E. coli Bacteria TMDLs for the Sheyenne River and an Unnamed Tributary to the Sheyenne River in Sheridan and Wells Counties, North Dakota

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1.0 INTRODUCTION AND DESCRIPTION OF THE WATERSHED

The Upper Sheyenne River sub-basin (09020202) encompasses approximately 1,907 square miles or 1,220,722 million acres located in Benson, Eddy, McHenry, Pierce, Sheridan, and Wells Counties (Figure 1 and Table 1). For the purposes of this TMDL, the impaired stream segments are located in Sheridan and Wells Counties and comprise a watershed area of approximately 347,914 acres. The Sheyenne River, including an unnamed tributary to the Sheyenne River, which are the focus of this TMDL report lie within the Northern Glaciated Plains (46) and Northwestern Glaciated Plains (42) level III ecoregions.

Table 1. General Characteristics of the Upper Sheyenne River, an Unnamed Tributary to Sheyenne River and Their Contributing Watershed.

Legal Name	Sheyenne River, Unnamed Tributary, and Sheyenne Headwaters
Stream Classification	Class IA and Class III
Major Drainage Basin	Sheyenne River
8-Digit Hydrologic Unit	09020202
Counties	Sheridan and Wells Counties
Level III Ecoregion	Northern Glaciated Plains (46) and Northwestern Glaciated Plains (42)
Watershed Area (acres)	347,914

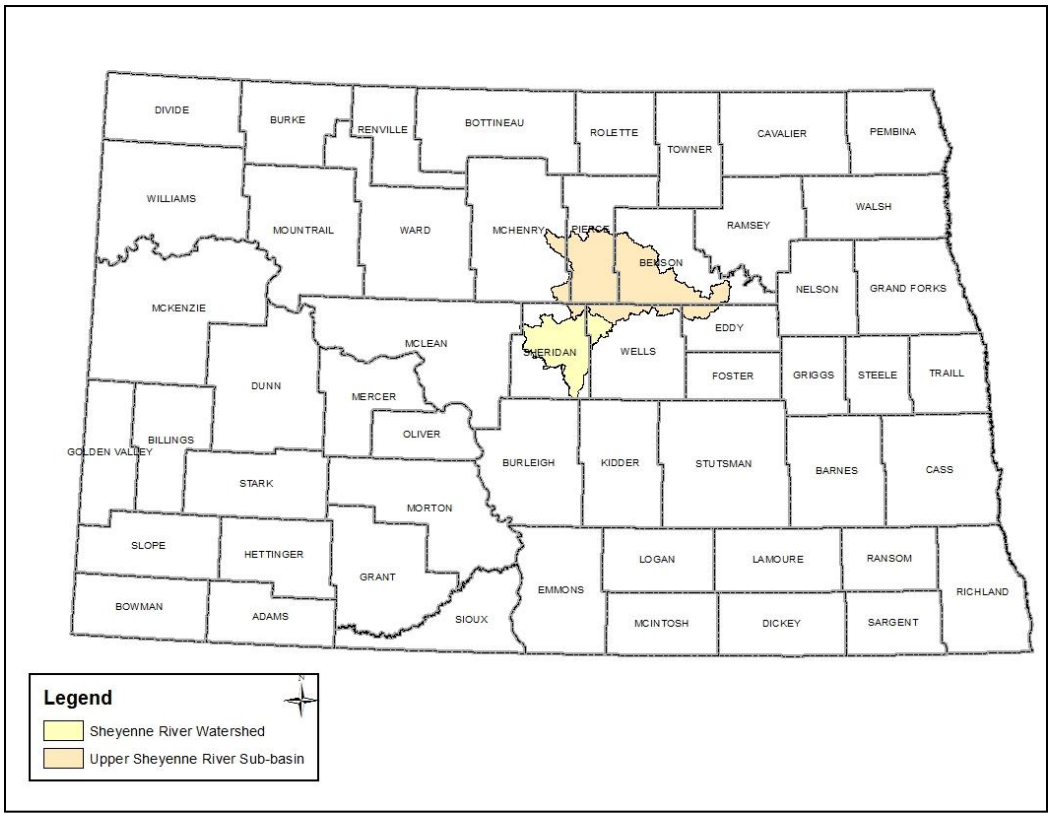

Figure 1. Upper Sheyenne River Sub-basin, Including the Watershed Area Represented by the TMDL Listed Waterbody Assessment Units ND-09020202-012-S_00, ND-09020202-013-S_00 and ND-09020202-015-S_00.

1.1 Clean Water Act Section 303(d) Listing Information

Based on the 2012 Section 303 (d) List of Impaired Waters Needing TMDLs (NDDoH, 2012), the North Dakota Department of Health has identified a 20.8 mile segment of the Sheyenne River from Coal Mine/Sheyenne Lakes downstream to Harvey Dam (ND-09020202-012-S_00) as fully supporting, but threatened for recreation use, a 36.24 mile segment of an unnamed tributary to the Sheyenne River (ND-09020202-012-S) as not supporting for recreation use, and a 17.2 mile segment of the Sheyenne River downstream to Coal Mine Lake/Sheyenne Lake as not supporting recreation use. The impairments are due to Escherichia coli (E. coli) bacteria (Tables 2-4, Figure 2).

Table 2. Section 303(d) Listing Information for Assessment Unit ID ND-090200202-012-S_00 (NDDoH, 2012).

Assessment Unit ID	ND-09020202-012-S_00
Waterbody Description	Sheyenne River from Coal Mine/Sheyenne Lakes downstream to Harvey Dam. Located along the Sheridan and Wells County border.
Size	20.8 miles
Designated Use	Recreation
Use Support	Fully Supporting, but Threatened
Impairment	E. coli Bacteria
TMDL Priority	High

Table 3. Section 303(d) Listing Information for Assessment Unit ID ND-09020202-013-S_00 (NDDoH, 2012).

Assessment Unit ID	ND-09020202-013-S_00
Waterbody Description	Unnamed tributary to the Sheyenne River (ND-09020202-012-S). Located in eastern Sheridan County.
Size	36.24 miles
Designated Use	Recreation
Use Support	Not Supporting
Impairment	E. coli Bacteria
TMDL Priority	High

Table 4. Section 303(d) Listing Information for Assessment Unit ID ND-09020202-015-S_00.

Assessment Unit ID	ND-09020202-015-S_00
Waterbody Description	Sheyenne River downstream to Coal Mine Lake/Sheyenne Lake
Size	17.2 miles
Designated Use	Recreation
Use Support	Not Supporting
Impairment	E. coli Bacteria
TMDL Priority	High

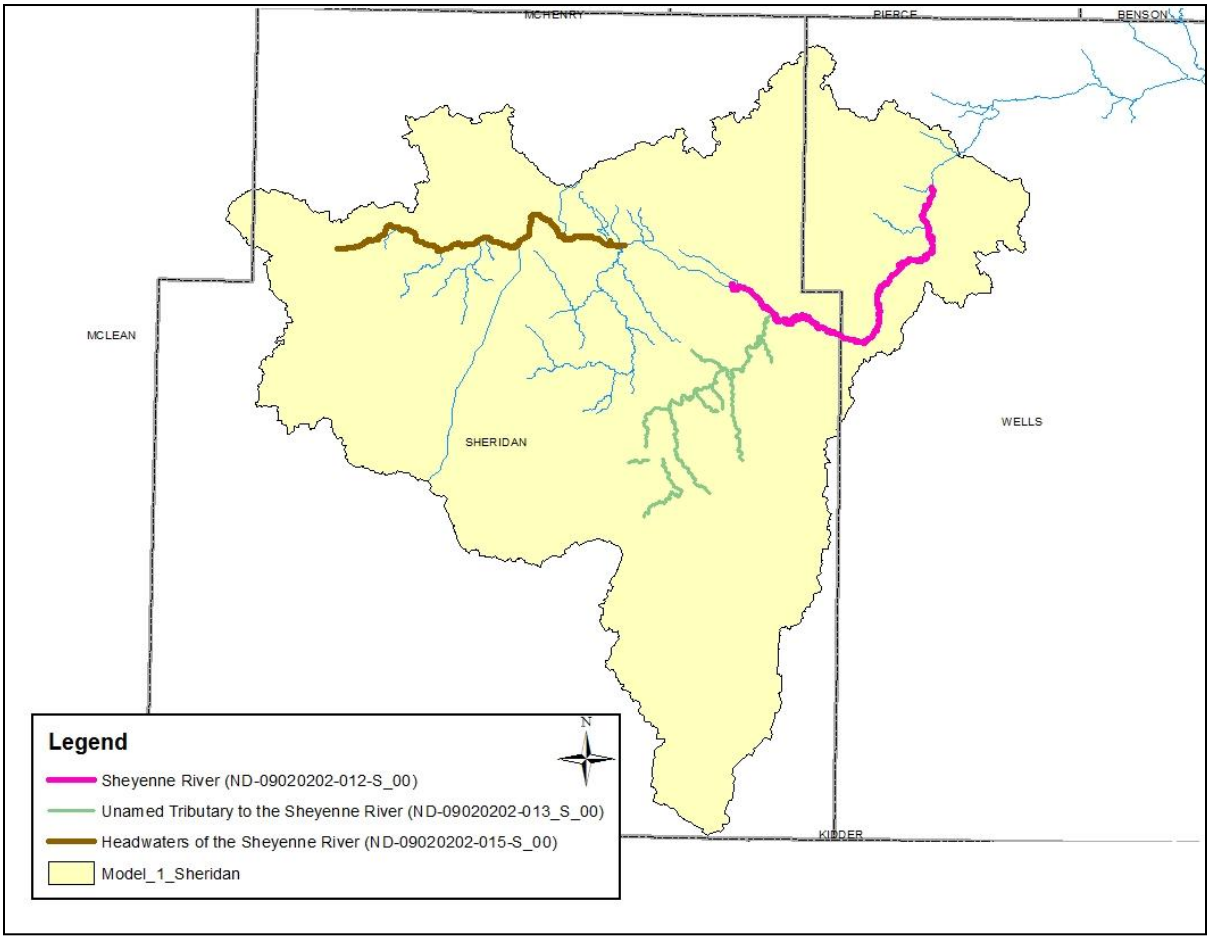

Figure 2. Map Depicting TMDL Listed Waterbodies ND-09020202-012-S_00, ND-09020202-013-S_00 and ND-09020202-015-S_00.

1.2 Ecoregions

The upper Sheyenne River watershed lies within two level IV ecoregions. These are the Missouri Coteau ecoregion (42a) and Drift Plains Ecoregion (46i) (Figure 3). The Missouri Coteau level IV ecoregion (42a) contains numerous wetlands and/or potholes that were created when the Wisconsinan glacier stalled on the Missouri escarpment, slowly melting beneath a mantle of sediment to create the pothole topography of the coteau. Land use within the coteau is a mixture of tilled agriculture in flat areas and grazing along steeper slopes.
The Drift Plains ecoregion (46i) was created from the retreating Wisconsinan glaciers which left a subtle rolling topography, thick glacial till and a large number of temporary and seasonal wetlands. The Drift Plains contain productive soils and level topography which largely favors cultivation practices. Historic grasslands of transitional and mixed grass prairie have been replaced with fields of spring wheat, barley, sunflowers and alfalfa (USGS, 2006).

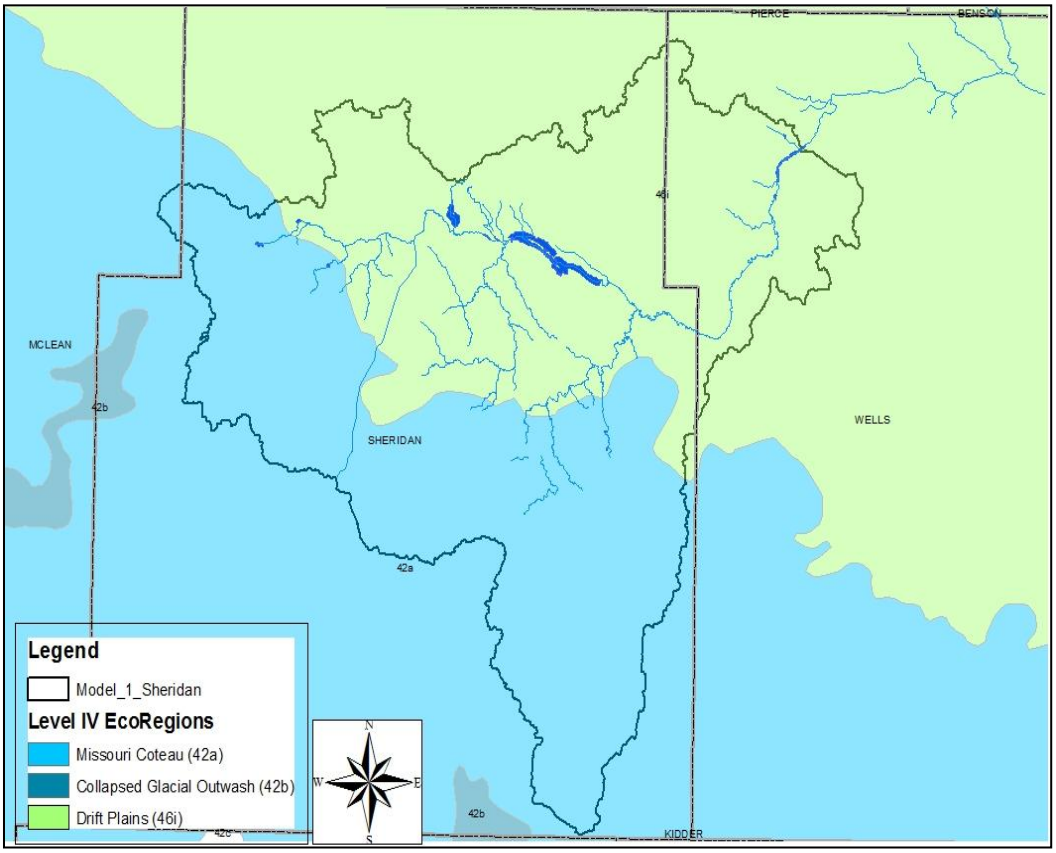

Figure 3. Level IV Ecoregions in the Upper Sheyenne River Watershed.

1.3 Land Use

The Sheyenne River watershed encompasses 347,914 acres in Sheridan and Wells Counties, North Dakota. According to National Agricultural Statistics Service (NASS) 2007 land cover data, the dominant land use in the watershed is agriculture with 62 percent used for grassland/pasture, 34 percent cropland, and the remaining 4 percent a combination of water, wetlands, or developed/open space (Figure 4). The dominant crops grown in the watershed are spring wheat, sunflowers, and soybeans.

