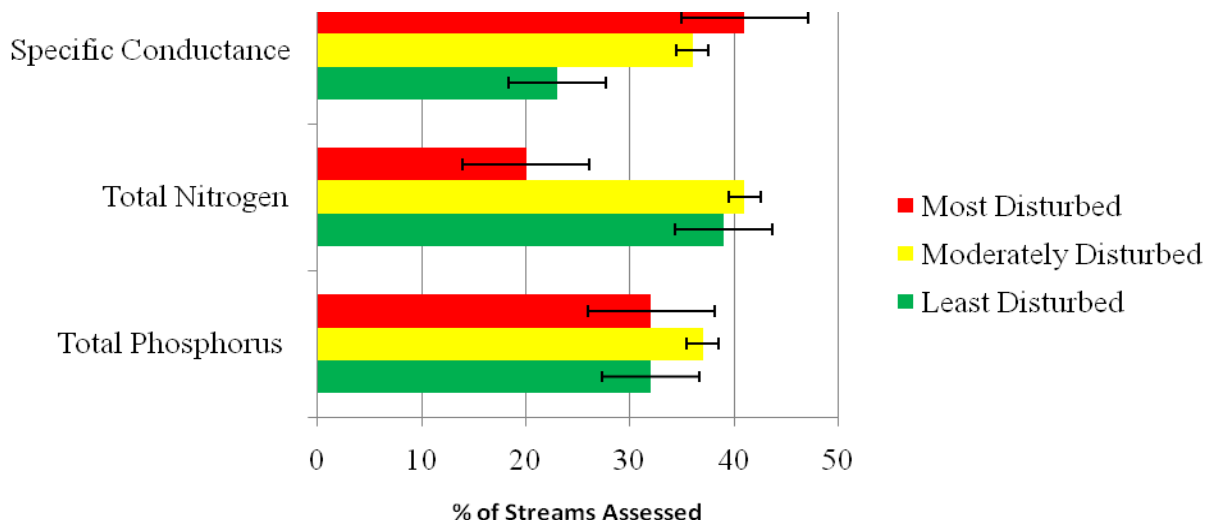

Figure 8. Stream Length in the Red River Basin Considered to be Least Disturbed, Moderately Disturbed or Most Disturbed Based on Three Chemical Stressors.

Physical Habitat Stressors

The physical habitat assessment consists of two components, the Rapid Bioassessment Protocol (RBP) visual assessment and a geomorphologic assessment comprised of physical measurements of the stream channel at each of 11 cross-sections throughout the sampling reach. Once IBI (dependent variable) scores were calculated, linear regressions were run in order to identify potential stressors (independent variable) for each ecoregion. Table 8 provides a list of RBP parameters evaluated during the visual assessment. In the Lake Agassiz Plain ecoregion, strong correlations exist between biological integrity and available cover, sediment deposition, riparian vegetative zone width, channel alteration and vegetative protection. In the Northern Glaciated Plains ecoregion, linear regressions revealed strong correlations with riparian vegetative zone width, vegetative protection, pool variability, channel sinuosity and channel alteration.

Table 16. Rapid Bioassessment Protocol (RBP) Visual Habitat Assessment Parameters.

Available Cover	Channel Sinuosity/Frequency of Riffles
Bank Stability	Embeddedness/Pool Variability
Bank Vegetative Protection	Riparian Vegetative Zone Width
Channel Alteration	Sediment Deposition
Channel Flow Status	Substrate Type

Physical habitat measurements of geomorphologic attributes revealed three primary stressors in the Red River basin; riparian disturbance, relative bed stability and available cover. Table 19 provides a list of physical measurements taken. Of the 2815.58 km of perennial stream in the Lake Agassiz Plain, 755.73 km (27%) were assessed using the physical habitat stressors below. Table 16 displays threshold values for each of the physical stressors.

Table 17. Threshold Values Used to Determine Condition Class for Three Physical Stressors in the Lake Agassiz Plain Ecoregion.

Physical Stressor	Most Disturbed	Moderately Disturbed	Least Disturbed
Riparian Disturbance	5th Percentile or < 2.08	≥ 2.08 and ≤ 2.45	25th Percentile or > 2.45
Relative Bed Stability	5th Percentile or <1.30	≥ 1.30 and ≤ 2.53	50th Percentile or > 2.53
Available Cover	5th Percentile or < 1.26	≥1.26 and ≤1.6	25th Percentile or > 1.6

Of the perennial 2040.39 km of perennial lotic waters in the Northern Glaciated Plains, 964.35 (47%) km were assessed during the physical habitat assessment. Table 17 displays threshold values for this ecoregion.

Table 18. Threshold Values Used to Determine Condition Class for Three Physical Stressors in the Northern Glaciated Plains Ecoregion.

Physical Stressor	Most Disturbed	Moderately Disturbed	Least Disturbed
Riparian Disturbance	5th Percentile or < 1.98	≥ 1.98 and ≤ 2.39	50th Percentile or > 2.39
Relative Bed Stability	10th Percentile or < 1.88	≥ 1.88 and ≤ 2.15	50th Percentile or > 2.15
Available Cover	5th Percentile or < 1.31	≥ 1.56 and ≤ 1.31	25th Percentile or > 1.56

Based on the condition class estimates developed for the Lake Agassiz Plain and Northern Glaciated Plains ecoregions (Table 17and 18), it is estimated that 754.95 km (27%) of the assessed perennial, wadeable streams in the Red River basin in North Dakota are “most disturbed” due to a lack of available cover, 1006.60 km (36%) are “most disturbed” due to poor relative bed stability, and 2097.09 km (75%) are “most disturbed” due to riparian disturbance (Figure 9). It was also estimated that 50, 42 and 6 percent of perennial, wadeable streams in the Red River basin in North Dakota are “least disturbed” with respect to these three habitat attributes, respectively (Figure 9).

Table 19 Physical Habitat Parameters Including Bank and Channel Measurements.

Bank Measurements	Stream Channel Measurements
Bank Angle	Bar Width
Bankfull Height	Canopy
Bankfull Width	Embeddedness
Channel Type	Riparian Buffer Distance
Incised Height	Substrate Size
Undercut Bank	Water Depth
Wetted Width	

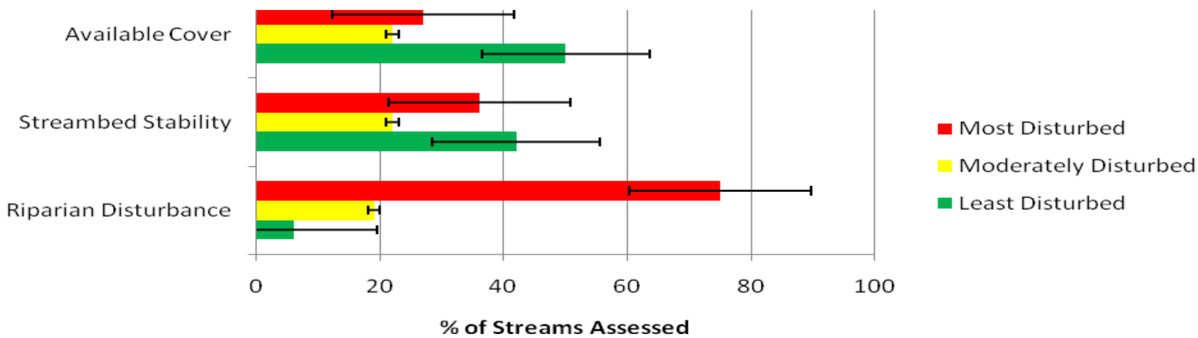

Figure 9. Stream Length in the Red River Basin of North Dakota Considered Least Disturbed, Moderately Disturbed and Most Disturbed Based on Three Physical Stressors.

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8.05 RED RIVER MAINSTEM BIOLOGICAL ASSESSMENT PROJECT

The following is a brief summary of the Red River Mainstem Biological Assessment Project. For the complete report the reader is referred to the final report entitled "Assessment of the Fish Assemblages and Habitat Quality in the Red River of the North, 2010 - U.S. Mainstem Portion: Wahpeton to Pembina, ND" prepared by Chris O. Yoder with the Midwest Biodiversity Institute (Yoder, 2011) which is available on the NDDoH website at www.ndhealth.gov.

Background and Goals

The Red River Mainstem Biological Assessment Project (project) was originally envisioned as a result of discussions after the International Water Institute sponsored the Red River of the North Ecosystem Assessment Workshop held on November 2-3, 2005 in Moorhead, MN. The presentations that were heard at this workshop suggested that there have been difficulties in assessing the fish assemblages of the Red River mainstem which led some of the workshop participants to believe that fish may not be a suitable assemblage for biological assessment purposes. Given the experience that Chris Yoder and his staff with the Midwest Biodiversity Institute (MBI) have in using fish to assess the quality of similarly sized and larger rivers throughout the Midwest region (Emery et al. 2007; MBI 2010b), the North Dakota Department of Health (NDDoH) entered into an agreement to conduct an intensive fish assemblage and habitat survey of the U.S. portion of the Red River mainstem. A parallel proposal to sample the Canadian portion of the Red River was also developed, but funding for this effort did not materialize. The goals of this project were to: 1) provide an ecological assessment of the Red River of the North mainstem in the U.S.; 2) to complement existing and future biological assessment efforts which have, and will be, conducted on Red River tributaries in North Dakota and Minnesota; and 3) demonstrate and train biologists and water quality specialists in the basin on procedures to sample large non-wadeable rivers like the Red River of the North.

Methods

In August of 2010, the NDDoH in conjunction with the MBI, conducted sampling for the project. A total of 54 sites were sampled from August 18, 2010 through September 1, 2010, including 52 sites on the mainstem Red River and one site each on the Bois de Sioux and Ottertail Rivers (Figure 10). All sites were sampled for fish, macroinvertebrates and water quality. In addition, a qualitative habitat assessment was conducted at each site.

Study Design

The sites sampled as part of the project (Figure 10) were selected using a stratified, intensive pollution survey design (Yoder et al. 2005). This spatially intensive design is employed to sample fish assemblages in mainstem rivers to comprehensively assess all major disturbances and modifications. The design includes multiple sampling sites that are positioned upstream, near, and downstream from these sources such that results can be analyzed and displayed in a longitudinal context. Both the spatial design and results interpretation, relative to disturbance sources, are based on that described earlier by Bartsch (1948) and Doudoroff and Warren (1951) to facilitate the detection and quantification of varying pollution influences along a river (i.e., a delineation of "pollution zones"). Reaches upstream from major sources of disturbance, in areas of immediate impact and potentially acute effects, through zones of increasing or lessening degradation, and zones of recovery are sampled at multiple sites positioned at intervals ranging from 0.5-10 miles. A primary goal is to visualize the impact of specific sources in addition to the cumulative effects of multiple sources. Additional tools based on indices like the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb) can then be used to quantify the extent (longitudinal distance) and severity (departure from a goal or criterion) of the impact within a defined river reach (Yoder et al. 2005).

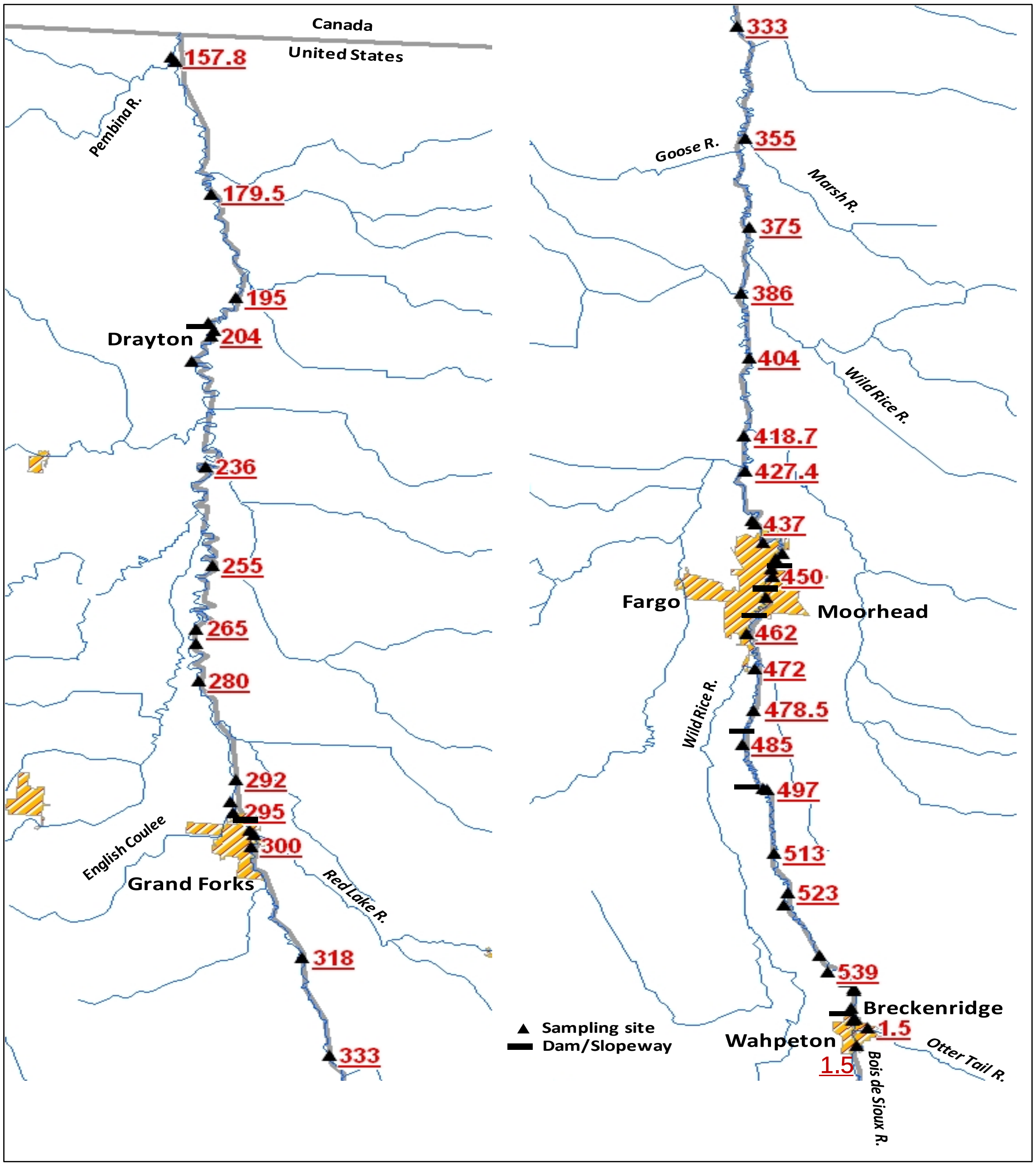

Figure 10. Location of Red River Mainstem Biological Assessment Project Sites.

Sampling Site Selection and Delineation

Individual electrofishing sites were located along the shoreline with the most diverse habitat features in accordance with established methods (Gammon 1973, 1976; Ohio EPA 1989; Lyons et al. 2001). This is generally along the gradual outside bends of large rivers, but this is not invariable. In free-flowing habitats, a portion of each zone should include run-riffle habitat in addition to shoal and pool habitat as each is available. Sampling distance was measured with a GPS unit and/or a laser range finder. Exact sampling locations were determined in the field and included a representative proportion of reaches along the mainstem with respect to pollution sources, habitat modifications (i.e., mostly impounded sections behind dams, channelized and leveed reaches), and relatively unmodified, free-flowing reaches.

Field Sampling Procedures

A boat-rigged, pulsed D.C. electrofishing apparatus was the single gear type employed for this project. This consisted of a 16' john boat that was specifically constructed and modified for electrofishing. The boat electrofishing crew consisted of a boat driver, a single bow netter, and one assist netter standing behind the primary netter. All 3 crew members have nets and each can capture all fish sighted. Reasonable attempts are made to capture all fish sighted including those that appear behind the boat. Limited access to the Red River frequently necessitated launching at an upstream location and recovering at a downstream location. Put-in and take-out sampling was conducted where barriers precluded contiguous navigation.

A concerted effort was made to capture every fish sighted by both the netters and driver. Since the ability of the netters to see stunned and immobilized fish was partly dependent on water clarity, sampling was conducted only during periods of "normal" water clarity and flows. Periods of unusually high turbidity and high flows were avoided due to their negative influence on sampling efficiency.

Sample Processing Procedures

Captured fish were immediately placed in an on-board live well for processing. Water was replaced regularly to maintain adequate dissolved oxygen levels and to minimize handling mortality. Special handling procedures were used for species of special concern. Fish not retained for voucher or other purposes were released back into the river after they were identified to species, examined for external anomalies, weighed and, if necessary, measured for total length. Every effort was made to minimize holding and handling times. The majority of captured fish were identified to species in the field; however, any uncertainty about the field identification of individual fish required their preservation for later laboratory identification. Individual fish that were too large to preserve were photographed in detail.

The sample from each 0.5 km electrofishing zone was processed by enumerating and recording weights by species or by three species age classes when this was distinguished. Fish weighing less than 1000 grams were weighed to the nearest gram on a spring dial scale (1000 g x 1 g) or a 1000 g hand held spring scale. Fish weighing more than 1000 grams were weighed to the nearest 25 grams on a 12 kg spring dial scale (12 kg x 50 g) or a 50 kg hand held spring scale. Species with a large number of individuals were batch weighed. Samples comprised of two or more distinct size classes of fish (e.g., y-o-y, juveniles, and adults) were processed separately.

The incidence of external anomalies is recorded following procedures outlined by Ohio EPA (1989) and refinements made by Sanders et al. (1999). The frequency of DELT anomalies (deformities, eroded fins and body parts, lesions, and tumors) is a good indication of chronic stress caused by biological agents, intermittent stresses, and chemical contaminants. The percentage of DELT anomalies is a metric that is included in most of the large river fish assemblage IBIs that have been developed across the U.S.

Habitat Assessment

A qualitative habitat assessment using an appropriate modification of the Qualitative Habitat Evaluation Index (QHEI; Rankin 1989; Ohio EPA 1989, 2006) for large rivers was completed by the crew leader at each electrofishing site. The QHEI is a physical habitat index designed to provide an empirical, qualitative evaluation of the lotic macrohabitat characteristics that are important to fish assemblages. The QHEI incorporates the types and quality of bottom substrates, the types and amounts of instream cover, several characteristics of channel morphology, riparian zone extent and quality, bank stability and condition, and pool-run-riffle quality and characteristics. Slope or gradient is also factored into the QHEI score. We followed the guidance and scoring procedures outlined in Ohio EPA (1989, 2006) and Rankin (1989) with some additional modifications made specifically for large rivers by MBI.

Data Management and Analysis

Data were analyzed using routines available in the Ohio ECOS data management system that was adapted for use by MBI in this and other fish assemblage assessment projects. Ohio ECOS produces standardized data outputs and reports on fish species relative abundance and condition that includes assemblage attributes such as numbers, biomass, functional and tolerance guilds, condition metrics, and compositional expressions. Relative abundance data is reported as numbers and biomass per kilometer. While several types of data expressions and indices are possible, we focused our analyses on two principal assessment tools; the modified Index of Well-Being (MIwb) and two versions of an Index of Biotic Integrity (IBI).

Index of Biotic Integrity (IBI)

Two indices of biotic integrity (IBI) were calculated for the 2010 Red River study area sites. A regionally derived index termed the Fish Assemblage Condition Index (FACI; Emery et al. 2007) was based on a regional assessment of the large river tributaries of the Upper Ohio and Upper Mississippi Rivers based on sampling conducted in 2004-2006. The FACI consists of 12 metrics that were selected based on screening 113 candidate metrics against a regionally derived stressor gradient. The final metrics were based on a combination of responsiveness, redundancy elimination, and ecological representativeness (Table 20). Metric scoring is done on a continuous scale following the CALU (Continuous All sites Upper and Lower threshold) method (Blocksom 2003) and the FACI was normalized to a range of 0-100 for our purposes.

The MPCA recently developed a set of IBIs based on ichthyofaunal classification regions and stream and river sizes as part of their biocriteria and TALU developmental process. The Southern Rivers IBI (SRIBI) included the Red River mainstem and is hence applicable herein. The SRIBI was developed based on a process in which hundreds of candidate metrics were identified and tested against a human disturbance gradient. The most responsive and representative metrics were selected and in the case of the SRIBI included 11 metrics (Table 21). Each metric is scored on a continuous scale and the sum score is normalized to a scale of 0-100.

Modified Index of Well-Being (MIwb)

Gammon (1976) and Gammon et al. (1981) originally developed and tested the Index of Well-Being (Iwb) as a multiparameter evaluation of large river fish assemblages. The Iwb is based on four measures of diversity, abundance, and biomass and represents an attempt to produce an integrated evaluation of these baseline assemblage attributes. The individual performance of numbers, biomass, and the Shannon index as consistent indicators of the quality of fish communities has historically been disappointing. However, when combined in the Iwb these individual community attributes respond in a more complimentary and intuitively predictable manner. For example, an increase in total numbers and/or biomass caused by one or two predominant species is usually offset by a corresponding decline in the Shannon index. In addition, the $\log_e$ transformation of the numbers and biomass components acts to reduce much of the variability inherent to these parameters alone. Gammon (1976) found the variability of each of the four Iwb components as measured by a coefficient of variation to range from 20-50%, yet the composite variability reflected by the Iwb was only 7%. High numbers and/or biomass are commonly, and at times inaccurately, perceived as a positive attribute of a fish assemblage. High numbers and biomass result in a high Iwb score only if a relative “evenness” is maintained between the abundance of the common species. However, this is not invariable, especially with environmental perturbations which tend to restructure fish assemblages without corresponding decreases in diversity (e.g., nutrient enrichment, habitat modification). Fish assemblages in habitat modified streams can frequently exhibit very high numbers, biomass, and moderate species richness. Such assemblages are usually predominated by tolerant species. Species intolerant of such disturbances either decline in abundance or are eliminated altogether. In such cases the Iwb can yield an inflated result that does not reflect true assemblage condition.

Table 20. Fish Assemblage Community Index (FACI; Emery et al. 2007) metrics and description.

Metric	Description	Stress Response	Scoring
Ind-T	Number of fish less tolerant species	Decrease	CALU[1]
Unique Sp	Total number of unique species	Decrease	CALU
Prop X_Sp	Proportion unique species that are exotic	Increase	CALU
Prop #T	Proportion of individuals that are tolerant	Increase	CALU
Prop #Int	Proportion of individuals that are intolerant	Decrease	CALU
Prop #Suck	Proportion individuals round-bodied suckers	Decrease	CALU
Prop DB	Proportion individuals deep-bodied suckers	Decrease	CALU
#Darter	Number of darter individuals	Decrease	CALU
Prop #Carni	Proportion of individuals that are carnivores	Decrease	CALU
Prop Gen_Sp	Proportion of species that are generalists	Increase	CALU
Prop #Herb	Proportion of individuals that are herbivores	Increase	CALU
Invert kg	Total biomass of all invertivore individuals	Decrease	CALU

CALU – Continuous All sites Upper and Lower threshold calibration method (Blocksom 2003).

A modification of the original Iwb was developed by Ohio EPA (1987) and further explained by Yoder and Smith (1999). The modified Iwb retains the same computational formula as the original Iwb, but eliminates species designated as highly tolerant or alien and all hybrids from the numbers and biomass metrics; these species are retained in the Shannon index calculations. This modification eliminates the “undesired” effect caused by a high abundance of tolerant species, but retains their “desired” influence in the Shannon indices. The computational formula used is as follows:

Modified Index of Well-Being (MIwb) = $0.5 \ln N + 0.5 \ln B + H\,(\text{no.}) + H\,(\text{wt.})$;

where:

N = CPUE; relative numbers minus species designated highly tolerant (Ohio EPA 1987);
B = CPUE; relative biomass minus species designated highly tolerant (Ohio EPA 1987);
H (no.) = Shannon diversity index based on numbers (version which uses log_e);
H (wt.) = Shannon diversity index based on weight (version which uses log_e).

