North Fork Crow Watershed (07010204)

Watershed Restoration and Protection Strategy Report

December 2014

CROW Joint Powers
CROW RIVER ORGANIZATION OF WATER
WWW.CROWRIVER.ORG

Minnesota Pollution Control Agency

CLEAN WATER LAND & LEGACY AMENDMENT

wq-ws4-06a

Table of Contents

The science and analysis described in this report began before the passage of the 2013 Clean Water Accountability Act. Thus, this report may not address all elements of the Clean Water Accountability Act. When this watershed is revisited (according to the 10-year cycle), the information will be updated according to the required elements of a Watershed Restoration and Protection Strategy (WRAPS) Report. This document is only the WRAPS report. It summarizes and references, but does not contain the Total Maximum Daily Load documents.

Key Terms

Assessment Unit Identifier (AUID): The unique water body identifier for each river reach comprised of the USGS eight-digit HUC plus a three-character code unique within each HUC.

Aquatic life impairment: The presence and vitality of aquatic life is indicative of the overall water quality of a stream. A stream is considered impaired for impacts to aquatic life if the fish Index of Biotic Integrity (IBI), macroinvertebrate IBI, dissolved oxygen, turbidity, or certain chemical standards are not met.

Aquatic recreation impairment: Streams are considered impaired for impacts to aquatic recreation if bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus, chlorophyll-a, or Secchi disc depth standards are not met.

Hydrologic Unit Code (HUC): A Hydrologic Unit Code (HUC) is assigned by the USGS for each watershed. HUCs are organized in a nested hierarchy by size. For example, the Mississippi River Basin is assigned a HUC-4 of 0701. The North Fork Crow River Watershed is assigned a HUC-8 of 07010204. There are 43 HUC -12 watersheds within the NFC HUC-8.

Impairment: Water bodies are listed as impaired if water quality standards are not met for designated uses including: aquatic life, aquatic recreation, and aquatic consumption.

Index of Biotic integrity (IBI): A method for describing water quality using characteristics of aquatic communities, such as the types of fish and invertebrates found in the waterbody. It is expressed as a numerical value between 0 (lowest quality) to 100 (highest quality).

Protection: This term is used to characterize actions taken in watersheds of waters not known to be impaired to maintain conditions and beneficial uses of the waterbodies.

Restoration: This term is used to characterize actions taken in watersheds of impaired waters to improve conditions, eventually to meet water quality standards and achieve beneficial uses of the waterbodies.

Source (or Pollutant Source): This term is distinguished from ‘stressor’ to mean only those actions, places or entities that deliver/discharge pollutants (e.g., sediment, phosphorus, nitrogen, pathogens).

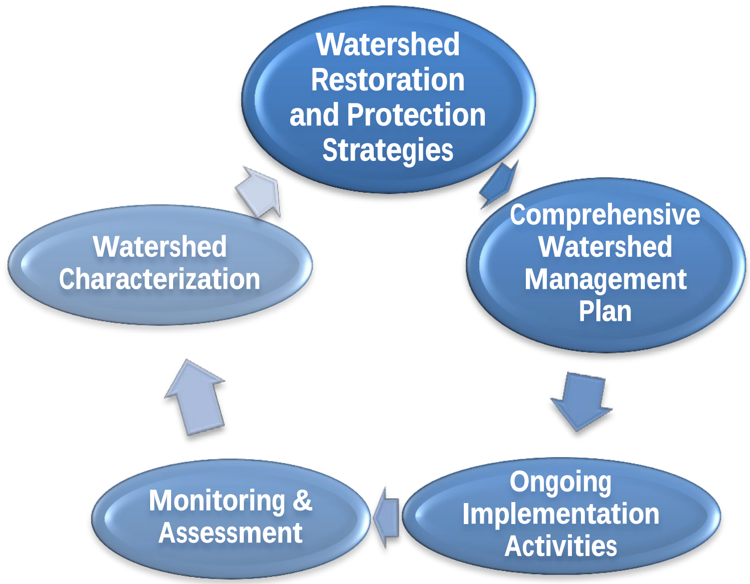
Stressor (or Biological Stressor): This is a broad term that includes both pollutant sources and non-pollutant sources or factors (e.g., altered hydrology, dams preventing fish passage) that adversely impact aquatic life.

Subwatershed: Subwatersheds are referred to in the HSPF generated map discussion in this report. Subwatersheds are smaller than HUC-12s and were derived for use in the HSPF model based on available climatology data and land use. There are 134 subwatersheds within the NFC HUC-8.

Total Maximum Daily Load (TMDL): Calculations of the maximum amount of a pollutant that may be introduced into a surface water and still ensure that applicable water quality standards for that water are met. A TMDL is the sum of the wasteload allocation for point sources, a load allocation for nonpoint sources and natural background, an allocation for future growth (i.e., reserve capacity), and a margin of safety as defined in the Code of Federal Regulations.

Watershed Health Assessment Framework (WHAF): A suite of watershed health index scores built on statewide GIS data have been calculated to represent many of the important ecological relationships for each of the 81 major watersheds.

What is the WRAPS Report?



The State of Minnesota has adopted a "watershed approach" to address the state's 81 "major" watersheds (denoted by 8-digit hydrologic unit code or HUC). This watershed approach incorporates **water quality assessment, watershed analysis, civic engagement, planning**, **implementation**, and **measurement of results** into a 10-year cycle that addresses both restoration and protection.

As part of the watershed approach, waters not meeting state standards are still listed as impaired and Total Maximum Daily Load (TMDL) studies are performed, as they have been in the past, but in addition the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health. A key aspect of this effort is to develop and utilize watershed-scale models and other tools to help state agencies, local governments and other watershed stakeholders determine how to best proceed with restoring and protecting lakes and streams. This report summarizes past assessment, diagnostic and TMDL work and outlines ways to prioritize actions and strategies for continued implementation.

Purpose	• Support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for subsequent implementation planning • Summarize Watershed Approach work done to date including the following reports: • North Fork Crow Watershed Monitoring and Assessment Report • Assessment of Selected Lakes within the North Fork Crow River Watershed • North Fork Crow Watershed HSPF Modeling • North Fork Crow Lakes Eutrophication Modeling • North Fork Crow and Lower Crow: Bacteria, Turbidity, and Low DO TMDL • North Fork Crow River, Rice Lake: Excess Nutrients • North Fork Crow River, Emma and Ann lakes: Excess Nutrients • Diamond Lake: Excess Nutrients
Scope	• Impacts to aquatic recreation and impacts to aquatic life in streams • Impacts to aquatic recreation in lakes
Audience	• Local working groups (local county, city and township governments, SWCDs, watershed management groups, etc.) • State agencies (MPCA, DNR, BWSR, etc.) • Federal agencies (NRCS, USFWS, etc.)

1. Watershed Background & Description

The North Fork Crow (NFC) River watershed is located in the Upper Mississippi River Basin and covers eight counties, which include Wright, Meeker, Kandiyohi, Stearns, Pope, Hennepin, McLeod, and Carver. The watershed is approximately 1,485 square miles, or 950,000 acres and is predominantly in the North Central Hardwood Forests ecoregion with a very small portion crossing into the Western Corn Belt Plains ecoregion. As the main stem of the NFC River passes through the central and eastern regions of the watershed, land use is dominated by crop and pasture land. There are 31 municipalities located completely or partially within the boundaries of the NFC Watershed (Figure 1). The NFC flows from its western headwaters to its confluence with the South Fork Crow near Rockford, Minnesota, after which it joins the Mississippi near Dayton, Minnesota. Additional background information and description of the NFC watershed can be found in the resources listed below.

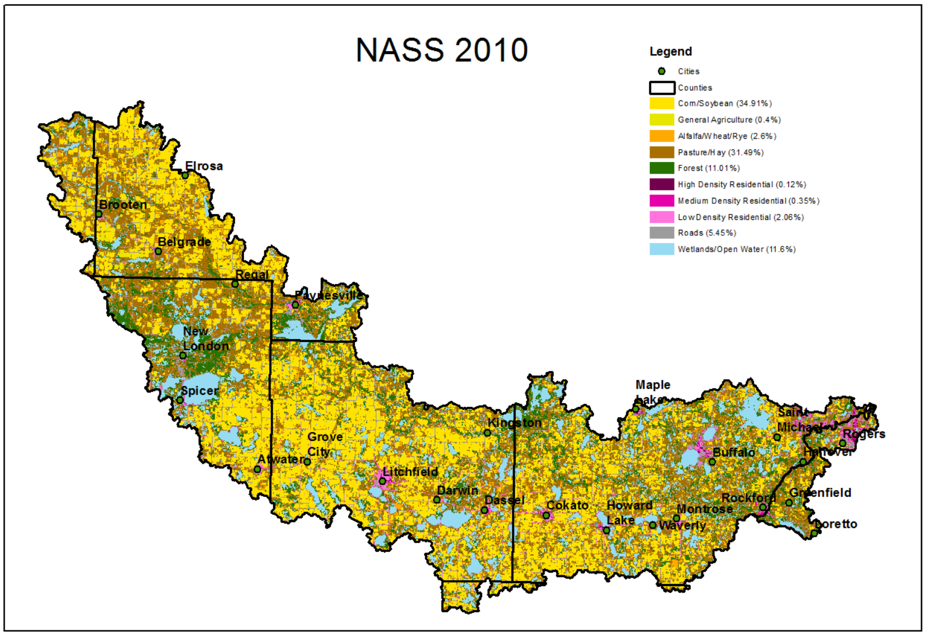


Figure 1. Land Cover (NASS, 2010) in the NFC watershed

Additional North Fork Crow Watershed Resources

USDA Natural Resources Conservation Service (NRCS) Rapid Watershed Assessment for the NFC River Watershed: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_022499.pdf

Past MPCA studies including assessment, TMDLs, and implementation in the NFC River Watershed can be found at: http://www.pca.state.mn.us/jsridda

Minnesota Department of Natural Resources (DNR) Watershed Assessment Mapbook for the NFC Watershed: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/wsmb18.pdf

2. Watershed Conditions

There are 679 lakes and 233 stream segments referred to as Assessment Unit IDs (AUIDs) in the watershed, although not all were assessed due to insufficient data, limited resource waters status, or predominantly channelized stream reaches. Of the lakes and streams mentioned previously, 90 lakes and 74 streams have been assessed (Tables 1 and 2). Although there are many streams and lakes that have been assigned AUIDs or DNR lake numbers, they may not have been assessed since they are too small (lakes under four hectares) or they are limited resource waters (ditches or heavily channelized streams).

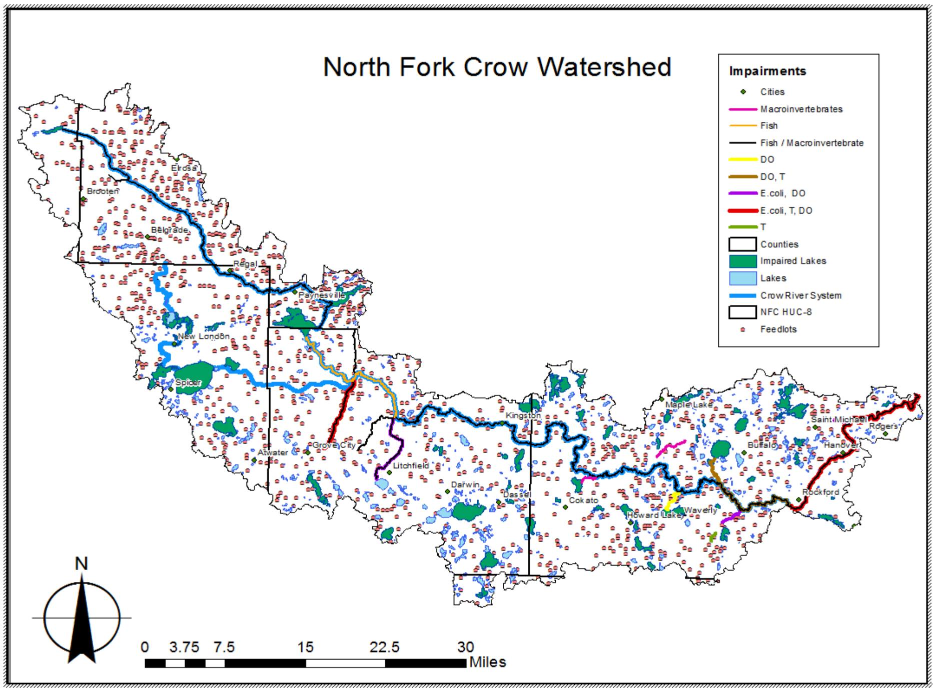


Figure 2. Impaired lakes, streams and feedlots in the NFC watershed.

In 2007 when this project began, the primary focus of the Minnesota Pollution Control Agency (MPCA) lake monitoring was lakes ≥500 acres (large lakes) in size since these represent 72% of the total lake area within Minnesota and generally provide the greatest aquatic recreational opportunity to Minnesota's citizens. The MPCA also supported monitoring of at least 25% of lakes between 100-499 acres (small lakes). Lakes also had to be accessible; therefore, many of the lakes that were assessed in this first 10 cycle meet one of these basic size criteria and have a public access.

Since this project begun as a demonstration and precursor of the watershed approach, all available lake data collected in a 10 year period ending in 2009 was used to assess selected lakes in the NFC watershed. Many of the assessed lakes had sufficient data points to assess water quality but in other cases, not enough data (minimum of five years) was available to detect clear water quality trends. (See *Assessment Report of Selected Lakes within the North Fork Crow River Watershed*)

Even when pooling MPCA, local and citizen resources, it was not possible to monitor and assess all 679 lakes in the NFC watershed in this first 10 year cycle. Agencies and local government units will coordinate with stakeholders to develop a monitoring program for the unassessed lakes. Collecting sufficient data points to fully assess the lakes that currently are classified as "IF" (Table 1) will be a priority for monitoring in the next cycle, which begins in 2017. Lakes that have active lake associations, high scores from the DNR's Watershed Health Assessment Framework Tool (WHAF), are designated by DNR as wild rice or priority shallow lakes, or unimpaired lakes that have a discernable downward trend will be targeted for assessment in the 2017 cycle.

Stream monitoring strategies utilized the nested watershed design that allows aggregation of watersheds from a coarse to a fine scale. Streams are broken into segments by HUCs to define separate waterbodies within a watershed. Minor subwatersheds are sampled near their outlets along with the major watershed outlet to provide a complete assessment of water quality. This monitoring approach, which was adopted by the MPCA in order to assess waters of the state via a 10-year cycle, provides a holistic and more fully integrated assessment of rivers and streams without monitoring every stream reach in the 8 digit HUC.

It is also important to note that only natural stream segments were assessed. Biological criteria has not been developed yet for channelized streams and ditches in Minnesota, therefore, assessment of fish and macroinvertebrate community data for aquatic life use support is not yet possible for channelized streams in Minnesota. Currently, the MPCA is deferring any new impairments on channelized reaches until new aquatic life use standards have been developed as part of the tiered aquatic life use (TALU) framework. For additional information on TALU see: http://www.pca.state.mn.us/index.php/water/water-permits-and-rules/water-rulemaking/tiered-aquatic-life-use-talu-framework.html

The NFC watershed lake and stream water quality conditions are typical of waters located in areas dominated by agricultural land uses. Although the watershed generally has water quality issues driven by land use, the general trend in lake water quality decreases from upstream to downstream (west to east) throughout the watershed. Further description of the condition of streams and lakes in the NFC watershed, including associated pollutant sources, are detailed in the following sections of this report.

The *North Fork Crow River Monitoring and Assessment Report* and the *Assessment of Selected Lakes within the North Fork Crow River Watershed (Pope, Stearns, Kandiyohi, Meeker, McLeod, Wright, and Hennepin Counties)* contain more detailed information on the lake and stream assessments that were completed for the NFC watershed project. These reports can be found at:

http://www.pca.state.mn.us/index.php/water/water-types-and-programs/watersheds/north-fork-crow-river.html

The *DNR Watershed Conditions Report – North Fork Crow River Watershed* contains more detailed information on watershed health index scores that represent important ecological relationships in the NFC watershed. More information can be found at:

http://www.dnr.state.mn.us/whaf/index.html

2.1 Condition Status

The purpose of this section is to summarize the impairment status of the lakes and streams assessed within the NFC watershed. The streams summarized in Table 1 have been assessed for aquatic life parameters including dissolved oxygen (DO), index of biotic integrity (IBI), and turbidity; in addition, aquatic recreation parameters include bacteria (fecal coliform or *E. coli*) were also used to assess streams. Lakes in Table 2 have been evaluated for aquatic recreation, which are assessed using total phosphorus (nutrient) criteria. Some of the waterbodies in the NFC watershed are impaired by mercury; however, this report does not cover toxic pollutants. For more information on mercury impairments see the statewide mercury TMDL at: http://www.pca.state.mn.us/wfhy9efl.

In general, water quality declines from upstream to downstream or from west to east. Most of the nutrient lake impairments, with a few exceptions, are located in the eastern half of the watershed while stream impairments are located throughout the watershed. Many of the impairments in the NFC watershed are typical of a predominantly agricultural watershed. As a result, lake eutrophication caused by excess nutrient runoff is a typical stressor for lake water quality, whereas stream channel modification and overland runoff are a primary stressor resulting in *E. coli*, turbidity, and dissolved oxygen violations (Wenck, 2012; Wenck, 2013).

Streams

Of the 233 reaches assigned AUIDs, 74 have been assessed for aquatic life or aquatic recreation. The parameters, as mentioned previously, used to assess aquatic life are IBI, DO, and turbidity, while the parameter used to assess aquatic recreation is bacteria (*E. coli* and fecal coliform). The 74 AUIDs assessed using the aforementioned criteria are summarized in Table 1, which is organized by HUC-10 watershed, listed from west to east. Of the 74 that have been assessed, four fully support aquatic life and one fully supports aquatic recreation, while 20 are impaired for aquatic life and 16 are impaired for aquatic recreation.

TMDLs were completed for stream reaches on the 2010 303(d) impaired waters list. Additional impairments were identified and added to subsequent 303(d) lists as assessments were completed through the NFC watershed process. Due to timing of the watershed process, budgeting and contracting constraints, the additional new stream impairments are deferred until the 2017 cycle.

Table 1. Assessment status of stream reaches in the NFC Watershed, presented (mostly) from upstream to downstream.

	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life				Aq Rec
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Bacteria
Lake Koronis - North Fork Crow (0701020401)	531	Skunk River	Headwaters to NFC River	NA	NA	IF		
	576	County Ditch 5	Unnamed Cr to N Fk Crow R	IF	IF		Sup	NA
	579	Sedan Brook	CD 36 to N Fk Crow R	Imp		Imp	Sup	NA
	580	County Ditch 7	Unnamed Ditch to N Fk Crow R	NA		IF	Sup	NA
	581	County Ditch 7	Unnamed Ditch to N Fk Crow R	NA	NA	IF	Sup	NA
	582	Judicial Ditch 1	Unnamed Ditch to Grove Lk			Imp	Sup	NA
	583	Judicial Ditch 1	Lincoln Lk to Unnamed ditch			Imp	Sup	NA
	584	Judicial Ditch 1	Unnamed Ditch to N Fk Crow R	NA		Imp	Sup	NA
	685	Crow River, North Fork	Headwaters (Grove Lk-61-0023-00) to Rice Lk	Imp		Imp	Sup	NA
	687	Crow River, North Fork	Rice Lk to Lk Koronis	NA	Imp	Imp	Sup	Sup
	553	Unnamed Creek (County Ditch 4)	Unnamed Cr to Lk Koronis	NA	NA	IF	Sup	
	578	County Ditch 32	Unnamed Ditch to N Fk Crow R	NA		Imp	Sup	
	504	Crow River, North Fork	Lk Koronis to M Fk Crow R	Imp	Imp	IF	Sup	
Middle Fork Crow River (0701020402)	536	County Ditch 37	Unnamed Cr to M Fk Crow R	NA	NA		Sup	NA
	537	Crow River, Middle Fork	Headwaters to Mud Lk	Sup	Sup		Sup	NA

Imp= Impaired for impacts to aquatic recreation, Sup= Fully supporting aquatic recreation, IF= Insufficient data to make an assessment, NA= Not assessed

Table 1, continued. Assessment status of stream reaches in the NFC Watershed, presented (mostly) from upstream to downstream.

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life				Aq Rec
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Bacteria
Middle Fork Crow River Continued (0701020402)	539	Crow River, Middle Fork	Mud Lk to Nest Lk	NA	NA	Imp	Sup	IF
	577	County Ditch B6	Unnamed Cr to N Fk Crow R	Sup	Sup		Sup	NA
	722	Unnamed Creek	Headwaters (Unnamed lk 34-0046) to Diamond Lk			IF	IF	NA
	723	Unnamed Creek	Hubbard Lk to Diamond Lk			IF	IF	NA
	724	Unnamed Creek (Alvig Slough)	Unnamed Lk (34-0113) to Green Lk			IF	IF	NA
	651	Unnamed Creek	Long Lake to M Fk Crow R	IF	IF			NA
	511	Crow River, Middle Fork	Green Lk to N Fk Crow R	NA	NA	IF	Sup	Imp
	541	Crow River, Middle Fork	Nest Lk to Green Lk				Sup	NA
	569	County Ditch 26	Unnamed ditch to Lk Calhoun	IF	IF		Imp	NA
	589	Unnamed Creek	Unnamed Cr to Diamond Lk	IF	IF			NA
	672	Unnamed Creek	Headwaters to Wheeler Lk	IF	IF			NA
Jewetts Creek-North Fork Crow River (0701020403)	514	Grove Creek	Unnamed Cr to N fk Crow R	Imp	Imp	Imp	Imp	Imp
	643	County Ditch 26	Unnamed Lk to Long Lake	NA			Imp	

Imp= Impaired for impacts to aquatic recreation, Sup= Fully supporting aquatic recreation, IF= Insufficent data to make an assessment, NA= Not assessed

Table 1, Continue. Assessment status of stream reaches in the NFC Watershed, presented (mostly) from upstream to downstream.

				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Bacteria
Jewetts Creek-North Fork Crow River continued (0701020403)	552	Unnamed Creek (Battle Creek)	T120 R31W S32, south line to Jewitts Cr	Imp	Imp			
	585	Jewitts Creek	Headwaters (Lk Ripley 47-0134-00) to NFC R	Imp	Imp	Imp	Sup	Imp
	506	Crow River, North Fork	Jewitts Cr to Washington Cr	Imp	Imp	IF	Sup	IF
	507	Crow River, North Fork	M Fk Crow R to Jewitts Cr	Imp	Sup	IF	Sup	Imp
	572	Stag Brook	Headwaters (Unnamed lk 73-0153-00) to NFC R	Imp	Imp			
Washington Creek (0701020404)	518	Washington Creek (CD 9)	Washington Lk to N Fk Crow R	NA	NA	Imp	Sup	Imp
	547	County Ditch 36	Powers Lk outlet to Washington Cr	NA	NA		Sup	
	728	Unnamed Creek	Headwaters to Lk Minnebelle					
	623	Unnamed Creek	Dunns Lk to CD 36					
	616	Unnamed Creak (CD 35)	Unnamed Cr to Richardson Lk					
	615	Unnamed Creak (CD 35)	Headwaters to Unnamed Cr					
	669	Lake Minnie Belle Outlet	Lk Minnie Belle to T118 R31W S12, east line			IF	Sup	Imp

Imp= Impaired for impacts to aquatic recreation, Sup= Fully supporting aquatic recreation, IF= Insufficient data to make an assessment, NA= Not assessed

Table 1, continued. Assessment status of stream reaches in the NFC Watershed, presented (mostly) from upstream to downstream.

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life				Aq Rec
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Bacteria
Big Swan Lake (0701020405)	546	Unnamed Creek (Big Swan Outlet)	Big Swan Lk to N Fk Crow R			IF	Sup	IF
	557	Silver Creek	Unnamed Cr to Collinwood Lk	NA			Sup	
	604	Collinwood Creek	Unnamed Cr (Unnamed Lk 47-0031) to Big Swan	NA		Imp	Imp	Imp
	720	Unnamed Creek	Maple Lk to Collinwood Lk				IF	
North Fork Crow River (0701020406)	682	Sucker Creek	Cokato Lk to N Fk Crow R	Sup	Imp	Imp	Imp	Imp
	684	Sucker Creek	Headwaters to Cokato	NA	NA	IF		IF
	559	County Ditch 10	Unnamed Ditch to Grass Lake				Imp	
	560	County Ditch 10	Grass Lake to Unnamed Ditch				Sup	
	561	Unnamed Ditch	Headwaters to CD 10				Imp	
	563	County Ditch 10	Unnamed Ditch to Unnamed ditch	NA	NA		Sup	
	564	County Ditch 10	Unnamed Ditch to Lk Ann				Sup	
	565	Unnamed Creek	Lk Emma to Twelvemile Cr				Sup	
	595	Unnamed Creek	Headwaters to Howard Lk				Sup	
	596	Unnamed Creek	Headwaters to Howard Lk				Sup	
	634	Unnamed Creek	Waverly Lk to Little Waverly Lk				Sup	Imp
	648	Unnamed Creek	Headwaters to Waverly Lk				Imp	
	679	Dutch Lake to Little Waverly Lake	Dutch Lk to Little Waverly Lk				Sup	

Imp= Impaired for impacts to aquatic recreation, Sup= Fully supporting aquatic recreation, IF= Insufficient data to make an assessment, NA= Not assessed

Table 1, continued. Assessment status of stream reaches in the NFC Watershed, presented (mostly) from upstream to downstream.

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life				Aq Rec
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Bacteria
North Fork Crow River continued (0701020406)	515	Mill Creek	Buffalo Lk to N Fk Crow R			Imp	Imp	Imp
	524	Mill Creek	Ramsey Lk to Buffalo Lk	Sup	Sup			
	681	Little Waverly Lk to NFC River	Little Waverly Lk to N Fk Crow R				IF	
	667	Unnamed Creek	Woodland WMA wetland to N Fk Crow R	NA			Sup	
	668	Unnamed Creek	Unnamed Cr to Woodland WMA Wetland			Imp	Sup	Imp
	503	Crow River, North Fork	Mill Cr. To S Fk Crow R	Imp	Imp	Imp	Imp	Imp
	509	Eagle Creek	Unnamed Cr to N Fk Crow R	NA				
	555	Crow River	North Fork Crow River	Imp	Imp			
	556	Crow River, North Fork	Meeker/Wright County line to Mill Creek	Imp	Imp	IF	Imp	Imp
	725	Crow River, North Fork	Unnamed Creek: Wetland to French Lake	IF	IF			IF
	543	Unnamed Creek	Headwaters to Unnamed Cr		Imp			
	592	French Creek	French Lk to N Fk Crow R	NA			Sup	
	656	Unnamed Creek	Headwaters to Unnamed Creek	NA				
Crow River (0701020407)	625	Unnamed Creek	Headwaters to Lk Sarah				Sup	
	628	Sarah Creek	Lk Sarah to Crow R	NA			Imp	
	627	Unnamed Creek	Headwaters to Lk Sarah				IF	
	542	Unnamed Creek (Regal Creek)	Unnamed Creek to Crow R			Imp	Sup	Imp
	502	Crow River	S Fk Crow to Mississippi R	Imp	Imp	Imp	Imp	Imp

Imp= Impaired for impacts to aquatic recreation, Sup = Fully supporting aquatic recreation, IF= Insufficient data to make an assessment, NA= Not assessed

Lakes

All 90 lakes assessed in the NFC watershed are classified as class 2B waters for which aquatic life and recreation are the protected beneficial uses (Table 2). The Minnesota standard for all class 2 waters states "…there shall be no material increase in undesirable slime growths or aquatic plants including algae." In order to evaluate whether a lake is in an impaired condition the MPCA developed "numeric translators" for the narrative standard for purposes of determining which lakes should be included in the section 303(d) list as being impaired for nutrients. Aquatic life impairments are determined using nutrient criteria parameters that include total phosphorus (TP), Secchi depth measurements, and chlorophyll-*a*.

Of the 90 lakes assessed, 46% are impaired for aquatic recreation, 33% are fully supporting aquatic recreation, and 21% have insufficient data to make an assessment. TMDLs were completed for all nutrient impaired NFC lakes on the draft 2012 303(d) impaired waters list.

Table 2. Assessment status of lakes in the NFC Watershed.

HUC-10 Subwatershed	Lake ID	Lake	Aquatic Recreation
Lake Koronis-North Fork Crow River (0701020401)	61-0023-00	Grove	Sup
	73-0200-02	Koronis (Main Basin)	IF
	73-0200-01	Koronis (Mud Lake)	Sup
	73-0144-00	Pirz	Sup
	73-0196-00	Rice	Imp
Middle Fork Crow River (0701020402)	34-0044-00	Diamond	Imp
	34-0049-00	Schultz	IF
	34-0062-00	Calhoun	Sup
	34-0066-00	Long	Sup
	34-0079-00	Green	Sup
	34-0119-00	Elkhorn	Sup
	34-0141-00	Woodcock	IF
	34-0142-00	George	Sup
	34-0154-00	Nest	Imp
	34-0158-01	Monongalia (Main Basin)	Sup
	34-0158-02	Monongalia (Middle Fork Crow River)	Sup
	34-0158-03	Crow River Mill Pond (East)	Sup
	34-0158-04	Crow River Mill Pond (Mid)	Sup
	34-0158-05	Crow River Mill Pond (West)	NA
	34-0051-01	Wheeler (Southwest Bay)	IF
	34-0051-02	Wheeler (Northeast Bay)	IF

Imp= Impaired for impacts to aquatic recreation, Sup= Fully supporting aquatic recration, IF= Insufficient data to make an assessment, NA= Not assessed

Table 2, continued. Assessment status of lakes in the NFC Watershed.

HUC-10 Subwatershed	Lake ID	Lake	Aquatic Recreation
Jewitts Creek-North Fork Crow River (0701020403)	47-0134-02	Ripley (West Portion)	Sup
	47-0138-00	Youngstrom	IF
	47-0177-00	Long	Imp
	47-0183-00	Hope	Imp
Washington Creek (0701020404)	47-0023-00	Arvilla	IF
	47-0046-00	Washington	Sup
	47-0050-00	Manuella	Sup
	47-0068-00	Stella	Sup
	47-0082-00	Dunns	Imp
	47-0088-00	Richardson	Imp
	47-0119-00	Minnie-Belle	Sup
Big Swan Lake (0701020405)	43-0073-00	Hook	Imp
	47-0014-00	Spencer	IF
	47-0015-00	Jennie	Imp
	47-0016-00	Wolf	IF
	47-0026-00	Long	Sup
	47-0032-00	Spring	Imp
	47-0038-00	Big Swan	Imp
	47-0064-00	Erie	Sup
	86-0293-00-00	Collinwood	Imp
North Fork Crow River (0701020406)	47-0002-00	Francis	Sup
	47-0040-00	Mud	IF
	86-0134-01	Upper Maple	Sup
	86-0190-00	Ann	Imp
	86-0199-00	Howard	Imp
	86-0263-00	Cokato	Imp
	86-0264-00	Brooks	Imp
	86-0273-00	French	Imp
	86-0274-00	Dans	IF
	86-0250-00	Smith	Imp
	86-0274-00	West Lake Sylvia	Sup
	86-0288-00	John	Sup
	86-0289-00	East Lake Sylvia	Sup
	86-0217-00	Granite	Imp
	86-0221-00	Camp	Imp
	86-0199-	Howard	Imp
	86-0184-00	Dutch	Imp

Imp= Impaired for impacts to aquatic recreation, Sup= fully supporting aquatic recreation, IF= Insufficient data to make an assessment, NA= Not assessed

Table 2, continued. Assessment status of lakes in the NFC Watershed.

HUC-10 Subwatershed	Lake ID	Lake	Aquatic Recreation
	0086-0190	Ann	Imp
	86-0188-00	Emma	Imp
	86-0193-00	Mary	Sup
	86-0182-00	Rock	Imp
	86-0106-00	Little Waverly	Imp
	86-0114-00	Waverly	Imp
	86-0120-00	Ramsey	Imp
	86-0097-00	Carrigan	IF
	86-0143-01	Upper Maple	Sup
	86-0119-00	Sullivan	IF
	86-0127-00	Albert	Imp
	86-0122-00	Light Foot	Imp
	86-0086-00	Fountain	Imp
	86-0112-00	Malardi	Imp
	86-0107-00	Deer	Imp
	86-0090-00	Buffalo	Imp
	86-0046-00	Crawford	Sup
North Fork Crow River (0701020406) Continued	86-0041-00	Dean	Imp
	86-0053-01	Little Pulaski	IF
	86-0053-02	Pulaski (Main Bay)	Sup
Crow River (0701020407)	86-0051-00	Constance	Imp
	86-0063-00	Green Mountain	IF
	86-0009-00	Martha	Sup
	86-0011-00	Charlotte	Sup
	86-0031-00	Pelican	Imp
	86-0023-00	Beebe	Imp
	86-0020-00	Wilhelm	IF
	27-0200-00	Rattail	IF
	27-0191-01	Sarah (West Bay)	Imp
	27-0191-02	Sarah (East Bay)	Imp
	27-0199-00	Hafften	Imp
	27-0177-00	Prairie	IF
	27-0171-00	Sylvan	IF
	27-0169-00	Cowley	Imp
	86-0001-00	Foster	Imp

Imp= Impaired for impacts to aquatic recreation, Sup= Fully supporting aquatic recreation, IF= Insufficient data to make an assessment, NA= Not assessed

2.2 Water Quality Trends

Long-term water quality was recorded at site S000-004 on the Crow River near Dayton, Minnesota from 1953 to 2009 for TSS, BOD, TP, Nitrite/Nitrate, Unionized Ammonia, chloride, and pH (Table 3). The MPCA used this dataset to analyze the long-term (1953 to 2009) and short-term (1995 to 2009) water quality trends (Seasonal Kendall Trend Test) in the NFC watershed (MPCA, 2011). Most parameters saw no significant change ($p < 0.1$) in long-term or short-term trends; however, total suspended solids decreased significantly from 1995 to 2009 and Nitrite/Nitrate and chloride increased significantly from 1953 to 2009 (MPCA, 2011).

Table 3. Water quality trends of the Crow River near Dayton, where green values indicate an improving trend in water quality for that parameter while red values indicate a degrading trend in water quality for that parameter (MPCA, 2011)

Parameter	Historical Trend (1953-2009)	Recent Trend (1995-2009)
Total Suspended Solids	no trend	-35%
Biochemical Oxygen Demand	no trend	no trend
Total Phosphorus	no trend	no trend
Nitrite/ Nitrate	+371%	no trend
Unionized Ammonia	no trend	no trend
Chloride	+893%	no trend
pH	no trend	no trend

2.3 Stressors and Sources

In order to develop appropriate strategies for restoring or protecting waterbodies the stressors and/or sources impacting or threatening them must be identified and evaluated. Biological stressor identification is done for streams with either fish or macroinvertebrate biota impairments and encompasses evaluation of pollutant and non-pollutant-related factors as potential stressors (e.g. altered hydrology, fish passage, habitat). Pollutant source assessments are done where a biological stressor ID process identifies a pollutant as a stressor as well as for the typical pollutant impairment listings. There are three stressor identification documents (SID) that were prepared for NFC AUIDs with biotic impairments. These documents are available at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/watersheds/north-fork-crow-river.html Section 3 of this report provides further detail on stressors and pollutant sources.

Stressors of Biologically-Impaired Stream Reaches

There are currently five streams in the NFC that are impaired for biotic integrity, which also have stressor ID reports published (MPCA, 2012; MPCA, 2013; MPCA, 2014; MPCA). The primary causes for IBI impairments in Table 4 are low dissolved oxygen and excess deposited and bedded sediment (MPCA, 2012; MPCA, 2013; MPCA, 2014; MPCA).

Table 4. Primary stressors to aquatic life in biologically-impaired reaches in the NFC Watershed.

HUC-10 Subwater-shed	AUID (Last 3 digits)	Stream	Reach Description	Biological Impairment	Primary Stressor							
					Dissolved Oxygen	Nitrate	Phosphorus	Turbidity	Fish Passage (dams)	Altered Hydrology	Habitat	Deposited & Bedded Sediment
Lake Koronis-North Fork Crow River	504	Crow River, North Fork	Lk Koronis to M Fk Crow R	Macroinvert.							●	●
Jewitts Creek-North Fork Crow River	514	Grove Creek	Unnamed Cr to N Fk Crow R	Fish & Macroinvert.	●			●				●
	552	Unnamed Creek	T120 R31W S32, south line to Jewitts Cr	Fish & Macroinvert.	●					●		●
	585	Jewitts Creek	Headwaters (Lk Ripley 47-0134-00) to N Fk Crow R	Fish & Macroinvert.	●							●
North Fork Crow River	543	Unnamed Creek	Unnamed Cr to Unnamed Cr	Macroinvert.	●					●	●	
Crow River	502	Crow River	S Fk Crow R to Mississippi R	Fish & Macroinvert.	●			●				

Pollutant Sources

Point and non-point sources of pollution were identified through previous TMDL processes, which are outlined in Table 5 and Table 6. Although each subwatershed in the NFC is unique, land use is similar throughout the 8 digit HUC watershed, which results in common pollutant sources in most streams or lakes. Section 3 uses the pollution source assessment to identify possible implementation steps and timelines for impaired and un-impaired stream reaches and lakes.

