E. coli Bacteria TMDL for the Wild Rice River in Sargent and Richland Counties, North Dakota

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1.0 INTRODUCTION AND DESCRIPTION OF THE WATERSHED

The Wild Rice River watershed is a 1.4 million-acre watershed located in Cass, Dickey, Ransom, Richland and Sargent Counties in southeastern North Dakota, and Marshall and Roberts Counties in northeastern South Dakota (Figure 1). For the purposes of this TMDL, the impaired watershed segments are located in Sargent and Richland Counties and comprise approximately 62,840 acres. The Wild Rice River impaired watershed segments lie within the Level III Northern Glaciated Plains (46) and Lake Agassiz Plain (48) Ecoregions.

Table 1. General Characteristics of the Wild Rice River Watershed.

Legal Name	Wild Rice River
Stream Classification	Class II
Major Drainage Basin	Red River
8-Digit Hydrologic Unit	09020105
Counties	Sargent and Richland
Level III Ecoregions	Northern Glaciated Plains (46) and Lake Agassiz Plain (48)
Watershed Area (acres)	62,840

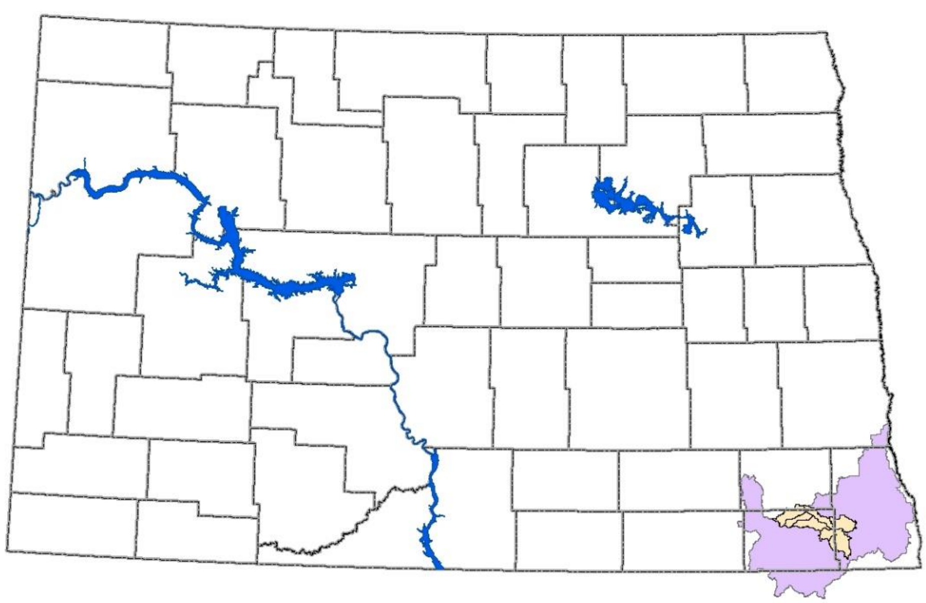

Figure 1. Wild Rice River Basin and TMDL Listed Segment Watersheds in North Dakota.

1.1 Clean Water Act Section 303(d) Listing Information

Based on the 2016 Section 303(d) List of Impaired Waters Needing TMDLs (NDDoH, 2017), the North Dakota Department of Health (NDDoH) has identified a 43.68 mile segment (ND-09020105-012-S_00) of the Wild Rice River from its confluence with Shortfoot Creek (ND-09020105-016-S_00) downstream to its confluence with Elk Creek (ND-09020105-010-S_00) as not supporting recreational use due to E. coli bacteria (Tables 2).

In 2011, the NDDoH revised the state water quality standard for bacteria from a fecal coliform bacteria standard to an E. coli bacteria standard for protection of recreational uses. Segment ND-09020105-012-S_00 was originally listed for a recreational use impairment due to fecal coliform bacteria and in 2010 a fecal coliform TMDL was approved by EPA Region 8. Following the completion of the fecal coliform TMDL, the NDDoH began collecting E. coli data and in 2014 listed the waterbody for a recreational use impairment due to E. coli bacteria. The purpose of this TMDL is to address the E. coli bacteria impairment. As a result, and due to the water quality standards change and newly gathered data, segment ND-09020105-012-S_00 will be delisted for fecal coliform bacteria impairment and this E. coli bacteria TMDL will supersede the previous fecal coliform bacteria TMDL.

Table 2. Wild Rice River Section 303(d) Listing Information for Assessment Unit ND-09020105-012-S_00 (NDDoH, 2017).

Assessment Unit ID	ND-09020105-012-S_00
Waterbody Description	Wild Rice River from its confluence with Shortfoot Creek (ND-09020105-016-S_00) downstream to its confluence with Elk Creek (ND-09020105-010-S_00)
Size	45.68 miles
Designated Use	Recreation
Use Support	Not Supporting
Impairment	E. coli Bacteria
TMDL Priority	High

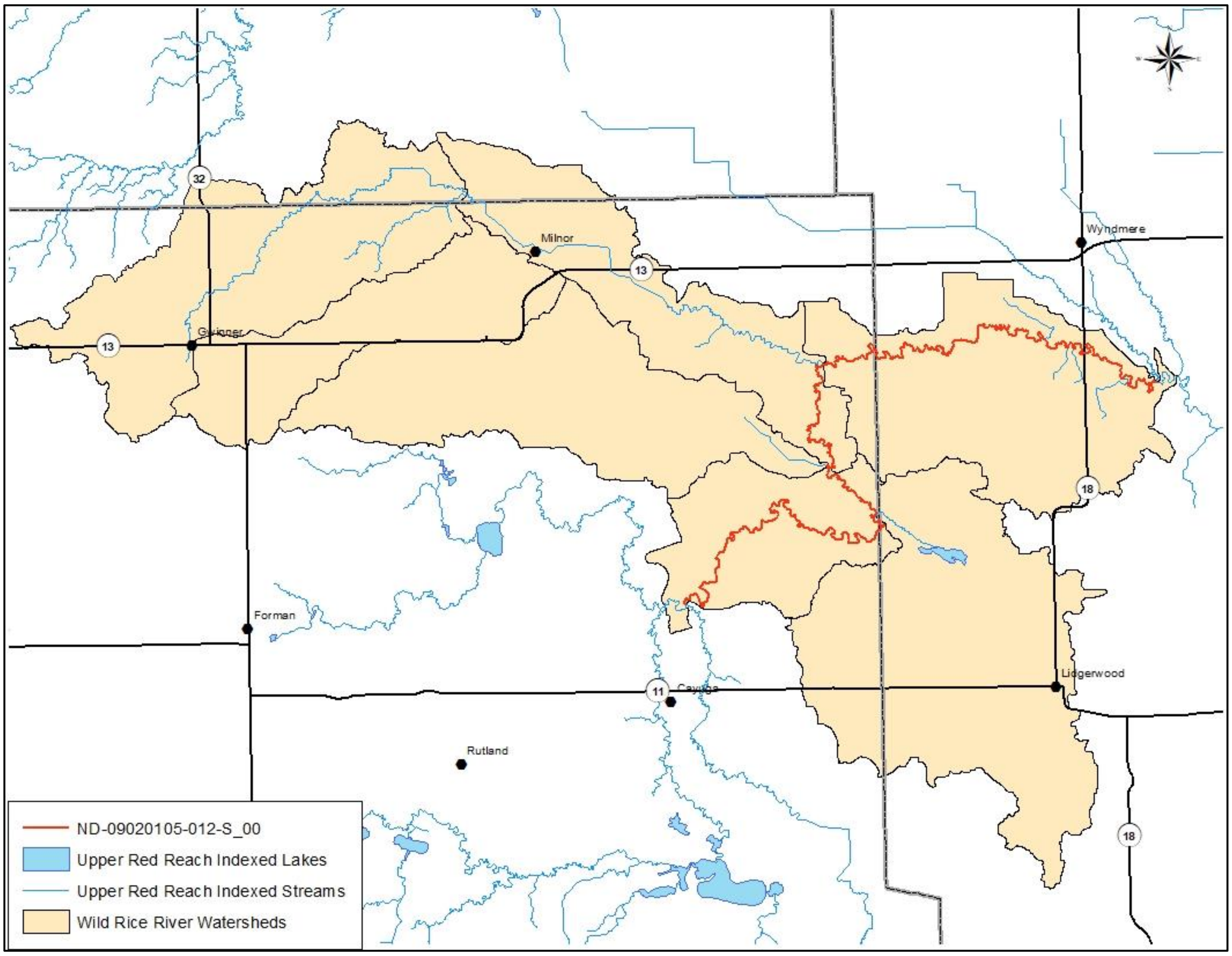

Figure 2. Wild Rice River TMDL Listed Segment.

1.2 Topography

The watershed for the Section 303(d) listed segment highlighted in this TMDL lies within the Level IV Tewaukon Dead Ice Moraine (46e), Drift Plains (46i), Glacial Lake Agassiz Basin (48a), and Sand Deltas and Beach Ridges (48b) ecoregions (Figure 3).

The Tewaukon Dead Ice Moraine (46e) ecoregion is a continuation of the Prairie Coteau extending below the Prairie Coteau Escarpment. A large density of semi-permanent wetlands provides feeding and nesting habitat for many species of waterfowl, with the remaining upland areas under cultivation.

The Drift Plains (46i) ecoregion was formed by the retreating Wisconsinan glacier that left a thick mantle of glacial till. The landscape consists of temporary and seasonal wetlands. Due to the productive soil of this ecoregion almost all of the area is under cultivation.

The Glacial Lake Agassiz Basin ecoregion (48a) is comprised of thick beds of glacial drift overlain by silt and clay lacustrine deposits from glacial Lake Agassiz. The topography of this ecoregion is extremely flat, with sparse lakes and pothole wetlands. Tallgrass prairie was the dominant habitat prior to European settlement, and has now been replaced with intensive agriculture. Agricultural production in the southern region consists of corn, soybeans, wheat, and sugar beets.

The Sand Deltas and Beach Ridges (48b) ecoregion disrupts the flat topography of the Red River Valley. The beach ridges are parallel lines of sand and gravel that were formed by wave action of the contrasting shoreline levels of Lake Agassiz. The deltas consist of lenses of fine to coarse sand and are blown into dunes (USGS, 2006).

