FOND DU LAC RESERVATION NONPOINT SOURCE ASSESSMENT REPORT

February 2021

PREPARED BY:

Kari Jacobson Hedin, Watershed Specialist, Fond du Lac Office of Water Protection, Environmental Program, Resource Management Division

With Assistance From:

Nancy Schuldt, Water Projects Coordinator, Fond du Lac Office of Water Protection, Environmental Program, Resource Management Division

Rick Gitar, Water Regulatory Specialist, Fond du Lac Office of Water Protection, Environmental Program, Resource Management Division

Shannon Kesner, former Wetland Specialist, Fond du Lac Office of Water Protection, Environmental Program, Resource Management Division

Cristina Weske, Groundwater Specialist, Fond du Lac Office of Water Protection, Environmental Program, Resource Management Division

Joy Wiecks, Air Projects Coordinator, Fond du Lac Air Program, Environmental Program, Resource Management Division

Thomas Howes, Natural Resources Manager, Fond du Lac Natural Resources Program, Resource Management Division

Kelsey Taylor, Invasive Species Coordinator, Fond du Lac Invasive Species Program, Resource Management Division

Christian Nelson, Forester, Fond du Lac Forestry Program, Resource Management Division

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

OVERVIEW

Goals of the Report

The Anishinaabeg (Ojibwe/Chippewa) people recognize a profound and direct relationship between the time of the ancestors and the time of the descendants. This recognition underlies the concept of looking ahead to the seventh generation, ensuring that decisions that are being made today do not have negative consequences on the quality of life of future generations. Anishinaabeg also consider all life on earth to be family or relatives, and this cultural framework affirms the interrelationship of all creation. Indigenous worldviews recognize the interdependency between humans and nature, the physical and spiritual worlds, the ancestors and future generations; all living things, animate or inanimate, are bound by a connection to everything else. This interconnectedness of all things is the first law of ecological thought (excerpted from the Fond du Lac Health Impact Assessment, 2018). Water or nibi is considered sacred, the lifeblood of Mother Earth, and all life relies upon it and is connected to it.

The goal of the Assessment Report is to provide information and guidance for managing nonpoint source pollution on the Fond du Lac Reservation. The report contains the following components:

1. Identification of navigable waters that cannot be expected to attain or maintain Tribal water quality standards without the control of nonpoint source pollution.

2. Identification of the categories and subcategories of nonpoint source pollution that contribute to the water quality problems for the individual waters and overall watersheds identified in #1 above.
3. Description of how the Tribe will identify the best management practices (BMPs) needed to control each category and subcategory of nonpoint source pollution identified in #2 above, as well as describing how the management practices will be used to reduce the level of pollution resulting from these sources.
4. Description of existing Tribal, State, Federal, and other programs that might be used for controlling nonpoint source pollution

This report serves as an update of Fond du Lac's 2004 319 Non-Point Source Pollution (NPS) Assessment Report.

INTRODUCTION

Updated Agency Information

The Fond du Lac Resource Management Division (FDL RM) has expanded considerably since the 2004 319 Assessment Report. The following programs within the Resource Management Division are referenced in this report:

- FDL Environmental Program: includes General Assistance Program, air and water quality, alternative energy, brownfields, wetlands protection and environmental education. The Office of Water Protection (OWP) is within the Environmental Program.
- FDL Forestry Program: includes forest management, fire management, timber sales, burn permits and public education.
- FDL Invasive Species Program: includes the protection of native and culturally significant species through the management of invasive species within the Fond du Lac Reservation boundaries and Ceded Territories.
- FDL Natural Resources Program: assists in tribal cultural resource harvesting, including treaty fisheries and treaty hunting management, technical assistance on resource management projects, and manoomin (wild rice) protection and management on the Reservation and in Ceded Territories.

Environmental Setting

The Reservation, established by treaty with the United States Government in 1854, is a 101,850-acre area located in east central Minnesota near the City of Cloquet (population 11,000), approximately 20 miles southwest of Duluth and Lake Superior (Figure 1). It includes 54,000 acres of forested land, plus approximately 44,000 acres of wetlands. There are 108 bodies of water, totaling 3,268 acres and 37 of those lakes and ponds are larger than 5 acres. Manoomin (wild rice) waters make up approximately 843 acres, or 26% of all water acreage on the Reservation. The Reservation also contains 96 miles of rivers and streams. The St. Louis River, the largest tributary to Lake Superior on the United States side, drains approximately 90% of the Reservation and comprises the entire northern and most of the eastern boundary. In addition, Fond du Lac owns land outside the Reservation boundaries, including in Duluth, the St. Louis River Estuary, the end of Wisconsin Point, and elsewhere (Figure 2). Fond du Lac is a signatory

to the 1837, 1842 and 1854 treaties and retains usufructuary rights in those Ceded Territories. Maps of the territories can be found at http://www.fdlrez.com/RM/fdlmaps.htm.

Figure 1. Fond du Lac Reservation Location

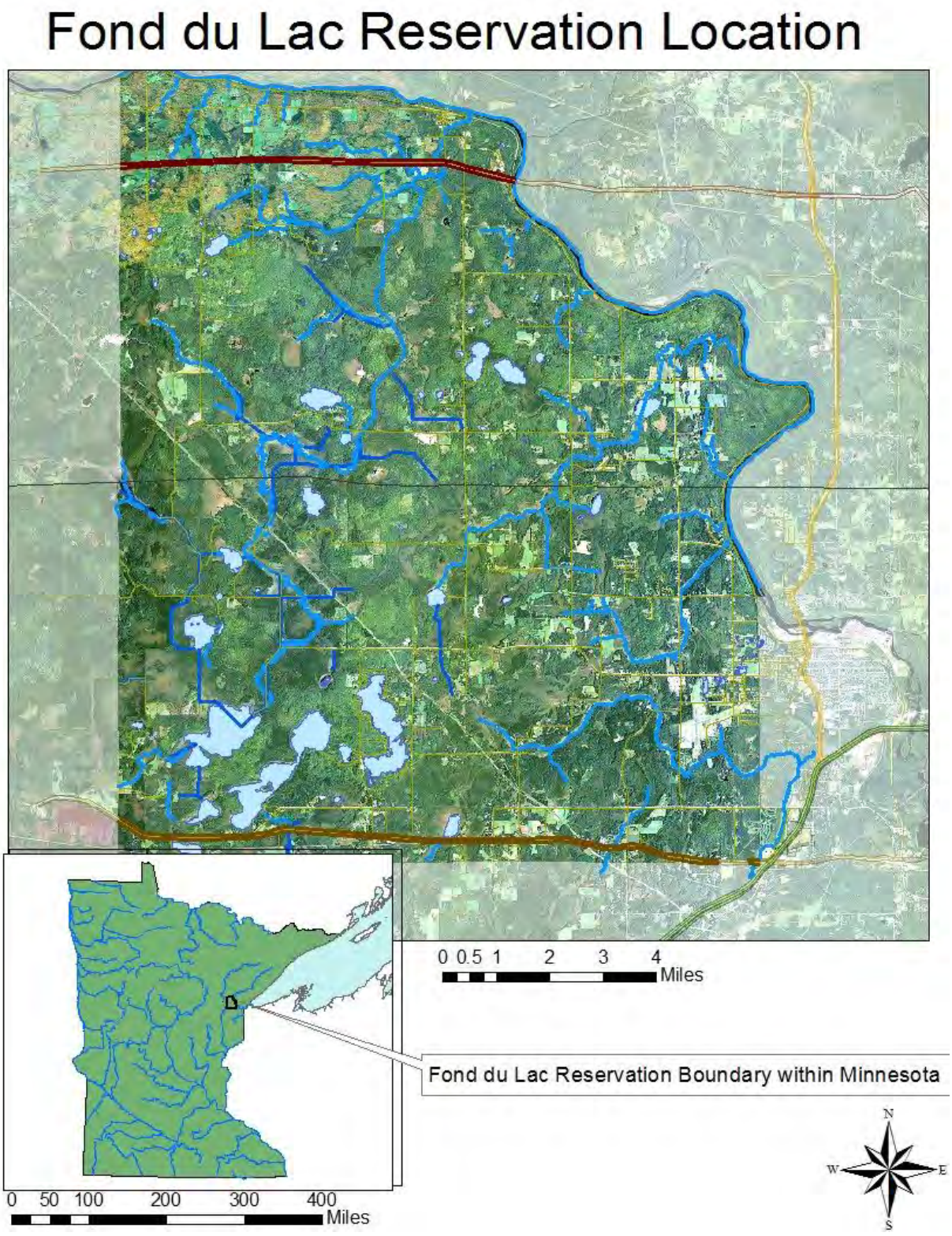
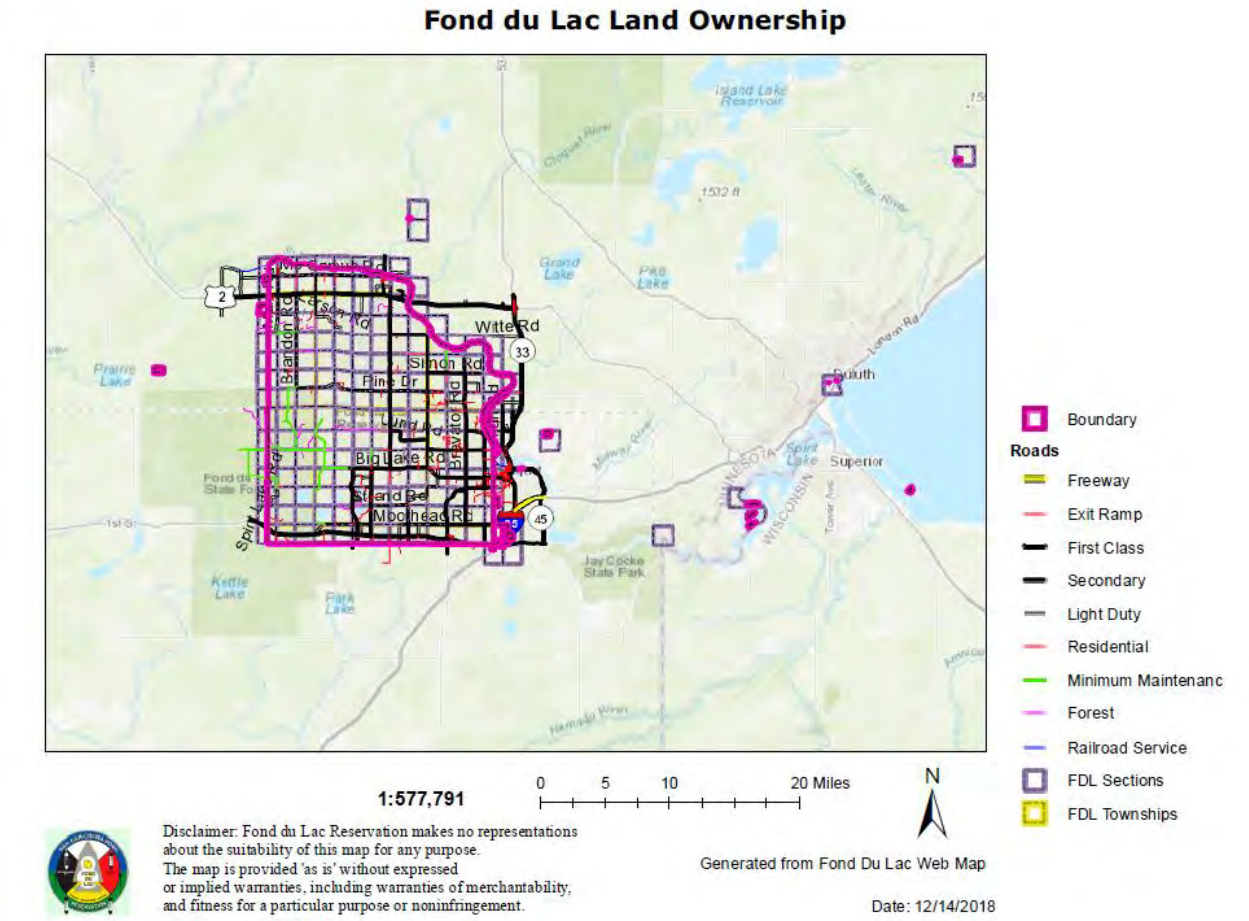


Figure 2. Fond du Lac Land Ownership in the Region



Updated Water Information

Surface Water Features

Watersheds

For purposes of this report, the Reservation has been delineated into 5 major watershed basins (Figure 3). Watershed delineation has been updated since the 2004 319 NPS Assessment Report; the Minnesota DNR Watershed Suite and the National Hydrography Dataset (NHD) both use updated light detection and ranging (LiDAR) and elevation data to create accurate watershed boundaries (Thomas, 2014). In some cases, watershed boundaries have been changed since the 2004 report.

Almost half of the Reservation is covered by lakes, streams, rivers, and wetlands (Figure 12). This includes:

- 23 lakes
    - 3,600 acres of fisheries and wild rice areas
    - 6 lakes have maximum depths greater than 12 feet – Big, Lac, Joe Martin, Third, Spruce, and West Twin

- 96 miles of streams and rivers

- 4 trout streams (34 miles) – Otter Creek, Martin Branch, Little Otter Creek, and Fond du Lac Creek
- All drain to the St. Louis River except for a small area in the south central portion which drains to the Kettle River

Stoney Brook Watershed

Comprising almost the entire western half of the Reservation, the upper end of this watershed has the largest concentration of recreational, fishing and wild rice lakes in the Reservation (Figures 3 and 4). The entire Stoney Brook drainage has been significantly altered by the construction of drainage ditches in the early 1900s. The ditches are mostly concentrated near Perch, Jaskari, Rice Portage, Spruce (Spirit), Miller (Mud), and Deadfish lakes. Today the major issues focus on maintenance associated with this artificially created drainage system and managing hydrologic and NPS from the pipeline corridor. Beaver dams also impact wild rice lake hydrology.

St. Louis River Watersheds

Located along the northern and eastern edge of the Reservation, these lands drain directly to the St. Louis River. They include high-quality deciduous floodplain forested wetlands (Figures 3 and 4)

Simian Creek Watershed and Big Lake Catchment

Located in the central and northeastern portion of the Reservation, Simian Creek is unique in that it contains the only flowage lake on the Reservation, Simian Lake, which is in-line with the creek (Figures3 and 4). There has been some minor impact by drainage ditch construction, but not nearly to the degree of Stoney Brook. The Big Lake catchment includes the largest recreational lake on the Reservation, which has been heavily impacted by shoreline development and failing septic systems.

Otter Creek and Fond du Lac Creek

Located in the southeastern quadrant of the Reservation, these state-designated brook trout streams have potentially been impacted by road crossings and Otter Creek and its tributary, Little Otter Creek, have the potential to be impacted by the Black Bear Casino and Golf complex (Figures 3 and 4). Jolicoeur Creek, a small groundwater-fed tributary to Otter Creek and an important source of cold water for brook trout, has been heavily impacted by collapsed roadways, a pipeline corridor and gravel mining.

Moosehorn River

Located in the south-central portion of the Reservation, this watershed forms the headwaters of the Kettle River Watershed (Figures 3 and 4). This watershed boundary constitutes a continental divide because it is in the Mississippi Basin, while the rest of the Reservation is in the Great Lakes Basin. There are no defined stream courses in this basin, except the outflow from Wild Rice Lake that forms the headwaters of the Moosehorn River (and flows into the Kettle River via the Moose River)

Figure 3. Minnesota DNR Watershed Boundaries

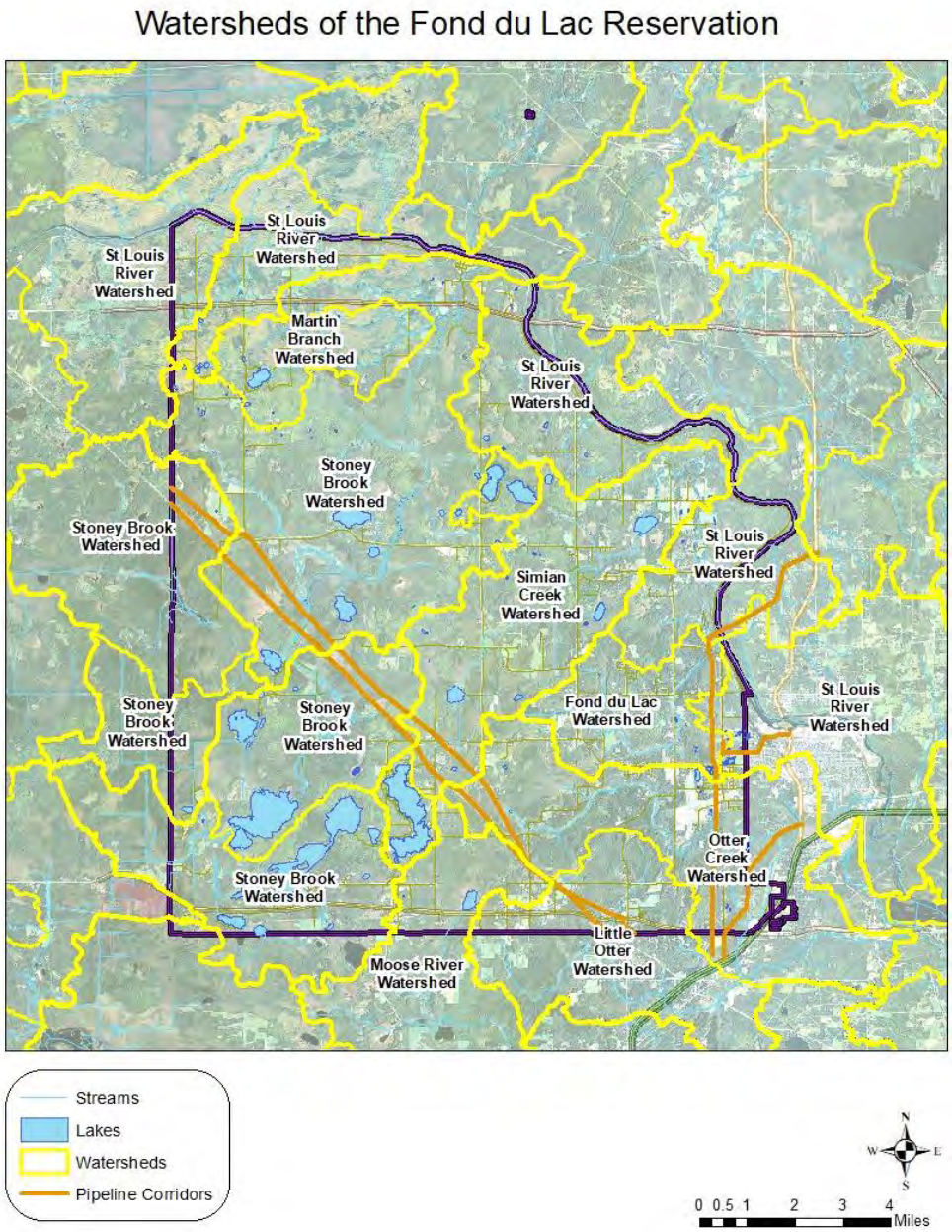
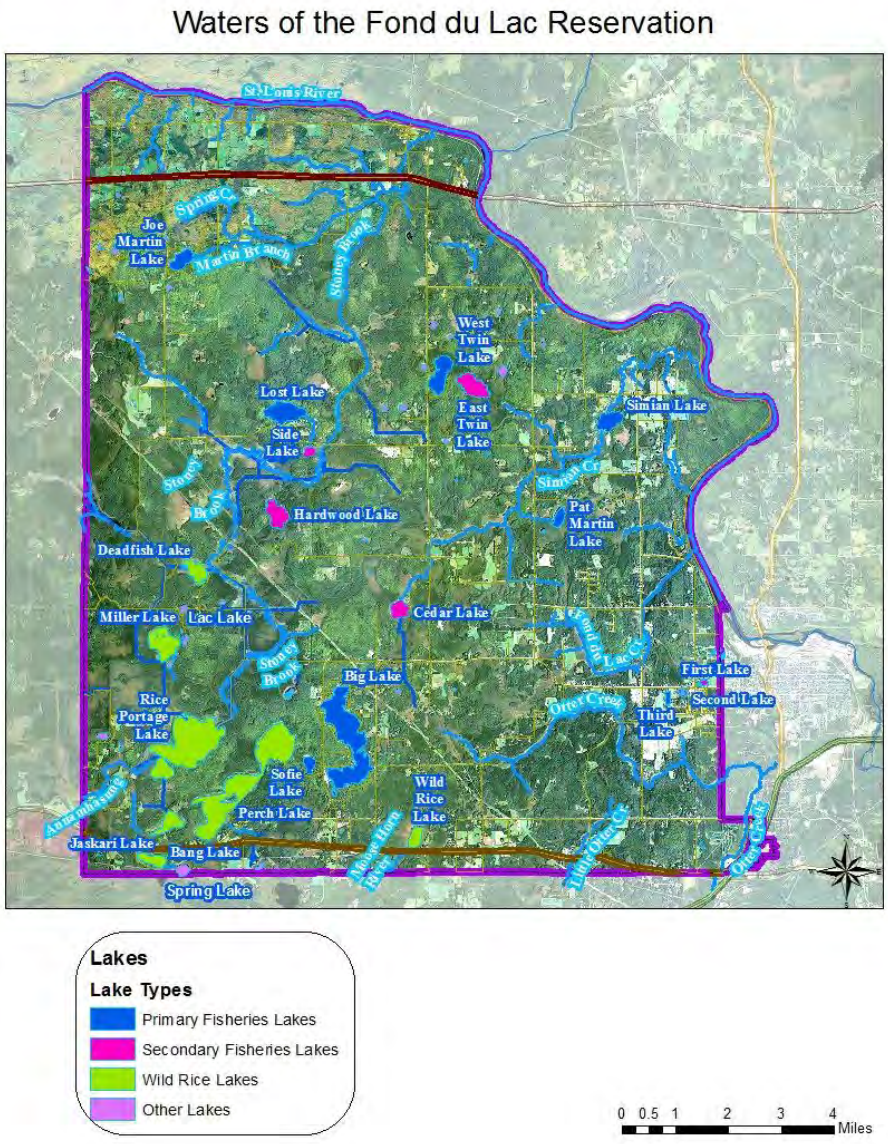


Figure 4.Waters of the Fond du Lac Reservation



Watershed Health Assessment Framework

The MN DNR maintains Watershed Health Assessment Framework (WHAF) Scores for each of the HUC-8 watersheds in the state, broken up into five components: Biology, Connectivity, Geomorphology, Hydrology and Water Quality. According to the WHAF website, "Watershed Health Index Scores show patterns of health within each of the five components. Scores are scaled 0 (least healthy) to 100 (best health). The Mean Watershed Score combines the mean (average) score for each of the five components into an overall average watershed health score. Each of the five components has an equal influence on the combined Mean Watershed Score." (MN DNR, 2020) The Mean Watershed Score for the St. Louis River Watershed is 66, and the 2015 WHAF Report Card for the St. Louis River Watershed (Appendix A) shows that the sub-basins within the Reservation have high scores, except in a few cases, including altered streams, terrestrial habitat quality and stream species quality (mussels and aquatic invertebrate IBIs[1]). The catchment around Big Lake received a very low score for septic systems. The Reservation sub-basins

score high for the only NPS-specific category included in the assessment framework, which is phosphorus risk.

[1]Note that the state and the tribe maintain different sites and methods for assessing macroinvertebrate scores. Fond du Lac's BCG scores tend to be higher than state scores, as we choose sites with higher-quality habitat that are representative of each stream. This is reflected in our BCG report (see the Water Quality Assessment Section).

Manoomin (Wild Rice)

Manoomin (wild rice) is perhaps the single most important natural resource on the Fond du Lac Reservation. To the Ojibwe people manoomin is amongst the most sacred of the gifts of the natural world and is central to the Ojibwe lifeway. Since arriving in the Great Lakes region hundreds of years ago the Ojibwe have relied upon manoomin for spiritual, physical and economic well-being. For the Fond du Lac Band the presence of manoomin played a key role in determining territory to retain as a permanent homeland during the negotiation of the 1854 Treaty of LaPointe. Manoomin is susceptible to damage from seasonal climactic events such as above average precipitation, drought, high winds, and hail.

There are five primary manoomin producing waterbodies on the Fond du Lac Reservation. These lakes are all within the Asini-ziibi (Stoney Brook) Watershed, which is tributary to the St. Louis River. Primary manoomin producing waterbodies can be defined as those waterbodies that support growth of manoomin to a degree that makes them of interest for human harvesting activities in most years. The total area on which manoomin is currently present on these lakes is approximately 843 acres. Seasonal variability in acreage is to be expected given the unique biological characteristics of manoomin. The average manoomin producing acreage on the individual lakes are:

- Aatawemegokokaaning (Perch Lake) 392 acres
- Mashkiigwaagamaag (Miller/Mud Lake) 141 acres
- Chi-awasonigaming (Rice Portage Lake) 161 acres
- Naawonigami zaaga'igan (Jaskari Lake) 75 acres
- Zhaaganaashiins Odabiwining (Deadfish Lake) 74 acres

Manoomin is also present in Beke-zaagidawaag (Side Lake), Gaagiizhikikaag (Cedar Lake), Manoomini-zaaga'iganing (Wild Rice Lake), Chi-wizo-zaaga'iganing(Simian Lake), and Chimaanakikii-zaaga'igan (Hardwood Lake). Beke-zaagidawaag and Chi-maanakikii-zaaga'igan are within the Asini-ziibi Watershed. Gaagiizhikikaag and Chi-wizo-zaaga'iganing are within the Chiwizo-ziibi (Simian Creek) Watershed. Manoomini-zaaga'iganing is the headwaters of the Moosehorn River, a tributary of Akiko-ziibi (Kettle River).

Updated Wetland Information

The Fond du Lac Reservation is rich in wetlands, and they have significant value to wildlife. In addition to the fishery, the species that benefit from these environments include ducks, geese, tundra swans, sandhill cranes, herons, bitterns, shorebirds, bald eagles, osprey, march hawks, mink, muskrat, beaver, otter, deer, and moose. The Reservation has high value wildlife habitat and supports important wildlife populations. The Tribe also values hunting, trapping, and fishing for Band and non-Band members.

National Wetland Inventory

The State of Minnesota developed a new National Wetland Inventory (NWI) geodatabase that correspond to base imagery for the years between 2009 and 2014. According to the Minnesota NWI metadata, "the updated NWI data delineate and classify wetlands according to the system developed by Cowardin et al.

(1979), which is consistent with the original NWI. The updated data also contain a simplified plant community classification (SPCC) and a simplified hydrogeomorphic (HGM) classification." (Kloiber, 2019). Figures 5 and 6 represent Fond du Lac wetland using the Cowardin classification system and the SPCC system, respectively.

Figures 7-9 show the three main types of wetland water flow on the Reservation using the HGM classification: outflow, throughflow and bi-directional/vertical (note that actual water flow is likely more complex than these maps represent, and flow type may change based on the amount of water contributed by surface water or groundwater). The NWI dichotomous key (USFWS, 2020, Tiner, 2003) for water flow path define the basic flow types. An outflow wetland "receives no surface or ground water inflow from a wetland or permanent waterbody at a higher elevation and surface or ground water is discharged from this wetland to a stream, wetland, or other waterbody at a lower elevation." A throughflow wetland "receives surface or ground water from a stream, other waterbody or wetland (i.e., at a higher elevation) and surface or ground water passes through the subject wetland to a stream, another wetland, or other waterbody at a lower elevation." A vertical flow wetland, also known as an isolated wetland, has "no surface or groundwater inflow from a stream, other waterbody, or wetland and no observable or known outflow of surface or ground water to other wetlands or waters" – this last category should not be confused with jurisdictionally isolated wetlands, but instead be understood as wetlands that exist because of a high water table. A bi-directional flow wetland exists where "water levels fluctuate due to lake influences or to variable river levels, but water does not flow through this wetland."

The updated NWI has been used for wetland delineations and determinations, a new Wetland Restoration Plan, and for a wetland monitoring and assessment program (FDL Office of Water Protection, 2013). A wetland functional analysis is available for the Reservation, which follows Tiner (2003, 2014) and highlights wetlands with high and moderate functions (Figure 10). The majority of high-functioning wetlands on the Reservation are either wild rice lakes (which are also classified as aquatic bed wetlands) or are adjacent to streams. The functional assessment then informed the creation of a wetland restoration prioritization, which shows places where wetlands are not meeting one or more functions at a high level, and restoration could improve their functions (Figure 11). Such analyses are considered in the 319 NPS assessment. Since the 2004 report, Fond du Lac now has an established protocol for assessing wetland quality, and the wetlands in each major watershed are assessed on a five-year rotating basis. Generally, wetlands on the Reservation are high-functioning, though impacts to wetland function are mostly due to NPS impacts, especially hydromodification and roads.

Wetland Types

The main types of wetlands found on the Fond du Lac Reservation are as follows:

- Forested Wetlands – These wetlands are dominated by trees. This is the most commonly found wetland type on the reservation. Over 29,000 acres or 66% of all the wetlands on the Reservation are forested.
- Scrub Shrub Wetlands – These wetlands are dominated by woody species other than trees. This is the second most prevalent type of wetland found on the Reservation. Over 12,000 acres or 28% of all the wetlands on the Reservation are scrub shrub wetlands.
- Emergent Wetlands – Emergent wetlands are those in which the primary plants "emerge" from the surface of the water. However, these wetlands sometimes do not have standing water but rather have saturated soils. Over 2,000 acres or 5% of all wetlands on the Reservation are emergent. Wild rice waters are included in this wetland type, therefore the majority of emergent

wetlands on the Reservation are actually wild rice lakes including Miller, Perch (south basin), Side, Jaskari, Bang, Wild Rice, Deadfish, and Rice Portage. Other emergent wetlands are dominated by cattails or various species of sedges or grasses.

- Aquatic Bed Wetlands – These wetlands have standing water year-round and are usually dominated by floating or submerged wetland plants. Usually these are deeper water wetlands with water depths up to 6.5 feet. If the water depth exceeds 6.5 feet then it is usually classified as a lake rather than a wetland. About 386 acres or less than 1% of all wetlands on the Reservation are aquatic bed wetlands.

Figure 5. Cowardin Classification for Wetlands

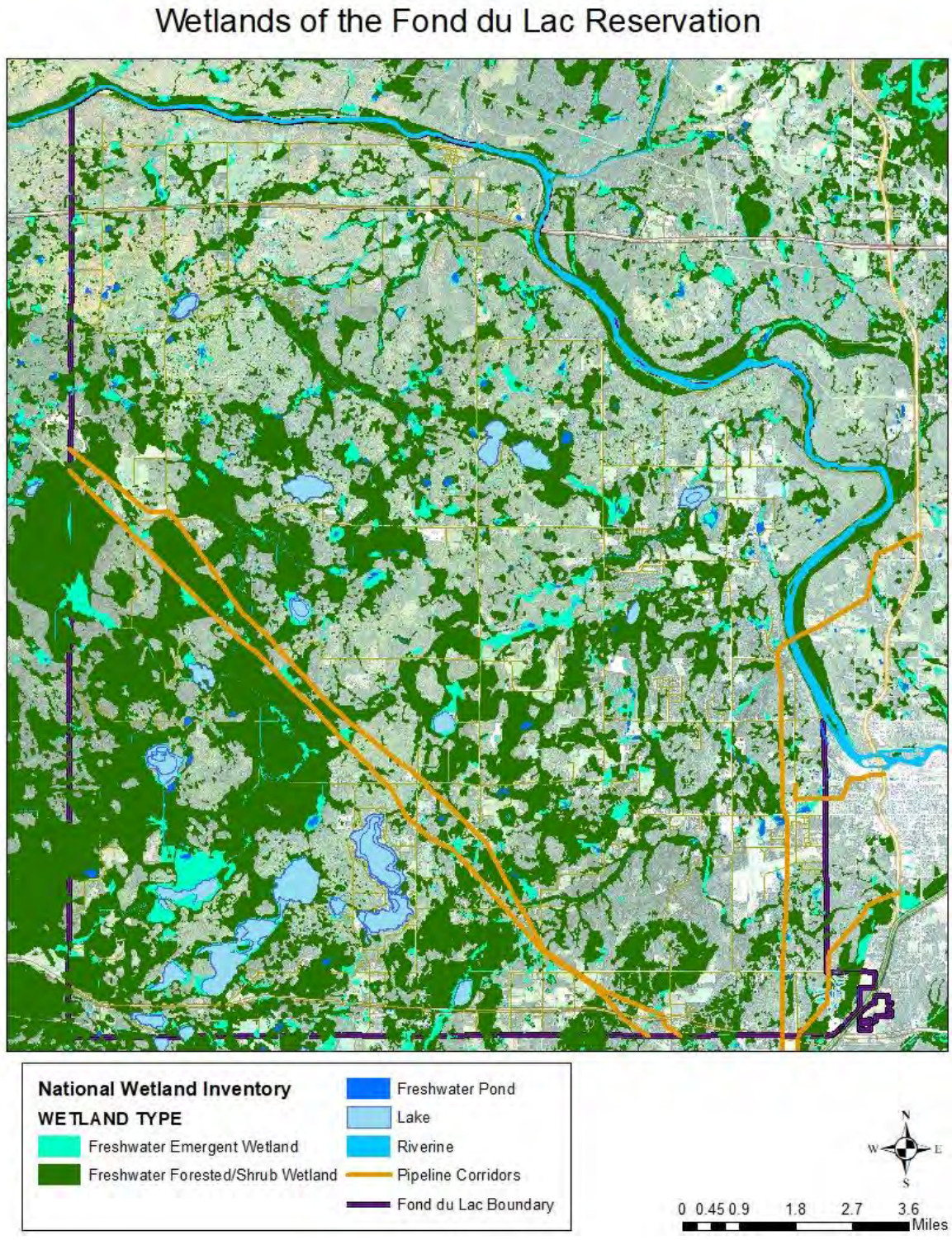


Figure 6. SPCC Classification for Wetlands

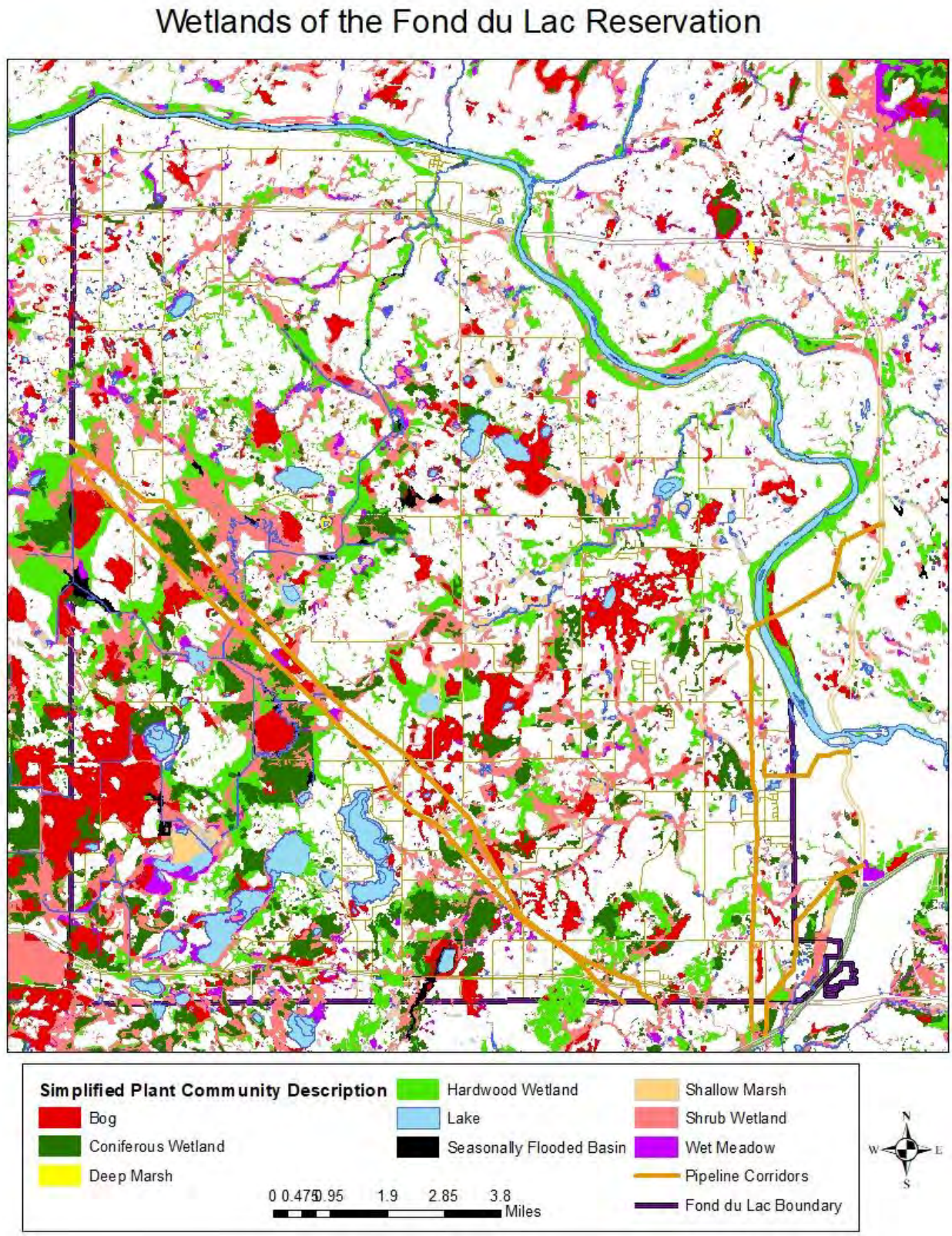


Figure 7. Outflow Wetlands

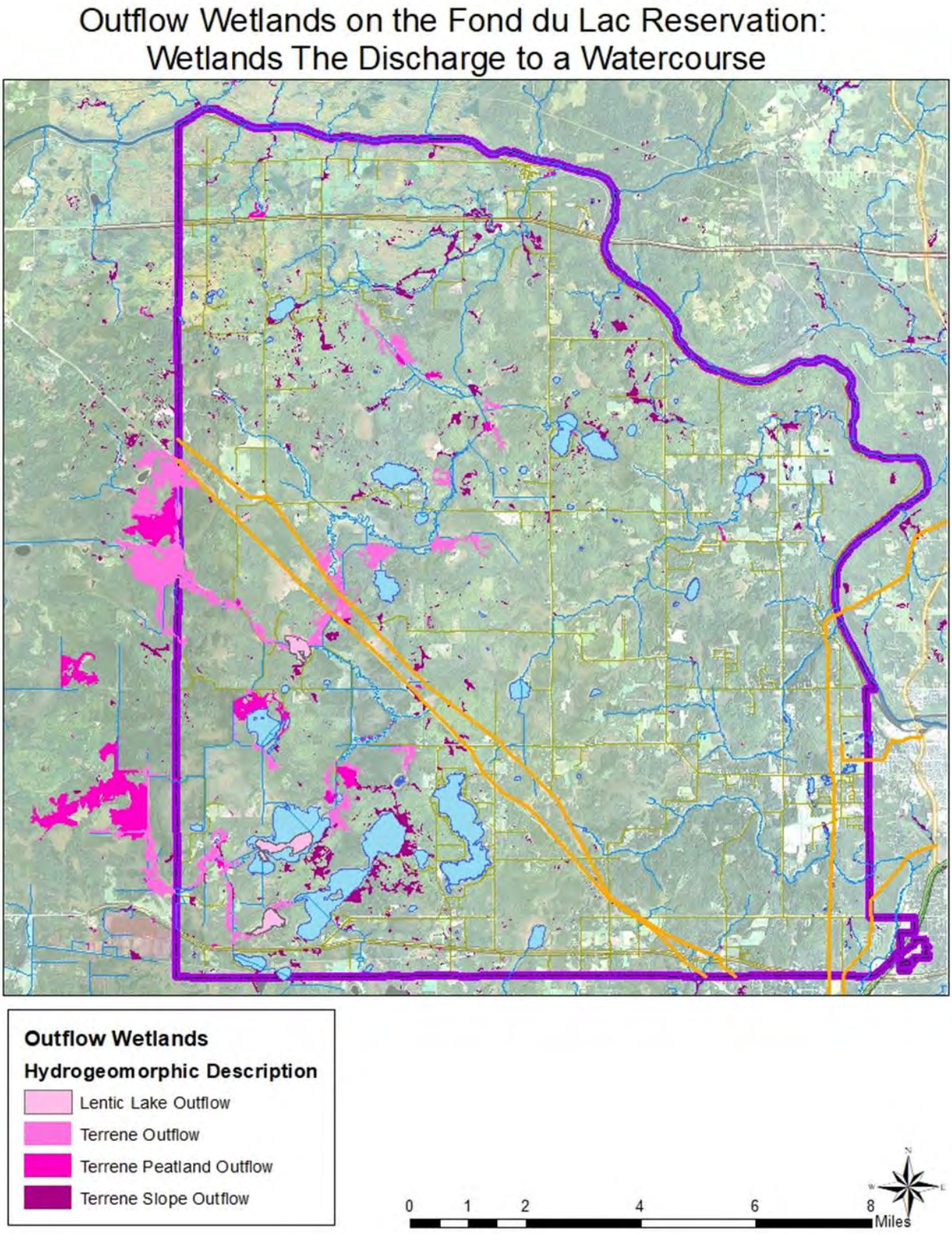


Figure 8. Throughflow Wetlands

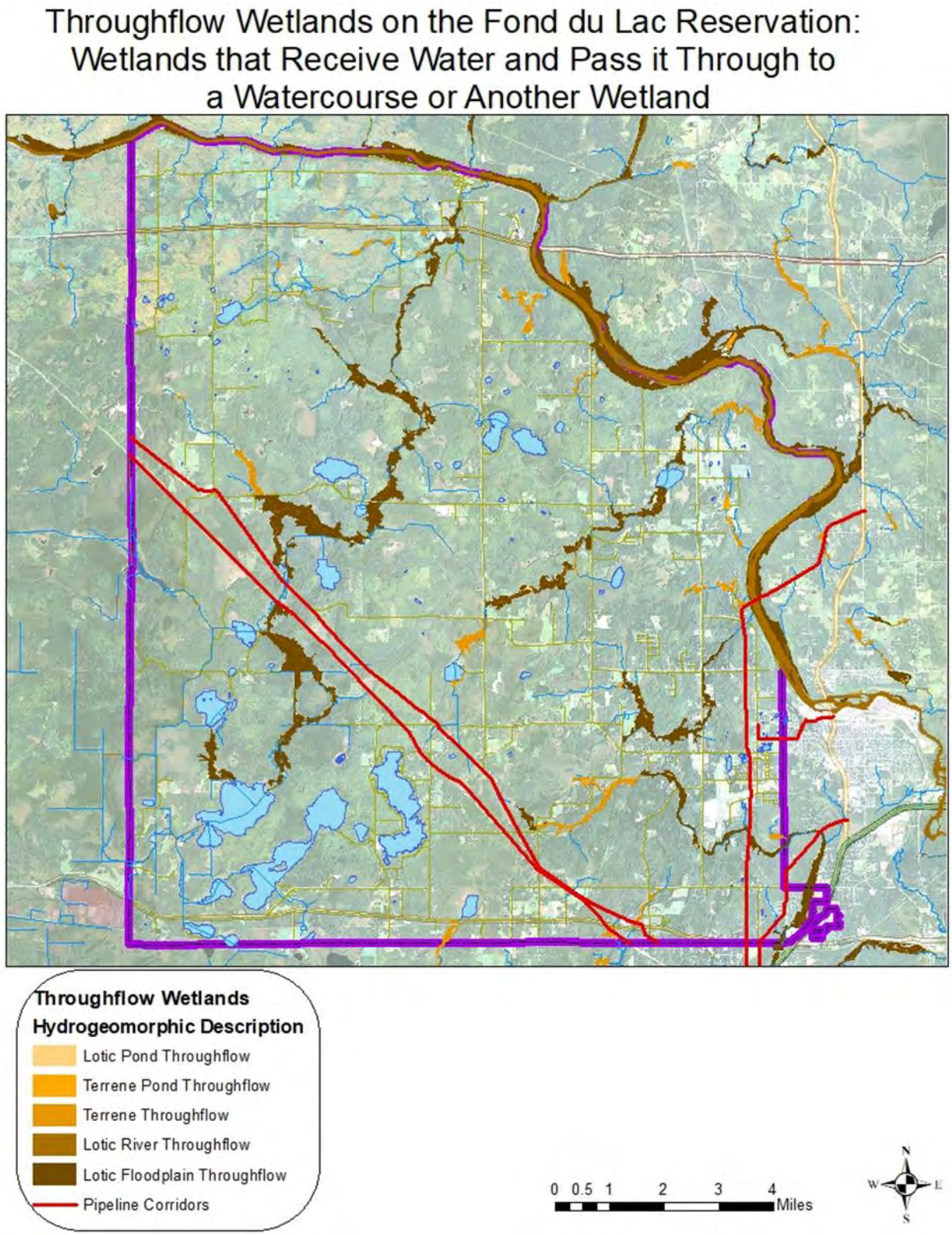


Figure 9. Bi-Directional Wetlands

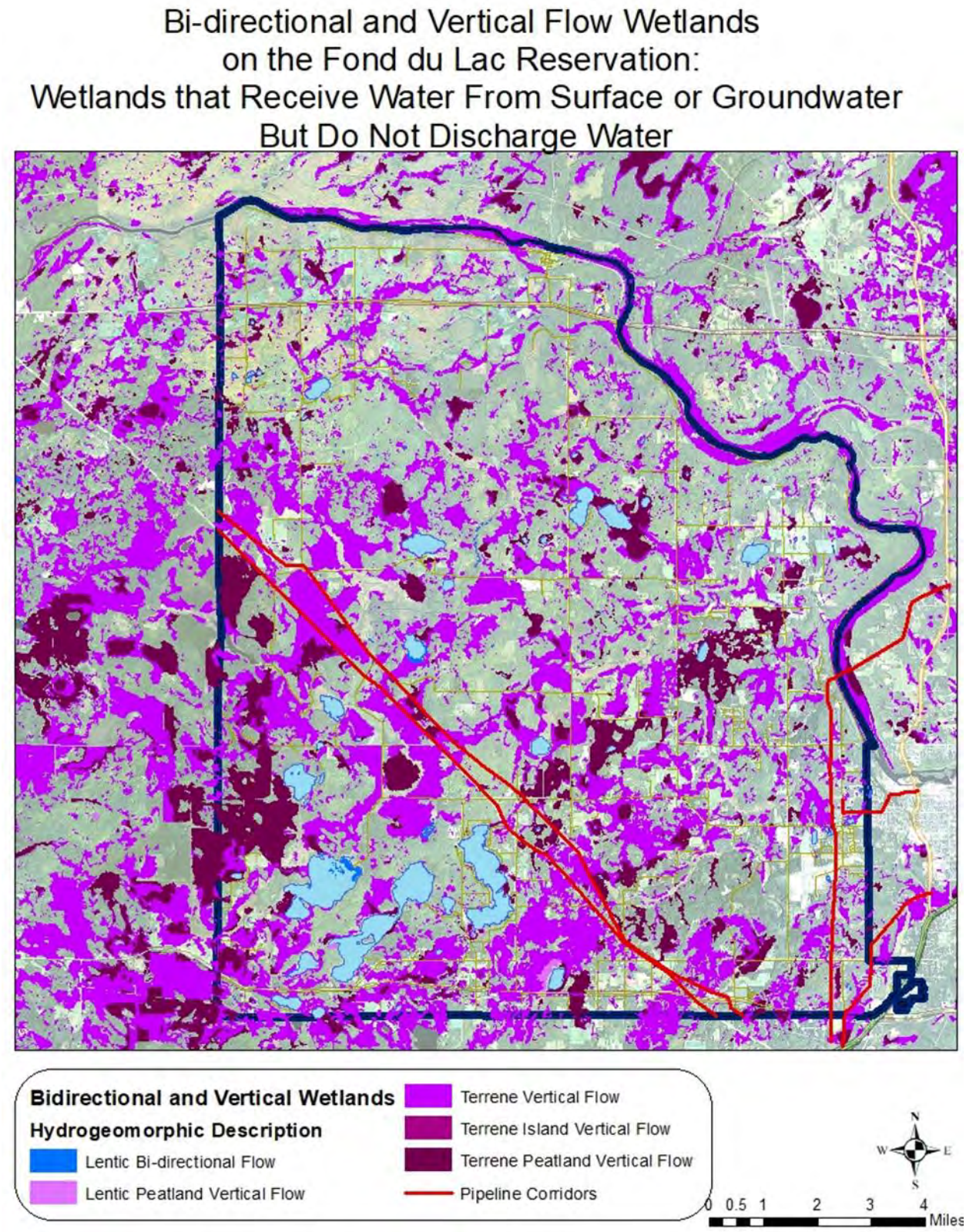
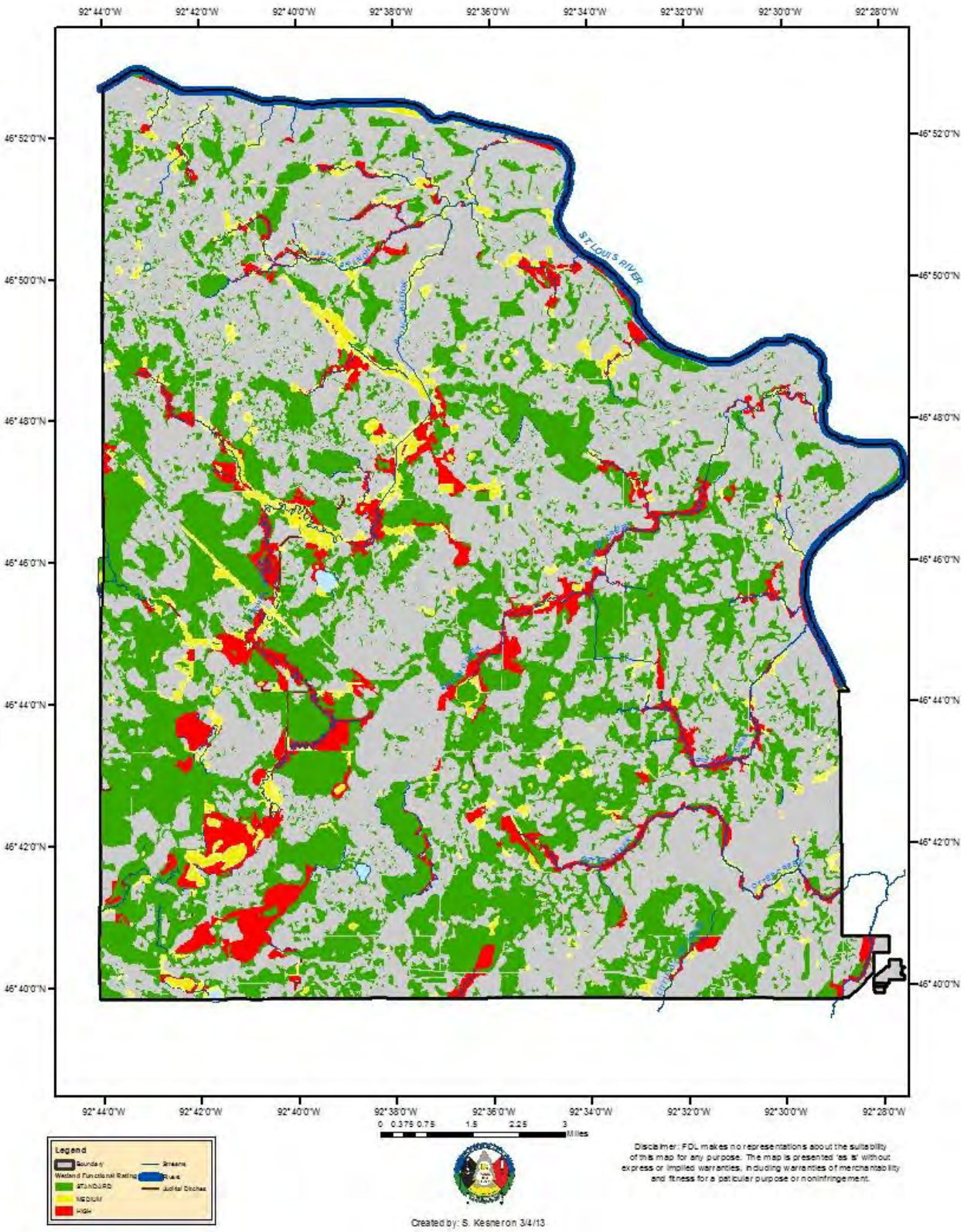
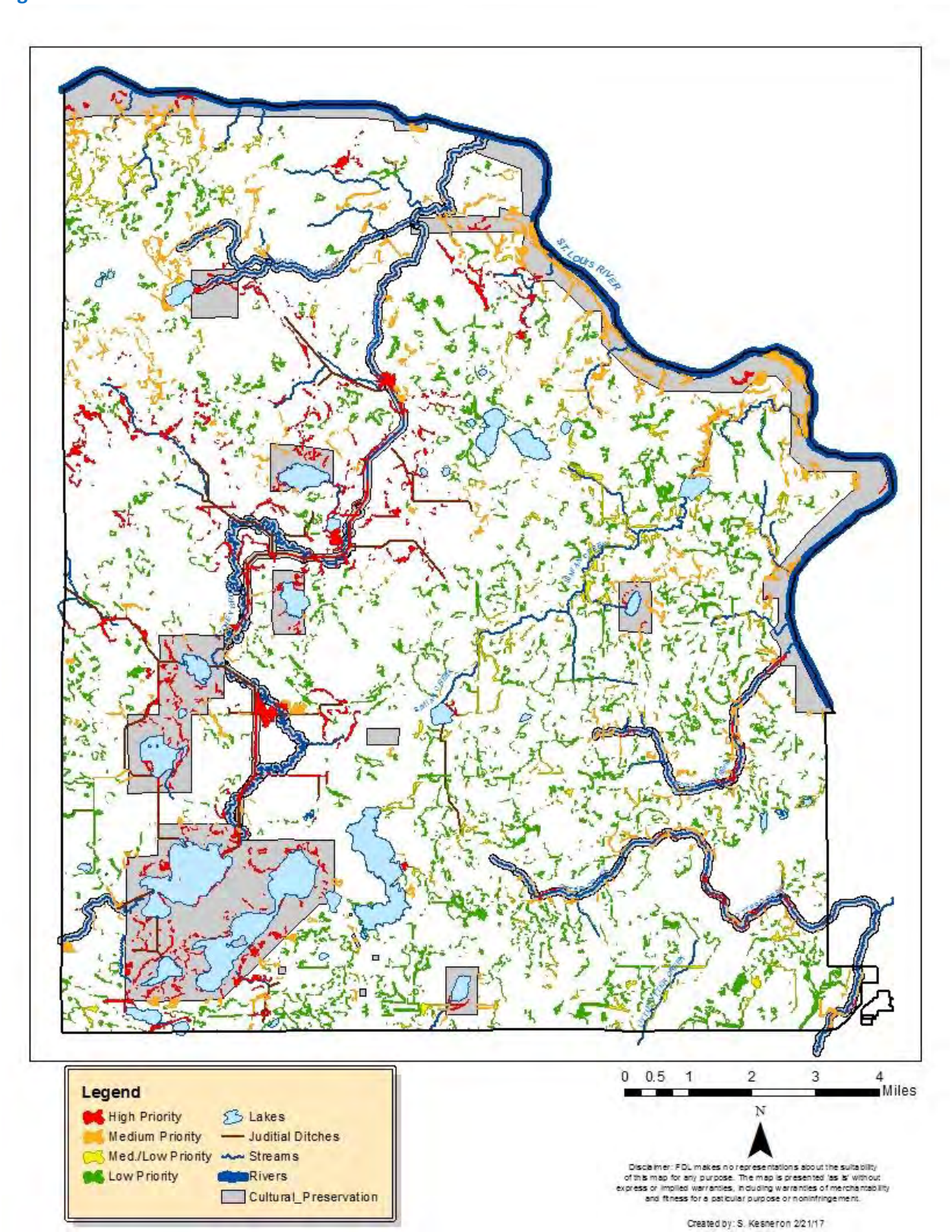


Figure 10. Fond du Lac Wetland Functional Analysis



Map created by Shannon Kesner, former FDL Wetland Specialist

Figure 11. Fond du Lac Wetland Restoration Priorities



Map created by Shannon Kesner, FDL Wetland Specialist

Updated Groundwater and Well Information

Groundwater supplies nearly 100% of drinking water and domestic water supply on the Reservation, with the exception of those residents on Cloquet municipal water supply. Cloquet draws its supply from a combination of groundwater and surface water (Lake Superior). Regional groundwater flow in all of the aquifer units intersecting the Reservation is toward the St. Louis River (Figure 12). Locally, groundwater may flow toward tributaries of the St. Louis River (Ruhl 1988). Groundwater occurs in three main aquifer units as described below (Ruhl 1988):

- The shallowest aquifer unit is an unconfined-drift aquifer. The aquifer is comprised mainly of outwash material, which covers approximately 1/3 of the Reservation (Ruhl 1988).
- The second aquifer type is a confined unit of sand and gravel present in the glacial drift. The confined unit is discontinuous across the Reservation. The confining layers associated with the confined aquifer are generally clayey glacial till.
- The deepest aquifer unit consists of a fractured bedrock aquifer present in the upper portion of the Thomson Formation. It is believed that groundwater occurs in the highly fractured upper portion of the bedrock under confined conditions.

When Minnesota passed the State Water Well Construction Code in 1974, it mandated that well drillers provide the State with a report for each well drilled after the code was enacted. Since then, Minnesota's Department of Health has collected a considerable amount of drilling reports, which provide basic information such as location of the well, the aquifer used, and the geology observed in the well core. In cooperation with the Minnesota Geology Survey, the County Well Index (CWI) was created by gathering data provided in the reports and making them accessible by county. It is updated on a continuous basis with an estimated 10,000 wells a year, but many of the wells are classified as "unlocated" if the well location has not been actively ground-truthed and verified. The Fond du Lac Reservation has a reported 743 private drinking wells on the Reservation, and 444 of those have been verified (Figure 13). The CWI database isn't meant to be the only tool used in land management policy development, but it useful in providing a snapshot of the region's general hydrogeology without performing any test bores. Figure 15 identifies the areas where wells are heavily concentrated in the community. These are high priority areas for protecting wellheads from point and nonpoint source pollution.

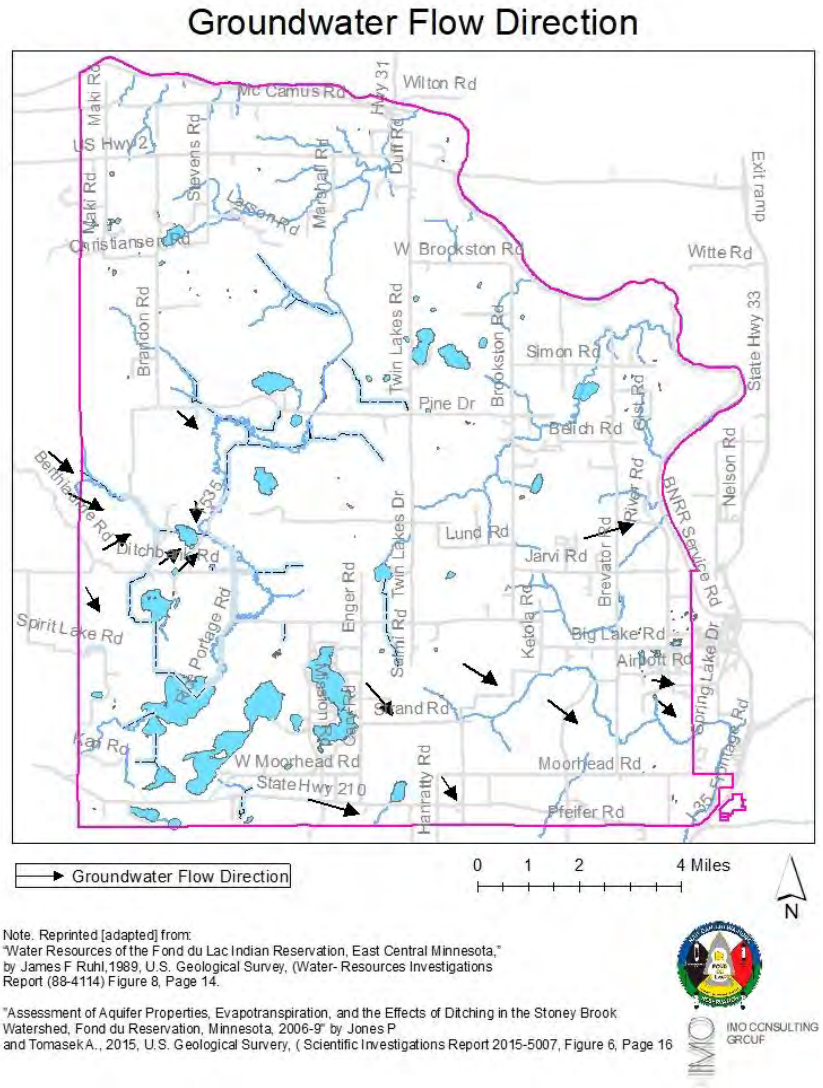
Carlton County Geologic Atlas

The County Geologic Atlas program produces maps and databases that describe the geology and water and mineral resources of a county in forms useful for land use planning and resource management (Boerboom, 2009). The Minnesota Department of Natural Resources (MNDNR) cooperates with the Minnesota Geologic Survey (MGS) in producing the atlases and funding them. MNDNR produces maps and databases focused on the quality, sensitivity, and quantity of water within the units mapped by MGS. The program supports informed decision-making and helps the counties, municipalities and other local government units achieve their goals and effectively fulfill their management obligations in a cost-effective manner. Tribal land use planners use geologic atlases to site environmentally sensitive facilities, to plan for the use and protection of natural resources, to guide implementation of best management practices, and to focus planning efforts and financial resources on those areas where they will have the greatest impact. Water resource planners use the atlases to support decisions about their water supply, to manage contamination, to identify and protect critical recharge zones, to assist in preparing wellhead protection plans, and to regulate well and septic system construction. The atlases are also widely used by

state agencies, consultants, well drillers and land owners. When Carlton County began work to update their geologic atlas, Fond du Lac provided funding from our Section §319 program grant to support that work and to add the portion of the Reservation within St. Louis County. Figure 14 shows pollution sensitivity for shallow groundwater aquifers and Figure 15 shows pollution sensitivity for near-surface materials; these data will be considered for the NPS assessment.

Arsenic is a naturally-occurring element that is part of surficial and bedrock geological features, and it is sometimes released into groundwater. In places where groundwater feeds into lakes and streams, it can cause high arsenic levels. Cedar Lake and Second Lake both have arsenic levels that sometimes rise above Fond du Lac's water quality standards, but these exceedances are due to natural conditions.

Figure 12. Groundwater Flow Direction



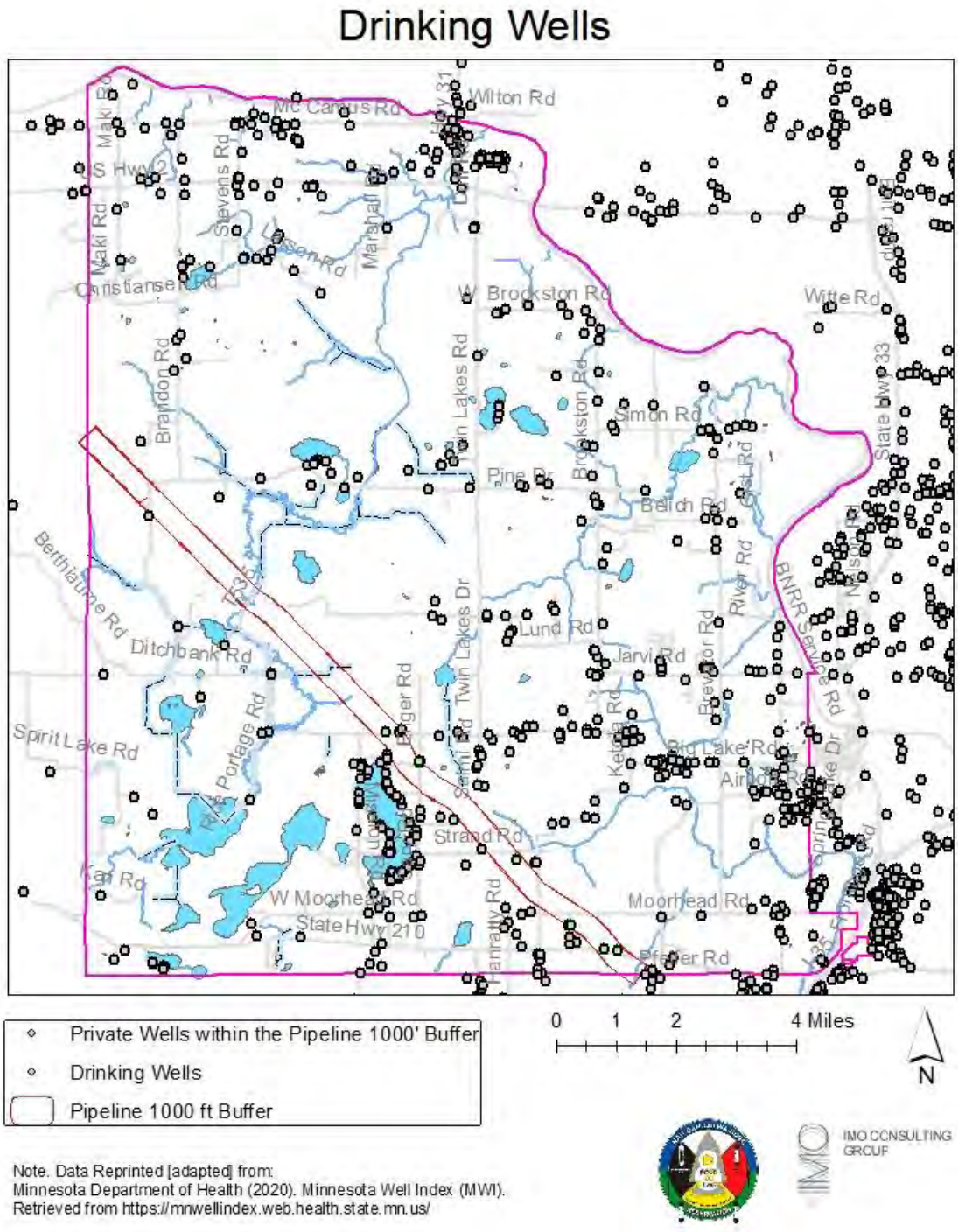
Note. Reprinted [adapted] from:
"Water Resources of the Fond du Lac Indian Reservation, East Central Minnesota,"
by James F Ruhl,1989, U.S. Geological Survey, (Water- Resources Investigations
Report (88-4114) Figure 8, Page 14.

