Watershed

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Upper/Lower Red Lake Watershed Restoration and Protection Strategy Report

MINNESOTA POLLUTION CONTROL AGENCY

Authors

Kayla Bowe (Red Lake DNR)

Shane Bowe (Red Lake DNR)

Denise Oakes (MPCA)

Meghan Funke (Emmons & Olivier Resources)

Jimmy Marty (Emmons & Olivier Resources)

Etoile Jensen (Emmons & Olivier Resources)

Joe Pallardy (Emmons & Olivier Resources)

Contributors/acknowledgements

Zach Gutknecht (Beltrami SWCD, Beltrami County)

Brent Rud (Beltrami SWCD, Beltrami County)

Chad Severts (BWSR)

Jeff Hrubes (BWSR)

Cari Roepke (Clearwater NRCS)

Chester Powell (Clearwater SWCD)

Jolen Simon (Koochiching SWCD)

Sam Soderman (Koochiching SWCD)

Brent Mason (DNR)

Scott Schroeder (MPCA)

Kevin Stroom (MPCA)

Corey Hanson (Red Lake Watershed District)

Editing and graphic design

Communications staff

Graphic design staff

Administrative Staff

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Contents

List of tables

List of figures

Key terms and abbreviations

Assessment Unit Identifier (AUID): The unique waterbody identifier for each river reach comprised of the U.S. Geological Survey (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 fecal bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus and either chlorophyll-a or Secchi disc depth standards are not met.

Hydrologic Unit Code (HUC): A HUC is assigned by the USGS for each watershed. HUCs are organized in a nested hierarchy by size. For example, the Rainy River Basin is assigned a HUC-4 of 0902 and the Upper/Lower Red Watershed is assigned a HUC-8 of 09020302.

Impairment: Waterbodies 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 nonpollutant sources or factors (e.g., altered hydrology, dams preventing fish passage) that adversely impact aquatic life.

Total Maximum Daily Load (TMDL): A calculation 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.

Executive summary

The Upper/Lower Red Lake Watershed (ULRLW) encompasses approximately 1.2 million acres of land primarily in Beltrami County with smaller portions in Clearwater, Koochiching, and Itasca Counties. Over one-third of the watershed falls within the boundaries of the Red Lake Reservation. The majority of the watershed is rural and much of it undeveloped. Almost three-quarters of the watershed is wetland or open water. Crop production accounts for less than 1% of land use in the watershed with only 6% pasture/hay. This watershed is a uniquely undeveloped headwaters area with many near pristine wetlands and streams. Due to the close associations between wetlands and streams and easily mobilized wetland soils, some streams in this region are particularly sensitive to disturbance and will require protection if development expands northward in the state.

The majority of streams have healthy biological communities. For those streams that do have poor biological communities, problems tend to be related to low dissolved oxygen (DO) and sedimentation. Other problems exist in the watershed relating to high Escherichia coli (*E. coli*) levels in streams. Some of the *E. coli* issues stem from natural conditions such as beavers and birds. A few lakes have problems with eutrophication. The largest lakes in the basin (Upper and Lower Red Lake) do not meet the state eutrophication standard but have been determined to require site specific criteria due to their unique characteristics and histories. Data is currently being collected for the development of that site specific criteria.

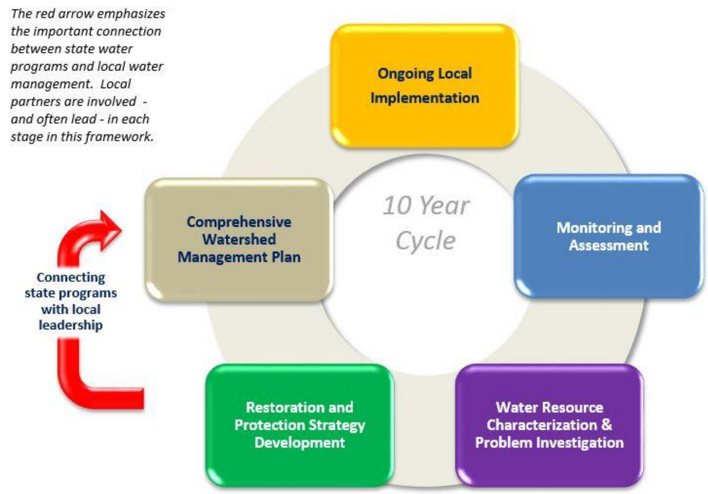
Restoration strategies to address impairments include restoring riparian zones/shorelines with native vegetation, enhancing vegetated buffer zones, shorelines, and exceptional aquatic habitats, adopting in-stream best management practices (BMPs) to improve reaches with sedimentation, erosion, and connectivity issues, livestock exclusion and prescribed grazing practices, rice paddy discharge management, wetland restoration, stormwater management, and nutrient management.

Streams were prioritized for protection if currently healthy but near the impairment threshold or currently healthy and indicating good water quality. The prioritization included landscape risk factors, amount of land in public ownership or permanent easement, and existing condition of biological communities. Lakes were prioritized based on existing water quality and aquatic life condition, return on investment value, biological significance, phosphorus sensitivity, and wild rice support. Protection strategies identified for these waters include shoreland protection for streams and lakes, forest protection programs, and implementation of restoration strategies at targeted areas to prevent degradation of high quality resources.

It is understood that the State of Minnesota does not have jurisdiction over tribal lands (includes reservation and tribal trust lands). However, this project has been a cooperative effort between the Minnesota Pollution Control Agency (MPCA) and Red Lake Department of Natural Resources (RL DNR) Water Resources Program to study and assess this watershed. Joint decisions and recommendations have been made by the two entities.

This Watershed Restoration and Protection Strategy (WRAPS) Report, the Watershed Total Maximum Daily Load (TMDL) Study, and other technical reports are available on the MPCA website for the ULRLW: https://www.pca.state.mn.us/water/watersheds/upperlower-red-lake.

What is the WRAPS Report?



Minnesota has adopted a watershed approach to address the state's 80 major watersheds. The Minnesota watershed approach incorporates **water quality assessment, watershed analysis, public participation, planning, implementation, and measurement of results** into a 10-year cycle that addresses both restoration and protection.

Along with the watershed approach, the MPCA developed a process to identify and address threats to water quality in each of these major watersheds.

This process is called Watershed Restoration and Protection Strategy (WRAPS) development. WRAPS reports have two parts: impaired waters have strategies for restoration, and waters that are not impaired have strategies for protection.

Waters not meeting state standards are listed as impaired, and TMDL studies are developed for them. TMDLs are incorporated into WRAPS. In addition, the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health, including both protection and restoration efforts. A key aspect of this effort is to develop and utilize watershed-scale models and other tools to identify strategies for addressing point and nonpoint source pollution that will cumulatively achieve water quality targets. For nonpoint source pollution, this report informs local planning efforts, but ultimately the local partners decide what work will be included in their local plans. This report also serves as the basis for addressing the U.S. Environmental Protection Agency's (EPA) Nine Minimum Elements of watershed plans, to help qualify applicants for eligibility for Clean Water Act Section 319 implementation funds.

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: •*Upper/Lower Red Lake Watershed Monitoring and Assessment* •*Upper/Lower Red Lake Watershed Biotic Stressor Identification* •*Upper/Lower Red Lake Watershed Total Maximum Daily Load*
Scope	•Impacts to aquatic recreation and impacts to aquatic life in streams •Impacts to aquatic recreation in lakes
Audience	•Local working groups (local governments, SWCDs, watershed management groups, etc.) •State agencies (MPCA, MN DNR, BWSR, etc.) •Red Lake Band of Chippewa Indians

1. Watershed background and description

The ULRLW encompasses approximately 1,241,690 acres (1,940 square miles) and is located primarily in Beltrami County with small portions in Koochiching, Clearwater, and Itasca Counties. A large part of the watershed is located within the Red Lake Reservation (483,246 acres, or 38.24%). The watershed is part of the larger Red River of the North Basin draining to Hudson Bay. Most of the watershed is in the Northern Minnesota Wetlands Ecoregion with small portions in the North Central Hardwood Forests and the Northern Lakes and Forests Ecoregions.

The ULRLW is quite rural with very little development. Over 48% of the watershed is wetland, 24% is open water, and 18% is forest/shrub (Figure 1). Less than 2% of the watershed is considered developed, approximately 6% is pasture/hay, and crop production is estimated under 1%. There are 445 farms in the watershed with 83% of them being less than 500 acres in size. Total population of the watershed from the 2010 census was 10,784 people. The largest communities include Blackduck, Funkley, Northome, and Kelliher and also the reservation communities of Little Rock, Red Lake, Ponemah, and Redby. Permitted point sources are limited to municipal wastewater treatment systems and concern for pollutants comes primarily from nonpoint sources.

Approximately 214 lakes are located within the ULRLW, including Upper and Lower Red Lake, the two largest waterbodies in Minnesota. Much of the ULRLW consists of a relatively flat landscape, with extensive wetlands dominating the northern half. Most streams of the watershed are low-gradient, with many flowing through large wetland complexes. Major tributaries within the watershed include the Sandy River, Blackduck River, South Cormorant River, North Cormorant River, North Branch of the Battle River, South Branch of the Battle River, Battle River, Lost River, and Tamarac River. Other smaller tributaries include Big Rock Creek, Little Rock Creek, Pike Creek, Mud River, Hay Creek, O'Brien Creek, and Shotley Brook.

This WRAPS was completed through a partnership between MPCA and the RL DNR. While the MPCA does not have jurisdiction on the Red Lake Nation lands, the Red Lake Nation and the MPCA cooperated on this watershed-wide project due to the benefits that would be realized by both the tribe and the State of Minnesota as a result of this project. The RL DNR accompanied the MPCA staff during biological sampling in tribal waters, assisted with water quality sampling, participated in assessment activities, conducted public participation events within the reservation and in other areas of the watershed outside their jurisdiction, provided a wealth of local knowledge of the watershed, and wrote significant sections of this WRAPS report.

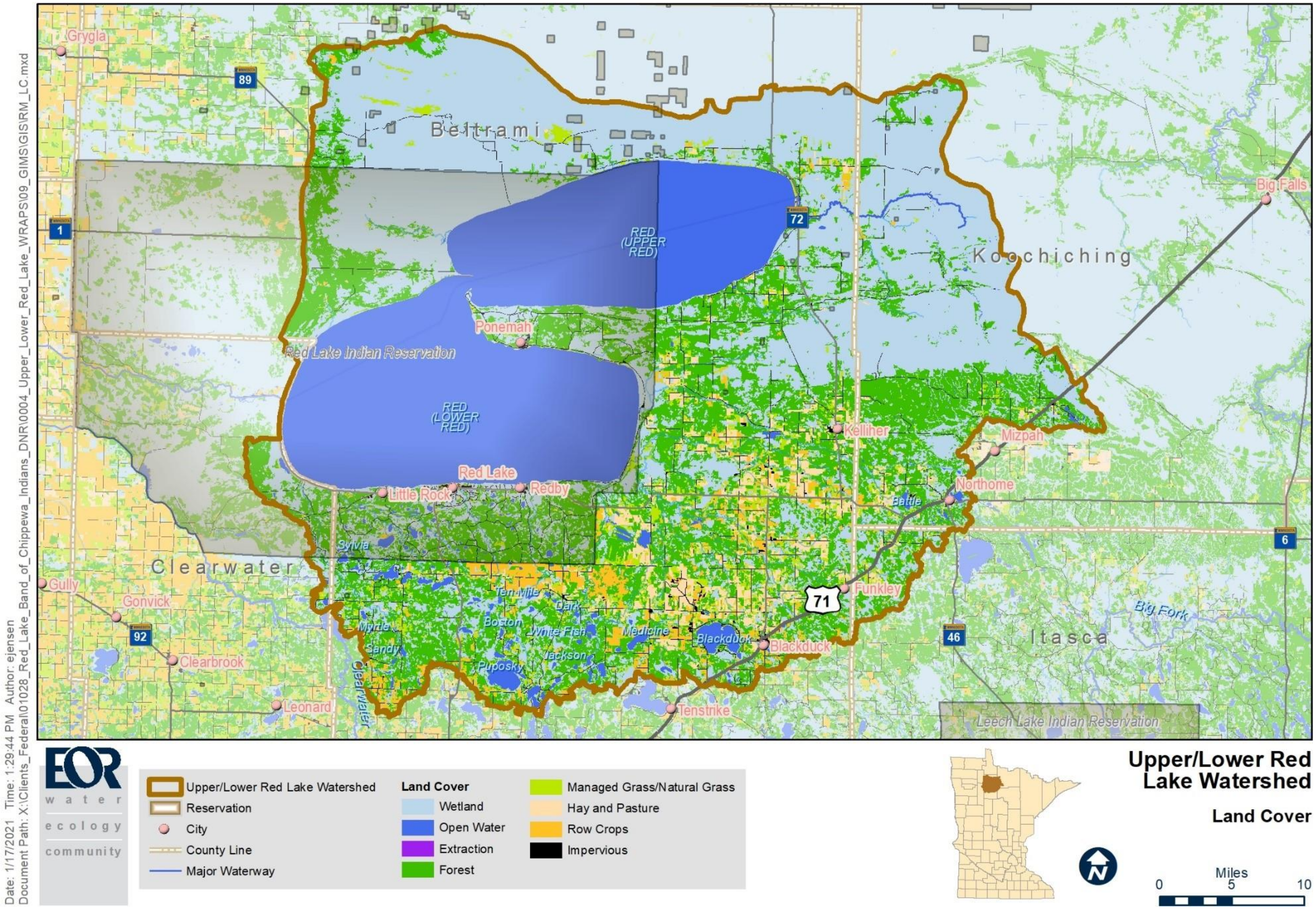


Figure 1. Upper/Lower Red Lake Watershed land cover.

2. Watershed conditions

Due to the vast surface area of Upper and Lower Red Lake (288,800 acres), open water accounts for more than 25% of the watershed's surface area. Lake water quality is generally very good across the watershed with several lakes exhibiting exceptional water quality. Much of the ULRLW falls within the Red Lake Reservation; as a result, many lakes have little to no anthropogenic influences because land uses are primarily forested and wetlands.

The majority of the streams within the ULRLW featured biological communities that were in good condition. Many of the smaller headwater streams had excellent habitat. The lower reaches of some of the larger streams (South Cormorant River, North Cormorant River, Blackduck River, and South Branch of the Battle River) had reduced habitat complexity. Most of the streams with poor biological communities (Tamarac River, Lost River, and North Branch of the Battle River) are profoundly influenced by wetlands.

The ULRLW also supports some notable high-quality wetland features including The Western Water Track of the Red Lake Peatland (designated a Wetland of Distinction) located near and along the northwestern boundary of the watershed. An estimated 84% of the wetlands in the ecoregion are in good to exceptional condition. In addition, wild rice populations have been documented on a number of mid to small sized lakes, wetlands and ponds in the southern portion of the watershed, as well as on Upper and Lower Red Lake (MPCA Protecting Wild Rice Waters).

Additional Upper/Lower Red Lake Watershed Resources

Red Lake Watershed District Upper/Lower Red Lake Subwatershed Website: https://www.rlwdwatersheds.org/2297560-general-info

Beltrami County Local Water Management Plan 2017-2027: http://www.co.beltrami.mn.us/Departments/SWCD/Resources/Local%20Water%20Plan.pdf

Clearwater County Comprehensive Water Plan 2010-2020: https://clearwaterswcd.com/county-water-plan

MPCA Upper/Lower Red Lake Watershed Website: https://www.pca.state.mn.us/water/watersheds/upperlower-red-lake

Minnesota Department of Natural Resources (DNR) Watershed Assessment Framework for the Upper/Lower Red Lake Watershed: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/context_report_major_62.pdf

DNR Context Report: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/context_report_major_62.pdf

DNR Watershed Health Report Card: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/ReportCard_Major_62.pdf

Minnesota Nutrient Planning Portal: https://mrbdc.mnsu.edu/mnnutrients/watersheds/upperlower-red-lake-watershed

Minnesota Nutrient Reduction Strategy: https://www.pca.state.mn.us/water/nutrient-reduction-strategy

Upper/Lower Red Lake Watershed Stressor Identification Report: https://www.pca.state.mn.us/sites/default/files/wq-ws5-09020302a.pdf

Upper/Lower Red Lake Monitoring and Assessment Report: https://www.pca.state.mn.us/sites/default/files/wq-ws3-09020302b.pdf

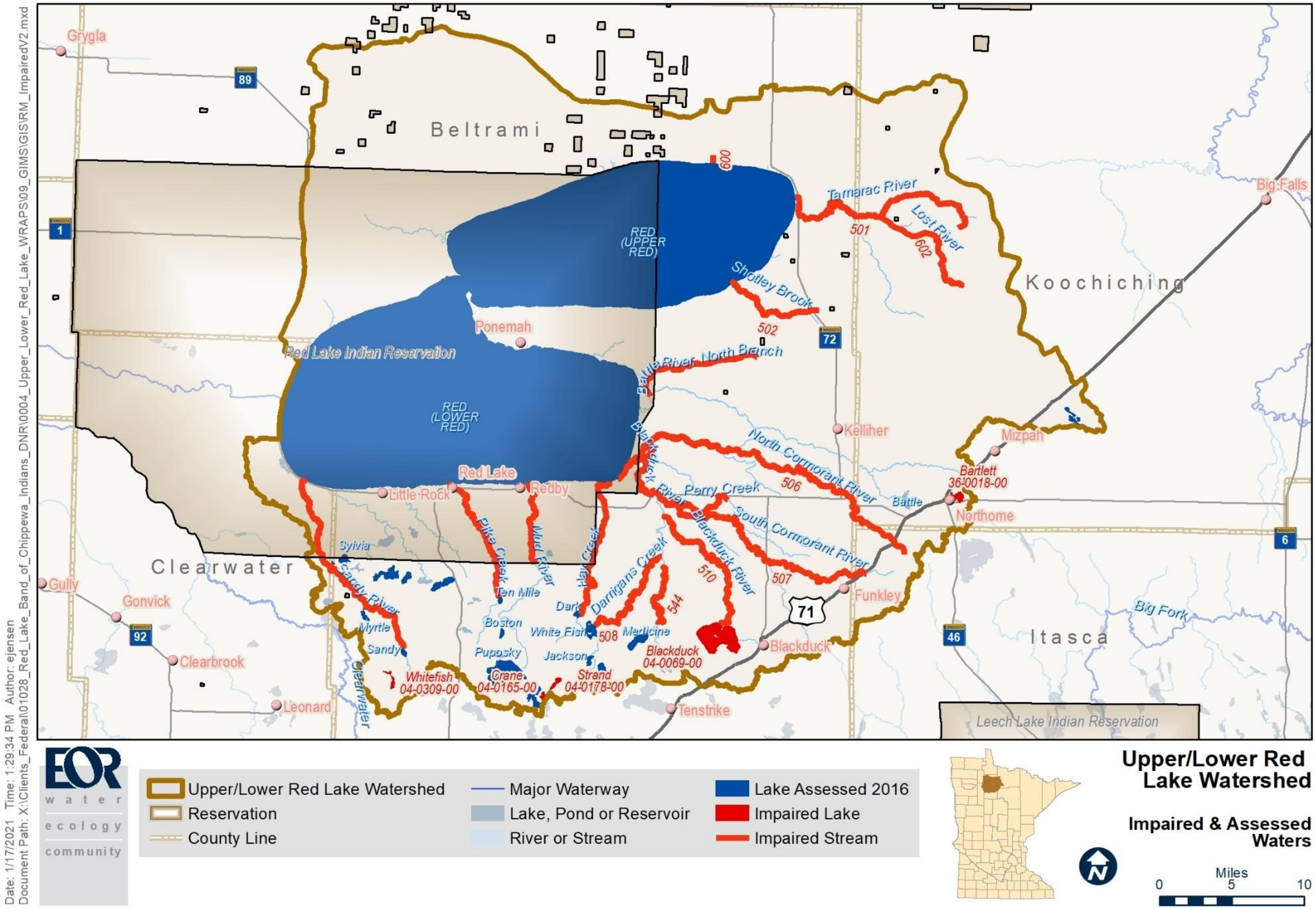


Figure 2. Upper/Lower Red Lake Watershed impaired and assessed waters.

2.1 Condition status

Beginning in 2014, the MPCA initiated an intensive watershed monitoring (IWM) effort of rivers, streams and lakes within the ULRLW. In total, 37 stream sites (35 newly established) were monitored for biology (fish and macroinvertebrates; see Table 17 in Section 4), 96 lakes for eutrophication indicators, and 11 lakes for fish community health. Four of these lakes were monitored as part of the Citizen Lake Monitoring Program (CLMP). The RL DNR sampled 16 stream sites for water chemistry as part of a Surface Water Assessment Grant and also monitored numerous lakes throughout the ULRLW and provided these data to the MPCA for assessment. The Red Lake Watershed District (RLWD) also sampled six stream sites and two lakes regularly and provided data to the MPCA for assessment. In general, most of the lakes and streams in the watershed are in good condition due in large part to the vast expanses of wetland and forest combined with light development which promote good water quality. The results of the monitoring and assessment are summarized in the sections below. Please refer to the Upper/Lower Red Lake Watershed Monitoring and Assessment Report (MPCA 2017) for full monitoring and assessment details. The MPCA has also developed a Stressor Identification (SID) Report (MPCA 2018) for the watershed. Results from the SID report were incorporated into this report in an effort to fully capture the existing condition of the watershed as well as the primary stressors to watershed resources.

The ULRLW has several lakes that have been identified as impaired based on mercury levels. This report does not cover toxic pollutants. For more information on mercury impairments, see the statewide mercury TMDL on the MPCA website at MPCA Statewide Mercury TMDL.

2.1.1 Streams

In the ULRLW, assessments were attempted on 40 of the 43 unique stream/river reaches (uniquely identified with assessment unit identifications or AUIDs) in 2016; 28 reaches were assessed for aquatic life use, and 20 reaches were assessed for aquatic recreation use (Table 1). Of the assessed stream reaches, 18 reaches fully supported aquatic life, and 8 reaches fully supported aquatic recreation. Ten reaches did not support aquatic life, and 12 reaches did not support aquatic recreation. Eight reaches had insufficient data to make an assessment determination for aquatic life use, and 7 reaches had insufficient data to make an assessment determination for aquatic recreation use. No stream reaches were classified as limited resource waters. The impaired stream reaches are shown in Figure 2. See Upper/Lower Red Lake Watershed Monitoring and Assessment Report (MPCA 2017) for detailed stream assessment results.

Overall, the majority of streams have biological communities (fish and aquatic insects) that are in good condition. Many of the headwater streams have excellent habitat. Most of the stream reaches with poor biological communities are profoundly affected by wetlands. Many of the aquatic life use impairments were the result of either 1) a lack of habitat heterogeneity or 2) low DO from natural wetland influence and altered hydrology. A few aquatic life use impairments were due to elevated total suspended solids (TSS).

Observed fish index of biotic integrity (FIBI) scores exceeded the exceptional use criteria on segments of the following streams: 1) Mud River, 2) Blackduck River, 3) South Cormorant River, 4) Spring Creek, and 5) Meadow Creek. The habitat in these streams was typically rated as good to exceptional and are addressed in Section 2.5 as high priority for protection efforts.

Bacteria (*E. coli*) concentrations are a concern in this watershed as 12 stream reaches had concentrations that exceeded the aquatic recreation standards. However, microbial source tracking data indicated that nine of these impairments are due to natural background wildlife sources and could not be directly linked to an anthropogenic source.

Table 1. Assessment summary for stream water quality in the Upper/Lower Red Lake Watershed.

Aggregated HUC-12 Subwatershed	Aquatic Life Uses				Aquatic Recreation Uses			
	# Assessed AUIDs	SUP	IMP	IF	# Assessed AUIDs	SUP	IMP	IF
ULRLW Total (09020302)	**36**	**18**	**10**	**8**	**27**	**8**	**12**	**7**
Sandy River (0902030208-01)	**2**	2	0	0	**1**	0	1	0
Lower Red Lake Frontal (0902030207-01)	**3**	1	1	1	**2**	1	1	0
Mud River (0902030207-02)	**3**	2	1	0	**1**	0	1	0
Blackduck River (0902030206-01)	**7**	3	2	2	**6**	1	4	1
South Cormorant River (0902030206-03)	**5**	2	1	2	**4**	0	1	3
North Cormorant River (0902030206-02)	**3**	1	1	1	**2**	0	1	1
Battle River (0902030205-01)	**6**	4	1	1	**4**	2	1	1
Lower Red Lake (0902030209-01)	**0**	0	0	0	**0**	0	0	0
Shotley Brook (0902030204-02)	**2**	1	1	0	**2**	0	1	1
Little Tamarac River (0902030201-02)	**2**	1	0	1	**1**	1	0	0
Lost River (0902030201-03)	**2**	1	1	0	**1**	1	0	0
Tamarac River (0902030201-01)	**1**	0	1	0	**1**	1	0	0
Deer River-Frontal Upper Red Lake (0902030202-02)	**0**	0	0	0	**1**	0	1	0
Upper Red Lake (0902030204-01)	**0**	0	0	0	**0**	0	0	0
Upper Red Lake Frontal (0902030202-01)	**0**	0	0	0	**0**	0	0	0
Manomin Creek (0902030203-01)	**0**	0	0	0	**1**	1	0	0

SUP = full support of designated use, IMP = new impairment, IF = insufficient information for assessment

2.1.2 Lakes

The ULRLW contains approximately 214 lakes, and the majority of lakes have good water quality. Major lakes include Blackduck, Puposky, Bartlett, Medicine, White Fish, Balm, and Upper and Lower Red Lake, which are the two largest lakes in the state. There are several lakes wholly within the Red Lake Reservation that are managed for trout including Island, Green, Kinney, Squaw Smith, and Heart. These five lakes exhibited excellent water quality and meet the Northern Lakes and Forests Ecoregion standards for trout lakes and are addressed in Section 2.5 as high priority for protection efforts. Upper and Lower Red Lake is relatively shallow in comparison with its vast surface area. As a result, nutrients in the lake bottom sediments are subject to becoming re-suspended via wind and wave action, which leads to nuisance algae blooms. Upper and Lower Red Lake did not meet current state water quality standards for eutrophication; however, results of a paleolimnological study indicated that conditions are natural and match historical records. The MPCA, the Science Museum of Minnesota's St. Croix Watershed Research Station, and RL DNR are working cooperatively to develop site specific standards for Upper and Lower Red Lake. This process is currently under development, and the lakes have not been listed as impaired.

Of the 96 lakes assessed for aquatic recreation, 59 lakes were fully supporting, 5 lakes were impaired, 30 lakes had insufficient data for an assessment determination and assessments on 2 lakes (Upper and Lower Red Lake) were deferred because of site specific standard development (Table 2). Waterbody assessments to determine aquatic life use support were completed for 11 lakes; 5 lakes were supporting of aquatic life and 6 lakes had insufficient data for an assessment determination. All lakes were assessed against standards for aquatic recreation that are designed to protect lakes based upon the ecoregion in which the lake is located. Lakes with trout populations were held to standards that are more stringent to protect those sensitive fish populations. See Upper/Lower Red Lake Watershed Monitoring and Assessment Report (MPCA 2017) for detailed lake assessment results.

Table 2. Assessment summary for lakes water quality in the Upper/Lower Red Lake Watershed.

Aggregated HUC-12 Subwatershed	Aquatic Life Uses				Aquatic Recreation Uses			
	# Assessed Lakes	SUP	IMP	IF	# Assessed Lakes	SUP	IMP	IF
ULRLW Total (09020302)	**11**	**5**	**0**	**6**	**94**	**59**	**5**	**30**
Sandy River (0902030208-01)	**1**	1	0	0	**13**	9	1	3
Lower Red Lake Frontal (0902030207-01)	**2**	1	0	1	**58**	36	0	22
Mud River (0902030207-02)	**2**	1	0	1	**8**	4	2	2
Blackduck River (0902030206-01)	**3**	2	0	1	**10**	7	1	2
South Cormorant River (0902030206-03	**0**	0	0	0	**0**	0	0	0
North Cormorant River (0902030206-02)	**0**	0	0	0	**0**	0	0	0
Battle River (0902030205-01)	**1**	0	0	1	**2**	0	1	1
Lower Red Lake (0902030209-01)	**0**	0	0	0	**1**	1	0	0
Shotley Brook (0902030204-02	**0**	0	0	0	**0**	0	0	0
Little Tamarac River (0902030201-02)	**0**	0	0	0	**0**	0	0	0
Lost River (0902030201-03)	**2**	0	0	2	**2**	2	0	0
Tamarac River (0902030201-01)	**0**	0	0	0	**0**	0	0	0
Deer River-Frontal Upper Red Lake (0902030202-02)	**0**	0	0	0	**0**	0	0	0
Upper Red Lake (0902030204-01)	**0**	0	0	0	**0**	0	0	0
Upper Red Lake Frontal (0902030202-01)	**0**	0	0	0	**0**	0	0	0
Manomin Creek (0902030203-01)	**0**	0	0	0	**0**	0	0	0

SUP = full support of designated use, IMP = new impairment, IF = insufficient information for assessment

2.2 Water quality trends

Year-to-year weather variations affect water quality observation data; for this reason, interpreting long-term data trends minimizes year-to-year variation and provides insight into changes occurring in a water body over time.

The MPCA completes annual trend analysis on lakes and streams across the state based on long-term transparency measurements. The data collection for this work relies heavily on volunteers across the state and incorporates any relevant agency and partner data submitted to Environmental Quality Information System (EQuIS). The water clarity trends are calculated using a Seasonal Kendall statistical test for sites with a minimum of eight years of transparency data: Secchi disk measurements in lakes and Secchi tube measurements in streams.

There are no volunteers enrolled in the Citizen Stream Monitoring Program (CSMP) to provide stream transparency data in the watershed. Four lakes in the watershed have volunteers in the CLMP. Water clarity has shown an increasing (improving) trend on Medicine (04-0122-00) and Blackduck (04-0069-00) Lakes and no trend on Dark (04-0167-00) and Balm (04-0329-00) Lakes (Table 3).

Table 3. Water clarity trends at citizen monitoring sites.

Upper/Lower Red Lake Watershed (09020302)	Citizen Stream Monitoring Program	Citizen Lake Monitoring Program
Number of sites w/ increasing trend	**0**	**2**
Number of sites w/ decreasing trend	**0**	**0**
Number of sites w/ no trend	**0**	**2**

The River Watch Citizen Monitoring Program (in partnership with International Water Institute) is conducted throughout the Red River Basin. This citizen program has water chemistry data available from streams, ditches, lakes, and impoundments throughout the Red River Basin. Information on these sites can be found at http://riverwatch.wq.io/.