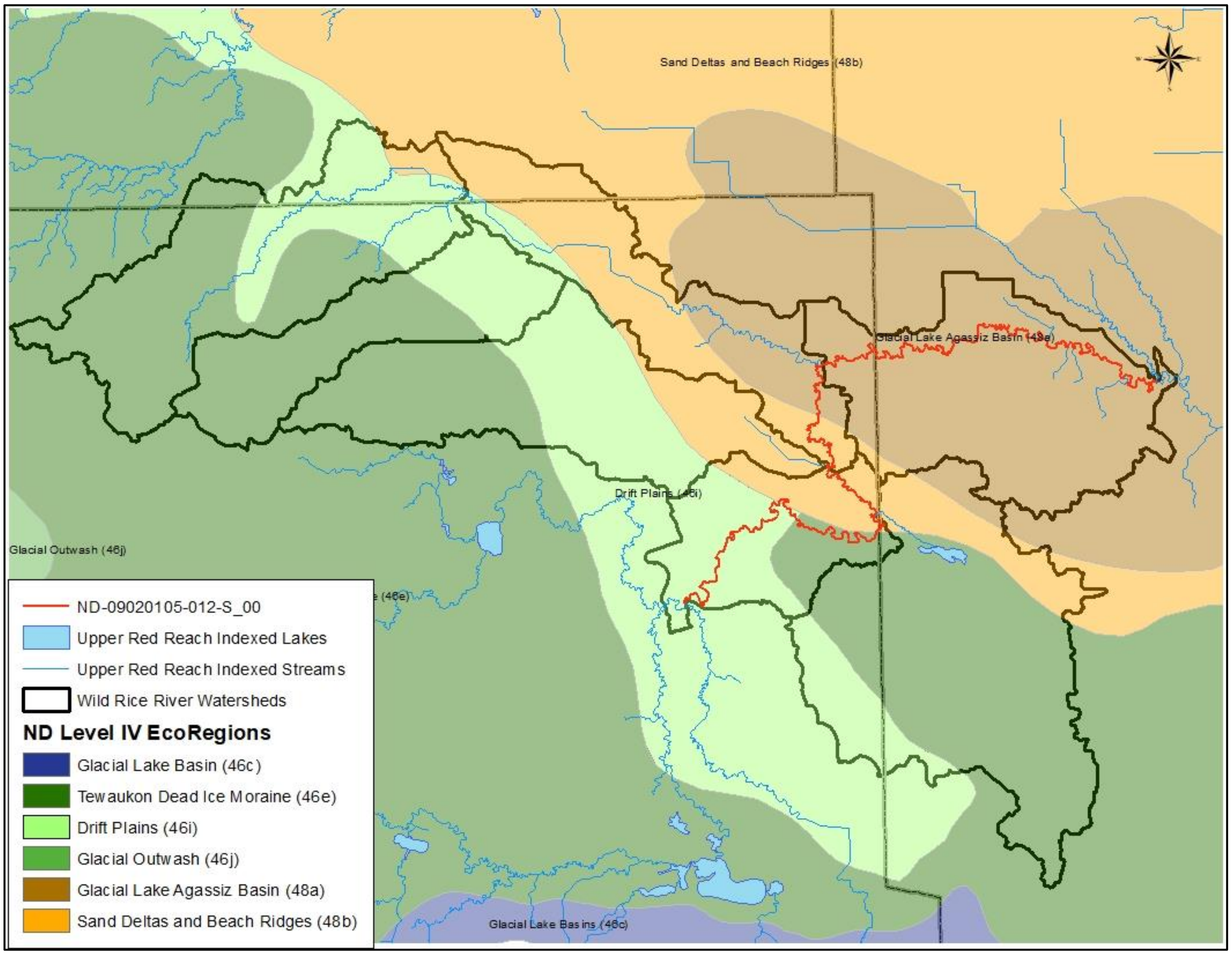

Figure 3. Level IV Ecoregions in the Wild Rice River TMDL Listed Segment Watershed.

1.3 Land Use

The dominant land use in the Wild Rice River TMDL listed segment watershed is row crop agriculture. According to the 2016 National Agricultural Statistical Service (NASS) land survey data, approximately 70 percent of the land is cropland, 8 percent is grassland, and 14 percent is wetlands. The remaining 8 percent is either developed space, woods, barren, hayland, or alfalfa. Most of the crops grown consist of soybeans, corn, spring wheat and alfalfa, with some grazing done within the watershed (Figure 4). Unpermitted animal feeding operations and “hobby farms” are also present in the Wild Rice River watershed, but their numbers and locations are unknown.

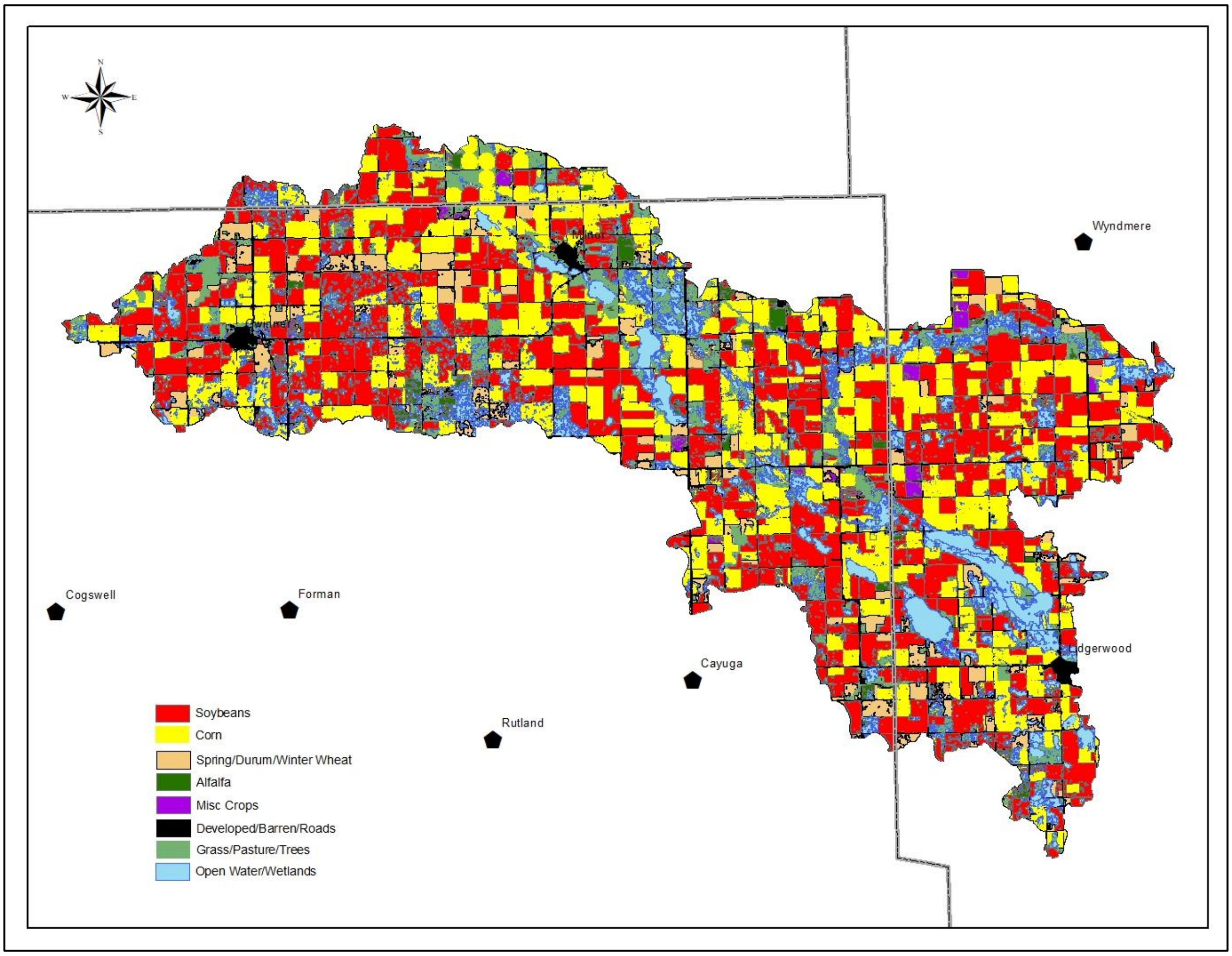

Figure 4. Land Use in the Wild Rice River TMDL Listed Segment Watershed (NASS, 2016).

1.4 Climate and Precipitation

Figures 5 and 6 show the monthly precipitation and temperature for the period 2010-2014 for the North Dakota Agriculture Weather Network (NDAWN) site located near Wyndmere, ND which is located near the Wild Rice River watershed. Sargent and Richland Counties have a sub humid climate characterized by warm summers with frequent hot days and occasional cool days. Average temperatures range from 12º F in winter to 60º F in summer. Precipitation occurs primarily during the warm period and is normally heavy in later spring and early summer. Total annual precipitation is about 20 inches.

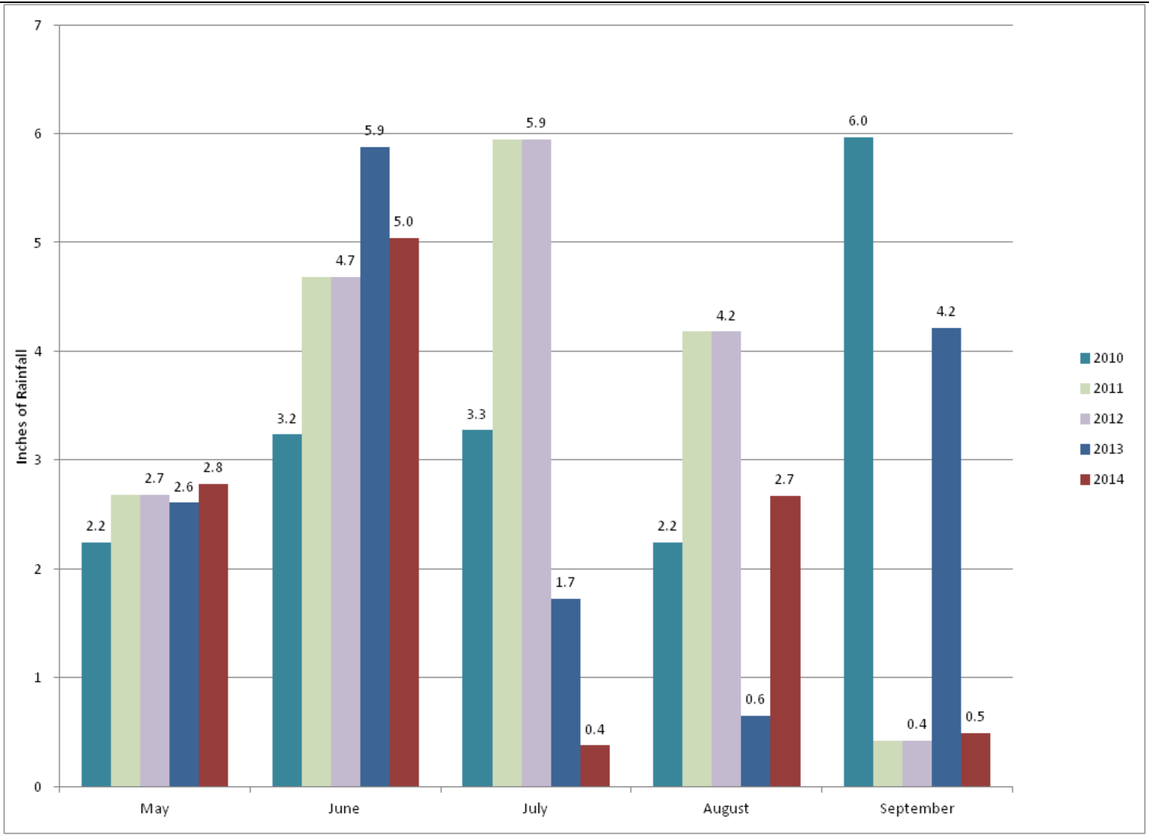

Figure 5. Monthly Precipitation at Wyndmere, North Dakota from 2010-2014 (NDAWN, 2016).