"Assessment of Aquifer Properties, Evapotranspiration, and the Effects of Ditching in the Stoney Brook
Watershed, Fond du Reservation, Minnesota, 2006-9" by Jones P
and Tomasek A., 2015, U.S. Geological Survey, (Scientific Investigations Report 2015-5007, Figure 6, Page 16

IMO CONSULTING GROUP

Map created by Cristina Weske, FDL Groundwater Specialist

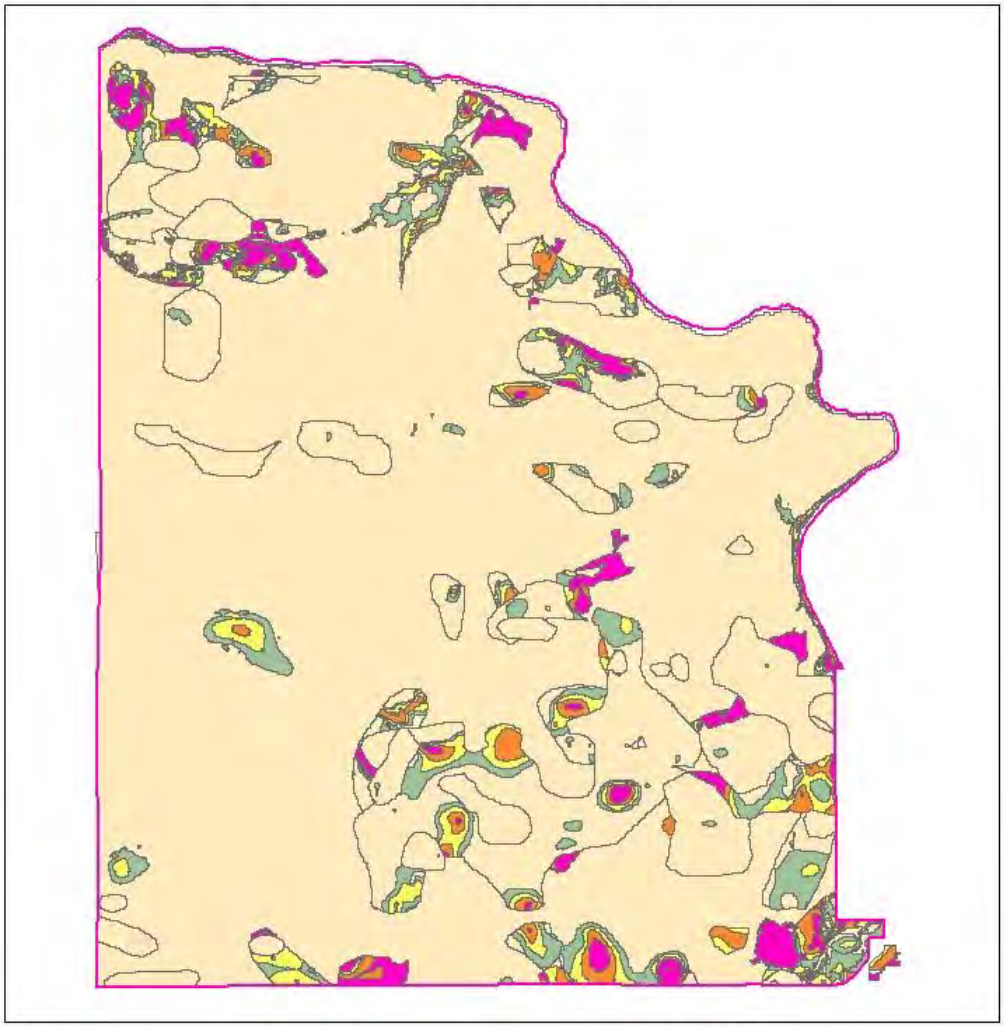
Figure 13. Drinking Wells



Note. Data Reprinted [adapted] from:
Minnesota Department of Health (2020). Minnesota Well Index (MWI).
Retrieved from https://mnwellindex.web.health.state.mn.us/

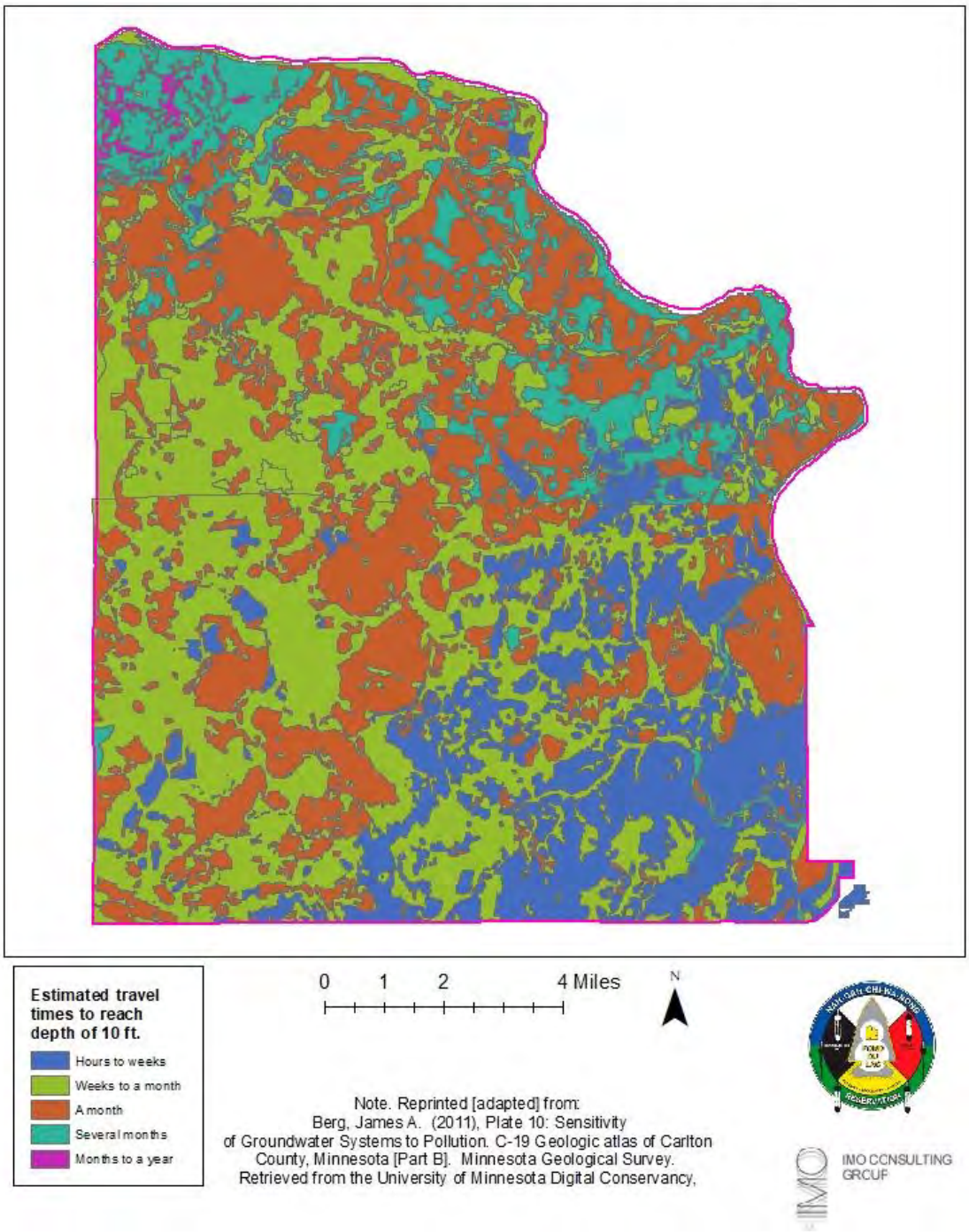
Map created by Cristina Weske, FDL Groundwater Specialist

Figure 14. Pollution Sensitivity Ratings for Buried Sand, Gravel and Bedrock Aquifers.



Map created by Cristina Weske, FDL Groundwater Specialist

Figure 15.Pollution Sensitivity Ratings for Near-Surface Materials within the Fond du Lac Reservation.



Map created by Cristina Weske, FDL Groundwater Specialist

Updated Forest Type Information

Reservation lands originally supported a coniferous and deciduous forest of eastern white pine, red pine, jack pine, black spruce, white spruce, balsam fir, tamarack, northern white cedar, aspen, maple, birch, basswood, and oak. Logging and the catastrophic fires of 1918 drastically altered the character of the forest. Today re-growth of the forest is mostly aspen and birch and the lands are harvested mostly for pulpwood.

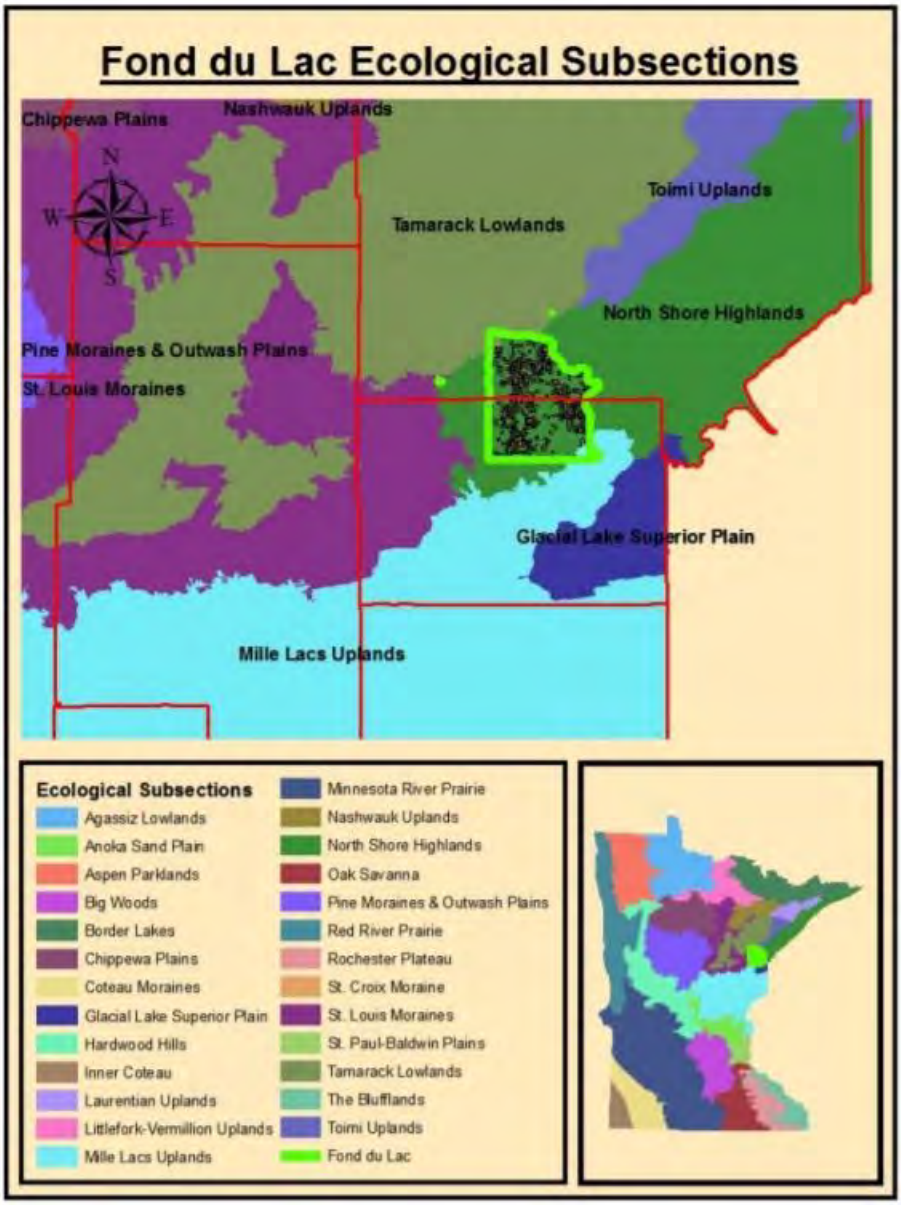
Ecological Subsections

FDL relies on the Ecological Classification System to determine forest types. According to FDL's Integrated Resource Management Plan (2018):

The Reservation is mostly within the North Shore Highlands Subsection, which lies within the Northern Superior Uplands section (Figure 16). The Northern Superior Uplands largely coincides with the extent of the Canadian Shield in Minnesota and is characterized by glacially scoured bedrock terrain with thin and discontinuous deposits of coarse loamy till (soil) and numerous lakes and wetlands. The Fond du Lac Band owns about 44,500 acres of land within the Reservation boundary. Of this, about 28,000 acres is forested. The majority of FDL forests are dominated by aspen, a fast-growing sun-loving tree species. Other cover types include several thousand acres of northern hardwoods (a mix of sugar maple, basswood, and yellow birch), red pine, black ash, and swamp conifers (a mix of black spruce, northern white cedar, and tamarack).

Foresters and technicians are able to determine the likely soil nutrient and soil moisture regime of the site, the historic vegetation likely present on the site, what the successional pathway of a given stand of trees is, and what tree species are best suited for the site. Aspen and birch made up over a third of the land base in the past and make up about half of the land base today. The amount of conifer bogs and swamps is substantially less today, and the number and distribution of upland conifer species (like white pine, red pine, and jack pine) present in the past was probably substantially larger than the number and distribution of upland pine species today. Conifer swamp lands were lost when the region had a judicial ditching system (drainage ditches) installed in the early 1900s and those swamps were essentially drained or greatly reduced in size and extent. Fires no longer burn, periodically, across large swaths of the landscape. The last large fire on the Reservation was the October 1918 fire that burned down the towns of Cloquet, Moose Lake, Kettle River and 35 other communities, and killed more than 450 people. Nearly 250,000 acres were burned, including many acres of the Reservation.

Figure 16. Ecological Subsections
(from the 2018 IRMP)



Forest Types

The map of the Reservation's land use shows that forest cover dominates the Reservation (Figure 17); the graph below from the 2018 IRMP shows that 72% of all land on the Reservation is forest, including forested wetlands (Figure 18). Of the forest types on the Reservation, aspen is the dominant cover type (Figure 19).

Figure 17. Vegetation Types on the Reservation
(from the 2015 Wildland Fire Management Plan)

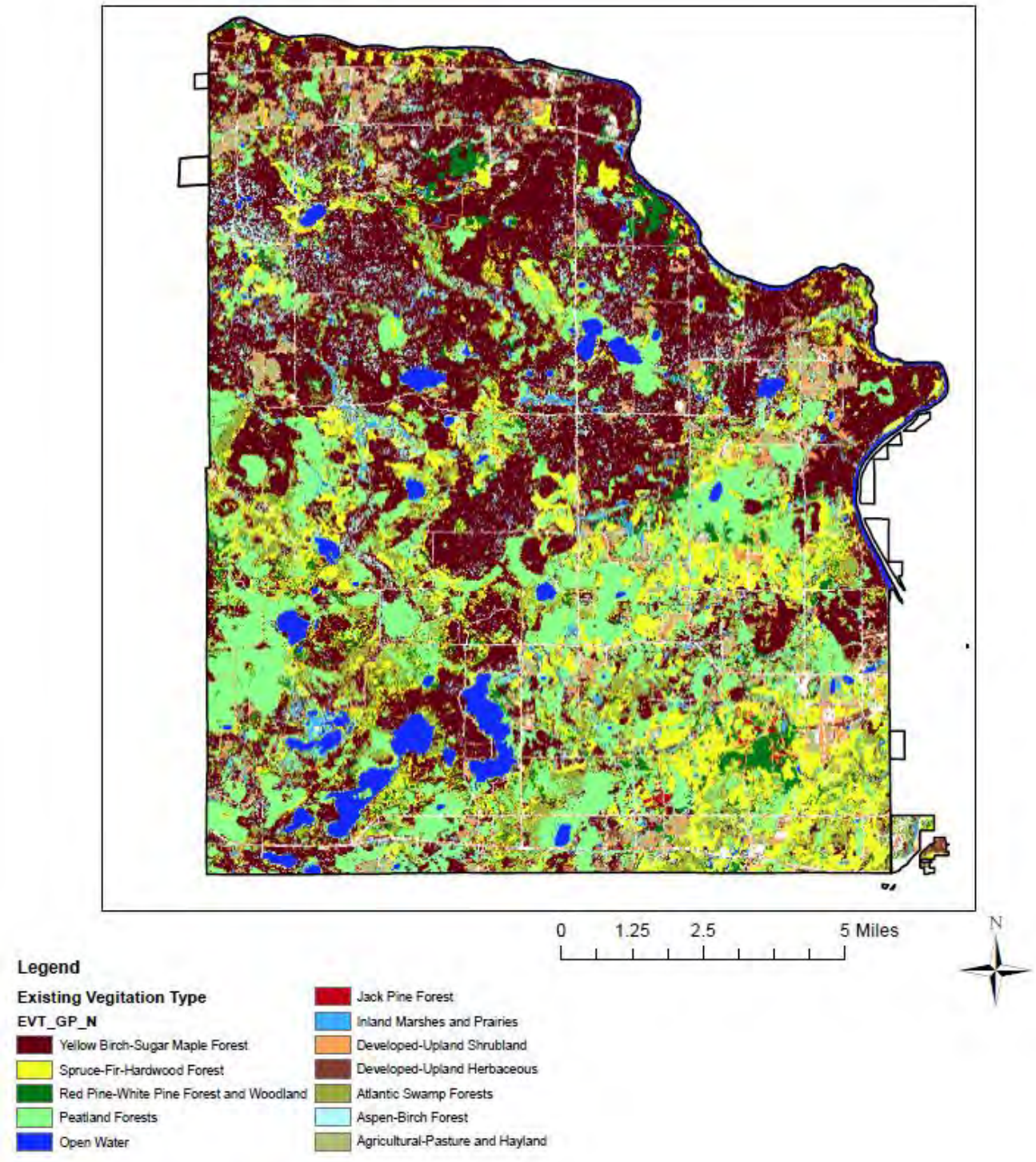


Figure 18. Percent of Land by Covertype on the Reservation
(from the 2018 IRMP)

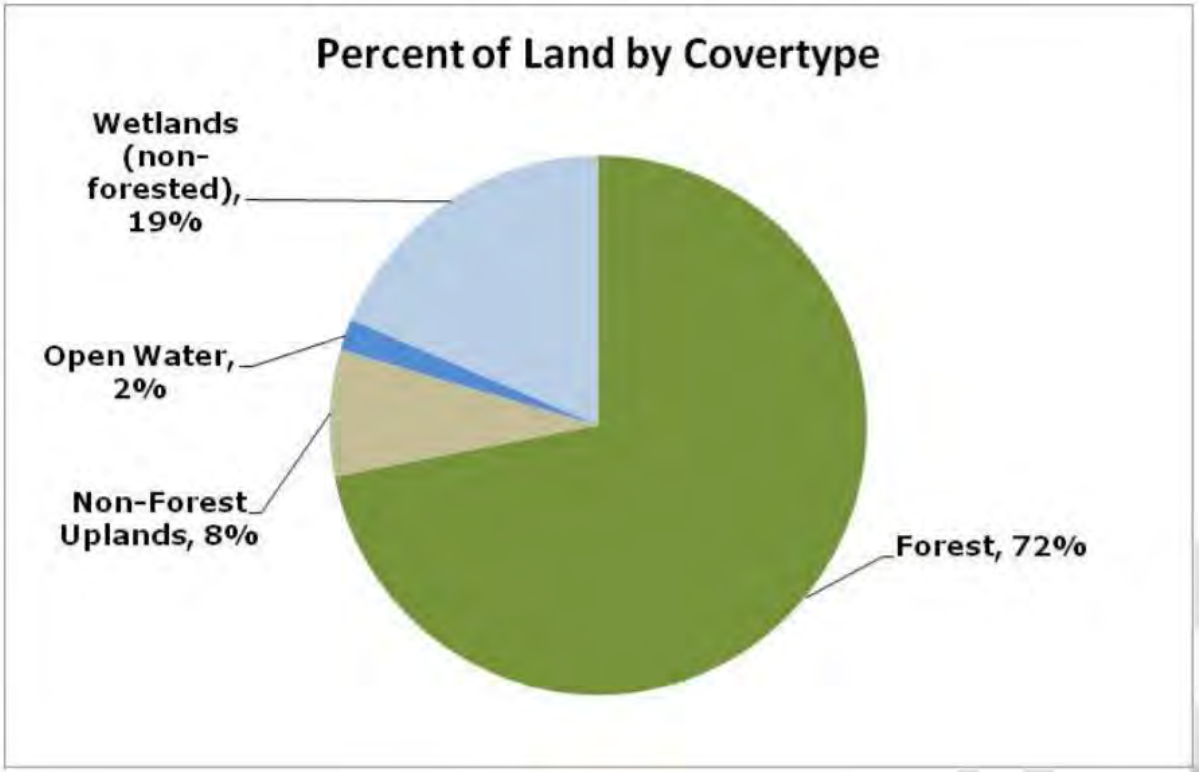
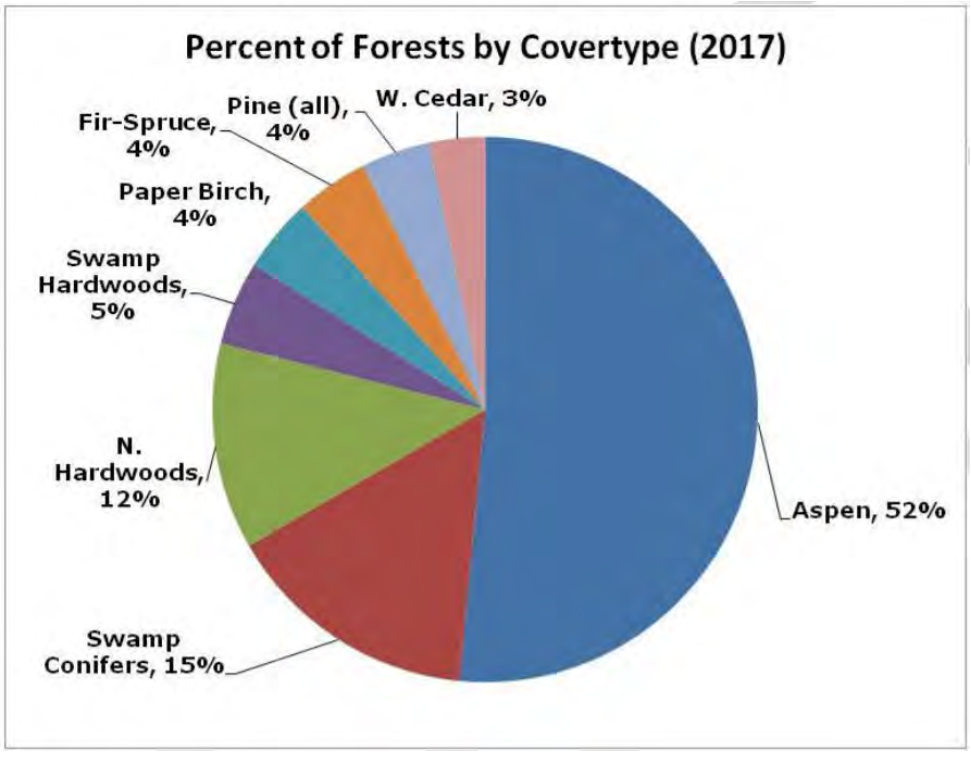


Figure 19. Percent of Forests by Covertype on the Reservation
(from the 2018 IRMP)



NON-POINT SOURCE ISSUES ON THE RESERVATION

With no permitted dischargers impacting Reservation waters, the major threat to Reservation surface water quality is from nonpoint sources: hydromodification, erosion and sedimentation, stormwater runoff and flooding, atmospheric deposition, and road crossings. With this understanding, our water quality program has been highly focused on documenting and monitoring these impacts, investigating potential remedial actions and seeking funding to implement them, and working to establish policies to minimize and control sources. Although much of the Reservation is undeveloped (forests, wetlands, lakes, streams, etc.), the northern third contains rural and residential development in and around Brookston to the north; the southern third contains rural development and intense development around Big Lake and the Casino complex; and the middle contains suburban expansion between the City of Cloquet and the Tribal Center's operations. In addition, there is a commercial center under construction near the Tribal Center. The Band strongly favors protection of cultural/historical sites, hunting and sugar bush land, and lakeshore and streambank areas.

Fond du Lac OWP submits a Section 106 Final Report every two years that summarizes water quality data. No new non-point source impacts were identified, but water quality is still being impacted by existing non-point sources.

Non-Point Source Pollution Categories and Subcategories on the Fond du Lac Reservation

The nonpoint source categories designated by EPA that are potentially responsible for a significant portion of the threatened or impaired waterbodies on the Reservation include:

- Agriculture
- Forestry
- Hydromodification and Habitat Alteration
- Roads, Highways and Bridges
- Urban Areas
- Wetland/Riparian Areas
- Invasive Species (additional category added by the Reservation)
- Climate Change (additional category added by the Reservation)

Water quality impairments due to atmospheric deposition of mercury are the largest NPS problem on the Reservation, and climate change paired with invasive species infestations are the largest future NPS threat to water quality. Improvement projects at Martin Branch, Fond du Lac Creek, and Third Lake have lessened NPS impacts at these water bodies, and they are discussed below.

Agriculture

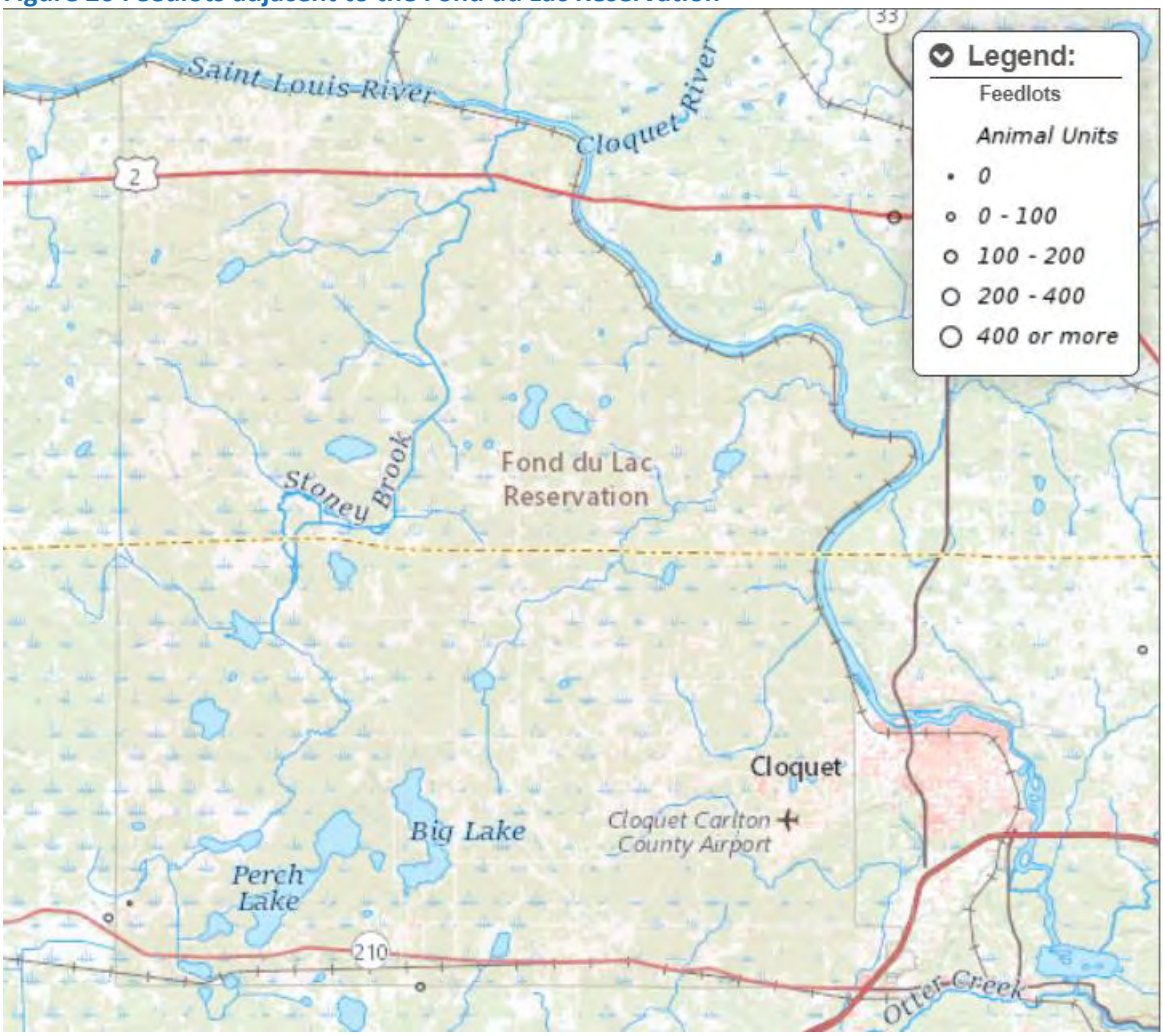
The geology and soils within the Reservation are not fertile enough to support large-scale agricultural operations, and much of the Reservation is wetland. Agricultural land on the Reservation is mainly devoted to small-scale livestock operations and hayfields. Some small-scale food farms also exist, and they are mainly run by Fond du Lac tribal government to support food sovereignty efforts. Two golf courses operate within the Reservation (Black Bear Golf Course and Big Lake Gold Course), and they are included under the Agricultural category. These land uses all have the potential to release sediment, pesticides, herbicides and nutrients into receiving waters.

An aerial photo survey of all lands on the Reservation was conducted to identify the location and size of all cultivated land on the Reservation. The total extent of lands used for agriculture (both crops and livestock) in 2020 was 133 acres across 13 farms, which constitutes an extremely small fraction of all Reservation lands.

Livestock Operations

2019 feedlot data maintained by the MPCA show one feedlot present on the Reservation, west of Jaskari Lake. Figure 20 shows two cattle feedlots directly outside the Reservation borders. One is in the Moose River watershed and the other is in the Stoney Brook watershed. Both feedlots have between 10 and 100 animals, and neither is classified as a Concentrated Animal Feeding Operation. They are each classified as having manure storage present, though the type of storage is unidentified. Feedlots are land uses that can have both point and nonpoint source pollution concerns.

Figure 20 Feedlots adjacent to the Fond du Lac Reservation



From the Natural Resources Research Institute Natural Resources Atlas

Hayfields and Pastures

The National Agricultural Statistics Survey crop-specific land cover data for the year 2018 shows that alfalfa is the main crop that is cultivated on the Reservation. Hayfields make up a small portion of the overall land use on the Reservation, as do pastures for livestock operations that are too small to be considered feedlots. Since hayfields can be planted and harvested more than once in a growing season, the risk for erosion during fallow periods is low. The risk from nutrient and chemical runoff is also low.

Golf Courses

The Black Bear Golf Course is part of the Black Bear Casino complex and has 18 holes; the Big Lake Golf Course has nine holes and is northeast of Big Lake. FDL OWP maintained an extra monitoring station on Otter Creek (called otter Creek (Station 1A)) downstream of the golf course for ten years to detect any changes in water quality due to the installation of the Black Bear Golf Course. The monitoring station was discontinued when no changes in water quality could be detected. The long-term monitoring station (called Otter Creek (Station 1) is also downstream of the golf course, and no changes in water quality have

been detected. Occasionally, FDL Resource Management will round up and remove Canada geese from the golf course, as they create nuisance conditions for golfers, but goose waste has not impacted Otter Creek. Both golf courses have the potential to create NPS pollution in the form of nutrients, pathogens and chemicals, but to date, our water quality monitoring data do not show any adverse effects.

Forestry

Forest cover is an important water quality indicator, as forest cover provides for uptake of nutrients, controls erosion and sedimentation, provides thermal protection, and reduces runoff rates and volumes. According to FDL's Integrated Resource Management Plan (FDL, 2018), "FDL Forestry's mission is to manage FDL's natural resources sustainably to achieve the needs and desires of the Band, while maintaining ecosystem health and integrity and fulfilling federal trust responsibility."

Logging

Logging can have NPS impacts, including increased erosion and sediment transport to receiving waters; increased water temperatures from increased turbidity and the removal of riparian shade; and the spread of invasive species. FDL Resource Management consults with the MN DNR, St. Louis County and Carlton County on timber sales. The DNR sends data on proposed timber sales on non-trust lands to FDL if the proposals are on or adjacent to the Reservation, which FDL staff review and discuss with DNR staff before proceeding.

From the 2018 Integrated Resource Management Plan:

The focus of early logging was the highly valued old growth white pine trees in northern Minnesota, which were depleted by 1924. Currently, timber sale design utilizes an Ecological Classification System (ECS) to assist in understanding how to grow trees well suited to soil moisture and nutrient qualities, and to mimic natural successional patterns. Forests are managed on the Reservation to improve the health and vigor of the forest and associated ecosystems. This includes maintaining diverse wildlife habitat, maintaining or increasing biodiversity, maintaining and increasing culturally important species such as paper birch, white cedar, sugar maple and blueberries.

FDL Forestry has been actively managing mixed aspen-northern hardwood forests to push them towards being less aspen dominated and more northern hardwood dominated. The results of past projects have been to take stands that were 80% aspen and 20% other species and turn them more into a 50/50 mix. In another few decades, the stands will ultimately become dominated by northern hardwoods with just a minor component of aspen. Timber sales are designed and implemented in such a way that reforestation often occurs naturally. Tree planting is done where natural regeneration is inadequate, when non-forested areas (e.g. old fields) are being converted to forested areas, or when there is a desire to add species that aren't naturally present or abundant.

2020 Google Maps image showing experimental clear-cuts within the U of M Cloquet Forestry Center

The University of Minnesota conducts forestry research on its lands within the Reservation, and occasionally does clear-cuts to approximate forest fires, and these areas (within the Otter Creek watershed) are potentially at increased risk for erosion. However, the University also follows forestry BMP practices such as buffer strips to prevent impacts to nearby water and wetlands.

All-Terrain Vehicle Management

When all-terrain vehicles (ATVs) or off-highway vehicles (OHVs) are used in sensitive wetland areas and stream crossings, they cause rutting and erosion, sedimentation, and damaged vegetation on the Reservation. As shallow groundwater seeps into the tracks or ruts, algal blooms form in the stagnant pools, and can then be flushed into nearby waterbodies during rain events. 6. Within the pipeline corridor, exposed pipes are used as bridges for 4-wheelers and snowmobiles, which is a risky practice that could potentially cause the pipes to rupture. Although there are no state managed ATV trails within Reservation boundaries, riders commonly use existing forestry roads and trails to access remote areas for recreation and hunting. Fond du Lac Division of Resource Management is particularly concerned about potential impacts to sensitive ecological areas such as the upper Stoney Brook watershed, in proximity to the manoomin lakes.

The OHV law in Minnesota gives counties the ability to prohibit ATV use on roadsides and ditches. The Minnesota Department of Natural Resources provides a map of designated OHV trails in the Fond du Lac State Forest, with updated information on trail closings and forest road closings: http://files.dnr.state.mn.us/maps/ohv/fond_du_lac.pdf

Wildfire

Wildfire poses two threats: 1) NPS arising from firefighting activities, including scooping water from Reservation lakes and also from fire retardants dropped on Reservation waters during wildland firefighting, including per- and polyfluoroalkyl substances (PFAS); and 2) Increased NPS in the aftermath of large and intense wildfires, including increased sediment, nutrients and toxicants flowing to receiving waters; the loss of large woody debris; altered nutrient cycling regimes and increased vulnerability to invasive species infestations.

In 1997, the Fond du Lac Band assumed responsibility for fire pre-suppression and initial attack in the protection of all federal trust lands within the Reservation. The Wildland Fire Management Plan guides development of site-specific projects for certain fire management activities, such as prescribed burns and fuel reduction in areas with a wildland-urban interface. For the remaining state, county, and private lands within the Fond du Lac boundaries, the MN DNR provides protection (FDL IRMP, 2018).

FDL Resource Management consults with the MN DNR on wildfire management. FDL and the DNR also maintain an agreement related to firefighting activities on or near the Reservation. FDL shares a list of lakes that pilots are restricted from using as sourcewater for aerial firefighting, including all of FDL's manoomin lakes. In addition, FDL and the DNR are negotiating the fire retardant restriction zones around FDL's manoomin lakes. See the Land Use section for a discussion of Fire Management Units.

Hydromodification and Habitat Alteration

The three sources of hydromodification on the Reservation are pipelines, ditching and beaver dams. They all alter the way that water moves through the landscape, which impacts nutrient cycling, geochemical processes, wetland function (including manoomin population health), aquatic habitat and fish passage.

Pipelines

The NPS impacts from pipelines are two-fold; they alter the natural hydrology along the length of the pipeline corridor, and they create a potential for leaks or spills anywhere along the length of the pipe. Secondary impacts include the hydrologic impacts of access roads through sensitive wetlands, and the risk for pollutants to be released through leaks or spills on construction and maintenance equipment. The pipeline corridor on the Reservation has also become a hotspot for invasive species introduction and spread, especially for tansy (*Tanacetum vulgare*) and wild parsnip (*Pastinaca sativa*). Enbridge Pipelines, Great Lakes/Trans Canada, Magellan/Williams Pipeline, Minnesota Energy Pipeline, Northern Natural Pipeline operate pipelines that traverse the Reservation. They cross several waterways, including Stoney Brook and Simian Creek, which drain into the St. Louis River. The following discussion focuses on the Enbridge pipeline corridor, which has the largest impact on the Reservation.

Pre-Pipeline Conditions

Prior to 1949, aerial photographs show the areas of the pipeline right-of way (ROW), which did not exist yet were mostly forested wetlands and uplands. The forested wetlands were dominated by conifers, such as black spruce, balsam fir, tamarack, and northern white cedar, while the uplands were mostly dominated by aspen, maples, and oak. In the southern portion of the Reservation, red pine plantations were numerous as well. Also, in the more southern portion (south of Big Lake Road), some fields were apparent, but row crops seemed to already be in decline and the fields more used for haying and grazing, much as they are today. Many roads already existed on the landscape, including Big Lake Road, Pine Drive, Strand Road, Cary Road, Mission Road, and the "ditchbank" roads.

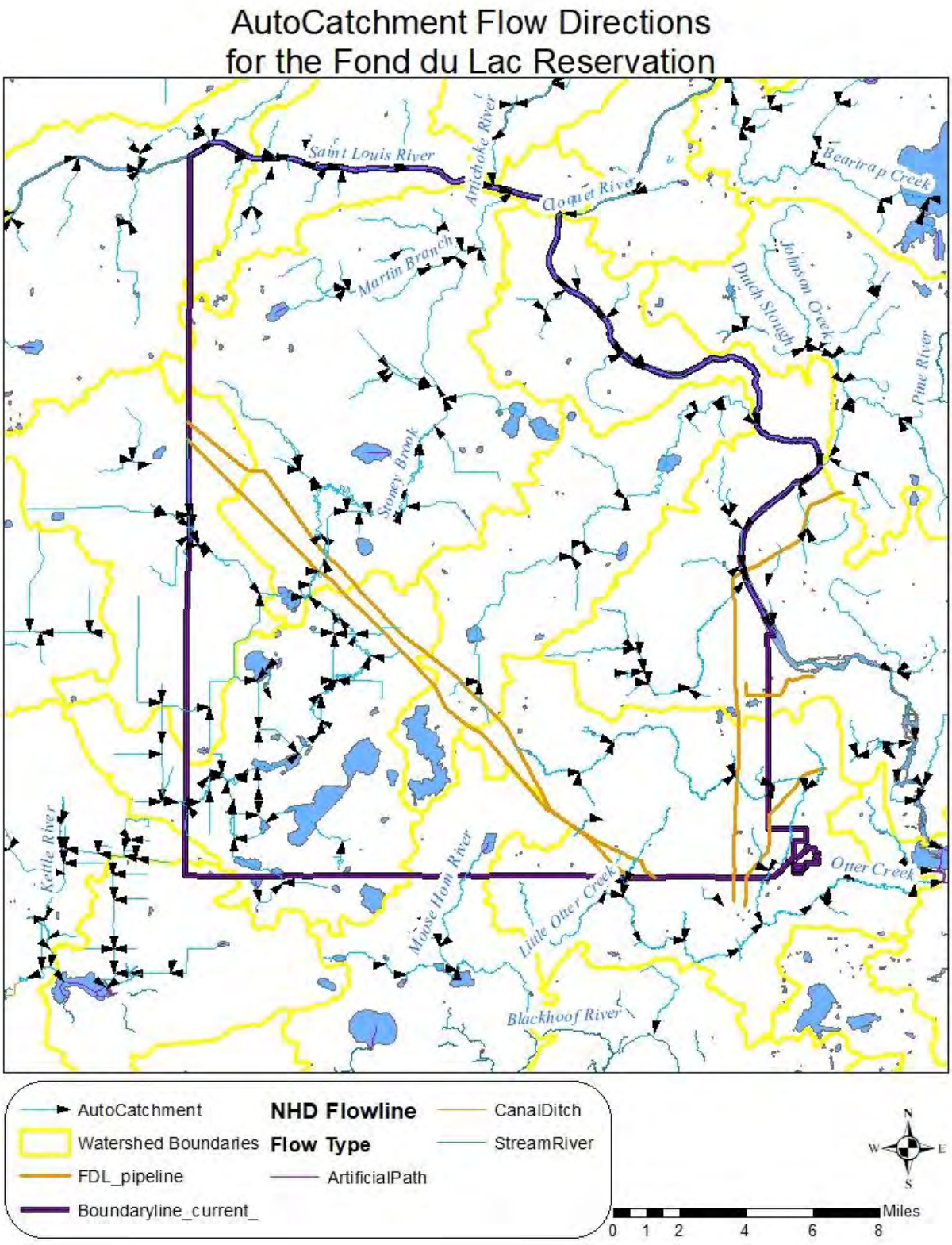
Current Conditions

The Enbridge pipeline corridor crosses four watersheds: Stoney Brook, Simian Creek, Otter Creek (which includes the Little Otter Creek subwatershed) and the Moosehorn River. The pipeline crosses several waterways; in most cases the pipes are buried beneath the streamcourses and ditches, most of which drain into the St. Louis River. The pipeline also crosses the northeast portion of the headwaters of the Moosehorn River watershed, which flows south to the Kettle River and is in the Mississippi River Basin.

AutoCatchments

The Minnesota DNR Watershed GIS Suite contains an "AutoCatchments" data layer that, according to the metadata, "represents a general model of the hydrologic flow across the landscape based on topographic elevation and stream connectivity. It is based on the best GIS data available in 2009 (no LiDAR used); no guarantee of real world accuracy is implied … the dataset provides a model of water flow at a smaller resolution than has been previously available, and it can provide insight into site-level analyses for which the standard layers have been too coarse." The autocatchment data for the Reservation shows general flow direction, and when paired with the water flow data from the NWI, can help predict where water flows (Figure 21). This is helpful both in restoration planning for hydrologically altered sites, and in predicting where a potential oil spill will flow.

Figure 21. AutoCatchment Flow Directions



Overview of the Enbridge Pipeline System

The Enbridge Pipeline System contains six pipelines that traverse through the Fond du Lac Reservation from northwest to southeast. The current right-of-way ranges between 145 ft and 300 ft. Starting from the northernmost outside line they are as follows (Table 1):

Table 1. Pipelines on the Reservation

Company	Pipeline ID	Size (Diameter)	Capacity (Barrels per day)[1]	Product(s)	Year Built	Valve Location
Enbridge	Line 1	18 inches	237,000	Natural Gas Liquid(NGL), Light	1947	One at the valve set on Arrowhead Forest Road and the other northwest of Cary Road.
Enbridge	Line 2B	26 inches	442,000	Light	1962	Manually operated, adjacent to Stoney Brook
Enbridge	Line 3	34 inches	3,900,002	Light	1960-1968	One at the valve set on Arrowhead Forest Road.
Enbridge	Line 4	36-48 inches	796,000	Heavy	1973-2000	One at the valve set on Arrowhead Forest Road and the other north of Moorhead Road
Enbridge	Line 13	20 inches	~ 240,000	Diluent	2009-2010	None on Reservation
Enbridge	Line 67	36 inches	800,000	Heavy	2010	None on Reservation
TransCanada (Great Lakes Gas Transmission)	Line 105000	36 inches	1.1 Billion ft^3	Natural Gas	1967	
TransCanada (Great Lakes Gas Transmission)	Line 205000	36 inches	1.1 Billion ft^3	Natural Gas	1967	
Magellan Midstream Partners	Line 6215	9 inches	Part of 1.2M ft^3	Non-Highly Volatile Liquid (Refined Product)	1957	
Northern Natural Gas	Line 179M430B	Unknown	Part of 1.7 Billion ft^3	Natural Gas	1956-1957	
Minnesota Energy Resources[3]	Cloquet	8 inches	Unknown	Natural Gas	1932-1980	

Hydromodification Impacts by Pipeline

- Line 2B: This pipeline was constructed in 1962 and does not have a major impact on hydromodification.
- Line 1: Some segments of this pipeline are at or near the ground surface, mainly between Arrowhead Forest Road and Stoney Brook.
- Line 3: This pipeline had an original maximum capacity of 760,000 bpd. However, due to failed coating and pipe corrosion problems, Enbridge has voluntarily reduced this capacity down to 390,000 bpd (a Consent Decree with the U.S. Dept. of Justice now requires the reduction). The pipe is at or near the surface in some places between Arrowhead Forest Road and Stoney Brook. This pipeline is slated to be replaced, which provides multiple opportunities for Fond du Lac and Enbridge to negotiate restoration and protection activities.
- Line 4: Depending upon the location, this pipeline is either 36 inches or 48 inches in diameter. On the Fond du Lac Reservation it is 36 inches from the western boundary to Arrowhead Forest Road. Then it is 48 inches through the rest of the Reservation. On the Reservation, many of the 48-inch sections of this pipeline were constructed with the pipe laying on the surface of the ground with soil material then piled on top for cover, which created a trench next to the pipe. Over time, this soil sloughed off, and has been compacted on the side of the pipe. Once the pipe became exposed, the wrapped coating dried out in the sun. The coating is now cracking and peeling, which releases the coating pieces into the surrounding water. Where the primary and secondary coating is missing, the pipe has begun to rust, which raises the risk for pipeline leaks. Where the pipeline sits at or above ground level in this wetland-rich area, hydrology has been severely disrupted for several forested wetlands on the Reservation. One is located between Arrowhead Forest Road and Stoney Brook (often referred to as “the Great Dismal Swamp”). Another is located between Stoney Brook and the East Ditch, while the third is located between the East Ditch and Ditchbank Road. A 10-mile section of this exposed pipe is slated to be replaced and buried below grade as part of the Line 3 replacement project.
- Line 13: This is a reverse-flow pipeline. This means that the product it carries (called “diluent”) is transported from Superior, Wisconsin to Alberta, Canada. This diluent is used as a solvent to make the tar sands oil (called “bitumen”) viscous. Enbridge does not report the carrying capacity of this pipeline. In fact, Enbridge does not include this pipeline in its pipeline system that it reports on its website. This pipeline was referred to as the Southern Lights Project during permitting and construction. All segments of this pipeline are at the federal standard for depth of cover.
- Line 67: This pipeline carries dilbit crude (a combination of diluent and bitumen heavy tar sands oil). After an upgrade of pump stations, this pipeline has a maximum carrying capacity of 800,000 barrels per day. It was constructed concurrently with the Southern Lights Project and was referred to as the Alberta Clipper Project. All segments of this pipeline are at the federal standard for depth of cover. On the Fond du Lac Reservation this pipeline, along with Line 13, swap positions within the Right-of-Way. When the two lines enter the Reservation on the western boundary, Line 13 is adjacent to Line 4 and Line 67 is on the outside. The two lines then cross over each other several hundred yards southeast of Arrowhead Forest Road so that Line 67 is adjacent to Line 4 and Line 13 is on the outside. The two lines then cross over one another again northwest of Strand Road so that Line 13 is again adjacent to Line 4 and Line 67 is on the outboard side of the Right-of-Way.

Hydromodification in Each Watershed Caused by the Pipeline Corridor

Figure 22 shows the locations where the pipeline corridor causes hydrologic impacts to streams and surface water movement. Each site is discussed in detail below.

Stoney Brook Watershed

Line 4 exposed at ground surface, causing water impoundment

Since the Stoney Brook watershed is extensively ditched, it is difficult to separate pipeline impacts from the overall impacts of ditching in this watershed. However, several high risk and impacted areas are discussed here. The pipeline corridor passes underneath the Stoney Brook main stem channel, so the risk of pipeline spills is low and there are no discernible effects on stream flow. The pipeline corridor also crosses the ditch that flows south from the pipeline corridor and into the Upper Deadfish Impoundment on the Reservation. Here, the pipeline crosses this waterway immediately below the bankfull channel so that water flows under the pipelines. The exposed nature of the pipelines puts this location at highest risk of direct impacts to surface water should a pipeline break or spill occur here (Figure 23).

In addition to hydrologic modifications caused by the pipeline corridors, the access roads leading to the pipelines have also impacted the original Stoney Brook streamcourse. The pipeline crosses another Stoney Brook ditch lateral east of Second Bridge (called East Ditch). Though not a direct pipeline corridor impact, the East Ditch access road does cause streamflow problems. The Stoney Brook historic channel crosses under the road at this location, but the culvert is not in line with the stream course and it is undersized. This causes water to pool on the road where the stream intersects the road (Figure 24).

Otter Creek and Little Otter Creek Watersheds

The pipeline crosses under wetlands that form the headwaters of Otter Creek. Since this area contains high-quality wetlands (Figure 25) and also constitutes the headwaters of Otter Creek, a designated trout stream, it is high-priority area for protection and monitoring. Figure 25 shows a house between the two pipeline corridors, and the driveway leading to the house is preventing water from moving toward Otter Creek, so that it is trapped between the driveway and the two pipeline corridors. This house and driveway will be removed during Line 3 construction. Figure 26 shows a tributary to Otter Creek; during times of high water; flow is blocked by the pipeline corridor, causing water to back up on the southwest side of the corridor.

The pipeline corridor crosses under two tributaries to Little Otter Creek just north of the southern border of the Reservation, south of State Highway 210. During high water periods, the pipeline causes water to back up on the eastern tributary (Figure 27). The western tributary has a beaver dam that impounds water over the pipeline corridor. An oil spill in the Little Otter Creek watershed has the potential to flow downstream into Otter Creek.

Moosehorn River Watershed

The pipeline corridor crosses into the northeast border of the Moosehorn River Watershed, which flows into the Kettle River and ultimately the Mississippi River. Most of the Reservation lands flow into the St. Louis River, so the Moosehorn River watershed boundary signifies a continental divide. The Minnesota DNR completed a watershed mapping analysis in 2008; overall goal of this mapping effort was to "produce the best watershed delineations available that reflect the current hydrology of the landscape as interpreted from as many data sources necessary to derive acceptable catchment delineations." Earlier watershed maps show less land area within the Moosehorn River watershed, but over time the pipeline corridor has changed the way water flows and has changed the borders of the continental divide – though this change likely occurred before 2003 and was captured by better mapping techniques in 2008 (Figure 28). A driveway crossing near the pipeline in the northwest corner of Figure 29 also has caused water to pond on either side of the driveway, and seems to be the cause for water ponding on the pipeline corridor for a considerable distance to the southeast. Though water retention is high in this peat-dominated watershed, a water monitoring site could potentially be placed here since this watershed boundary constitutes a continental divide.

Figure 22. Pipeline Hydrologic Impacts - Overview

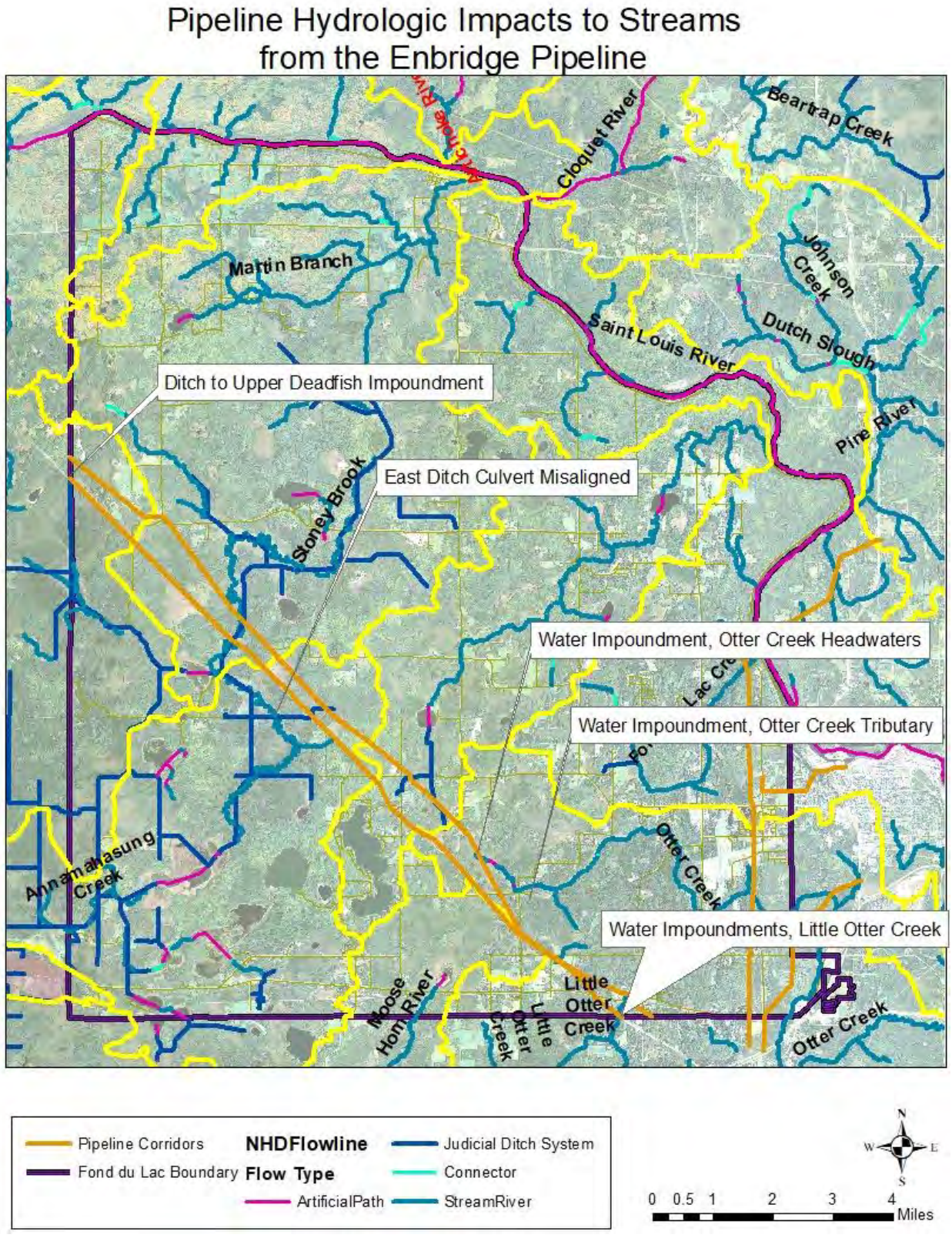


Figure 23. Ditch lateral that flows south into the Upper Deadfish Impoundment.
The pipelines cross this waterway at bankfull height rather than underground (2019 Google Maps).

Figure 23. East Ditch Culvert near Stoney Brook.

Figure 24.Pipeline Effects in the Otter Creek Watershed

Figure 25.Otter Creek Water Impoundments

Figure 26. Little Otter Creek Water Impoundments

Figure 27.Moosehorn Watershed Changes

Figure 28. Moosehorn Pipeline Impacts

Pipeline Impacts on Lakes

The pipeline corridor has the largest impact on wetlands both from a hydrologic impact standpoint, and from the direct risks of oil spills in wetlands adjacent to the pipeline. Any lakes with hydrologic connections to those impacted wetlands have likely also experienced some hydrological or water quality changes, though not at a level that can be observed separately from impacts caused by other landscape features, such as ditches.

The main impacts to lakes from pipelines include providing source water for hydrostatic testing and subsequent release of that water to upland locations. All lakes with a downstream hydrological connection to pipelines are at risk for contamination from pipeline spills, and also from erosion, aquatic invasive species and other impacts related to pipeline construction and maintenance.

Pipeline Impacts on Wetlands

The judicial ditching and associated negative impacts to manoomin resources were only exacerbated by additional fragmentation of the watershed caused by the construction of pipelines in the latter half of the 20th century. The primary impact of pipeline construction was the fragmentation of wetlands and subsequent hydrologic and hydraulic changes. Construction practices used at the time of installation resulted in placement of pipes at grade which caused some wetlands to become saturated and converting to other wetland type while other wetlands became less saturated and converted to another type. These conversions refer to plant and tree community shifts which are easily documented via historic aerial photography and on the ground observation (Figures 30 and 31).

Figure 29. Altered Wetland Due to Pipeline Hydromodification. Called "The Great Dismal Swamp."

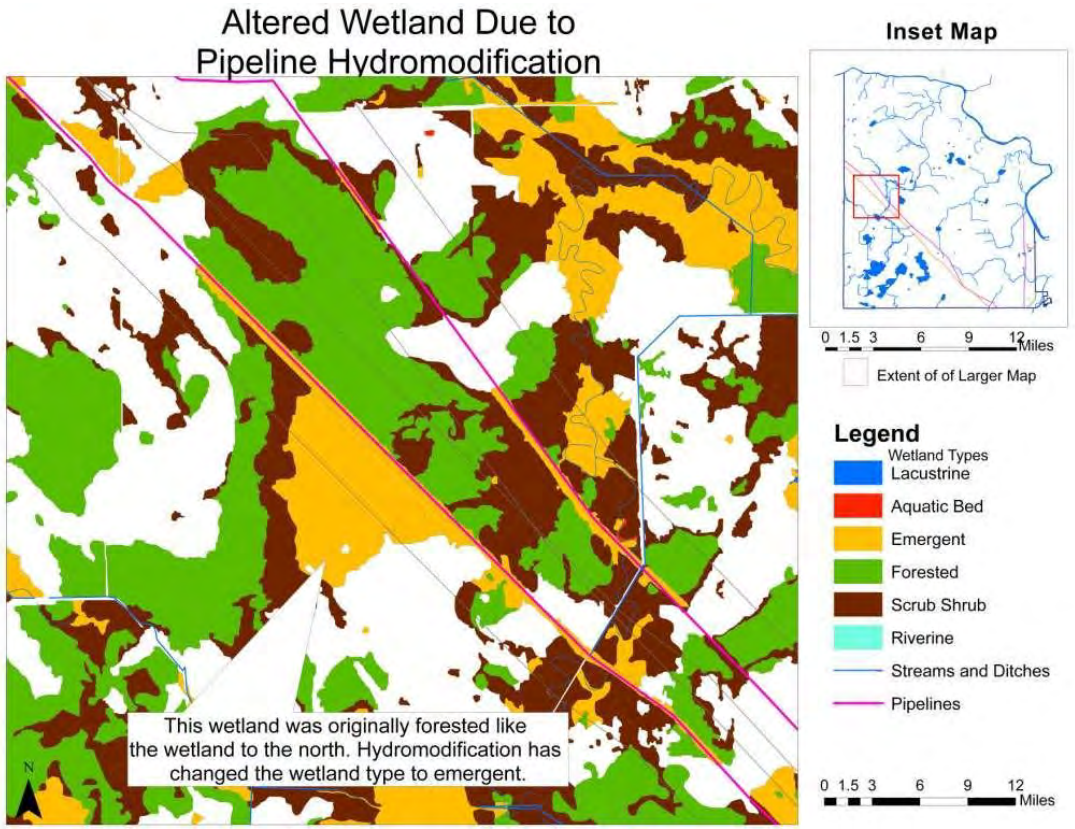


Figure 30. Changes in wetland vegetation at the "Great Dismal Swamp"
between 2003 (top) and 2015 (bottom). Photo source: Google Earth. The wetland to the southwest of the westernmost pipeline converted to a swamp long before 2003, but forest cover between the two pipelines decreased substantially between 2003 and 2015.

Judicial Ditch System

Impacts from channel modification activities can deprive wetlands of enriching sediments, change the ability of natural systems to both absorb hydraulic energy and filter pollutants from surface waters, and cause interruptions in the different life stages of aquatic organisms. Channel modification activities can also alter instream water temperature and sediment characteristics, as well as the rates and paths of sediment erosion, transport, and deposition. A frequent result of channelization and channel modification activities is a diminished suitability of instream and riparian habitat for fish and wildlife. Regularly scheduled maintenance activities to preserve and maintain the ditches and water levels are necessary under current manoomin lake level management practices. These maintenance activities may also result in a continual disturbance of instream and riparian habitat. In some cases, there can be substantial displacement of instream habitat due to the magnitude of the changes in surface water quality, morphology and composition of the channel, stream hydraulics, and hydrology.

The 47-mile Judicial Ditch system in the Stoney Brook/Asini-ziibi watershed was constructed in the early 1900s with the intent to provide for agriculture activities (Figure 31). Due to the extremely flat grade of the channel and the large areas of poorly drained organic soils, the original intent of converting lands to

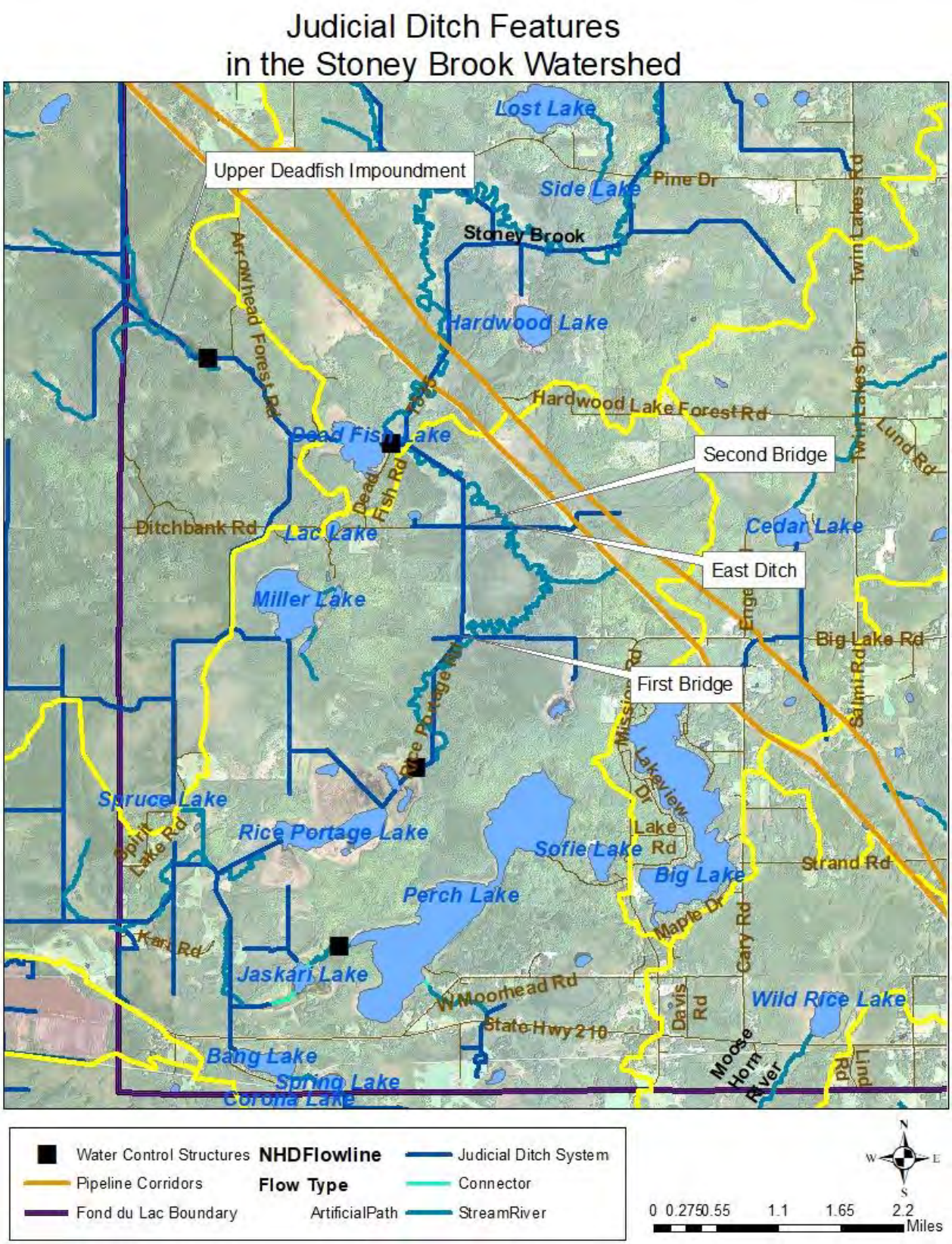
agricultural production was not realized. Estimates of wetland loss range between 2,000 and 4,000 acres as a result of the ditching, and the hydrology of the Stoney Brook watershed has been drastically changed. Ditching significantly altered water levels on five manoomin lakes (Perch, Jaskari, Rice Portage, Deadfish, and Miller); these lakes are important to Band members for harvesting manoomin. For example, the open water area of Rice Portage Lake was reduced from 634 acres to 114 acres. The lower water levels that resulted from the judicial ditching allowed competing vegetation to encroach on areas that at one time supported manoomin. These lower water levels and larger water-level fluctuations following precipitation events resulted in reduced manoomin production rates. The photos below show how large rain events can impact each lake differently. Jaskari Lake, near the headwaters of the watershed, experiences less water level fluctuation after a rain event than Deadfish Lake, which is the middle of the watershed and has several subwatersheds contributing water. A June 2018 rain event did not affect Jaskari Lake, but it severely impacted manoomin during its vulnerable floating leaf stage on Deadfish Lake.