In June 2014, the MPCA published its final trend analysis of river monitoring data located statewide based on the historical Milestones Network. There are no long-term monitoring locations in the ULRLW; however, there is a gage on the Red Lake River near Fisher, Minnesota. Users can access this data via the MPCA's Watershed Pollutant Load Monitoring Network (WPLMN) which shows the location of long-term monitoring sites in the watershed and includes links to the MPCA's Environmental Data Access portal, which contains all monitoring data for the entire period of record, including more recent data through 2018.

A Seasonal Kendall statistical test for water quality trends was conducted using "R", a statistical software program that can be used to identify statistically significant trends in the water quality of streams and lakes in the watershed. This analysis was controlled to include only data collected from June through September, and trends were only reported for constituents with at least eight years of data and 90% statistical confidence. Balm (Turtle) Lake was the only waterbody identified as having a significant trend, with decreasing (declining) Secchi depth (Table 4).

Table 4. Water quality trends (2008-2018).

Waterbody Name	AUID	Parameter	Trend
Balm (Turtle)	04-0329-00	Depth, Secchi disk depth	Significantly decreasing (declining)
Bass Lake	40-0281-00	Chl.- *a*. corrected for pheophytin	Decreasing slightly, not significant
		Depth, Secchi disk depth	Increasing slightly (improving), not significant
		Phosphorus	Stable, no trend
Blackduck	04-0069-00	Depth, Secchi disk depth	Decreasing slightly (declining), not significant
Dark	04-0167-00	Depth, Secchi disk depth	Decreasing slightly (declining), not significant
Fullers Lake East Basin	40-0283-00	Chl.- *a*. corrected for pheophytin	Decreasing slightly, not significant
		Depth, Secchi disk depth	Decreasing slightly (declining), not significant
		Phosphorus	Increasing slightly, not significant
Lower Red Lake	40-0035-20	Depth, Secchi disk depth	Decreasing slightly (declining), not significant
		Phosphorus	Increasing slightly, not significant
Medicine	04-0122-00	Depth, Secchi disk depth	Increasing slightly (improving), not significant
Mud River	09020302-541	Phosphorus	Decreasing slightly, not significant
		Total suspended solids	Decreasing slightly, not significant
Upper Red Lake	40-0035-10	Chl.- *a*. corrected for pheophytin	Decreasing slightly, not significant
		Depth, Secchi disk depth	Decreasing slightly (declining), not significant
		Phosphorus	Increasing slightly, not significant

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.

A **stressor** is something that adversely impacts or causes fish and/or macroinvertebrate communities in streams to become unhealthy. Biological SID is conducted for streams with either fish or macroinvertebrate biota impairments and encompasses the evaluation of both pollutants (such as nitrate-nitrogen, phosphorus, and/or sediment) and nonpollutant-related (such as altered hydrology, fish passage, and habitat) factors as potential stressors.

Pollutant source assessments are completed where a biological SID process identifies a pollutant as a stressor, as well as for the typical pollutant impairment listings such as TSS. Pollutants to lakes and streams include point sources (such as wastewater treatment plants; WWTP) or nonpoint sources (runoff).

2.3.1 Stressors of biologically-impaired stream reaches

SID is a key component of the major watershed restoration and protection projects being carried out under Minnesota's CWLA. A SID study was conducted to identify the factors (i.e., stressors) that are causing the fish and macroinvertebrate community impairments in the ULRLW. For more details on the ULRLW stressors and the process used to identify the stressors causing the biological impairments, please consult the Upper/Lower Red Lake SID Report (MPCA 2018).

Based on a review of human activity, the following anthropogenic stressors were deemed most likely factors causing the fish and macroinvertebrate community impairments in the ULRLW:

- Road crossings where culverts were either improperly sized or placed to allow for fish passage;
- Pasturing cattle in riparian areas and allowing cattle to access stream channels;
- Field ditches and legacy peatland ditches.

Table 5 provides a summary of the primary stressors identified for each biologically-impaired reach in the ULRLW. Seven AUID reaches were brought into the SID process because they were determined to have substandard biological communities during the 2014 IWM and the subsequent 2016 assessment of waters within the ULRLW.

Other stressors appear to be due to natural situations including the following:

- Low DO when source water comes from bogs or other wetlands;
- Beaver activity (dams) that can block fish passage to upstream locations;
- Low flows in later parts of summer, which have more of a tendency to occur in western parts of Minnesota due to the lesser amounts of rain that fall there relative to eastern Minnesota.

From an overarching watershed perspective, key issues include: 1) Returning the hydrological regime of streams to more closely match the original, unmodified hydrological patterns in the upper half of the watershed and 2) Restoring a more natural flow regime in the southern half of the watershed, where hydrological alteration from agricultural drainage has altered natural stream channels. Eliminating or reducing local stressors, such as excluding cattle from stream channels and near-channel banks, and replacing culverts using designs and installation practices that allow fish passage, will allow biological communities to improve in the streams that are impaired by those situations.

Table 5. Stressors to aquatic life in biologically-impaired reaches in the Upper/Lower Red Lake Watershed.

Aggregated HUC-12 Subwatershed	AUID (Last 3 digits)	Stream	Reach description	Biological impairment	Primary stressor						
					Dissolved oxygen	Phosphorus	Sediment/TSS	Connectivity	Altered Hydrology	Channel Alteration	Habitat
Tamarac River 0902030201-01	501	Tamarac River	Headwaters to Upper Red Lake	Fish	⬬				♦		
Tamarac River 0902030204-02	502	Shotley Brook	Headwaters to Upper Red Lake	Macro-Invertebrates			⬬		♦	⬬	⬬
Battle River 0902030205-01	503	North Branch Battle River	Headwaters (Unnamed ditch) to S Br Battle R	Fish	⬬			⬬	◊		
Blackduck River 0902030206-01	508	Darrigans Creek	Whitefish Lk 04-0137-00) to O'Brien Cr	Macro-Invertebrates			⬬			♦	
Lost River 0902030201-03	602	Lost River	Unnamed cr to Tamarac R	Fish	⬬		?			?	?
South Cormorant River 0902030206-03	605	Perry Creek	Unnamed cr to Cormorant R	Fish				⬭	⬭		
North Cormorant River 0902030206-02	506	North Cormorant R	Headwaters to Blackduck R	Fish and Macro -Invertebrates			⬬		♦	⬬	⬬

♦ A "root cause" stressor, which causes other consequences that become the direct stressors.
◊ Possible contributing root cause.
⬬ Determined to be a direct stressor.
⬭ A stressor, but anthropogenic contribution, if any, not quantified. Includes beaver dams as a natural stressor.
? Inconclusive

2.3.2 Pollutant sources

This section summarizes the sources of pollutants (such as phosphorus, bacteria or sediment) to lakes and streams in the ULRLW.

Hydrologic Simulation Program-Fortran (HSPF) model results were used to evaluate the relative magnitude of nonpoint versus point sources in the ULRLW as demonstrated in Table 6. A detailed breakdown of phosphorus sources for a specific reach of the Tamarac River is shown in Figure 3 and is generally representative of watershed-wide results. The 2021 Upper/Lower Red Lake Watershed TMDL Study used HSPF model results to identify point and nonpoint phosphorus sources to the watershed's lakes that were impaired by excess nutrients (phosphorus). The TMDL study also identified point and nonpoint sources of bacteria and suspended solids (sediment) to the watershed's impaired streams. More information about the HSPF model is provided in Section 3.1 of this document.

Table 6. Percent contribution to total phosphorus load leaving the subwatershed for major drainage areas to Upper and Lower Red Lake and the direct drainage area to Upper and Lower Red Lake.

Water Resource Drainage Area	Upland Nonpoint	Non-Permitted Feedlot	Individual Septics	Point Source	Atm. Dep.	Bed/Bank
Bartlett Lk	88.9%	0.5%	0.2%	0%	10.4%	0%
Blackduck R	90.5%	0.5%	0.3%	0%	8.7%	0%
Darrigans Cr	94.8%	1.2%	0.3%	0%	3.7%	0%
Hay Cr	99.4%	0.0%	0.3%	0%	0.3%	0%
Lost R	98.2%	0.0%	0.3%	0%	1.5%	0%
Lower Red Lk	9.7%	0.0%	0.0%	0%	90.3%	0%
Mud R	97.9%	0.5%	0.3%	0%	0.6%	0%
N. Branch Battle R	99.3%	0.0%	0.4%	0%	0.3%	0%
N. Cormorant R	98.1%	0.8%	0.3%	0%	0.7%	0%
O'Brien Cr	98.4%	1.1%	0.2%	0%	0.2%	0%
Perry Cr	98.0%	1.5%	0.2%	0%	0.3%	0%
Pike Cr	98.1%	1.2%	0.4%	0%	0.3%	0%
Puposky Lk	69.6%	0.2%	0.3%	0%	30.0%	0%
S. Cormorant R	98.0%	0.6%	0.4%	0%	1.0%	0%
Sandy R	98.2%	0.2%	0.3%	0%	0.7%	0.7%
Shotley Br	99.2%	0.0%	0.3%	0%	0.4%	0%
Strand-Crane Lk	87.2%	0.0%	0.3%	0%	12.5%	0%
Tamarac R	97.1%	0.0%	0.5%	0%	2.3%	0%
Upper Red Lk	39.7%	0.0%	0.2%	0%	60.1%	0%

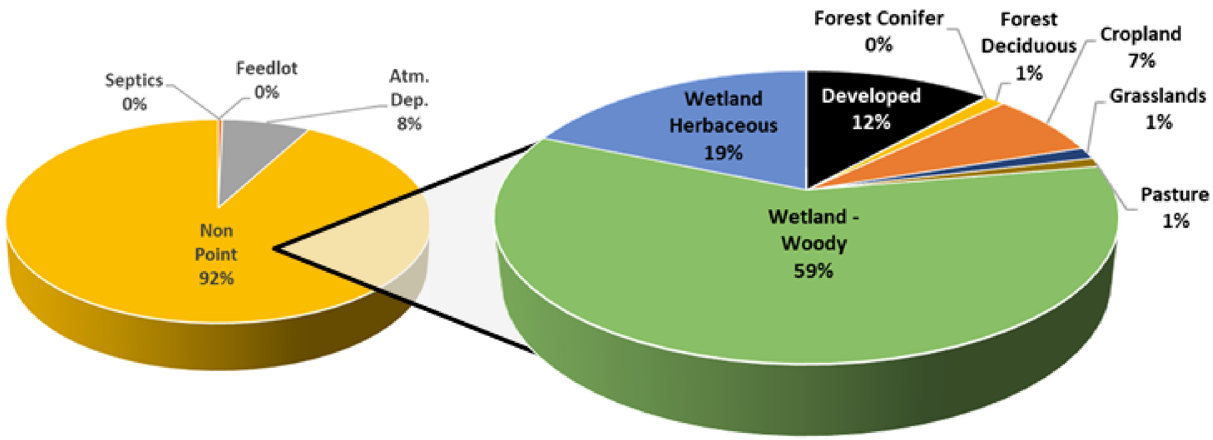


Figure 3. Breakdown of phosphorus sources for HSPF Reach 190 – Tamarac River. Percentages are generally representative of watershed-wide results.

2.3.2.1 Point sources

Point sources are defined as facilities that discharge stormwater or wastewater to a lake or stream and have a National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit (Permit). There are two municipal wastewater facilities, four industrial facilities, and three permitted feedlots that require NPDES or SDS permitting located in the ULRLW (Table 7). Figure 4 shows all permitted point sources in the ULRLW.

Table 7. Point sources in the Upper/Lower Red Lake Watershed.

Aggregated HUC-12 Subwatershed	Point source			Pollutant reduction needed?
	Name	Permit #	Type	
Lost River 0902030201-02	Gerald W Albrecht Quarries	MNG490209	Industrial	No
Lower South Branch Battle River 0902030205-02	Kelliher WWTP	MNG585068	Domestic	No
Pike Creek 0902030207-04	Alaskan Acres Holsteins	MPCA-CSF-0043	Feedlot	No
	Pete Mistic Jr Farm	MNG920120	Feedlot	No
	Stanley P Mistic Farm	MNG441107	Feedlot	No
Upper Blackduck River 0902030206-04	Blackduck WWTP	MN0052302	Domestic	No
Battle River 0902030205-01	Northstar Materials, Inc. (2 sites)	MNG490038	Industrial	No
Upper North Cormorant River 0902030206-08	Stoney Creek Sand & Gravel	MNG490531	Industrial	No
Sandy River 0902030208-01	Anderson Contracting, Inc.	MNG490109	Industrial	No

Phosphorus

The Blackduck WWTP contains a stabilization pond system within the Blackduck Lake (04-0069) Subwatershed; however, at this facility, treated wastewater is land applied using a spray irrigation system. No surface discharge is included in the permit for this facility.

Bacteria

The City of Kelliher WWTP (09020302-502 subwatershed) is the only NPDES-permitted WWTP whose surface discharge falls within an *E. coli* impaired stream subwatershed. As previously mentioned, the City of Blackduck is also served by an NPDES permitted pond system; however, at this facility, treated wastewater is land applied using a spray irrigation system.

Total suspended solids

There are a total of three permitted animal feeding operations (AFO) located within the drainage area of a TSS impaired stream. An AFO is a general term for an area intended for the confined holding of animals, where manure may accumulate, and where vegetative cover cannot be maintained within the enclosure due to the density of animals. The permits for the three feedlots located in the drainage area to a TSS impaired stream require that the feedlots have zero discharge to surface water.

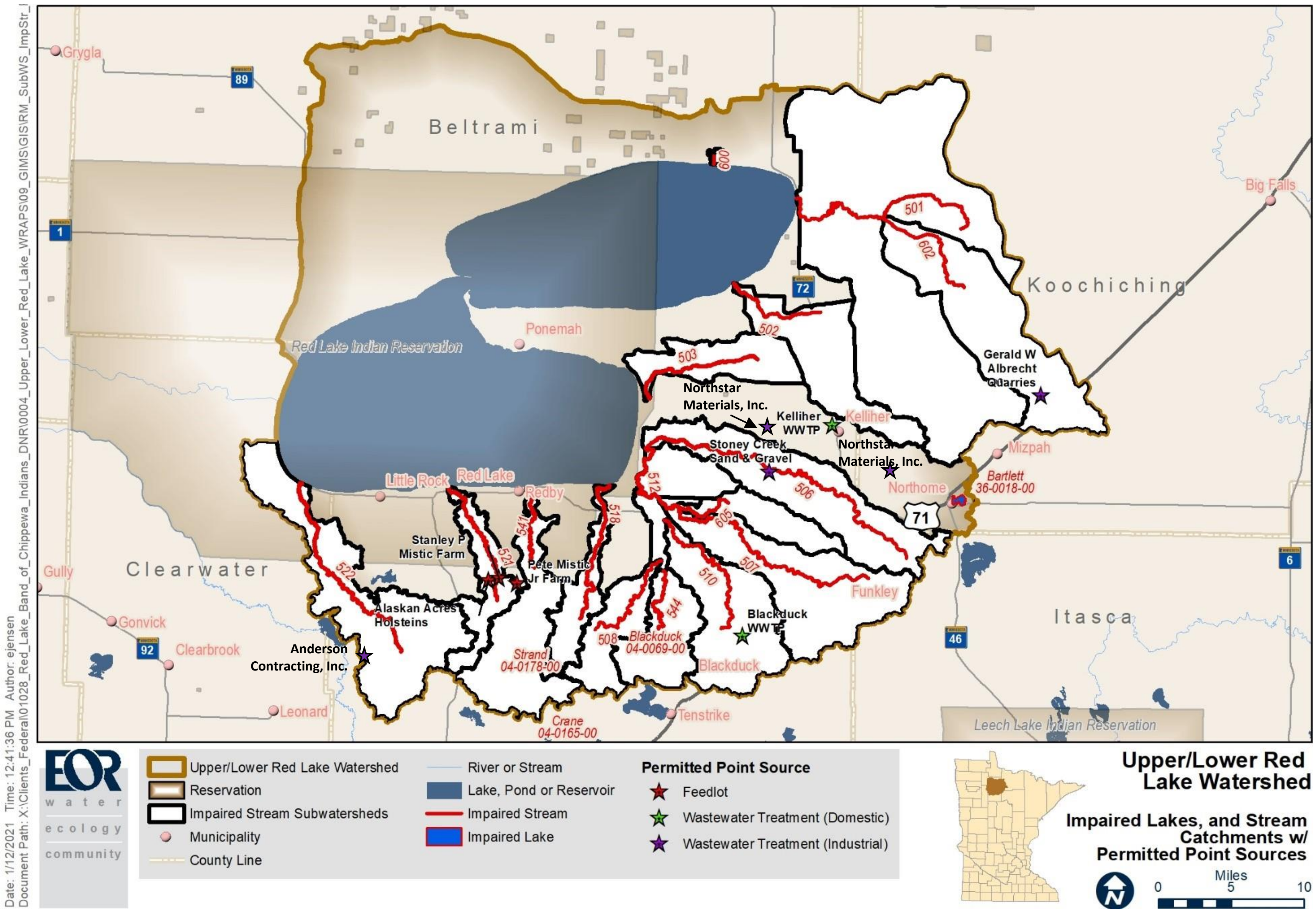


Figure 4. NPDES industrial and domestic wastewater point source sites.

2.3.2.2 Nonpoint sources

Nonpoint pollution sources, unlike pollution from industrial and municipal sewage treatment plants, come from many different sources. Nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground from a number of diffuse sources. As the runoff moves, it picks up and carries away natural and human-caused pollutants and deposits them into lakes and streams. According to the Nonpoint Source Pollution Index, the ULRLW ranks as tied for 8th out of the 80 watersheds in Minnesota (where 1st is best, or has the least threat). Wetlands are the leading nonpoint pollutant source in the ULRLW (Figure 3). However, the magnitude of pollutant loss (e.g. phosphorus yield) per acre from the wetland portions of the watershed is low relative to loading rates for cropland and developed land uses (Figure 5). The following list provides an overview of phosphorus sources in the ULRLW from most dominant to least dominant.

- Lake internal loading: Lake sediments and macrophytes contain large amounts of phosphorus that can be released into the lake water through physical mixing or under certain chemical conditions or during the senescence of macrophytes. Internal sources of phosphorus were documented as a leading source of phosphorus to impaired lakes in the watershed including Blackduck Lake, Crane Lake, Strand Lake, Whitefish Lake, and Bartlett Lake.
- Atmospheric deposition: Atmospheric deposition represents the phosphorus that is bound to particulates in the atmosphere and is deposited directly onto surface waters.
- Wetland export: Phosphorus export from wetlands is a well-known phenomenon in northern Minnesota wetlands (Dillon and Molot 1997, Banaszuk et al. 2005, O'Brien et al. 2013). Altered hydrology resulting from the installation of wetland ditches has resulted in higher peak flows, unstable habitat, and ultimately a vector for increased phosphorus export.
- Watershed runoff: The HSPF model was used to estimate watershed runoff volumes and total phosphorus (TP) loads for all 112 individual subwatersheds in the ULRLW based on land cover and soil type and was calibrated using meteorological data from 1996 through 2014.
- Upstream lakes and streams: Some lakes receive most of their phosphorus from upstream lakes and streams. For these lakes, restoration and protection efforts should focus on improving the water quality of the upstream lakes and streams.
- Runoff from impervious areas: The ULRLW ranks at the 96th percentile of the state's 80 watersheds for the lack of impervious cover; only three other watersheds have a smaller percentage of impervious surface. There are a small number of incorporated towns in the ULRLW, all of which are small communities. None of these towns is large enough to require an MS4 stormwater plan. There are localized situations, such as the immediate shoreline properties of lakes with significant development, where impervious surfaces may be an important water quality issue.
- Runoff from agricultural land: Agricultural land use, consisting primarily of pasture and hay production, occurs primarily within the southern and southeastern portion of the watershed. Only 0.8% of the total land area in the ULRLW is utilized for row crop production. Runoff from cropland does represent a localized source of phosphorus in portions of the watershed as shown in Figure 3, where cropping land uses contribute 7% of the TP load to the Tamarac River.

- Runoff from nonpermitted feedlots: Fertilizer and manure contain high concentrations of phosphorus, nitrogen, and bacteria that can run into lakes and streams when not properly managed. The southern and southeastern part of the ULRLW contains nearly all of the watershed's animal agriculture. More specifically, runoff from nonpermitted feedlots was expected to contribute 0.9 pounds of TP per year to Whitefish Lake.
- Failing septic systems: Septic systems that are not maintained or are failing near a lake or stream can contribute excess phosphorus, nitrogen, and bacteria. Most rural homes/cabins in the ULRLW are not connected to a municipal sewer system, and thus have individual treatment systems. Rural areas may also have residences that unlawfully discharge wastes directly to streams, but the numbers are declining. Recent septic system statistics for Koochiching County indicate 10% of the individual treatment systems were estimated to be "Imminent Public Health Threats" (i.e., direct discharge to stream), and 67% "Failing", with 23% of systems in compliance (MPCA 2013). These statistics are quite poor relative to many of Minnesota's counties. Statistics for Beltrami County are not available. Failing septics were documented as a reducible source of phosphorus and bacteria in the ULRLW TMDL for Blackduck Lake, Crane Lake, Strand Lake, Whitefish Lake, and Bartlett Lake. Failing septic systems are not expected to be a significant source of *E. coli* within the drainage areas of the impaired streams.
- Wildlife fecal runoff: Dense or localized populations of wildlife, such as beavers or geese, can contribute phosphorus and bacteria pollutants to streams or ponds. Microbial DNA data collected by the RL DNR and analyzed by a contract lab confirmed that birds (waterfowl) and beavers are localized sources of bacteria to the 12 streams in the watershed that are currently impaired by bacteria.

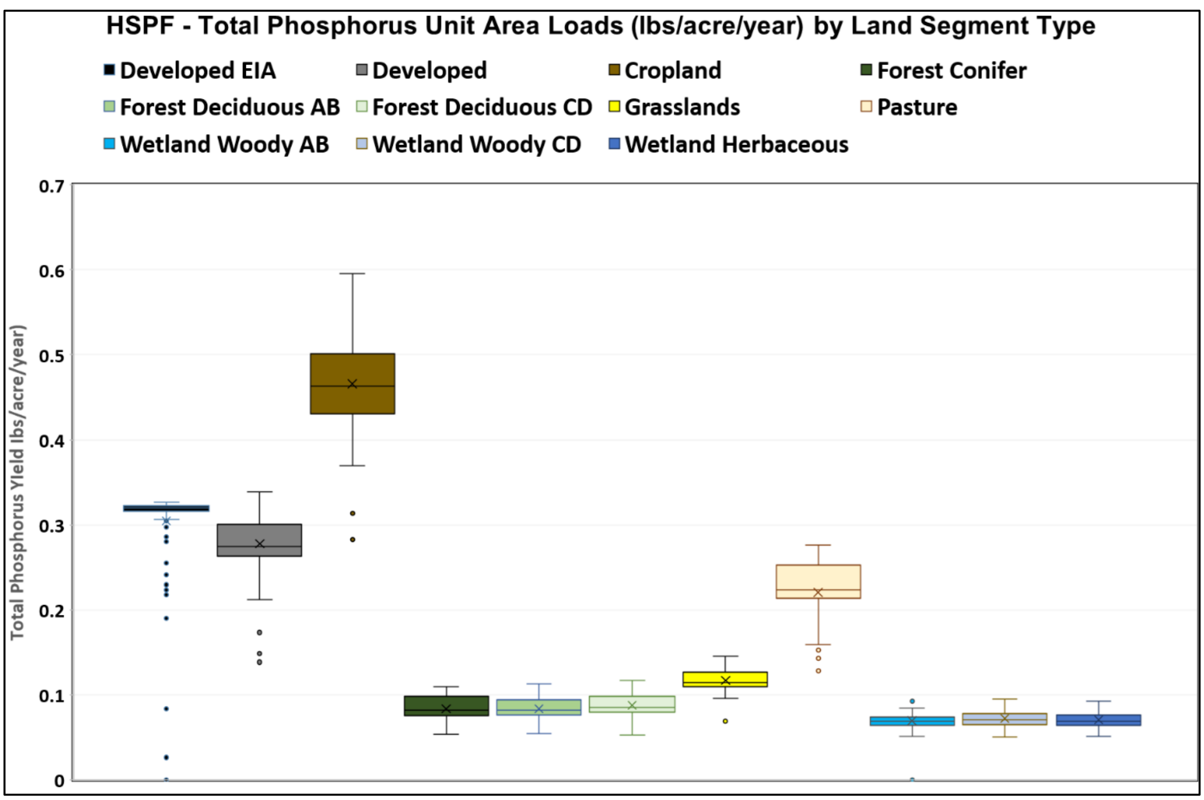


Figure 5. HSPF total phosphorus yield (lbs/acre/year) by land segment type.

Microbial source tracking

The RL DNR collected water samples that were filtered for microbial DNA from the bacteria impaired streams during the months of August and September in 2017. These data were analyzed using five microbial biomarkers to identify potential source animals of the fecal pollution. For streams where pollution was detected, the source and concentration (low, moderate, or high) are listed below in Table 8.

Table 8. Detected sources of *E. coli* by stream (August-September 2017).

Stream AUID	Stream Name	Anthropogenic Sources			Wildlife Sources	
		Ruminant	Human: Dorei	Human: EPA	Bird	Beaver
09020302-502	Shotley Brook				Low	
09020302-503	Battle River, North Branch	Moderate				Low
09020302-506	North Cormorant River	Moderate				Low
09020302-507	South Cormorant River					Low
09020302-508	Darrigans Creek	High		Low		
09020302-510	Blackduck River	Low				
09020302-512	Blackduck River					Low
09020302-518	Hay Creek				Low	Low
09020302-522	Sandy River				Low	Low
09020302-541	Mud River					Low
09020302-544	O'Brien Creek	Low			Low	Low
09020302-600	Unnamed Stream		Low		Low	Low

2.4 TMDL summary

A TMDL is a calculation of how much pollutant a lake or stream can receive before it does not allow recreational uses or support aquatic life. These studies are required by the Clean Water Act for all impaired lakes and streams. TMDLs have been developed for five lake eutrophication impairments, nine stream bacteria impairments, and one stream TSS impairment in the ULRLW (Table 9).

The TMDL study developed phosphorus lake response models and calculated phosphorus TMDLs for the five lake eutrophication impairments:

- 36-0018-00: Bartlett Lake
- 04-0069-00: Blackduck Lake
- 04-0165-00: Crane Lake
- 04-0178-00: Strand Lake
- 04-0309-00: Whitefish Lake

The TMDL study developed *E. coli* load duration curves and TMDLs for the nine *E. coli* impairments that were linked to anthropogenic sources (human or ruminant) identified through Microbial Source Tracking (see Section 2.3):

- 09020302-503: Battle River, North Branch
- 09020302-506: North Cormorant River
- 09020302-507: South Cormorant River
- 09020302-508: Darrigans Creek
- 09020302-510: Blackduck River, Blackduck Lk to O'Brien Ck
- 09020302-522: Sandy River
- 09020302-541: Mud River
- 09020302-544: O'Brien Creek
- 09020302-600: Unnamed creek

A linkage to anthropogenic sources could not be made for three *E. coli* impairments. These impairments are being deferred while MPCA considers potential recategorization to category 4D. Evidence of wild bird and beaver sources of *E. coli* was from Microbial Source Tracking results (see Table 8).

- 09020302-502: Shotley Brook
- 09020302-512: Blackduck River, South Cormorant R to North Cormorant R
- 09020302-518: Hay Creek

Only one aquatic life use impairment had a strong link to a pollutant-based stressor (TSS) and was addressed by a TSS TMDL:

- 09020302-541: Mud River

Two TSS impaired reaches are being considered for recategorization to 4B and potential future de-listing:

- 09020302-506: North Cormorant River - recent (2007 – 2016) water quality data meets the TSS water quality standard. This reach is being considered for recategorization to 4B and potential future de-listing.
- 09020302-521: Pike Creek - The biological impairments on Pike Creek were largely due to a culvert sizing issue. This culvert has been replaced. Recent (2007 – 2016) water quality data meets the TSS water quality standard. This reach is being considered for recategorization to 4B and potential future de-listing.

The 11 additional aquatic life use impairments on 9 stream reaches were linked to a nonpollutant based stressor (connectivity, altered hydrology, channel alteration, and habitat) and will be considered for recategorization to 4C as well as addressed through the implementation strategies identified in this WRAPS report.

See Upper/Lower Red Lakes TMDL Study (MPCA 2020) or the existing pollutant loading, wasteload and load allocations, load reductions needed to meet water quality goals, and pollutant source summaries for each impaired stream or lake.

2.5 Protection considerations

2.5.1 Rivers and streams

The MPCA and DNR have worked together to create a prioritization process for Minnesota streams that are supportive of designated aquatic life uses. The goal of this prioritization exercise was to identify and prioritize streams that are 1) currently healthy but near the impairment threshold or 2) currently healthy and are indicating good water quality. For those streams that are currently healthy, further prioritization exercises were performed to identify watersheds that are largely protected versus those that are at risk for being developed.

The stream protection and prioritization exercise identified two main landscape risks to biological condition including 1) percent disturbed land and 2) density of roads. Each risk factor was assessed at two different scales including the riparian scale (200m buffer on each side of stream) and the stream's watershed scale.

The exercise then identified the amount of land in public ownership or permanent easement at both the riparian scale and watershed scale. Next, each stream was assessed to determine the number of communities (fish, macroinvertebrates, or both) that were near the impairment threshold (Figure 6). Each risk factor was assessed relative to a statewide database for fully supporting streams. The final Protection Priority Rank was calculated as follows:

Protection Priority Rank =

(IBI Threshold Proximity) x (Riparian Risk + Watershed Risk + Current Protection)

As an example, a stream with biological communities (fish and macroinvertebrates) that were near the IBI impairment threshold, with a large number of roads in the stream's watershed, and a low percentage of land in protection (e.g., public lands) would result in a high risk or Priority A stream. The South Branch of the Battle River was the only Priority A stream segment identified in the ULRLW (Figure 7). Both the fish and macroinvertebrate communities in this high quality stream segment were identified as being near the tipping point toward one or more impairments and therefore represented the highest priority for protection efforts. Furthermore, 12 Priority B stream segments were identified in the ULRLW; these streams represent a secondary priority for protection based efforts. The remaining 5 streams (of the 18 fully supportive streams) were classified as Priority C (lower priority) streams.