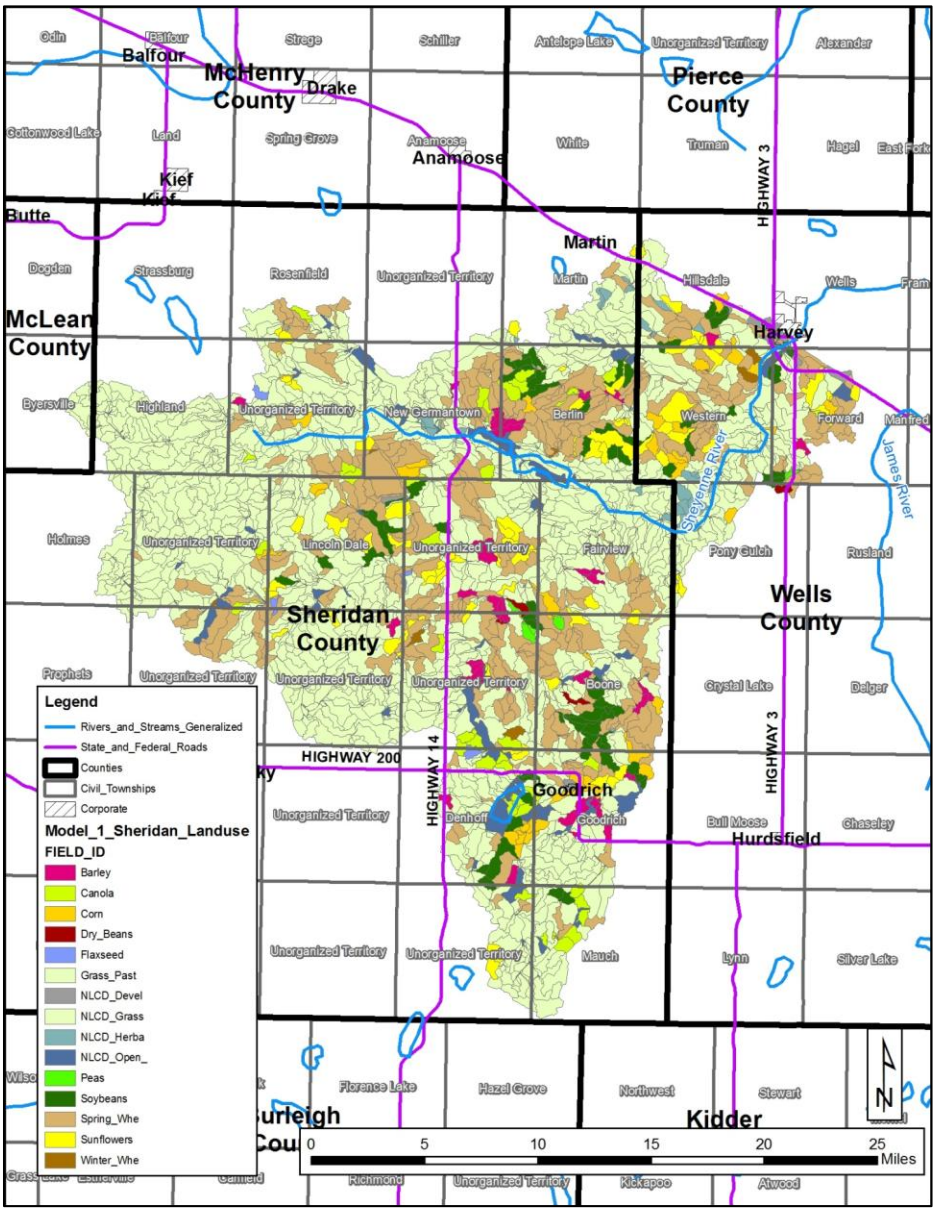

Figure 4. Land Use in the Upper Sheyenne River Watershed (NASS, 2007).

1.4 Climate and Precipitation

Precipitation data for the upper Sheyenne River, including an unnamed tributary to the Sheyenne River were obtained from the North Dakota Agricultural Weather Network (NDAWN) station located near Harvey, ND in the northeast corner of the watershed. Figure 5 shows monthly precipitation data averaged for the years of 1995 to 2008 compared to the precipitation totals for each month during 2009 and 2010. Snowfall data had not been converted into precipitation for the months of January through March and November through December for the years 1995 to 2010, and so those months do not appear in Figure 5.

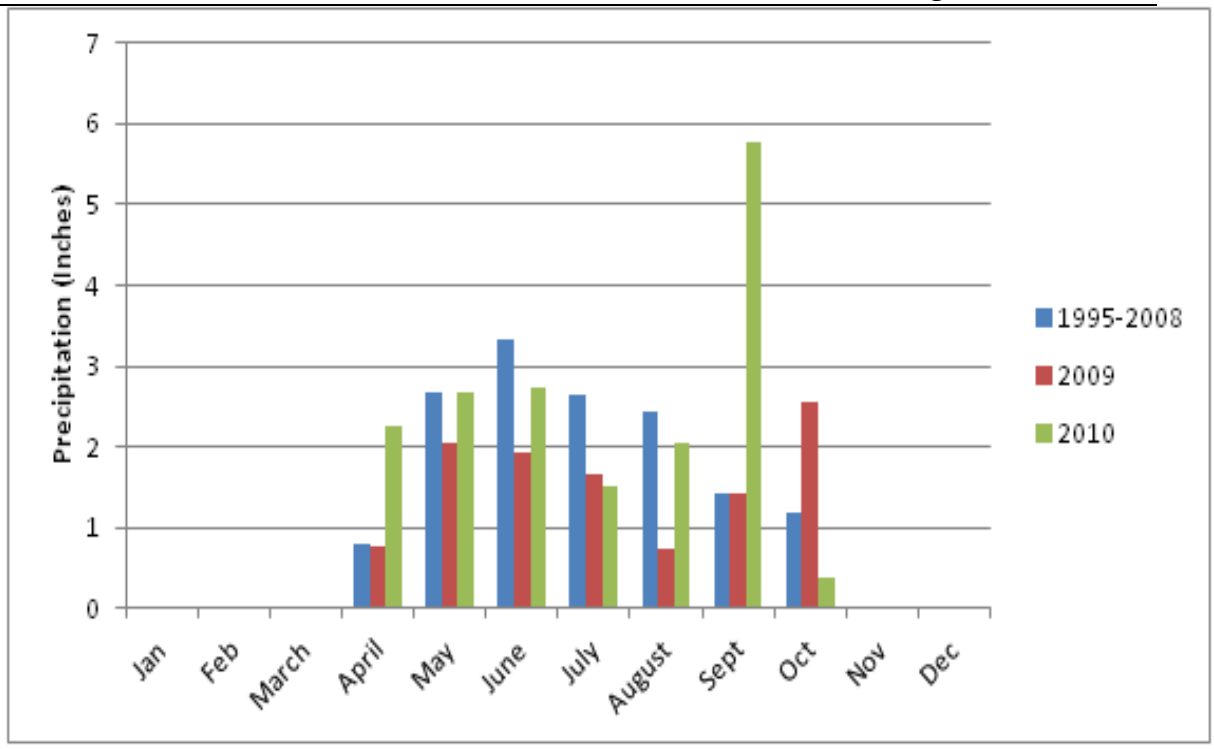

Figure 5. Monthly Precipitation for the NDAWN Weather Station Located Near Harvey, ND.

1.5 Available Data

1.5.1 E. coli Bacteria Data

E. coli bacteria samples were collected at one location within each TMDL listed stream reach (Figure 6). Monitoring site 380135 is located on the Sheyenne River (ND-09020202-012-S_00) 4 miles south and 1.5 miles west of Harvey, ND. Monitoring site 380137 is located on an unnamed tributary to the Sheyenne River (ND-09020202-013-S_00) 2.5 miles southeast of Coal Mine Lake. Monitoring site 384020 is located on the headwaters of Sheyenne River (upstream of Coal Mine Lake/Sheyenne Lake) (ND-09020202-015-S_00). This site is located 8 miles south, 3 miles west, and 3 miles south of Anamoose, ND. Sites 3380135, 380137, and 384020 were monitored weekly or when flow conditions were present during the recreation season (May-September) of 2009 and 2010. Each monitoring station was sampled by personnel with the Wells County Soil Conservation District.

Table 5 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 monthly geometric mean E. coli bacteria concentration and the percent of samples over 409 CFU/100ml for each month (May-September) were calculated based on samples collected during 2009 and 2010.

Table 5. Summary of 2009 and 2010 E. coli Bacteria Data for Monitoring Sites 380135, 380137 and 384020.

380135					
Recreational Season	**May**	**June**	**July**	**August**	**September**
Number of Samples	7	9	8	9	9
Geometric Mean	16	94	43	158	300
% Eceeded 409 CFU/100 mL	0%	11%	0%	22%	33%
Recreational Use Assessment	FS	FS	FS	NS	NS
380137					
Recreational Season	**May**	**June**	**July**	**August**	**September**
Number of Samples	6	10	8	5	4
Geometric Mean	56	94	430	138	161
% Eceeded 409 CFU/100 mL	17%	0%	50%	40%	25%
Recreational Use Assessment	FSbT	FS	NS	NS	NS
384020					
Recreational Season	**May**	**June**	**July**	**August**	**September**
Number of Samples	6	9	5	2	4
Geometric Mean	55	65	176	300	219
% Eceeded 409 CFU/100 mL	0%	0%	20%	50%	50%
Recreational Use Assessment	FS	FS	NS	INSFD	NS

FS – Fully Supporting; FSbT- Fully Supporting but Threatened; NS – Not Supporting; INSFD – Insufficient Data

An analysis of the 2009 and 2010 E. coli bacteria data collected at site 380135, showed that for the months of May, June, and July, recreation use was fully supporting (Table 5). In August and September, estimates for both the geometric mean concentration and percentage of samples exceeded the E. coli bacteria water quality standards, therefore recreation use was assessed as not supporting (Table 5).

The recreational use support assessment based on E .coli bacteria data collected in 2009 and 2010 for site 380137 showed that during the months of July, August, and September recreation use was not supporting, while May was assessed as fully supporting, but threatened, and June was fully supporting recreational beneficial uses (Table 5).

The recreation use assessment for site 384020 concluded that during the months of May and June recreation use was fully supporting, while July was assessed as not supporting (Table 5). A recreational use assessment could not be made for the month of August due to an insufficient amount of samples taken in 2009 and 2010.

1.5.2 Hydraulic Discharge

Daily stream discharge values for the period 1990-2010 were available at one stream location within the upper Sheyenne River watershed. This location was at the United States Geological Survey (USGS) gaging station located on Sheyenne River near Harvey, ND (05054500). The USGS station has operated continuously since 1956 and is collocated with NDDoH monitoring site 380135.

A discharge record was constructed for site 384020, representing the Sheyenne River downstream to Coal Mine Lake/Sheyenne Lake (ND-09020202-015-S_00) and for site 380137, representing the unnamed tributary to the Sheyenne River (ND-09020202-013-S_00), using the Drainage Area Ratio Method (Ries et al., 2000) and the historical discharge measurements collected by the USGS at gaging station 05054500 from 1990-2010 (Figure 6).

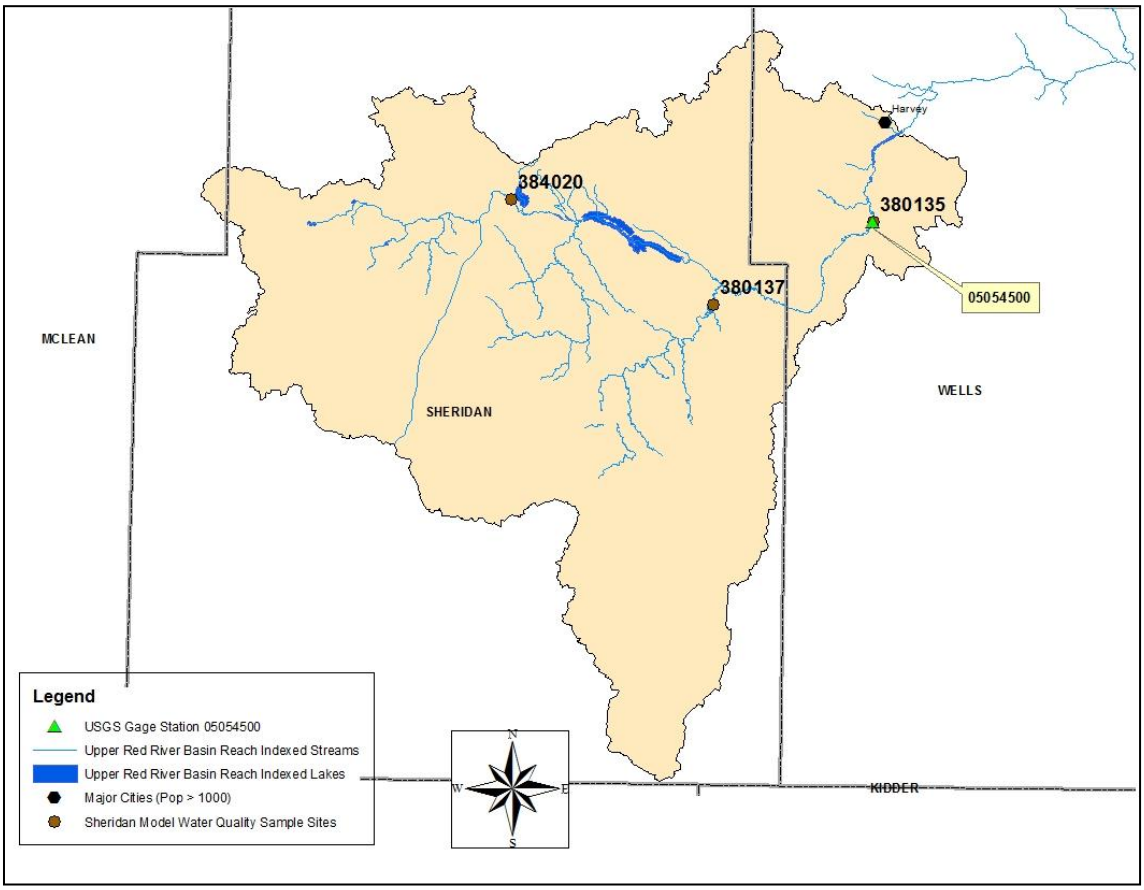

Figure 6. NDDoH Monitoring Sites and USGS Gauge Station 05054500 in the Upper Sheyenne River Watershed.

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, which in this case is E. coli bacteria.

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 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 Sheyenne River, including the reach downstream to Coal Mine Lake/Sheyenne Lake (ND-09020202-015-S_00) and the reach from Coal Mine Lake downstream to Harvey Dam (ND-09020202-012-S_00), is a Class IA stream. The NDDoH definition of a Class IA stream is shown below (NDDoH, 2011).

Class IA- The quality of the waters in this class shall be the same as the quality of class I streams, except that where natural conditions exceed class I criteria for municipal and domestic use, the availability of softening or other treatment methods may be considered in determining whether ambient water quality meets the drinking water requirements of the department.

Most tributaries to the Sheyenne River, including the unnamed tributary which is the focus of this TMDL report (ND-09020202-013-S_00) are Class III streams. The NDDoH definition of a Class III stream is shown below (NDDoH, 2011).

Class III- The quality of the waters in this class shall be suitable for agricultural and industrial uses. Streams in this class generally have low average flows with prolonged periods of no flow. During periods of no flow, they are of limited value for recreation and fish and aquatic biota. The quality of these waters must be maintained to protect secondary contact recreation uses (e.g., wading), fish and aquatic biota, and wildlife uses.

