E. coli Bacteria TMDL for the Des Lacs River in Ward, Mountrail, and Renville Counties, North Dakota

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1.0 INTRODUCTION AND DESCRIPTION OF THE WATERSHED

The Des Lacs River watershed (8 digit hydrologic unit code 09010002) is a 662,735 acre watershed located in Ward, Burke, Mountrail, and Renville Counties in northwestern North Dakota, with a small portion in Saskatchewan, Canada. The impaired stream reach and that portion of the watershed included in this TMDL is located in Ward, Mountrail, and Renville Counties and comprises approximately 223,209 acres (Table 1, Figure 1). The listed segment lies primarily within the Northern Glaciated Plains Level III Ecoregion, with some small part extending into the Northwestern Glaciated Plains Level III Ecoregion. Just upstream of this impaired reach is the Des Lacs National Wildlife Refuge and Lower Des Lacs Reservoir, which are operated and maintained by the U.S. Fish and Wildlife Service (Figure 2).

Table 1. General Characteristics of the Des Lacs River Watershed.

Legal Name	Des Lacs River
Stream Classification	Class II
Major Drainage Basin	Souris River
8-Digit Hydrologic Unit	09010002
Counties	Ward, Mountrail, and Renville Counties
Level III Ecoregion	Northern Glaciated Plains (46), Northwestern Glaciated Plains (42)
8 digit HUC Watershed Area (in U.S)	662,735 acres
Impaired Reach Watershed Area	223,209 acres

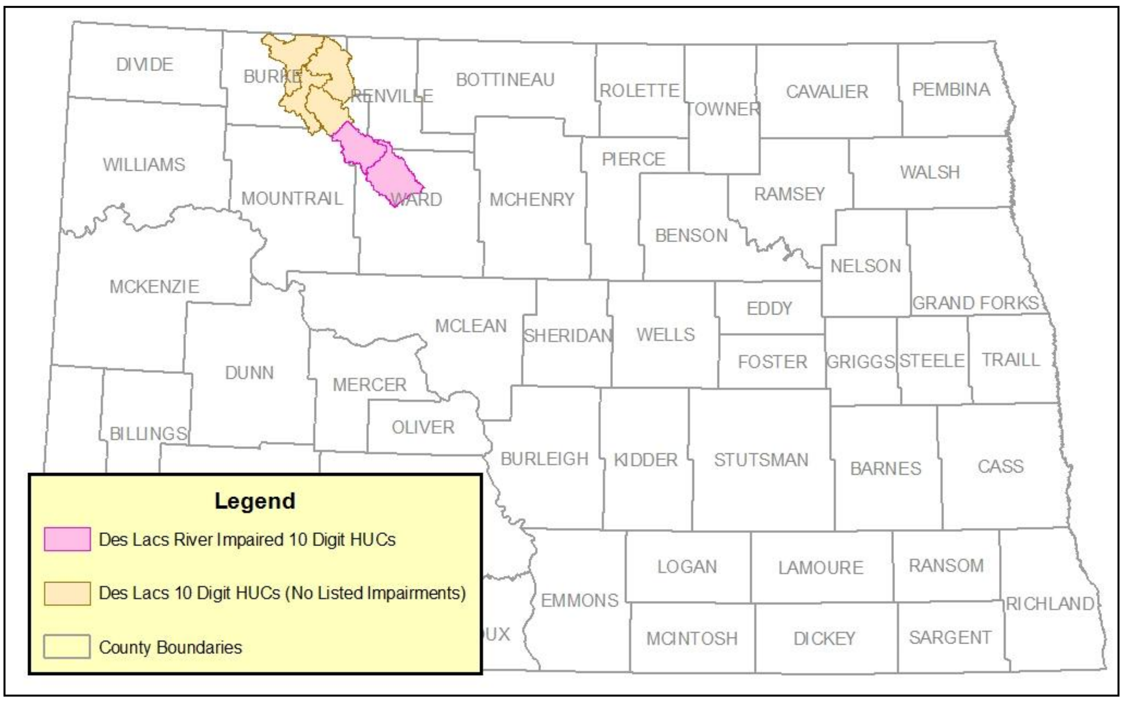

Figure 1. Des Lacs River Watershed in North Dakota.

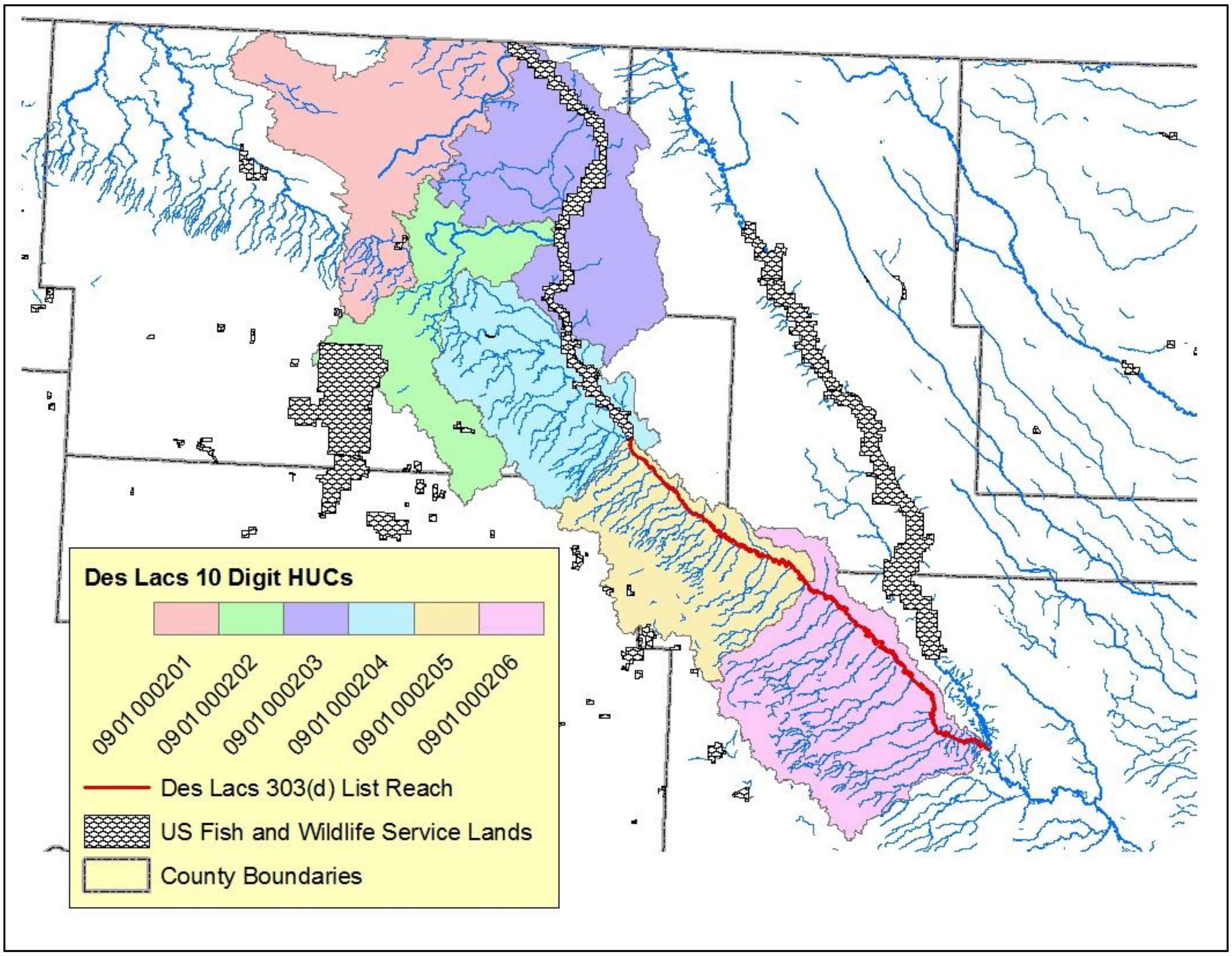

Figure 2. Des Lacs River TMDL Listed Segment.