Table 5. Point Sources in the NFC Watershed

HUC-10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit conditions/limits?	Notes
	Name	Permit #	Type		
Lake Koronis-North Fork Crow River (701020401)	Paynesville GWP	MNG790109	Municipal stormwater	No	WLAs based on current permitted TSS limit of 45 mg/L, fecal coliform limit of 200 organisms/100 mL
	AMPI – Paynesville	MN0044326	Industrial wastewater	No	WLAs based on current permitted TSS limit of 45 mg/L, fecal coliform limit of 200 organisms/100 mL
	Paynesville WWTP	MN0020168	Municipal stormwater	No	WLAs based on current permitted TSS limit of 45 mg/L, fecal coliform limit of 200 organisms/100 mL
	Brooton WWTP	MN0066753	Municipal stormwater	No	WLAs based on current permitted TSS limit of 45 mg/L, fecal coliform limit of 200 organisms/100 mL
	Jennie-O Turkey Store - Groen Farm	MNG440598	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Wilner Farm	MNG440097	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Fritz Farm	MNG440097	CAFO	No	Zero Discharge Permit
	Paul Magedanz Farm 1	MN0069841	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Pearson Farm	MNG440598	CAFO	No	Zero Discharge Permit
	Anderson Farms - Stern Farm	MNG440980	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Munson Brood	MNG440097	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Roseville Farm	MNG440097	CAFO	No	Zero Discharge Permit

Table 5, continued. Point Sources in the NFC Watershed.

HUC-10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit conditions/limits?	Notes
	Name	Permit #	Type		
Lake Koronis-North Fork Crow River (0701020401) Continued	Freddy's Chicks Inc - Home Site	MNG441243	CAFO	No	Zero Discharge Permit
	Anderson Farms - West Qtr Finish Barns	MNG441097	CAFO	No	Zero Discharge Permit
	Anderson Farms - Jim's Place	MNG440967	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Ironside	MNG440875	CAFO	No	Zero Discharge Permit
Middle Fork Crow (0701020402)	Atwater WWTP	MN0022659	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 45 mg/L, fecal coliform limit of 200 organisms/100 mL
	Green Lake SSWD WWTP	MN0052752	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L, fecal coliform limit of 200 organisms/100 mL
	Belgrade WWTP	MN0051381	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 45 mg/L, fecal coliform limit of 200 organisms/100 mL
	Bushmills Ethanol	MN0067211	Industrial Wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L
	Jennie-O Turkey Store - Roulet Farm	MNG440103	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Galaxy Brood	MNG440103	CAFO	No	Zero Discharge Permit
	COJO Dairy	MNG441087	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Martin Farm	MNG440104	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Manannah Brood	MNG440103	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Wilcox Lake Farm	MNG440103	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Gausdahl Farm	MNG440875	CAFO	No	Zero Discharge Permit

Table 5, continued. Point sources in the NFC Watershed.

HUC-10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit conditions/limits?	Notes
	Name	Permit #	Type		
Middle Fork Crow (0701020402) Continued	Jennie-O Turkey Store - Belgrade 3	MNG440875	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Bach Farm	MNG440103	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Belgrade 2	MNG440875	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Belgrade 1	MNG440875	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Thorson Farm	MNG440598	CAFO	No	Zero Discharge Permit
	Sonset Ridge	MNG441086	CAFO	No	Zero Discharge Permit
	Willmar Poultry Farms Inc - Highway 71	MNG440123	CAFO	No	Zero Discharge Permit
Jewitts Creek-North Fork Crow River (0701020403)	Litchfield WWTP	MN0023973	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L, fecal coliform limit of 200 organisms/100 mL
	Grove City WWTP	MN0023574	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L, fecal coliform limit of 200 organisms/100 mL
	Shoreview Farm Inc	MNG440408	CAFO	No	Zero Discharge Permit
	Sparboe Farms Inc	MNG440447	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Ross Farm	MNG440104	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Johnson Grower	MNG440104	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - Johnson Brooder	MNG440104	CAFO	No	Zero Discharge Permit
	Jennie-O Turkey Store - White Oak Farm	MNG440104	CAFO	No	Zero Discharge Permit
	Kandi Pork Inc	MNG440833	CAFO	No	Zero Discharge Permit

Table 5, continued. Point Sources in the NFC Watershed.

HUC-10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit conditions/limits?	Notes
	Name	Permit #	Type		
Washington Creek (0701020404)	Darwin WWTP	MNG580150	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 45 mg/L, fecal coliform limit of 200 organisms/100 mL
	Dassel WWTP	MN0054127	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 45 mg/L, fecal coliform limit of 200 organisms/100 mL
North Fork Crow River (0701020406)	Faribault Foods - Cokato	MN0030635	Industrial wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L
	Buffalo WWTP	MN0040649	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L, fecal coliform limit of 200 organisms/100 mL
	Annandale/Maple Lake/Howard Lake WWTP	MN0066966	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 45 mg/L, fecal coliform limit of 200 organisms/100 mL
	Cokato WWTP	MN0049204	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 45 mg/L, fecal coliform limit of 200 organisms/100 mL
	Montrose WWTP	MN0024228	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 45 mg/L, fecal coliform limit of 200 organisms/100 mL
	Great River Energy of Dickinson	MN0049077	Industrial wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L
	Northern Lights 2009-2010 Zone EF	MN0069396	Industrial wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L
	Woodland Dairy Inc	MN0064041	CAFO	No	Zero Discharge Permit
	Forsman Farms Inc	MNG440334	CAFO	No	Zero Discharge Permit
	Alpha Foods LLP	MNG440324	CAFO	No	Zero Discharge Permit

Table 5, continued. Point Sources in the NFC Watershed.

HUC-10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit conditions/limits?	Notes
	Name	Permit #	Type		
Crow River (0701020407)	Rogers WWTP	MN0029629	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L, fecal coliform limit of 200 organisms/100 mL
	Meadows of Whisper Creek WWTP	MN0066753	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L, fecal coliform limit of 200 organisms/100 mL
	Saint Michael WWTP	MN0020222	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L, fecal coliform limit of 200 organisms/100 mL
	Greenfield WWTP	MN0063762	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L, fecal coliform limit of 200 organisms/100 mL
	Rockford WWTP	MN0024627	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L, fecal coliform limit of 200 organisms/100 mL
	Otsego East WWTP	MN0064190	Municipal Wastewater	No	WLAs based on current permitted TSS limit of 30 mg/L, fecal coliform limit of 200 organisms/100 mL

Table 6. Nonpoint Sources in the NFC Watershed. Relative magnitudes of contributing sources are indicated.

HUC-10 Subwatershed	Stream/Reach (AUID) or Lake (ID)	Pollutant	Pollutant Sources														
			Fertilizer & manure run-off	Livestock overgrazing in riparian	Failing septic systems	Wildlife	Stream Channelization	Upland soil erosion	Urban Runoff	Internal TP Sediment Release	Aquatic Vegetation	Upstream Lakes	Rough Fish	WWTP Discharge	In-stream Algal production	Sediment BOD	Bank Erosion
Lake Koronis-North Fork Crow River (0701020401)	Rice lake (73-0196)	TP	~							™							
Middle Fork Crow River (0701020402)	Nest (34-0154)	TP	›							~	Δ	~					~
Jewitts Creek-North Fork River (0701020403)	Long (47-0177)	TP	~							~			Δ				
	Hope (47-0183)	TP	~							~			™				
	Grove Creek (515)	Turbidity						~				™			™		
		E. coli	~	™	™	™											
		DO					~							›			
	Jewitts Creek (585)	*E. Coli*	~	™	™	™											
		DO					~										
Washington Creek (0701020404)	Richardson (47-0088)	TP	~							~			Δ				
	Dunns (47-0082)	TP			›					~		›	Δ				
Big Swan (0701020405)	Hook (43-0073)	TP	›							~			Δ				
	Jennie (47-0015)	TP	~							›	Δ		Δ				
	Collinwood (86-0293)	TP	~						›	›	Δ		Δ				
	Spring (47-0032)	TP	›		›				›	~	Δ		Δ				
	Big Swan (47-0038)	TP	~								™	Δ	™				

Key: ~ = High › = Moderate ™ = Low Δ = Potential source, relative magnitude unknown

Table 6, continued. Nonpoint Sources in the NFC Watershed. Relative magnitudes of contributing sources are indicated.

HUC-10 Subwatershed	Stream/Reach (AUID) or Lake (ID)	Pollutant	Pollutant Sources														
			Fertilizer & manure run-off	Livestock overgrazing in riparian	Failing septic systems	Wildlife	Stream Channelization	Upland soil erosion	Urban Runoff	Internal TP Sediment Release	Aquatic Vegetation	Upstream Lakes	Rough Fish	WWTP Discharge	In-stream Algal production	Sediment BOD	Bank Erosion
North Fork Crow River (0701020406)	Brooks (86-0264)	TP	›		›					~	Δ						
	Cokato (86-0263)	TP	~		›						Δ		Δ				
	French (86-0273)	TP	~		›								Δ				
	Smith (86-0250)	TP	›							~							
	Granite (86-0217)	TP	~							~	Δ		Δ				
	Camp (86-0221)	TP	~							~							
	Howard (86-0199)	TP	›							~	Δ		Δ				
	Dutch (86-0184)	TP	~							~	Δ		Δ	™			
	Rock (86-0182)	TP	›		›					~	Δ		Δ				
	Little Waverly (86-0106)	TP	~							›		›	Δ				
	Waverly (86-0114)	TP	~						›	~	Δ		Δ	™			
	Ramsey (86-0120)	TP	~		›					›	Δ		Δ				
	Albert (86-0127)	TP	›							~			Δ				
	Light Foot (86-0122)	TP	~		›					~	Δ		Δ				
	Fountain (86-0273)	TP	™		™					~							

Key: ˜ = High › = Moderate ™ = Low Δ = Potential source, relative magnitude unknown

Table 6, continued. Nonpoint Sources in the NFC Watershed. Relative magnitudes of contributing sources are indicated.

HUC-10 Subwatershed	Stream/Reach (AUID) or Lake (ID)	Pollutant	Fertilizer & manure run-off	Livestock overgrazing in riparian	Failing septic systems	Wildlife	Stream Channelization	Upland soil erosion	Urban Runoff	Internal TP Sediment Release	Aquatic Vegetation	Upstream Lakes	Rough Fish	WWTP Discharge	In-stream Algal production	Sediment SOD	Bank Erosion
			Pollutant Sources														
North Fork Crow River Continued (0701020406)	Malardi (86-0112)	TP	›							˜							
North Fork Crow River Continued (0701020406)	Deer (86-0107)	TP								›	Δ	˜	Δ				
North Fork Crow River Continued (0701020406)	Buffalo (86-0090)	TP	›		›					˜	Δ	˜	Δ				
North Fork Crow River Continued (0701020406)	Dean (86-0041)	TP	˜		™					˜							
North Fork Crow River Continued (0701020406)	Mill Creek (515)	DO	˜				›					˜					
North Fork Crow River Continued (0701020406)	Mill Creek (515)	Turbidity						˜			Δ				™		
North Fork Crow River Continued (0701020406)	Count Ditch 31 (667)	DO	˜				˜										
North Fork Crow River Continued (0701020406)	Count Ditch 31 (667)	*E. coli*	˜	™	™	™											
North Fork Crow River Continued (0701020406)	Unnamed Creek (668)	Turbidity						˜									
North Fork Crow River Continued (0701020406)	North Fork Crow River (503)	Turbidity						˜									˜
North Fork Crow River Continued (0701020406)	Ann (86-0190)	TP	˜							˜							
North Fork Crow River Continued (0701020406)	Emma (86-0188)	TP	˜					˜		˜							
Crow River (0701020407)	Constance (86-0051)	TP	›		›					˜	Δ						
Crow River (0701020407)	Pelican (86-0031)	TP	›							›							
Crow River (0701020407)	Beebe (86-0023)	TP	˜		›					˜	Δ		Δ				›
Crow River (0701020407)	Hafften (86-0199)	TP	›							˜							
Crow River (0701020407)	Foster (86-0001)	TP	˜							˜	Δ						
Crow River (0701020407)	Crow River (502)	*E. coli*	›	˜	™												
Crow River (0701020407)	Crow River (502)	Turbidity	™												˜		
Crow River (0701020407)	Regal Creek (542)	DO														˜	
Crow River (0701020407)	Regal Creek (542)	*E. coli*	˜	™	™	™											

Key: ˜ = High › = Moderate ™ = Low Δ = Potential source, relative magnitude unknown

2.4 TMDL Summary

The TMDL studies have been conducted that include the North Fork Crow and Lower Crow Bacteria, Turbidity, and Low Dissolved Oxygen TMDL (Wenck Assoc., approved 2013), Rice Lake Excess Nutrient TMDL (Wenck Associates, approved 2012), Diamond Lake (Houston Eng., approved 2011), Ann and Emma Lakes (Wenck Assoc., approved 2012) and North Fork Crow River TMDL: Bacteria, Nutrients, and Turbidity (Wenck Assoc., *In review.)* These documents contain allocation load reductions for stream and lake impairments, which are summarized for reference in Table 7 and Table 8 of this report. Additionally, Section 3 prioritizes watersheds into protection and restoration areas using pollutant loading analysis, which also outlines strategies for watershed loading reductions. The comprehensive TMDL reports for the NFC can be found at the links provided above.

Table 7. Allocation summary for completed lake TMDLs in the NFC River watershed.

			Allocations (lbs/year)										
			Wasteload Allocation			Load Allocation					MOS	RC	
HUC-10	Lake (ID)	Pollutant	WWTFs	Construction & Industrial Stormwater	MS4 Communities	Watershed Load	Internal Load	Upstream Lakes	SSTS	Atmosphere	Margin of Safety	Reserve Capacity	Percent Reduction
Lake Koronis-North Fork Crow River (701020401)	Rice Lake (73-0196)	TP	3,144	9	--	23,393	445	--	--	301	1,484	--	53%
Middle Fork Crow (0701020402)	Nest (34-0154)	TP	1,017	14	--	1,280	747	2,389	0	241	299	--	13%
	Diamond (34-0044)	TP	--	--	--	1,550	227	343	0	258	668	--	44%
Jewitts Creek-North Fork Crow River (0701020403)	Hope (47-0183)	TP	--	165	--	250	147	--	0	60	33	--	85%
	Long (47-0177)	TP	--	152	--	1,936	276	361	0	184	153	--	89%
Washington Creek (0701020404)	Richardson (47-0088)	TP	--	12	--	452	61	--	0	26	29	--	57%
	Dunns (47-0082)	TP	--	0.3	--	17	157	113	0	34	17	--	73%
Big Swan Lake (701020405) Continued	Hook (43-0073)	TP	--	3	--	298	339	--	0	73	38	--	66%
	Jennie (47-0015)	TP	--	14	--	1,271	851	96	0	254	131	--	12%

Table 7, continued. Allocation summary for all completed lake TMDLs in the NFC River Watershed.

HUC-10	Lake (ID)	Pollutant	Allocations (lbs/year)										Percent Reduction
			Wasteload Allocation			Load Allocation					MOS	RC	
			WWTFs	Construction & Industrial Stormwater	MS4 Communities	Watershed Load	Internal Load	Upstream Lakes	SSTS	Atmosphere	Margin of Safety	Reserve Capacity	
Big Swan Lake (701020405) Continued	Collinwood (86-0293)	TP	--	47	--	1,531	147	478	0	152	124	--	72%
	Spring (47-0032)	TP	--	0.9	--	62	166	38	0	52	17	--	57%
	Big Swan (47-0038)	TP	--	38	--	1,194	58	1,059	0	166	132	--	63%
North Fork Crow River (701020406)	Brooks (86-0254)	TP	--	0.2	--	7	69	--	0	21	5	--	57%
	Cokato (86-0263)	TP	794	46	--	2,800	77	30	0	130	204	--	34%
	Smith (86-0250)	TP	--	3	--	87	133	--	0	50	14	--	86%
	French (86-0273)	TP	--	7	--	674	105	--	0	83	46	--	13%
	Granite (86-0217)	TP	--	--	--	357	296	--	0	78	15	--	50%
	Camp (86-0221)	TP	--	3	--	128	248	--	0	26	12	--	70%

Table 7, continued. Allocation summary for all completed lake TMDLs in the NFC River Watershed.

HUC-10	Lake (ID)	Pollutant	Allocations (lbs/year)										Percent Reduction
			Wasteload Allocation			Load Allocation					MOS	RC	
			WWTFs	Construction & Industrial Stormwater	MS4 Communities	Watershed Load	Internal Load	Upstream Lakes	SSTS	Atmosphere	Margin of Safety	Reserve Capacity	
North Fork Crow River (701020406) Continued	Deer (86-0107)	TP	--	1.6	--	143	220	1,793	0	39	116	--	55%
	Dutch (86-0184)	TP	--	7	--	75	48	90	0	39	14	--	87%
	Little Waverly (86-0106)	TP	--	33	--	420	120	1,478	0	79	112	--	85%
	Waverly (86-0114)	TP	--	5	--	444	534	123	0	116	64	--	9%
	Rock (86-0182)	TP	--	1	--	66	148	--	0	148	7	--	44%
	Ramsey (86-0120)	TP	--	12	--	756	180	72	0	74	58	--	47%
	Albert (86-01270)	TP	--	1	--	32	22	--	0	14	4	--	87%
	Light Foot (86-0122)	TP	--	27	--	411	21	171	0	15	33	--	84%
	Buffalo (86-0090)	TP	--	19	274	799	643	1,445	0	371	186	--	66%
	Ann (86-0190)	TP	--	18	--	1,181	229	--	0	83	80	--	82%
	Emma (86-0188)	TP	--	4	--	284	193	985	0	42	78	--	60%
	Fountain (86-0086)	TP	--	18	--	130	362	--	0	102	32	--	87%
	Malardi (86-0112)	TP	--	3	--	55	43	--	0	26	7	--	95%
	Dean (86-0041)	TP	--	8	--	75	47	--	0	42	9	--	91%
Crow River (701020407)	Constance (86-86-0051)	TP	--	1	<1	54	125	--	0	39	11	--	75%
	Beebe (86-0023)	TP	--	2	--	78	214	--	0	66	19	--	48%
	Pelican (86-0031)	TP	--	29	243	1,129	2,678	69	0	827	260	--	74%
	Hafften (27-0199)	TP	--	<1	--	12	38	101	0	10	9	--	34%
	Foster (86-0001)	TP	--	9	220	--	135	--	0	27	20	--	87%

Of the aforementioned approved TMDL studies, with the exception of the *North Fork and Lower Crow Bacteria, Turbidity, and Low Dissolved Oxygen TMDL*, all have a corresponding approved implementation plan. The restoration strategies set forth in this document will serve as the basis for the NF & Lower Crow TMDL implementation as well as the draft North Fork Crow Bacteria, Nutrients and Turbidity TMDL.

Table 8. Allocation summary for all completed bacteria and sediment TMDLs in the NFC River watershed.

<table>
<tr><th rowspan="3">HUC-10</th><th rowspan="3">Stream/Reach (AUID)</th><th rowspan="3">Pollutant</th><th rowspan="3">Flow Zone</th><th colspan="4">E. coli Allocations (billions organisms/day)
Sediment Allocations (tons/year)</th><th rowspan="3">Percent Reduction</th></tr>
<tr><th colspan="2">Wasteload Allocation</th><th>Load Allocation</th><th>MOS</th></tr>
<tr><th>WWTFs</th><th>Regulated Stormwater (CSW/ISW/MS4)</th><th>Watershed Load</th><th>Margin of Safety</th></tr>
<tr><td rowspan="15">Jewitts Creek-North Fork Crow River (0701020403)</td><td rowspan="10">Grove Creek (514)</td><td>E. coli</td><td rowspan="2">Very High</td><td>1.1</td><td>--</td><td>268</td><td>30</td><td>0%</td></tr>
<tr><td>TSS</td><td><0.1</td><td>--</td><td>6.6</td><td>0.3</td><td>0%</td></tr>
<tr><td>E. coli</td><td rowspan="2">High</td><td>1.1</td><td>--</td><td>104</td><td>12</td><td>0%</td></tr>
<tr><td>TSS</td><td><0.1</td><td>--</td><td>2.5</td><td>0.1</td><td>40%</td></tr>
<tr><td>E. coli</td><td rowspan="2">Mid</td><td>1.1</td><td>--</td><td>40</td><td>4.5</td><td>47%</td></tr>
<tr><td>TSS</td><td><0.1</td><td>--</td><td>1.0</td><td>0.1</td><td>45%</td></tr>
<tr><td>E. coli</td><td rowspan="2">Low</td><td>1.1</td><td>--</td><td>15</td><td>1.8</td><td>50%</td></tr>
<tr><td>TSS</td><td><0.1</td><td>--</td><td>0.4</td><td><0.1</td><td>0%</td></tr>
<tr><td>E. coli</td><td rowspan="2">Dry</td><td>1.1</td><td>--</td><td>8.4</td><td>1.1</td><td>72%</td></tr>
<tr><td>TSS</td><td><0.1</td><td>--</td><td>0.2</td><td><0.1</td><td>0%</td></tr>
<tr><td rowspan="5">Jewitts Creek (585)</td><td rowspan="5">E. coli</td><td>Very High</td><td>11.3</td><td>28.8</td><td>183.4</td><td>24.8</td><td>0%</td></tr>
<tr><td>High</td><td>11.3</td><td>11.3</td><td>71.7</td><td>10.5</td><td>0%</td></tr>
<tr><td>Mid</td><td>11.3</td><td>4.0</td><td>25.2</td><td>4.5</td><td>0%</td></tr>
<tr><td>Low</td><td>11.3</td><td>1.3</td><td>8.3</td><td>2.3</td><td>41%</td></tr>
<tr><td>Dry</td><td>11.3</td><td>0.2</td><td>1.4</td><td>1.4</td><td>55%</td></tr>
<tr><td rowspan="10">Jewitts Creek-North Fork Crow River (0701020406)</td><td rowspan="5">Unnamed Creek (667)</td><td rowspan="5">E. coli</td><td>Very High</td><td>--</td><td>--</td><td>172</td><td>19</td><td>40%</td></tr>
<tr><td>High</td><td>--</td><td>--</td><td>14</td><td>1.5</td><td>19%</td></tr>
<tr><td>Mid</td><td>--</td><td>--</td><td>1</td><td><1</td><td>67%</td></tr>
<tr><td>Low</td><td>--</td><td>--</td><td><1</td><td><1</td><td>62%</td></tr>
<tr><td>Dry</td><td>--</td><td>--</td><td><1</td><td><1</td><td>86%</td></tr>
<tr><td rowspan="5">Unnamed Creek (668)</td><td rowspan="5">TSS</td><td>Very High</td><td>--</td><td>--</td><td>3.7</td><td>0.2</td><td>0%</td></tr>
<tr><td>High</td><td>--</td><td>--</td><td>0.7</td><td><0.1</td><td>0%</td></tr>
<tr><td>Mid</td><td>--</td><td>--</td><td>0.1</td><td><0.1</td><td>0%[1]</td></tr>
<tr><td>Low</td><td>--</td><td>--</td><td><0.1</td><td><0.1</td><td>0%[1]</td></tr>
<tr><td>Dry</td><td>--</td><td>--</td><td>0.0*</td><td>0.0*</td><td>0%[1]</td></tr>
</table>

Table 8, continued. Allocation summary for all completed bacteria and sediment TMDLs in the NFC River Watershed

HUC-10	Stream/Reach (AUID)	Pollutant	Flow Zone	E. coli Allocations (billions organisms/day) Sediment Allocations (tons/year) — Wasteload Allocation: WWTFs	Wasteload Allocation: Regulated Stormwater (CSW/ISW/MS4)	Load Allocation: Watershed Load	MOS: Margin of Safety	Percent Reduction
Jewitts Creek-North Fork Crow River (0701020406) (continued)	Mill Creek (515)	TSS	Very High	--	13.0	70.0	6.5	0%
			High	--	2.6	14.2	1.3	0%
			Mid	--	0.5	2.7	0.3	33%
			Low	--	0.1	0.5	<0.1	0%
			Dry	--	<0.1	0.2	<0.1	20%
	North Fork Crow (503)	*TSS*	Very High	2.8	20.8	345	3.8	35%
			High	2.8	8.5	135	12.1	40%
			Mid	2.8	2.4	36.6	2.0	13%
			Low	2.8	1.0	12.5	0.7	46%
			Dry	2.8	0.7	6.8	0.2	0%
Crow River (0701020407)	Crow River (502)	*E. coli*	Very High	109	242	5,758 (NFC) 593(LC)	1,367	5%
		TSS		3.4	59.5	308(NFC) 32(LC)	23	39%
		E. coli	High	109	138	3,326 (NFC) 333 (LC)	778	32%
		TSS		3.4	20.4	103(NFC) 11(LC)	21	87%
		E. coli	Mid	109	72	1,641 (NFC) 169 (LC)	406	41%
		TSS		3.4	5.8	27(NFC) 2.8(LC)	3.4	41%
		E. coli	Low	109	23	454 (NFC) 47 (LC)	129	26%
		TSS		3.4	2.3	8.7(NFC) 0.9(LC)	1.3	26%
		E. coli	Dry	109	7	65 (NFC) 7 (LC)	38	0%
		TSS		3.4	1.6	4.8(NFC) 0.5(LC)	0.4	0%
	Regal Creek (542)	*E. coli*	Very High	--	173.4	234.0	45.3	1%
			High	--	60.3	81.4	15.7	0%
			Mid	--	18.2	24.6	4.8	46%
			Low	--	6.6	8.9	1.7	83%
			Dry	--	3.7	5.0	1.0	81%

* No flow during median conditions

[1]Insufficient data

2.5 Protection Considerations

Even though there will be significant restoration efforts in the NFC, there are areas identified for protection as well. Of the 74 stream reaches that have been assessed, four fully support aquatic life and one fully supports aquatic recreation, while 20 are impaired for aquatic life and 16 are impaired for aquatic recreation. Of the 90 lakes assessed, 46% are impaired for aquatic recreation, 33% are fully supporting aquatic recreation, and 21% have insufficient data to make an assessment.

The following protection efforts are already underway and/or ongoing in the NFC:

Partner Organizations

CROW

The Crow River Organization of Water (CROW) has received a Clean Water Partnership (CWP) grant to develop protection strategies for individual chains of lakes aimed at maintaining the current water quality. These studies focus on water quality control, rough fish management, invasive species management, and other strategies to protect these resources. The Crow Lakes Protection and Resource Investigation CWP Project furthers CROW's diagnostic and assessment program by using a TMDL-like process to assess and protect high valued lakes. The Project's "virtual TMDL" studies will evaluate lake water quality relative to the MPCA eutrophication standards, assess external and internal TP loads, quantify maximum TP allocations, and identify TP reduction (or stabilization) plans or strategies for source areas. The Project will focus on ten lakes: Minnie-Belle, Manuella, Stella, Lake Washington, Francis, West Sylvia, East Sylvia, John, Charlotte, and Martha. These lakes are located throughout Meeker and Wright counties, are highly used recreational lakes with adjacent park lands: Greater Minnesota Girl Scout Council on Lake Charlotte (48.53 acres); Koinonia Retreat Center on East Sylvia (86.4 acres); St. John's Lutheran Camp on both East/West Sylvia (39.2 acres); and Lake Manuella Park (2 acres). These key lakes are parts of lake chains in which the whole chain is not impaired, and the protection strategies developed through this project will complement the TMDL implementation efforts to focus on comprehensively managing the chain as a system.

All of the lakes also are significant components because they provide quality water to the NFC River which is locally and regional important because it empties into the Mississippi River 20 miles upstream from the Minneapolis Water Plant intake. The Mississippi River provides drinking water to Minneapolis and provides most of the flow to the lower Mississippi Recreational area and the lower Mississippi Wildlife Refuge before flowing into Lake Pepin. The Crow River is a major river system in Wright County that directly drains two thirds of the county. It is a major recreational area in its own right, but also flows into the Mississippi River; a premier smallmouth bass fishery. At Project completion, diagnostic studies and implementation plans for 100% of the non-impaired chain of lakes in the NFC River Watershed will be completed.

NFCRWD

North Fork Watershed District has been awarded a 2013 Clean Water Fund Conservation Drainage Grant. The District is planning on implementing agricultural BMPs, including 100 Alternative Inlets (rock inlets or dense pattern tile intakes) and two saturated buffers, to reduce the nutrients, sediment and volume of water being transported by field tile. Implementation of these practices and continued education of landowners will hopefully lead to further acceptance from the agricultural community leading to landowner's installation of these BMP's improving water quality.

The NFC River Watershed is mainly agricultural and has numerous public and private drainage ditches. These ditches have become overwhelmed by land use change and sub-surface drainage, and are major contributors to the sediment and nutrient loading into the NFC River and District Lakes. The District received a Clean Water Assistance grant to assist in the protection and restoration of the District's water resources and help the District reach the Rice Lake TMDL phosphorous reductions goals. The District has landowners willing to contribute land on public drainage systems to retain water and restore wetlands at three locations with total anticipated yearly pollutant removal of 200 tons of total suspended sediment (TSS) and 235 pounds of phosphorus (TP).

MFWD

In 2011, the Middle Fork Watershed District partnered with Ducks Unlimited and the Diamond Lake Area Recreational Association to investigate the feasibility of actively managing water levels on the Hubbard, Schultz, and Wheeler chain of lakes to enhance their condition. Much of this feasibility work was completed with funding from Minnesota's Outdoor Heritage Fund as recommended by the Lessard-Sams Outdoor Heritage Council. The project has been deemed feasible, and in 2013 the Middle Fork Crow River Watershed District initiated the Hubbard, Schultz, and Wheeler lakes project.

DNR

The Minnesota DNR maintains a list of high priority shallow lakes for wildlife protection in the Crow River watershed. All shallow lakes of Minnesota were identified using Arc GIS by querying out of the lakes layer using the criteria of less than 15 feet deep and greater than 50 acres in size. Priority status would be given to those adjacent to or completely within public lands.

Many of these lakes have completed TMDLs while the remaining are either not assessed (IF) or support (FS) beneficial uses. These IF and FS shallow lakes also need protection strategies focused on maintaining or improving wildlife habitat. Additional information can be found in Appendix B: DNR Watershed Conditions Report.

Tools

MNLeap

The MPCA conducted MNLeap model (a lake assessment tool developed by the MPCA) assessments for each of the protection lakes to determine their best possible water quality conditions (MPCA 2010). General lake assessment for the NFC was aggregated by HUC 11 watershed units to determine if they were best suited to general protection or restoration strategies. The following HUC 11 watershed units were identified to have good water quality, therefore placed in protection status, based on a combination of MNLeap model assessment and observed water quality data: (See Appendix C)

- Upper Middle Fork Crow River
- Central Middle Fork Crow River
- Washington Creek

- Louzers Lake Outlet

The following HUC 11 watershed units were identified for restoration practices to prevent further water quality impacts (threatened): (See Appendix C)

- Upper NFC River
- Mill Creek

Stressor Identification (SID)

Conclusion from the NFC River SID Report states, "Index of Biological Integrity (IBI) scores are quite low throughout the length of the NFC/Lower Crow River mainstem. As a result, it is difficult to identify areas of outstanding ecological health that are deserving of protection status based solely on IBI data. Without question, the majority of implementation efforts in this watershed must be in the form of restoration, effective use of best management practices, and education and outreach. However, a stream reach located approximately two miles west of Paynesville, Minnesota has a good riparian corridor of mature trees and streambanks which are relatively stable. Coarse substrate for gravel spawning fish and darter species is abundant and substrate embeddedness appeared to be lower compared to other sites in the area. Fish IBI scores at site 96UM004, which is located in the upper portion of this potential protection priority area, are some of the highest on the NFC.

"Stream reconnaissance efforts revealed a few reaches of the NFC that may represent "best available" conditions for supporting healthy fish/macroinvertebrate populations. Most of these locations do not have biological data associated with them. Future monitoring in the watershed should target these locations to assess their condition and status as potential protection targets."

All of the streams and lakes that are currently supporting their beneficial uses (aquatic life and recreation), should have protection strategies developed. Strategies for addressing protection of these waters are further discussed in Section 3 of this report.

3. Prioritizing and Implementing Restoration and Protection

The Clean Water Legacy Act (CWLA) requires that WRAPS reports summarize priority areas for targeting actions to improve water quality, identify point and nonpoint sources of pollution with sufficient specificity to prioritize and geographically locate watershed restoration and protection actions. In addition, the CWLA requires including an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources.

This section of the report provides the results of such prioritization and strategy development. Because much of the nonpoint source strategies outlined in this section rely on voluntary implementation by landowners, land users and residents of the watershed it is imperative to create social capital (trust, networks, and positive relationships) with those needed to voluntarily implement best management practices. Thus, effective ongoing civic engagement is an essential part of the overall plan for moving forward.

CROW has been approved for state funding for the purpose of creating a single watershed plan for the NFC through the *One Watershed, One Plan* (1W1P) granting process. The 1W1P effort will require participation by 20+ organization/agency stakeholders in the NFC watershed that include: two watershed districts, two metro-water management authorities, and seven SWCDs. The CROW will include additional planning members by establishing a Memorandum of Understanding (MOU) between the aforementioned and CROW. Project partners are poised and eager to apply their knowledge and skills to make this project a success.

The 1W1P approach will provide a unique opportunity/catalyst for cost-effective coordination and implementation of local government and State government initiatives within the watershed. The 1W1P will serve as a “road-map” for the coordination and strengthening of local activities/plans, which will identify the most cost- effective solutions to accomplish water quality and quantity management, and establish a comprehensive framework for finance and implementation. A multi-jurisdictional standard, i.e., performance provision of the Plan, can serve to diffuse and deflect local politics in enforcement issues. Another very significant benefit of the 1W1P will be the efficiencies gained by updating only one plan every 10 years as compared to the current status of updating 10 separate and often overlapping water management plans every 10 years. The 1W1P is a natural progression with the WRAP reports for targeting actions to improve water quality, identify point and nonpoint sources of pollution that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources. For more information on the 1W1P refer to: http://www.bwsr.state.mn.us/planning/1W1P/index.html

3.1 Targeting of Geographic Areas

Targeting has been used at several scales to help identify priority areas in the NFC. The following discussion begins at the state and basin scale and moves to smaller more focused areas based on the specific tools used for this project.

State and Mississippi Basin Scale

The *Minnesota Nutrient Reduction Strategy* (MPCA, 2013) was developed in response to concern about excessive nutrient levels that pose a substantial threat to Minnesota’s lakes and rivers, as well as downstream waters including the Great Lakes, Lake Winnipeg, the Mississippi River, and the Gulf of Mexico. In recent decades, nutrient issues downstream of Minnesota have reached critical levels, including the effect of nutrients in the Gulf of Mexico which resulted in a dead zone, eutrophication issues in Lake Winnipeg, and algal blooms in the Great Lakes. Several state-level initiatives and actions highlighted the need for a statewide strategy that ties separate but related activities together to further progress in making nutrient reductions. Minnesota conducted both nitrogen and phosphorus assessments to identify nutrient source contributions. The main nutrient sources to the Mississippi River are Phosphorus from agricultural cropland runoff, wastewater, and streambank erosion, and Nitrogen from agricultural tile drainage and water leaving cropland via groundwater. The associated Phase I milestones for the Mississippi River basin N and P are 20% and 35% reduction from baseline by 2025 respectively. Additional milestones call for 30% (N) and 45% (P) by 2035 and 45% reduction from baseline in N by 2045.

Nitrogen in Minnesota Surface Waters (MPCA, 2013) was developed in response to a concern for human health when elevated Nitrogen levels reach drinking water supplies. The 10 mg/l nitrate-N drinking water standard established for surface and groundwater drinking water sources and for cold water streams is exceeded in numerous wells and streams. As noted in the Nutrient Reduction study above, the concern about nitrogen (N) in surface waters has grown due to nitrogen’s role in causing a large oxygen-depleted hypoxic zone in the Gulf of

Mexico, and an increasing body of evidence showing toxic effects of nitrate on aquatic life. The purpose of this study was to provide an assessment of the science concerning N in Minnesota waters so that the results could be used for current and future planning efforts, thereby resulting in meaningful goals, priorities, and solutions.

More specifically, the purpose of this project was to characterize N loading to Minnesota's surface waters, and assess conditions, trends, sources, pathways, and potential BMPs to achieve nitrogen reductions in our waters. The Nitrogen study contains a spreadsheet tool called the NBMP tool. (NBMP is described in more detail in the nitrogen study report chapter F1.) The NBMP tool was applied to the NFC watershed to calculate approximate acres of BMP adoption necessary to achieve roughly a 20% N reduction, which also aligns with the NRS Phase I reduction goal for N. Table 9 displays results of the NBMP tool.

Table 9. BMPs needed to achieve watershed goals.

Combination of needed BMPs	North Fork Crow (acres)
Reduce avg. N application rate 30 lbs (corn after soy)	158,000
Perennials in riparian and marginal lands	19,000
Constructed wetlands to treat tile water	9,000
Controlled drainage or bioreactors	6,000
Cover Crops	55,000

HUC 8 Scale

A wide variety of tools (datasets and GIS) were available to target geographic areas that are in need of restoration or protection (Table 10). Since the pollutants of primary concern in the NFC watershed are Total Phosphorous (TP), bacteria, suspended solids (turbidity) and nitrogen, a specific set of tools was used to assess the pollutant loading throughout the entire NFC watershed. The tools that were used in this WRAP report are:

- Hydrological Simulation Program – Fortran (HSPF)
    - Hydrology
    - Sediment Load
    - Total Phosphorus Load
    - Nitogen Load
- Watershed Bacteria Production by Source
- Environmental Benefit Index (EBI)

In addition to the tools used to target protection and restoration areas on a major basin scale (i.e. North Fork Crow Watershed), others were used on a finer scale in the TMDL process to target specific pollutant loading sources in each impaired watershed. The source assessment and reduction strategies derived from these focused tools are also summarized in Table 11. These tools include:

- The Revised Universal Soil Loss Equation (RUSLE)
- Watershed Bacteria Production by Source

- In Lake Nutrient Response Model (BATHTUB)
- Stream Power Index Using Light Detection and Ranging (LiDAR)

Priorities Based on HSPF Results

The HSPF model (see description in Table 11) for the NFC watershed was constructed by RESPEC, a consulting firm under contract with the MPCA. A detailed report summarizing calibration and validation results is available here. The HSPF model was first divided into 43 HUC-12 watersheds. To provide more detail the HUC-12 watersheds were further divided into subwatersheds based on differences in available climatology data and landscape characteristics such as a strategically located tributary or lake. The model simulated a period from 1996-2009 in one hour time steps. Results for average annual runoff and average annual load for TP, TN and TSS are shown in Figures 3-6.