Table 6 provides a summary of the numeric E. coli water quality criteria which applies to Class IA and III streams. The E. coli bacteria standard applies only during the recreation season from May 1 to September 30.

Table 6. North Dakota E. coli Bacteria Water Quality Standards for Class IA and III 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 Sheyenne River and the unnamed tributary to the Sheyenne River are based on the NDDoH water quality standard for E. coli bacteria.

3.1 Sheyenne River and Unnamed Tributary to the Sheyenne River Target Reductions in E. coli Bacteria Concentrations

The two Sheyenne River segments (ND-09020202-012-S_00 and ND-09020202-015-S_00) and the unnamed tributary to the Sheyenne River (ND-09020202-013-S_00) are impaired for recreation 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 a 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

There are no known point sources to the TMDL listed segments of the Sheyenne River or to the unnamed tributary to the Sheyenne River. E. coli bacteria polluting the river are from nonpoint sources.

There are four known animal feeding operations (AFOs) in the upper Sheyenne River watershed. The four AFOs include two small (0-300 animal units (AUs)) AFOs and two medium (301-999 AUs) AFOs which have a permit to operate. All four AFOs are zero discharge facilities and are not deemed a significant point source of E. coli bacteria loadings to the Sheyenne River or its tributaries.

4.2 Nonpoint Source Pollution Sources

The TMDL listed segments of the Sheyenne River and the unnamed tributary to the Sheyenne River are experiencing E. coli bacteria pollution from nonpoint sources in the watersheds. Livestock production is the dominant agricultural practice in the North Dakota side of the watersheds livestock grazing and watering in proximity to the Sheyenne River are common along the TMDL listed segments

The northeast section of North Dakota typically experiences long duration or intense precipitation during the 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, it is likely that this contributes E. coli bacteria to the Sheyenne River and its tributaries.

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

Wildlife may also contribute to the E. coli bacteria found in the water quality samples, but most likely in a lower concentration. Wildlife are nomadic with fewer numbers concentrating in a specific area, thus decreasing the probability of their contribution of fecal matter in significant quantities.

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 the 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 (EPA, 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 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 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 an explicit margin of safety of 10 percent.

5.1 Mean Daily Stream Flow

Daily stream discharge values were collected at one stream location within the upper Sheyenne River watershed. This location was at the United States Geological Survey (USGS) gauging station located above Harvey, N.D (05054500). The USGS station has operated continuously since1956 and is collocated with NDDoH monitoring site 380135.

For the purposes of this assessment report, the last twenty-one years (1990-2010) of historical discharge records will be used to describe the hydrology of the watershed. This block of time should account for wet and dry cycles through the hydrological history of USGS gauge station 05054500.

During the period 1990-2010, the average discharge was 20 cfs (Figure 7). From 1990 to 1992, the annual average discharge of the Sheyenne River above Harvey, ND was very low, most likely due to drought conditions in the late 1980's. Then from 1993-2001 the average annual discharge fluctuated from average to above average flows, most likely due to a wet cycle (Figure 7). Flows dropped significantly from 2002-2008, increasing again in 2009 and 2010 where the discharge was up to 2 1/2 times higher than the average discharge for the period. The increase in flow in 2009 and 2010 can be attributed to record snowfalls and above average spring rains that were present all across North Dakota during the time period.

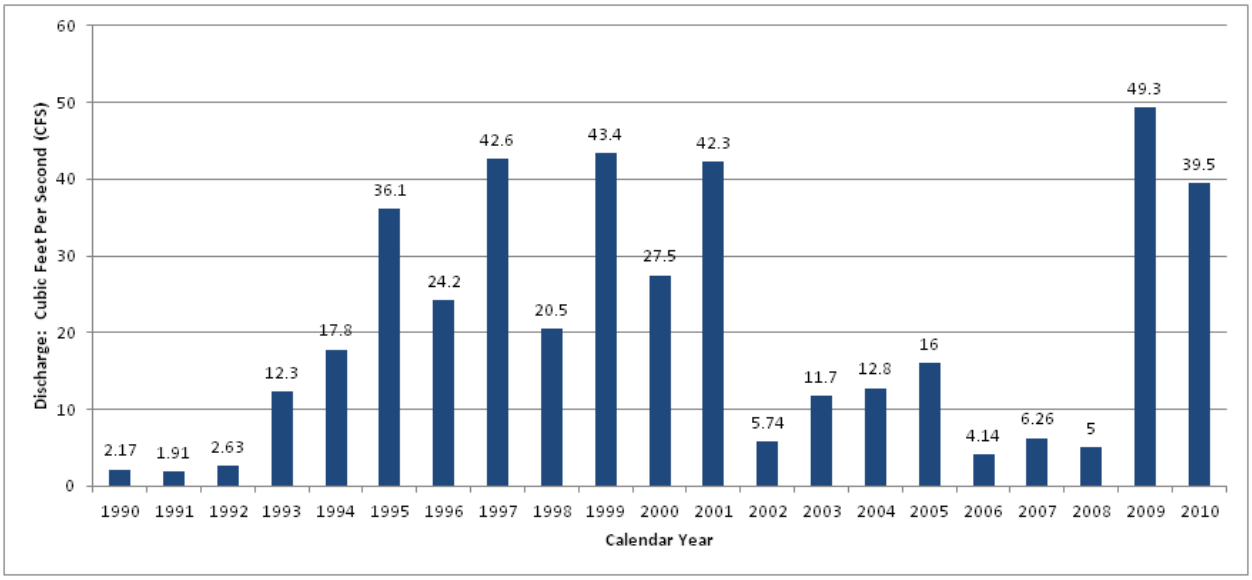

Figure 7. Average Annual Discharge at USGS Gauging Station 05054500 Located on the Sheyenne River above Harvey, ND.

In northeastern 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 ungauged water quality monitoring sites 380137 and 384020 were determined by utilizing the Drainage-Area Ratio Method developed by the USGS (Ries et. al, 2000). The Drainage-Area Ratio Method assumes that the stream flow 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 ungaged sites, 3840137 and 384020, are nested on the same reach as the index station, USGS gauging station 05054500.

Stream flow data for the index station, 05054500, was obtained from the USGS Water Science Center website. The index station 05054500 stream flow data was then divided by the drainage area to determine stream flows per unit area at the index station. Those values are then multiplied by the drainage area for the ungaged sites to obtain estimated flow statistics for the ungaged sites.

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). Therefore, as depicted in Figure 8, a flow duration interval of twenty five (25) percent, associated with a stream flow of 15 cfs, implies that 25 percent of all observed mean daily discharge values equal or exceed 15 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). As depicted in Figure 8, the flow duration curve for site 380135 representing TMDL segment ND-09020202-012-S was divided into four zones, one representing high flows (0-5 percent), another for moist conditions (5-31 percent), one for dry conditions (31-85 percent) and one for low flows (85-96 percent). Based on the flow duration curve analysis, no flow occurred 4 percent of the time (96 to100 percent).

Similarly, as depicted in Figure 9, the flow duration curve for water quality site 380137 and representing TMDL segment ND-09020202-013-S was also divided into four zones, one representing high flows (0-5percent), another for moist conditions (5-48 percent), dry conditions (48-91 percent), and one for low flows (91-96 percent). Based on the flow duration curve analysis, no flow (or zero flow) was met or exceeded 96-100 percent.

Likewise, as depicted in Figure 10, the flow duration curve for water quality site 384020 and representing TMDL segment ND-09020202-015-S was also divided into four zones, one representing high flows (0-10 percent), another for moist conditions (10-55 percent), dry conditions (55-80 percent), and one for low flows (80-96 percent). Based on the flow duration curve analysis, no flow (or zero flow) was met or exceeded 96-100 percent.

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 (Figures 8-10). 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.

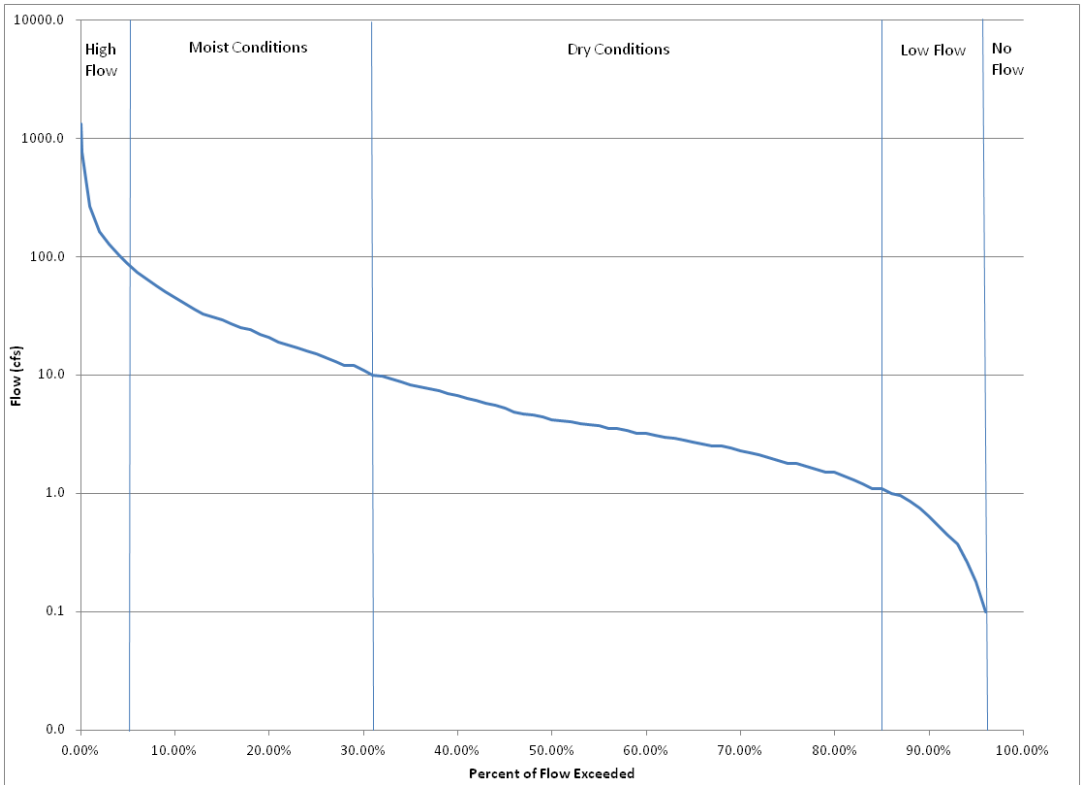

Figure 8. Flow Duration Curve for the Sheyenne River Monitoring Site 380135.

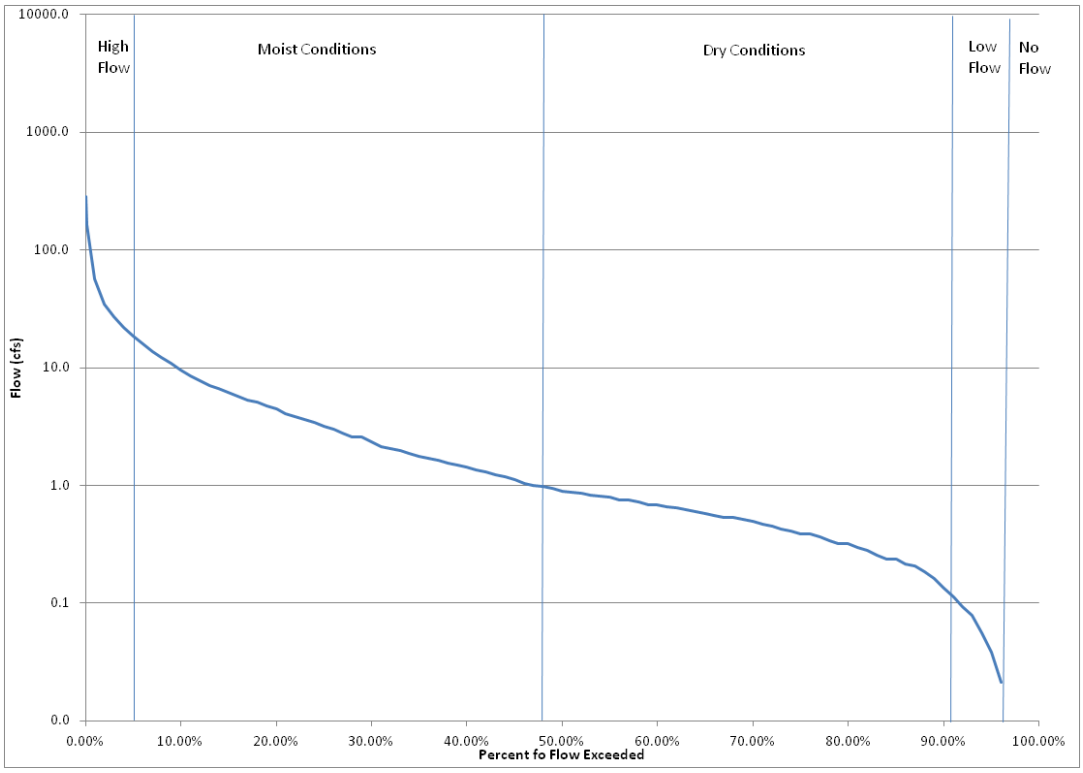

Figure 9. Flow Duration Curve for Unnamed Tributary to the Sheyenne River Monitoring Site 380137.

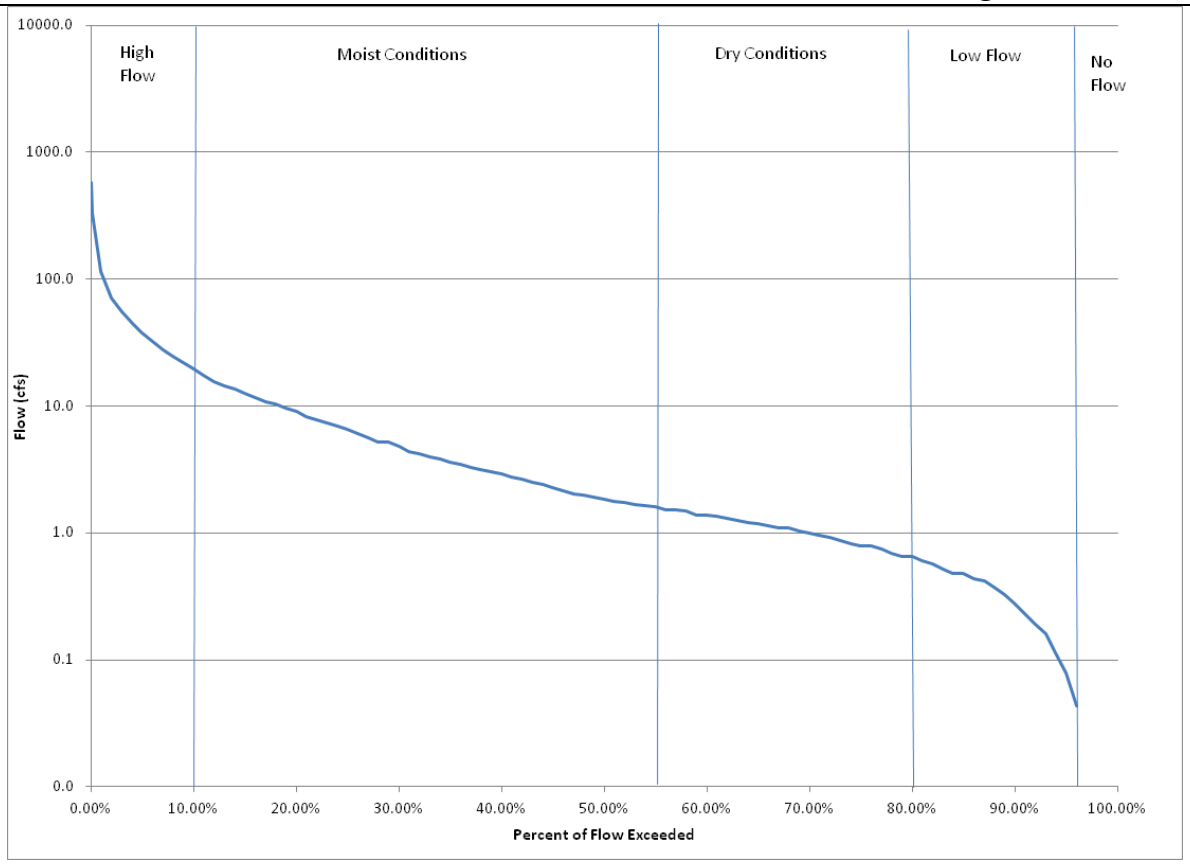

Figure 10. Flow Duration Curve for Sheyenne River Monitoring Site 384020.