1.1 Clean Water Act Section 303(d) Listing Information

Based on the 2010 Section 303 (d) List of Impaired Waters Needing TMDLs (NDDoH, 2010), the North Dakota Department of Health (NDDoH) has identified a 71.5 mile segment (ND-09010002-001-S_00) of the Des Lacs River upstream from its confluence with the Souris River to the Lower Des Lacs reservoir (Figure 2) as fully supporting but threatened for recreational uses. The impairments are due to fecal coliform bacteria (Table 2).

The Des Lacs River was originally listed for fecal coliform bacteria impairment. The State's fecal coliform bacteria water quality standard was eliminated in 2011 and replaced with an E. coli bacteria water quality standard. Therefore, the TMDL for the Des Lacs River will be written based on the new E. coli bacteria water quality standard (Table 4). Please refer to Section 2.2 for more information regarding the bacteria water quality standards change.

Table 2. Des Lacs River Section 303(d) Listing Information for Assessment Unit ID ND-09010002-001-S_00 (NDDoH, 2010).

Assessment Unit ID	ND-09010002-001-S_00
Waterbody Description	Des Lacs River from Lower Des Lacs Reservoir downstream to its confluence with the Souris River.
Size	71.5 miles
Designated Use	Recreation
Use Support	Fully Supporting, but Threatened
Impairment	Fecal Coliform Bacteria
TMDL Priority	High

1.2 Ecoregions

The watershed for the Section 303(d) listed segment highlighted in this TMDL lies primarily within the Northern Black Prairie (46g) level IV ecoregion, with small portions occurring within the Northern Dark Brown Prairie (46h), Drift Plains (46i), Missouri Coteau (42a) and Northern Missouri Coteau (42d) level IV ecoregions (Figure 3). The Northern Black Prairie (46g) ecoregion represents a broad phenological transition zone marking the introduction from the north of a boreal influence in climate. Aspen and birch appear in wooded areas, willows grow on wetland perimeters, and rough fescue becomes evident in grassland associations. This ecoregion has the shortest growing season and the lowest January temperature of any level IV ecoregion in the Dakotas. Most of the area is used for growing small grains, with durum wheat being a major crop. The Northern Dark Brown Prairie (46h) is divided from the Northern Black Prairie (46g) by the Souris and Des Lacs Rivers. This area is a broad transitional zone between subhumid and semiarid climatic conditions. Soils west of the rivers developed under drier conditions than those soils further east. They have less organic material which gives them a lighter color. In addition, crop and native grass production is generally lower than in ecoregions further east. 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 rolling hummocks of the Missouri Coteau (42a) ecoregion enclose countless wetland depressions or potholes. Land use on the Coteau is a mixture of tilled agriculture in flatter areas and grazing land on steeper slopes. The Northern Missouri Coteau (42d) lies in a transition zone to a more boreal climate to the north and a more arid climate to the west. Wetlands tend to dry out earlier in the summer than on the Missouri Coteau (42a) to the south and east. Mixed dryland agriculture is the major land use. The Coteau is the major waterfowl production area in North America (USGS, 2006).

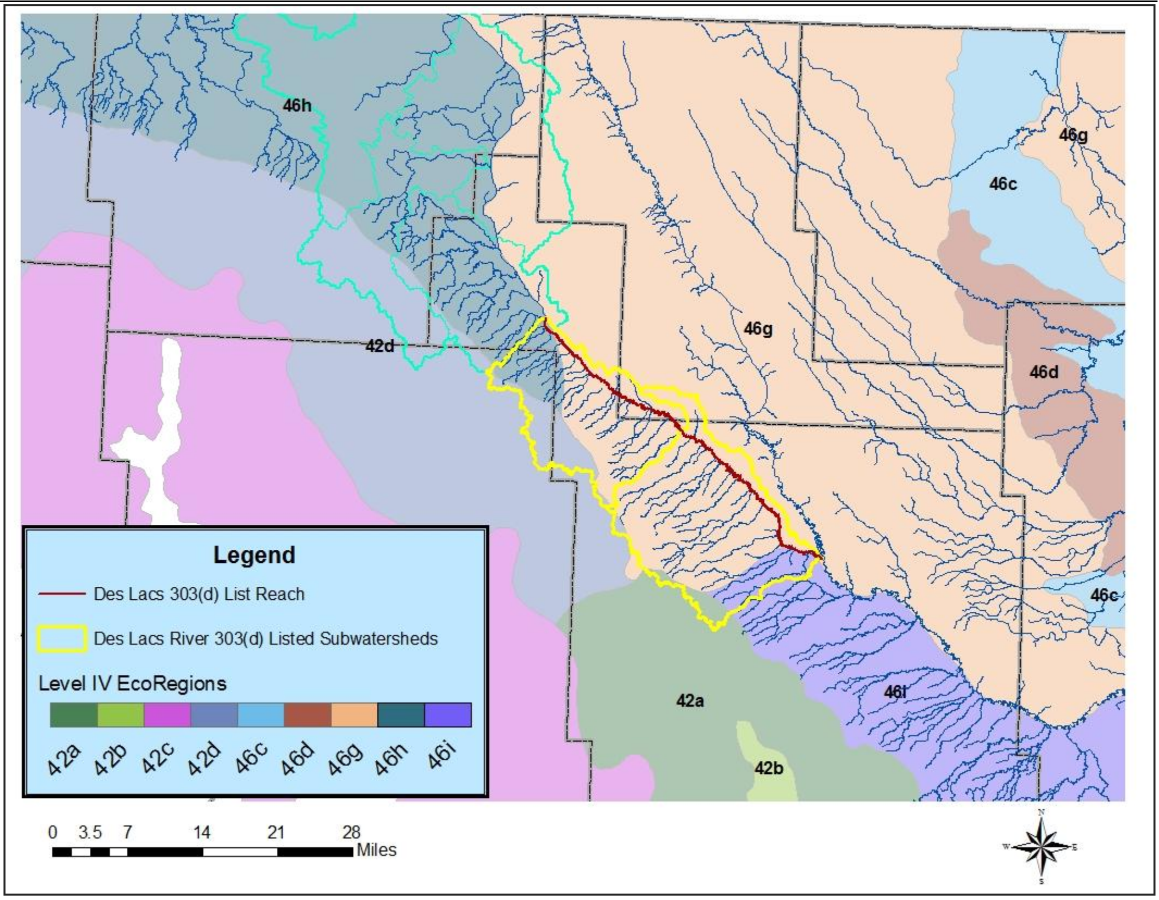

Figure 3. Level IV Ecoregions in the Des Lacs River TMDL Listed Watershed.

1.3 Land Use

The dominant land use in the Des Lacs River watershed is small grain agriculture. According to the 2007 National Agricultural Statistical Service land survey data (NASS, 2007), approximately 71 percent of the land is cropland; 14 percent in grassland, pasture, or Conservation Reserve Program (CRP); 10 percent in wetlands; and the remaining 5 percent as either developed space or barren. The majority of the crops grown consist of durum/spring wheat, winter wheat, sunflowers, and oil seeds (Figure 4).

There are a few permitted animal feeding operations (AFOs) in the watershed. They consist of one medium AFO which has zero discharge, and two small AFOs which are dairy operations and have zero discharge. One more small AFO is currently undergoing the permitting process. Unpermitted animal feeding operations are also present in the Des Lacs River watershed, but their number and location have not be documented.