The HSPF generated maps allow a quick visual comparison that can be used to generally identify priority areas for protection and restoration based on the aggregated HUC-12 subwatersheds. The following Table (Table 10) is a compilation of the general visual comparison of the HSPF and the EBI scores (Figure 7).

Table 10. HSPF map based priority subwatersheds within HUC-12s

	Restoration						Protection					
Aggregated HUC 12	**Runoff**	**TN**	**TP**	**TSS**	**Bacteria**	**EBI**	**Runoff**	**TN**	**TP**	**TSS**	**Bacteria**	**EBI**
Co Ditch 7 - NFCR							X	X	X	X		
Lake Koronis - NFCR	X				X	X	X	X		X		X
Upper Middle Fork Crow					X	X	X		X	X		X
Lower Middle Fork Crow					X		X			X		
Grove Creek	X			X								
Jewitts Creek		X										
City of Kingston - NFCR					X							
Washington Creek	X		X	X		X					X	X
Rock Lake -NFCR	X			X		X						X
Big Swan Lake			X	X		X				X	X	X
Cokato Lake			X									
Twelvemile Creek	X		X									
Mill Creek						X					X	X
North Fork Crow River	X	X	X	X							X	
Pelican Lake	X			X		X						X
Crow River		X				X						X

Priorities Based on the SID Results

Improving habitat in channelized streams

Once a ditch is constructed or a stream channelized, it will attempt to return to a natural, stable state by meandering (Hansen et al., 2006). Due to differences in management approach, some ditches are not actively cleaned out and have begun to function like natural streams again. Examples of unmaintained and "naturalizing" drainage ditches occur in the NFC watershed, and several of them achieve fish and macroinvertebrate IBI scores that are higher than ditches that are routinely cleaned and straightened. In the NFC watershed there are 15 county ditch systems consisting of approximately 100 miles of total ditch length. There are also many miles of private ditch networks in the watershed and a buried tile system containing 11,280 feet of underground drainage tile. Due to the prevalence of agricultural ditching in the NFC watershed, it was identified as a potential cause of fish and invertebrate impairments.

Loss of riparian buffer zones

The NFC/Lower Crow River watershed becomes increasingly populated and developed from the city of Kingston, Minnesota east to the confluence with the Mississippi River. Near the cities of Rockford and St. Michael, individual residences and multi-home sub-developments are more common features of the riparian corridor. The presence of turf grass lawns in the immediate riparian corridor of the river can increase runoff rates (Figure 3) and nutrient (Figure 4 and 5) delivery to surface waters, increase bank erosion rates, and decrease shading and woody debris/detritus inputs that provide habitat and support aquatic food webs.

Animal Agriculture

Animal agriculture is a prominent land-use in the NFC/Crow River watershed. Large tracts of pasture land are common features of the landscape in this region of Minnesota, supporting herds of cattle, horses, sheep, and swine. In the NFC watershed, pasture areas in the riparian corridor are quite common in the headwaters area and Alluvium Outwash watershed zone upstream of and around Paynesville, Minnesota (Figure 1).

Uncontrolled grazing of riparian corridors can negatively impact habitat for fish, macroinvertebrates, and other organisms found in riparian zones. Some common impacts are (1) wider, shallower, less stable stream channel (Rosgen, 1996); (2) increased bank erosion and sediment deposition; and (3) reduced shading, woody debris, and fish cover.

Cultivated Cropland

The predominant land use in the NFC is cultivated cropland. In most locations along the river, vegetated buffers of varying width and quality are in place to separate cultivated land from the active stream channel and floodplain. However, several areas along the NFC River lack buffers and have shown high susceptibility to erosion and lateral channel migration. The development of priority areas in this watershed should include areas where adequate buffers are not in place. (Also see Riparian Vegetation discussion in Appendix B.)

Priorities Based on EBI Results

The Environment Benefit Index (EBI) is an assessment to help guide the allocation of funds, planning effort, technical support, and landowner support through a compilation of six categories of assessment of benefit.

- Wildlife Habitat Cover Benefits
- Water Quality Benefits
- Air Quality Benefits
- Erodibility Index
- Enduring Benefit Factor
- Cost Effectiveness

The goal is to target areas where the most efficient and effective practices and management tools can be placed onto the landscape.

The conservation value of a parcel of land is based on several factors:

- Soil erosion risk of the land based on soil and slope characteristics
- Water quality risk of the land based on the shape of the terrain and its proximity to surface water
- Habitat quality based on the Statewide Conservation and Preservation Plan

These factors are integrated into an Environmental Benefits Index - a score which represents a summary of the above factors (Figure 8). This methodology has unique characteristics; it includes soils and landscape (terrain) analysis which are relatively new to conservation targeting efforts. It addresses erosion potential and runoff potential and includes surface water quality, and wildlife habitat factors. Finally, the EBI integrates these layers to address multiple conservation benefits simultaneously.

Priorities Based on DNR Watershed Data Report and WHAF

Recently, the Minnesota DNR developed the Watershed Health Assessment Framework (WHAF) which provides a comprehensive overview of the ecological health of Minnesota's watersheds). The WHAF is based on a "whole-system" approach that explores how all parts of the system work together to provide a healthy watershed. The WHAF divides the watershed's ecological processes into five components: biology, connectivity, geomorphology, and hydrology and water quality. A suite of watershed health index scores have been calculated that represent many of the ecological relationships within and between the five components. These scores have been built into a statewide GIS database that is compared across Minnesota to provide a baseline health condition report for each of the 81 major watersheds in the state. The DNR has applied the condition report to larger (HUC-8) watersheds, and more recently has applied the framework at smaller (HUC-12) subwatershed levels. Moving forward, the WHAF will be a helpful resource in monitoring and assessing the health of the NFC River watershed as restoration and protection practices are implemented. Refer to Appendix B for the complete DNR watershed report and detailed WHAF information for the NFC watershed which includes protection and restoration areas.

Specific DNR recommendations are:

- Bonanza Valley GWMA -- enhancing recharge areas and promoting wetland restoration to facilitate groundwater recharge to minimize effects to groundwater resources
- Calcareous Fens -- areas surrounding these fens should be considered for protection due to their unique and rare nature
- Riparian connectivity should be protected where it exists and restored in areas where it is lacking
- Perennial cover should be protected where it exists and restored in areas where it is lacking

Protection Lake Prioritization

Priority lakes for protection were chosen based on the criteria of having two or more of the following attributes:

- DNR designated wild rice lake and/or priority shallow lake
- FS lakes with a downward water quality trend
- FS lakes located in a predominantly impaired HUC-11
- Lakes with an active lake association

Lake physical characteristics, water quality, biological attributes and status are summarized in Appendix C.

Table 11. Tools for prioritizing and targeting watershed restoration efforts.

Tool	Description	How can/was the tool (be) used?	Notes	Analysis Scale
Hydrological Simulation Program – FORTRAN (HSPF) Model	Simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants from pervious and impervious land. Typically used in large watersheds (greater than 100 square miles).	Incorporates watershed-scale and non-point source models into a basin-scale analysis framework. Addresses runoff and constituent loading from pervious land surfaces, runoff and constituent loading from impervious land surfaces, a groundwater component and flow of water and transport/ transformation of chemical constituents in stream reaches. HSPF was used to supply watershed and SSTS loads for each lake.	Local or other partners can work with MPCA HSPF modelers to evaluate at the watershed scale: 1) the efficacy of different kinds or adoption rates of BMPs, and 2) effects of proposed or hypothetical land use changes.	Impaired watershed Scale
Watershed Bacteria Production by Source	Uses literature rates and available data/estimates of all known bacteria sources in the watershed to calculate total watershed bacteria production. Bacteria sources for this assessment include: wildlife (primarily birds and deer), feedlot and livestock, total # of septic systems and estimated failure rates, wastewater treatment facility effluent, and pet populations for urban areas.	This tool helps estimate the total amount of bacteria produced in a given watershed or subwatershed. On a large watershed scale, results are helpful in identifying subwatersheds with higher rates of bacteria production to focus monitoring efforts and potential BMPs.(Fig. 7)	Bacteria production analysis was originally developed to aid TMDL source assessment for the NFC River Watershed *E. coli* impaired reaches. This analysis was extended to include all NFC River sub-watersheds (non-impaired reaches) for use in the WRAPS report.	Impaired watershed Scale
Light Detection and Ranging (LiDAR)	Elevation data in a digital elevation model (DEM) GIS layer. Created from remote sensing technology that uses laser light to detect and measure surface features on the earth.	General mapping and analysis of elevation/terrain. These data have been used for: erosion analysis, water storage and flow analysis, siting and design of BMPs, wetland mapping, and flood control mapping. A specific application of the data set is to delineate small catchments. Not used this cycle.	The layers are available on the MN Geospatial Information website for most counties.	Impaired Watershed Scale
Environmental Benefits Index (EBI)	Integrated tool using GIS and raster datasets to create a source grid with soil erodibility, terrain analysis and biological habitat scores.	This tool can help target lands with a high potential for precipitation runoff and soil erosion to surface waters. The application can identify areas for conservation practices and restoration projects.(Fig. 8)	This tool nearly covers the entire state of Minnesota; however gaps in coverage exist where source data were not available.	Impaired Watershed Scale
Revised Universal Soil Loss Equation	RUSLE predicts the long term average annual rate of erosion on a field slope based on rainfall pattern, soil type, topography, land use and management practices.	This model provides an assessment of existing soil loss from upland sources and the potential to assess sediment loading through the application of Best Management Practices. This tool was used as a screening tool to identify where the areas of greatest potential soil loss may be occurring.	It is important to note that model results represent the maximum amount of soil loss that could be expected under existing conditions and have not been calibrated to field observations or observed /monitored data.	Subwatershed Scale

Table 11, continued. Tools for prioritizing and targeting watershed restoration efforts.

Tool	Description	How can the tool be used?	Notes	Analysis Scale
BATHTUB Model	Simulates average total phosphorus, chlorophyll-a and Secchi depth for deep and shallow lakes.	The tool can be used to estimate changes in water quality based on changes in external and internal sources of nutrient loading. This tool was used to set allocations for impaired lakes	The models can be used for future lake planning to assess effects of changes in land use and nutrient loads.	Individual Lakes
Stream Power Index (SPI)	Stream Power Index (SPI) is a GIS exercise that calculates the erosive power of overland flow, which can be used to help identify potential flow erosion.	The stream power index analysis can identify and prioritize geographic areas that may be contributing sediment by means of stream bank erosion.	This tool focused on areas near (<500 feet) the main-stem channel and major tributary channels since sediment erosion from these areas is more likely to be effectively delivered to the impaired reach.	Subwatershed Scale

North Fork Crow River, Average Annual Runoff, 1996-2009

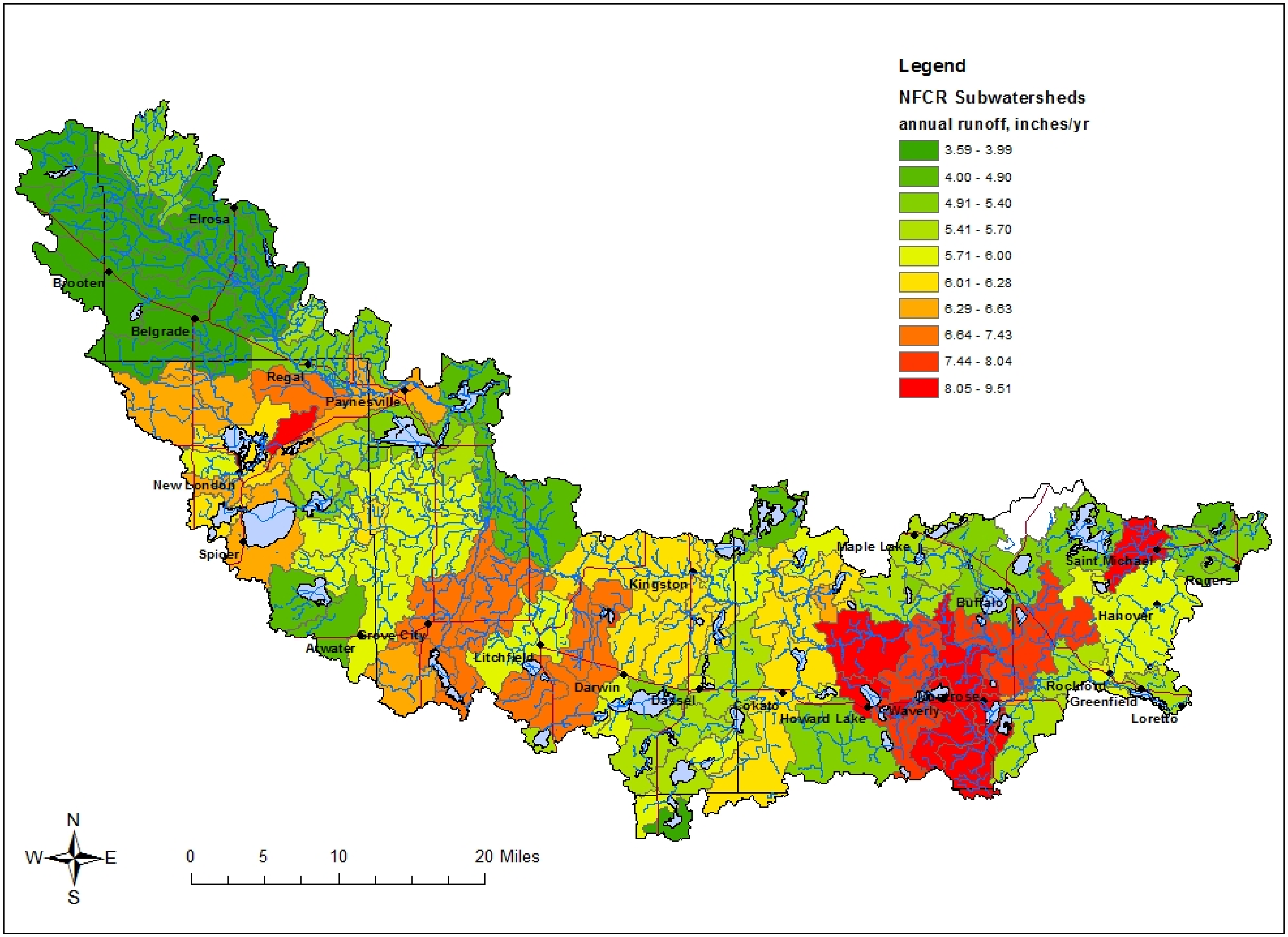


Figure 3. Annual runoff by sub-watershed in the NFC watershed

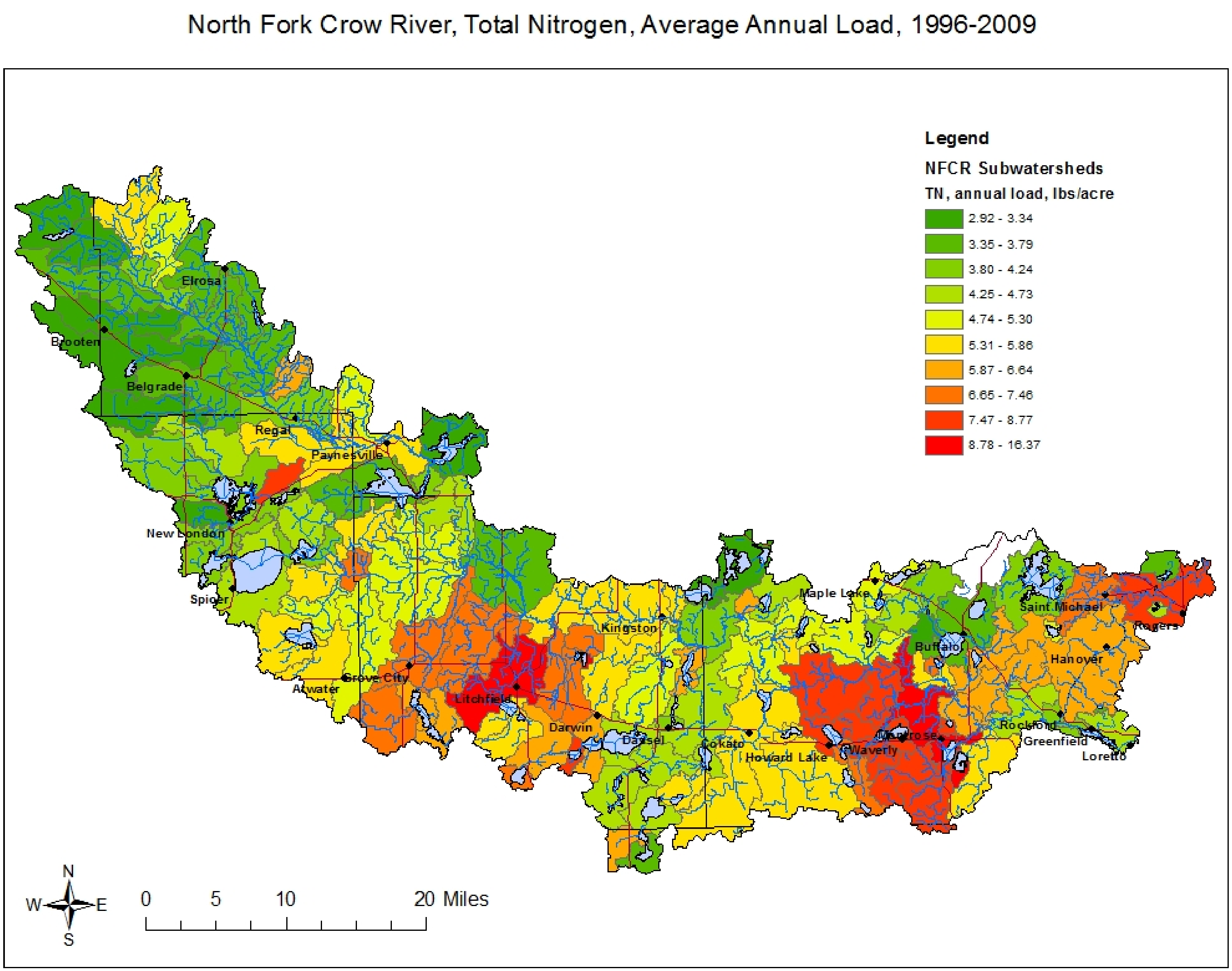


Figure 4. Total nitrogen loading by sub-watershed in the NFC watershed.

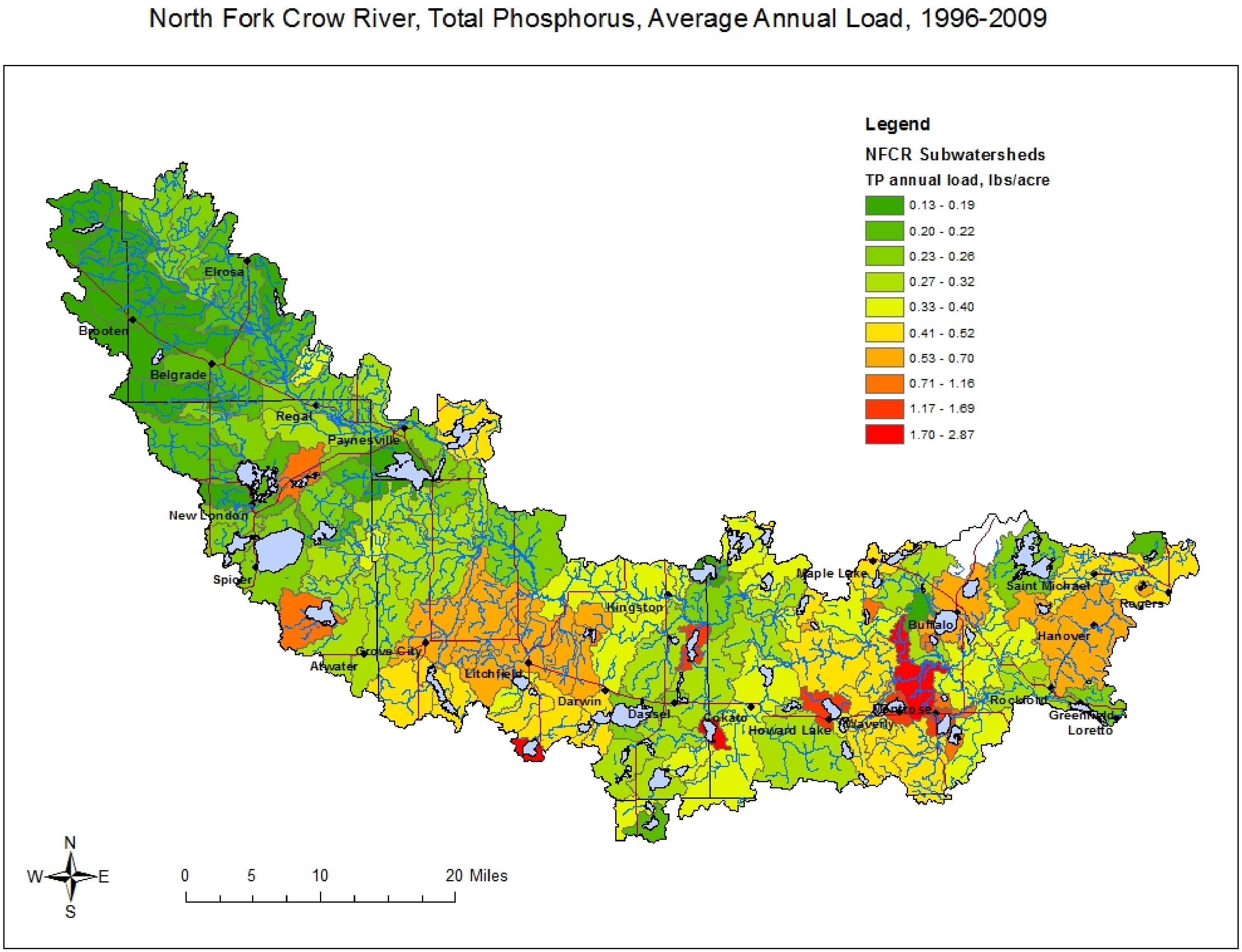


Figure 5. Total phosphorous loading by sub-watershed in the NFC watershed

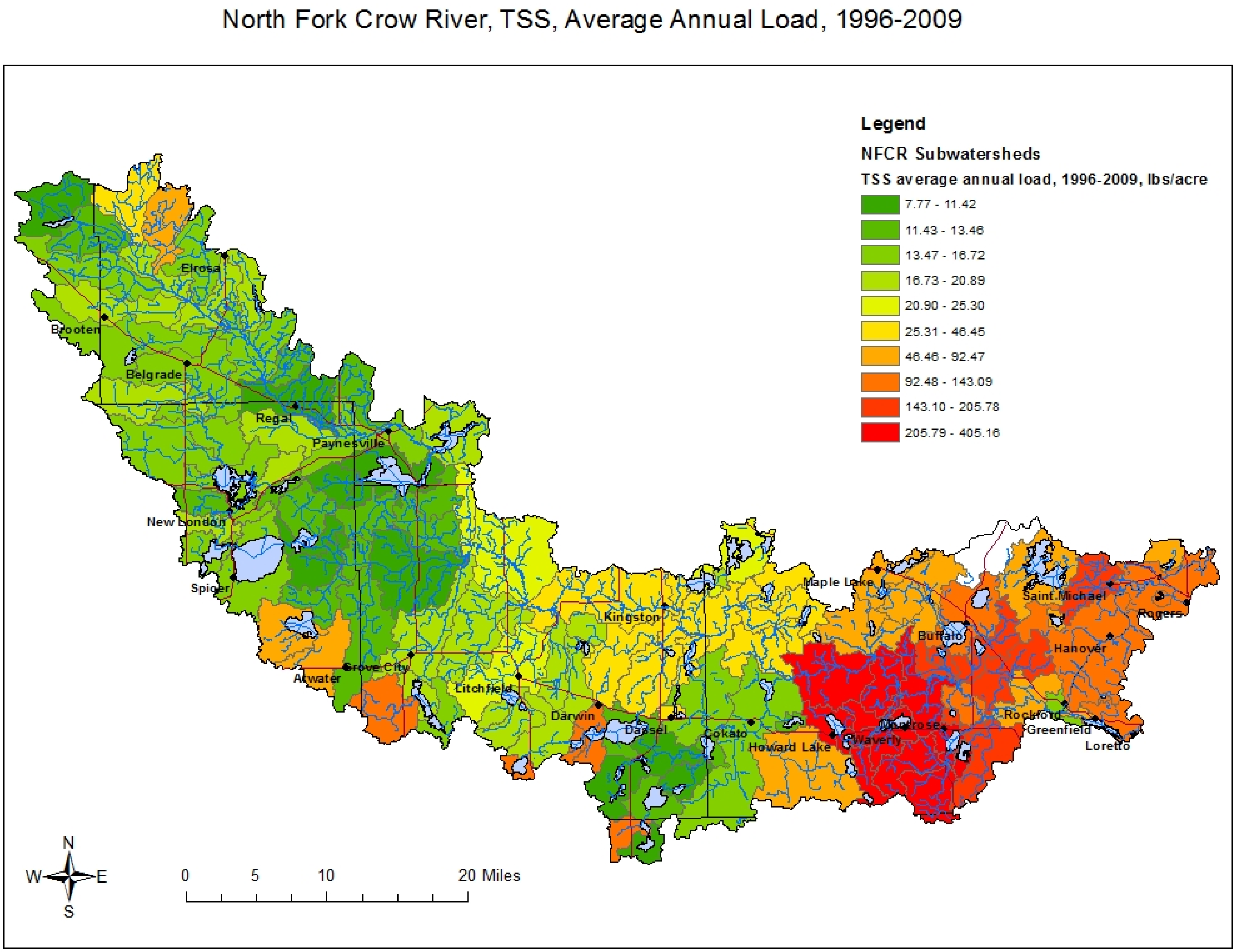


Figure 6. Sediment loading by sub-watershed in the NFC watershed

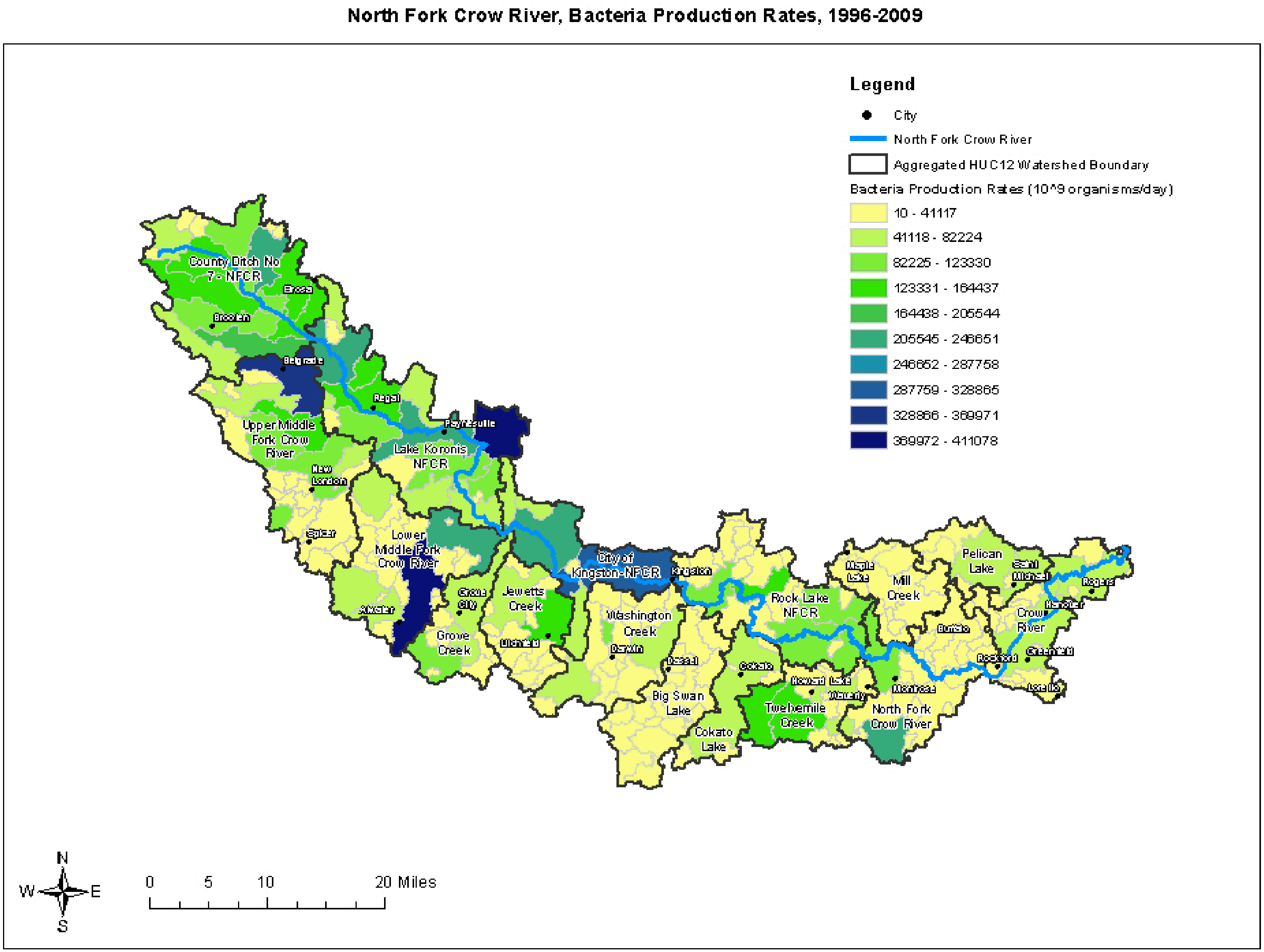


Figure 7. Bacteria loading by sub-watershed in the NFC watershed.

North Fork Crow River Environmental Benefit Index (EBI)

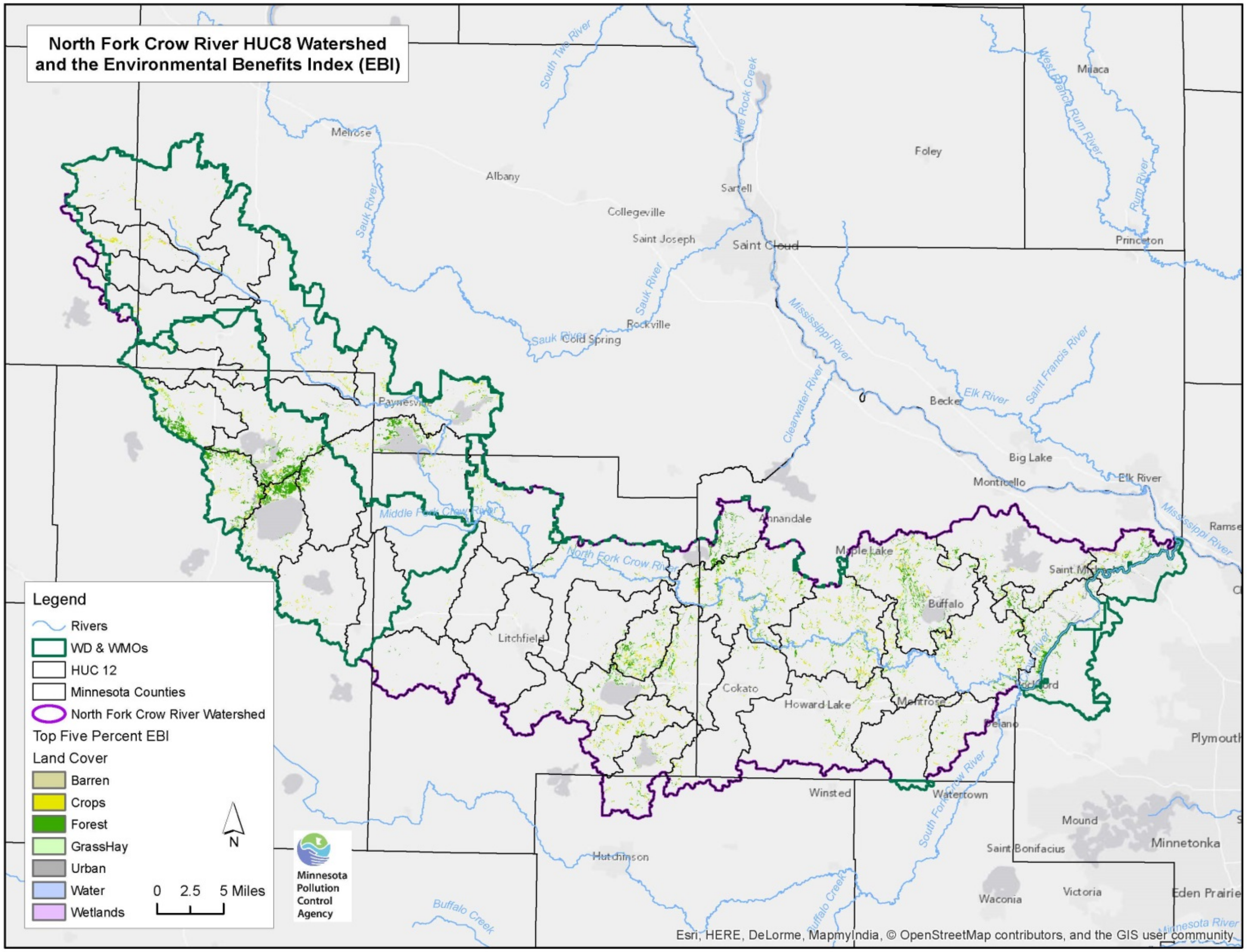


Figure 8. Board of Soil and Water Resources Environmental Benefit Index (EBI) tool top 5% priority areas within the NFC watershed.

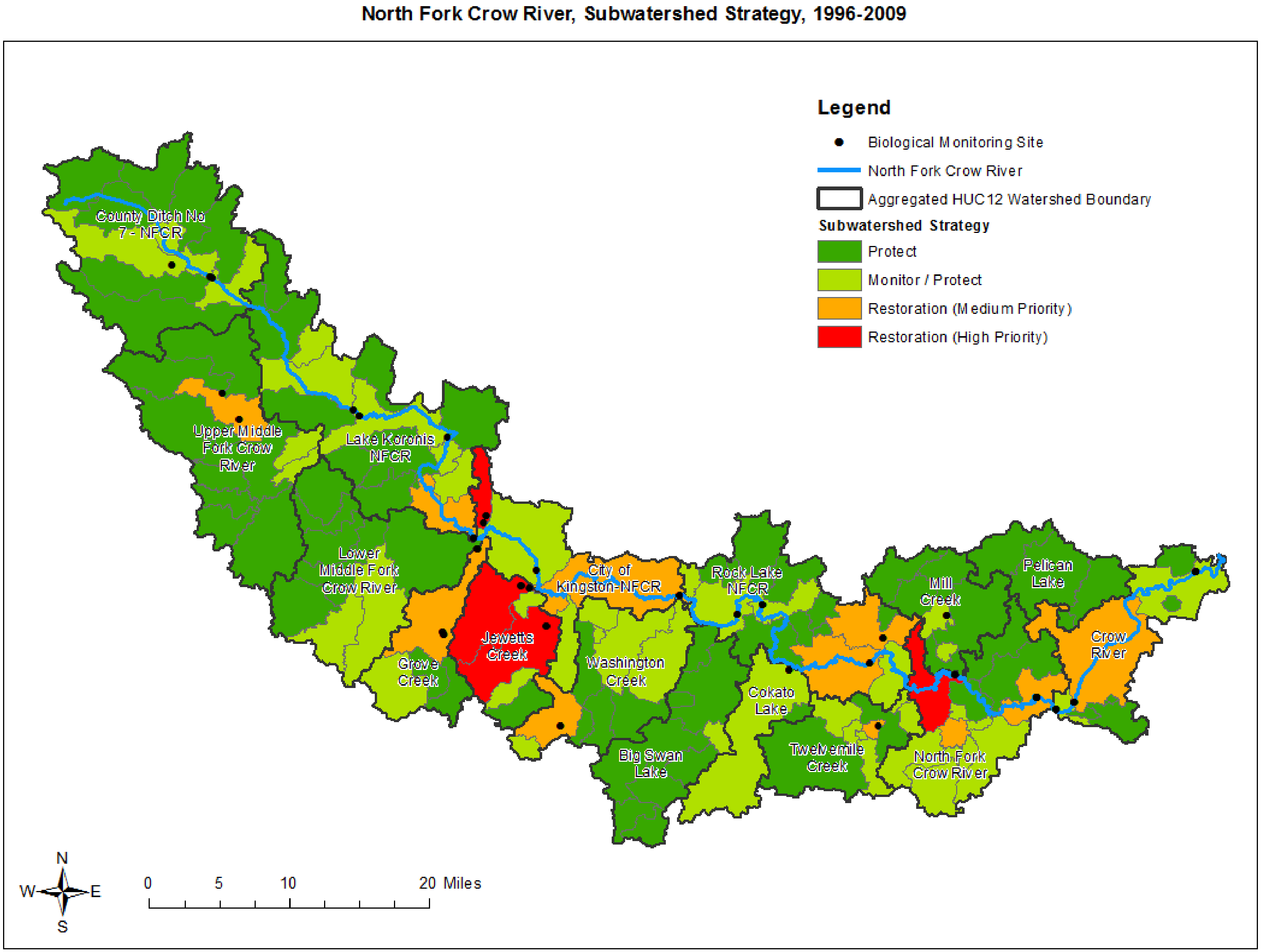
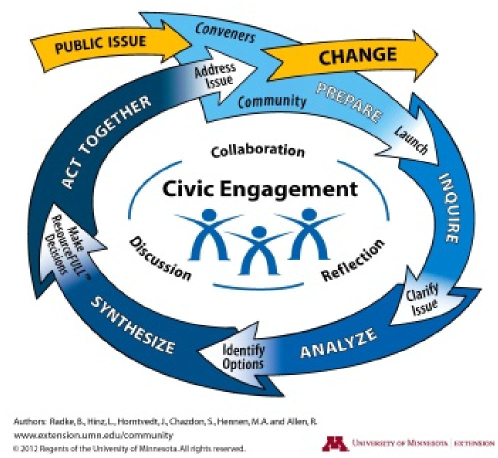


Figure 9. Subwatershed targeting in the NFC watershed for protection and restoration planning.