We used the MIwb to assess the assemblage level properties of the 2010 results as an additional assessment tool to the IBI, not as an alternate or replacement.

Table 21. Southern Rivers IBI developed by the MPCA.

Metric	Description	Floor 5th %ile	Ceiling 95th %ile	Stress Response
Insect TolPct	% of insectivore species (excludes tolerants)	12.01	81.99	Decrease
Piscivore	Number of piscivorous species	1	7.9	Decrease
Sensitive TXPct	% of all taxa that are sensitive	-23.59	15.81	Decrease
SLithop	Number of species that are simple lithophils	-6.71	2.59	Decrease
SLvdPct	% of individuals that are short lived	0.83	60.10	Increase
SSpnTXPct	% of all taxa that are serial spawners	14.39	38.04	Increase
TolPct	% of individuals that are tolerant	5.37	82.30	Increase
VtolTXPct	% of all taxa that are very tolerant	5.04	33.33	Increase
DetNWQTXpct	% of all taxa that are detritivorous	15.38	41.62	Increase
GeneralPct	% of individuals that are generalists	5.63	64.72	Increase
DomTwoPct	% of individuals of the two dominant species	30.39	75.00	Increase

Results

Flow Conditions

Flows were well above the historical median at all USGS gages on the Red River during the August 18 – September 1, 2010 survey. Figure 11 depicts daily flows at the Wahpeton, ND and Pembina, ND gages compared to the historical median flows. Although flows were elevated beyond the median, conditions were conducive to effective sampling and were within the specifications of the project QAPP (MBI 2010a).

Water Quality Results

Water quality data were collected at each fish sampling location and included grab measurements of daytime dissolved oxygen (D.O.), temperature, conductivity, pH, and secchi depth. The results for DO, temperature, and conductivity were plotted by sampling location indexed to river mile and shown from upstream to downstream (Figures 12-14). Major sources are depicted as they occurred along the longitudinal continuum.

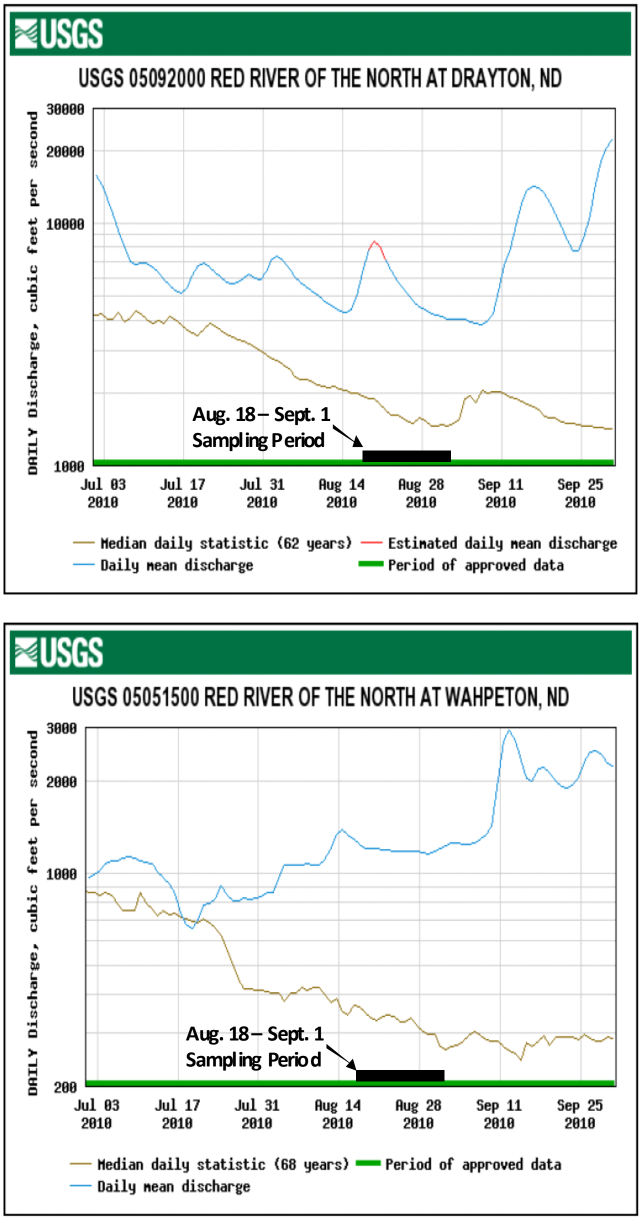

Figure 11. Flow hydrograph during July 1 – September 30, 2010 at the Wahpeton, ND and Drayton, ND flow gages operated by USGS. The August 18-September 1 sampling period is indicated on each.

Dissolved Oxygen (D.O.)

D.O. concentrations in the mainstem ranged from a low of 3.47 mg/L at RM 539.0 to 13.31 mg/L at RM 497.0 in the reach downstream from the Wahpeton- Breckenridge area (Figure 12). Most values throughout the remainder of mainstem were within 1.0-1.5 mg/L of the mean of 7.64 mg/L. The longitudinal profile in the approximate 50 mile reach downstream of the Wahpeton- Breckenridge area and the concentration of point sources and stormwater discharges suggests an effect from excessive loadings of oxygen demanding wastes and the assimilation of those wastes. Three recorded daytime values were below the North Dakota 5.0 mg/L minimum water quality criterion.

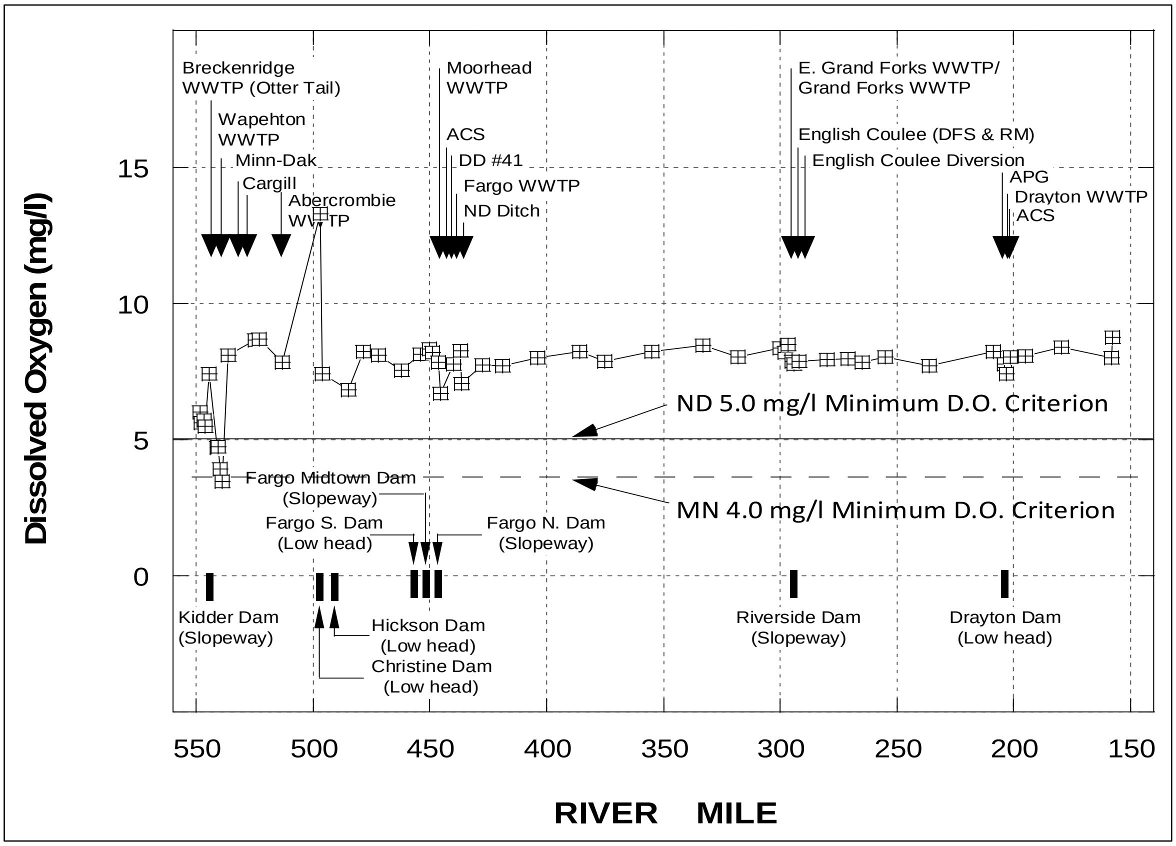

Figure 12. Dissolved oxygen (D.O.) values (mg/L) at all 54 locations in the Red River mainstem between Wahpeton and Pembina, ND during the period August 18-September 1, 2010

Temperature (°C)

Temperature values were fairly uniform throughout the mainstem ranging from 21.4°C at RM 157.8 to 24.7°C at RM 450.0 with a mean of 22.8°C (Figure 13). The maximum temperatures observed during the study occurred in the Fargo-Moorhead area declining slightly for the remainder of the mainstem. The slight decline could well have been due the initial decline in seasonal temperatures that occurs in late August and September. No exceedences of North Dakota or Minnesota water quality criteria for temperature were observed.

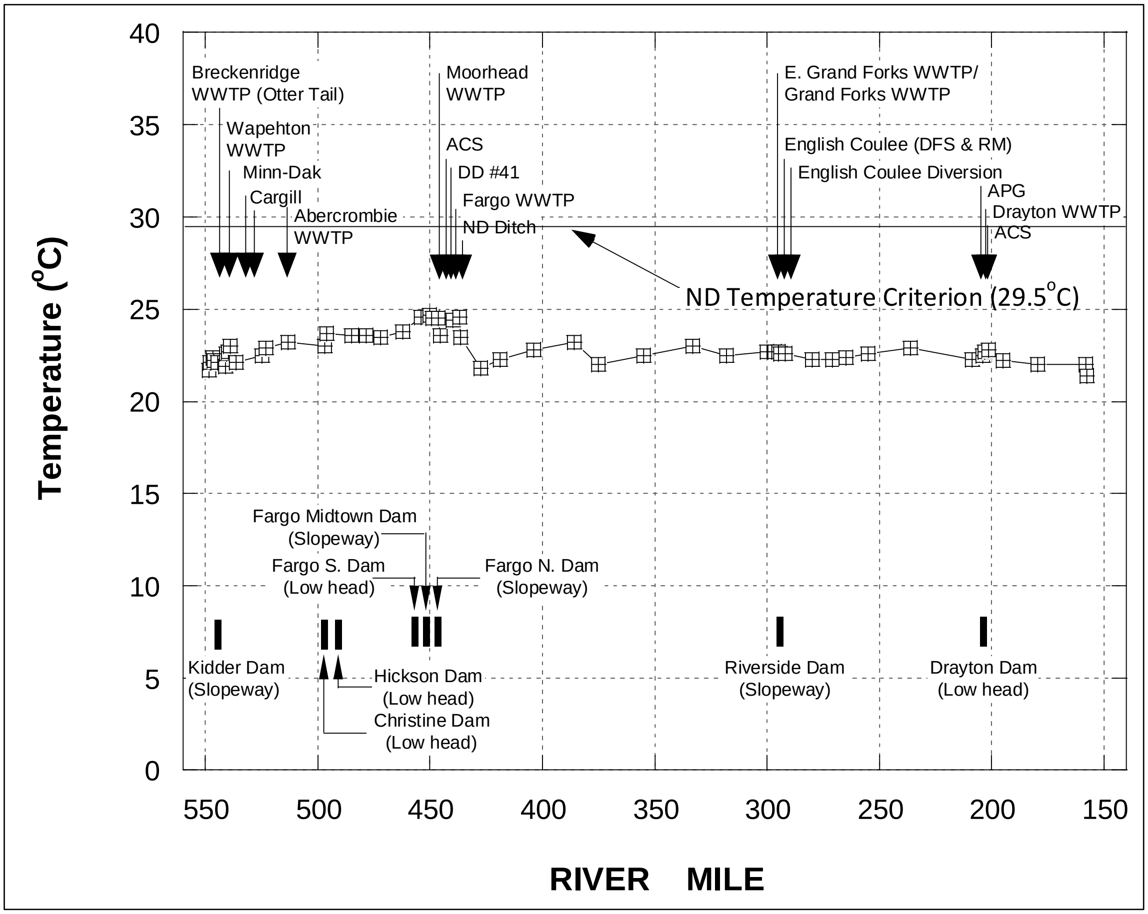

Figure 13. Temperature (°C) values at all 54 locations in the Red River mainstem between Wahpeton and Pembina, ND during the period August 18-September 1, 2010.

Conductivity (µS/cm^2)

Conductivity values ranged from 409 µS/cm^2 at RM 1.5 in the Otter Tail River to 1338 µS/cm^2 at RM 1.5 in the Bois de Sioux River (Figure 14). The high value in the Bois de Sioux River is a reflection of soils, flow management, and land use in that watershed. The opposing low value in the Otter Tail River is likewise a reflection of those same attributes in that watershed. The mean conductivity value of 495 µS/cm^2 in the Red River between Wahpeton- Breckenridge and Fargo-Moorhead reflects the addition of flow by the Otter Tail River. Conductivity values increased to 806 µS/cm^2 downstream from Fargo-Moorhead beginning at RM 427.4 which is immediately downstream from the confluence with the Sheyenne River. Again, this is a reflection of the background conditions in the Sheyenne River and this effect remained until the Grand Forks area where a slight decline was noted due to inflows from the Red Lake River. These results suggest that conductivity values are the result of natural conditions along the mainstem and in the more influential tributaries.

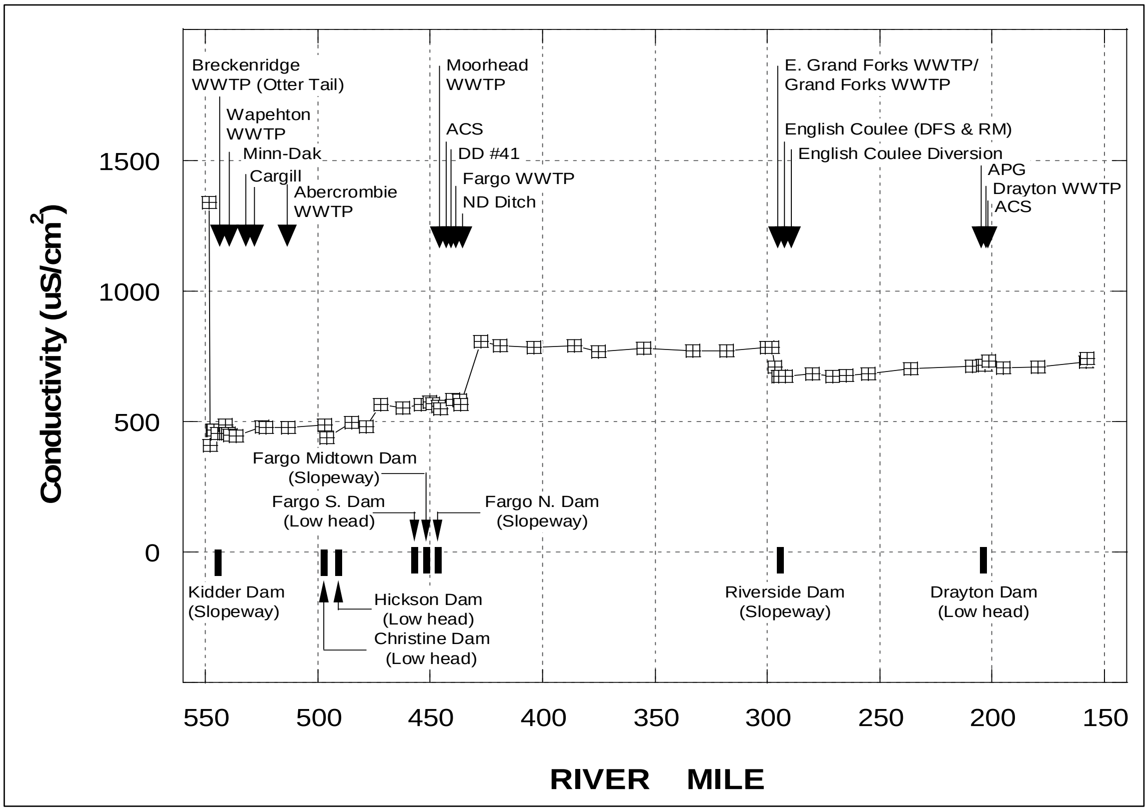

Figure 14. Conductivity (µS/cm^2) values at all 54 locations in the Red River mainstem between Wahpeton and Pembina, ND during the period August 18-September 1, 2010.

Habitat Quality

The quality of physical habitat was determined visually using the Qualitative Habitat Evaluation Index (QHEI; Rankin 1989, 1995; Ohio EPA 2006). QHEI scores sites based on the numbers and types of habitat attributes that are important for aquatic life, fish assemblages in particular. The QHEI is scored on a 0-100 scale and has an effective range of 20-100 depending on the quality of the habitat. Values above 60 are generally regarded as being sufficient to support fish assemblages that meet the minimum goal of the CWA and values >75 indicate exceptional quality habitat. QHEI scores <45 reflect modifications and deficiencies that do not support CWA goals. Narrative ratings include exceptional (>75), good (>60), fair (45-60), poor (30-45), and very poor (<30) quality. In addition to the QHEI scores, a QHEI matrix that depicts the occurrence of attributes that favor higher quality fish assemblages (termed good attributes) and those that have the opposite effect (termed modified attributes) based on analyses by Rankin (1989, 1995) was also examined. The occurrence of modified:good ratios >2:1 indicates that habitat quality is likely unsuitable for support assemblages reflective of CWA goals, hence this was examined in addition to the QHEI scores themselves.

QHEI scores ranged from 39.0 at RM 204.0 in the Drayton Dam impoundment to 79.75 at RM 539.0 downstream from the Cargill discharge north of Wahpeton with a mean of 56.7 across all sites (Figure 15). There were 5 sampling sites located in the impoundments formed by 5 dams or slopeways. The mean QHEI for these impounded sites was 47.0 (range 39.0 – 56.5) compared to a mean of 57.9 (range 49.5-79.75) for all other sites that were considered to be free flowing.

The longitudinal pattern in QHEI scores was a general decline downstream from the Wahpeton- Breckenridge area where values were mostly good to exceptional (Figure 15). Downstream of this area which essentially ends at the Christine Dam (RM 496.5), QHEI scores were at or below 60 at all except one site in Grand Forks (RM 295.0) for the entire remainder of the mainstem. This overall pattern may well be related to the decline in gradient that occurs in a general downstream direction (Figure 15).

The analysis of QHEI attributes for each site shows that all except 3 sites had modified attributes. More importantly, the modified:good ratios were less than 2.0 at all except 6 sites. The highest ratio of 4.0 occurred at RM 454.0 which is in the impoundment effect of the Fargo Midtown Dam (RM 452.2) and the next highest of 3.0 occurred at RM 204.0 which is in the Drayton dam impoundment. The most frequently occurring modified attributes were sparse or no cover, heavy/moderate siltation, fair/poor development, no fast current, high/moderate embeddedness both overall and within riffle/runs, and no riffle/run habitats. These represent a mix of naturally occurring conditions and impacts ranging from impoundment to the predominant agricultural land uses, controlling the latter of which is key to improving overall habitat conditions in the Red River mainstem.

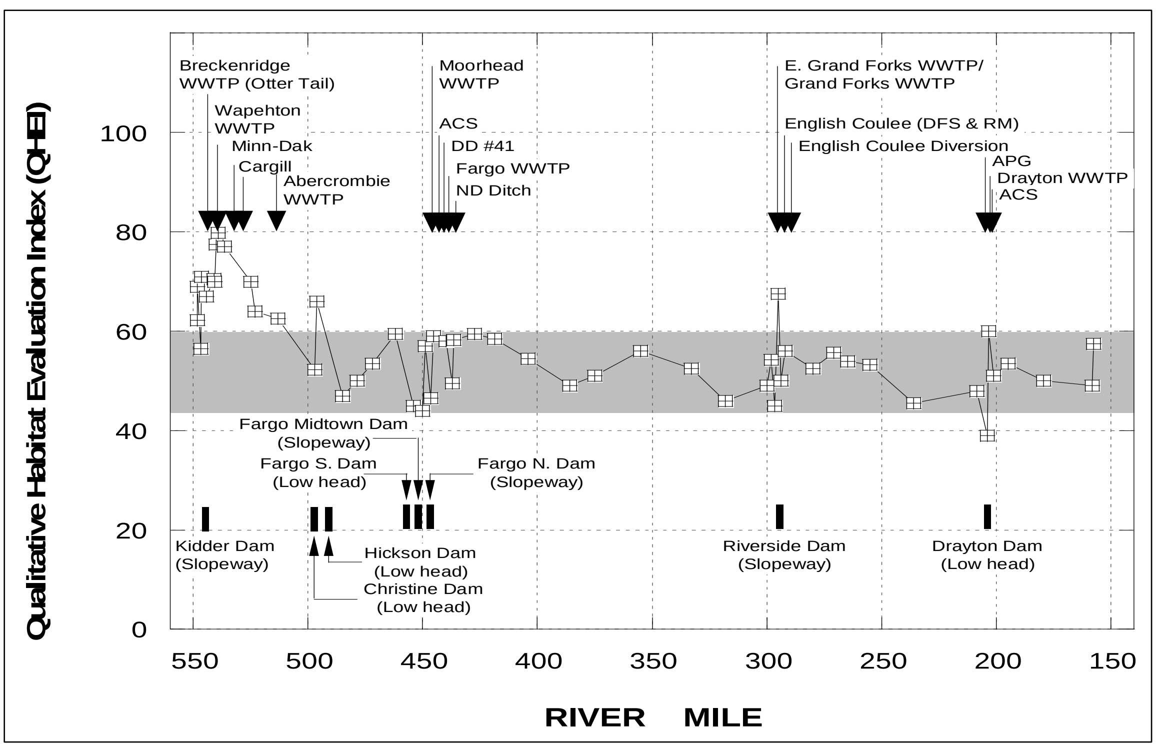

Figure 15. QHEI scores (upper) and gradient (feet/mile) values at all 54 locations in the Red River mainstem between Wahpeton and Pembina, ND during the period August 18-September 1, 2010.

Fish Assemblage Results

An average of 186.4 individual fish/km with an average weight of 31.51 kg/km were collected at the 54 boat electrofishing sites in the Red River mainstem between Wahpeton and Pembina, ND. Of the 41 species that were collected, those that predominated in terms of numbers and biomass are listed in Tables 22 and 23.

Channel catfish *(Ictalurus punctatus)*, spotfin shiner *(Cyprinella spilopterus)*, goldeye *(Hiodon tergisus)*, and common carp *(Cyprinus carpio)* were numerically predominant comprising more than 60% of the collections by numbers. In terms of biomass, common carp, channel catfish, goldeye, quillback carpsucker *(Carpiodes cyprinus)*, freshwater drum *(Aplodinotus grunniens)*, and bigmouth buffalo *(Ictiobus cyprinellus)* comprised more than 80% of the collections by weight. In all the Red River fish assemblage that we observed in 2010 is comprised mostly of a mix of species that are tolerant of turbid water and soft or fine substrates with the presence of some large river obligate species.

Table 22. Numerically predominant fish species (>1.0% by numbers) collected by boat electrofishing in the U.S. portion of Red River of the North mainstem, 2010.