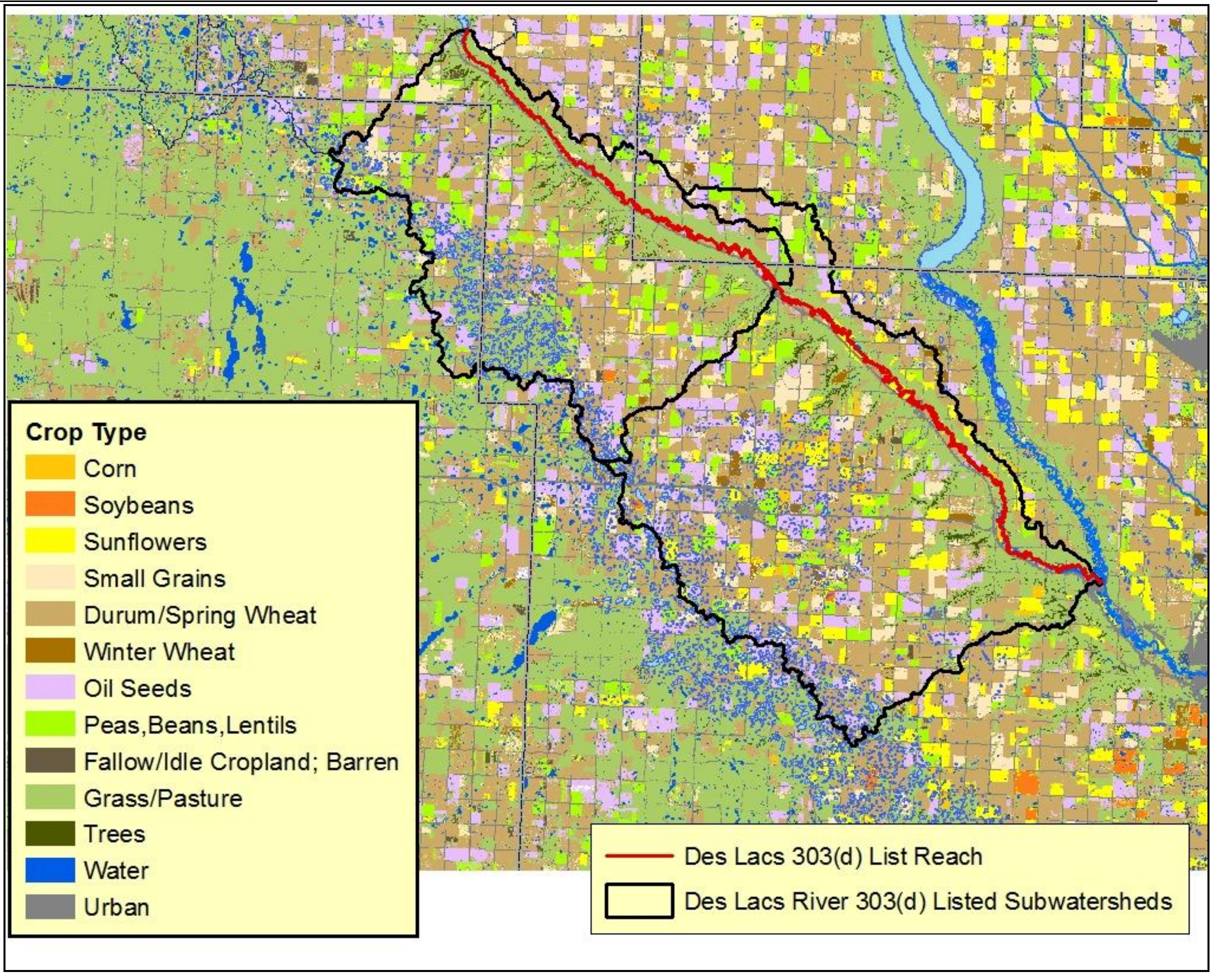

Figure 4. Land Use in the Des Lacs River TMDL Listed Watershed (NASS, 2007).

1.4 Climate and Precipitation

North Dakota's climate is characterized by large temperature variations across all time scales, light to moderate irregular precipitation, plentiful sunshine, low humidity, and nearly continuous wind. Its location at the geographic center of North America results in a strong continental climate, which is exacerbated by the mountains to the west. There are no topographical barriers to the north or south so a combination of cold dry air masses originating in the far north and warm humid air masses originating in the tropical regions regularly flow over the state. Movement of these air masses and their associated fronts cause near continuous wind and often result in large day to day temperature fluctuations in all seasons. The average last freeze in spring occurs in late May. In the fall, the first 32 degree or lower temperature occurs between September 10th and 25th. However, freezing temperatures have occurred as late as mid-June and as early as mid-August.

About 75 percent of the annual precipitation falls during the period of April to September, with 50 to 60 percent occurring between April and July. Most of the summer rainfall is produced during thunderstorms, which occur on an average of 25 to 35 days per year. On the average, rains occur once every three to four days during the summer. Winter snowpack, although persistent from December through March, only averages around 15 inches (Enz, 2003).

Figures 5 and 6 show the yearly total and normal monthly precipitation at the Berthold, ND (Ward County) North Dakota Agriculture Weather Network (NDAWN) station from 2001-2010. This weather station is located approximately eight miles southwest of the lower end of the impaired reach.

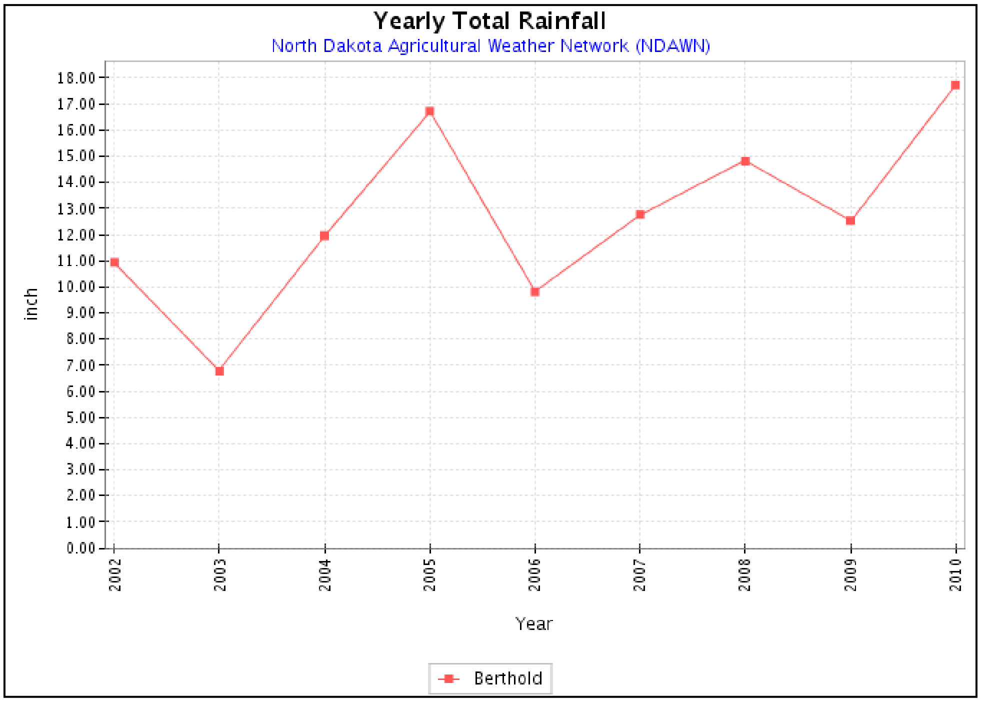

Figure 5. Yearly Total Rainfall at Berthold, North Dakota from 2001-2010. North Dakota Agricultural Weather Network (NDAWN).