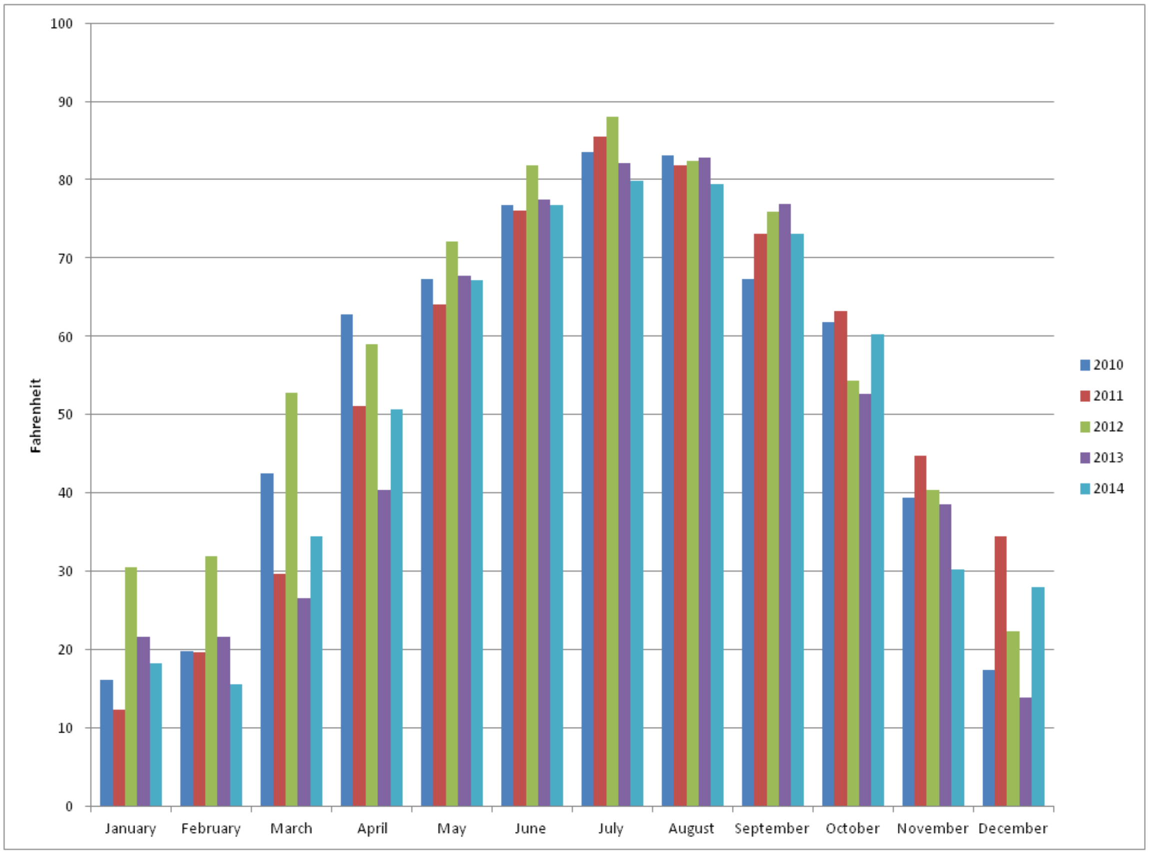

Figure 6. Monthly Air Temperature at Wyndmere, North Dakota from 2010-2014 (NDAWN, 2016).

1.5 Available Data

1.5.1 E. coli Bacteria Data

E. coli bacteria samples were collected at one location within the TMDL listed reach (Figure 7). The monitoring site 385234 is located six miles west and three miles south of Wyndmere, ND. Site 385234 was monitored weekly or when flow conditions were present during the recreation season of 2011 to 2014 by the Sargent County Soil Conservation District.

Table 3 provides a summary of E. coli geometric mean concentrations, the percentage of samples exceeding 409 CFU/100mL for each month and the recreational use assessment by month. The geometric mean E. coli bacteria concentration and the percent of samples over 409 CFU/100mL was calculated for each month (May-September) using those samples collected during each month in 2011 to 2014.

Table 3. Summary of E. coli Bacteria Data for Site 385234 Data Collected in 2011-2014.

Month	N	Geometric Mean Concentration (CFU/100mL)	Percentage of Samples Exceeding 400 CFU/100mL	Recreational Use Assessment
May	28	64	18%	Fully Supporting but Threatened
June	30	87	7%	Fully Supporting
July	30	102	7%	Fully Supporting
August	34	111	6%	Fully Supporting
September	30	153	13%	Not Supporting

Based on the data collected in 2011 to 2014, geometric mean and percent exceeded calculations determined that during the month of September, the TMDL listed segment of the Wild Rice River was not supporting recreational beneficial use. The months of June, July, and August were fully supporting, while May was fully supporting but threatened the recreational beneficial use (Appendix A).

1.5.2 Hydraulic Discharge

A discharge record was constructed for the listed segment using the Drainage Area Ratio Method (Ries et al., 2000) and the historical discharge measurements collected by the USGS at gauging station 05052000 from 2011-2014.

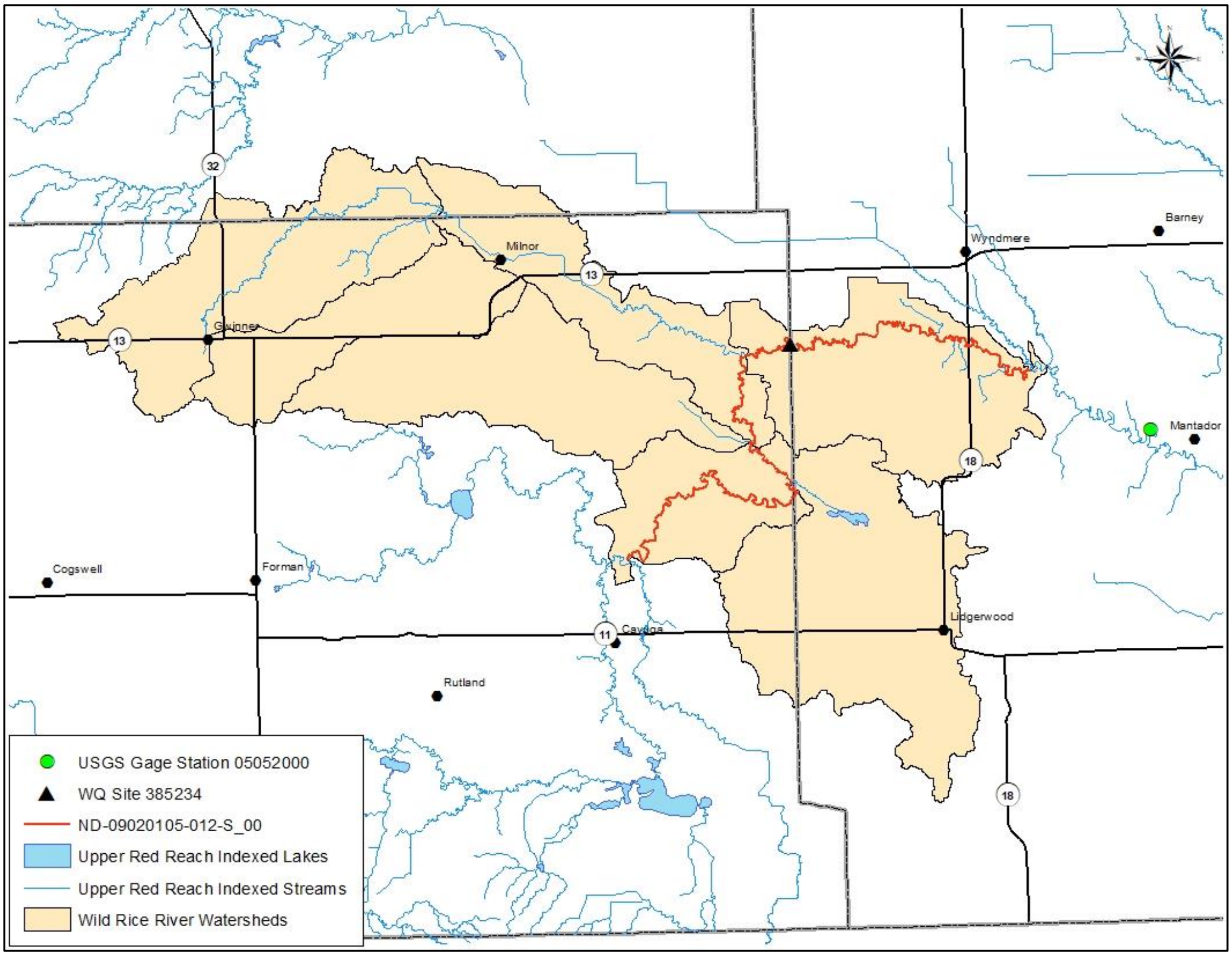

Figure 7. E. coli Bacteria Sample Site and USGS Gauge Station (05052000) on the TMDL Listed Segment of the Wild Rice River.

2.0 WATER QUALITY STANDARDS

The Clean Water Act requires that TMDLs be developed for waters on a state's Section 303(d) list. A TMDL is defined as "the sum of the individual wasteload allocations for point sources and load allocations for non point sources and natural background" such that the capacity of the waterbody to assimilate pollutant loadings is not exceeded. The purpose of a TMDL is to identify the pollutant load reductions or other actions that should be taken so that impaired waters will be able to attain water quality standards. TMDLs are required to be developed with seasonal variations and must include a margin of safety that addresses the uncertainty in the analysis. Separate TMDLs are required to address each pollutant or cause of impairment, which in this case is E. coli bacteria.

2.1 Narrative Water Quality Standards

The NDDoH has set narrative water quality standards that apply to all surface waters in the State. The narrative general water quality standards are listed below (NDDoH, 2014).