Species	Number/km	%Number
Channel catfish *(Ictalurus punctatus)*	46.1/km	24.7%
Spotfin shiner *(Cyprinella spiloptera)*	35.0/km	18.8%
Goldeye *(Hiodon tergisus)*	18.0/km	9.6%
Common carp *(Cyprinus carpio)*	17.9/km	9.6%
Spottail shiner *(Notropis hudsonius)*	5.7/km	3.0%
Shorthead redhorse *(Moxostoma macrolepidotum)*	5.6/km	3.0%
Freshwater drum *(Aplodinotus grunniens)*	5.0/km	2.7%
Emerald shiner *(Notropis atherinoides)*	4.8/km	2.6%
Fathead minnow *(Pimephales promelas)*	4.8/km	2.6%
Sauger *(Sander canadensis)*	4.8/km	2.6%
White bass *(Morone chrysops)*	4.7/km	2.5%
Silver chub *(Macrhybopsis storeriana)*	4.0/km	2.1%
Golden redhorse *(Moxostoma erythrurum)*	3.9/km	2.1%
Orangespotted sunfish *(Lepomis humilis)*	3.5/km	1.9%
Silver redhorse *(Moxostoma anisurum)*	3.3/km	1.8%
Quillback carpsucker (Carpiodes cyprinus)	2.7/km	1.5%
Trout-perch *(Percopsis omiscomaycus)*	2.7/km	1.5%
Smallmouth bass *(Micropterus dolomieu)*	2.1/km	1.1%
Sand shiner *(Notropis stramineus)*	2.0/km	1.1%
Northern pike *(Esox lucius)*	1.9/km	1.0%

Table 23. Predominant fish species in terms of biomass (>1.0% by weight) collected by boat electrofishing in the U.S. portion of Red River of the North mainstem, 2010.

Species	**Kg/km**	**%Biomass**
Common carp *(Cyprinus carpio)*	10.14/km	32.2%
Channel catfish *(Ictalurus punctatus)*	7.11/km	22.5%
Goldeye *(Hiodon tergisus)*	3.44/km	10.9%
Quillback carpsucker (Carpiodes cyprinus)	1.77/km	5.6%
Freshwater drum *(Aplodinotus grunniens)*	1.63/km	5.2%
Bigmouth buffalo *(Ictiobus cyprinellus)*	1.60/km	5.1%
Shorthead redhorse *(Moxostoma macrolepidotum)*	1.45/km	4.6%
Silver redhorse *(Moxostoma anisurum)*	1.09/km	3.5%
Golden redhorse *(Moxostoma erythrurum)*	0.67/km	2.1%
Northern pike *(Esox lucius)*	0.57/km	1.8%
Walleye *(Sander vitreum)*	0.35/km	1.1%
Sauger *(Sander canadensis)*	0.35/km	1.1%

Species Richness

The number of species ranged from 8-20 at all sites with a mean of 14 species (Figure 16). There was a perceptible decline from Wahpeton- Breckenridge to downstream from Fargo-Moorhead followed by a general increase to and through Grand Forks. Species richness declined below Grand Forks and with one exception remained at 10-14 species.

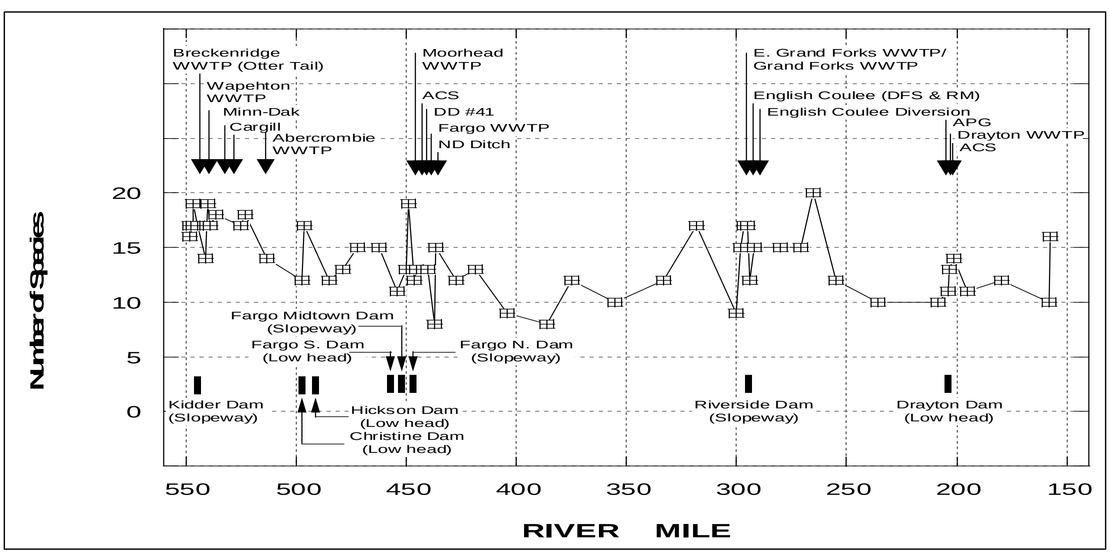

Figure 16. Fish species richness at all 54 locations in the Red River mainstem between Wahpeton and Pembina, ND during the period August 18-September 1, 2010. *Density (number/km)*

Relative numbers of fish ranged from 42-390/km with an overall mean of 186.4/km (Figure 17). There was an overall decline in numbers in a downstream direction with numbers <200/km and up to near 400/km in and immediately below Wahpeton- Breckenridge. With the exception of higher numbers in and below Fargo-Moorhead and Grand Forks most sites had numbers <200/km.

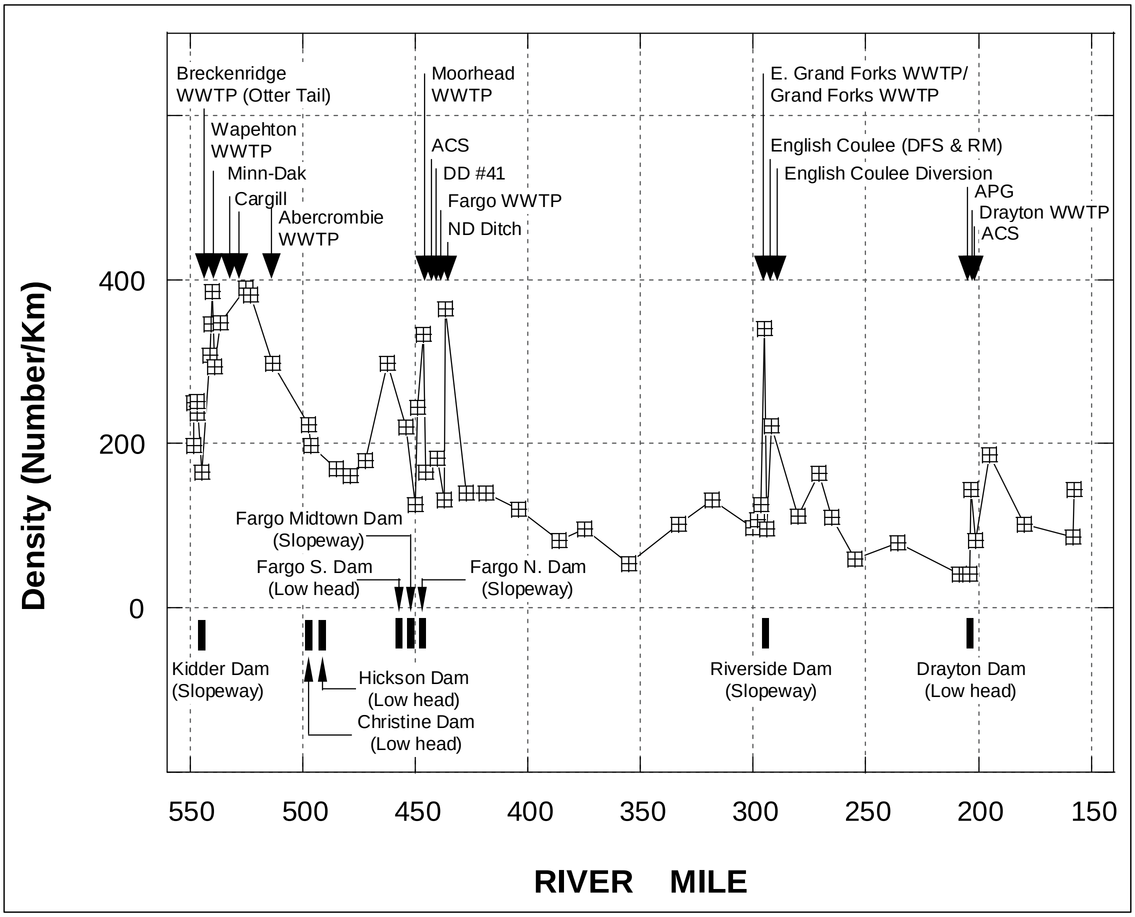

Figure 17. Fish density (number/km) at all 54 locations in the Red River mainstem between Wahpeton and Pembina, ND during the period August 18-September 1, 2010.

Modified Index of Well-Being (MIwb)

Modified Iwb (MIwb) scores ranged from 5.72-9.49 with a mean of 7.63 (Figure 18. Being an index comprised of transformed inputs (numbers, biomass, and diversity) it was not nearly as spatially variable as its components. Visually there was a slight overall decline in a downstream direction with the highest values >8.0-9.0 in and immediately below Wahpeton- Breckenridge. Beyond that area MIwb values were infrequently >8.0 and some values were <6.0.

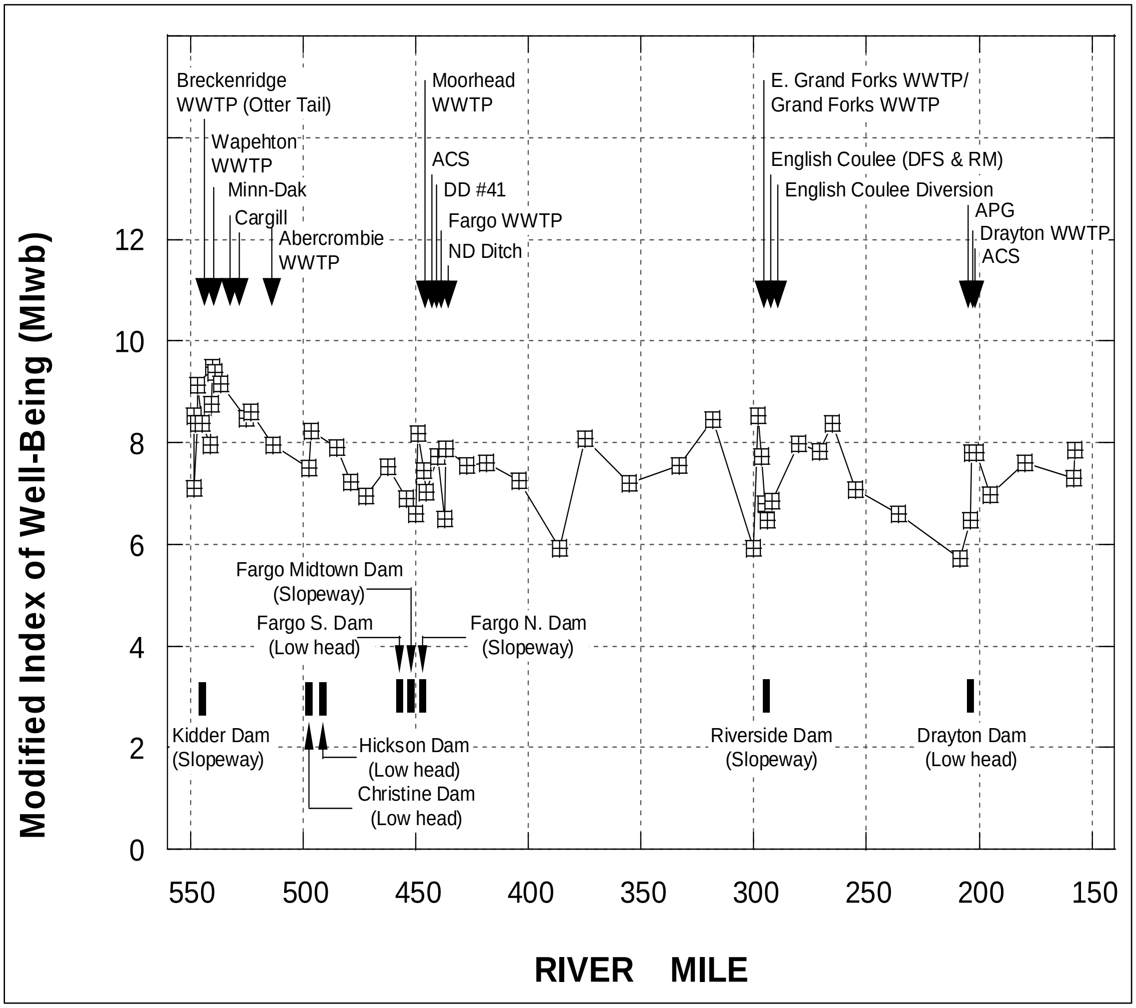

Figure 18. Modified Index of Well-Being Scores at all 54 locations in the Red River mainstem between Wahpeton and Pembina, ND during the period August 18-September 1, 2010.

Indices of Biotic Integrity (IBI)

Two indices of biotic integrity were calculated for the 2010 data. The Fish Assemblage Condition Index (FACI; Emery et al. 2007) was developed from a regional assessment of large river tributaries to the Upper Ohio and Upper Mississippi Rivers in 2004-2006. The metrics were derived by examining many more candidate metrics than those that comprise the final index and by testing metrics for responsiveness, redundancy, and ecological relevance. The second IBI was recently developed by MPCA and specifically for the ichthyofaunal region within which the Red River occurs (MPCA, unpublished analyses). This IBI is termed the Southern Rivers IBI and it applies to large rivers across Minnesota that lay within MPCA's southern ichthyofaunal region. Like the FACI, the Southern Rivers IBI was developed based on an examination of a large number of candidate metrics and by testing for metric responsiveness in keeping with the process described by Whittier et al. 2007. Both indices have a 0-100 scoring range and tentative biological criteria have been determined for each following a reference condition/stressor gradient approach, however the geographic domains of each were different.

FACI scores ranged from 34.7-53.3 with an overall mean of 45.4 (Figure 19). The 25th percentile reference value is 48 and could serve as a biological criterion for a preliminary status assessment. Unlike the prior observations about the assemblage abundance, diversity, and condition parameters there was little evidence of any overall trend along the longitudinal continuum. There were some local changes, but none suggested any spatially significant impacts. Most of the FACI scores were below the 25th percentile reference value of 48 which is based on the FACI stressor gradient.

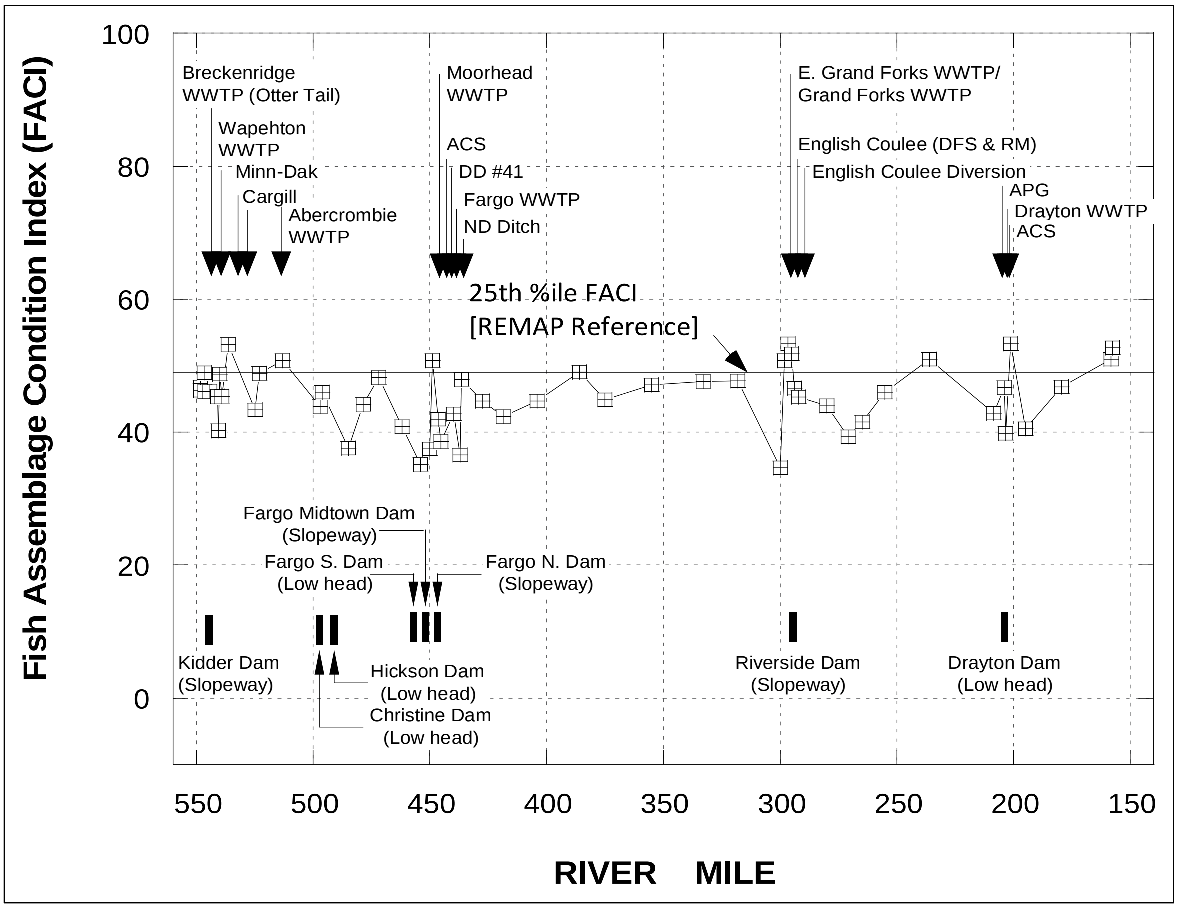

Figure 19. Fish Assemblage Condition Index (FACI) Scores at all 54 locations in the Red River mainstem between Wahpeton and Pembina, ND during the period August 18-September 1, 2010.

The Southern Rivers IBI (SRIBI) scores ranged from 39.9-75.3 with an overall mean of 62.9 (Figure 20). The variation in scores was greater than the FACI and some general longitudinal patterns were evident. SRIBI scores declined in a general downstream direction from Wahpeton- Breckenridge then increased with much variation between sites through the remainder of the study area. Most SRIBI scores were above the interim MPCA General Use biological criterion with only 4 sites below that threshold. A few sites were above the interim threshold for an "exceptional" or upper tier biocriterion with most of these occurring in Wahpeton- Breckenridge and in and below the greater Grand Forks area.

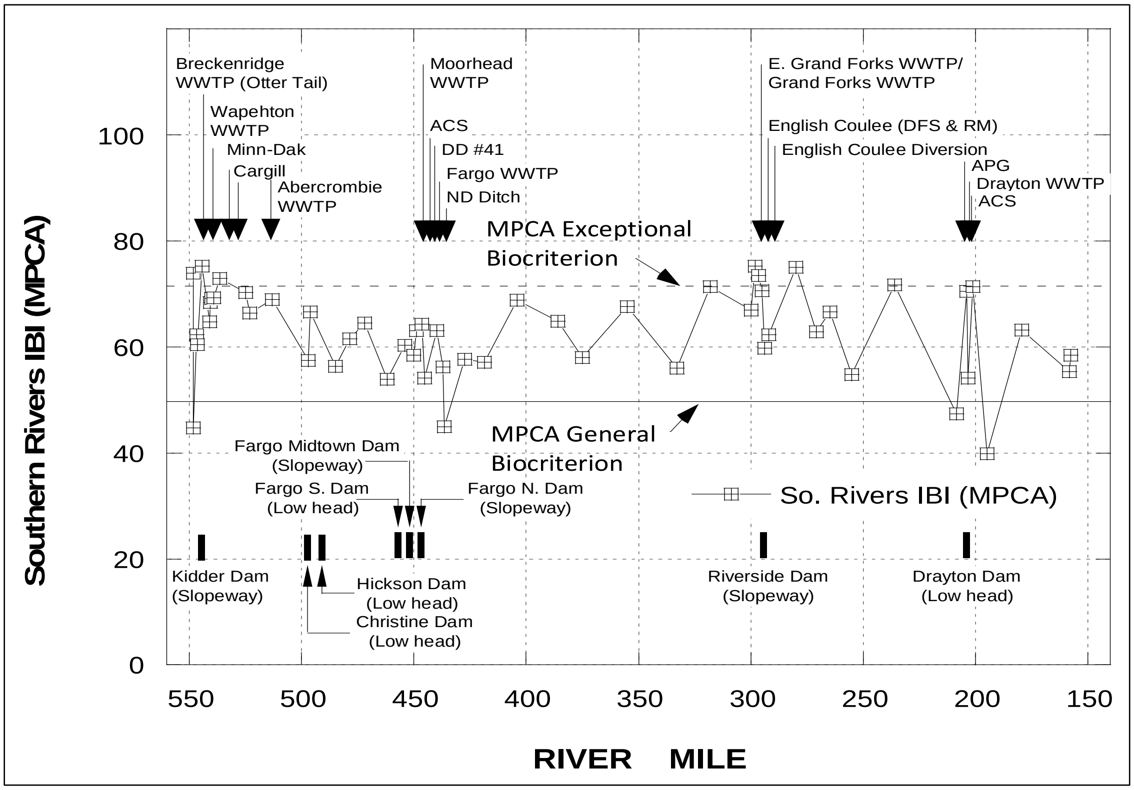

Figure 20. MPCA Southern Rivers IBI Scores at all 54 locations in the Red River mainstem between Wahpeton and Pembina, ND during the period August 18-September 1, 2010.

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9.0 ADDITIONAL ACTIVITIES IN THE RED RIVER BASIN

As outlined in Appendix A – International Red Rive Board Directive, the duties of the Board include maintaining an awareness of other agencies in the basin, of developments and conditions that may effect water levels and flows, water quality and ecosystem health of the Red River and its transboundary tributaries, and activities that contribute to a better understanding of the aquatic ecosystems. Chapter 9 provides and overview of a number of relevant activities and developments in the basin.

9.01 Garrison Diversion Project - <u>Dakota Water Resources Act</u>

The Dakota Water Resources Act (DWRA) of December 2000 amended authorizing legislation for the Garrison Diversion Project. The legislation outlines a program to meet Indian and non-Indian water supply needs in North Dakota and authorizes water uses including municipal, rural and industrial, fish and wildlife, recreation, irrigation, flood control, stream flow augmentation, and ground water recharge.

<u>Red River Valley Water Supply Project</u>

In December 2007 a final Environmental Impact Statement (EIS) was completed which identified a preferred alternative for delivery of Missouri River water, via existing and new facilities, to meet both short- and long-term water needs in the Red River Valley in North Dakota and Minnesota. The Bureau of Reclamation has completed the DWRA required NEPA analyses.

Secretary of the Interior Kempthorne signed a formal determination on January 13, 2009, finding that the EIS' proposed water treatment for the importation of Missouri River water for the Red River Valley project was adequate under applicable federal law and treaty provisions. The selected approach to water treatment was developed in close consultation with U.S. EPA and the U.S. Department of State, as required by DWRA. The preferred biota treatment alternative identified in the final EIS meets or exceeds treatment goals proposed by the Province of Manitoba.

Secretary Kempthorne deferred signing a Record of Decision (ROD) concluding it would be more appropriate to defer a ROD until Congress has authorized construction of the project features identified in the EIS. If and when authorized by subsequent legislation, as DWRA requires for such an importation project, the Department of the Interior would then review the authorized project to determine whether any additional National Environmental Policy Act (NEPA) is required or appropriate.

<u>Northwest Area Water Supply Project</u>

In March 2006, Reclamation initiated preparation of an environmental impact statement (EIS) to evaluate water treatment techniques to further reduce the risks of transfer of non-native species from the Missouri River Basin into the Hudson Bay Basin. The final EIS was released to the public in December 2008. Reclamation signed a Record of Decision (ROD) for the EIS on January 15, 2009. In February 2009, the Department of Justice notified the U.S. District Court that Reclamation had completed the final EIS and ROD. Shortly thereafter the Province of Manitoba filed a Supplemental Complaint arguing that the final EIS was insufficient. A day later the State of Missouri filed a complaint against the Department of the Interior and the U.S. Army Corps of Engineers in the same District Court in Washington D.C. In March 2009, the court combined the Missouri suit with the Manitoba suit. Numerous briefs from all parties involved in the litigation were filed with the court throughout 2009. On March 5, 2010, the District Court remanded the case to Reclamation for further analysis. Reclamation has decided to prepare a supplemental EIS. A notice of intent was published in the Federal Register on August 12, 2010. Public scoping meetings are scheduled for September 13-16, 2010, in four locations throughout the project service area. Reclamation will address the areas of concern identified by the court as well as other issues identified during public scoping.