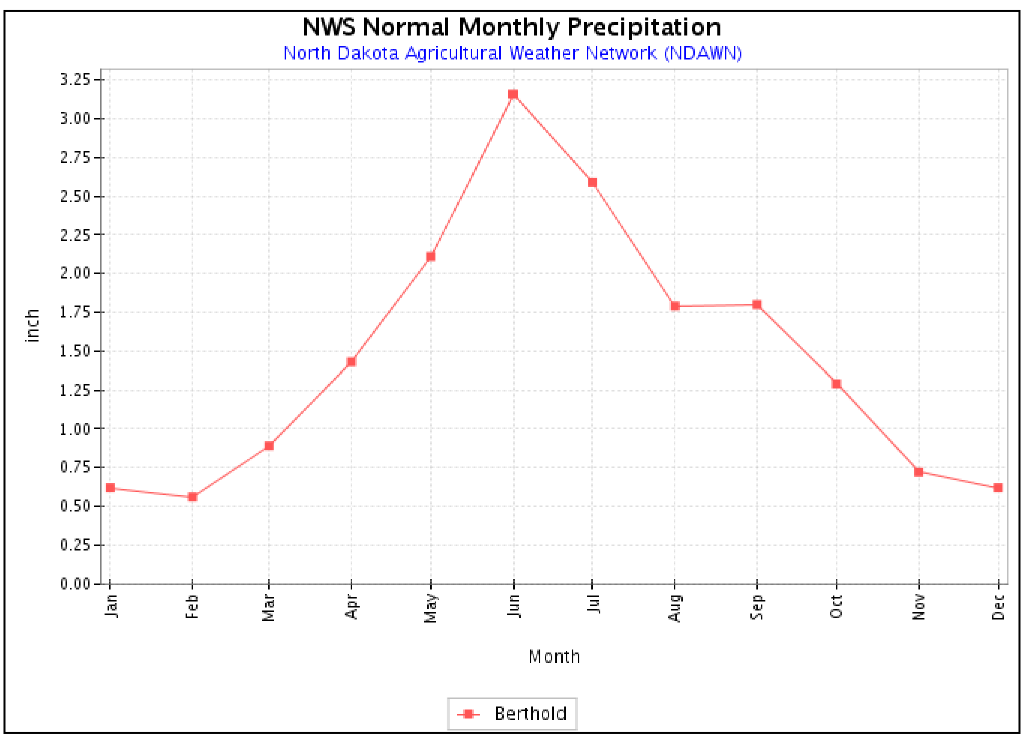

Figure 6. Normal Monthly Precipitation at Berthold, North Dakota from 2001-2010. North Dakota Agricultural Weather Network (NDAWN).

1.5 Available Data

1.5.1 E. coli Bacteria Data

E. coli bacteria samples were collected at one monitoring site located on the TMDL listed stream segment (Figure 7). This monitoring site, station ID 380021, is located 0.1 mile north of Foxholm, ND. This site is part of the NDDoH's Ambient Water Quality Monitoring Program network and is sampled every six weeks during the open water flow period and once during ice cover (NDDoH, 2009). Samples are collected by personnel with the NDDoH's Surface Water Quality Management Program.

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 from 2001 through 2010.

Table 3. Summary of E. coli Bacteria Data for Site 380021 (data collected from 2001 to 2010).

Month	N	Geometric Mean Concentration (CFU/100mL)	Percentage of Samples Exceeding 409 CFU/100mL	Recreational Use Assessment
May	8	16.3	0%	Fully Supporting
June	8	118.1	12.5%	Fully Supporting, but Threatened
July	7	35.4	14.3%	Fully Supporting, but Threatened
August	5	83.6	20.0%	Fully Supporting, but Threatened
September	8	92.3	12.5%	Fully Supporting, but Threatened

According to the data collected in 2001 and 2010 geometric mean and percent exceeded calculations determined that during the months of June through September the TMDL Listed Segment of the Des Lacs Rice River is fully supporting, but threatened for recreational beneficial use because of E. coli bacteria. E. coli bacteria data is presented in Appendix A.

1.5.2 Hydraulic Discharge

A discharge record was constructed for the listed segment using data from United States Geological Survey (USGS) gauging station 05116550 which is co-located with NDDoH sampling station 380021. The historical daily discharge record for the period 1980-2010 was used for this TMDL.

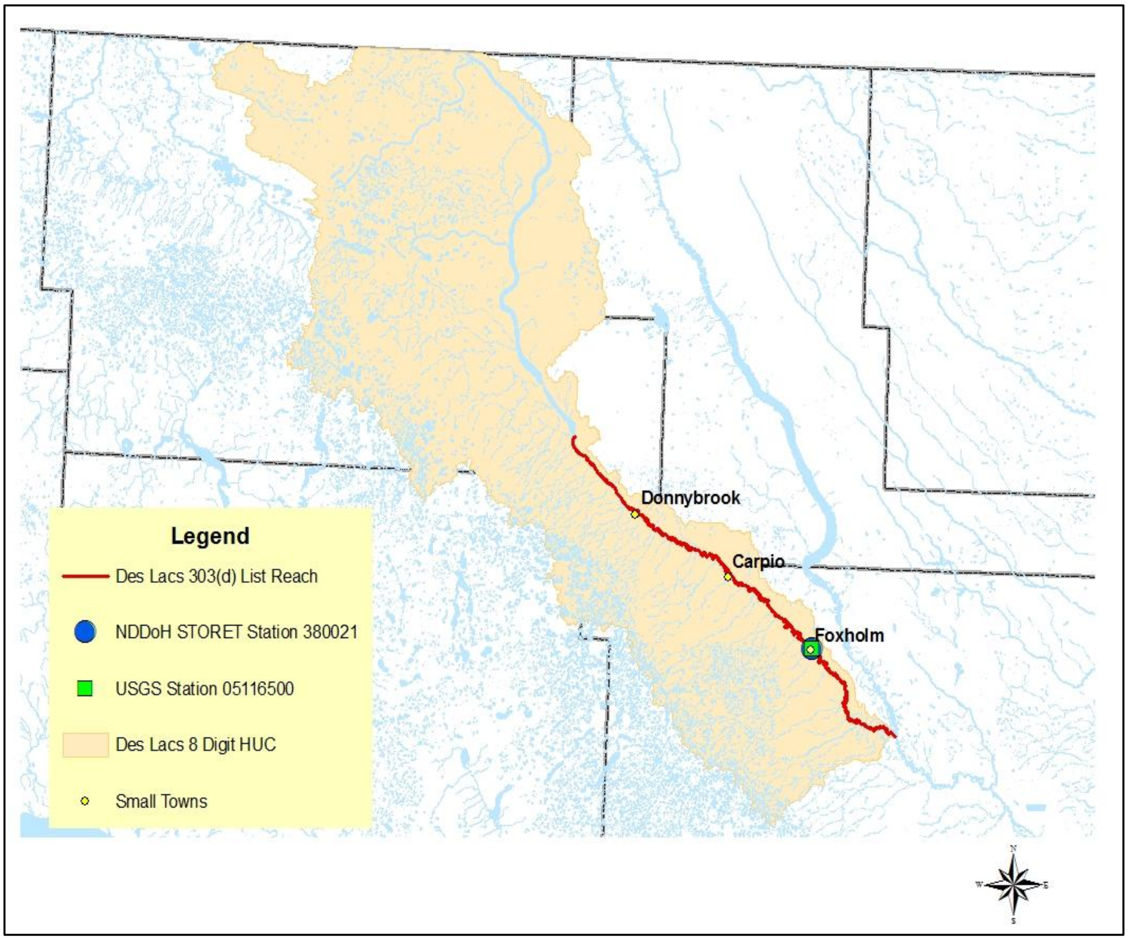

Figure 7. E. coli Bacteria Sample Site 380021 and USGS Gauge Station 05116550 Located on the Des Lacs River.