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 two TMDL listed Sheyenne River stream segments and the unnamed tributary to the Sheyenne River. The load duration curves for the three impaired reaches were 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 sites 380135, 380137, and 384020 in 2009 and 2010 (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 (Figures 11-13). 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 curves for sites 380135, 380137, and 384020 depicting a regression relationship for each flow interval are provided in Figures 11-13.

The regression lines for the moist condition and dry condition flow regimes for sites 380135 and 380137 and the high and moist condition flow regimes for monitoring site 384020, 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. For example, in the example provided in Figure 11, the regression relationship between observed E. coli bacteria loading and percent exceeded flow for the moist and dry condition flow intervals are:

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

Where the midpoint of the moist condition interval from 5 to 31 percent is 18 percent, the existing E. coli bacteria load is:

E. coli bacteria load (10^7 CFUs/day) = antilog (4.52 + (-1.71*0.18))
= 16,250x 10^7 CFUs/day

Where the midpoint of the dry condition interval from 31 to 85 percent is 58 percent, the existing E. coli bacteria load is:

E. coli bacteria load (10^7 CFUs/day) = antilog (4.07 + (-0.97*0.58))
= 3,209 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 18 and 58 percent exceeded flow derived from the 126 CFU/100 mL TMDL target curves are 7,399 x 10^7 CFUs/day, and 1,048 x 10^7 CFUs/day, respectively.

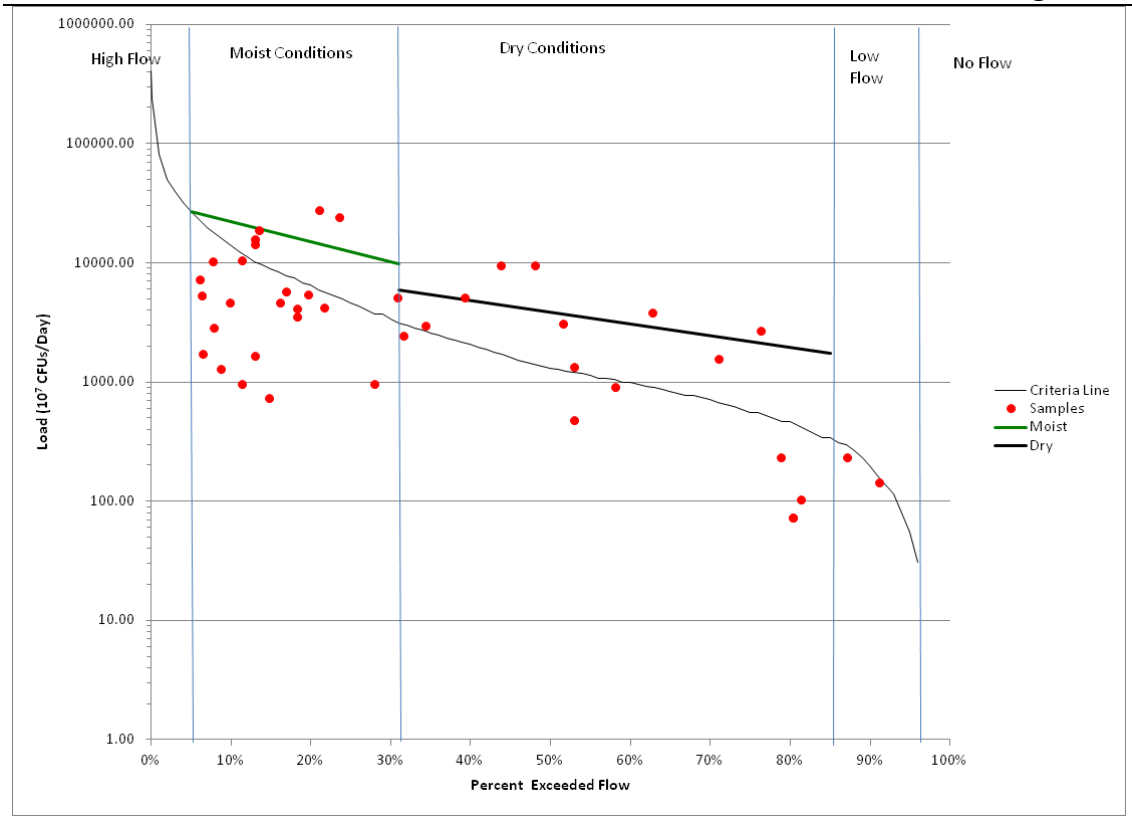

Figure 11. E. coli Bacteria Load Duration Curve for Sheyenne River Monitoring Site 380135 (The curve reflects flows from 1990-2010).

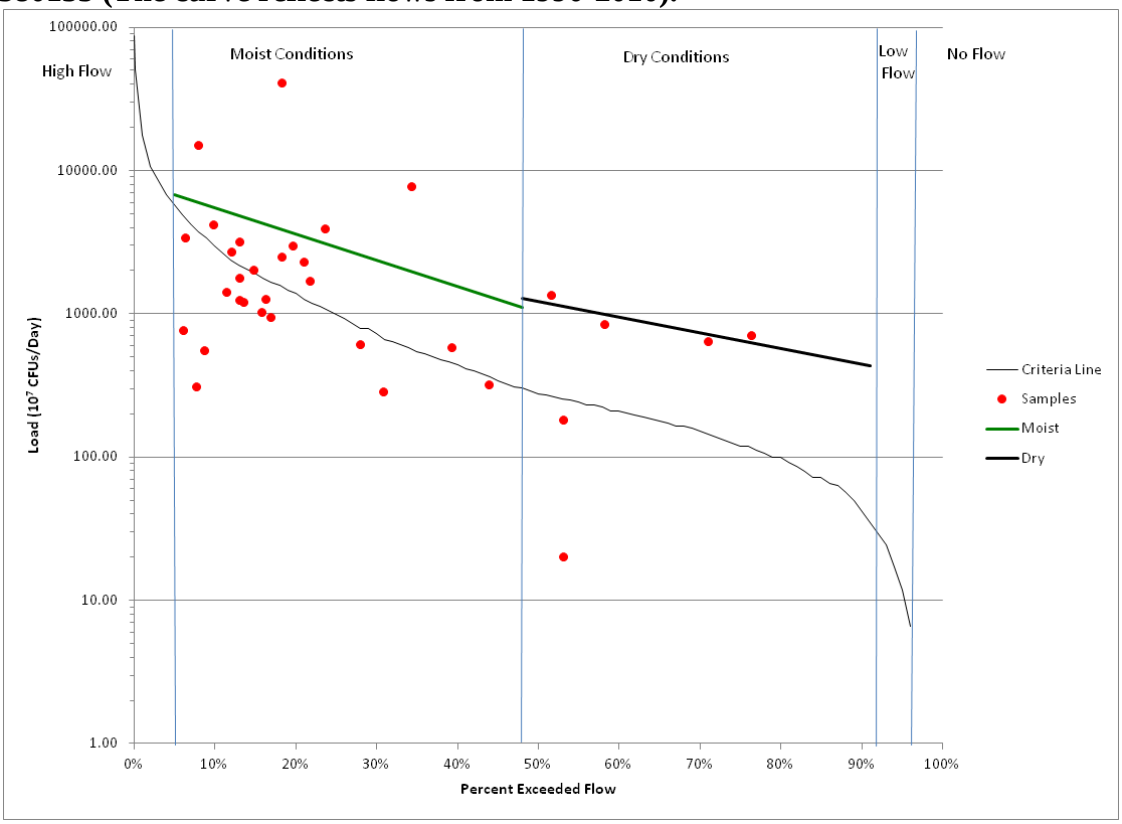

Figure 12. E. coli Bacteria Load Duration Curve for Unnamed Tributary to the Sheyenne River Monitoring Site 380137 (The curve reflects flows from 1990-2010).

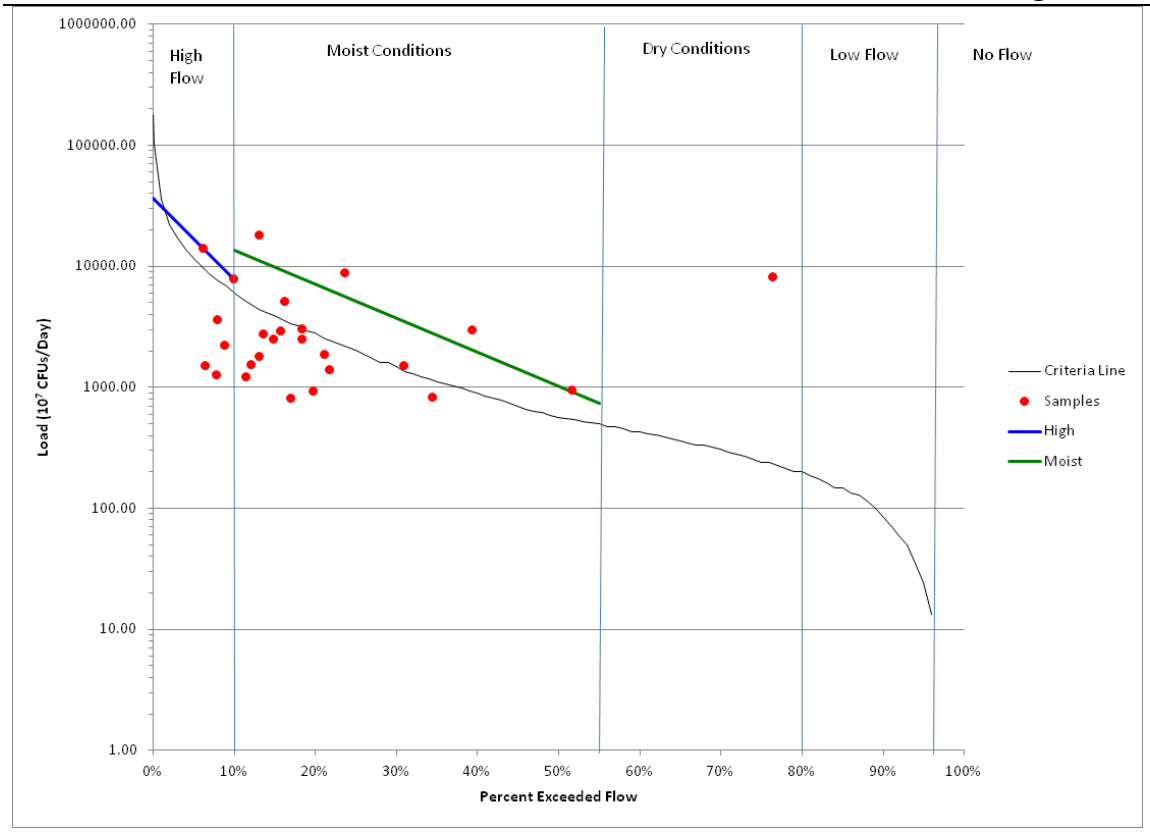

Figure 13. E. coli Bacteria Load Duration Curve for Sheyenne River Monitoring Site 384020 (The curve reflects flows from 1990-2010).

5.4 Loading Sources

The E. coli bacteria load reductions needed for the Sheyenne River and the unnamed tributary to the Sheyenne River can generally be allotted to nonpoint sources. Based on the data available, the general focus of BMPs and load reductions for the listed waterbodies should be on riparian grazing adjacent to or in close proximity to the Sheyenne River and its tributaries.

Significant 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, two flow regimes (i.e., moist and dry conditions) were selected to represent the hydrology of the listed segments on the Sheyenne River from Coal Mine Lake downstream to Harvey Dam (ND-09020202-012-S_00) and the unnamed tributary to the Sheyenne River (ND-09020202-013-S_00) (Figures 11 and 12). These two flow regimes were used for sites 380135 and 380137 because samples indicated exceedences of the water quality standard during periods of moderate flows. Additionally, two flow regimes (high and moist conditions) were selected to represent the hydrology of the impaired segment of the Sheyenne River downstream to Coal Mine Lake (ND-09020202-015-S_00) (Figure 13). These two flow regimes were used for site 384020 because samples indicated exceedences of the water quality standard during periods of high and moderate 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 7). 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 7). 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 7. 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 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.

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 Sheyenne River, unnamed tributary to the Sheyenne River, and headwaters of the Sheyenne River TMDL addresses seasonality because the flow duration curve was developed using 20 years of USGS gauge data encompassing all 12 months of the year. 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 8 provides an outline of the critical elements of the E. coli bacteria TMDL for the three TMDL listed stream segments that are the focus of this report. TMDLs for the Sheyenne River from Coal Mine Lake downstream to Harvey Dam (ND-090200202-012-S_00), the unnamed tributary to the Sheyenne River (ND-09020202-013-S_00), and the Sheyenne River downstream to Coal Mine Lake/Sheyenne Lake (ND-09020202-015-S_00) are summarized in Tables 9-11, respectively. The TMDLs provide 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 and 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 8. TMDL Summary for the Sheyenne River and an Unnamed Tributary to the Sheyenne 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	No contributing Point Sources in Subwatershed
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 9. E. coli Bacteria TMDL (10^7 CFU/day) Assessment Unit ID ND-09020202-012-S_00 as Represented by Monitoring Site 380135.

	Flow Regime			
	High Flow	**Moist Conditions**	**Dry Conditions**	**Low Flow**
Existing Load		16,249	3,208	
TMDL	50,230[1]	7,399	1,048	193[1]
WLA	No Reduction Necessary	0	0	No Reduction Necessary
LA		6,659	727	
MOS		739.9	320.8	

[1]TMDL load is provided as a guideline for watershed management and BMP implementation.

Table 10. E. coli Bacteria TMDL (10^7 CFU/day) for Assessment Unit ID ND-09020202-013-S_00 as Represented by Monitoring Site 380137.