9.02 Devils Lake Sub-Basin

DEVILS LAKE UPDATE

Devils Lake

Hydrology:

The water surface elevation on August 15, 2012 was 1452.4 msl. This is about 0.9 feet below the January 21, 2012 elevation and about 1.9 feet below the record high of 1454.30 msl set on June 27, 2011.

The water surface increased about 0.3 feet in the spring of 2012, peaking around 1453.6 msl in early May. Since May it has steadily fallen about 1.2 feet. In comparison, the 2009 spring rise was 3.5 feet, with an inflow of 540,000 ac.-ft and the 2010 spring rise was 1.8 feet with an inflow of 312,000 ac.-ft. In 2011, the spring stage increase was about 2.7 feet, with a total inflow of about 595,000 acre-feet. The total storage of Devils Lake (including Stump Lake) is now 3.79 million ac-ft., covering an area of 186,500 acres. This is a decrease of 210,000 ac. ft. of storage and 10,500 acres in surface area from the beginning of 2012.

Date	Elevation (msl)	Area (acres)	Volume (acre-feet)
Jan. 16, 2010	1449.92	162,100	3.36 million
June 27, 2010	1452.05	182,800	3.73 million
Nov. 20, 2010	1451.26	175,000	3.59 million
Jan. 16, 2011	1451.65	178,600	3.66 million
June 27, 2011	1454.30	208,500	4.19 million
January 21, 2012	1453.3	197,000	4.00 million
May 7, 2012	1453.6	200,057	4.03 million
Aug. 15, 2012	1452.4	186,500	3.79 million

State Emergency Outlet Project Update:

Operation:

West Devils Lake Outlet

The releases of Devils Lake water from the west outlet into the Sheyenne River began on April 2, 2012. Little spring runoff in the Sheyenne River watershed allowed the early start. Maintenance of the pumps limited the discharge amount initially, although it was eventually increased to the 250 cfs capacity. The pumps were shut down for a short time during the week of June 9, for maintenance of vegetation problems in the channel.

East Devils Lake Outlet:

Installation of about 27,000 feet of 8 foot diameter pipe was completed on December 12, 2011. Construction of the inlet and outlet structures and installation of pumps was completed near the beginning of June 2012. Testing of the system started in early June. It started discharging at full capacity, of 350 cfs, around June 26. The discharge was reduced during the week of July 9 in order to remain well within the water quality limits in the Sheyenne River, while maintenance was done on the west outlet. (The water quality is better from the west outlet. Mixing of the water from each outlet is required to ensure that the Sheyenne River remains quality within the water quality standards.)

The following table summarizes the extent of discharge from the outlet for 2012:

Month	Days Discharge Occurred		Average Discharge (cfs)		Monthly Volume (acre-feet)	
	West	East	West	East	West	East
April 2012	27		117		6,263	
May	31		135		8,286	
June	30	10	215	160	12,755	3,489
July	30	30	221	296	13,644	18,182
August						
Sept.						
Oct.						
Nov. 2011	___	____	____	____	______	______
TOTAL						

Note: The first number is for west outlet, second number is for east outlet. A detailed summary is not yet available beyond June 2012.

The following is a summary of the volume and inches of water removed from the lake since pumping was started in 2005:

Year	Volume Removed (acre-feet)	Inches Removed (inches)
2005	38	0.00
2006	0	0.00
2007	298	0.02
2008	1,241	0.09
2009	27,653	2.04
2010	62,969	4.30
2011	48,228	2.9
TOTAL	140,427	9.35

Devils Lake Outlet Committee:

The Devils lake Outlet Committee met on May 22, 2012 in Carrington, ND. The committee includes a representative from Manitoba and Minnesota.

Construction:

Emergency Gravity Water Transfer Channel:

The proposed gravity flow channel would provide an outlet from Stump Lake, extending south to Tolna Coulee. The control elevation at the bottom of the channel is proposed at 1452 msl. The channel would include stop logs to control releases based on downstream conditions. The channel would have a capacity of 100 cfs when Stump Lake is at an elevation of 1454 msl, if the stop logs were not in place. The channel would be operated to maintain downstream water quality uses. An operating committee is being proposed for the project.

Soil borings have been taken along the proposed alignment. Some of the soil conditions are not of the quality expected. Borings may be required along a different alignment, if a suitable change in the design is not possible at the original location. The Devils Lake Joint Water Resource Board is the local sponsor for this project. They have recently indicated that they are withdrawing as the lead agency of the gravity outlet.

Tolna Coulee Control Structure:

This project is a cooperative effort between the State Water Commission and the U.S. Army Corps of Engineers. The Corps of Engineers was overseeing the construction.

Construction of this project is complete, with dedication held in July. This is a control structure project consisting of a combination of sheet pile, embankment, and a steel stop log weir structure. The purpose of this project is to allow the natural erosion of the divide between Stump Lake and the Tolna Coulee, while protecting downstream communities from an uncontrolled release of the water in Stump Lake. To this end, this structure is designed to allow flow in the Tolna Coulee to cause erosion the same as would occur naturally while providing the ability to lower the lake elevation in a controlled manner as the divide erodes. It is not the purpose of this project to impound water in Stump Lake above the natural outlet elevation, as it exists now or what it may become in the future.

Upstream Storage:

The State Water Commission (SWC) is committed to a three-pronged approach to flooding in the Devils Lake basin, of which upper basin water management is an integral part. Several programs exist to store water, including the Extended Storage Acreage Program (ESAP), and projects by the ND Natural Resources Trust (Trust), and the U.S. Fish and Wildlife Service. The new Devils Lake Executive Committee action plan has reinforced and placed emphasis on the need to increase upper basin storage where possible.

The Trust is pursuing a plan to acquire privately held land for a multipurpose, multi-wetland restoration project in northeastern Ramsey County. SWC staff has estimated that this project will store approximately 631 acre-feet of additional water over existing conditions. The project requires commitments from multiple funding sources, including the Wetland Reserve Program (WRP), the North American Wetlands Conservation Act, ND Game and Fish, and the Trust. The project will put the land under a 30-year WRP easement with the ND Game and Fish taking title to the land for use as a public access wildlife conservation area. Total project cost is estimated at $2,048,000, and would result in long term water storage on land available for public use. The Trust has requested water storage funding from the SWC in the amount of $125,000. If approved, the SWC will develop a seven-year contract for water storage at the Johnson Farms site. Annual inspections will be conducted to ensure water storage at the site for the duration of the agreement. This expenditure equates to about $30.00/acre-foot per year of storage for the duration of the contract, which is comparable to the rates paid for existing ESAP temporary storage easements. The acquisition plan developed by the Trust involves several partners and as a result has several contingencies.

Outlet Mitigation Plan:

Beginning in 1993, as Devils Lake began its historically unprecedented rise, the State Water Commission (SWC) has been at the forefront of efforts to combat flooding in the basin. The lake level has now risen 30 feet expanding from about 49,000 acres to over 200,000 acres. At its overflow elevation of 1458 feet msl, where it naturally spills into the Sheyenne River, Devils Lake will cover more than 261,000 acres. To combat the growing flooding problem, local, state, and federal authorities adopted a three-pronged approach in the mid 1990s: infrastructure protection for roads, levees, and relocations; upper basin water management, including water storage in the upper basin; and discharge of flood water through an emergency west-end outlet to the Sheyenne River. This approach was designed with the interests of both Devils Lake basin and downstream residents in mind. The principal concept has been to manage water and flood damage within the Devils Lake basin, while attempting to prevent a potentially catastrophic natural overflow through Tolna Coulee to the Sheyenne River.

The 2011 Devils Lake Outlet Mitigation plan being developed by SWC staff with input from stakeholders, including the Devils Lake Outlet Advisory Committee, provides important direction in addressing problems that could arise downstream from emergency measures taken at Devils Lake to protect the safety and general welfare of both basin and downstream residents. The draft plan has two key components; construction of emergency outlets to remove floodwater from Devils Lake and a course of action to address downstream issues along the Sheyenne River that may result from operating the emergency outlet projects.

Devils Lake Embankment:

Work continues on raising the 13 mile long embankment that protects the town of Devils Lake. This is a Corp of Engineers project.

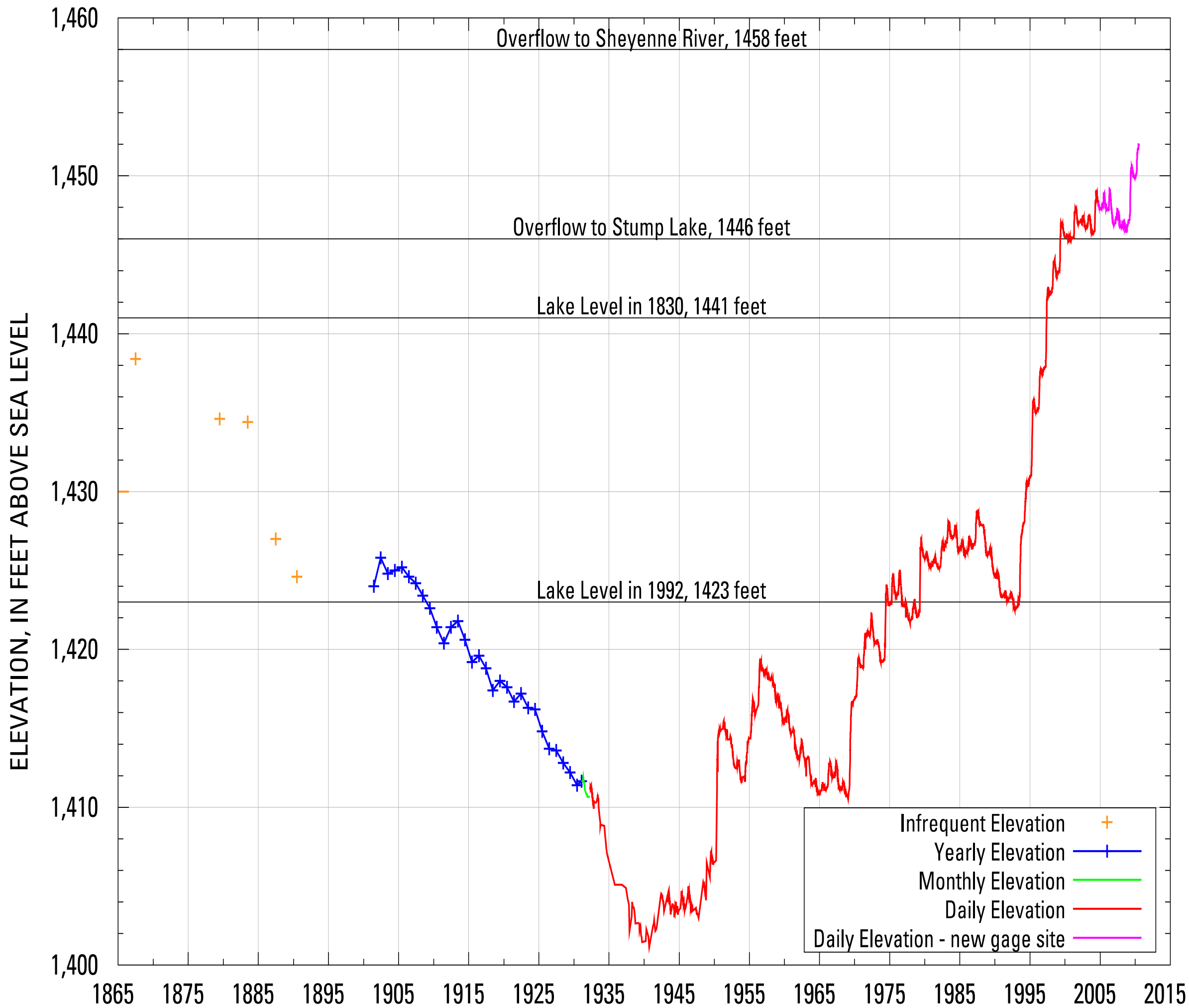

Figure 21. Devils Lake Historic Water Levels

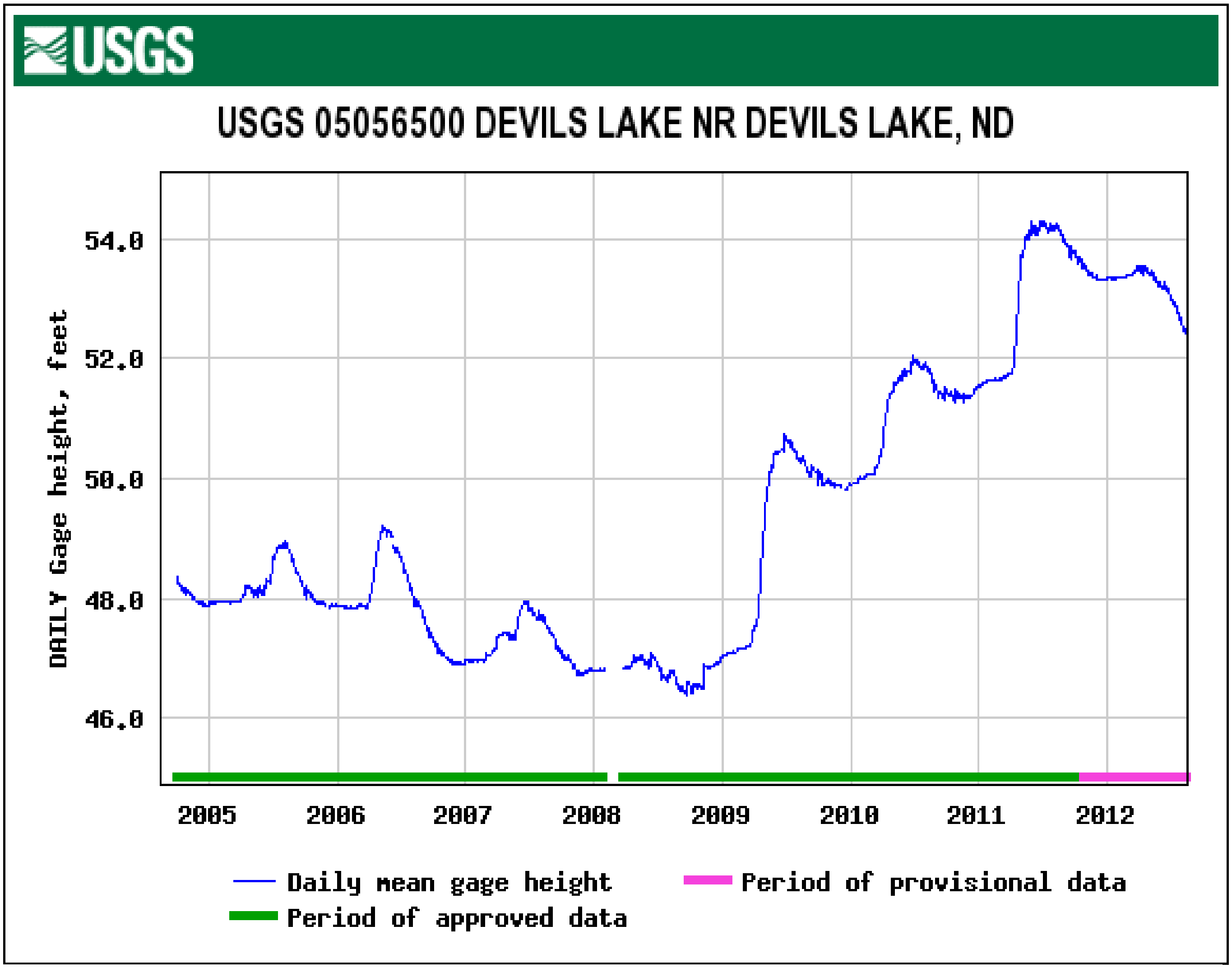

Figure 22. Devils Lake Water Levels (2005-2012)

Red River Retention Authority

The Red River Joint Water Resource District (RRJWRD) of ND and the Red River Water Management Board (RRWWB) of MN formed the Red River Retention Authority in August 2010. The Authority will provide the two entities with a better opportunity to jointly coordinate aggressive pursuit of retention projects within the watershed. The Red River Retention Authority will prioritize retention projects; facilitate interaction with federal agencies; provide assistance to member districts in obtaining regulatory approvals; seek federal, state, and other cost-share assistance; develop long-term watershed goals; and otherwise seek reduction of peak flows on the Red River.

9.03 U.S. Army Corps of Engineers Flood Control Activities

Introduction

The Corps of Engineers has a long history of involvement in water resource issues in the Red River of the North basin. Current Corps activities in the basin include operating flood control and multi-purpose reservoirs, conducting flood risk management and ecosystem restoration studies, constructing flood risk management and ecosystem restoration projects, conducting and participating in special studies and initiatives, regulating work in navigable waters and other waters of the United States, and providing emergency assistance and disaster response. The Corps cooperates and collaborates with other Federal and State agencies, local watershed districts, environmental groups, and local communities to address water resource problems and opportunities in the basin.

Construction Projects

Breckenridge, Minnesota and Wahpeton, North Dakota

Wahpeton and Breckenridge are at the confluence of the Bois de Sioux and Otter Tail Rivers, the beginning of the Red River of the North. The flood risk management projects for these cities are treated as two separate, but dependent, projects. The levee portions of both projects were initiated together to avoid adverse impact to the city on the other side of the river.

The Breckenridge project consists of a high-flow diversion channel north of the Otter Tail River and two separable permanent levee reaches that would protect all of Breckenridge. Construction of the diversion was completed in 2005. The first two of four stages of levee construction were awarded in April 2009. The third stage was advertised for bids on 21 December 2009. The total estimated cost for the Breckenridge project is $39.4 million. The project was re-authorized at a higher cost in the 2009 Energy and Water Appropriation Bill.

The Wahpeton project, authorized under the Corps' Section 205 Continuing Authority, consists of a permanent levee system and flood easements. Construction of the Wahpeton project began in 2003 with interior flood control features, which are now complete. The first of three stages of levee construction began in June 2008. The second stage began in June 2009. The total estimated cost for the Wahpeton project is $18.8 million.

Crookston, Minnesota

Construction of a flood risk management project for the Thorndale, Woods, and Downtown/Riverside neighborhoods was essentially completed in November 2004. Two rock berms protecting the upstream side of two cutoff channels were damaged from ice flows in April 2005. Work to repair the berms is scheduled to be completed in 2011.

Fargo, North Dakota (Ridgewood Addition)

Construction of a floodwall at the Department of Veterans Affairs hospital is substantially complete. By December 2009 construction of the Levee and floodwall on the city portion of the project has progressed far enough to serve as the line of protection, all construction work should be completed by September 2010. The project will reduce flood risk for the Department of Veterans Affairs hospital and the portion of Fargo between 15th Avenue North and 22nd Avenue North.

Grand Forks, North Dakota, and East Grand Forks, Minnesota
Construction of the flood risk management project for the cities of Grand Forks and East Grand Forks is essentially complete. The project has been certified as providing a 100-year level of flood protection in accordance with the Federal Emergency Management Agency's national flood insurance program. The levee construction has now been completed to a 250-year level of protection. Project close out and miscellaneous repairs remain to be completed. The project consists of 30 miles of levees and 3 miles of floodwall set back from the river. The levees and floodwalls form rings around the communities. The project also includes stabilization of an existing dam, removal of a former railroad bridge, construction of interior flood control features, 24 pump stations, numerous road and railroad closures, and two diversion channels. The project was also authorized to provide recreation features including 24 miles of trails and seven trailheads constructed in the new river greenway. The design level of protection is equivalent to the peak discharge experienced during the 1997 flood. Total estimated project cost is $409,300,000.

North Dakota Environmental Infrastructure Program (Section 594)
The Corps is assisting communities and rural areas in North Dakota under the North Dakota Environmental Infrastructure Program. The program authorizes the Corps to provide assistance to North Dakota public entities in the form of "design and construction assistance for water-related environmental infrastructure and resource protection and development projects in North Dakota, including projects for wastewater treatment and related facilities, combined sewer overflow, water supply, storage, treatment, and related facilities, environmental restoration, and surface water resource protection and development." The program was authorized in the Consolidated Appropriations Act (CAA) of 2008 which amended Section 594 of the Water Resources Act of 1999 and established a program authorization of $100,000,000 for North Dakota. To date, the Corps has received over $49 M and participated in the following projects in and near the Red River Basin including projects for Devils Lake, Valley City, the Southeast Rural Water Users District, the Cass Rural Water Users District, Barnes Rural Water District, Greater Ramsey Water District, Traill Rural Water District, and the Langdon Rural Water District.

Roseau, Minnesota
A flood risk management project for the city of Roseau, Minnesota was authorized in the Water Resources Development Act of 2007. The estimated project cost is $35 million, including land acquisition and relocations. The project's principle feature is a 4+ mile long diversion channel around Roseau's east side. The diversion channel will include recreation features, control structures and substantial floodwater retention areas. As part of the project, the city is constructing two highway bridges which will be completed in early 2010. The Corps is completing plans and specifications for the remaining portions of the project to be ready for construction in the spring of 2010.

Sheyenne River, West Fargo, North Dakota

Construction to repair the diversion channel that was damaged by erosion and sloughing in 2005 is scheduled to be complete in Sept 2010. Construction of the West Fargo project was essentially completed in 1994.

Studies

Ada, Minnesota

A Section 205 flood risk management feasibility study is under way for the city of Ada in the Marsh River watershed. The study is scheduled to be completed in early 2010. Flooding at Ada typically occurs when the Wild Rice River breaks out of its banks and flows into the Marsh River. Judicial Ditch 51 flows through the city, complicating flood control measures. Preliminary analyses indicate that the National Economic Development (NED) plan will be diversion of a portion of Judicial Ditch 51 combined with a levee system built to withstand the 200-year flood. The current estimate of implementation cost is $16 million.

Devils Lake Embankment, North Dakota

Construction began this fall on the first phase to raise the Devils Lake, North Dakota embankment from elevation 1460 to 1465. The Corps was developing a plan for additional flood risk management measures for the city when unprecedented inflows in the spring of 2009 triggered the decision to proceed to construction. The lake rose over 3.5 feet to a record elevation of 1450.72 (NGVD 29) in July and is currently at an elevation of 1450.2 (NGVD 29). This first phase of construction is along the most critical reach of the embankment where the wave run-up is the greatest. The work involves rising approximately 8,800 feet of embankment 5 feet and replacing an interior flood control pump station. Future phases of construction to complete the embankment raise are scheduled to begin in 2010 and 2011. When the raise is complete, the embankments will increase in length from 8 miles to 12 miles. The cost to complete the raise to elevation 1465 is estimated at approximately $100 million. The Corps will continue to work with the other communities and the Spirit Lake Nation that are also being impacted by the record lake levels.

Drayton Dam, Drayton, North Dakota

A Section 206 aquatic ecosystem restoration feasibility study of the Drayton Dam began in July 2008. The study will assess ways to provide fish passage and eliminate dangerous hydraulic conditions at the dam while maintaining the pool for water supply and bank stability.

Fargo-Moorhead Metropolitan Area, North Dakota and Minnesota

A feasibility study of flood risk management measures for the entire Fargo-Moorhead metropolitan area began in September 2008. The primary study goal is to develop a regional system to reduce flood risk. The study considered an array of potential alternatives including nonstructural flood proofing, diversion channels, levee/floodwall systems, and flood storage. Only the diversion channel concept survived initial screening, and efforts are under way to determine the optimal and locally preferred alignments and capacities. The study is scheduled for completion in December 2011 .