3.2 Civic Engagement

A key prerequisite for successful strategy development and on-the-ground implementation is meaningful civic engagement. This is distinguished from the broader term 'public participation' in that civic engagement encompasses a higher, more interactive level of involvement. Specifically, the University of Minnesota Extension's definition of civic engagement is "Making 'resourceFULL' decisions and taking collective action on public issues through processes that involve public discussion, reflection, and collaboration." A resourceFULL decision is one based on diverse sources of information and supported with buy-in, resources (including human), and competence. Further information on civic engagement is available at: http://www1.extension.umn.edu/community/civic-engagement/



Accomplishments and Future Plans

Local stakeholders in the NFC watershed met to develop a Civic engagement planning team, made up of staff from watershed districts, CROW, DNR and SWCD. The team developed a plan to create diverse ownership in the water resources of the NFC watershed. The team explored what we were doing well and what to accomplish for diverse ownership. A civic engagement plan was developed that outlined deliverables for prioritized projects.

- Contact or Meet Ag Community groups and look for ways to assist and work together
- Recognition & Publicizing of Efforts in the watershed
    - Annual Watershed Wide Open House
    - Project of the Year
    - MPCA's NFC Story Map
- Expand Recreational Opportunities
    - Paddle the Crow River Day
    - Paddler Patch
    - Fishing Clinics
- Establish Local Media Partnerships
    - Participate in a call in show for local radio
- Build Volunteer Programs
    - Volunteer for every lake and stream stretch
    - Volunteer Recognition program
- Expand Youth Education Programs
    - Expand Middle Fork Crow River Watershed District's In-School program
    - Develop additional Envirothon and YES teams as needed
    - Developing Community Education programs
- Storm Water Task Force
- Address SSTS/Unsewered Community Issues

The NFC WRAPS was on public notice from October 13, 2014, through November 12, 2014.

3.3 Restoration & Protection Strategies

The Subwatershed Strategy map (Figure 9) was created by overlaying and combining into one map the following layers: Human Disturbance Score, Watershed Bacteria Production by Source, Fish and Macroinvertebrate IBI Scores, TN Average Annual Load, TP Average Annual Load and TSS Average Annual Load by assigning weighted values (1 = low impact/pollutant loading to 4 = Very High impact/pollutant loading) to all subwatersheds in each map. The weighted values were determined based on equal interval classification of each individual layer. A final score for each subwatershed was calculated by adding up all the scores and again applying an equal interval classification. Thus, the final map (Fig. 9) represents the sum of all the subwatershed scores. This exercise is intended to give a general sense of which areas in the watershed should be targeted for restoration, and those that should be targeted for protection. It is important to note here that this is a **generalization** since areas that could not be assessed for fish and macroinvertebrate IBI may reflect "protection" is warranted, when it may actually be another management category. For this reason, the biological monitoring sites are displayed on this map to help distinguish the more generalized watershed areas from the more clearly defined areas. Results of the final overlay were divided into the four management categories described below:

High Priority Restoration – Two or more of the layers combined scores indicate very high degradation/impact and pollutant loading. These subwatersheds should be considered high priority for restoration and BMP implementation planning

Moderate Priority Restoration – Two or more of the layers combined scores indicate high to very high degradation/impact and pollutant loading. These subwatersheds should be considered a moderate to high priority for restoration and BMP implementation planning.

Monitor/Protect – Most of the layers combined scores indicate moderate to low levels of degradation/impact and pollutant loading. These subwatersheds should be monitored and protected to ensure resources do not become degraded or impaired.

Protection – Most of the layers combined scores currently indicate low levels of degradation/impact and pollutant loading. These subwatersheds should be targeted for protection planning.

Since these groupings and analyses are intended to help identify general areas, (subwatersheds) where restoration and protection planning/efforts may begin to focus, a more detailed analyses within each subwatershed will need to be done to help watershed organizations and state agencies better target specific BMPs, programs and funding activities.

The water quality and protection strategies for the NFC River watershed were developed in collaboration with State, Federal and Local partners. The development of the broad restoration and protection strategies by these groups drew on several resources including: monitoring and assessment and stressor identification (previously discussed in this report), an analysis of the pollutant reduction necessary to meet water quality standards (previously mentioned completed TMDL studies), and the restoration and protection assessment mapping discussed above. The final list of broad restoration and protection strategies for each 10-digit HUC in the NFC River watershed is presented in Table 12. These strategies represent first priorities. Because a strategy is not identified as a priority in a particular watershed does not necessarily mean that strategy is not appropriate for that location.

The Restoration and Protection strategies presented in Table 12 are intended to be further refined into specific implementation projects and applied by local working groups to target conservation practices. The strategies can be further refined (i.e. spatially targeted) using any number of tools available, some of which are presented and discussed throughout this report. Eventually, the refined restoration and protection strategies may be reflected in local water plans, comprehensive watershed plans, and applications for federal and state clean water funds. The NFC has been selected as a pilot 1W1P watershed which will begin a process to unify the various plans (local water plans and WD comprehensive plans) within the watershed with the WRAPS.

The NFC River watershed is highly agricultural with a mix of row crops and animal agriculture. Because much of the watershed is predominantly agriculture and contains large numbers of animal units throughout the watershed, most of the strategies are applicable throughout the watershed. However, many of the strategies are presented on a lake-by-lake basis to include other important sources such as stormwater and internal phosphorus release.

Table 12 also contains a list of the impaired waters in the NFC River watershed along with restoration goals and appropriate strategies. (Refer to the NFC TMDL documents and Implementation Plans for resource specific strategies and implementation.) Protection strategies are provided on a watershed-wide scale and generalized for unimpaired streams and lakes. However, more detail should be developed for the protection strategies based on the factors that may result in the most stress on those resources. For example, lakes that may receive heavy development pressure in the future should focus on stormwater rules to protect water quality while lakes in agricultural drainages may need to focus on agricultural practices. In general, most of the waterbodies in need of protection are in the agricultural portions of the watershed.

The timeline for achieving water quality standards is at least 50 to 100 years due to the size of the watershed, number and magnitude of the impairments. The "Timeline" in Table 12 aligns with the MN Nutrient Reduction Strategy milestone goals which describe a 45% reduction overall from baseline in both P and N by 2045. With that in mind, realistic 10-year milestones for each of the impaired waters are identified to ensure progress toward achieving the NRS milestone goals is made. Water quality monitoring from future WRAPS projects can be used to assess progress toward meeting the NRS goals and water quality standards. As the water quality dynamics within the watershed are better understood, management activities will be changed or refined to efficiently meet the TMDLs and lay the groundwork for de-listing the impaired reaches. Adaptive management will be employed throughout implementation to set new milestones and utilize new technology as it is developed.

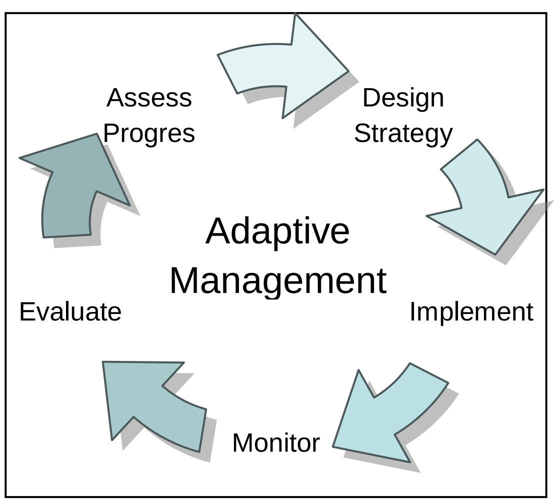


Figure 10. Adaptive management

Table 12. Restoration and Protection Strategies.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Estimated Scale of Adoption Needed	Strategies and Responsible Governmental Unit[1]														Stakeholder and WHAF Based Strategies					Timeline	Interim 10-yr Milestones
	Waterbody (ID)	**Location** and Upstream Influence Counties		Current Conditions	Goals / Targets		Septic System Compliance	Livestock, pasture and feedlot management	Crop and Manure management	Streambank Restoration	Internal TP Release Reduction	Cropland Erosion Reduction	Wetland Phosphorus Reduction	Shoreline Protection	Wetland Restoration/ Enhancement	Roadside erosion Control	Stormwater management	Channel Restoration	NPDES Point Source Compliance	Riparian Corridor Enhancement	Ground Water Protection	Surface Water Retention	Perennial Cover Preservation	Perennial Cover Restoration	Synced with the NRS milestone goals	Number of BMPs per 10 yr Cycle
All	Unimpaired Streams	**All**	Suspended Solids	Varies	90% of samples ≤42 mg/L TSS	NFC Watershed Wide						B,**E**													30 yrs	Implement 4 BMPs
			E. coli	Varies	Geometric Mean ≤ 126 org/ 100 mL	NFC Watershed Wide	A,B,**C**, I, J	A, B, **C** E, I, J	A, B, **E**, I, J					A, **B**, C, I, J					**F**						20 yrs	Implement 5 BMPs
			Biologic habitat	Varies	Varies	NFC Watershed Wide				A, **B**, G, I, J								A, B, **G**, I, J							30 yrs	Implement 3 BMPs
All	Unimpaired Lakes	**All**	Nutrients	Varies	Varies	NFC Watershed Wide	A, B, **C**, I, J	A, B, **C** E, I, J	A, B, **E**, I, J		A,B, **H**	B,**E**		A, **B**, C, I, J											30 yrs	Implement 5 BMPs
All	Priority Shallow Lakes	**All**	Nutrients	Varies	Varies	NFC Watershed Wide	A, B, **C**, I, J	A, B, **C** E, I, J	A, B, **E**, I, J		A,B, **H**	B,**E**		A, **B**, C, I, J											30 yrs	Implement 2 BMPs
Lake Koronis-North Fork Crow River (0701020401)	Rice Lake (73-0196)	Stearns	TP	55 to 62 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**, J		A,B, **H**, J														30 yrs	Implement 2 BMPs
	North Fork Crow (504)	Stearns	Biota (Bedded Sediment)			Contributing Watershed												A,B, **G**, H, J							30 yrs	Implement 2 BMPs
Middle Fork Crow River (0701020402)	Nest (34-0154)	Kandiyohi	TP	45 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**				A, **I**										30 yrs	Implement 2 BMPs
Jewitts Creek North Fork River (0701020403)	Long (47-0177)	Meeker Kandiyohi	TP	385 µg/L	Summer TP Mean ≤ 60 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**														30 yrs	Implement 1 BMPs
	Hope (47-0183)	Meeker	TP	257 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**														30 yrs	Implement 1 BMPs

Key: Red rows = impaired waters requiring restoration; Green rows = unimpaired waters requiring protection

[1]Responsible Governmental Unit for Restoration Strategy (**Governmental Unit in Bold will be considered Lead Entity**): A = CROW; B= SWCD; C= County; D = City; E = NRCS; F = MPCA; G=Minnesota DNR H = Lake Association I=MFCRWD J=NFCRWD

Table 12, continued. Restoration and Protection Strategies.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Estimated Scale of Adoption Needed	Strategies and Responsible Governmental Unit[1]													Stakeholder and WHAF Based Strategies					Timeline	Interim 10-yr Milestones
	Waterbody (ID)	**Location** and Upstream Influence Counties		Current Conditions	Goals / Targets		Septic System Compliance	Livestock, pasture and feedlot management	Crop and Manure management	Streambank Restoration	Internal TP Release Reduction	Cropland Erosion Reduction	Wetland Phosphorus Reduction	Shoreline Protection	Wetland Restoration/ Enhancement	Roadside erosion Control	Stormwater management	Channel Restoration	NPDES Point Source Compliance	Riparian Corridor Enhancement	Ground Water Protection	Surface Water Retention	Perennial Cover Preservation	Perennial Cover Restoration	Synced with the NRS milestone goals	Number of BMPs per 10 yr Cycle
Jewitts Creek North Fork River (0701020403	Grove Creek (514)	Meeker	*E. Coli*	Very High: 17 cfu/100 mL	Very High: 0% Reduction	Contributing Watershed	A,B, **C**	A, B, **C**, E	A, B, **E**										**F**						20 yrs	Implement 3 BMPs
				High: 62 cfu/100 mL	High: 0 % Reduction																					
				Mid: 237 cfu/100 mL	Mid: 47% Reduction																					
				Low: 252 cfu/100 mL	Low: 50% Reduction																					
				Dry: 445 cfu/100 mL	Dry: 72% Reduction																					
			Suspended Solids	Very High: 6 ton/d	Very High: 0% Reduction	Contributing Watershed			A, B, **E**							A, **B**									30 yrs	Implement 3 BMPs
				High: 26 mg/L	High: 40% Reduction																					
				Mid: 48 mg/L	Mid: 45% Reduction																					
				Low: 18 mg/L	Low: 0% Reduction																					
				Dry: 5 mg/L	Dry: 0% Reduction																					
			Dissolved Oxygen	10% of Samples ≤ 5 mg/L DO	90% of samples ≥ 5.0 mg/L DO	Contributing Watershed												A,B, **G**	**F**						20 yrs	Implement 1 BMPs
	Jewitts Creek (585)	Meeker	*E. Coli*	Very High: 55 cfu/100 mL	Very High: 0% Reduction	Contributing Watershed	A,B, **C**	A, B, **C**, E	A, B, **E**								**D**		**F**						10 yrs	Implement 3 BMPs
				High: 18 cfu/100 mL	High: 0 % Reduction																					
				Mid: 74 cfu/100 mL	Mid: 0% Reduction																					
				Low: 214 cfu/100 mL	Low: 41% Reduction																					
				Dry: 282 cfu/100 mL	Dry: 55% Reduction																					

Key: Red rows = impaired waters requiring restoration; Green rows = unimpaired waters requiring protection

[1]Responsible Governmental Unit for Restoration Strategy (**Governmental Unit in Bold will be considered Lead Entity**): A = CROW; B= SWCD; C= County; D = City; E = NRCS; F = MPCA; G=Minnesota DNR H = Lake Association I=MFCRWD J=NFCRWD

Table 12, continued. Restoration and Protection Strategies.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Estimated Scale of Adoption Needed	Strategies and Responsible Governmental Unit[1]													Stakeholder and WHAF Based Strategies					Timeline	Interim 10-yr Milestones
	Waterbody (ID)	**Location** and Upstream Influence Counties		Current Conditions	Goals / Targets		Septic System Compliance	Livestock, pasture and feedlot management	Crop and Manure management	Streambank Restoration	Internal TP Release Reduction	Cropland Erosion Reduction	Wetland Phosphorus Reduction	Shoreline Protection	Wetland Restoration/ Enhancement	Roadside erosion Control	Stormwater management	Channel Restoration	NPDES Point Source Compliance	Riparian Corridor Enhancement	Ground Water Protection	Surface Water Retention	Perennial Cover Preservation	Perennial Cover Restoration	Synced with the NRS milestone goals	Number of BMPs per 10 yr Cycle
Jewitts Creek North Fork River (0701020403) (continued)	Jewitts Creek (585) (continued)	Meeker	Dissolved Oxygen	10% of Samples ≤ 5 mg/L DO	90% of samples ≥ 5.0 mg/L DO	Contributing Watershed												A,B,**G**	**F**						20 yrs	Implement 2 BMPs
Jewitts Creek North Fork River (0701020403) (continued)	Jewitts Creek (585) (continued)	Meeker	Biota (DO and Bedded Sediment)	See current conditions for Suspended solids and dissolved oxygen	See reductions for suspended solids and dissolved oxygen	Contributing Watershed			A, B, **E**							A, B, **C**		A,B,**G**	**F**						30 yrs	Implement 1 BMPs
Washington Creek (0701020404)	Richardson (73-0196)	Meeker	TP	82 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**														30 yrs	Implement 1 BMPs
Washington Creek (0701020404)	Dunns (47-0082)	Meeker	TP	97 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**		A,B, **H**														30 yrs	Implement 1 BMPs
Big Swan -701020405	Jennie (47-0015)	Meeker	TP	60 µg/L	Summer TP Mean ≤ 60 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**														30 yrs	Implement 1 BMPs
		McLeod																							30 yrs	Implement 1 BMPs
	Collinwood (47-0293)	Meeker	TP	103 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**						A, B, **D**								30 yrs	Implement 1 BMPs
		McLeod																							30 yrs	Implement 1 BMPs
	Spring (47-0032)	Meeker	TP	69 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**		A,B, **H**						A, B, **D**								30 yrs	Implement 1 BMPs
		McLeod																							30 yrs	Implement 1 BMPs
	Hook (43-0073)	McLeod	TP	121 µg/L	Summer TP Mean ≤ 60 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**														30 yrs	Implement 1 BMPs
	Big Swan (47-0038)	Meeker	TP	92 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**														30 yrs	Implement 1 BMPs
		McLeod																							30 yrs	Implement 1 BMPs

Key: Red rows = impaired waters requiring restoration; Green rows = unimpaired waters requiring protection [1]Responsible Governmental Unit for Restoration Strategy (**Governmental Unit in Bold will be considered Lead Entity**): A = CROW; B= SWCD; C= County; D = City; E = NRCS; F = MPCA; G=Minnesota DNR H = Lake Association I=MFCRWD J=NFCRWD

Table 12, continued. Restoration and Protection Strategies.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Estimated Scale of Adoption Needed	Strategies and Responsible Governmental Unit[1]													Stakeholder and WHAF Based Strategies					Timeline	Interim 10-yr Milestones
	Waterbody (ID)	**Location** and Upstream Influence Counties		Current Conditions	Goals / Targets		Septic System Compliance	Livestock, pasture and feedlot management	Crop and Manure management	Streambank Restoration	Internal TP Release Reduction	Cropland Erosion Reduction	Wetland Phosphorus Reduction	Shoreline Protection	Wetland Restoration/ Enhancement	Roadside erosion Control	Stormwater management	Channel Restoration	NPDES Point Source Compliance	Riparian Corridor Enhancement	Ground Water Protection	Surface Water Retention	Perennial Cover Preservation	Perennial Cover Restoration	Synced with the NRS milestone goals	Number of BMPs per 10 yr Cycle
North Fork Crow River (0701020406)	Brooks (86-0264)	Wright	TP	64 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**		A,B, **H**	A,**B**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Cokato (86-0263)	Wright	TP	49 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**			A,**B**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	French (86-0273)	Wright	TP	41 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**			A,**B**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Smith (86-0250)	Wright	TP	215 µg/L	Summer TP Mean ≤ 60 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,**B**			**B**	**B**									30 yrs	Implement 2 BMPs
	Granite (86-0217)	Wright	TP	61 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,**B**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Camp (86-0221)	Wright	TP	110 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,**B**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Howard (86-0199)	Wright	TP	83 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,B	A,**B**		**B**	**B**									30 yrs	Implement 3 BMPs
	Dutch (86-0184)	Wright	TP	173 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,B			**B**	**B**			**F**						30 yrs	Implement 2 BMPs
	Rock (86-0182)	Wright	TP	56 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**		A,B, **H**	A,B	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Little Waverly (86-0106)	Wright	TP	394 µg/L	Summer TP Mean ≤ 60 µg/L	Contributing Watershed			A, B, E		A,B, **H**	A,**B**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Waverly (86-0114)	Wright	TP	42 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,**B**	A,**B**		**B**	**B**	A, B, **D**		**F**						30 yrs	Implement 2 BMPs
	Ramsey (86-0120)	Wright	TP	60 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**		A,B, **H**	A,**B**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs

Key: Red rows = impaired waters requiring restoration; Green rows = unimpaired waters requiring protection [1]Responsible Governmental Unit for Restoration Strategy (**Governmental Unit in Bold will be considered Lead Entity**): A = CROW; B= SWCD; C= County; D = City; E = NRCS; F = MPCA; G=Minnesota DNR H = Lake Association I=MFCRWD J=NFCRWD

Table 12, continued. Restoration and Protection Strategies.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Estimated Scale of Adoption Needed	Strategies and Responsible Governmental Unit[1]													Stakeholder and WHAF Based Strategies					Timeline	Interim 10-yr Milestones
	Waterbody (ID)	**Location** and Upstream Influence Counties		Current Conditions	Goals / Targets		Septic System Compliance	Livestock, pasture and feedlot management	Crop and Manure management	Streambank Restoration	Internal TP Release Reduction	Cropland Erosion Reduction	Wetland Phosphorus Reduction	Shoreline Protection	Wetland Restoration/ Enhancement	Roadside erosion Control	Stormwater management	Channel Restoration	NPDES Point Source Compliance	Riparian Corridor Enhancement	Ground Water Protection	Surface Water Retention	Perennial Cover Preservation	Perennial Cover Restoration	Synced with the NRS milestone goals	Number of BMPs per 10 yr Cycle
North Fork Crow River (0701020406)	Albert (86-0127)	Wright	TP	137 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,**B**			**B**	**B**									30 yrs	Implement 2 BMPs
	Light Foot (86-0122)	Wright	TP	195 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**		A,B, **H**	A,**B**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Fountain (86-0273)	Wright	TP	334 µg/L	Summer TP Mean ≤ 60 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**		A,B, **H**	A,**B**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Malardi (86-0112)	Wright	TP	405 µg/L	Summer TP Mean ≤ 60 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,**B**			**B**	**B**									30 yrs	Implement 2 BMPs
	Deer (86-0090)	Wright	TP	83 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,**B**			**B**	**B**									30 yrs	Implement 2 BMPs
	Buffalo (86-0107)	Wright	TP	87 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**		A,B, **H**	A,**B**	A,**B**		**B**	**B**									30 yrs	Implement 3 BMPs
	Dean (86-0041)	Wright	TP	211 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**		A,B, **H**	A,**B**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Unnamed Creek (667)	Wright	*E. coli*	Very High: 209 cfu/100 mL High: 155 cfu/100 mL Mid: 383 cfu/100 mL Low: 330 cfu/100 mL Dry: 870 cfu/100 mL	Very High: 40% Reduction High: 19 % Reduction Mid: 67% Reduction Low: 62% Reduction Dry: 86% Reduction	Contributing Watershed	A,B,**C**	A,B,**C**	A, B, **E**										**F**						20 yrs	Implement 3 BMPs

Key: Red rows = impaired waters requiring restoration; Green rows = unimpaired waters requiring protection [1]Responsible Governmental Unit for Restoration Strategy (**Governmental Unit in Bold will be considered Lead Entity**): A = CROW; B= SWCD; C= County; D = City; E = NRCS; F = MPCA; G=Minnesota DNR H = Lake Association I=MFCRWD J=NFCRWD

Table 12, continued. Restoration and Protection Strategies.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Estimated Scale of Adoption Needed	Strategies and Responsible Governmental Unit[1]													Stakeholder and WHAF Based Strategies					Timeline	Interim 10-yr Milestones
	Waterbody (ID)	**Location** and Upstream Influence Counties		Current Conditions	Goals / Targets		Septic System Compliance	Livestock, pasture and feedlot management	Crop and Manure management	Streambank Restoration	Internal TP Release Reduction	Cropland Erosion Reduction	Wetland Phosphorus Reduction	Shoreline Protection	Wetland Restoration/ Enhancement	Roadside erosion Control	Stormwater management	Channel Restoration	NPDES Point Source Compliance	Riparian Corridor Enhancement	Ground Water Protection	Surface Water Retention	Perennial Cover Preservation	Perennial Cover Restoration	Synced with the NRS milestone goals	Number of BMPs per 10 yr Cycle
North Fork Crow River (0701020406) (continued)	Unnamed Creek (668)	Wright	Suspended Solids	Very High: 10 mg/L High: 5 mg/L Mid: 1 mg/L Low: 5 mg/L Dry: 8 mg/L	Very High: 0% Reduction High: 0% Reduction Mid: 0% Reduction Low: 0% Reduction Dry: 0% Reduction	Contributing Watershed			A, B, **E**							A, **B**									30 yrs	Implement 1 BMPs
	Mill Creek (515)	Wright	Suspended Solids	Very High: 10 mg/L High: 27 mg/L Mid: 63 mg/L Low: 40 mg/L Dry: 53 mg/L	Very High: 0% Reduction High: 0% Reduction Mid: 33% Reduction Low: 0% Reduction Dry: 20% Reduction	Contributing Watershed			A, B, **E**							A, **B**									30 yrs	Implement 1 BMPs
			Dissolved Oxygen	10% of Samples ≤ 5 mg/L DO	90% of samples ≥ 5.0 mg/L DO	Contributing Watershed	A,B,**C**		A, B, **E**									A,B,**G**							20 yrs	Implement 1 BMPs
	North Fork Crow (503)	Wright	Suspended Solids	Very High: 153 ton/d High: 133 ton/d Mid: 56 ton/d Low: 28 ton/d Dry:14	Very High: 36% Reduction High: 40% Reduction Mid: 13% Reduction Low: 46% Reduction Dry: 0% Reduction	Contributing Watershed			A, B, **E**							A, **B**									30 yrs	Implement 3 BMPs

Key: Red rows = impaired waters requiring restoration; Green rows = unimpaired waters requiring protection [1]Responsible Governmental Unit for Restoration Strategy (**Governmental Unit in Bold will be considered Lead Entity**): A = CROW; B= SWCD; C= County; D = City; E = NRCS; F = MPCA; G=Minnesota DNR H = Lake Association I=MFCRWD J=NFCRWD

Table 12, continued. Restoration and Protection Strategies.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Estimated Scale of Adoption Needed	Strategies and Responsible Governmental Unit[1]													Stakeholder and WHAF Based Strategies					Timeline	Interim 10-yr Milestones
	Waterbody (ID)	**Location** and Upstream Influence Counties		Current Conditions	Goals / Targets		Septic System Compliance	Livestock, pasture and feedlot management	Crop and Manure management	Streambank Restoration	Internal TP Release Reduction	Cropland Erosion Reduction	Wetland Phosphorus Reduction	Shoreline Protection	Wetland Restoration/ Enhancement	Roadside erosion Control	Stormwater management	Channel Restoration	NPDES Point Source Compliance	Riparian Corridor Enhancement	Ground Water Protection	Surface Water Retention	Perennial Cover Preservation	Perennial Cover Restoration	Synced with the NRS milestone goals	Number of BMPs per 10 yr Cycle
Crow River (0701020407)	Constance (86-0051)	Wright	TP	91 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**		A,B, **H**	A,B,**E**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Pelican (86-0031)	Wright	TP	137 µg/L	Summer TP Mean ≤ 60 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,B,**E**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Beebe (86-0023)	Wright	TP	58 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed	A,B,**C**		A, B, **E**		A,B, **H**	A,B,**E**	A,**B**		**B**	**B**									30 yrs	Implement 2 BMPs
	Hafften (86-0199)	Hennepin	TP	55 µg/L	Summer TP Mean ≤ 40 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,B,**E**			**B**	**B**									30 yrs	Implement 1 BMPs
	Foster (86-0001)	Wright	TP	259 µg/L	Summer TP Mean ≤ 60 µg/L	Contributing Watershed			A, B, **E**		A,B, **H**	A,B,**E**	A,**B**		**B**	**B**									30 yrs	Implement 1 BMPs
	Regal Creek (542)	Wright Hennepin	*E. coli*	Very High: 127 cfu/100 mL High: 76 cfu/100 mL Mid: 232 cfu/100 mL Low: 720 cfu/100 mL Dry: 675 cfu/100 mL	Very High: 1% Reduction High: 0% Reduction Mid: 46% Reduction Low: 83% Reduction Dry: 81% Reduction	Contributing Watershed	A,B,**C**	A,B,**C**	A, B, **E**	A, **B**, E	A, **B**, C								**F**						10 yrs	Implement 2 BMPs
			Dissolved Oxygen	10% of Samples ≤ 5 mg/L DO	90% of samples ≥ 5.0 mg/L DO	Contributing Watershed																			20 yrs	Implement 1 BMPs

Key: Red rows = impaired waters requiring restoration; Green rows = unimpaired waters requiring protection [1]Responsible Governmental Unit for Restoration Strategy (**Governmental Unit in Bold will be considered Lead Entity**): A = CROW; B= SWCD; C= County; D = City; E = NRCS; F = MPCA; G=Minnesota DNR H = Lake Association I=MFCRWD J=NFCRWD

Table 12, continued. Restoration and Protection Strategies.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Estimated Scale of Adoption Needed	Strategies and Responsible Governmental Unit[1]													Stakeholder and WHAF Based Strategies					Timeline	Interim 10-yr Milestones
	Waterbody (ID)	**Location** and Upstream Influence Counties		Current Conditions	Goals / Targets		Septic System Compliance	Livestock, pasture and feedlot management	Crop and Manure management	Streambank Restoration	Internal TP Release Reduction	Cropland Erosion Reduction	Wetland Phosphorus Reduction	Shoreline Protection	Wetland Restoration/ Enhancement	Roadside erosion Control	Stormwater management	Channel Restoration	NPDES Point Source Compliance	Riparian Corridor Enhancement	Ground Water Protection	Surface Water Retention	Perennial Cover Preservation	Perennial Cover Restoration	Synced with the NRS milestone goals	Number of BMPs per 10 yr Cycle
Crow River (0701020407) (continued)	Crow River (502)	Wright Hennepin	Suspended Solids	Very High: 360 ton/d	Very High: 5% Reduction	Contributing Watershed			A, B, **E**							A, **B**									30 yrs	Implement 2 BMPs
				High: 162 ton/d	High: 32% Reduction																					
				Mid: 43 ton/d	Mid: 41% Reduction																					
				Low: 17 ton/d	Low: 26% Reduction																					
				Dry:10 ton/d	Dry: 0% Reduction																					
			E. coli	Very High: 320 cfu/100 mL	Very High: 0% Reduction	Contributing Watershed			A,B,**C**, **E**	A, **B**, E	A, **B**, E								**F**						20 yrs	Implement 3 BMPs
				High: 1,770 cfu/100 mL	High: 0% Reduction																					
				Mid: 861 cfu/100 mL	Mid: 5% Reduction																					
				Low: 650 cfu/100 mL	Low: 13% Reduction																					
				Dry: 1,083 cfu/100 mL	Dry: 0% Reduction																					
			Fish & Macroinverts	See current conditions for suspended solids	See reductions for suspended solids	Contributing Watershed			A, **B**, E						A, **B**	A, **B**		A,B, **G**							20 yrs	Implement 2 BMPs
Judicial Ditch #1 to NFC	DNR # 1800300	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H, J	A, **B**,C, E, H, J	A, **B**,C, E, H, J	30 yrs	Implement 1 BMPs
Outlet of Buffalo Lake	DNR # 1807000	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H	A, **B**,C, E, H	A, **B**,C, E, H	30 yrs	Implement 1 BMPs

Key: Red rows = impaired waters requiring restoration; Green rows = unimpaired waters requiring protection [1]Responsible Governmental Unit for Restoration Strategy (**Governmental Unit in Bold will be considered Lead Entity**): A = CROW; B= SWCD; C= County; D = City; E = NRCS; F = MPCA; G=Minnesota DNR H = Lake Association I=MFCRWD J=NFCRWD

Table 12, continued. Restoration and Protection Strategies.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Estimated Scale of Adoption Needed	Strategies and Responsible Governmental Unit[1]													Stakeholder and WHAF Based Strategies					Timeline	Interim 10-yr Milestones
	Waterbody (ID)	**Location** and Upstream Influence Counties		Current Conditions	Goals / Targets		Septic System Compliance	Livestock, pasture and feedlot management	Crop and Manure management	Streambank Restoration	Internal TP Release Reduction	Cropland Erosion Reduction	Wetland Phosphorus Reduction	Shoreline Protection	Wetland Restoration/ Enhancement	Roadside erosion Control	Stormwater management	Channel Restoration	NPDES Point Source Compliance	Riparian Corridor Enhancement	Ground Water Protection	Surface Water Retention	Perennial Cover Preservation	Perennial Cover Restoration	Synced with the NRS milestone goals	Number of BMPs per 10 yr Cycle
Unnamed Trib to Crow River	DNR # 1808600	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H	A, **B**,C, E, H	A, **B**,C, E, H	30 yrs	Implement 2 BMPs
NFC above Unnamed trib sub-basin	DNR # 1806600	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H	A, **B**,C, E, H	A, **B**,C, E, H	30 yrs	Implement 2 BMPs
Unnamed trib CD #5 to NFC	DNR # 1804200	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H	A, **B**,C, E, H	A, **B**,C, E, H	30 yrs	Implement 2 BMPs
NFC aboved Unnamed trib sub-basin	DNR # 1803700 & 1803600	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H	A, **B**,C, E, H	A, **B**,C, E, H	30 yrs	Implement 2 BMPs
Unnamed trib to NFC	DNR # 1803600	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H	A, **B**,C, E, H	A, **B**,C, E, H	30 yrs	Implement 2 BMPs
Crow River to Mississippi	DNR # 1802100	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H	A, **B**,C, E, H	A, **B**,C, E, H	30 yrs	Implement 2 BMPs
Washington Creek - CD #9	DNR # 1806101	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H	A, **B**,C, E, H	A, **B**,C, E, H	30 yrs	Implement 2 BMPs
Unnamed trib to NFC	DNR # 1801600	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H	A, **B**,C, E, H	A, **B**,C, E, H	30 yrs	Implement 2 BMPs
Unnamed trib to NFC	DNR # 1801600	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H	A, **B**,C, E, H	A, **B**,C, E, H	30 yrs	Implement 2 BMPs
Unnamed trib to 12 Mile Creek	DNR # 1807700	**All**																		A, **B**,C, D, E, H		A, **B**,C, E, H	A, **B**,C, E, H	A, **B**,C, E, H	30 yrs	Implement 2 BMPs

Key: Red rows = impaired waters requiring restoration; Green rows = unimpaired waters requiring protection [1]Responsible Governmental Unit for Restoration Strategy (**Governmental Unit in Bold will be considered Lead Entity**): A = CROW; B= SWCD; C= County; D = City; E = NRCS; F = MPCA; G=Minnesota DNR H = Lake Association I=MFCRWD J=NFCRWD

Table 12, continued. Restoration and Protection Strategies.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Estimated Scale of Adoption Needed	Strategies and Responsible Governmental Unit[1]													Stakeholder and WHAF Based Strategies					Timeline	Interim 10-yr Milestones
	Waterbody (ID)	**Location** and Upstream Influence Counties		Current Conditions	Goals / Targets		Septic System Compliance	Livestock, pasture and feedlot management	Crop and Manure management	Streambank Restoration	Internal TP Release Reduction	Cropland Erosion Reduction	Wetland Phosphorus Reduction	Shoreline Protection	Wetland Restoration/ Enhancement	Roadside erosion Control	Stormwater management	Channel Restoration	NPDES Point Source Compliance	Riparian Corridor Enhancement	Ground Water Protection	Surface Water Retention	Perennial Cover Preservation	Perennial Cover Restoration	Synced with the NRS milestone goals	Number of BMPs per 10 yr Cycle
Bonanza Valley	DNR # 1800401	**All**																			A, B, C, E, F, **G**, H, J				30 yrs	Implement 2 BMPs
NFC above Eagle Creek	DNR # 1806200	**All**																		A, **B**,C, D, E, H		A, **B**,C, D, E, H	A, B,C, D, E, H	A, B,C, D, E, H	20 yrs	Implement 2 BMPs
NFC above CD #17 (Jewitt's Creek)	DNR # 1806300	**All**																		A, **B**,C, D, E, H		A, **B**,C, D, E, H	A, B,C, D, E, H	A, B,C, D, E, H	20 yrs	Implement 2 BMPs
CD #36 to MF Crow	DNR # 1803800	**All**																		A, **B**,C, D, E, H, I		A, **B**,C, D, E, H, I	A, B,C, D, E, H, I	A, B,C, D, E, H, I	20 yrs	Implement 2 BMPs
MF Crow to Mud Lake	DNR # 1803900	**All**																		A, **B**,C, D, E, H, I		A, **B**,C, D, E, H, I	A, B,C, D, E, H, I	A, B,C, D, E, H, I	20 yrs	Implement 2 BMPs
CD #37 to MF Crow	DNR # 1802400	**All**																		A, **B**,C, D, E, H, I		A, **B**,C, D, E, H, I	A, B,C, D, E, H, I	A, B,C, D, E, H, I	20 yrs	Implement 2 BMPs
																									Proposed BMPs in each 10 yr cycle.	**162**

Key: Red rows = impaired waters requiring restoration; Green rows = unimpaired waters requiring protection

[1]Responsible Governmental Unit for Restoration Strategy (**Governmental Unit in Bold will be considered Lead Entity**): A = CROW; B= SWCD; C= County; D = City; E = NRCS; F = MPCA; G=Minnesota DNR H = Lake Association I=MFCRWD J=NFCRWD

Table 13. Key for Strategies Column.