- All waters of the State shall be free from substances attributable to municipal, industrial, or other discharges or agricultural practices in concentrations or combinations that are toxic or harmful to humans, animals, plants, or resident aquatic biota.

- No discharge of pollutants, which alone or in combination with other substances shall:

  a. Cause a public health hazard or injury to environmental resources;
  b. Impair existing or reasonable beneficial uses of the receiving water; or
  c. Directly or indirectly cause concentrations of pollutants to exceed applicable standards of the receiving waters.

In addition to the narrative standards, the NDDoH has set a biological goal for all surface waters in the state. The goal states "the biological condition of surface waters shall be similar to that of sites or waterbodies determined by the department to be regional reference sites" (NDDoH, 2014).

2.2 Numeric Water Quality Standards

The impaired segment of the Wild Rice River is a Class II stream. The NDDoH definition of a Class II stream is shown below (NDDoH, 2014).

Class II- The quality of the waters in this class shall be the same as the quality of class I streams, except that additional treatment may be required to meet the drinking water requirements of the department. Streams in this classification may be intermittent in nature which would make these waters of limited value for beneficial uses such as municipal water, fish life, irrigation, bathing, or swimming.

Table 4 provides a summary of the current numeric E. coli criteria which applies to all streams. The E. coli bacteria standard applies only during the recreation season from May 1 to September 30.

Table 4. North Dakota E. coli Bacteria Water Quality Standards for all Streams.

Parameter	Standard	
	Geometric Mean[1]	Maximum[2]
E. coli Bacteria	126 CFU/100 mL	409 CFU/100 mL

[1] Expressed as a geometric mean of representative samples collected during any consecutive 30-day period.
[2] No more than 10 percent of samples collected during any consecutive 30-day period shall individually exceed the standard.

2.3 Antidegradation Policy

A third element called antidegradation is included in the water quality standards. Antidegradation policy and procedures have been established by NDDoH as necessary in the protection of waterbodies with current water quality exceeding already applicable standards. This was created to intentionally maintain these particular water resources at their high quality, above the level of water quality standards currently in place. This Policy is for activities such as Section 401, 402 and 404 of the Clean Water Act. (NDDoH, 2014).

The antidegradation implementation procedure delineates the process that will be followed by the North Dakota State Department of Health for implementing the antidegradation policy found in the Standards of Water Quality for the State of North Dakota, Rule 33-16-02.

Under this implementation procedure, all waters of the state are afforded one of three different levels of antidegradation protection. All existing users, and the water quality necessary for those uses, shall be maintained and protected. Antidegradation requirements are necessary whenever a regulated activity is proposed that may have some effect on water quality.

Regulated actions include permits issued under Section 402 (NDPDES) and 404 (Dredge and Fill) of the Clean Water Act (CWA), and any other activity requiring Section 401 water quality certification. **Nonpoint sources of pollution are not included.** When reviewing 404 nationwide permits, the department will issue 401 certifications only where it determines that the conditions imposed by such permits are expected to result in attainment of the applicable water quality standards, including the antidegradation requirements.

However, it is anticipated that the department will exclude certain nationwide permits from the antidegradation procedures for Category1 waters on the basis that the category of activities covered by the permit is not expected to have significant permanent effects on the quality and beneficial uses of those waters, or the effects will be appropriately minimized and temporary.

3.0 TMDL TARGETS

A TMDL target is the value that is measured to judge the success of the TMDL effort. TMDL targets must be based on state water quality standards, but can also include site specific values when no numeric criteria are specified in the standard. The following TMDL target for the Wild Rice River is based on the NDDoH water quality standard for E. coli bacteria.

3.1 Wild Rice River Target Reductions in E. coli Bacteria Concentrations

The Wild Rice River segment (ND-09020105-012-S_00) is impaired for recreational use due to E. coli bacteria concentrations exceeding the North Dakota water quality standard. The North Dakota water quality standard for E. coli bacteria is a geometric mean concentration of 126 CFU/100 mL during the recreation season from May 1 to September 30. Thus, the TMDL target for this report is 126 CFU/100 mL. In addition, no more than ten percent of samples collected for E. coli bacteria should exceed 409 CFU/100 mL.

While the standard is intended to be expressed as the 30-day geometric mean, for purposes of these TMDLs, the target is based on an E. coli concentration of 126 CFU/100 mL expressed as a daily average based on individual grab samples. Expressing the target in this way will ensure the TMDL will result in both components of the standard being met, and recreational uses are restored.

4.0 SIGNIFICANT SOURCES

4.1 Point Source Pollution Sources

Within the watersheds of the TMDL listed reach of the Wild Rice River there are two cities located within the tributary watershed of impaired reach ND-09020105-012-S_00 which are Gwinner and Milnor, ND. Each town has a permitted wastewater treatment system through the North Dakota Pollutant Discharge Elimination System (NDPDES) Program. Each system is allowed to discharge on an "as needed" basis. Monitoring E. coli bacteria is not required in any of the NDPDES permits, therefore no data is available. The Gwinner facility will not be given a wasteload allocation due to its proximity (over 20 miles) from the impaired reach ND-09020105-012-S_00.

There are seven permitted animal feeding operations (AFOs) in the TMDL listed segment watershed of the Wild Rice River. The NDDoH has permitted one large (1,000 + animal units (AUs)), four medium (301-999 AUs) and two small (0-300 (AUs)) AFOs to operate. All seven AFOs are zero discharge facilities and are not deemed a significant point source of E. coli bacteria loadings to the Wild Rice River.

4.2 Nonpoint Source Pollution Sources

The TMDL listed segment on the Wild Rice River is experiencing E. coli bacteria pollution from nonpoint sources in the watershed. This assessment is also supported by utilizing landuse data, load duration curve analysis and the Wild Rice River Restoration and Riparian Project PIP.

The Wild Rice River Restoration and Riparian Project identified potential sources of E. coli bacteria pollution which includes runoff from manure from cropland, pasture and animal feeding operations, direct deposit of manure from livestock, leaking septic systems and wildlife. Also success of the Antelope Creek Watershed and the Riparian Corridor of the Wild Rice River Implementation Project has identified and implemented various best management practices including septic system renovations.

5.0 TECHNICAL ANALYSIS

In TMDL development, the goal is to define the linkage between the water quality target and the identified source or sources of the pollutant (i.e., E. coli bacteria) to determine the load reduction needed to meet the TMDL target. To determine the cause and effect relationship between the water quality target and the identified source, the "load duration curve" methodology was used.

The loading capacity or TMDL is the amount of a pollutant (e.g., E. coli bacteria) a waterbody can receive and still meet and maintain water quality standards and beneficial uses.

5.1 Mean Daily Stream Flow

In southeastern North Dakota, rain events are variable occurring during the months of April through August. Rain events can be sporadic and heavy or light, occurring over a short duration. Precipitation events of large magnitude, occurring at a faster rate than absorption, contribute to high runoff events. These events are represented by runoff in the high flow regime. The medium flow regime is represented by runoff that contributes to the stream over a longer duration. The low flow regime is characteristic of drought or precipitation events of small magnitude and do not contribute to runoff.

Flows for TMDL segment (ND-09020105-012-S_00) was determined by utilizing the Drainage-Area Ratio Method developed by the USGS (Ries et. al, 2000 and Emerson, Vecchia, and Dahl, 2005). The Drainage-Area Ratio Method assumes that the streamflow at the ungauged site is hydrologically similar (same per unit area) to the stream gauging station used as an index. This assumption is justified since the ungauged site (385234) is nested on the same reach as the index station (05052000).

Streamflow data for the index station (05052000) was obtained from the USGS Water Science Center website. The index station (05052000) streamflow data was then divided by the drainage area to determine streamflows per unit area at the index station. Those values are then multiplied by the drainage area for the ungauged site and a seasonal regression equation (Emerson, Vecchia, and Dahl, 2005) to obtain estimated flow statistics for the ungauged site.

Winter: $Qy = 1.24(Ay/Ax)^{0.85}\,Qx$

Spring: $Qy = 1.02(Ay/Ax)^{0.91}\,Qx$

Summer: $Qy = 1.06(Ay/Ax)^{1.02}\,Qx$

5.2 Flow Duration Curve Analysis

The flow duration curve serves as the foundation for the load duration curve used in the TMDL. Flow duration curve analysis looks at the cumulative frequency of historic flow data over a specified time period. A flow duration curve relates flow (expressed as mean daily discharge) to the percent of time those mean daily flow values have been met or exceeded. The use of *"percent of time exceeded"* (i.e., duration) provides a uniform scale ranging from 0 to 100 percent, thus accounting for the full range of stream flows for the period of record. Low flows are exceeded most of the time, while flood flows are exceeded infrequently (EPA, 2007).

A basic flow duration curve runs from high to low (0 to 100 percent) along the x-axis with the corresponding flow value on the y-axis (Figure 8). Using this approach, flow duration intervals are expressed as a percentage, with zero corresponding to the highest flows in the record (i.e., flood conditions) and 100 to the lowest flows in the record (i.e., drought and/or freeze over). Therefore, as depicted in Figure 8, a flow duration interval of twenty five (25) percent, associated with a stream flow of 153 cfs, implies that 25 percent of all observed mean daily discharge values equal or exceed 153 cfs.

Once the flow duration curve is developed for the stream site, flow duration intervals can be defined which can be used as a general indicator of hydrologic condition (i.e., wet vs. dry conditions and to what degree). These intervals or zones provide additional insight about conditions and patterns associated with the impairment (E. coli bacteria in this case) (EPA, 2007).