Fargo-Moorhead and Upstream Area, North Dakota, South Dakota and Minnesota
This feasibility study is looking for opportunities to reduce flood damages and restore aquatic ecosystems in the entire watershed upstream of Fargo-Moorhead. The study began in August 2004. Phase 1a was completed in June 2005 and concluded that a system of impoundments could reduce the 1-percent-chance flood stage in Fargo-Moorhead up to 1.6 feet, but the system is not likely to be economically justified based on economic benefits alone. Phase 1b began in April 2008 to develop hydrologic and hydraulic models of the Wild Rice River in North Dakota to assess specific potential storage sites. Scoping for Phase 2 of the study is under way; Phase 2 will include more detailed investigations of environmental benefits and site-specific economic benefits.

Fort Abercrombie, North Dakota
A Section 14 Emergency Streambank Protection study began in September 2008. Erosion along the Red River of the North is threatening the historic Fort Abercrombie site. Work is continuing on the planning phase for this project.

Marsh Creek, Mahnomen County, Minnesota
The Section 205 flood risk management feasibility study is on hold pending completion of the Ada, Minnesota, feasibility study. The initial study phase determined that there is a Federal interest with benefits in excess of the cost of the project, but measures proposed for Ada would affect the benefits of the Marsh Creek project.

Pembina River Basin, North Dakota
The Corps and the State of North Dakota began a study of the Pembina River in August 2008 under the Section 22 Planning Assistance to States program. The study will develop a HEC-RAS unsteady flow model of the lower Pembina River and the Red River of the North from Drayton, ND to the international border.

A reconnaissance study of the Pembina River basin is under way but on hold pending identification of a non-Federal sponsor for the feasibility phase of study. The reconnaissance study began in April 2006. The draft report identified flooding in the lower Pembina valley from Walhalla, North Dakota, to Pembina, North Dakota, as the primary problem in the study area. An existing road/dike along the international border is the subject of ongoing litigation; uncertainty regarding the future of that dispute has complicated the study efforts. The Corps reconnaissance study focuses on potential solutions that lie within the United States, but it appears that more creative and beneficial solutions to flooding in the lower Pembina River basin would be possible with a cooperative United States-Canadian planning effort.

Red River Basin Watershed Study
The Corps began a basin-wide watershed study in June 2008 through a partnership with the Red River Watershed Management Board and the ND Red River Joint Water Resources Board. The first phase of study was to use LIDAR to collect detailed topographic information and develop a digital elevation model of the entire watershed in cooperation with the International Water Institute. The second phase was to develop basin-wide hydraulic and hydrologic models in the basin including an HEC-RAS model of the entire Red River mainstem and HEC-HMS models for the watersheds along the Red River. The final phase which has been initiated in cooperation with the Red River Basin Commission and the International Water Institute is to develop a decision support system and prepare a Comprehensive Watershed Management Plan which will be designed around the needs of the local water resource decision makers. These efforts will ultimately result in a framework of information that can be used for implementation of projects within the Red River Basin.

Sheyenne River Watershed Study, North Dakota
The Corps has begun a 905(b) Reconnaissance study for the Sheyenne River Basin.

Valley City, North Dakota
The Corps has begun a 905(b) Reconnaissance study for Valley City, North Dakota.

Wild Rice River Basin, Minnesota
The Wild Rice Watershed District has requested that the current feasibility study for ecosystem restoration and flood risk management be terminated in 2010, after the completion of a terrestrial survey contract.

Operations

The Corps of Engineers maintains several stream gages and operates five reservoir projects within the Red River basin: Homme Dam and Lake, Baldhill Dam, Orwell Dam, Lake Traverse, and Red Lake Dam.

Stream Gaging. The Corps provides funding to support stream gaging in the Red River and Souris River watersheds. The Corps maintains gages at several locations including Wahpeton, Valley City and Minot, North Dakota. These gages provide critical information related to flood forecasting, drought management and the overall health of the watersheds.

Homme Dam and Lake is on the South Branch of the Park River 2 miles west of the city of Park River, North Dakota, on North Dakota State Highway 17. Homme Dam was built for flood control and water supply purposes.

Baldhill Dam (Lake Ashtabula) is in eastern North Dakota 75 miles west of Fargo and 9 miles northwest of Valley City, North Dakota. The dam is on the Sheyenne River, 271 river miles upstream from its confluence with the Red River of the North. The dam provides flood protection for urban areas along the Sheyenne River. It also provides substantial water supply and pollution abatement for the Sheyenne River and the Red River of the North.

Orwell Dam is on the Otter Tail River, 6 miles southwest of Fergus Falls, Minnesota, on County Road 15. Project purposes are flood control, water supply, and pollution abatement. The Minnesota Department of Natural Resources leases 1,985 acres of the project for wildlife management purposes, of which 660 acres are a wildlife sanctuary. Hunting and fishing are permitted in some project areas, but not in the wildlife sanctuary.

Lake Traverse is located at the border between northeastern South Dakota and western Minnesota. The primary purposes of the Lake Traverse project are flood control along the Bois de Sioux River and in the lower Red River Valley and water conservation for frequent periods of drought. The project includes two dams, two lakes, and the Browns Valley dike at the southern end of the project. The Browns Valley dike lies directly on the continental divide. White Rock Dam, which forms Mud Lake, is at the extreme north end of the project and controls water flowing north on the Bois de Sioux River. Reservation Dam controls the pool level at Lake Traverse and the water flow north into Mud Lake; it also serves as a levee that separates the two lakes.

Red Lake Dam is on the Red Lake River at the outlet of Lower Red Lake. The project is operated for water supply, pollution abatement, flood reduction, water conservation, recreation, and fish and wildlife enhancement. Construction of a fish passage structure at the dam began in 2007 and is scheduled to be completed in 2010.

Regulatory Programs

The Corps of Engineers Regulatory Programs include permitting authorities under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. The St. Paul District has jurisdiction in Minnesota. Omaha District has jurisdiction in North Dakota and South Dakota. Under Section 10, a Corps permit is required to do any work in, over or under a navigable water of the United States. Water bodies have been designated as navigable waters of the United States based on their past, present, or potential use for transportation for interstate commerce. Under Section 404, a Corps permit is required for the discharge of dredged or fill material into waters of the United States.

Contact Person

The St. Paul District, Corps of Engineers, point-of-contact for planning and studies in North Dakota is Craig Evans, Senior Planner, Project Management Branch. Telephone: (651) 290-5594
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Project information sheets with details on all St. Paul District projects can be found on the St. Paul District, Corps of Engineers, Internet homepage at: **www.mvp.usace.army.mil**

9.04 USGS Water Resource Investigations and Activities

Physical Habitat, Water Quality, and Riverine Biological Assemblages of Selected Reaches of the Sheyenne River, North Dakota (http://pubs.usgs.gov/sir/2011/5178/)

This USGS report, in cooperation with the North Dakota State Water Commission, was published in March 2012. In 2010, data on physical habitat, water quality, and riverine biological assemblages were collected at selected reaches in four locations (Kleven, Sheyenne, Cooperstown, and West Fargo) on the Sheyenne River in east-central North Dakota. Three of the locations (Kleven, Sheyenne, and Cooperstown) are above Baldhill Dam and one location (West Fargo) is below Baldhill Dam on the Sheyenne River. The 2010 data provide information to establish a better understanding of the water-quality and ecological conditions of the Sheyenne River. Concerns were raised about the water-quality and ecological conditions of the Sheyenne River because of the interbasin transfer of water from nearby Devils Lake.

Determination of the Distribution, Transport, and Load of Sediment in the Red River of the North and its Tributaries near Fargo

Natural resource agencies are concerned about possible geomorphic impacts of proposed diversion projects in the Fargo-Moorhead area. Site-specific information available on sediment transport and riverine geomorphic processes is very limited and prohibits accurate geomorphic modeling to address the concerns. The existing Horace-West Fargo diversion represents a good field scale example of what could happen to the sediment transport and distribution if the proposed ND Diversion Channel is constructed. The 2010 and 2011 spring breakup events provided a unique opportunity to sample sites during high-flow conditions when most sediment generally is transported.

The USGS, in cooperation with the US Army Corps of Engineers, collected suspended-sediment, bedload, and bed-material samples at 9 sites on the Red, Sheyenne, Maple, Wild Rice, Rush, Lower Rush, and Buffalo Rivers in the Fargo area during the 2010 and 2011 spring high-flow periods from March through May and during rainfall-runoff events and baseflow conditions from June through November 2011. The data will provide information to describe the distribution and transport of sediment near the Fargo-Moorhead area. The methods and results of the 2010 data collection were compiled in a USGS Scientific Investigations Report (http://pubs.usgs.gov/sir/2011/5064/) and the 2011 results were compiled in a USGS Scientific Investigations Report (http://pubs.usgs.gov/sir/2011/5134/

APPENDICES A-F

APPENDIX A

DEVILS LAKE WHITE PAPER

White Paper on
Devils Lake and Associated Issues Pertaining to Red River of the North
Prepared by the
International Red River Board
for Presentation to the International Joint Commission

Devils Lake

Hydrology:

The Devils Lake Basin is a 3,810 mi^2 (9867 km^2) closed sub-basin in the Red River of the North Basin. At an elevation of 1,446.5 feet above sea level (ft asl), Devils Lake begins to flow into Stump Lake; and at elevation of about 1458 ft asl, the combined lakes begin to spill through Tolna Coulee into the Sheyenne River, a tributary of the Red River.

Since the end of glaciation about 10,000 years ago, Devils Lake has fluctuated from about 1,458 ft asl, the current natural spill elevation of the lake to the Sheyenne River, to about 1,400 ft asl. These evidences also show that, sometime in the past 1,800 years, Devils Lake overflowed into the Sheyenne River (Wiche et al., 2000)[1].

Climate of the Devils Lake Basin

Devils Lake responds directly to climate variability across the region. The climate variability generally can be regarded as the movement of the jet stream from season to season and from year to year. The jet stream, which is a ribbon of high-velocity air located about 30,000 feet above the Earth's surface, exists because of temperature differences between air masses at the Earth's poles and at the equator. The movement of the weather systems along the jet stream determines the distribution of precipitation about the globe. Climate variability results from long-term shifts in circulation patterns of the jet stream. Devils Lake has an enhanced sensitivity to long-term shifts in global circulation patterns as the level of the lake depends on many years of antecedent precipitation, runoff and evaporation. If at any time precipitation, runoff, or evaporation is dominant, a corresponding dramatic response occurs in the lake level (Wiche et al., 2000)[1].

Red River of the North

The Red River of the North flows north from its headwaters in Minnesota, across the Canada-United States international boundary, to its outlet at Lake Winnipeg in Manitoba (Figure 1). It meanders through the flat and fertile valley of the former glacial Lake Agassiz. The river basin occupies substantial portions of North Dakota, northwestern Minnesota, southern Manitoba and a very small portion of northeastern South Dakota. It covers 116,500 square kilometers or 45,000 square miles, excluding the Assiniboine River basin, which joins the Red River at Winnipeg (IJC, 2000)[2].

The climate of the Red River of the North basin is continental and ranges from dry sub-humid in the western part of the basin to sub-humid in the eastern part. Human and climatic impacts on water resources change based on agriculture, and economic development activities. These changes continually present challenges for appropriate water management as it relates to water quality and quantity in times of flood, periods of drought, and normal hydrologic patterns (RRWMC, 2004)[3].

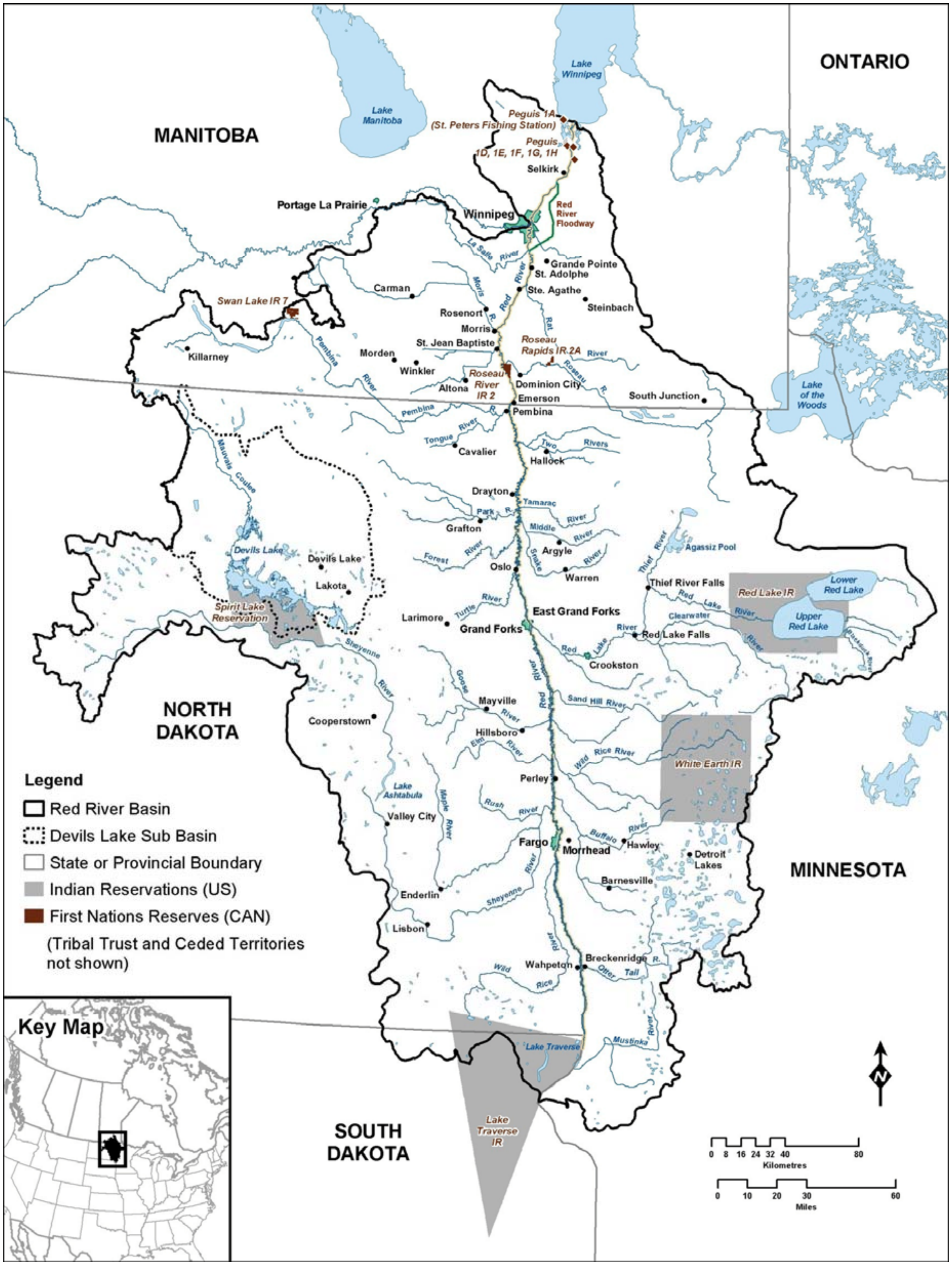

Figure 1: Red River basin and Devils Lake Sub-basin

The Red River is unpredictable for the many residents whose daily lives can be influenced by it. A major river system that flows north, the Red River has a long history of flooding. The 1997 flood, also known as the flood of the century, caused more property damage, loss of life and disruption than any of the preceding floods in the Red River basin as a whole.

In 2001, the IJC amalgamated the International Red River Pollution Board and the Red River portion of the International Souris-Red Rivers Engineering Board and created the International Red River Board (IRRB). This merger was necessary to ensure a more ecosystemic approach to transboundary water issues and to achieve operational efficiencies. This Board remains as the main assisting board to the International Joint Commission in regards to Red River issues including the transfer of invasive species from Devils Lake into the Red River.

Mandate

The International Red River Board (IRRB) has been mandated to assist the IJC in preventing and resolving transboundary disputes regarding the waters and aquatic ecosystem of the Red River and its tributaries and aquifers. This will be accomplished through the application of best available science and knowledge of the aquatic ecosystem of the basin and an awareness of the needs, expectations, and capabilities of residents of the Red River basin. The Board maintains an awareness of basin-wide development activities and conditions that may affect water levels and flows, water quality and the ecosystem health of the Red River and its transboundary tributaries and informs the IJC about transboundary issues. The Board provides a continuing forum for the identification, discussion and resolution of existing and water-related issues relevant to the Red River basin. In addition, the Board also recommends appropriate strategies to the IJC concerning water quality, quantity, and aquatic ecosystem health objectives in the basin (IRRB, 2000)[4].

Current Conditions:

The water surface elevation on August 15, 2012 was 1452.4 msl. This is about 0.9 feet below the January 21, 2012 elevation and about 1.9 feet below the record high of 1454.30 msl set on June 27, 2011.

The water surface increased about 0.3 feet in the spring of 2012, peaking around 1453.6 msl in early May. Since May it has steadily fallen about 1.2 feet. In comparison, the 2009 spring rise was 3.5 feet, with an inflow of 540,000 ac.-ft and the 2010 spring rise was 1.8 feet with an inflow of 312,000 ac.-ft. In 2011, the spring stage increase was about 2.7 feet, with a total inflow of about 595,000 acre-feet. The total storage of Devils Lake (including Stump Lake) is now 3.79 million ac-ft., covering an area of 186,500 acres. This is a decrease of 210,000 ac. ft. of storage and 10,500 acres in surface area from the beginning of 2012.

Date	Elevation (msl)	Area (acres)	Volume (acre-feet)
Jan. 16, 2010	1449.92	162,100	3.36 million
June 27, 2010	1452.05	182,800	3.73 million
Nov. 20, 2010	1451.26	175,000	3.59 million
Jan. 16, 2011	1451.65	178,600	3.66 million
June 27, 2011	1454.30	208,500	4.19 million
January 21, 2012	1453.3	197,000	4.00 million
May 7, 2012	1453.6	200,057	4.03 million
Aug. 15, 2012	1452.4	186,500	3.79 million

State Emergency Outlet Project Update:

Operation:

West Devils Lake Outlet

The releases of Devils Lake water from the west outlet into the Sheyenne River began on April 2, 2012. Little spring runoff in the Sheyenne River watershed allowed the early start. Maintenance of the pumps limited the discharge amount initially, although it was eventually increased to the 250 cfs capacity. The pumps were shut down for a short time during the week of June 9, for maintenance of vegetation problems in the channel.

East Devils Lake Outlet:

Installation of about 27,000 feet of 8 foot diameter pipe was completed on December 12, 2011. Construction of the inlet and outlet structures, and installation of pumps was completed near the beginning of June 2012. Testing of the system started in early June. It started discharging at full capacity, of 350 cfs, around June 26. The discharge was reduced during the week of July 9 in order to remain well within the water quality limits in the Sheyenne River, while maintenance was done on the west outlet. (The water quality is better from the west outlet. Mixing of the water from each outlet is required to ensure that the Sheyenne River remains quality within the water quality standards.)

The following table summarizes the extent of discharge from the outlet for 2012:

Month	Days Discharge Occurred		Average Discharge (cfs)		Monthly Volume (acre-feet)	
	West	East	West	East	West	East
April 2012	27		117		6,263	
May	31		135		8,286	
June	30	10	215	160	12,755	3,489
July						

Note: The first number is for west outlet, second number is for east outlet. A detailed summary is not yet available beyond June 2012. The following is a summary of the volume and inches of water removed from the lake since pumping was started in 2005:

Year	Volume Removed (acre-feet)	Inches Removed (inches)
2005	38	0.00
2006	0	0.00
2007	298	0.02
2008	1,241	0.09
2009	27,653	2.04
2010	62,969	4.30
2011	48,228	2.90
TOTAL	140,427	9.35

Devils Lake Outlet Committee:

The Devils lake Outlet Committee met on May 22, 2012 in Carrington, ND. The committee includes a representative from Manitoba and Minnesota.

Construction:

Emergency Gravity Water Transfer Channel:

The proposed gravity flow channel would provide an outlet from Stump Lake, extending south to Tolna Coulee. The control elevation at the bottom of the channel is proposed at 1452 msl. The channel would include stop logs to control releases based on downstream conditions. The channel would have a capacity of 100 cfs when Stump Lake is at an elevation of 1454 msl, if the stop logs were not in place. The channel would be operated to maintain downstream water quality uses. An operating committee is being proposed for the project.

Soil borings have been taken along the proposed alignment. Some of the soil conditions are not of the quality expected. Borings may be required along a different alignment, if a suitable change in the design is not possible at the original location. The Devils Lake Joint Water Resource Board is the local sponsor for this project. They have recently indicated that they are withdrawing as the lead agency of the gravity outlet.

Tolna Coulee Control Structure:

This project is a cooperative effort between the State Water Commission and the U.S. Army Corps of Engineers. The Corps of Engineers was overseeing the construction.

Construction of this project is complete, with dedication held in July 2012. This is a control structure project consisting of a combination of sheet pile, embankment, and a steel stop log weir structure. The purpose of this project is to allow the natural erosion of the divide between Stump Lake and the Tolna Coulee, while protecting downstream communities from an uncontrolled release of the water in Stump Lake. To this end, this structure is designed to allow flow in the Tolna Coulee to cause erosion the same as would occur naturally while providing the ability to lower the lake elevation in a controlled manner as the divide erodes. It is not the purpose of this project to impound water in Stump Lake above the natural outlet elevation, as it exists now or what it may become in the future.

Upstream Storage:

The following description is not changed from the previous report.

The State Water Commission (SWC) is committed to a three-pronged approach to flooding in the Devils Lake basin, of which upper basin water management is an integral part. Several programs exist to store water, including the Extended Storage Acreage Program (ESAP), and projects by the ND Natural

Resources Trust (Trust), and the U.S. Fish and Wildlife Service. The new Devils Lake Executive Committee action plan has reinforced and placed emphasis on the need to increase upper basin storage where possible.

The Trust is pursuing a plan to acquire privately held land for a multipurpose, multi-wetland restoration project in northeastern Ramsey County. SWC staff has estimated that this project will store approximately 631 acre-feet of additional water over existing conditions. The project requires commitments from multiple funding sources, including the Wetland Reserve Program (WRP), the North American Wetlands Conservation Act, ND Game and Fish, and the Trust. The project will put the land under a 30-year WRP easement with the ND Game and Fish taking title to the land for use as a public access wildlife conservation area. Total project cost is estimated at $2,048,000, and would result in long term water storage on land available for public use. The Trust has requested water storage funding from the SWC in the amount of $125,000. If approved, the SWC will develop a seven-year contract for water storage at the Johnson Farms site. Annual inspections will be conducted to ensure water storage at the site for the duration of the agreement. This expenditure equates to about $30.00/acre-foot per year of storage for the duration of the contract, which is comparable to the rates paid for existing ESAP temporary storage easements. The acquisition plan developed by the Trust involves several partners and as a result has several contingencies.

Outlet Mitigation Plan:

Beginning in 1993, as Devils Lake began its historically unprecedented rise, the State Water Commission (SWC) has been at the forefront of efforts to combat flooding in the basin. The lake level has now risen 30 feet expanding from about 49,000 acres to over 200,000 acres. At its overflow elevation of 1458 feet msl, where it naturally spills into the Sheyenne River, Devils Lake will cover more than 261,000 acres. To combat the growing flooding problem, local, state, and federal authorities adopted a three-pronged approach in the mid 1990s: infrastructure protection for roads, levees, and relocations; upper basin water management, including water storage in the upper basin; and discharge of flood water through an emergency west-end outlet to the Sheyenne River. This approach was designed with the interests of both Devils Lake basin and downstream residents in mind. The principal concept has been to manage water and flood damage within the Devils Lake basin, while attempting to prevent a potentially catastrophic natural overflow through Tolna Coulee to the Sheyenne River.

The 2011 Devils Lake Outlet Mitigation plan being developed by SWC staff with input from stakeholders, including the Devils Lake Outlet Advisory Committee, provides important direction in addressing problems that could arise downstream from emergency measures taken at Devils Lake to protect the safety and general welfare of both basin and downstream residents. The draft plan has two key components; construction of emergency outlets to remove floodwater from Devils Lake and a course of action to address downstream issues along the Sheyenne River that may result from operating the emergency outlet projects.