Additional information for all named Priority A and Priority B streams is provided below to provide added context that more clearly outlines the reasoning behind the priority classification.

Risk Factors	Impairment Risk Level	Rank
Road Density - Riparian % Disturbed Land – Riparian	Low road density Low % disturbed Low Risk → High Risk	**RIPARIAN RISK** (low) 3 2 1 (high)
Road Density – Watershed % Disturbed Land – Watershed	Low road density Low % disturbed Low Risk → High Risk	**WATERSHED RISK** 3 2 1
Protective Factors		+
Current Protection – Riparian Current Protection –Watershed	High % current riparian protection High % current watershed protection Low Risk → High Risk	**CURRENT PROTECTION** 3 2 1
IBI Threshold Proximity Factor		×
Number of communities close to IBI Impairment threshold	Neither Community One Both Low Risk → High Risk	**IBI THRESHOLD PROXIMITY** 3 2 1
PROTECTION PRIORITY	**Priority Level**	=
High Risk = High Priority Rank Low Risk = Low Priority Rank	**Lower Priority** → **Higher Priority**	**PROTECTION PRIORITY RANK** (lower priority) C B A (higher priority) (low rank) 27 14 3 (high rank)

Figure 6. Stream protection and prioritization matrix.

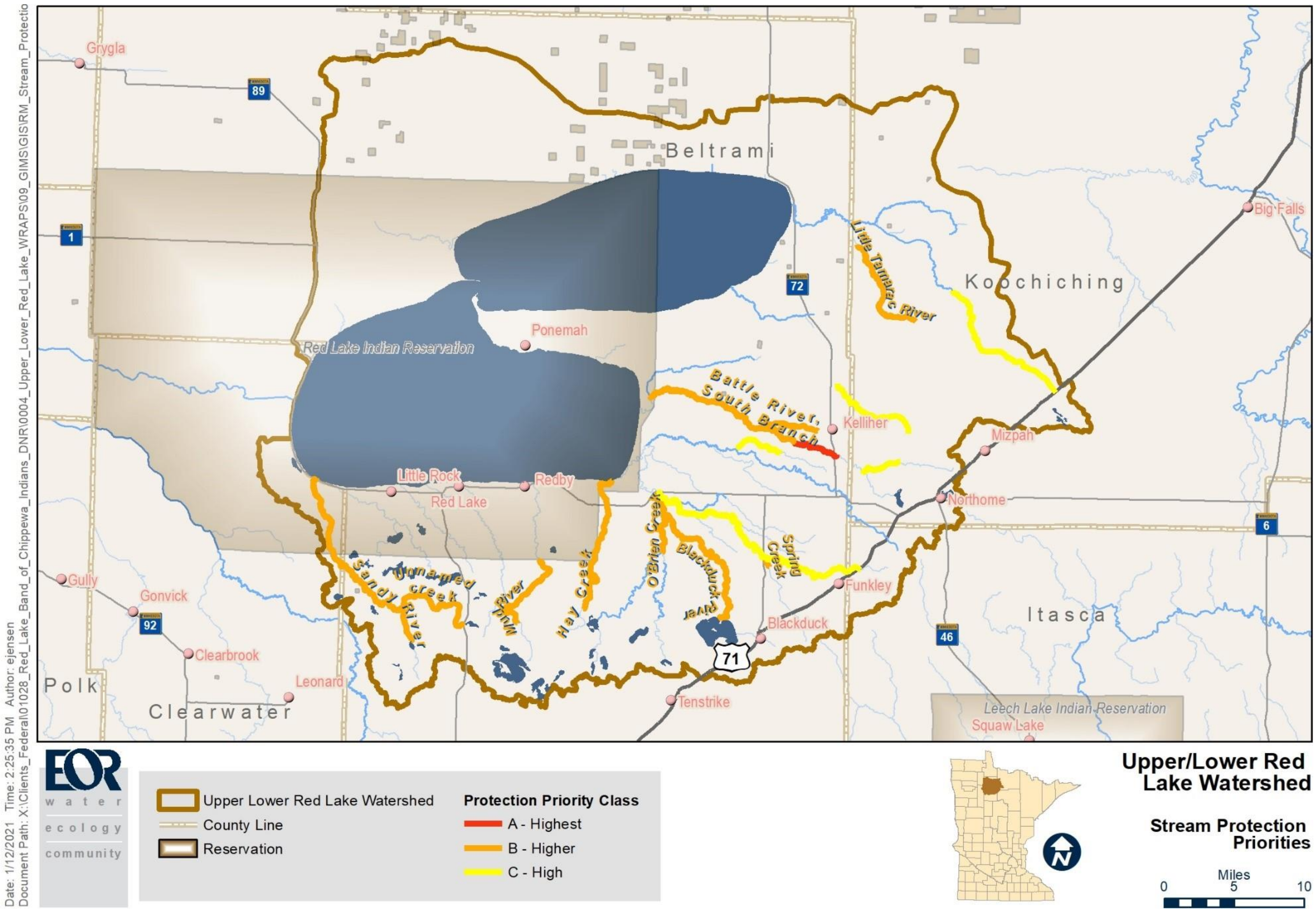


Figure 7. Stream protection priorities.

2.5.1.1 Battle River- South Branch

Originating from Battle Lake, the South Branch of the Battle River flows northwest for approximately eight miles before becoming a designated cold water stream that supports a trout fishery. The cold water segment is approximately five miles long and is located just south of Kelliher. A 2010 visit found low numbers of rainbow trout and northern brook lamprey (cold water species) present in the sample. The Battle River was stocked with stream trout annually for nearly 50 years until 1989. In 2009, trout management efforts were renewed and catchable size (8 to 11 inches) rainbow trout were stocked shortly before the trout opener in mid-April. The stream is wadeable with the bottom comprised mostly of sand and gravel. Anglers have access to the stream via public lands adjacent to River Bluff Road, southwest of Kelliher. The entire South Branch of the Battle River was assessed as being fully supportive of both aquatic life and aquatic recreation designated uses.

2.5.1.2 Blackduck River

The furthest upstream portion of the Blackduck River that is associated with MPCA monitoring station 14RD119 (Upstream of Deer Trail Rd, 3 mi. NW of Langor) exceeded the exceptional use criteria and was the highest FIBI score in the ULRLW. The fish sample contained high numbers of fish that utilize coarse substrate for spawning and insectivores. Excellent stream habitat consisting of coarse substrate, woody debris, and abundant aquatic macrophytes was present within the sampling reach. Good riffle habitat and channel development were also present.

Downstream reaches of the Blackduck River are heavily influenced by extensive wetland riparian habitat. These portions of the Blackduck River do not support the same high-quality types of biologically diverse communities. Fish species observed in these portions of the Blackduck River were dominated by wetland inhabiting species. Excessive bacteria concentrations were observed on tributaries to the Blackduck River and the Blackduck River itself; subsequently, this reach has been identified as being impaired for aquatic recreation.

2.5.1.3 Hay Creek

Hay Creek originates from Dark Lake and flows north through hayfields along the edge of the Red Lake Reservation for approximately 12 miles before entering the reservation and emptying into Lower Red Lake. Hay Creek is a low gradient stream; habitat within the reach consisted of fine sediment, limited woody debris, and abundant aquatic macrophytes. Observed FIBI and macroinvertebrate IBI (MIBI) scores were good, fish sampled included several sensitive species, wetland species, and high numbers of insectivores and other fish species that utilize coarse substrate for spawning. However, excessive bacteria concentrations were found on Hay Creek during several summer months, which warranted an aquatic recreation impairment.

2.5.1.4 Little Tamarac River

The Little Tamarac River originates from a large black spruce bog and winds northwest for approximately 12 miles before joining with the Tamarac River. The last 1.9 miles of the Little Tamarac River have been channelized. Several ditches, which drain areas of spruce bog, flow into the Little Tamarac River. The 2014 visit FIBI score was low but passing. The central mudminnow, a very tolerant species, was the second most abundant species in the fish sample. Multiple trophic generalist species were also present in the sample along with some lithophilic spawners (fish that utilize coarse substrate for spawning) and insectivores. Stream habitat within the sampling reach was poor. Substrate consisted of shifting sand

and silt; no coarse substrate was present. Sparse amounts of woody debris and aquatic vegetation were present. The poor habitat is likely the result of channelization.

2.5.1.5 Lost River

The Lost River originates from a large black spruce bog located near the community of Gemmell in the heavily forested far southeast corner of the ULRLW. The river flows north for approximately 20 miles before turning toward the west and joining the Tamarac River. Most of the river has a low gradient and features a broad, wetland riparian zone. Results from a 2014 FIBI survey found a healthy fish community comprised of pollutant sensitive, headwater species including pearl dace, finescale dace, and northern redbelly dace. The land within the Lost River Subwatershed is over 90% wetland. As such, the stream is characterized by fine sediments, emergent macrophytes within the channel margins, and abundant submergent macrophytes. Water chemistry, including DO concentrations, is also heavily influenced by the surrounding wetlands.

2.5.1.6 Meadow Creek

Meadow Creek is a small tributary of the North Cormorant River. At station 14RD141, just upstream of the confluence with the North Cormorant River near Fireweed Lane NE, the FIBI exceeded exceptional use criteria and was one of the highest in the ULRLW. The sample was dominated by pearl dace, a sensitive headwaters species, and also included good numbers of lithophilic spawners, insectivores, and other sensitive species. The MIBI score was good with several sensitive taxa present. The habitat in this reach consists of sand and gravel substrates, riffles, a variety of cover types, and good channel development. The limited amount of water chemistry data was insufficient for assessment. Additional sampling was conducted as part of the WRAPS process to acquire more water chemistry data. Low DO was noted as an issue, but beaver activity in the area was an influencing factor (beaver dam upstream). There were a couple of high TSS and *E. coli* samples, but not enough data was available for a full assessment.

2.5.1.7 Mud River

The observed fish community within the portion of Mud River that is associated with MPCA monitoring station 14RD107 (downstream of Farmer Drive, two miles NW of Nebish) exceeded the exceptional use criteria. Streams that exceed the exceptional use criteria exhibit the highest quality assemblages (as measured by assemblage attributes and indices) in Minnesota. Multiple sensitive (pollution intolerant), headwaters, and insectivore fish species were observed during the 2014 IWM effort. Additionally, the MIBI score was almost exceptional in this portion of the Mud River with excellent macroinvertebrate taxa richness present in the sample; nine Trichoptera taxa were present along with three Plecopetera taxa and several Odonates. Excellent stream habitat consisting of coarse substrate, woody debris, good channel development, and riffle habitat is present in this stretch of the Mud River.

Despite the observations noted in the middle portion of the Mud River, there are several anthropogenic factors influencing other portions of the river. The headwaters portions of the Mud River consist of a channelized ditch which flows through wetlands. The fish community observed in these upstream headwaters reaches was poor. Despite good riffle habitat, various forms of coarse substrate, and several cover types present in the downstream portion of the Mud River, observed FIBI scores were lower than expected. Furthermore, water chemistry data from the lower reach of the Mud River indicated that over a quarter of the TSS samples taken during the assessment period were in excess of the North River

Nutrient Region TSS standard. *E. coli* concentrations across the summer months indicated an aquatic recreation impairment. The downstream portion of the Mud River adjacent to Lower Red Lake is impaired for both aquatic life and aquatic recreation.

The Mud River is in a recovery phase following multiple restoration efforts including a dam removal in 2014, two road crossings which included culvert replacement and bank stabilization (one in 2017 and one in 2019), and a bank erosion project (completed in 2019). Restoration locations are shown on Figure 8). It is likely that the outcome of these projects will bring water within TSS standards.

2.5.1.8 O'Brien Creek

O'Brien Creek originates from a forested area just west of Blackduck Lake and flows north. Significant areas of row crop and hay/pasture land occur within the O'Brien Creek Watershed. A 2014 fisheries survey resulted in a good FIBI score. High numbers of tolerant generalist species were present in the sample; however, good numbers of insectivores and lithophilic spawning species (including redhorse and adult walleye) were also present.

2.5.1.9 Sandy River

The Sandy River originates from Sandy Lake and flows northwest for 25 miles along the southwestern edge of the ULRLW before entering Lower Red Lake. The river passes through some agricultural land (pasture and hay) before entering the heavily forested Red Lake Reservation. The Sandy River has a wetland and/or wooded riparian for most of its 25-mile flow length. Fisheries surveys conducted on the Sandy River observed a generally healthy fish community with sensitive species, insectivores, and good numbers of fish that utilize coarse substrate for spawning; however, several generalist taxa, tolerant of low DO concentrations, were also observed. Additionally, elevated bacteria were found during the summer months on the Sandy River, which warranted an aquatic recreation impairment.

2.5.1.10 Spring Creek

Spring Creek is a small tributary to the South Cormorant River originating in the southeastern corner of the ULRLW near the town of Funkley. A 2014 biological survey on Spring Creek resulted in an FIBI score of 78.4, which exceeded the exceptional use criteria. The observed FIBI score was amongst the highest scores in the ULRLW as the fish sampled contained multiple headwater species and pollution sensitive species.

2.5.1.11 South Cormorant River

The observed fish community at all three MPCA monitoring locations on the South Cormorant River exceeded the exceptional use criteria. In-stream and near-channel riparian habitat in the upstream portions of the South Cormorant River contains good riffle habitat with coarse substrate, woody debris, and moderate amounts of submerged aquatic vegetation. While the aquatic life community appears to be intact, water chemistry data available on the South Cormorant River indicated high levels of bacteria were present throughout the summer months; subsequently, the river has been listed impaired for aquatic recreation.

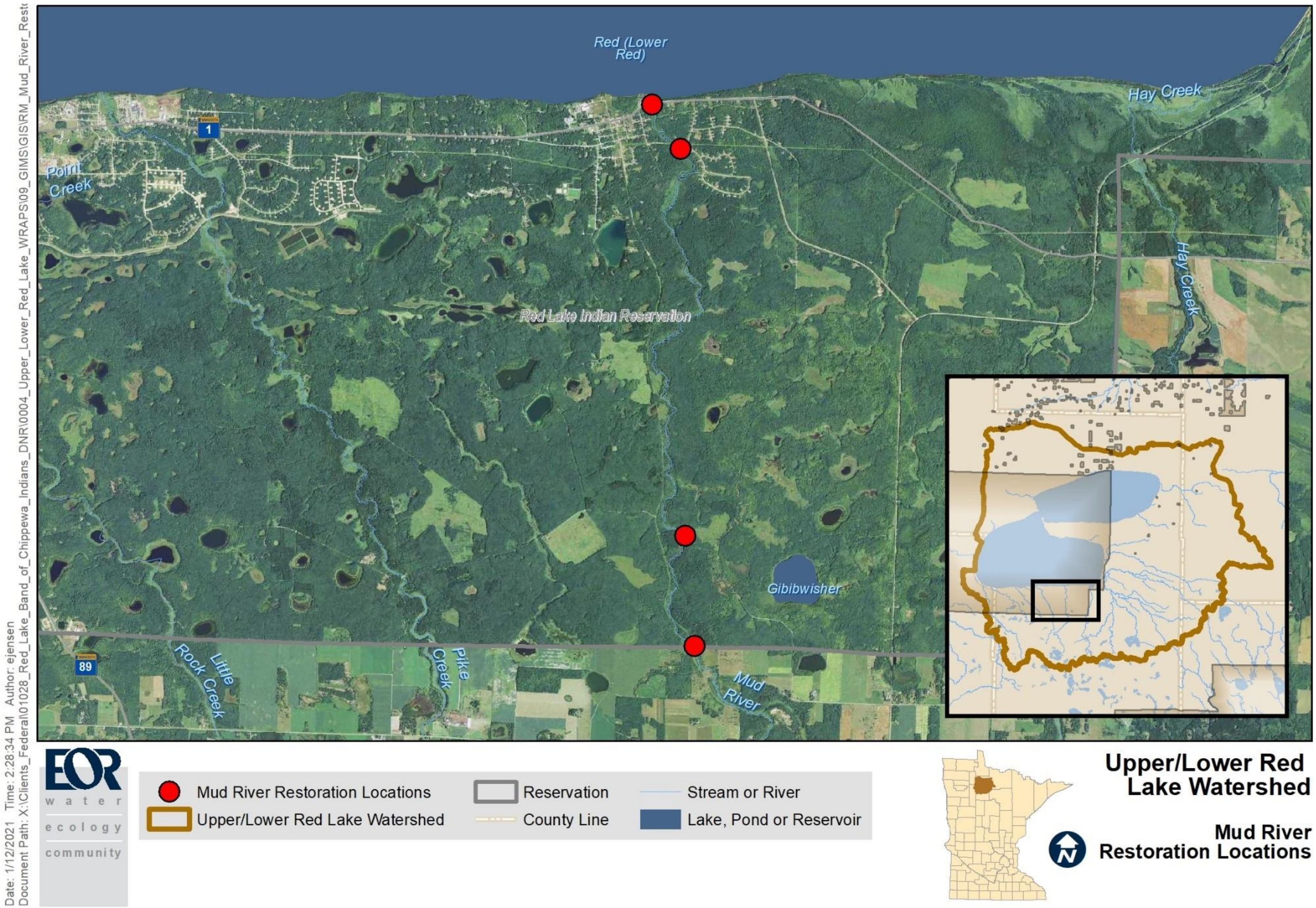


Figure 8. Mud River restoration locations.

2.5.2 Lakes

The objective of the tools detailed in this section was to prioritize the watershed's 200+ lakes into a smaller subset of 42 lakes (Table 9; Figure 9) that will be the priority focus of protection efforts over the next 10 years.

Lake Prioritization Criteria:

- Data collected during the IWM indicated exceptional water quality or water quality impairment;
- Data collected during IWM indicated exceptional aquatic life or aquatic life impairment;
- Any lake identified by the MPCA as being a high-quality, high-value lake that provided the best return on investment in terms of benefit achieved per dollar invested using the MPCA's Lake Benefit: Cost Assessment (LBCA) ranking system (Figure 10).
- Any Lake on the MPCA/DNR's Lakes of Biological Significance (Figure 11)
- Any Lake on the MPCA/DNR's Lakes Phosphorus Sensitivity Significance; (Figure 12)
- Any Lake on the DNR's Lakes Supporting Wild Rice (Figure 13)

Table 9. Priority protection lakes.

Lake Name	DNR ID	Acres	LBCA Rating	Biological Significance	Phosphorus Sensitivity	Red Lake Indian Reservation	FIBI > Exceptional Use Criteria	WQ Exceeds Coldwater Lake Standards	Trout Lake	Wild Rice	Trophic Status	Water Clarity	
												(ft)	Trend
Balm	04-0329-00	537	Higher		Highest						M	12	↓
Bartlett	36-0018-00	304	High	Moderate	Impaired						E	3	↑
Bass	04-0139-00	113	Higher		Higher	•					M	15	---
Battle	36-0024-00	286	High		High						M	7	---
Blackduck	04-0069-00	2,686	High	Moderate	Impaired						E	6	↑
Bog	04-0243-00	142	High		Higher						M	3	---
Boston	04-0244-00	93	High		High						M	7	---
Bullhead	04-0028-00	35		Moderate							---	---	---
Clear	36-0011-00	89	High		Higher						M	12	---
Cranberry	04-0123-00	61	High	Outstanding	High					•	M	3	---
Crane	04-0165-00	99			Impaired						E	6	---
Dark	36-0014-00	120	High	Moderate	High						---	---	---
Dellwater	04-0331-00	199	Higher	High	Highest						M	10	---
George	04-0175-00	88								•	M	3	---
Green	04-0193-00	66				•		•	•		O/M	20	---
Hagali	04-0136-00	97	High		High						M	10	---
Heart	04-0271-00	12				•	•	•	•	•	M	15	---
Island	04-0265-00	424	Higher		Higher						M	6	---
Jackson	04-0138-00	128	High		High						M	10	---
Julia	04-0166-00	511	High	Outstanding	Higher		•				M	12	↔
Kesagiagan	04-0315-00	515				•					M	10	---
Kinney	04-0181-00	31				•	•	•	•		M	12	---
Little Puposky	04-0197-00	129	High	Outstanding	High					•	E	3	---
Little Rice	04-0170-00	75								•	---	---	---
Loon	04-0125-00	136	High		High						M	3	---
Medicine	04-0122-00	461	High	Outstanding	High					•	M	10	↑
Moose	04-0326-00	132	High		Higher						M	15	---
Myrtle	04-0304-00	118	High		Higher						M	12	---
Norman	04-0029-00	61								•	---	---	---

Lake Name	DNR ID	Acres	LBCA Rating	Biological Significance	Phosphorus Sensitivity	Red Lake Indian Reservation	FIBI > Exceptional Use Criteria	WQ Exceeds Coldwater Lake Standards	Trout Lake	Wild Rice	Trophic Status	Water Clarity (ft)	Water Clarity Trend
Pickerel	15-0003-00	72	High		High						M	12	---
Puposky	04-0198-00	2,177	Higher	Outstanding	Higher					●	M	5	↔
Red (Lower Red)	04-0035-02	164,520	Highest		Higher	●				●	M	4	---
Red (Upper Red)	04-0035-01	119,295	High	Outstanding	Higher	●				●	E	5	↓
Rice	04-0174-00	55	High		High					●	E	1.5	---
Rice	04-0121-00	68								●	M/E	3	---
Sandy	04-0307-00	103	High		High		●				M	12	---
Sandy	04-0124-00	261	High		High						M	10	↓
Silversack	36-0039-00	19	High		High						---	---	---
Strand	04-0178-00	137			Impaired						E	6	---
Squaw Smith	04-0200-00	41				●	●	●	●		O/M	22	---
Ten Mile	04-0267-00	69	High		High						M	12	---
White Fish	04-0137-00	382	High		High					●	M	15	↑
Whitefish	04-0309-00	122			Impaired						E	3	---

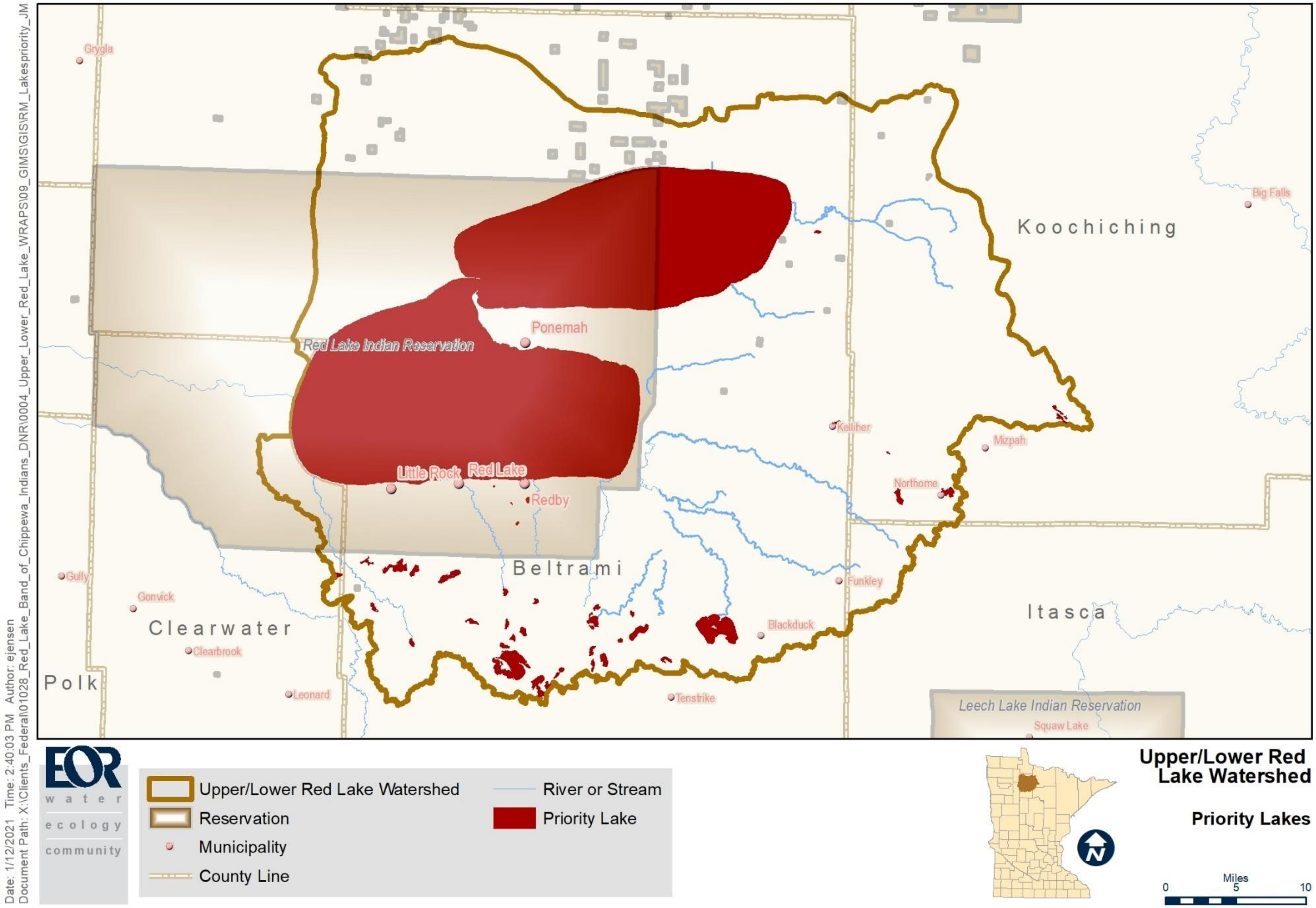


Figure 9. Priority lakes.

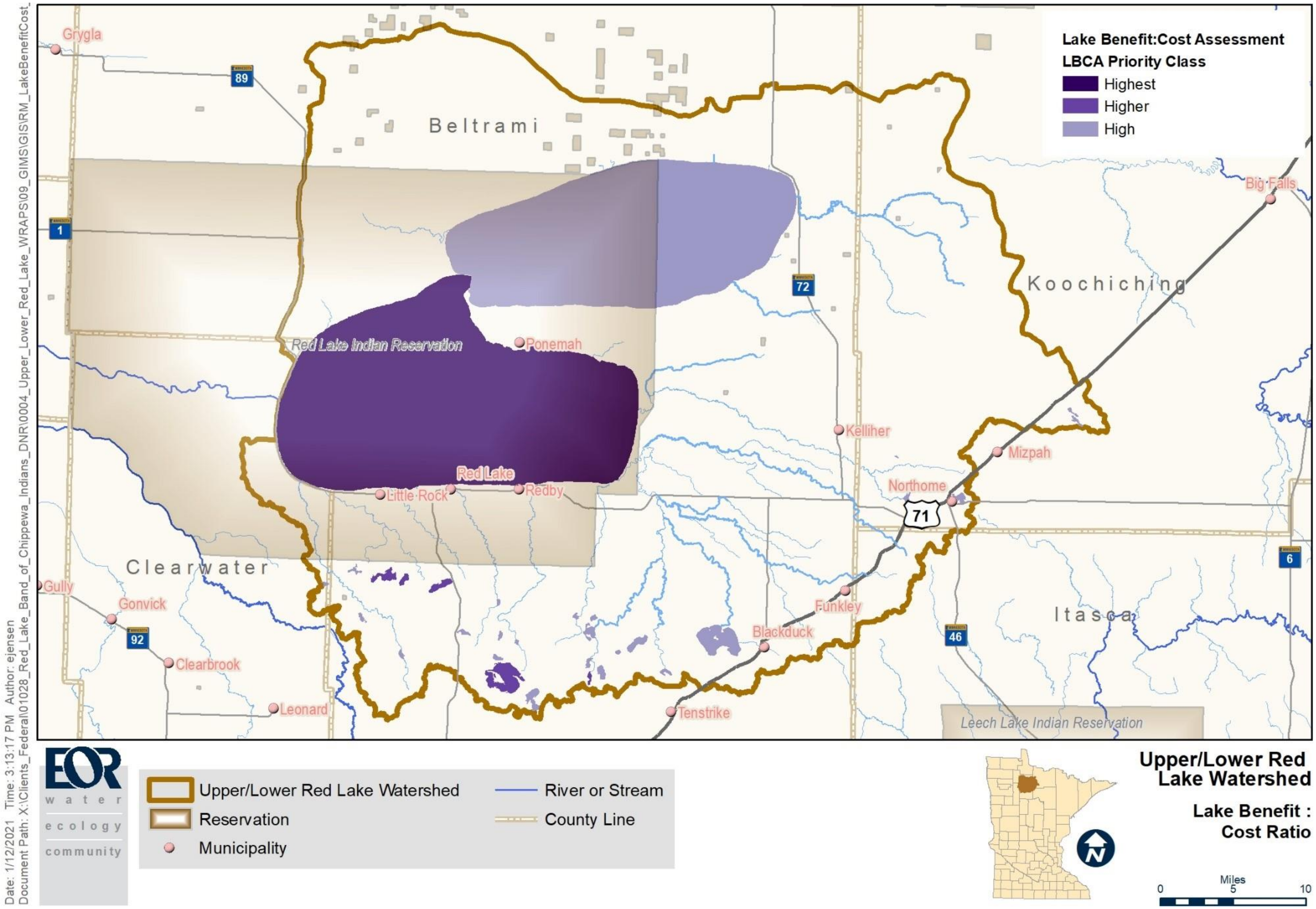


Figure 10. MPCA/DNR - Lake benefit: cost assessment (LBCA) score.