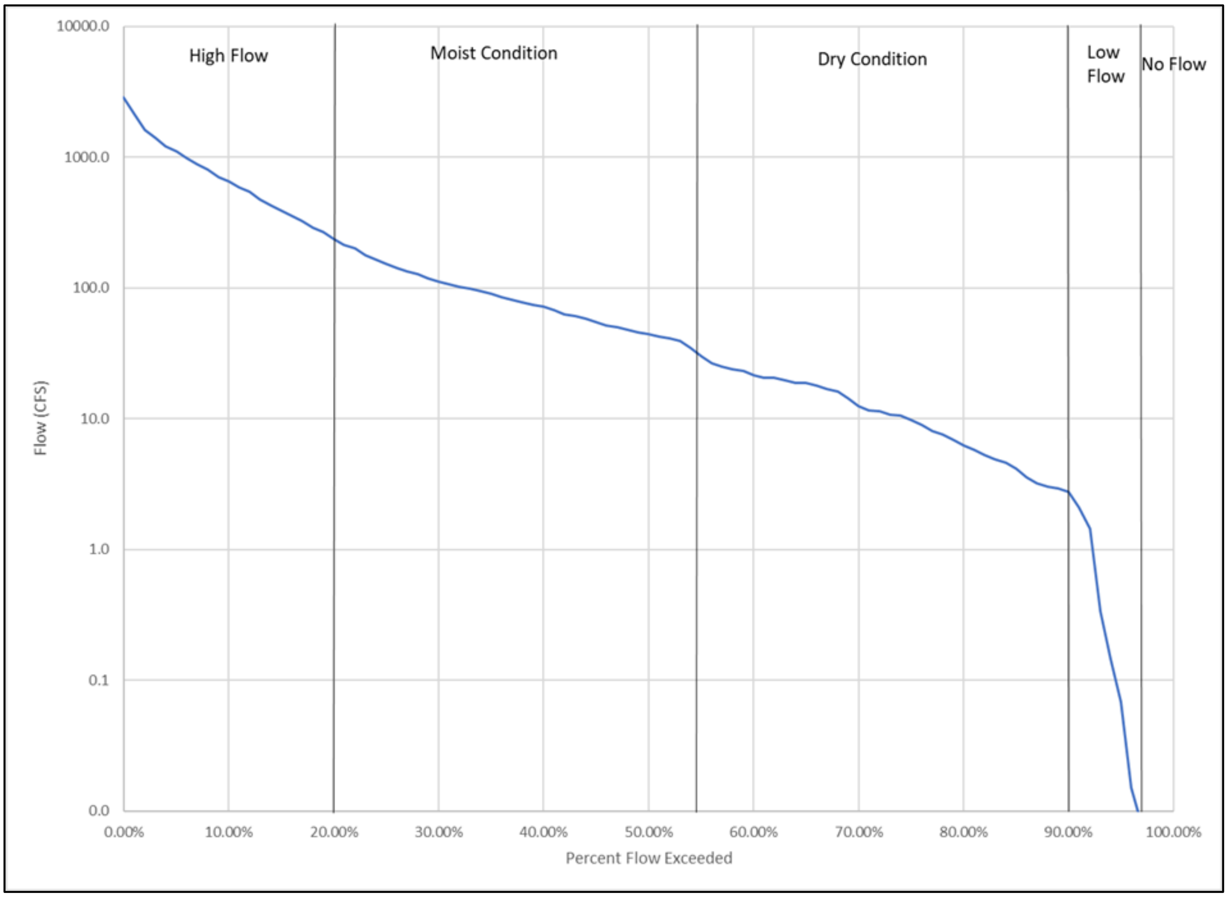

Figure 8. Flow Duration Curve for the Wild Rice River Monitoring Station 385234 at Wyndmere, North Dakota and USGS Station 05052000 near Matador, North Dakota.

5.3 Load Duration Analysis

An important factor in determining Nonpoint Source Pollution (NPS) loads is variability in stream flows and loads associated with high and low flow. To better correlate the relationship between the pollutant of concern and the hydrology of the Section 303(d) TMDL listed segment, a load duration curve was developed for the Wild Rice River TMDL listed segment. The load duration curve for the TMDL listed reach was derived using the E. coli bacteria TMDL target of 126 CFU/100 mL and the flow generated as described in Sections 5.1 and 5.2.

Observed in-stream E. coli bacteria data obtained from monitoring site 385234 in 2011 through 2014 (Appendix A) were converted to a pollutant load by multiplying E. coli bacteria concentrations by the mean daily flow and a conversion factor. These loads are plotted against the percent exceeded of the flow on the day of sample collection (Figure 8). Points plotted above the 126 CFU/100 mL target curve exceed the State water quality target. Points plotted below the curve are meeting the State water quality target of 126 CFU/100 mL.

For each flow interval or zone, a regression relationship was developed between the samples which occur above the TMDL target (126 CFU/100 mL) curve and the corresponding percent exceeded flow. The load duration curve for site 385234 depicting the regression relationship for each flow interval is provided in Figure 8.

The regression lines for the high, moist and dry condition and low flows for site 385234 were then used with the midpoint of the percent exceeded flow for that interval to calculate the existing E. coli bacteria load for that flow interval. In the example provided in Figure 8, the regression relationship between observed E. coli bacteria loading and percent exceeded flow for the high, moist condition, dry condition, and low flow interval are:

E. coli bacteria load (expressed as 10^7 CFUs/day) = antilog (Intercept + (Slope*Percent Exceeded Flow))

Where the midpoint of the high flow interval from 0.01 to 20 percent is 10.0 percent, the existing E. coli bacteria load is

E. coli bacteria load (10^7 CFUs/day) = antilog (6.53+ (-5.93*0.10))
= 865,731 x 10^7 CFUs/day

Where the midpoint of the moist condition interval from 20 to 55 percent is 37.5 percent, the existing E. coli bacteria load is

E. coli bacteria load (10^7 CFUs/day) = antilog (5.88+ (-2.98*0.375))
= 57,623 x 10^7 CFUs/day

Where the midpoint of the dry condition interval from 55 to 90 percent is 72.5 percent, the existing E. coli bacteria load is

E. coli bacteria load (10^7 CFUs/day) = antilog (6.64+ (-3.66*0.725))
= 9,683 x 10^7 CFUs/day

Where the midpoint of the low flow interval from 90 to 97 percent is 93.5 percent, the existing E. coli bacteria load is

E. coli bacteria load (10^7 CFUs/day) = antilog (53.37+ (-54.19*0.935))
= 507 x 10^7 CFUs/day

The midpoint for the flow intervals is also used to estimate the TMDL target load. In the case of the previous examples, the TMDL target load for the midpoints or 10.0, 37.5, 72.5 and 93.5 percent exceeded flow derived from the 126 CFU/100 mL TMDL target curves are 201,666 x 10^7 CFUs/day, 24,560 x 10^7 CFUs/day, 3,300 x 10^7 CFUs/day, and 63 x 10^7 CFUs/day, respectively.

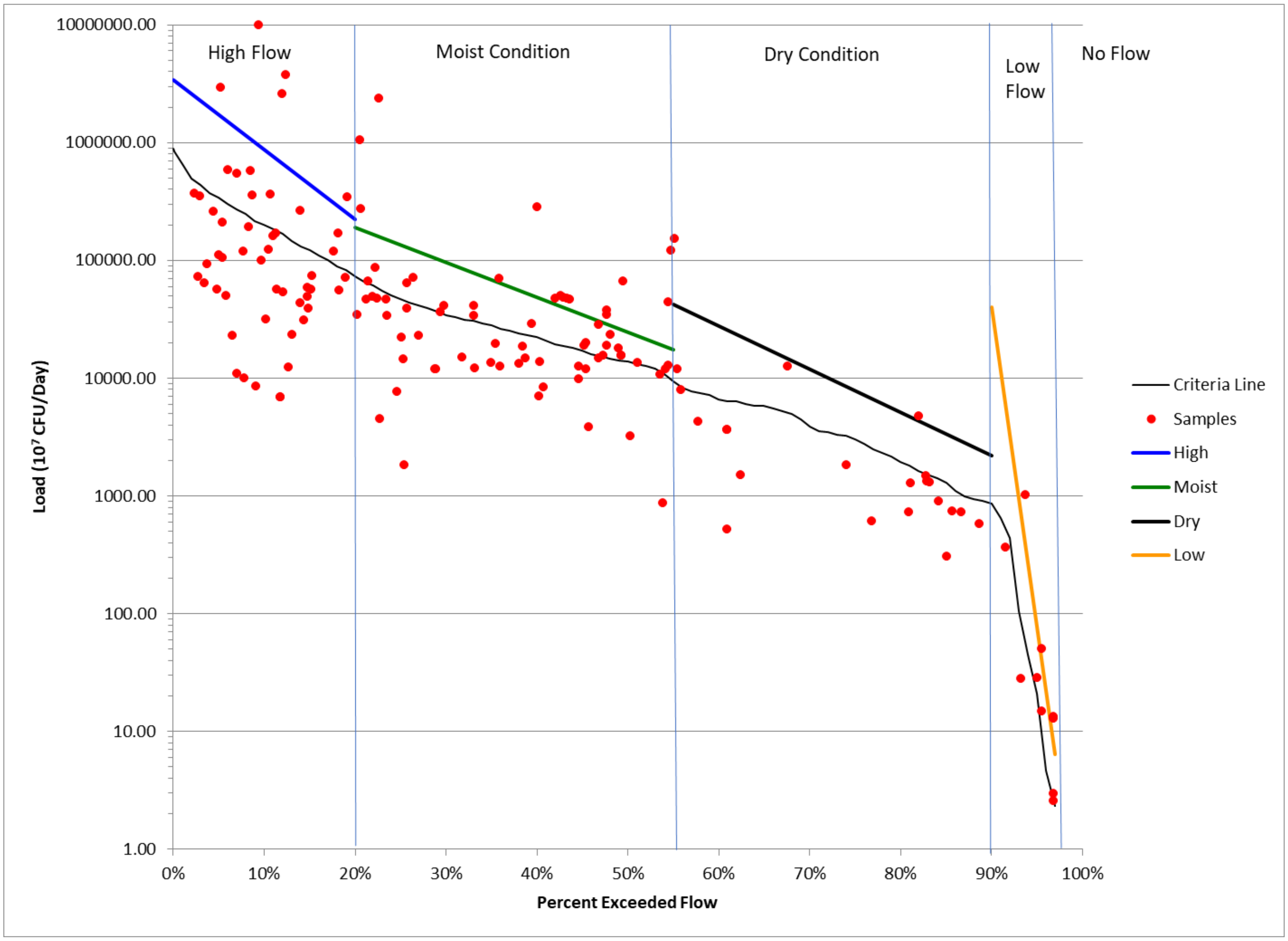

Figure 9. Load Duration Curve for the Wild Rice River Monitoring Station 385234; (The curve reflects flows collected from 2011-2014).

5.4 Wasteload Allocation Analysis

Waste load allocation calculations for the city of Milnor, ND will be calculated based on the following criteria:

1) The maximum daily discharge will be used in wasteload allocation calculations. This value was chosen because it represents the highest discharge volume on record that the facility has produced and will allow for flexibility in bacterial loading, due to the variability of the facilities discharge volumes and durations.

2) Since no E. coli bacteria data has been collected, the systems are assigned the water quality standards value of 126 CFU/100mL for this TMDL. This value was chosen both because it is the North Dakota water quality standard, and because those dischargers throughout the state that are required to sample for bacteria are assigned this same value in their permit.

It should also be noted that this facility is allowed under their NDPDES permit to discharge on an "as needed" basis.

5.4.1 Milnor, ND Wastewater Treatment System

The city of Milnor, ND has one permitted wastewater treatment system (Figure 2). Discharge monitoring reports (DMRs) indicate this wastewater treatment system discharged two times in 2011 and once each in 2013 and 2014 during the recreational season. The largest discharge occurred on July 26, 2013, the total discharge volume was 17.49 million gallons for the duration of 9 days (Appendix D). This calculates to a maximum daily discharge of 1.94 million gallons per day (MGD) (Appendix D).