Strategy	Practices (NRCS Code)
Nonpoint Source	
Livestock, pasture and feedlot management	Managed/restricted area fencing (382 and 472), pasture runoff controls, buffers (322/390), heavy use protection-stream crossing areas, alternative watering sources, rotational grazing
Cropland and manure management	Chemical addition to manure, spreading in sensitive areas, soil P testing, nutrient management (590), conservation and reduced tilling methods (329, 345 and 346), sediment and water control structures and basins (350), cover crops (340), grassed waterways, lined waterways and channels, manure runoff control, manure storage facilities (313)
Septic Systems	Imminent threat to public health and safety (ITPHS) upgrades, septic upgrades in shoreline areas
Streambank restoration	Streambank stabilization (580), re-meanders, habitat improvement
Internal P release (lakes)	Chemical addition to lake sediment to immobilize Phosphorus release from sediment
Shoreline protection	Shoreline protection (580), natural plantings, setbacks
Wetland restorations	Restore degraded and impacted wetlands that may be P source (651)
Roadside erosion control	Flow/erosion control basins near crossings to reduce sediment/flow (638)
Dam/Culvert management	Assess culverts/dams for sizing, retention, fish passage and hydrologic function
Channel Restoration	
City Stormwater management	
Forestry management	Timber stand improvement (666), early habitat succession (647)
Point Source	
NPDES point source compliance	All NPDES-permitted sources shall comply with conditions of their permits, which are written to be consistent with any assigned wasteload allocations

4. Monitoring Plan

Funding mechanisms for effectiveness monitoring are limited. However, there are a number of local entities that conduct monitoring in the NFC River watershed including but not limited to the Crow River Organization of Water, NFC River Watershed District, the Middle Fork Crow River Watershed District, and local SWCDs. Both the NFCRWD and the MFCRWD work under watershed management plans where monitoring activities are specified. Local entities continue to pursue funding to assess and monitor water quality in the NFC River watershed to fill identified data gaps, measure progress toward implementation goals for both protection and restoration and provide the basis for future planning and adaptive management. Some of the tools used by the local entities to measure implementation progress are:

- Annual local monitoring reports showing trends (if appropriate) and progress are produced, posted on websites and distributed by the CROW, NFCRWD and the MFCRWD.
- Numbers of BMPs funded by state/federal funds are reported and tracked annually through the BWSR eLINK reporting system which also calculates pollutant reductions.
- Annual reports and open houses highlight BMP protection and restoration projects.

Current Monitoring Efforts

Table 14 below depicts the ongoing monitoring by entity in the NFC River watershed.

Table 14. NFC monitoring by entity.

ENTITY	BASELINE	IMPLEMENTATION	FLOW	EFFECTIVENESS	TREND	VALIDATION
CROW	X					X
NFCRWD	X		X	X	X	X
MFWD	X		X	X	X	
SWCD	X				X	X
DNR			X			
MPCA	X		X		X	

CROW: The CROW will continue to seek funding to help on-going monitoring for baseline conditions and validation of TMDL allocations. CROW will collaborate with local partners and the MPCA on the large scale effectiveness monitoring project.

MFWD: The Middle Fork Crow River Watershed District (MFCRWD) has received a Clean Water Partnership (CWP) grant to evaluate baseline water quality conditions on eight major recreational lakes, four shallow lakes, and five river monitoring locations. The MFCRWD works with volunteers to collect water quality data on eight major recreational lakes: Long, Monongalia, George, Nest, Green, Elkhorn, Calhoun, and Diamond. Flow measurements and continuous stage measurements are collected at three of the five Middle Fork Crow River monitoring locations. The MFCRWD has also procured funds from the Board of Water and Soil Resources to implement conservation drainage practices and monitor their effectiveness for pollutant removal. Implementation activities for the Diamond Lake Nutrient TMDL are in progress and include connecting Diamond Lake residents to the Green Lake Regional Wastewater Treatment System, Upstream Management to Achieve Clear Water States within Hubbard, Schultz, and Wheeler Lakes, Implementation of Agricultural Conservation Practice Programs, Lakeshore and Urban Best Management Practices, and Macrophyte Management to Control Curly Leaf Pondweed. Implementation activities to control internal sources of TP loading in Nest and Diamond Lakes include Aquatic Macrophyte Management via chemical and mechanical methods. The District will continue to work with its partners to provide cost-share and technical assistance to implement water quality practices that address impairments and provide protection of non-impaired waters.

NFCRWD: The NFCRWD monitoring program includes annual monitoring of 4 recreational lakes, river sites along the NFC River and drainage ditches within its boundary. The lake samples are collected with help of volunteer boat drivers on Grove, Koronis, Pirz, and Rice Lakes. The NFCRWD works on projects which include agricultural and shoreline BMPs to improve water quality throughout the district. Monitoring data is collected to measure improvements. The NFCRWD applies to BWSR and the MPCA for funds to implement BMPs for water quality improvement. The Rice Lake TMDL was completed in 2011; continual monitoring of Rice Lake and the upstream reaches is utilized to detect significant changes in nutrient loading if any. The NFCRWD collects stream water samples from ice out to ice on. All samples are analyzed for nutrients, chemistry and flows at each stream site. Monitoring data is analyzed annually to help detect trends in nutrient loading.

Wright SWCD: The surface water monitoring activities in Wright County serve one of two goals; assist in the revelation of the existing condition of our surface water resources in the county or to identify the highest phosphorus exporting sub-watersheds within the Crow River Basin.

The Wright County Lake Monitoring Program is on its 16th year and consists of 30-35 lakes in the county. This program collects an integrated sample monthly May thru September (5 samples). Three parameters are collected: Secchi depth, Chl-a, and total phosphorus.

Long-term monitoring is conducted at the outflow of five basins at approximately the HUC-10 level. These sites are monitored monthly for total phosphorus and dissolved phosphorus levels. The stream stage is also continuously recorded. The size of these sub-basins range from 20,000 acres to 80,000 acres; it is at this scale we hope to recognize long term improvements in water quality.

Through the Wright SWCD’s water monitoring efforts during the past six years, we have found that certain wetlands fulfill varying roles in the phosphorus cycle of our surface waters. Conventional wisdom has categorized our wetlands as the filters for our water systems. Our monitoring shows this to only be partially accurate. Wetlands are indeed very effective in the trapping of sediment from run-off. This phosphorus laden sediment under anaerobic conditions however, will ultimately be released as soluble phosphorus. Identifying wetlands that are significant contributors in a lakeshed, is critical in the protection of a non-impaired lake or the rehabilitation of one which is impaired. Once identified and the total annual load calculated we will be able to prioritize these wetlands for future phosphorus reduction projects. For us to achieve the phosphorus targets identified by the TMDL and WRAPS process for impaired lakes or to further protect lakes that meet standards, the sequestering of this phosphorus is critical.

DNR: The DNR will be collecting additional geomorphology data relating the pattern and profile of the mainstem of the NFC and many of the major tributaries. The preliminary plan includes data collection on at least five reaches of the mainstem NFC and data collection on the following major tributaries:

- Sedan Brook
- Skunk River
- Middle Fork Crow River
- Stag Brook
- Grove Creek
- Jewitts Creek
- Battle Creek
- Washington Creek
- Collinwood Creek
- Sucker Creek

MPCA: Large scale effectiveness monitoring will be provided by the MPCA through on-going monitoring in the watershed including the major outlet monitoring program, the statewide Load Monitoring Network as well as the Intensive Watershed Monitoring (IWM) associated with the Watershed Approach. As part of the 10 year cycle, the IWM for the NFC will begin again in 2017 which will allow another round of watershed- wide data collection of biology, hydrology and chemistry that will be used for comparison with current conditions.

Future Monitoring Needs

Stream Monitoring

Routine stream monitoring in the NFC River watershed is conducted by a number of agencies throughout the watershed. For example, the NFCRWD is currently targeting subwatersheds for intense monitoring to assess pollutant sources in the watershed. However, some special studies are needed to further understand the dynamics in the watershed. Following is a brief description of some of these studies.

Synoptic Surveys

The Dissolved Oxygen TMDL for 12-mile Creek relied upon model outputs and literature values for several of the model inputs. A targeted synoptic survey to fill these data gaps will improve our understanding of dissolved oxygen in this stream. Similar work is needed in the main stem of the NFC River where DO violations occurred at high flows.

Lake Monitoring

Inputs to lake response models for the TMDLs in the NFC River watershed relied upon an HSPF model calibrated at a much broader scale than the lakesheds. These HSPF generated inputs for external nutrients were used in the lake models when monitoring data was insufficient leading to increased uncertainty in the lake model results. Furthermore, internal loading for almost all of the lakes (excluding Buffalo, Fountain, Dean, Rice, Ann, and Emma Lakes) was based on lake response model residuals. Due to these modeling constraints, verification of model inputs should be the focus of the monitoring program moving forward. A few lakes such as Ann, Emma, and Nest Lake, had relatively robust watershed monitoring and therefore no validation is required. However, the majority of the lakes should have their primary inflow monitored for a minimum of 1 year and preferably 3 years. Internal loading should be monitored using laboratory sediment nutrient release assays to determine nutrient release rates. These data, combined with dissolved oxygen monitoring provide a more robust understanding of the role of external versus internal nutrient loading.

Groundwater Monitoring

The upper portion of the NFC watershed coincides with the southeastern extent of the Bonanza Valley Aquifer system (see Figure 5, Appendix B), a regionally important groundwater resource which is highly utilized by area landowners for high capacity use, the majority of which is for crop irrigation. The Bonanza Valley aquifer system has been recently designated as a Groundwater Management area by the Minnesota DNR for several reasons, including the high density of existing users, the rapidly increasing demand for water for high-capacity systems, and potential negative implications for ecosystem services, all of which are significant concerns for the sustainability of this resource for ecosystems, water quality, and the ability of future generations to meet their needs. The DNR is currently undergoing a major planning cycle with the goal of ensuring sustainability of use within this system as well as assessing any significant issues to natural resources to ensure sustainability and continuation of ecosystem services throughout this area.

The Minnesota legislature created groundwater management areas as a tool for the DNR to address difficult groundwater-related resource challenges. The purpose of the Bonanza Valley pilot planning project is to learn how to effectively create and establish GWMAs in other areas of the state facing similar groundwater management challenges.

There are currently a number of observation wells in place within the Bonanza Valley area; however, additional wells may be necessary to accurately gauge the water level variations within these aquifers. (See Appendix B for more information on the Bonanza Valley GWMA.)

Inventory Updates

Updated Feedlot/animal number inventories and SSTS in the subwatersheds that have a high potential to contribute to bacteria impairments will be need to be updated to achieve reduction goals.

Volunteer Monitoring

Expanding both the citizen stream and lake monitoring programs (CSMP and CLMP) in the watershed would help to obtain data in areas that have not been assessable due to either lack of access or staff time and local resources will help to improve the monitoring dataset that would enable measuring improvements and developing trends.

HSPF Modeling

HSPF Modeling of the Sauk River, Crow River, and South Fork Crow River, (RESPEC 2012) has the following recommendations for future HSPF modeling that were created based on "lessons learned" in the process of formulating, calibrating, and executing the models. The Crow models are well calibrated and can be used for future evaluations and studies. Internal loading should be incorporated into lake modeling in the future. However, further refinement of internal loading approach is recommended to reduce the numerous runs required for its implementation and potentially represent additional internal loading processes.

- Scenario 3—Point Sources at Permitted Levels-should be refined with input from the MPCA staff. The complex, interrelated nature of HSPF and the changes in discharges over time make the results from this scenario not intuitive to understand. Therefore, refinements should be made to add clarity on an individual point-source level.
- The Crow and Sauk Watersheds have an abundance of flow and water-quality data. This level of data collection should be continued if possible. Additionally, sediment source apportionment data, tillage transects, septic tank studies, and other supplemental information cited in the HSPF report were very helpful for modeling and should be continued.
- To further improve the model calibration, particularly for sediment and water temperature, additional stream cross-sectional and lake outlet hydraulics information should be collected.
- Currently, the model combines the watershed loading from chemical and organic fertilizers. If required for specific management scenarios, the watershed loading should be split to represent manure specifically. Additional information and methodology would be required to implement this recommendation.

General Conclusions

- Protection and restoration strategies in Table 12 are dictated by the predominantly agricultural land use in the NFC
- Lake TMDLs were completed for all nutrient impaired NFC lakes on the 2012 303(d) list
- Stream TMDLs were completed for NFC impaired stream reaches on the 2010 303(d) list
- Aquatic recreation is impaired due to excessive nutrients and E.coli while the primary stressors to the stream biology are low dissolved oxygen and excess deposited and or bedded sediment
- Monitoring and modeling data gaps still exist to further understand the NFC watershed dynamics
- The timeline for achieving water quality standards in the NFC is at least 50 to 100 years due to the size of the watershed, number and magnitude of the impairments

5. References and Further Information

Wenck Associates, Inc. 2011. Ann Lake and Lake Emma Excess Nutrient TMDL. October 2011.

Wenck Associates, Inc. 2012. North Fork Crow River, Rice Lake: Excess Nutrients. April 2012.

Wenck Associates, Inc. 2013. North Fork Crow and Lower Crow Bacteria, Turbidity, and Low Dissolved Oxygen TMDL. May 2013.

Houston Engineering, Inc. 2011. Diamond Lake Total Maximum Daily Load. August 2011.

RESPEC, 2012. HSPF Modeling of the Sauk River, Crow River, and South Fork Crow River. July 2012.

Minnesota Pollution Control Agency. 2010. Assessment Report of Selected Lakes within the North Fork Crow River Watershed Upper Mississippi River Basin. November 2010.

Minnesota Pollution Control Agency. 2011 North Fork Crow River Watershed Monitoring and Assessment Report. December 2011

Minnesota Pollution Control Agency. 2012. North Fork Crow River Watershed Biotic Stressor Identification Report. Winter 2012.

Minnesota Pollution Control Agency. 2013. Grove Creek Biotic Stressor Identification Report. October 2013.

Minnesota Pollution Control Agency. 2013. Jewitts Creek Biotic Stressor Identification Report. Unpublished.

North Fork Crow Reports

North Fork Crow reports referenced in this document are available at the North Fork Crow Watershed webpage: *http://www.pca.state.mn.us/jsridda*

North Fork Crow Story Map

http://pca-gis02.pca.state.mn.us/nfcr/index.html

Appendix A: North Fork Crow Priority Shallow Lakes

These shallow lakes are deemed high priority lakes by the Minnesota DNR based on adjacent public lands and wildlife habitat. (See Appendix B for more information on shallow lakes.)

LAKE	Lake ID	Area (Acres)
Calhoun	34006200	1018.85
Mud	34015800	2997.55
Unnamed	34016100	441.63
Unnamed	34016600	133.50
Unnamed	34051000	443.21
Unnamed	34052700	615.25
Unnamed	34061100	231.02
Unnamed	34061200	312.83
Echo	43008100	83.02
Spencer	47001400	147.59
Wolf	47001600	262.36
Arvilla	47002300	137.85
Round	47010200	266.33
Stone	47013100	162.56
Unnamed	47013200	116.12
Youngstrom	47013800	153.23
Minnesota	47014000	126.73
Madsen	47014600	334.71
Unnamed	47014800	129.73
Horseshoe	47015100	180.03
Thoen	47015400	397.19
Popple	47017300	73.14
Long	47017700	787.03
Unnamed	47018700	75.85
Unnamed	47018900	130.86
Lund	47019200	188.95
Miller	47019400	101.41
Peterson	47019800	137.19
Unnamed	73026800	66.62

LAKE	Lake ID	Area (Acres)
Unnamed	73027700	146.31
Tamarack	73027800	493.61
Raymond	73028500	75.29
Rice	86000200	60.67
Pelican	86003100	2317.33
Mud	86004400	130.86
Green Mountain	86006300	156.02
Mud	86008500	611.48
Fountain	86008600	538.48
Varner	86009100	100.16
Little Waverly	86010600	338.00
Malardi	86011200	153.57
School Section	86018000	39.37
Unnamed	86019100	152.90
Willima	86020900	259.03
White	86021400	121.60
Smith	86025000	294.61
Shakopee	86025500	152.56
Grass	86025700	424.23
Unnamed	86027700	79.11
Swan	86029500	465.57
Beaver Dam	86029600	221.08
Unnamed	86044200	76.60
Unnamed	86003500	76.14
Ox Yoke	27017800	318.47
Little Kandiyohi	34009600	975.35
Unnamed	34001900	68.24

Appendix B

WATERSHED DATA REPORT—NORTH FORK CROW RIVER WATERSHED

August 14, 2014

Ethan Jenzen,

Area Hydrologist

Minnesota Department of Natural Resources

Summary of this report

The NFC River watershed is an eight digit Hydrologic Unit Code (HUC) watershed draining approximately 1476 mi^2 of a mixture of agricultural and forested land. The following report is a summary of existing data and collective information related to the hydrology, connectivity, geomorphology, and human alteration/use available in the watershed.

This document is intended to be a working report that continues to progress as more data and information in regards to the above mentioned watershed components is collected during the next five years. Recommendations will be made for targeted watershed practices, including recommendations for protection or restoration directed activities, based on the data presented.

Methods

Hydrology

Watershed discharge data can be used to review daily, monthly, seasonal, annual and long-term trends within a watershed and examine changes in the discharge characteristics such as periods of low or zero flow, flood frequency, base flow volume, and seasonal variability. Discharge data for the NFC River were reviewed from the Rockford site (USGS/DNR# 18087001). At this point, only the long-term trend analysis for this site (which includes the South Fork Crow as well, as this particular site is downstream of the confluence) has been completed. In the future, additional comparative and trend analyses will be conducted using discharge data from various other gage sites located on the mainstem NFC throughout the watershed, including the Rockford (Farmington Ave, DNR# 18088001), Koronis Lake Outlet (18055001), Middle Fork Crow River (18033001), and Manannah (18063001) gage locations.

Double Mass Curve Analysis

A double mass curve is an analysis based on a cumulative comparison of an independent and dependent variable. This is useful in hydrological data as it allows examination of the relationship between two variables. This technique was used to compare precipitation and stream discharge relationships (annual and seasonal) and well elevation fluctuations relative to precipitation.   When plotted, a straight line indicates consistency in the relationship while a break in the slope would mean a change in the relationship.

When used with long-term discharge data sets, the curve can demonstrate when the change in the relationship began to occur. All double mass curves presented are runoff (discharge/watershed area) and monthly precipitation in inches. All discharge values are converted to inches by dividing total volume by the watershed area (the annual discharge converted to acre–ft. and then to inches of runoff over the watershed). Additional information on double mass curve development and interpretation can be found on the following website: http://pubs.usgs.gov/wsp/1541b/report.pdf

Precipitation

Precipitation data is based on the long-term data collection location nearest to the stream data collection site. All precipitation data is acquired through the "High Density Radius Retrieval" website maintained by the Minnesota State Climatology Office. Precipitation data is used to examine long-term trends within a watershed, and the relationship and response of discharge, runoff, and baseflow conditions relative to recorded precipitation totals. Long-term precipitation data was available at Rockford (site# 217020) in Minnesota.

Groundwater Usage

Permitted groundwater usage will be reviewed to examine changes in type of usage and volume over time. Data will be collected through the State Water Use Data System (SWUDS) from 1988-2013. The data will be used to review total volume appropriated, volume appropriated by county, aquifer type, and well level fluctuations relative to precipitation. This data has not yet been analyzed, but will be included as a portion of the report with the next iteration of intensive monitoring and assessment commencing in 2017.

WHAF

The DNR has recently developed the Watershed Health Assessment Framework (WHAF). The WHAF is a suite of watershed health index scores that have been calculated and represent many of the important ecological relationships within and between the components. These scores are built on statewide GIS data that is compared consistently across Minnesota to provide a baseline health condition report for each of the 81 major watersheds in the state. More information can be located at http://www.dnr.state.mn.us/whaf/index.html. For the purpose of this study, the information displayed is on a 12-digit HUC scale.

Riparian Connectivity

Riparian connectivity analyses were done using ArcMap, and the Minnesota DNR Watershed Health Assessment Framework (WHAF). Specifically, near channel areas of the mainstem NFC and significant tributaries were analyzed for the presence of perennial vegetation and continuous buffers. At the present time, this analysis is incomplete and will require additional study for field level verification. Several of the major tributaries were selected for additional analysis based on field observations of good riparian habitat and continuous buffers. These tributaries were then prioritized for additional study during the upcoming field seasons. These tributaries include Grove Creek and Stag Brook, and several portions of the mainstem NFC.

Riparian vegetation and habitat will be qualitatively assessed at each field survey site. Type of vegetation, root depth, root density, and weighted root density (i.e., [root depth/study bank height] * root density) are all measured to help assess the quality of vegetation for that particular stream reach. Lack of quality in vegetation typically relates to poor stream stability and high sediment supply through bank erosion.

Results

Hydrology

Stream flow data in the NFC River watershed were collected at the Rockford gage site. Stream data collection at Rockford began in 1910 through the USGS, but was discontinued in 1920. The site was reestablished in April of 1935 and is currently operating. This data set is ideal for in-depth analysis of changes over time, as it is a continual record from 1935 to the present. Long-term data allows for better analysis within a watershed and can help show trends or pinpoint when relationships changed.

It is important to note that this gage site incorporates the entirety of the Crow River watershed, including both the North and South Fork watersheds, and therefore any changes indicated may not reference changes specifically indicative of hydrology impacts in the North Fork watershed. For this study, however, the discharge data from the Rockford site was used as it is the largest and most continuous data set for this watershed.

Double Mass Curves

Double mass curves were developed for the data collected at the Rockford gage site. Precipitation data was collected from the Rockford area as well. This gage does include winter discharge data, and as such, all available data was used in the development of these curves. The double mass curve for this site (Figure 1) displays two distinct relationships over the period of record. From 1935-1982, a relatively linear relationship between precipitation and runoff is observed. The relationship noted from 1983-2013 displays a significantly higher volume of runoff during this timeframe than was noted earlier. This change in the relationship that runoff is increasing independent of the amount of rain in this watershed. As both low and high annual precipitation volumes were recorded during the period of record from 1935-1982 and 1983-2013, it is apparent that these relationships are not directly affected by periods of wet or dry conditions, and is likely a result in changes to the flow pathways or hydrologic alterations within the watershed itself.

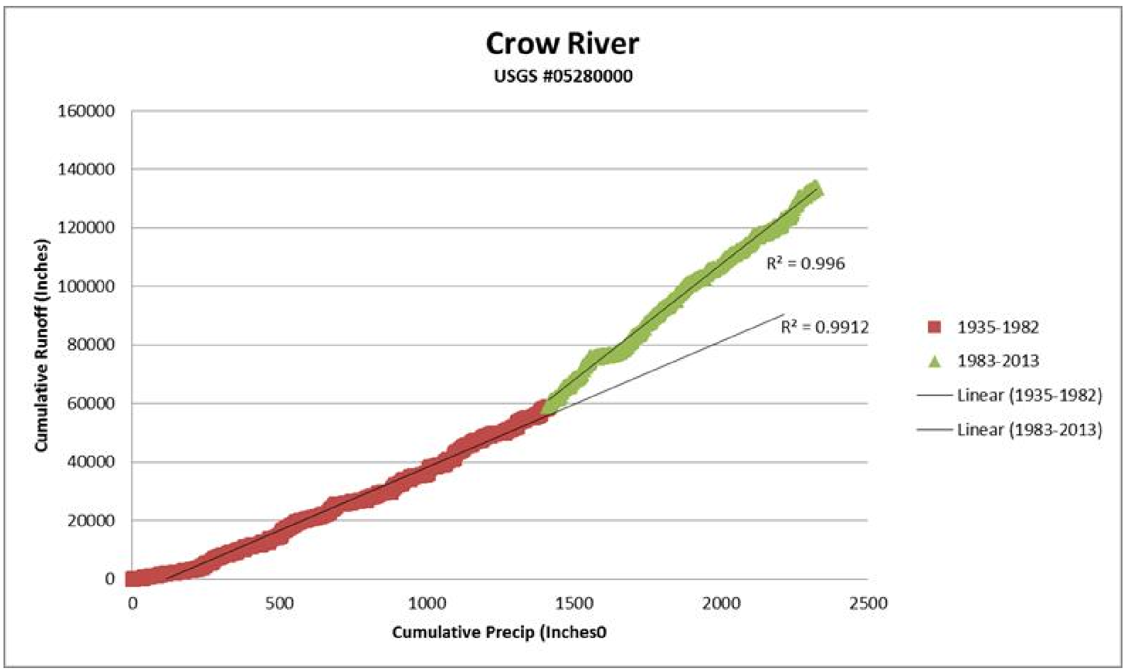


Figure 1: **Preliminary** Double Mass Curve for the Crow River at Rockford, showing the relationship between precipitation and river discharge.

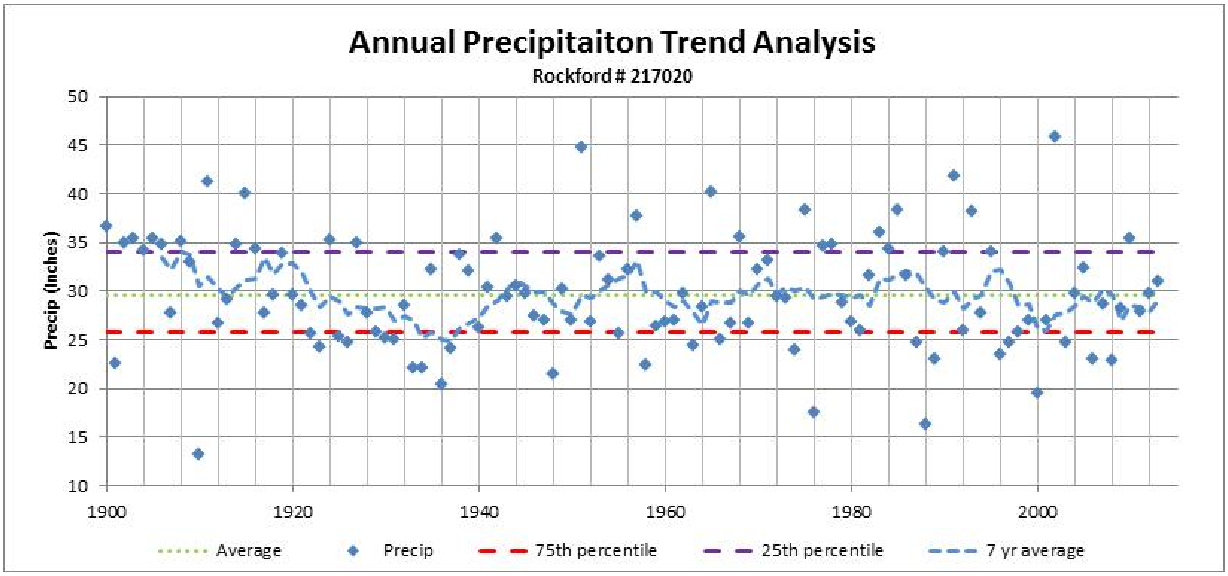


Figure 2: **Preliminary** Trend Analysis of Precipitation at the Rockford gaging station

This hydrograph (Figure 2) depicts cumulative runoff (discharge over watershed area inches) and monthly precipitation over time. This also shows that in recent years, runoff volumes are increasing while precipitation is remaining relatively steady over the period of record. This may be in relation to a number of changes in hydrology, land use, and alteration of the landscape, including decreases in watershed storage capacity, changes in agricultural cropping patterns, increased hydrologic alteration including pattern drainage, and other alterations that move water off the landscape.

A double mass curve was also generated for the Middle Fork Crow River (Figure 3). Stream flow data in the Middle Fork Crow River watershed were collected at the Kandiyohi County Road 2 gage site. Stream data collection at this site began in 1949 through the USGS, but was discontinued in 1996. The site was reestablished in April of 1996 through DNR/USGS agreement but was discontinued in 2013. This data set is ideal for in-depth analysis of changes over time, as it is a nearly continual record from 1949 to the present.

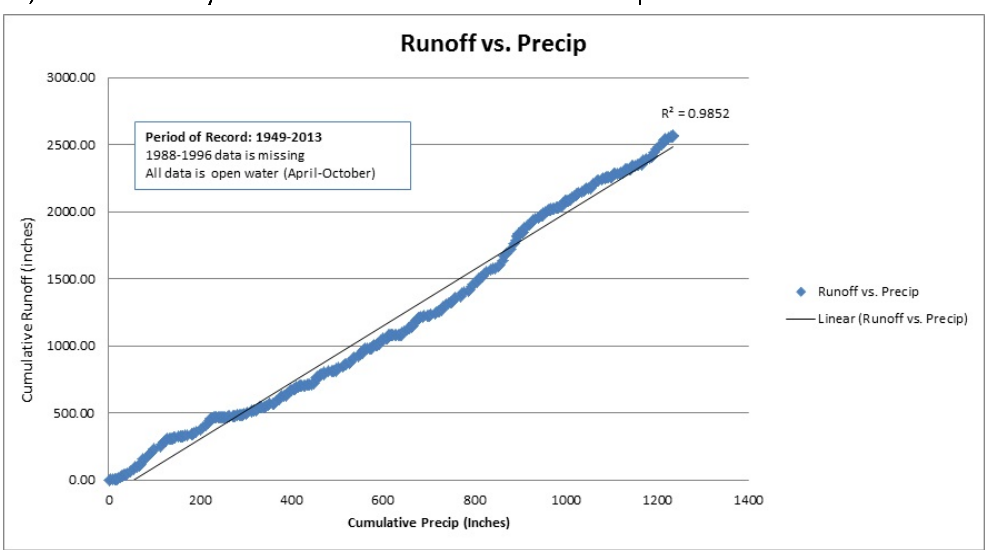


Figure 3: Preliminary Double Mass Curve for the Middle Fork Crow River at the Kandiyohi County Road 2 gaging site, showing the relationship between precipitation and river discharge.

The data displayed in this curve (Figure 3) is significantly different from the curve for the Crow River at Rockford. The runoff relationship displayed at this location is relatively linear over the entire period of record, and does not display an increase in runoff per unit discharge as displayed in the Rockford curve. This data shows no net increase in discharge over the period or record. This indicates a more stable precipitation to discharge with less hydrologic alteration throughout the watershed. This is likely related to a number of factors within the watershed, including the significant amount of depressional storage available in the number of lakes and wetlands along the mainstem of the river, and less alteration of hydrology as a whole within the subwatershed over the period of record. Precipitation was also relatively stable within the watershed over the period of record. As both low and high annual precipitation volumes were recorded during this period, it is apparent that the precipitation/runoff relationships are not directly affected by periods of wet or dry conditions.

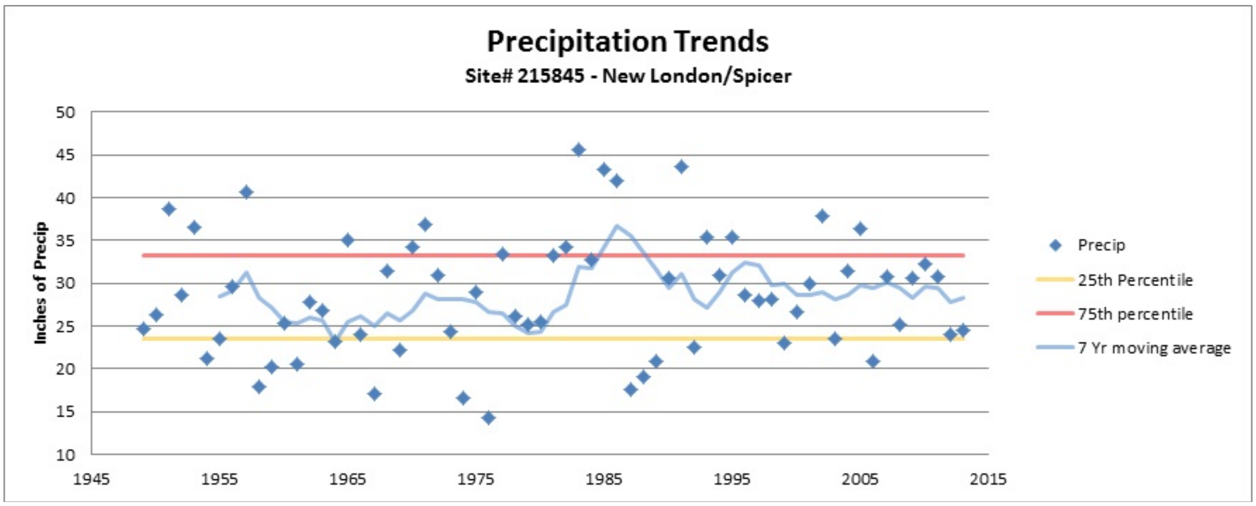


Figure 4: Preliminary Precipitation Trends for the Middle Fork Crow River Watershed at the New London/Spicer site.

Additional Hydrology Information

Additional analyses, including discharge characteristics such as periods of low or zero flow, flood frequency, base flow volume, and seasonal variability will be conducted prior to the next iteration of the watershed study commencing in 2017, and will have more analyses specifically referencing the North Fork watershed. Specifically, additional comparative and trend analyses will be conducted using discharge data from various other gage sites throughout the watershed, including the Rockford (Farmington Avenue site, DNR# 18088001), Koronis Lake Outlet (18055001), Middle Fork Crow River (18033001), and Manannah (18063001) gage sites. These data sets are significantly shorter in duration; however, smaller data sets can still provide useful data to analyze for smaller, more recent shifts or changes within the period of record.

Groundwater

This groundwater usage and observation well data has not yet been analyzed as a part of trend analysis and water level fluctuations in aquifers, but will be included as a portion of the report with the next iteration of watershed monitoring commencing in 2017.

The upper portion of the NFC watershed coincides with the southeastern extent of the Bonanza Valley Aquifer system (Figure 5), a regionally important groundwater resource which is highly utilized by area landowners for high capacity use, the majority of which is for crop irrigation. The Bonanza Valley aquifer was recently designated a Groundwater Management Area (GWMA) by the Minnesota DNR, due to significant concern related to potential overuse and contamination of the groundwater resource. The DNR will be undergoing a major planning cycle with the goal of ensuring sustainability of use within this system as well as assessing any significant issues to natural resources to ensure sustainability and continuation of ecosystem services throughout this area.

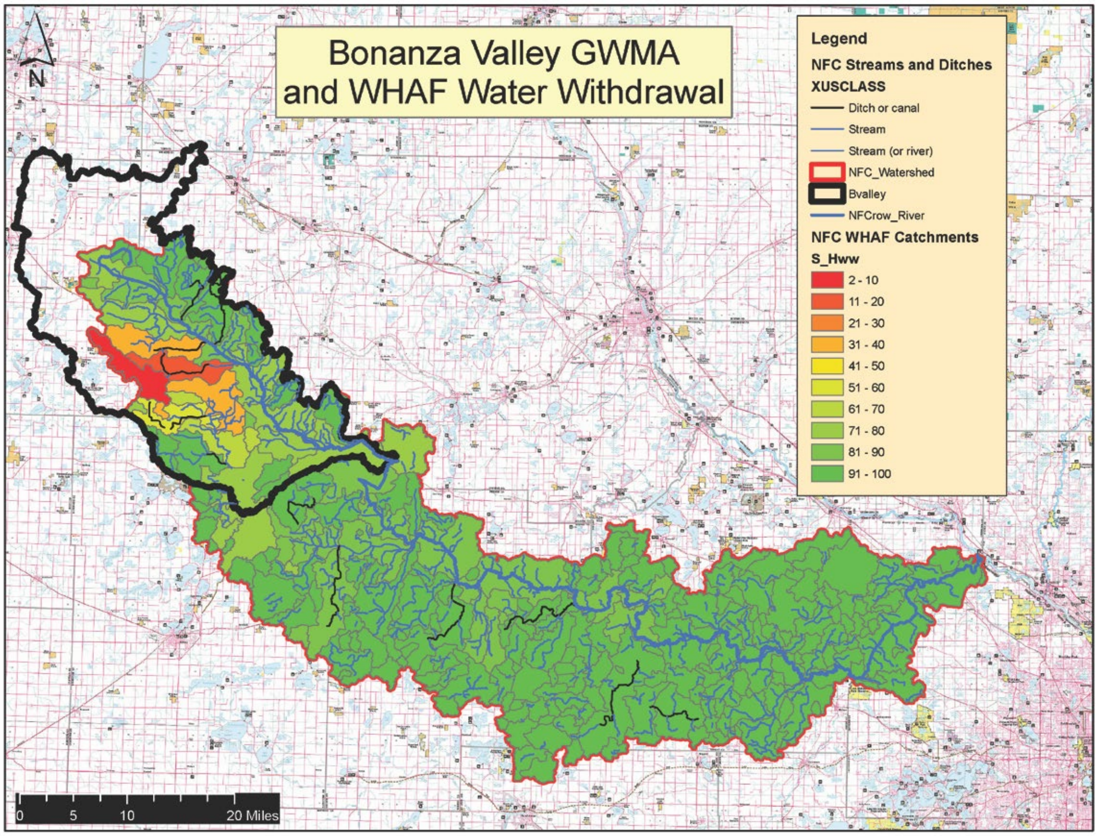


Figure 5: Bonanza Valley GWMA and WHAF Water Withdrawal Scores

There is currently a network of water level observation wells in-place within the Bonanza Valley area; however, additional wells may be necessary to accurately gage the water level variations within these aquifers. Data will be presented as it becomes available.

The WHAF layer detailing water withdrawal is noted in Figure 5. Water withdrawals can lower water tables and reduce water storage in aquifers. In turn, withdrawals may: reduce discharge to or increase recharge from surface waters to depleted aquifers; increase recharge from other aquifers; increase the fluctuation in surface water levels; or cause permanent damage to an aquifer. Furthermore, the withdrawal of surface water can reduce the flow in streams and the water levels in lakes and wetlands, which in turn can reduce recharge to or increase discharge from ground water. The Bonanza Valley GWMA contains the subwatersheds with the lowest WHAF scores for water withdrawal, indicating that the water withdrawn from groundwater units is the highest in proportion to surface runoff, and has the greatest potential for effects to surface water systems.