Healthy manoomin in floating leaf stage on Jaskari Lake in June 2018

A large rain event in June 2018 caused water levels to rise in Deadfish Lake, drowning out the manoomin in floating leaf stage

Restoring the primary manoomin producing lakes on the Reservation is contingent upon mimicking the more natural annual hydrological cycle and managing lake depth to stay within the optimal range for manoomin (0.5 to 4 ft). The implementation of the Rice Portage Wild Rice and Wetland Restoration Project in the late 1990s resulted in the construction of four water control structures. The Fond du Lac Band installed outlet structures on Perch, Rice Portage, and Deadfish Lakes; the structures have stop logs to manipulate lake levels throughout the year and outlet gates to release water following runoff events. In addition to the lake outlet structures, a gated storage area upstream of Deadfish Lake (named Upper Deadfish Impoundment) was installed to control up to approximately 373 acre feet of runoff. The outlet structures are designed to hold water back in the lakes during periods of low water, and to release water after storm events to prevent extreme fluctuations in water levels. Manoomin is most vulnerable during the floating leaf stage in June of each year, when the seed puts up a leaf that floats on the surface of the water. If the water level rises too quickly, it can either uproot the floating leaves or down them out, both of which will result in a reduced or nonexistent manoomin stand for that year. Water level fluctuations as little as 4 inches within a 7-day period during period of May through July can impact manoomin production.

Figure 31. Judicial Ditch Features in the Stoney Brook Watershed



A hydrologic model was produced in conjunction with the US Geological Survey (USGS) and the Natural Resources Conservation Service (NRCS) (USDA, 2009). The model's purpose was to provide a hydrologic and hydraulic assessment of the Stoney Brook watershed including recommendations for optimizing water levels for manoomin production in Perch, Rice Portage, and Deadfish Lakes. This project, which took place between 2005 and 2009, utilized hydrology and hydraulic models to estimate impacts of rainfall events and outlet structure management options on lake level fluctuations on Perch, Rice Portage, and Deadfish Lakes. Excerpts from the report are below. Conclusions from the model include:

- From Rice Portage Lake downstream, the water surface slope is relatively low (1.6 ft/mile) for typical runoff events while upstream of Rice Portage Lake the water surface is essentially flat up to Jaskari Lake. Flat water surface slopes and the subsequent high water stages downstream of each lake is a concern. As tailwater conditions increase, the ability of a lake's outlet structure to release water and limit fluctuations is diminished. For 2-inch rain events and smaller, the channel water surface downstream of Rice Portage and Perch Lakes' outlet structures is below optimal lake level however Deadfish Lake outlet would be submerged. For events larger than 2 inches in 24-hour event, however, water levels downstream of the structures are at or above optimal lake levels for all the lakes signifying potential lake fluctuation problems.

- All road crossings have relatively little effect on restricting flows. The largest water surface differential is for First Bridge for larger events (~ 0.5 feet). Water overtops Second Bridge at approximately a 5-year event and since the road does not have a high fill, overflows from larger events do not back up significantly. Flows overtop Pine Drive and First Bridge at approximately the 25-yr and 50-yr respectively. Replacing/cleaning out of these crossings would have relatively little impact on water surface elevation in the ditch or lake fluctuations. However, if the road over Second Bridge were to be raised to prevent overtopping on event larger than the 5-yr, the culverts would have to be replaced with larger ones to prevent raising upstream water levels above current conditions.

- Based on the hydraulic modeling of the Stoney Brook channel, it can be concluded that Stoney Brook is slow to recede following rainfall events mainly due to its naturally flat grade and not to any particular blockage or restriction (roads, sediment buildup, etc.).

- Without managing outlet gates, Rice Portage and Deadfish Lakes have fluctuations exceeding 4 inches whenever 24-hr rainfall amounts exceed 1.5 inches. Perch Lake fluctuations would exceed 4 inches when 24-hr rainfall amounts exceed 2.5 inches.

Several different alternatives aimed at reducing lake fluctuation were evaluated with the models. These included main ditch cleanout, outlet structure gate management, Upper Deadfish Impoundment, spoil bank breaching, and diversion of some runoff out of the Deadfish sub basin. A summary of these alternatives is outlined below:

- Managing the outlet gates can keep fluctuations below 4 inches for smaller events (up to 2 inches in 24-hours). For rainfall events of 3 inches or more in 24 hours, the outlet structure openings are unable to prevent excessive fluctuations. Without opening gates, Rice Portage and Deadfish Lake fluctuate up to 1 foot following a 2 inch in 24-hour runoff event. By managing the gates, this fluctuation can be reduced to 4 inches. With all gates fully open and all stoplogs removed, fluctuations on Rice Portage and Deadfish would be 10 inches and 22 inches respectively during passage of the 3 inches in 24-hour event.

- Between Rice Portage Lake and Pine Drive, portions of the main channel have filled in with 2-4 feet of sediment (likely due to side slope sloughing). An analysis was made which simulated the impacts of cleaning out the ditch to its original dimensions and grade. For the 3 inches in 24-hour event, this alternative, combined with managing the gates, can reduce fluctuations to 5 inches and 10 inches for Rice Portage and Deadfish Lakes respectively.

- According to the modeling analysis, the Upper Deadfish Impoundment area can effectively store up to 212 acre-feet (the amount of runoff from a 1.5-inch rainfall event). In order to keep fluctuations 4 inches or less on Deadfish Lake for the 2 inches in 24-hour event, both gate manipulation and utilization of the Upper Deadfish Impoundment area is required. Gate manipulation on the Upper Deadfish Impoundment area alone would not keep fluctuations within the 4-inch tolerance.

- Spoil banks along the ditched section of Stoney Brook prevent water from accessing floodplain storage. Modeling analysis shows that creating large breaks in the spoil and allowing water onto the floodplain could reduce stages in the main Stoney Brook by 0.5 and 1.5 feet for the 2-year and 5-year events respectively (no change for smaller events since the flows would be below the floodplain). This would have a minimal effect on the fluctuations within Deadfish and Rice Portage Lakes, however this may be still be desired for habitat improvement reasons.

- An analysis of altering Rice Portage and Deadfish Lake outlet structures was made. It was concluded that creating larger weirs or adding additional gates would not be significantly improve lake fluctuation conditions due to excessive tailwater conditions. If a downstream channel cleanout is ever done to lower tailwater, then this option may significantly improve FDL's ability to control fluctuations on larger events (> 2 inch in 24-hour rainfalls).

The report concluded that natural hydrology can be restored in several places by breaching ditch walls and allowing water to flow into the original channel. In addition, the Deadfish outflow causes significant backwater effects, and ditch dredging or other restoration activities could reduce water level bounce in this lake. A second report (Jones and Tomasek, 2013) summarizes the groundwater resources and the relationships between groundwater and the existing drainage system. The conclusions from this report indicate that the ditch system has a larger impact on surface water flows than on groundwater throughout the Stoney Brook watershed.

Fond du Lac renewed its partnership with USGS, and a new HEC-RAS and HEC-HMS model will be completed in 2021, along with an EPA-based Nine-Element Watershed Plan. The new model will help Fond du Lac with water control structure guidelines, since the first model did not address best management practices for day-to-day operation of the water control structures; the model will also include climate change scenarios with extreme conditions such as floods or drought. The model will also identify potential restoration locations where the ditch could be breached to allow more water to flow in the original channel. The model could also potentially be used to predict how water will flow on the landscape and predict the fate and transport of any oil spills coming from the pipeline.

Effect of Ditching on Mercury Geochemistry

Many waterbodies in the St. Louis River basin are impaired for both mercury in the water column and mercury in fish tissue. Fond du Lac's water quality standards include a standard of 0.77 ng/L for the Aquatic Life Subsistence Fishing (Netting) Designated Use for mercury in the water column, and all waterbodies on the Reservation exceed that standard. The high mercury is a result of localized and global mercury deposition from rainfall, coupled with wetlands rich in sulfate-reducing bacteria, which methylate mercury as part of their metabolic processes.

Methylmercury is the form that can bioaccumulate up the food chain and cause adverse effects for wildlife and humans when they eat fish high in mercury. At this time, no tribal programs are authorized to implement CWA §303(d) programs or develop Total Maximum Daily Loads (TMDLs). In 2010 Fond du Lac began a study with EPA Region 5, Minnesota Pollution Control Agency, and the Wisconsin Department of Natural Resources to develop a TMDL for the St. Louis River, to address the watershed-wide mercury fish consumption impairment, plus other bioaccumulative legacy toxics in the lower St. Louis River Area of Concern. However, in 2013, the MPCA withdrew from the study; only sporadic data collection and sediment transport studies have been conducted since then. The Band is still considering applying for Treatment as a State (TAS) for an impaired waters program under CWA §303(d). We are in early discussions with the MPCA and our other partners to re-initiate the St. Louis River mercury TMDL studies and analyses necessary to address the mercury impairment, which restricts the safe consumption of local fish and the health and spiritual/cultural benefits of tribal traditional lifeways. The OWP has continued to collect data (water column mercury concentrations, flow rates, fish tissue mercury) from reservation waters that can support this critical TMDL study.

Fond du Lac entered into a Ditched Peatlands study, headed by USGS and in partnership with MPCA in 2020 to sample ditched systems in the St. Louis River basin to understand the role they play in exacerbating the influx of methylated mercury to this system. Ditches convey water through watershed more quickly than natural streams, and tend to have higher and more frequent water fluctuations. The drying and wetting of the adjacent wetlands create the perfect environment for mercury methylation and its subsequent release into receiving waters. Results from the study will help the partners target areas where ditch plugging or restoration can reduce mercury pollution in the St. Louis River basin.

Beaver Dams

Fond du Lac RM has taken the approach to remove beavers and beaver dams only if they cause flooding and impact human structures or manoomin waters, since beavers have been an important part of the region's ecology for thousands of years. The challenge is in respecting their right to exist on the landscape

while balancing that with the human need to maintain harvestable manoomin populations. Since the Reservation has flat topography in many locations, it can be difficult to discern if roadways, beaver dams or other features are impacting hydrology, and has led to several investigations using hydrologic models to determine that beaver dams are in fact causing water level changes that lead to manoomin loss. A small change in hydrology caused by beaver dams can cause manoomin lakes to become too deep to support sustainable populations of manoomin. Managing beaver dams is a complex challenge, since the dams are often built in areas that are difficult to access, such as in wetland-rich areas or on private land, and beavers often rebuild dams after FDL NR staff removes them. In the past century, beaver pelts brought in a good price and beaver trapping was common. Discussions with landowners around Cedar Lake show that the next generation is not trapping beavers at the rate of previous generations, and so beaver management falls to FDL NR workers (Jaakola, pers. comm.). Beaver dams cause high water and the loss of harvestable manoomin in both Cedar Lake and Wild Rice Lake.

Wild Rice Lake

Wild Rice Lake is the headwaters of the Moosehorn River and listed as an Outstanding Reservation Resource Water by the Fond du Lac Band. The importance of the lake to the Fond du Lac Band is further codified through its manoomin cultural use designation. This cultural use designation is defined as "A stream, reach, lake or impoundment, or portion thereof, presently, historically or with the potential to be vegetated with manoomin" (Fond du Lac Band of Lake Superior Chippewa, Ordinance #12/98, as amended, 2001). FDL band members who are elders remember their parents and grandparents being able to harvest manoomin in this lake, but that hasn't been possible in the last several decades as the manoomin stand has severely declined (Howes, pers. comm.)

Wild Rice Lake is classified as severely impaired from a nonpoint source standpoint in this report. In talks with elders and based on 20 years of observation, we know that the manoomin population in Wild Rice Lake has significantly declined over the past 40+ years, and this decline in manoomin is due to sustained high water levels in the lake. A pond leveler was installed in the culvert under Highway 210 at the outlet of Wild Rice Lake in the mid-2000s, which temporarily lowered water levels. Manoomin was seeded into the lake, but the population quickly declined and the lake is now nearly covered by water shield in the summer. The pond leveler failed after about seven years.

Possible contributing factors to high water levels in Wild Rice Lake include beaver activity in the low-gradient reach of the Moose Horn River downstream of the lake's outlet. In 2019, the Minnesota Department of Transportation (MNDOT) assessed the culvert under State Highway 210 that is directly downstream of Wild Rice Lake and concluded that it is functioning properly. Using historic aerial photos, hydrologic models, state records on culvert maintenance at this location, and in-person observations, MNDOT and Fond du Lac Resource Management jointly concluded that the main reason for sustained high water in the lake is due to tailwater effects from a series of beaver dams downstream of the lake. Increased precipitation due to climate change is another potential contributing factor. Strategies to address the decline of manoomin in Manoomini-zaaga'iganing/Wild Rice Lake identified in discussion with tribal staff include improving hydrologic connectivity and potential water level management.

FDL OWP consulted with the MPCA in writing the draft section of their Kettle River Watershed Restoration and Protection Strategy that pertained to Wild Rice Lake, since it is in the Kettle River Watershed. This document also concludes that hydromodification is the main NPS pollution impact on this lake, and that cooperative beaver management will be needed to lower thee lake water levels enough to allow manoomin to grow.

Cedar Lake

Water levels in Cedar Lake, which is a shallow 59-acre lake in the Simian Creek watershed, have been too high to support substantial stands of manoomin for several decades. Cedar Lake is classified as severely impaired from a nonpoint source standpoint in this report. Homeowners on the shore of Cedar Lake report being able to harvest manoomin in the 1980s (Jaakola, pers. comm.) In 2007, a test plot was seeded with 200 pounds of manoomin seed, concurrently with beaver dam removal, to promote lower water levels. In 2008, this test plot area was revisited to assess the results of the reseeding. Although some manoomin did seed with that effort, as of the fall of 2010, no manoomin was growing in the lake. Manoomin was seeded again in 2011, but after a large storm in 2012 manoomin remains as a small remnant population in the littoral zone on Cedar Lake. Water levels have remained high since 2010, so that very little manoomin is present in the lake.

Internal discussions within Resource Management highlighted our uncertainty about the reasons for the sustained high water levels. Because the watershed is relatively flat, it was equally likely that the high water was caused by increased water inputs from the upstream ditch or tailwater effects from downstream beaver dams and/or road culverts. As a result, FDL requested assistance from the U.S. Army Corps of Engineers (USACOE) to develop hydrologic and hydraulic models to improve the knowledge and management of Cedar Lake.

Cedar Lake Watershed Model

Model results help to understand the impacts that hydrologic and hydraulic changes may have on manoomin growth and propagation due to water level fluctuations (USACOE, 2019). The study area includes the Simian Creek watershed on the Fond du Lac Reservation between the headwaters upstream of Cedar Creek to just downstream of Kultala Road near the confluence with the St. Louis River, or just over 20 square miles of drainage area. Cedar Lake is in the upper portion of the Simian Creek watershed, with a contributing area of just under 3 square miles. In addition to Cedar Lake, East Twin Lake and West Twin Lake form the headwaters of a small tributary in the middle of the watershed, and Simian Lake is a flowage lake located on Simian Creek in the lower portion of the watershed.

The water level data collected over two growing seasons and the model results suggest that the surface water level at Cedar Lake is elevated at a higher level than it was historically, and the backwater causing these elevated lake levels is likely due to a series of extremely large beaver dams downstream of Cedar Lake. In addition, sustained high water may have caused sedge mats to proliferate at the lake's outlet, thereby increasing channel roughness and reducing the channel's ability to drain water, as overgrowth of vegetation may have reduced the channel efficiency. Some of these channel constrictions may not become apparent until after the beaver dams are removed. Model simulations with various management scenarios, including removing beaver dams and dredging the outlet channel, lead to a range of possible lake depths. Figure 32 shows the possible extent of lake depths for optimal manoomin growth under different management strategies.

Other stressors for manoomin establishment and growth include beaver dams and blocked culverts in the watershed, contaminated sediments, sulfates and nutrient loads, turbidity, and sediment deposition. Factors favoring manoomin re-establishment in Cedar Lake include:

- Good water quality in Cedar Lake;
- A relatively undeveloped watershed and shoreline around Cedar Lake;
- Strong support for manoomin re-establishment by tribal leadership and Reservation Council;
- This is a high priority for the Fond du Lac OWP and the Fond du Lac Natural Resources Program.

Figure 32. Comparison of the 2015 simulations at Cedar Lake.
Removing the beaver dams and increasing the channel cross-sectional area significantly reduces the water levels in Cedar Lake. The green area indicates the extent the lake level could be within the optimal water depths for manoomin growth under three different management scenarios that range from minimal effort to maximum effort.

Roads, Highways and Bridges

Roads create impervious surfaces, which allow runoff to quickly move to receiving waters, along with pollutants and sediment. In northern climates, road salt is applied in winter to prevent icy conditions; this can lead to chloride impairments in receiving water because chloride does not degrade or evaporate in water. Sensitive organisms can only tolerate low chloride concentrations. Recent water quality assessments using Fond du Lac water quality standards show no water quality exceedances due to roads, including from chloride applied as road salt to manage ice and snow on roads and parking lots. Roads also create barriers to water movement and have negative impacts on stream connectivity and geomorphology, especially when culverts are perched, failing or improperly sized. Railroads cause similar impacts to waters as roads do, so they are included under the Roads category. In 2019, a train derailment on the Reservation led to a coal spill in the St. Louis River, highlighting the pollution threat posed by railroads. Several roads and railroads on the Reservation also have failing bridges, which present both a hydromodification and a pollutant threat to receiving waters.

Forest roads, like this one next to Sofie Lake, are not built with any design standards and often have wet crossings.

As with pipelines and ditches, the main impact from roads on the Reservation comes in the form of hydromodification. Both St. Louis County and Carlton County are working on updating their culvert inventories, and when roads are repaired or replaced, Fond du Lac adds stipulations to Wetland Permits and Clean Water Act Section 401 Certifications to assure that the new culverts are properly sized and placed.

Major roadways in the area include US Highway 2, State Highway 210, and Interstate 35. Maintenance of these roads and associated culverts is an important nonpoint source

pollution issue, causing erosion, sedimentation, and winter sand and salt loading impacts to the water resources. Furthermore, major transportation networks in and near the area can increase the likelihood of spills occurring that could affect water quality.

Culverts, Bridges and Road/Railroad Crossings

Improperly sized and placed culverts, failing culverts and sinking or failing bridges create problems all over the Reservation. Many of these road crossing problems have been addressed, but some still remain.

Road improvements since the 2004 NPS Report:

Since the 2004 319 NPS report, Fond du Lac has successfully worked with state and federal agencies to improve roads on the Reservation.

- Fond du Lac Creek: Fond du Lac worked with USACE Detroit District Office to complete a Reconnaissance Study on Fond du Lac Creek, describing existing conditions and identifying potential alternatives for improving connectivity, especially for the perched culvert on reservation road. The culvert at this location had been identified in the 2004 NPS report as a moderate NPS impact because the culvert was perched too high to accommodate fish passage and maintain the hydrologic connection to the St. Louis River. During a massive flood in 2012, Fond du Lac Creek blew a hole through Reservation Road (Figure 33). The road was closed for over a year while a new bridge was constructed using Federal Highway Administration funds. A bridge was justified because of the impairment listing in the 2004 319 NPS Report, along with the conclusions from the USACE Reconnaissance Study. The previous culvert had created a fish migration barrier but after the bridge was installed FDL OWP fish surveys showed that new species of fish are now able to migrate up Fond du Lac Creek from the St. Louis River. FDL OWP staff personally planted willow cuttings along the stream border to create riparian shade. A study by Brady et al. (2013) that compared aquatic biota and stream habitat collected in 2010 and in 2012 (post-flood) showed that the physical changes that resulted from flood damage in Fond du Lac Creek led to noticeable but not substantial changes in macroinvertebrate assemblages. In 2012 there were increased proportions of chironomids, amphipods and isopods, and oligochaetes compared to 2010, and the changes resulted in a significantly lower EPA tolerance score for the stream in 2012 than in 2010.
- Otter Creek: Cartwright Road was originally a forest road created with no design standards, and the culverts at Otter Creek failed regularly; water was also prevented from flowing through the culverts properly, causing a large water impoundment on the upstream side of the road. The June 2012 flood created caused the road to be closed for over a year because the crossing with Otter Creek was impassable (Figure 34). The entire forest road was replaced by Carlton County with a paved road in 2014 that was designed with erosion control standards (wetland avoidance, ditches with check dams on slopes) to prevent further erosion. A box culvert was installed at the Otter Creek crossing, which allowed the water impoundment to drain properly (Figure 34).
- Martin Branch at Marshall Road: a collapsed culvert created a barrier to fish passage for many years until it was replaced with a box culvert in 2011 (Figure 35). FDL OWP used Natural Resources Conservation Service Environmental Quality Project (NRCS EQIP) funds to create the design specifications for the new culvert. The large impoundment caused by the collapsed culvert drained once the culvert was replaced, restring the upstream reach of the stream. A study by Brady et al. (2013) that compared aquatic biota and stream habitat collected in 2010 and in 2012 (post-flood) showed that draining the impounded water upstream of the culvert resulted in an increase of riffle habitat and coarser substrate in 2012 than in 2010. According to Brady et al. (2013), these physical changes were accompanied by a more than doubling of the taxa richness

of Ephemeroptera, Plecoptera, and Trichoptera and Chironomid taxa, but this did not result in a change in EPA tolerance scores calculated for the reach.

- Both St. Louis County and Carlton County have replaced bridges on the Reservation. A crumbling bridge across Stoney Brook in the town of Brookston was replaced. A bridge crossing Otter Creek on University Road was replaced in 2015, solving some problems with water impoundments on the upstream side of the bridge.

Figure 33. Photos of Fond du Lac Creek after the 2012 flood.
The flood washed out Reservation Road after the June 2012 flood caused the improperly-sized culvert to fail (left); and after (right) a new bridge was installed to prevent further washouts.

Figure 34. Photos of Otter Creek at Cartwright Road.
Cartwright Road washed out many times and was closed after the 2012 flood. A new box culvert was installed, which drained the impounded water on the upstream side of the creek.

Figure 35. Aerial photos of Martin Branch at Marshall Rd in 2004 (top) and 2015 (bottom).
A new road crossing has restored stream connectivity and drained a large water impoundment on the upstream side of the road. Photo source: Google Earth.

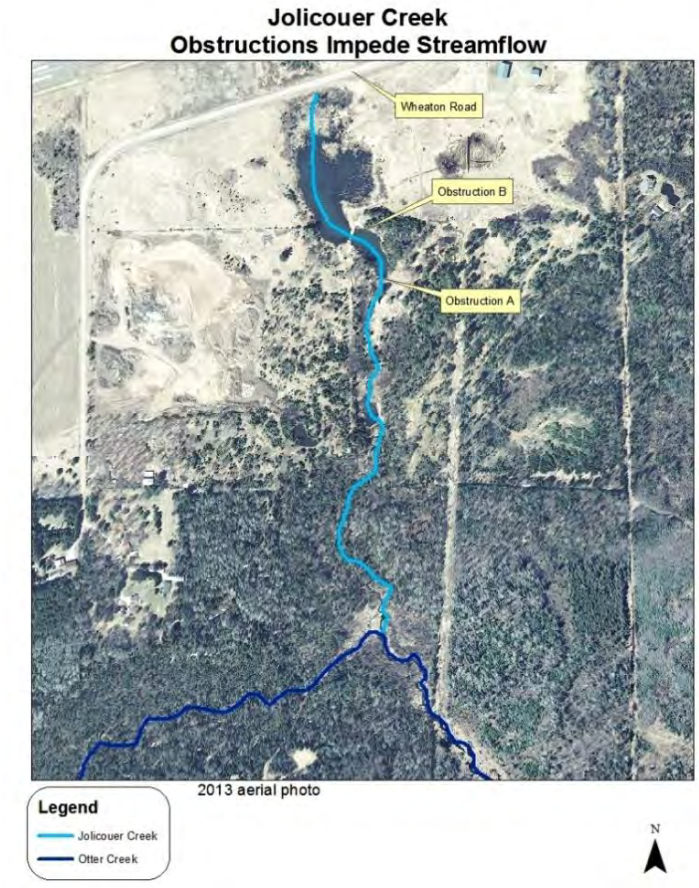
Existing Culvert/Road Crossing Problems on the Reservation:

- Two unused roads, both with collapsed culverts, have created two impoundments on Jolicoeur Creek on the Fond du Lac (FDL) Reservation. The NPS impact is listed as High. Jolicoeur Creek is a coldwater tributary to Otter Creek, a state-designated brook trout stream. The impoundments have degraded brook trout habitat on Jolicoeur Creek by killing the riparian vegetation in these areas and by creating warm water conditions and algae blooms (Figures 36 and 37). Brook trout are culturally significant to FDL Band members, and maintaining opportunities for Band members to harvest brook trout is a priority for the Band.
- Martin Branch at Stevens Road is crossed by a bridge that has been slowly sinking into the streambed for many years (Figure 38). As it sinks, the upstream side of the stream has become impounded, braided and choked with sedge mats and large woody debris and much of the stream has been rerouted across the road on the south side of the bridge. The north side of the road is also sinking, which causes the nearby trees to lean dangerously over the road. The sinking road has required periodic additions of cobble and gravel to raise the roadbed, and has also created large unshaded ditches that are filled with warm, algae-covered water. The NPS impact is listed as High. FDL OWP conducts fish surveys via backpack electroshocking at the Martin Branch (Stevens Road) site, since this headwater stream serves as brook trout rearing habitat – brook trout are not present downstream at the Martin Branch (Marshall Road) monitoring site, so the reach that supports brook trout is short and important to protect. The brook trout population crashed at this site after the June 2012 flood, and though populations have recovered, they continue to fluctuate as the habitat at this site degrades due to the sinking bridge. Fond du Lac Band members use this road to access culturally-significant resources and sites.

- A railroad bridge that crosses over Fond du Lac Creek at its confluence with the St. Louis River is in disrepair. Although this bridge survived the June 2012 flood that caused catastrophic road failure further upstream on Fond du Lac Creek, portions of the bridge became silted in. The concrete structure is crumbling in several places.
- There are multiple failing and improperly placed and sized culverts on the ditchbank road system in the Stoney Brook watershed. These culverts will be replaced as part of FDL's pipeline restoration and monitoring plan. Refer to the discussion in the hydromodification section. Figure 24 depicts the culvert at East Ditch that is misaligned on the original Stoney Brook stream channel.

Figure 36. Impoundments on Jolicoeur Creek.

Aerial photo of two impoundments on Jolicoeur Creek caused by two roadways with collapsed culverts. On-the-ground photo shows the two impoundments on Jolicoeur Creek.



The map shows the locations of Obstruction A and Obstruction B. The photo shows Obstruction B (looking northeast), dividing the first and second (in foreground) impoundments on Jolicoeur Creek

Figure 37. Impacts caused by Roadway Impoundments on Jolicoeur Creek.

Photo A. One of one of the frequent algae blooms that occur within the impounded area of Jolicoeur Creek. Photo B. The of the badly failing culvert downstream of Obstruction A. Photo C. Downstream reach of Jolicoeur Creek that will serve as a reference reach for restoration.

A.

B.

C.

Figure 38. Photos of the sinking bridge across Martin Branch at Stevens Road.
Photo A shows the bridge, which is sinking and impounding the water on the upstream side and causing it to flow around the bridge and across the south side of the road. Photos B and C show how the bridge has subsided into the wetland and how the stream has become impounded, braided and choked with large woody debris. Photo D shows what the unimpacted streamcourse looks like, upstream of the bridge, and serves as a reference for future BMPs.

A.

B.

C.

D.

Road Washouts

Road washouts typically happen on unpaved gravel roads and logging roads, but road washouts do occur on paved roads during major floods, such as the June 2012 flood. There are numerous forest access roads on the Reservation, including the ditchbank roads, abandoned township or county roads, and roads constructed for timber harvest. There also numerous gravel roads on the Reservation that were built before modern design standards for roads were put in place. All these types of rural roads are at risk for washouts that release sediment into nearby wetlands and water bodies, and often do. Road washouts can occur anywhere on a roadway, not just at a water crossing. Since the majority of the Reservation is wetland, road washouts often carry sediment, nutrients and other pollutants into wetlands and adjacent waterways.

Roadside Spraying

In 2009, Fond du Lac entered into a Memorandum of Understanding (MOU) with the MN Department of Transportation (MNDOT) to address roadside herbicide spraying. The issue was initially raised by the Fond du Lac Elders Concerns group, because some Band members practice plant gathering along roadsides and they were concerned about potential chemical exposure. Under the MOU, both parties agreed to engage in more frequent communication about roadside vegetation management and invasive species. MNDOT agreed to notify Fond du lac OWP when applying herbicides, and they also agreed to not use herbicides in certain areas designated by the Band, and to instead use mechanical methods of control. The entire MOU is included in Appendix B.

Urban Development

Land development on the Reservation takes place in a rural rather than an urban setting, but any development can result in wetland fill, increased impervious surfaces, habitat fragmentation and shoreline alteration, which reduces the ability of the landscape to slow surface water flow and allow it to percolate slowly into groundwater rather than immediately running into surface waters. Impervious surfaces increase the potential for runoff to move quickly into lakes and streams, along with pollutants and sediment.

Shoreland Development

Big Lake

Shoreland development and the accompanying potential for increased nutrient inputs (septic systems, water softeners and lawn chemicals), human pathogens, and erosion are factors that affect water quality on many Reservation lakes. Big Lake, the most heavily developed recreational lake on the Reservation, has more than 250 homes and cabins along its shoreline (Figure 39). Blue-green algae blooms are occasionally noted in parts of Big Lake, especially near the public boat landing on the north side of the lake. Pathogen monitoring at Big Lake's two swimming beaches typically leads to occasional beach closures due to exceedance of the fecal coliform criteria for primary contact recreational use (126 organisms/100 ml). The Minnesota Department of Natural Resources (MNDNR) maintains a public access and an active fisheries assessment and stocking program for Big Lake. The volume of nonresident usage of the lake raises the potential for introduction of invasive species. The MNDNR and state Department of Health have historically included fish from Big Lake in their state fish consumption advisory program, and mercury levels in walleye are similar to those seen in other Reservation waters.

Blue-green algae bloom in Big Lake in 2011

Big Lake is significantly impaired for the designated uses of primary contact recreation and aquatic life; these impairments are due to:

- removal of shoreline and slope vegetation,
- shoreline alteration and other landscape practices

- macrophyte control,
- erosion,
- non-compliant and failing septic systems that can discharge excess nutrients and pathogens to lakes and streams,
- turf management practices on lawns and at the Big Lake Country Club Golf Course,
- increased impervious surface

Because cabins were built around big lake before modern zoning laws, they are very close together, with little land left over to place new septic mounds and drain fields when the original ones fail. Many of the septic systems around Big Lake do not function at optimal capacity, or are at the end of their functional lifespan, which can allow untreated wastewater releases directly to the lake. Because of dense development, there is no available land on which to site new septic systems. The MN DNR's Watershed Health Assessment Framework (2020) shows that very few subwatersheds in the St. Louis River Watershed are impaired due to septic systems, but the Big Lake subwatershed receives the lowest score for septic system impacts (Figure 40). The FDL OWP worked in partnership with other agencies (MN Department of Health, Big Lake Association, Carlton County, and the Western Lake Superior Sanitary District) to get the Big Lake Wastewater Treatment Project on the 2013 bonding bill. The funds will help the Western Lake Superior Sanitary District extend a sewer line out to Big Lake, thereby bypassing many of the non-compliant and failing septic systems around the lake and sending the wastewater to be properly treated. However, political considerations at the local level have stalled this project indefinitely.

Water quality data show that chloride concentrations are increasing in Big Lake. This could be due to road salt applications, but we don't see similar trends in other Reservation lakes that are also near roadways (Appendix C). Therefore, the increase in chloride could be due to homeowners' use of water softeners, which leads to chloride releases through septic systems. Figure 41 shows the increasing trend in chloride in Big Lake over a ten-year period. While still well below the state chloride standard of 230 mg/L for chronic aquatic life and recreation, the increasing trend is cause for concern.

Though other lakes on the Reservation have developed shoreland (notably West Twin Lake, Third Lake, Bang (Long) Lake, Sofie lake Lost Lake, and Joe Martin Lake), their impacts are much smaller than shoreland development on Big Lake.

Figure 39. Shoreland Development Around Big Lake.

The red area denotes the dense shoreland development surrounding Big Lake. All houses are served by septic systems, and in many cases the development is too dense to allow for siting drain fields in new locations when old drain fields are no longer operational.

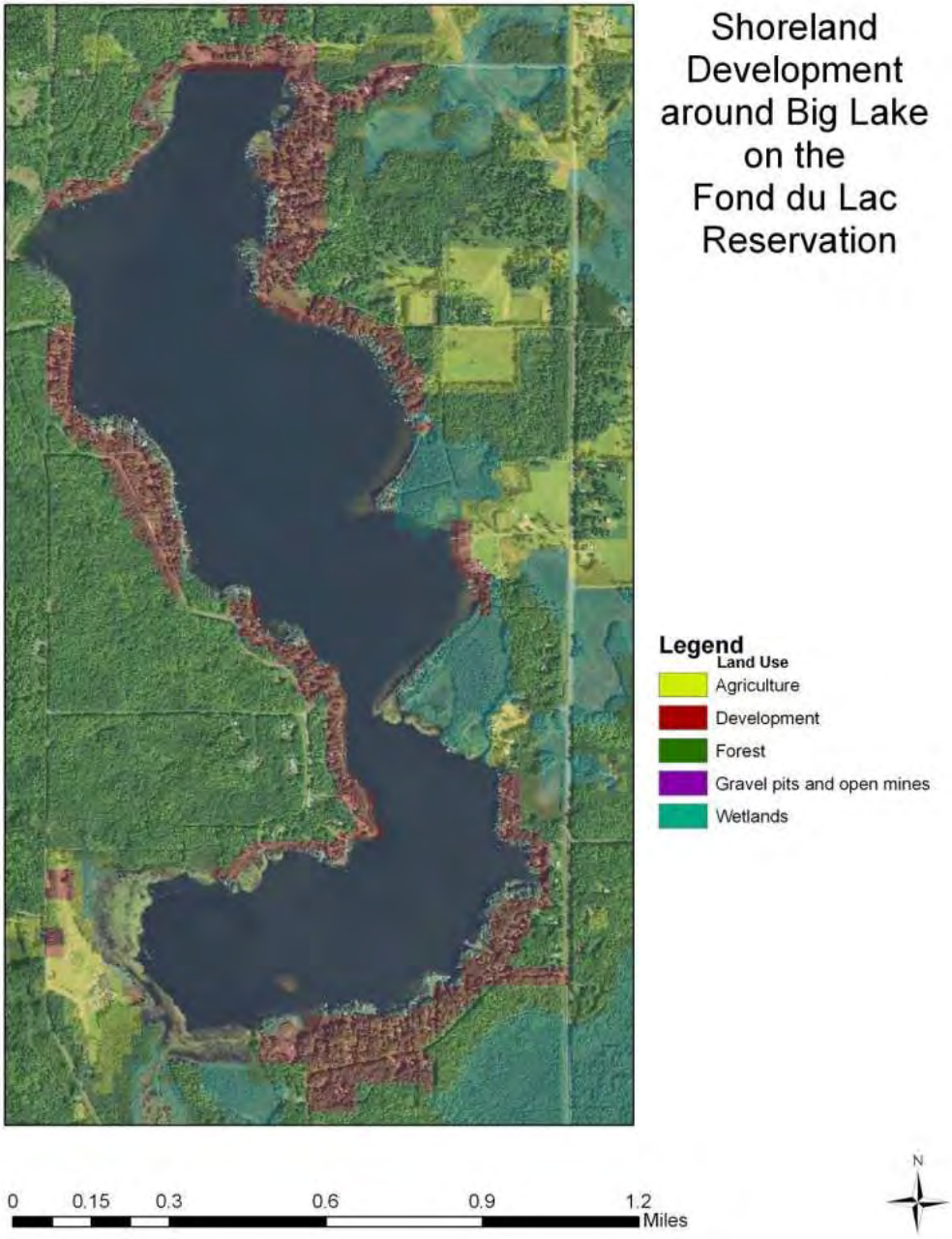


Figure 40. WHAF Map for the St. Louis River Watershed.

This map depicts the Minnesota Department of Natural Resources Watershed Health Assessment Framework subwatershed health scores for septic system impacts to water quality for the St. Louis River Watershed. The inset map shows that the Big Lake Watershed gets the lowest/worst score for septic system impacts (in red on inset map).

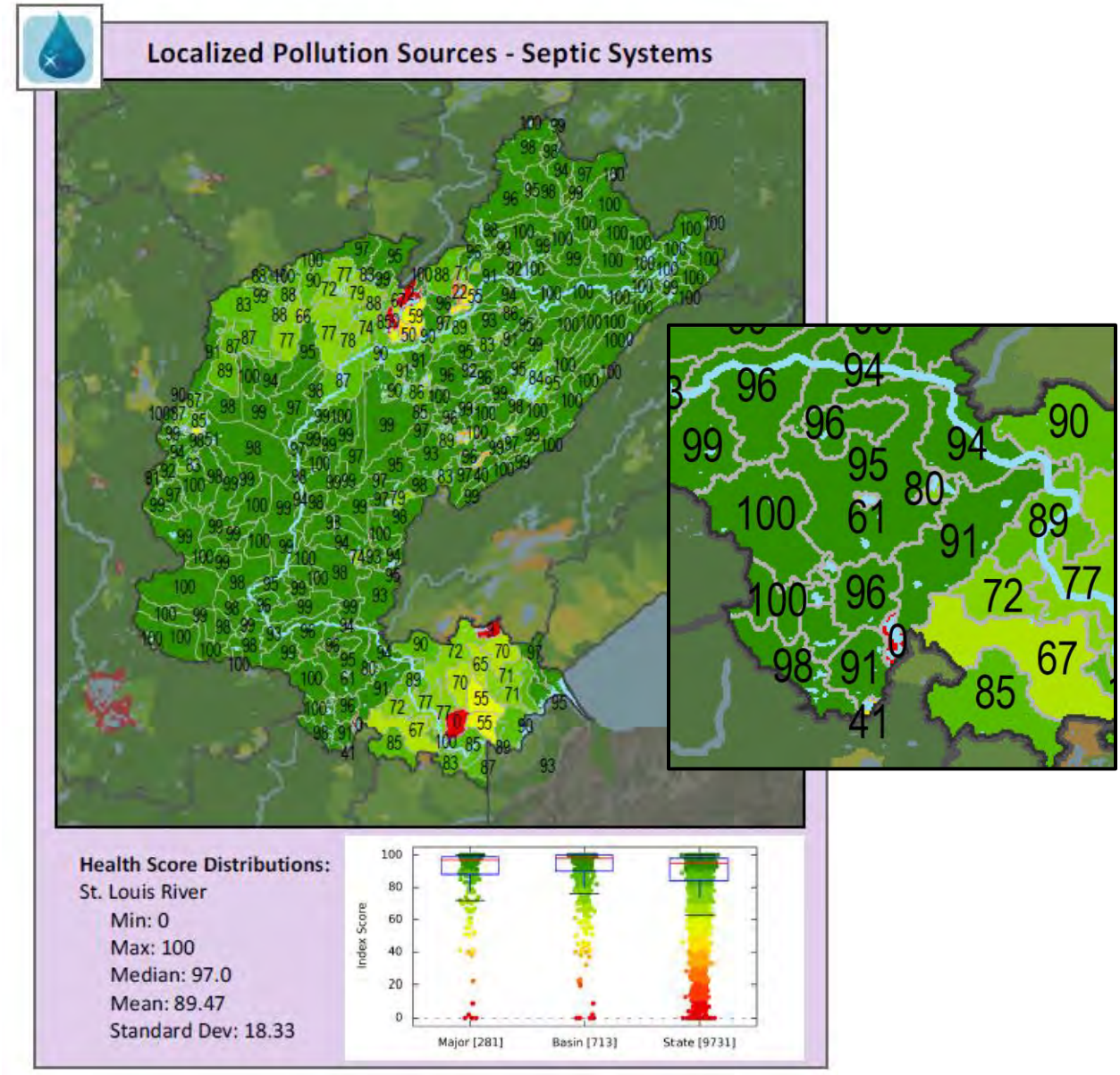
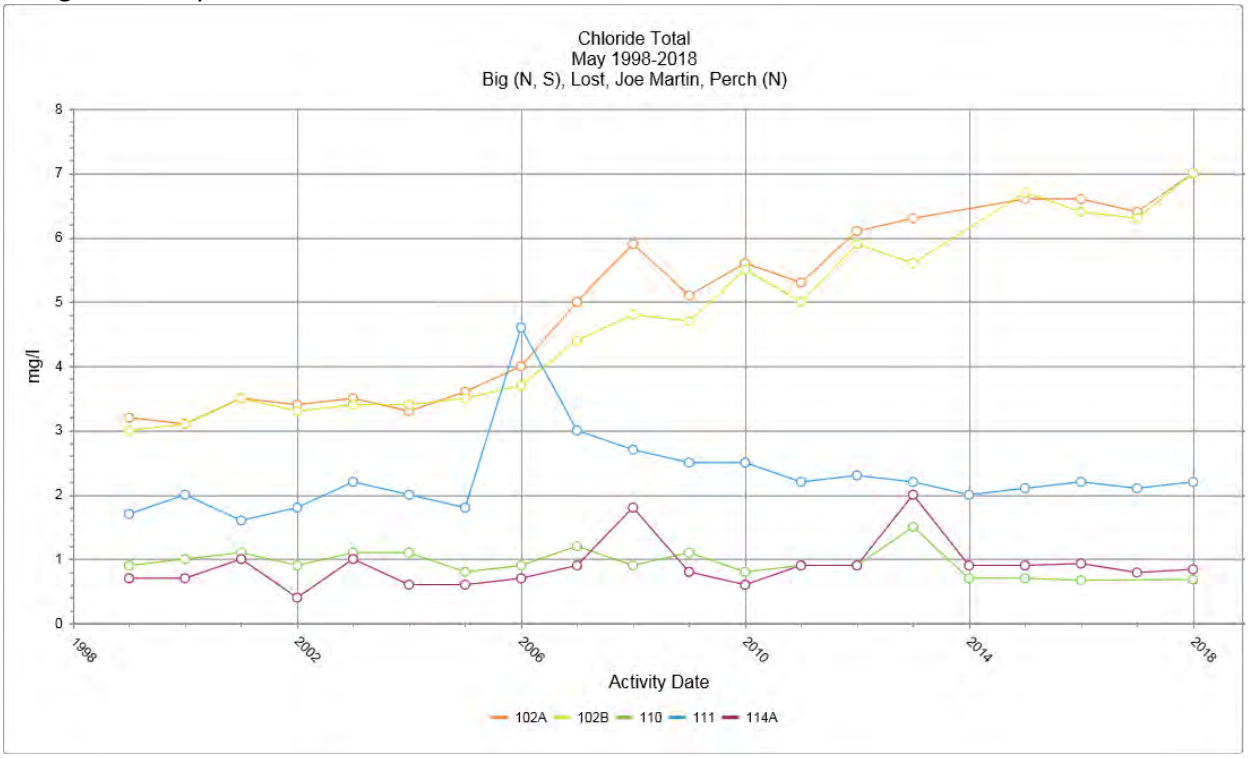


Figure 41. Spring chloride data for Big Lake (North Basin, Big Lake (South Basin), Lost Lake, Joe Martin Lake and Perch Lake (North Basin).

Note the increasing trend in Big Lake compared to similar fisheries lakes. Big Lake is indicated by the orange line and yellow line.



Second Lake

Subwatershed Classification

Conversations with local landowners, nearby wetland delineations (that show majority non-jurisdictional wetlands without a significant nexus to navigable waters) and analysis of the sandy soil types in the First Lake-Second Lake-Third Lake complex, show that all three of these lakes are groundwater-fed lakes with no discernible inlets or outlets. At the HUC-9 scale, the catchments for all three lakes are classified as "headwaters," meaning they are at the top of their respective watersheds (Figure 42). First Lake and Third Lake are in the Otter Creek watershed, which flows southeast to the St. Louis River, while Second Lake is in the Fond du Lac Creek watershed, which then flows northeast to the St. Louis River. All three lakes have small contributing watersheds, and interestingly, the Min No Aya Win healthcare complex is split in half between the First Lake and Second Lake catchments.

Figure 42. Catchments for the First Lake-Second Lake-Third Lake complex.
The Second Lake HUC-9 catchment is highlighted in blue.

NPS Impacts

The lake began experiencing water quality changes after the nearby Min No Aya Win clinic expansion in 2017, which included a larger parking lot and two stormwater ponds, one of which connects directly to Second Lake (Figures 43 and 44). The most recent water quality assessment in 2019 lists this lake as impaired for aquatic life due to exceedance of the standard for total suspended solids. This is likely due to stormwater runoff from the expanded clinic complex. Reconnaissance in the spring of 2020 showed that even after much of the spring snowmelt had occurred, stockpiled snow still remained and was releasing sediment-laden discharge to Second Lake (Figure 45). Flooding in the spring of 2019 likely overtopped the stormwater pond along Big Lake Road and the access road adjacent to the lake, and the access road itself was closed for a few weeks due to flooding. Though the clinic is likely the largest source of NPS pollution in the small Second Lake subwatershed, the expansion of the Big Lake Trail along Big Lake

Road on the south of Second Lake in 2019 may also be a contributing factor. Reconnaissance of the culvert under Big Lake Road during a very dry period in 2020 shows that the culvert outlet is partially blocked by muck and could potentially cause water to back up in the wetland on the other side of Big Lake Road (Figure 46).

Figure 43. Aerial imagery of Min No Aya Win clinic before (top) and after (bottom) expansion.
Image sources: Minnesota DNR Landview (top) and Landsat Earth Explorer (bottom)

Figure 44. Stormwater ponds at the Min No Aya Win Clinic.
Clockwise from the top, they are the north, south and west ponds. The north and west ponds are connected via an underground culvert. The west pond has a direct hydrological connection to Second Lake via a boulder-lined channel. Photo source: Landsat Earth Explorer

Figure 45. Spring 2020 photos of the stormwater ponds at the Min No Aya Win Clinic.
Clockwise from the top: 1) the snow from the parking lot is pushed next to the north stormwater pond, which allows sediment-rich meltwater to drain into it; 2) a pile of construction debris that sits next to the snow pile and serves as a sediment source for receiving water; 3) meltwater and sediment running into the north stormwater pond, causing erosion and carrying sediment-rich water through the culvert and into the west pond, and ultimately, Second Lake; 4) showing the direct hydrological connection between the west pond and Second Lake. The channel between the west pond and the lake is lined with boulders, which prevents erosion from high-velocity runoff, but may do little to prevent suspended sediment from entering the lake, especially during snowmelt.

Figure 46. Photos of the new Big Lake Trail

Depicts the wall and the water flow pathways that connects the wetland north of Big Lake Road to Second Lake (left). During low rainfall periods, this section of Second Lake dries up and we can see the culvert is perched and does not line up with the natural water flow pathway between the wetland and the lake (right).

Construction Stormwater

Without proper erosion control measures, construction activities can lead to erosion, and this leads to sediment, nutrients and toxicants flowing to receiving waters during storm events. FDL OWP works to prevent stormwater erosion through Stormwater Protection Plans, and by requiring construction designs to include stormwater ponds and other erosion control measures. New construction, including the expansion of the Black Bear Casino complex, and the extension of the Min No Aya Win Clinic both included stormwater ponds in their designs.

Brownfields

Land uses that include gravel pits, auto salvage yards, waste dumping sites and transfer stations all have the potential to release toxicants, sediment and nutrients into receiving waters. The brownfields subcategory also includes illegal trash dumping at sites such as beaches, boat launches and roadside ditches. FDL has a Brownfields Program that works with landowners to clean up waste dump sites, and several of the largest unregulated dumps on the reservation have been cleaned up in the past decade. A auto salvage yard is present on Highway 210 near the Black Bear Casino, and FDL maintains a waste transfer site (including household waste, hazardous waste and yard waste), with plans to expand to a new location. FDL also funds a cleanup crew in the summer months to pick up trash at sites where people commonly leave trash, including the shores of both Big Lake and Pat Martin Lake.

Wetland/Riparian Management

It's important to note that nearly every water body on the Reservation is impaired for mercury in the water column and (where assessed) mercury in fish tissue – it's by far the biggest NPS problem on the Reservation, and one of the hardest to address. Fond du Lac's wetland-rich landscape plays a role in sequestering mercury from atmospheric deposition and then releasing bioavailable mercury to receiving waters.

Atmospheric Deposition of Mercury and Wetland Geochemical Processes

Peatlands serve as sinks for both mercury and sulfate from atmospheric deposition, making them conducive environments for mercury methylation via the metabolic processes of sulfate-reducing bacteria; they then contribute to methylmercury loading of downstream aquatic ecosystems when these compounds are flushed from the landscape into receiving waters (Kolka et al., 2011). Methylmercury is the bioavailable form of mercury that can bioaccumulate within food webs, and it is a neurotoxin that can cause health problems in organisms higher on the food web, including predator fish species, piscivorous waterfowl, and humans (USEPA, 1997). High mercury in some fish species has led Fond du Lac, the Great Lakes Indian Fish and Wildlife Commission and the Minnesota Department of Health to publish fish consumption advisories. Ditched peatlands (such as the ones on the Fond du Lac Reservation and throughout the St. Louis River basin) are more susceptible to sudden and large fluctuations in water level because they convey water across the landscape more quickly than intact streams and rivers. The regularly-inundated peatlands surrounding these ditched waterways then release sequestered methylmercury into receiving waters, providing regular pulses of methylmercury pollution, which impacts the lakes, streams and rivers in the St. Louis basin, and ultimately Lake Superior (Lepak et al., 2020). As discussed in the Overview Section, FDL OWP has completed a Wetland Functional Analysis and a Wetland Restoration Plan to prioritize locations where wetland functions can be improved. However, wetland restoration alone will not reduce mercury-related water quality impairments on the Reservation; FDL OWP will need to work in consultation with both Minnesota and Wisconsin state agencies and the USEPA to enact a St. Louis Watershed-specific TMDL to reduce mercury pollution.

Manoomin Management

Manoomin grows in shallow lakes that are also classified as emergent marshes. Manoomin is a keystone species that performs important nutrient cycling functions within a water body, while also providing habitat and food for a suite of species, including but not limited to muskrats, rice worms and other insects, swans and geese, and humans. The places where manoomin grows in the present day are beacons of environmental health, because they still contain the right parameters for manoomin to grow despite human-caused stressors that put those places at risk. Manoomin is also considered to be a social-ecological keystone species because it hosts exceptional biodiversity while also forming the underpinnings of traditional human lifeways, going back to the Woodland era and up to the present Anishinaabe culture (Winter et al., 2018, Vennum 1998). Humans have long been integral to manoomin – where thoughtful harvest occurs, manoomin populations flourish (Kimmerer, 2015).

Within a narrow band of environmental parameters, manoomin can be resilient to a range of conditions. It requires shallow high-quality water, productive aquatic sediment, and the relative absence of pressure from pests and herbivores. Water depths of 0.5 to 3.5 ft are ideal, but within that range, manoomin can thrive on the fringes of deep lakes, the shorelines and estuaries of Lake Superior, shallow lakes with mucky bottoms, and along the edges of fast-flowing rivers with sandy beds (Moyle 1944, 1945). Because of this, manoomin was once abundant across the United States and especially northern Minnesota. To mark what has been lost, one must only look at a Minnesota map showing all the lakes and areas with "Rice" or "Mahnomen" in their names that no longer have manoomin. Tribal elders cite locations where they or their relatives used to harvest manoomin, but stopped because the manoomin populations crashed (HIA Steering Committee pers. comm.).

Most manoomin populations are under threat from multiple stressors at once, most of which are due to non-point source pollution: changes in hydrology that arise from landscape modification or changes in rainfall patterns due to climate change; wildlife management practices that lead to herbivory by swans and Canada geese; inadequate enforcement of water discharge permits that cause pollution, namely from releases containing high sulfate; warmer temperatures during the growing season that lead to increases in disease such as brown spot fungus; and the influx of aquatic invasive species that overtake manoomin habitat (Pastor et al. 2017, Stults et al., 2016 UW-Madison, 2014, MN DNR, 2014). Many of these stressors are complex and must be addressed on a case-by-case basis; however, sulfate pollution poses a clear threat to manoomin at the landscape scale, and enforcing the Minnesota state criteria of 10 mg/L would protect manoomin populations downstream of the mining region in the northeastern part of the state (Johnson et al., 2019, Minnesota Wild Rice Task Force, 2018, Myrbo et al., 2017)). Manoomin serves as a bellwether for environmental and human health. Both traditional ecological knowledge and western science have lent insight into some of the requirements for manoomin to thrive, but our knowledge is incomplete and multi-disciplinary research must continue to add deeper understanding so we can manage manoomin in a good way.

Invasive Species

Invasive species can impair quality habitat for all native lifeforms, and are very difficult to eradicate once they are incorporated into an ecosystem. Aquatic invasive species directly impact lakes, wetlands and streams by outcompeting native vegetation, including manoomin, and altering nutrient and geochemical cycling processes within water bodies. They also change the habitat and food sources that native animals require to survive, which in turn can impact aquatic macroinvertebrate and fish Biological Condition Gradient scores. Upland invasive species can also impact water quality; for instance, invasive species that alter forest composition and dynamics can lead to changes in erosion rates, and changes in evapotranspiration that alter water tables. Grants from the Great Lakes Restoration Initiative allowed FDL to form its own Invasive Species Program, which includes an Invasive Species Management Plan for the Reservation. The FDL Invasive Species Program conducts invasive species surveys, management activities, and they maintain maps and lists of invasive species that are present on the Reservation. An exhaustive list of invasive species present on the Reservation or at risk of spreading to the Reservation, are discussed in FDL's Invasive Species Management Plan. Any species that causes a decline in native species, by disease, direct competition, or by changing the landscape in ways that make it inhospitable to native species, are

a concern. This includes but is not limited to gypsy moth, spruce budworm, earthworms, eastern larch beetle, purple loosestrife, zebra mussels, Chinese mystery snail, spotted knapweed, wild parsnip and buckthorn.

Boating

Boats are a major vector for spreading aquatic invasive species. Boaters who travel from a lake infested with aquatic invasive species to an uninfested lake can cause new infestations if they don't follow the proper procedures. FDL's Invasive Species Program partners with the Minnesota DNR and the Minnesota Sea Grant Program to provide education and signage at all boat launches on the Reservation (in both English and Anishinabek), reminding boater of the "Clean. Drain. Dry." slogan. This refers to the practice of draining all live wells and sumps at the launch site, allowing wet areas to dry, and cleaning the boat and any equipment of all plant fragments or aquatic mussels. FDL has two public boat launches, one on Big Lake and one on the St. Louis River at Highway 2. Informal launches also exist at the following lakes: Perch (South Basin), Rice Portage, Deadfish, Miller (Mud) (accessible by portage only), Jaskari, Bang (Long), Joe Martin, Pat Martin, Simian, Sofie and Third.

Emerald Ash Borer

Emerald ash borer, a non-native insect that infests ash trees, is present in cities close to the Reservation, including Duluth, MN and Superior, WI. Emerald ash borer causes almost complete mortality in ash stands. Since ash stands are prevalent on the Reservation, especially black ash in wetland areas, the total loss of ash on the Reservation will cause significant changes in the ecology and natural processes of our forests. Since black ash trees act as major transpiration pumps in wetlands, drawing down groundwater levels in wetlands, ash eradication will likely lead to a higher water table in many wetlands, which will drive changes in wetland type, often resulting in cattail swamps, which are poorly-functioning wetlands. These degraded wetlands may have limited ability to detain and retain water, which could lead to increased stormwater runoff to receiving waters, leading to systems that are "flashier" in response to rain events. Since black ash stands exist in headwater areas of the Reservation, upstream of our manoomin lakes, these changes in water mass balance could have deleterious impacts on manoomin by increasing water levels in these lakes. Manoomin has a narrow range of water depths in which it thrives. FDL OWP and FDL Forestry have partnered in a pilot project to conduct understory planting in existing black as stands to discover which, if any, tree species could fill the niche that will be vacated by black ash in the coming years.

Climate Change and Extreme Weather Events

The effects of climate change on the Reservation will likely be far-reaching (Figure 47), and FDL OWP acknowledges that climate change is influenced by global drivers outside the scope of this report. Here, we focus on the effects of climate change on hydrology and water temperature on the Reservation.

From the 2018 IRMP:
The Fond du Lac Reservation may be more sensitive to climate change due to its location. The southern edge of the Northern Superior Uplands ecological section is characterized by boreal tree species like aspen, paper birch, balsam fir, and white spruce. These species rapidly decrease in abundance south of the Reservation. Fond du Lac Forestry is implementing two forest management strategies to help mitigate

negative effects from climate change: where possible, continue to grow culturally valuable species for as long as we can successfully do so, and to start to plant species that are predicted to do well (e.g. oak, red maple, sugar maple, white pine) even as more vulnerable species fare worse.

From the MNDNR report *Adapting to Climate Change in Minnesota* (2017) (Figures 47 and 48):
Both the science summarized in the National Climate Assessment and high-quality climatic data show that in Minnesota and the Midwest, rising temperatures have been driven by a dramatic warming of winter and also nights, with both the frequency and the severity of extreme cold conditions declining rapidly. Annual precipitation increases have been punctuated by more frequent and more intense heavy rainfall events. The heaviest snowstorms have also become larger, even as winter has warmed … In the years and decades ahead, winter warming and increased extreme rainfall will continue to be Minnesota's two leading symptoms of climate change.

Climate change concerns specific to wetlands include increased colonization by invasive species, loss of carbon sequestration, loss of black ash (culturally important species), impacts to vernal pool habitat and associated species, loss of boreal tree species that are a significant component of our forested wetlands, loss of wetland functions, amphibian population decline, and changes in wetland type plant diversity. The OWP's wetland monitoring and assessment program, and the Band's Invasive Species monitoring and management program provide data that enables staff to track some of these changes over time.

Figure 47. Projected Climate Changes in Minnesota
(MNDNR, 2017)

Hazard	Projections through century	Confidence in projected changes
Extreme cold	Continued loss of cold extremes and dramatic warming of coldest conditions	Highest
Extreme rainfall	Continued increase in frequency and magnitude; unprecedented flash-floods	
Heat waves	More hot days with increases in severity, coverage, and duration of heat waves	High
Drought	More days between precipitation events, leading to increased drought severity, coverage, and duration	Moderately High
Heavy snowfall	Large events less frequent as winter warms, but occasional very large snowfalls	Moderately low
Severe thunderstorms & tornadoes	More "super events" possible, even if frequency decreases	

Lowest	Low	Moderately Low	Moderately High	High	Highest

Confidence Scale

Fond du Lac OWP will also rely on the wealth of traditional knowledge of the water, landscape and the living beings of our area, and refer to places where that knowledge is being translated into climate adaptation strategies that will help support sustainability and resiliency for all the living beings that rely on clean water and healthy landscapes (Tribal Adaptation Menu Team, 2019, Stults, et al., 2016)

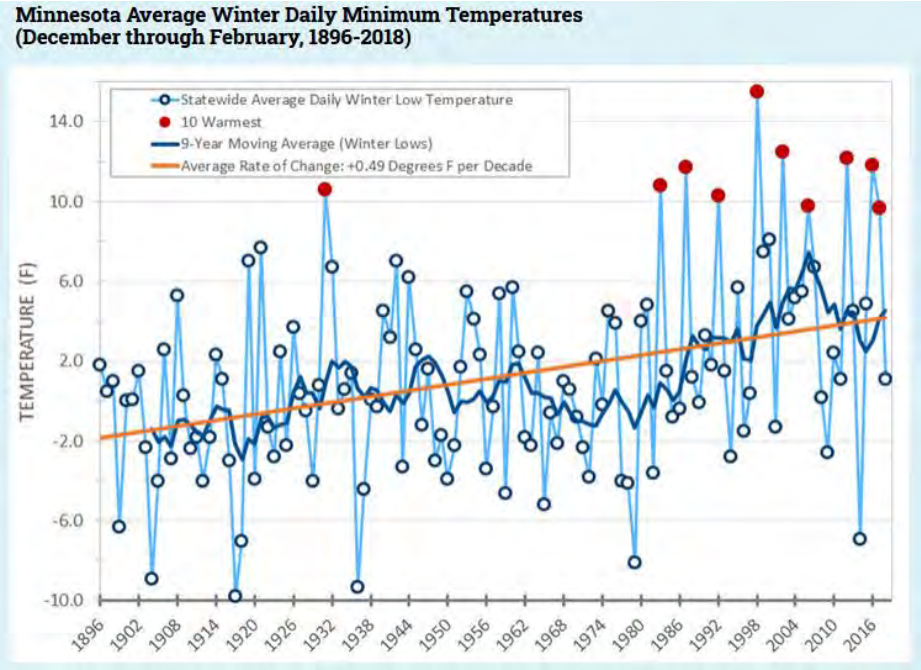
Water Temperature

Figure 48 shows the measured increase in average daily winter minimum temperatures between 1896 and 2018, and the upward trend is likely to continue (MNDNR 2020). This will also likely lead to fewer days of ice cover on Minnesota lakes, which has implications for everything from trophic cascades to susceptibility to AIS to water clarity. Fond du Lac takes part in the Regional Monitoring Network, an EPA/State/Tribal collaboration to collect data on the changes to water quality, temperature and hydrology in streams and lakes. As a result of this collaboration, Fond du Lac OWP began deploying a phenocam at Joe Martin Lake, which we have chosen as our "sentinel lake" for climate change and as a reference lake for the National Aquatic Resource Surveys. We deploy the phenocam in early winter and again in late winter, and then analyze the images and keep a record of ice-on and ice-off dates for each year.

As surface water temperatures increase, this may lead to a decrease or loss of cold-water species such as brook trout and sculpin, as well as sensitive macroinvertebrates. This effect may be measurable in future Biological Condition Gradient scores for Reservation streams. FDL is beginning to focus its work on identifying cold-water refugia in Reservation trout streams, and had conducted thermal surveys of Fond du Lac Creek and part of Stoney Brook in order to locate groundwater inputs to these streams as a way of rating their resilience to increasing water temperatures. FDL Resource Management has also worked with Carlton County SWCD to identify riparian areas that could be planted with trees and shrubs that could provide shade.

In addition, "historical observations show that shifts in temperatures and warming water may be impacting mercury methylation rates, leading to increased bioaccumulation of mercury in fish and other aquatic organisms" (Stults et al., 2016).