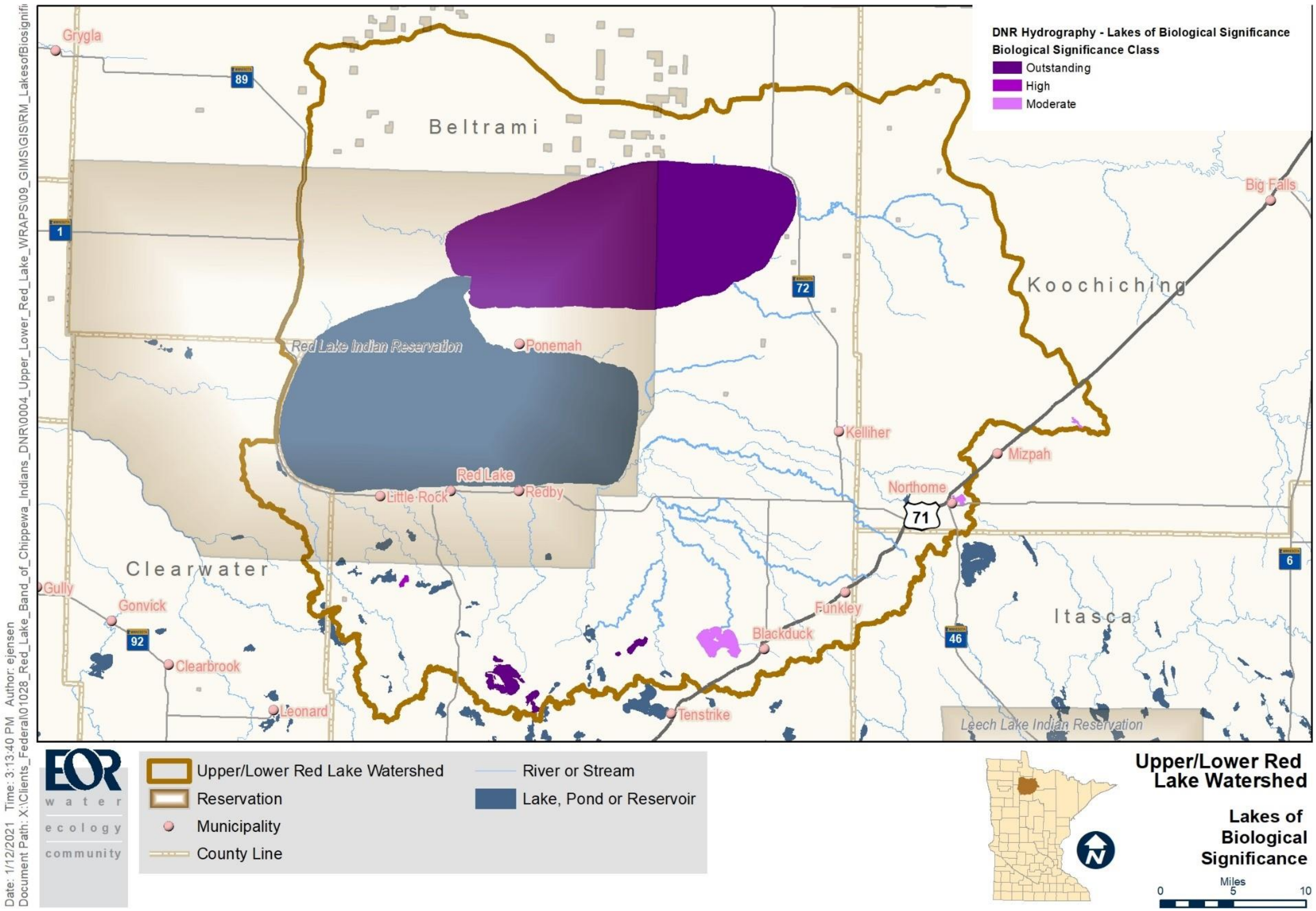


Figure 11. MPCA/DNR lakes of biological significance. Lower Red Lake was not included because lakes within reservation boundaries were not assessed.

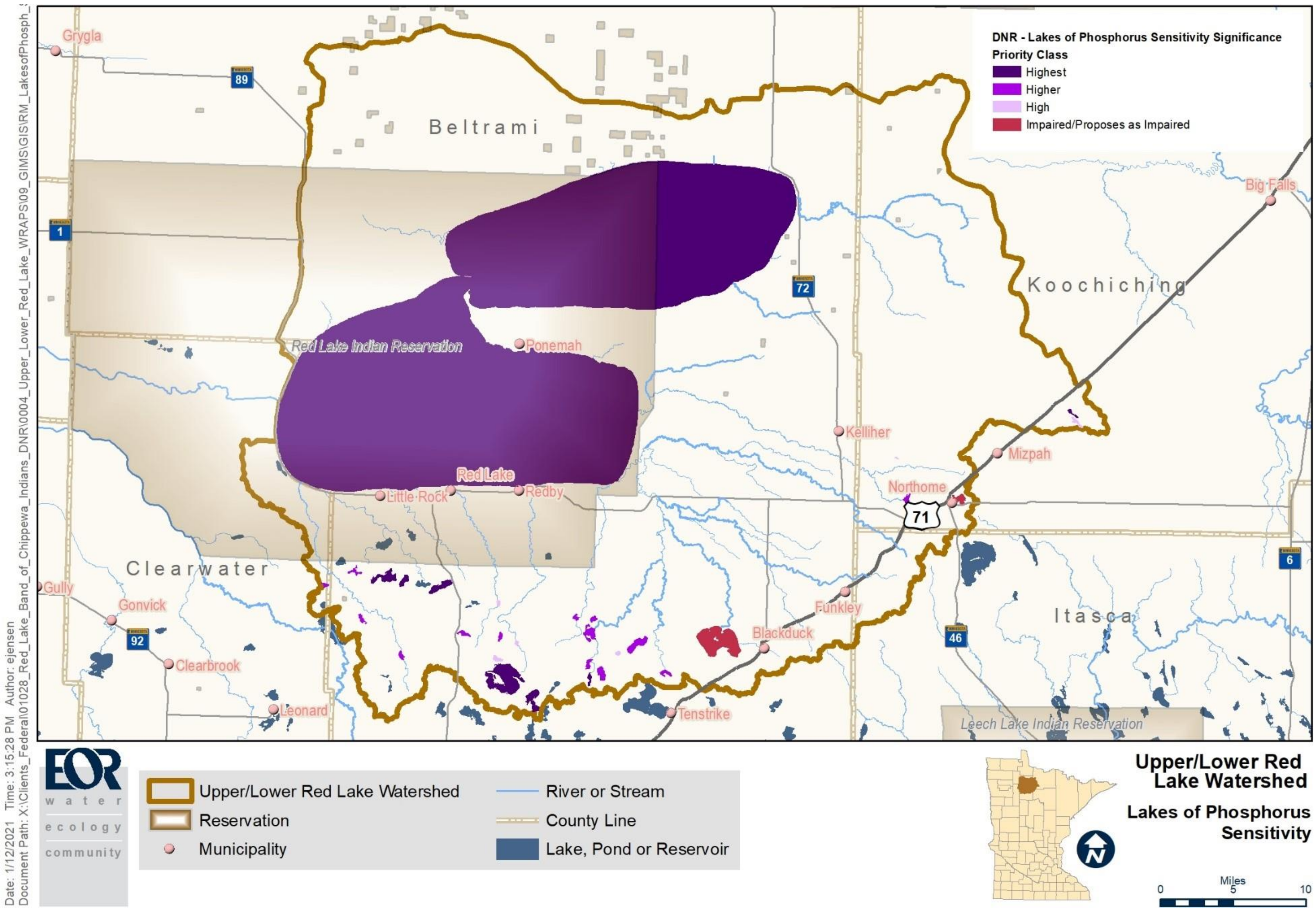


Figure 12. MPCA/DNR lakes of phosphorus sensitivity significance.

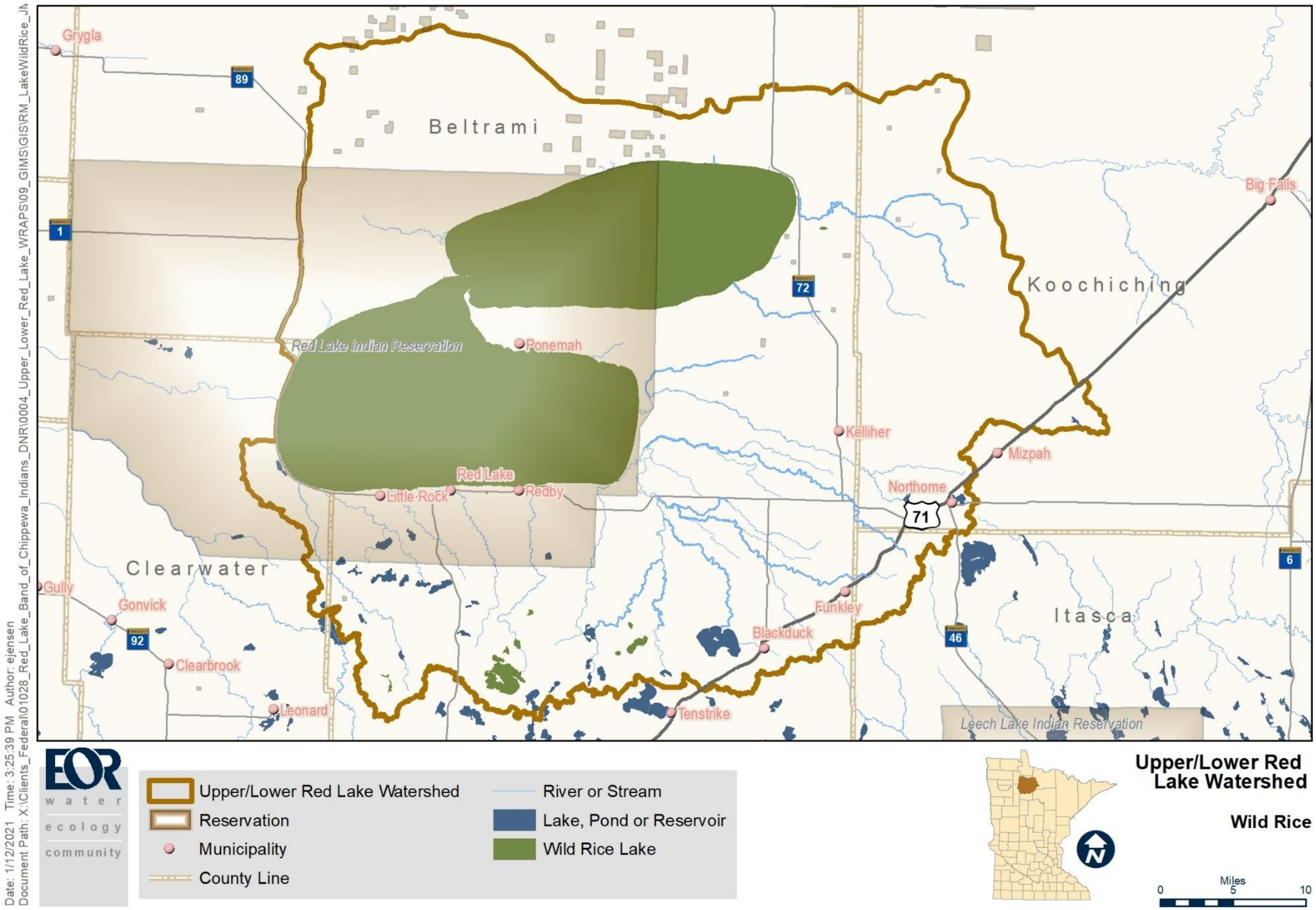


Figure 13. DNR wild rice lakes.

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 and identify point sources 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 for protection of water quality in the ULRLW. Because many 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 who will be needed to voluntarily implement BMPs. Thus, effective ongoing public participation is fully a part of the overall plan for moving forward.

The implementation strategies, including associated scales of adoption and timelines, provided in this section are the result of watershed modeling efforts and professional judgment based on what is known at this time and, thus, should be considered approximate. Furthermore, many strategies are predicated on needed funding being secured. As such, the proposed actions outlined are subject to adaptive management—an iterative approach of implementation, evaluation and course correction.

3.1 Targeting of geographic areas

Given the existing high quality status of lakes and rivers in the ULRLW, the focus of targeting efforts was on protection related strategies. While it is important to strive towards the protection of all surface and groundwater resources, funding is limited and priorities for protection need to be established to make the most cost-effective use of available implementation funding. A variety of tools and existing data resources were used to identify 1) priority streams and lakes in the watershed and 2) key geographic areas and/or natural resources deemed important to maintaining not only the resources themselves but also the associated hydrologic functions and values (designated uses) provided by these resources as described in the following paragraphs.

3.1.1 Categorization and prioritization for restoration and protection

The methods used to prioritize streams and lakes in the ULRLW were originally developed by the Planning Work Group and Advisory Committee from the Thief River One Watershed, One Plan (1W1P) project (Personal Communication, Corey Hanson, RLWD). These same methods were used to develop restoration and protection strategies for individual water resources in the Clearwater River Watershed and Thief River Watershed as part of the WRAPS for both watersheds.

These methods use water quality and biological data to categorize and identify waters that need restoration and protection efforts. Restoration efforts are applied to lakes and streams that are included in the 2018 303(d) List of Impaired Waters. Actions will be taken to improve conditions in those streams so that they meet water quality standards in future assessments. Protection efforts will also be needed to improve and prevent future impairments of streams that are not on the 2018 303(d) List of Impaired Waters.

Assessment statistics (exceedance rate, for example) for TSS, *E. coli* bacteria, DO, TP, FIBI, MIBI, and Lake Eutrophication were compared to impairment thresholds and other statistical benchmarks (Table 11). Maps were created (Figure 14 through Figure 22) for a more visual and spatial representation of the assessment results. Waterbodies were categorized into five restoration and protection categories according to the proximity of their current condition to the water quality standards:

1. **Protection** – lakes and streams that meet water quality standards by a relatively wide margin. There is no immediate concern that these highest quality lakes and streams may become impaired, but protection is still recommended to prevent degradation of water quality.
2. **Nearly impaired** – lakes and streams that meet water quality standards by a relatively narrow margin and are not on the 2018 303(d) list of impaired waters. Degradation of water quality in these lakes and streams could result in future impairments.
3. **Nearly restored** – lakes and streams that did not meet water quality standards by a relatively narrow margin and are on the 2018 303(d) list of impaired waters. These lakes and streams are assumed to require the least amount of effort for restoration and short-term goals could potentially result in restoration of good water quality and/or habitat.
4. **Restoration** – lakes and streams that failed to meet water quality standards by a relatively wide margin and are on the 303(d) list of impaired waters. These lakes and streams presumably require more effort to restore and will require more short and long-term goals to restore water quality and/or habitat.
5. **Potential impairment** – lakes and streams that did not meet water quality standards or thresholds and are not on the 2018 303(d) list of impaired waters.

Some lakes and streams did not have sufficient water quality data available to determine an appropriate restoration and protection category and were categorized as having ‘Insufficient data’. Future monitoring should be considered for these lakes and streams.

Table 10. Protection and restoration category criteria for the Upper/Lower Red Lake Watershed (based on monitoring data collected from 2007-2016).

Water Type	Category	Classification					Category Criteria	Numerical Standard and Minimum Data Requirements
		Potential Impairment	Restoration	Nearly Restored	Nearly Impaired	Protection		
Stream/Lake	**Included in the Draft 2018 303(d) List of Impaired Waters**	No	**Yes**	**Yes**	No	No		
Stream/Lake	**Meets Water Quality Standard?**	No	No	No	Yes	Yes		
Stream	**Total Suspended Solids (TSS)**	>10%	>12.5%	10-12.5%	7.5-10%	<7.5%	Percent of discrete samples that exceed the standard	– 15 mg/L (Northern River Nutrient Region) – At least 20 TSS measurements collected in April through September
	Bacteria (*E. coli*)	>126 org/100mL	>157.5 org/100mL	126-157.5 org/100mL	94.5-126 org/100mL	<94.5 org/100mL	Maximum monthly geometric mean	– Monthly geometric mean >126 org/100mL – At least 5 measurements collected per calendar month in April through October
	Dissolved Oxygen (DO)	>10%	>12.5%	10-12.5%	7.5-10%	<7.5%	Percent of discrete daily minimums that are below the standard	– 5 mg/L (warmwater streams) – At least 20 DO measurements collected in May through September
	Total Phosphorus (TP)	>50 µg/L	>62.5 µg/L	50-62.5 µg/L	37.5-50 µg/L	<37.5 µg/L	Growing season (June-September) average	– 50 µg/L – Northern River Nutrient Region – At least 12 TP measurements collected over at least 2 years in June through September
	Fish Index of Biological Integrity (FIBI)	<0	<-10.85	-10.85-0	0-10.85	>10.85	Average points from threshold for all visits	– Threshold varies by stream class: 42-47 – At least one visit
	Macroinvertebrate Index of Biological Integrity (MIBI)	<0	<-12.89	-12.89-0	0-12.89	>12.89	Average points from threshold for all visits	– Threshold varies by stream class: 32-51 – At least one visit
Lake	**Eutrophication**	TP >30 µg/L and at least one response variable exceeds	TP >37.5 µg/L	TP 37.5-30 µg/L	TP 22.5-30 µg/L OR TP >30 µg/L and both response variables meet	TP <22.5 µg/L	Growing season (June-September) average	– TP > 30 µg/L and at least one response variable does not meet standards (chlorophyll-*a*/Chl-*a* > 9 µg/L, and Secchi > 2.0 m) – Northern Lakes and Forests – At least 12 TP measurements collected over at least 2 years in June through September

Table 11. Upper/Lower Red Lake Watershed stream restoration and protection categories.

Stream Name	Reach Description	Impairment	AUID	TSS	DO	Bacteria (*E. coli*)	Fish IBI	Macroinvertebrate IBI	Habitat Minimum MSHA	Pfankuch Stability
Battle River	N Br Battle R to Lower Red Lk (Tribal water)		09020302-505	Insufficient data	Insufficient data	Protection	------	------	------	------
Battle River, North Branch	Headwaters (Unnamed ditch) to S Br Battle R	*E. coli*, FIBI, DO	09020302-503	Protection	Restoration	Restoration	Restoration	Nearly impaired	Fair score (45<MSHA<66)	Moderately Unstable
Battle River, South Branch	T151 R30W S5, east line to N Br Battle R		09020302-539	Protection	Protection	Potential impairment	Protection	Protection	Fair score (45<MSHA<66)	------
Big Rock Creek	Johnson Lk to Lower Red Lk		09020302-548	Protection	Insufficient data	Insufficient data	------	------	------	------
Blackduck River	South Cormorant R to North Cormorant R	*E. coli*	09020302-512	Potential impairment	Protection	Restoration	------	------	------	------
	North Cormorant R to Lower Red Lk		09020302-513	Insufficient data	Potential impairment	Protection	Insufficient data	------	Fair score (45<MSHA<66)	------
	Blackduck Lk to O'Brien Cr	*E. coli*	09020302-510	Nearly impaired	Insufficient data	Restoration	Protection	Potential impairment	Good score (>66)	------
Coburn Creek	Headwaters to Blackduck Lk		09020302-515	------	------	------	------	------	------	------
Darrigans Creek	Headwaters (Whitefish Lk 04-0137-00) to O'Brien Cr	*E. coli*, M-IBI	09020302-508	Protection	Insufficient data	Restoration	Protection	Restoration	Fair score (45<MSHA<66)	------
Hay Creek	Headwaters (Dark Lk 04-0167-00) to Lower Red Lk	*E. coli*	09020302-518	Protection	Insufficient data	Restoration	Protection	Protection	Fair score (45<MSHA<66)	------
Little Tamarac River	Headwaters to State Forest Rd 98		09020302-614	Insufficient data	Insufficient data	Protection	Nearly impaired	Protection	Poor score (<45)	------
Lost River	Unnamed cr to Tamarac R	FIBI	09020302-602	Insufficient data	Potential impairment	Protection	Restoration	Protection	Fair score (45<MSHA<66)	Moderately Unstable
Manomin Creek	Unnamed lk (04-0466-00) to Upper Red Lk		09020302-550	Insufficient data	Insufficient data	Protection	------	------	------	------
Meadow Creek	T151 R31W S3, east line to North Cormorant R		09020302-543	Insufficient data	Insufficient data	Insufficient data	------	------	------	
Mud River	T150 R33W S16, south line to Lower Red Lk	*E. coli*, TSS	09020302-541	Restoration	Protection	Restoration	Nearly impaired	Protection	Fair score (45<MSHA<66)	------
North Cormorant River	Headwaters to Blackduck R	*E. coli*, DO, TSS	09020302-506	Restoration	Restoration	Restoration	Protection	Nearly impaired	Fair score (45<MSHA<66)	------
O'Brien Creek	T149 R32W S2, south line to T150 R32W S23, north line	*E. coli*, DO	09020302-544	Protection	Restoration	Restoration	------	------	------	------
	Darrigans Creek to Blackduck River		09020302-514	Insufficient data	Insufficient data	Insufficient data	Protection	Protection		
Pike Creek	Headwaters (Tenmile Lk 04-0267-00) to Lower Red Lk	MIBI, TSS, DO	09020302-521	Restoration	Restoration	Protection	Protection	Restoration	Fair score (45<MSHA<66)	------
Sandy River	Headwaters (Sandy Lk 04-0307-00) to Lower Red Lk	*E. coli*	09020302-522	Protection	Protection	Restoration	Protection	Protection	Fair score (45<MSHA<66)	Moderately Unstable
Shotley Brook	Headwaters to Upper Red Lk	*E. coli*, MIBI	09020302-502	Insufficient data	Insufficient data	Nearly restored	Protection	Restoration	Fair score (45<MSHA<66)	------
South Cormorant River	Headwaters to Blackduck R	*E. coli*	09020302-507	Protection	Insufficient data	Restoration	Protection	Nearly impaired	Fair score (45<MSHA<66)	------
Spring Creek	T149 R30W S10, south line to T149 R30W S5, north line		09020302-546	Insufficient data	Insufficient data	Insufficient data	------	------	------	------
Tamarac River	Headwaters to Upper Red Lk	FIBI	09020302-501	Insufficient data	Insufficient data	Protection	Restoration	Protection	Fair score (45<MSHA<66)	Stable
Unnamed creek	Headwaters to Upper Red Lk (04-0035-01)	*E. coli*	09020302-600	Insufficient data	Insufficient data	Restoration	------	------	------	------

Table 12. Table of Upper/Lower Red Lake Watershed lake restoration and protection needs (Lake names in all UPPERCASE had water quality data provided by MPCA, lake names in lowercase had water quality data provided by RL DNR.).

Lake Name	AUID	TP (µg/L)	Chl-a (µg/L)	Secchi (m)	Category
Alaska	04-0319-00	14		1.7	Protection
Ankeewinsee	04-0258-00	10		4.3	Protection
Artist	#N/A	31		2.2	Nearly impaired
Balif	04-0273-00	12		3.9	Protection
BALM (TURTLE)	04-0329-00	17	4.6	3.7	Protection
BARTLETT	36-0018-00	32	20.7	1.0	Nearly restored
BASS	04-0139-00	9	2.7	5.2	Protection
Bass: Northwest Basin	04-0281-00	15	9.7	3.7	Protection
Bass: Southeast Basin	04-0281-00	22	7.5	2.8	Protection
Beasty	04-0405-00	17		2.6	Protection
Bender	15-0042-00	15		2.4	Protection
Big Thunder	04-0275-00	12	6.3	3.8	Protection
Bitney	04-0430-00	11		4.6	Protection
Bizhiki	#N/A	10		2.1	Protection
BLACKDUCK	04-0069-00	34	20.2	2.2	Nearly restored
BOG	04-0243-00	18	4.8	1.3	Protection
Border	04-0257-00	16		3.4	Protection
BOSTON	04-0244-00	25	2.5	2.3	Protection
Burns	04-0433-00	10		1.8	Protection
Burt	04-0284-00	14		3.7	Protection
Chain: Middle	04-0201-00	17	6.8	3.0	Protection
Chain: South	04-0201-00	18	5.7	3.2	Protection
CLEAR	36-0011-00	9	4.2	4.5	Protection
Colombo	04-0272-00	24	9.0	3.9	Protection
CRANBERRY	04-0123-00	30	2.7	1.0	Nearly impaired
CRANE	04-0165-00	38	15.5	2.0	Restoration
Crooked	04-0314-00	11		2.5	Protection
DARK	04-0167-00	13	10.7	4.7	Protection
DELLWATER (DALE)	04-0331-00	14	3.3	3.2	Protection
Dickens	04-0256-00	18	6.0	3.8	Protection
Dunbar	04-0320-00	14		3.6	Protection
Dune	04-0469-00	18		2.6	Protection
East of Bender	#N/A	18		2.2	Protection
Elephant Ear	#N/A	15		3.5	Protection
Emerald	04-0270-00	12	4.5	3.5	Protection
Fairbanks	04-0311-00	20		2.1	Protection
Fox	04-0251-00	22		3.0	Protection
Francis	04-0339-00	25		1.5	Nearly impaired

Lake Name	AUID	TP (µg/L)	Chl-a (µg/L)	Secchi (m)	Category
Frisby	04-0324-00	16		4.4	Protection
Fullers: East Basin	04-0283-00	13	6.0	4.1	Protection
Fullers: West Basin	04-0283-00	14	4.7	3.7	Protection
GEORGE	04-0175-00	15	2.3	0.9	Protection
Gibibwisher	04-0184-00	25	5.3	2.3	Protection
Gourd	04-0253-00	27	10.0	3.4	Nearly impaired
Graning	04-0337-00	21		2.9	Protection
Grass Island	04-0340-00	10		3.7	Protection
Green (Red)	04-0277-00	11	5.0	4.2	Protection
Green (Redby)	04-0193-00	8		6.0	Protection
Gwin	04-0317-00	19		2.2	Protection
HAGALI	04-0136-00	22	6.1	2.7	Protection
HAGGERTY	15-0002-00	15	3.9	1.9	Protection
Head	#N/A	30	8.7	1.4	Potential impairment
Heart	04-0271-00	11	4.0	4.4	Protection
Heritage	15-0198-00	14		1.8	Protection
ISLAND	04-0265-00	22	4.1	2.5	Protection
Island	04-0265-00	11	4.0	5.1	Protection
JACKSON	04-0138-00	19	6.0	3.0	Protection
Johnson	04-0336-00	23		2.7	Protection
Jourdain	04-0274-00	21		3.1	Protection
JULIA	04-0166-00	23	5.9	4.0	Protection
Kesagiagan	04-0315-00	13		2.3	Protection
Kinney	04-0181-00	10	4.0	5.0	Protection
Laxon	04-0341-00	9		4.2	Protection
Leslin	04-0255-00	22		3.5	Protection
LITTLE PUPOSKY	04-0197-00	45	3.3	1.1	Potential impairment
Little Thunder	04-0275-00	13	5.3	4.1	Protection
Long (Burt)	04-0284-00	11		4.5	Protection
LOON	04-0125-00	19	4.7	1.2	Protection
Lower Red: Central	04-0035-02	36	16.5	1.2	Site-specific standard
Lower Red: East	04-0035-02	35	10.0	1.2	Site-specific standard
Lower Red: East-Central	04-0035-02	34	13.0	1.2	Site-specific standard
Lower Red: West	04-0035-02	37	13.5	1.2	Site-specific standard
Lower Red: West-Central	04-0035-02	35	12.0	1.2	Site-specific standard
Lussier	04-0278-00	15		2.7	Protection
Masquot	#N/A	18		2.1	Protection
McCall	04-0261-00	11		3.9	Protection
MEDICINE	04-0122-00	30	8.7	3.1	Nearly impaired
Methane	#N/A	11		2.7	Protection
Mistic	04-0185-00	13		2.5	Protection

Lake Name	AUID	TP (µg/L)	Chl-a (µg/L)	Secchi (m)	Category
MOOSE	04-0326-00	12	2.8	5.3	Protection
Morrison	15-0045-00	13		3.7	Protection
Muerlin	04-0260-00	14		3.4	Protection
MYRTLE	04-0304-00	11	2.8	4.0	Protection
No-Name	04-0252-00	12		4.2	Protection
PICKEREL	15-0003-00	12	2.0	3.9	Protection
PUPOSKY	04-0198-00	14	6.5	1.8	Protection
RICE	04-0121-00	21			Protection
Round (Sylvia)	04-0322-00	8		5.5	Protection
Rush	04-0338-00	22		1.9	Protection
SANDY	04-0124-00	19	5.5	3.1	Protection
Sandy	04-0124-00	10		5.4	Protection
Shackle	04-0201-00	19	10.0	3.1	Protection
Shell	04-0318-00	11		4.2	Protection
Shemahgun	04-0269-00	13	4.0	4.8	Protection
Squaw Smith	04-0200-00	12	4.0	5.4	Protection
Stone	04-0334-00	40		1.3	Potential impairment
STRAND	04-0178-00	36	10.8	1.9	Nearly restored
TEN MILE	04-0267-00	15	5.8	3.7	Protection
Townline	04-026800	19	6.0	3.5	Protection
Tuck	04-0480-00	12		2.2	Protection
Upper Red: Central	04-0035-01	47	11.7	0.8	Site specific standard
Upper Red: East	04-0035-01	42	12.7	0.8	Site specific standard
Upper Red: East-Central	04-0035-01	41	11.3	0.8	Site specific standard
Upper Red: West	04-0035-01	44	13.7	0.8	Site specific standard
Upper Red: West-Central	04-0035-01	41	12.3	0.8	Site specific standard
Wending	04-0183-00	18		1.5	Protection
WHITE FISH	04-0137-00	12	3.5	4.5	Protection
WHITEFISH	04-0309-00	86	39.1	1.2	Restoration
Williams	04-0199-00	22	4.0	3.5	Protection

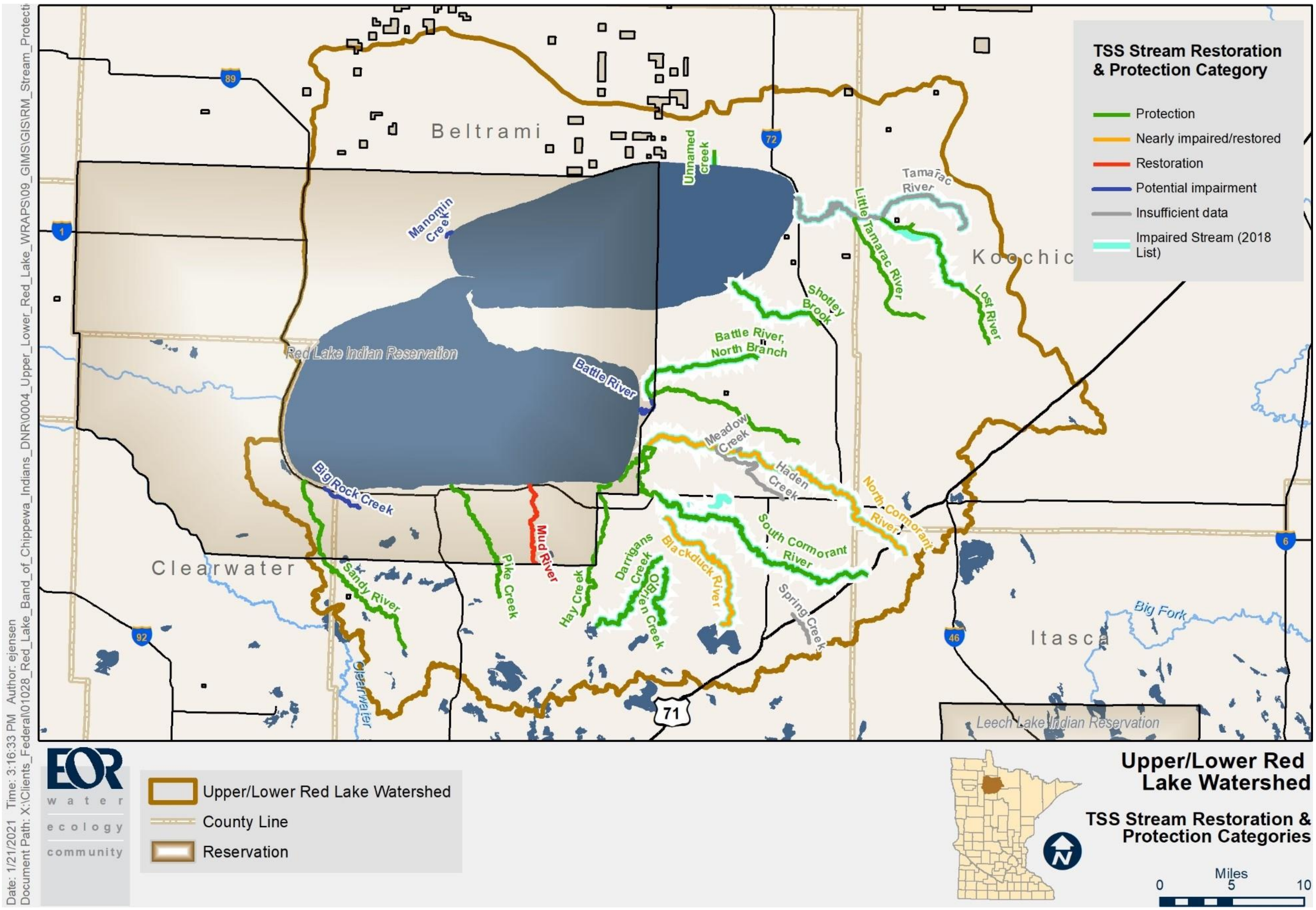


Figure 14. Map of Upper/Lower Red Lake Watershed TSS restoration and protection needs.