	Flow Regime			
	High Flow	**Moist Conditions**	**Dry Conditions**	**Low Flow**
Existing Load		2,749	747	
TMDL	10,732[1]	922	151	24[1]
WLA	No Reduction Necessary	0	0	No Reduction Necessary
LA		829.8	135.9	
MOS		92.2	15.1	

[1]TMDL load is provided as a guideline for watershed management and BMP implementation.

Table 11. E. coli Bacteria TMDL (10^7 CFU/day) for Assessment Unit ID ND-09020202-015-S_00 as Represented by Monitoring Site 384020.

	Flow Regime			
	High Flow	**Moist Conditions**	**Dry Conditions**	**Low Flow**
Existing Load	16,789	3,164	8,231	
TMDL	11,657	1,259	241	71[1]
WLA	0	0	0	No Reduction Necessary
LA	10,491.3	1,133.1	216.9	
MOS	1,165.7	125.9	24.1	

[1]TMDL load is provided as a guideline for watershed management and BMP implementation.

8.0 ALLOCATION

There are no known point sources impacting the watershed in North Dakota. Therefore the entire E. coli bacteria load for this TMDL was allocated to nonpoint sources in the watersheds. 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, waste management).

To achieve the TMDL targets identified in the report, it will require the wide spread support and voluntary participation of landowners and residents in the watershed. The TMDLs described in this report are 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," (EPA, 2001). This TMDL plan is put forth as a recommendation for what needs to be accomplished for the Sheyenne River and its tributaries 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.

Nonpoint source pollution is the sole contributor to elevated E. coli bacteria levels in the Sheyenne River and its tributaries. The load duration curve analysis for the impaired reaches for stream segments ND-09020202-012-S, the Sheyenne River from Coal Mine Lake downstream to Harvey Dam, and ND-09020202-013-S_00, the unnamed tributary to the Sheyenne River, identified moist and dry condition flow regimes as the flow regimes where E. coli bacteria concentrations exceeded the 126 CFU/100 mL target. The load duration curve analysis also identified the high and moist flow regimes for ND-09020202-015-S, the Sheyenne River downstream to Coal Mine Lake/Sheyenne Lake, as the two flow regimes where E. coli bacteria concentrations exceeded 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 upper Sheyenne River and its tributaries. The following sections describe in detail those BMPs that will reduce E. coli bacteria levels in the upper Sheyenne River and its tributaries.

Table 12. 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. 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 banks 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. (1998), as presented by EPA (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 13) 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 bacteria loading originating from confined animal feeding areas (Table 14). 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 13. 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

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 is quite successful. Results from a study by Pennsylvania State University (1992a) as presented by EPA (1993) (Table 14), suggest that vegetative filter strips are capable of removing up to 55 percent of bacteria loading to rivers and streams (Table 14). 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 (EPA, 2002).

Table 14. 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.

9.0 PUBLIC PARTICIPATION

To satisfy the public participation requirements of this TMDL, a letter was sent to the following agencies and/or organizations notifying them that the draft report was available for review and public comment. Those included in the mailing are as follows:

- Wells and Sheridan County Soil Conservation Districts;
- Wells and Sheridan County Water Resource Boards;
- South Dakota Department of Environment and Natural Resources;
- Natural Resource Conservation Service (State Office); and
- U.S. Environmental Protection Agency, Region VIII

In addition to notifying specific agencies of this draft TMDL report's availability, the report 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 McClusky Gazette (serving Sheridan County) and the Herald Press (serving Wells County).

10.0 MONITORING

As stated previously, 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.

Specifically, monitoring will be conducted for the variables that are currently causing impairments to the beneficial uses of the waterbody. Once a watershed restoration plan (e.g., 319 PIP) is implemented, monitoring will be conducted in the TMDL listed stream segments 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 EQIP), as well as securing a local project sponsor and the required matching funds. Provided these three requirements are in place, a project implementation plan (PIP) is developed in accordance with the TMDL and submitted to the North Dakota Nonpoint Source Pollution Task Force and EPA for approval. The implementation of the best management practices contained in the NPS PIP is voluntary. Therefore, success of any TMDL implementation project is ultimately dependent 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.

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Appendix A
E. coli Bacteria Data for Sites 380135, 380137, and 384020

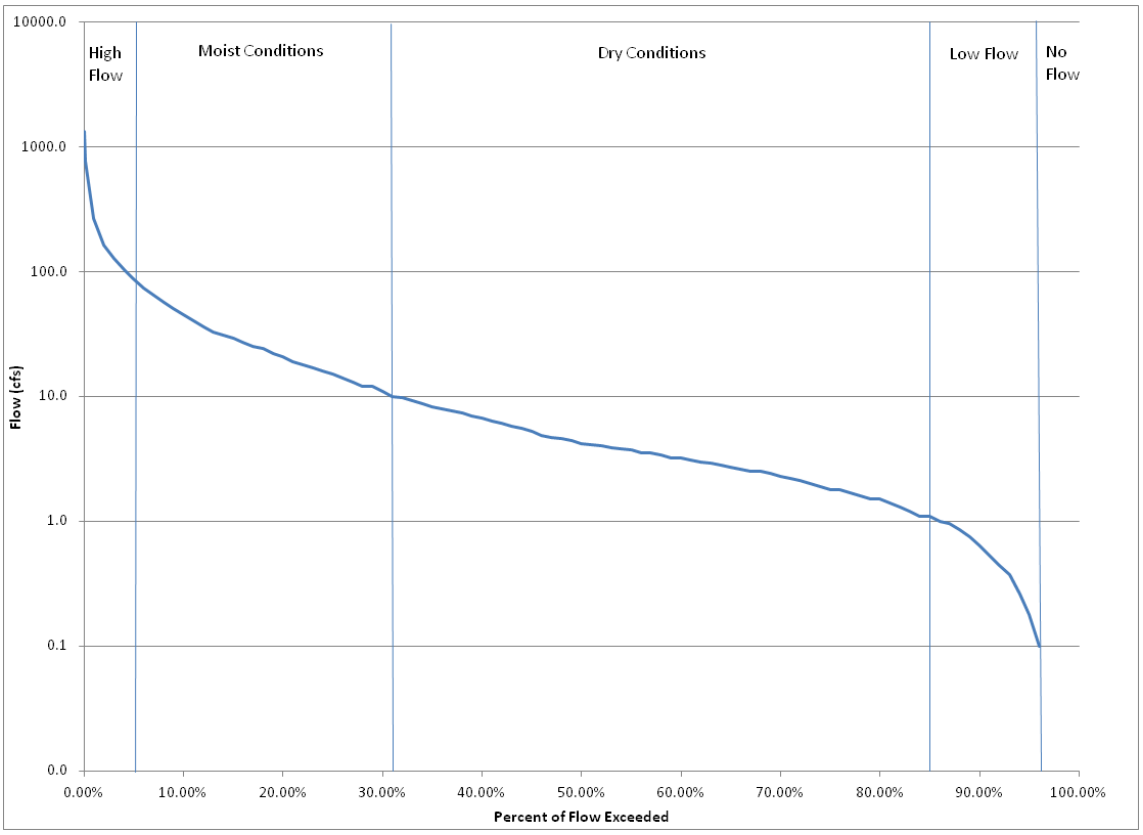
380135										
	May		June		July		August		September	
	12-May-09	10	03-Jun-09	90	08-Jul-09	100	04-Aug-09	40	01-Sep-09	310
	20-May-09	10	10-Jun-09	70	14-Jul-09	110	11-Aug-09	110	08-Sep-09	840
	27-May-09	20	16-Jun-09	100	21-Jul-09	20	18-Aug-09	60	15-Sep-09	300
	05-May-10	10	23-Jun-09	30	28-Jul-09	30	25-Aug-09	190	22-Sep-09	520
	11-May-10	20	30-Jun-09	700	06-Jul-10	20	02-Aug-10	230	29-Sep-09	290
	18-May-10	10	01-Jun-10	140	12-Jul-10	40	10-Aug-10	560	08-Sep-10	580
	24-May-10	70	14-Jun-10	100	20-Jul-10	30	16-Aug-10	140	14-Sep-10	170
			22-Jun-10	50	28-Jul-10	70	24-Aug-10	110	20-Sep-10	190
			30-Jun-10	60			30-Aug-10	610	28-Sep-10	90
N		7		9		8		9		9
Geometric Mean		16		94		43		158		300
% Eceeded 409 CFU/100 mL		0%		11%		0%		22%		33%
Recreational Use Assessment	Fully Supporting		Fully Supporting		Fully Supporting		Not Supporting		Not Supporting	

380137										
	May		June		July		August		September	
	20-May-09	20	03-Jun-09	70	08-Jul-09	3300	04-Aug-09	10	08-Sep-10	440
	27-May-09	500	10-Jun-09	70	14-Jul-09	260	18-Aug-09	90	14-Sep-10	180
	05-May-10	20	16-Jun-09	130	21-Jul-09	90	02-Aug-10	630	20-Sep-10	50
	11-May-10	90	23-Jun-09	90	28-Jul-09	110	16-Aug-10	160	28-Sep-10	170
	18-May-10	10	30-Jun-09	70	06-Jul-10	220	30-Aug-10	560		
	24-May-10	170	02-Jun-10	140	12-Jul-10	1700				
			09-Jun-10	70	20-Jul-10	480				
			14-Jun-10	200	28-Jul-10	760				
			22-Jun-10	100						
			30-Jun-10	70						
N		6		10		8		5		4
Geomean		56		94		430		138		161
% Exceed 409 CFU/100 mL		17%		0%		50%		40%		25%
Recreational Use Assessment	Fully Supporting but Threatened		Fully Supporting		Not Supporting		Not Supporting		Not Supporting	

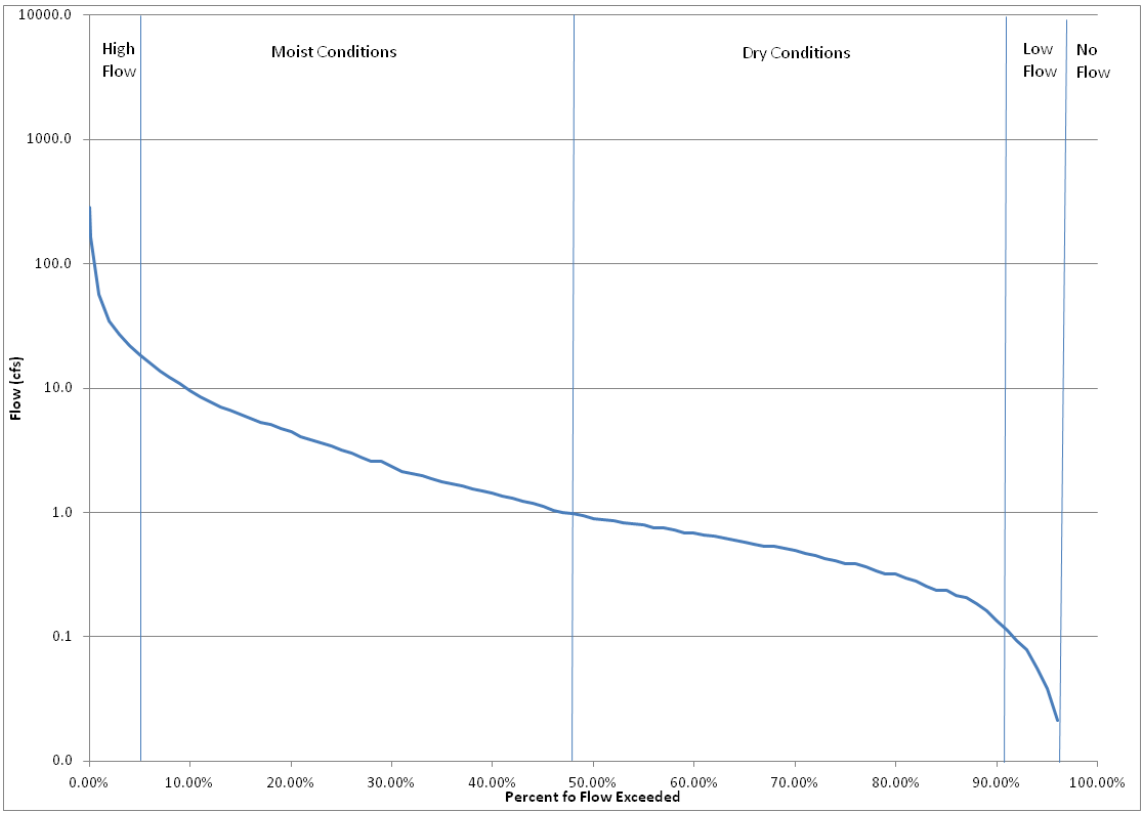
384020										
	May		June		July		August		September	
	20-May-09	40	03-Jun-09	30	08-Jul-09	120	02-Aug-10	220	08-Sep-10	500
	27-May-09	60	10-Jun-09	50	14-Jul-09	40	16-Aug-10	410	14-Sep-10	510
	05-May-10	180	16-Jun-09	80	06-Jul-10	90			20-Sep-10	130
	11-May-10	20	23-Jun-09	180	12-Jul-10	90			28-Sep-10	70
	18-May-10	20	30-Jun-09	30	28-Jul-10	4300				
	24-May-10	160	02-Jun-10	40						
			09-Jun-10	100						
			14-Jun-10	100						
			30-Jun-10	80						
N		6		9		5		2		4
Geomean		55		65		176		300		219
% Exceeded 409 CFU/100 mL		0%		0%		20%		50%		50%
Recreational Use Assessment	Fully Supporting		Fully Supporting		Not Supporting		Insufficient Data		Not Supporting	