Since no E. coli bacteria data are collected as a permit requirement, an E. coli bacteria concentration of 126 CFUs/100 mL is assumed for the wasteload allocation calculation. The wasteload allocation for Milnor, ND was determined by taking the maximum daily discharge volume of 1.94 MGD multiplied by an E. coli bacteria concentration of 126 CFUs/100 mL, times appropriate conversion factors.

WLA = 1.94 million gallons/ day * 126 CFUs/100mL

= 1.94 million gallons/day * 3.7854 L/gal*1000mL/L* 126 CFU/100mL

= 925.3 x 10^7 CFUs/day

5.4 Loading Sources

The majority of load reductions can generally be allotted to nonpoint sources. However, to account for uncertainty due to periodic discharges from permitted municipal facility (e.g., Milnor, ND), WLA is included for the impaired segment ND-09020105-012-S_00. The most significant sources of E. coli bacteria loading were defined as nonpoint source pollution originating from livestock, septic systems and wildlife. Based on the data available, the general focus of best management practices (BMPs) and load reductions for the listed segments should be on livestock activities, septic systems and unpermitted AFOs in close proximity of the mainstem Wild Rice River. One of the more important concerns regarding nonpoint sources is variability in stream flows.

Variable stream flows often cause different source areas and loading mechanisms to dominate (Cleland, 2003). As previously described, four flow regimes (i.e., High, Moist and Dry Conditions and Low Flow) were selected to represent the hydrology of the listed segment when applicable (Figure 9). The four flow regimes were used for site 385234 because samples indicated exceedances of the water quality standard during periods of high, moist, dry and low flows.

By relating runoff characteristics to each flow regime, one can infer which sources are most likely to contribute to E. coli bacteria loading. Animals grazing in the riparian area contribute E. coli bacteria by depositing manure where it has an immediate impact on water quality. Due to the close proximity of manure to the stream or by direct deposition in the stream, riparian grazing impacts water quality at high flow or under moist and dry conditions (Table 5). In contrast, intensive grazing of livestock in the upland and not in the riparian area has a high potential to impact water quality at high flows, and under moist conditions impact at moderate flows (Table 5). Exclusion of livestock from the riparian area eliminates the potential of direct manure deposit and therefore is considered to be of high importance at all flows. However, intensive grazing in the upland creates the potential for manure accumulation and availability for runoff at high flows and a high potential for E. coli bacteria contamination.

Table 5. Nonpoint Sources of Pollution and Their Potential to Pollute at a Given Flow Regime.

Nonpoint Sources	Flow Regime		
	High Flow	Moist Conditions	Dry Conditions
Riparian Area Grazing (Livestock)	H	H	H
Animal Feeding Operations	H	M	L
Manure Application to Crop and Range Land	H	M	L
Intensive Upland Grazing (Livestock)	H	M	L

Note: Potential importance of nonpoint source area to contribute E. coli bacteria loads under a given flow regime. (H: High; M: Medium; L: Low)

6.0 MARGIN OF SAFETY AND SEASONALITY

6.1 Margin of Safety

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency (EPA) regulations require that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality." The margin of safety (MOS) can be either incorporated into conservative assumptions used to develop the TMDL (implicit) or added to a separate component of the TMDL (explicit).

To account for the uncertainty associated with known sources and the load reductions necessary to reach the TMDL target of 126 CFU/100 mL, a ten percent explicit margin of safety was used for these TMDLs. The MOS was calculated as ten percent of the TMDL.

6.2 Seasonality

Section 303(d)(1)(C) of the Clean Water Act and associated regulations require that a TMDL be established with seasonal variations. The TMDLs which are included in this report address seasonality because the flow duration curve for the Wild Rice River segment (ND-090200105-012-S_00) was developed using 2011 to 2014 flow data (4 years). Additionally, the water quality standard is seasonally based on the recreation season from May 1 to September 30 and controls will be designed to reduce E. coli bacteria loads during the seasons covered by the standard.

7.0 TMDL

Table 6 provides an outline of the critical elements of the E. coli bacteria TMDL for the TMDL listed segment. A TMDL for the Wild Rice River (ND-09020105-012-S_00) is summarized in Table 7. The TMDL provides a summary of average daily loads by flow regime necessary to meet the water quality target (i.e., TMDL). The TMDL load includes a load allocation from known nonpoint sources and a 10 percent margin of safety. It should be noted that the TMDL loads, load allocations, and the MOS are estimated based on available data and reasonable assumptions and are to be used as a guide for implementation. The actual reduction needed to meet the applicable water quality standards may be higher or lower depending on the results of future monitoring.

Table 6. TMDL Summary for the Wild Rice River.

Category	Description	Explanation
Beneficial Use Impaired	Recreation	Contact Recreation (i.e. swimming, fishing)
Pollutant	E. coli Bacteria	See Section 2.1
TMDL Target	126 CFU/100 ml	Based on the current State water quality standard for E. coli bacteria. Monitoring will be conducted to determine compliance with the current water quality standard of 126 CFU/100 mL
Significant Sources	Nonpoint Point	Includes nonpoint sources to the segment (e.g. unpermitted AFOs and riparian grazing) and waste load allocation for Milnor, ND
Margin of Safety (MOS)	Explicit	10 percent

TMDL = LC = WLA + LA + MOS

where

LC = loading capacity, or the greatest loading a waterbody can receive without violating water quality standards;

WLA = waste load allocation, or the portion of the TMDL allocated to existing or future point sources;

LA = load allocation, or the portion of the TMDL allocated to existing or future non-point sources;

MOS = margin of safety, or an accounting of the uncertainty about the relationship between pollutant loads and receiving water quality. The margin of safety can be provided implicitly through analytical assumptions or explicitly by reserving a portion of the loading capacity.

Table 7. E. coli Bacteria TMDL (10^7 CFU/day) for the Wild Rice River Waterbody ND-09020105-012-S_00 as represented by Site 385234.

	Flow Regime			
	High Flow	Moist Conditions	Dry Conditions	Low Flow
Existing Load	865,730	57,623	9,683	507
TMDL	201,666	24,560	3,299	62
WLA	952.3	952.3	952.3	0
LA	180,547.1	21,142.7	2,016.8	55.8
MOS	20,166.6	2,465	329.9	6.2

8.0 ALLOCATION

Nonpoint source pollution is the sole contributor to elevated E. coli bacteria levels in the Wild Rice River watershed. However, to account for uncertainty due to periodic discharges from the permitted municipal facility (e.g., Milnor, ND). A WLA is included for the impaired segment ND-09020105-012-S_00 for the high, moist and dry condition flow regimes. The low flow regime will not have a WLA for the city of Milnor, ND due to extremely low existing and TMDL E. coli bacteria loads. Therefore, the entire load allocation for low flow will be given to nonpoint sources.

The E. coli bacteria samples and load duration curve analysis of the impaired reach identified the high, moist and dry condition and low flow regimes as the time of E. coli bacteria exceedances of the 126 CFU/100 mL target. To reduce NPS pollution for the high, moist and dry condition and low flow regimes, specific “Best management practices” (BMPs) are described in Section 8.1 that will mitigate the effects of E. coli bacteria loading to the impaired reach.

Based on the potential sources identified by the Wild Rice River Restoration and Riparian Project, the general focus of BMPs and load reductions for impaired segment ND-09020105-012-S_00 will be on riparian grazing, failing septic systems and unpermitted animal feeding operations adjacent to or in close proximity of the Wild Rice River.

To achieve the TMDL targets identified in the report, it will require the widespread support and voluntary participation of landowners and residents in the watershed. The TMDL described in this report are a plan to improve water quality by implementing BMPs through non-regulatory approaches. BMPs are methods, measures, or practices that are determined to be a reasonable and cost-effective means for a land owner to meet nonpoint source pollution control needs,” (USEPA, 2001). This TMDL plan is put forth as a recommendation for what needs to be accomplished for the Wild Rice River and associated watershed to restore and maintain its recreational uses. Water quality monitoring should continue in order to measure BMP effectiveness and determine through adaptive management if loading allocation recommendations need to be adjusted.

Controlling nonpoint sources is an immense undertaking requiring extensive financial and technical support. Provided that technical/financial assistance is available to stakeholders, these BMPs have the potential to significantly reduce E. coli bacteria loading to the Wild Rice River.

8.1 Livestock Management Recommendations

Livestock management BMPs are designed to promote healthy water quality and riparian areas through management of livestock and associated grazing land. Fecal matter from livestock, erosion from poorly-managed grazing, land and riparian areas can be a significant source of E. coli bacteria loading to surface water. Precipitation, plant cover, number of animals, and soils are factors that affect the amount of bacteria delivered to a waterbody because of livestock. These specific BMPs are known to reduce nonpoint source pollution from livestock. These BMPs include:

Livestock exclusion from riparian areas- This practice is established to remove livestock from grazing riparian areas and watering in the stream. Livestock exclusion is accomplished through fencing. A reduction in stream bank erosion can be expected by minimizing or eliminating hoof trampling. A stable stream bank will support vegetation that will hold the bank in place and serve a secondary function as a filter from nonpoint source runoff. Added vegetation will create aquatic habitat and shading for macroinvertebrates and fish. Direct deposit of fecal matter into the stream and stream banks will be eliminated as a result of livestock exclusion by fencing.

Water well and tank development- Fencing animals from stream access requires and alternative water source. Installing water wells and tanks satisfies this need. Installing water tanks provides a quality water source and keeps animals from wading and defecating in streams. This will reduce the probability of pathogenic infections to livestock and the public.

Prescribed grazing- This practice is used to increase ground cover and ground stability by rotating livestock throughout multiple fields. Grazing with a specified rotation minimizes overgrazing and resulting erosion. The Natural Resource Conservation Service (NRCS) recommends grazing systems to improve and maintain water quality and quantity. Duration, intensity, frequency, and season of grazing can be managed to enhance vegetation cover and litter, resulting in reduced runoff, improved infiltration, increased quantity of soil water for plant growth, and better manure distribution and increased rate of decomposition, (NRCS, 1998). In a study by Tiedemann et al. (1988), as presented by USEPA (1993), the effects of four grazing strategies on bacteria levels in thirteen watersheds in Oregon were studied during the summer of 1984. Results of the study (Table 8) showed that when livestock are managed at a stocking rate of 19 acres per animal unit month, with water developments and fencing, bacteria levels were reduced significantly.