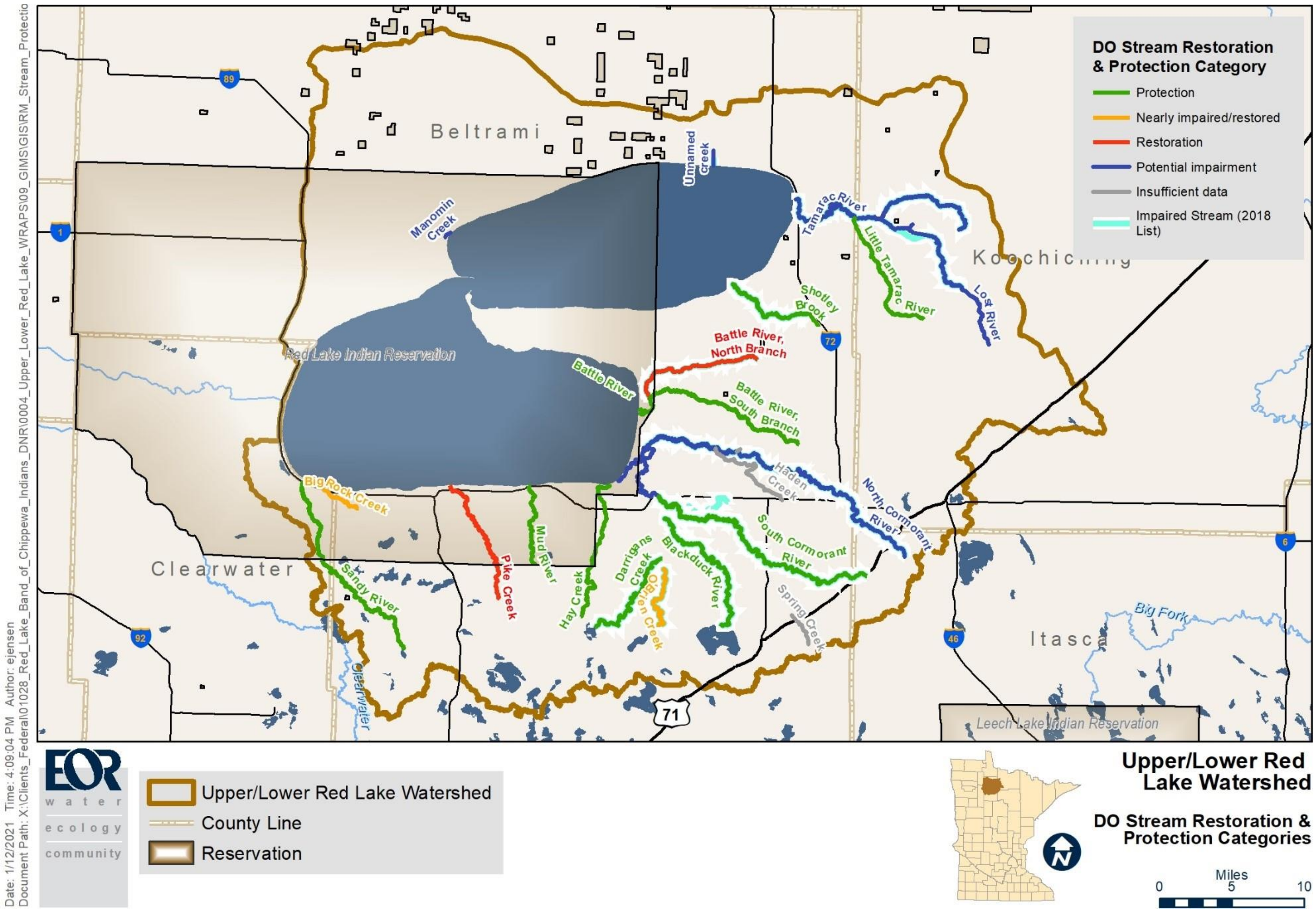


Figure 15. Map of Upper/Lower Red Lake Watershed DO restoration and protection needs.

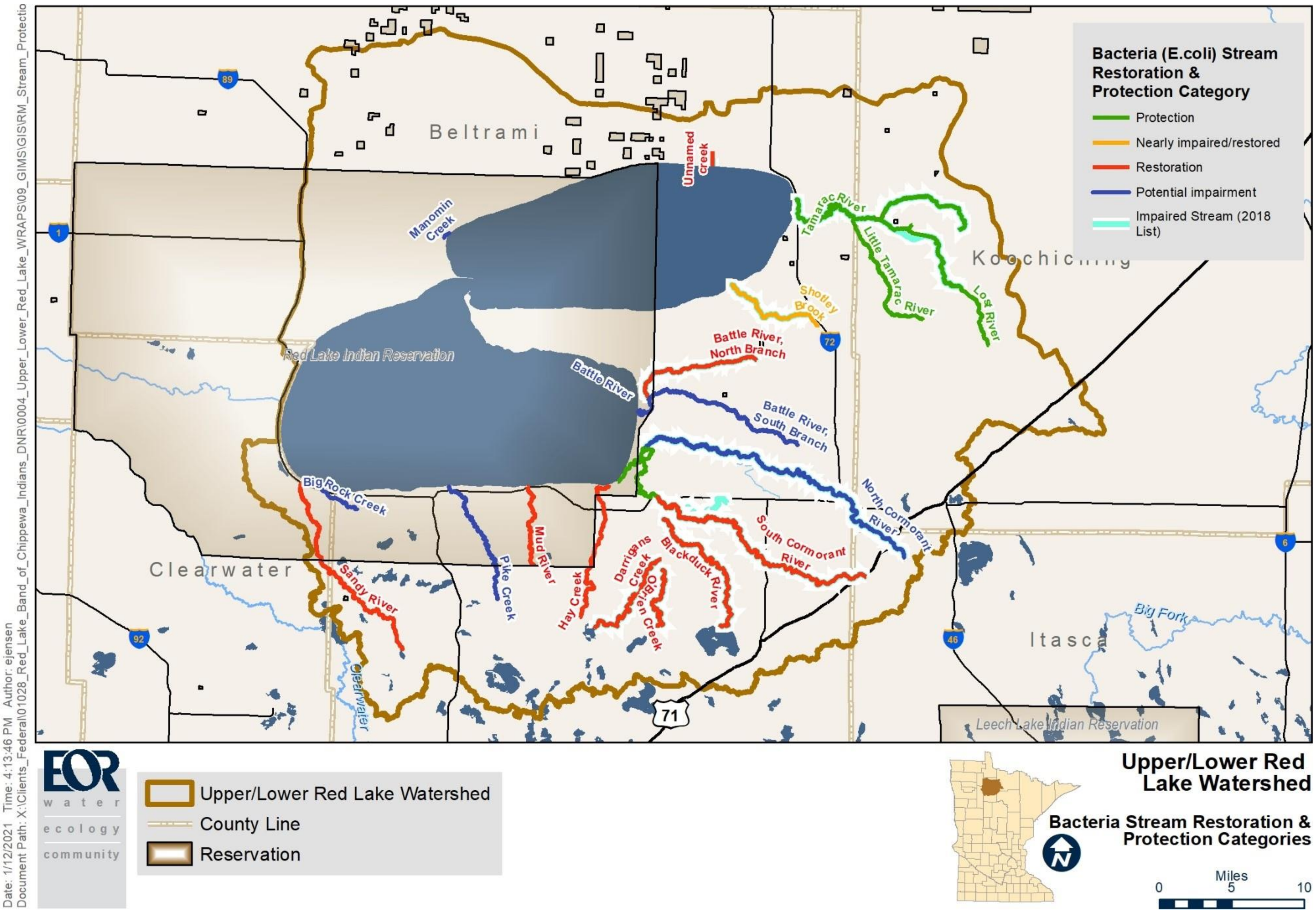


Figure 16. Map of Upper/Lower Red Lake Watershed *E.coli* restoration and protection needs.

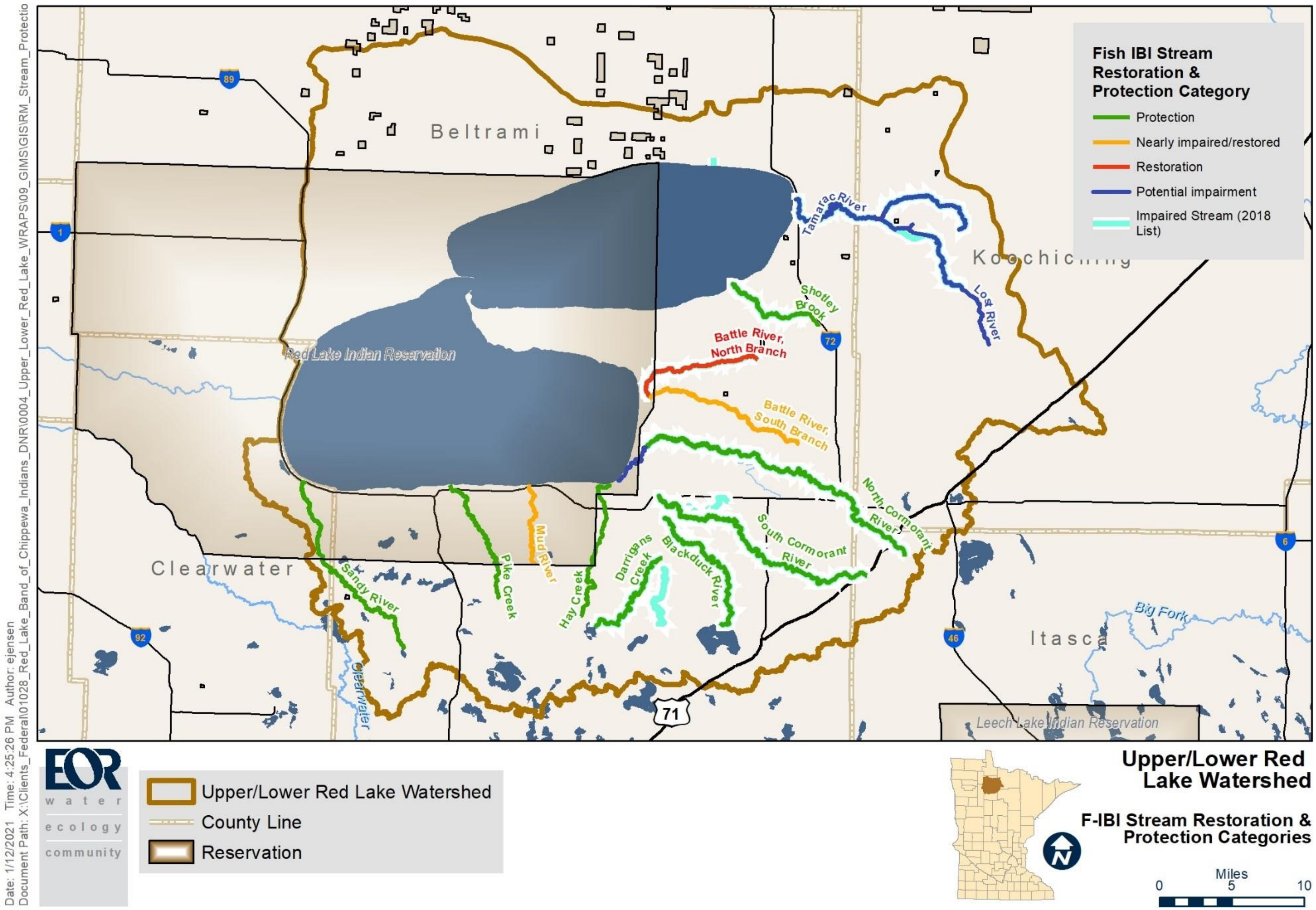


Figure 17. Map of Upper/Lower Red Lake Watershed FIBI restoration and protection needs.

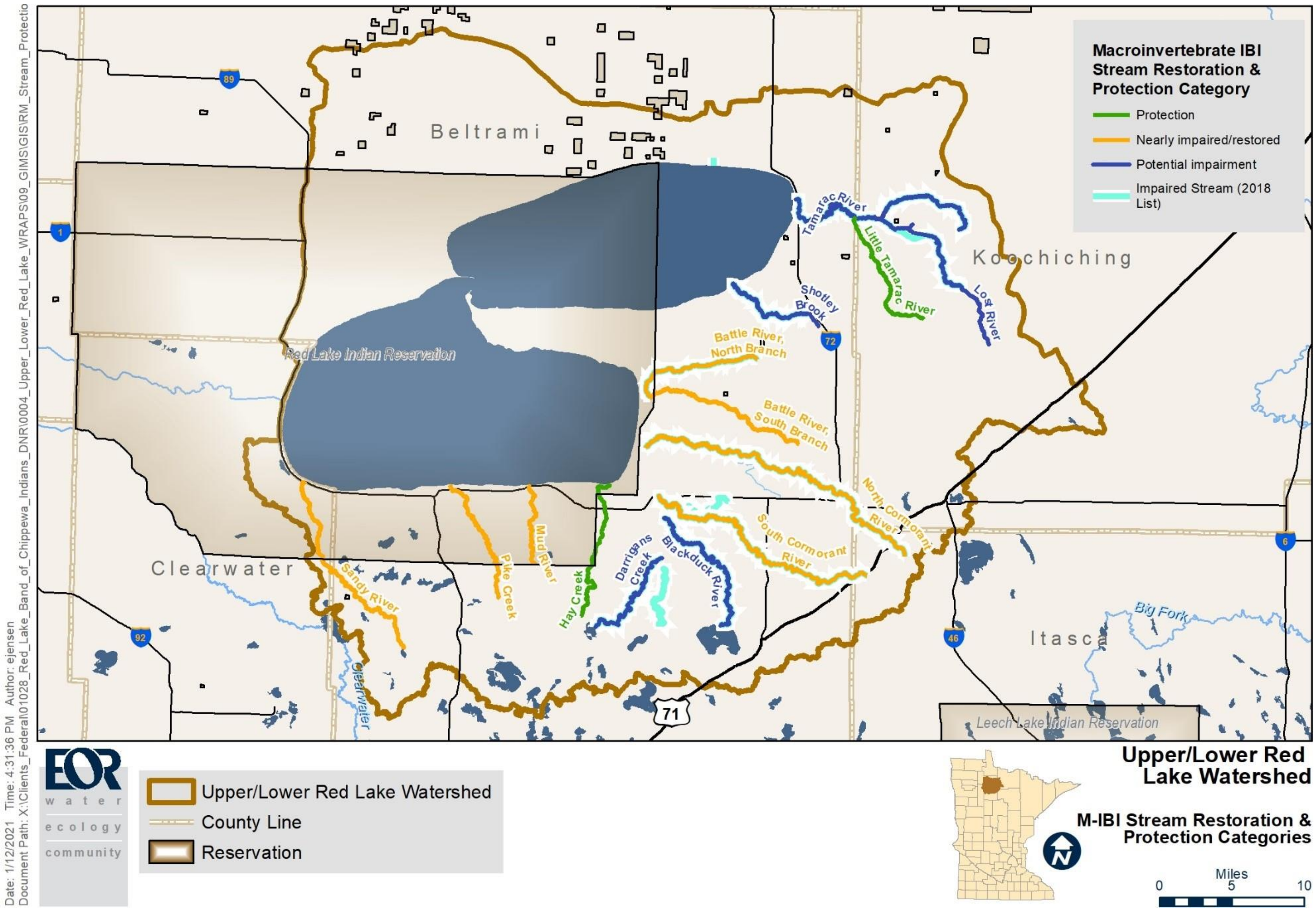


Figure 18. Map of Upper/Lower Red Lake Watershed MIBI restoration and protection needs.

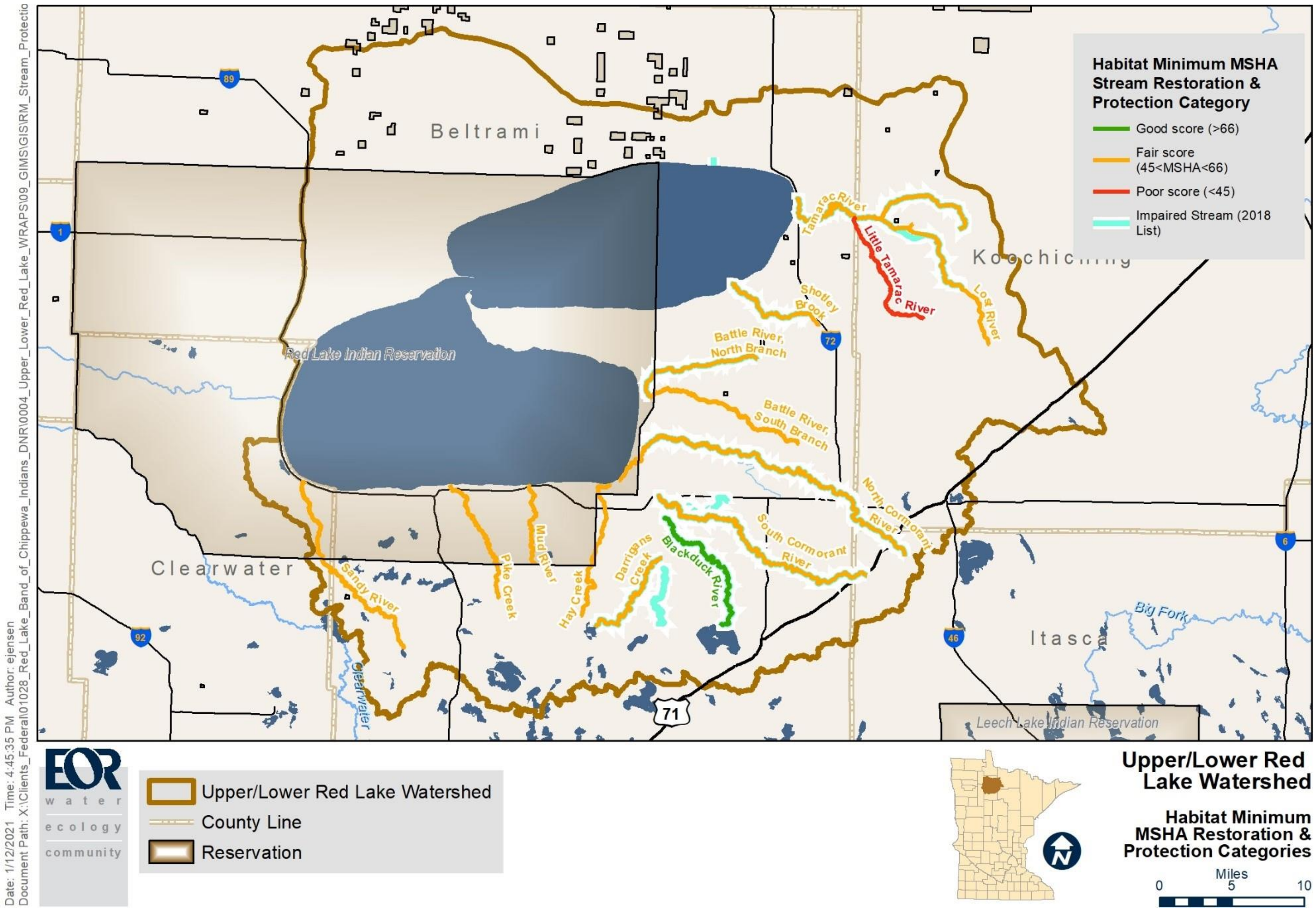


Figure 19. Map of Upper/Lower Red Lake Watershed Minnesota Stream Habitats Assessment (MSHA) –based restoration and protection needs.

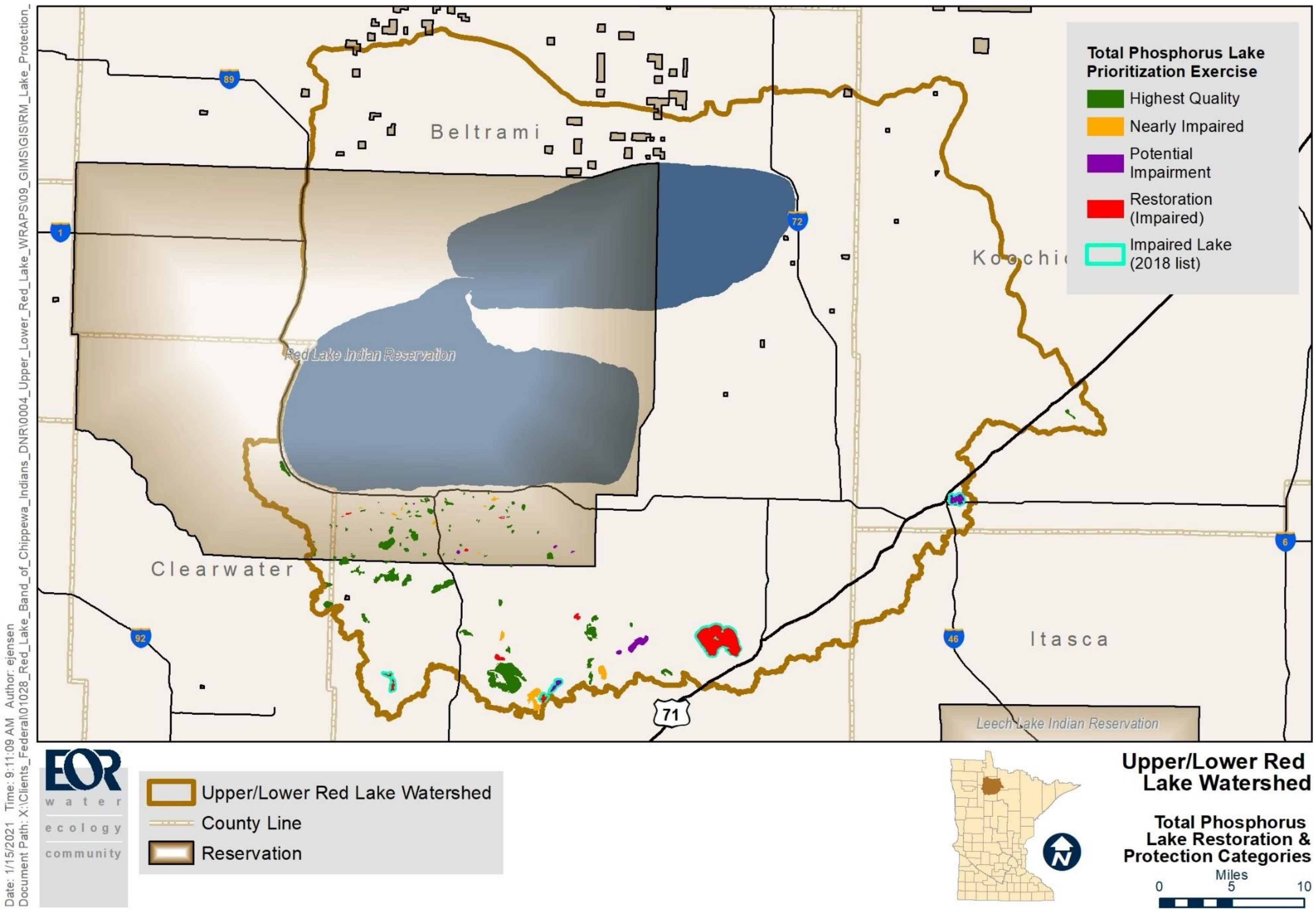


Figure 20. Map of Upper/Lower Red Lake Watershed lake total phosphorus restoration and protection needs.

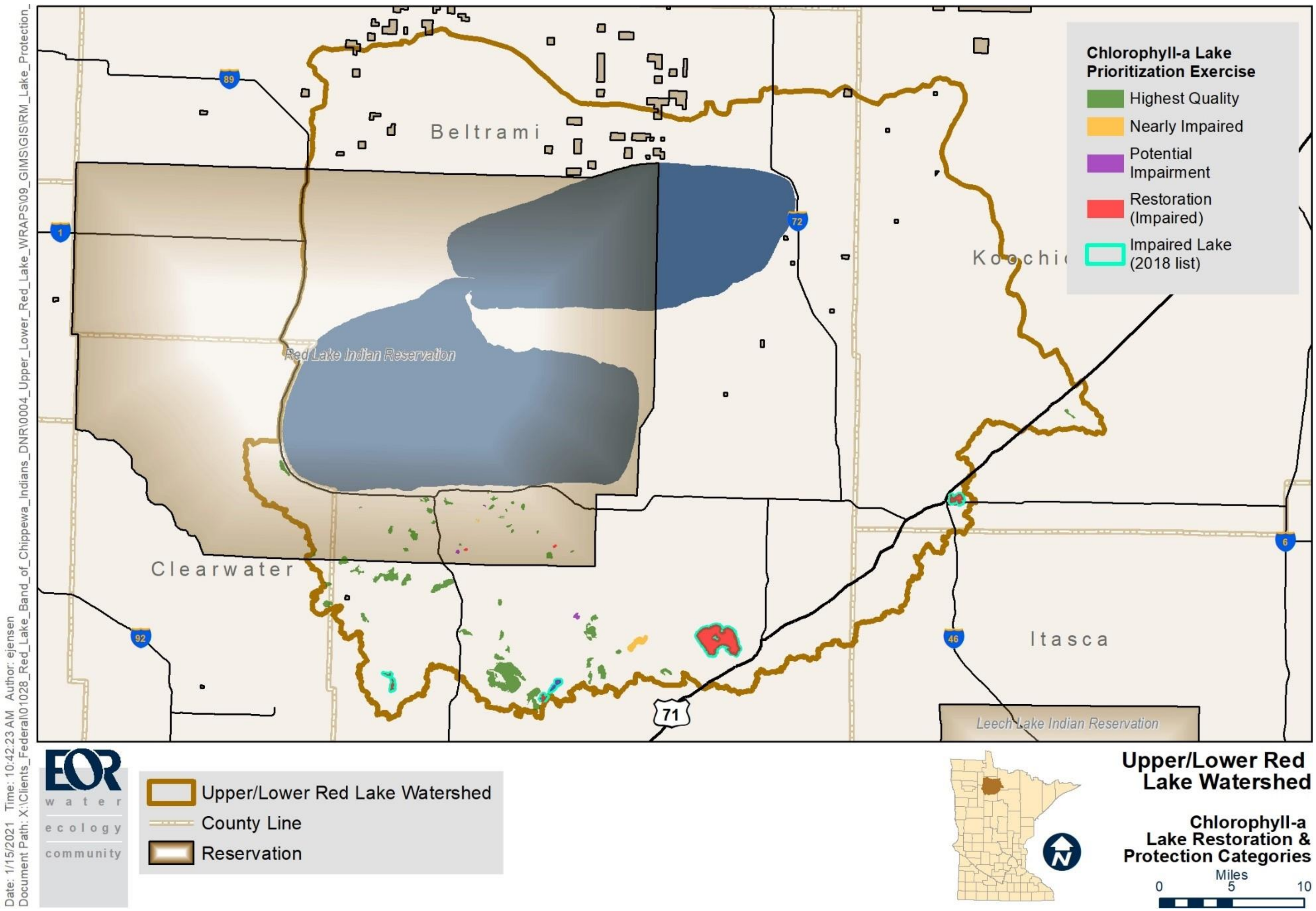


Figure 21. Map of Upper/Lower Red Lake Watershed lake chlorophyll-*a* restoration and protection needs.