Figure 48. Increase in Minnesota's Winter Daily Minimum Temperatures

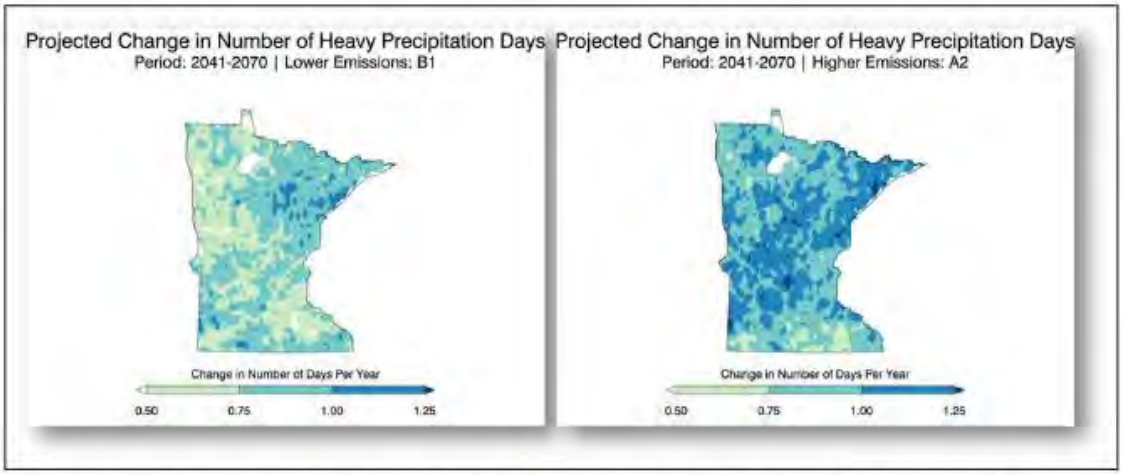


From: MNDNR Climate Trends (2020)

Hydrology

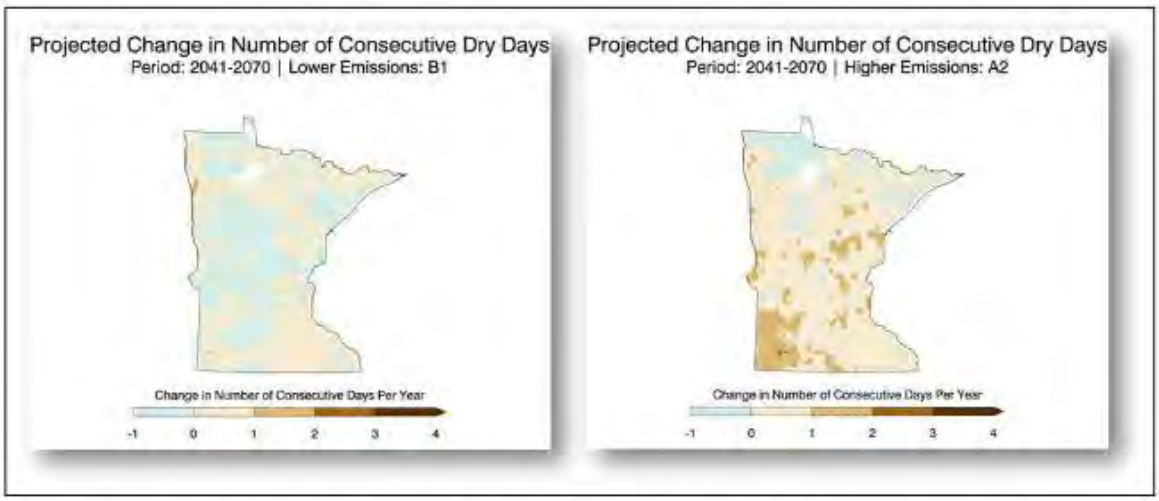
Increased rainfall and drought, which are both predicted to occur with more severe impacts in the coming decades (Figures 49 and 50), will impact water quality and aquatic life on the Reservation. The primary tree communities may also shift, from conifer-dominated to deciduous-dominated, and this could also lead to an increase in surface water flows. Changes in water level will have the most direct effect on manoomin, since this species relies on a narrow shallow-water niche.

Figure 49. Projected Increases in Heavy Precipitation Days for Minnesota
(MNDNR, 2017)



Projected changes by mid-century in number of days annually with heavy rainfall, defined as the upper 2% of daily precipitation for the 1971-2000 climate period. Left image is the "ensemble" or model average for a lower emissions scenario. The right image is the same, but for a higher emissions scenario. Images derived from output used for the 2014 National Climate Assessment, courtesy of GLISA (Great Lakes Integrated Science + Assessments).

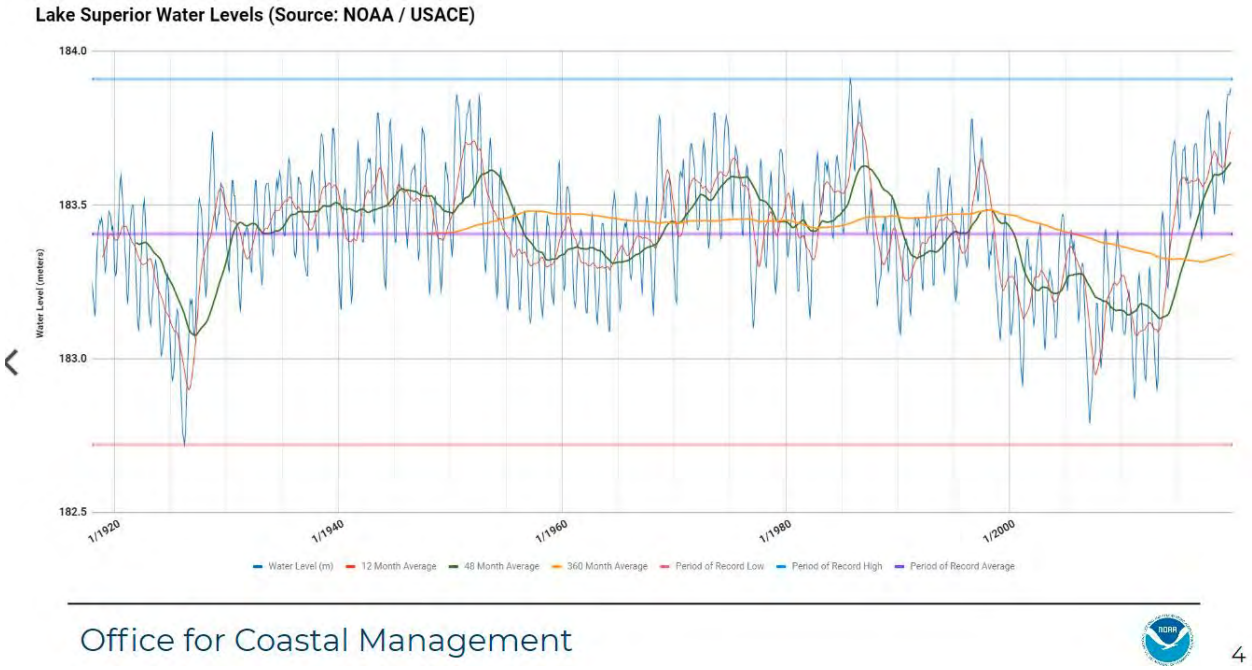
Figure 50. Projected Changes in the Number of Dry Days for Minnesota
(MNDNR 2017)



Projected changes by mid-century in annual average number of dry days between precipitation events. More consecutive dry days would suggest greater potential for at least short-term drought. Note that lower emissions scenario (left) yields no net change statewide, while higher emissions result in a nearly statewide increase. Both images show the "ensemble" or model averages given emissions scenarios. Images derived from output used for the 2014 National Climate Assessment, courtesy of GLISA (Great Lakes Integrated Science + Assessments).

Currently, the Western Lake Superior region is in an extreme wet phase. Precipitation for the decade beginning in 2010 has in general been above average. The decade before 2010 was drier than normal, and these two decades together indicate the new regime that may become more prevalent under future climate change scenarios, where we experience extremes in both wet and dry weather overall, and more extreme single rain events that lead to more runoff and NPS in receiving waters (Figures 49 and 50). Figure 51 is a long-term graph of water level in Lake Superior that shows the extreme dry period in the early 2000s followed by the record-breaking wet period of the 2010s.

Figure 51. Lake Superior Water Levels between 1920 and 2019
(Krumwiede, 2019)



Graph created by Brandon Krumwiede, Great Lakes Regional Geospatial Coordinator for NOAA

Road closure on Pine Drive at Stoney Brook due to severe flooding after the June 2012 flood

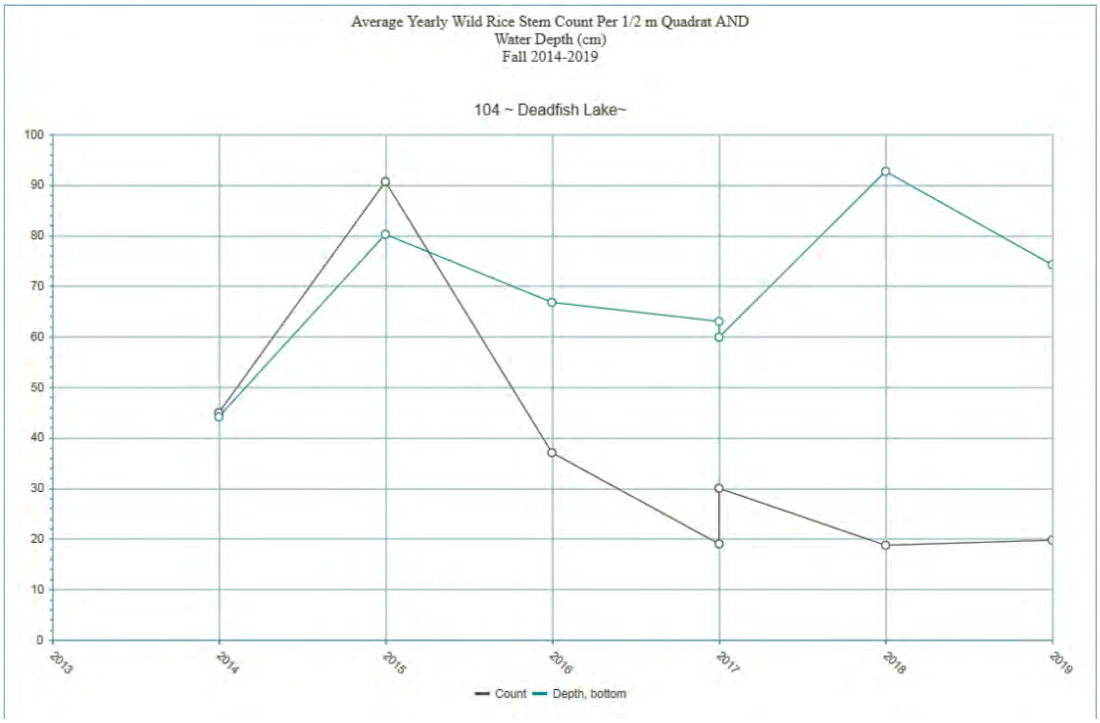
In June of 2012, the Reservation and the Western Lake Superior region experienced a 500-year storm event. Massive and extensive flooding led to numerous road washouts on the Reservation, and the crossing at Fond du Lac Creek blew out catastrophically. Since the flood occurred during the most vulnerable life stage for manoomin, the floating leaf stage, the sudden water level increase led to the manoomin plants being uprooted in all Reservation lakes in 2012. We expect such flooding events to become more frequent in coming decades. One surprising result of the flood was that, although manoomin was uprooted on all Reservation Lakes in 2012, manoomin populations rebounded considerably in 2013. This may be due to the fact that high water also wiped out all competing native vegetation on the manoomin lakes, and may also have stirred up the seed bank on the lake bottom.

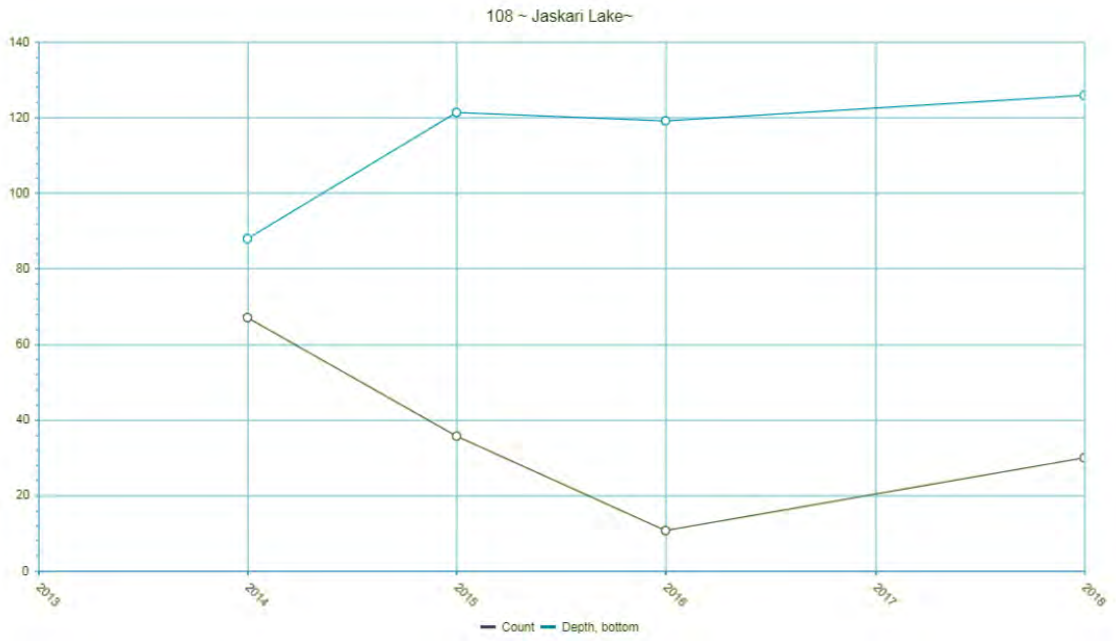
However, sustained high water on the manoomin lakes has led to population decline since 2014. The graphs in Figure 52 show that manoomin stem counts on Reservation lakes are negatively correlated with water depth. This confirms that single large storm events are not the only climate change impact on manoomin lakes; sustained high water likely causes stress during the floating leaf stage by drowning out many individual plants. Although it is not represented below, 2020 was different from recent years in that we experienced a localized summer drought that kept water levels low in all manoomin lakes, leading to one of the most dense and numerous manoomin populations in all of the Reservation's lakes. The MNDNR manages some shallow lakes in the state by complete winter drawdown, as a way to maintain shallow water depths and encourage healthy populations of native aquatic plants that thrive in shallow lakes (Hansel-Welch, 2020).

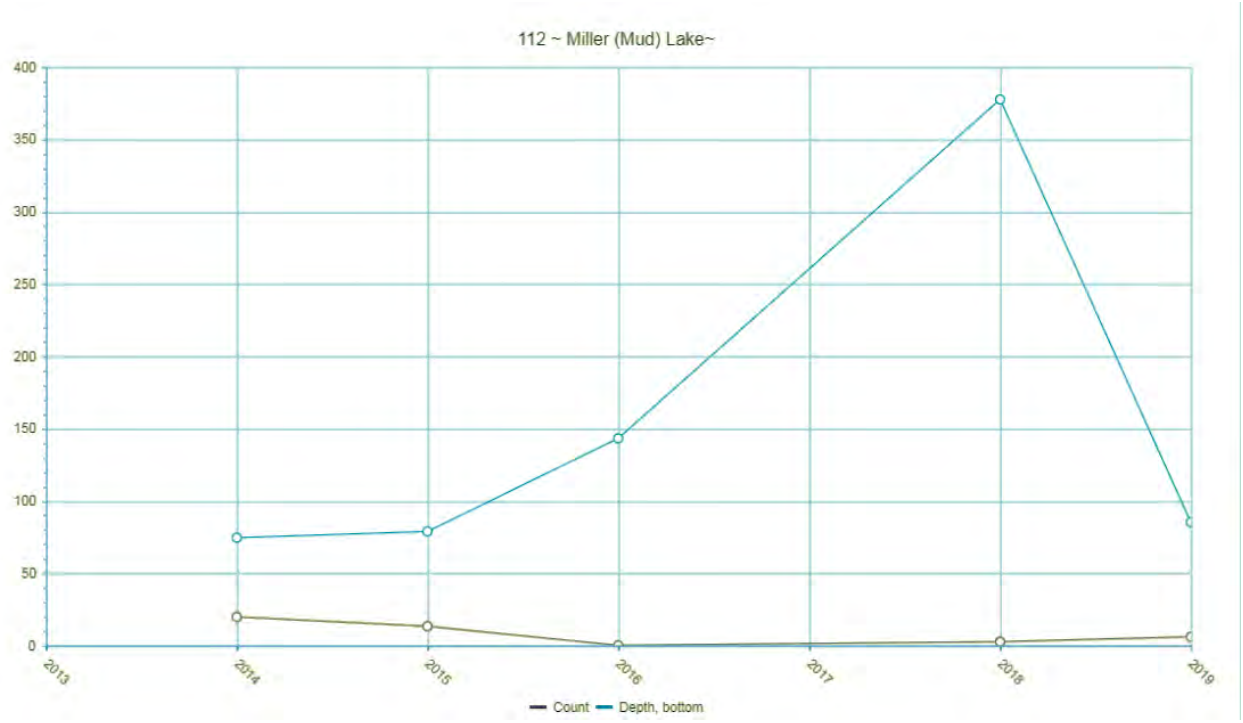
As flood damage becomes a more frequent challenge on the Reservation, Fond du Lac OWP will continue to rely on the Section §319 NPS Assessment Report and Management Plan to provide adaptive management strategies for risk assessment and hazard mitigation.

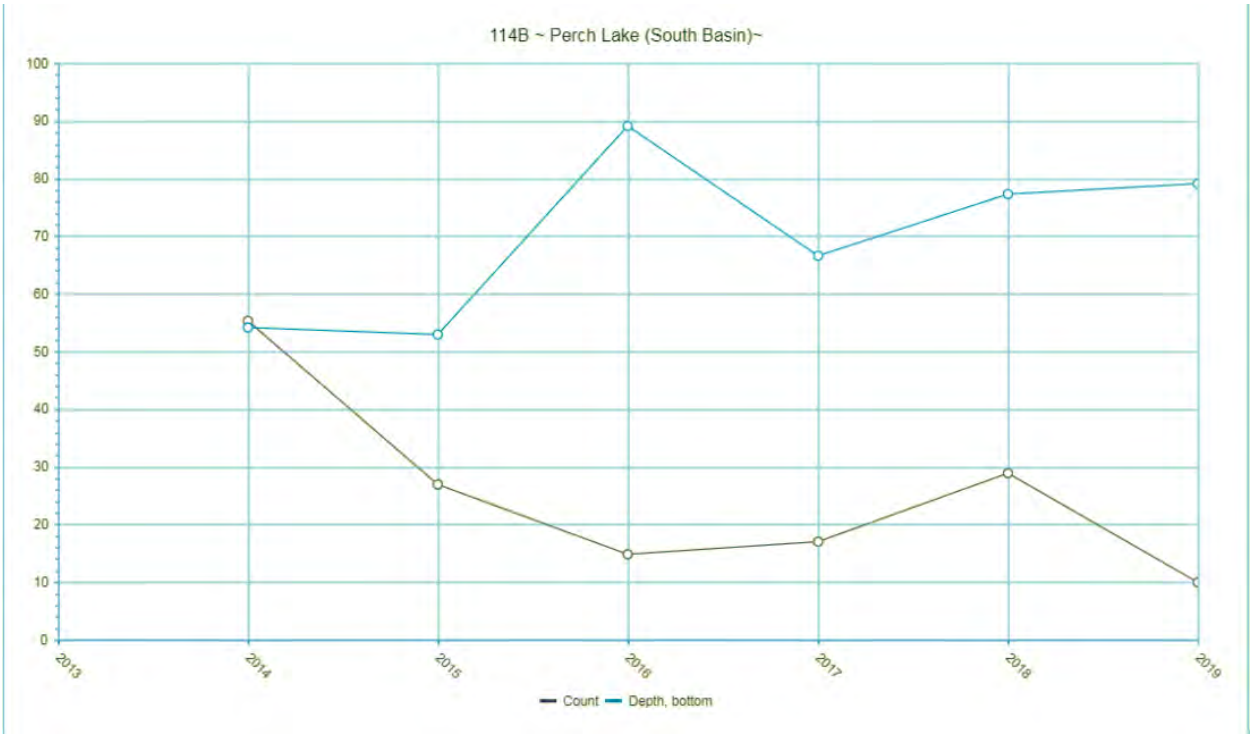
Figure 52. Comparison Between Average Yearly Wild Rice Stem Count Per ½ m Quadrat and Water Level (cm)

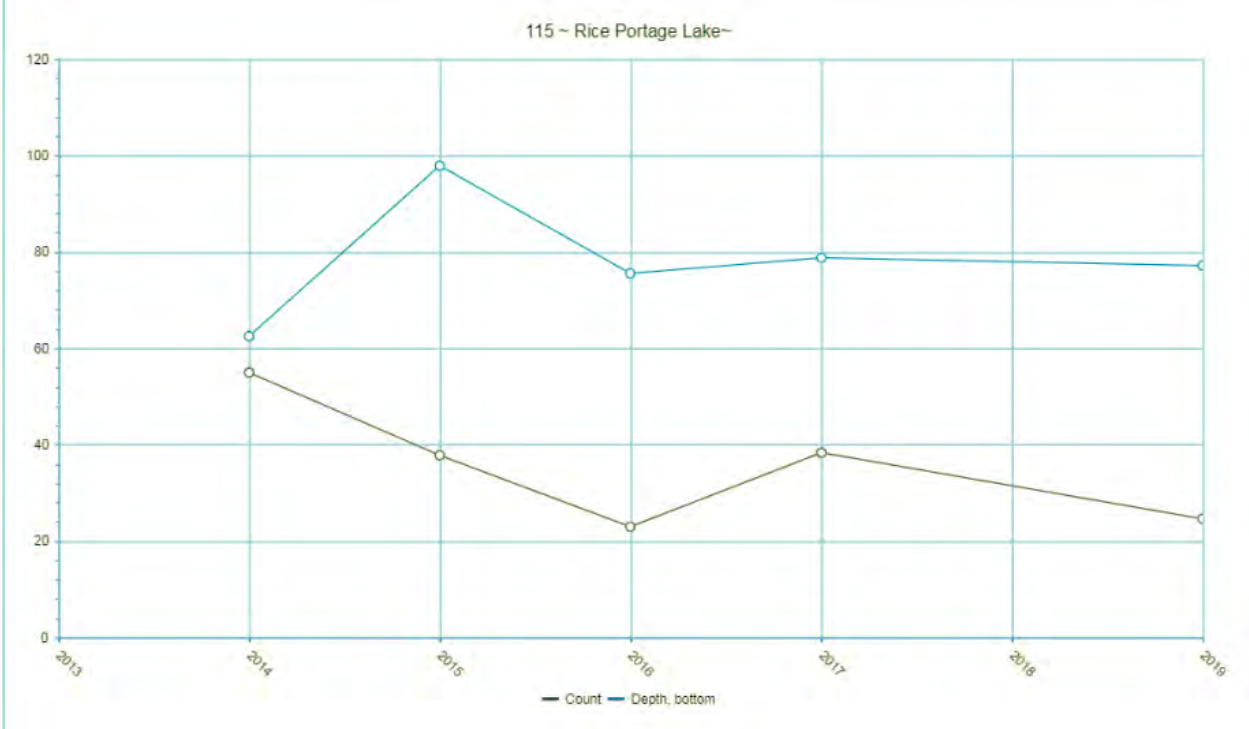
Note that the y axes denote both depth (cm) and stem count per ½ m quadrat.




108 ~ Jaskari Lake~
140
120
100
80
60
40
20
0
2013
2014
2015
2016
2017
2018
Count
Depth, bottom


112 ~ Miller (Mud) Lake~
400
350
300
250
200
150
100
50
0
2013
2014
2015
2016
2017
2018
2019
Count
Depth, bottom


114B ~ Perch Lake (South Basin)~
100
90
80
70
60
50
40
30
20
10
0
2013
2014
2015
2016
2017
2018
2019
Count
Depth, bottom


115 ~ Rice Portage Lake~
120
100
80
60
40
20
0
2013
2014
2015
2016
2017
2018
2019
Count
Depth, bottom

LAND USE SUMMARY

Black Bear Resort and Casino with stormwater pond in the foreground. Photo from Google Street View,

Population and Land Ownership

As of 2018 there were 4,221 enrolled Band members, of whom 1,492 live directly on the Reservation. An additional 2,400 American Indian people live within 25 miles of the Reservation (US Census Bureau, 2017). New population numbers will be available after the 2020 census. Approximately 44% of the land within Reservation boundaries is tribally-owned as Band lands, allotment lands, and Minnesota Chippewa Tribe lands (Figure 53, Table 2). This is an increase since the 2004 NPS Report when 27% of Reservation land was in tribal ownership. The Reservation is divided in half by two counties: St. Louis and Carlton. St. Louis County and Carlton County together own 8% of land within the Reservation, and 37% is under private ownership. Allotments arose from the Dawes General Allotment Act, which was passed in 1887 (US National Archives, 1887). The head of each family allotted was 160 acres on the Reservation; other adults were allotted 80 acres and children were allotted 40 acres. Ownerships then became fractionated among their descendants. “Private” allotments are allotments in which the Band itself has no ownership interests. Band majority allotments are allotments in which the Band itself has more than 50.0% or more ownership interest. "Private" allotments equal 779 acres; Band majority allotments equal 10,606 acres. Some of the land was switched to Band majority allotments under the Cobell Land Buy-Back Program (US Department of Interior, 2018). The Reservation is still heavily checker-boarded with regard to ownership patterns, but buying back lands within and also outside the exterior boundaries of the Reservation is a continuing goal of the Band (Figure 54).

Table 2. Fond du Lac Reservation Land Ownership

Fond du Lac Reservation Land Ownership
Reservation Boundary = 101,500 acres, original boundary was 125,294 acres. Established 1854 by La Pointe Treaty (MN became state in 1858).
Ceded territories: 1837 is 13 million acres, 1842 is 10.5 million acres, 1854 is 6.3 million acres. TOTAL: 29.8 million acres

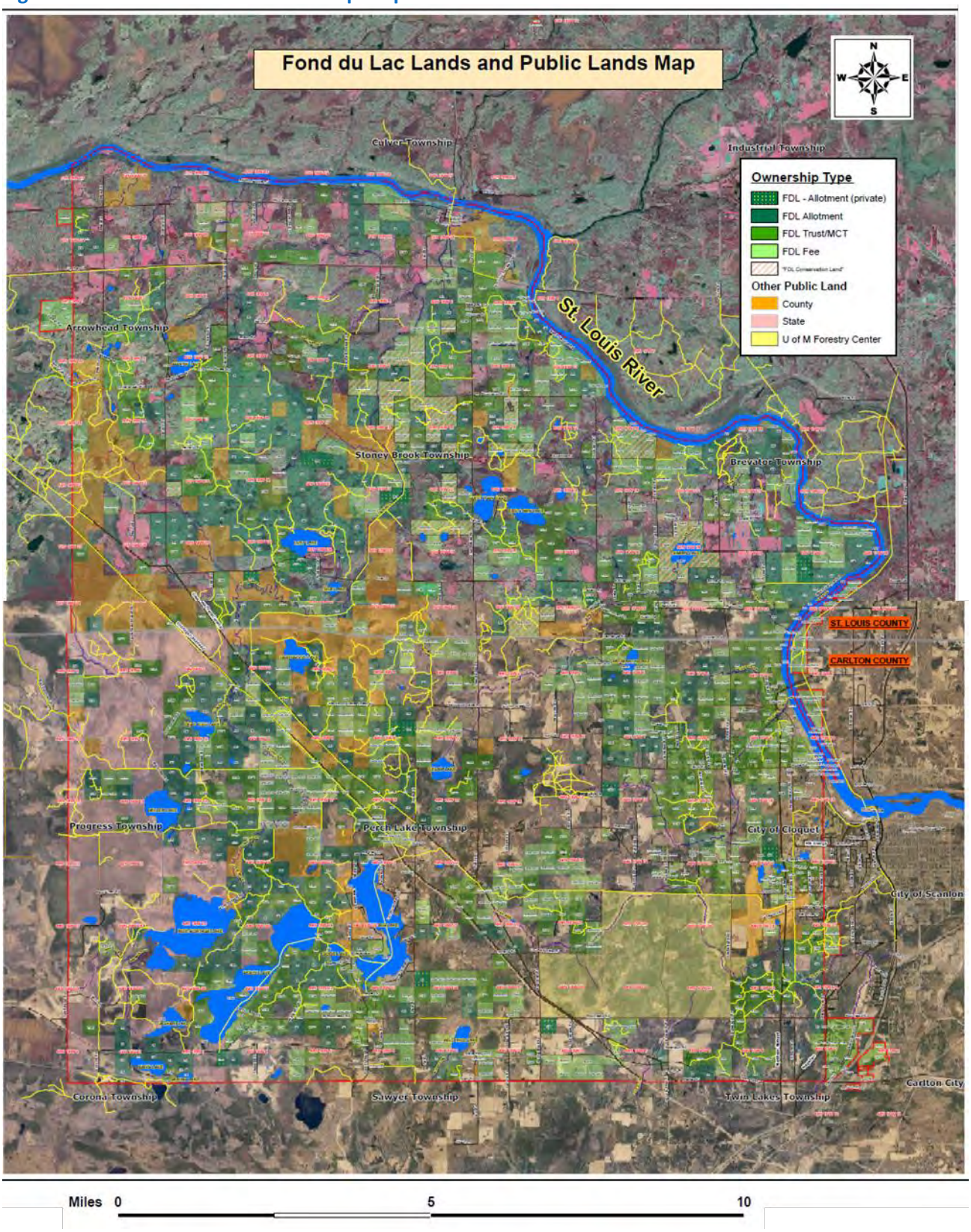
Land Ownership within FDL Boundary		
ENTITY	ACRES	% of Reservation
Fond du Lac	45,016	44.4%
Carlton County	2,387	2.4%
Saint Louis County	5,820	5.7%
State of MN	6,154	6.1%
University of MN	3,363	3.3%
Private	37,148	36.6%

Fond du Lac Ownership Detail	
OWNERSHIP TYPE	ACRES
Allotment Land	15,781
Band Land	10,915
MN Chippewa Tribe Land	4,708
Band Land Owned in Fee	13,612
TOTAL	45,016

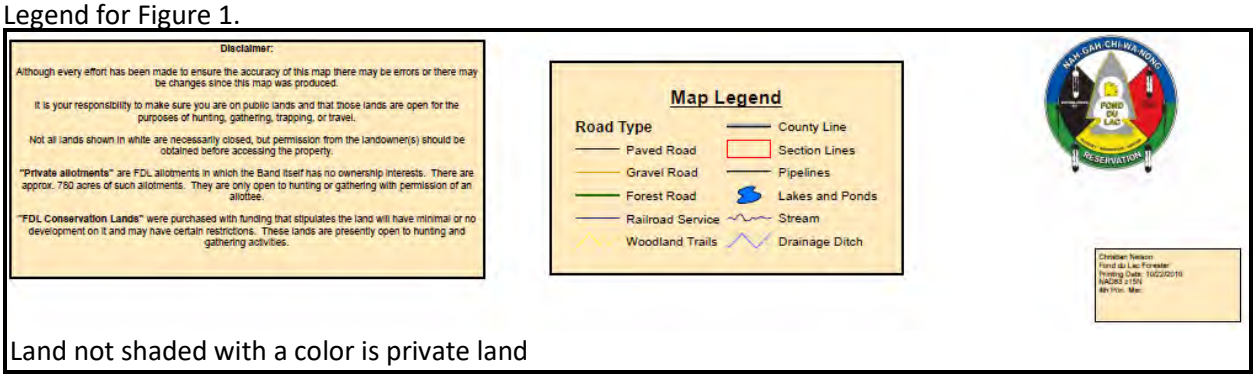
Land Use Types Under FDL Ownership	Acres	Description
Forests	30,677	Includes non-productive forests
Non-forest uplands	2,945	Fields, housing, or business/industrial areas.
Water/Wetlands	7,977	Bogs, marshes, ponds, lakes, and other **non-forest** wetlands owned by FDL.

Information compiled by Christian Nelson, FDL Forester, using current FDL Land Info. Dept. and Forestry records - July 19, 2018

Figure 53. Fond du Lac Land Ownership Map

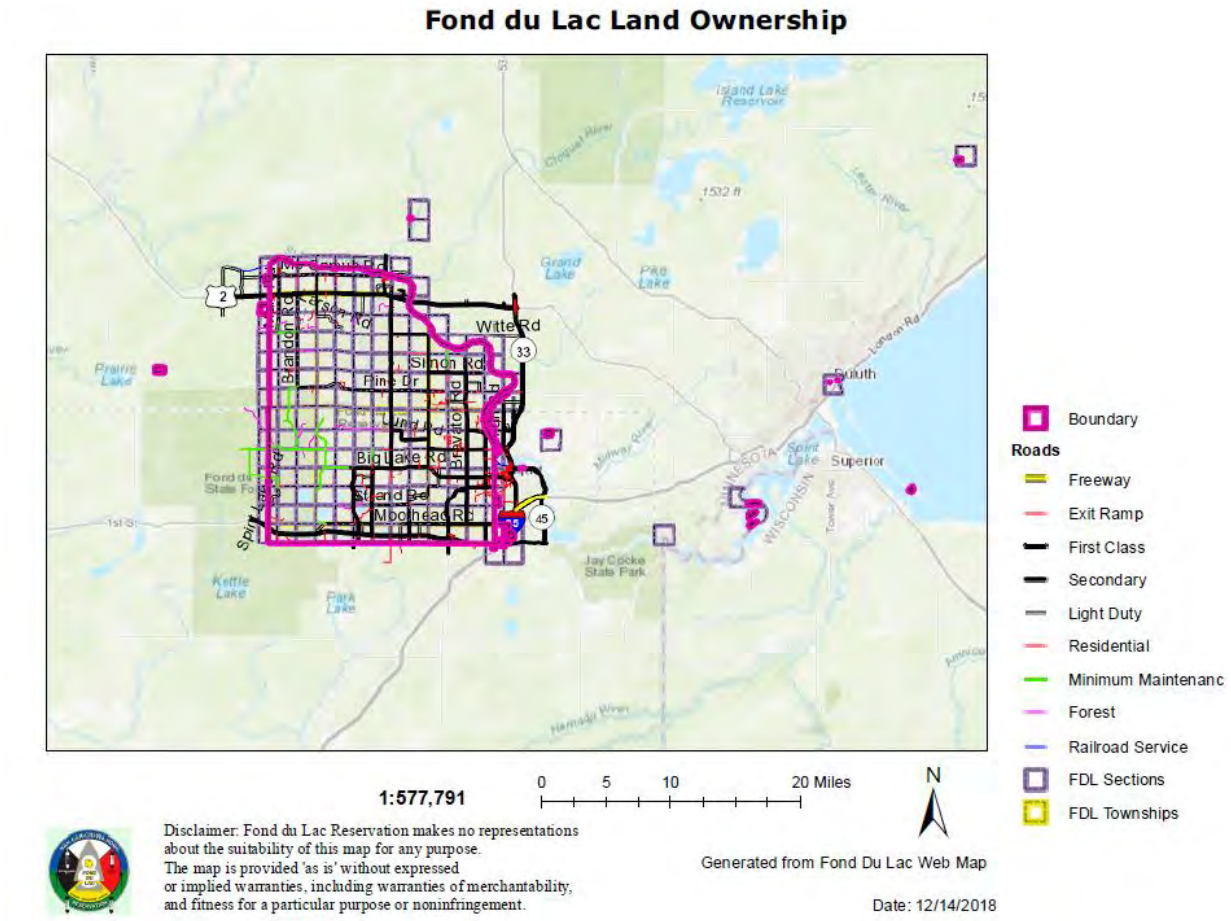


Legend for Figure 1.



Land not shaded with a color is private land

Figure 54. Fond du Lac Land Ownership in the Region



Land Use

Land uses have not changed significantly since the 2004 319 NPS Assessment Report, but new and more accurate land cover and impervious surface data is available that uses both LiDAR data and Landsat 8 satellite imagery (Knight, 2016). Figures 55 and 56 compare land cover maps created with 2007 data and 2016 data to show that that land use hasn't changed over time. Much of what was inaccurately classified as cultivated, grass and shrub lands in the 2004 NPS report is now correctly classified as forest. Table 3 summarizes the 2007 and 2016 land uses classes, and shows that most of the land cover is primarily in the forest and wetland cover types. According to the 2016 data, only 4% of Reservation land cover is classified as impervious, and 5.3% of Reservation land has been converted to pasture or crops. Although impervious cover has increased over time, Table 3 shouldn't be used to quantify the changes in in any of the land use classes over time, since the two mapping efforts used different approaches and classified land differently, especially in the case of impervious cover.

The City of Cloquet is the largest city in Carlton County and one of the largest areas of impervious surface in northeastern Minnesota (Figure 57). Cloquet's impervious area does not affect Reservation water quality, since all water from Cloquet flows north and east into the St. Louis River, downstream of the Reservation. The largest areas of impervious surface within the Reservation include the tribal government offices (Tribal Headquarters, Ojibwe School, Headstart Gym, Transportation and Resource Management, and the planned Cultural Center); the Black Bear Casino and Hotel complex, the Carlton County Airport; a developed area on Big Lake Road near the border with Cloquet (includes residential areas, tribal housing, the Fond du Lac Gas and Grocery and the Min No Aya Win Human Services Center); a housing development on Danielson Road; shoreline development around Big Lake; the town of Brookston; and major roads (Figure 57).Gravel extraction is the next largest class of land use that contributes to impervious surface, with gravel pits on Pine Drive, Jokela Road, Ditchbank Road north of Big Lake, Airport Road and Wheaton Road. Although Figures 55 and 56 list row crops as a land cover class on the Reservation, most fields under cultivation on the Reservation are hayfields (Figure 57). Since pipelines are underground features, they do not appear as a land cover type in the 2016 land cover assessment, except occasionally in the "cultivated" land cover type. They do show up as impervious cover in the 2007 assessment (Figure 55).

Figure 55. 2007 Land Use Data

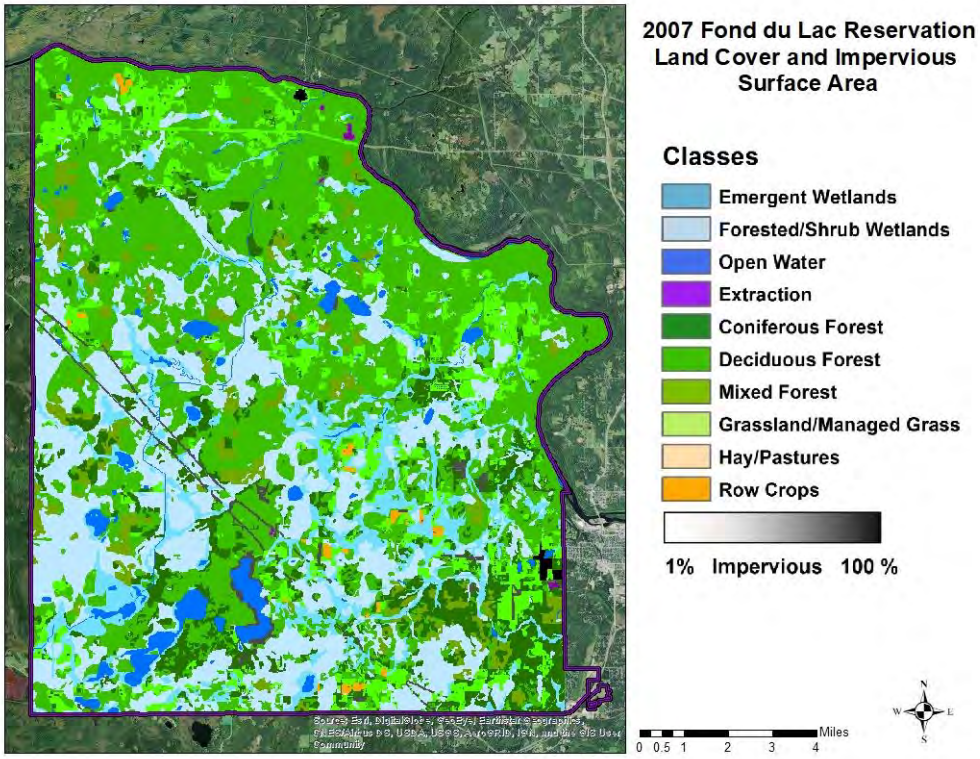


Figure 56. 2016 Land Use Data

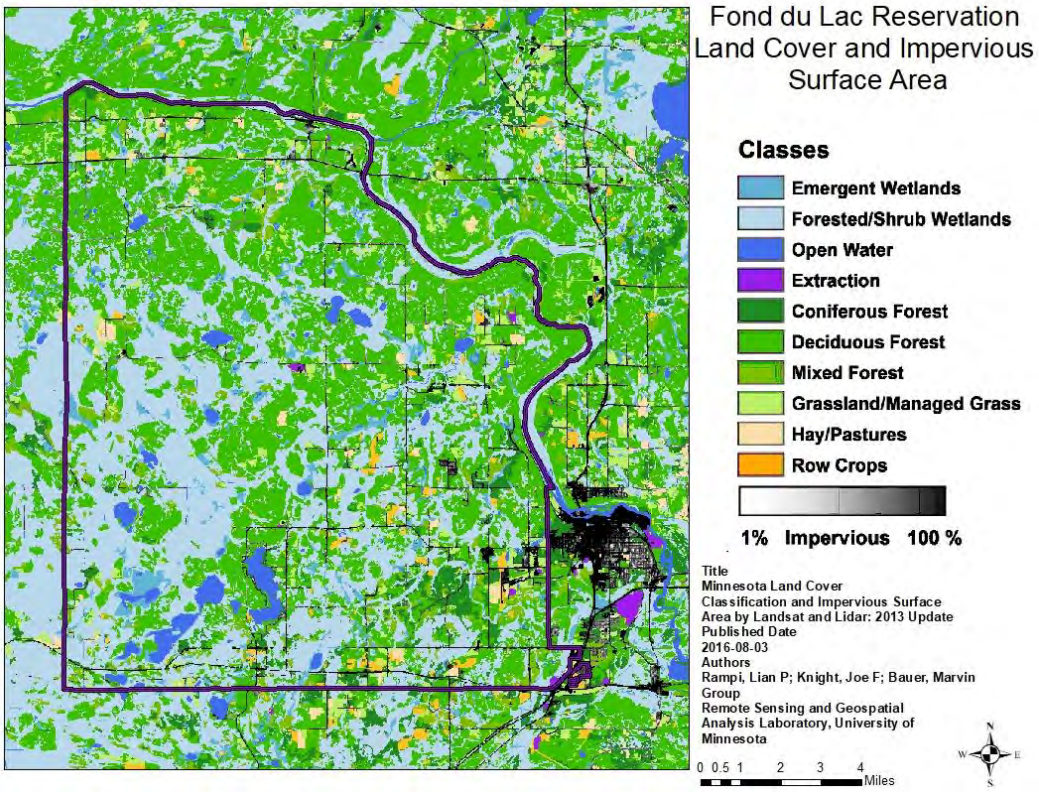
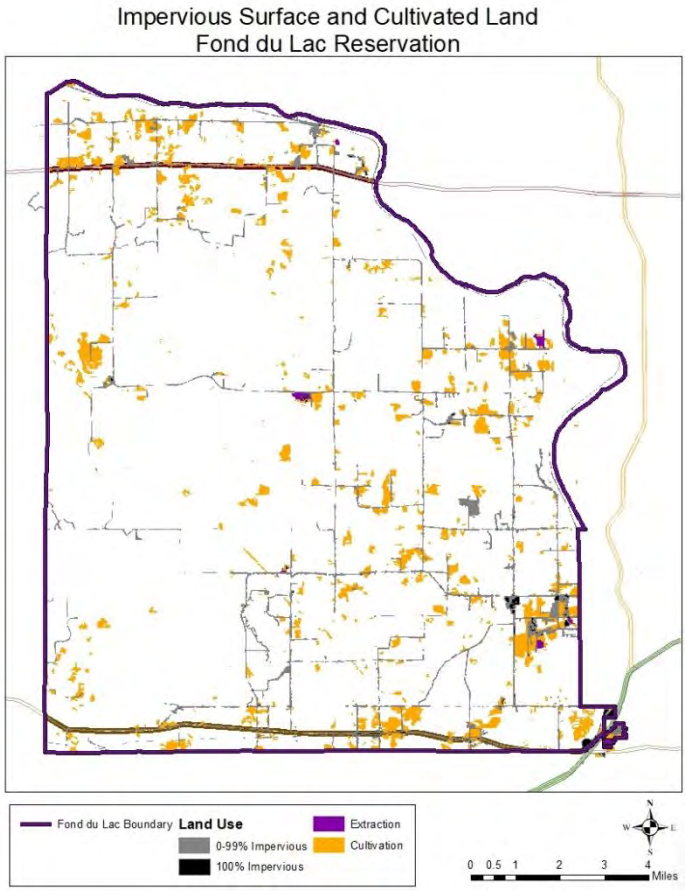


Table 3. 2007 and 2016 Fond du Lac Reservation Land Use

Land Use Class	2007 Land Cover		2016 Land Cover	
	Area (km^2)	Percent of Land Use	Area (km^2)	Percent of Land Use
Emergent Wetland	35.6	8.7	15.8	3.8
Forested/Shrub Wetland	93.7	22.9	152.0	36.7
Surface Water	14.8	3.6	15.1	3.7
Extraction	0.4	0.1	0.4	0.1
Coniferous Forest	36.4	8.9	14.2	3.4
Deciduous Forest	166.7	40.6	165.6	40.0
Mixed Forest	16.9	4.1	12.3	3.0
Grassland/Hay/Pastures	39.5	9.6	16.9	4.1
Row Crops	1.5	0.4	5.0	1.2
1% - 99% Impervious	3.9	1.0	14.2	3.4
100% Impervious	0.7	0.2	2.6	0.6
TOTAL	410.2	100	414.1	100

Figure 57. Impervious Surface and Cultivated Land



Fond du Lac Land Use Committee

Fond du Lac's Land Use Committee's purpose is to "preserve and enhance the resources [of the Fond du Lac Reservation] in a manner which is consistent with, and reflective of, traditional Anishinaabe values" (FDL Land Use Ordinance, 2007). The Land Use Committee meets regularly and works under a set of bylaws to set land use priorities and uniform standards for Reservation land; the group is led by the Land Use and Zoning Administrator and the committee is comprised of three enrolled members of the Fond du Lac Band and four employees of the Band. Their purpose is to protect the environment and residents of the Reservation through the "regulation of commercial and industrial development, non-residential use, residential development, preservation of sensitive areas, and shoreland areas" (FDL Land Use Ordinance, 2007). They also issue or deny permits for Conditional Use, Special Use, Shoreland, and Subdivision Permits. Access to affordable housing can be a challenge for Band members, which is also a regional and national issue. The Land Use Committee is tasked with balancing the need for affordable housing with protecting cultural and natural resources. They take several approaches to achieve this goal, including buying existing houses from private owners and putting them into federal trust, and also clustering new housing developments to enhance efficient and economical land use. Because the Reservation has extensive wetlands, finding developable land for new housing is a challenge. The Land Use ordinance also prohibits certain activities on the Reservation, including hazardous and radioactive waste disposal, salvage and junk yards, sanitary landfills, and commercial fish, wildlife and wild rice preserves.

The Fond du Lac Reservation is divided into eight districts or zones (Figure 58):

- Cultural Preservation (CP): To sustain areas which have cultural, environmental or historical significance to the people of the Fond du Lac Reservation, to protect sensitive natural resources and to provide a place for traditional practices. This District shall be applied to designated wild rice lakes, sugar bush sites, gathering sites, burial sites, and sites of historical remains or artifacts. Hunting, fishing and gathering are permitted.
- Residential (R): To provide areas where families can make homes and enjoy a setting that is free of commercial and industrial activity, noise and pollution, or any activity that may threaten the peace, safety and health of residents.
- Mixed Use (M): To provide areas suitable for mixed uses, such as the area developed as the institutional core of the Fond du Lac Reservation on Big Lake Road, and the town of Brookston. Housing, administrative buildings, businesses, churches, warehouses, and educational buildings are permitted.
- Natural Resource Management District (NR): To provide for the uses that allow forest production and management, agricultural farms and to provide areas managed for fish, wildlife and other natural resources; and to sustain and enhance areas for traditional hunting, fishing and gathering. Timber harvesting, agriculture, trails, and other resource management activities are permitted, as well as hunting, fishing and gathering. Conditional use permits are allowed for building homes and educational facilities.
- Commercial (C): To provide adequate space for retail, wholesale, office and service buildings, and gaming activities. This includes golf courses, parking lots and parking ramps.
- Industrial (I): To encourage the development of manufacturing, warehousing and similar and related uses in specified portions of the Reservation that are uniquely suited for this type of land use.
- Parks and Recreation (PR): To provide for recreational opportunities to Fond du Lac Band members and their families. Included in this district are the various housing development parks

on the Reservation and the Band's public access areas on Big Lake. Conditional uses include visitor centers, public restrooms, parking lots and single homes.

- Shoreland Overlay (S): To provide for the effective management, protection, and conservation of shorelands within the Reservation to preserve and enhance surface water and groundwater quality and retain traditional practices associated with these areas (Table 4). A Shoreland Permit is required for any activity, including constructing or altering building and accessory structures, such as docks; installing or altering individual sewage treatment systems; grading and filling activities; extraction and excavation activities; and removing vegetation within the Shoreland Overlay District (Figure 59). Shoreland is classified as land located within 1,000 ft from the Ordinary High Water Level and 300 ft from either bank of a watercourse. The Shore Impact Zone is defined as the buffer area immediately adjacent to water bodies or watercourses that is critical to preserving the water quality, wildlife habitat and visual screening of the area farther from shore.

The State of Minnesota offers four funds created by the Clean Water, Land and Legacy Amendment; one of those is the Outdoor Heritage Fund. The Lessard-Sams Outdoor Heritage Council makes funding recommendations for the Outdoor Heritage Fund, and awards grants that are related to the "restoration, protection, and enhancement of wetlands, prairies, forests, and habitat for fish, game, and wildlife, and that prevent forest fragmentation, and encourage forest consolidation" (Legislative Coordinating Commission, 2020). Fond du Lac was one of the first tribal nations in Minnesota to receive a grant from the Outdoor Heritage Fund, and the money was used to purchase properties in St. Louis County and put them into a permanent conservation easement.

Wetland Protection and Management Ordinance

The Fond du Lac Band recognizes that wetlands are fragile natural resources with significant development constraints due to flooding, erosion, and soil limitations. In their natural state, wetlands provide important tribal and public benefits and ecological functions. They provide habitat areas for fish, wildlife, and vegetation, water quality maintenance and pollution control, flood control, shoreline erosion control, natural resource education, scientific study, open space, recreation opportunities, environmental niches, and most importantly the traditional, cultural, and spiritual aspects of Fond du Lac's heritage. Previous construction, land development, and other direct and indirect impacts have displaced, polluted, or degraded many wetlands. Piecemeal or cumulative losses are a continuing threat to the remaining wetlands and damaging or destroying wetlands threatens public safety and the general welfare of the Band. Preserving wetlands in their natural condition is necessary to maintain the hydrologic, economic, recreational, subsistence, cultural, spiritual, and aesthetic assets for current and future residents of the Fond du Lac Reservation. The purpose of the Fond du Lac Wetlands Protection and Management Ordinance (WPMO) is to ensure maximum protection for wetlands by discouraging development activities in wetlands and those activities in adjacent upland sites that may adversely affect wetlands. The WPMO was enacted with the intent of providing a reasonable balance between the rights of individual property owners to the free use of his/her property and the rights of present and future generations (Wetlands Protection and Management Ordinance, 2006).

The Office of Water Protection (OWP), operating under the Resource Management Division is responsible for the application, processing, and review of Wetland Activity Permits and Exemption Certificates under the provisions of the Fond du Lac Wetlands Protection and Management Ordinance (2006). Exemption Certificates are available by submitting an Exemption Certificate Request Form to the OWP at least 10 days before the commencement of the activity. Please see the WPMO for details on Exemption Certificate

eligibility. Two types of Wetland Activity Permits are available for activities that will impact wetlands. A Letter-of-Permission Wetland Activity Permit (LOP-WAP) authorizes impacts of less than 2 acres of wetlands; while a Standard Wetland Activity Permit (S-WAP) authorizes impacts to wetlands 2 acres or greater. A 30-day Public Notice for an LOP-WAP and a 60-day Public Notice for an S-WAP will be issued by the OWP to request comments regarding the issuance of such permits for a given proposed project impacting wetlands. Because wetlands on the Reservation may also be subject to federal and/or state wetland permitting requirements, Fond du Lac OWP works in collaboration with federal and state regulators to prepare and review wetland permits.

Figure 58. Land Use Zones

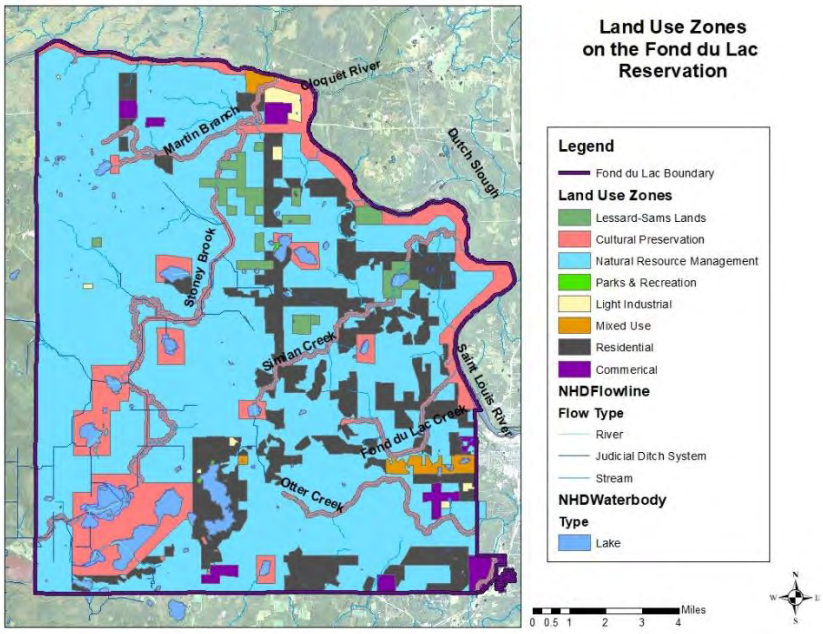


Figure 59. Shoreland Districts

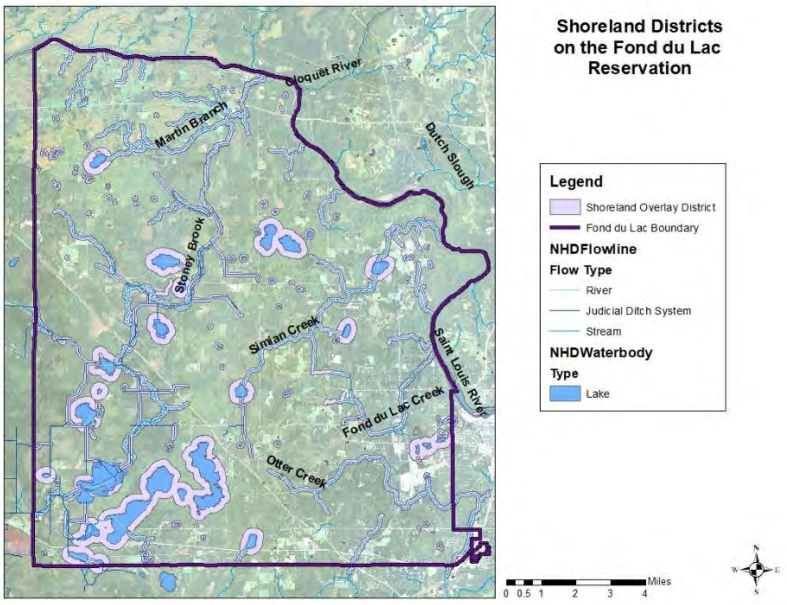


Table 4. Land Use District Categories for Lakes and Watercourses on the Fond du Lac Reservation

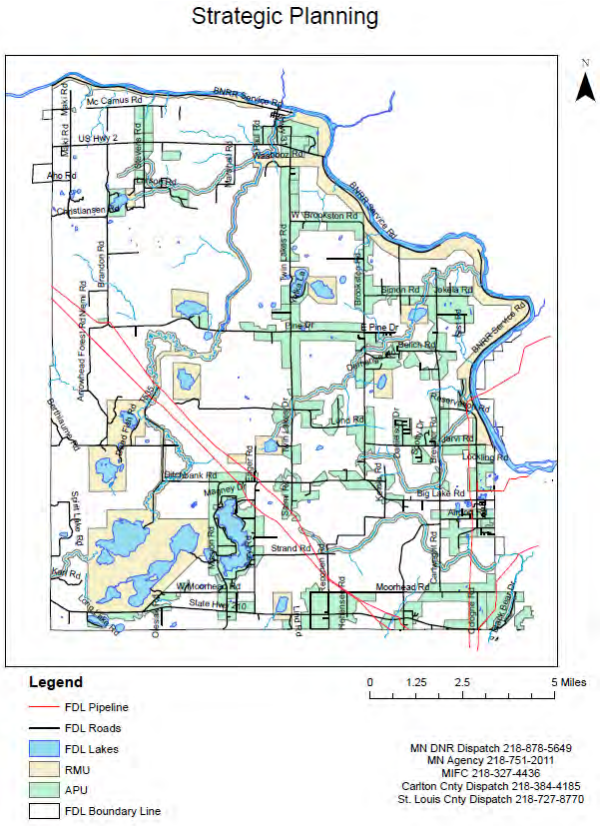
Lakes	CP District	R District	NR District	M District
Bang (Long) Lake		*		
Big Lake		*		
Cedar Lake			*	
Deadfish Lake	*			
East Twin Lake			*	
First Lake				*
Hardwood Lake	*			
Jaskari Lake	*			
Joe Martin Lake	*	*		
Lac Lake	*			
Lost Lake	*	*		
Miller (Mud) Lake	*			
Pat Martin Lake	*			
Perch Lake	*			
Rice Portage Lake	*			
Second Lake				*
Side Lake			*	
Simian Lake		*		
Sofie Lake	*	*		
Spring Lake			*	
Spruce (Spirit) Lake			*	
Third Lake				*
West Twin Lake		*		
Wild Rice Lake	*			
Watercourses	**CP District**	**R District**	**NR District**	**M District**
Annamhasung Creek	*			
Fond du Lac Creek	*			
Martin Branch	*			
Otter Creek	*			
Simian Creek	*	*		
Spring Creek	*			
St. Louis River	*			
Stoney Brook	*			

Fire Management Units

FDL Resource Management maintains the Wildland Fire Management Plan, which bestows different types of protection and management approaches to lands and waters on the Reservation (FDL Wildland Fire Management Plan, 2015). Figure 60 depicts the Fire Management Units on the Reservation. According to the plan, there are three types of standardized FMUs:

- Asset Protection Unit (APU): Protection of life/property, infrastructure, and high value resources without compromising firefighter safety. Wildland fire may be undesirable. Emphasize fuel treatments to create fire-adapted communities.
- Resource Management Unit (RMU): Protection of life/property, infrastructure, and high value resources without compromising firefighter safety. Promote the use of fire as a desirable component of the ecosystem. Coordinate fuels treatments with proposed strategies for unplanned ignitions to protect values at risk and promote landscape resiliency.
    - Dozers and fire retardant restricted to areas outside of 300 feet from any stream or waterbody.
    - Minimize negative impacts to native fish and other aquatic species with any upstream water depletions or sedimentation.
- Wildland Management Unit (WMU): With emphasis on firefighter and public safety, use wildland fire to protect, maintain, and enhance natural and cultural resources. Enable fire to function in its ecological role and maintain the natural fire regime. Weigh the costs and associated environmental impacts of suppression actions against the values to be protected while considering benefits/resource objectives and firefighter and public safety.

Figure 60. Fire Management Units on the Reservation



Geology and Topography

Geology and Soils

Although the bedrock geology on the Reservation is some of the oldest in the world, the surficial geology is relatively young and comprised of features created during the last Ice Age (Holocene and Late Pleistocene, ~10,000 years ago). The Reservation is located near the southern edge of the Canadian shield, and is underlain by Precambrian bedrock (>600 million years ago) (Boerboom, 2009). The Reservation is underlain by slate and metagraywacke, which is a metamorphic Paleoproterozoic rock (Boerboom, 2009). No bedrock outcrops occur on the reservation, though they do occur immediately downstream of the Reservation in the St. Louis River basin (Figure 61). As ice sheets expanded and contracted over what is now Lake Superior, several glacial lakes occupied the basin. Glacial outwash, which has sand and gravel components, formed in the southeastern region of the Reservation as a result (Figure 62). Glacial Lake Duluth, the larger predecessor to Lake Superior, existed ~11,000 years ago and had its outlet through the Kettle River, whose present-day headwaters are on the southern border of the Reservation (University of Minnesota Sea Grant, 2014). The remainder of the Reservation is dominated by glacial till deposits and peat, including kettle bog lakes, such as Pat Martin Lake and Spruce (Spirit) Lake. Because the Reservation is relatively flat, even areas with sandy soils are classified as wetlands (Figure 63).

In 2012, the Minnesota Geological Survey updated its geologic atlas for Carlton County, and Fond du Lac contributed funding from our CWA §319 Base Program Fund to add the St. Louis County portion of the Reservation to the survey (Figures 61 and 62). The soil map was produced from the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey (USDA, 2019). Since soil surveys occurred at different times and using different methods, some of the soil types differ between St. Louis County and Carlton County, and are visible at the county line (Figure 63).