Waste management system- Waste management systems can be effective in controlling up to 90 percent of E. coli bacteria loading originating from confined animal feeding areas (Table 9). A waste management system is made up of various components designed to control nonpoint source pollution from concentrated animal feeding operations (CAFOs) and animal feeding operations (AFOs). Diverting clean water from the feeding area and containing dirty water from the feeding area in a pond are typical practices of a waste management system. Manure handling and application of manure is designed to be adaptive to environmental, soil, and plant conditions to minimize the probability of contamination of surface water.

Table 8. Bacterial Water Quality Response to Four Grazing Strategies (Tiedemann et al., 1988).

Grazing Strategy		Geometric Mean E. coli Count
Strategy A:	Ungrazed	40/L
Strategy B:	Grazing without management for livestock distribution; 20.3 ac/AUM.	150/L
Strategy C:	Grazing with management for livestock distribution: fencing and water developments; 19.0 ac/AUM	90/L
Strategy D:	Intensive grazing management, including practices to attain uniform livestock distribution and improve forage production with cultural practices such as seeding, fertilizing, and forest thinning; 6.9 ac/AUM	950/L

8.2 Other Recommendations

Vegetative filter strip- Vegetative filter strips are used to reduce the amount of sediment, particulate organics, dissolved contaminants, nutrients, and in the case of this TMDL, E. coli bacteria to streams. The effectiveness of filter strips and other BMPs in removing E. coli bacteria is quite successful. Results from a study by Pennsylvania State University (1992a) as presented by USEPA (1993) (Table 9), suggest that vegetative filter strips are capable of removing up to 55 percent of E. coli loading to rivers and streams (Table 9). The ability of the filter strip to remove contaminants is dependent on field slope, filter strip slope, erosion rate, amount and particulate size distribution of sediment delivered to the filter strip, density and height of vegetation, and runoff volume associated with erosion producing events (NRCS, 2001).

Table 9. Relative Gross Effectiveness[a] of Confined Livestock Control Measures (Pennsylvania State University, 1992a).

Practice[b] Category	Runoff[c] Volume	Total[d] Phosphorus (%)	Total[d] Nitrogen (%)	Sediment (%)	E. coli (%)
Animal Waste System[e]	-	90	80	60	85
Diversion System[f]	-	70	45	NA	NA
Filter Strips[g]	-	85	NA	60	55
Terrace System	-	85	55	80	NA
Containment Structures[h]	-	60	65	70	90

NA = Not Available.
a Actual effectiveness depends on site-specific conditions. Values are not cumulative between practice categories.
b Each category includes several specific types of practices.
c - = reduction; + = increase; 0 = no change in surface runoff.
d Total phosphorus includes total and dissolved phosphorus; total nitrogen includes organic-N, ammonia-N, and nitrate-N.
e Includes methods for collecting, storing, and disposing of runoff and process-generated wastewater.
f Specific practices include diversion of uncontaminated water from confinement facilities.
g Includes all practices that reduce contaminant losses using vegetative control measures.
h Includes such practices as waste storage ponds, waste storage structures, waste treatment lagoons.

Septic System – Septic systems provide an economically-feasible way of disposing of household wastes where other means of waste treatment are unavailable (e.g., public or private treatment facilities). The basis for most septic systems involves the treatment and distribution of household wastes through a series of steps involving the following:

1. A sewer line connecting the house to a septic tank

2. A septic tank that allows solids to settle out of the effluent
3. A distribution system that dispenses the effluent to a leach field
4. A leaching system that allows the effluent to enter the soil

Septic system failure exists when one or more components of the septic system do not work properly and untreated waste or wastewater leaves the system. Wastes may pond in the leach field and ultimately run off directly into nearby streams or percolate into groundwater. Untreated septic system waste is a potential source of nutrients (nitrogen and phosphorus), organic matter, suspended solids, and E. coli bacteria. Land application of septic system sludge, although unlikely, may also be a source of contamination.

Septic system failure can occur for several reasons, although the most common reason is improper maintenance (e.g. age, inadequate pumping). Other reasons for failure include improper installation, location, and choice of system. Harmful household chemicals can also cause failure by killing the bacteria that digest the waste. While the number of systems that are not functioning properly is unknown, it is estimated that 28 percent of the systems in North Dakota are failing (USEPA, 2002).

9.0 PUBLIC PARTICIPATION

To satisfy the public participation requirement of this TMDL, a hard copy of the TMDL for The Wild Rice River and a request for comment was mailed to participating agencies, partners, and to those who request a copy. Those included in the mailing of a hard copy are as follows:

- Richland County Soil Conservation District;
- Richland County Water Resource Board;
- Sargent County Soil Conservation District;
- Sargent County Water Resource Board;
- Natural Resource Conservation Service (State Office); and
- U.S. Environmental Protection Agency, Region VIII

In addition to mailing copies of this TMDL for the Wild Rice River to interested parties, the TMDL was posted on the North Dakota Department of Health, Division of Water Quality web site at http://www.ndhealth.gov./WQ/SW/Z2 TMDL/TMDLs Under PublicComment/B Under Public Commment.html . A 30-day public notice soliciting comment and participation was published in the following newspapers:

- The Daily News (Wahpeton), representing Richland County
- The Sargent County Teller (Milnor), representing Sargent County
- The Fargo Forum

10.0 MONITORING

As stated previously, it should be noted that the TMDL loads, waste load allocations, load allocations, and the MOS are estimated based on available data and reasonable assumptions and are to be used as a guide for implementation. The actual reduction needed to meet the applicable water quality standards may be higher or lower depending on the results of future monitoring.

Specifically, monitoring will be conducted for all variables that are currently causing impairments to the beneficial uses of the waterbody. These include, but are not limited to E. coli bacteria and E. coli bacteria. Once a watershed restoration plan (e.g. Section 319 Non point Source Project Implementation Plan [PIP]) is implemented, monitoring will be conducted in the watershed beginning two years after implementation and extending five years after the implementation project is complete.

Currently, the focus of the Wild Rice River Riparian Restoration project is on Shortfoot and Crooked Creek watersheds which are major tributaries to the Wild Rice River. This phase of the 319 project will be active until 2019. Water Quality monitoring will continue to be conducted in accordance with an approved Quality Assurance Project Plan (QAPP), which can be utilized for any future 319 Project Implementation Plans.

11.0 TMDL IMPLEMENTATION STRATEGY

The Sargent County SCD began a 319 Watershed Implementation Plan in 2010 until 2015. The focus of BMPs on the Wild Rice River and its tributaries. The objective of the project was to reduce fecal coliform bacteria concentrations by implementing manure management systems in feeding areas, range and pasture management plans comprised of fencing, pipelines, ponds, prescribed grazing, range plantings, trough and tank, wells and solar pumps.

In 2016 the Wild Rice River Riparian Restoration project switched its focus to the Shortfoot Creek and Crooked Creek watersheds and mainstem Wild Rice River. The focus of the project continued to improve water quality but also would work with the International Water Institute to develop a Decision Support Tool. The Decision Support Tool with allow for better prioritization of landuse issues and appropriate BMP type and placement.

In 2017, the Wild Rice River Riparian Restoration project entered into its third phase of providing conservation planning to farmers and ranchers of Sargent County. Project area focus will continue to be the mainstem Wild Rice River and Shortfoot and Crooked Creek watersheds.

12.0 REFERENCES

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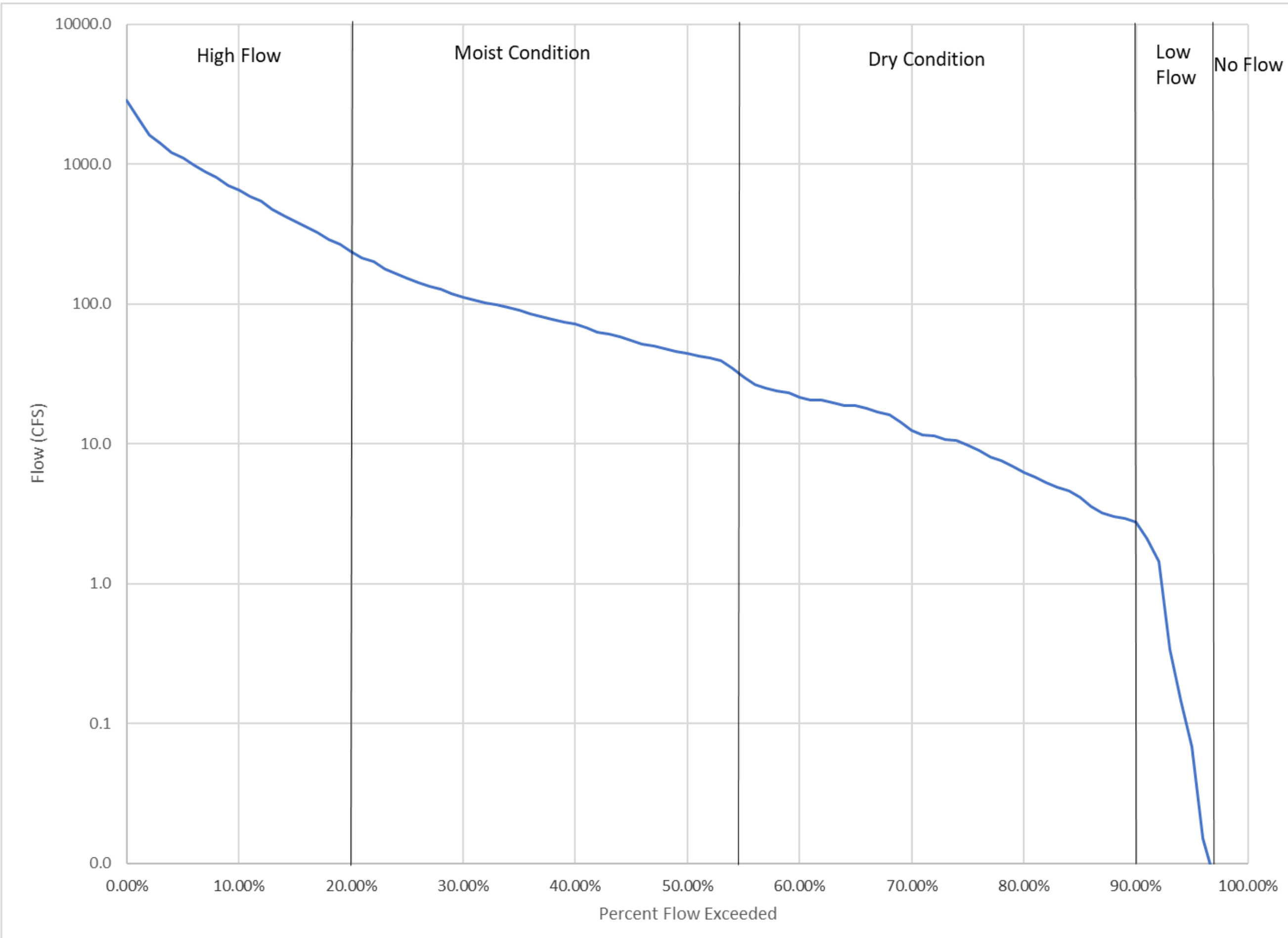
Appendix A
E. coli Bacteria Data Collected for Site 385234 (2011-2014)