Devils Lake Embankment:

Work continues on raising the 13 mile long embankment that protects the town of Devils Lake. This is a Corp of Engineers project.

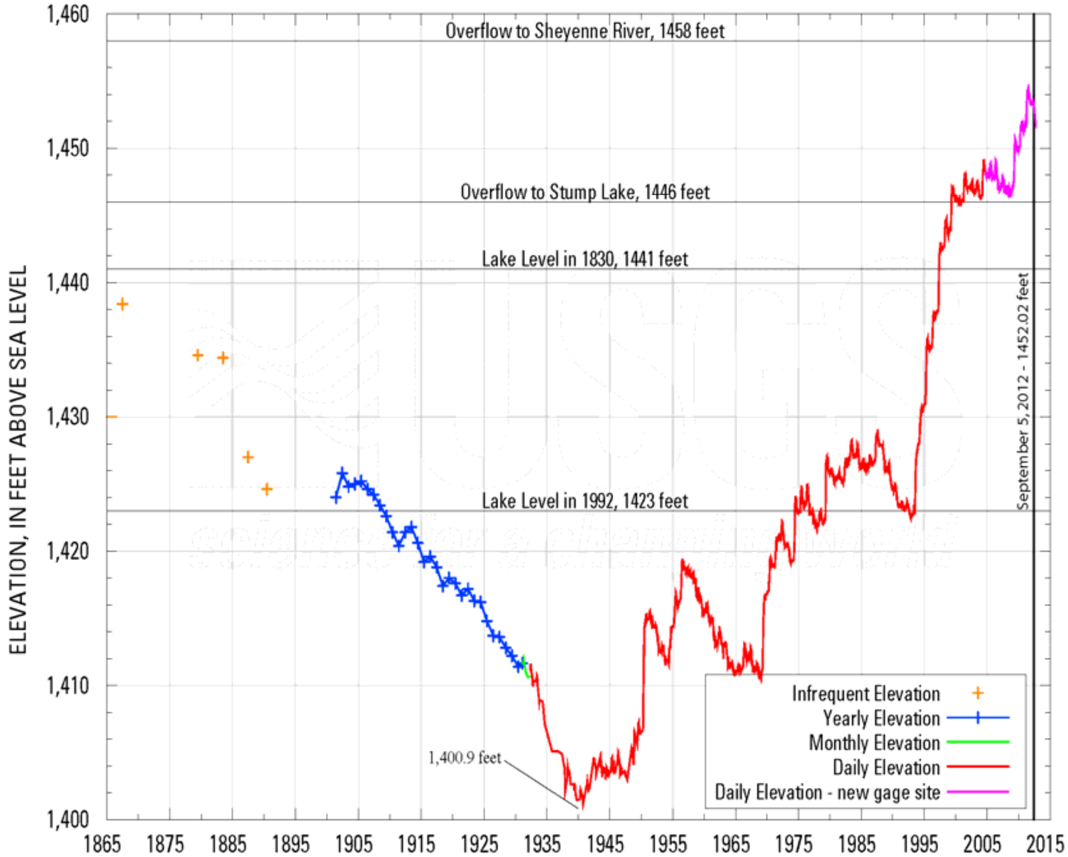

Figure 2: Devils Lake Water Levels (USGS) Current Elevation 1451.66 September 20, 2012, Maximum Elevation 1454.29 June 28, 2011

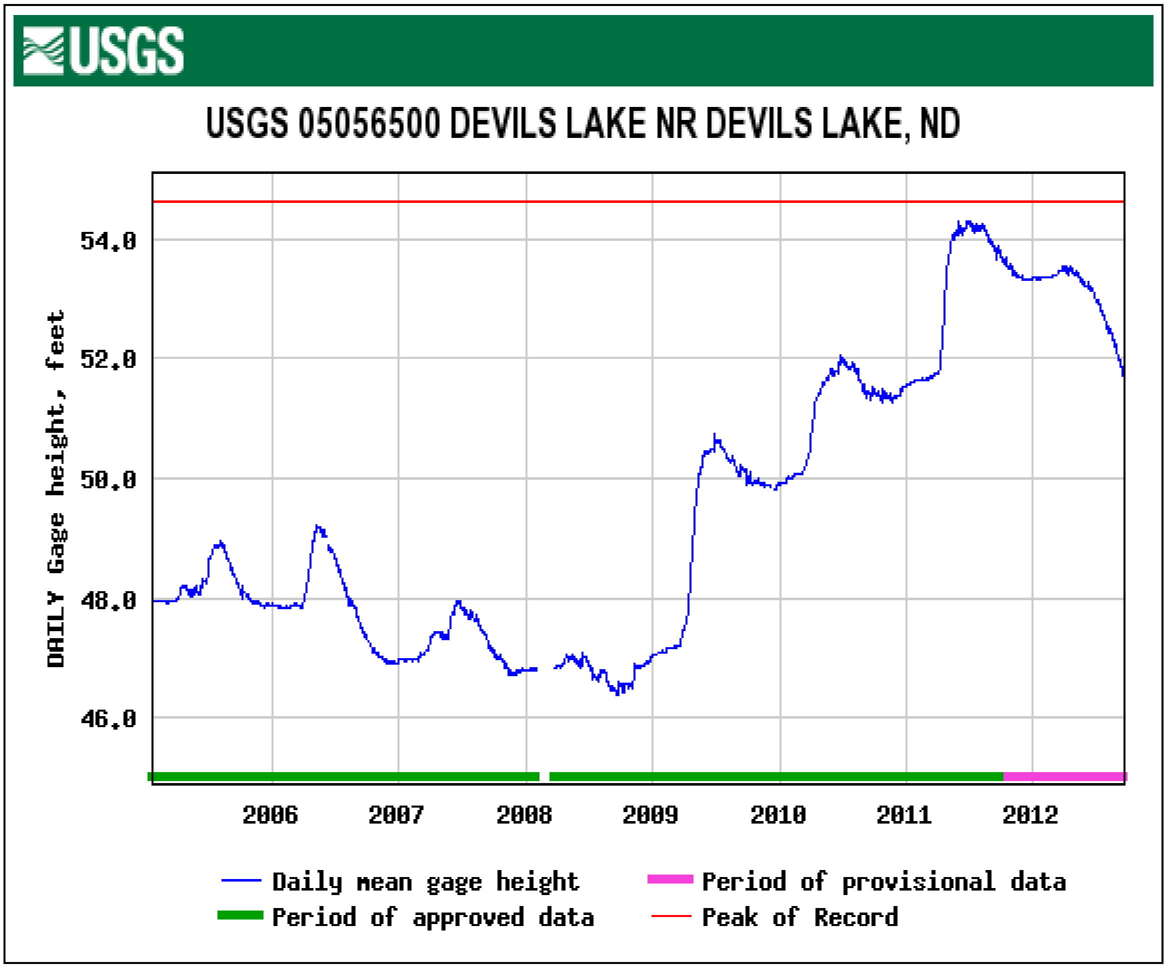

Figure 3: Devils Lake Water Levels (USGS) – 2006-2012

Water Quantity/Flooding

The first concern is related to Devils Lake, located in a closed drainage basin, that has risen rapidly since 1993 in response to above-normal precipitation. Devils Lake continues to rise and have come up 5 feet between 2009 and 2010 alone. The lake level is currently around 1,451.7 ft asl, 6.3-feet below its natural spill elevation into the Sheyenne River. In an effort to reduce flooding, North Dakota built a canal in 2005 to divert Devils Lake water into the Sheyenne River, a tributary of the Red River. The pumping capacity was set at 100 cfs with water quality license restrictions in the Sheyenne River. Due to the ineffectiveness of the diversion in lowering lake levels, North Dakota relaxed its license for sulfates from 450 mg/L to 750 mg/L (from headwaters of Sheyenne to downstream of Baldhill Dam - length below Baldhill Dam remains with 450 mg/L for sulfates) and raised the pumping capacity to 250 cfs effective end of June 2010. Communities along the Sheyenne River downstream of the outlet structure, Manitoba and Canada continue to express their concerns related to impaired water quality, particularly higher sulfate levels and the potential transfer of invasive species into the Red River and eventually into Lake Winnipeg (more details under the Water Quality and Biota Transfer sections later).

Future Scenarios

Since the late 1970's, the activity of El Nino (a variation in sea-surface temperatures) has been greater than at any other time during the 20th Century. This heightened El Nino activity and its interaction with other global circulation patterns has resulted in an increased frequency of storms bearing Gulf of Mexico moisture across the Devils Lake Basin, causing a higher frequency of wet years in the basin. Since the late 1970's, the movement of the jet stream position over time has resulted in warmer late winter and early spring temperatures. However, the annual average temperature for the region has decreased slightly since the mid-1980's, associated with greater cloud cover and precipitation. Since the 1990's, unusually high precipitation amounts have occurred during May and June and again during the early fall. The future and duration of the recent wet conditions can not be determined with certainty because of the complex interaction between global weather factors. However, according to estimates by the Regional Weather Information Center, University of North Dakota (Wiche et al., 2000), the present wet conditions are expected to continue beyond the first decade of the new century into 2015.

1.2 Potential for Natural Overflow of Devils Lake into the Sheyenne

Based on work of North Dakota Geological Survey and confirmed by USGS stochastic simulation model transitions between normal/wet "cycles" have been occurring for thousands of years in Devils Lake basin. Though highly variable, and random in duration, on average, wet cycles occur once every 150 years, trigger spills to Stump Lake about once every 400 years, and trigger spills out of Stump Lake (via Tolna Coulee) about once every 1200 years. There is no way to predict exactly when "normal" (drier) conditions will return. Chances are high that wet conditions will continue for at least 10, 30, or 60 more years with a 72%, 37%, and 14% chance, respectively. Although it is by no means certain that Devils Lake will continue to rise to the spill elevation of 1458 ft, simulation show there is a substantial risk of spill in the next 20 years (S. Vecchia, 2010)[5].

The study results (S. Vecchia, 2010) also show that the 250 cfs (recently increased discharge from 100 cfs) State outlet with emergency downstream operating constraints is effective in reducing, but not eliminating, the risk of a potential spill. For example, the State outlet nearly cuts in half the chance of spill within the next 20 years – from 13.8% chance with no outlet to 7.7% chance with the outlet. Unfortunately, the State outlet does not eliminate the risk of a spill. Even with the outlet, there is a relatively high risk of nearly 2 % that a spill could occur by 2012 and nearly 8% risk that a spill could occur by 2029.

Infrastructure and farmland inundation due to flooding would be eminent because of higher lake levels. Impacts to downstream communities and aquatic ecosystems could be severe both from flooding, impaired water quality including erosion, and potential transfer of invasive species in particular because of uncontrolled flooding from Devils Lake.

1.3 Devils Lake Outlet Operations

The Board is dealing with several ongoing issues regarding Devils Lake. As noted above and according to a study by the U.S. Geological Survey if the lake rises and begins to spill naturally into the Sheyenne River, there could be severe consequences downstream, including flooding, erosion, and water quality impacts. The figure below (Figure 2) shows a continuous trend of rising lake levels, particularly after the mid-1990's. As the lake level continues to rise, planning is needed to address these concerns and identify triggers at which future actions should be taken.

1.4 Actions taken by the State of North Dakota

After reviewing requests from the City of Devils Lake and the North Dakota Water Commission, the North Dakota Department of Health – acting under the provisions of North Dakota Century Code 28-32-02 – has implemented an emergency rule for a segment of the Sheyenne River. A recent federal appeals court ruling on a Florida case, found that "water to water" transfers do not need a Section 402 Pollutant Discharge Elimination System permit. Because of this ruling, the North Dakota Department of Health was requested to terminate the permit and allow the operation of the Devils Lake outlet be based upon the water quality standards set for the Sheyenne River. The Health Department approved this request on June 25, 2009.

The ND Health Department has amended the sulfate concentration level from 450 mg/L to 750 mg/L for the segment of the river from the Sheyenne headwaters to a point just downstream of the Baldhill Dam. The Sheyenne River below Baldhill Dam is still limited to the existing 450 mg/L standard for sulfate.

The ND Health Department took this action (relaxed permit) to allow additional discharges from Devils Lake to address concern regarding the potential for uncontrolled overflow from the east end of the lake, loss of agriculture land, stresses on local infrastructure and increasing lake levels. This interim action became effective immediately on June 25, 2009.

1.5 Actions by Other Agencies to date

In December 2004, Minnesota Governor Pawlenty conveyed to Secretary of State Colin Powell his support for the Canadian Government's request to have the proposals surrounding Devils Lake outlet referred to the IJC. In this letter he raised the need for a deliberative decision because construction of the state outlet was underway and would be possibly operational by spring 2005. Minnesota requested the Secretary to consider halting construction until a decision could be made.

US and Canadian Federal agency efforts resulted in an agreement (U.S. Dept. of State, press release, 8/5/2005)[6] between governments that has not been fully implemented. The agreement states installation of a permanent filter, monitoring and rapid response systems to remove and track micro-biota which have not come to fruition.

The Regulatory controls established for operation of the state outlet in the original permit have been removed by North Dakota through modification of the permit (2006), elimination of NPDES permitting of water transfers (2008), rescission of the permit (2009), and emergency sulfate rule and proposed standard change (2009) to be revisited in the State's triennial standards review. Communities downstream of the outlet structure continue to express their concerns regarding the permit modification.

There is a disagreement among jurisdictions and stakeholders about the overall effectiveness of the state outlet as a drain relative to the environmental risks. These regulatory changes were made without adequately addressing Minnesota, Manitoba and other stakeholder concerns. The IRRB received regular reports on state outlet status and took action to develop this report in January 2010.

2.0 Water Quality

The second concern related to Devils Lake is impaired water quality. As noted in the Water Quantity/Flooding section, North Dakota built a diversion canal / outlet in 2005 from Devils Lake to the

Sheyenne River in an effort to reduce flooding impacts. Since Devils Lake is situated in a closed drainage basin its water quality is characterized as impaired and not fit for irrigation and human consumption because of its excessive salinity. There are also concerns that the lake, being located in an isolated basin for over a thousand years, might be habitat to invasive species that are not found downstream of Devils Lake in the Red River Basin. Furthermore, the high levels sulfates and other dissolved solids are indicative of the general poor water quality conditions of the lake.

2.1 Sulfates

Devils Lake consists of a series of interconnected basins with sulfate concentration increasing in an eastward direction. For example, the 2009 water quality data shows sulfate values ranging from 575 mg/L in West Bay to 2580 mg/L in East Devils Lake (Figure 2). In general, water quality conditions seem to deteriorate west to east across the lake. Sulfates occur in nature and are a particular type of dissolved solid compound - a combination of sulfur and oxygen that may be leached from some soil and rock formations. Sulfates in drinking water can cause odour problems have a laxative effect on people that can lead to dehydration especially in infants.

The Devils Lake state outlet discharge increases the potential for exceedance of the IRRB total dissolved solids and sulfate objectives at the International Border which is set at 250 mg/L. Discharge of Devils Lake through the Tolna Coulee outlet would increase the potential for even greater exceedances due to the higher chemical concentrations on the east side of the Lake. Minnesota and Manitoba have raised concerns about impact of these higher concentrations on Red River water quality and violation of their respective water quality standards. Manitoba is particularly concerned that poor water quality (higher levels of sulfate and total dissolved solids) including invasive species could have severe environmental and economic impacts to the aquatic life of the Red River and Lake Winnipeg in particular that supports a multi-million dollar fishing industry.

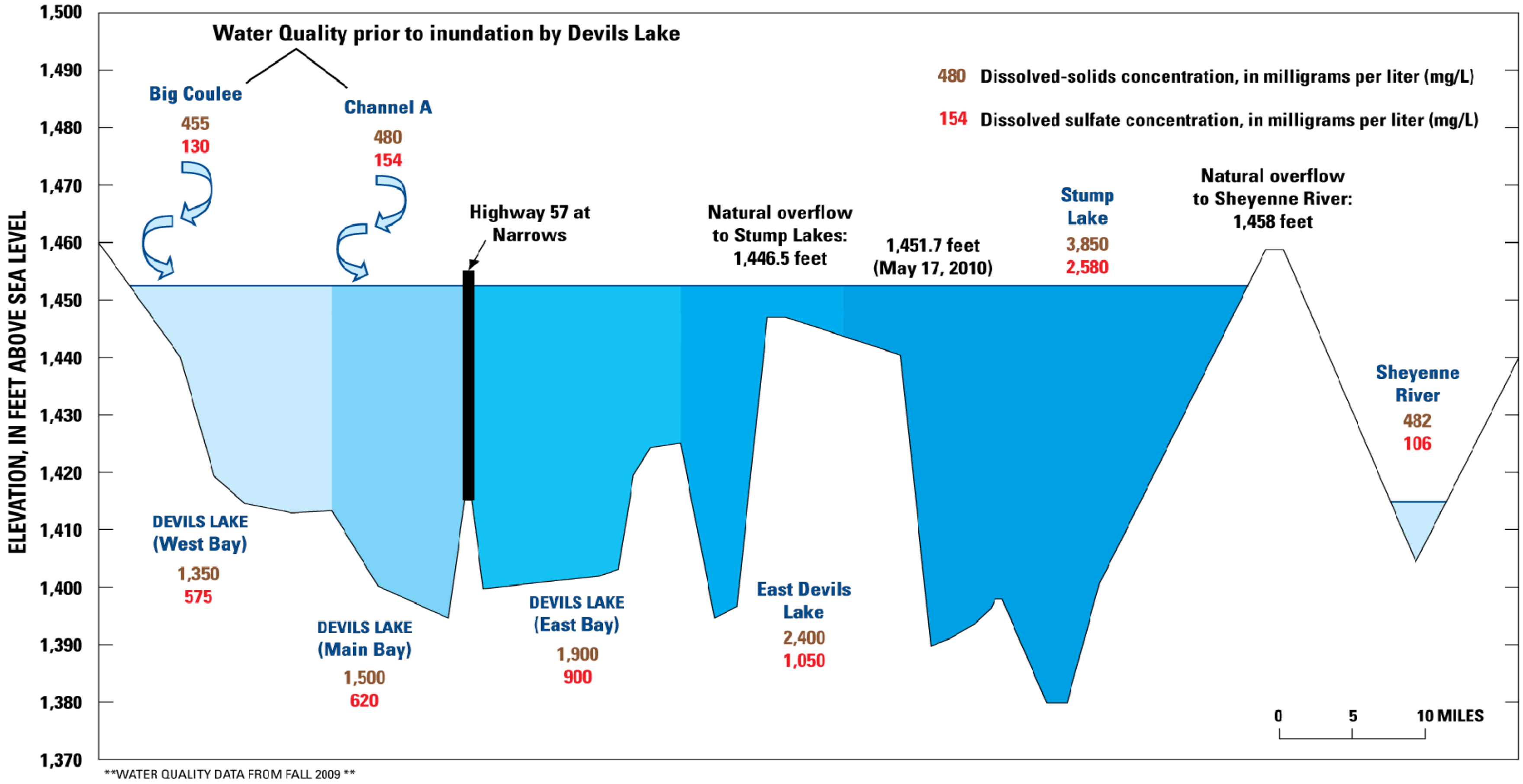

Figure 4: Devils Lake Water Quality Data – Fall 2009 (ND Dept. of Health & USGS)

In 2009, the Devils Lake outlet operated until November 1 at its full capacity (100 cubic feet per second / 200 acre-feet per day) without exceeding the new 750 mg/L Sheyenne River sulfate criterion (500-520mg/L was the highest level recorded). However, starting at the end of June 2010, the newly expanded outlet has become operational at a capacity of 250 cubic feet per second and its impact on sulfate levels and other water pollutants in the Sheyenne River have not yet been determined. No changes were made to the existing gravel filter treatment system. This also raises the question of the meaning of the 250 mg/L sulfate objective at the International border and its utility for compliance. TDS and sulfate levels at the International border have been exceeded several times in the past.

Sulfate level in Devils Lake (Round Lake Station) was 674 mg/L; and Sheyenne River above the Outlet (Flora Station) was 314 mg/L on May 27. The Sulfate level in Sheyenne River below Baldhill Dam was 216 mg/L, and 243 mg/L in the Red River at Pembina on May 26 and 25, 2010, respectively.

2.2 Nutrients

The other ongoing issue related to water quality is nutrients and their impacts on downstream aquatic ecosystems in the Red River Basin. The contribution of nutrients from Devils Lake has not been quantified. The relative contributions of nutrients from North Dakota, South Dakota and Minnesota have not been quantified. Currently, the IRRB AEC is moving forward with a nutrient objective project to address this issue. AEC has developed "***Principles for Developing Ecologically Based Nutrient Objectives***" this issue (AEC, January 2010)[7]. The highlights of the Principles state that to improve Lake Winnipeg's ecosystem health it will be important to:

- Maintain the Lake Winnipeg ecosystem structure and ecosystem functional relationships;
- Ensure that an optimum balance is achieved between nutrient enrichment, productivity of the commercial and subsistence fishery and subsequent economic return to communities, while protecting the lake's ecosystem health and recreational uses;
- Be protective of the upstream contributing watersheds and downstream environments in the Nelson River and Hudson Bay;
- Recognize water quality objectives established for the contributing watersheds and tributaries of the Red River and that water quality objectives for nutrients established in the contributing watersheds should endeavor to lower the trophic status of Lake Winnipeg; and
- Consider the social, economic and environmental implications of objectives implementation and compliance.

Discussions will continue at future Board and AEC meetings on how to determine and implement science-based nutrient objectives.

3.0 Biota Transfer

3.1 Pathogens/Parasites Survey Results to date

Completion of a three-year sampling program for parasites and pathogens as a result of multi-agency negotiations led by the White House Council on Environmental Quality (CEQ) was a significant IRRB undertaking during the reporting period. The objective of the sampling program, which was initiated in September 2006, was to determine the presence and prevalence of fish parasites and pathogens in resident fish from Devils Lake, the Sheyenne River, Red River, and Lake Winnipeg, and to address the risks associated with transfer of such biota from the Devils Lake outlet to aquatic ecosystems downstream. A further objective is to use the comprehensive fish survey to support the overall framework for biological monitoring in the Red River basin as identified in the IRRB work plan.

The three year pathogens and parasites sampling program was completed in 2008. Both Canadian and US analyses of fish samples collected over the three year period (2006-2008) have been analysed. The Final Synthesis Report was completed by the end of June 2011. The study examined a total of 7 species and 1616 fish were collected from Devils Lake; and 21 species and 4272 fish from 6 other locations in the Red River Basin including the Red River Delta and Lake Winnipeg in Canada. The Aquatic Ecosystems Committee (AEC) conducted a workshop on April 12-13, 2011 in Bismarck, ND with a team of experts who reviewed the fish parasite, pathogen, and histopathology data collected from 2006 to 2008. The team discussed the issues and what these data meant and made recommendations for a basin-wide monitoring in the basin, not just Devils Lake.

After the workshop, the team of eight fish experts from Canada and the U.S. conducted a qualitative risk assessment and discussed the risks downstream The following were questions addressed by the qualitative risk assessment:

Mechanisms for transport from Devils Lake to other aquatic ecosystems in the Red River basin and Lake Winnipeg,

What are the known environmental factors to trigger a disease outbreak for the identified pathogens and parasites,

If pathogens and parasites were transferred elsewhere in the basin, what are the risks and their likelihood of causing disease,

What is the North American distribution of these pathogens and parasites, and what is their relative abundance? and,

Does the current mitigation measure (rock/gravel filter) reduce the impact of potential transfer of pathogens and parasites?

Summary of the Pathogens and Parasites Study

Three bacteria, one parasite, and several lesions were identified from fish in Devils Lake that were not identified elsewhere in the basin. The fish pathologists concluded that the fish parasites and pathogens in Devils Lake could be transferred from the Lake through the gravel and rock filter currently in place, by birds (often the intermediate or final parasite host), and by unintentional and intentional transfer by people (or their boats). The parasites and bacteria found in Devils Lake were generally widely distributed throughout much of North America. All were opportunistic pathogens that could adversely affect fish health only if fish health was compromised for other reasons. None were foreign parasite or pathogen species. For these reasons, all experts concluded that the risk to downstream fish and fisheries was low from the parasites and pathogens found in Devils Lake, and the potential for causing disease was negligible.