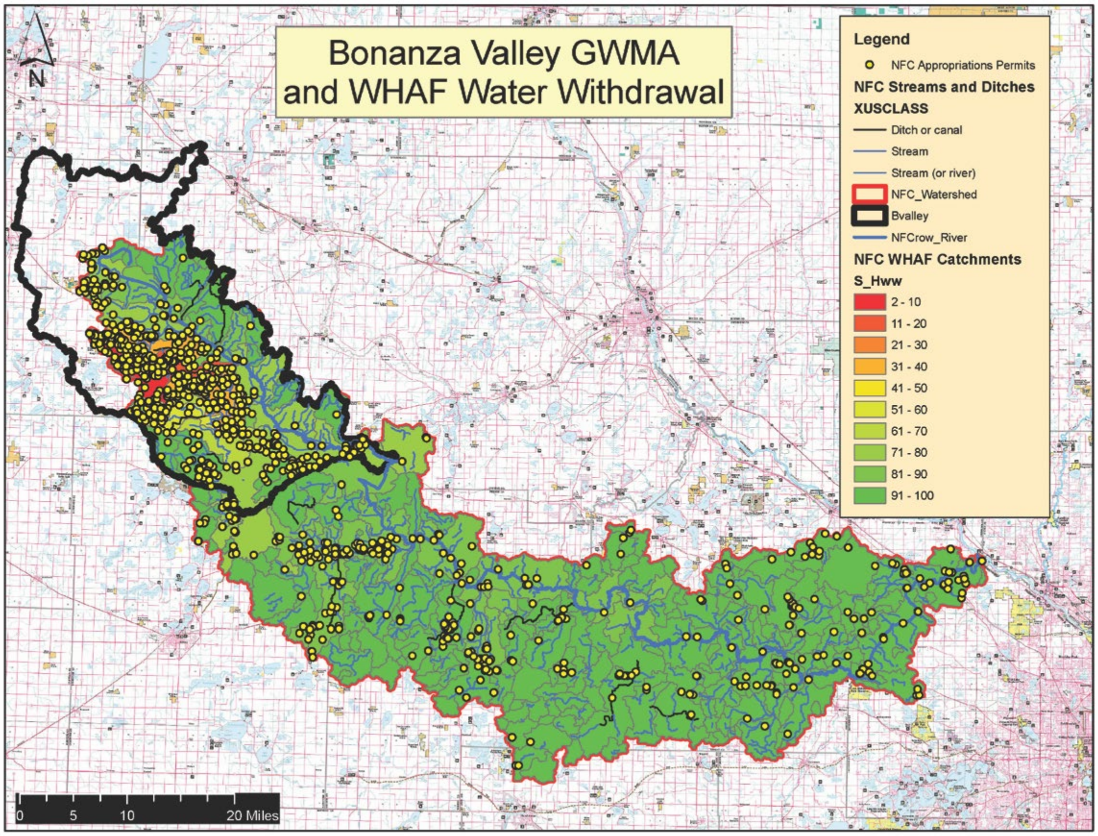


Figure 6: Appropriations permit locations within the NFC Watershed.

Currently, there are 614 high capacity wells associated with 414 appropriations permits within the Bonanza Valley portion of the NFC Watershed (Figure 6). Analysis done of the State Water Use Data System (SWDUS) system conducted prior to the onset of the GWMA show significant use of shallow/surficial wells in proximity to the mainstem river and/or major tributaries. Appropriation from the surficial/shallow system may have significant effects on discharge within the streams during low flow conditions, and may result in exacerbation of existing impairments (such as DO) or concentration of nutrients. Additional study will be conducted on this parameter in this area.

In addition, there are a significant number of high capacity wells in proximity to the Middle Fork Crow River east of Lake Calhoun Kandiyohi County, and the same concerns apply to this reach.

Wetlands - Similarly, groundwater withdrawals in the vicinity of wetlands and shallow lakes can have significant effects on water levels within the basins. Several studies are currently underway within the Bonanza Valley area, including one study on the Burbank USFWS Waterfowl Production Area, with respect to determination of the effects of high capacity use on nearby wetlands, and it is anticipated that this information will be available for inclusion in the report to accompany the WRAPS report commencing 2017.

As there is significant potential for impacts to surface waters, restoration strategies and priorities in this area should include enhancing recharge areas and promoting wetland restoration to facilitate groundwater recharge to minimize effects to groundwater resources.

Shallow Lakes

Minnesota's diverse wildlife populations are influenced in large part by our state's abundant water resources. While all lakes support wildlife needs, it is the shallow water zone, characterized by aquatic plants and generally less than 15 feet deep, that provides the most important wildlife habitat. There are more than 5000 shallow lakes over 50 acres in size in Minnesota. These lakes have permanent or semi-permanent water regimes and are typically dominated by wetland habitat (less than 15 feet deep). Although water quality degradation, altered watersheds, modified outlets, urban development, intensive agriculture and exotic species have reduced their wildlife benefits, shallow lakes remain a critical habitat component for Minnesota's wildlife. (MNDNR, 2010)

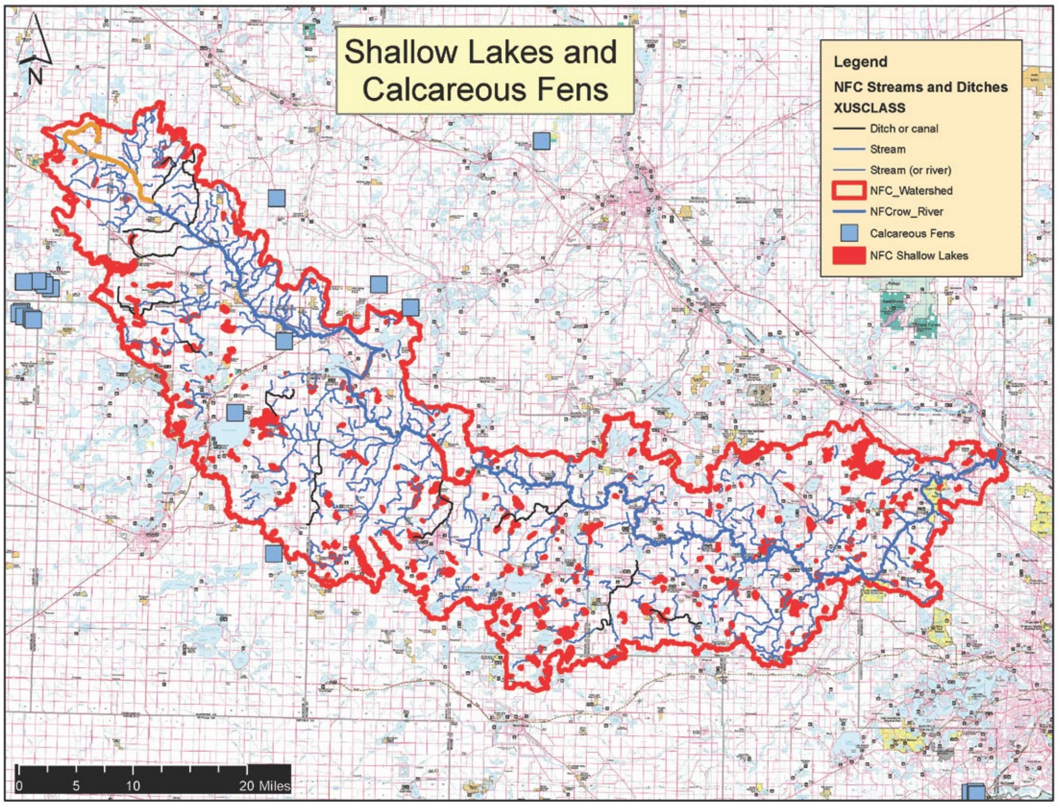


Figure 7: NFC Shallow Lakes and Calcareous Fens

The NFC watershed contains 263 shallow lakes identified using this criteria (Figure 7). Although water quality degradation, altered watersheds, modified outlets, urban development, intensive agriculture and exotic species have reduced their wildlife benefits, shallow lakes remain a critical habitat component for Minnesota's wildlife. At the time of this study, priority for management was given to shallow lakes located either adjacent to or completely within currently owned state lands. Other information is considered for specific projects potentially outside of this priority scale, including involvement of partners and willingness of riparian landowners to conduct the project.

Shallow lakes and their immediate watersheds, due the importance of these basins to habitat and the sensitivity to water quality changes as well as the high potential for restoration and management, are also priority areas for both protection and restoration activities. As per information gathered from DNR shallow lake surveys within the NFC watershed, there are shallow lakes basins with good water quality that exist in a clear water state.

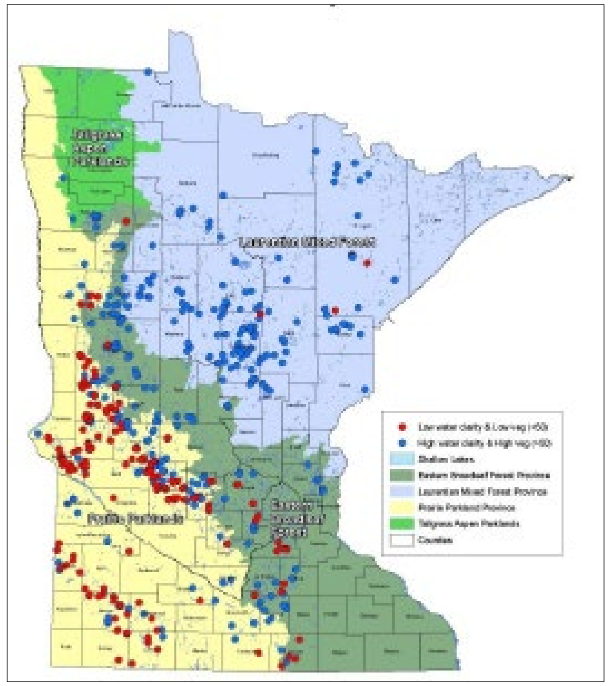


Figure 8: Shallow Lakes and most recently surveyed condition (MNDNR, 2010).

Calcareous Fens

In addition, there are several rare water resource features that are present due to unique geologic conditions that warrant protection. Specifically, calcareous fens develop in areas where mineral-rich groundwater is discharged from underlying calcareous mineral soil and forced through peat soils by artesian pressure. These communities are very rare, as they are dependent on specific geologic and hydrologic conditions, including upwelling of cold, anoxic water, and are very sensitive to minor changes in these conditions. Several plant species are found only in calcareous fens in Minnesota. In addition, it has been noted that fens are present in a number of settings, but are typically close to higher-elevation groundwater recharge areas (MNDNR, 2005). Due to rarity and sensitive nature of these sites, calcareous fens and the surrounding areas must be considered for protection from development and groundwater diversion and/or overuse. There are currently two of these unique water features designated within the NFC watershed (Figure 7).

Geomorphology

At the time of this report, six stream reaches within the NFC watershed have undergone basic reconnaissance site visits (Figure 9) to gather information related to stream condition, overall pattern, and profile. Two reaches were assessed using the BANCS method, including the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) methods to estimate the nature of stream bank erosion consistent with the stream assessment methods developed and taught by Dr. Dave Rosgen. These surveys were conducted to better determine the general condition of the stream with the intention of returning to the stream to conduct more detailed analyses based on stream bed pattern and profile. In addition, these reconnaissance surveys also allow for a qualitative assessment of the stream corridor, relating to access to the floodplain, riparian vegetation, development presence of major bed features, and location of potential priority project/practice locations.

At this point in the study, stream and valley type have not yet been determined. This is will be a portion of the additional information collected during more intensive study within these stream reaches in coming years.

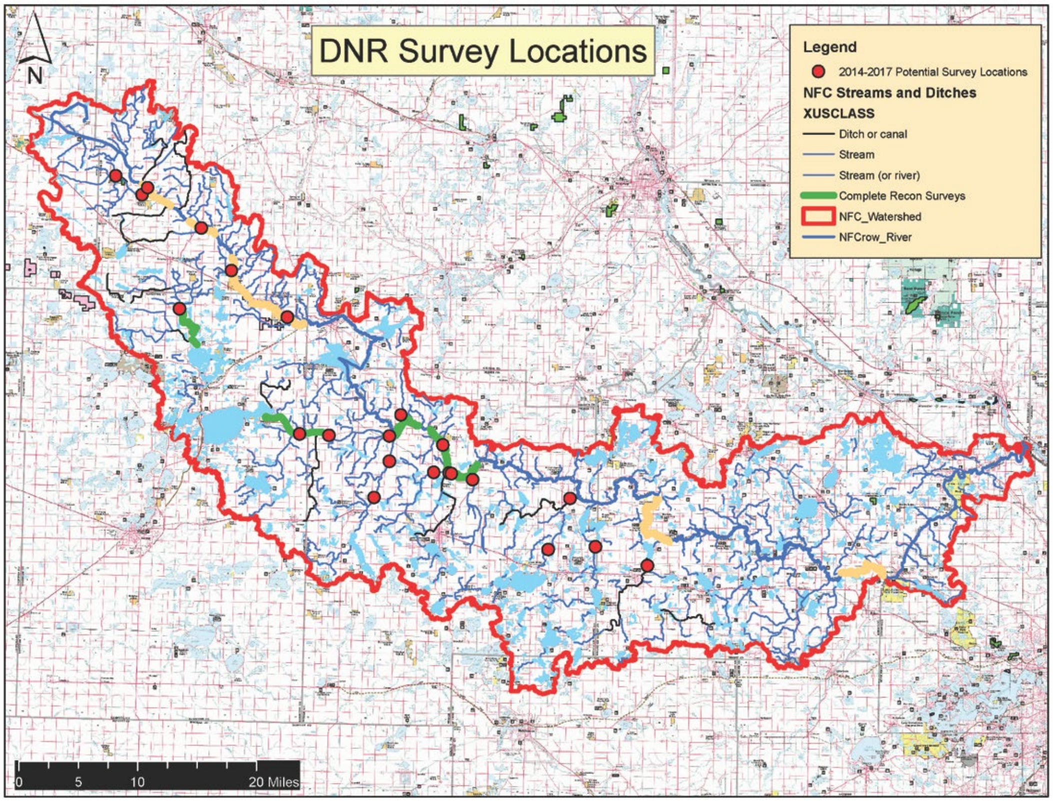


Figure 9: DNR Stream Reconnaissance and Potential Detailed Survey Site Locations

At the time of this study, the specific locations of the stream surveys were not coordinated with PCA staff. For the upcoming round of major watershed monitoring and assessment commencing in 2017 for the NFC watershed, additional detailed survey locations will be coordinated with local PCA staff to coincide with priority tributaries and locations on the mainstem river.

Reach 1: Middle Fork Crow River, Kandiyohi County Rd 35 to Mud Lake

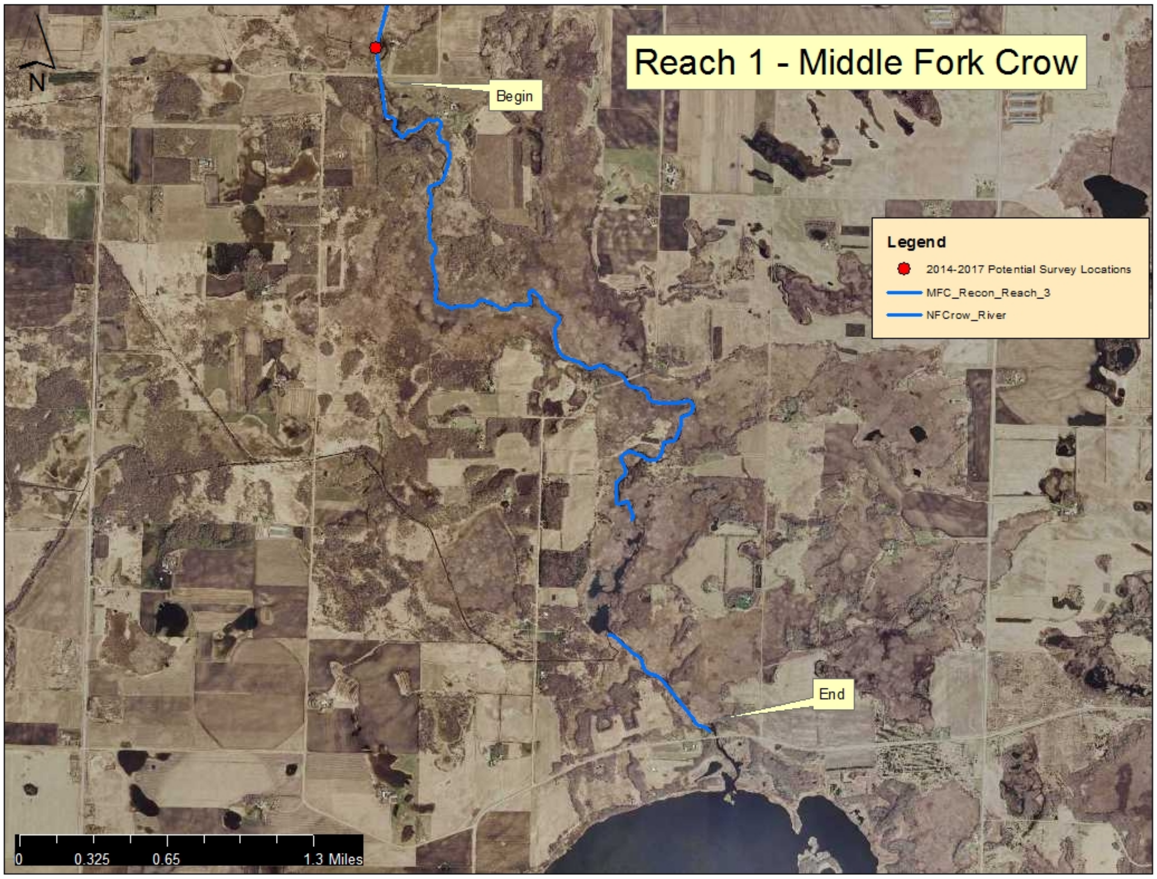


Figure 10: Middle Fork Crow River, Reach #1

This 3.5 mile reach was surveyed in September 2011. The reach displayed excellent riparian vegetation and floodplain connectivity throughout, indicating good channel stability. The majority of the reach is located within a number of large Type III/IV wetlands connected by short stretches of stream channel. Very little erosion was noted in this reach and, in cases where erosion was noted, it was only in proximity to road crossings, likely as the result of high flows or improperly sized culverts. As the majority of the reach was located within wetlands, bed features were difficult to note aside from a small portion of the streambed at the upstream end of the reach. Additional detailed survey information is planned to be collected at this site.

Qualitative analysis of the stream corridor detailed potential reference reach conditions, as very little erosion was noted, channel width, depth, water height to bankfull elevation appeared reasonable for this stream, and floodplain connectivity is very good. The channel does not appear at this time to be over-wide or entrenched due to excessive flows and good access to the floodplain, however, additional data will need to be collected to quantitatively determine these parameters. The reach visited was located immediately downstream of a lengthy channelized reach, and served as the transition from a channelized reach to a meandered stream reach. The primary reason for selection of this reach was to determine if there was a significant affect to the downstream meandered reach as a result of the upstream channelization.

Strategies in this reach would tend toward protection status, through preservation of the riparian vegetation and buffer/riparian corridor continuity. Additional study including a detailed channel analysis will be needed to properly classify this reach and make additional recommendations.

Reach 2: Middle Fork Crow River, New London Dam crossing to Nest Lake.

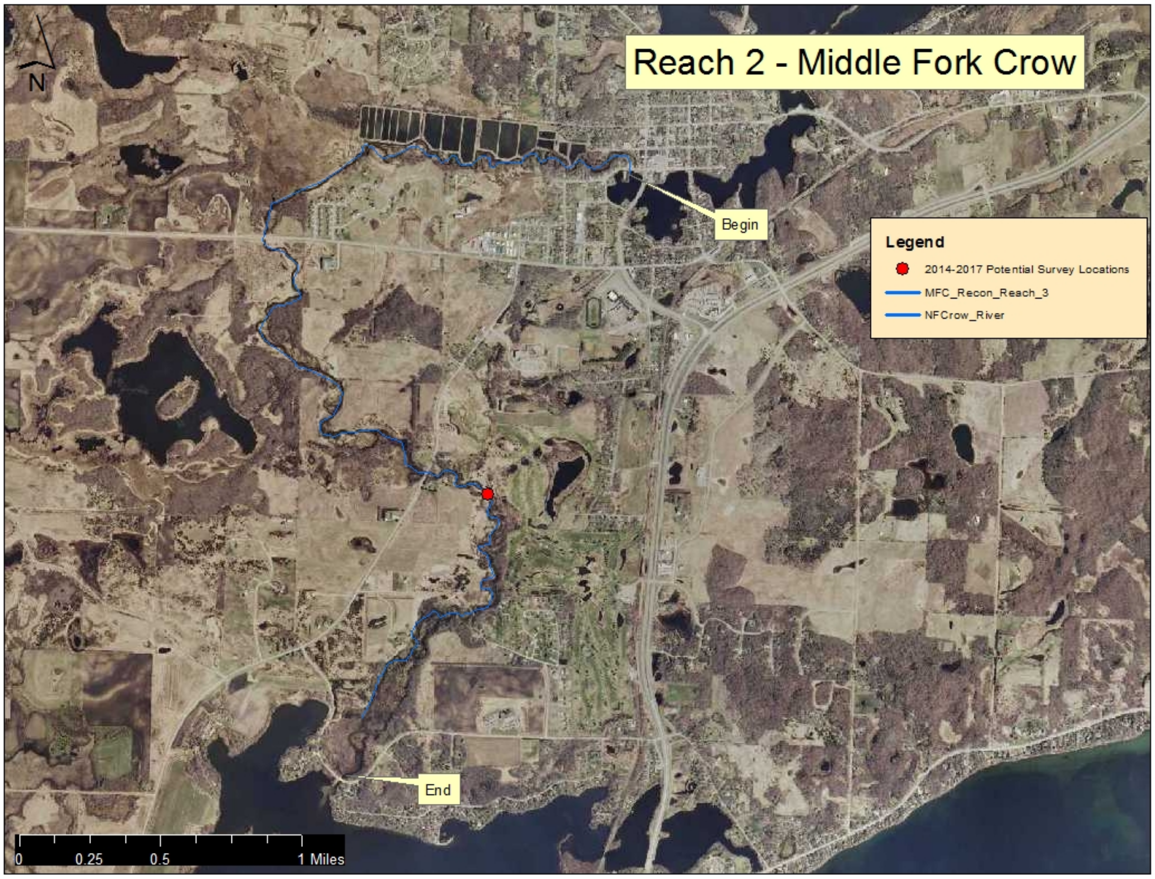


Figure 11: Middle Fork Crow River, Reach #2

This reach displayed significantly altered conditions from those noted upstream. The stream was much more incised in most areas, and limited floodplain accessibility was noted, both of which are indicative of instability throughout this reach. Significantly increased streambank erosion was noted in this reach, many moderately sized actively eroding banks ranging from 3-8 feet in height, and several banks exceeding 10 feet in height were noted. Riparian vegetation and buffers were present in most locations; however, there were several sites where the streambanks displayed erosion that likely could have benefitted from a larger buffer.

Qualitative analysis of the stream corridor detailed impaired reach conditions, as significant erosion was noted, channel width was beginning to increase throughout the reach, and mid channel bars were noted in several locations. BEHI and NBS information were not collected in this reach, but will be collected in the future as a portion of more intensive surveys. Access to the floodplain was becoming limited and floodplain connectivity is relatively poor. This portion of the stream is also likely impacted from stormwater runoff from the city of New London, and the effects of the New London Dam.

Strategies in this area would trend toward restoration activities, with buffer maintenance and installation as well as potential streambank restoration may be necessary. Systematic issues related to stormwater and potential retention will need to be addressed, however, it will be necessary to first identify the source of the instability in this reach. Additional study including a detailed channel analysis will be needed to properly classify this reach and make additional recommendations.

Reach 3: Middle Fork Crow River, Calhoun Lake Outlet Structure to 520th Avenue

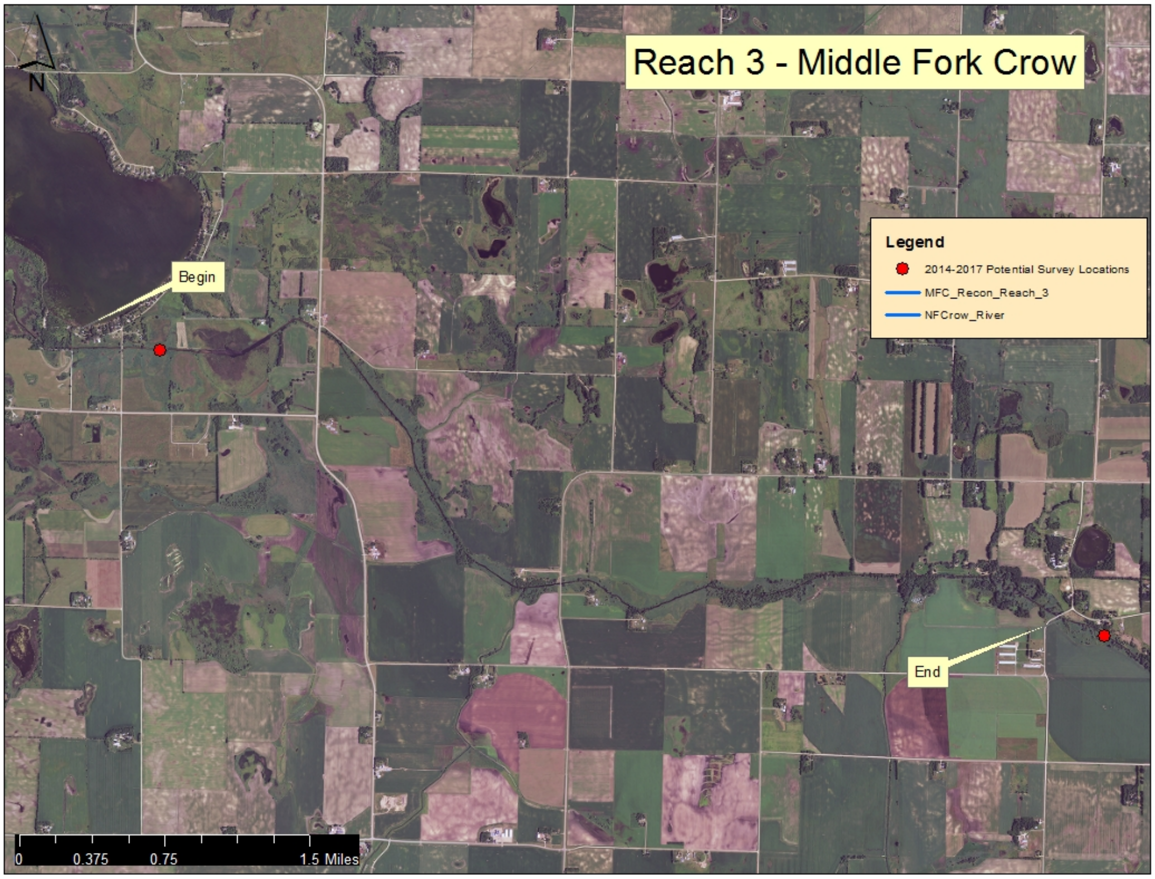


Figure 12: Middle Fork Crow River, Reach #3

The stream is channelized for the entirety of this reach, and displayed significantly higher instability than was seen in upstream reaches. Significant streambank erosion was noted in the portion of the reach downstream of Kandiyohi County Rd 2, and numerous trees had fallen into the river as a result of erosion at the toe of the slope and the resulting rotational failures. Sediment loading from the bank erosion sites was not estimated in this reach; however, several bank erosion sites were noted for future study.

In addition, this reach contains the confluence with Kandiyohi County Ditch 28. At the time of the survey, the water clarity in the Middle Fork was approximately 1.0 meters. Flow from the outlet of CD 28 into the Middle Fork had significantly lower water clarity, indicating much higher sediment loads. Downstream of this confluence, water clarity was significantly decreased. As a portion of future study, CD 28 will be assessed to determine the sources of sediment in this watershed in attempts to decrease sediment loads within the system as a whole.

This reach was also dominated by the presence of mid channel bars throughout the reach from the outlet of Lake Calhoun to Kandiyohi County Rd 2. These features are indicative of a stream that is over-widened and unable to transport sediment loads at low to moderate flows. It is likely that this reach is beginning to become over-wide, and access to the floodplain is becoming limited in many areas.

Strategies in this area would trend toward restoration activities, with implementation of targeted BMPs, including buffer maintenance and installation as well as potential streambank restoration. Additional study including a detailed channel analysis will be needed to properly classify this reach and make additional recommendations.

Reach 4: Middle Fork Crow River, Meeker County Rd 30 to North Fork Crow River Confluence.

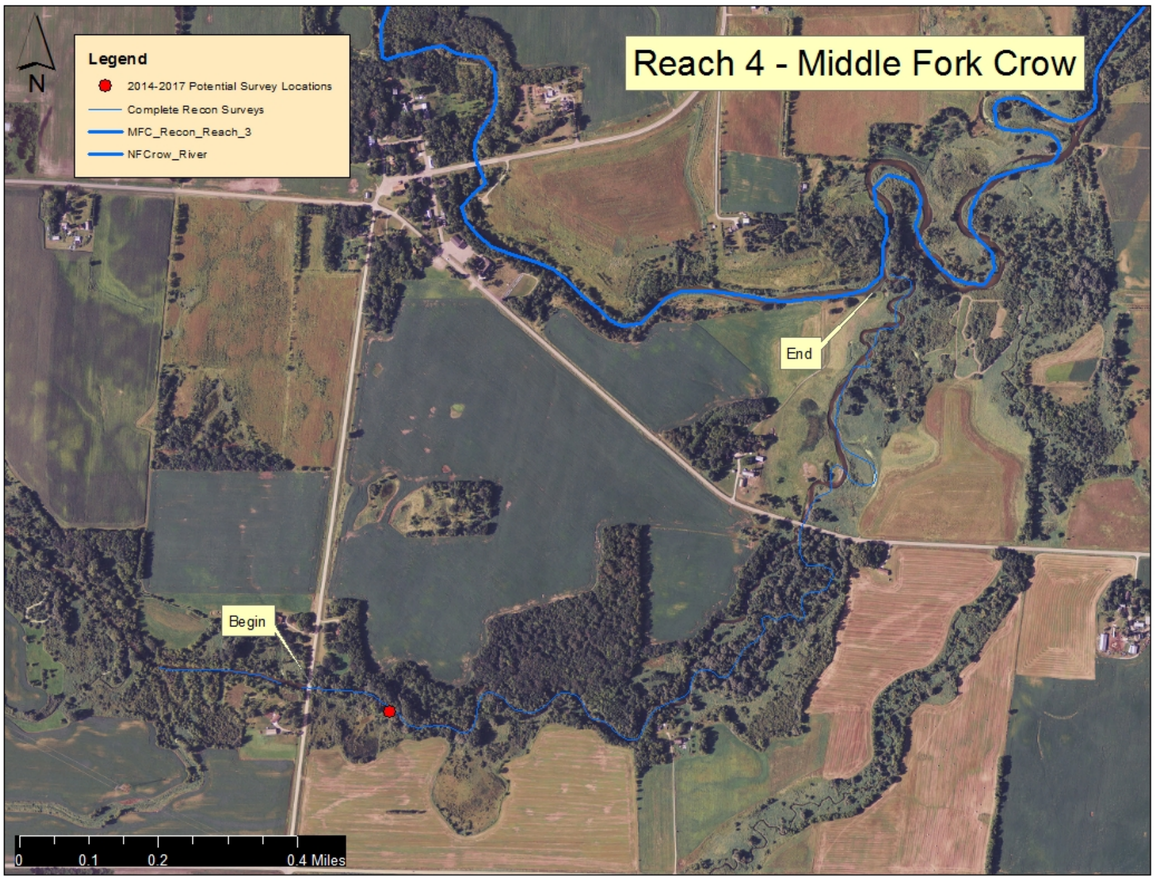


Figure 13: Middle Fork Crow River, Reach 4

This reach is located at the termination of the channelized portion of the Middle Fork, and includes a higher gradient portion as the stream descends into NFC River Valley. In spite of the location of this reach at the downstream end of a large channelized portion of the stream, and immediately downstream of a large cattle pasture, the streambanks are in relatively good condition. The riparian corridor is well vegetated and contiguous throughout this reach. Some instability was noted, but to a lesser extent than that noted immediately upstream. In addition, several riffles were noted in this section, and very few rotational failures were seen. Stability in this reach may be as a result of the riffles acting as grade controls and preventing additional erosion due to increased flows. In addition, several stable bankfull bench features were noted.

Qualitative analysis of the stream corridor downstream of Meeker CSAH 3 detailed some impaired reach conditions, as active erosion was noted, channel width was beginning to increase throughout the reach, and mid channel bars were noted in several locations. Access to the floodplain was becoming limited and floodplain connectivity is relatively poor in the downstream portion of this reach as well.

Strategies for this section would likely incorporate both restoration, through implementation of targeted BMP's, and protection through preservation of the riparian corridor. Additional study will be conducted within this reach.

Reach 5: NFC Mainstem, Meeker County Rd 30 to 592nd Ave.

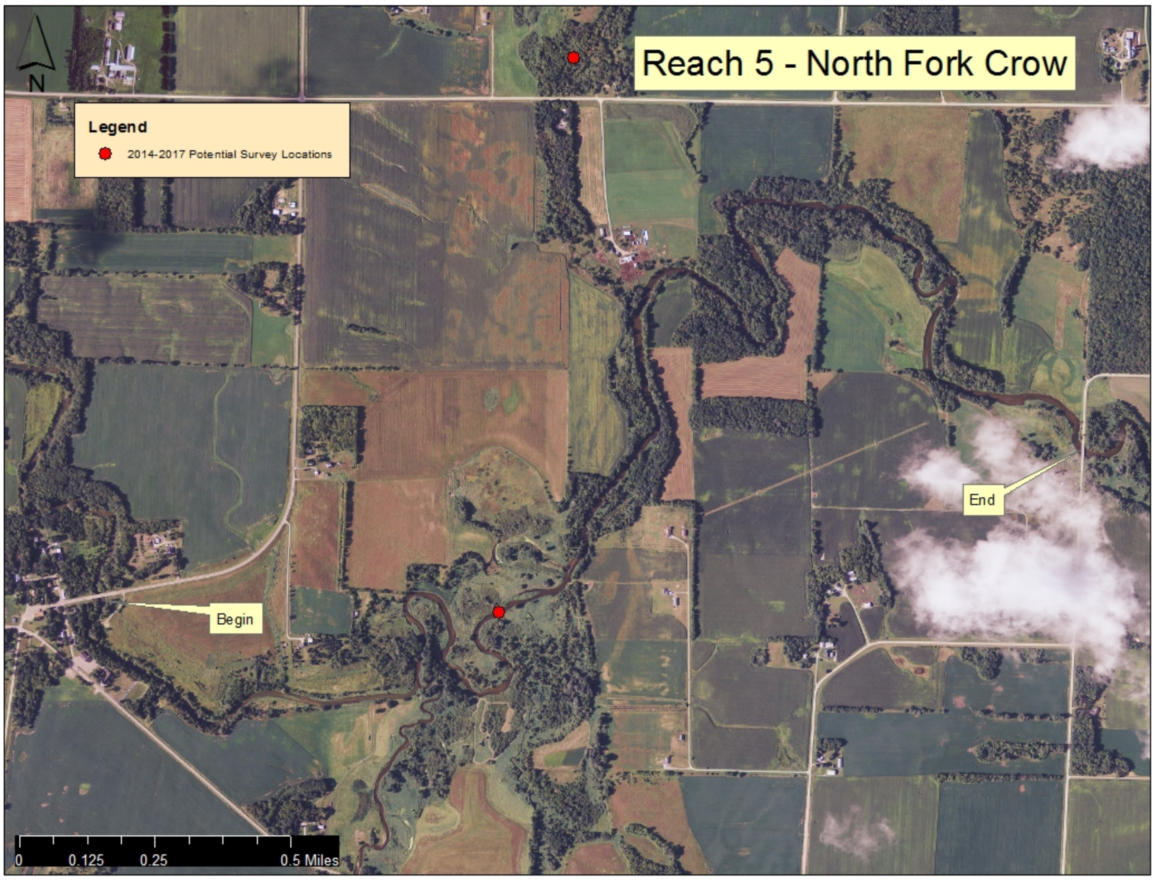


Figure 14: North Fork Crow River, Reach 5

This reach contains the confluence with the Middle Fork Crow and Grove Creek. In addition, significant erosion is noted within this stream reach in several locations. The primary locations for significant streambank erosion are noted in reaches that intersect the stream valley wall. This reach also includes an active meander loop cutoff immediately downstream of the confluence with Grove Creek, which is indicative of active stream channel migration within the floodplain.

Analysis of elevation data in this area indicates that river valley is relatively narrow for the majority of this reach and does not extend outside of the meander belt width of the river, except for the area of the confluence with the NFC, MFC and Grove Creek. The channel migration is likely a significant source of sediment for this portion of the stream. Additional comparisons will be made using historical photographs to help estimate rate of migration.