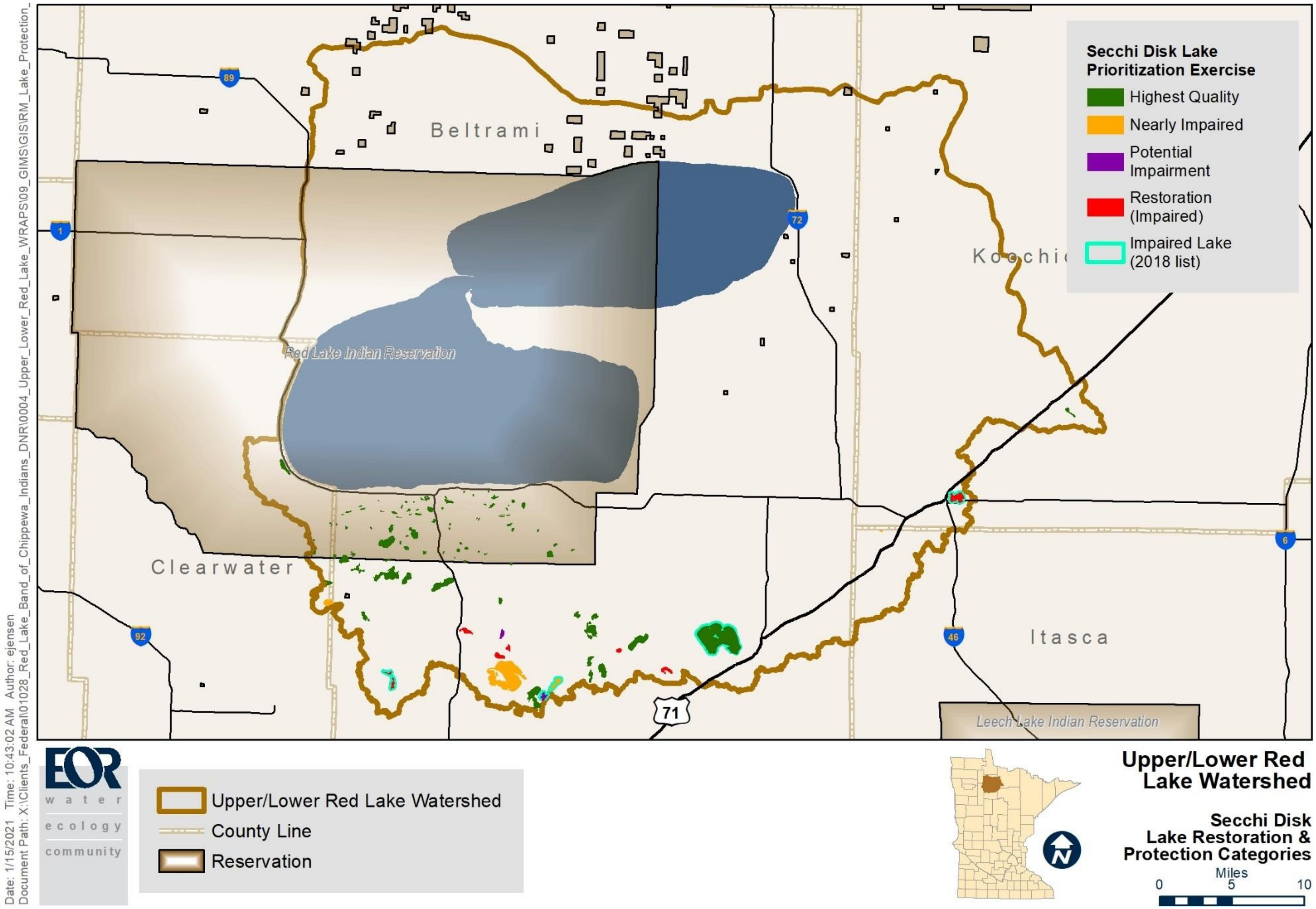


Figure 22. Map of Upper/Lower Red Lake Watershed lakes Secchi disk restoration and protection needs.

3.1.2 Watershed management framework for Minnesota lakes

Lake water quality depends largely on land use in the watersheds. Agricultural and urban runoff contains significantly more nutrients than undisturbed forests, grasslands, and wetlands. Catchments with undisturbed lands lie primarily in the forested ecoregions and generally provide good water quality. Fisheries research has shown that healthy watersheds with intact forests are fundamental to good fish habitat. Modeling of over 1,300 lakes by the DNR Fisheries Research Unit (Cross and Jacobson 2013) has revealed that phosphorus concentrations in lakes are directly related to land use disturbance in the watershed. Phosphorus concentrations start to become elevated when land use disturbance reaches 25% of the lakes watershed and are greatly elevated when land use disturbances exceed 60%. If land in the watershed is less than 25% disturbed and the remaining 75% is permanently protected forest, the lakes and streams in the watershed will have a high probability of sustaining a healthy ecosystem. Using land use disturbance and protection status allows for the categorization of lakes into a protection vs. restoration framework:

Vigilance (Dark Green): Lakes with watershed disturbance less than 25% and protection greater than 75% can be considered sufficiently protected. (Vigilance status is largely due to keeping public lands, forested)

Protection (Light Green): Lakes with watershed disturbances less than 25%, but levels of protection less than 75% are excellent candidates for protection efforts.

Full Restoration (Yellow): Lakes with watersheds that have moderate levels of disturbance (25% to 60%) have realistic chances for full restoration of water quality to natural levels.

Partial Restoration (Red): Restoration of lakes with intensive urban and agricultural watersheds (>60% disturbance) to natural levels may not be realistic. The suggested approach for these lakes is partial restoration of water quality that restores some degree of ecological integrity.

Figure 23 indicates that most of the ULRLW is currently in Protection or Vigilance mode. Watersheds in protection mode include those that have an opportunity to reach or exceed the 75% protection threshold to make this watershed sufficiently protected. While most of the subwatersheds could reach or exceed 75% protected, a few subwatersheds in the southeastern portion of the ULRLW require full ecological restoration. This portion of the watershed contains the highest percentages of privately owned land.

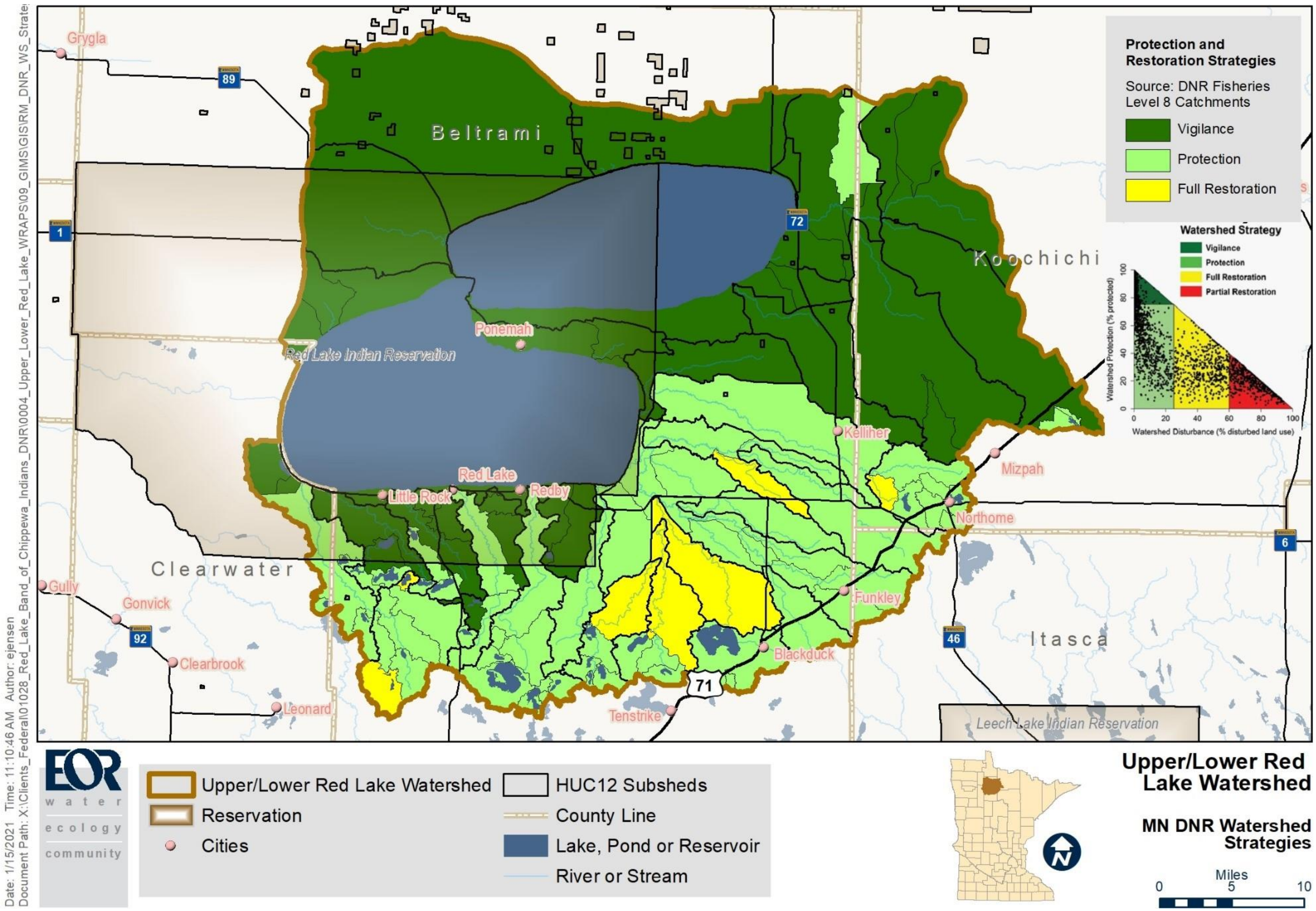


Figure 23. Watershed protection and restoration strategies.

3.1.3 Fish habitat conservation framework for Minnesota lakes

In June of 2016, the DNR developed a fish habitat conservation framework to guide protection and restoration efforts for Minnesota Lakes (Jacobson et al. 2016). Surrogate measures of habitat quality were used to assess fish habitat conditions in more than 1,800 Minnesota lakes. Two fundamental fish habitat types in lakes were described (physical and water quality) and geographic information system-based surrogate measures of habitat condition (shoreline and watershed disturbance) were quantified for each habitat type. Simultaneous consideration of the two habitat types were used to develop a bivariate classification of habitat condition. Habitat condition classifications were identified using data from previous studies to categorize lakes into protection and restoration classes. Appropriate protection and restoration actions were then tailored for each classification of habitat condition. This classification distinguishes lakes identified with *restoration* priorities for water quality improvements (C) from lakes with physical habitat restoration tied to residential development (B) or both (D). Importantly, it identifies lakes with unimpaired fish habitat functionality (A) that warrant habitat *protection*, usually the most inexpensive and cost-effective strategy (Figure 25).

The majority of the lakes in the ULRLW fall near the border of Quadrant A and Quadrant C because while shoreline disturbance is relatively low (less than 10 docks/km of shoreline), most of the lakes are located in watersheds with close to 25% or greater disturbance (Figure 25).

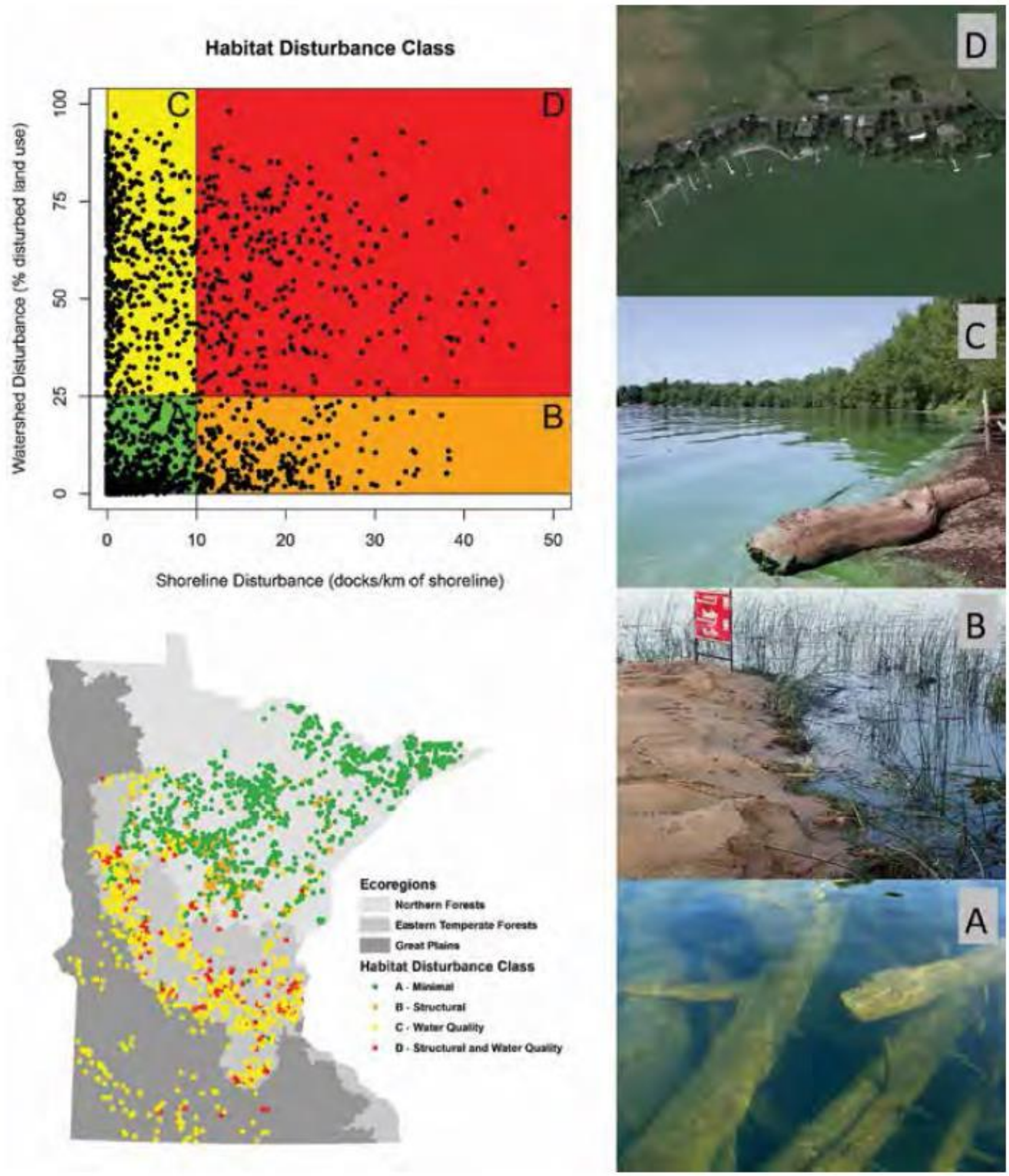
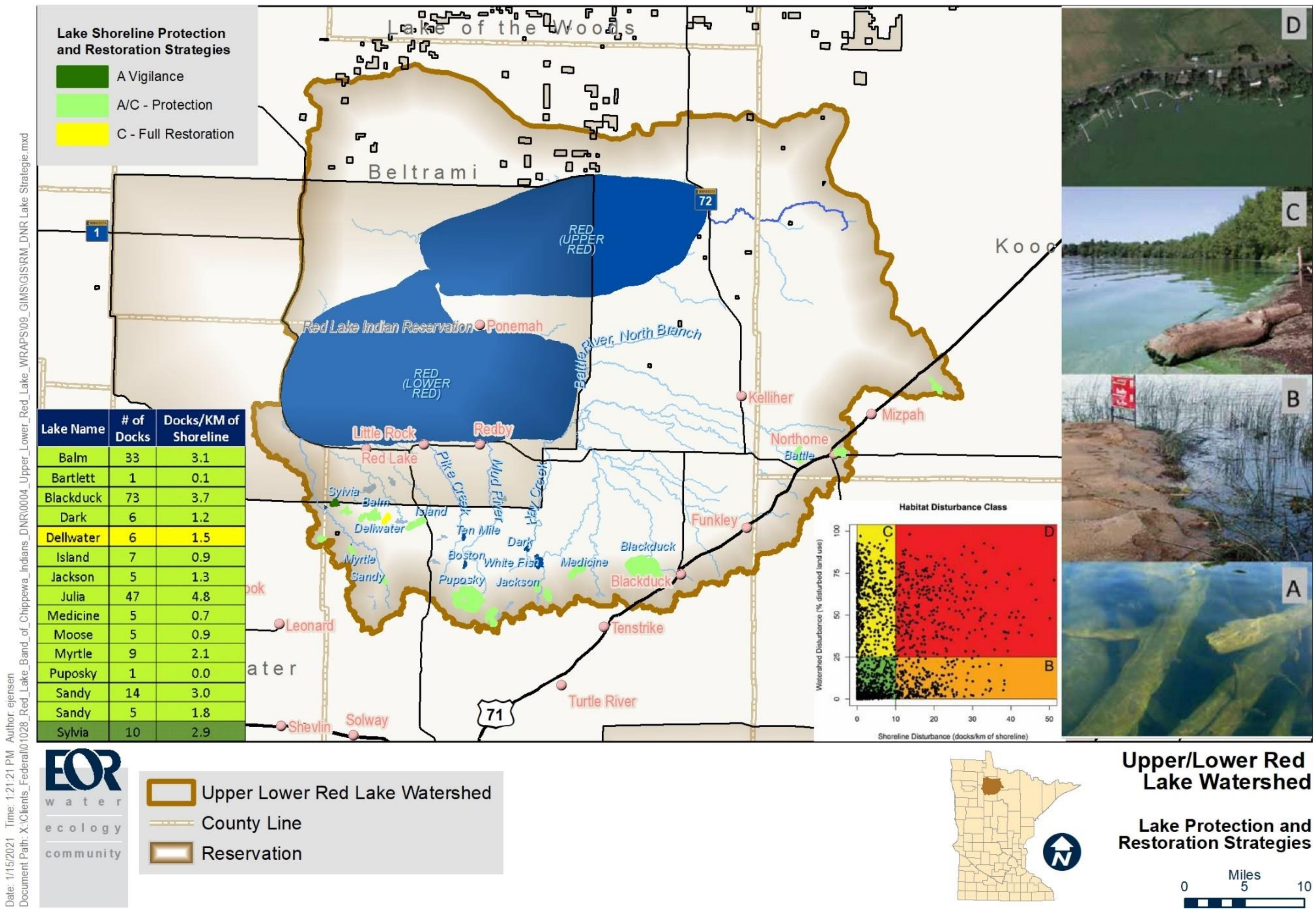


Figure 24. Bivariate plot and map of disturbance classes of physical and water quality habitats in 1849 lakes in Minnesota, with images of representative lakes within each disturbance class. Also displayed are Commission for Environmental Cooperation (1997) Level 1 ecoregions. Photo credits: (A) Michael Duval, (B) Dave Barsness, (C) Peter Jacobson, (D) Google Earth (Figure 6 in Jacobson et al. 2016).



Lake Name	# of Docks	Docks/KM of Shoreline
Balm	33	3.1
Bartlett	1	0.1
Blackduck	73	3.7
Dark	6	1.2
Dellwater	6	1.5
Island	7	0.9
Jackson	5	1.3
Julia	47	4.8
Medicine	5	0.7
Moose	5	0.9
Myrtle	9	2.1
Puposky	1	0.0
Sandy	14	3.0
Sandy	5	1.8
Sylvia	10	2.9

Figure 25. Lake protection and restoration strategies.

3.1.4 HSPF runoff, sediment, and phosphorus yields

The HSPF model was not used directly in the prioritization of subwatersheds but will be used to prioritize subwatershed pollution reductions for the benefit and protection of Upper and Lower Red Lake.

The model simulated annual runoff totals and the relative magnitude of point and nonpoint sources of phosphorus and total suspended sediment generated in each subwatershed of the ULRLW. HSPF has been used extensively in Minnesota and nationwide in support of TMDLs to simulate the complex nutrient cycling associated with TP, nitrogen, DO, algal growth, and biological oxygen demand. The model splits a watershed into small segments based on unique combinations of homogenous soils, land slope, land cover, and climate. From these segments, daily landscape hydrology and water quality are simulated and routed through the channel network to the watershed outlet. The model was calibrated and run using data from 1996 to 2014.

HSPF model development includes the addition of point source data in the watershed, including both domestic and industrial wastewater treatment facilities. The HSPF model was also used to evaluate the extent of contributions from point, nonpoint, and atmospheric sources. Average annual runoff flow, TP, and total sediment yields were calculated from HSPF modeled daily outputs and are summarized graphically in Figure 26 through Figure 28.

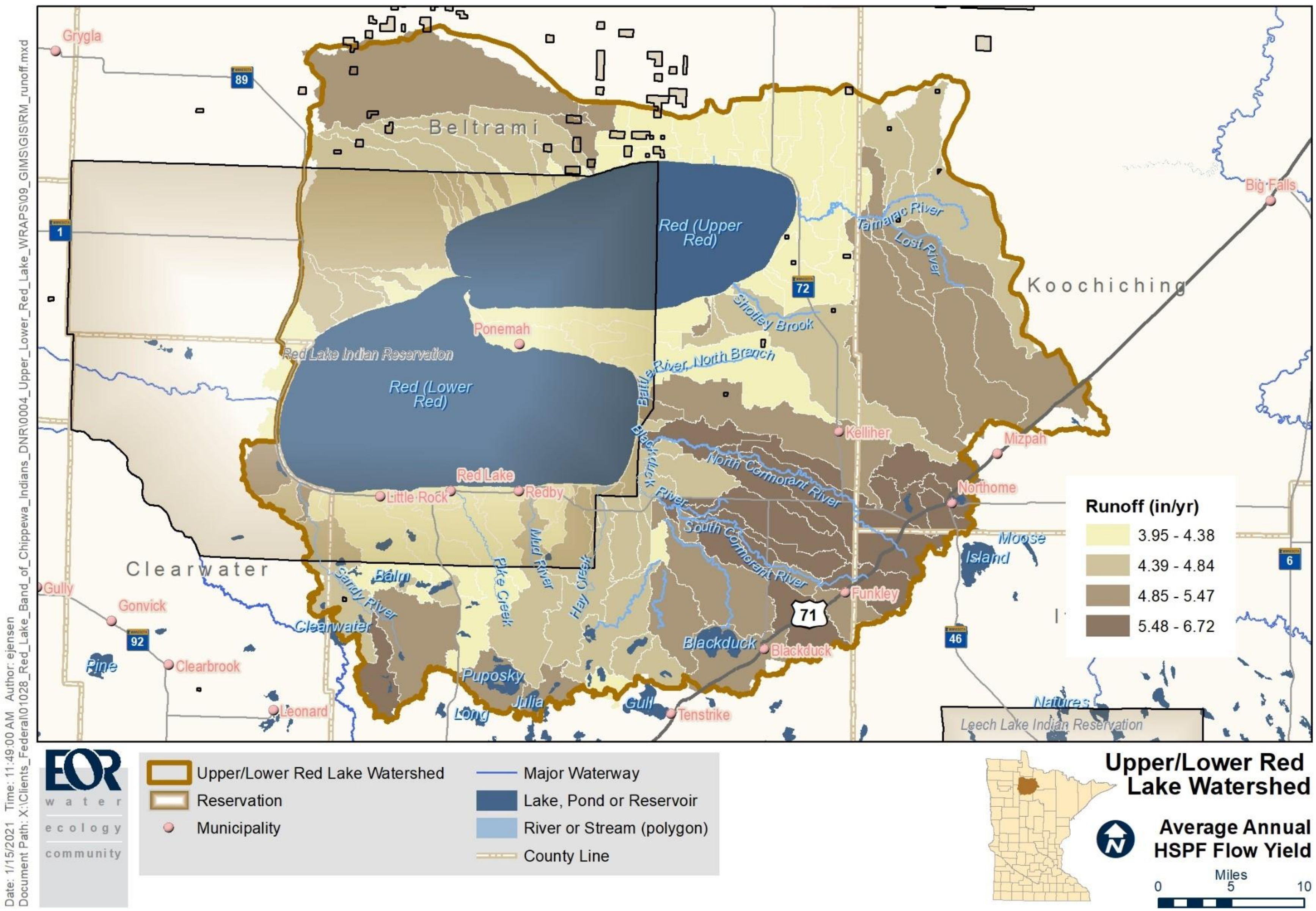


Figure 26. HSPF 2007-2014 average annual runoff flow yields by subbasin.

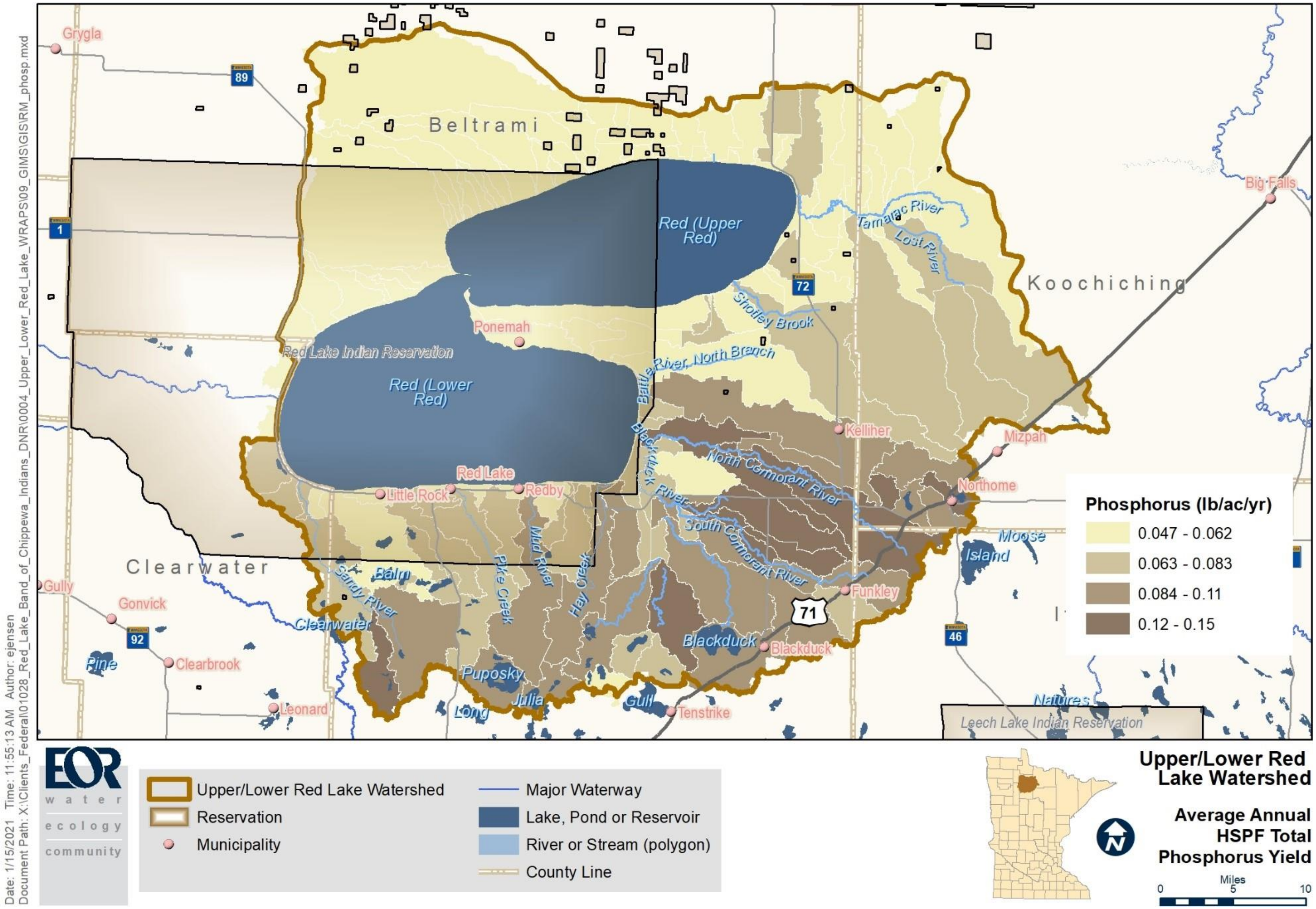


Figure 27. HSPF 2007-2014 average annual phosphorus yields by subbasin.

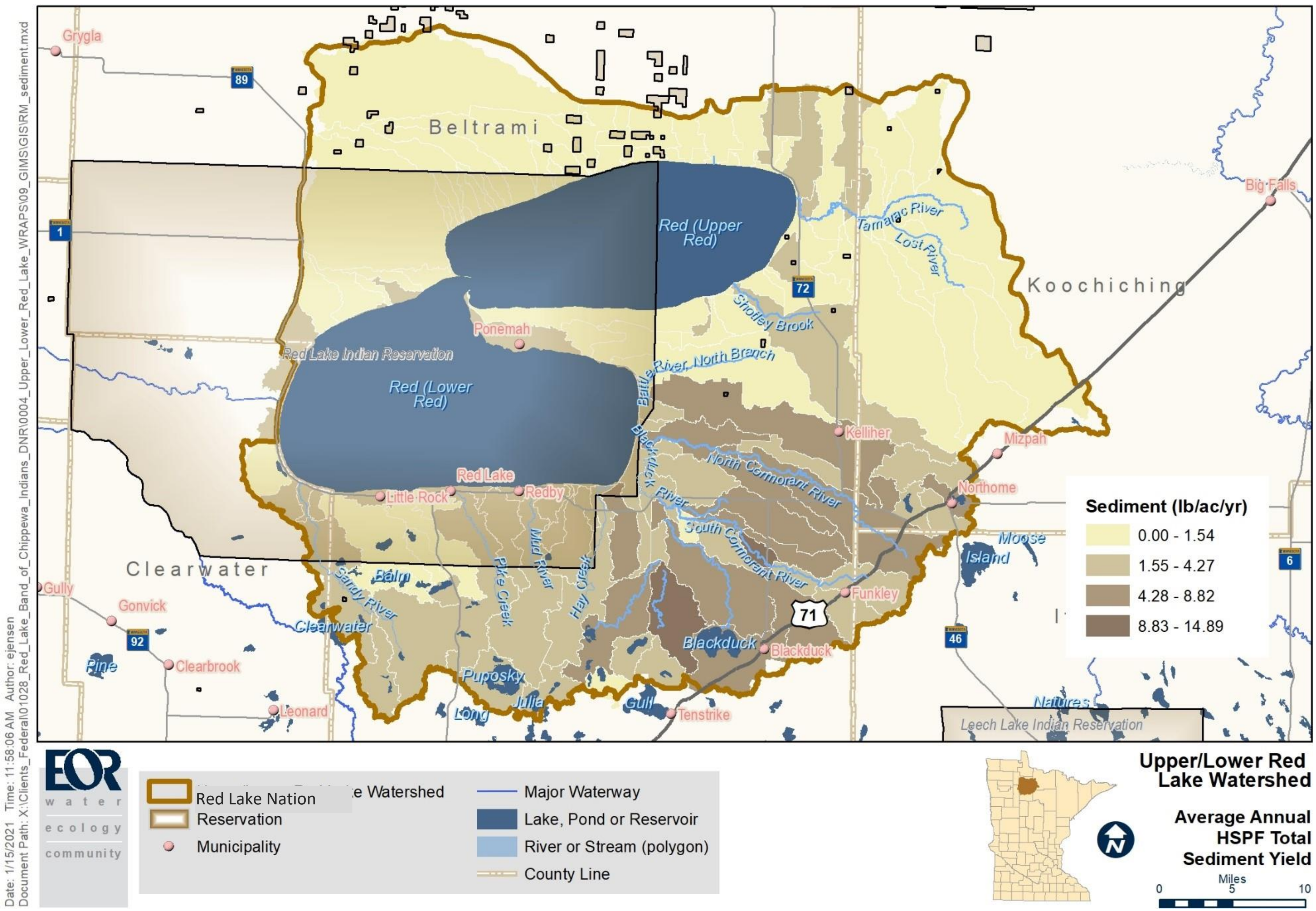
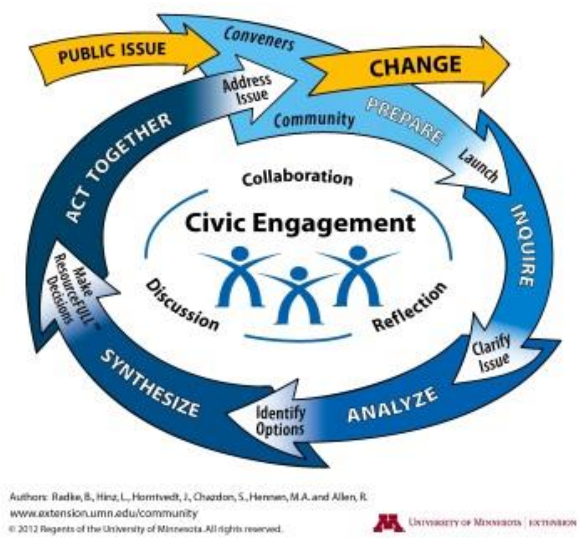


Figure 28. HSPF 2007-2014 average annual total sediment yields by subbasin.