Appendix B
Flow Duration Curves for Sites 380135, 380137 and 384020

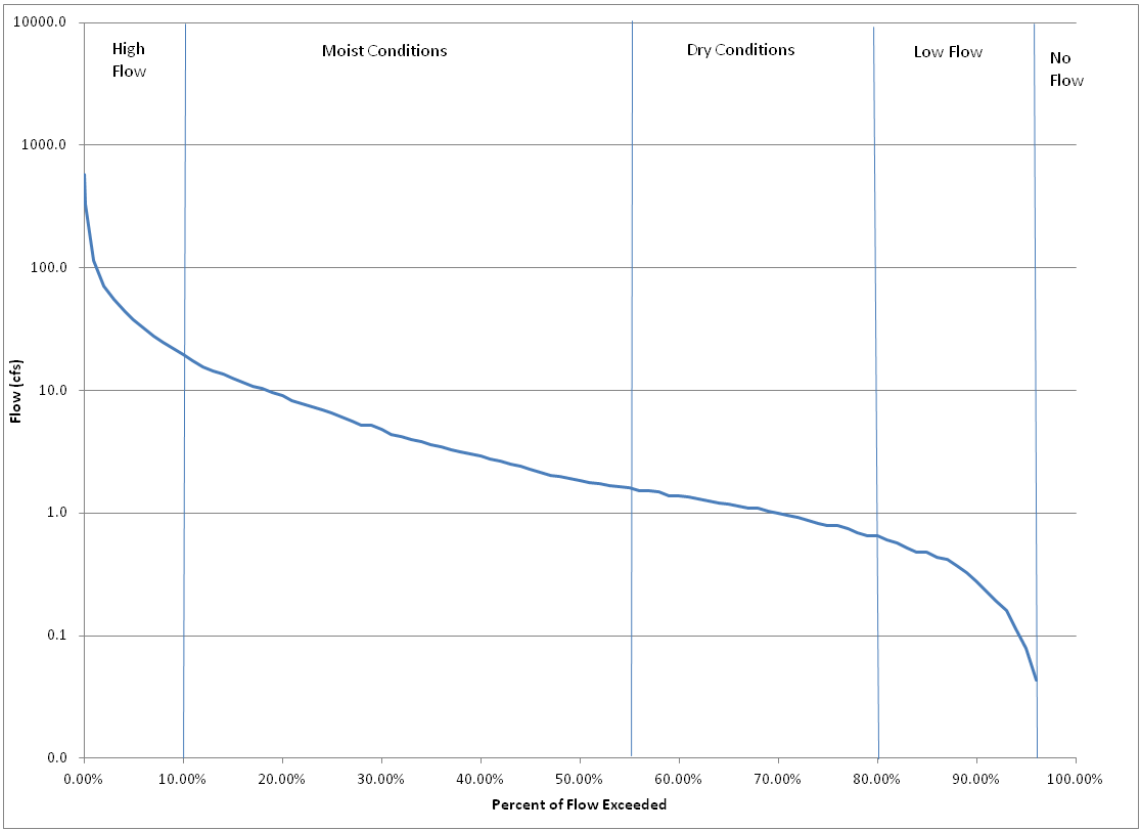
Site 380135



Site 380137



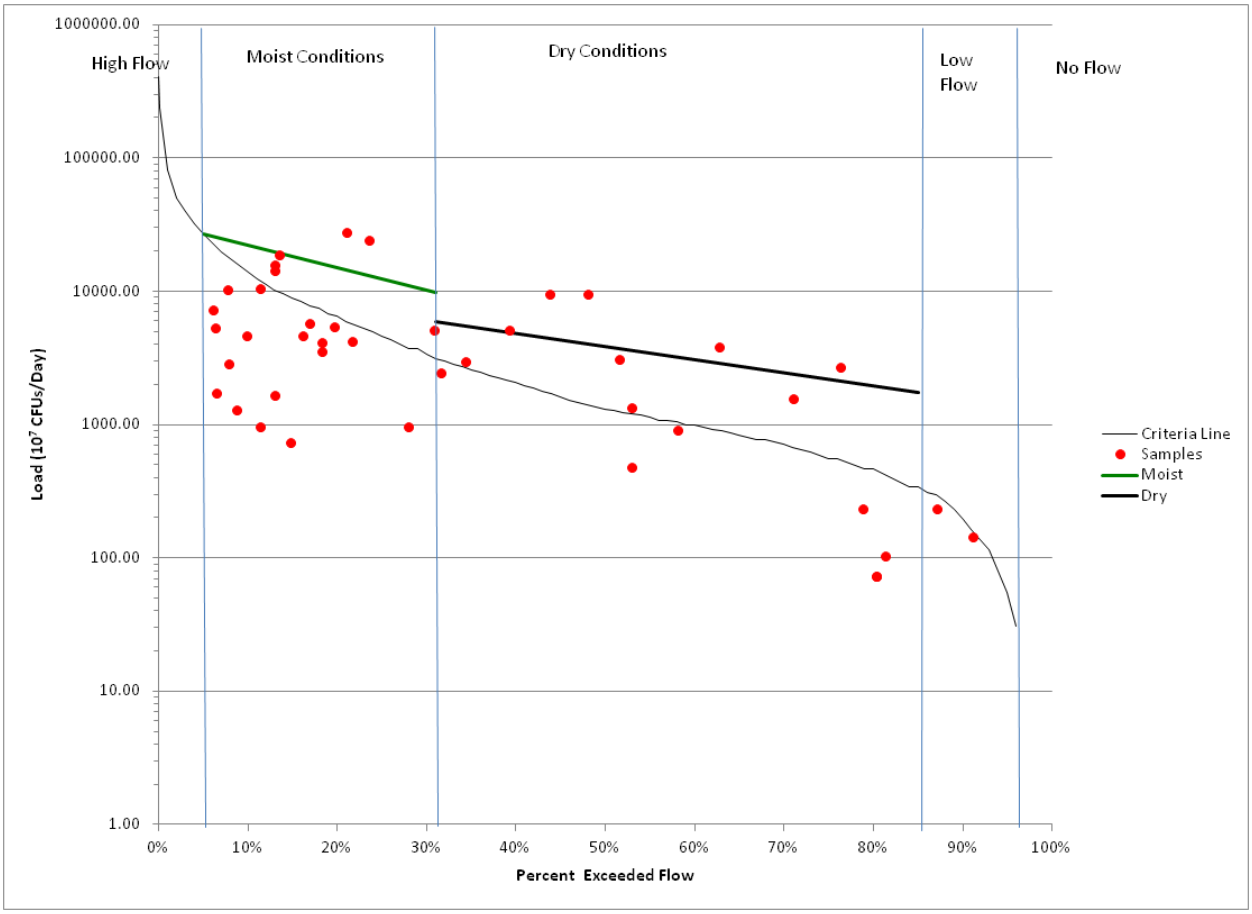
Site 384020


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

Appendix C
Load Duration Curves, Estimated Loads, TMDL Targets, and Percent Load Reduction Required for Sites 380135, 380137 and 384020

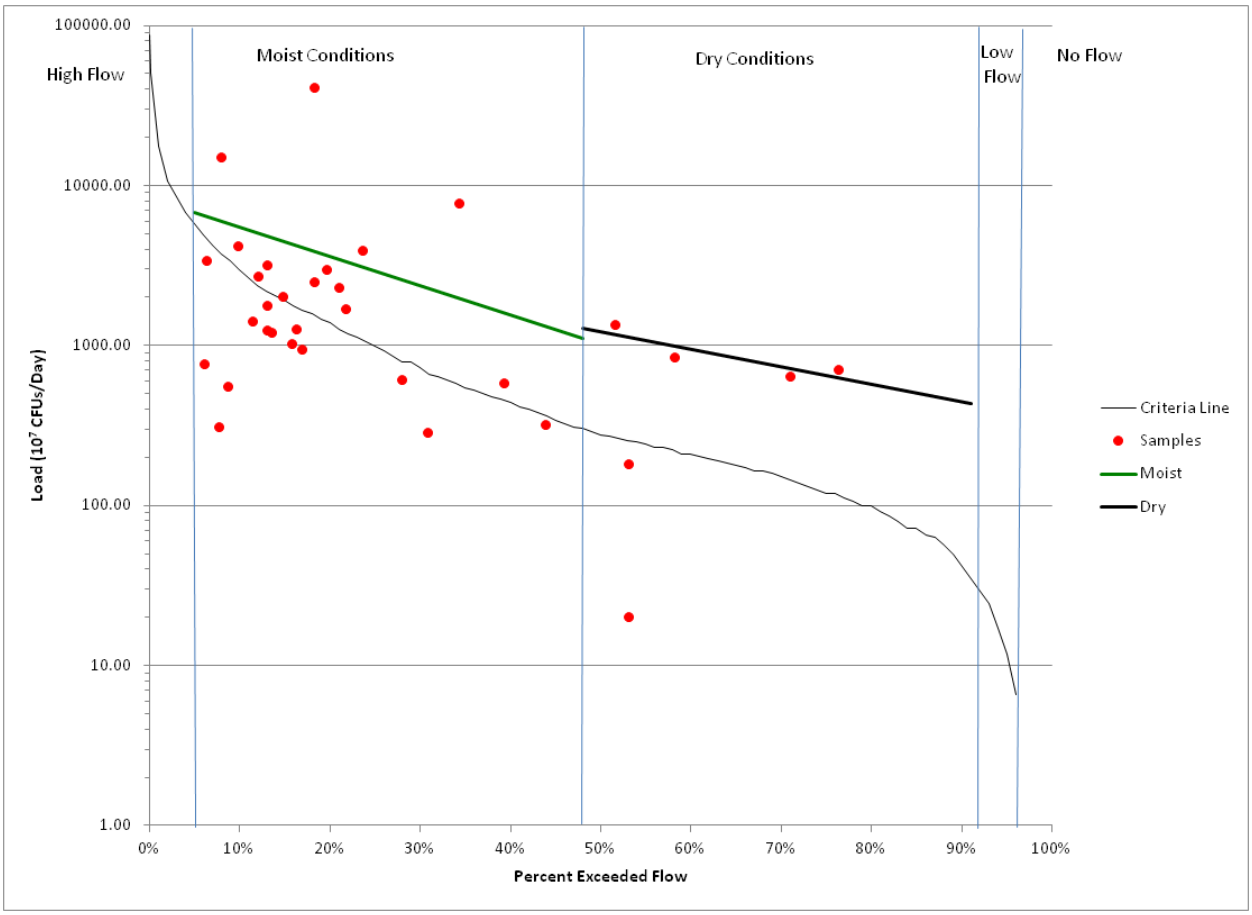
380135 Sheyenne River above Harvey Dam

	Load (10^7 CFUs/Day)				Load (10^7 CFUs/Period)		
	Median Percentile	Existing	TMDL	Days	Existing	TMDL	Percent Reduction
Moist	18.00%	16249.89	7399.42	94.90	1542114.53	702205.15	54.46%
Dry	58.00%	3208.51	1048.25	197.10	632396.50	206610.36	67.33%
			Total	292	2174511	908816	58.21%



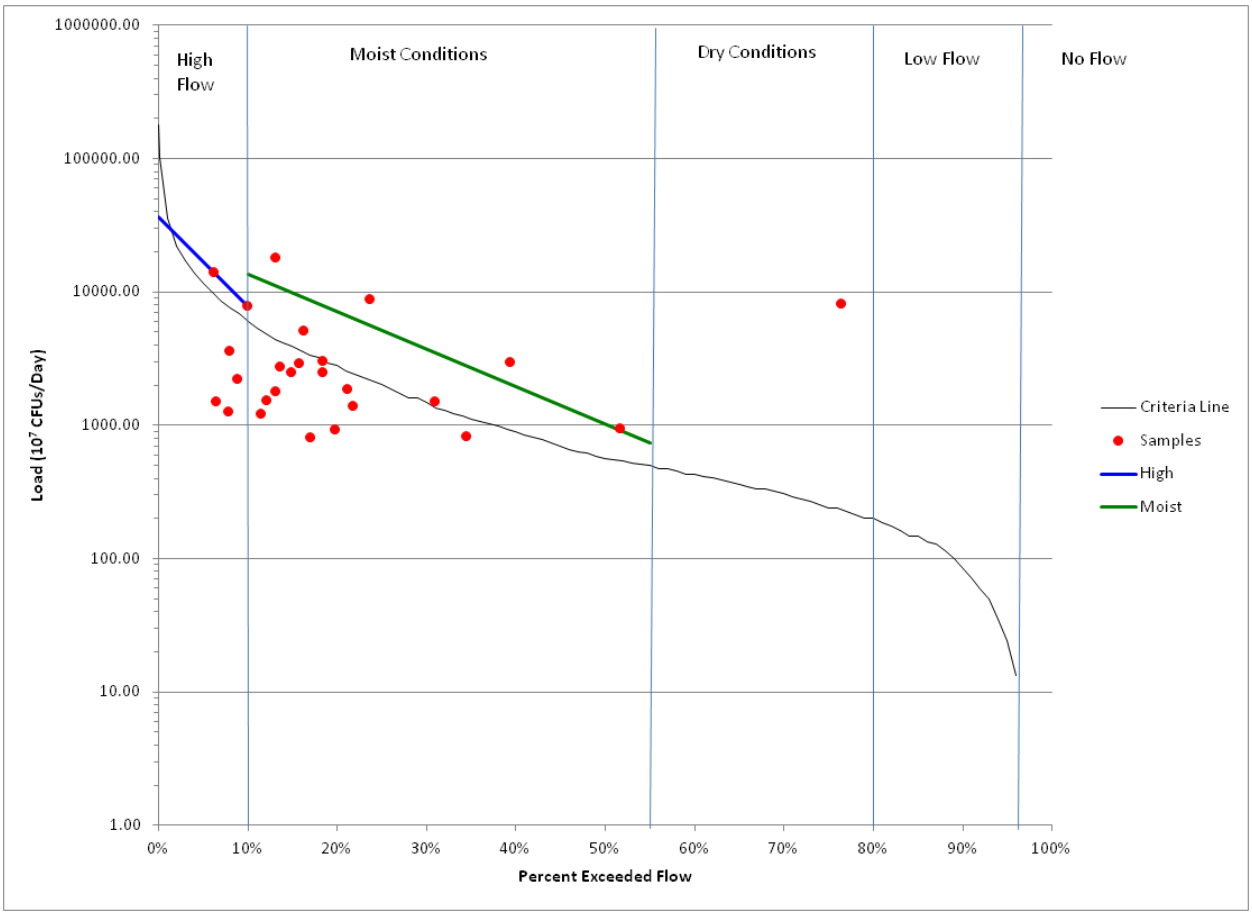
380137 Unnamed Tributary of the Sheyenne River near Coal Mine Lake

	Load (10^7 CFUs/Day)				Load (10^7 CFUs/Period)		
	Median Percentile	Existing	TMDL	Days	Existing	TMDL	Percent Reduction
Moist	26.50%	2749.08	922.24	156.95	431468.22	144745.73	66.45%
Dry	69.50%	747.09	151.51	156.95	117256.48	23779.66	79.72%
			Total	314	548725	168525	69.29%



384020 Headwaters of the Sheyenne River near Anamoose, North Dakota

	Load (Million CFU/Day)				Load (Million CFU/Period)		
	Median Percentile	Existing	TMDL	Days	Existing	TMDL	Percent Reduction
High	5.00%	16789.06	11657.28	36.50	612800.65	425490.55	30.57%
Moist	32.50%	3164.71	1259.52	164.25	519804.09	206876.44	60.20%
			Total	201	1132605	632367	44.17%



Appendix D
US EPA Region 8 TMDL Review and Comments

EPA REGION 8 TMDL REVIEW FORM AND DECISION DOCUMENT

TMDL Document Info:

Document Name:	**E. coli Bacteria TMDLs for the Sheyenne River and an Unnamed Tributary to the Sheyenne River in Sheridan and Wells Counties, North Dakota**
Submitted by:	**Mike Ell, North Dakota Department of Health**
Date Received:	**July 27, 2012**
Review Date:	**August 20, 2012**
Reviewer:	**Vern Berry, US Environmental Protection Agency**
Rough Draft / Public Notice / Final Draft?	**Public Notice**
Notes:	

Reviewers Final Recommendation(s) to EPA Administrator (used for final draft review only):

- ☐ Approve
- ☐ Partial Approval
- ☐ Disapprove
- ☐ Insufficient Information

Approval Notes to the Administrator:

This document provides a standard format for EPA Region 8 to provide comments to state TMDL programs on TMDL documents submitted to EPA for either formal or informal review. All TMDL documents are evaluated against the TMDL review elements identified in the following 8 sections:

1. Problem Description
   a. …TMDL Document Submittal
   b. Identification of the Waterbody, Impairments, and Study Boundaries
   c. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   a. Data Set Description
   b. Waste Load Allocations (WLA)
   c. Load Allocations (LA)
   d. Margin of Safety (MOS)
   e. Seasonality and variations in assimilative capacity
5. Public Participation
6. Monitoring Strategy
7. Restoration Strategy
8. Daily Loading Expression

Under Section 303(d) of the Clean Water Act, waterbodies that are not attaining one or more water quality standard (WQS) are considered "impaired." When the cause of the impairment is determined to be a pollutant, a TMDL analysis is required to assess the appropriate maximum allowable pollutant loading rate. A TMDL document consists of a technical analysis conducted to: (1) assess the maximum pollutant loading rate that a waterbody is able to assimilate while maintaining water quality standards; and (2) allocate that assimilative capacity among the known

sources of that pollutant**.** A well written TMDL document will describe a path forward that may be used by those who implement the TMDL recommendations to attain and maintain WQS.