2.0 WATER QUALITY STANDARDS

The Clean Water Act requires that Total Maximum Daily Loads (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.

2.1 Narrative North Dakota Water Quality Standards

The North Dakota Department of Health 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, 2011).

- 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, 2011).

2.2 Numeric North Dakota Water Quality Standards

The Des Lacs River is a Class II stream. The NDDoH definition of a Class II stream is shown below (NDDoH, 2011).

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.

Effective January 2011, the NDDoH revised the State water quality standards. In these latest revisions the NDDoH eliminated the fecal coliform bacteria standard, retaining only the E. coli bacteria standard for the protection of recreational uses. This change in water quality standard was recommended by the US Environmental Protection Agency as E. coli is believed to be a better indicator of recreational use risk (i.e., incidence of gastrointestinal disease).

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

Table 4. North Dakota E. coli Bacteria Water Quality Standards for Class II 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.

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 Des Lacs River is based on the NDDoH water quality standard for E. coli bacteria.

3.1 Des Lacs River Target Reductions in E. coli Bacteria Concentrations

The Des Lacs River is impaired because of E. coli bacteria. The Des Lacs River recreation beneficial use is identified as fully supporting, but threatened because E. coli bacteria counts exceed the State water quality standard. The State water quality standard for E. coli bacteria is a geometric mean concentration of 126 CFU/100 mL during the recreation season of May 1st through September 30th. 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, the target is based on the 126 CFU/100 mL geometric mean standard. Expressing the target in this way will ensure the TMDL will result in both components of the standard being met and recreational uses will be restored.

4.0 SIGNIFICANT SOURCES

4.1 Point Source Pollution Sources

Within the watershed of the TMDL listed reach of the Des Lacs River there are two wastewater treatment systems permitted through the North Dakota Pollution Elimination System (NDPDES) Program. They are for the communities of Carpio and Donnybrook, North Dakota (Figure 7). Each system is allowed to discharge on an “as needed” basis. When these facilities do discharge they do so only once per year. However, the Carpio facility has not discharged in over 20 years and the Donnybrook facility has not discharged in the last 13 years (Appendix D). No fecal or E.coli bacteria monitoring is required in any of the NDPDES permits, so currently only one sample was taken at Donnybrook in 1998, and none at Carpio. Due to the limited bacteria data, allocations were derived using the State’s water quality standard and are explained in Section 5.4. The town of Foxholm is also within the impaired reach’s contributing watershed. This community has no permitted wastewater treatment system. Residents in this community utilize individual septic systems.

There are three permitted animal feeding operations (AFOs) in the TMDL listed watershed. The NDDoH has permitted one medium (301-999 animal units [Aus]) and three small (300 AUs or less) AFOs, which are all zero discharge facilities and are not deemed a significant point source of E. coli bacteria loadings to the Des Lacs River. The one small AFO currently in the permitting process will also be a zero discharge facility.

4.2 Nonpoint Source Pollution Sources

The E. coli bacteria pollution to this segment is originating from nonpoint sources in the watershed. Unpermitted animal feeding operations (AFOs) and livestock grazing and watering in proximity to the Des Lacs River are common along the TMDL listed segment.

The northwest area of North Dakota typically experiences short duration but intense precipitation during the spring and early summer months. These storms can cause overland flooding and rising river levels. Due to the close proximity of livestock grazing and watering to the river (grassland areas on the land use map, Figure 4), it is likely that they contribute to the E. coli bacteria pollution in this listed segment of the Des Lacs River.

These assessments are supported by the load duration curve analysis (Section 5.3) which shows all of the exceedences of the E. coli bacteria standard occurring during high, moist and dry conditions.

Wildlife may also contribute to the E. coli bacteria found in the water quality samples. A US Fish and Wildlife Service Wildlife Refuge is located immediately upstream of the listed segment and is managed primarily for the production of waterfowl. However, little can be done to reduce the effects of a migratory wildlife population, so the majority of conservation practices will be focused on human induced impairments.

Septic system failure might also contribute to the E. coli bacteria in the water quality samples. Failures 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).

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 establish 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 total maximum daily load (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. The following technical analysis addresses the E. coli bacteria reductions necessary to achieve the water quality standards target for E. coli bacteria of 126 CFU/100 mL with a margin of safety.

5.1 Mean Daily Stream Flow

In northwestern North Dakota, rain events are variable generally 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 the watershed were obtained for gauging station 05116550 from the USGS Water Science Center website. This gauging station is co-located with the NDDoH sampling station 380021.

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 (USEPA, 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). Therefore, as depicted in Figure 8, a flow duration interval of 25 percent, associated with a stream flow of 10 cfs, implies that 25 percent of all observed mean daily discharge values equal or exceed 10 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) (USEPA, 2007). The flow duration curve (Fig. 8) was divided into four zones, one representing high flows (0-12 percent), another for moist conditions (12-46 percent), one for dry conditions (46-80 percent) and one for low flows (80-93 percent). Based on the flow duration curve analysis, no flow occurred seven percent of the time.

These flows intervals were defined by examining the range of flows for the site for the period of record and then by looking for natural breaks in the flow record based on the flow duration curve plot. A secondary factor in determining the flow intervals used in the analysis is the number of E. coli bacteria observations available for each flow interval.

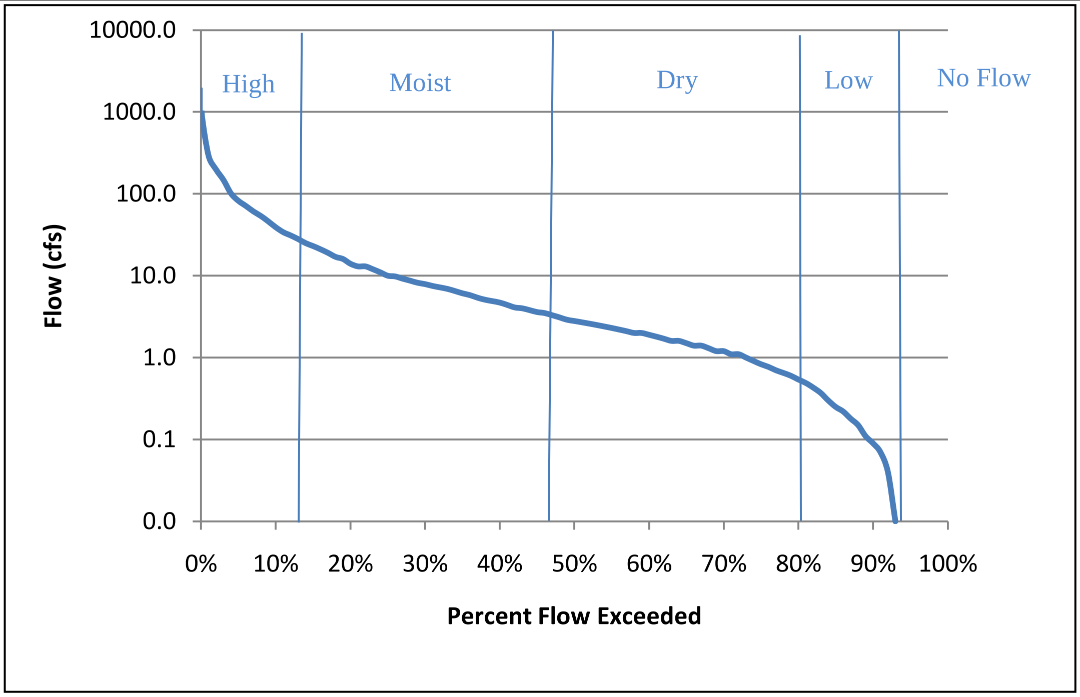

Figure 8. Flow Duration Curve for the Des Lacs River Monitoring Station 380021.