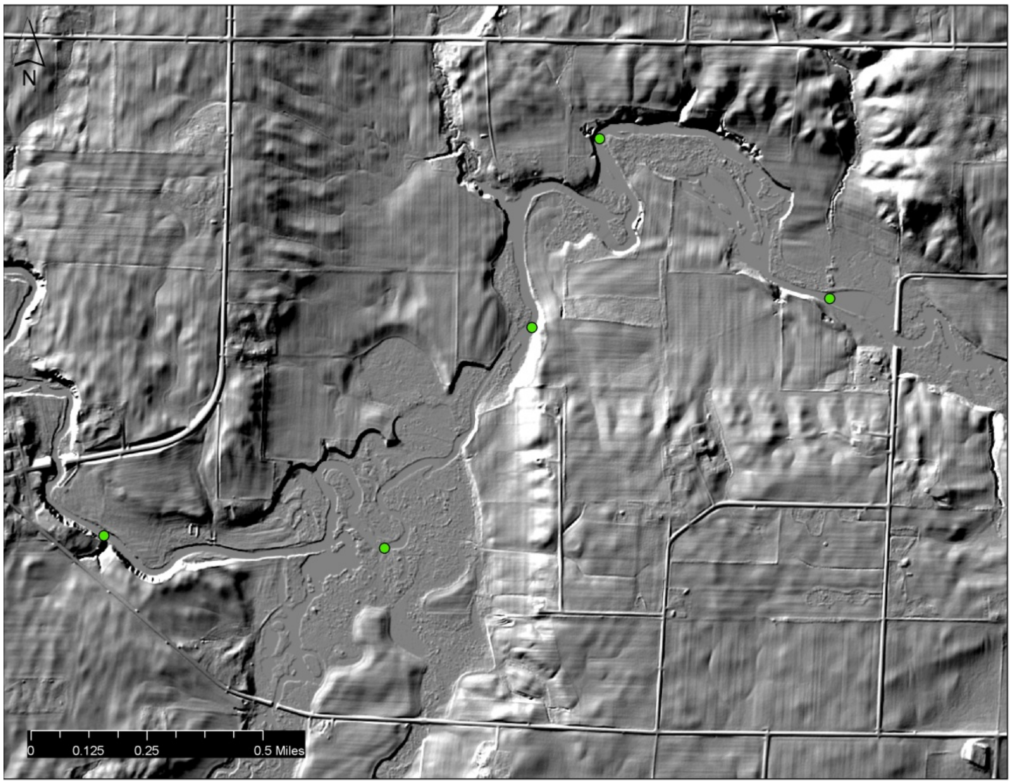


Figure 15: LIDAR Hillshade photo of Reach 5

Terrain analysis (Figure 15) shows that a portion of this reach may be confined within the river valley, and these valley constraints may have exacerbated bank erosion in the areas where the river channel nears the valley wall. This is the case for Bank #1 and Bank #4 referenced below.

Bank #	Bank Height	BKF Height	Root Depth	Bank Angle	BKF Width	BEHI TOTAL	Ranking
1	18	2.0	6.0	60	75	**44.0**	**V. High**
2	3.5	2.0	1.0	90	75	**40.2**	**V. High**
3	12	2.0	3.0	75	75	**45.5**	**V. High**
4	15	2.0	3.0	60	60	**43.0**	**V. High**

Table 1: Streambank characteristics and correlated BEHI adjective ratings for assessed banks in Reach 5.

Figures 16 & 17: Significant streambank erosion at Bank #1 and Bank #4 in this reach.

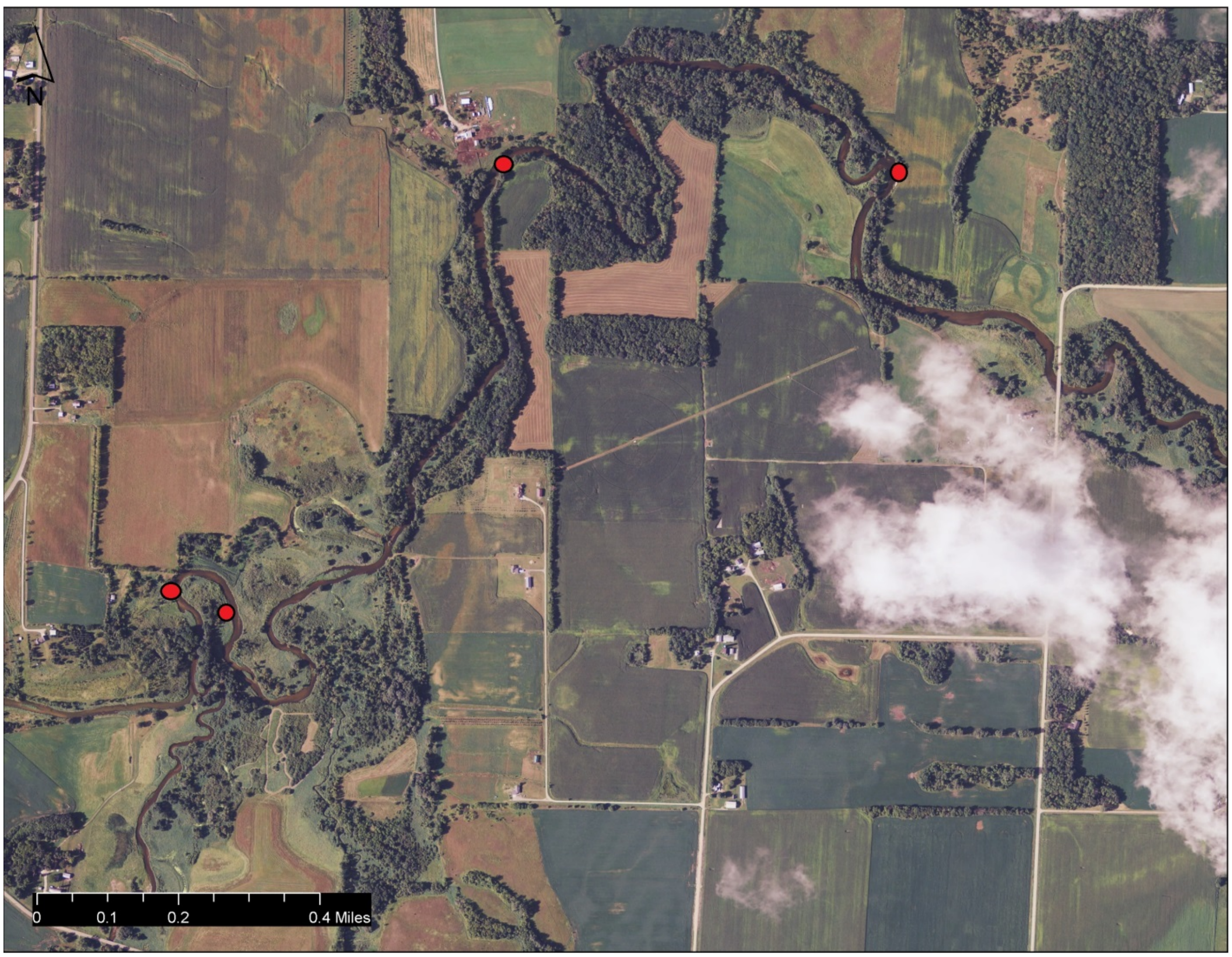


Figure 18: Recon bank locations, numbered 1-4 from upstream to downstream

Stream: North Fork Crow River				Location: Meeker County				
Graph Used: Colorado		Total Stream Length (ft):					Date: 6/6/2012	
Observers: Ethan Jenzen			Valley Type: VIII			Stream Type:		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Station (ft)	BEHI rating (Worksheet 3-11) (adjective)	NBS rating (Worksheet 3-12) (adjective)	Bank erosion rate (Figure 3-9 or 3-10) (ft/yr)	Length of bank (ft)	Study bank height (ft)	Erosion subtotal [(4)×(5)×(6)] (ft^3/yr)	Erosion Rate (tons/yr/ft) {[(7)/27] × 1.3 / (5)}	Erosion total per bank (tons/yr)
1. 1	Very High	High	0.573	300.0	18.0	3094.20	0.49660	148.98
2. 2	Very High	Low	0.250	800.0	3.5	700.00	0.04213	33.70
3. 3	Very High	Low	0.250	250.0	12.0	750.00	0.14444	36.11
4. 4	Very High	Very High	0.872	300.0	15.0	3924.00	0.62978	188.93
15.								
Sum erosion subtotals in Column (7) for each BEHI/NBS combination					Total Erosion (ft^3/yr)	8468.20		
Convert erosion in ft^3/yr to yds^3/yr {divide Total Erosion (ft^3/yr) by 27}					Total Erosion (yds^3/yr)	313.64		
Convert erosion in yds^3/yr to tons/yr {multiply Total Erosion (yds^3/yr) by 1.3}					Total Erosion (tons/yr)	407.73		
Calculate erosion per unit length of channel {divide Total Erosion (tons/yr) by total length of stream (ft) surveyed}					Unit Erosion Rate (tons/yr/ft)	0.2471		

Table 2: Prediction of annual erosion rate using the BANCS method in Reach 5.

Erosion estimates using the BANCS method were 407.73 tons of sediment per year, or 0.2471 tons/yr/ft (Table 2). Specific reach cross-section and longitudinal profile information will be included in following additional study in this reach to validate these estimates.

This reach was specifically selected due to the confluence of the Middle Fork Crow and Grove Creek with the mainstem NFC with interest in the potential effects on the streambank stability immediately adjacent to and downstream of the confluences. Instability was noted in the mainstem channel for approximately 1500' feet downstream of the Middle Fork outlet (Banks 1 and 2), and the erosion rates are estimated above. Bankfull width also appeared to marginally increase, however, this observation was not confirmed during this study, and will be analyzed in future study.

Changes of this nature were not observed at the confluence with Grove Creek; however, due to the presence of an existing meander cutoff resulting to channel migration, any influence at this location from flows emanating from Grove Creek may be difficult to distinguish.

The presence of significant eroding banks points toward instability within this reach. In addition, qualitative analysis indicates that this stream is widening. The presence of a large mid-channel bar at one point within the reach also indicates that the stream may be over widened, and is unable to transport the sediment bedload. All of this information indicates that this reach of the stream is trending towards instability. This is also supported by the apparent lack of significant riffle structures within this reach (additional survey will be needed to confirm this observation). The riparian corridor is relatively consistent throughout the reach with a mixture of forest and floodplain grasses, with reed-canary grass being the dominant grass present. Strategies in the reach should trend towards restoration, with implementation of targeted BMP's including buffers, selective streambank restorations, and similar practices.

Reach 6: NFC Mainstem, MN Hwy 22 to MN Hwy 24.

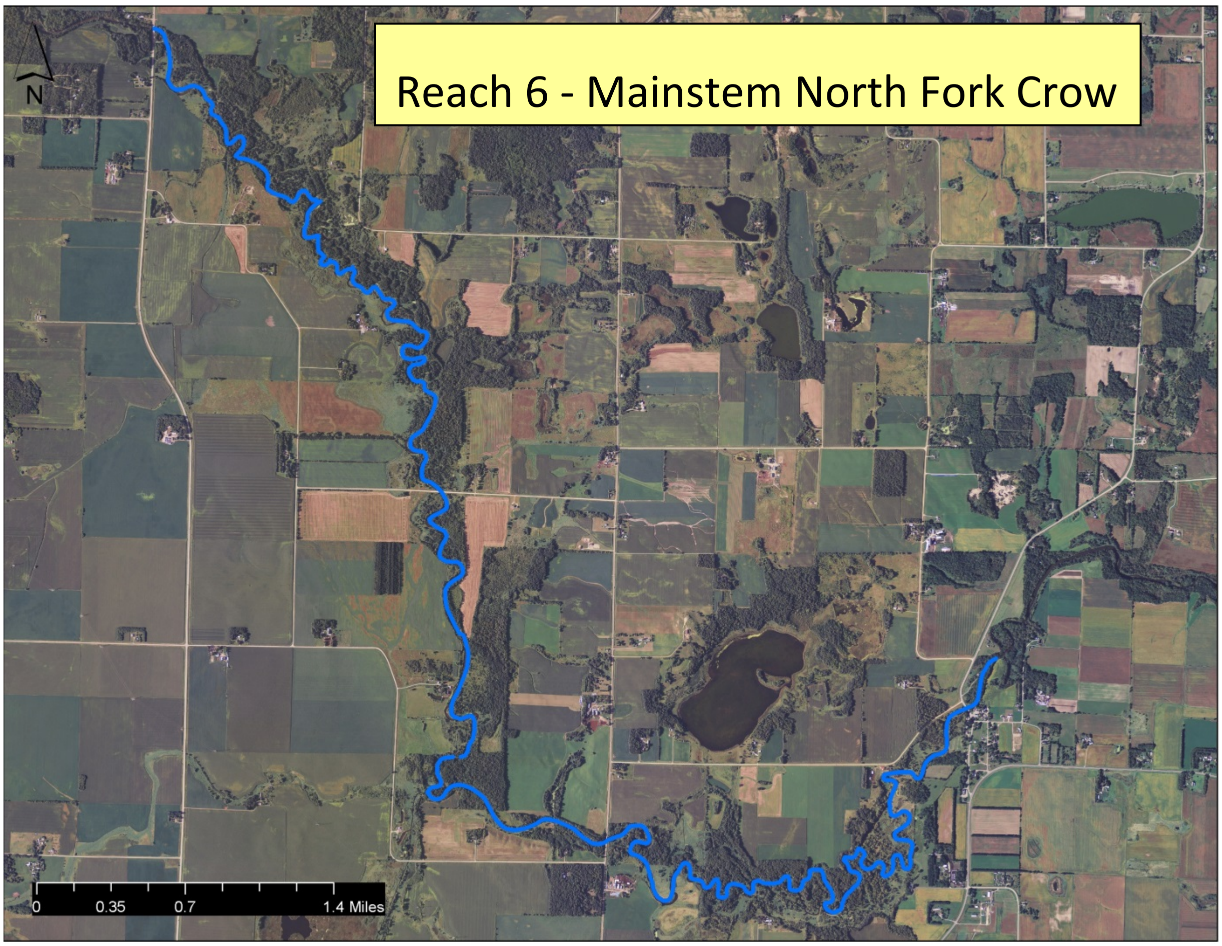


Figure 19: Reach 6, Mainstem North Fork Crow River

This reach is approximately 11 miles long, and is dominated by excellent riparian vegetation and excellent access to floodplain area throughout. While several unstable and eroding streambanks were noted, the vast majority of streambanks displayed were stable and significant vegetation was noted. Qualitative analysis of several more areas of this stream corridor detailed potential reference reach conditions, as very little erosion was noted, and floodplain connectivity is very good for the most part. Additional study will be needed to quantify and adequately characterize these reaches.

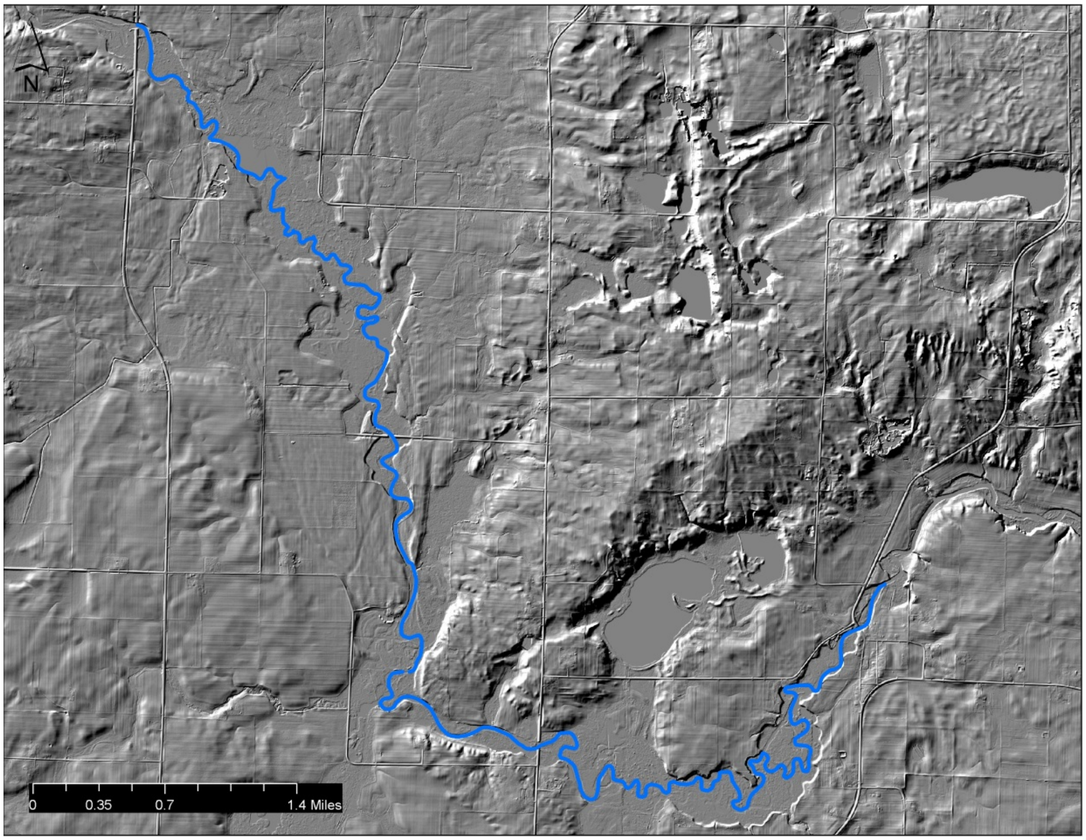


Figure 20: LIDAR Hillshade Map of Reach 6.

As with Reach 5, terrain analysis (Figure 20) indicates that there are several locations in the downstream portion of this reach where the stream channel approaches the valley wall. The only significant active erosion areas noted in this reach are located near the valley wall. In addition, analysis of elevation data noted a significantly wider floodplain in the upstream portions of this reach than what was observed in other areas, and is associated with the most sinuous portion of this stream. This portion of the stream is most likely to display reference conditions, and additional analysis will be completed to characterize and record these conditions.

Figure 21: Stream conditions within this reach.

In addition, analysis and comparison of recent aerial photos show several active meander loop cutoffs. In the upstream portion of this reach, several large mid-channel bars are noted, indicative an over-wide stream with reduced flow velocity, leading to sediment deposition during low to moderate flows within the channel itself. This may also be the result of an improperly sized bridge at the Minnesota Highway 22 crossing, which results in increased velocity and scour during moderate to high flow events, and additional sediment loads to the immediate downstream area.

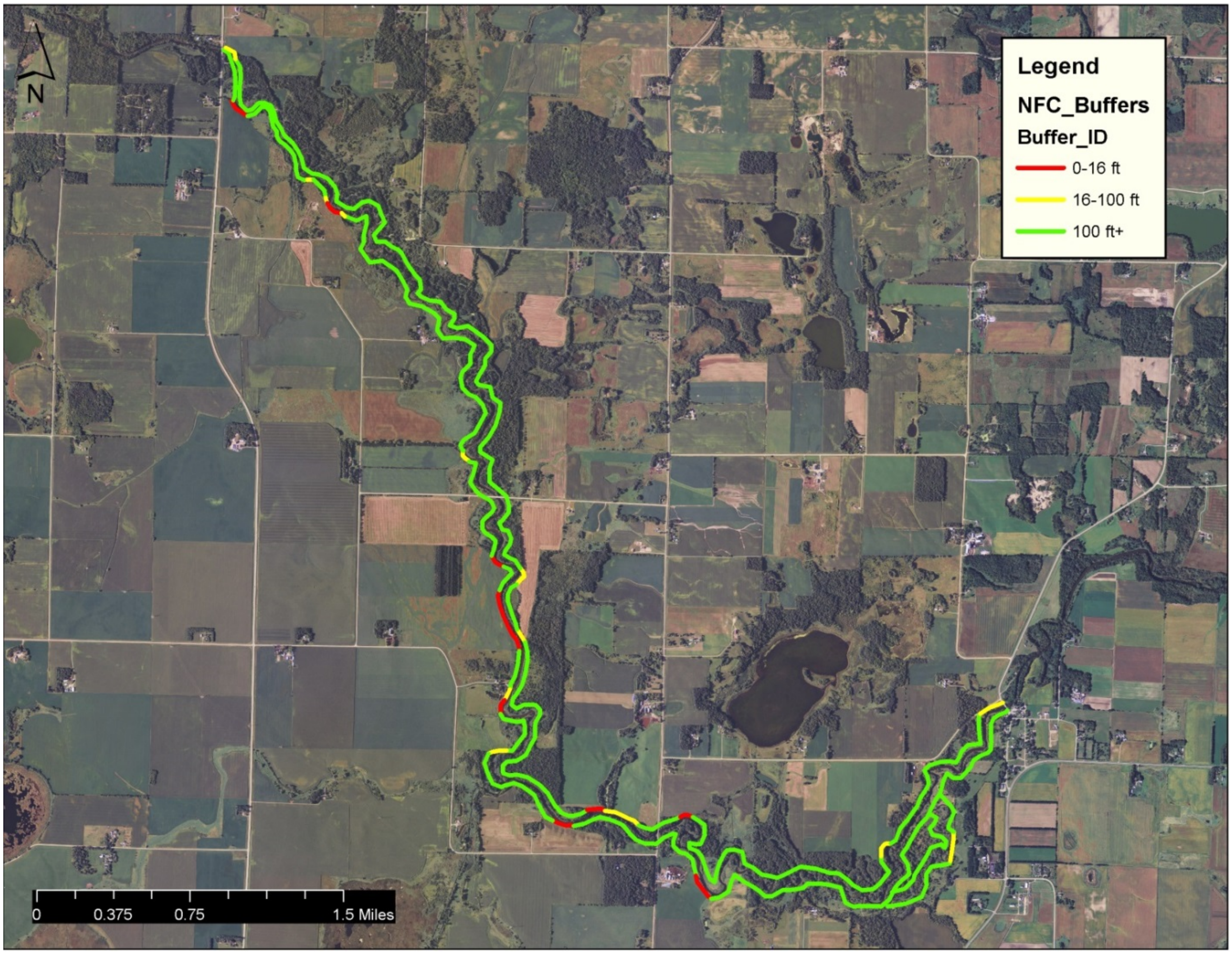


Figure 22: Buffer analysis of Reach 6.

This reach was specifically selected for survey due to the presence of a significant contiguous riparian corridor throughout the vast majority of the reach. In addition, aerial photo analysis indicates that the upstream portion of this reach has maintained higher channel sinuosity than the reaches immediately upstream, and is potentially more indicative of reference conditions. Channel migration within the river floodplain is also noted in many areas throughout this reach in comparative analysis of aerial photos.

The near channel corridor for this reach of the stream is dominated by a nearly contiguous buffer consisting of primarily floodplain forest with intermixed small grassy areas. The buffer analysis displayed in Figure 22 shows that while the buffer exceeds 100 feet for the majority of the stream reach, there are several areas that would benefit from increased buffer width.

Additional Data and Considerations

Lake Watersheds

Several lakes in the mid to upper portions of this watershed that show water quality and water clarity in excess of the normal rates for this watershed, and as per information collected by DNR Fisheries, display much higher fish IBI scores than other area lakes. The lakes include Green (34-79P), Long Lake (34-66P), and George Lake (34-142P), and to some degree Lake Koronis. All of these basins display water quality and clarity characteristics more consistent with a moderate production trophic status consistent with a mesotrophic designation instead of the more commonly seen eutrophic status associated with highly productive turbid basins. Additional monitoring data will be necessary to further this designation.

Long Lake and George Lake have small watersheds (Less than 1000 acres) that are dominated by perennial vegetation and are located within largely undeveloped areas, outside of the immediate riparian area. Green Lake has a large watershed (~80000 acres) and lies on the mainstem of the Middle Fork Crow River, however, there is a large number of wetlands and depressional storage areas upstream of the lake that reduce sediment inputs to the lake itself. In addition, much of the direct watershed to Green Lake is dominated by perennial vegetation and smaller near-channel or directly connected wetlands that buffer flows and reduce sediment inputs to the lake itself. The direct contributing watersheds of these basins (and other basins with similar water quality) should be prioritized for protection status to maintain the water quality within these basins.

DNR Prioritization Tools

The recently developed DNR “Watershed Health Assessment Framework Tool” (WHAF) was also used to assess watershed health based on a number of additional criteria on a 12-digit HUC scale, including impervious surface, perennial cover, and aquatic connectivity. These tools should help to prioritize both restoration and protection strategies based on the scores received in the subwatersheds.

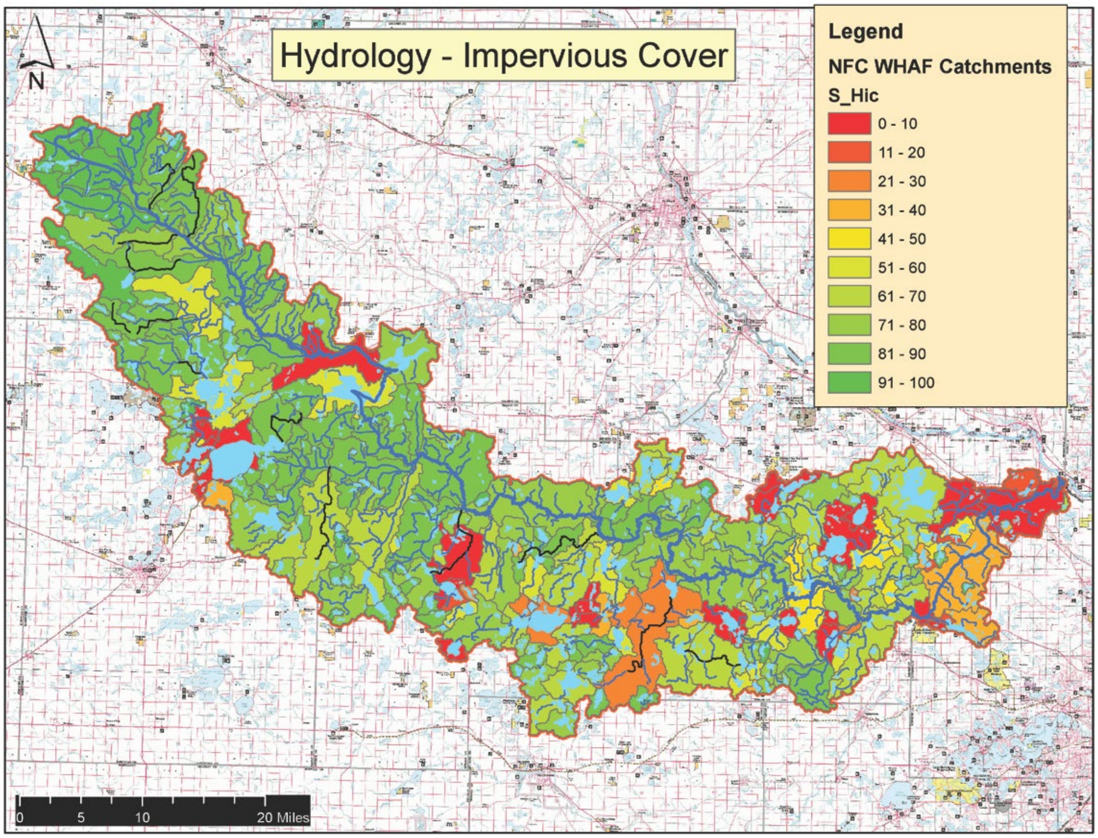


Figure 23: Impervious surface coverage

Figure 23 displays areas with significant impervious surface coverage in the NFC watershed. Areas with high impervious surface have significantly lower scores than areas with natural cover or agricultural land. Nearly all areas that score poorly using this index are associated with municipalities, and therefore the greatest potential for the use of this data is through implementation of protection strategies based on better stormwater policies and enforcement of ordinances that require stormwater treatment before delivery to downstream areas.

Riparian Connectivity

Data has also been collected and compiled in the WHAF in regards to riparian connectivity (Figure 24). Riparian connectivity in this tool is defined as the number of crossings, dams, and/or culverts within a watershed area. Using this tool, the areas that display good riparian connectivity should be prioritized for maintenance of the riparian areas, and subwatersheds with low scores can be targeted for removal of unnecessary crossings, installation/placement of buffers or for enrollment of riparian land into conservation programs.

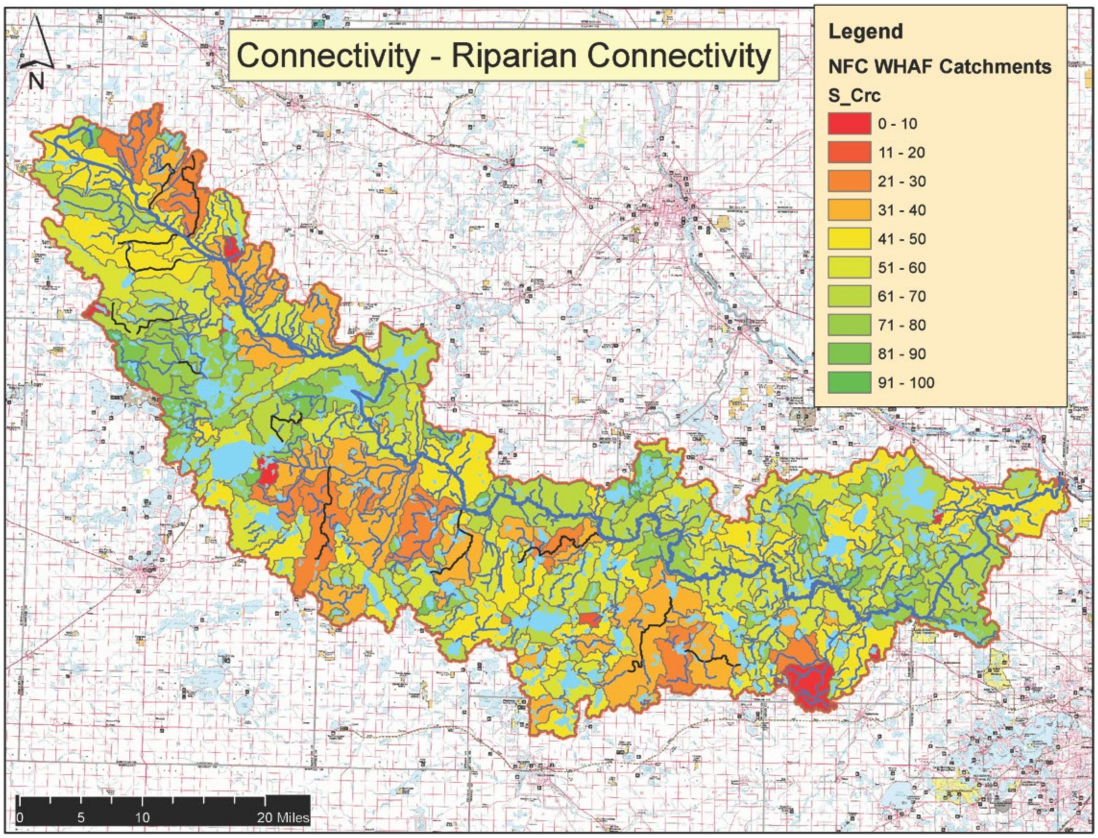


Figure 24: Riparian Connectivity

Riparian Vegetation - Perennial Cover

Several stream reaches throughout the watershed were noted for good riparian vegetation, and for the presence of buffers in excess of 50 feet for the length of certain reaches. Similarly, PMZ development should also be considered in areas with intact riparian corridors and wide riparian buffers. Several areas with intact riparian corridors and significant buffers have been identified during a desktop analysis using ArcGIS tools, which will be field verified as a portion of the next WRAPS study. These reaches include:

- Grove Creek, from Hwy 12 north to the confluence with NFC Mainstem – predominantly wetland/pasture/grassland vegetation
- The Middle Fork Crow River, from 560th Street to the NFC Mainstem – predominantly floodplain forest.
- The NFC Mainstem, from Minnesota Highway 22 to Meeker County Road #2 – predominantly floodplain forest.
- Stag Creek, from the confluence with the NFC upstream approximately 3 miles – predominantly upland forest

These reaches should be prioritized for protection based on the presence of the intact riparian corridors.

In addition, it was noted that several of the riparian corridors were used for pasture ground for livestock. Specifically, portions of the Grove Creek, the Middle Fork Crow, and Stag Brook are known to have potential impacts from livestock activity within the riparian corridor that may affect stream stability and water quality. These areas should be prioritized for restoration through targeted implementation of projects such as cattle exclusion or riparian buffer programs.

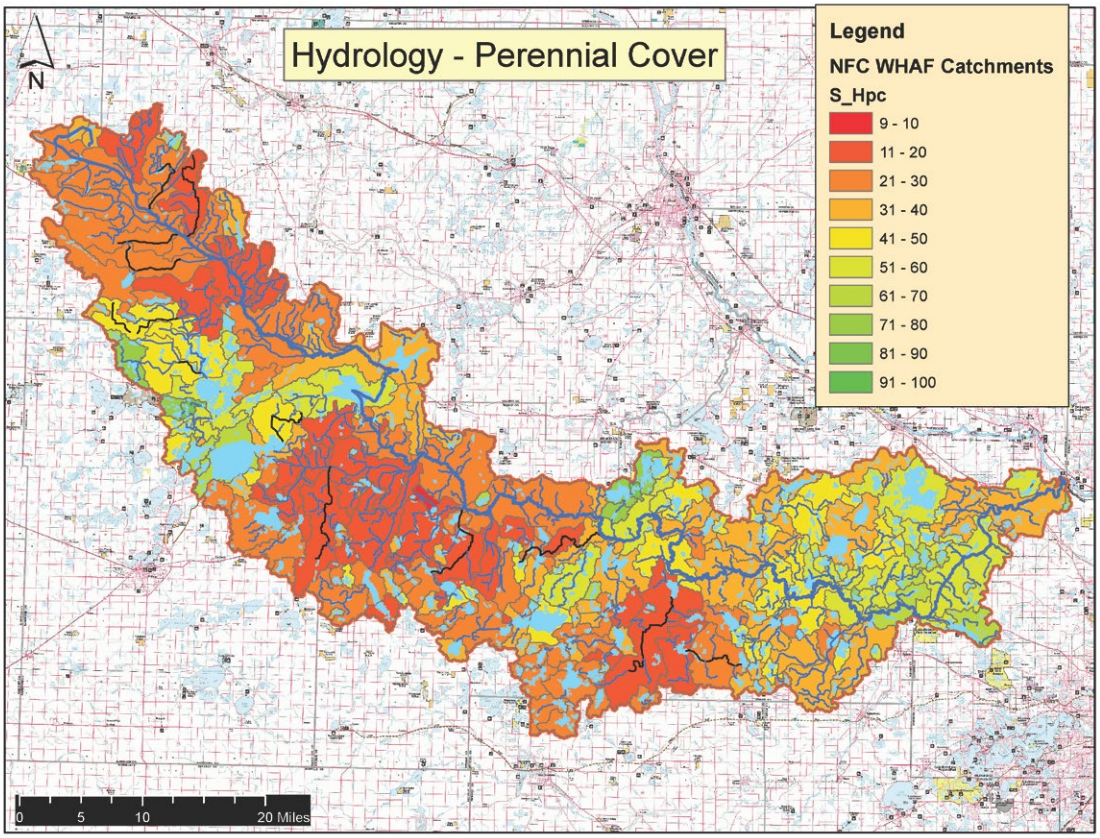


Figure 25: Perennial Cover

Another parameter calculated by the WHAF is perennial cover. Figure 25 indicates the presence of perennial vegetation and is represented as a percentage of total land area within the watershed. While it is difficult to determine from this graphic how much of the vegetation is in the near channel area, the presence of a significant portion of the watershed in perennial vegetation will have significant water quality benefits ranging from reduced runoff and increased infiltration of precipitation to decreased nutrient delivery to receiving waters. The areas with higher percentages of land in perennial vegetation should be prioritized for protection through preservation efforts and set-aside programs for land not currently enrolled. Areas with lower perennial vegetation coverage, which in this area are dominated by land in agricultural production, should be prioritized for restoration strategies involving buffer installation, conservation tillage, cover crops, and enrollment into conservation projects and land retirement programs.

Aquatic Connectivity

Aquatic connectivity was assessed as a portion of the WHAF, and specifically denotes the presence of structures in the stream corridor, including bridges, culverts, and dams that affect the lateral and longitudinal hydrologic connectivity of this system (Figure 26). Higher scores denote areas with few structures or crossings in the stream channel, and lower scores indicate proportionately more structures. The areas in which scores are lower in this index in particular should be prioritized for a culvert/structure analysis to indicate the potential effects of these structures on the channel, including proper sizing to limit hydraulic restriction, limit scour, allow for fish migration, and proper construction on multiple barrel systems.

In addition, the data that is displayed in the Figure 26 is the best estimate of crossings present via MNDOT and local highway department records. Several crossings not included in this collection have been located in other watershed studies, and therefore may affect the WHAF scores if present in this watershed. Additional data was not collected in regards to horizontal connectivity, which assesses floodplain/river channel connectivity.