Figure 61.Bedrock Geology

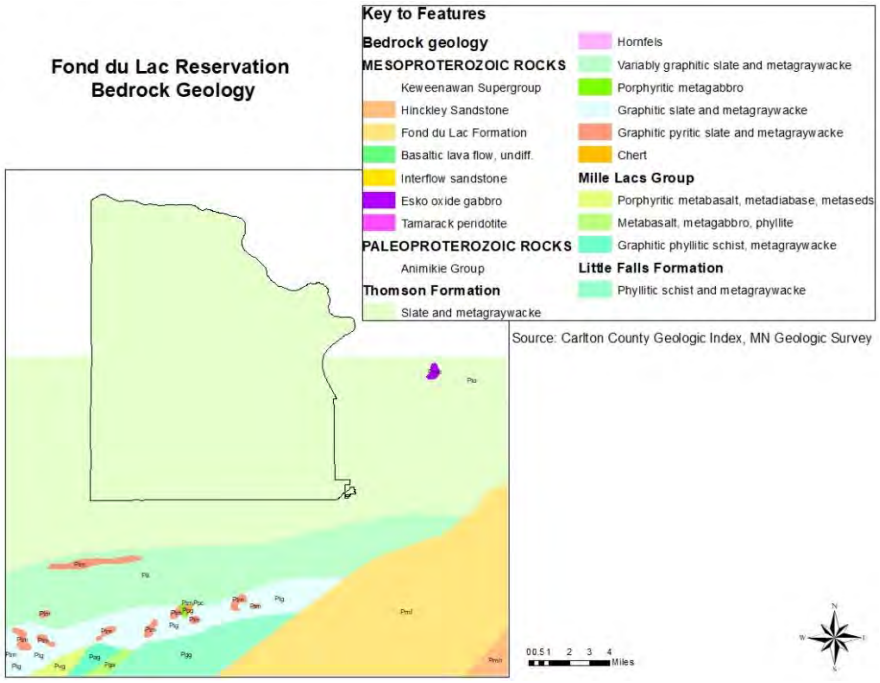


Figure 62. Surficial Geology

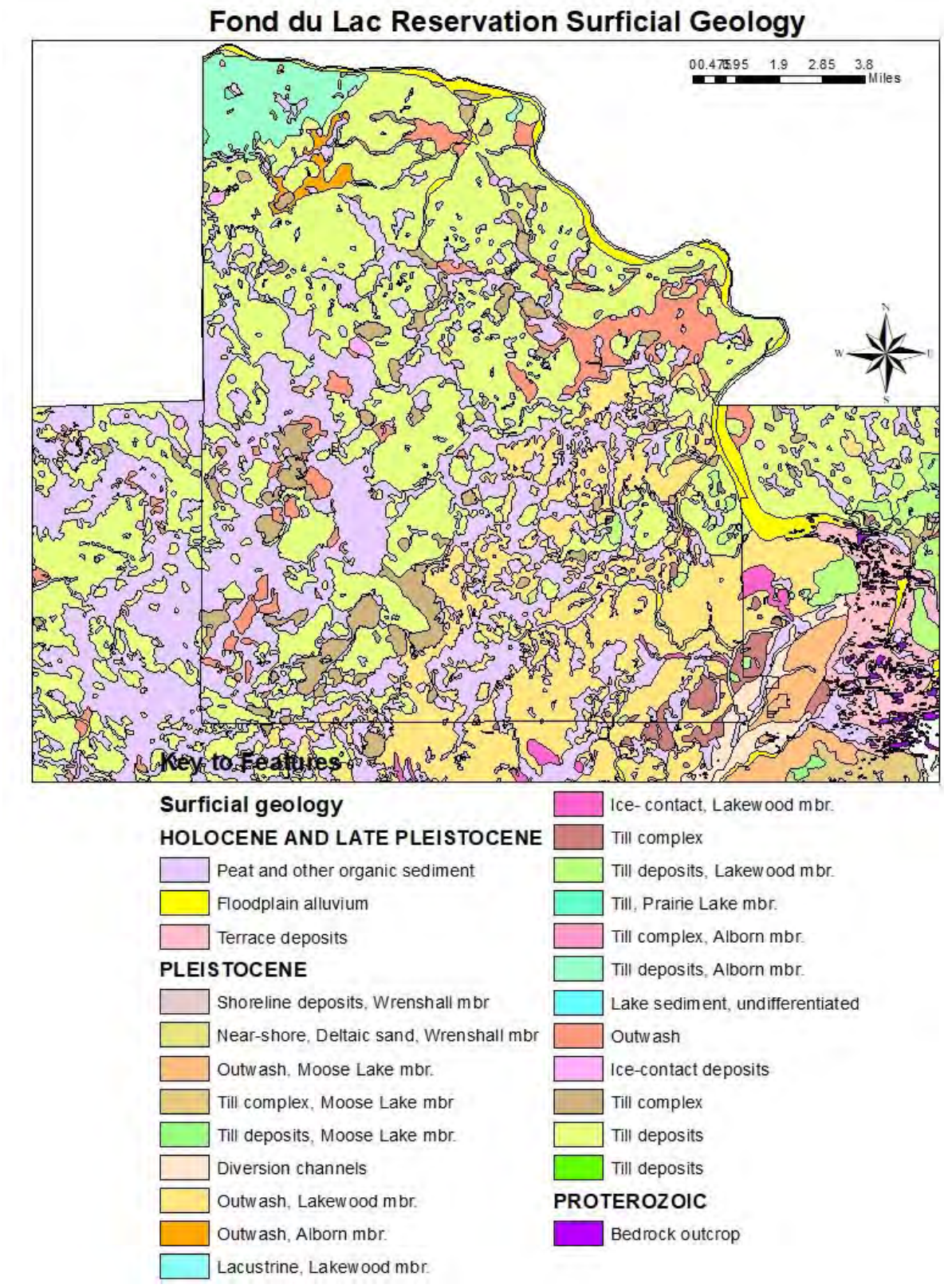
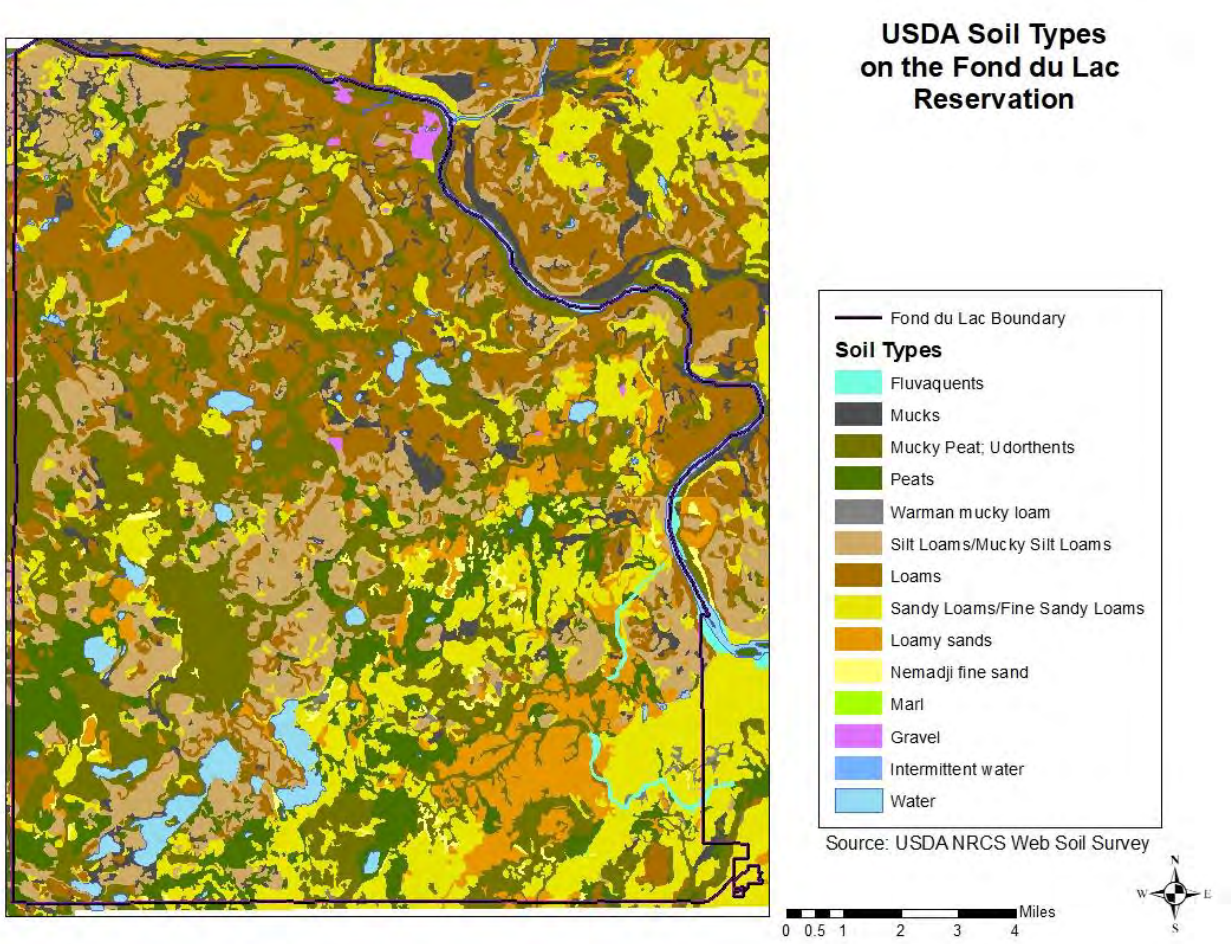


Figure 63. Soil Types



The soils on the Reservation are primarily hydric soils, so they are not good soils for productive farmland. This is why pastures and hayfields are the only type of cultivated land on the Reservation (Figure 63).

Topography

The Reservation is generally flat, so steep hillslopes do not contribute to erosion risk. The northwest area of the Reservation, close to Joe Martin Lake, has the hilliest topography. The St. Louis River and Fond du Lac Creek have the steepest river banks on the Reservation. Figure 64 shows topography and hillshade coverage derived from 1m LiDAR and Figure 65 shows slope (Rader, 2012).

Figure 64. Hillshade

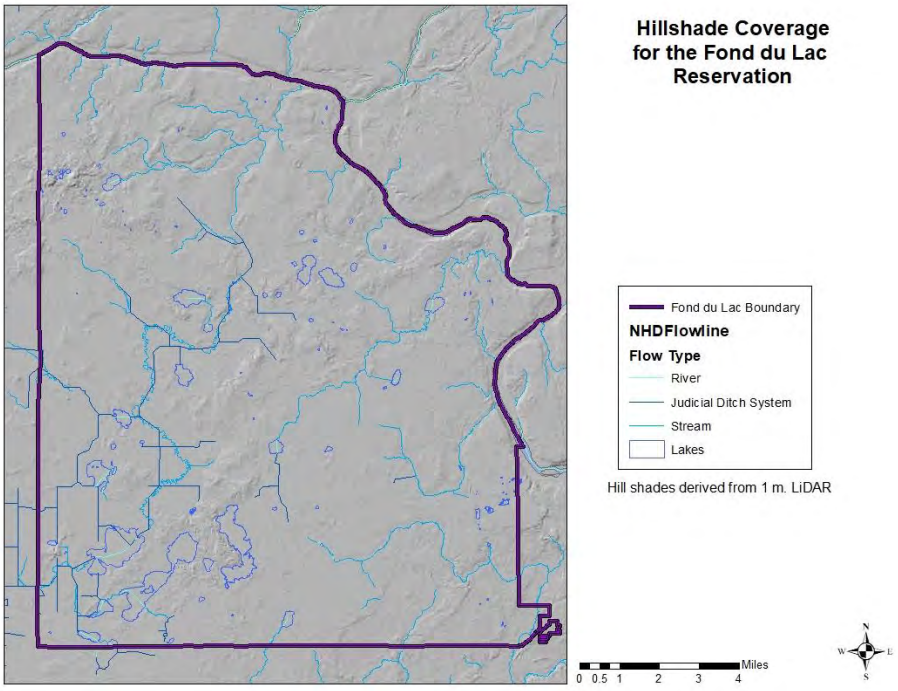
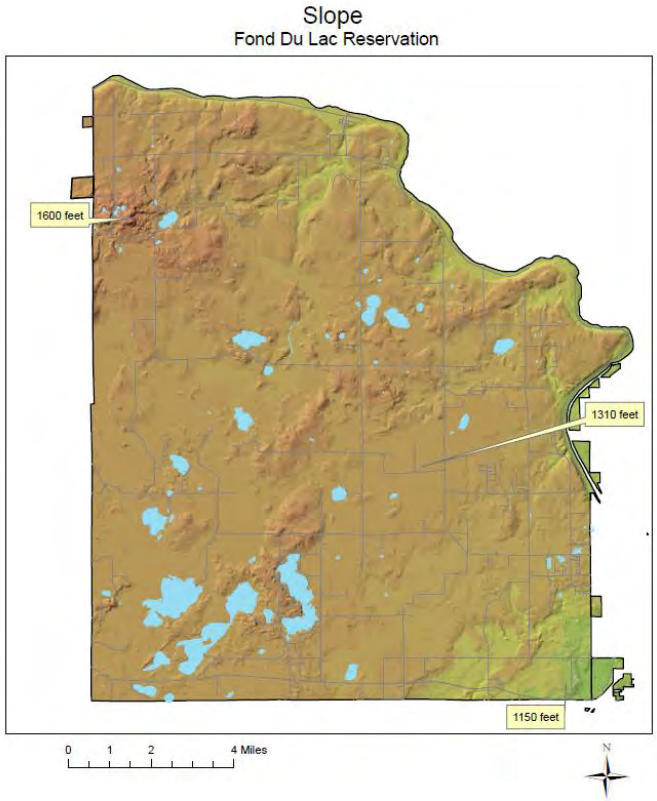


Figure 65. Mapped Slopes on the Reservation

(from the 2015 Wildland Fire Management Plan)



Timber Management

From the 2018 IRMP:
Timber sales on Fond du Lac lands strive to achieve a sustainable balance between the needs and desires of the Band, economic constraints or opportunities, and ecological concerns and opportunities. Examples include providing a source of income to landowners; regenerating a declining species; improving wildlife habitat and increasing the growth rate for longer-lived species like white pine and sugar maple. Every sale has a written set of objectives and a silvicultural prescription. In addition, cultural resources, surface and ground water, and naturally occurring flora and fauna are protected by following best management practices.

Fond du Lac has inventoried nearly 3,000 acres of Fond du Lac-owned forested stands that are dominated by sugar maple larger than 8" in diameter. An additional 600 acres of sugar maple dominated stands smaller than 8" in diameter have been mapped. There are also 1,000 acres of red maple dominated stands currently mapped. Forest management in sugar maple stands has largely been hands-off to date, but active management is an option in the future. Tree disease, invasive species, climate change and deer browse are four concerns. Managed forests are healthier forests; practices include removing diseased trees and thinning crowded trees so remaining trees grow faster and are healthier. Healthier trees have larger crowns that produce more sap, and can provide more sunlight to seedlings and saplings. Ultimately, the goal is to manage forests so that sugar maples can be tapped sustainably for a long time into the future.

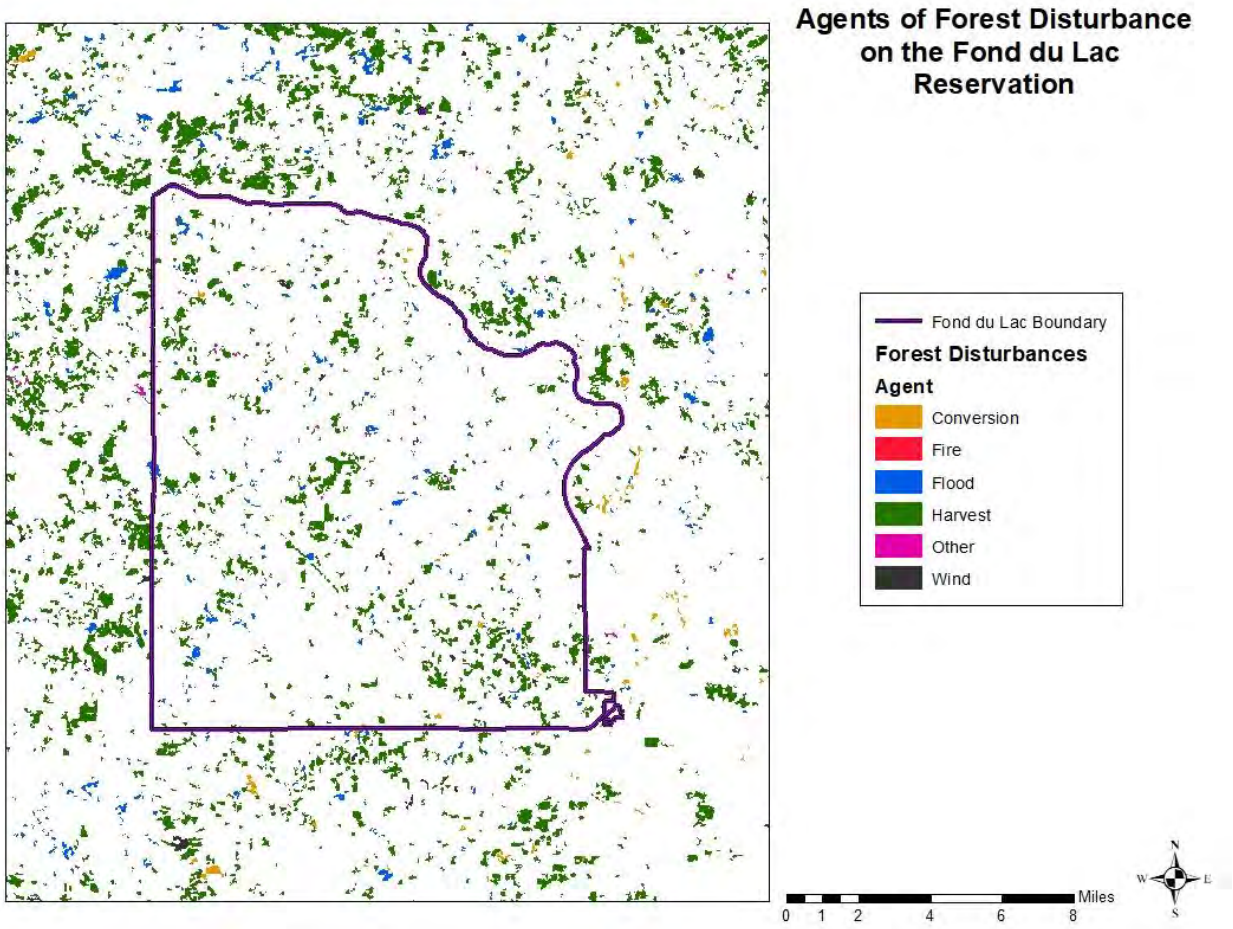
FDL also has management plans to encourage the planting and protection of northern white cedar and paper birch, both of which are culturally important species for Band members (FDL IRMP, 2018).

Forest Disturbance

Figure 66 shows the most recent agents forest disturbance for a given forest patch or stand as delineated from Landsat time series methodologies, covering the time period of 1974-2018. The change patches are further classified by the agent of change through random forest classification modeling. The year of onset for the disturbance event is provided. Only changes occurring over less than four years and at least ~1 hectare in size (eleven Landsat pixels) were retained in the final change map. Patterns of forest structure and mosaics of stand ages across landscapes are largely driven by disturbance regimes. Disturbance events, whether abrupt or slower declines, impact stand boundaries, age, related structure, and potential recovery trajectories. The agent of change (e.g. harvest, fire, insects) may also have varying influences on ecosystem services such as erosion control, water quality, support of biodiversity, and climate change mitigation (Vogeler, 2019).

The main agent of forest change on the Reservation is harvesting activities. Though harvesting activities are driven by forestry best management practices, one challenge to large-scale management is the fact that allotment ownership is still highly fragmented despite recent buy-back programs, leading to a piecemeal approach. The pipeline corridor, visible as a diagonal line in Figure 66 shows up as forest disturbance because the pipeline is kept free of woody vegetation at all times. The second most prevalent agent of forest change on the Reservation is flooding, which in many cases is likely due to hydromodification that causes water impoundments the flood out forests stands, plus heavy rain events that may be a component of climate change.

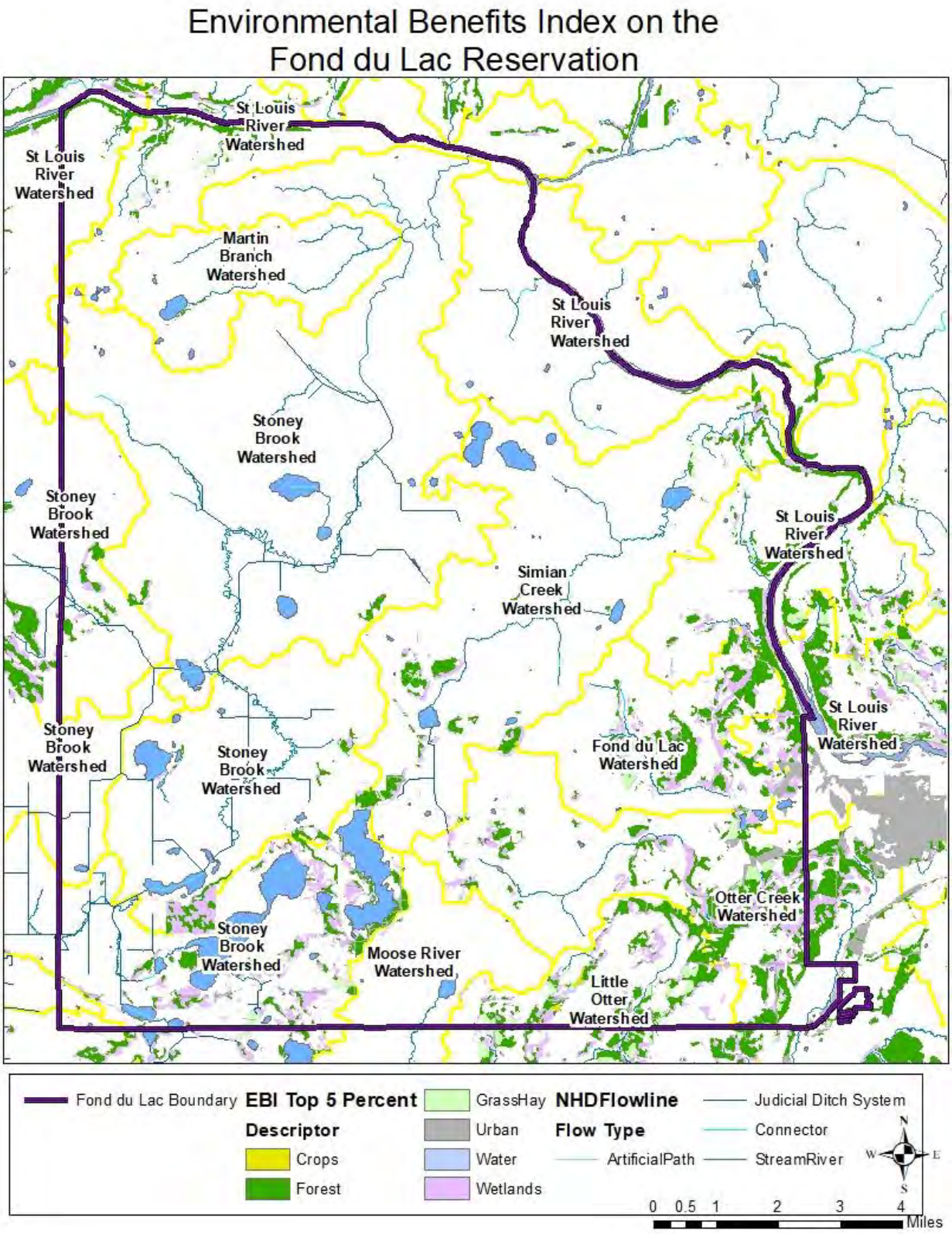
Figure 66. Forest Disturbance



Environmental Benefit Index

The MN Board of Water and Soil Resources created a data layer called the Environmental Benefits Index Top Five Percent Areas (MN Board of Water and Soil Resources, 2017). This layer identifies areas in Minnesota that have high potential for precipitation runoff and soil erosion. It uses a simplified version of the 2011 National Land Cover Database, and it was created by selecting the five percent of the area of each major watershed (HUC-8) in Minnesota with the highest EBI scores. Figure 67 shows the areas with the highest potential for runoff and soil erosion on the Fond du Lac Reservation. The southeastern region of the Reservation, which has more sandy soils than the peat-dominated northwestern region, has more areas at risk for erosion. Because the Reservation is rural, the land cover types with the highest representation are forested and wetland areas.

Figure 67. Environmental Benefits Index



SURFACE AND GROUND WATER QUALITY SUMMARY

Surface Water Overview

Water quality is a priority that has been clearly expressed by Band members. The Band historically has relied upon aquatic resources (manoomin, fish, and associated wildlife and waterfowl, plants for food and medicine). Culturally, natural resources are an integral part of Band members' lives.

Non-Point Source Pollution Assessment Purpose

The purpose of the assessment is to identify waterbodies for which uses have been or are likely to be impaired (threatened) by nonpoint sources of pollution unless alternate management practices are implemented. In keeping with the Environmental Protection Agency's definition of nonpoint source pollution (NPS), the following definition will be used:

NPS is caused by diffused sources that are not regulated as point sources and normally is associated with agricultural, silvicultural, and urban runoff, runoff from construction activities, etc. Such pollution results in the human-made or human-induced alteration of the chemical, physical, biological, and radiological

integrity of water. In practical terms, NPS does not result from a specific, single location (such as a single pipe), but generally results from land runoff, precipitation, atmospheric deposition, or percolation. Pollution from nonpoint sources occurs when the rate at which pollutant materials entering surface and ground waters exceeds natural levels.

All of the waters within the Reservation are relatively pristine, as there are no direct industrial or municipal discharges to the waters. Outstanding Reservation Resource Waters (ORRW) are designated by the RBC for their exceptional cultural, aesthetic, recreational or ecological significance. Aesthetic Waters have has been determined by the RBC to possess exceptional beauty or be significant to the preservation or exercise of the traditional value system of the Band. The two most common impairments are for mercury in the water column and mercury in fish tissue, both of which are caused by NPS pollution (atmospheric deposition). Fond du Lac's designated uses are impaired if the Water Quality Criteria (as defined in the Fond du Lac Reservation Water Quality Standards and the Fond du Lac Assessment Methodology) are not met.

In some cases, waters of the Reservation are used as reference sites for larger studies, which is a testament to their good water quality. The EPA's National Aquatic Resource Surveys project uses Joe Martin Lake and the St. Louis River Mile 53 sites to collect monitoring data that it uses as a reference when it assesses water quality on a national scale. The same is true of Fond du Lac's wetlands; monitoring data shows that most wetlands on the Reservation are intact and high-functioning. Protecting Fond du Lac's good water and wetland quality is our highest priority.

Types Nonpoint Source Pollution/Stressors

FDL's CWA §319 Assessment report includes assessment conclusions grouped by the NPS categories listed in the Introduction. Under each NPS category, the types of pollution and stressors are included. We considered these types of pollution in our assessments. The section on our monitoring program discusses the types of parameters we monitor to capture data on these pollutants.

Atmospheric Deposition

Industries such as coal-burning power plants, mining processing plants, crematoria and chemical or fuel processing plants emit pollutants into the air, which can travel long distances before settling out of the atmosphere. Pollutants can include nutrients and nitric oxide/sulfur dioxide, as well as other persistent bioaccumulative and toxic substances. Industries that generate energy using coal, such the mining processing plants on the Iron Range in Minnesota, also emit mercury into the atmosphere. Mercury is the toxicant of greatest concern for the Fond du Lac Band. When mercury is deposited on wetland-rich areas like on the Reservation, sulfate-reducing bacteria can methylate the mercury, which can then bioaccumulate up the food chain. In its methylated form, mercury bioaccumulates in the higher aquatic trophic levels, to concentrations that are hazardous to top predators (piscivorous fish, eagles, osprey, loons, kingfishers, mink, otters, and humans). Consequently, fish caught in Reservation waters can be dangerously high in mercury content. Since some Band members rely upon fish at a subsistence level in their diet, criteria for the WQS were calculated under an assumed fish consumption rate that is much higher than what the State of Minnesota or the Great Lakes region (Great Lakes Water Quality Initiative) assumes for the general population. This standard applies to the designated use for Aquatic Life: Subsistence Fishing/Netting (Appendix D).

Habitat Alteration

Habitat alteration is a stressor. On the Fond du Lac Reservation it usually relates to habitat fragmentation, wetland loss, alteration of wetland type, or a degraded wetland value/function. Wetlands on the Reservation serve as a source of food, shelter (from predators or for birthing and rearing young), overwintering grounds and migration stopovers. They also serve an important role in critical life stages of certain species, such as providing vernal pools for freshwater shrimp. Wetlands provide important plants that support cultural traditions and lifeways, including berry-picking, ash trees for basket-making and traditional medicines. Manoomin is of critical importance, and any NPS pollution that results in manoomin loss is detrimental to the ecological, spiritual, cultural and physical health of Band members (FDL HIA, 2018). Any NPS source that leads to habitat alteration will also lead to changes in natural cycles (such as nutrient cycling or geochemical processes) and species loss, especially for sensitive native species.

Nutrients

Increased nutrients in receiving waters stimulate aquatic plant growth, especially algae. When algae and aquatic plants die, the process of bacterial decomposition (respiration) can deplete dissolved oxygen in the water, especially within the hypolimnion. Low dissolved oxygen can lead to fish kills, especially when the lake is covered in ice and can't mix with oxygen from the atmosphere. Hypolimnetic anoxia also provides the right environment for the labile nutrients in the lake's bottom to be recycled up into the water column, leading to further rounds of plant growth and decomposition (internal inputs). External inputs of nutrients originate from fertilizers, animal wastes, failing septic systems, soil erosion, urban runoff, and atmospheric emissions. Algae blooms can block sunlight and alter zooplankton assemblages, and also limit the growth of aquatic plants, which serve as critically important habitat and food. Algae blooms can also render the water aesthetically unattractive or unsuitable for recreation. Harmful algae blooms can lead to health problems when people or pets swim in affected waters, and they can cause taste and odor problems in drinking water. Excess nitrate (>10 ppm) in drinking water may cause methemoglobinemia or "blue baby syndrome" in infants. According to the EPA, over 10,000 water quality impairments in the United States are due to nutrient pollution (USEPA, 2000).

Pathogens

Pathogens are disease-causing organisms often associated with fecal matter; fecal coliform bacteria are found in the intestines of warm-blooded animals. Their presence in waters indicates that pathogenic organisms may also be present, such as *Escherichia coli*. These pathogens often cause gastrointestinal illnesses, which can sometimes be serious. Pathogen sources include failing septic tanks and drain fields from individual sewage treatment systems, pet wastes, high numbers of waterfowl (particularly geese), and grazing animals. Pathogens are often problematic at public swimming beaches, where pet, waterfowl and human waste can wash into the water. High levels of pathogens can lead to beach closures in the summer.

Sediment

Human activity (including tilling, grazing, construction, vegetation clearing and management, urbanization, and forestry) accelerates erosion rates and sediment loading to receiving waters, mostly during rainfall events. Excess sediment loading can smother aquatic habitat, reduce water clarity, increase water temperature as it becomes more turbid and absorbs sunlight, and deplete oxygen. Nutrients, toxicants and metals may be adsorbed onto sediment particles and transported along with the sediments into and through aquatic systems. Sediments can also physically impact fish spawning and rearing habitat, abrade fish gills, and impair the production of fish food organisms in streams. The EPA lists sediment as the most common pollutant in lakes and streams.

Stream Connectivity and Water Level

Although not a pollutant in the classic sense, stream connectivity and water level can serve as a stressor for aquatic plants and animals. Impaired stream connectivity leads to barriers for fish passage and species migration. Streams that are disconnected also impair the natural historical ability for a given watershed to drain water from the landscape, and this can cause changes in water levels in both lakes and streams. Changes in hydrology can lead to altered function and value in surrounding wetlands, and can exacerbate flooding that impacts human infrastructure. Changes in water level in manoomin lakes can be devastating to manoomin populations, and a change in water level of just a few inches can mean the difference between a thriving, harvestable manoomin population and a water body with no manoomin. Ditching has caused such large-scale changes to water levels in the Stoney Brook watershed that Rice Portage Lake is a fraction of its original size, and much of what was once manoomin habitat is now dominated by sedge mats. The FDL Natural Resources Division spends considerable effort and time every season removing competing native vegetation, such as sedge mats and pickerelweed, from the manoomin lakes on the Reservation.

Toxicants

Toxicants can include any chemical arising from human activities that can make its way to receiving waters. Toxic substances include heavy metals, petroleum byproducts, and herbicides/pesticides. They can be harmful to aquatic and human life and often are resistant to degradation. Sources of toxic contaminants include industrial (paper mills), commercial (dry cleaners, printers, etc.), households, and auto emissions. Mercury is the most significant toxic substance of concern on the Reservation, but originates almost exclusively from off-site sources (air emissions). Right-of-way management on pipeline corridors and roadways on the Reservation can be a source of toxicants, both from herbicides used to control vegetation and road salts used to manage snow and ice. Inorganic salts can result in increased conductivity in receiving waters, which can result in loss of sensitive aquatic organisms (Lake Superior Streams, 2009). Toxicants can also come in the form of fire retardants dropped during firefighting activities.

Thermal Stress

Thermal stress results in elevated water temperatures that can harm native species while helping non-native species to spread. Thermal stress is caused by runoff from heat-absorbing impervious surfaces, removal of streamside vegetation, shallow water impoundments, and decreased base flow. Sediment inputs increase water turbidity, and darker water can absorb more heat from sunlight. Thermal stress is also a result of climate change, which will lead to large scale increases in surface water temperatures. Most of Fond du Lac's trout streams are listed a "cool water" rather than "cold water" streams, which means they are at higher risk of losing cold water-sensitive species such as brook trout and sculpin. Identifying cold water refugia for these species is a priority for FDL OWP.

Trash

Trash includes plastics, metal, tires, paper, etc. It threatens aquatic life and detracts from recreational and aesthetic values. Trash is a result of illegal dumping, street litter, beach litter, and boating waste.

Waters Resources of the Fond du Lac Reservation

Watersheds of the Fond du Lac Reservation

Fond du Lac straddles a continental divide; 97% of the watershed area on the Reservation drains to the St. Louis River and the Great Lakes Basin, which ultimately drains to the St. Lawrence Seaway and the Atlantic Ocean. Three percent of the watersheds on the Reservation drain to the Kettle River, and the Mississippi River Basin, which ultimately drains to the Gulf of Mexico (Figure 68, Table 5). Wild Rice Lake, near the southern border of the Reservation, forms the headwaters of the Moose Horn River watershed (also called the Moose River watershed), which connects to the Kettle River watershed. Table 5 shows the size of each watershed at the Hydrologic Unit Code (HUC) level 7, since this is the scale at which we do most of our monitoring and management. The Stoney Brook watershed comprises 49% of the land on the Reservation (this includes the Martin Branch subwatershed), while the Otter, Little Otter, Fond du Lac and Simian Creek watersheds together comprise 32% of the land on the Reservation. The Little Otter Creek watershed drains into the larger Otter Creek watershed south of the Reservation. The remaining 16% of the land on the Reservation includes land that drains directly into the St. Louis River, through small, unnamed waterways. Figure 68 shows HUC-7, HUC-8 and HUC-10 level watersheds. The HUC-10 boundary demarcates the continental divide; the HUC-8 boundary shows the entirety of the Stoney Brook watershed and the Moose Horn River watershed, and it lumps the smaller eastern watersheds together. The HUC-7 boundaries show each of the subwatersheds. Figure 68 also shows the Cloquet River watershed, which drains into the St. Louis River on the northeastern border of the Reservation; the Cloquet River is the largest tributary to the St. Louis River.

Depending on the data layer, watershed boundaries on the Reservation can vary. Flat topography on the Reservation leads to uncertainty about the direction of flow for some sub-basins. The Minnesota DNR Watershed GIS dataset puts Big Lake in the Stoney Brook Watershed and West Twin Lake/East Twin Lake in the Simian Creek Watershed. The National Hydrography Dataset puts Big Lake in the Simian Creek Watershed and West Twin Lake/East Twin Lake in the Stoney Brook Watershed. The Minnesota DNR watershed map dataset is depicted in Figure 68.

Waters of the Fond du Lac Reservation

Figure 69 and Tables 6-7 show the waters of the Reservation. Each major lake on the Reservation is classified by its use: Primary Fishery, Secondary Fishery, or Wild Rice Lake – these are color coded in Figure 2. Big Lake is the most popular lake for fishing, swimming and boating, followed by West Twin Lake; land development around these and other lakes will likely continue because they are highly sought after for homes and cabins. Most manoomin (wild rice) lakes are in the Stoney Brook watershed, and are vital for manoomin harvest and also duck hunting. Rice Portage Lake is only a fraction of its original size; it was drained during ditching activities in the early 1900s. Most of the lakes on the Reservation are relatively shallow and dimictic, though many do not strongly stratify in the summer due to their shallow depths. The Anishinaabe name for Perch Lake (Table 6) roughly translates as the place that has fish kills, and these are still observed in late winter on the north end of the lake due to natural anoxia. Two streams on the Reservation, Fond du Lac Creek and Otter Creek, are state-designated brook trout streams, though they are also classified as coolwater rather than coldwater streams. Brook trout also exist in the headwaters of Martin Branch. Although upstream mining impacts are discernible in the portion of the St. Louis River that forms the border of the Reservation, it continues to be a source of life, health and cultural connection.

Figure 68. Watersheds of the Fond du Lac Reservation

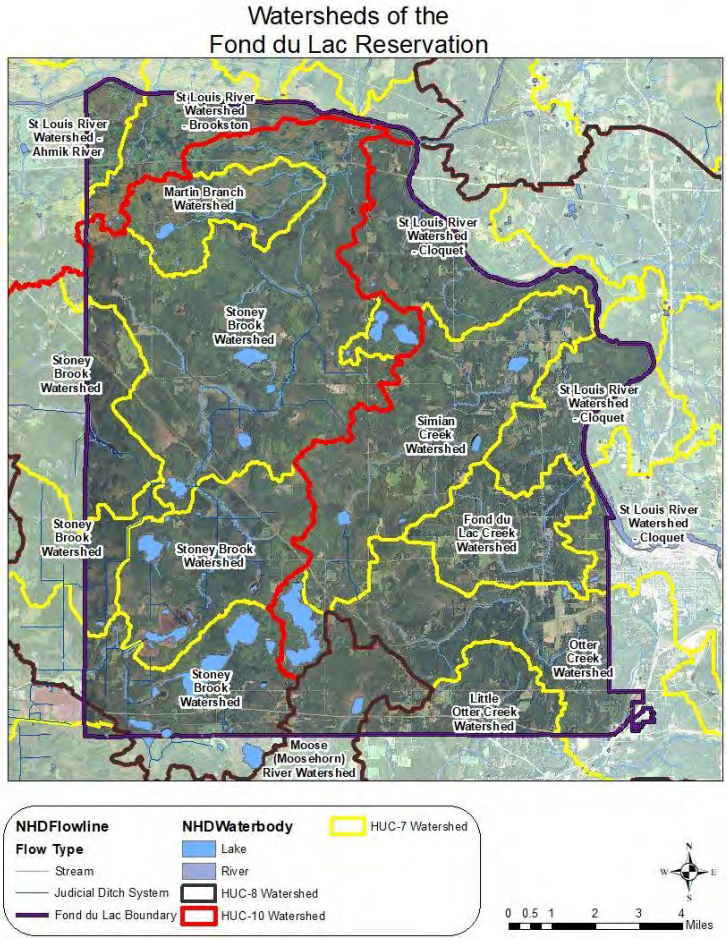


Table 5. Watersheds on the Fond du Lac Reservation.

Both the total size of the watersheds and the size of the watershed within the Reservation are listed.

HUC-7 Watershed	HUC-10 Watershed	HUC-7 Acres	HUC-7 Square Miles	Acres on the Reservation	Square Miles on the Reservation
Saint Louis River - Cloquet	St. Louis River	31,175	49	11,249	17
Saint Louis River - Ahmik	St. Louis River	13,016	20	1,429	2
Saint Louis River - Brookston	St. Louis River	7,417	12	3,831	6
Otter Creek	St. Louis River	15,169	24	9,138	14
Little Otter Creek	St. Louis River	10,884	17	3,818	6
Fond du Lac Creek	St. Louis River	5,469	9	5,469	9
Simian Creek	St. Louis River	14,178	22	14,178	22
Stoney Brook	St. Louis River	37,262	58	44,430	70
Martin Branch (part of Stoney Brook)	St. Louis River	4,467	7	4,467	7
Moosehorn (Moose) River	Kettle River	14,689	23	3,204	5
Kettle Lake*	Kettle River	11,689	18	148	0.2
Kettle River*	Kettle River	7,224	11	143	0.2

*A small portion of these watersheds are within the FDL Reservation boundary, and don't include any surface water features.

Figure 69. Waters of the Fond du Lac Reservation

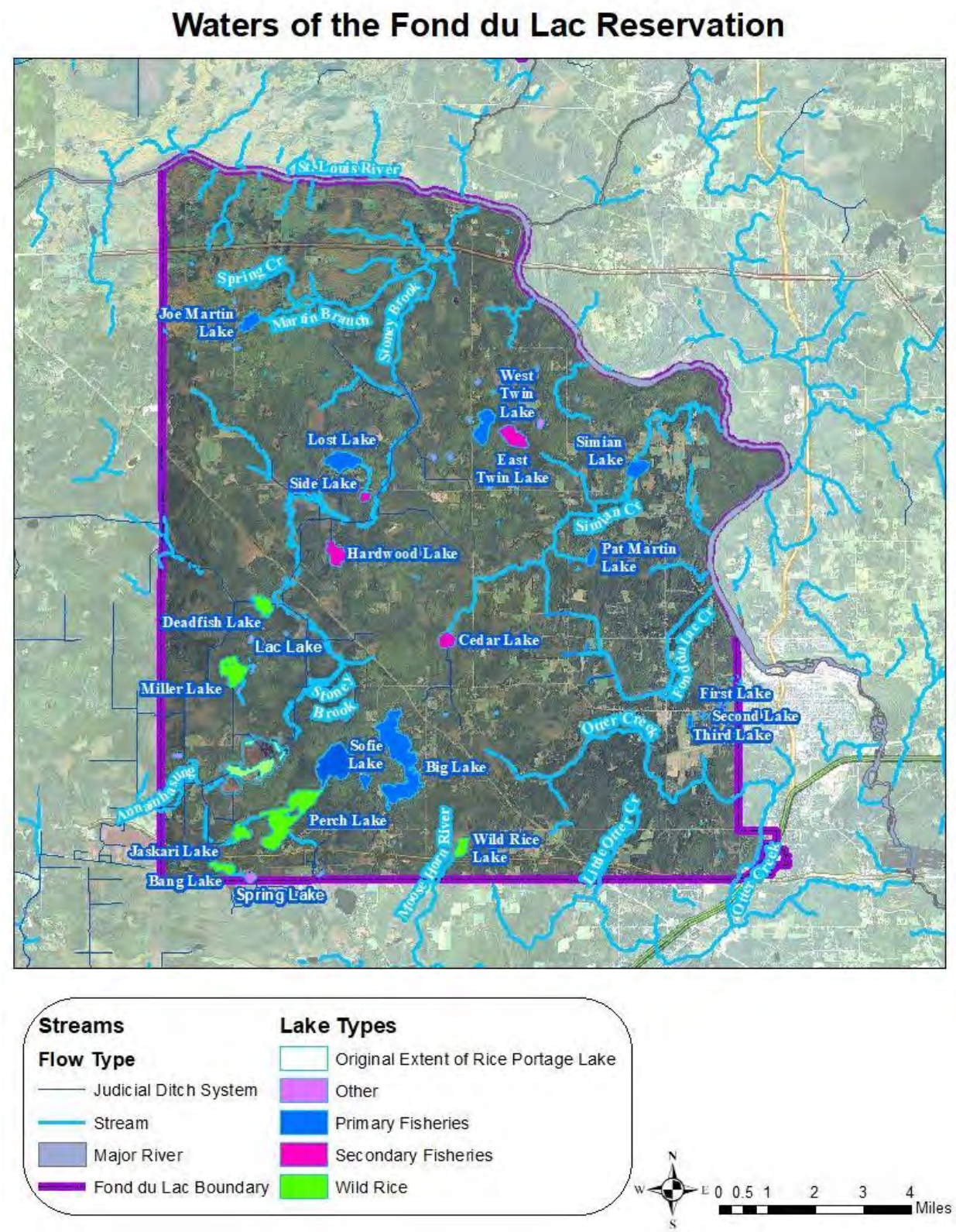


Table 6. Summary Information for Lakes on the Fond du Lac Reservation

Lake Name	Station ID	Anishinaabe Name	Primary Use	Secondary Use	Monitored	Acres	Hectares
Bang (Long) Lake	101		Wild Rice Lake		1998-present	63.8	25.8
Big Lake	102	Chi-zaaga'iganing	Primary Fisheries Lake		1998-present	550.1	222.6
Cedar Lake	103	Gaagiizhikikaag	Primary Fisheries Lake	Wild Rice Lake	1998-present	75.6	30.6
Deadfish Lake	104	Zhaaganaashiins Odabiwining	Wild Rice Lake	ORRW	1998-present	132.9	53.8
East Twin Lake	105		Secondary Fisheries Lake		1998-present	114.8	46.5
First Lake	106		Secondary Fisheries Lake		1998-present	25.4	10.3
Hardwood Lake	107	Chimaanakikii-zaaga'igan	Primary Fisheries Lake	Wild Rice Lake	200-2004, 2008, 2014	97.3	39.4
Jaskari Lake	108	Naawonigami zaaga'igan	Wild Rice Lake	ORRW	1998-present	83.6	33.8
Lac Lake	109		Secondary Fisheries Lake	ORRW	1998-present	9.8	4.0
Lost Lake	110	Wanishini-zaaga'igan	Primary Fisheries Lake		1998-present	137.1	55.5
Joe Martin Lake	111		Primary Fisheries Lake		1998-present	68.7	27.8
Miller (Mud) Lake	112	Mashkiigwaagamaag	Wild Rice Lake		1998-present	156.3	63.3
Pat Martin Lake	113		Primary Fisheries Lake		1998-present	40.9	16.5
Perch Lake (South Basin)	114A	Aatawemegokokaaning	Wild Rice Lake	ORRW	1998-present	392.0	158.6
Perch Lake (North Basin)	114B	Aatawemegokokaaning	Primary Fisheries Lake		1998-present	448.9	181.7
Rice Portage Lake*	115	Chi-awasonigaming	Wild Rice Lake	ORRW	1998-present	147.3	59.6
Second Lake	116		Secondary Fisheries Lake		1998-present	16.8	6.8
Side Lake	117	Beke-zaagidawaag	Secondary Fisheries Lake	Wild Rice Lake	1999, 2000, 2002	24.0	9.7
Simian Lake	118	Chi-wizo-zaaga'iganing	Primary Fisheries Lake	Wild Rice Lake	1998-present	81.2	32.8
Sofie Lake	119		Primary Fisheries Lake		1998-present	38.0	15.4
Spring Lake	120		Secondary Fisheries Lake		2014	27.0	10.9
Spruce (Spirit) Lake	121		Secondary Fisheries Lake		1998-present	13.8	5.6
Third Lake	122		Primary Fisheries Lake		1998-present	15.0	6.1
West Twin Lake	123	Webiindikomaan-zaaga'iganing	Primary Fisheries Lake		1998-present	127.5	51.6
Wild Rice Lake	124	Manoomini-zaaga'iganing	Wild Rice Lake	ORRW	1998-present	104.3	42.2

* the original extent of Rice Portage Lake was 729.7 acres, 295.3 hectares

Table 7. Summary Information for Streams on the Fond du Lac Reservation.
Names in bold indicate the main stem of each stream.

Stream Name	Anishinaabe Name	Primary Use	Secondary Use	Monitored	Cumulative Length (m)
Fond du Lac Creek	Anishinaabekwe-ziibiwishe	Cold Water Fishery Trout Stream	Aesthetic Water*	1998-present	12228.1
Tributaries to Fond du Lac Creek				Not monitored	6219.1
Otter Creek	Nigigo-ziibiwishe	Cold Water Fishery Trout Stream	Aesthetic Water	1998-present	33100.4
Jolicoeur Creek		Secondary Stream	Trout Stream	2019; 2014 temperature	983.5
Tributaries to Otter Creek				Not monitored	7227.2
Little Otter Creek		Secondary Stream	Trout Stream	2014 temperature	3757.2
Tributaries to Little Otter Creek				Not monitored	1411.4
Simian Creek	Chiwizo-ziibi	Warm Water Fishery		1998-present	21986.9
Tributaries to Simian Creek				Not monitored	9528.4
Spring Creek				Not monitored	3920.0
Stoney Brook	Asini-ziibi			1998-present	41418.0
Stoney Brook Ditch Lateral				Not monitored	63163.7
Original Stoney Brook				Not monitored	45020.1
Unnamed Streams				Not monitored	24054.3
Martin Branch		Warm Water Fishery; Trout Stream in headwaters only	Aesthetic Water	1998-present	7158.4
Tributaries to Martin Branch				Not monitored	9575.8
Annamhasung Creek		Secondary Stream		2000	9396.2
Original Annamhasung Creek				Not monitored	3876.4
St. Louis River (Reservation Boundary Only)	Chi-gamii-zaiibi	Major River	Warm Water Fishery	2005-present	35327.7
Moosehorn River	Headwaters to Akiko-ziibi (Kettle River)^	Secondary Stream		Not monitored	58251.6

*Included in 2019 update to FDL Water Quality Standards ^Flows to the Mississippi River Basin

Methods for Conducting Nonpoint Source Assessments

Water Quality Standards

The Band was granted "treatment as a state" authority (TAS) in 1996, under the Federal Clean Water Act (CWA), enabling it to enact and enforce such standards. In 1998, the Fond du Lac Reservation Business Committee adopted water quality standards for Reservation waters. Those standards were federally approved in 2001 and updated in 2020 to include several new standards (Appendix D). The Fond du Lac Reservation OWP has developed and implemented a broad-based tribal water quality protection program that includes federally approved water quality standards under §303(c) of the CWA, a comprehensive monitoring program (under CWA §106) designed to assess the health of Reservation lakes and streams, and protection plans for wetlands and ground water resources. Fond du Lac has been implementing its water quality monitoring strategy for the lakes and streams of the Reservation since 1998. Tables 6 and 7 list the waters monitored by FDL OWP and the primary uses associated with each water body under FDL's Water Quality Standards. The Water Quality Monitoring Plan (WQMP) outlines in detail the strategy used to monitor and assess the water quality of the lakes and streams identified in the Water Quality Standards (WQS). A Quality Assurance Project Plan (QAPP) was developed that includes the data quality objectives and thorough documentation of field and laboratory methods to be used in the monitoring effort. The QAPP was reviewed and approved by EPA Region 5 staff, and is updated regularly. FDL OWP follows the monitoring schedule outlined in its WQMP; it has water monitoring data for each year between 1998 and the present. The assessments in this report cover the years between 1998 and 2018, though 2019 and 2020 conditions are also discussed. FDL OWP has a contract with Gold Systems to use the Ambient Water Quality Monitoring System (AWQMS), funded by a grant from the National Environmental Information Exchange Network, where it stores all water quality data in a cloud-based system. AQWMS allows FDL OWP to review and analyze data, complete water quality assessments, and submit its data to the Water Quality Exchange (WQX), EPA's national water quality database. As part of the Fond du Lac Environmental Program, the OWP is responsible for surface water, ground water, and wetland protection through monitoring, assessment, restoration, and mitigation activities. OWP staff dedicated to this process includes a Water Projects Coordinator, a Water Regulatory Specialist, a Groundwater Specialist, and a Watershed Specialist, as well as student interns during the summer field season. A Wetland Specialist position is funded whenever FDL receives grant funding through the EPA Wetland Program Development Block Grants.

The FDL OWP completed its most recent water quality standards triennial review process in 2019. The Band is required to periodically review our standards, and propose any updates or revisions that reflect new information or research, so that our standards can be as protective as possible of the Reservation's abundant water resources. We consider any necessary updates to designated uses, narrative and numeric criteria, our antidegradation policy and implementation, and contemplate additional culturally specific language and perspectives that are relevant to the implementation of our standards. We consider all applicable water quality standards that we are required to review every three years, including new CWA §304(a) criteria recommendations. The 2019 triennial review of Fond du Lac's WQS includes a new national aquatic life use criterion (ammonia), numeric nutrient criteria for priority fisheries lakes and biological criteria for streams, narrative wetlands water quality standards, and an aquatic life use criterion for specific conductance. We also specifically examined our standards for protecting manoomin and determined the need and scientific basis for maintaining the existing sulfate criterion, and expanding habitat and natural hydrology protection through new narrative standards.

Monitoring Program

Protecting human health requires monitoring for indicators that assess the safety of eating fish or other aquatic wildlife, swimming, and boating. Protecting and restoring ecosystems require an assessment of indicators that measure the diversity and health of aquatic plant and animal communities. In order to assure viability of the plant and animal communities, these indicators must include water quality and sediment parameters. The Water Quality Monitoring Plan (Appendix E) was designed to assess physical, chemical, and biological indicators for both human health and aquatic life and to identify waters that need restoration or further protection. The monitoring outlined in the plan includes habitat quality, primary productivity (including algal taxonomy in fisheries lakes), multiple assemblages of the biotic community (benthic macroinvertebrates in streams and lakes; zooplankton and macrophytes in lakes; fish), and different trophic levels. We also collect water level data and we have developed new numeric biocriteria for our streams.

Every ten years, the MPCA conducts water quality monitoring on the Reservation as part of their St. Louis River basin sampling. They obtain permission from the Band to conduct physical and water quality sampling in streams and lakes, and they are usually accompanied by an FDL OWP staff member. FDL and MPCA have an agreement to share all water quality data collected for FDL sites, and we discuss any water quality assessment decisions the state makes with those data, since MPCA does not have jurisdiction over water quality assessment decisions within Fond du Lac Reservation boundaries.

Surface Water Monitoring Sites and Gauge Sites

All monitoring locations have associated latitude and longitude coordinates measured with a hand-held Global Positioning System (GPS) unit, so water quality data can be linked into the Reservation's Geographic Information System (GIS) database (Figure 71). Lakes are sampled at fixed stations in the deepest point of the basin, and three lakes have two sampling stations because of their double-basin morphology. West Twin Lake and Big Lake are the two fisheries lakes with this protocol, and Perch Lake has its north basin sampled as a fisheries lake, while its south basin is sampled as a manoomin lake. In 2008 we used our BioSonics echosounder to ping the lake bottoms of all the lakes we could access by motor boat or johnboat. We then created bathymetric maps and bottom type maps for each lake, and we used them to find the GPS point of the deepest point in each lake for our sampling program (Figure 70). We used the bathymetric maps of Cedar Lake and Simian Lake for the Simian Creek watershed model.

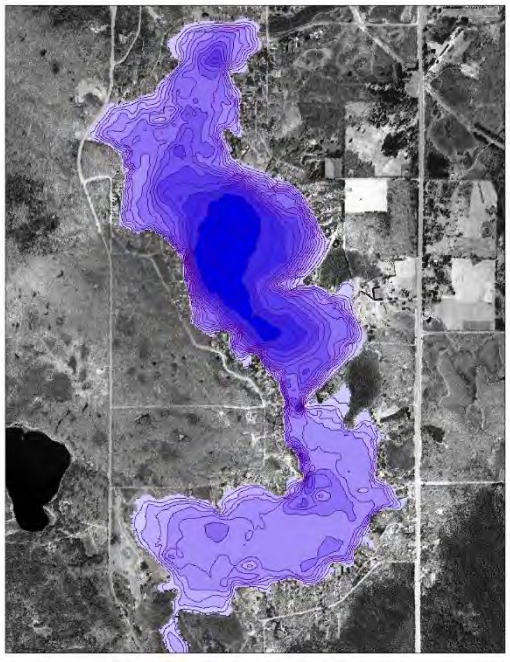
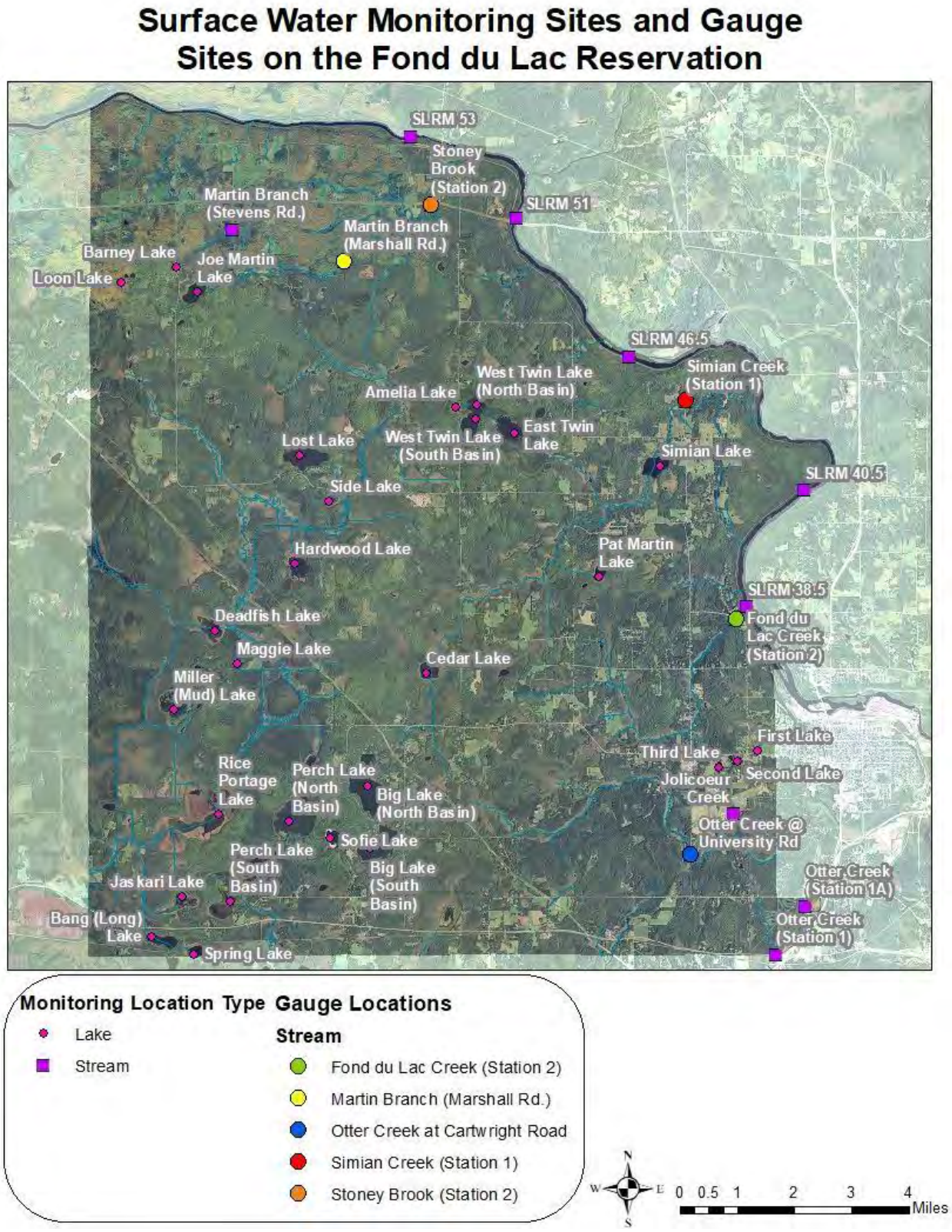


Figure 70. Bathymetric depth map of Big Lake created using the BioSonics echosounder

Figure 71. Water Monitoring Sites and Gauge Sites



Sampling Schedule

Primary fisheries lakes and manoomin lakes are sampled four times annually (May, June, August and October). Primary streams are sampled across three seasons (May, August and October). Lakes and streams designated "other" (of lesser priority as a resource to Band members) are sampled once a year at midsummer to provide a "snapshot" of conditions in those water bodies during peak productivity. Beginning in 2005, we initiated a monitoring program on the St. Louis River, with five stations spread equally out along the length of the river along the Reservation border. We collect midsummer samples in the thalweg of the river and include the suite of parameters as we do in streams, except we collect Secchi readings and we don't collect algae or periphyton samples. Some lakes are either too small and/or remote for regular monitoring and have only been sampled once (Maggie, Amelia, Barney, Loon, Side and Spring). Hardwood Lake has a few years of monitoring data but is also remote. This tiered approach to setting monitoring priorities and corresponding frequencies is in keeping with the Intergovernmental Task Force on Monitoring framework. We strive for a completeness goal of 90% of sites visited each season, and we use at least ten years of data for each parameter for water quality assessments for our water quality standards. In some cases, the ten years of data may not be consecutive.

Algae and periphyton samples are taken three times a year (May, August, October, with secondary lakes being sampled in July), while fish, zooplankton samples are taken in July and August, and benthic macroinvertebrate samples are taken in August or September. We have shifted our midsummer samples in manoomin lakes from mid-August to late July, in response to band members' concern about damage to manoomin from our sampling visits.

Parameters

Physical Water Quality Parameters

Field measurements of physical parameters performed at every site visit include conductivity, dissolved oxygen, pH, temperature, and turbidity. In lakes, a depth profile of these parameters is recorded using an In-Situ AquaTROLL 500 and a tablet, and Secchi transparency is measured with a Secchi disk. Laboratory measurements done by FDL OWP staff include total alkalinity, total hardness, and color (true and apparent), which yield information about underlying geology and watershed characteristics. All other samples are analyzed by contract labs.

Physical characteristics and habitat assessments of streams utilize the field data sheets from the MPCA Stream Habitat Assessment Protocol. Habitat assessments are conducted approximately every ten years; the most recent habitat assessments were completed in 2014. Permanent monitoring stations have been established in streams as representative habitat types, avoiding wetland headwaters reaches that have naturally low biotic diversity and simple habitat structure.

Until recently, stream flow rates were measured with a Marsh-McBirney flowmeter, but in 2019 we purchased a SonTek Flow Meter 2 which takes more precise and accurate water flow and discharge measurements compared to our old equipment. As discussed above, continuous temperature and water level loggers are installed at all five stream sites. Temperature data is critical for assessing trout streams and detecting potential thermal impacts from nonpoint sources.

Since the previous CWA §319 Assessment Report and beginning in 2010, FDL OWP has installed long-term water level monitoring sites at four of our five long-term stream monitoring sites, and at one lake (Cedar

Installing a pressure transducer at the gauge site on Martin Lake). The long-term monitoring site at Otter Creek (Station 1) was not suitable for tracking water level, so we installed the gauge at the crossing of Otter Creek and University Road. When the bridge on University Road had to be replaced in 2015, we moved the gauge site to the crossing at Otter Creek and Cartwright Road, which was fully repaired in 2011 (Figure 71, gauge map). Each site has a vented stand pipe with a barometric pressure transducer data logger suspended within a PVC pipe that records pressure data and water temperature every 30 minutes during the growing season. Several pressure transducers are installed in air to collect barometric pressure data, so water pressure data can be corrected for barometric pressure data. An outside staff gauge next to the stand pipe allows us to take water level readings that we use to calibrate the pressure data and convert it to water level. FDL used CWA §319 funds to provide staff with Rosgen Geomorphology training (Levels I and II). With the addition of a SonTek Flow Meter 2 in 2019, FDL is now able to take accurate flow readings at these stream monitoring sites. A gap remains in tribal capacity, in that we lack the training and software to create useful rating curves and use them to apply shifts. FDL continues to work with the Red Lake Nation and USGS to provide training so tribes can have the same abilities as state and federal agencies to analyze their water level data. Over time, we hope to create rating curves and convert our water level data into discharge, which can then be used in pollutant load calculations. In addition to creating a long-term record of discharge and flow, our water level logger data has been used in two watershed models, in the Simian Creek watershed and the Stoney Brook watershed. The results of the Stoney Brook watershed model will inform the forthcoming Nine-Element Watershed Plan for that area.

Chemical Water Quality Parameters

Laboratory analysis of water samples is contracted for nitrogen (ammonia, nitrate + nitrite, total Kjeldahl), phosphorus (total, ortho), and total suspended solids. In addition, manoomin lakes are analyzed for sulfate.

Collecting a springtime mercury sample using the clean hands/dirty hands protocol.

Laboratory analysis is contracted for one spring (snowmelt) sample per year per lake for a suite of toxic chemicals and heavy metals (chloride, arsenic, cadmium, chromium, copper, lead, nickel, selenium, and zinc). Laboratory analysis of sediment samples taken in October from the manoomin lakes is contracted for nitrogen, phosphorus, total solids, total volatile solids (a measure of organic matter), and iron (essential micronutrient). In 2011, with funding assistance from the Great Lakes Restoration Initiative, we began sampling mercury in water (both dissolved and total), since it is a persistent bioaccumulative toxin in the Lake Superior Basin (Lake Superior Partnership, 2015). We sample the St. Louis River and the stream sites in early spring to catch the spike in mercury that occurs with snowmelt, and we collect samples again in midsummer. We sample lakes less

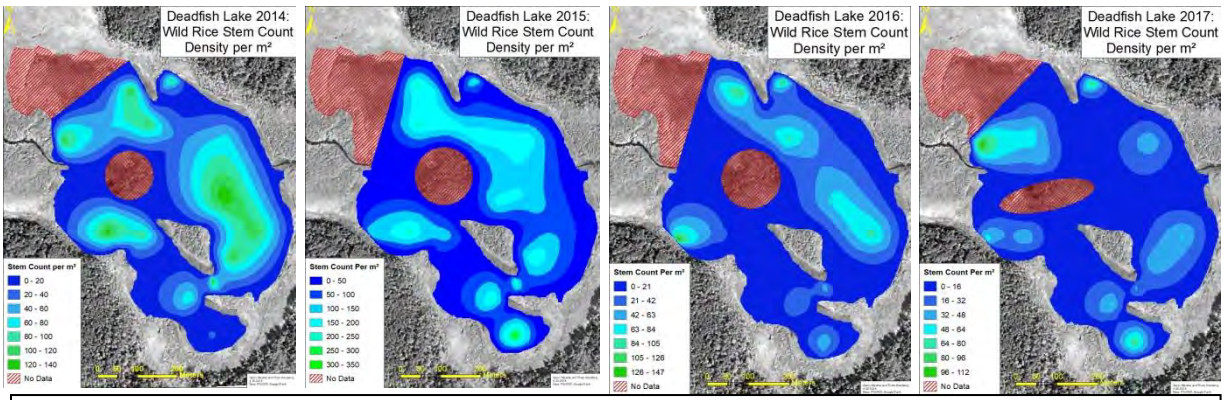
frequently at midsummer as funding allows. We have also collected mercury in fish tissue from select fisheries lakes as funding allows.

Biological Water Quality Assessments

Biological indicators include algae in lakes (lab analysis is contracted for chlorophyll α and an algal community scan), periphyton in streams (lab analysis is contracted for chlorophyll α and primary productivity estimates), zooplankton in lakes (duplicate vertical tows preserved, then identified to species and enumerated by Fond du Lac staff), and benthic macroinvertebrates and fish in streams. In 2014, in response to an analysis by Tetra Tech that showed our macroinvertebrate sample sizes were often too small to reliably assess each stream's biological condition, we changed our sampling methods to match those of the MPCA Qualitative Multihabitat Sample method. We now record metadata using the MPCA Stream Invertebrate Visit Form, where we divide 20 samples equally among the habitat samples in the reach (e.g. rock riffle/run, leaf pack, etc.), and choose the number of each habitat type to be representative of the sample reach. We no longer pick macroinvertebrates before sending to the lab; instead we composite the entire sample, preserve it in alcohol, and send it to the lab to have at least 300 individuals be identified to species.

The Tribal fisheries biologist and summer interns assist OWP staff in electroshocking the primary streams for fish community data, and share lake fisheries community data with the Minnesota Department of Natural Resources (MNDNR) as it is updated. In 2014, in response to an analysis by Tetra Tech that showed our fish sample sizes were often too small to reliably assess each stream's biological condition, we changed our sampling methods to match those of the MPCA Fish Community Sampling Protocol for Stream Monitoring Sites. We increased the sampled reach length to equal 35 times the mean stream width at our long-term monitoring sites.

FDL OWP received a National Environmental Exchange Network grant; part of the funding was dedicated to implementing a new manoomin population survey protocol published by Minnesota Sea Grant (Kjerland, 2015) and uploading this new type of data to WQX. Since 2014, FDL has conducted population surveys on the following lakes: Rice Portage, Deadfish, Perch (South Basin), Miller (Mud) and Jaskari. We collect representative plants and weigh seeds, roots and shoots to get a sense for biomass trends as well. Over time, data on manoomin population trends will be helpful in pinpointing landscape-level or lake-level changes that impact manoomin, and the management actions that are most successful in supporting thriving populations.