Each of the following eight sections describes the factors that EPA Region 8 staff considers when reviewing TMDL documents. Also included in each section is a list of EPA's review elements relative to that section, a brief summary of the EPA reviewer's findings, and the reviewer's comments and/or suggestions. Use of the verb "must" in this review form denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term "should" below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable.

This review form is intended to ensure compliance with the Clean Water Act and that the reviewed documents are technically sound and the conclusions are technically defensible.

1. Problem Description

A TMDL document needs to provide a clear explanation of the problem it is intended to address. Included in that description should be a definitive portrayal of the physical boundaries to which the TMDL applies, as well as a clear description of the impairments that the TMDL intends to address and the associated pollutant(s) causing those impairments. While the existence of one or more impairment and stressor may be known, it is important that a comprehensive evaluation of the water quality be conducted prior to development of the TMDL to ensure that all water quality problems and associated stressors are identified. Typically, this step is conducted prior to the 303(d) listing of a waterbody through the monitoring and assessment program. The designated uses and water quality criteria for the waterbody should be examined against available data to provide an evaluation of the water quality relative to all applicable water quality standards. If, as part of this exercise, additional WQS problems are discovered and additional stressor pollutants are identified, consideration should be given to concurrently evaluating TMDLs for those additional pollutants. If it is determined that insufficient data is available to make such an evaluation, this should be noted in the TMDL document.

1.1 TMDL Document Submittal

When a TMDL document is submitted to EPA requesting review or approval, the submittal package should include a notification identifying the document being submitted and the purpose of the submission.

Review Elements:

☒ Each TMDL document submitted to EPA should include a notification of the document status (e.g., pre-public notice, public notice, final), and a request for EPA review.

☐ Each TMDL document submitted to EPA for final review and approval should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute**.** The submittal letter should contain such identifying information as the name and location of the waterbody and the pollutant(s) of concern, which matches similar identifying information in the TMDL document for which a review is being requested.

Recommendation:

☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information ☐ N/A

Summary: *The notification of the availability of the public notice draft TMDL document was submitted to EPA via a letter received on July 27, 2012. The letter includes the details of the public notice, explains how to obtain a copy of the TMDL, and requests the submittal of comments to NDDoH by August 28, 2012.*

Comments: *No comments.*

1.2 Identification of the Waterbody, Impairments, and Study Boundaries

The TMDL document should provide an unambiguous description of the waterbody to which the TMDL is intended to apply and the impairments the TMDL is intended to address. The document should also clearly delineate the physical boundaries of the waterbody and the geographical extent of the watershed area studied. Any additional information needed to tie the TMDL document back to a current 303(d) listing should also be included.

Review Elements:

☒ The TMDL document should clearly identify the pollutant and waterbody segment(s) for which the TMDL is being established. If the TMDL document is submitted to fulfill a TMDL development requirement for a waterbody on the state's current EPA approved 303(d) list, the TMDL document submittal should clearly identify the waterbody and associated impairment(s) as they appear on the State's/Tribe's current EPA approved 303(d) list, including a full waterbody description, assessment unit/waterbody ID, and the priority ranking of the waterbody. This information is necessary to ensure that the administrative record and the national TMDL tracking database properly link the TMDL document to the 303(d) listed waterbody and impairment(s).

☒ One or more maps should be included in the TMDL document showing the general location of the waterbody and, to the maximum extent practical, any other features necessary and/or relevant to the understanding of the TMDL analysis, including but not limited to: watershed boundaries, locations of major pollutant sources, major tributaries included in the analysis, location of sampling points, location of discharge gauges, land use patterns, and the location of nearby waterbodies used to provide surrogate information or reference conditions. Clear and concise descriptions of all key features and their relationship to the waterbody and water quality data should be provided for all key and/or relevant features not represented on the map

☒ If information is available, the waterbody segment to which the TMDL applies should be identified/geo-referenced using the National Hydrography Dataset (NHD). If the boundaries of the TMDL do not correspond to the Waterbody ID(s) (WBID), Entity ID information or reach code (RCH_Code) information should be provided. If NHD data is not available for the waterbody, an alternative geographical referencing system that unambiguously identifies the physical boundaries to which the TMDL applies may be substituted.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary:
Physical Setting and Listing History*:*
This TMDL document includes three impaired stream segments within the upper Sheyenne River sub-basin (HUC 09020203) in east-central North Dakota. These stream segments are part of the larger Red River of the North basin. The three impaired segments are located in Sheridan and Wells Counties which cover a watershed area of approximately 347,914 acres.

The three impaired segments included in this TMDL document are: 1) Sheyenne River from Coal Mine / Sheyenne Lakes downstream to Harvey Dam (20.8 miles; ND-09020202-012-S_00); 2) Unnamed Tributary to the Sheyenne River (36.24 miles; ND-09020202-013-S_00); and 3) Sheyenne River downstream to Coal Mine Lake / Sheyenne Lake (17.2 miles; ND-09020202-015-

S_00). These segments are listed as impaired for E. coli bacteria and are a high priority for TMDL development.

CHAPTER 33-16-02.1, Appendix 1 of the North Dakota Century Code assigns the following classifications for the stream segments in this TMDL document. All tributaries not specifically mentioned in Appendix 1 are classified as Class III streams:

Class IA – Sheyenne River, segments 012 and 015
Class III – Unnamed tributary to the Sheyenne River

The designated uses for Class IA and Class III streams are discussed in the Water Quality Standards section below.

***Impairment status**:*
The 2012 North Dakota Integrated Report identifies the Sheyenne River (2 segments) and the Unnamed Tributary to the Sheyenne River as impaired based on the following information:

Stream Segment	**Designated Use / Support Status**	**Impairment Cause**	**TMDL Priority**
Sheyenne River ND-09020202-012-S_00	*Recreation / Fully supporting but threatened*	*Escherichia coli*	*High*
Unnamed Tributary to the Sheyenne River ND-09020202-013-S_00	*Recreation / Not supporting*	*Escherichia coli*	*High*
Sheyenne River ND-09020202-015-S_00	*Recreation / Not supporting*	*Escherichia coli*	*High*

Comments: *No comments.*

1.3 Water Quality Standards

TMDL documents should provide a complete description of the water quality standards for the waterbodies addressed, including a listing of the designated uses and an indication of whether the uses are being met, not being met, or not assessed. If a designated use was not assessed as part of the TMDL analysis (or not otherwise recently assessed), the documents should provide a reason for the lack of assessment (e.g., sufficient data was not available at this time to assess whether or not this designated use was being met).

Water quality criteria (WQC) are established as a component of water quality standard at levels considered necessary to protect the designated uses assigned to that waterbody. WQC identify quantifiable targets and/or qualitative water quality goals which, if attained and maintained, are intended to ensure that the designated uses for the waterbody are protected. TMDLs result in maintaining and attaining water quality standards by determining the appropriate maximum pollutant loading rate to meet water quality criteria, either directly, or through a surrogate measurable target. The TMDL document should include a description of all applicable water quality criteria for the impaired designated uses and address whether or not the criteria are being attained, not attained, or not evaluated as part of the analysis. If the criteria were not evaluated as part of the analysis, a reason should be cited (e.g. insufficient data were available to determine if this water quality criterion is being attained).

Review Elements:

☒ The TMDL must include a description of the applicable State/Tribal water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criterion, and the anti-degradation policy. (40 C.F.R. §130.7(c)(1)).

☒ The purpose of a TMDL analysis is to determine the assimilative capacity of the waterbody that corresponds to the existing water quality standards for that waterbody, and to allocate that assimilative capacity between the identified sources. Therefore, <u>all TMDL documents must be written to meet the existing water quality standards</u> for that waterbody (CWA §303(d)(1)(C)). *Note: In some circumstances, the load reductions determined to be necessary by the TMDL analysis may prove to be infeasible and may possibly indicate that the existing water quality standards and/or assessment methodologies may be erroneous. However, the TMDL must still be determined based on existing water quality standards. Adjustments to water quality standards and/or assessment methodologies may be evaluated separately, from the TMDL.*

☒ The TMDL document should describe the relationship between the pollutant of concern and the water quality standard the pollutant load is intended to meet. This information is necessary for EPA to evaluate whether or not attainment of the prescribed pollutant loadings will result in attainment of the water quality standard in question.

☒ If a standard includes multiple criteria for the pollutant of concern, the document should demonstrate that the TMDL value will result in attainment of all related criteria for the pollutant. For example, both acute and chronic values (if present in the WQS) should be addressed in the document, including consideration of magnitude, frequency and duration requirements.

Recommendation:

☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The Sheyenne River (2 segments) and the Unnamed Tributary to the Sheyenne River stream segments addressed by this TMDL document are impaired based on E. coli concentrations impacting the recreational uses.*

The Sheyenne River is a Class IA stream. The quality of the waters in this class shall be the same as the quality of Class I streams, except that where natural conditions exceed Class I criteria for municipal and domestic use, the availability of softening or other treatment methods may be considered in determining whether ambient water quality meets the drinking water requirements of the department.

The Unnamed Tributary to the Sheyenne River is a Class III stream. The quality of the waters in this class shall be suitable for agricultural and industrial uses. Streams in this class generally have low average flows with prolonged periods of no flow. During periods of no flow, they are of limited value for recreation and fish and aquatic biota. The quality of these waters must be maintained to protect secondary contact recreation uses (e.g., wading), fish and aquatic biota, and wildlife uses.

Numeric criteria for E. coli in North Dakota, Class IA and Class III streams have been established and are presented in the excerpted Table 6 shown below. Discussion of additional applicable water quality standards for these stream segments can be found on pages 8 – 10 of the TMDL document.

Table 6. North Dakota Bacteria Water Quality Standards for Class IA and III 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.

Comments: *No comments.*

2. Water Quality Targets

TMDL analyses establish numeric targets that are used to determine whether water quality standards are being achieved. Quantified water quality targets or endpoints should be provided to evaluate each listed pollutant/water body combination addressed by the TMDL, and should represent achievement of applicable water quality standards and support of associated beneficial uses. For pollutants with numeric water quality standards, the numeric criteria are generally used as the water quality target. For pollutants with narrative standards, the narrative standard should be translated into a measurable value. At a minimum, one target is required for each pollutant/water body combination. It is generally desirable, however, to include several targets that represent achievement of the standard and support of beneficial uses (e.g., for a sediment impairment issue it may be appropriate to include a variety of targets representing water column sediment such as TSS, embeddedness, stream morphology, up-slope conditions and a measure of biota).

Review Elements:

☒ The TMDL should identify a numeric water quality target(s) for each waterbody pollutant combination. The TMDL target is a quantitative value used to measure whether or not the applicable water quality standard is attained. *Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard. Occasionally, the pollutant of concern is different from the parameter that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as a numerical dissolved oxygen criterion). In such cases, the TMDL should explain the linkage between the pollutant(s) of concern, and express the quantitative relationship between the TMDL target and pollutant of concern. In all cases, TMDL targets must represent the attainment of current water quality standards.*

☒ When a numeric TMDL target is established to ensure the attainment of a narrative water quality criterion, the numeric target, the methodology used to determine the numeric target, and the link between the pollutant of concern and the narrative water quality criterion should all be described in the TMDL document. Any additional information supporting the numeric target and linkage should also be included in the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The water quality targets for these TMDLs are based on the numeric water quality standards for E. coli bacteria established to protect the recreational beneficial uses for the two segments of the Sheyenne River and the Unnamed Tributary to the Sheyenne River. The E. coli standards are expressed in coliform forming units (cfu) per 100 milliliters (mL) of the water sample. The E. coli target for each impaired segment is: 126 cfu/100 mL during the recreation season from May 1 to September 30. While the standard is intended to be expressed as the 30-day geometric mean, the target for each stream segment was used to compare to values from single grab samples. This ensures that the reductions necessary to achieve the targets will be protective of both the acute (single sample value) and chronic (geometric mean of 5 samples) standard.*

Comments: *No comments.*

3. Pollutant Source Analysis

A TMDL analysis is conducted when a pollutant load is known or suspected to be exceeding the loading capacity of the waterbody. Logically then, a TMDL analysis should consider all sources of the pollutant of concern in some manner. The detail provided in the source assessment step drives the rigor of the pollutant load allocation. In other words, it is only possible to specifically allocate quantifiable loads or load reductions to each identified source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each identified source (or source category) should be specified and quantified. This may be accomplished using site-specific monitoring data, modeling, or application of other assessment techniques. If insufficient time or resources are available to accomplish this step, a phased/adaptive management approach may be appropriate. The approach should be clearly defined in the document.

Review Elements:

☒ The TMDL should include an identification of the point and nonpoint sources of the pollutant of concern, including the geographical location of the source(s) and the quantity of the loading, e.g., lbs/per day. This information is necessary for EPA to evaluate the WLA, LA and MOS components of the TMDL.

☒ The level of detail provided in the source assessment should be commensurate with the nature of the watershed and the nature of the pollutant being studied. Where it is possible to separate natural background from nonpoint sources, the TMDL should include a description of both the natural background loads and the nonpoint source loads.

☒ Natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g. measured in stream) unless it can be demonstrated that the anthropogenic sources of the pollutant of concern have been identified, characterized, and quantified.

☒ The sampling data relied upon to discover, characterize, and quantify the pollutant sources should be included in the document (e.g. a data appendix) along with a description of how the data were analyzed to characterize and quantify the pollutant sources. A discussion of the known deficiencies and/or gaps in the data set and their potential implications should also be included.

Recommendation:

☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The TMDL document includes the landuse breakdown for the watershed based on the 2007 National Agricultural Statistics Service (NASS) data. In 2007, the dominant land use in the upper Sheyenne River watershed was agriculture. Approximately 34 percent of the landuse in the watershed was cropland, 62 percent was grassland / pastureland, and the remaining 4 percent was wetlands, developed space, barren or woods. The majority of the crops grown consisted of soybeans, spring wheat, and sunflowers.*

Section 4.0, Significant Sources beginning on page 10, provides the pollutant source analysis for the three listed segments in the upper Sheyenne River watershed. There are no known point sources located within the drainage area of the three listed stream segments.

There are four known animal feeding operations (AFOs) in the contributing watershed of the upper Sheyenne River. The four include two small (0-300 animal units (AUs)) and two medium (301-999 AUs) AFOs. All four AFOs have permits to operate, are zero discharge facilities and are not deemed significant point sources of E. coli bacteria loading to the two segments of the Sheyenne River, or the Unnamed Tributary.