Recommendations:

The investigation undertaken in 2006, 2007, and 2008 is a significant effort to isolate and identify pathogens and parasites in a watershed that is shared by North Dakota and Manitoba. Based on the data collected, the risk assessment indicates that, at present, there is limited risk to downstream fish species or communities from the organisms found in Devils Lake. However, the U.S. and Canada fish health experts provided the

following recommendations that would help to ensure that risk of certain pathogens and invasive species entering the Red River basin is reduced and would monitor for the presence of invasive species in the basin.
1. Adopt a proactive model and precautionary approach to prevent and monitor transfer of invasive species and certain fish pathogens into the Hudson Bay Basin. To effectively prevent transfer of invasive species and non – endemic fish pathogens into the Hudson Bay Basin, provincial, state, and federal agencies should adopt a general model with the following key components:

A) enact legislation and develop policies to prevent transfer of foreign species and fish pathogens into the Hudson Bay basin,

B) maintain active enforcement of invasive species policies and legislation, and fish disease prevention and control policies and legislation.

C) monitor selected organisms and pathogens in aquatic ecosystems at a few biophysically unique locations to assess the effectiveness of legislation, enforcement, and remedial actions to prevent the introduction and spread of invasive species into the Hudson Bay Basin, and to provide a feedback loop for adaptive fish disease control and invasive species management programs.

2. Use the data generated in the present study to conduct a risk assessment to fish in the Red River Basin from the parasites and pathogens found throughout the Red River Basin, including Lake Winnipeg. Innovative risk analysis methods and techniques such as computer modeling should be used.

3. A fish parasites and pathogens monitoring program should be established based on selected and restrictive criteria. A workshop could be held to develop protocols, methods, and short- and long-term monitoring goals. This focused monitoring program should use multiple approaches and methods, and could include the following key components:

A) one sampling location in Canada and one sampling location in the USA;

B) fish parasites and pathogens should be assessed every three years at these two sites;

C) field and laboratory methods for Canada and the USA should be standardized. Methods should be standardized to ensure that data are comparable and compatible and costs for monitoring are kept at reasonable levels;

D) based on expert input, monitoring should be targeted to specific species of concern and problematic parasites, bacteria or virus.

E) fish species should be selected that are more susceptible than others to disease producing organisms. Ongoing targeted surveillance should be coordinated with the National Aquatic Animal Health Program (NAAHPs) that is in the process of being implemented in Canada and the USA.

4. State and provincial agencies should continue to maintain and to improve surveillance procedures to prevent transfer of organisms into the Hudson Bay Basin.
5. The science literature and other information should be regularly reviewed by the International Red River Board and member agencies to identify those organisms that are extending their range

toward the Hudson Bay Basin possibly because of climate change, biological factors, or anthropogenic activities. The likelihood of these organisms moving into the basin should be modeled, and a risk assessment should be undertaken as part of this process to provide decision makers with information that could be used to prevent invasive species from entering the Basin, or could be used to develop invasive species management strategy should an invasive species become established.

6. Implement a project to determine route of transfer, rate of spread, and distribution of the Asian tapeworm (Bothriocephalus acheilognathi) in the Hudson Bay Basin. These population characteristics of the Asian tapeworm could be used as a model to study invasion pathways of foreign species into the watershed (AEC Qualitative Risk Assessment Report, October 2011). For more details, please go to http://www.ijc.org/conseil_board/red_river/irrb_pub.php?language=english#other

and click on Devils Lake – Red River Basin Fish Parasite and Pathogen Project, Qualitative Risk Assessment.

Water Quality and Ecosystem Health
In 2003, the AEC prepared a conceptual framework to monitor the long-term aquatic ecosystem health of the watershed and an action plan outlining specific activities and resource requirements. The framework and action plan were endorsed by the Board and form the basis of the IRRB work plan. The overarching aquatic ecosystem health goal for the watershed, as articulated by the AEC, is to "assure that water resources of the Red River of the North basin support and maintain a balanced community of organisms with species composition, diversity and functional organization comparable to the natural habitats within the basin without regard to political boundaries".

Devils Lake Outlet Enhanced Monitoring
In early 2005, the North Dakota Devils Lake state outlet was completed and operation of the outlet was imminent. Operation of the outlet connects a closed basin in North Dakota, which is also part of the Hudson Bay drainage system, with the additional potential of transferring fish parasites and pathogens into the Hudson Bay watershed to the detriment of fish populations, especially to commercial and sport fish populations in the Red River and in Lake Winnipeg.
Given the transboundary implications of outlet operations and concerns to Manitoba and Canada regarding potential transfer of foreign organisms, multi-lateral negotiations were launched involving diplomatic levels, federal, state and provincial authorities, and the White House Council on Environmental Quality (CEQ). The negotiations resulted in the installation of a temporary gravel filter at the outlet to act as a barrier against the transfer of fish and some plants into the Red River system. The negotiations also resulted in a three-year sampling program to address issues related to the transfer of invasive species.

In summary, the objectives of the sampling program are to: determine the presence and prevalence of fish parasites and pathogens in resident fish from Devils Lake, the Sheyenne River, Red River, and Lake Winnipeg, and; to address the risks associated with transfer of such parasites and pathogens from the Devils Lake outlet to downstream aquatic ecosystems. A further objective is to use the comprehensive fish survey data to support the overall framework for biological monitoring in the Red River basin as identified in the IRRB work plan.
The three-year program comprising 7 sampling sites and 13 target fish species was initiated in September 2006. A report on the 2006 data collection was to provide the basis for any necessary refinement of the program for the following 2 years. Further, the results of the 3-year sampling program would be used to

establish a focused long-term monitoring program for fish parasites and pathogens in the Red River basin, including select tributaries to the Red River and Lake Winnipeg.

The project plan assigns technical and financial responsibility to Canada for the collection and analysis of the biological data in the Canadian portion of the basin, and to the United States for like work carried out in the United States. Consistent methods, as confirmed in a workshop of experts in August 2006, are being applied to both streams of work. The project is being coordinated and managed by the Canadian and United States Co-Chairs of the AEC, with implementation and technical management of the project assigned to Fisheries & Oceans Canada and U.S. Fish & Wildlife Service. The project design allows for peer review of the interpretive
reports. The three year sampling was completed in 2008.

The results from the 2006 -2008 Pathogen Survey of Devils Lake, the Red and Sheyenne Rivers indicate statistical confidence on six species from Devils Lake. There was no detection of viral agents, which was very significant. Some of the bacterial finings were not unusual for this type of aquatic environment; and the results were repeatable from previous years. The initial sampling results were presented to governments via a conference call on March 10, 2009 (see also Section 1.02 of this report). The final report of the Pathogens and Parasite Study was presented to the IJC at fall 2011 appearance in Ottawa, Canada. Another presentation was also made to the general public at the winter Red River Basin Commission Conference on January 26, 2012 by the Co-Chairs of IRRB.

For more information, please go to
http://www.ijc.org/conseil_board/red_river/en/irrb_home_accueil.htm, “publications/other reports”.

The Board is currently planning to develop Phase II of the Pathogens and Parasites Study and to explore the possibility of conducting a basin-wide study in the Red River Basin.

APPENDIX B

A PROPOSED APPROACH TO DEVELOPING A BASIN-WIDE NUTRIENT MANAGEMENT STRATEGY FOR THE INTERNATIONAL RED RIVER WATERSHED

A Proposed Approach to Developing a Basin-Wide Nutrient Management Strategy for the International Red River Watershed

Background

Excessive nutrients such as phosphorus and nitrogen are one of the greatest water quality issues facing the international Red River watershed and Lake Winnipeg. While all jurisdictions within the watershed have various regulatory frameworks, plans and approaches in place to reduce the contribution of nutrients to water, the development of an enhanced, coordinated, and systematic strategy is desirable.

The development of a basin-wide plan for the management of nutrients within the shared international Red River watershed was agreed to as part of recent Four-Party discussions between the federal governments of the United States and Canada, the State government of North Dakota, and the Provincial government of Manitoba. For additional background, please see http://www.gov.mb.ca/chc/press/top/2010/10/2010-10-08-135100-9904.html and http://www.gov.mb.ca/chc/press/top/2010/11/2010-11-22-163100-10229.html. All jurisdictions involved in the Four-Party discussions agreed that South Dakota and Minnesota should be engaged in the development of a nutrient management plan.

The Red River Basin Commission also recognized the need to improve basin-wide cooperation and collaboration on water quality management, in particular with respect to nutrients. Through the support of the Red River Basin Commission, North Dakota, Minnesota, and Manitoba worked to develop a draft "Conceptual Water Quality Management Plan for the Red River Basin". While this draft conceptual plan has not been finalized, the major concepts including the mission, guiding principles, and some of the main objectives have been incorporated into this document reflecting the previous discussions and excellent work that had already occurred in this area.

Mission Statement

To develop a collaborative, science and watershed-based approach to managing nutrients in the Red River and its watershed with the goal of restoring and protecting aquatic ecosystem health and water uses in the Red River watershed and Lake Winnipeg.

Guiding Principles

The development of the nutrient management strategy will be guided by the following principles:

• Efforts, decisions and outcomes will be based on and supported by scientifically defensible methods and research.

• An integrated watershed perspective and approach will be used in priority setting and decision making.

• Coordinated, cooperative and collaborative processes will be used where appropriate and desirable. Notwithstanding, it is understood that jurisdictional independence will be maintained and that jurisdictional participation is voluntary.

• The strategy and its objectives will be goal/outcome based with particular focus on the protection and/or restoration of aquatic ecosystems and water uses.

• Synergies between sub basins and sub watersheds in the Red River watershed will be recognized and considered.
• Lake Winnipeg is the end point and receiving surface water body for the Red River. Efforts and decisions should strive to benefit both Lake Winnipeg and local water quality.

• Information exchange and input between the jurisdictions will be coordinated where possible.

• The Parties will use a consensus-based approach to decision making (for the purpose of this document consensus-based means "unanimous" in that all parties agree on the decision).

Proposed Approach for Developing a Nutrient Management Strategy

Where it is possible, practical and advantageous to do so, it is proposed that the Red River watershed include the Assiniboine River watershed. For example, water quality monitoring data are collected for the Assiniboine River watershed and can be included in the determination of nutrient sources to the Red River. Similarly, many of the nutrient reduction actions and activities undertaken in Manitoba will most likely be applied across both the Red and Assiniboine River watersheds.

The following components are not intended to be undertaken consecutively but in fact work could occur concurrently on some components.
• **Component One – Seek Endorsement of the Proposed Approach from the International Red River Board**

It is proposed that the development and implementation of a Nutrient Management Strategy for the Red River Watershed be administered through the International Joint Commission's International Red River Board and a new committee established specifically to develop and implement the Nutrient Management Strategy in cooperation with the Red River Basin Commission and the Red River Water Resources Council. The International Red River Board would be asked to endorse the proposed approach to developing a Nutrient Management Strategy for the Red River Watershed and would work to ensure the Strategy is developed and implemented.

• **Component Two - Develop a Shared Understanding of Jurisdictions' Nutrient Regulatory Frameworks and Identify Current Nutrient Reduction Actions, Activities and Plans for the Red River Watershed**

Jurisdictions across the Red River watershed have already implemented some nutrient reduction actions and activities to achieve local water quality goals and to assist in reaching the interim goal of reducing nutrient loading into Lake Winnipeg by 10 % (endorsed by the International Red River Board in 2004). In addition, each of the jurisdictional regulatory frameworks requires different mechanisms for establishing nutrient reduction targets and for implementing nutrient reduction actions and activities.

It is proposed that jurisdictions would compile an overview document describing the different regulatory frameworks in place across the Red River watershed. Work is also underway through several jurisdictions in planning, monitoring, stressor identification and delineation of priority management areas.

It is also proposed that jurisdictions would identify actions and activities that:

1) Are currently contributing to nutrient reductions across the Red River watershed.

2) Have been proposed or are to be implemented in the next two years that are expected to reduce nutrient loading to the Red River watershed.

Where possible, jurisdictions would provide information on the costs of implementing nutrient reduction actions and activities including information to quantify the nutrient reduction and any ecological goods and services provided by the actions and activities.

Jurisdictions would ensure information exchange regarding nutrient reduction actions, innovative options for nutrient reduction, and practical beneficial practices with demonstrated effectiveness.

Examples of nutrient reduction actions and activities include wastewater treatment technologies, beneficial management practices for agriculture and forestry, education and stewardship programs aimed at individual households and businesses, innovative technological approaches for nutrient reductions in small communities, and surface water management programs such as stormwater retention and constructed wetlands.

Nutrient reduction measures could be compiled in a matrix organized by area of the Red River watershed and type of reduction action or activity (point, non-point, education, etc.).

Proposed Timelines: Complete by December 31, 2011

• **Component Three - Recommend and Implement Nutrient Load Allocation and/or Water Quality Targets for Nutrients**

Jurisdictions would work collaboratively to develop nutrient load allocations and/or water quality targets for nutrients along the Red River including at the international boundary and at sub watershed discharge points in the Red River watershed. Work to develop nutrient objectives will be coordinated with other work underway across the watershed including the development of nutrient objectives for Lake Winnipeg and could include water quality modelling and additional research to better understand the nutrient stressor and response relationship in the Red River. The nutrient load allocations and water quality targets will include timelines for implementation.

A number of subcomponents to this project have been identified including:

o **Identify High Priority Areas for Implementing Nutrient Reduction Measures**

Using existing data and information, jurisdictions would identify sub-watersheds that are a high priority for implementation of projects that contribute to reducing nutrient loading to the Red River and its watershed. Work could include watershed modelling and/or compiling information on nutrient export rates.

o **Identify Nutrient Reduction Actions and Activities for the Red River Watershed that could assist in achieving Nutrient Load Allocations and/or Water Quality Targets for Nutrients**

Building on the work in component two, the jurisdictions would collectively identify actions and activities that could be implemented to help achieve Nutrient Load Allocations and/or Water Quality Targets for Nutrients. It is recognized that ultimately jurisdictions will make the final decisions regarding the nutrient reduction measures that are most appropriate for their own jurisdiction but this component is intended to provide open communication, information exchange and to support consistency wherever possible.

o **Develop a Common Set of Indicators for Measuring Progress**
Where possible, develop a common set of indicators for measuring progress towards reducing nutrient loading to the Red River watershed. Indicators would likely include nutrient concentrations and loads but also measures of aquatic ecosystem health.

Proposed Timelines for Component Three: Complete by March 31, 2013

• **Component Four - Monitor and Report on Progress towards Meeting Water Quality Targets and Nutrient Load Allocations**
1) Assess comparability of existing water quality monitoring programs and data throughout the watershed with emphasis on nutrients and identify and reconcile differences where possible and/or appropriate.

Proposed Timelines: Start immediately

2) Determine what additional information is required to develop the nutrient load allocations and/or water quality targets under Component Three.

Proposed Timelines: Start immediately

3) Determine what information is required to monitor progress towards meeting nutrient load allocations and/or water quality targets for nutrients for local water bodies, the Red River, and Lake Winnipeg.

Proposed Timelines: Start immediately and refine as targets are developed

4) Monitor and report water quality conditions and progress in improvement of the Red River watershed and Lake Winnipeg on a periodic basis.

Proposed Timelines: Begin immediately

• **Component Five - Facilitate ongoing technical, scientific and methodological dialogue and information sharing relevant to nutrients and nutrient loading in the Red River watershed including exchanging information on the goals and scientific basis for the long-term ecologically relevant objectives that are under development for Lake Winnipeg.**

Proposed Timelines: Ongoing

• **Component Six - Adapt the nutrient management strategy based on progress and ongoing evaluation.**

Proposed Timelines: Ongoing

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APPENDIX C

DIRECTIVES OT THE RED RIVER BOARD

DIRECTIVE TO THE
INTERNATIONAL RED RIVER BOARD

1. Pursuant to the Boundary Waters Treaty of 1909, responsibilities have been conferred on the Commission under a 1948 Reference from the governments of Canada and the United States with respect to the use and apportionment of the waters along, across, or in the vicinity of the international boundary from the eastern boundary of the Milk River drainage basin on the west up to and including the drainage basin of the Red River on the east, and under the May 1969 authorization from the governments to establish continuous supervision over the quality of the waters crossing the boundary in the Red River and to recommend amendments or additions to the objectives when considered warranted by the International Joint Commission.

2. This directive replaces previous directives and instructions provided by the International Joint Commission to the International Souris-Red Rivers Engineering Board, and in the February 8, 1995 Directive to the International Red River Pollution Board. This Directive consolidates the functions of those two former boards into one board, to be known as the International Red River Board (Board).

3. The Board's mandate is to assist the Commission in preventing and resolving transboundary disputes regarding the waters and aquatic ecosystem of the Red River and its tributaries and aquifers. This will be accomplished through the application of best available science and knowledge of the aquatic ecosystem of the basin and an awareness of the needs, expectations and capabilities of residents of the Red River basin.

4. The geographical scope of the Board's mandate shall be the Red River basin, excluding the Assiniboine and Souris Rivers. The Board's activities shall focus on those factors which affect the Red River's water quality, water quantity, levels and aquatic ecological integrity.

5. The Board's duties shall be to:

   A. Maintain an awareness of basin-wide development activities and conditions that may affect water levels and flows, water quality and the ecosystem health of the Red River and its transboundary tributaries and inform the Commission about transboundary issues.

   B. Provide a continuing forum for the identification, discussion and resolution of existing and water-related issues relevant to the Red River basin.

   C. Recommend appropriate strategies to the Commission concerning water quality, quantity and aquatic ecosystem health objectives in the basin.

   D. Maintain continuing surveillance and perform inspections, evaluations and assessments, as necessary, to Determine compliance with objectives agreed to by governments for water quality, levels and quantity in the Red River basin.

   E. Encourage the appropriate regulatory and enforcement agencies to take steps to ensure that agreed objectives are met.

   F. Encourage the appropriate authorities, such as resource and emergency planning agencies, to establish and maintain contingency plans, including early warning procedures, for appropriate reporting and action on accidental discharges or spills, floods and droughts.

G. Monitor and report on flood preparedness and mitigation activities in the Red River basin and their potential effects on the transboundary aquatic ecosystems, and encourage and facilitate the development and maintenance of flood-related data information systems and flood forecasting and hydrodynamic models. In carrying out this responsibility, the Board shall:

   i. Monitor progress by the governments (federal, state, provincial, municipal) in implementing the recommendations of the Commission's report on the Red River basin flooding, and in maintaining and advancing the work of the Task Force's legacy projects, and to this end provide opportunities for the public to comment on the adequacy of such progress.

   ii. Encourage governments to develop and promote a culture of flood preparedness in the Red River valley.

   iii. Encourage government efforts to develop and implement a long-term strategy for flood mitigation emergency preparedness.

   iv. Encourage the sharing of accurate and timely transboundary information to support the development of improved flood forecasting techniques and procedures for early flood warnings and to improve communication of flood forecasts.

   v. Provide through the activities of the Board a forum for the exchange of best practices and for other flood-related information on preparedness, mitigation, response and recovery to assist in transboundary problem solving.

   vi. Promote the application of innovative technologies for supporting flood modeling and mapping.

   vii. Monitor the adequacy of data and information collection networks (meteorological, hydrometric, water quality) for flood preparedness, forecasting and mitigation, within the larger context of overall water management needs in the basin.

   viii. Monitor potential transboundary effects of flood mitigation and other works in the basin, and encourage cooperative studies necessary to examine these effects.

   ix. Encourage governments to integrate floodplain management activities in watershed and basin management.

   x. Interact with all levels of government to help decision-makers become aware of transboundary flood-related and associated water management issues.

   xi. Assist in facilitating a consultative process for resolution of the lower Pembina River Flooding issue.

H. Involve the public in the work of the Board, facilitate provision of timely and 'pertinent information within the basin in the most appropriate manner', including electronic information networks; and conduct an annual public meeting in the Red River basin.

I. Provide an annual report to the Commission, plus other reports as the Commission may request or the Board may feel appropriate in keeping with this Directive.

J. Maintain an awareness of the activities of other agencies and institutions, in the Red River basin.

6. The Board shall continue to report on the non-Red River geographic areas under the responsibility of the former International Souris-Red Rivers Engineering Board, including the Popular and Big Muddy basins, but excluding the Souris River basin until the Commission determines otherwise.

7. The Board shall have an equal number of members from each country. The Commission shall normally appoint each member for a three-year term. Members may serve for more than one term. Members shall act in their personal and professional capacity, and not as representatives of their countries, agencies or institutions. The Commission shall appoint one member from each country to serve as co-chairs of the Board. An alternate member may not act as a co-chair.

8. At the request of any members, the Commission may appoint an alternate member to act in the place of such member whenever the said member, for any reason, is not available to perform such duties as are required of the member.
9. The co-chairs of the Board shall be responsible for maintaining proper liaison between the Board and the Commission, and among the Board members. Chairs shall ensure that all members of the Board are informed of all instructions, inquiries, and authorizations received from the Commission and also activities undertaken by or on behalf of the Board, progress made, and any developments affecting such progress.

10. Each chair, after consulting the members of the Board, may appoint a secretary. Under the general supervision of the chair(s), the secretary(ies) shall carry out such duties as are assigned by the chairs or the Board as a whole.

11. The Board may establish such committees and working groups as may be required to discharge its responsibilities effectively. The Commission shall be kept informed of the duties and composition of any committee of working group. Unless other arrangements are made, members of the Board, committees or working groups will make their own arrangements for reimbursement of necessary expenditures.

12. The Commission should also be informed of the Board's plans and progress and of any developments or cost impediments, actual or anticipated, which are likely to affect carrying out the Board's responsibilities.

13. The Commission shall be informed, in advance, of plans for any public meetings or public involvement in the Board deliberations. The Board shall report in a timely manner, to the Commission on these meetings, including representations made to the board.

14. The Board shall provide the text of media releases and other public information materials to the Secretaries of the Commission for review by the Commission's Public Information Officers, prior to their release.

15. Reports, including annual reports and correspondence of the Board shall, normally, remain privileged and be available only to the Commission and to members of the Board and its

committees until their release has been authorized by the Commission.

16. If, in the opinion of the Board or of any member, any instruction, directive, or authorization received from the Commission lacks clarity or precision, the matter shall be referred promptly to the Commission for appropriate action.

17. In the event of any unresolved disagreement among the members of the Board, the Board shall refer the matter forthwith to the Commission for decision.

18. The Commission may amend existing instructions or issue new instruction to the Board at any time.

APPENDIX D

D.1 WATER QUALITY OBJECTIVES

D.2 WATER QUALITY ALERT LEVELS

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D.1 WATER QUALITY OBJECTIVES

The purpose of the water quality objectives and alert levels is to restore and maintain the chemical, physical, and biological integrity of the waters of the Red River. Five specific objectives were adopted for the Red River at the international boundary by the IJC in 1969.

Water quality objectives are used when necessary to secure government commitment to pollution abatement action. Compliance with the objectives is the primary means by which the International Red River Board identifies major water quality issues to the IJC.

The term 'exceedence' is used to describe a situation where an objective is not met. A situation is classified as an exceedence if an individual instantaneous sample, obtained from the continuous auto-monitor, or through a grab sample, is equal to or greater than the corresponding water quality objective (except for dissolved oxygen, which must be observed to be equal to or less than the objective). The five specific parameters and corresponding objective are listed below.

E. Coli	200 colonies/100 ml
Chloride	100 mg/L
Sulphate	250 mg/L
Total Dissolved Solids	500 mg/L
Dissolved Oxygen	5 mg/L

D.2 WATER QUALITY ALERT LEVELS

Water quality alert levels are used to complement water quality objectives. If exceeded, alert levels will trigger investigative action on the part of the IRRB or its representatives. The exceedence is addressed in terms of its magnitude, implications to water uses and possible resolutions. On the basis of alert level exceedances and subsequent investigations, the IRRB may advance proposals for additional objectives.