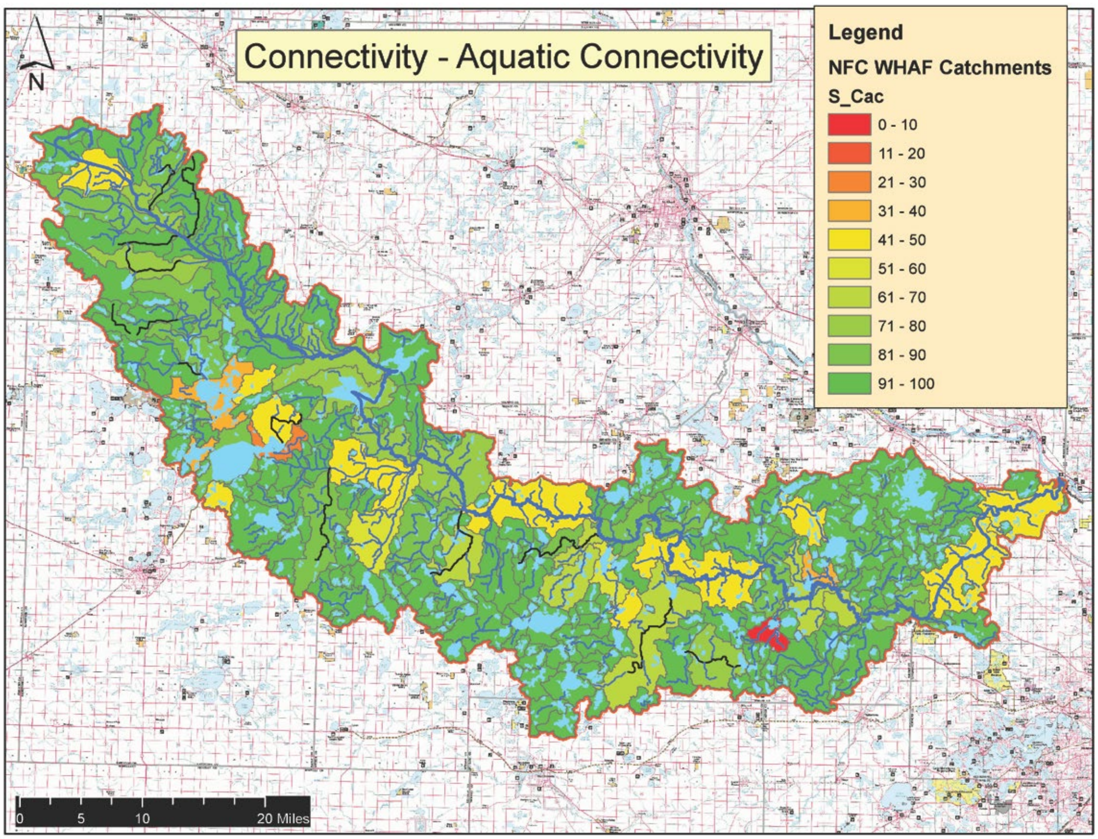


Figure 26: Aquatic Connectivity (WHAF)

Fisheries Lake IBI information

In addition, DNR Fisheries has developed an assessment using the IBI for area lakes. While these scores are based on a range of fish present in the basin, the overall scores will allow for some prioritization of the habitat present within the basin. A number of lakes within the area score very high on the IBI scale (Figure 27). Specifically, the development of strategies for either protection or restoration in the watershed for a basin would benefit from the use of this information. The basins with higher IBI scores would likely display better water quality and benefit more from protection activities, whereas basins with lower IBI scores will likely display lower water quality and benefit more from restoration activities.

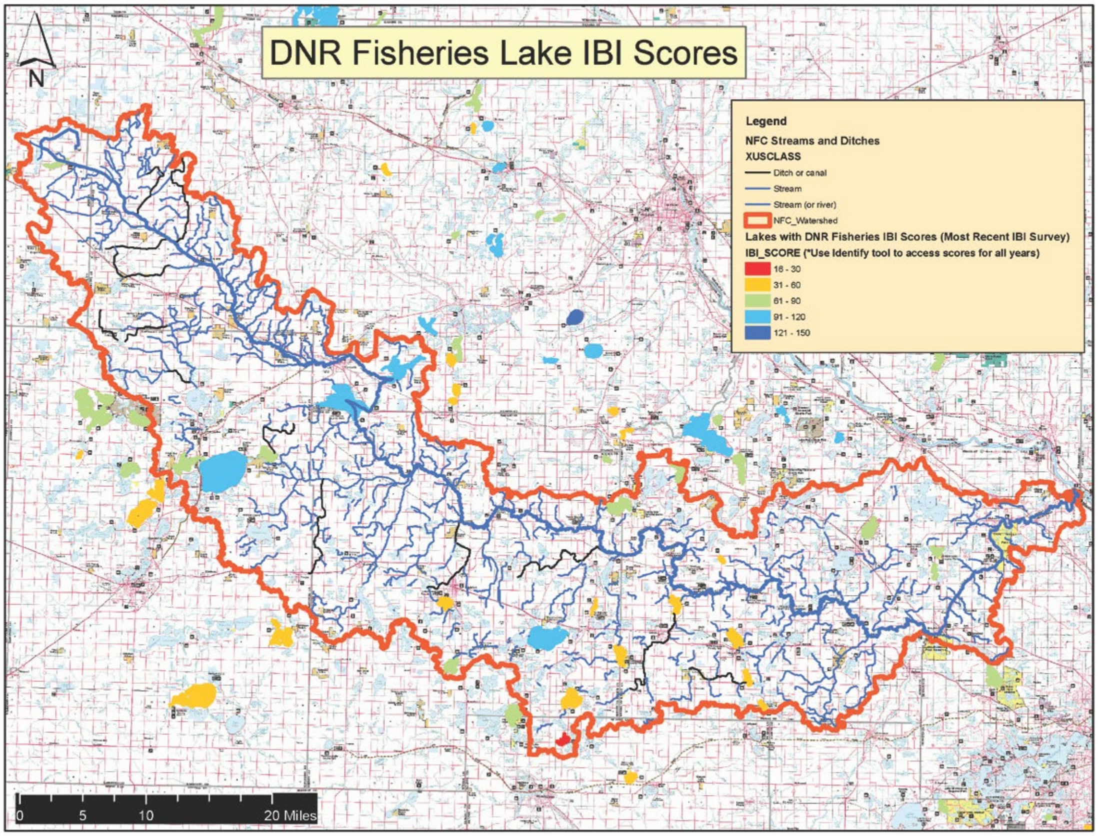


Figure 27: Lake IBI Scores determined by DNR Fisheries

Future Studies

As previously stated, additional geomorphology data relating the pattern and profile of the mainstem NFC and many of the major tributaries is planned to be collected prior to and during the upcoming WRAP study commencing in 2017. The preliminary plan includes data collection on at least five reaches of the mainstem NFC, and data collection on the following major tributaries:

- Sedan Brook
- Skunk River
- Middle Fork Crow River
- Stag Brook
- Grove Creek
- Jewitts Creek
- Battle Creek
- Washington Creek
- Collinwood Creek
- Sucker Creek

These reaches were selected based on the following criteria:

- PCA AUID
- Confluence portion of tributaries to a mainstem creek
- Significant identified resource value (intact riparian corridor, potential reference conditions, etc.)
- Stability or reference condition noted
- Significant hydrologic impact noted (channelized reach, confluence between channelized and meandered reaches, impact noted on hillshade/LIDAR/aerial photos)
- Noted significant bed feature (riffles, etc.)
- Lack of presence of other hydrologic controls (crossings, culverts, etc.)
- Geographic coverage of headwaters reaches

Participation in core teams will also affect the nature of reach selection and sampling, and the sampling plan will be adjusted as needed to meet the specific needs of the core team goals.

Data needed

- Buffer analysis of the mainstem river and major tributaries.

References

Minnesota Department of Natural Resources, Shallow Lakes Program, *Statewide Shallow Lakes Plan* (MNDNR, 2010).

http://files.dnr.state.mn.us/recreation/hunting/waterfowl/shallowlakesplan.pdf

Minnesota Department of Natural Resources, 2005. *Field Guide to Native Plant Communities of Minnesota: The Prairie Parkland and Tallgrass Aspen Parklands Provinces*. Ecological Land Classification Program, Minnesota Bounty Biological Survey, and Natural Heritage and Nongame Research Program, MNDNR, St. Paul.

Appendix C. North Fork Crow Lake Prioritization

Table C.1 below identifies the implementation focus for each HUC-11 listed in Appendix C.

Table C.1

HUC-11	ABBREVIATION
Upper North Fork Crow River	UNF
Upper Middle Fork Crow River	UMF
Central Middle Fork Crow River	CMF
Lower Middle Fork Crow River	LMF
Long Lake Outlet	LGLO
Jewitts Creek	JC
Litchfield	L
Washington Creek	WC
Collinwood Creek	CC
Sucker Creek	SC
Twelvemile Creek	TMC
Mill Creek	MC
Louzers Creek Outlet	LZCO
Lower North Fork Crow River	LNF
Sarah Creek	SRC
St Michael	STM
Crow River	CR
ACTION	**KEY**
Restore	
Protect	
Threatened	

Table C.2 below identifies the Trophic Status Index ranges for Appendix C

Table C.2. Trophic Status Ranges

TROPHIC STATUS	RANGE
Oligotrophic	< 40
Mesotrophic	40-50
Eutrophic	50-70
Hypereutrophic	>70

MGMT FOCUS	LAKE	BAY	ID	COUNTY	SURFACE AREA (hectares)	MAX DEPTH (feet)	% AG	INVASIVE SPECIES	Sanitary Sewer Hook-Up	WILD RICE LAKES	DNR PRIORITY SHALLOW LAKES	HSPF	LAKE ASSOC.	TROPHIC INDEX	NUTRIENTS (TP) (ug/L)	CHL-a (ug/L)	CLARITY (m)	LAKE ASSESS.	LAKE STATUS	HUC-11 ACTION	WSHED SURFACE	% LITTORAL	DRAIN AREA	FISH SURVEY, STOCK, AQ PLANT SURVEY
	Laura		27-0123-00	Hennepin	14				no											CR				
	Cowley		27-0169-00	Hennepin	19	2			Older lots on south & west not, new development on east is hooked up					79	744	75	1	•	Impaired	CR				
	Unnamed		27-0170-00	Hennepin	16				no											CR				
	Sylvan		27-0171-00	Hennepin	44	10			no					69	447	28	2↑			CR				
	Prairie		27-0177-00	Hennepin	11				no					53	27	13	2→			CR				
	Sarah	West	27-0191-01	Hennepin	138	59			1-2 holdouts, otherwise 100%				•	67	102	58	1→	•	Impaired	SRC	2,227			
	Sarah	East	27-0191-02	Hennepin	80	59			1-2 holdouts, otherwise 100				•	66	87	48	1↓	•	Impaired	SRC	2,227			
	Schwappauf		27-0194-00	Hennepin	16				no					56	49	9	1			CR				
	Schandell		27-0196-00	Hennepin	16	29			no											CR		71		
Mixed	Hafften		27-0199-00	Hennepin	16	44	66		no				•	61	53	27	1	•	Impaired	CR		61	1,561	F survey
	Rattail		27-0200-00	Hennepin	5	63			no					58	52	16	1↓			CR		32		
	Unnamed		27-0379-00	Hennepin	4	8			no											CR				
	Unnamed		34-0019-00	Kandiyohi	27.6				no		•													
	Pay		34-0023-00	Kandiyohi	13				no											LMF				
	Summit		34-0027-00	Kandiyohi	55	6			no											LMF				
	Unnamed		34-0028-00	Kandiyohi	9				no											LMF				
	Sperry		34-0040-00	Kandiyohi	53				no					84						LMF				
	Diamond		34-0044-00	Kandiyohi	628	27			100%			•	•	61	71	40	2↓	•	Impaired	LMF	7,280	41		FSS
	Taits		34-0046-00	Kandiyohi	5				no											LMF				
	Schultz		34-0049-00	Kandiyohi	63				no					80	216	154	0			LMF				
	Wheeler	SW	34-0051-01	Kandiyohi	104				no					71	149	55	1			LMF				
	Wheeler	NE	34-0051-02	Kandiyohi					no					81	381	163	0			LMF				
	Unnamed		34-0056-00	Kandiyohi	9				no															
	Jesse		34-0060-00	Kandiyohi	31				no					87	312		0			CMF				
	Calhoun		34-0062-00	Kandiyohi	251	13			no		•		•	54	32	11	1.3↓	•	Full Support	CMF	3,066	100		FSS
	Long		34-0066-00	Kandiyohi	127	45			no			•		44	19	5	4↑	•	Full Support	UMF	982	44		FSS
	Bass		34-0078-00	Kandiyohi	20	30.5			no											LMF		62		F survey
	Green		34-0079-00	Kandiyohi	2,239	110			100%			•	•	43	16	5	3.7↑	•	Full Support	CMF	37,716	38		FSS
	Woodcock		34-0112-00	Kandiyohi	46				no					74	125		0			CMF				
	Unnamed		34-0113-00	Kandiyohi	5				no											CMF				
	Carlson		34-0114-00	Kandiyohi	11				no											CMF				
	Henderson		34-0116-00	Kandiyohi	28	57			100%					42	15	4	4→		Insufficient	CMF		37		FSS
	Elkhorn		34-0119-00	Kandiyohi	28	40			no					42	13	3	4	•	Full Support	CMF	622	35		FSS
	Alvig		34-0120-00	Kandiyohi	29				no					82	152		0			CMF				
	Gina		34-0126-00	Kandiyohi	20				no											CMF				
	Woodcock		34-0141-00	Kandiyohi	69	8			no					74	140		0		Insufficient	CMF				
	George		34-0142-00	Kandiyohi	90	32			100%				•	42	15	3	4↑	•	Full Support		193			FSS
	Unnamed		34-0144-00	Kandiyohi	5				no											CMF				
	Eight		34-0146-00	Kandiyohi	22				no	•										CMF				
	Bear		34-0148-00	Kandiyohi	56	18			no	•										CMF		85		F survey
	Unnamed		34-0151-00	Kandiyohi	6				no											UMF				
Mixed	Nest		34-0154-00	Kandiyohi	396	40	69		100%			•	•	56	41	19	2→	•	Impaired	CMF	31,842	56	74,139	FSS
	Unnamed		34-0156-00	Kandiyohi	8				no											CMF				
	Unnamed		34-0157-00	Kandiyohi	15				no											CMF				
	Monongalia	Main	34-0158-01	Kandiyohi	360	7.8			not 100%	•	•	•		60	52	8	0.6	•	Full Support	UMF	25,922			FSS, AP
	Monongalia	Mid Frk Crow Rvr	34-0158-02	Kandiyohi	329	7.8			not 100%					53	36	8	1.7	•	Full Support	UMF	25,922			
	Crow River Mill Pond	East	34-0158-03	Kandiyohi	13	7.8			not 100%					52	36	8	1.8	•	Full Support	UMF	25,922			

MGMT FOCUS	LAKE	BAY	ID	COUNTY	SURFACE AREA (hectares)	MAX DEPTH (feet)	% AG	INVASIVE SPECIES	Sanitary Sewer Hook-Up	WILD RICE LAKES	DNR PRIORITY SHALLOW LAKES	HSPF	LAKE ASSOC.	TROPHIC INDEX	NUTRIENTS (TP) (ug/L)	CHL-a (ug/L)	CLARITY (m)	LAKE ASSESS.	LAKE STATUS	HUC-11 ACTION	WSHED SURFACE	% LITTORAL	DRAIN AREA	FISH SURVEY, STOCK, AQ PLANT SURVEY
	Crow River Mill Pond	Mid	34-0158-04	Kandiyohi	8	7.8			not 100%					50	31	6	1.9	●		UMF	25,922			
	Crow River Mill Pond	West	34-0158-05	Kandiyohi		7.8			not 100%															
	Unnamed		34-0161-00	Kandiyohi	10				no		●									UNF				
	Unnamed		34-0166-00	Kandiyohi	54				no		●													
	Skull		34-0243-00	Kandiyohi	8				no											UMF				
	Unnamed		34-0391-00	Kandiyohi	6				no											CMF				AP
	Unnamed		34-0510-00	Kandiyohi	7				no		●									UNF				
	Unnamed		34-0527-00	Kandiyohi	248.9				no		●													
	Unnamed		34-0611-00	Kandiyohi	17				no		●									CMF				
	unnamed		34-0612-00	Kandiyohi	126.6				no		●													
	Longanans		43-0070-00	McLeod	26				no											CC				
	Todd		43-0071-00	McLeod	87	6			no											CC				
In-lake	Hook		43-0073-00	McLeod	131	18	76		no			●		71	124	77	1↓	●	Impaired	CC		99	3,014	FSS
	Emily		43-0074-00	McLeod	31				no											CC				
	Echo		43-0081-00	McLeod	34				no		●									CC				
	Dettmans		43-0102-00	McLeod	6				no											CC				
	Campbells		43-0108-00	McLeod	11				no											CC				
	Maple		47-0001-00	Meeker	55	6.5			no											CC		100		F survey
	Francis		47-0002-00	Meeker	425	17			no			●	●	50	21	8	1.9→	●	Full Support	LNF	4,496	96		FSS, AP
	Byron		47-0004-00	Meeker	137				no											SC				
	Butternut		47-0005-00	Meeker	31				no											CC				
	Unnamed		47-0007-00	Meeker	8				no											CC				
	Pigeon		47-0008-00	Meeker	101				no											CC				
	Unnamed		47-0009-00	Meeker	31				no											CC				
	Spencer		47-0014-00	Meeker	57				no		●			65	87	25	1		Insufficient	CC				
Watershed	Jennie		47-0015-00	Meeker	428	14	79		no			●	●	61	61	28	1.6↓	●	Impaired	CC	5,001	100	10,664	FSS
	Wolf		47-0016-00	Meeker	107	11			no		●		●	61	52	20	1		Insufficient	CC				F survey
	Collins Lake		47-0017-00	Meeker	23				no											CC				
	Little Wolf		47-0019-00	Meeker	25				no											CC				F survey
	Arvilla		47-0023-00	Meeker	53	9			no		●		●	66	86	38	1		Insufficient	WC		100		FSS
	Little Swan		47-0025-00	Meeker	20	31			no					53	14	4	4		Full Support	CC	116	44		F survey
	Long		47-0026-00	Meeker	66	28			no					51	37	10	2↑	●	Full Support	CC	398	66		FSS
	Hart		47-0029-00	Meeker	23				no											WC				F survey
	Mud		47-0031-00	Meeker	39				no											CC				
In-lake	Spring		47-0032-00	Meeker	60	30	57		20 homeowners are hooked up, rest are not.			●	●	61	59	25	1↑	●	Impaired	CC		76	1,036	F survey
	Unnamed		47-0033-00	Meeker	4				no											CC				
	Sellards		47-0035-00	Meeker	40	9			no											WC		100		
	Little Spring		47-0036-00	Meeker	28				no											CC				
	Boo		47-0037-00	Meeker	14				no											CC				
Watershed	Big Swan		47-0038-00	Meeker	261	32	80		no			●	●	67	91	47	1.1↓	●	Impaired	CC	20,363	54	45,478	FSS
	Mud		47-0040-00	Meeker	27	26			no					52	29	10	2		Insufficient	LNF				F survey
	Heenan Lake		47-0043-00	Meeker	11				no											CC				
	Jewitt		47-0044-00	Meeker	102	5			no											CC				
	Fallon		47-0045-00	Meeker	89	5			no											CC				
	Washington		47-0046-00	Meeker	979	17		EWM	no			●	●	56	26	10	1.1→	●	Full Support	WC	9,136	93		FSS, AP
	Unnamed		47-0047-00	Meeker	16				no											WC				
	Powers		47-0048-00	Meeker	101				no					88	330		0			WC				

MGMT FOCUS	LAKE	BAY	ID	COUNTY	SURFACE AREA (hectares)	MAX DEPTH (feet)	% AG	INVASIVE SPECIES	Sanitary Sewer Hook-Up	WILD RICE LAKES	DNR PRIORITY SHALLOW LAKES	HSPF	LAKE ASSOC.	TROPHIC INDEX	NUTRIENTS (TP) (ug/L)	CHL-a (ug/L)	CLARITY (m)	LAKE ASSESS.	LAKE STATUS	HUC-11 ACTION	WSHED SURFACE	% LITTORAL	DRAIN AREA	FISH SURVEY, STOCK, AQ PLANT SURVEY
	Manuella		47-0050-00	Meeker	117	50			no			●	●	49	19	7	2↓	●	Full Support	WC	4,496	37		FSS
	Birch		47-0055-00	Meeker	20				no											WC				
	Porter		47-0057-00	Meeker	41				no											CC				
	Erie		47-0064-00	Meeker	75	34			no					54	30	11	2	●	Full Support	CC	239	46		FSS
	Stella		47-0068-00	Meeker	241	74			no			●	●	52	21	10	2.1↑	●	Full Support	WC	3,069	51		FSS
	North Buckley		47-0069-00	Meeker	4				no											WC				
	South Buckley		47-0070-00	Meeker	25				no											WC				
	East Andrew Nelson		47-0073-00	Meeker	16				no											JC				
	Turtle		47-0074-00	Meeker	19				no											WC				
	Darwin		47-0076-00	Meeker	63				no					62	54					WC				AP
	Stevens		47-0077-00	Meeker	11				no											WC				AP
	Casey		47-0080-00	Meeker	34				no											WC				
In-lake	Dunns		47-0082-00	Meeker	63	20	85		no			●	●	69	106	43	1	●	Impaired	L	2,260	61	5,426	FSS
	Mud		47-0085-00	Meeker	50				no					69	90									
	Rice		47-0087-00	Meeker	28				no					93	697		0			L				
Watershed	Richardson		47-0088-00	Meeker	48	47	88		no			●	●	58	68	32	1.1→	●	Impaired	L	2,057	41		FSS
	Andrew Nelson		47-0101-00	Meeker	36				no											JC				
	Round		47-0102-00	Meeker	106	8			no		●			53	27	11	2			JC		100		F survey
	Hoosier		47-0116-00	Meeker	42				no											JC				
	Minnie-Belle		47-0119-00	Meeker	240	49		EWM	no			●	●	44	27	5	3.5	●	Full Support	WC	783	31		FSS, AQ
	Unnamed		47-0130-00	Meeker	12				no											LGLO				
	Stone		47-0131-00	Meeker	65.8	2			no		●													
	Unnamed		47-0132-00	Meeker	10				no		●									JC				
	Chicken		47-0133-00	Meeker	41				no											JC				
	Ripley	East	47-0134-01	Meeker	54	18		EWM	no			●	●							JC				
	Ripley	West	47-0134-02	Meeker	241	18		EWM	3/4 covered, 1/4 (south side not hooked up)				●	55	34	9	2.1↑	●	Full Support	JC	3,343			FSS
	West Hanson		47-0136-00	Meeker	21				no											JC				
	Harold		47-0137-00	Meeker	49				no					81	124		0			JC				
	Youngstrom		47-0138-00	Meeker	67	5			no		●			56	38	6	1		Insufficient	JC				F survey
	Minnesota		47-0140-00	Meeker	47				no		●			56	28		1			JC				
	Towers		47-0142-00	Meeker	21				no					68	82					JC				
	Mary		47-0143-00	Meeker	37				no											JC				
	Half Moon		47-0144-00	Meeker	7				no											JC				
	Madsen		47-0146-00	Meeker	135.5				no		●													
	Schultz		47-0147-00	Meeker	18				no											JC				
	Unnamed		47-0148-00	Meeker	24				no		●									JC				
	Horseshoe		47-0151-00	Meeker	8	1			no		●			64	86		1							
	Thoen		47-0154-00	Meeker	85				no		●			77	119		0			JC				
	Pigeon		47-0155-00	Meeker	11				no															
	Popple		47-0173-00	Meeker	18				no		●									LGLO				
Mixed	Long		47-0177-00	Meeker	282	3	72		no		●			82	323	229	0↑	●	Impaired	LGLO	7,353	100	4,213	
	Sather		47-0178-00	Meeker	27				no											LGLO				
	Moe		47-0179-00	Meeker	16				no											LGLO				
Mixed	Hope		47-0183-00	Meeker	118	10	76		no			●		80	249	238	0	●	Impaired	LGLO	1,856	100	16,927	
	Unnamed		47-0187-00	Meeker	30.7				no		●													
	Unnamed		47-0189-00	Meeker	12				no		●									LGLO				
	Unnamed (Grove)		47-0191-00	Meeker	13				no											LGLO				

MGMT FOCUS	LAKE	BAY	ID	COUNTY	SURFACE AREA (hectares)	MAX DEPTH (feet)	% AG	INVASIVE SPECIES	Sanitary Sewer Hook-Up	WILD RICE LAKES	DNR PRIORITY SHALLOW LAKES	HSPF	LAKE ASSOC.	TROPHIC INDEX	NUTRIENTS (TP) (ug/L)	CHL-a (ug/L)	CLARITY (m)	LAKE ASSESS.	LAKE STATUS	HUC-11 ACTION	WSHED SURFACE	% LITTORAL	DRAIN AREA	FISH SURVEY, STOCK, AQ PLANT SURVEY
	Lund		47-0192-00	Meeker	45				no		●			53	24		1			LGLO				
	Wilcox		47-0193-00	Meeker	24				no					65	59		1			LMF				
	Miller		47-0194-00	Meeker	32				no		●									LMF				
	Peterson		47-0198-00	Meeker	54	15			no		●			73	116					LMF		96		
	Helga		47-0199-00	Meeker	47				no											LMF				
	Emma		47-0201-00	Meeker	24				no															
	Whitney		47-0205-00	Meeker	22				no											LMF				
	Unnamed		47-0338-00	Meeker	26				no											CC				
	Unnamed		61-0017-00	Pope	9				no											UNF				
	Mud		61-0019-00	Pope	13				no											UNF				
	Lincoln		61-0020-00	Pope	11				no											UNF				
	Grove		61-0023-00	Pope	144	9			no			●		53	34	12	2↑	●	Full Support	UNF	3,922	69		
	McCloud		61-0024-00	Pope	89.4	10			no											UNF				
	Alice		61-0032-00	Pope	90	3			no											UNF				
	Unnamed		61-0310-00	Pope	46				no											UNF				
	Pirz		73-0144-00	Stearns	27				no				●	48	26	7	3↑	●	Full Support	UNF	348			
Upstream	Rice		73-0196-00	Stearns	27	41			no			●	●	60	60	30	1.6→	●	Impaired	UNF	70,075	58		
	Koronis	Mud Lake	73-0200-01	Stearns	613	13			no			●	●		54	10	0.6	●	Full Support	UNF	74,488	100		
	Koronis	Main	73-0200-02	Stearns	55	13.2			no				●	54	40	18	2.2↑	●	Full Support	UNF	74,542			
	George		73-0258-00	Stearns	1191	39			no											UNF				
	Unnamed		73-0268-00	Stearns	27				no		●													
	Unnamed		73-0277-00	Stearns	127				no		●													
	Tamarack		73-0278-00	Stearns	30	3.5			no		●									UNF				
	Crow		73-0279-00	Stearns	113	1			no	●										UMF				
	Fish		73-0281-00	Stearns	91	1			no	●										UMF				
	Raymond		73-0285-00	Stearns	70	1			no		●			62	55		1							
Mixed	Foster		86-0001-00	Wright	26	10	63		no				●	76	262	130	0.5↑	●	Impaired	CR		100	2,850	
	Rice		86-0002-00	Wright	52	3			no	●	●									CR				
	Unnamed		86-0008-00	Wright	20				no											CR				
	Martha		86-0009-00	Wright	40	22			particle - St. Michael WWTF					54	24	8	2↑	●	Full Support	CR	177	74		
	Wagner		86-0010-00	Wright	40	7			no											CR				
	Charlotte		86-0011-00	Wright	44	46			particle - St. Michael WWTF					41	15	4	4.9↑	●	Full Support	CR	1,776	40		
	Uhl		86-0017-00	Wright	95	14			no					58			1↓			CR				
	Gonz		86-0019-00	Wright	35	2.5			no	●										CR				
	Wilhelm		86-0020-00	Wright	10	1			no					69	128	58	1→			CR				
	Mud		86-0021-00	Wright	39				no											STM				
	Steele		86-0022-00	Wright	28				no											CR				
Mixed	Beebe		86-0023-00	Wright	55	23.5	74		no				●	62	59	39	1.1↑	●	Impaired	STM	389	61	655	
	Moore		86-0028-00	Wright	120	8			no											CR				
	Schmidt		86-0029-00	Wright	74				no											STM				
In-lake	Pelican		86-0031-00	Wright	71	9	72		no	●	●			68	153	60	0.4	●	Impaired	STM	9,344	100	19,060	
	Unnamed		86-0033-00	Wright	945	3			no											LNF				
	Unnamed		86-0035-00	Wright	30				no		●													
	Unnamed		86-0039-00	Wright	4				no											LNF				
	Dean		86-0041-00	Wright	4	20	73		no					73	217	82	0.6↓	●	Impaired	LNF	672	72	1,474	
	Unnamed (Rooney)		86-0043-00	Wright	70	7			no											LNF				
	Mud		86-0044-00	Wright	24				no		●									LNF				

MGMT FOCUS	LAKE	BAY	ID	COUNTY	SURFACE AREA (hectares)	MAX DEPTH (feet)	% AG	INVASIVE SPECIES	Sanitary Sewer Hook-Up	WILD RICE LAKES	DNR PRIORITY SHALLOW LAKES	HSPF	LAKE ASSOC.	TROPHIC INDEX	NUTRIENTS (TP) (ug/L)	CHL-a (ug/L)	CLARITY (m)	LAKE ASSESS.	LAKE STATUS	HUC-11 ACTION	WSHED SURFACE	% LITTORAL	DRAIN AREA	FISH SURVEY, STOCK, AQ PLANT SURVEY
	Crawford		86-0046-00	Wright	43	19			no					45	22	4	4↑	•	Full Support	LNF	184	98		
	Mary		86-0049-00	Wright	43	6			particle - Buffalo WWTF	•										LNF				
In-lake	Constance		86-0051-00	Wright	137	23	70		no					66	91	74	1.4→	•	Impaired	STM	375	54	753	F survey
	Little Pulaski		86-0053-01	Wright	67	87			100%					48	24	6	3↑			MC				
	Pulaski	Main	86-0053-02	Wright	291	27		EWM	100%					47	19	6	3.9→	•	Full Support	MC	1,349			FSS
	Washington		86-0056-00	Wright	50	12			no				•							STM		100		
	Pohl		86-0061-00	Wright	14	9.5			no											STM		100		
	Green Mountain		86-0063-00	Wright	64				no		•			73	187	98	1		Insufficient	STM				F stock
	Gilchrist		86-0064-00	Wright	102	9			no	•										STM				
	Slough		86-0078-00	Wright	11				no											STM				
	Paradise		86-0082-00	Wright	13				no											STM				
	Mud		86-0085-00	Wright	247.5				no		•													
In-lake	Fountain		86-0086-00	Wright	171	15	74		no		•	•		97	1221	2892	0	•	Impaired	LNF		100	1,086	
	Tamarack		86-0089-00	Wright	23	26			no					74	128	88	0			MC		85		F survey
In-lake	Buffalo		86-0090-00	Wright	620	33	63		100%			•		67	78	61	1↓	•	Impaired	MC	12,473	49	24,654	FSS
	Varner		86-0091-00	Wright	40.5				no		•													
	Carrigan		86-0097-00	Wright	54				particle - Montrose/Waverly WWTF	•				80	633	170	1			LZLO				
	Lauzers		86-0100-00	Wright	29				no											LZLO				
	Pooles		86-0102-00	Wright	30	5.5			no	•										LNF				
	Ida		86-0103-00	Wright	33	26			no											LZLO		76		F survey
Watershed	Little Waverly		86-0106-00	Wright	135	12	74	EWM	no		•	•		76	431	72	1↓	•	Impaired	TMC		100	10,995	FSS
US lakes	Deer		86-0107-00	Wright	69	27	63	EWM	no			•		66	81	54	1	•	Impaired	MC	25,403	77	25,403	F survey
	Goose		86-0108-00	Wright	20	14		EWM	no											MC		100		F survey
	Fadden		86-0109-00	Wright	7	48			no											MC		57		F survey
In-lake	Malardi		86-0112-00	Wright	39	2.9	76		no	•	•	•		86	446	297	0	•	Impaired	LNF		100	700	
Mixed	Waverly		86-0114-00	Wright	197	70.5	61	EWM	particle - Montrose/Waverly WWTF			•		54	37	16	2↑	•	Impaired	TMC		29	1,674	FSS
	BIrch		86-0116-00	Wright	41	31			no											MC		76		F survey
	Sullivan		86-0119-00	Wright	28.3	58			no					57	42	28	2↑							F survey
Watershed	Ramsey		86-0120-00	Wright	124	82	86		no					60	52	29	1↑	•	Impaired	MC		49	1,000	FSS
Mixed	Light Foot		86-0122-00	Wright	25	22	79		no			•		74	196	113	1	•	Impaired	MC		87	10,995	F survey
	North Twin		86-0123-00	Wright	18	58		EWM	no											MC		47		F survey
	Unnamed (Pauman)		86-0124-00	Wright	8				no											MC				
	South Twin		86-0126-00	Wright	15	19			no											MC		83		F survey
In-lake	Albert		86-0127-00	Wright	22.6	47	85		no					68	109	83	1↓	•	Impaired			49	304	
	Abbie		86-0132-00	Wright	45				no											MC				
	Upper Maple		86-0134-01	Wright	293	10		EWM	no					47	21	8	3↑	•	Full Support	MC	1,192			FSS
	Upper Maple		86-0134-02	Wright	46	3			no											MC				
	Maple	NE	86-0134-03	Wright	0	9			no											MC		51		
	Yaeger		86-0177-00	Wright	39				no											TMC				F survey
	Dog		86-0178-00	Wright	41	25			no					58	37	23	1→			LZLO		78		F survey
	Mains		86-0179-00	Wright	5				no											LNF				
	School Section		86-0180-00	Wright	14	2			no	•	•									TMC				
	Little Rock		86-0181-00	Wright	17	51			no											LNF		58		FSS
In-lake	Rock		86-0182-00	Wright	73	37	69	EWM	no			•		60	55	52	1↑	•	Impaired	LNF		57	943	FSS
Mixed	Dutch		86-0184-00	Wright	63	20.5	73		particle - annandale/Maple Lake/Howard Lake WWTF			•		73	168	63	1↑	•	Impaired	TMC		100	4,422	FSS
	Emma		86-0188-00	Wright	73	14		EWM	no					68	118	53	1	•	Impaired	TMC		73		F survey
	Ann		86-0190-00	Wright	151	18.5			no			•		71	190	62	1↓	•	Impaired	TMC		29		FSS

MGMT FOCUS	LAKE	BAY	ID	COUNTY	SURFACE AREA (hectares)	MAX DEPTH (feet)	% AG	INVASIVE SPECIES	Sanitary Sewer Hook-Up	WILD RICE LAKES	DNR PRIORITY SHALLOW LAKES	HSPF	LAKE ASSOC.	TROPHIC INDEX	NUTRIENTS (TP) (ug/L)	CHL-a (ug/L)	CLARITY (m)	LAKE ASSESS.	LAKE STATUS	HUC-11 ACTION	WSHED SURFACE	% LITTORAL	DRAIN AREA	FISH SURVEY, STOCK, AQ PLANT SURVEY
	Unnamed		86-0191-00	Wright	62				no		•													
	Round		86-0192-00	Wright	17	29		EWM	no											TMC		71		F survey
	Mary		86-0193-00	Wright	74	46			no					50	26	10	2.4↑	•	Full Support	LZLO	195	47		
	Long		86-0194-00	Wright	20	3			no	•										TMC				
In-lake	Howard		86-0199-00	Wright	295	36	79	EWM	particle - annandale/Maple Lake/Howard Lake WWTF				•	63	82	33	1.3↑	•	Impaired	TMC	1726	100	3,535	FSS
	Spring		86-0200-00	Wright					no	•										TMC				
	Unnamed		86-0203-00	Wright	45				no											LNF				
	Taylor		86-0204-00	Wright	20				no	•										LNF				
	Doefler		86-0206-00	Wright	36				no											TMC		44		
	Willima		86-0209-00	Wright	105				no	•	•			73	255		1							
	White		86-0214-00	Wright	47				no	•	•									LNF				
Mixed	Granite		86-0217-00	Wright	143	34	73	EWM	no			•	•	60	59	32	2↑	•	Impaired	LNF		32	2,054	FSS
	Maxim		86-0218-00	Wright	19	18			no											LNF		89		F survey
Mixed	Camp		86-0221-00	Wright	48	52	78	EWM	no	•		•	•	63	108	41	2↑	•	Impaired	LNF		38	476	FSS
In-lake	Smith		86-0250-00	Wright	74	5	85		no	•	•	•		84	236	227	0	•	Impaired	SC		100	1,105	F survey
	Shakopee		86-0255-00	Wright	46	1.5			no		•									SC				
	Grass		86-0257-00	Wright	171.7				no		•													
Watershed	Cokato		86-0263-00	Wright	221	52	86		no			•	•	58	54	22	1.9→	•	Impaired	SC	11,855	34	29,535	FSS
In-lake	Brooks		86-0264-00	Wright	39	21	54		particle - Cokato WWTF					64	63	43	1→	•	Impaired	SC		62	114	F survey
	Moose		86-0271-00	Wright	32	43			no					42	14	4	4			LNF		72		F survey
Watershed	French		86-0273-00	Wright	137	50	73	EWM	no			•		57	38	16	1↑	•	Impaired	LNF		47	5,055	FSS
	Dans		86-0274-00	Wright	30	27			no					77	352	105	1			LNF		70		F survey
	Unnamed		86-0277-00	Wright	32				no		•													
	Goose		86-0278-00	Wright	36	6			no											LNF				
	West Lake Sylvia		86-0279-00	Wright	360	88		EWM	no			•	•	37	10	3	5.4↑	•	Full Support	LNF	3,241	33		FSS
	John		86-0288-00	Wright	160	28		EWM	no				•	50	26	9	2.4↑	•	Full Support	LNF	1,452	86		FSS
	East Lake Sylvia		86-0289-00	Wright	271	78		EWM	no				•	39	10	4	5.2↑	•	Full Support	LNF	2,051	26		FSS
Watershed	Collinwood		86-0293-00	Wright	253	28	79		no			•	•	65	99	47	1.6↓	•	Impaired	CC	13,185	60	28,967	FSS
	Swan		86-0295-00	Wright	25	2			no		•									CC				
	Beaver Dam		86-0296-00	Wright	8				no	•	•									CC				
	Unnamed		86-0442-00	Wright	31				no		•													