Changes in manoomin stem count density in Deadfish Lake, 2014-2017.

The Fond du Lac OWP conducts a beach monitoring program, testing for the presence of total coliforms and *Escherichia coli* using our in-house IDEXX Colilert system. High prevalence of total coliforms indicates a likelihood of the presence of disease-causing pathogens, such as *E. coli* and *Shigella.* We visit Bassett's Beach on the south shore of Big Lake, and Kiwenz Beach on the north shore of Big Lake once per week from Memorial Day to Labor Day. We post beach advisories whenever there are multi-day exceedances of the bacterial criteria for primary contact recreational use (126 organisms/100 ml). Beach advisories are rare, though they did occur after the 500-year flood event in June 2012, and during sustained and extreme high-water levels in the summer of 2018.

Water Quality Data Summaries

FDL's Water Monitoring Plan discusses the timing of monitoring and the parameters measured for FDL surface waters, while the Quality Assurance Project Plan covers the methods we follow to assure sample and data quality. Appendix C includes all water quality data collected between 1998 and 2018. Notable water quality results are discussed in the Water Quality Assessments section. Groundwater water quality is discussed in the groundwater section. Waters are grouped by similarity for ease of comparison, so the following waters are grouped together on each graph:

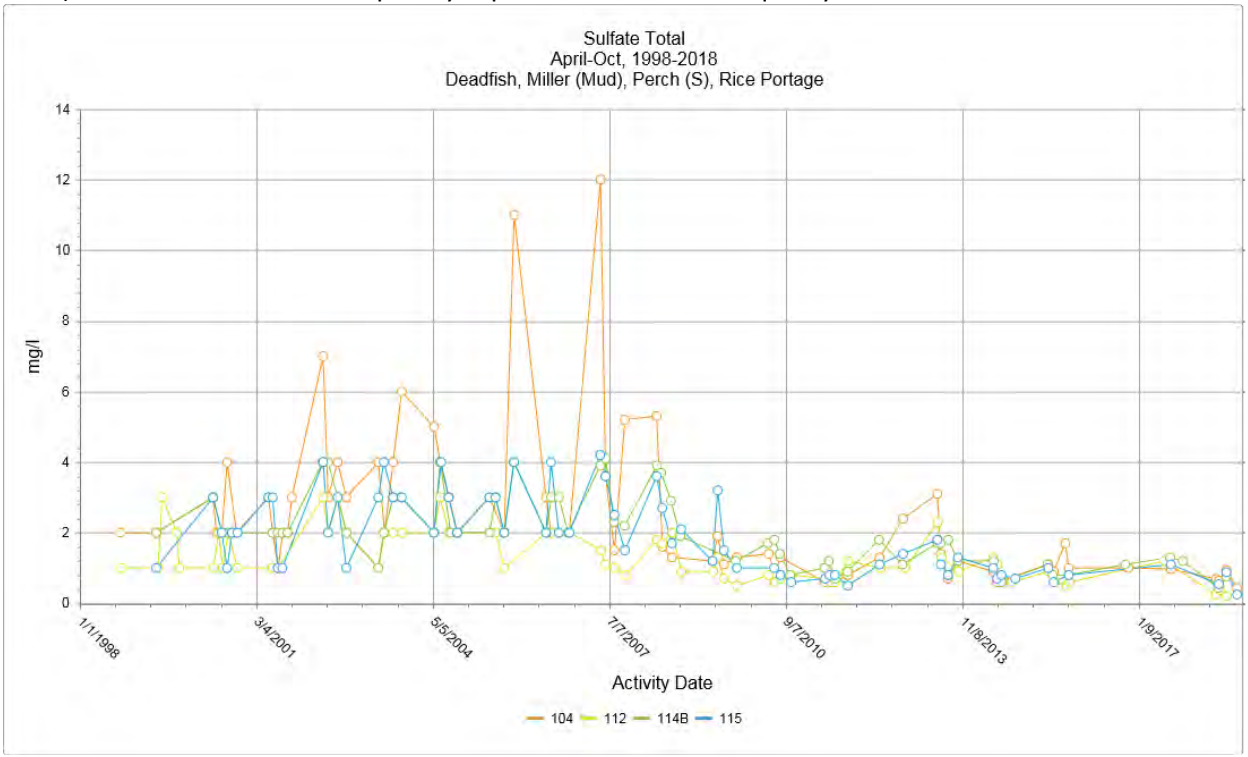
- Primary fisheries lakes group one: Big N (102A), Big S (102B), Lost (110), Joe Martin (111), Perch N (114A)
- Primary fisheries lakes group two: Pat Martin (113), Simian (118), Sofie (119), West Twin N (123A), West Twin S (123B)
- Secondary fisheries lakes group one: First (106)*, Second (116)*, Third (122) – includes Third Lake, which is a primary fisheries lake, but shares ecological similarities, trends and proximity to First Lake and Second Lake – all appear to be primarily groundwater fed, unlike most other lakes on the Reservation.
- Secondary fisheries lakes group two: East Twin (105)*, Lac (109)*, Side (117), Spring (120), Spruce (Spirit) (121)*
- Manoomin lakes, group one: Bang (Long) (101), Cedar (103)*, Hardwood (107)*, Jaskari (108), Wild Rice (124)
- Manoomin lakes, group two: Deadfish (104), Miller (Mud) (112), Perch S (114B), Rice Portage (115)
- Streams: Fond du Lac (202B), Martin Branch (203A), Otter Station 1 (204A), Simian (205), Stoney (207B)
- St. Louis River: St. Louis River Miles 38.5, 40.5, 46.5, 51 and 53

As part of this report, we thought it was important to include all of FDL's water quality monitoring data, from 1998 to 2018 (Appendix C). Although we conduct yearly water quality assessments for our water quality standards, this is the first time we have summarized and compiled the entirety of our water quality data. This is important for several reasons. Yearly water quality assessments provide a ten-year snapshot of water quality, but don't provide the chance to assess our water quality data on a longer time scale. FDL has one of the more mature tribal water quality programs, and it's important to use that data to look for trends on a longer time scale. Discussions with fellow resource managers in Western Lake Superior (MN Sea Grant, MNDNR, MPCA, Lake Superior Reserve, Regional Stormwater Protection team) have all noted similar long-term trends that span the last two decades. The period between 2000 and ~2010 was relatively dry, and the period between 2010 and the present has been significantly wetter, leading to record-breaking high-water levels on all the Great Lakes. The period of high water that we are currently in is notable in our water quality data. For instance, sulfate levels on all of our manoomin lakes have decreased during this wetter period, likely due to dilution from increased water volume (Figure 72).

Assessing a ten-year snapshot of data would not show this overall shift in precipitation regimes. Therefore, we are using the opportunity of updating our CWA §319 Assessment Report to provide conclusions based on all of FDL's water data.

Figure 72. Sulfate trends

Twenty-year sulfate data for manoomin lakes on the Fond du Lac Reservation. Sulfate levels are higher during a drier ten-year period (1998-2009), and lower during the following wetter ten-year period (2010-2018). Such trends are not completely captured in FDL's water quality assessments.



Wetland Monitoring

Fond du Lac received a Wetland Program Development Grant (CWA §104(b)(3)) in FY 2007, and developed a stand-alone "Comprehensive Wetland Assessment and Monitoring Plan" (CWAMP) along with an associated Quality Assurance Project Plan. The CWAMP incorporates the appropriate assessment tools for each wetland type on the Reservation: forested, scrub/shrub, wet (fresh) meadow, and floodplain. Our wetland monitoring regime includes annual monitoring of a set of reference wetlands, along with a unique set of 25-30 wetlands selected each year for assessment on a five-year rotation among the five identified subwatersheds.

Ground Water Quality Monitoring

Ground water data available for the Reservation as it relates to this plan includes several sites that were investigated as part of an Administration for Native Americans Ground Water Protection Grant. Three sites were investigated via monitoring wells and potable well sampling to determine if any of the sites needed additional investigation or clean up and to determine the relative human health risks of these sites on the Reservation.

Four wells were installed at the abandoned Perch Lake Dump site to determine if ground water contamination was a threat to nearby housing. Soil samples were taken from the soil borings when the

wells were installed. Potable wells within one mile of the site were also sampled with permission of the homeowners. All of the wells and the soil samples were analyzed for compounds that are typically found at dump sites and landfills (metals, anions, cations, nitrate, nitrite, polycyclic aromatic hydrocarbons, pesticides, polychlorinated biphenyls, diesel range organics, and volatile organic compounds. No contamination was detected in the soil borings, monitoring wells, or potable wells above EPA Maximum Contaminant Levels (MCLs) for any of the compounds sampled. Manganese was detected at levels above the secondary drinking water standard. This is a common problem on the Reservation in wells completed in the glacial till, and it is likely the problem is not associated with the dump.

One well was installed and sampled near the new Fond du Lac Ojibwe School because the site was the former location of a furnace factory and had the potential to be a brownfield site. The well was sampled once for the same list of contaminants used at the abandoned Perch Lake Dump site. No compounds were detected above EPA MCLs for any of the compounds sampled. Manganese was detected at levels above the secondary drinking water standard. Again, this is a common problem on the Reservation in wells completed in the glacial till, and it is likely the problem is not associated with the furnace factory. Several volatile organic compounds were detected at very low levels, close to the detection limit (chloroethane, dichlordifloromethane, and methylene chloride). The detections are well below EPA drinking water standards. Their source is unknown.

Three wells were installed near the intersection of Highway 210 and University Road. The site was chosen because of its location near an illegal dump site that was cleaned up within the last 5 years. The well was sampled once for the same list of contaminants used at the Perch Lake Dump Site. No compounds were detected above EPA MCLs for any of the compounds sampled. Manganese was detected at levels above the secondary drinking water standard. This is a common problem on the Reservation in wells completed in the glacial till, and it is likely the problem is not associated with the illegal dump site. Phenanthrene (a polycyclic aromatic hydrocarbon compound) was found at low levels in one of the wells at the site. Since no other compounds were found at the site, the source of the phenanthrene is unknown.

Other Water Resource Monitoring Projects

Contaminant Studies

In 2000, FDL OWP partnered with the Minnesota Department of Health and the Grand Portage Band to collect and analyze fish tissue contaminants from Reservation lakes and the St. Louis River (preferred fishing waters). We collected species of fish favored by Band members (channel catfish, walleye, northern pike, and smallmouth bass) from the St. Louis River, and included those species in the study, plus panfish such as bluegills and crappies from seven of the Reservation lakes. In 2008, FDL Natural resources staff completed a second round of fish captures on Reservation lakes so we could compare contaminant levels in 2000 and 2008. A third round of fish tissue analysis for mercury was conducted in 2015.

FDL OWP completed a study funded by Minnesota Sea Grant to determine the risks and benefits associated with the consumption of traditional foods, including manoomin, waterfowl and moose. These foods carry the risk of having potentially elevated mercury and lead levels, and we compared those risks with the nutritional and cultural benefits of consuming wild foods versus market alternatives. FDL OWP also partnered with Minnesota Department of Health and Fond du Lac Human Services Division to conduct a biomonitoring study, funded through the Great Lakes Restoration Initiative, that measured the concentration of a wide array of Great Lakes legacy toxicants in the blood and urine samples from American Indians who live within the Band's health services district, along with a survey on what kinds of

foods they eat, and how often they eat them. An important conclusion of the survey was that the people would like to eat more wild-caught animals, but they refrain because of the potential for harm due to toxicants (FDL Biomonitoring Study, 2014).

Atmospheric Quality Parameters

Atmospheric deposition is an important part of the hydrologic cycle; nutrients, pesticides, and other chemical contaminants can travel in particulate form, long distances from their point of application or emission. More than 3 million tons of nitrogen, derived either naturally from chemical reactions or from the combustion of fossil fuels such as coal and gasoline are deposited in the United States each year from the atmosphere. The highest contributions of nitrogen from the atmosphere occur in a broad band from the Upper Midwest through the Northeast. Fond du Lac Reservation participated for a few years in the National Atmospheric Deposition Program and collected weekly precipitation samples to be analyzed for a suite of chemical parameters, including pH, conductivity, sulfate, chloride, ammonium, and nitrate. As the Air Program has grown, other monitors have been installed and operated to measure small particulates (PM2.5), dioxin, ozone, and nitrogen oxides. Fond du Lac's air emissions inventory was completed in March 2020.

Atmospheric deposition of mercury is of particular concern in this boreal forest and wetland ecoregion, as geochemical and microbial processes enhance mercury availability to the aquatic food web. Since 1997, the Fond du Lac Tribal Air Program has been monitoring atmospheric deposition of mercury weekly, and specifically measured methyl mercury deposition in 2003. In order to better understand the fate and transport of mercury and other contaminants in the aquatic ecosystems, the OWP has initiated several projects to investigate contaminant levels and potential exposure scenarios. A sediment project assessed sediment contaminant levels of mercury, polychlorinated biphenyls (PCBs), and lead and sediment physical characteristics for twelve Reservation lakes. This provided a baseline sediment quality database for the Reservation. Results confirmed elevated mercury and lead levels that exceed threshold effects concentrations in some sediment samples of the study lakes, although toxicity tests conducted on samples from half of the study lakes found no significant toxicity associated with the lake sediments. An additional twelve sediment sample sites on the St. Louis River were evaluated for the same parameters, including the measurement of methyl mercury sediment concentrations. Both projects were funded through EPA's Great Lakes National Program Office.

Big Lake Wastewater Studies

2011 algae bloom in the north basin of Big Lake

Big Lake, the most heavily developed recreation lake and a popular fishery, has more than 250 homes and cabins along its shoreline. Tribal water quality data and a pilot septic compliance survey indicated that failing septic systems are a potential ecological and human health threat to the lake. The Environmental Program developed a partnership with the Big Lake Association, Carlton County, and the Western Lake Superior Sanitary District, and secured Minnesota Clean Water Partnership funding to do a wastewater collection and treatment feasibility study to identify options for solving this problem. The Fond du Lac Environmental Program has also initiated a beach monitoring program for *E. coli* testing throughout the summer at frequently used swimming areas. Beach advisories are rare, though they did occur after the 500-year flood event in June 2012, and during sustained and extreme high-water levels in the summer of 2018.

Golf Course/Casino/Hotel Development Monitoring

A casino/hotel complex developed in 1994, adjacent to Otter Creek, has the potential to degrade the quality of this designated trout stream. Impervious surface runoff from parking lots and rooftops during storm events carries toxic chemicals, nutrients, and road deicing salt and contributes heated runoff to thermally-sensitive streams. An eighteen-hole championship golf course was constructed in 2001 at this site and additional stream and ground water monitoring was instituted to ensure that construction and subsequent golf course management activities did not adversely impact Otter Creek. Since the final golf course design included impacts (dredging and filling) to over 26 acres of wetlands in the watershed, an Army Corps of Engineers Section 404 Individual Permit was required before proceeding with the project. The OWP was instrumental in recommending course design changes, identifying potential mitigation projects, and developing comprehensive monitoring plans for water quality and erosion control, all of which facilitated the granting of the permit and demonstrated a Tribal commitment to protect its aquatic resources. Ultimately, the completed golf course impacted just under 26 acres of wetlands through ongoing design modifications, with mitigation predominantly on-site. Routine erosion control inspections proved effective in preventing sedimentation problems in the adjacent wetlands and Otter Creek. Aerial photography was acquired during pre- and post- construction to identify areas of ground water intrusion in the wetland buffer zone between the course and Otter Creek. Four observation wells were established in this buffer zone before construction commenced, and four additional wells were established on the course after completion. Ground water was routinely monitored from the observation wells for nutrients, nitrate, pesticides and herbicides from 2003 to 2012 in order to detect potential impacts to shallow ground water, the adjacent wetlands, and Otter Creek. Since no impacts were detected for X consecutive years, this monitoring program was discontinued 2012.

Water Quality Assessment Methods

FDL OWP conducts water quality assessments as part of its Treatment as a State for §106 of the CWA. We compile and analyze our water quality data, and use our Assessment Methodology to determine if the designated uses in our Water Quality Standards are being met. These data, assessments and conclusions are summarized in this report. Since FDL has no point source pollution, all impairments are due to NPS. Changes since the 2004 CWA §319 Assessment Report include new water quality standards, criteria and assessment methods and decisions, which are discussed below.

NPS Category Assessment Methods

In addition to the assessment decisions reported in ATTAINS (below), FDL OWP used a suite of information to compile the assessments for each NPS category, reported in Tables 12-19. We relied on water quality data; site visits; aerial and ground photography; knowledge of the site from conversations with landowners and fellow resource managers and companion reports such as the IRMP.

Updated Water Quality Assessment Methodology and ATTAINS

In 2016, FDL OWP joined the Tribal Pilot for the Assessment TMDL Tracking and ImplementatioN System (ATTAINS), along with tribes from EPA Regions 6 and 9. ATTAINS is an online system where states and tribes can report their water quality assessment determinations. Waters that do not meet water quality standards for a given designated use are listed as impaired. States then use ATTAINS to track impaired waters using Total Maximum Daily Loads (TMDLs) under Section 303(d) of the Clean Water Act (Impaired Waters). Since there are no tribes in the nation that have Treatment as a State for Section 303(d), tribes only use ATTAINS to track water quality assessment decisions. Between 2016 and 2019, FDL OWP has submitted yearly water quality assessments decisions based on ten-year averages for each applicable water quality parameter. Table 8 shows the designated uses listed under FDL's Water Quality Standards.

As part of FDL's participation in the Tribal Pilot for ATTAINS, we updated our Water Quality Assessment Methodology (Appendix F), and incorporated the new water quality criteria written into our updated water quality standards. Generally, assessment rules state that a parameter supports a given designated use if ≤10% samples exceed the water quality standard within a ten-year time frame. A parameter does not support a given designated use if >10% samples exceed the water quality standard within a ten-year time-frame, and the water would be listed as impaired (unless the exceedance has supporting evidence that it is due to natural background conditions). Numeric biocriteria results support a designated use if Biological Condition Gradient score stays the same or decreases (indicates same or improving conditions). The designated use is not supported if Biological Condition Gradient score increases by one unit (indicates increase in stressors). For E. coli, the designated use is supported if the monthly geometric mean does not exceed threshold of 126 organisms/100 mL, based on number of samples. The assessment methodology for nutrients, which reflects the new lake-specific criteria in FDL's water quality standards, is discussed below. In cases where insufficient samples are available in a ten-year period, additional years can be included to increase the number of samples. For mercury, fewer than 10 years of data exists, so all data (2011-present) will be used. Lakes may only have 1-2 years of mercury data. Mercury assessment results are also discussed in the Results section.

The ATTAINS website creates reports based on the water quality assessment decisions that are submitted. Fond du Lac's water quality assessments show that nearly all assessment units, including lakes and streams, are impaired for both mercury in fish tissue and mercury in the water column under the Aquatic Life: Subsistence Fishing (Netting) designated use and the Wildlife designated use. Second Lake is not

meeting its Aquatic Life Use: Warm Water Fisheries designated use because its high total suspended solids levels are above the standard.

Table 7. Surface Water Resources and Use Designations

Category	Code	Location	Designated Uses
Wild Rice Lakes:			
	101	Bang (Long) Lake	B, C2, D1, D2, E1, F, G, H
	104	Deadfish Lake	B, C2, D1, E1, F, G, H
	108	Jaskari Lake	B, C2, D1, E1, F, G, H
	112	Miller (Mud) Lake	B, C2, D1, E1, F, G, H
	114A	Perch Lake	B, C2, D1, E1, E2, F, G, H
	115	Rice Portage Lake	B, C2, D1, E1, E2, F, G, H
	124	Wild Rice	B, C2, D1, E1, F, G, H
Fisheries Lakes:			
	102A & B	Big Lake	B, C2, C3, D1, D2, F, G, H
	110	Lost Lake	B, C2, C3, D1, D2, F, G, H
	111	Martin (Joe Martin) Lake	B, C1, C2, C3, D1, D2, E2, F, G, H
	113	Pat Martin Lake	B, C2, C3, D1, E1, F, G, H
	114B	Perch Lake	B, C2, C3, D1, E1, E2, F, G, H
	118	Simian Lake	B, C2, C3, D1, E1, F, G, H
	119	Sofie Lake	B, C2, C3, D1, F, G, H
	122	Third Lake	B, C2, C3, D1, D2, F, G, H
	123A & B	West Twin Lake	B, C2, C3, D1, D2, E1, F, G, H
Other Lakes:			
	103	Cedar Lake	B, C2, D1, E1, F, G, H
	105	East Twin Lake	B, C2, D1, E1, F, G, H
	106	First Lake	B, F, G, C2, D1, H
	107	Hardwood Lake	B, C2, D1, E1, F, G, H
	109	Lac Lake	B, C2, D1, E2, F, G, H
	116	Second Lake	B, E1, C2, D1, F, G
	117	Side Lake	B, D1, E1, F, G, H, C2
	120	Spring Lake	B, C2, D1, E1, F, G, H
	121	Spruce Lake	B, C2, D1, E1, F, G, H
Trout Streams:			
	204	Otter Creek	B, C1, C3, D1, E2, F, H, G
	207	Stoney Brook	B, C1, C2, C3, D1, F, G, H
	202B	Fond du Lac Creek	B, C1, C3, D1, F, H, G
Drainage Streams:			
	203A & B	Martin Branch	B, C1, C3, D1, E2, F, H, G
	205A & B	Simian Creek	B, C2, C3, D1, F, H, G
Other Streams:			
	201	Annamhasung Creek	B, C2, D1, F, H, G
	206	Spring Creek	B, C2, D1, F, H, G
	208	St. Louis River	B, C2, C3, D1, D2, E2, F, G, H

Key - Designated Uses

A	Public Water Supply	D2	Secondary Contact Recreational
B	Wildlife	E1	Cultural, Wild Rice Areas
C1	Aquatic Life, Cold Water Fisheries	E2	Cultural, Aesthetic Waters
C2	Aquatic Life, Warm Water Fisheries	F	Agricultural
C3	Aquatic Life, Subsistence Fishing	G	Navigation
D1	Primary Contact Recreational	H	Industrial

New Numeric Biocriteria Assessment Methods

Since 1999, FDL has been collecting macroinvertebrate and fish data from streams as part of their routine biomonitoring program. In 2014, FDL hired Tetra Tech to create the "Strategy for Developing Numeric Biocriteria for Wadeable Streams on Fond du Lac Reservation Lands." (Appendix G). Aquatic biota are known to be responsive to a wide variety of human disturbances and, at the community level, can be used to measure the synergistic effects of stressors on the aquatic biota residing in a waterbody (Barbour et al. 1999). Monitoring the biology increases the likelihood of detecting the effects of episodic events (e.g., spills, dumping, treatment plant malfunctions), toxic nonpoint source pollution (e.g., agricultural pesticides), cumulative pollution (e.g., multiple impacts over time or continuous low-level stress), nontoxic mechanisms of impact (e.g., trophic structure changes due to nutrient enrichment), or other impacts that periodic chemical sampling might not detect. Biotic response to impacts on the physical habitat such as sedimentation from stormwater runoff and physical habitat alterations from dredging, filling, and channelization can also be detected using biological assessments. Biological criteria are a way of describing the qualities that must be present to support a desired condition in a waterbody.

Using FDL's water quality and habitat data, and pairing it with remote sensing and land cover data, Tetra Tech developed a disturbance index and a numeric Biologic Condition Gradient (BCG) tool for each stream on the Reservation (Davies and Jackson 2006). Table 8 shows the disturbance gradient scores for FDL streams, where a higher score means a less disturbed site. The MPCA Human Disturbance Score System, upon which the FDL Disturbance Index is based, lists any site with a score above 61 as being eligible to be a reference site. All stream sites on the Reservation could therefore be reference sites, except for Otter Creek (Station 1), which is adjacent to a highway and the Black Bear Casino.

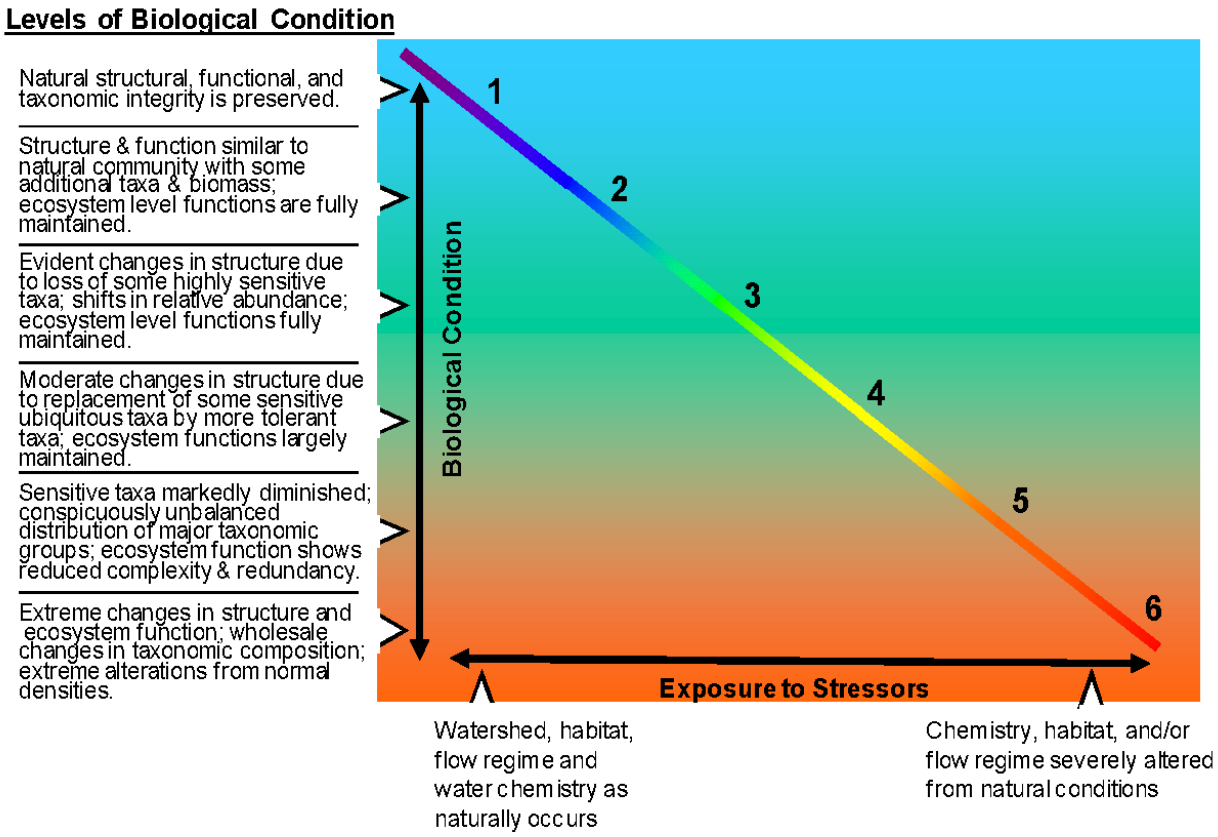
Table 8. Disturbance Index for Fond du Lac Reservation Stream Sampling Sites.
A higher score indicates fewer human-caused ecological disturbances to a stream.

Station Name	FDL Disturbance Index
Annamhasung Creek	64
Fond du Lac Creek Station 1	71
Fond du Lac Creek Station 2	74.2
Fond du Lac Creek Station 3	67
Martin Branch (Marshall Rd.)	74.9
Martin Branch (Stevens Rd.)	75.7
Otter Creek Station 1	53.8
Otter Creek Station 2	69.9
Otter Creek Station 3	69.1
Otter Creek Station 4	75.1
Simian Creek Station 1	69.1
Simian Creek Station 2	75.2
Simian Creek Station 3	68.4
Stoney Brook Station 1	63.7
Stoney Brook Station 2	68.5

The BCG is a conceptual, narrative model that describes how biological attributes of aquatic ecosystems change along a gradient of increasing human disturbance. It provides a framework for understanding current conditions relative to natural, undisturbed conditions (versus the Index of Biotic Integrity, which is driven more by available conditions). The BCG is divided into 6 levels of biological condition along the stressor-response curve, ranging from observable biological conditions found at no or low levels of stress (level 1) to those found at high levels of stress (level 6) (Figure 73). Samples are assigned to BCG levels

based on quantitative decision rules that are developed from consensus expert judgment. FDL participated in a project several years ago to calibrate BCG models for cold and cool water macroinvertebrate and fish communities in the Upper Midwest (Stamp and Jessup, 2015, Gerritsen and Stamp 2012).

Figure 73. Biological Condition Gradient
(Davies and Jackson 2006)



Updated Nutrient Assessment Methods

Updated Fond du Lac Water Quality Standards, which completed triennial review in 2020, include lake-specific nutrient standards for Primary Fisheries Lakes and Secondary Fisheries Lakes on the Reservation: "Waters of the Fond du Lac Reservation shall be free from nutrients (nitrogen and phosphorus) entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae . . . the thresholds for nitrogen, phosphorus and chlorophyll α shall be used to assess attainment of this standard, prioritize restoration projects and establish water quality targets for restoration, and inform §401 certifications."

In addition, the nutrient standard language includes the following assessment methodology, where summer mean is defined as June 1 through September 30:
"The lakes . . . will be considered in attainment with their nitrogen thresholds if the summer mean concentration for nitrogen is not exceeded. Exceedance of the summer mean total phosphorus threshold and either the summer mean chlorophyll-a threshold or the summer mean Fond du Lac Secchi disk transparency index, developed as a component of the Fond du Lac Assessment Methodology, is required to indicate a polluted condition."

For assessment purposes, we calculate summer means for total nitrogen, total phosphorus, chlorophyll α and Secchi depth using ten years of data.

Total Nitrogen, Total Phosphorus and Chlorophyll α Criteria

FDL OWP developed lake-specific nutrient criteria for several reasons. The US EPA has requested that scientifically defensible ecoregional numerical nutrient criteria be developed to protect designated uses of water bodies (USEPA 2000a). Because lakes with high water quality can have varying nutrient levels, researchers have recommended that more sensitive indicators of biological status be used to help determine what appropriate nutrient criteria should be. In cases where FDL Water Quality Standards do not include applicable numeric criteria, we often look to state standards. The state of Minnesota relies on ecoregional numerical criteria and does not yet have site-specific criteria for lakes. FDL Lakes fall within the Northern Lakes and Forests (NLF) Ecoregion, where many lakes are deep, clear and oligotrophic. The NLF standards for phosphorus and chlorophyll α are 0.03 mg/L and 9 ug/L, respectively, while Secchi depth is <2.0 m, which is often deeper than the actual lakes on the Reservation. Most of the lakes on the Reservation are shallow, highly stained and mesotrophic, while also being classified as minimally impacted. The ten-year summer averages for total phosphorus, chlorophyll α and Secchi depth (the three parameters needed to determine whether lakes are meeting their use for nutrient enrichment under the Aquatic Life, Primary Contact Recreation and Secondary Contact Recreation designated use categories) for Reservation lakes often exceed the NLF criteria for nutrient enrichment, so if we used these standards we would classify these lakes as not meeting their use. The acknowledgement of FDL lakes being in a minimally-impacted state is important because they presently have high nutrient concentrations relative to lakes in the NLF ecoregion. The important distinction is that these lakes exceed the Minnesota state standard even though they have few or no NPS impacts. The high nutrient levels in these lakes can be attributed to shallow depths and high dissolved organic carbon (DOC) concentrations, so these lakes are not listed as impaired for excessive primary productivity because this is their natural background condition. We know from several studies, as well as observational data and other water quality parameters, that Reservation lakes are not impaired due to eutrophication, so we proposed lake-specific nutrient standards in the 2019 triennial review of our water quality standards.

FDL OWP commissioned two studies to set our nutrient criteria. The Soranno (2011) study compares nutrient data in NLF lakes across the ecoregion to FDL lake nutrient data as well as lake nutrient data from the Grand Portage Reservation, and uses those to suggest lake-specific criteria for FDL lakes (Table 10). Using nutrient data from each lake, the expected condition was calculated as the full range of expected concentrations for each variable and each lake. From there, nutrient criteria were calculated as upper 90th percentile of each variable within a season, across all years of the study. Figure 74 shows the distribution of lake-specific nutrient criteria for each lake (blue diamonds), compared to median in black and the NLF criterion.

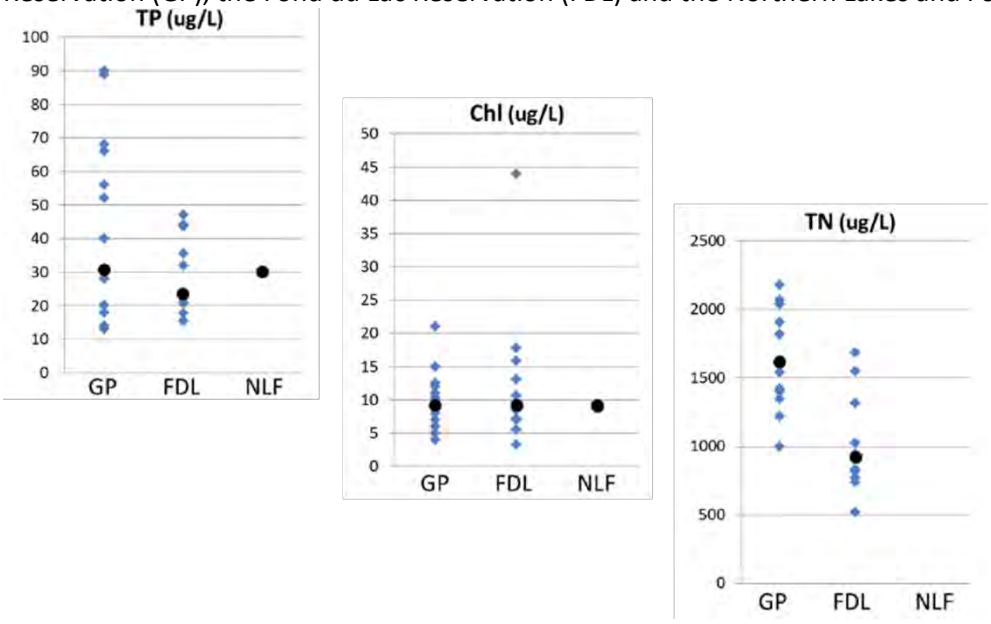
Table 9. Lake-specific nutrient criteria for FDL lakes

(Sorrano, 2015)

Lake	TN Threshold (mg/L)	TP Threshold (mg/L)	Chl α Threshold (ug/L)
Big Lake (North Basin)	0.77	0.018	7*
Big Lake (South Basin)	0.83	0.021	
Lost Lake	1.025	0.023	13
Joe Martin Lake	0.618	0.015	3
Pat Martin Lake	0.739	0.021	7
Perch Lake (North Basin)	0.944	0.032	18
Perch Lake (South Basin)	1.686	0.044	8
Simian Lake	1.352	0.047	16
Sofie Lake	0.854	0.036	33
Third Lake	1.548	0.044	44
West Twin Lake (North Basin)	0.83^	0.022	11^
West Twin Lake (South Basin)		0.024	
* Applies to both north and south basins of Big Lake			
^ Applies to both north and south basins of West Twin Lake			

Figure 74. Distribution of Lake-Specific Nutrient Criteria

For total phosphorus (TP), chlorophyll α (Chl) and total nitrogen (TN) for lakes in the Grand Portage Reservation (GP), the Fond du Lac Reservation (FDL) and the Northern Lakes and Forests Ecoregion (NLF)

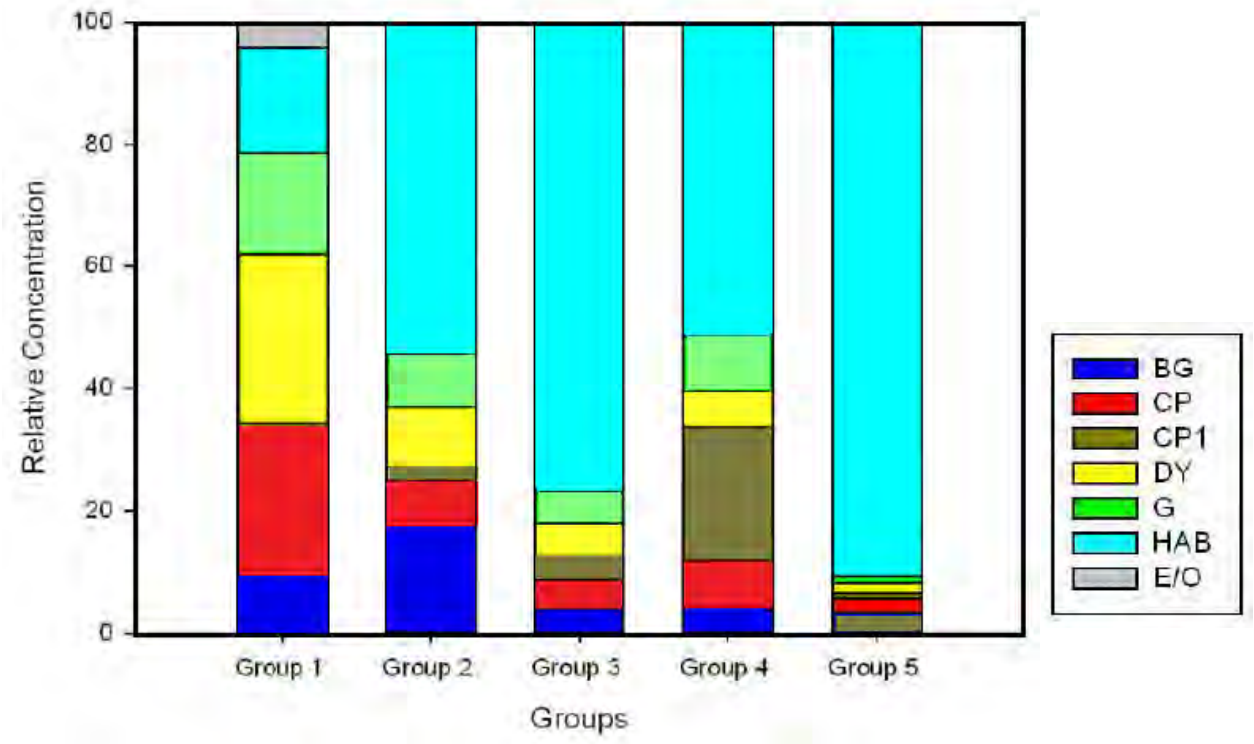


The St. Amand (2015) study validated these criteria by studying the biological responses to nutrient levels in FDL lakes compared to impacted and unimpacted lakes in southern Minnesota, and concluded that the nutrient standards are protective of these minimally impacted lakes. Chlorophyll α is a commonly and easily measured water quality indicator, but it is a cumulative indicator that can't detect subtle shifts in nutrient loading. Algal communities, on the other hand, are sensitive indicators of changes to nutrient

loading, as these communities will shift between dominant taxa in response to changes in nutrient levels. This study compared phytoplankton assemblages between FDL fisheries lakes and a suite of southern Minnesota lakes of varying productivity (impacted vs. unimpacted by human activity), in order to determine whether there is evidence that the FDL lakes are impacted by human activities. In this report, a Phytoplankton Rapid Assay data from 1998 to 2012 were used to assess the current biological state of the FDL fisheries lakes in an effort to substantiate the unique character and good water quality of the FDL lakes. Figure 75 shows that the study lakes were lumped into five groups based on similarities in their phytoplankton assemblages, where group 1 includes the most ecologically stable (minimally impacted) lakes, and group 5 includes the lakes most impacted by human activities (with a preponderance of algal communities that contribute to harmful algal blooms). All of the FDL lakes were included in Group 1, and all FDL lakes were stable ecologically in their algal community response over the entire study period. Therefore, this study corroborates conclusions from the previous report that set FDL lake-specific nutrient criteria based on the assumption that all FDL fisheries lakes are minimally impacted by human activity.

Figure 75. Relative percent algal composition by functional group classification

For the five lake groups, they are, averaged over all samples and years by Group. Group 1, n=613: Group 2, n=316, Group 3, n=182, Group 4, n=99, Group 5, n=82 (St. Amand, 2015). BG = all other Cyanobacteria, CP = Cryptophyte/Pyrrophyta (CP) taxa, CP1 = *Ceratium hirundinella* (CP1), DY = Chrysophyta/ Bacillariophyta, G = Chlorophyta, HAB = Harmful Algal Bloom taxa, E/O = Euglenophyta/Other (Amand, 2015)



Secchi Thresholds

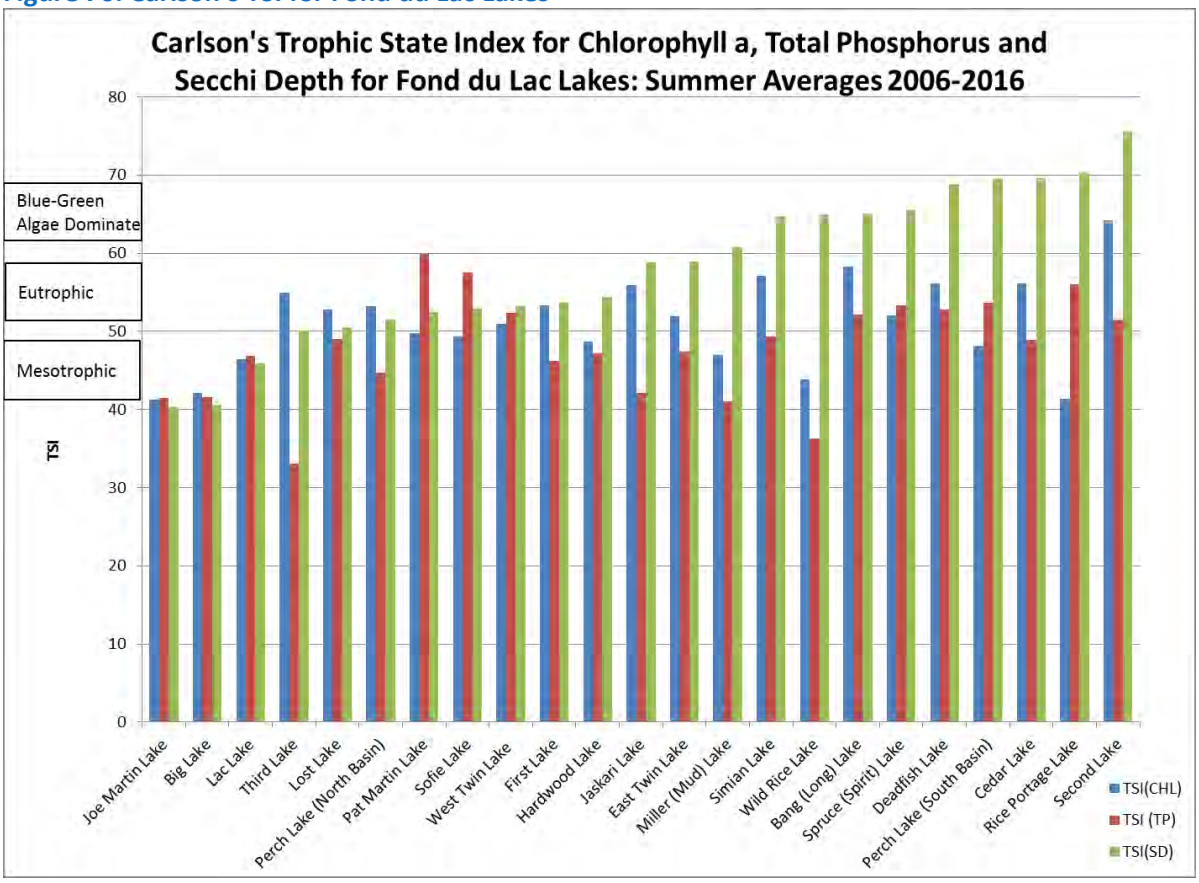
Carlson's Trophic State Index (TSI) uses phosphorus, chlorophyll α and Secchi depth to determine a lake's trophic status (Carlson, 1983). The major assumption behind the TSI is that suspended particulate material in the water controls Secchi depth and that algal biomass is the major source of particulates. However, in Fond du Lac lakes, Secchi depth is more strongly driven by lake color than by algal biomass. A highly stained lake with low Secchi depth readings can skew the relationships between TSI variables, and can inadvertently lead to classifying a lake as hypereutrophic or eutrophic when in fact the lake is in the mesotrophic or oligotrophic range. This is especially true in FDL's shallow manoomin lakes and its bog-influenced lakes. According to Carlson's TSI ratings for FDL lakes, they are classified as mainly eutrophic or blue-green algae dominated because of their low Secchi depth readings (Carlson, 1983). Figure 76 shows elevated TSI ratings for Secchi depth relative to phosphorus and chlorophyll α for FDL lakes. However, our data and our observations do not validate this rating, as our lakes meet fall in the mesotrophic/oligotrophic range for both chlorophyll α and total phosphorus. Table 11 shows the role that color plays in influencing the TSI, thereby acknowledging the subtleties at play when employing the TSI to classify lakes.

Table 11. Relationships between TSI variables and the conditions that drive those relationships.
FDL lakes fall in the TSI(TP) = TSI(SD) > TSI(CHL) category.

Relationship Between TSI Variables	Conditions
TSI(Chl) =TSI(TP) =TSI(SD)	Algae dominate light attenuation; TN/TP ~ 33:1
TSI(Chl) >TSI(SD)	Large particulates, such as *Aphanizomenon* flakes, dominate
TSI(TP) =TSI(SD) >TSI(CHL)	Non-algal particulates or color dominate light attenuation
TSI(SD) =TSI(CHL) >TSI(TP)	Phosphorus limits algal biomass (TN/TP > 33:1)
TSI(TP) >TSI(CHL) =TSI(SD)	Algae dominate light attenuation but some factor such as nitrogen limitation, zooplankton grazing or toxics limit algal biomass.

FDL water quality standards include a turbidity standard, but they don't include a standard for Secchi depth, which is one of the parameters considered when making an overall use determination for eutrophication. Minnesota's NLF Secchi depth criterion for Class 2Bd lakes, shallow lakes, and reservoirs is listed as not less than 2.0 m (MPCA, 2005). Class 2Bd surface waters allow the propagation and maintenance of a healthy community of cool or warm water aquatic biota and their habitats. These waters shall be suitable for aquatic recreation of all kinds, including bathing (State of Minnesota, 2018). This criterion was derived from a survey of lakes in the NLF ecoregion that were mostly deep, clear and oligotrophic. Consequently, it is hard to apply this criterion to Fond du Lac lakes, which are mostly shallow and stained. In fact, the NLF Secchi standard for Class 2Bd lakes is actually deeper than the maximum depth of many FDL lakes. Since TSI alone does not accurately characterize FDL lakes without clarifying the source of light attenuation, and the NLF standard does not apply to our shallow, stained lakes, we created a Secchi depth index based on color to help classify our lakes and set thresholds.

Figure 76. Carlson's TSI for Fond du Lac Lakes



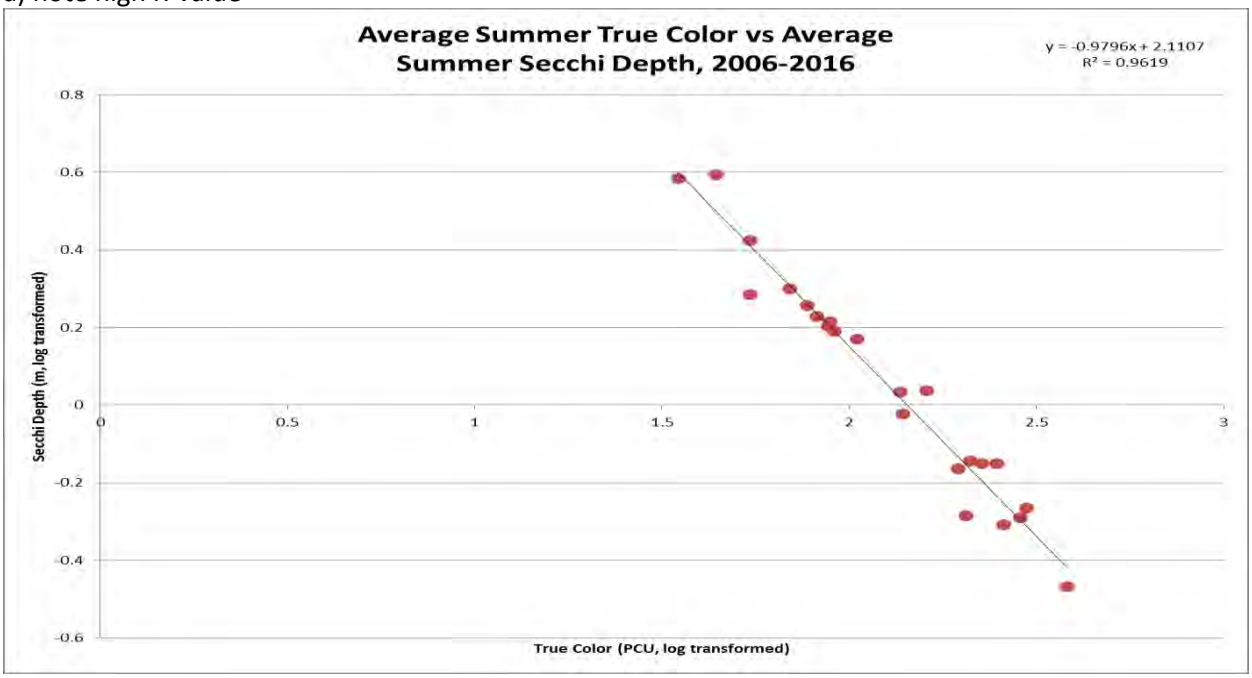
CHL = chlorophyll α, TP = total phosphorus, SD = Secchi depth

A Secchi index was created using summer values (when a lake is most productive) for apparent color and true color data between 2006 and 2016. Even though FDL's nutrient criteria apply only to fisheries lakes, we included all of FDL's monitored lakes in the Secchi index so we can track trends over time. We chose color as a proxy for DOC. DOC is more a measure of dissolved organic matter (DOM) quantity and color more is a measure of DOM quality, but DOC is expensive to monitor, so we use color data instead. Figure 77 shows that lake color is more strongly correlated with Secchi depth than with chlorophyll α, which indicates that in FDL lakes, color confounds Secchi depth readings rather than Secchi depth being driven by algal biomass. These graphs helped justify our use of color data to help us create a Secchi index for FDL lakes.

FDL lakes were grouped by the level of difference between apparent color, which is a measure of both particulate and DOM, and true color, which is more a measure of DOM alone. Lake water is filtered before taking a true color reading to remove any particulates, so a lake that has a high color reading after filtering likely has high DOM concentrations, and a smaller difference between apparent color and true color than lakes with high particulate matter concentrations. Sorting the lakes this way can help interpret which lakes have high color due to particulate matter and which lakes have high color because they are highly stained. FDL lakes were grouped into four categories for assessment: Clear Lakes, Stained Lakes, Moderately Clear lakes and Moderately Turbid Lakes (Figure 78). Figure 79 then shows the Secchi depth thresholds for each of the lake classes, which were based on average summer Secchi depth between 2006 and 2016.

Figure 77. The relationship between true color and Secchi depth (a) and between chlorophyll α and Secchi depth (b) for FDL lakes

a) note high R-value



b)

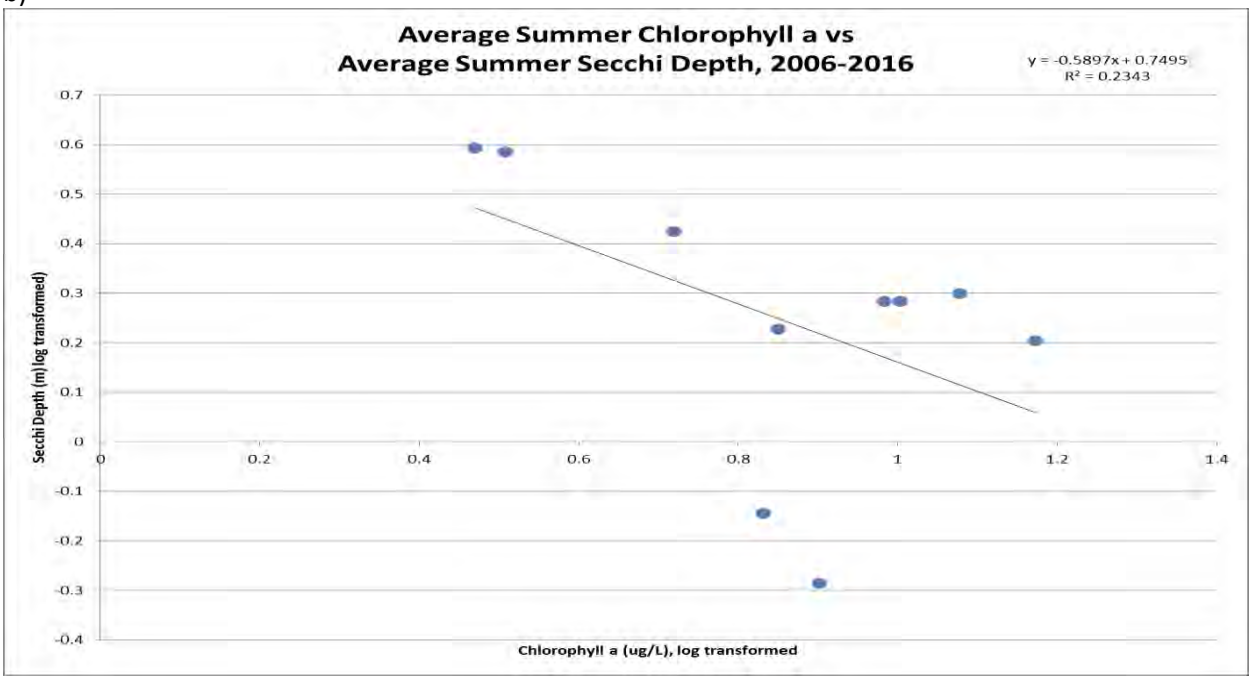


Figure 78. Categories for FDL lakes based on apparent color and true color data

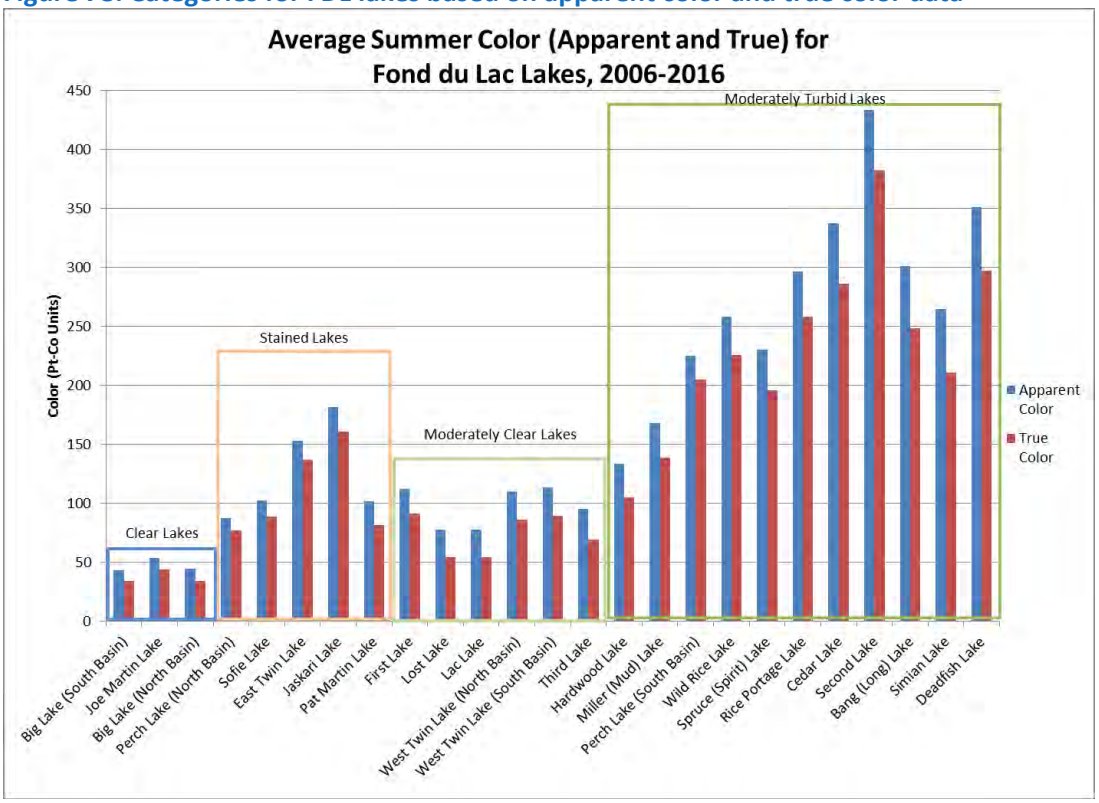
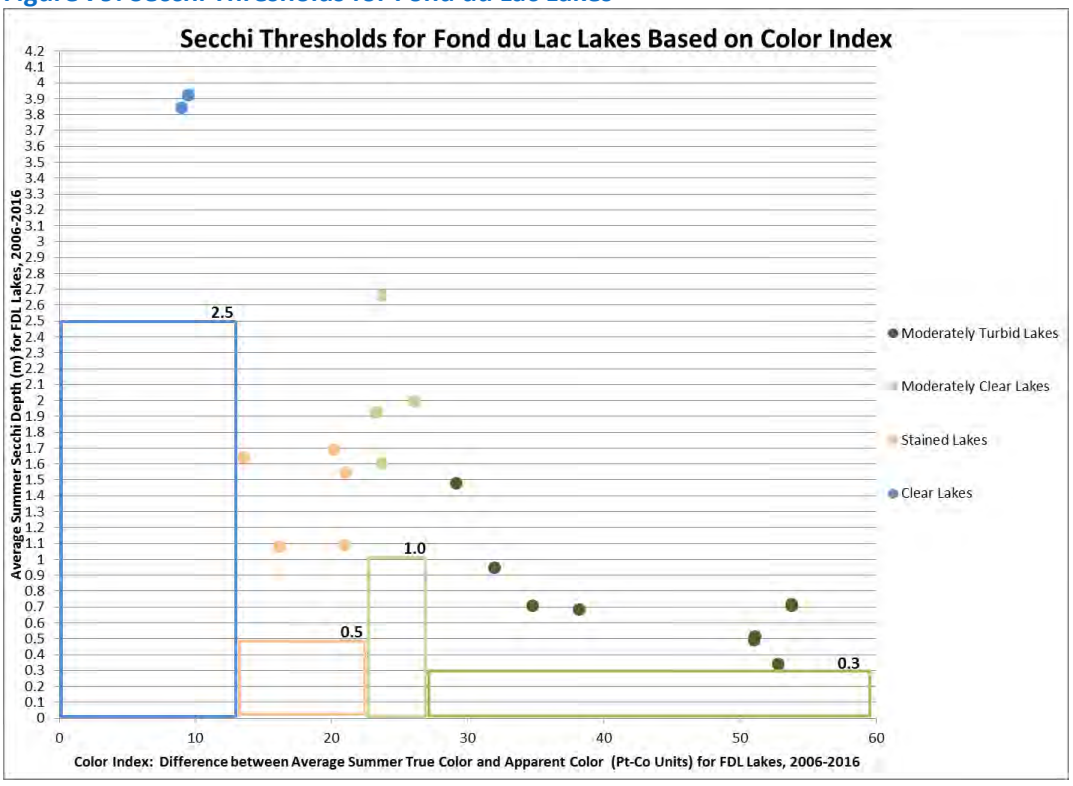


Figure 79. Secchi Thresholds for Fond du Lac Lakes



Water Quality Assessment Results

Water Quality Assessment Results by Non-Point Source Pollution Category

Tables 12-19 reflect the assessment conclusions for each NPS category. In addition to the tables, we also included new assessments that have been conducted since the last CWA §319 Assessment Report, such as assessments using site-specific nutrient criteria for FDL's fisheries lakes, a multi-media mercury investigation, and our work on climate change as part of EPA's Regional Monitoring Network.

Tables 12-19. Each NPS Category has its own table. An overall assessment is given for each watershed, which includes all waterbodies within that watershed; specific waterbodies are included where additional information is warranted to highlight specific NPS issues. Note that the watershed as a whole may have an overall severity rating that is different than a rating for a specific waterbody or group of waterbodies.