Water quality alert levels, for a wide range of parameters, in addition to the five specific parameters noted above, were developed by a working group in 1985. These alert levels were approved by the predecessor International Red River Pollution Board in January 1986. The alert levels that are currently in effect are listed in the following table. Further, the table provides a comparison of alert levels with the North Dakota and Minnesota Water Quality Standards, and with the Manitoba Water Quality Objectives as of 1990. The table has not been updated to reflect recent state and provincial revisions. The IRRB Aquatic Ecosystem Committee established by the IRRB in June 2001 will be reviewing the issue of objectives and alert levels with respect to monitoring requirements, analytical methodologies, and reporting protocols.

COMPARISON OF WATER QUALITY ALERT LEVEL STANDARDS AND OBJECTIVES - August 20, 1990

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
Fecal Coliform	200/100 ml geometric mean 10% of samples not to exceed 2,000 based on a minimum of 5 samples in a 30 day period from Mar. 1 – Oct. 31. HH*	200 fecal coliforms per 100 ml. This standard shall apply only during the recreation season, May 1 to September 30. HH	100/100 ml. At least 90% of samples in any consecutive 30 day period should have a fecal coliform density of less than 100 per 100 ml. HH	200/100 ml geometric mean with 10% of samples not to exceed 400 based on min. 5 samples – 30 day period – May 1 – Oct. 31 and for the balance of year not to exceed 1000/100 ml. Current IJC objective.	Minnesota and North Dakota based on primary body contact recreation.
Chloride	100 mg/l (total) ID	100 mg/l (total) ID	100 mg/l (soluble) ID	100 mg/l (dissolved) Current IJC Objective	All agencies based on industrial consumption.
Sulfate	250 mg/l (total) DW	250 mg/l (total) DW	250 mg/l (dissolved) DW	250 mg/l (total) Current IJC Objective	All agencies based on domestic consumption.
TDS	500 mg/l DW	None	500 mg/l DW	500 mg/l Current IJC Objective	All agencies, excluding North Dakota based on domestic consumption.
Dissolved Oxygen	5 mg/l (minimum)	5 mg/l (minimum)	47% saturation or more.	5 mg/l (minimum) Current IJC Objective	All agencies for the protection of aquatic life.
Chemical Characteristics					
pH	6.5 - 9.0 AL	7.0 - 9.0 AL	6.5 – 9.0 AL	6.5 - 9.0	All agencies based on protection of aquatic life.

- DW – Drinking Water
- HH – Human Health
- AL – Aquatic Life
- ID – Industrial Consumption
- IR - Irrigation

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
Dissolved Gas					
Ammonia-N	.04 mg/l as N unionized (warm water) Al	Unionized as N (dissolved). Calculation from standards. See page 8-10. AL	Variable, ranging from 0.0184 to 0.050 mg/l ammonia as NH_3.*		Minnesota and North Dakota for the protection of aquatic life.
Metals (Total)					
Aluminum	Total 125 µg/l AL	None	None	None	Minnesota for the protection of aquatic life.
Cadmium	Total The chronic standard shall not exceed: $_e$ [0.7852 {ln (total hardness mg/l)} – 3.49]. For hardness values greater than 400 mg/l, 400 mg/l shall be used in the calculation of the standard. Cadmium standards in µg/l at various hardness values: 50 mg/l hardness = 0.66 µg/l, 100 mg/l hardness = 1.1 µg/l, 200 mg/l hardness = 2.0 µg/l AL	Total The one-hour average, concentration in µg/l cannot exceed the numerical value given by $_e$ [1.128{ln(hardness as mg/l)} –3.828] more than once every 3 years on the average. AL The four day average concentration in µg/l cannot exceed the numerical value given by $_e$ [.7852{ln(hardness as mg/l)} –3.490] more than once every 3 years on the average.	$_e$ [0.7852 {ln(hardness as mg/l)} –3.49], where hardness is expressed in mg/l $CaCO_3$ and the resultant objective is expressed in µg/l. (e.g.) 50 mg/l $CaCO_3$ = 0.66 µg/l, 100 mg/l $CaCO_3$ = 1.1µg/l, 200 mg/l $CaCO_3$ = 2.0 µg/l. AL	Less than detection.	Minnesota and Manitoba for the protection of aquatic life and wildlife.
Chromium	None	Total 50 µg/l DW	$_e$ [0.8190 {ln (hardness)} +1.561], where hardness is expressed in mg/l $CaCO_3$ and the resultant objectives is expressed in µg/l.	50 µg/l	North Dakota based on domestic consumption.

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
			(e.g.) 50 mg/l $CaCO_3$ = 120 µg/l, 100 mg/l $CaCO_3$ = 210 µg/l, 200 mg/l $CaCO_3$ = 370 µg/l.		
Chromium, Trivalent	Total The chronic standard shall not exceed: exp. [0.819{ln (total hardness mg/l}+ 1.561]. For hardness values greater than 400 mg/l, 400 mg/l shall be used in the calculation of the standard. Chromium +3 standards in µg/l at various hardness values: 50 mg/l hardness = 117 µg/l, 100 mg/l hardness = 207 µg/l, 200 mg/l hardness = 365 µg/l. AL	None	$_e$ [0.8190 {ln (hardness)} +1.561], where hardness is expressed in mg/l $CaCO_3$ and the resultant objectives is expressed in µg/l. (e.g.) 50 mg/l $CaCO_3$ = 120 µg/l, 100 mg/l $CaCO_3$ = 210 µg/l, 200 mg/l $CaCO_3$ = 370 µg/l.. AL	None	Manitoba and Minnesota for the protection of aquatic life.
Chromium, Hexavalent	Total The chronic standard is 11 µg/l AL	None	11 µg/l AL	None	Manitoba and Minnesota for the protection of aquatic life.

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
Copper	Total The chronic standard shall not exceed: exp. [0.62 {ln (total hardness mg/l}) -0.57]. For hardness values greater than 400 mg/l, 400 mg/l shall be used in the calculation of the standard. Copper standards in µg/l at various harness values: 50 mg/l hardness = 6.4 µg/l, 100 mg/l hardness = 9.8 µg/l, 200 mg/l hardness = 15 µg/l . AL	Total The one-hour average concentration in µg/l cannot exceed the numerical value given by e[.9422{1n (hardness as mg/l})-1.464] more than once every 3 years on the average. The four-day average concentration in µg/l cannot exceed the numerical value given by e [8545{ln (hardness as mg/l)} –1.465] more than once every 3 years on the average. AL	e[0.8545{ln(hardness)}-1.465], where hardness is expressed in mg/l $CaCO_3$ and the resultant objective is expressed in µg/l. (e.g.) 50 mg/l $CaCO_3$ = 6.5 µg/l., 100 mg/l $CaCO_3$ = 12 µg/l, 200 mg/l $CaCO_3$ = 21 µg/l.		Minnesota and Manitoba for the protection of aquatic life.
Iron	300 µg/l DW	None	300 µg/l DW	300 µg/l	Minnesota, Manitoba based on domestic consumption.
Lead	Total The chronic standard shall not exceed: exp. [1.273{ln (total hardness mg/l)}-4.705]. For hardness values greater than 400 mg/l, 400 mg/l shall be used in the calculation of the standard. Lead standards in µg/l at various hardness values: 50 mg/l hardness = 1.3 µg/l 100 mg/l hardness = 3.2 µg/l 200 mg/l hardness = 7.7 µg/l AL	Total The one-hour average concentration in µg/l cannot exceed the numerical value given by e [1.266{In (hardness as mg/l) - 1.416] more than once every 3 years on the average. The four-day average concentration in µg/l cannot exceed the numerical value given by e (1.266{ln (hardness as mg/l) - 4.661) more than once every 3 years on the average. AL	e [1.273{ln (hardness)} - 4.705], where hardness is expressed in µg/l $CaCO_3$ and the resultant objective is expressed in µg/l. (e.g.) 50 mg/l $CaCO_3$ = 1.3 µg/l, 100 mg/l $CaCO_3$ = 3.2 µg/l, 200 mg/l $CaCO_3$ = 7.7 µg/l,		Manitoba, Minnesota and North Dakota for the protection of aquatic life and wildlife.
Manganese	50 µg/l DW	None	50 µg/l DW	50 µg/l	Minnesota and Manitoba based on domestic consumption.

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
Mercury	Total 0.0069 µg/l AL	Total Acute 2.4 µg/l Chronic 0.012 µg/l AL	Acid soluble mercury 0.006 µg/l	Less than detection in water. 0.5 micrograms per gram in fish fillets.	Minnesota, North Dakota and Manitoba for protection of aquatic life, animal life and humans as a result of bioconcentrations in tissue in the food chain.
Nickel	Total The chronic standard (CS) shall not exceed the human health-based criterion of 88 µg/l. For waters with total hardness values less than 50 mg/l, the CS shall not exceed: exp. [0.846{ln(total hardness mg/l)} + 1.1645]. AL and HH	None	**e** **[**0.76{ln(hardness)} None +1.06], where hardness is expressed in mg/l) $CaCO_3$ and the resultant objective is expressed in µg/l (e.g.) 50 mg/l $CaCO_3$ = 56 µg/l, 100 mg/l $CaCO_3$ = 96 µg/l, 200 mg/l $CaCO_3$ = 160 µg/l, AL	None	Minnesota for the protection of aquatic life and human health. Manitoba for the protection of aquatic life.
Selenium	Total 5 µg/l AL	10 µg/l DW	10 µg/l DW	10 µg/l	Manitoba and North Dakota based on domestic consumption. Minnesota for the protection of aquatic life.
Silver	Total The chronic standard shall not exceed 1.0 µg/l. AL	The one-hour average concentration in µg/l cannot exceed the numerical value given by **e** [1.72{ln(hardness)} as mg/l)}-6.52] more than once every three years on the average. AL	0.1 µg/l AL	None	Manitoba, Minnesota and North Dakota for protection of aquatic life.

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
Zinc	Total The chronic standard shall not exceed: exp. [0.8473{ln(total hardness mg/l)} + 0.7615], For hardness values greater than 400 mg/l, 400 mg/l shall be used in the calculation of the standard. Zinc standards in µg/l at various hardness values: 50 mg/l hardness = 59 µg/l 100 mg/l hardness = 106 µg/l 200 mg/l hardness = 191 µg/l AL	Total The one-hour average concentration in µg/l cannot exceed the numerical value given by $_e$ [.8473{ln(hardness as mg/l)} +.8604] more than one every 3 years on the average. The four-day average concentration in µg/l cannot exceed the numerical value given by $_e$ [.8473 {ln(hardness as mg/l})+.7614] more than once every 3 years on the average. AL	47 µg/l AL	47 µg/l	Minnesota, North Dakota and Manitoba for the protection of aquatic life.
Nutrients					
Nitrates (N)	Total 10 mg/l DW	Dissolved 1.0 mg/l DW	Total 10 mg/l DW	Total 10 mg/l	Minnesota and Manitoba based on domestic consumption.
Toxic Substances					
Arsenic	Total 50 µg/l DW and AL	Total 50 µg/l DW	Acid soluble arsenic 50 µg/l DW	Total 10 µg/l (under review)	Minnesota based on domestic consumption and for protection of aquatic life.
Boron	500 µg/l IR	750 µg/l IR	500 µg/l IR	Total 500 µg/l	Minnesota, Manitoba based on irrigation water.
Chlorine	Total residual 6 µg/l	None	None	None	Minnesota for protection of aquatic life.
Cyanide	Free cyanide	Total	Free cyanide	Total	Minnesota and North

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
	5.2 µg/l AL	5 µg/l AL	5.2 µg/l cyanide AL	5 µg/l	Dakota for protection of aquatic life.
Dioxin	None	None	None	Not detectable in any media analyzing to parts per trillion.	Task Force
PCBs	Total 0.000029 µg/l AL and HH	Total Acute 2.0 µg/l Chronic 0.014 µg/l AL	.014 µg/l AL	Not detectable in water, in fish total PCBs not exceeding 2 micrograms per gram in fillets.	Body burden: Manitoba, North Dakota and Minnesota for protection of aquatic life, animal life and human life.
Phenolics	None	None	1 µg/l DW	10 µg/l	North Dakota to protect against taste and odor in water and fish.
Phenol	123 µg/l AL	Total 10 µg/l DW	1.0 µg/l 2.0 AL	None	North Dakota to protect against taste and odor in water and fish.
Pentachlorophenol	The chronic standard shall not exceed: exp.[1.005{pH} – 5 .290]. Pentachlorophenol standards in µg/l at, various pH values: pH 7.0 = 5.7 µg/l, pH 7.5 = 9.5 µg/l, pH 8.0 = 16 µg/l. AL	Acute 20.0 µg/l Chronic 13.0 µg/l AL	0.06 mg/l DW	None	Minnesota and North Dakota for the protection of aquatic life. Manitoba based on domestic consumption.
Pesticides and Volatile Hydrocarbons	Acenapthene 12 µg/l Acrylonitrile 0.38 µg/l Anthracene 0.029 µg/l	Aldrin (total) Acute 3.0 µg/l Chlordane (total)	Aldicarb 0.009 mg/l Aldrin + Dieldrin	Not detectable in water**	All agencies for the protection of aquatic life, animal life domestic

** Limits in fish tissue are being researched by the Task Force.
Tissue samples have been collected by North Dakota and Manitoba.

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
	Benzene 6.9 µg/l Bromoform 128 µg/l Carbon Tetrachloride 1.9 µg/l Chlordane 0.00029 µg/l Chlorobenzene 10 µg/l Chloroform 55 µg/l Chlorpyrifos 0.041 µg/l DDT 0.0017 µg/l 1,2-Dichloroethane 3.8 µg/l Dieldrin 0.000026 µg/l Di-2-Ethylhexyl phthalate 1.9 µg/l Di-n-Octyl phthalate 30 µg/l Endosulfan 0.15 µg/l Endrin 0.016 µg/l Ethylbenzene 68 µg/l Fluoranthene 4.1 µg/l Heptachlor 0.00039 µg/l Heptachlor epoxide 0.00048 µg/l Hexachlorobenzene 0.00022 µg/l Lindane 0.032 µg/l Methylene chloride 46 µg/l Parathion 0.013 µg/l Phenanthrene 2.1 µg/l 1,1,2,2-Tetrachloroethane 1.54 µg/l Tetrachloroethylene 3.8 µg/l 1,1,1-Trichloroethane 263µg/l 1,1,2-Trichloroethylene25µg/l 2,4,6-Trichlorophenol 2.0µg/l	Acute 2.4 µg/l Chronic 0.0043 µg/l Dieldrin (total) Acute 2.5 µg/l Chronic .002 µg/l Endosulfan (total) Acute .22 µg/l Chronic .06 µg/l (continued) Endrin (total) Acute .18 µg/l Chronic .0023 µg/l Heptachlor (total) Acute .52 µg/l Chronic .004 µg/l Lindane (Hexachlorocyclohexane) Acute 2.0 µg/l Chronic .06 µg/l Toxaphene (total) Acute .73 µg/l Chronic .0002 µg/l AL	0.0007 mg/l Atrazine 0.06 mg/l Azinphos-methyl 0.02 mg/l Bendiocarb 0.04 mg/l Benzene 0.005 mg/l Benzo (a) pyrene 0.00001 mg/l Bromoxynil 0.005 mg/l Carbaryl 0.09 mg/l Carbofuran 0.09 mg/l Carbon tetrachloride 0.005 mg/l Chlordane 0.0043 µg/l Chlorpyrifos 0.09 mg/l Cyanazine 0.01 mg/l Diazinon 0.02 mg/l Dicamba 0.12 mg/l 1,2-Dichlorobenzene 0.2 mg/l 1,4-Dichlorobenzene 0.005 mg/l DDT and metabolites		consumption and human health.

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
	Toluene 253 µg/l Toxaphene 0.0013 µg/l Vinyl Chloride 0.15 µg/l Xylene(total m, p and o) 166 µg/l		0.001 µg/l 1,2-Dichloroethane 0.005 mg/l Dichloromethane 0.05 mg/l 2,4-Dichlorophenol 0.9 mg/l 2,4-D – 0.9 mg/l (continued) Diclofop-methyl 0.009 mg/l Dieldrin – 0.0019 µg/l Dimethoate – 0.02 mg/l Diquat – 0.07 mg/l Diuron – 0.15 mg/l Endosulfan – 0.056 µg/l Endrin – 0.0023 µg/l Glyphosate – 0.18 mg/l Heptachlor and heptachlor epoxides – 0.0038 µg/l Hexachlorobutadiene 0.1 µg/l Lindane – 0.080 µg/l Malathion – 0.19 mg/l Methoxychlor – 0.9 mg/l Metribuzin – 0.08 mg/l Monochlorobenzene 0.08 mg/l Nitrilotriacetic acid 0.05 mg/l Paraquat – 0.01 mg/l Parathion – 0.05 mg/l Phthalic acid esters: Dibutylphthalate–4.0 µg/l Dii-(2-ethylhexyl) phthalate 0.6 µg/l other phthalates –0.2 µg/l Phorate – 0.002 mg/l Picloram – 0.19 mg/l		

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
			Polychlorinated biphenyls 0.014 µg/l Simazine – 0.01 mg/l Temephos – 0.28 mg/l Terbufos – 0.001 mg/l (continued) 2,3,4,6-Tetrachlorophenol 0.1mg/l Toxaphene – 0.013 µg/l Triallate – 0.23 mg/l Trichloroethylene 0.05 mg/l 2,4,6-Trichlorophenol 0.005 mg/l 2,4,5-T – 0.28 mg/l Trifluralin – 0.045 mg/l Trihalomethanes 0.35 mg/l DW and AL		
Oil and Grease	500 µg/l HH	No visible film or sheen upon the waters.	Free from oil and grease residues which cause a visible film or sheen upon the waters or any discolouration of the surface of adjoining shorelines, or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines.	No visible sheen on the surface.	All agencies based on aesthetics, taste and odor in water and fish, and bathing.

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APPENDIX E

WATER POLLUTION CONTROL CONTINGENCY

PLAN LIST OF CONTACTS

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Notification List
For D.O. Depletions, Non-toxic, Oil, and Toxic Spills

United States:

Minnesota Pollution Control Agency – Detroit Lakes, MN

Will Haapala
(218) 856-0730 office
(218) 846-0719 Fax
1-800-422-0798 (24hr)

Molly MacGregor
(218) 846-0494 office
(218) 846-0719 Fax
1-800-422-0798

Minnesota Department of Natural Resources – Bemiji, MN (Fisheries)

Henry Drews
(208) 755-3959 office
1-800- 422-0798 (24hr)

North Dakota Health Department – Bismark, ND

Dennis Fewless
(701) 328-5210 office
(701) 328-5200 fax
1-800-472-2121 (24hr in-state-ask for REACT Officer)
(701) 328-9921 (24hr out-of-state – ask for REACT Officer)

Environmental Protection Agency – Denver, CO

Bert Garcia
(303) 312-6670 office
(303) 312-7206 fax
1-800-424- 8802 (24hr National Response Center)

Canada:

<u>Manitoba Water Stewardship – Winnipeg, MB</u>

Dwight Williamson
(204) 945-7030 office
(204) 948-2357 fax
(204) 256-3706 res.
(204) 944-4888 (24hr telephone service emergency number)

<u>Environment Canada – Regina, SK</u>

David Donald
(306) 780-6723 office
(306) 780-5311
(306) 586-1468 res.

Girma A. Sahlu
(306) 780-6425 office
(306) 780-5311fax
(306) 757-2892 res.

APPENDIX F

HYDROLOGY COMMITTEE, AQUATIC ECOSYSTEM COMMITTEE, AND WATER QUALITY MEMBERSHIP LIST

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International Red River Board
Hydrology Committee
Membership

Name	Organization	Phone	E-mail
Bob Harrison (Chair) Steve Topping (Alt.)	Manitoba Water Stewardship, Winnipeg	(204) 945-7411 (204) 945-6398	Bob.Harrison@gov.mb.ca stopping@gov.mb.ca
Steve Robinson (Chair) Gregg Wiche (Alt.)	USGS, Bismarck	(701) 775-7221 (701) 250-7400	Smrobins@usgs.gov gjwiche@usgs.gov
Girma A. Sahlu	Environment Canada, Secretary IRRB, Regina, SK	(306) 780-6425	Girma.Sahlu@EC.GC.CA
Scott Jutila	Corps of Engineers, Secretary IRRB, St. Paul, MN	(651) 290-5631	Scott.A.Jutila@usace.army.mil
Randy Gjestvang	N.D. State Water Commission, West Fargo	(701) 282-2318	rgjest@water.swc.state.nd.us
Chuck Fritz	International Water Institute, Fargo	(701) 231-9747	charles.fritz@ndsu.nodak.edu
Al Kean	Minnesota Board of Water and Soil Resources,	(651) 297-2907	Al.kean@bwsr.state.mn.us
Haitham Ghamry	Dept. of Fisheries & Oceans Canada	(204)	Ghamry,Haitham K: DFO XCA
Vacant	Minnesota DNR, Bemidji		
Kip Gjerde Amy Ambuehl (Alt.)	U.S. Bureau of Reclamation, Billings	(406) 247-7813 (701) 250-4242 ext. 3615	jgjerde@gp.usbr.gov aambuehl@gp.usbr.gov

International Red River Board
Aquatic Ecosystem Committee
Membership

Name	**Organization**	**Phone**	**E-mail**
David Rathke (Sec.)	EPA/Denver	(303) 312-6016	rathke.david@epa.gov
Mike Sauer	NDHD/Bismarck	(701) 328-5237	msauer@state.nd.us
Mike Ell	NDHD/Bismarck	(701) 328-5214	mell@nd.gov
Wayne Berkas	USGS/Bismarck	(701) 250-7429	wrberkas@usgs.gov
Mike Vavricka	MPCA/Detroit Lakes	(218) 846-8137	michael.vavricka@state.mn.us
Lance Yohe	RRBC/Moorhead	(218) 291-0422	lancer2b2@corpcomm.net
Chuck Fritz	Int’l Water Institute, Fargo	(701) 231-9747	charles@iwinst.org
Bethany Kurz	EERC, Grand Forks	(701) 777-5050	bkurz@undeerc.org
Patricia Ramlal (Chair)	Fisheries and Oceans Canada	(204) 983-8838	Patricia.Ramlal@dfo-mpo.gc.ca
David Donald	Environment Canada, Regina	(306) 780-6723	david.donald@ec.gc.ca
Dwight Williamson	Manitoba Water Stewardship, Winnipeg	(204) 945-7030	dwilliamso@gov.mb.ca

International Red River Board
Water Quality Committee
Membership

Name	Organization	Phone	E-mail
Jim Ziegler, (Co-chair)	Minnesota Pollution Control Agency		Jim.Ziegler@state.mn.us
Nicole Armstrong, (Co-Chair)	Manitoba Conservation and Water Stewardship	(204) 945-3991	nicole.armstrong@gov.mb.ca
Mike Ell	North Dakota State Department of Health	(701) 328-5214	mell@nd.gov
Dennis Fewless	North Dakota State Department of Health		dfewless@nd.gov
Mike Vavricka	MPCA/Detroit Lakes		michael.vavricka@state.mn.us
Lance Yohe	RRBC/Moorhead		lancer2b2@corpcomm.net
Rochelle Nustad	U.S. Geological Survey		ranustad@usgs.gov
Leah Thvedt	Red River Basin Commission		leah@redriverbasincommission.org
Eric Steinhaus	U.S. Environmental Protection Agency		Steinhaus.Eric@epamail.epa.gov
Sharon Reedyk	Agriculture and Agri-Food Canada		Sharon.Reedyk@AGR.GC.CA
Iris Griffin	Environment Canada		iris.griffin@ec.gc.ca
Rob Sip	Minnesota Department of Agriculture		rob.sip@state.mn.us