5.3 Load Duration Analysis

An important factor in determining NPS pollution 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 segments, a load duration curve was developed for the Des Lacs River impaired stream reach. 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 flows generated as described in Sections 5.1 and 5.2.

Observed in-stream E. coli bacteria data obtained from monitoring site 380021 (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 9). Points plotted above the 126 CFU/100 mL target curve exceed the State water quality standard or TMDL target. Points plotted below the curve are meeting the State water quality standard 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 380021 depicting a regression relationship for each flow interval is provided in Figure 9. There was only one E. coli bacteria sample concentration above the TMDL target in the low flow regime for site 380021, therefore a regression relationship and existing load could not be calculated for this flow regime.

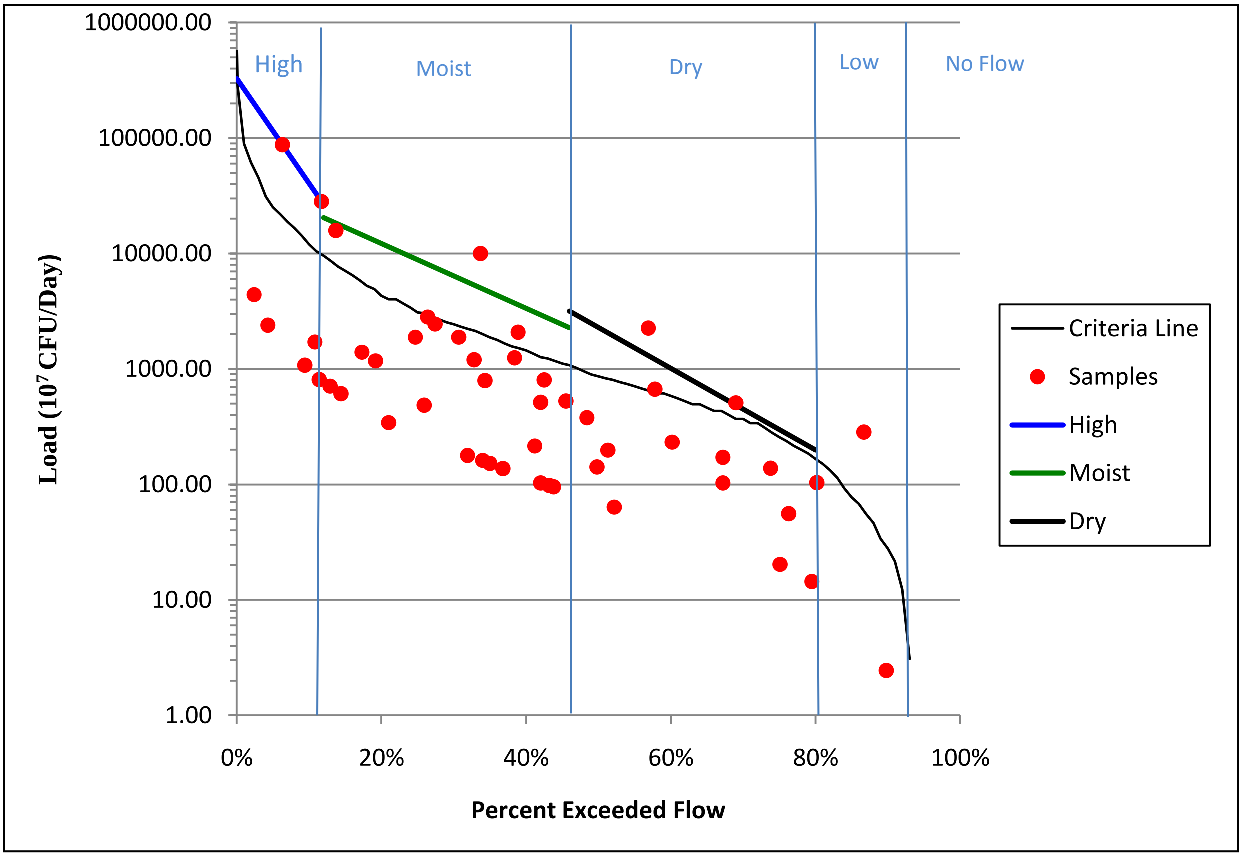

Figure 9. E. coli Bacteria Load Duration Curve for the Des Lacs River Monitoring Station 380021. The curve reflects flows collected from 1980-2010.

The regression lines for the high, moist, and dry condition flows for site 380021 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. The following equation is used by the load duration curve model to determine existing load:

E. coli bacteria load (10^7 CFUs/day) for each flow interval

= antilog (Regression Line Intercept + (Regression Line Slope*Midpoint of Exceeded Flow))

Table 5 below provides a summary of the data used with the above equation to determine the existing loads for each flow interval.

Table 5. Summary of Data Used to Determine Existing E. coli Load Based on Flow Interval.

Interval	Regression Line Intercept	Regression Line Slope	Midpoint of Exceeded Flow	Existing Load
High	5.51437	-9.09660	6.0%	93,019
Moist	4.64601	-2.80394	29.0%	6,806
Dry	5.12580	-3.53383	63.0%	793

The midpoint for the flow intervals is also used to estimate the TMDL target load. Therefore, the TMDL target load for the midpoints of 6, 29, and 63 percent exceeded flow derived from the 126 CFU/100 mL TMDL target curves are 21,890 x 10^7 CFUs/day, 2,528 x 10^7 CFUs/day, and 493 x 10^7 CFUs/day, respectively.

5.4 Wasteload Allocation Analysis

There are three small towns (population less than 200) located along the impaired reach of Des Lacs River. Foxholm has no wastewater treatment system. Residents there utilize individual septic systems. Both Donnybrook and Carpio have permitted wastewater treatment systems, though they rarely discharge into the Des Lacs River. However, significant population increases are occurring in towns nearby due to the oil boom associated with the Bakken formation in western North Dakota, so it was determined that E. coli bacteria waste load allocations should be provided to these two systems to accommodate the potential increases in population. These wasteload allocations will be used to set effluent limits in future NDPDES permits. At such a time as wastewater treatment systems are improved, expanded, or added to the impaired reach's contributing watershed, the TMDL will be revisited to determine if any changes are needed in the wasteload allocations.

5.4.1 Donnybrook, ND Wastewater Treatment System

Donnybrook is a town located along the Des Lacs River with a reported population of 83 people in 2009. According to the NDPDES permit for the Donnybrook facility, it is allowed to discharge on an "as needed basis." The Discharge Monitoring Report (DMR) indicates this wastewater treatment system only discharges once per year when it needs to discharge. There have been no reported discharges for the last 13 years (Appendix D). Based on the DMR data, when the system discharges it discharges 0.5 million gallons of treated wastewater over an average of five days. This is equal to 100,000 gallons per day. Since no E. coli bacteria data were collected for this site, the system is assigned the water quality standards value of 126 CFU/100mL for this TMDL.

The wasteload allocation for Donnybrook was determined by taking the average daily discharge and multiplying by the assumed E. coli bacteria maximum concentration of 126 CFU/100 mL, times appropriate conversion factors.

WLA = 0.1 million gallons/day * 126 CFUs/100mL

= 100,000 gallons/day * 3.7854L/gal * 1,000 mL/L * 126 CFUs/100mL

= 47.696 x 10^7 CFUs/day

This was rounded to 48 x 10^7 CFUs/day for the purposes of this TMDL.

5.4.2 Carpio, ND Wastewater Treatment System

Carpio is also a town located along the impaired reach of the Des Lacs River with a reported population of 148 in 2009. According to the NDPDES permit for the Carpio facility, it is allowed to discharge on an "as needed basis." Based on the DMR data for this facility, this wastewater treatment system has not discharged in the past twenty years. There are also no fecal coliform or E. coli bacteria data on record for this system. Because this small town is considered comparable in size to Donnybrook, the same wasteload allocation of 48 x 10^7 CFUs/day was given to this system.