Table 10. Agriculture

Non-Point Source Pollution Category			
Agriculture			
Potential Pollutants/Stressors			
Nutrients, sediment, pathogens, thermal stress			
Affected Watersheds		Subcategories	Severity of Impairment
Fond du Lac Creek Watershed		Hayfields	Low
Simian Creek Watershed		Hayfields, pastures	Low
	Primary Fisheries Lakes		
	Simian Lake	Hayfields, pastures	Low
Otter Creek Watershed		Livestock, hayfields and pastures, Black Bear Golf Course	Low
	Primary Fisheries Lakes		
	Second Lake, Third Lake	Livestock, hayfield	Moderate
	Secondary Streams		
	Jolicoeur Creek	Hayfield	Low
Little Otter Creek Watershed		Hayfields and pastures	Low
Stoney Brook Watershed		Hayfields, pastures, golf course, livestock, feedlots	Low
	Primary Fisheries Lakes		
	Big Lake	Big Lake Golf Course	Low
	Secondary Streams		
	Annamhasung Creek	Feedlot	Unknown
Martin Branch Watershed		Hayfields and pastures	Low
St. Louis River Watershed		Hayfields	Low
Moosehorn River Watershed		Feedlot (downstream of Reservation)	Unknown

Table 11. Forestry

Non-Point Source Pollution Category		
Forestry		
Potential Pollutants/Stressors		
Nutrients, sediment, thermal stress, toxicants		
Affected Watersheds	Subcategories	Severity of Impairment
Fond du Lac Creek Watershed	Logging	Low
Simian Creek Watershed	Logging, ATV management	Low
Otter Creek Watershed	Logging (experimental clear cutting at the Cloquet Forestry Center)	Moderate
Little Otter Creek Watershed	Logging	Low
Stoney Brook Watershed	Logging, ATV management, wildfire	Moderate
Manoomin Lakes Bang (Long) Lake, Jaskari Lake, Perch Lake (South Basin), Rice Portage Lake, Deadfish Lake, Miller (Mud) Lake	Wildfire Protection Zone: cannot be used as sourcewater for aerial firefighting; no fire retardant can be dropped within protection zone	Unknown
Martin Branch Watershed	Logging, ATV management, wildfire	Low
St. Louis River Watershed	Logging, ATV management, wildfire	Low
Moosehorn River Watershed	Logging, ATV management, wildfire	Low
Manoomin Lakes Wild Rice Lake	Wildfire Protection Zone: cannot be used as sourcewater for aerial firefighting; no fire retardant can be dropped within protection zone	Unknown

Table 12. Hydromodification and Habitat Alteration

Non-Point Source Pollution Category		
Hydromodification and Habitat Alteration		
Potential Pollutants/Stressors		
Nutrients, sediment, thermal stress, stream connectivity and water level		
Affected Watersheds	Subcategories	Severity of Impairment
Fond du Lac Creek Watershed	Pipeline corridors, beaver dams	Moderate
Simian Creek Watershed	Beaver dams, ditching	Moderate
Primary Streams		
Simian Creek	Ditching in headwaters; pipeline corridor in headwaters	Moderate
Manoomin Lakes		
Cedar Lake	Beaver dams create tailwater; water level too high to support manoomin.	High
Otter Creek Watershed	Pipeline corridors, beaver dams	Moderate
Little Otter Creek Watershed	Pipeline corridors, beaver dams	Moderate
Stoney Brook Watershed	Ditching, pipeline corridors, beaver dams	High
Primary Streams		
Stoney Brook	Extensive ditching has altered the watercourse in over half the watershed, affecting geomorphology, connectivity, flooding patterns, and aquatic life BCG scores. Pipeline corridors and beaver dams further impact stream connectivity. Original watercourse is rife with beaver dams.	High
Manoomin Lakes		
Jaskari Lake, Perch Lake (South Basin), Rice Portage Lake, Deadfish Lake, Miller (Mud)	Water level in the manoomin lakes is impacted by ditching and pipeline corridors, and exacerbated by beaver dams; water control structures and watershed models in place to try to manage water levels to allow for harvestable manoomin.	High
Martin Branch Watershed	Beaver dams	Low
St. Louis River Watershed	Beaver dams	Low
Moosehorn River Watershed	Beaver dams	High
Manoomin Lakes		
Wild Rice Lake	Numerous beaver dams on the lake's outflow cause sustained high water levels; manoomin population has crashed.	High

Table 13. Roads

Non-Point Source Pollution Category		
Roads, Highways and Bridges, Including Railroads		
Potential Pollutants/Stressors		
Nutrients, sediment, thermal stress, toxicants, trash, stream connectivity and water level		
Affected Watersheds	Subcategories	Severity of Impairment
Fond du Lac Creek Watershed	Culverts, railroad bridges, gravel road washouts on side roads.	Moderate
Primary Stream		
Fond du Lac Creek	Failing railroad bridge at stream mouth	Moderate
Simian Creek Watershed	Culverts and bridges; gravel road washouts on Brookston Rd, Hardwood Lk Rd, Kultala Rd, Demenge Rd , Belich Rd, Lund Rd, Jokela Rd, Burnett Rd, numerous side roads.	Low
Otter Creek Watershed	Culverts and bridges, gravel road washouts on Wheaton Rd, numerous side roads.	Moderate
Secondary Stream		
Jolicoeur Creek	Two collapsed roadways with nonfunctioning culverts have led to two major impoundments in this groundwater-fed tributary to Otter Creek.	High
Little Otter Creek Watershed	Culverts and bridges	Low
Stoney Brook Watershed	Culverts and bridges; gravel road washouts on Spirit Lk Rd, Ditchbank Rd, Moorhead Rd, Pine Dr, Arrowhead Rd, Brandon Rd, Maki Rd, numerous side roads.	Moderate
Primary Stream		
Stoney Brook	Numerous culverts in the ditchbank roads are perched and improperly sized/located.	Moderate
Primary Fisheries Lake		
Sofie Lake	Truck trail from Sofie Lake to Perch Lake (North Basin) is in disrepair, rutted and covered in water	Moderate
Martin Branch Watershed	Culverts and bridges; gravel road washouts on Martin Rd, Stevens Rd, numerous side roads.	Moderate
Primary Stream		
Martin Branch	The bridge at Stevens Road is sinking into streambed, causing a braided watercourse, degrading the cedar swamp and impairing trout habitat	High
St. Louis River Watershed	Culverts, railroad bridges, gravel road washouts on McCamus Rds, numerous side roads	Moderate
Moosehorn River Watershed	Culverts and bridges	Low

Table 14. Urban

Non-Point Source Pollution Category		
Urban		
Potential Pollutants/Stressors		
Nutrients, sediment, pathogens, thermal stress, toxicants, trash		
Affected Watersheds	Subcategories	Severity of Impairment
Fond du Lac Creek Watershed	Development, construction stormwater, brownfields	Moderate
Primary Stream		
Fond du Lac Creek	Construction stormwater effects are possible during construction of Cultural Center	Moderate
Secondary Fisheries Lake		
Second Lake	Impaired for Aquatic Life: Warm Water Fisheries Designated Use for total suspended solids; also has increasing nutrient trends due to recent expansion of Min No Aya Win Clinic and Big Lake Road walking trail	High
First Lake	Shoreland development	High
Simian Creek Watershed	Development, construction stormwater	Moderate
Primary Stream		
Simian Creek	Construction stormwater effects are possible during construction of drinking water system and water tower	Moderate
Primary Fisheries Lakes		
West Twin Lake	Shoreland development	Moderate
Manoomin Lake		
Cedar Lake	Shoreland development	Moderate
Otter Creek Watershed	Development, construction stormwater, brownfields	High
Primary Stream		
Otter Creek	Continued urban stressors from Black Bear Casino complex and Cloquet Airport	High
Secondary Stream		
Jolicoeur Creek	Continued urban stressors due to large gravel pit adjacent to stream	High
Primary Fisheries Lake		
Third Lake	Shoreland development	Moderate

Little Otter Creek Watershed	Development, construction stormwater	Low
Secondary Stream		
Little Otter Creek	Continued urban stressors from auto salvage yard on Hwy 210	Moderate
Stoney Brook Watershed	Development, construction stormwater, brownfields	Moderate
Primary Fisheries Lake		
Big Lake	Severe impacts due to failing septic systems, extensive shoreland development, potential for pathogens at two swimming beaches	Severe
Sofie Lake, Lost Lake	Shoreland development	Moderate
Manoomin Lakes		
Bang (Long) Lake	Shoreland development	Moderate
Martin Branch Watershed	Development, construction stormwater, brownfields	Low
Primary Fisheries Lake		
Joe Martin Lake	Shoreland development	Moderate
St. Louis River Watershed	Development, construction stormwater, brownfields	Low
Moosehorn River Watershed	Development, construction stormwater, brownfields	Low

Table 15. Wetland/Riparian Management

Non-Point Source Pollution Category		
Wetland/Riparian Management		
Potential Pollutants/Stressors		
Atmospheric deposition (mercury), habitat alteration (manoomin loss)		
Affected Watersheds	Subcategories	Severity of Impairment
Fond du Lac Creek Watershed	All monitored waterbodies impaired for Aquatic Life and Wildlife Designated Uses for mercury in the water column	High
Simian Creek Watershed	All monitored waterbodies impaired for Aquatic Life and Wildlife Designated Uses for mercury in the water column	High
Primary Fisheries Lakes Pat Martin Lake, Simian Lake, West Twin Lake	Also impaired for the Aquatic Life Subsistence Fishing/Netting Designated Use for mercury in fish tissue	High
Manoomin Lake Cedar Lake	Manoomin loss	High
Otter Creek Watershed	All monitored waterbodies impaired for Aquatic Life and Wildlife Designated Uses for mercury in the water column	High
Little Otter Creek Watershed	All monitored waterbodies impaired for Aquatic Life and Wildlife Designated Uses for mercury in the water column	Unknown
Stoney Brook Watershed	All monitored waterbodies impaired for Aquatic Life and Wildlife Designated Uses for mercury in the water column	High
Primary Fisheries Lake Sofie Lake, Lost Lake	Also impaired for the Aquatic Life Subsistence Fishing/Netting Designated Use for mercury in fish tissue	High
Manoomin Lakes Bang (Long) Lake, Jaskari Lake, Perch Lake (South Basin), Rice Portage Lake, Deadfish Lake, Miller (Mud) Lake	Manoomin loss	High

Martin Branch Watershed	All monitored waterbodies impaired for Aquatic Life and Wildlife Designated Uses for mercury in the water column	High
Primary Fisheries Lake Joe Martin Lake	Also impaired for the Aquatic Life Subsistence Fishing/Netting Designated Use for mercury in fish tissue	High
St. Louis River Watershed	All monitored waterbodies impaired for Aquatic Life and Wildlife Designated Uses for mercury in the water column	High
Moosehorn River Watershed	All monitored waterbodies impaired for Aquatic Life and Wildlife Designated Uses for mercury in the water column	High
Manoomin Lakes Wild Rice Lake	Manoomin loss	High

Table 16. Invasive Species

Non-Point Source Pollution Category		
Invasive Species		
Potential Pollutants/Stressors		
Sediment, habitat alteration, thermal stress		
Affected Watersheds	Subcategories	Severity of Impairment
Fond du Lac Creek Watershed	Emerald ash borer, purple loosestrife, buckthorn	Moderate
Simian Creek Watershed	Emerald ash borer, purple loosestrife, spotted knapweed	Moderate
Primary Fisheries Lake		
West Twin Lake	Chinese mystery snail	High
West Twin Lake, Simian Lake, Pat Martin Lake	Informal boat launches create risk for invasive species introduction	Unknown
Manoomin Lake		
Cedar Lake	Future risk of manoomin loss due to higher water table caused by loss of black ash stands from emerald ash borer	Unknown*
Otter Creek Watershed	Emerald ash borer, purple loosestrife, buckthorn, spotted knapweed	Moderate
Little Otter Creek Watershed	Emerald ash borer, purple loosestrife	Moderate
Stoney Brook Watershed	Emerald ash borer, purple loosestrife, wild parsnip, buckthorn	Moderate
Primary Fisheries Lake		
Big Lake	Public boat launch puts this site at higher risk for invasive species introduction	Unknown
Sofie Lake	Informal boat launch creates risk for invasive species introduction	Unknown
Manoomin Lakes		
Bang (Long) Lake, Jaskari Lake, Perch Lake (South Basin), Rice Portage Lake, Deadfish Lake, Miller (Mud) Lake	Future risk of manoomin loss due to higher water table caused by loss of black ash stands from emerald ash borer. Informal boat launches create risk for invasive species introduction	Unknown*
Martin Branch Watershed	Emerald ash borer, buckthorn	Moderate
Primary Fisheries Lake		
Joe Martin Lake	Informal boat launch creates risk for invasive species introduction	Unknown
St. Louis River Watershed	Emerald ash borer, spiny water flea, buckthorn, purple loosestrife	Moderate

Major River		
St. Louis River Miles 46.5, 53	Public boat launches put these sites at higher risk for invasive species introduction	Unknown
St. Louis River	Posted as infested with spiny water flea	Unknown
Moosehorn River Watershed	Emerald ash borer, spotted knapweed	Moderate
Manoomin Lakes		
Wild Rice Lake	Future risk of manoomin loss due to higher water table caused by loss of black ash stands from emerald ash borer	Unknown*

*Denotes that even though FDL has maps of invasive species in and around FDL lakes, we don't have data showing measured impacts to water quality. Emerald ash borer has not yet been detected on the Reservation, but it has been detected in Duluth, MN.

Table 17. Climate Change

Non-Point Source Pollution Category		
Climate Change		
Potential Pollutants/Stressors		
Nutrients, sediment, thermal stress, habitat alteration		
Affected Watersheds	Subcategories	Severity of Impairment
Fond du Lac Creek Watershed	Thermal stress, extreme weather, sustained high water, drought, mercury methylation	High
Simian Creek Watershed	Thermal stress, extreme weather, sustained high water, drought, mercury methylation	High
Manoomin Lake Cedar Lake	Manoomin loss	High
Otter Creek Watershed	Thermal stress, extreme weather, sustained high water, drought, mercury methylation	High
Little Otter Creek Watershed	Thermal stress, extreme weather, sustained high water, drought, mercury methylation	High
Stoney Brook Watershed	Thermal stress, extreme weather, sustained high water, drought, mercury methylation	High
Manoomin Lakes Bang (Long) Lake, Jaskari Lake, Perch Lake (South Basin), Rice Portage Lake, Deadfish Lake, Miller (Mud) Lake	Manoomin loss	High
Martin Branch Watershed	Thermal stress, extreme weather, sustained high water, drought, mercury methylation	High
St. Louis River Watershed	Thermal stress, extreme weather, sustained high water, drought, mercury methylation	High
Moosehorn River Watershed	Thermal stress, extreme weather, sustained high water, drought, mercury methylation	High
Manoomin Lakes Wild Rice Lake	Manoomin loss	High

Water Quality Assessment Results by Designated Use

ATTAINS

When FDL Waters are reported by EPA Integrated Reporting Category, only two Assessment Units, Perch Lake (North Basin) and Perch Lake (South Basin) are listed under Category 1: "All designated uses are supported, and no use is threatened" (Table 20). Two Assessment Units, Spring Lake and Side Lake, are listed under Category 2: Available data and/or information indicate that some, but not all of the designated uses are supported. Both lakes are remote and visited rarely, so we have insufficient information to make assessment decisions its designated uses. All other Assessment Units are listed under Category 5: Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed (USEPA, 2018). Table 20 and Figure 80 show the number of assessment units in each designated use that are supporting or not supporting that use, as well as the number of waters with insufficient information to make a use determination. The waters that have insufficient information to make a use determination are the waters we monitor only rarely, such as Spring Lake, so we do not have ten years of data to make assessment decisions. For a complete list and description of Fond du Lac's designated uses, refer to Appendix D.

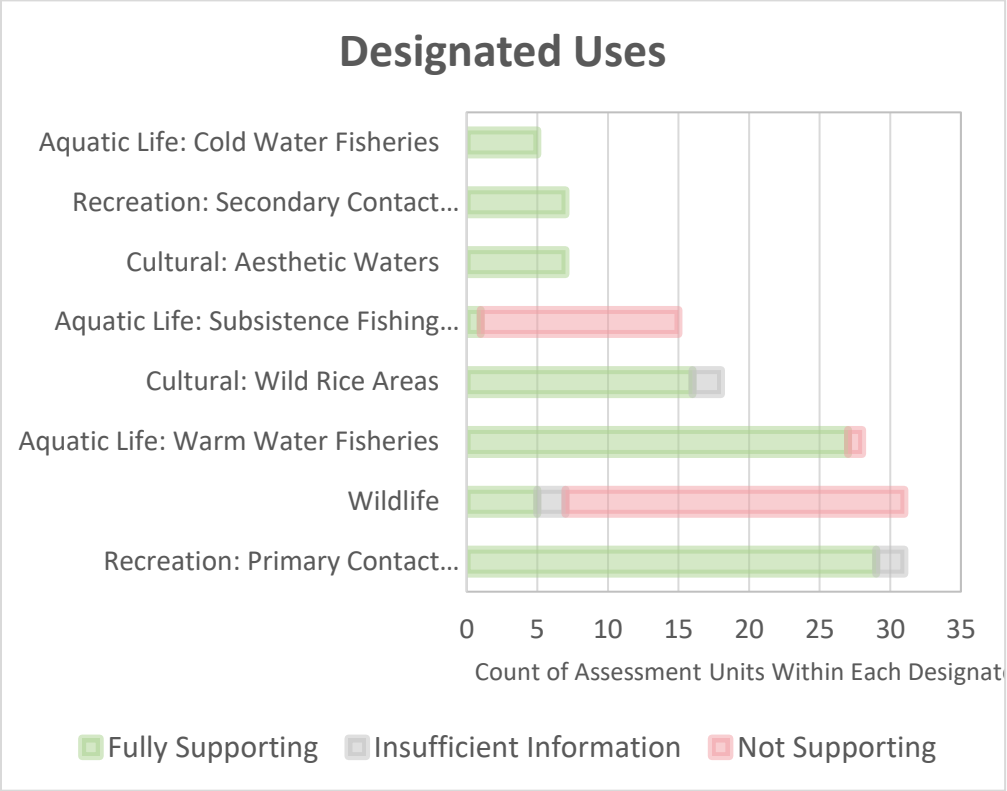
Table 18. 2019 Assessment Results for Fond du Lac Waters.
Classification by EPA Integrated Reporting (IR) Category

EPA IR Category Summary		
IR Category	Description	Assessment Unit Count
1	Fully Supporting	97
2	Not Supporting	39
5	Insufficient Information	6

Note that an Assessment Unit can be fully supporting its water quality standards for one use but can be listed as not supporting its water quality standards for another use.

Figure 80. Integrated Reporting Assessment Categories for Fond du Lac Waters

The Number of Assessment Units that are Fully Supporting or Not Supporting Each Designated Use*. Based on 2019 Assessment Results.



*In some cases, there is not enough information to make an assessment decision on a given designated use.

Second Lake

Second Lake is a shallow, highly stained bog lake bordered by Big Lake Road to the north and the Min No Aya Win clinic to the east. Recent impacts include a clinic expansion (beginning in 2017) and the construction of the Big Lake Road walking trail (2019). Second Lake has a hydrological connection with the wetland north of Big Lake Road. Figure 81 shows the increasing TSS trends for Second Lake. Over a ten-year period (1998-2018), TSS values exceeded the threshold of 15 mg/L three times, which is above the 10% rule for this parameter, and leads to an impairment listing for TSS. Although Second Lake does not have a lake-specific nutrient criterion, it does demonstrate an increasing trend for total phosphorus (Figure 82), which could indicate additional NPS impacts.

Figure 81. Total suspended solids data

First Lake (106, red line), Second Lake (116, yellow line) and Third Lake (122, green line) between 1998 and 2018. Second Lake shows an increasing TSS trend beginning in 2015.

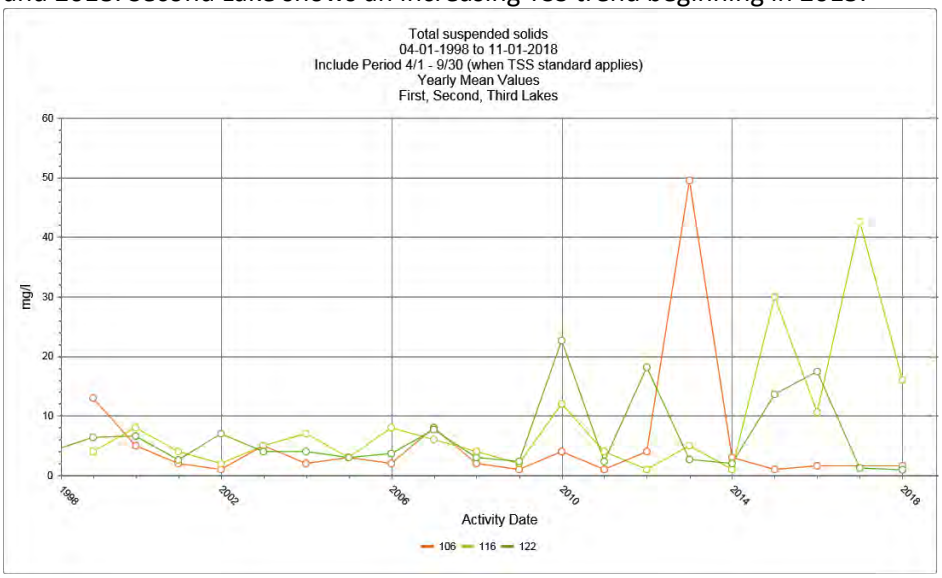
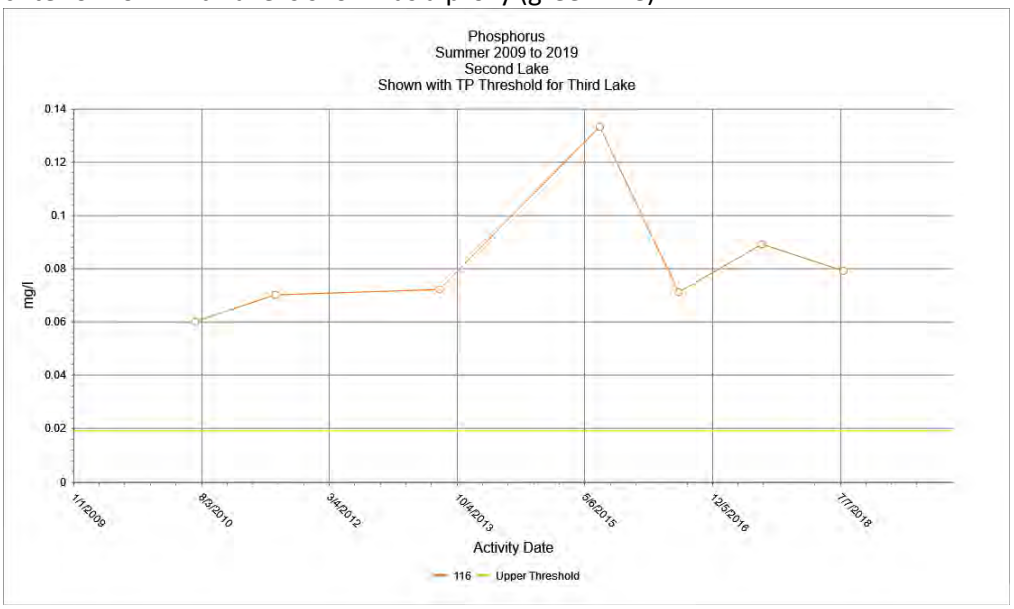


Figure 82. Total phosphorus values for Second Lake, 2010-2018.

TP shows an increasing trend. A lake-specific nutrient criterion is not available for Second Lake; the criterion for Third Lake is shown as a proxy (green line).



Numeric Biocriteria Assessment Results

Tetra Tech Developed BCG scoring systems for both fish and macroinvertebrates on the Reservation. Table 21 shows the range of BCG scores for each monitoring location on the Reservation, using fish and macroinvertebrate data from 1999-2014. Overall, the BCG scores are moderate, meaning some impact to the streams has occurred, which shifts the presence of fish and biological communities from sensitive taxa to more tolerant taxa. The impacts to these streams are primarily due to NPS stressors, including stormwater runoff and improperly sized culverts and bridges.

Table 19. BCG Models for the Fond du Lac Reservation

Using fish and macroinvertebrate data between 1999 and 2014

Waterbody name	StationID	BCG Model	Fish BCG	Macroinvertebrate BCG
Stoney Brook	207B	Cool water	3-4/5 tie	3-5
Simian Creek	205	Cool water	2-4	3-4
Fond du Lac Creek	202B	Cold water	2-3	1-3
Otter Creek	204	Cold water	3-6	2-3
Martin Branch (Stevens Road)	203B	Cold water	3	2-3
Martin Branch (Marshall Road)	203A	Cold water	4-6	3-5

Brook Trout

In addition to numeric biocriteria, FDL OWP specifically tracks brook trout populations, since they are a coldwater species that is vulnerable to warming waters due to climate change, and they are a culturally-significant species. Fish surveys completed via backpack electroshocking for FDL streams show that brook trout populations can fluctuate wildly on Reservation streams (Figure 83). Some of this may be due to timing of sampling relative to rain events. Brook trout populations crashed after the June 2012 flood at the Martin Branch (Stevens Road) site, where a sinking bridge is causing in-stream habitat degradation. The bridge is becoming a barrier to water flow, causing the stream to become braided and warmer over time, creating the likelihood that this site could become inhospitable to trout. Interestingly, replacing the washed-out culvert on Fond du Lac Creek with a bridge allowed fish passage from the St. Louis River for the first time in many decades, and FDL OWP is tracking a change in the fishery, where walleye are now coexisting with brook trout in the stream (Figure 84).

Figure 83. Number of brook trout sampled in FDL streams (July electroshocking), 1999-2018

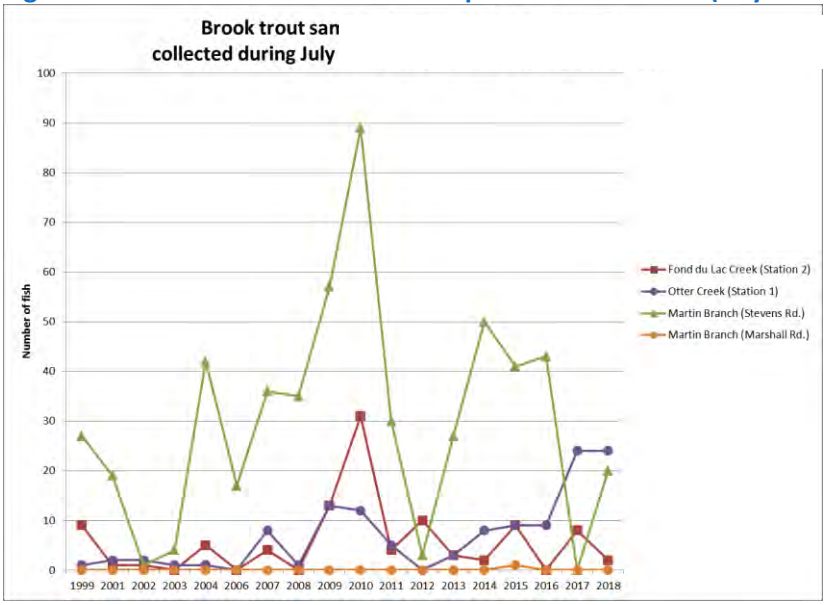
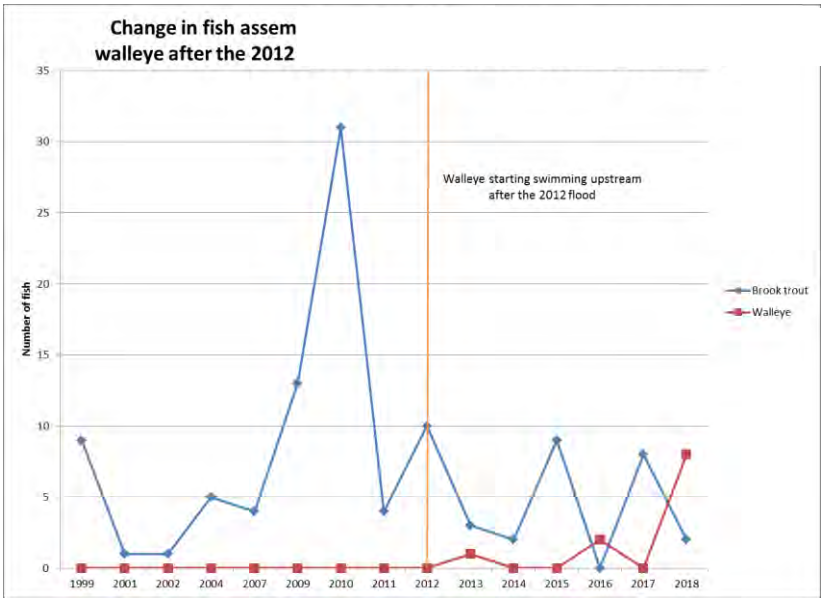


Figure 84. Change in fish assemblages at Fond du Lac Creek after the 2012 flood restored connectivity to the St. Louis River.



Nutrient Water Quality Assessment Results

Using FDL's new lake-specific nutrient criteria, along with FDL's Secchi depth index, assessment results show that all FDL lakes are meeting their primary productivity standards (preventing eutrophication). Figures 85-88 show the 2019 assessment cycle results for FDL lakes. These results are in keeping with our conclusion that FDL lakes are minimally impacted by human activities. To maintain good water quality in FDL lakes, FDL OWP remains committed to monitoring, assessing and protecting water quality in light of increasing development and impacts from climate change.

Figure 85. Average Summer Total Nitrogen (2009 to 2019) Compared to Total Nitrogen Thresholds for Each Lake on the Fond du Lac Reservation

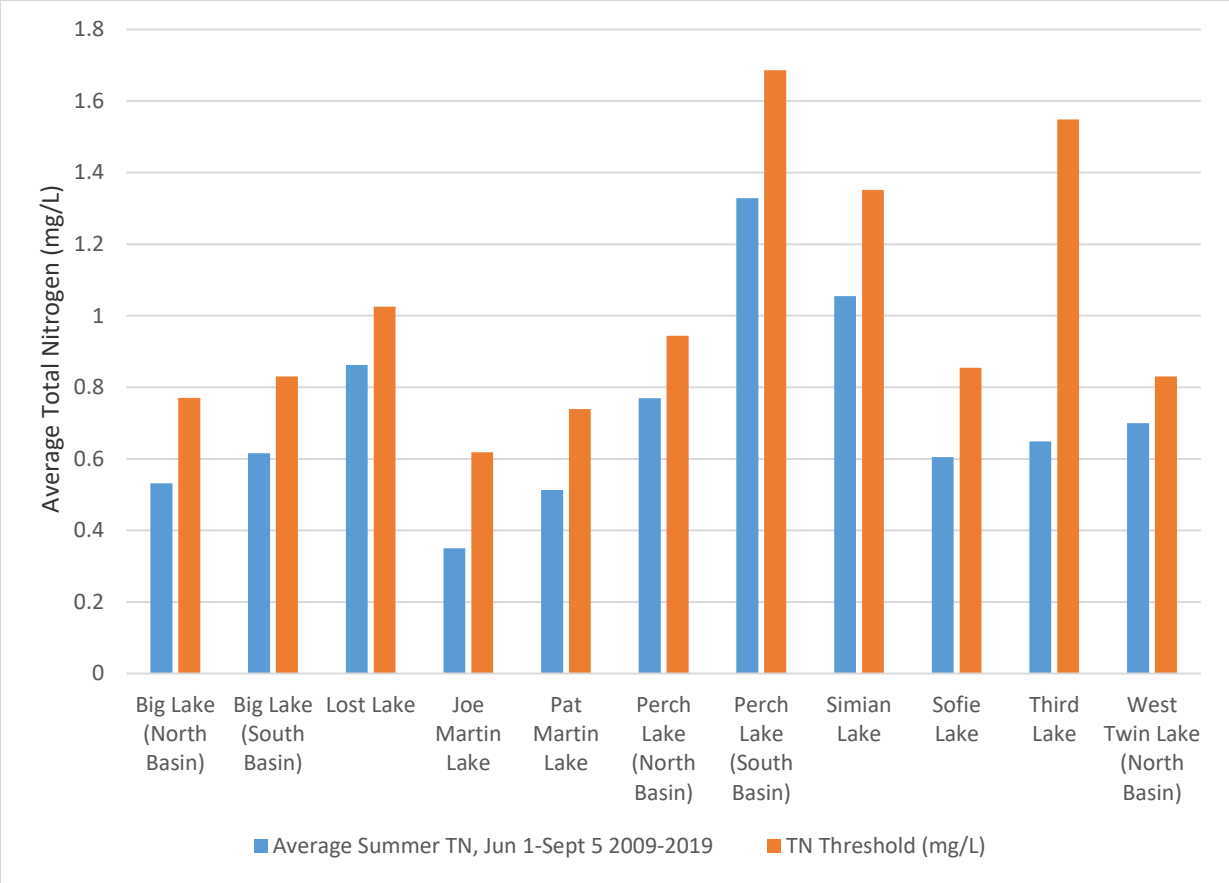


Figure 86. Average Summer Total Phosphorus Compared to Total Phosphorus Thresholds for Fond du Lac Lakes

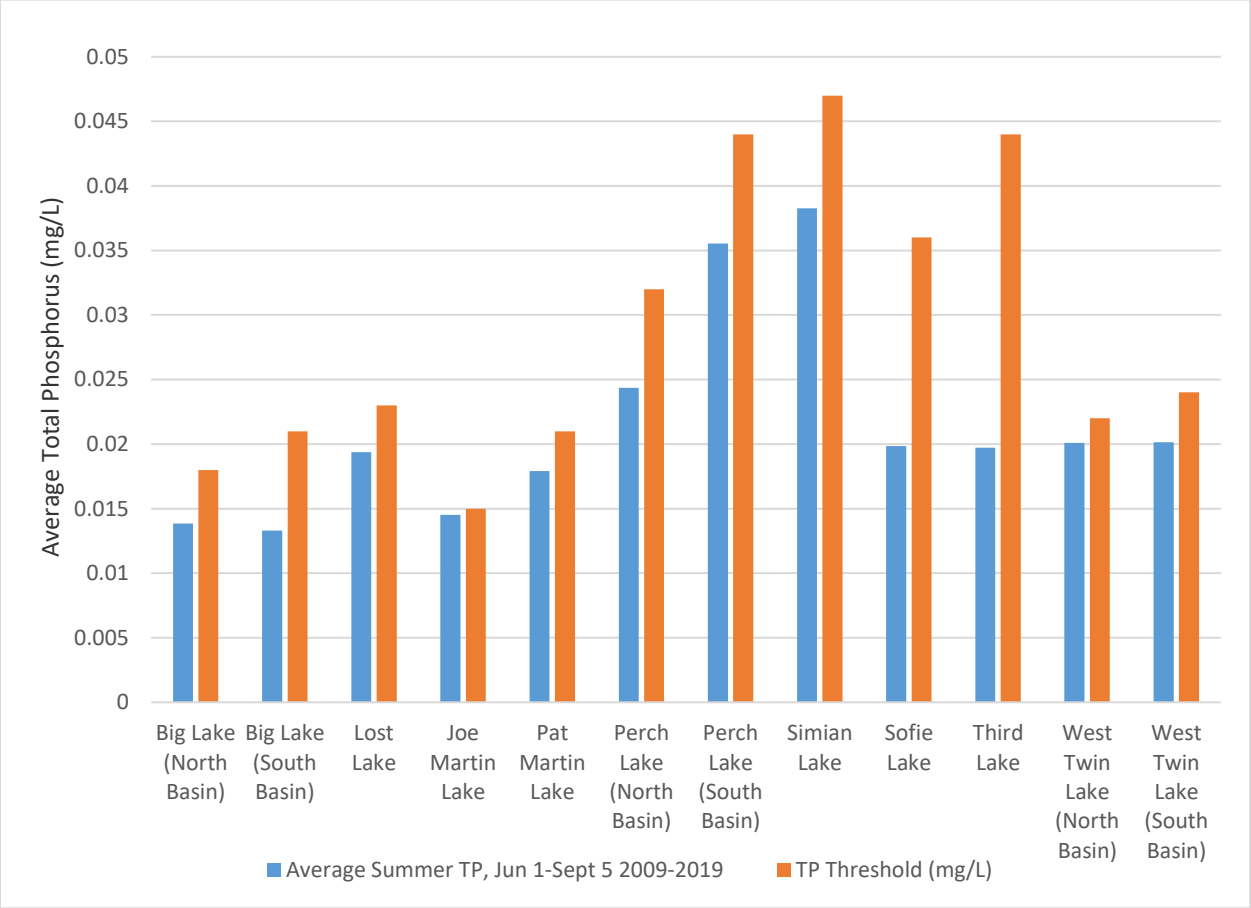


Figure 87. Average Summer Chlorophyll α Concentrations Compared to Chlorophyll α Thresholds for Fond du Lac Lakes

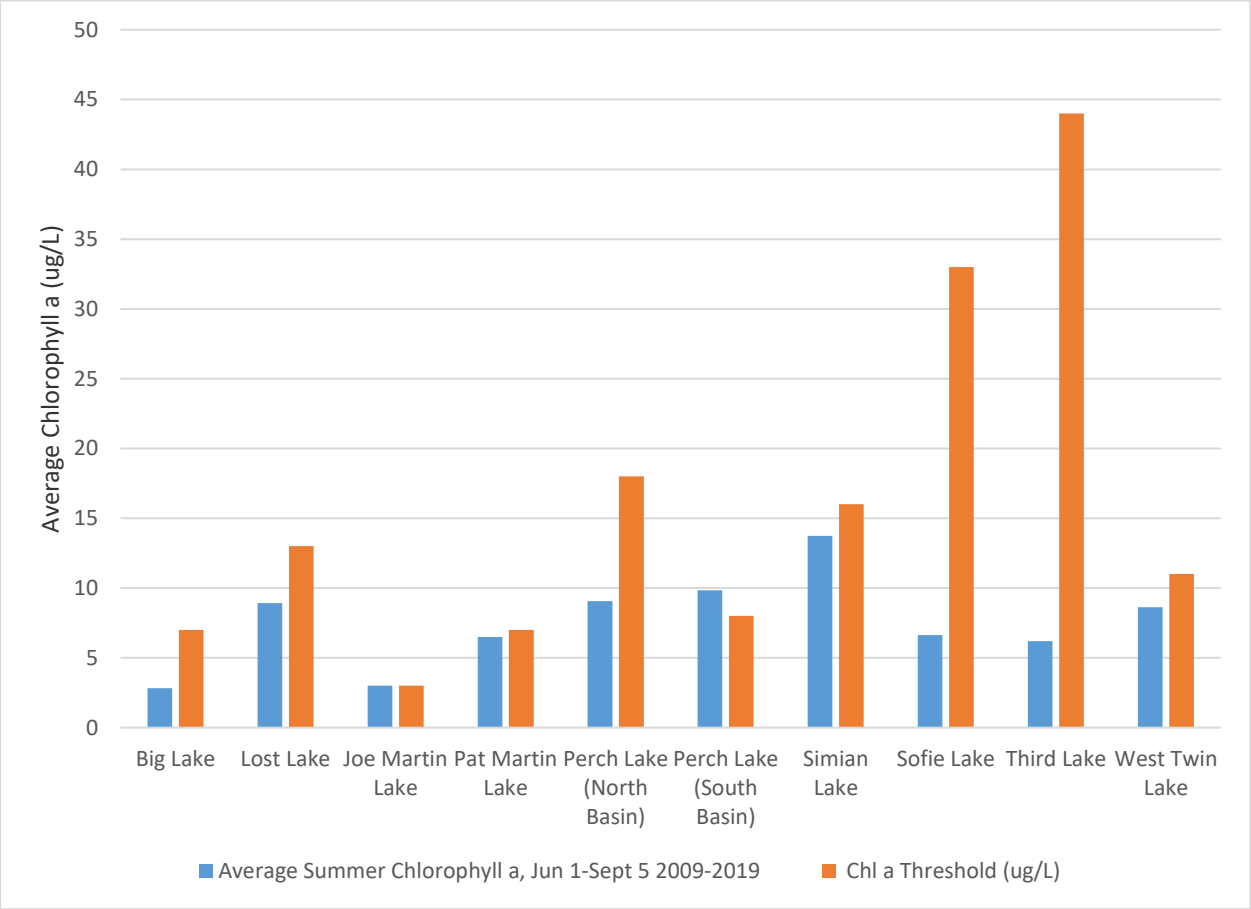
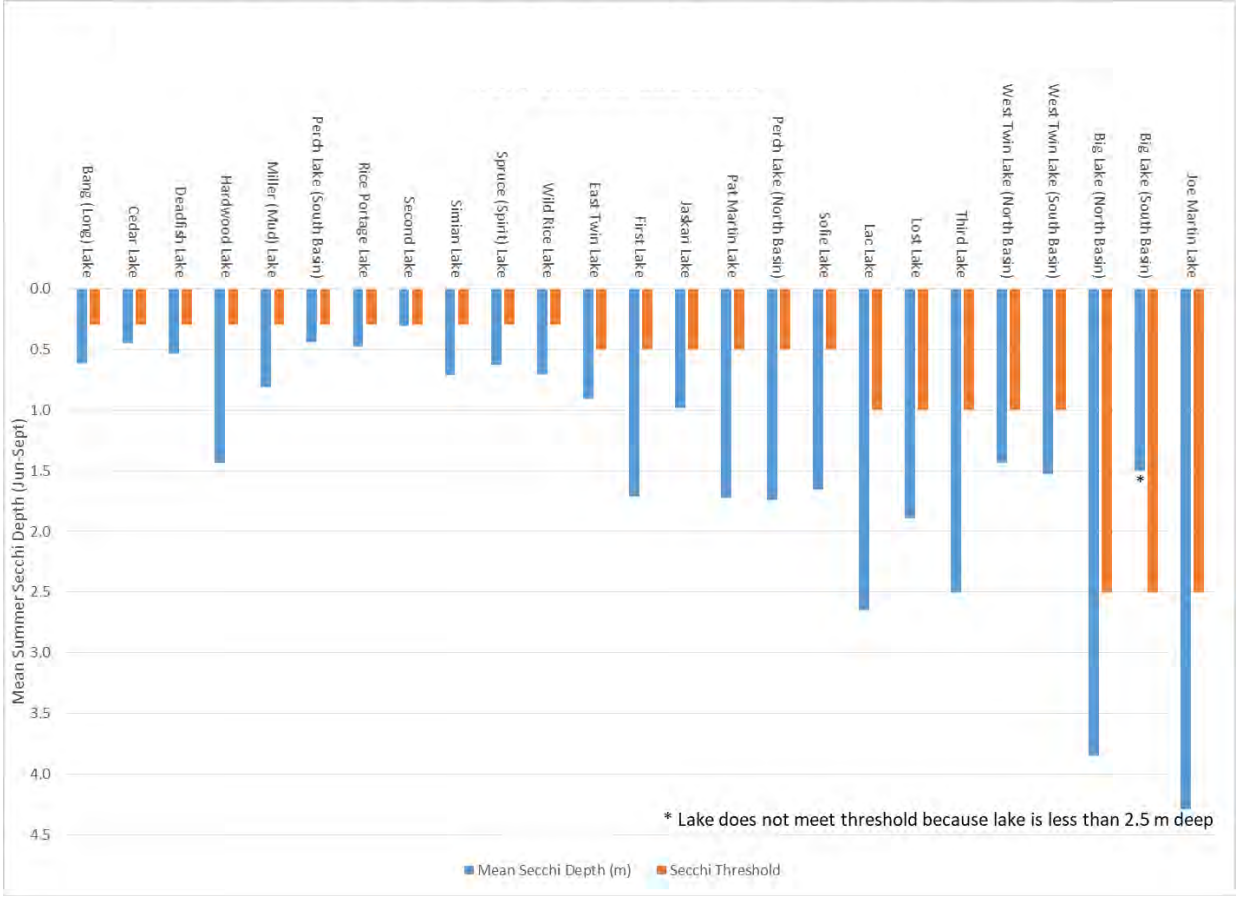


Figure 88. Mean Summer Secchi Depth Compared to Secchi Thresholds for Fond du Lac Lakes



Third Lake

In 2011, Fond du Lac OWP received a two-year competitive CWA §319 grant to reduce the external and internal nutrient loads in Third Lake. Fond du Lac's 2004 NPS Report listed Third Lake as impaired for primary contact recreation and aquatic life due to excessive nutrient loads. Efforts to reduce nutrient loading included working with a shoreland horse farm owner to reduce manure runoff, and internal phosphorus loading was reduced with an alum treatment. The project also included targeted monitoring to track improvements due to nutrient load reduction, including collecting water quality samples in the hypolimnion to track changes in internal phosphorus loading. Since the alum was applied in late 2012, post-treatment monitoring data shows marked decrease in nutrient levels and water quality improvements (Figure 89). One of the water-quality based goals of this project was to achieve a 90% reduction of phosphorus in the water column due to external and internal load reductions. The alum treatment alone can account for an 87% decrease in TP levels at the bottom of the lake. This provides evidence that the alum treatment successfully bound phosphorus in the upper sediment layer at the bottom of Third Lake (Jacobson Hedin, 2013). The horse farm owners have removed manure stockpiles on the shore, and have reduced the number of horses they keep, which has effectively reduced the external loads to this lake.

Figure 89. Comparison of Hypolimnetic Phosphorus in Third Lake Before and After Alum Treatment

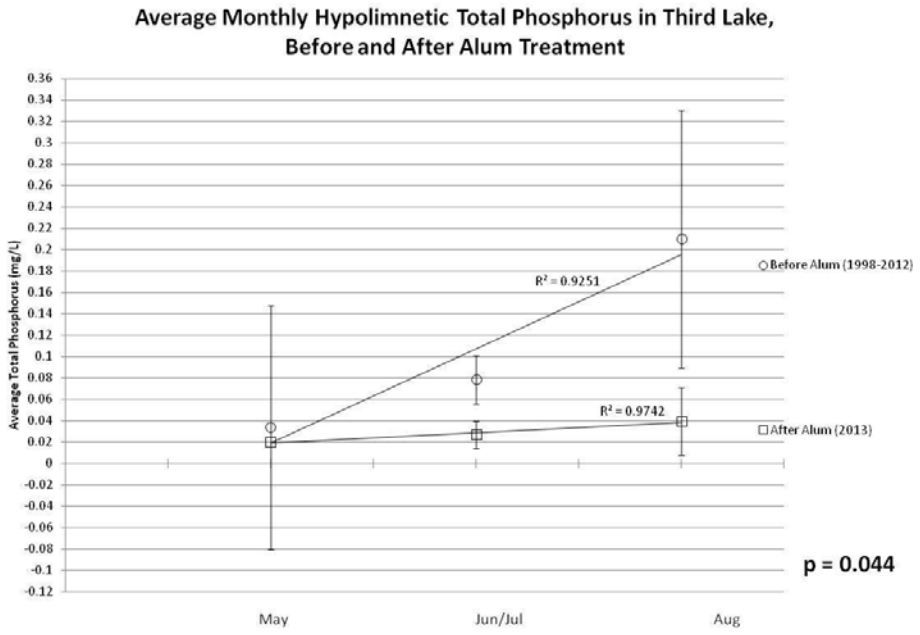
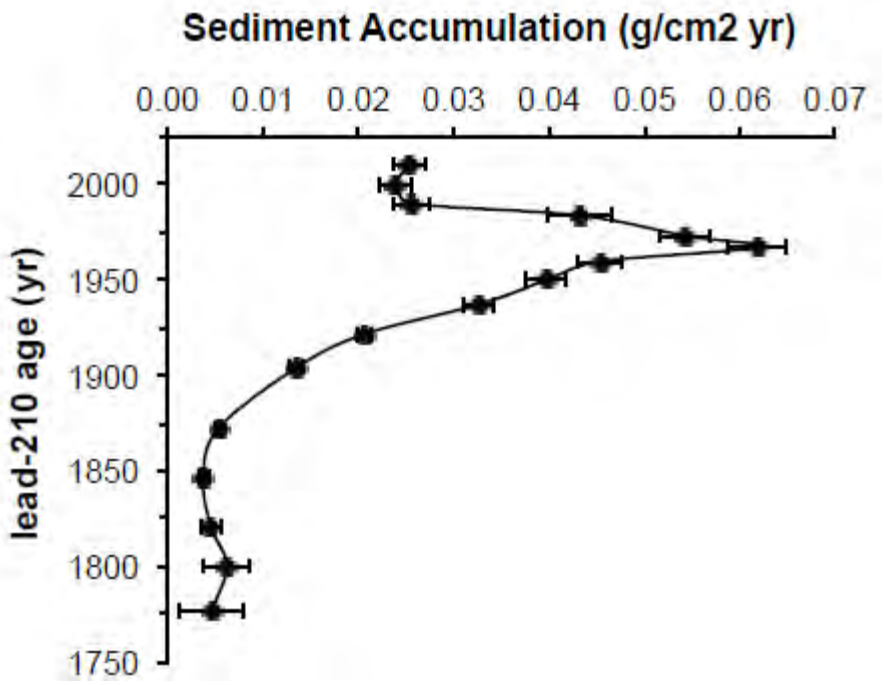


Figure 90. Sedimentation rates from a sediment core taken in Third Lake.

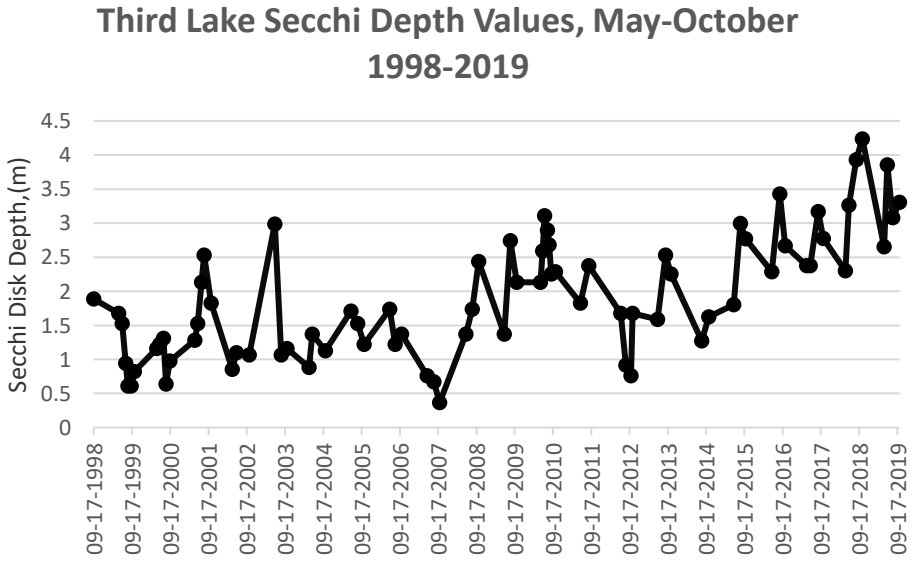
Lead-210 dating was used to age the core. After an initial spike in sedimentation rates during a time of land clearing for farming, rates have declined in recent times (Ramstack Hobbs, 2013)



A sediment core analysis from this lake (Ramstack Hobbs, 2013) shows that sedimentation rates increased dramatically in the near past, but these rates have declined in recent years (Figure 90). Sedimentation rates can be used as a proxy for nutrient loading, since nitrogen and phosphorus can bind to sediment particles and be delivered to a receiving water body during runoff-producing events. In addition, phenological observations taken during water quality sampling events show a significant increase in the extent of submerged aquatic vegetation (SAV) in the littoral zone of Third Lake that has been sustained from the year of the alum treatment into the present, indicating a shift from an algae-dominated community to an aquatic plant-dominated community. The reduction in nutrient loading led to a decrease in algal biomass in this lake, which in turn significantly increased water clarity and allowed submerged aquatic vegetation to thrive. The Secchi depth readings from this lake bear this out, as Figure 91 shows an increasing trend in Secchi depth starting the season after the fall 2012 alum treatment (though this increasing trend may also be due to the wet cycle that began in 2010). Appendix C Vertical Profile data also show that vertical profiles for specific conductance and dissolved oxygen have changed after the alum treatment in 2012. Recent water quality assessments show that this lake is no longer listed as impaired for nutrients under the Aquatic Life and Primary Contact Recreation designated uses (Figures 85-88). Based on the Soranno (2011) and St. Amand (2015) based nutrient criteria framework, we list Third Lake as a minimally impacted lake that is not significantly impacted by NPS pollution.

Photo of the littoral zone in Third Lake with extensive SAV that grew after the 2012 alum

Figure 91. Third Lake Secchi Depths, 1998 to 2019



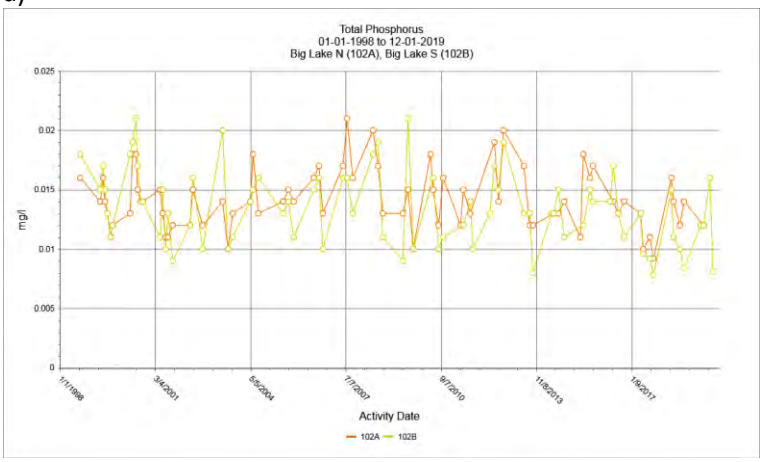
Big Lake

Within the Urban NPS category, Big Lake is listed as having severe impacts due to shoreline development and failing septic systems. Figure 41 shows a concerning increase in chloride concentrations. Despite these stressors, Big Lake water quality is otherwise good. Figure 92 shows that there are no upward trends in total phosphorus and chlorophyll α and no downward trend in Secchi depth, which all indicate the lake has not yet been significantly impacted by anthropogenic nutrient enrichment. There are two possible stable states for Big Lake: 1) its current stage as a clearwater lake with primary productivity in the form of submerged aquatic vegetation, and 2) a possible future state in which primary productivity flips to an algae-dominated system, including HABs. In this state, Big Lake would be less likely to support recreation, swimming, fishing and would likely lead to lower shoreline property values.

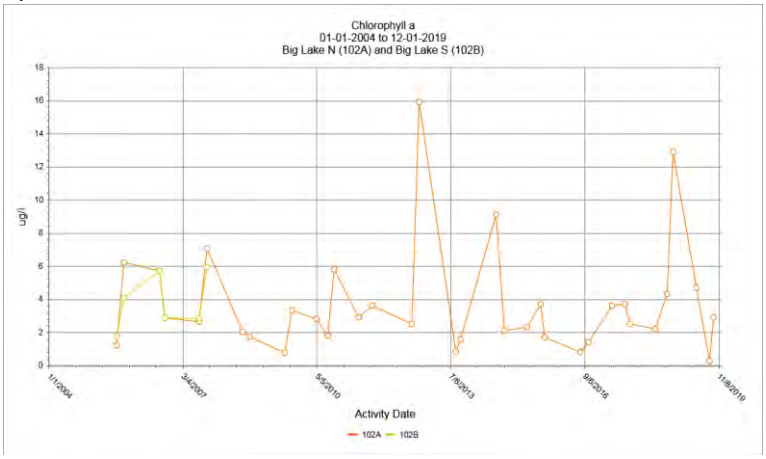
Figure 92. Eutrophication-related water quality data for Big Lake (1998-2019).

a) Total phosphorus, b) Chlorophyll α, c) Secchi depth.

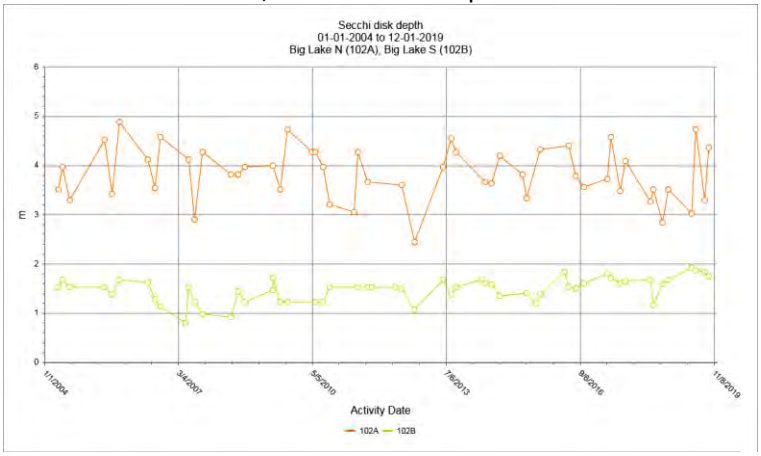
a)



b)



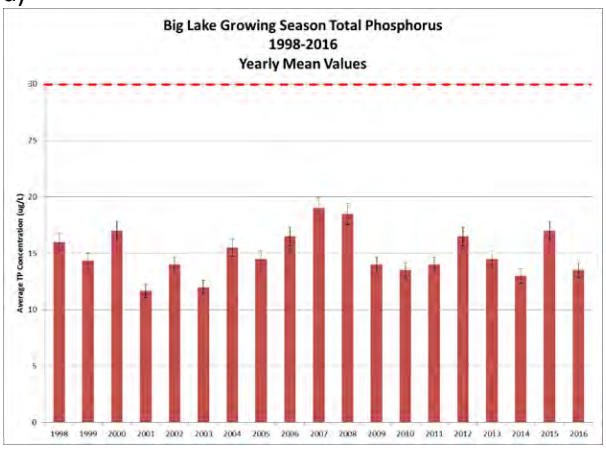
c) Note that Secchi depth is lower in the south basin of Big Lake (102B) because the maximum depth of the basin is below 2m, so the Secchi depth is often visible on the lake bottom.



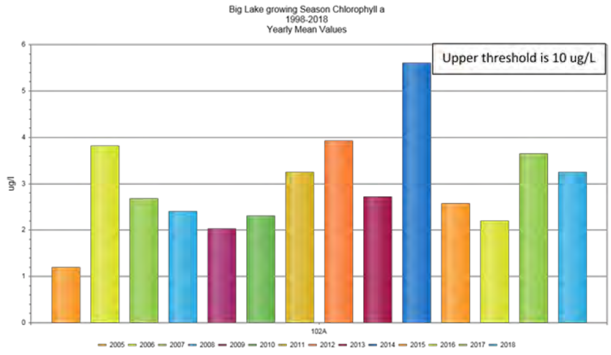
Another way to represent Big Lake data is to show that it is meeting its lake-specific nutrient criteria. Figure 93 shows Big Lake growing season averages from the 2016 water quality assessment.

Figure 93. Big Lake assessment for a) mean total phosphorus, b) mean chlorophyll α, c) mean Secchi depth.

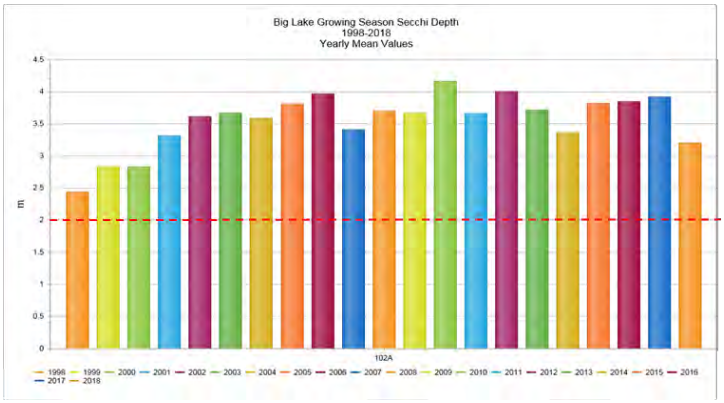
a)



b)



c) Depicts Secchi depth readings from the north basin



Mercury Assessment Results

To have a complete picture of the impacts of mercury pollution on the Reservation, FDL OWP, in partnership with the FDL Air Program, embarked on a multi-media investigation of mercury on the Reservation. Since the major source for mercury is atmospheric deposition, we included our results of a mercury mass balance study. We then included data on mercury in the water column of lakes, and in lake sediments. We then translate that data to mercury in fish tissue, where it has the potential to impact hum and wildlife health. The results of this multi-media investigation show the extent of mercury pollution on the Reservation; it remains our biggest threat to water quality.

Mercury in Atmospheric Deposition

The Fond du Lac Air Program has been collecting wet mercury deposition data on Fond du Lac since 1998, and they collected methylmercury deposition in 2003. The cumulative deposition rate at FDL's air monitoring site for total mercury was 36 ug/m^2 for six years, and 190 ng/m^2 of methylmercury (MeHg) over three years. They then calculated a mean annual deposition rate for total mercury (6 ug/m^2) and methylmercury (63.3 ng/m^2), and determined the mass of mercury and methylmercury deposited in each watershed annually. In addition to the wet deposition site, in 2012 the FDL Air Program began collecting dry deposition mercury data on three sites on the Reservation where they placed six to seven bins that caught leaf litter from deciduous and coniferous trees. The leaves were ground and processed for mercury concentrations. The dry deposition study was conducted because of a gap in data in the mass balance of mercury for Fond du Lac and there was an assumption it was bound up in leaf litter. Studies of mercury in litterfall indicate that the dry deposition of mercury to forest landscapes can be similar in magnitude or somewhat greater than mercury in wet deposition, ranging from 25 to 69 percent of total deposition (Risch et al. 2011b). Figure 94 shows the downward trend in mercury (Hg) from the wet deposition site; however, Figures 95 and 96 show that even though the trend in the rate of mercury deposition is declining, mercury still accumulates. Once mercury is in the system, it cycles between different forms. Wetlands can store mercury but also provide the right environmental conditions to cause mercury methylation. This methylated mercury then can be released to lakes and accumulate up the food chain. The dry deposition data was similar to the wet deposition data shared below.

Figure 94. Time trend of annual volume weighted average mercury concentrations for monitoring site on the Fond du Lac Reservation

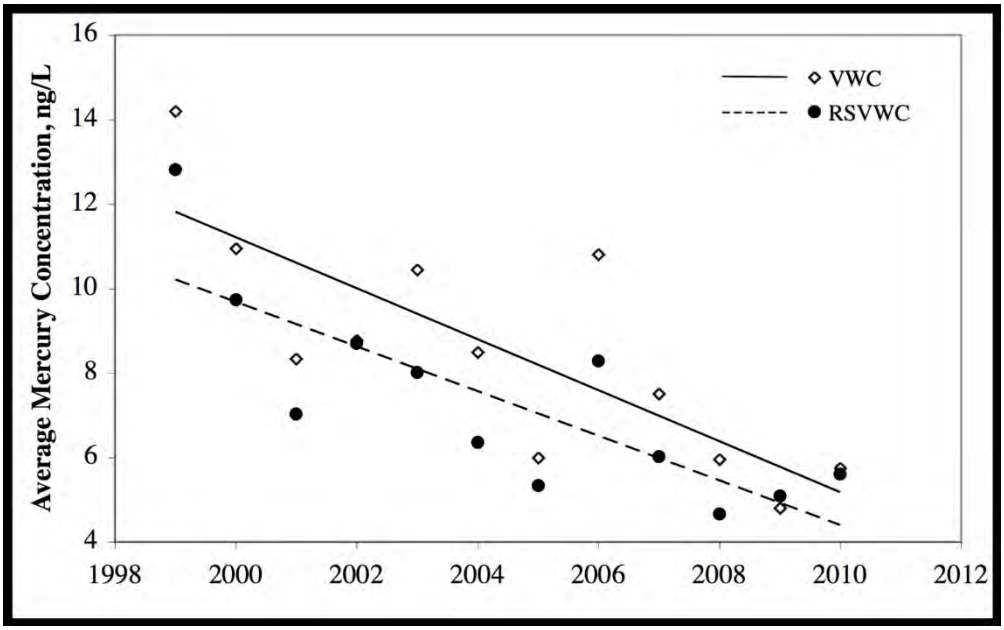


Figure 95. Weekly and Cumulative Mercury Deposition. Fond du Lac Reservation, 1998-2003.

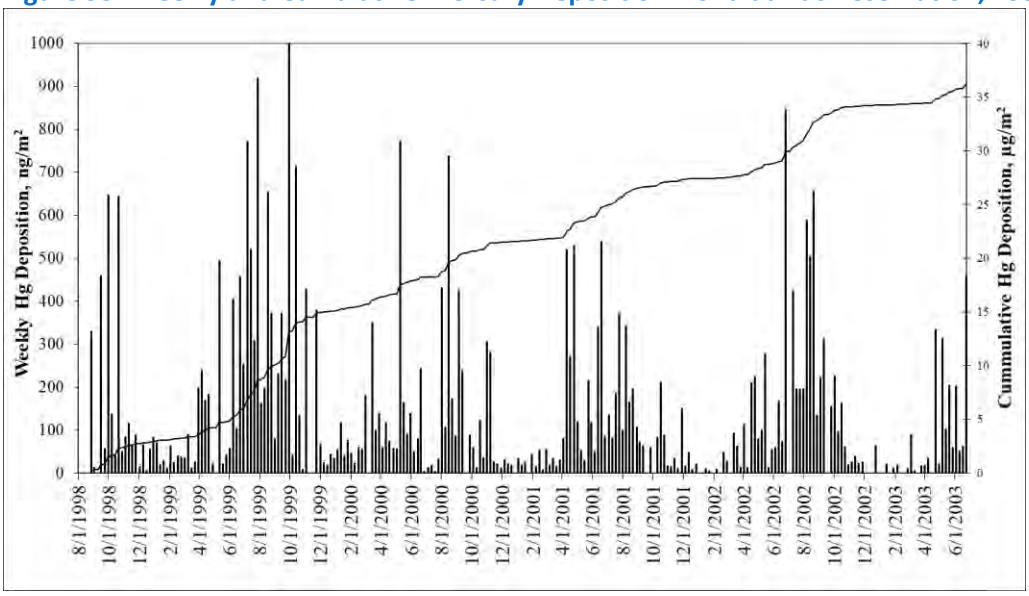
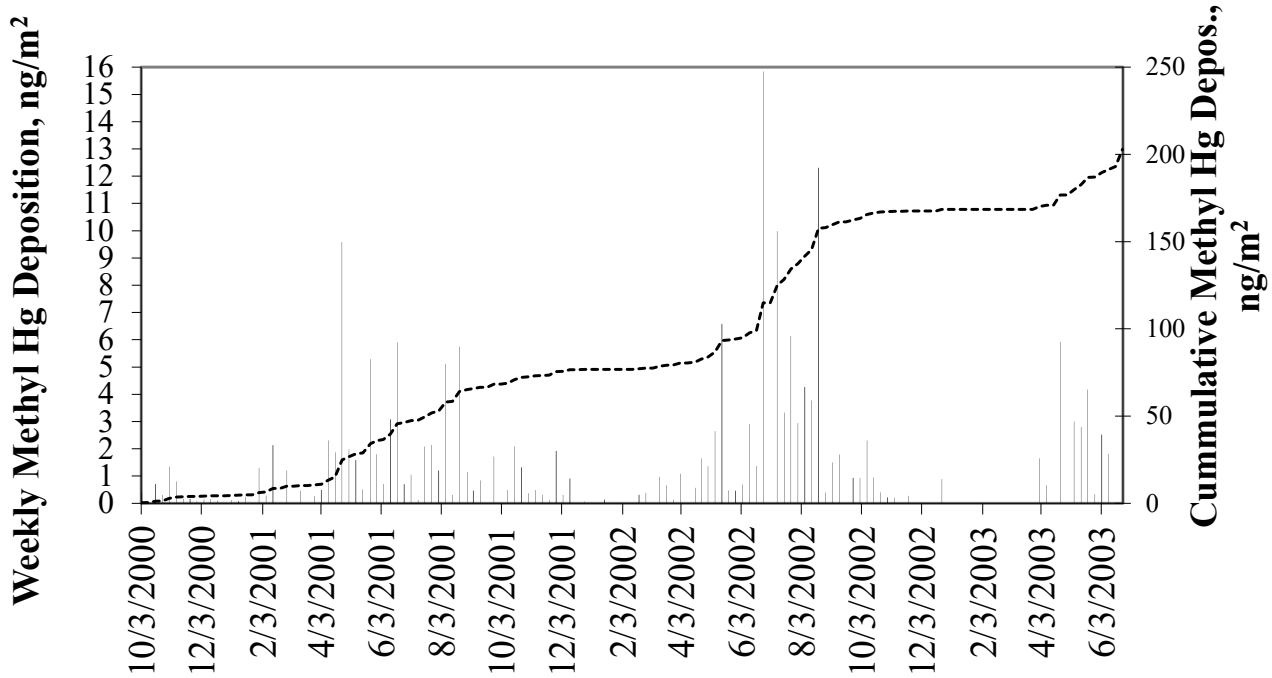


Figure 96. Weekly and Cumulative Methylmercury Deposition. Fond du Lac Reservation, 1998-2003.