3.2 Public Participation

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. The MPCA has coordinated with the University of Minnesota Extension Service for years on developing and implementing civic engagement approaches and efforts for the watershed approach. 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." Extension defines a resourceFULL decision as one based on diverse sources of information and supported with buy-in, resources (including human), and competence. Further information on civic engagement is available on the University of Minnesota Extension website at: https://extension.umn.edu/community-development/leadership-and-civic-engagement



3.2.1 Accomplishments and future plans

Throughout the watershed, various agencies and groups have been involved with citizens in promoting the protection of water resources. This includes the Beltrami SWCD and Environmental Services Department, the Natural Resources Conservation Service (NRCS), RL DNR Water Resources Program, RLWD, Koochiching, Clearwater, and Itasca County SWCDs, Board of Water and Soil Resources (BWSR), MPCA, DNR, and locally-led groups such as the Upper Red Lake Area Association. Activities include outreach and education such as annual Water Festivals for area 5th graders, Envirothon sponsorship, and informational booths at county fairs. Various programs are also offered through the listed agencies for prevention and BMPs such as aquatic invasive species monitoring and education, septic system management, shoreland management, wetland programs, CLMPs, well water testing services, among many others. Additionally, specific information relating to the ULRLW was provided through the following resources:

- Approximately 2000 mailings to landowners

- RL DNR Civic Engagement Plan *Draft* (September 22, 2016)
- Updates on the RL DNR Facebook Page
- Updates on the RL DNR Website
- Public meetings with landowners
    - October 11, 2016 – Kelliher, MN
    - October 12, 2016 – Ponemah, MN
    - October 13, 2016 – Red Lake, MN
    - April 24, 2018 – Kelliher, MN
    - December 12, 2019 – Kelliher, MN

3.2.2 Public notice for comments

An opportunity for public comment on the draft WRAPS report was provided via a public notice in the *State Register* from March 22, 2021 through April 21, 2021. There was one comment letter received and responded to as a result of the public comment period.

3.3 Restoration and protection strategies

This section includes watershed wide restoration and protection strategies as well as customized tables identifying restoration and protection strategies that are specific to the water resources in the ULRLW.

3.3.1 Watershed-wide strategies

3.3.1.1 Shoreland protection

Minnesota's buffer law requires perennial vegetative buffers along public ditches, lakes, rivers, and streams. Buffers along lakes, rivers, and streams are to be 50 feet in width, and buffers along public ditches are to be 16.5 feet wide or more. These buffers help filter out phosphorus, nitrogen, and sediment. Buffers are critical to protecting and restoring water quality and healthy aquatic life, natural stream functions, and aquatic habitat due to their immediate proximity to the water.

The law provides some flexibility for landowners to install alternative practices if they provide equal or better water quality benefits. An example of an alternative practice could be a narrower buffer if the land slopes away from the water body. Alternative practices must be approved by the local governmental unit that implements the buffer law. However, buffers that are most effective at protecting water quality and habitat are characterized by native, deep rooted vegetation, although any type of perennial cover is covered under the buffer definition.

The BWSR maintains an up to date map showing the estimated compliance rate of all parcels on a County by County basis. Beltrami, Clearwater, Koochiching, and Itasca Counties are all 95% to 100% compliant with the Buffer Law. County SWCDs should continue to work with landowners in the watershed to evaluate compliance with the buffer law.

3.3.1.2 Forest protection programs

Water quality in this watershed is currently in good shape due to well managed forestlands, grasslands, and agricultural lands. Forestland ranks among the best land cover in providing clean water by absorbing rainfall and snow melt, slowing storm runoff, recharging aquifers, sustaining stream flows, filtering pollutants from the air and runoff before they enter the waterways, and providing critical habitat for fish and wildlife. In addition, forested watersheds provide abundant recreational opportunities, help support local economies, provide an inexpensive source of drinking water, and improve the quality of our lives.

Minnesotans have strong conservation values. Citizens of Minnesota have long since recognized the value of forests and clean water by creating various legislative conservation programs to help conserve working land forests. There are many groups dedicated to helping protect water quality in this watershed including the RL DNR, Upper Red Lake Area Association, Beltrami County Lakes and Rivers Association, and others.

Fortunately, many minor watersheds are already forested in the ULRLW and are protected by public ownership (federal, tribal, state, and county) (Figure 29 and Figure 30). Forest protection programs play a major role in ensuring private forest lands stay working forest lands to provide optimal ecosystem services while providing landowners with a monetary incentive to keep the land forested. Table 14 outlines applicable forest protection programs that will help the ULRLW continue to maintain its biological integrity and provide healthy waters by promoting forest land stewardship. See the DNR Forest Stewardship webpage for additional information: https://www.dnr.state.mn.us/foreststewardship/index.html

Table 13. Forest protection programs for the Upper/Lower Red Lake Watershed.

Forest Protection Program	Applicability to Upper/Lower Red Lake Watershed
Forest Stewardship Plan	An instrumental plan for family forest landowners who own 20 acres or more of forestland. This voluntary plan offers land management recommendations to landowners based on their goals for their property from a natural resource professional. Plans are updated every 10 years to stay current with your needs and your woods. A Forest Stewardship Plan registered with the DNR qualifies you for woodland tax and financial incentive programs.
Sustainable Forest Incentive Act (SFIA)	SFIA is a tax incentive program available for landowners that have a registered Forest Stewardship Plan. This program offers an annual tax incentive payment per acre based off the amount of forest stewardship acres you have. Payments per acre range from the $9-16.50, based off the length of covenant the landowner decides to enroll into. SFIA restricts land use conversion and subdivision of the parcel(s). A minimum of 3 acres must be excluded from the SFIA program if there is a residential structure present, landowners can exclude more acres if they plan to make future improvements on the land.
Conservation Easements	Most, but not all conservation easements are perpetual. Some landowners want to ensure their land will never be developed or converted to another use by selling or donating a conservation easement. Conservation easements serve a variety of conservation purposes and are generally intended to protect important features of the property. They are voluntary, legally binding agreements by the landowner to give up some of the rights associated with their property such as the right to develop, divide, mine, or farm the land to protect the conservation features such as wildlife habitat, water quality, and forest health, to name a few

Forest Protection Program	Applicability to Upper/Lower Red Lake Watershed
Land Acquisition	Land acquisition is an option to permanently protect the land by selling the land to a conservation organization, agency, or other land trust. Once purchased land is restored or maintained to perpetually protect important natural resource values.

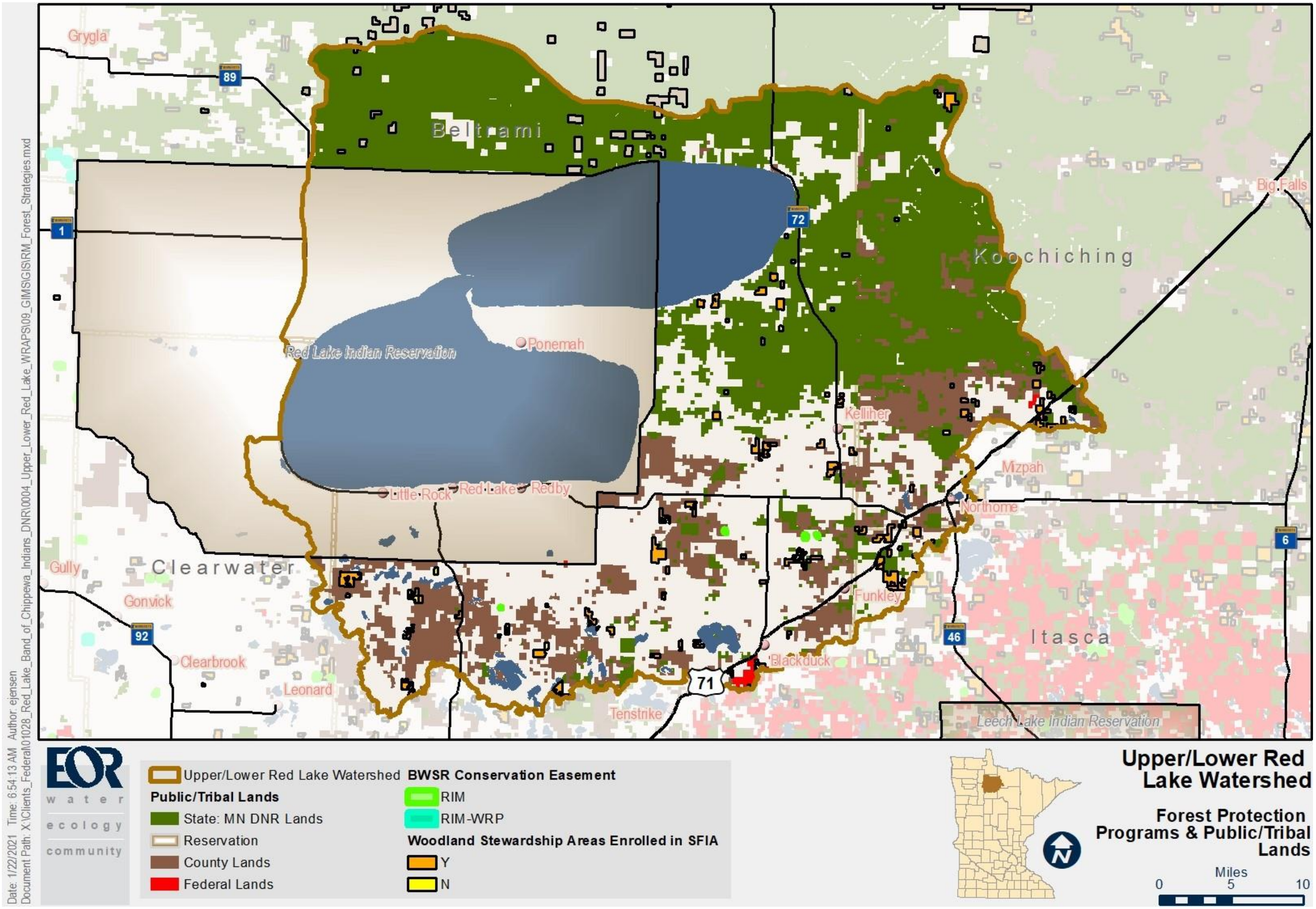


Figure 29. Forest protection program located on public lands

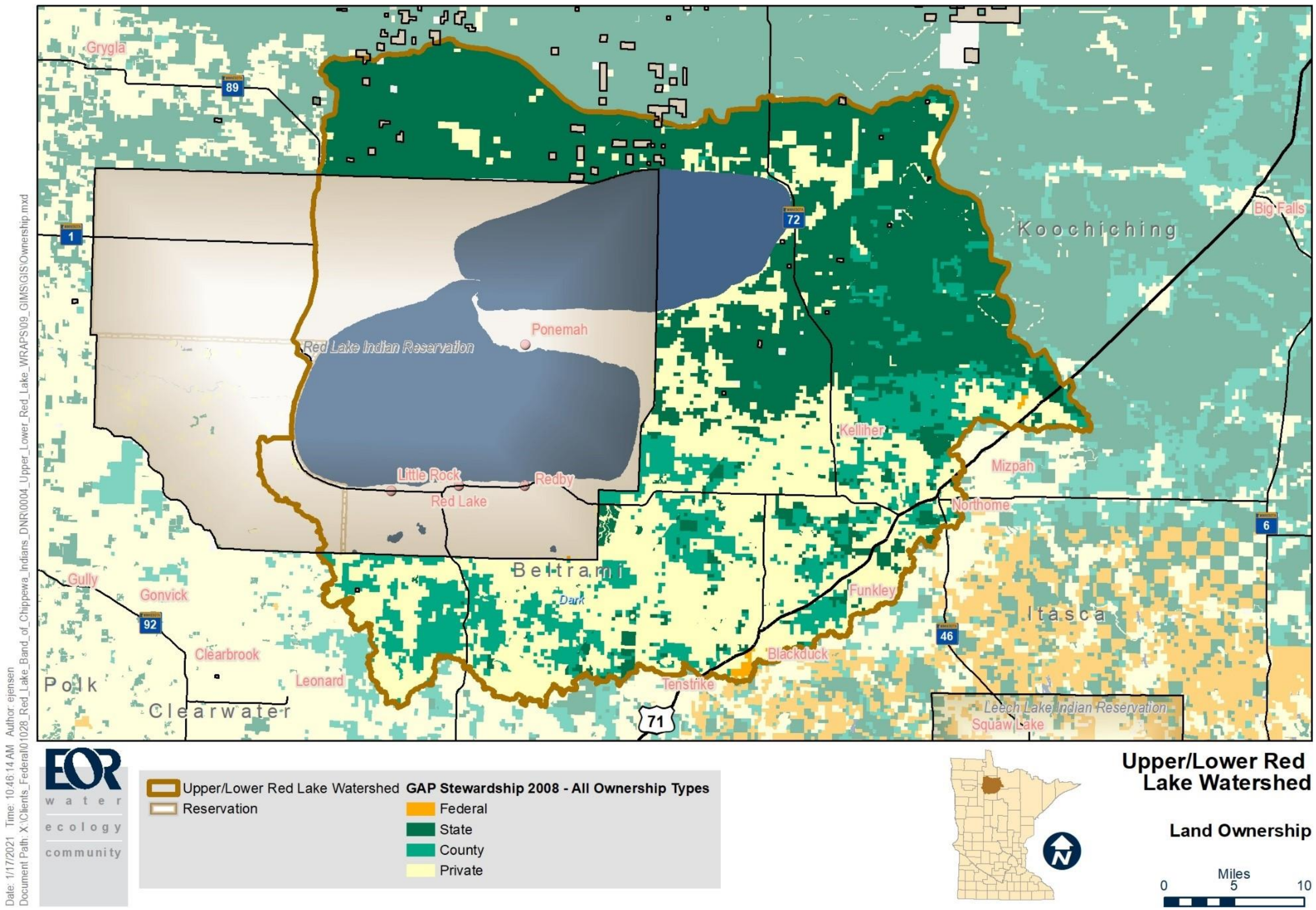


Figure 30. The majority of land in the Upper/Lower Red Lake Watershed is either public or tribal land (Red Lake Indian Reservation). Source- 2008 GAP Stewardship.

3.3.2 Subwatershed strategies

In addition to the watershed-wide strategies described above, the following subwatershed-specific strategies were identified during the September 30, 2019, WRAPS workshop. The subwatershed-specific strategies are listed for each subwatershed in Table 15. The Upper/Lower Red Lake WRAPS Subwatersheds are shown in Figure 33.

3.3.2.1 Rice paddy management

For subwatersheds with wild rice farms, wild rice growers should be encouraged and provided financial support to continue to improve quality of water discharged from rice paddies. Research from wild rice farms in Clearwater County found that installation of main line tile systems provides numerous benefits for water quality and farmers (Hanson 2009). When main line tile drainage is used in wild rice paddies without internal surface drainage, it has all the same benefits as conventional tile drainage (low phosphorus and sediment) while also having low nitrate levels compared to high levels found in conventional agriculture tile drainage. Main line tile drainage also has many benefits to the wild rice farmer such as more evenness of rice quality and maturity, less ditch maintenance, fewer ruts during harvest, more control over drainage, no top soil loss, and reduced plugging of tile outlets. Where main line tile is not feasible, other options (such as sediment traps or settling ponds) should be considered to limit discharge to surface waters and prevent flowing ditch water from leaving paddies.

More information can be found in the Red Lake River Farm to Stream Tile Drainage Water Quality Study Final Report (Hanson 2009). Wild Rice BMPs are proposed for the Tamarac/Lost, Shotley, Cormorant (North and South), and Blackduck Subwatersheds.

Figure 31. Comparison of surface drained wild rice paddy sample (left) and main line tile drained sample (right). Photo credit: Hanson 2009.

3.3.2.2 Wetland restoration

Options for the restoration of ditched wetlands in the Upper Red Subwatershed should be explored. Negative impacts from wetland ditches include higher peak flows, lower summer base flows, unstable habitat, and increased phosphorus export. Ongoing DNR research is investigating the effects of ditch abandonment on peatland restoration in northwestern Minnesota. Peatland restoration methods include ditch filling (including using natural fill such as vegetation), ditch checks, breaching embankments, and vegetation management. Additionally, large scale peatland restoration may be an opportunity for wetland banking.

3.3.2.3 Water quality monitoring

Monitoring should be conducted at sites with potential impairments or insufficient data to establish water quality trends. Additional monitoring could include targeted assessment of specific issues, legacy load identification, assessment of management actions (e.g. alum treatment at Blackduck Lake), and additional bacteria monitoring to validate assumptions of microbial source tracking results.

3.3.2.4 In-stream management

Stable watercourses are an important component of a healthy watershed, and in-stream management measures help to maintain channel stability. A majority of channels assessed during the 2018 ULRLW Fluvial Geomorphology Report were narrow and deep (stream type E, Figure 32) with gravel or sand substrates (DNR 2018). These stream types are very sensitive to disturbance such as changes to the sediment or water supply. Protection and reestablishment of riparian vegetation is extremely important for stream type E to maintain their pattern and profile. Additionally, vegetation cover is crucial for some channels where the adjacent floodplain consists of highly erodible soils (such as North Branch Battle River, Shotley Brook, Perry Creek, Darrigans Creek, South Cormorant River, and Pike Creek).

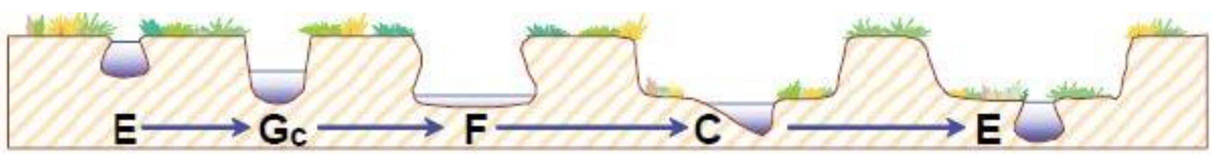


Figure 32. Example of channel types and succession (Source: Rosgen 2006). Most channels assessed within ULRLW were categorized as stream type E.

Further, several streams did not have access to floodplain at bankfull elevation and encounter stress to banks and bed during minor flooding events (Shotley Brook, North Branch Battle River, very minor at South Cormorant River and Little Tamarac River). Though none were considered severely incised, steps could be taken to reconnect channels to the floodplain. Consider installation of riffles or other in-stream restoration to reconnect incised channels to floodplains.

Improper road crossings can impact stream stability and fish passage. Road crossings should be assessed throughout the watershed or at least where streams are unstable or not meeting biological standards. Stream sites assessed with road crossing issues included Perry Creek (near Milkweed Drive and Buckeye Road) and Pike Creek (culvert replacement completed in 2017).

3.3.2.5 In-lake management

All of the impaired lakes in the ULRLW have issues with internal loading. Implementation strategies for lake internal loading reduction include water level drawdown, sediment phosphorus immobilization or chemical treatment (e.g., alum), and biomanipulation (e.g., carp).

Sequencing of in-lake management strategies both relative to each other as well as relative to external load reduction is important to evaluate and consider. In general, external loading, if moderate to high, should be the initial priority for reduction efforts. Biomanipulation may also be an early priority, which can follow water level drawdowns. However, it is generally believed that further in-lake management efforts involving chemical treatment (e.g., alum) can be considered after substantial external load reduction has occurred. The success of alum treatments depends on several factors including lake morphometry, water residence time, alum dose used, and presence of benthic-feeding fish (Huser et al. 2016).

The MPCA recommends feasibility studies for any lakes in which water level drawdown or chemical treatment is considered. The EOR 2018 Bartlett Lake In-Lake Management Alternatives report discusses the relationship between shallow lake biology and water quality in Bartlett Lake and discusses management recommendations for improving water quality in shallow lakes (EOR 2018). All of the impaired lakes in the ULRLW have a shallow lake zone (<15 feet) that covers 50% or more of the lake surface area. Many of the recommendations developed for Bartlett Lake are applicable to the remaining shallow, impaired lakes in the ULRLW.

3.3.2.6 Wildlife education

For several subwatersheds, a likely cause of elevated bacteria concentrations is from wildlife such as beavers and waterfowl. For example, beaver dams impound stream flow and create stagnant conditions conducive for bacteria growth. The 2017 MST analysis indicated that several bacteria impaired streams had bacteria sourced from birds or beavers but not anthropogenic sources such as humans or ruminants (Shotley Brook, South Cormorant River, Blackduck River 512, Hay Creek, Sandy River, and Mud River). A strategy for these subwatersheds should include public education about natural background sources of *E. coli* from wildlife.

3.3.2.7 Stormwater management

Proper urban, residential, and road/highway stormwater management reduces runoff volume and the contribution of sediment, nutrients, and other pollutants to receiving waters. Stormwater management practices may include infiltration trenches, installation or maintenance of filtration ponds, installation of buffers, swales, and rain gardens, and proper roadway design.

Stormwater management was identified as a strategy within the Blackduck Subwatershed, specifically for Coburn Creek within the City of Blackduck. This strategy could include assessment and implementation of stormwater BMPs such as buffers and retrofitting within the City of Blackduck, as well as developing partnerships and public education opportunities with the City. Monitoring of Coburn Creek should continue due to its high phosphorus loading.

3.3.2.8 Nutrient management

In subwatersheds where row crops are more common, nutrient management plans can be developed. Nutrient management plans should follow NRCS and Minnesota Department of Agriculture (MDA) Conservation Practice Standards (NRCS 2007, Lenhart et al. 2017). These plans are an effective way to improve water quality and focus on nutrient budgets and supply, proper manure application, application timing and source, minimization of agricultural nonpoint source pollution, and maintaining healthy soils.

3.3.2.9 Pasture/manure management

Pasture and manure management should focus on implementing access control and prescribed grazing BMPs. Several subwatersheds currently have or have a history of unrestricted cattle access along streams (Darrigans Creek, Blackduck, Battle, Cormorant). Cattle trampling and overgrazing of the stream bank results in bank erosion, vegetation loss, and channel widening as documented along Darrigans Creek in the SID report. Excluding or minimizing grazing access to these areas would reestablish vegetation and reduce erosion and nutrient input. This strategy will help protect and maintain riparian vegetation as described for the In-Stream Management strategy.

Excluding cattle from the riparian corridor via access control is highly effective at preventing water pollution (Lenhart et al. 2017). However, fencing can be impractical particularly for streams with high sinuosity such as those within the ULRLW due to loss of pasture lands from linear fencing corridors. Implementation of exclusion fencing should be evaluated on a case by case basis.

Prescribed grazing of the riparian corridor is an alternative to complete exclusion and provides similar benefits (Lenhart et al. 2017). Intensive (or “flash”) grazing may graze areas for as little as 12 hours, though grazing duration is generally based on plant heights or site conditions rather than specific times. This type of grazing generally controls the class or number of animals as well as the distribution, location, duration, or timing of grazing. Prescribed grazing also benefits the producer by increasing the carrying capacity of the pasture and reducing the need for feed.

Providing alternative water supplies for livestock allows animals to access drinking water away from the stream, thereby minimizing the impacts to the stream and riparian corridor. Some researchers have studied the impacts of providing alternative watering sites without structural exclusions and found that cattle spend 90% less time in the stream when alternative drinking water is furnished (EPA 2003).

For feedlots or areas where manure is concentrated, wastewater filter strips or clean runoff diversion can be installed. Wastewater filter strips consist of a strip of permanent herbaceous vegetation that receives runoff from a feedlot or basin. Clean runoff diversions are any diversion that moves clean water around the lot to reduce the runoff volume from the feedlot. Diversions may consist of roof gutters, drip trenches, berms, or channels that divert clean runoff.

3.3.3 Proposed strategies and actions by subwatershed

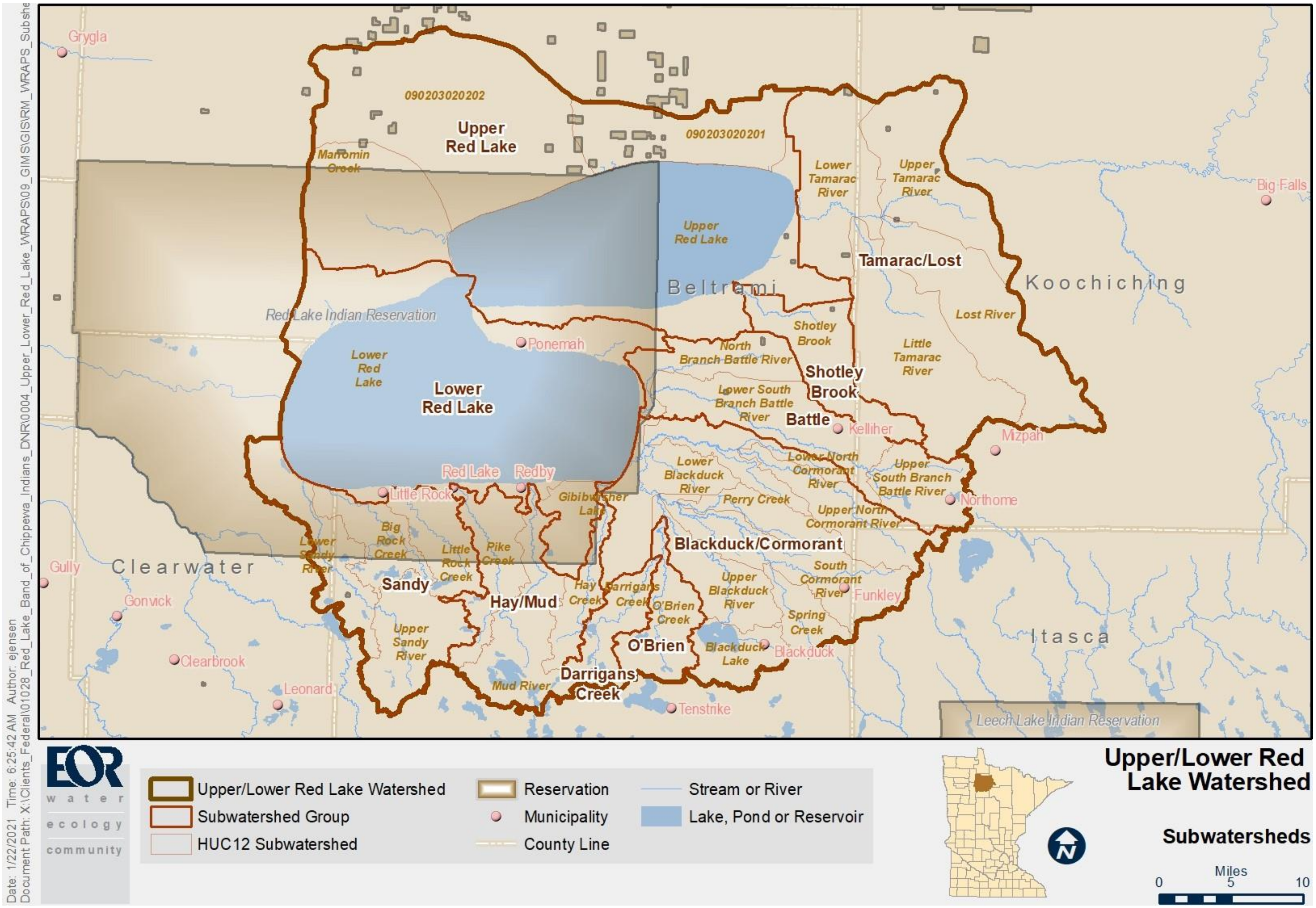


Figure 33. Upper/Lower Red Lake WRAPS Subwatersheds

Table 14. Strategies and actions by subwatershed proposed for the Upper/Lower Red Lake Watershed.

Subwatershed Group	Priority	Waterbodies	Current WQ Conditions	Strategy Category	Restoration/Protection Strategy
Tamarac/Lost	Medium	Tamarac River	Potential impairments: DO, FIBI, MIBI Protection needs: *E. coli* Insufficient data: TSS	Rice Paddy Discharge Management	Installation of main line tile drainage in rice paddies.
		Little Tamarac River	Protection needs: TSS, DO, *E. coli*, MIBI Insufficient data: FIBI		
		Lost River	Potential impairments: DO, FIBI, MIBI Protection needs: TSS and *E. coli*	In-stream Management	Install riffles to raise channel and reconnect to floodplain.
Upper Red	Medium	Direct drainage area of Upper Red Lake		Wetland Restoration	Explore wetland restoration options for abandoned ditched wetlands.
Shotley	Low	Shotley Brook	Nearly restored: *E. coli* Protection needs: DO, TSS, FIBI Potential impairment: MIBI	Rice Paddy Discharge Management	Installation of main line tile drainage in rice paddies.
				In-stream Management	Install riffles to raise channel and reconnect to floodplain. Maintain and reestablish riparian vegetation.
Battle	High	Battle River – North Branch	Protection needs: TSS Restoration: DO, *E. coli*, FIBI Nearly impaired: MIBI	In-stream Management	There is a small field road crossing that appears to be acting as a small dam a short distance downstream of site 14RD130 (see Figure 20 and 21 in the ULRLW SID report, MPCA 2018a) limiting stream connectivity.
				Livestock/Pasture Management	Cattle exclusion and prescribed grazing BMPs.
				Wildlife Management	Education and outreach about natural background sources of bacteria from wildlife.
				Rice Paddy Discharge Management	Installation of main line tile drainage in rice paddies.
				Forest Protection Programs	Target private lands for forest protection programs.
		Battle River – South Branch	Protection needs: TSS, DO Potential impairment: *E. coli* Nearly impaired: FIBI, MIBI	Livestock/Pasture Management	Battle River Sports Club may have interest in helping to fund projects. Cattle exclusion and prescribed grazing BMPs.
				Rice Paddy Discharge Management	Installation of main line tile drainage in rice paddies.
				Forest Protection Programs	Target private lands for forest protection programs.
		Bartlett Lake	Nearly restored	In-lake Management	Lake Management Plan in development by RLWD
		Battle Lake	Insufficient data	Monitoring	Explore additional monitoring options, including an assessment of the gravel pit and in-lake sediment legacy loads.
Blackduck/Cormorant	High	Blackduck Lake	Nearly restored	Monitoring	Continue lake monitoring to assess effectiveness of alum treatment.
				Stormwater Management	Continue nutrient load monitoring on Coburn Creek – RLWD and RL DNR has some data as part of a SWAG.
					Implement buffers on City-owned golf course. Use the golf course to demonstrate desirable examples of what golf courses can look like. Explore partnership and education opportunities with the City.
					Stormwater retrofit assessment for City and golf course to identify phosphorus reduction practices.
				Forest Protection Programs	Target private lands for forest protection programs.
		Blackduck River (AUIDs 09020302-510 and 09020302-512	Nearly impaired: TSS Restoration: *E. coli*	Nutrient Management	Implement NRCS and MDA nutrient management plans.
				Rice Paddy Discharge Management	Installation of main line tile drainage in rice paddies.