	May		June		July		August		September	
	5/18/2011	5	6/1/2011	200	7/5/2011	40	8/1/2011	110	9/6/2011	160
	5/23/2011	60	6/6/2011	10	7/6/2011	20	8/2/2011	5	9/7/2011	80
	5/25/2011	20	6/7/2011	5	7/11/2011	100	8/8/2011	20	9/12/2011	60
	5/31/2011	5800	6/13/2011	40	7/12/2011	60	8/9/2011	20	9/13/2011	500
	5/7/2012	10	6/14/2011	40	7/18/2011	100	8/15/2011	1100	9/19/2011	100
	5/9/2012	40	6/20/2011	30	7/19/2011	20	8/16/2011	100	9/20/2011	180
	5/14/2012	50	6/21/2011	250	7/25/2011	30	8/22/2011	80	9/26/2011	110
	5/16/2012	60	6/27/2011	310	7/9/2012	70	8/23/2011	240	9/27/2011	80
	5/21/2012	30	6/28/2011	40	7/11/2012	30	8/29/2011	80	9/4/2012	140
	5/23/2012	600	6/4/2012	130	7/17/2012	350	8/30/2011	120	9/10/2012	540
	5/29/2012	330	6/6/2012	10	7/18/2012	90	8/6/2012	80	9/11/2012	200
	5/30/2012	1600	6/11/2012	70	7/23/2012	80	8/7/2012	90	9/17/2012	360
	5/6/2013	5	6/13/2012	30	7/24/2012	30	8/13/2012	110	9/18/2012	350
	5/7/2013	5	6/18/2012	70	7/30/2012	120	8/15/2012	110	9/25/2012	80
	5/13/2013	10	6/20/2012	1600	7/31/2012	50	8/20/2012	80	9/26/2012	70
	5/14/2013	20	6/25/2012	140	7/1/2013	90	8/22/2012	90	9/3/2013	30
	5/21/2013	5100	6/27/2012	120	7/8/2013	240	8/27/2012	40	9/4/2013	130
	5/22/2013	1900	6/4/2013	60	7/10/2013	2900	8/28/2012	2300	9/9/2013	2100
	5/28/2013	20	6/5/2013	110	7/15/2013	110	8/5/2013	80	9/11/2013	560
	5/29/2013	5	6/11/2013	60	7/17/2013	540	8/7/2013	160	9/16/2013	320
	5/5/2014	40	6/12/2013	140	7/22/2013	180	8/13/2013	40	9/18/2013	150
	5/7/2014	40	6/18/2013	100	7/30/2013	60	8/14/2013	50	9/24/2013	120
	5/12/2014	80	6/19/2013	80	7/31/2013	90	8/19/2013	90	9/25/2013	140
	5/14/2014	60	6/24/2013	1900	7/9/2014	240	8/21/2013	140	9/2/2014	120
	5/19/2014	50	6/26/2013	250	7/14/2014	40	8/26/2013	230	9/3/2014	200
	5/21/2014	60	6/2/2014	210	7/15/2014	150	8/28/2013	160	9/8/2014	160
	5/27/2014	90	6/4/2014	70	7/22/2014	330	8/4/2014	290	9/10/2014	170
	5/28/2014	100	6/9/2014	40	7/23/2014	320	8/5/2014	320	9/15/2014	10
			6/10/2014	130	7/28/2014	170	8/12/2014	70	9/16/2014	70
			6/16/2014	130	7/30/2014	70	8/13/2014	90	9/22/2014	310
							8/18/2014	320		
							8/19/2014	310		
							8/25/2014	140		
							8/26/2014	160		
Geometric Mean	64		87		102		111		153	
% Exceeded 409 CFU/100 mL	18%		7%		7%		6%		13%	
Recreational Use Assessment	FSbT		FS		FS		FS		NS	
# Samples	28		30		30		34		30	

Appendix B
Flow Duration Curve for Site 385234

Site 385234

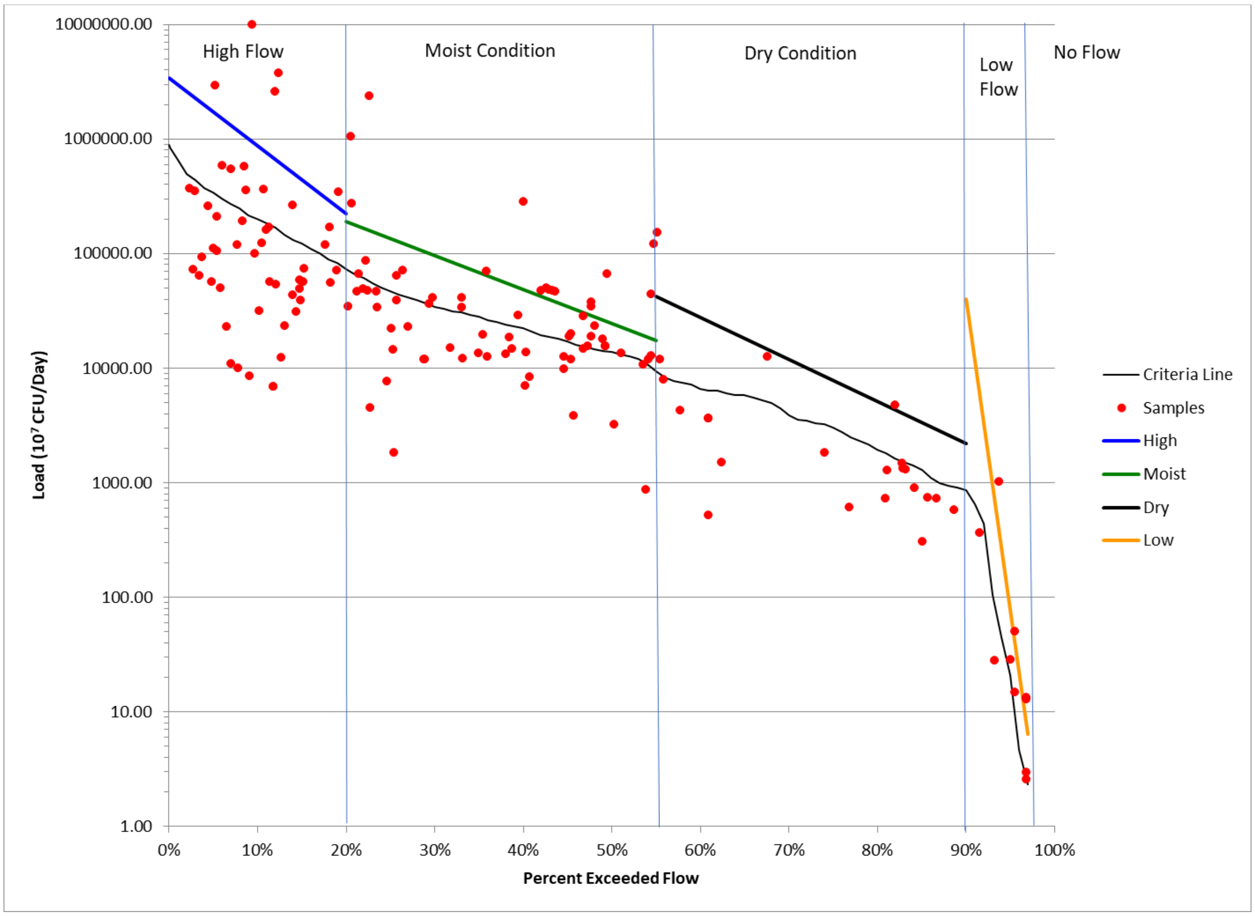


High Flow
Moist Condition
Dry Condition
Low Flow
No Flow
Flow (CFS)
10000.0
1000.0
100.0
10.0
1.0
0.1
0.0
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
Percent Flow Exceeded

Appendix C
Load Duration Curve, Estimated Loads, TMDL Targets, and Percentage of Reduction Required for Site 385234

385234 Wild Rice River near Wyndmere, ND

	Median Percentile	Load (10^7 CFUs/Day) Existing	TMDL	Days	Load (10^7 CFUs/Period) Existing	TMDL	Percent Reduction
High	10.00%	865730.62	201666.48	73.00	63198335.00	14721652.79	76.71%
Moist	37.50%	57623.41	24560.38	127.75	7361390.52	3137588.92	57.38%
Dry	72.50%	9683.31	3299.54	127.75	1237042.66	421515.87	65.93%
Low	93.50%	507.31	62.52	25.55	12961.66	1597.37	87.68%
			Total	354	71809730	18282355	74.54%



Appendix D
US EPA Region 8 TMDL Review and Comments

Mike,

Thanks for the opportunity to review the draft TMDLs for the Wild Rice River, Segment 012 (45.68 miles) and Segment 003 (47.49 miles). I don't have any significant comments for these TMDLs, therefore please consider these as informal suggestions for your consideration. If you decide to make revisions, I can send you more formal comments for the record if needed.

For Segment 012 - I do suggest changing the Low Flow allocations in Table 7 since you can't have a negative LA – I can work with Mike Hargiss to make those changes;
For both Segments – I suggest checking the listing references to make sure they are all for the 2016 cycle (i.e., make sure they reference NDDoH, 2017).

As you know, we approved a fecal coliform TMDLs for the same segments on 09/28/2010 and 09/29/2009 respectively. That raises a few policy issues (see below) that we can talk about for future TMDLs.

Appendix E
NDDoH Response to Comments

EPA Comment: For Segment -012 I do suggest changing the Low Flow allocations in Table 7 since you can't have a negative LA

NDDoH Response: The low flow waste load allocation was changed in Table 7 to reflect a positive load allocation per EPA request. Language was added to Section 8.0 to justify the change to the low flow waste load allocation.

EPA Comment: For both Segments – I suggest checking the listing references to make sure they are all for the 2016 cycle (i.e., make sure they reference NDDoH, 2017).

NDDoH Response: The listing references for both segments were checked and revised per EPA request.

EPA Comment: As you know, we approved a fecal coliform TMDLs for the same segments on 09/28/2010 and 09/29/2009 respectively. That raises a few policy issues that we can talk about for future TMDLs.

NDDoH Response: The Fecal Coliform TMDL for segment ND-09020105-012-S_00 will be delisted for fecal coliform bacteria and the E. coli TMDL will supersede the previous fecal coliform TMDL. Language has been added to paragraph 2 in Section 1.1 clarifying this decision.