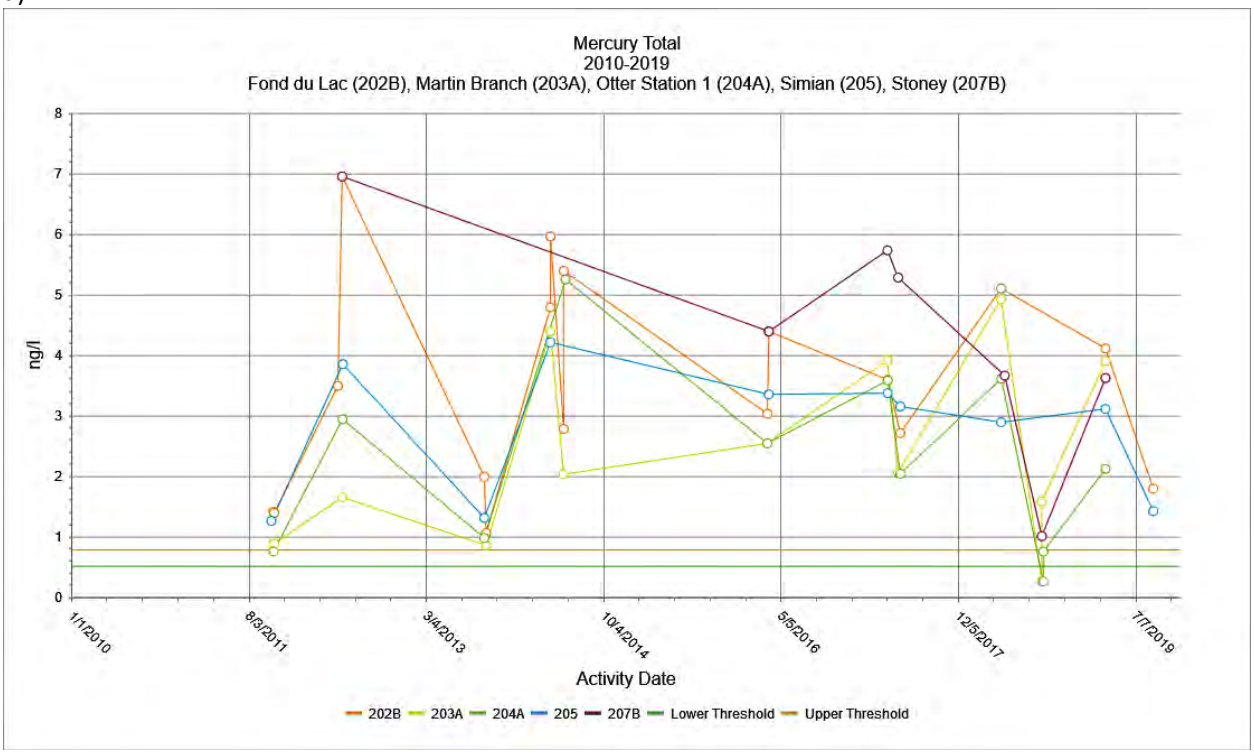
Mercury in Water

Figure 97 shows total mercury in streams and lakes. In both cases, mercury levels are well above the water quality criterion for mercury in water (0.077 ng/L) for Aquatic Life: Subsistence Fishing/Netting designated use. The Fond du Lac standard is more stringent than the state of Minnesota or the federal standard because it assumes that Fond du Lac Band members consume wild-caught fish at a higher/subsistence rate compared to the rest of the state's population. The daily human consumption of fish caught by Fond du Lac Band members is assumed to be 0.060 kg/day. That's double the daily consumption of fish for non-Band members. Fond du Lac waters are listed as impaired for mercury in the water column because mercury concentrations (both total and dissolved) are above this criterion for more than 10% of the data. Even though FDL doesn't yet have ten years of mercury data, the waters are listed as impaired because of the weight of evidence that mercury levels are consistently high.

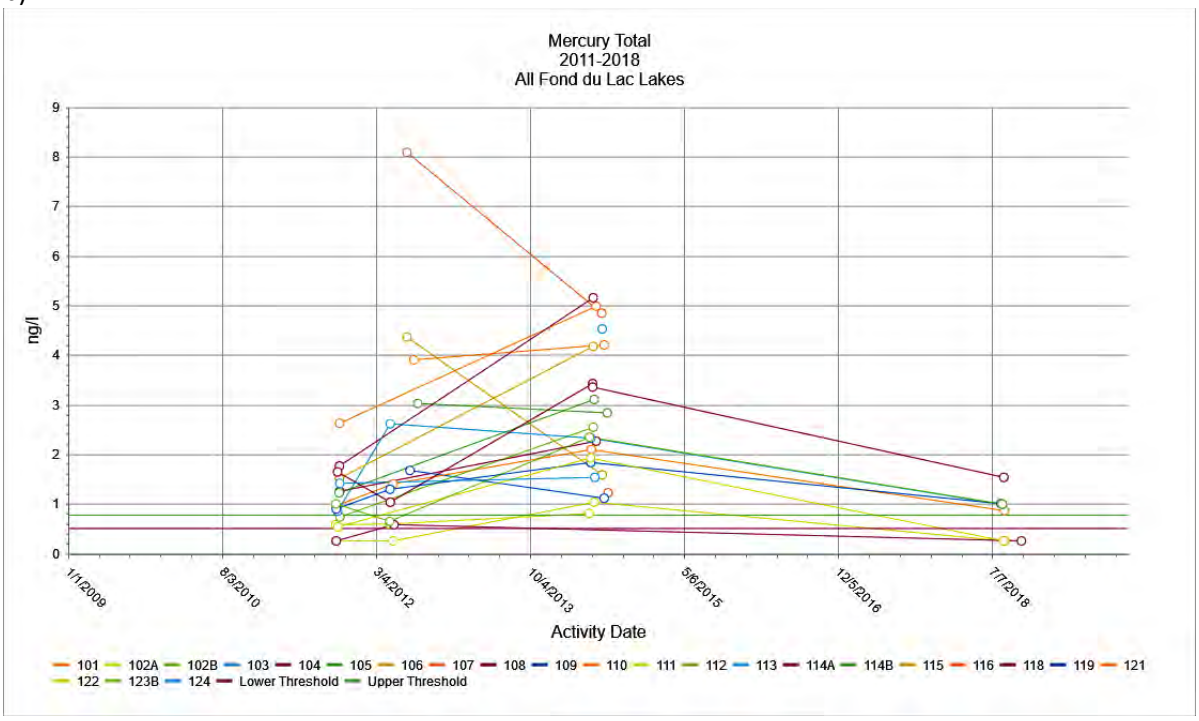
In addition to ongoing mercury monitoring, Fond du Lac partnered with USGS, MPCA, MNDNR and the Natural Resources Research Institute in 2019 for a mercury load monitoring study in the St. Louis River basin, funded by GLRI. The study includes 18 sampling sites for Hg, MeHg, total organic carbon, and streamflow. Of the 18 sites, four are in ditched peatlands, three are in natural peatlands, three are in restored (plugged) peatlands and eight are in river/tributary sites. To inform any upcoming mercury TMDL for the St. Louis River, we need to better understand of the role of ditched peatlands in conveying methylated mercury to the river. The study will also help managers identify high-priority hotspots that could be targeted for restoration via natural channel design methods, in the hopes that such work would reduce the overall mercury load to the river and Lake Superior.

Figure 97. Total mercury in Reservation streams (a) and lakes (b) between 2011 and 2019.
The upper threshold denotes the 0.077 ng/L criterion while the lower threshold denotes the limits of detection (0.05 ng/L).

a)



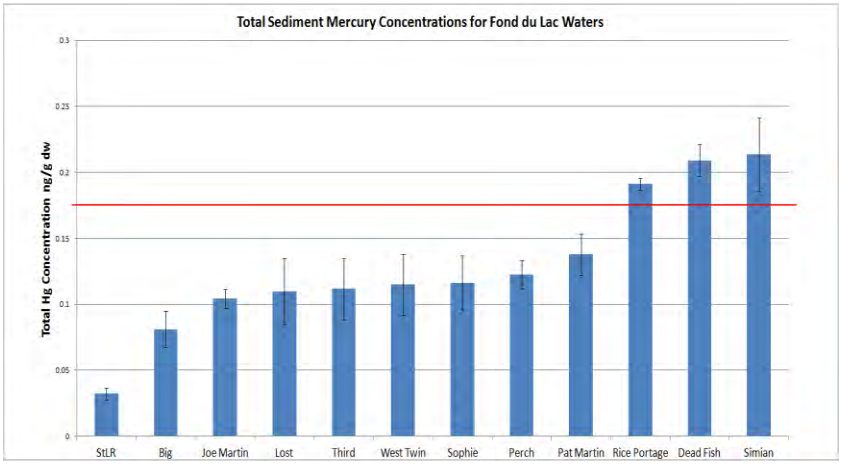
b)



Mercury in Lake Sediments

Using funding from the Great Lakes National Program Office (GNPO), Fond du Lac OWP studied mercury in lake sediments between 2000 and 2002. This study was part of a larger effort that included the mercury deposition data to contribute a weight-of-evidence approach to decision-making about FDL's water resources. GLNPO funded a study of 12 Reservation lakes to characterize sediments and assess contaminant levels in the bioavailable portion for mercury (Hg), PCBs and lead. Overall, 30 of 96 sites had dry weight mercury concentrations exceeding EPA Level I Sediment Quality Triad (SQT) of 0.18ug/g (Figure 98). Shallow manoomin lakes and shallow flowage lakes (which are typically highly stained, and DOC often binds to mercury) had consistently higher mercury levels (Costa, 2003).

Figure 98. Total sediment mercury concentrations for Fond du Lac waters.
The red threshold line denotes EPA's Level I SQT of 0.18ug/g



From the Phase II Sediment Quality Assessment Report (Costa, 2003):
We saw a significant positive correlation between total Hg sediment concentration (lakewide means) and total watershed size (Figure 99). We also noted a significant negative relationship between total Hg in sediments (lakewide means) and the ratio of water to total watershed area. In other words, for watersheds where the open water area comprises a large proportion of the total watershed area, we saw lower total Hg in the sediments than in watersheds with large terrestrial areas relative to open water. Finally, we observed a strong positive correlation between total Hg and the ratio of wetland to water area (Figure 100); those watersheds with proportionately greater wetland acreage had higher concentrations of total Hg in sediments.

The lake sediment study backs up our hypothesis that wetlands serve as both mercury sinks and sources for mercury methylation, so watersheds with relatively abundant wetlands had water bodies with higher mercury concentrations in their lake sediments.

Figure 99. Correlations between total watershed size and total Hg concentrations in Fond du Lac lakes.

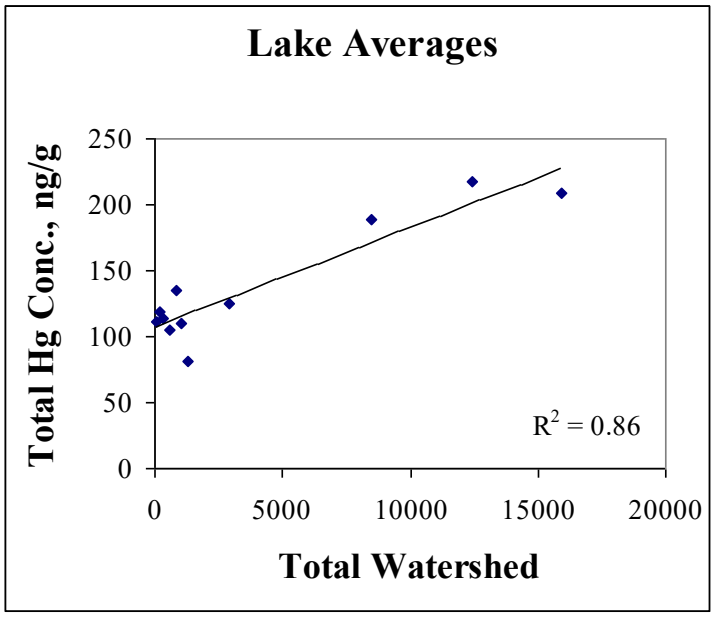
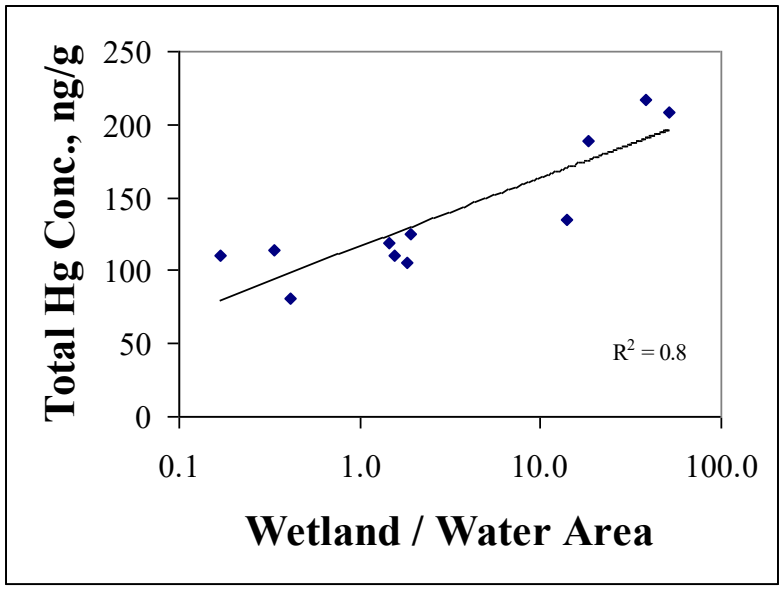


Figure 100. Correlation between the ratio of wetland to water area and total Hg concentrations in Fond du Lac lakes.



Mercury in Fish Tissue and Traditional Foods

The results of the fish tissue sampling efforts in 2000, 2008 and 2015 show that larger fish that are also predator species (northern pike and walleye) tend to have mercury levels above the EPA health criterion for fish consumption (Figures 101 and 102). The new EPA criterion is 0.3 mg/kg (ppm) methylmercury in fish muscle tissue. This EPA criterion is based on the EPA-derived reference dose of 0.1 µg/kg/day (USEPA, 2012). Since all FDL-assessed lakes had at least one fish with tissue mercury levels above the EPA consumption criteria, these lakes are listed as not meeting the Aquatic Life: Subsistence Fishing (Netting) designated use.

The fish tissue analyses showed that mercury was the only contaminant of concern (of those we measured) for fish from Fond du Lac waters, and we have developed and updated Reservation-specific consumption guidelines that describe how much, what size, and what species of fish band members can safely consume. These guidelines were intended to encourage Band members to eat fish frequently, as they are a healthy source of protein and other nutrients. The advice directs people towards smaller fish (walleye, northern pike and catfish) and those species of fish (sunfish, crappies) that tend to have lower levels of mercury in them. We plan to resample fish from Reservation waters in the future as funding allows, in order to track any trends in fish mercury levels. These culturally sensitive guidelines encourage Band members to freely eat the identified sizes and species of fish that have lower mercury concentrations.

The results of the traditional/wild foods analysis (manoomin, waterfowl and moose) showed that waterfowl and fish tissue have comparable mercury levels, so consideration of dietary mercury health risks should also consider other wild-caught foods.

Figure 101.Average Mercury in Fish Tissue from Fond du Lac Lakes, 2000 and 2008

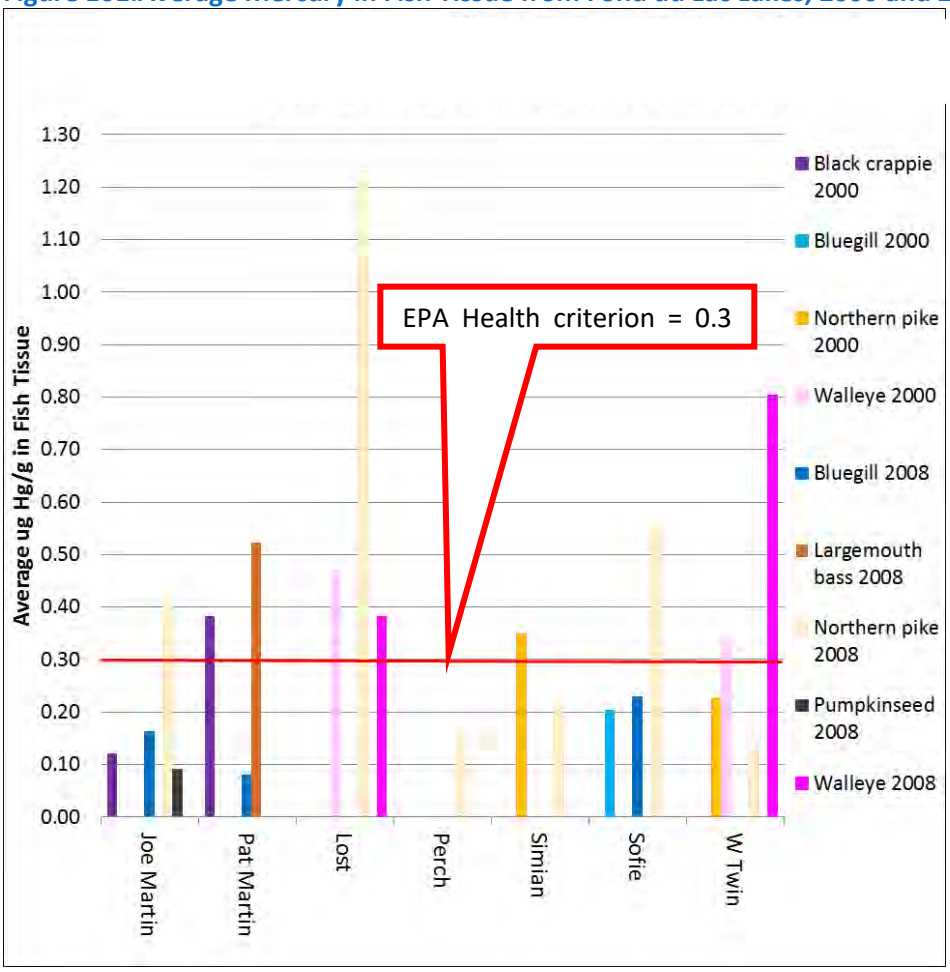
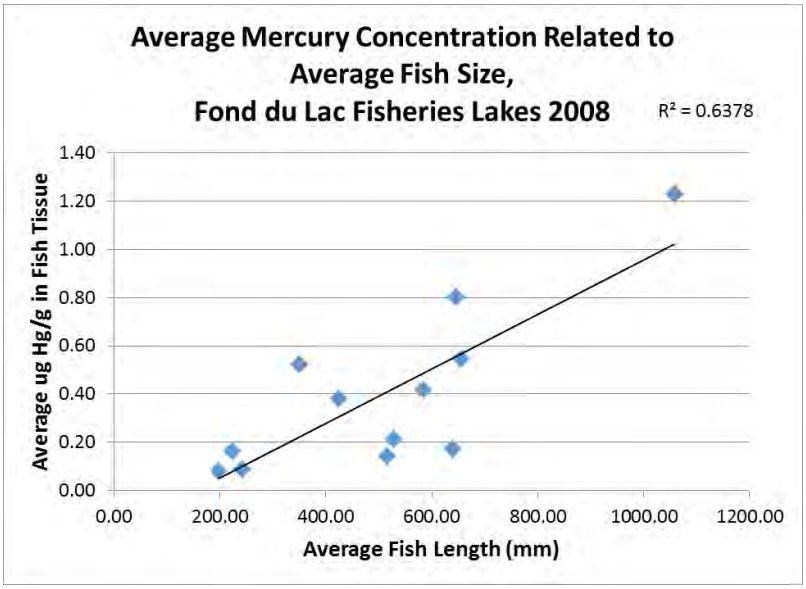


Figure 102. Mercury Concentrations vs. Fish Size



Climate Change

One interesting trend has been a notable decrease in certain constituents in Reservation lakes during the recent wet period, such as a watershed-wide decrease in sulfate in our manoomin lakes, which is likely due to higher water volume (Figure 72, above) or dilution effect. We have also noted a smaller catch rate while conducting electroshocking in some streams, especially after frequent large rain events; it's likely the fish are being washed downstream.

We can also track both water level and water temperature at our long-term gauge sites. The water level data for Fond du Lac Creek (Figure 103) shows both the 2012 flood event as well as the especially sustained high water period in 2017. The water temperature data for the two gauge sites at Otter Creek (Figure 104) show how we track water temperature in a trout stream to detect periods when temperature rises above the lethal limit for brook trout.

Because future climate predictions also include droughts, we partnered with NOAA National Integrated Drought Information System NIDIS to contribute to a report on the expected impacts that drought could have on Tribal natural resources and cultural resources (available at www.drought.gov in 2021). Though drought conditions did occur in 2020, most of our data reflect the exceptionally wet conditions we have been experiencing for the past ten years.

Figure 103. Fond du Lac Creek water level

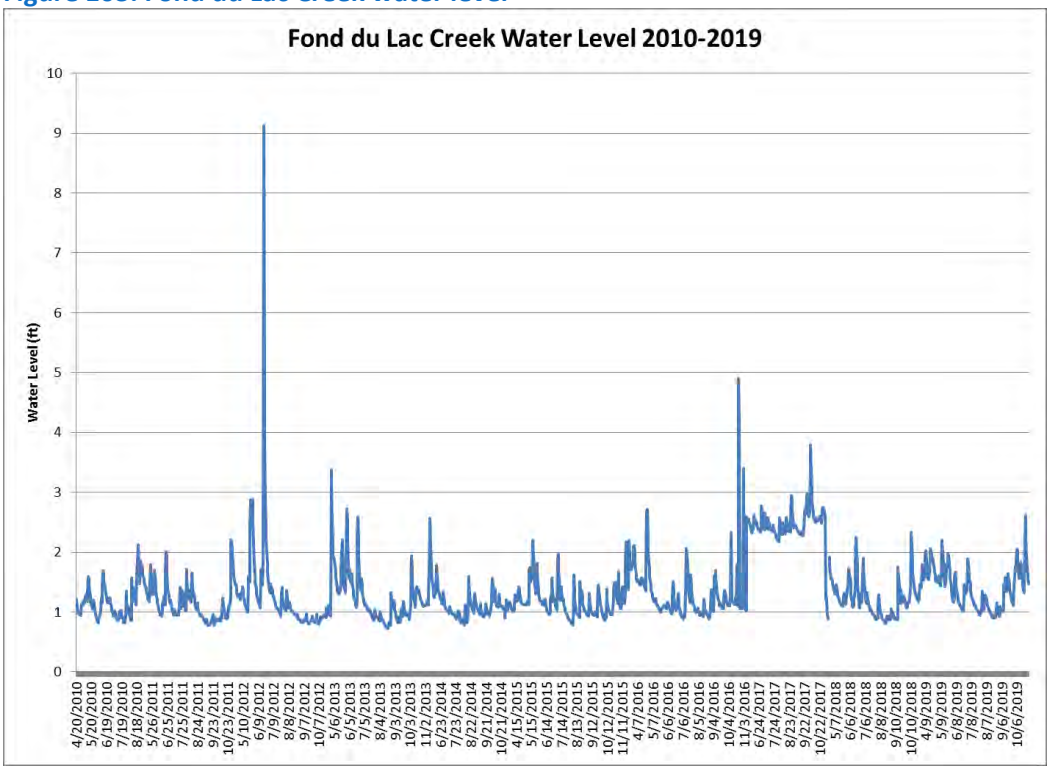
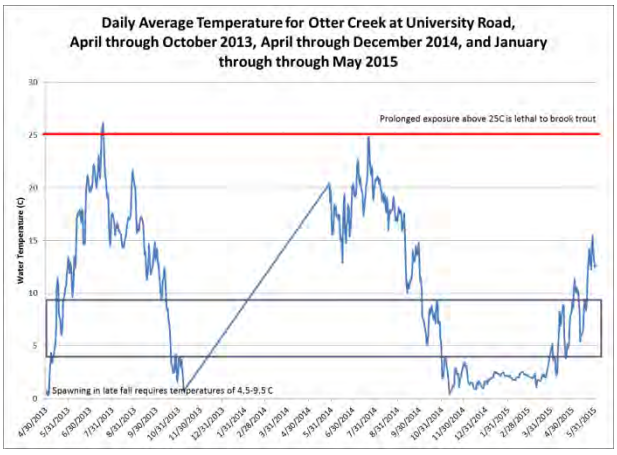
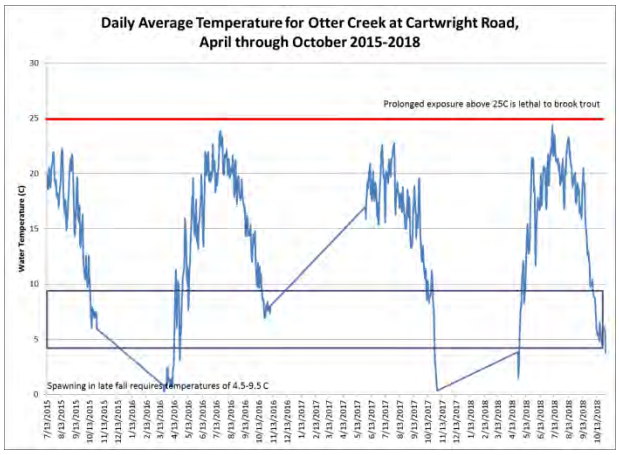


Figure 104. Water temperature at Otter Creek.





Discussion

Overall, the waters of the Reservation have good water quality. This is reflected in the antidegradation stance taken in FDL's water quality standards. Our WQS states that "any surface waters not specifically classified as Outstanding Reservation Resource Waters are classified as Exceptional Resource Waters, and are roughly equivalent to EPA's regulatory definition of Tier 2 waters under the Agency's antidegradation policy." Since there are no point sources of pollution on the Reservation, our efforts to protect our lakes, streams and rivers are focused on managing NPS and preventing water quality degradation.

As highlighted in the NPS category tables in the Results section, the most severe threats to water quality come from mercury pollution and climate change. The weight of evidence from Fond du Lac's studies on mercury in water, fish tissue, wet/dry deposition and lake sediments all point to the same thing: Fond du Lac waters are not attaining our water quality standards for mercury. In addition, the St. Louis River is listed as impaired for mercury by the state of Minnesota and the state of Wisconsin, but they have been slow to begin the TMDL process for this river.

Hydromodification also poses a threat to water quality and hydrology, and FDL OWP has identified locations where ditching and pipeline corridors are having a dual impact on stream connectivity and manoomin, especially when paired with road crossings. Beavers are an integral part of the ecosystem in northern Minnesota, but they are included as an NPS impact in cases where beaver dams impact resources valued by Band members, including manoomin and human infrastructure. As discussed throughout this Assessment Report, manoomin populations face many pressures, including from invasive species and hydrologic and water level changes due to hydromodification, land use and climate change. These and other stressors work in concert, and each lake on the Reservation faces each threat to a different degree. For instance, Perch Lake (South Basin), which is near the headwaters of the Stoney Brook watershed, has fewer problems with water level fluctuation, but more management issues related to controlling competing native species like pickerelweed. Deadfish Lake, which is further downstream in the watershed and has multiple subwatersheds draining into it, has more stressors related to water level fluctuations. Cedar Lake, Wild Rice Lake and to some degree Miller (Mud) Lake have severely diminished manoomin stands because of sustained high water levels, while Bang (Long) Lake faces manoomin loss from shoreline development. Supporting sustainable manoomin populations on each lake must be addressed on a lake-specific basis.

Roads and culverts also change how water moves across the landscape. In the Roads category, we highlight two locations, Jolicoeur Creek and Martin Branch (Marshall Road), where failing road are impairing stream connectivity, riparian vegetation and aquatic organisms. These two locations are a high priority for restoration activities.

Although urban impacts are overall small in this rural landscape, there are localized severe impacts, such as the issues with septic systems and shoreline development at Big Lake, and stormwater runoff leading to a TSS impairment at Second Lake. Impacts from agriculture and forestry management practices are low.

SELECTION OF BEST MANAGEMENT PRACTICES ON THE FOND DU LAC RESERVATION

The following discussion outlines how Best Management Practices (BMPs) will be selected under Fond du Lac's §319 NPS Program. Fond du Lac OWP takes a systems approach to selecting BMPs. This means we prioritize solutions to NPS that consider the effects of a BMP at a given site but also the effectiveness of a suite of BMPs across interconnected watersheds, and we take into account the economic and social factors that support successful NPS management. The sections below outline the strengths of Tribal government, the Fond du Lac community and our partnerships in analyzing, planning and implementing effective BMPs. This includes adaptive management, by which we assess BMP effectiveness over time and respond accordingly.

Core Participants

The core participants are broken down into several levels of participation, including technical assistance, education, demonstration projects and financial assistance.

Lead: Fond du Lac Band of Lake Superior Chippewa, Office of Water Protection

The Office of Water Protection (OWP), which is within the Environmental Program and under the Resource Management Division, will direct committees in the selection of BMPs on the Fond du Lac Reservation. Where possible, we will follow workgroup guidelines laid out in our Integrated Resource Management Plan. The OWP includes a Water Projects Coordinator, a Water Regulatory Specialist, a Watershed Specialist, a Groundwater Specialist, and (when funding allows) a Wetland Specialist.

The OWP will work internally with the following Fond du Lac entities as needed to select BMPs:

- Natural Resources Program
- Tribal Historic Preservation
- Invasive Species Program
- Forestry Program
- Fisheries Program
- Wildlife Program
- Brownfields Program
- Land Division
- Water and Wastewater Division
- Alternative Energy Program
- Conservation Enforcement Program
- Planning Division
- Elders Concerns Committee

OWP will work with the Land Department to incorporate NPS BMPs into their upcoming Comprehensive Plan. OWP will also work with the Legal Department and the Reservation Business Committee as needed to review and complete projects and contracts related to BMP work. In cases where projects need to be reviewed by the Fond du Lac Conservation Committee, we will discuss our proposed work with them in a timely manner.

Fond du Lac OWP will approach NPS management and selecting BMPs using a systems approach, including the following steps (Ghahramani and Mattox, 2000):

- Outline the NPS pollution problem and create a needs analysis. The types of NPS pollution and their relative effects will be identified in relation to the types of topography, economy, and possible pollutant producers. The critical area must be defined since the viability of a project is defined in terms of the entire watershed and not any single source of contamination.
- Set objectives and project plans. This includes short-term and long-term environmental goals as well as social, economic, and geographic goals. Planning also involves adaptive management, so that data collection, monitoring and evaluation are built into the project.
- Secure funding and define partner roles. Fond du Lac OWP has a rich network of partners, collaborators and funding sources to draw from, as outlined in the headings below and in Fond du Lac's NPS Management Plan.
- Implement and evaluate projects. This includes ongoing assessment and improvement (where needed) for each project and how they relate together on landscape, social and economic scales to manage NPS pollution. Results will be documented and shared with the community, partners and collaborators, and other agencies.

Technical Assistance

Fond du Lac receives technical assistance from the following agencies, and will do so as the need arises for implementing future BMPs:

- US EPA Region 5, NPS Division: Fond du lac OWP will work closely with their NPS Project Officers in EPA Region 5 as needed to plan, fund and implement NPS BMPs. Staff will attend the NPS Training Conferences offered by EPA as they are able.
- US EPA Mid-Continent Ecology Division (MED): The MED provides regular updates on science related to Great Lakes and St. Louis River ecology, including paleolimnology, wildlife surveys, algal assays and bloom monitoring, nutrient cycling, aquatic plant ecology and isotopic mercury investigations in trophic webs between the St. Louis River and Lake Superior. We rely on them for a balanced understanding of Great Lakes ecology and consult with them when needed.
- Great Lakes Indian Fish and Wildlife Commission: They provide a wealth of information on Tribal treaties and Tribal ecological knowledge, including history, law and current efforts to uphold treaty rights. They publish updates, maps and printed materials related to Tribal environmental resources, including fish consumption advisories, invasive species and manoomin management and protection.
- 1854 Treaty Authority: They partner with Fond du Lac on efforts such as climate adaptation planning, fish population assessments and harvests, sturgeon telemetry, wildlife research, invasive species assessment, mapping and management, reviewing state and federal permits related to mining and other projects, and monitoring, mapping and managing manoomin in the 1854 Ceded Territory.
- Minnesota Chippewa Tribe (MCT): The MCT Environmental Program collaborates with its member Tribes to protect MCT lands, water and air quality both on-reservation and off-reservation. The member Tribes include Bois Forte, Fond du Lac, Grand Portage, Leech Lake, Mille Lacs and White Earth. They assist with environmental education and outreach, technical assistance on reviewing state and federal permits that affect MCT land, water and air quality, and resources for Tribes on up-to-date statutes, regulations and policies directly impacting environmental protection activities.

- Natural Resources Conservation Service (NRCS): Provides design plans for conservation projects through their Environmental Quality Incentives Program (EQIP) such as specs for stream crossings. Fond du Lac houses a NRCS tribal liaison within its Resource Management offices.
    - The Fond du Lac OWP Watershed Specialist serves on the EQIP Local Workgroup, which focuses on conservation planning and practice installation and discusses updates to relevant Farm Bill measures.
    - NRCS Tribal Conservation Advisory Committee: Fond du Lac Resource Management Division serves as the staff location for committee coordinator for Minnesota Tribes, in order to help tribes prioritize conservation projects and get them funded through NRCS programs.
- Regional Monitoring Network: A state/Tribal/EPA project, in partnership with consulting firm Tetra tech, that provides Standard Operating Procedures for monitoring and tracking water discharge data to track changes in hydrology due to climate change, which can be used to inform BMP design.
- Minnesota Pollution Control Agency (MPCA): Collaborates with local entities for its Watershed Restoration and Protection Strategies (WRAPS), which encompasses its Integrated Reporting for water quality with a priority framework that outlines the major stressors in each major watershed in the state, with strategies for implementing BMPs. Fond du Lac OWP collaborates on the WRAPS for the St. Louis River, Nemadji River, Cloquet River and Kettle River basins.
- Minnesota Board of Water and Soil Resources (BOWSR): Provides local watershed-based planning through their One Watershed, One Plan (1W1P) framework, where counties prioritize BMP implementation based on the WRAPS and other watershed-based data. Fond du Lac is the first tribe in the state to serve on the Policy Committee for a 1W1P, in this case for the St. Louis River. Fond du Lac OWP also served on the Advisory Committee for the Nemadji River 1W1P.
- Minnesota Department of Natural Resources (MNDNR): Provides data for assessing where BMPs are needed through its Watershed health Assessment Framework (WHAF). DNR hydrologists provide technical assistance for projects including stream crossings and wetland impacts. The DNR also publishes monthly Climate Conversations, many of which have to do with the intersection between infrastructure and changing rainfall patterns, and ways we can adapt using Green Infrastructure.
- St. Louis River Area of Concern (AOC): An EPA effort to remove Beneficial Use Impairments (BUI) in the AOC related to water quality, habitat and aquatic life. The Fond du Lac Reservation, the State of Minnesota and the State of Wisconsin each have appointed an AOC coordinator, and Fond du Lac staff sit on the BUI workgroups that implement strategies, restoration projects and BMPs to delist each BUI.
- Minnesota Department of Agriculture (MDA): Provides assistance for farming practices that affect water quality, such as stream buffers near agricultural fields. Provides assistance on projects related to Food Sovereignty, which has a water quality component when considering site design.
- Minnesota Department of Transportation (MNDOT): Consults with us on culvert maintenance, design and replacement for stream crossings on the Reservation. Shares hydrologic modeling data with us.
- US Army Corps of Engineers (USACE), Detroit District: Provides project design and watershed modeling assistance through their Technical Project Planning (TPP) program.
- US Geological Survey (USGS): Provides assistance on collecting physical water parameters, such as stream discharge monitoring, through their Technical training in Support of Native American Relations (TESNAR) program. Provides technical assistance for creating watershed models we can use to base our approaches for implementing BMPs.

- Carlton County Soil and Water Conservation District/Land Department: A key partner in the St. Louis River 1W1P and the Nemadji River 1W1P. Provides technical assistance on sustainable approaches to beaver management and information related to road projects and restoration work. Partners with us on wetland permits and Technical Advisory Panels for the Wetland Conservation Act. Works in partnership with us on BMPs such as stream crossings, trout thermal refugia projects, and stream restoration projects. Worked in partnership with us to update the Carlton County Geologic Atlas.
- St. Louis County Soil and Water Conservation District/Land Department: A key partner in the St. Louis River 1W1P. Provides data on culvert inventories and rad projects. Partners with us on wetland permits and Technical Advisory Panels for the Wetland Conservation Act.
- Natural Resources Research Institute: Provides data and mapping capabilities through their Natural Resources Atlas for making conservation decisions. Provides the latest science on paleolimnology, hydrology and nutrient cycling studies, limnology, invasive species, wildlife and fisheries research, and water quality monitoring. Their lab processes and analyses our algae and chlorophyll α samples.
- Tribal Environmental Groups: Minnesota Tribal Environmental Council, Regional Tribal Operations Committee's Tribal Caucus, and Region 5 Tribes/EPA Monthly Water Conference Call. These working groups host a wealth of knowledge and experience on how to implement conservation projects on Tribal lands, and are good forums for requesting advice and expertise.
- Minnesota Sea Grant: Minnesota Sea Grant has developed an educational program for local decision makers called Nonpoint Source Education for Municipal Officials (NEMO). A NEMO program was incorporated as an information and educational component for the development of Fond du Lac's Nonpoint Source Assessment Report and Management Program. Fond du Lac staff will continue to use these materials. In addition, Sea Grant staff provide excellent resources on water quality, invasive species prevention and outreach, monitoring and environmental education. They partner with us on technical panels for delisting the St. Louis River Area of Concern and also on the WRAPS.
- National Oceanic and Atmospheric Administration (NOAA), Lake Superior National Estuarine Research Reserve (Reserve): They serve as the "go to" organization for research, stewardship, education and updates on Area of Concern milestones in the St. Louis River estuary. They also host the Habitat Workgroup, which coordinates restoration and resource management projects in the estuary and Area of Concern. Fond du Lac OWP serves on the Reserve Advisory Board.

Education

Local teachers learn about the cultural importance of manoomin to Fond du Lac Band members during the Rivers2LakeProgram

Fond du Lac had an Environmental Education and Outreach Specialist for many years who assisted with watershed-based education. However, due to cuts in our GAP funding, we are no longer able to sustain that position and must rely on outside partnerships.

Fond du Lac OWP works with the following agencies and groups to provide watershed-based education:

- Fond du Lac Tribal and Community College (FDLTCC): Partners with us to bring watershed-based education and water quality monitoring to elementary through high school classrooms through the St. Louis River RiverWatch Program. Learning culminates in a day-long RiverWatch Congress where students learn about water quality from multiple perspectives and disciplines. FDLTCC partners with Fond du Lac Resource Management to write grants to fund their students' research into topics such as mercury loading in benthic macroinvertebrates in the St. Louis River, and using eDNA to monitor the presence of invasive species in Fond du Lac's manoomin lakes.
- Thirteen Moons Extension Program: Thirteen Moons, which is housed in the Fond du lac Resource Management Building and has ties to FDLTCC and the US Department of Agriculture, aims to connect Band members to the natural world and traditional cultural practices through hands-on workshops and teaching sessions. These often include staff from Fond du Lac OWP. Thirteen Moons also works with Fond du Lac Resource Management to plan and host the annual Gichi Manidoo Giizis Pow Wow at the Black Bear Casino, where Pow Wow participants gather with local environmental agencies to dance and also learn about local efforts to protect land and water.
- Regional Stormwater Protection Team (RSPT): RSPT mainly serves the urban areas of Duluth, MN and Superior, WI to provide stormwater-based education to landowners and local officials as a part of these cities' Municipal Separate Storm Sewer System permits. However, their outreach approaches are widely applicable, including their road salt application trainings, their partnerships with MPCA to promote smart salt-spreading for homeowners, and their social media, print, radio and television-based efforts to provide engaging outreach for the community on ways to reduce

NPS pollution. Fond du Lac OWP staff recently joined their Stormwater Communication Committee, which gives us access to all their outreach materials and new initiatives.

- National Oceanic and Atmospheric Administration (NOAA), Lake Superior National Estuarine Research Reserve (Reserve): Fond du Lac OWP staff serve on the Reserve Advisory Board and participate in joint watershed-based outreach efforts with the Reserve. These include helping to plan the annual St. Louis River Summit and working on the student outreach committee to encourage student participation in the Summit. Fond du Lac has also participated for eight years in the Rivers2Lake program, where the Reserve holds a week-long watershed-based training session for K-12 teachers in Western Lake Superior. Teachers spend the week in the St. Louis River Watershed, traveling from the headwaters down to the estuary and learning how to incorporate watershed-based education into their curricula. They spend one day on the Reservation, where they help track radio-tagged sturgeon, collect water quality samples from the river, visit a manoomin lake, and learn about tribal treaty rights. We follow up with the teachers throughout the school year, and in the 2019-2020 school year we assisted a fourth-grade class in Cloquet as they used field cameras to track wildlife use of a forested corridor along the St. Louis River. The reserve also hosts monthly River Talks, a community event that highlights the culture, history and ecology of the St. Louis River. Fond du Lac OWP staff have also worked with the Reserve in their Coastal Training Program, which provides watershed-based outreach to local officials who make zoning and land management decisions.
- Fond du Lac Ojibwe School: Fond du Lac OWP serve as guest teachers for Ojibwe School classes, most recently assisting a high school class conduct water quality monitoring at nearby Jolicoeur Creek with assistance from the Reserve. Every year, Fond du Lac OWP hosts the community-wide Ganawenjigewin Maawanji'idiwin (Taking Care of Things Gathering) on the Ojibwe School Pow Wow grounds, in which we students to come out for puppet shows and live animal demonstrations as they learn about water quality and manoomin.
- Minnesota Sea Grant: They provide watershed-based outreach materials that we use when we conduct classroom sessions, including the Watershed Game and the Enviroscape Model.
- University of Minnesota (U of M): Though our partnership with the U of M via the Kawe Gidaa-Naanaagadawendaamin Manoomin workgroup, Fond du Lac OWP has participated as guest lecturers in classes ranging from Hydrogeology to Environmental Sustainability and Land Management, where we discuss water-quality-related topics. In addition, Fond du Lac participates in the U of M's Research Experiences for Undergraduates (REU) Program by hosting students to participate in all aspects of our conservation work during the field season, while also receiving assistance from us as part of their research projects. U of M Extension also provides NPS-based webinars via their Watering Wisdom Webinar Series and their Stormwater Webinar Series.
    - University of Minnesota, Cloquet Forestry Center: They offer continuing education classes on plant and forestry management, often with a tie to water quality.
- Minnesota Pollution Control Agency: Fond du Lac OWP partnered with MPCA on their We Are Water Exhibit, which is a travelling exhibit that showcases what water means to local communities throughout the state. MPCA provides a wealth of NPS-related educational resources, including Smart Salting trainings and online resources such as their Stormwater Manual.
- The Minnesota Erosion Control Association (MECA): a non-profit, member organization that provides education, resource information and business opportunities for professionals in the erosion and sediment control industry.
- Twin Ports Freshwater Folk: an informal working group of water and wetland professionals from the private and public sector, including academia. We meet for monthly talks on a range of water-related subjects based near the port cities of Duluth and Superior.

- Twin Ports Climate Coalition: a group hosted by the Lake Superior Coastal Program of the Minnesota Department of Natural Resources. Fosters communication and collaboration as we adapt to climate challenges in the Twin Ports region. Twin Ports Climate Conversations is a monthly online meeting that covers a range of topics, including stormwater management for individuals, businesses and governments.

Note: Fond du Lac OWP staff have moved all of these programs online during the 2020-2021 period of distance learning.

Demonstration Projects

- Fond du Lac Resource Management Building Rain Garden and Green Roof: Completed in 2010, the Resource Management Building was built using Leadership in Energy and Efficient Design (LEED) standards. This included a green roof over the front awning and a rain garden at the back of the building. Fond du Lac RM staff also planted a native pollinator garden in the traffic island in the front of the building. The Fond du Lac Resource Management Building constantly receives tour groups, both local and international visitors (the building closed to visitors during Covid-19), making it ideal for educating the public about stormwater design features for buildings.
- Giikinoo-amaage-gidiwin Gitigaan Journey Garden: In partnership with the US Department of Agriculture, the garden's purpose is to teach American Indian youth about food sovereignty and how to grow food for themselves and their community. The garden, which is more of a small farm, also serves as a demonstration for how to follow organic farming and NPS conservation practices to prevent water pollution.

Financial Assistance

EPA Financial Assistance to Tribes

The major objective of the grants provided through the CWA is to restore and maintain the chemical, physical and biological integrity of Reservation's waters primarily through eliminating or controlling the discharge of pollutants into water systems (rivers, streams, lakes, estuaries, aquifers, wetlands). Fond du Lac manages its CWA Section §106 and §319 grants under a Performance Partnership Grant

The Tribal Environmental and Natural Resource Assistance Handbook is intended to provide a central location for federal sources of both technical and financial assistance available to Tribes for environmental management. The is an excellent source of funding opportunities and is available at http://www.epa.gov/owindian/pdfs/tribook.pdf

CWA Section §106: Provides financial assistance for the prevention, reduction and elimination of water pollution. A grant from Section 106 can be used to fund a variety of projects for the protection of water quality. Tribes have used Section 106 grants to develop water quality standards, conduct stream bioassessment surveys, gather baseline water quality data, and develop a water classification system. The Fond du Lac Environmental Program has received Section 106 funding since 1997 to implement its water quality program on the Reservation.

CWA Section §319: EPA provides grants and technical assistance to support tribal environmental programs in assessing and managing NPS pollution problems and threats. A wide range of activities are eligible for funding under §319, including but not limited to: NPS training for tribal staff, developing watershed-based plans, riparian planting, livestock exclusion fencing, lake protection and restoration activities, NPS ordinance development, outreach and education, and many more.

Competitive Grants

EPA Grants:

- Great Lakes Restoration Initiative (GLRI): Fond du Lac is in the Lake Superior Basin, and so we receive funding to help us achieve water quality-related goals and restoration projects. Current funding helps us with NPS work related to mercury pollution monitoring in lakes and rivers, and an upcoming grant will help us address severe erosion on Spirit Island in the St. Louis River.
- EPA CWA Section §319 NPS Competitive Clean Water Act Grants: Once Fond du Lac's Assessment Report and Management Plan are complete, we will rely on the goals and objectives in the plan to pursue competitive grants to achieve our NPS-related goals. A past competitive grant allowed us to conduct an alum treatment in Third Lake.
- EPA CWA Section §104(b)(3) Wetlands Program Development Grants: The wetlands program development grant (WPDG) provides states, tribes, local governments, interstate agencies, and inter-tribal consortia an opportunity to carry out projects to develop and refine comprehensive wetland programs. WPDGs provides eligible applicants an opportunity to conduct projects that promote the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. Fond du Lac has been successful in receiving multiple WPDG to create and implement our wetland condition assessments and restoration plans. EPA typically awards between $50,000 to $350,000 per project grant. Funding is dependent upon amount requested and the overall size and need of the project.
- CWA Tribal Set-Aside Program, Wastewater Infrastructure: EPA utilizes the Indian Health Service (IHS) Sanitation Deficiency System (SDS) list to select projects that are eligible for funding. Tribes have an option of receiving a direct grant or receive an Interagency Agreement (IAG) with their corresponding IHS area office. EPA contacts the selected Tribe directly and requires a written response on the selected option to receive funds. Examples of eligible activities include interceptor sewers, wastewater treatment facilities (conventional or alternate), infiltration/inflow correction, collector sewers, major sewer rehabilitation, on-site systems (e.g., septic systems).
- Safe Drinking Water Act (SDWA): Grants to assure that the Nation's drinking water supply is safe for human consumption by regulating both public water supply systems and ground water supplies are available through section 1443(a) Drinking Water Programs – Public Water Supply Supervision (PWSS) Program Development and Implementation, Section 1443(b) Underground Injection Control Program Development and Implementation and section 1442(b)(2) R & D, Pilot Projects & Special Studies PWSS, Wellhead Protection.
- Federal Insecticide, Fungicide, And Rodenticide Act (FIFRA): To regulate the sale and use of pesticides to ensure the least risk possible to human health and the environment from pesticides, grants are available through Section 23(a)(1) Pesticide Enforcement Program Development and Implementation including: endangered species, pesticides in ground water worker protection & safety, and Section 20 R & D, pilot projects & special studies.

- National Environmental Education Act: Grants are available through Section 6, Environmental Education Grant Program to support the design and implementation of environmental education programs that enhance critical thinking and problem-solving skills to ensure informed responsible decisions are made to protect the environment.

BIA Grants:

- Bureau of Indian Affairs Water Resources Grants: This grant program aims to manage, conserve and utilize water resources on tribal lands. Fond du Lac OWP currently has a Water Resources grant to complete a watershed model and Nine-Element Watershed Plan for the Stoney Brook Watershed, in partnership with USGS.

USFWS Grants:

- USFWS North American Wetlands Conservation Act: Provides grant funds (Public Law 101-233, as amended, 16 U.S.C. 4401) for wetlands conservation projects in the United States, Canada, and Mexico. Funds are used to acquire lands if the acquisition will ensure that the lands will be administered for the long-term conservation, restoration, or enhancement of such lands and waters including the migratory birds and other fish and wildlife dependent on them. Further, NAWCF funds derived from the Coastal Wetlands Planning, Protection and Restoration Act may only be used in coastal wetlands ecosystems in coastal States.
- USFWS Tribal Landowner Incentive Program (TLIP): These projects include those by Indian Tribes to improve, preserve, or maintain habitat for endangered, threatened, candidate, or other at-risk species, including species designated by Tribes to be at-risk. Examples of the types of projects the service might fund include prescribed burning to restore grasslands that support imperiled species, fencing to exclude animals from sensitive habitats, or planting native vegetation to restore degraded habitat. A project that proposes a land purchase must clearly justify the necessity and long-term conservation benefit of the acquisition (permanent easement will be required). TLIP funds can be used for environmental review, habitat evaluation, permit review (e.g., Section 404), and other environmental compliance activities provided they are directly related to the TLIP project and are discussed in the budget narrative. TLIP funds cannot be used to conduct activities to comply with a Biological Opinion or with a permit (e.g., mitigation responsibilities) for another program or project. However, TLIP funds can be used to implement conservation recommendations.
- USFWS Tribal Wildlife Grants (TWG): Eligible projects include those submitted by Tribes to develop and implement programs for the benefit of wildlife and their habitat, including species of Tribal cultural or traditional importance and species that are not hunted or fished. Activities may include, but are not limited to, planning for wildlife and habitat conservation, ongoing and/or new fish and wildlife conservation and management actions, fish and wildlife related laboratory and field research, natural history studies, habitat mapping, field surveys and population monitoring, habitat preservation, land acquisition, conservation easements, and public education that is relevant to the project. A project that proposes a land purchase must clearly justify the necessity and long-term conservation benefit of the acquisition (permanent easement will be required). TWG funds can be used for environmental review, habitat evaluation, permit review (e.g., Section 404), and other environmental compliance activities provided they are directly related to the TWG project and are discussed in the budget narrative. TWG funds cannot be used to conduct activities to comply with a Biological Opinion or with a permit (e.g., mitigation responsibilities) for another program or project. However, TWG funds can be used to implement conservation recommendations

USDA Grants:

- Natural Resources Conservation Service: Provides design plans for conservation projects through their Environmental Quality Incentives Program (EQIP) such as specs for stream crossings. Fond du Lac houses a NRCS tribal liaison within its Resource Management offices, and we work with them to maintain a prioritized list of funding needs.

US Army Corps Grants:

- US Army Corps, Detroit District: Provides project design and watershed modeling assistance through their Technical Project Planning (TPP) program. Past funding through their Planning Assistance to States program allowed us to complete a watershed model for the Simian Creek Watershed.

FEMA Grants:

- Federal Emergency Management Agency (FEMA):
    - FEMA Building Resilient Infrastructure and Communities (BRIC): a grant program aimed at reducing hazards due to natural disasters, including designing projects that reduce water pollution and other hazards related to flooding.
    - FEMA's Hazard Mitigation Grant Program: provided to eligible applicant states/tribes/territories that, in turn, provide sub-grants to local governments. FEMA's hazard mitigation assistance provides funding for eligible mitigation measures that reduce disaster losses, including from flooding.

Minnesota Grants:

- MN Board of Water and Soil Resources: Fond du Lac serves on the Policy and Steering Committees for the BOWSR's One Watershed, One Plan effort for the St. Louis River Watershed. The plan will prioritize conservation and restoration projects in the watershed, which will then be used to spend considerable funds from the state's Clean Water, Land and Legacy Amendment program.
- Minnesota DNR Coastal Program Grants: These grants, available to organizations within the Lake Superior Coastal Zone, have three funding opportunities – annual, short-term and conference/training support. The grants are focused on components such as habitat, natural disaster resiliency, water quality protection, sustainable development and education for governments and citizens.
- Minnesota Sea Grant: Through NOAA, MN Sea Grant releases competitive funding RFPs for two-year research projects that that address water quality in the context of supporting sustainable and healthy use of these resources.
- Minnesota State Bonding: Fond du Lac has pursued state bonding requests in the past to extend sewer service out to Big Lake, and could pursue future requests for NPS-related BMPs if warranted.

National Fish and Wildlife Foundation Grants:

- Sustain Our Great Lakes Program (SOGLR): with funding from GLRI, SOGLR's mission is to release competitive grant RFPs that focus on sustaining, restoring and protecting fish and wildlife habitat in the Great Lakes Basin. Their focus is on awarding grants for on-the-ground habitat restoration and enhancement.

Public Participation and Governmental Coordination

Governmental Coordination

Fond du Lac OWP works with the following governmental entities when planning and implementing BMPs:

- Internal Fond du Lac Resource Management Review: Based on the guidelines in Fond du Lac's Internal Resource Management Plan, Fond du Lac OWP will work with all other Resource Management programs as applicable to brainstorm ideas, set priorities, and coordinate efforts related to NPS BMP planning and implementation.
- Tribal Government: During the planning stage of BMP selection, Fond du Lac OWP will work with our Legal Department and our Reservation Business Committee (RBC) for any contracts, reviews and approvals that are needed. All funding requests must be approved by the RBC before submittal.
- County/City/Township Governments: In cases where projects take place on land owned or administered by St. Louis County, Carlton County, the cities of Brookston, Sawyer or Cloquet, and the local townships, FDL OWP will work with their Land Departments, Soil and Water Conservation Departments and Legal Departments to receive the proper agreements and approvals to proceed. In many cases
- University of Minnesota, Cloquet Forestry Center: Since the Forestry Center is owned and operated by the U of M and is entirely within the Fond du Lac Reservation, the OWP will work with the Forestry Center on any NPS projects that take place on Forestry Center land.
- Minnesota DNR: FDL OWP will work with DNR Ecological and Water Resources Division on any projects that require review for stream crossings.
- Wetland Permitting: In some cases, BMP projects may require wetland permits from Fond du Lac OWP, the State of Minnesota Wetland Conservation Act, and the US Army Corps. In these cases, Fond du Lac works in concert with all three entities, submits proposed projects to the Technical Evaluation Panel for review and approval, and publishes and posts comment period notifications.
- Federal Programs: Any projects near lands with federal oversight may require review and approval from federal agencies, such as the Federal Railway Administration for projects near railroads, and the Federal Aviation Administration for projects near the Cloquet Airport.

EPA guidance indicates that the relationship between nonpoint source pollution control and water quality standards should be based upon three basic principles:

1. BMPs must be designed to meet water quality standards. It is recognized that BMPs are the primary mechanism to enable the achievement of WQS. It is intended that proper installation of Tribe approved BMPs will achieve WQS. For proposed nonpoint source activities, BMPs designed and implemented in accordance with a Tribe approved process will normally constitute compliance with the CWA. Once BMPs have been approved by the Tribes, the BMPs become the primary mechanism for meeting WQS. Proper installation, operation, and maintenance of Tribal approved BMPs are presumed to meet a landowner's or manager's obligation for compliance with applicable WQS.

2. BMP effectiveness must be demonstrated. Once the BMPs have been installed/applied and sufficient time has elapsed to establish the controls and monitor their effectiveness, attainment or maintenance of WQS and other water quality goals should be verified. If

subsequent evaluation indicates that approved and properly implemented BMPs are not achieving WQS, the Tribes should take steps to revise the BMPs, evaluate the WQS for appropriateness, or both. Through the interactive process of monitoring and adjustments of BMPs and/or WQS, it is anticipated and expected that BMPs will lead to achievement of WQS.

3. If BMPs cannot adequately protect and maintain water quality standards, the Tribes must either revise the BMPs to ensure protection and maintenance of WQS or revise the standards or reevaluate the activity. If WQS are not being met, then the Tribe may require that the NPS controls be modified or the practice causing the nonpoint source pollution cease.

Public Participation

FDL OWP will follow all necessary legal guidelines for public notice of proposed BMP projects. This includes:

- Wetland Permitting: In some cases, BMP projects may require wetland permits from Fond du Lac OWP, the State of Minnesota Wetland Conservation Act, and the US Army Corps. In these cases, Fond du Lac works in concert with all three entities, submits proposed projects to the Technical Evaluation Panel for review and approval, and publishes and posts comment period notifications for all three regulatory programs. Comments are reviewed by all programs where applicable, including by Fond du Lac's Wetland Regulatory Specialist.
- General Public Outreach: FDL OWP is will use local communication tools to share updates about BMP projects and how they protect and enhance Reservation waters. These outreach tools include email, social media, the Fond du Lac website, the Fond du Lac Radio Station (WGZS) and the Fond du Lac Newspaper. Wider outreach would include the Duluth News Tribune, Great Lakes Indian Fish and Wildlife Commission's Mazina'igan newsletter, Duluth television stations and Minnesota Public Radio.

Existing BMPs

Table 20. Existing BMPs for Each NPS Category

Non-Point Source Pollution Category
Forestry
Existing BMPs
Avoid wetland crossings and impacts during logging and forest management activities
Filter strips of at least 50' from wetland edges
Cutting only during frozen ground conditions to avoid wetland impacts and soil compaction
Avoid cutting sugar maple and black ash
Riparian management zones extending 150' from wetland edges
Wildfire Protection Zone: Manoomin lakes cannot be used as sourcewater for aerial firefighting; no fire retardant can be dropped within protection zone
Locked gates to prevent ATV access at end of Marshall Road, Jaskari Lake and within the Cloquet Forestry Center
Relevant Guidelines
Temporary Stream and Wetland Crossing Options for Forest Management

Natural Resource Conservation Service Conservation Stewardship Program
Fond du Lac Integrated Resource Management Plan
Minnesota Forest Resources Council Guidebook
Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers
Wisconsin's Forestry Best Management Practices for Water Quality/Field Manual
Partners
Fond du Lac Forestry, MN DNR, NRCS, Carlton County, St. Louis County, Cloquet Forestry Center
Funding
Bureau of Indian Affairs, NRCS
Hydromodification and Habitat Alteration
Existing BMPs
Beaver dam management on Stoney Brook ditch to maintain water levels in the manoomin lakes
Watershed models for Stoney Brook and Simian Creek to inform water level management
Channel clearing in Wild Rice Lake outlet to lower water level
Relevant Guidelines
Watershed Model Reports for Simian Creek and Stoney Brook, upcoming Watershed Plan for Stoney Brook
Natural Resource Conservation Service Conservation Stewardship Program
FDL Wetland Ordinance, MN Wetland Conservation Act, WOTUS rules, MN Construction Rules
Fond du Lac Integrated Resource Management Plan
USEPA Management Measure for Hydromodification
Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices
MNDOT Erosion Control Handbook
Field Guide for Maintaining Rural Roadside Ditches, Protecting Lakes and Streams Through Proper Ditch Management
Field Guide for Maintaining Rural Roadside Ditches, Protecting Lakes and Streams Through Proper Ditch Management
Partners
USGS, NRCS, US Army Corps, MNDOT
Funding
BIA, US Army Corps, CWA §319
Roads, Highways and Bridges, Including Railroads
Existing BMPs
Bridge replacing collapsed culvert on Fond du Lac Creek/Reservation Road crossing
Box culvert with correct alignment replacing two failing pipe culverts on Otter Creek/Cartwright Road crossing
Road construction projects all follow Stormwater Pollution Protection Plans
Failing bridge replaced on Stoney Brook on the County Rd 31 crossing in the town of Brookston
Ongoing repairs of gravel road washouts on Brookston Road and Hardwood Lake Road
Complete replacement of all culverts crossing under Big Lake Road between the Tribal Center and Big Lake Road
Failing bridge replaced on Otter Creek/University Road crossing

Culvert inventory on Ditchbank Road
Box culvert with correct alignment replacing failing pipe culvert on Martin Branch/Marshall Road crossing
Relevant Guidelines
Construction General Permit Statutes
EPA Guidelines for Stormwater Pollution Prevention Plans
Natural Resource Conservation Service Conservation Stewardship Program
FDL Wetland Ordinance, MN Wetland Conservation Act, WOTUS rules, MN Construction Rules
MNDOT Road Design Manual
FHA Bridge Design Standards
Fond du Lac Integrated Resource Management Plan
Field Guide for Maintaining Rural Roadside Ditches, Protecting Lakes and Streams Through Proper Ditch Management
MPCA Stormwater Best Management Practices Manual
USEPA Green Infrastructure Manual
USEPA Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices
Field Manual on Sediment and Erosion Control: Best Management Practices for Contractors and Inspectors,
Partners
MNDOT, MN DNR, Carlton County, St. Louis County, NRCS, FHA, BIA, FEMA
Funding
State and county funding, NRCS, FHA
Urban
Existing BMPs
Stormwater ponds at the Black Bear Casino Complex
Demonstration green roof and rain garden at the Fond du Lac Resource Management Building
Demonstration native plant garden at the Center for American Indian Resources in Duluth
Stormwater pond at the expanded Min No Aya Win Clinic
Third Lake alum treatment, legacy manure management and grazer exclusion from riparian area
Big Lake workgroup to extend sewer service to septic system owners around Big Lake
Cleanups of major junkyards, such as on Strand Road and on Marshall Road
Cleanup crews pick up trash at public water landings and on roadsides
Relevant Guidelines
Construction General Permit Statutes
EPA Guidelines for Stormwater Pollution Prevention Plans
Natural Resource Conservation Service Conservation Stewardship Program
FDL Wetland Ordinance, MN Wetland Conservation Act, WOTUS rules, MN Shoreland Rules, MN Construction Rules
Fond du Lac Integrated Resource Management Plan
USEPA Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices
Minnesota Urban Small Sites BMP Manual: Stormwater Best Management Practices for Cold Climates
MPCA Plants for Stormwater Design
USEPA National Management Measures to Control Nonpoint Source Pollution from Urban Areas

Partners
MN DNR, Carlton County, St. Louis County, NRCS, BIA
Funding
Tribal Development Funds, EPA Brownfield Program
Wetland/Riparian Management
Existing BMPs
New narrative wetland water quality standards in updated water quality standards
CWAMP - Fond du Lac's wetland monitoring program
Using FDL Wetland Restoration Plan to inform NPS pollution BMPs
Partnering with USGS and MPCA to conduct mercury methylation study in St. Louis River watershed ditched wetlands
Education and outreach through school visits, public events and press releases and social media posts
Relevant Guidelines
Fond du Lac Invasive Species Management Plan
MNDNR's A Minnesota State Management Plan for Invasive Species
Fond du Lac Wetland Restoration Plan
Fond du Lac Wetland Monitoring Plan
FDL Invasive Species Ordinance, MN Noxious Weed Rules, FDL Wetland Ordinance, MN Wetland Conservation Act, WOTUS rules
Fond du Lac Integrated Resource Management Plan
US EPA Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices
Partners
MN DNR, MPCA, Carlton County, St. Louis County, NRCS, EPA Region 5 Wetlands Office, US FWS, US Army Corps, USGS
Funding
EPA Wetland Program Development Block Grants, Great Lakes Restoration Initiative
Invasive Species
Existing BMPs
Removing Chinese mystery snails from West Twin Lake and mapping locations
Setting rusty crayfish traps in lakes and streams on a rotating basis
Controlling invasive plants (purple loosestrife, wild parsnip, buckthorn, etc.) by using the approved and most effective control methods for each species, and mapping locations
Conducting aquatic plant surveys on Reservation lakes on a rotating basis
Setting and monitoring traps for the presence of emerald ash borer
Staffing boat launches and educating boat users
Decontaminating all Resource Management equipment after it has been out in the field; checklists for equipment cleaning
Education and outreach through school visits, public events and press releases and social media posts
Installing boot brush kiosks at Reservation buildings
Relevant Guidelines
Fond du Lac Invasive Species Management Plan
MN DNR's Minnesota State Management Plan for Invasive Species
MN Sea Grant Invasive Species Identification Guides, outreach materials on Clean, Drain, Dry

FDL Invasive Species Ordinance, MN Noxious Weed Rules
Fond du Lac Integrated Resource Management Plan
MNDNR's A Minnesota State Management Plan for Invasive Species
Partners
MN DNR, MN Sea Grant, Carlton County, St. Louis County, NRCS, MN Invasive Species Advisory Council
Funding
Great Lakes Restoration Initiative
Climate Change
Existing BMPs
Phenocam to record ice-on and ice-off dates at Joe Martin Lake
Water level loggers at five stream sites to track hydrologic and temperature changes due to climate change
Partnering with University of Minnesota to track biophysical changes in manoomin lakes due to climate change and other stressors
Education and outreach through school visits, public events and press releases and social media posts
Relevant Guidelines
Red Lake's Climate Change Monitoring Plan
1854 Treaty Authority Climate Change Vulnerability Assessment and Adaptation Plan
Dibaginjigaadeg Anishinaabe Ezhitwaad: A Tribal Climate Adaptation Menu.
Fourth National Climate Assessment, U.S. Global Change Research Program
Regional Monitoring Network
MN DNR: Minnesota's 2020 State Forest Action Plan
Fond du Lac Integrated Resource Management Plan
Climate Change Field Guide for Northern Minnesota Forests
Partners
1854 Treaty Authority, Red Lake Band of Chippewa, MN DNR, MPCA, Carlton County, St. Louis County, NRCS, EPA Region 5, EPA RMN, US FWS, US Forest Service, Army Corps, University of Minnesota
Funding
Great Lakes Restoration Initiative, National Science Foundation