Subwatershed Group	Priority	Waterbodies	Current WQ Conditions	Strategy Category	Restoration/Protection Strategy
			Protection needs: DO, FIBI Potential impairment: MIBI	Livestock/Pasture Management	Cattle exclusion and prescribed grazing BMPs.
				Forest Protection Programs	Target private lands for forest protection programs.
		North Cormorant River	Nearly impaired: TSS, MIBI Potential impairment: DO, *E. coli* Protection needs: FIBI	Shoreland Protection	Opportunities for enhanced field buffers in North Cormorant drainage.
				Livestock/Pasture Management	Cattle exclusion and prescribed grazing BMPs.
				Rice Paddy Discharge Management	Installation of main line tile drainage in rice paddies.
				Forest Protection Programs	Target private lands for forest protection programs.
		Perry Creek	Insufficient data	Livestock/Pasture Management	Cattle exclusion and prescribed grazing BMPs.
				Wildlife Management	Education and outreach about natural background sources of bacteria from wildlife.
				In-stream Management	Replace culvert.
				Forest Protection Programs	Target private lands for forest protection programs.
		South Cormorant River	Protection needs: TSS, DO, FIBI Restoration: *E. coli* Nearly impaired: MIBI Exceptional fish community.	Wildlife Management	Education and outreach about natural background sources of bacteria from wildlife.
				Livestock/Pasture Management	Cattle exclusion and prescribed grazing BMPs.
				Forest Protection Programs	Target private lands for forest protection programs.
O'Brien	Low	O'Brien Creek	Protection needs: TSS Nearly restored: DO Restoration: *E. coli*	Livestock/Pasture Management	Cattle exclusion and prescribed grazing BMPs.
				Forest Protection Programs	Target private lands for forest protection programs.
		Loon Lake	High quality	Forest Protection Programs	Consider land conservation and easements. Examine current land ownership.
		Medicine Lake	Nearly impaired	Shoreland Protection	Work with resort owners on education about BMPs for resort. Shoreland restoration. Septic compliance check.
Sandy	Low	Sandy River	Protection needs: TSS, DO, FIBI Restoration: *E. coli* Nearly impaired: MIBI	Livestock/Pasture Management	Cattle exclusion and prescribed grazing BMPs.
				Forest Protection Programs	Target private lands for forest protection programs.
		Balm Lake	High quality, but declining clarity trend	Forest Protection Programs	Consider land conservation and easements. Examine current land ownership.
		Dellwater Lake	High quality	Forest Protection Program	Consider land conservation and easements. Examine current land ownership.
				Shoreland Protection	Work with camp owners on education about best practices. Shoreland restoration. Beltrami County/SWCD? Septic compliance check.
		Island Lake	High quality	Forest Protection Programs	Consider land conservation and easements. Examine current land ownership.
		Whitefish Lake	Impaired	In-Lake Management	Review historic aerials to identify potential livestock legacy loads near lake. Alum treatment.
Hay/Mud	Medium	Hay Creek	Protection needs: TSS, DO, FIBI, MIBI Restoration: *E. coli*	Monitoring	Collect additional bacteria monitoring data to validate assumptions.

4. Monitoring plan

As part of the MPCA IWM strategy, 37 stream sites were monitored for biology (fish and macroinvertebrates; Table 16) and 16 sites for water chemistry (Table 17) in 2014-2015. Additional sites will be sampled in the next 10 year cycle. Details about the MPCA IWM strategy can be found in the ULRLW Monitoring and Assessment Report (MPCA 2017).

The RLWD has been collecting water quality samples in the watershed for its long-term monitoring program since 2008. They monitor six stream sites four times each year for stage, DO, temperature, specific conductivity, pH, turbidity, TP, orthophosphate, TSS, total Kjeldahl nitrogen, ammonia-nitrogen, *E. coli*, nitrite-nitrate, and biological oxygen demand at some sites (Table 18 and Figure 35Figure 35). In addition, RLWD coordinates monthly monitoring May through September of Long Lake near Pinewood (04-0295-00) and Bartlett Lake for TP, chlorophyll-*a*, and Secchi depth.
The RL DNR has been monitoring sites in the ULRLW since the early 1990s. Fourteen stream sites are monitored in the watershed on a regular basis (Table 19). Thirteen of the sites flow into Upper and Lower Red Lakes, and one monitoring site is at the outlet of Lower Red Lake on the Red Lake River. Sites are monitored for nutrients (TP, ammonia-nitrogen, total Kjeldahl nitrogen, nitrite-nitrate, and TSS) four times per year including a storm event. Stream physical parameters are measured twice per month from snowmelt to freeze up and include stage (tape-down or gage readings), DO, temperature, pH, specific conductivity, and turbidity.

The RL DNR maintains a robust lake monitoring program throughout ULRLW with frequency and intensity of the lake monitoring grouped into four lake monitoring categories: Primary Lakes, Upper and Lower Red Lake, Secondary Lakes, and Shallow Lakes (Table 19). A description of each lake monitoring category is summarized below:

- <u>Primary Lakes</u>: monitored once monthly June through September for physical parameter profiles (DO, temperature, conductivity, pH), TP, chlorophyll-*a*, turbidity, and alkalinity as well as Secchi depth and site conditions (algae presence, etc.). In the winter, these lakes are also monitored once through the ice if conditions permit for physical profiles, TP, turbidity, alkalinity, snow and ice depth, as well as site conditions (presence of algae, etc.).
- <u>Red Lakes</u>: monitored twice monthly May through September at 10 sites for physical parameter profiles, Secchi depth, site conditions, TP, chlorophyll-*a*, turbidity and alkalinity. Once a month, surface water samples are also analyzed for total Kjeldahl nitrogen, nitrite-nitrate, ammonia-nitrogen, orthophosphate, total dissolved solids, TSS, total suspended volatile solids, and bottom water samples are collected and analyzed for TP and orthophosphate. In addition, plankton tows are collected at each event May through September and identified by the DNR as part of an invasive species monitoring effort. During the winter, Upper and Lower Red Lake is sampled once through the ice at each of the 10 sites for physical profiles, TP, turbidity, alkalinity, snow and ice depth.
- <u>Secondary Lakes</u>: monitored every four years, June through September once monthly with one additional sample (for a total of five during those months) for physical parameter profiles, TP, chlorophyll-*a*, turbidity, and alkalinity as well as Secchi depth and site conditions (algae presence, etc.). In the winter, these lakes are also monitored once through the ice if conditions

permit for physical profiles, TP, turbidity, alkalinity, snow and ice depth, as well as site conditions (presence of algae, etc.).

- Shallow Lakes: initially monitored as part of an intensive study about 10 years ago for 3 years, then revisited for 2 years. RL DNR intends to revisit these lakes at least every 10 years. These lakes are monitored once per month May through September for surface physical conditions (DO, temperature, conductivity, and pH), TP, total dissolved phosphorus, orthophosphate, total Kjeldahl nitrogen, nitrite-nitrate, ammonia-nitrogen, total nitrogen, chlorophyll-*a*, turbidity and alkalinity, and fish and invertebrates.

The MPCA, RL DNR, and RLWD will continue to monitor their long-term sites at the same frequencies. If data collected indicates issues at a particular site, additional monitoring or additional monitoring sites may be added to determine where issues may be arising.

It is the intent of the implementing organizations in this watershed to make steady progress in terms of pollutant reduction. Accordingly, as a very general guideline, progress benchmarks are established for this watershed that assume that improvements will occur resulting in a water quality pollutant concentration decline every 10-years equivalent to approximately 10% of the starting (i.e., long-term) pollutant concentration. For example, for a lake with a long-term growing season TP concentration of 90 µg/L, by year 10 it would be 90 – (10 * 0.9) = 81 µg/L. Impaired lakes and streams have more aggressive pollutant load reduction goals, as reported in the ULRLW TMDL (MPCA 2021). Again, this is a general guideline. Factors that may mean slower progress include limits in funding or landowner acceptance, challenging fixes (e.g., unstable bluffs and ravines, invasive species) and unfavorable climatic factors. Conversely, there may be faster progress for some impaired waters, especially where high-impact fixes are slated to occur. Stream monitoring data can be used to show pollutant reduction progress at sites downstream of implemented projects or BMPs.

Table 15. ULRLW 2014-2015 intensive watershed monitoring stream biological stations.

AUID	Biological Station ID	Waterbody Name	Biological Station Location
09020302-501	14RD139	Tamarac River	Upstream of Steel Bridge Rd, 0.5 mi. S of Waskish
09020302-501	14RD143	Tamarac River	NW of Balsiger Rd, 6 m.i E of Waskish
09020302-614	14RD138	Little Tamarac River	Upstream of Balsiger Rd, 5 mi. SE of Waskish
09020302-602	14RD148	Lost River	Downstream of Balsiger Rd, 6 mi. E of Waskish
09020302-603	14RD142	Lost River	Upstream of Lost River Rd, 8 mi. N of Forest Grove
09020302-502	14RD136	Shotley Brook	Downstream of CSAH 23, 3.5 mi. NE of Shotley
09020302-547	14RD137	Hoover Creek	Upstream of CR 105, 2.5 mi. N of Kelliher
09020302-503	14RD130	Battle River, North Branch	Downstream of CSAH 23, 2 mi. N of Saum
09020302-523	14RD134	Trib. to Battle River, South Branch	Upstream of CSAH 38, 7 mi. SW of Saum
09020302-538	09RD064	Battle River, South Branch	Upstream of CR 103, 2.7 mi. SW of Kelliher
09020302-539	14RD129	Battle River, South Branch	Downstream of CSAH 23, 0.5 mi. N of Saum
09020302-574	14RD132	Armstrong Creek	Across private property at end of CR 63, 5 mi. NW of Northome

AUID	Biological Station ID	Waterbody Name	Biological Station Location
09020302-508	14RD112	Darrigans Creek	Upstream of Everts Rd (CSAH 23), 5.5 mi. S of Quiring
09020302-510	14RD114	Blackduck River	Upstream of Deer Trail Rd, 3 mi. NW of Langor
09020302-511	14RD158	Blackduck River	0.3 mi. E of CSAH 23, 1.25 mi. SW of Quiring
09020302-512	05RD088	Blackduck River	Upstream of CR 23, 13 mi. SW of Kelliher
09020302-513	14RD122	Blackduck River	Upstream of BIA 18, 3 mi. NW of Quiring
09020302-514	14RD110	O'Brien Creek	West of Darrigans Creek Rd NE, 2 mi. S of Quiring
09020302-506	14RD124	North Cormorant River	Downstream of CSAH 23, 2.5 mi. S of Saum
09020302-506	14RD127	North Cormorant River	Downstream of Hwy 72, 0.5 mi. N of Shooks
09020302-506	14RD128	North Cormorant River	Downstream of CSAH 36, 5.5 mi SW of Kelliher
09020302-542	14RD141	Meadow Creek	Upstream of Fireweed Ln NE, 5.5 mi. SE of Saum
09020302-507	14RD115	South Cormorant River	Adjacent to Hwy 1, 0.8 mi. SW of Quiring
09020302-507	14RD117	South Cormorant River	Upstream of fire road crossing S of Buckeye Rd, 3 mi. W of Inez
09020302-507	14RD119	South Cormorant River	Downstream of CSAH 41, 3.5 mi. NW of Funkley
09020302-552	14RD121	Spring Creek	East end of CR 306 and Hwy 72 intersection, 4 mi. N of Blackduck
09020302-605	14RD116	Perry Creek	At end of unnamed rd S of Hwy 1, 2.5 mi. SW of Quiring
09020302-518	14RD109	Hay Creek	Upstream of BIA 18, 5 mi. E of Redby
09020302-521	14RD126	Pike Creek	On unnamed trail, 0.5 mi. S of Red Lake
09020302-521	14RD153	Pike Creek	Downstream of BIA 1, 3 mi. NE of Island Lake
09020302-540	14RD107	Mud River	Downstream of Farmer Dr, 2 mi. NW of Nebish
09020302-541	14RD106	Mud River	At end of unnamed trail in Redby (streets near trail unnamed)
09020302-613	14RD157	Mud River	Upstream of CSAH 13, 5 mi. NW of Puposky
09020302-522	14RD100	Sandy River	Upstream of BIA 5, 7 mi. SW of Little Rock
09020302-522	14RD102	Sandy River	Upstream of CSAH 32 (Lumberjack Rd), 2 mi. NW of Debs
09020302-604	14RD103	North Fork River	Downstream of CR 32, 3 mi. NE of Debs
09020302-501	14RD139	Tamarac River	Upstream of Steel Bridge Rd, 0.5 mi. S of Waskish

Table 16. ULRLW 2014-2015 intensive watershed monitoring stream chemistry stations.

AUID	EQuIS ID	Biological Station	Waterbody Name	Location
09020302-539	S003-952	14RD129	South Branch Battle River	At CSAH 23, 0.5 mi N of Saum
09020302-506	S003-961	14RD124	North Cormorant River	At CSAH 23, 2.5 mi S of Saum
09020302-503	S003-962	14RD130	North Branch Battle River	At CSAH 23, 2 mi N of Saum
09020302-507	S007-883	14RD115	South Cormorant River	Adjacent to MN 1, 0.8 mi. SW of Quiring
09020302-502	S007-884	14RD136	Shotley Brook	At CR 23, 3.5 mi. NE of Shotley
09020302-614	S007-885	14RD138	Little Tamarack River	At Balsiger Rd, 5 mi SE of Waskish

AUID	EQuIS ID	Biological Station	Waterbody Name	Location
09020302-501	S007-887	14RD139	Tamarac River	At Steel Bridge Rd, 0.5 mi S of Waskish
09020302-602	S007-886	14RD148	Lost River	At Balsiger Rd, 6 mi E of Waskish
09020302-600	S007-888	14RD149	Tributary to Upper Red Lake	At North Shore Dr, 6.5 mi NW of Waskish
09020302-522	S007-877	14RD100	Sandy River	Indian Service Rd 6, 7 mi SW of Little Rock, MN
09020302-548	S007-878	14RD104	Big Rock Creek	At BIA 8, 5mi. W of Little Rock
09020302-541	S007-881	14RD106	Mud River	On trail W of subdivision road off of BIA 15 in SW Redby
09020302-518	S007-880	14RD109	Hay Creek	At BIA 18, 5 mi E of Redby
09020302-513	S007-882	14RD122	Blackduck River	Along BIA 18, 3 mi NW of Quiring
09020302-521	S007-879	14RD126	Pike Creek	0.5 mi W of unnamed road that meets end of BIA 12, 1 mi S of Red Lake
09020302-557	S003-955	--	Manomin Creek	0.25 mi upstream of Upper Red Lake, 18 mi N of Red Lake

Table 17. RLWD long-term stream monitoring sites.

AUID	Site ID	Waterbody Name	Monitoring Location
09020302-508	S004-832	Darrigans Creek	CSAH 23
09020302-544	S004-833	O'Brien Creek	Harvest Rd NE
09020302-510	S004-831	Blackduck River	Deer Trail Rd
09020302-507	S004-834	South Cormorant River	CSAH 37
09020302-515	S000-388	Coburn Creek	N Blackduck Lk Rd
09020302-506	S007-606	North Cormorant River	CSAH 36

Table 18. RL DNR stream monitoring sites.

AUID	Site ID	Waterbody Name	Monitoring Location
09020302-505	BATT-I	Battle River	at BIA-18
09020302-503	BATT-NB	North Branch Battle River	at CSAH 23
09020302-539	BATT-SB	South Branch Battle River	at CSAH 23
09020302-512	BLAC-H	Blackduck River	at MN HWY 1
09020302-513	BLAC-I	Blackduck River	at BIA-18
09020302-506	CORM-B	North Cormorant River	at CSAH 23
09020302-541	MUDR-I	Mud River	0.1 mi Upstream from Lower Red Lake
09020302-541	MUDR-M	Mud River	On trail E of subdivision road off BIA 60 in Redby
09020302-521	PIKE-B	Pike Creek	at South Boundary Rd
09020302-521	PIKE-I	Pike Creek	at MN HWY 1
09020302-521	PIKE-OR	Pike Creek	at CSAH 32
09020303-560	REDL-O	Red Lake River	at Outlet of Lower Red Lake
09020302-522	SANR-U	Sandy River	0.75 mi Upstream from Lower Red Lake
09020302-501	TAMA-B	Tamarac River	at Steel Bridge Rd

Table 19. RL DNR lake monitoring locations and monitoring category.

Lake Site ID	Lake Name	Monitoring Category
ALAS	Alaska Lake	Shallow Lakes
ANKE	Ankeewinsee Lake	Secondary Lakes
ARTI	Artist Lake	Shallow Lakes
BAIL	Bailey Lake	Shallow Lakes
BALI	Balif Lake	Secondary Lakes
BASS-NW	Bass Lake - Northwest Basin	Primary Lakes
BASS-SE	Bass Lake - Southeast Basin	Primary Lakes
BEAS	Beasty Lake	Secondary Lakes
BEND	Bender Lake	Shallow Lakes
BIGT	Big Thunder Lake	Primary Lakes
BITN	Bitney Lake	Secondary Lakes
BIZH	Bizhiki Lake	Shallow Lakes
BLAK	Blake Lake	Secondary Lakes
BORD	Border Lake	Secondary Lakes
BURN	Burns Lake	Shallow Lakes
BURT	Burt Lake	Secondary Lakes
CAHI	Cahill Lake	Shallow Lakes
CANV	Canvasback Lake	Shallow Lakes
CHAI-M	Chain: Middle Lake	Primary Lakes
CHAI-S	Chain: South Lake	Primary Lakes
COLL	Collier Lake	Shallow Lakes
COLO	Colombo Lake	Secondary Lakes
CROO	Crooked Lake	Secondary Lakes
CURT	Curtis Lake	Shallow Lakes
DICK	Dickens Lake	Primary Lakes
DUNB	Dunbar Lake	Secondary Lakes
DUNE	Dune Lake	Secondary Lakes
EAST	East of Bender Lake	Shallow Lakes
ELEP	Elephant Ear Lake	Secondary Lakes
EMER	Emerald Lake	Primary Lakes
GIBI	Gibibwisher Lake	Secondary Lakes
FAIR	Fairbanks Lake	Secondary Lakes
FOUR	Fourth Lake	Secondary Lakes
FOX	Fox Lake	Secondary Lakes
FRAN	Francis Lake	Secondary Lakes
FRIS	Frisby Lake	Secondary Lakes
FULL-E	Fullers Lake - East Basin	Primary Lakes
FULL-W	Fullers Lake - West Basin	Primary Lakes
GIMI	Gimiwan Lake	Shallow Lakes
GOUR	Gourd Lake	Secondary Lakes

Lake Site ID	Lake Name	Monitoring Category
GRAN	Graning Lake	Secondary Lakes
GRAS	Grass Island Lake	Secondary Lakes
GREE-REDBY	Green Lake - Redby	Primary Lakes
GREE-REDLAKE	Green Lake - Red Lake	Primary Lakes
GROU	Grouse Lake	Shallow Lakes
GWIN	Gwin Lake	Secondary Lakes
HEAR	Heart Lake	Primary Lakes
HERI	Heritage Lake	Shallow Lakes
ISLA	Island Lake	Primary Lakes
JOHN	Johnson Lake	Primary Lakes
JOUR	Jourdain lake	Secondary Lakes
KESA	Kesagiagan Lake	Secondary Lakes
KINN	Kinney Lake	Primary Lakes
LAXO	Laxon Lake	Secondary Lakes
LESL	Leslin Lake	Secondary Lakes
LITT	Little Thunder Lake	Primary Lakes
LONG	Long Lake (Burt)	Primary Lakes
LUSS	Lussier Lake	Secondary Lakes
MASQ	Masquot Lake	Shallow Lakes
MCCA	McCall Lake	Secondary Lakes
METH	Methane Lake	Shallow Lakes
MISK	Miskogineau Lake	Shallow Lakes
MIST	Mistic Lake	Shallow Lakes
MORR	Morrison Lake	Primary Lakes
MUER	Muerlin Lake	Secondary Lakes
NONA	No-Name Lake	Primary Lakes
REDH	Redhead Lake	Shallow Lakes
RICH	Richards Lake	Shallow Lakes
ROOS	Roosevelt Lake	Shallow Lakes
ROUN	Round Lake	Primary Lakes
RUSH	Rush Lake	Secondary Lakes
SAND	Sandy Lake	Primary Lakes
SHAC	Shackle Lake	Secondary Lakes
SHEL	Shell Lake	Primary Lakes
SHEM	Shemahgun Lake	Primary Lakes
SQUA	Squaw Smith Lake	Primary Lakes
STON	Stone Lake	Secondary Lakes
TEAL	Teal Lake	Shallow Lakes
TOWN	Townline Lake	Secondary Lakes
TUCK	Tuck Lake	Shallow Lakes
WEND	Wending Lake	Shallow Lakes

Lake Site ID	Lake Name	Monitoring Category
WILL	Williams Lake	Secondary Lakes
LRW	Lower Red West	Red Lakes
LRW-C	Lower Red West-Central	Red Lakes
LRC	Lower Red Central	Red Lakes
LRE-C	Lower Red East-Central	Red Lakes
LRE	Lower Red East	Red Lakes
URW	Upper Red West	Red Lakes
URW-C	Upper Red West-Central	Red Lakes
URC	Upper Red Central	Red Lakes
URE-C	Upper Red East-Central	Red Lakes
URE	Upper Red East	Red Lakes

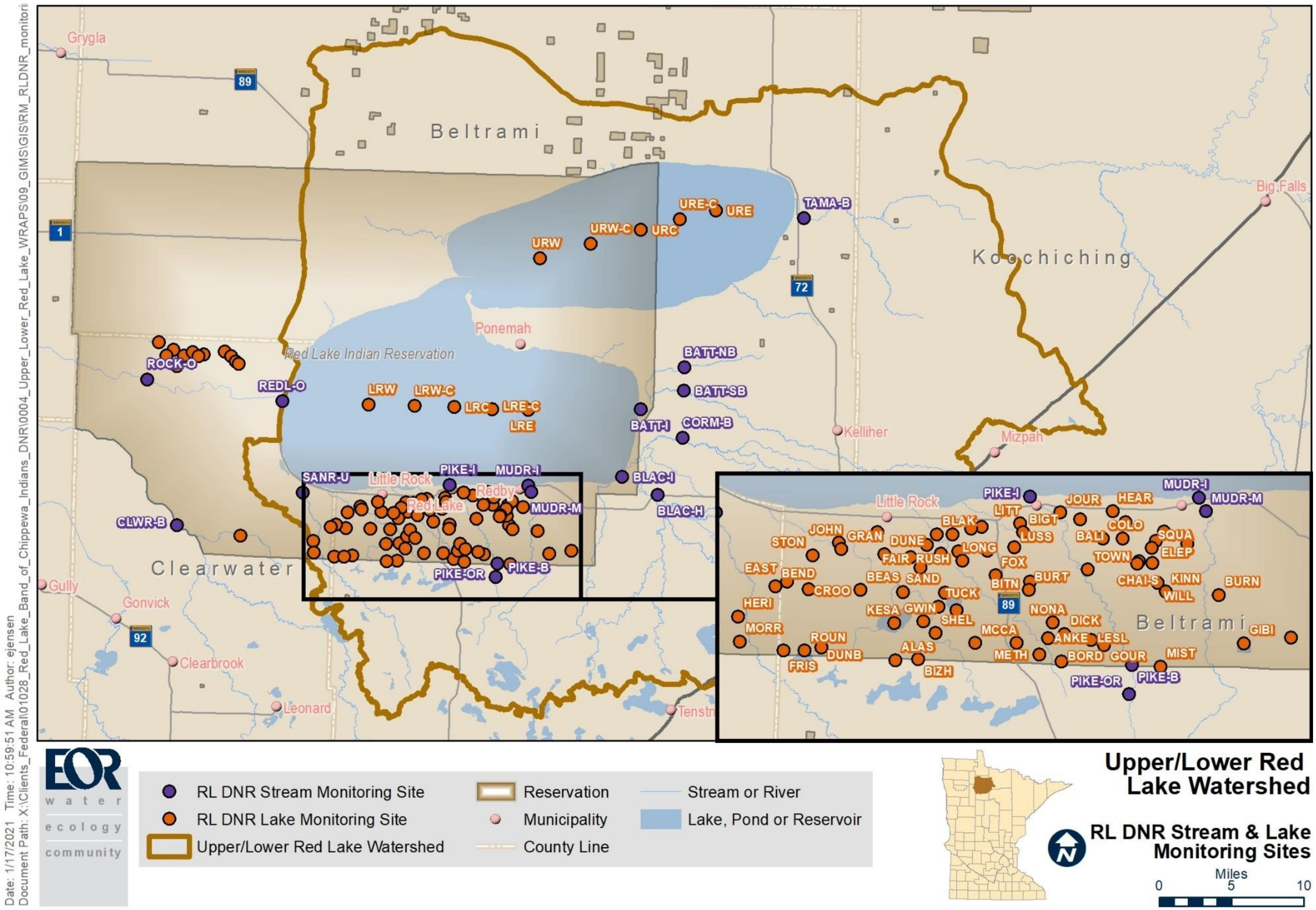


Figure 34. RL DNR stream and lake monitoring sites.

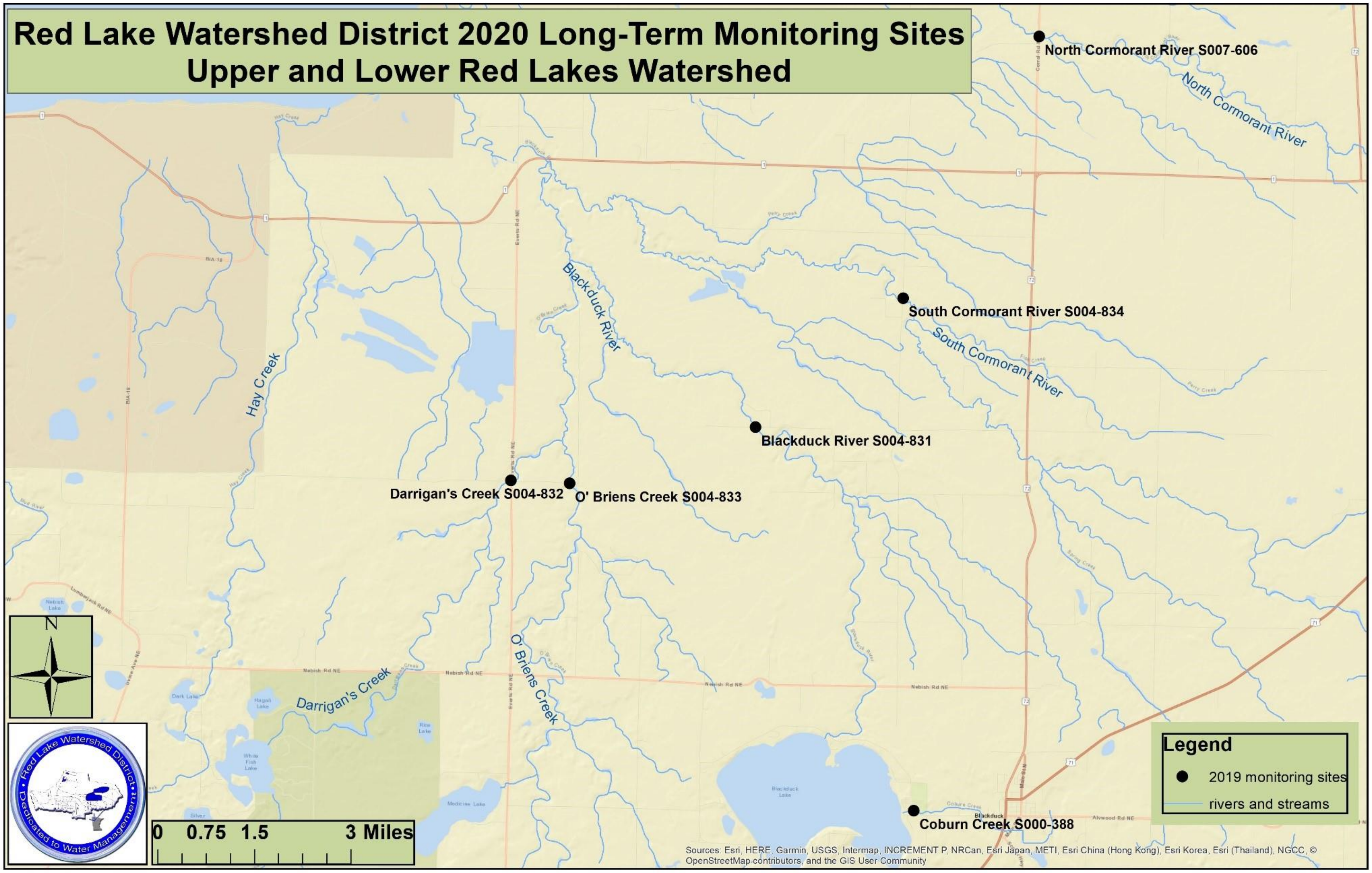


Figure 35. RLWD long-term monitoring stream sites.

Upper/Lower Red Lake Watershed Reports

All Upper/Lower Red Lake reports referenced in this watershed report are available at the Upper/Lower Red Lake Watershed webpage: https://www.pca.state.mn.us/water/watersheds/upperlower-red-lake

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