5.5 Loading Sources

The load reduction needed for the listed segment of the Des Lacs River E. coli bacteria TMDL can primarily be allotted to nonpoint sources, with the two point sources mentioned in Section 5.4 given a very small portion of the TMDL. Based on the data available, the general focus of BMPs and load reductions for the listed waterbody should be on unpermitted animal feeding operations and riparian grazing adjacent to or in close proximity to the river.

Controllable sources of E. coli bacteria loading were defined as nonpoint source pollution originating from livestock. 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, three flow regimes (i.e., High, Moist, and Dry Conditions) were selected to represent the hydrology of the listed segment on the Des Lacs River for the purpose of the TMDL. The three flow regimes were used in conjunction with water quality data for site 380021 because samples indicated exceedences of the E. coli water quality standard during these flows.

By relating runoff characteristics to each flow regime one can infer which sources are most likely to contribute to coliform bacteria loading. Animals grazing in the riparian area contribute coliform 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, medium (moist and dry conditions on flow duration curve) and low flows (Table 6). In contrast, intensive grazing of livestock in the upland and not in the riparian area has a high potential to impact water quality primarily at high flows (Table 6). 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 coliform bacteria contamination.

Table 6. Nonpoint Sources of Pollution and Their Potential to Pollute at a Given Flow Regime.

NonpointSources	Flow Regime		
	High Flow	Medium Flow	Low Flow
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 coliform 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 this TMDL. The MOS was calculated as ten percent of the TMDL. In other words ten percent of the TMDL is set aside from the load allocation as a MOS. The ten percent MOS was derived by taking the difference between the points on the load duration curve using the 126 CFU/100 mL standard and the curve using the 113 CFU/100 mL.

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 Des Lacs River TMDL addresses seasonality because the flow duration curve was developed using 30 years of USGS gauge data encompassing all 12 months of the year. Additionally, the water quality standard is seasonally based on the recreation season of May 1 through September 30 and controls will be designed to reduce E. coli bacteria loads during the season covered by the standard.

7.0 TMDL

Table 7 provides an outline of the critical elements of the E. coli bacteria TMDL for the TMDL listed segment. The TMDL for the Des Lacs River (ND-09010002-001-S_00) is summarized in Table 8. The TMDL provides a summary of average daily loads by flow regime necessary to meet the water quality target (i.e. TMDL). The TMDL for each segment and flow regime provide an estimate of the existing daily load, an estimate of the average daily loads necessary to meet the water quality target (i.e. TMDL load). 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 7. TMDL Summary for Des Lacs River.

Category	Description	Explanation
Beneficial Use Impaired	Recreation	Contact Recreation (i.e. swimming, fishing)
Pollutants	E. coli Bacteria	See Section 2.1
E. coli TMDL Target	126 CFU/100 mL	Based on the current State water quality standard for E. coli bacteria.
Significant Sources	Nonpoint Sources Very Limited Point Sources	Nonpoint Sources most significant. Point sources haven't contributed in last 13 years.
Margin of Safety (MOS)	Explicit	10%

TMDL = LC = WLA + LA + MOS

where

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

WLA = wasteload 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 8. E. coli Bacteria TMDL (10^7 CFU/day) for the Des Lacs River, Assessment Unit ID ND-09010002-001-S_00, as represented by Site 380021.

	Flow Regime			
	High Flow	**Moist Conditions**	**Dry Conditions**	**Low Flow**
Existing Load	93,019	6,806	793	
TMDL	21,890	2,528	493	**77**[1]
WLA – Donnybrook, ND	48	48	0[2]	No Reduction Necessary
WLA – Carpio, ND	48	48	0[2]	
LA	19,605	2,179	444	
MOS	2,189	253	49	

[1]TMDL load is provided as a guideline for watershed management and BMP implementation.
[2]Since dry conditions are defined as flows between 3.3 and 0.6 cfs, it was determined that wastewater treatment systems would not be discharging during those flows.

8.0 ALLOCATION

The two point sources in the watershed are given a small wasteload allocation based on their historic and future projected discharges, population size, and State water quality standards. The remaining E. coli load allocation for this TMDL is allocated to nonpoint sources in the watershed. The entire nonpoint source load is allocated as a single load because there is not enough detailed source data to allocate the load to individual uses (e.g., animal feeding, septic systems, riparian grazing, or waste management).

To achieve the TMDL target identified in the report, will require significant reductions in the load allocation assigned to nonpoint sources. This reduction will require wide spread support and voluntary participation of landowners and residents in the watershed. The TMDL described in this report is a plan to improve water quality by implementing best management practices through non-regulatory approaches. "Best management practices" (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 Des Lacs River and associated watershed to restore and maintain 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.

Nonpoint source pollution is the primary contributor to elevated E. coli bacteria levels in the Des Lacs River watershed. The E. coli bacteria samples and load duration curve analysis of the impaired Des Lacs River reach (ND-09010002-001-S) identified high, moist, and dry condition flow regimes as the time of E. coli bacteria exceedences of the 126 CFU/100 mL target. To reduce NPS pollution for the high, moderate, and low flow regimes, specific BMPs are described in Section 8.1 that will mitigate the effects of E. coli bacteria loading to the impaired reaches.

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 Des Lacs River. The following describe in detail those BMPs that will reduce E. coli bacteria levels in the TMDL listed segment.

Table 9. Management Practices and Flow Regimes Affected by Implementation of BMPs.

Management Practice	Flow Regime and Expected Reduction		
	High Flow-70%	Moderate Flow-80%	Low Flow-74%
Livestock Exclusion From Riparian Area	X	X	X
Water Well and Tank Development	X	X	X
Prescribed Grazing	X	X	X
Waste Management System	X	X	
Vegetative Filter Strip		X	
Septic System Repair		X	X

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:

<u>Livestock exclusion from riparian areas</u>- 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 banks in place and 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.

<u>Water well and tank development</u>- Fencing animals from stream access requires an 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.

<u>Prescribed grazing</u>- 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. (1998), 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 10) 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.

<u>Waste management system</u>- Waste management systems can be effective in controlling up to 90 percent of bacteria loading originating from confined animal feeding areas (Table 11). 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 10. Bacterial Water Quality Response to Four Grazing Strategies (Tiedemann et al., 1988).

Grazing Strategy		Geometric Mean Bacteria 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

Table 11. 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 (%)	Fecal Bacteria (%)
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.

8.2 Other Recommendations

Vegetative filter strip- Vegetated 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 has been documented. Results from a study by Pennsylvania State University (1992a) as presented by USEPA (1993) (Table 11), suggest that vegetative filter strips are capable of removing up to 55 percent of bacteria loading to rivers and streams. 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).

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 occurs 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 fecal 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 Des Lacs River and a request for comment will be mailed to participating agencies, partners, and to those who request a copy. Those included in the mailing of a hard copy are as follows:

- Ward, Mountrail, and Renville County Soil Conservation Districts;
- Ward, Mountrail, and Renville County Water Resource Boards;
- Natural Resource Conservation Service (State Office); and
- U.S. Environmental Protection Agency, Region VIII

In addition to mailing copies of this TMDL for the Des Lacs River to interested parties, the TMDL will be 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 will also be published in the Minot Daily News.

10.0 MONITORING

As stated previously, it should be noted that the TMDL loads, wasteload 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. To ensure that the best management practices (BMPs) that are implemented and technical assistance that is provided as a part of any watershed restoration program are successful in reducing E. coli bacteria loadings to levels prescribed in this TMDL, water quality monitoring will be conducted in accordance with an approved Quality Assurance Project Plan (QAPP).

Specifically, monitoring will be conducted for all variables that are currently causing impairments to the beneficial uses of the waterbody. This includes, but is not limited to, 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.

11.0 TMDL IMPLEMENTATION STRATEGY

Implementation of TMDLs is dependent upon the availability of Section 319 NPS funds or other watershed restoration programs (e.g. USDA Environmental Quality Incentive Program), as well as securing a local project sponsor and required matching funds. Provided these three requirements are in place, a PIP is developed in accordance with the TMDL and submitted to the ND Nonpoint Source Pollution Task Force and US EPA for approval. The implementation of the BMPs contained in the NPS PIP is voluntary. Therefore, success of any TMDL implementation project is ultimately dependant on the ability of the local project sponsor to find cooperating producers.

Monitoring is an important and required component of any PIP. As a part of the PIP, data are collected to monitor and track the effects of BMP implementation as well as to judge overall project success. Quality Assurance Project Plans (QAPPs) detail the strategy of how, when, and where monitoring will be conducted to gather the data needed to document the TMDL implementation goal(s). As data are gathered and analyzed, watershed restoration tasks are adapted to place BMPs where they will have the greatest benefit to water quality.

Also, as part of any implementation plan for this TMDL, it is recommended that the permitted point sources (i.e., CAFOs, AFOs) in the watershed be inspected to ensure that they are being operated in compliance with their permit conditions, and to verify that they aren't significant E. coli sources. Currently, it is the policy of the NDDoH that all permitted CAFOs (greater than or equal to 1000 animal units) be inspected annually. Permitted AFOs (<1000 animal units) in Des Lacs watershed are inspected on an as needed basis.

12.0 REFERENCES

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Appendix A
E. coli Bacteria Data Collected for Sites 380021
(2001-2010)

E. Coli Bacteria Data for Site 380021

By Year	Date	Result (CFU/100mL)
2001	5/9/2001	20
	6/19/2001	70
	7/31/2001	110
	9/11/2001	20
2002	5/21/2002	50
	6/25/2002	360
	7/30/2002	420
	9/4/2002	70
2003	5/14/2003	10
	8/6/2003	130
2004	5/4/2004	Non-Detect*
	7/26/2004	30
	9/8/2004	60
2005	5/16/2005	10
	6/20/2005	510
	8/9/2005	30
	9/19/2005	100
2006	5/15/2006	10
	6/27/2006	20
	8/7/2006	60
	9/18/2006	160
2007	5/9/2007	50
	6/11/2007	170
	7/24/2007	50
	8/21/2007	30
	9/24/2007	80
2008	6/2/2008	30
	7/15/2008	10
	8/26/2008	580
2009	5/6/2009	Non-Detect*
	6/16/2009	120
	7/27/2009	Non-Detect*
	9/8/2009	80
2010	6/8/2010	240
	7/20/2010	Non-Detect*
	9/1/2010	610

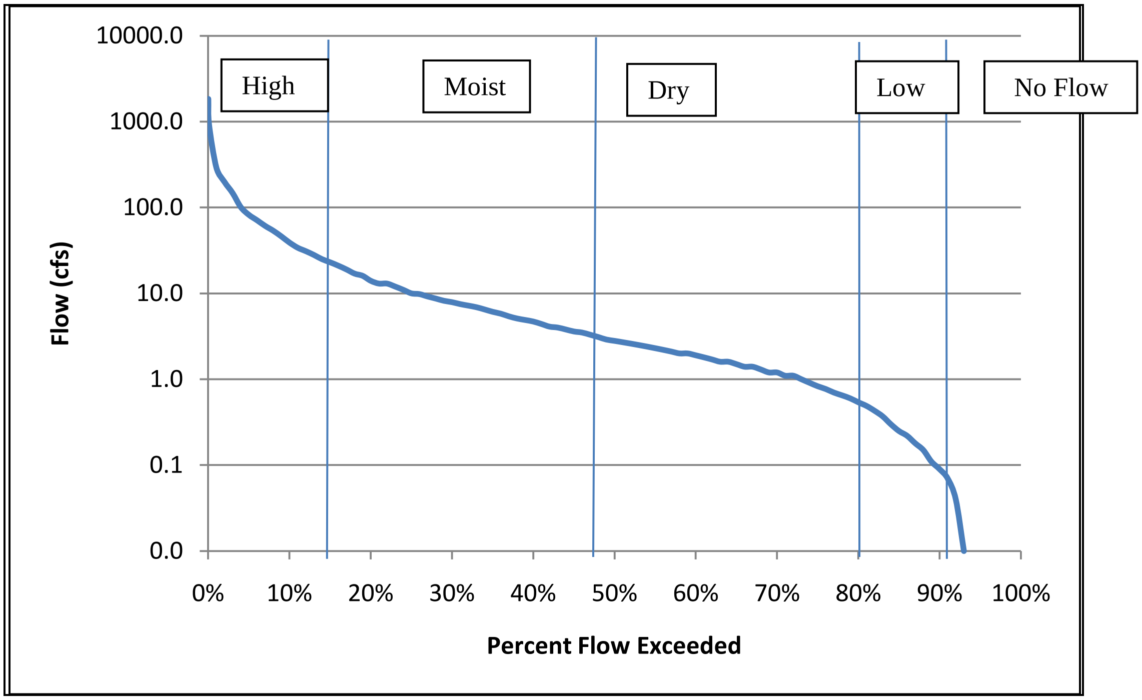
By Month	Date	Result (CFU/100mL)
May	5/9/2001	20
	5/21/2002	50
	5/14/2003	10
	5/4/2004	ND*
	5/16/2005	10
	5/15/2006	10
	5/9/2007	50
	5/6/2009	ND*
June	6/19/2001	70
	6/25/2002	360
	6/20/2005	510
	6/27/2006	20
	6/11/2007	170
	6/2/2008	30
	6/16/2009	120
	6/8/2010	240
July	7/31/2001	110
	7/30/2002	420
	7/26/2004	30
	7/24/2007	50
	7/15/2008	10
	7/27/2009	ND*
	7/20/2010	ND*
August	8/6/2003	130
	8/9/2005	30
	8/7/2006	60
	8/21/2007	30
	8/26/2008	580
September	9/11/2001	20
	9/4/2002	70
	9/8/2004	60
	9/19/2005	100
	9/18/2006	160
	9/24/2007	80
	9/8/2009	80
	9/1/2010	610

Summary of E. Coli Data 2001-2010 for Site 380021

	N	Geomean	Percent Samples Exceed 409 CFU/100mL	Number of Non-Detects	Percent of Samples Returned as Non-Detect	Use Support
May	8	16.30689409	00.0%	2	25%	Fully Supporting
June	8	118.0647963	12.5%	0	0	Fully Supporting But Threatnened
July	7	35.37334879	14.3%	2	28.6%	Fully Supporting But Threatnened
Aug	5	83.55126336	20.0%	0	0	Fully Supporting But Threatnened
Sep	8	92.25472842	12.5%	0	0	Fully Supporting But Threatnened

Appendix B
Flow Duration Curves for Site 380021

STORET Site 380021/USGS Site 05116550



Appendix C
Load Duration Curve, Estimated Loads, TMDL Targets, and Percentage of Reduction Required for Site 380021

380021 Des Lacs River near Foxholm, ND

	Load (10^7 CFU/Day)			Load (Million CFU/Period)			
	Median Percentile	Existing	TMDL	Days	Existing	TMDL	Percent Reduction
High	6.00%	93019.50	21889.96	43.80	4074253.97	958780.10	76.47%
Moist	29.00%	6805.70	2528.14	124.10	844587.77	313741.66	62.85%
Dry	63.00%	793.39	493.29	124.10	98459.16	61217.88	37.82%
			Total	292	5017301	1333740	73.42%