The E. coli bacteria pollution to these segments originates from nonpoint sources in the watershed. Livestock grazing and watering in proximity to these streams is common along the TMDL listed segments. Intense early summer storms can cause overland flooding and rising river levels. Due to the close proximity of livestock grazing and watering to these stream segments, it is likely that runoff from these activities contribute to the E. coli bacteria pollution in the upper Sheyenne River watershed.

Wildlife may also contribute to the E. coli bacteria found in the water quality samples, but most likely in a lower concentration. Wildlife is nomadic with fewer numbers concentrating in a specific area, thus decreasing the probability of their contribution of fecal matter in significant quantities.

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 system design. 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.

Comments: *The first sentence of Section 1.3, Land Use, cites NASS 2007 land cover data. However, the description of Figure 4, Land Use in the Upper Sheyenne River Watershed, cites NASS 2006 data. Please revise as necessary to include the correct year of the land use dataset.*

4. TMDL Technical Analysis

TMDL determinations should be supported by an analysis of the available data, discussion of the known deficiencies and/or gaps in the data set, and an appropriate level of technical analysis**.** This applies to **all** of the components of a TMDL document. It is vitally important that the technical basis for **all** conclusions be articulated in a manner that is easily understandable and readily apparent to the reader.

A TMDL analysis determines the maximum pollutant loading rate that may be allowed to a waterbody without violating water quality standards. The TMDL analysis should demonstrate an understanding of the relationship between the rate of pollutant loading into the waterbody and the resultant water quality impacts. This stressor → response relationship between the pollutant and impairment and between the selected targets, sources, TMDLs, and load allocations needs to be clearly articulated and supported by an appropriate level of technical analysis. Every effort should be made to be as detailed as possible, and to base all conclusions on the best available scientific principles.

The pollutant loading allocation is at the heart of the TMDL analysis. TMDLs apportion responsibility for taking actions by allocating the available assimilative capacity among the various point, nonpoint, and natural pollutant sources. Allocations may be expressed in a variety of ways, such as by individual discharger, by tributary watershed, by source or land use category, by land parcel, or other appropriate scale or division of responsibility.

The pollutant loading allocation that will result in achievement of the water quality target is expressed in the form of the standard TMDL equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

Where:

TMDL	=	Total Maximum Daily Load (also called the Loading Capacity)
LAs	=	Load Allocations
WLAs	=	Wasteload Allocations
MOS	=	Margin Of Safety

Review Elements:

☒ A TMDL must identify the loading capacity of a waterbody for the applicable pollutant, taking into consideration temporal variations in that capacity. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

☒ The total loading capacity of the waterbody should be clearly demonstrated to equate back to the pollutant load allocations through a balanced TMDL equation. In instances where numerous LA, WLA and seasonal TMDL capacities make expression in the form of an equation cumbersome, a table may be substituted as long as it is clear that the total TMDL capacity equates to the sum of the allocations.

☒ The TMDL document should describe the methodology and technical analysis used to establish and quantify the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

☒ It is necessary for EPA staff to be aware of any assumptions used in the technical analysis to understand and evaluate the methodology used to derive the TMDL value and associated loading allocations. Therefore, the TMDL document should contain a description of any important assumptions (including the basis for those assumptions) made in developing the TMDL, including but not limited to:

- the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
- the distribution of land use in the watershed (e.g., urban, forested, agriculture);
- a presentation of relevant information affecting the characterization of the pollutant of concern and its allocation to sources such as population characteristics, wildlife resources, industrial activities etc…;

- present and future growth trends, if taken into consideration in determining the TMDL and preparing the TMDL document (e.g., the TMDL could include the design capacity of an existing or planned wastewater treatment facility);
- an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments; chlorophyll *a* and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

☒ The TMDL document should contain documentation supporting the TMDL analysis, including an inventory of the data set used, a description of the methodology used to analyze the data, a discussion of strengths and weaknesses in the analytical process, and the results from any water quality modeling used. This information is necessary for EPA to review the loading capacity determination, and the associated load, wasteload, and margin of safety allocations.

☒ TMDLs must take critical conditions (e.g., steam flow, loading, and water quality parameters, seasonality, etc…) into account as part of the analysis of loading capacity (40 C.F.R. §130.7(c)(1)). TMDLs should define applicable critical conditions and describe the approach used to determine both point and nonpoint source loadings under such critical conditions. In particular, the document should discuss the approach used to compute and allocate nonpoint source loadings, e.g., meteorological conditions and land use distribution.

☐ Where both nonpoint sources and NPDES permitted point sources are included in the TMDL loading allocation, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document must include a demonstration that nonpoint source loading reductions needed to implement the load allocations are actually practicable [40 CFR 130.2(i) and 122.44(d)].

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the upper Sheyenne River watershed TMDLs describes how the E. coli loads were derived in order to meet the applicable water quality standards for the 303(d) impaired stream segments.*

The TMDL loads and loading capacities were derived using the load duration curve (LDC) approach. To better correlate the relationship between the pollutant of concern and the hydrology of each Section 303(d) listed waterbody, LDCs were developed for each stream segment. Daily stream flow values were collected at the USGS gage station 05054500 located on the Sheyenne River segment ND-09020202-012-S_00 above Harvey, ND. This gage station is collocated with the NDDoH monitoring station 380135. Flows for the ungaged water quality monitoring sites 380137 (Unnamed Tributary segment ND-09020202-013-S_00) and 384020 (Sheyenne River segment ND-09020202-015-S_00) were determined by utilizing the Drainage-Area Ratio Method developed by the USGS. The Drainage-Area Ratio Method assumes that the streamflow at the ungaged site is hydrologically similar (same per unit area) to the stream gaging station used as an index.

The LDCs were derived for each segment using the daily flow record, the 126 cfu/100 mL TMDL target (i.e., state water quality standard) and the observed E. coli data collected from the three monitoring stations (see Figure 6 of the TMDL document for a map of the monitoring locations).

Observed in-stream E. coli bacteria data, obtained from the monitoring stations, were converted to pollutant loads by multiplying E. coli bacteria concentrations by the mean daily flow and a conversion factor. These loads were plotted against the percent exceeded of the flow on the day of sample collection (see Figures 11, 12 and 13 in the TMDL document). Points plotted above the 126 cfu/100 mL target curve exceeded 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.

To estimate the required percent reductions in loading needed to achieve the TMDL for each stream segment, a linear regression line through the E. coli load data above the TMDL curve in each flow regime was plotted. The required percent reductions needed under the four regimes were determined using the linear regression line (see Appendix C in the TMDL document).

The LDCs represent flow-variable TMDL targets across the flow regimes shown in this TMDL document. For the three upper Sheyenne River watershed stream segments covered by this TMDL document, the LDCs are dynamic expressions of the allowable load for any given daily flow. Loading capacities were derived from this approach for each of the listed stream segments at each flow regime. Tables 9, 10 and 11 show the loading capacity load (i.e., TMDL load) for each of the listed segments in the upper Sheyenne River watershed.

Comments: *No Comments.*

4.1 Data Set Description

TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis. An inventory of the data used for the TMDL analysis should be provided to document, for the record, the data used in decision making. This also provides the reader with the opportunity to independently review the data. The TMDL analysis should make use of all readily available data for the waterbody under analysis unless the TMDL writer determines that the data are not relevant or appropriate. For relevant data that were known but rejected, an explanation of why the data were not utilized should be provided (e.g., samples exceeded holding times, data collected prior to a specific date were not considered timely, etc…).

Review Elements:

☒ TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis such that the water quality impairments are clearly defined and linked to the impaired beneficial uses and appropriate water quality criteria.

☒ The TMDL document submitted should be accompanied by the data set utilized during the TMDL analysis. If possible, it is preferred that the data set be provided in an electronic format and referenced in the document. If electronic submission of the data is not possible, the data set may be included as an appendix to the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary*: The upper Sheyenne River TMDL data description and summary are included in the Available Data section (Section 1.5) and in the data tables in Appendix A. Recent water quality monitoring was conducted from May – September 2009-2010 and included 42 E. coli samples at*

station 380135 on the Sheyenne River, segment 012; 33 E. coli samples at station 380137 on the Unnamed Tributary to the Sheyenne River, segment 013; and 26 E. coli samples at station 384020 on the Sheyenne River, segment 015 . The data set also includes approximately 20 years of flow record from USGS gauging station 05054500 (co-located with sampling station 380135). The flow data, the E. coli data and the TMDL targets, were used to develop the E. coli load duration curves for the three segments of the upper Sheyenne River watershed.

Comments: *No Comments.*

4.2 Waste Load Allocations (WLA):

Waste Load Allocations represent point source pollutant loads to the waterbody. Point source loads are typically better understood and more easily monitored and quantified than nonpoint source loads. Whenever practical, each point source should be given a separate waste load allocation. All NPDES permitted dischargers that discharge the pollutant under analysis directly to the waterbody should be identified and given separate waste load allocations. The finalized WLAs are required to be incorporated into future NPDES permit renewals.

Review Elements:

☒ EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit. If no allocations are to be made to point sources, then the TMDL should include a value of zero for the WLA.

☐ All NPDES permitted dischargers given WLA as part of the TMDL should be identified in the TMDL, including the specific NPDES permit numbers, their geographical locations, and their associated waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary*: Within the upper Sheyenne River watershed, there are no known point sources located within the drainage area of the three listed stream segments. Therefore, the E. coli WLA is zero for each segment.*

There are four known animal feeding operations (AFOs) in the contributing watershed of the upper Sheyenne River. The four include two small (0-300 animal units (AUs)) and two medium (301-999 AUs) AFOs. All four AFOs have permits to operate, are zero discharge facilities and are not deemed significant point sources of E. coli bacteria loading to the two segments of the Sheyenne River, or the Unnamed Tributary.

Comments*: No comments.*

4.3 Load Allocations (LA):

Load allocations include the nonpoint source, natural, and background loads. These types of loads are typically more difficult to quantify than point source loads, and may include a significant degree of uncertainty. Often it is necessary to group these loads into larger categories and estimate the loading rates based on limited monitoring data and/or modeling results. The background load represents a composite of all upstream pollutant loads into the waterbody. In addition to the upstream nonpoint and upstream natural load, the background load often includes upstream point source loads that are not given specific waste load allocations in this particular TMDL analysis. In instances where nonpoint source loading rates are particularly difficult to quantify, a performance-based allocation approach, in which a detailed monitoring plan and adaptive management strategy are employed for the application of BMPs, may be appropriate.

Review Elements:

☒ EPA regulations require that TMDL expressions include LAs which identify the portion of the loading capacity attributed to nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Load allocations may be included for both existing and future nonpoint source loads. Where possible, load allocations should be described separately for natural background and nonpoint sources.

☒ Load allocations assigned to natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g., measured in stream) unless it can be demonstrated that the anthropogenic sources of the pollutant of concern have been identified and given proper load or waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The TMDL document includes the landuse breakdown for the watershed based on the 2007 National Agricultural Statistics Service (NASS) data. In 2007, the dominant land use in the upper Sheyenne River watershed was agriculture. Approximately 34 percent of the landuse in the watershed was cropland, 62 percent was grassland / pastureland and the remaining 4 percent was water, wetlands, developed space, barren or woods. The majority of the crops grown consist of soybeans, spring wheat and sunflowers.*

The E. coli bacteria pollution to this segment is originating from nonpoint sources in the watershed. Intense early summer storms can cause overland flooding and rising river levels. Due to the close proximity of livestock grazing and watering to the river, it is likely that they contribute to the E. coli bacteria pollution in the listed segments in the upper Sheyenne River watershed.

Wildlife and failing septic systems may also contribute to the E. coli bacteria found in the water quality samples, but most likely in a lower concentration.

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, moist and dry condition, and low flows. 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 medium impact at moist condition flows. 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.

Source specific data are limited so aggregate LAs are assigned to nonpoint sources with a ranking of important contributors under various flow regimes provided as seen in the following excerpted table. Aggregate load allocations for each of the three impaired segments in the upper Sheyenne River watershed are included in Tables 9, 10 and 11 of the TMDL document.

Table 7. 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)

Comments: *No comments.*

4.4 Margin of Safety (MOS):

Natural systems are inherently complex. Any mathematical relationship used to quantify the stressor → response relationship between pollutant loading rates and the resultant water quality impacts, no matter how rigorous, will include some level of uncertainty and error. To compensate for this uncertainty and ensure water quality standards will be attained, a margin of safety is required as a component of each TMDL. The MOS may take the form of a explicit load allocation (e.g., 10 lbs/day), or may be implicitly built into the TMDL analysis through the use of conservative assumptions and values for the various factors that determine the TMDL pollutant load → water quality effect relationship. Whether explicit or implicit, the MOS should be supported by an appropriate level of discussion that addresses the level of uncertainty in the various components of the TMDL technical analysis, the assumptions used in that analysis, and the relative effect of those assumptions on the final TMDL. The discussion should demonstrate that the MOS used is sufficient to ensure that the water quality standards would be attained if the TMDL pollutant loading rates are met. In cases where there is substantial uncertainty regarding the linkage between the proposed allocations and achievement of water quality standards, it may be necessary to employ a phased or adaptive management approach (e.g., establish a monitoring plan to determine if the proposed allocations are, in fact, leading to the desired water quality improvements).

Review Elements:

☒ TMDLs must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d) (1) (C), 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

☐ If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS should be identified and described. The document should discuss why the assumptions are considered conservative and the effect of the assumption on the final TMDL value determined.

☒ If the MOS is explicit, the loading set aside for the MOS should be identified. The document should discuss how the explicit MOS chosen is related to the uncertainty and/or potential error in the linkage analysis between the WQS, the TMDL target, and the TMDL loading rate.

☐ If, rather than an explicit or implicit MOS, the TMDL relies upon a phased approach to deal with large and/or unquantifiable uncertainties in the linkage analysis, the document should include a description of the planned phases for the TMDL as well as a monitoring plan and adaptive management strategy.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The Sheyenne River TMDL document includes explicit MOSs for each of the three listed segments in the watershed. The MOSs were derived by calculating 10 percent of the loading capacity for each segment. The explicit MOS for the Sheyenne River, segment 012, is included in Table 9; the explicit MOS for the Unnamed Tributary to the Sheyenne River, segment 013, is included in Table 10; and the explicit MOS for the Sheyenne River, segment 015, is included in Table 11 of the TMDL document.*

Comments*: No comments.*

4.5 Seasonality and variations in assimilative capacity:

The TMDL relationship is a factor of both the loading rate of the pollutant to the waterbody and the amount of pollutant the waterbody can assimilate and still attain water quality standards. Water quality standards often vary based on seasonal considerations. Therefore, it is appropriate that the TMDL analysis consider seasonal variations, such as critical flow periods (high flow, low flow), when establishing TMDLs, targets, and allocations.

Review Elements:

☒ The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variability as a factor. (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary*: By using the load duration curve approach to develop the TMDL allocations seasonal variability in fecal coliform loads are taken into account. The highest steam flows typically occur during late spring, and the lowest stream flows typically occur during the winter*

months. The TMDL also considers seasonality because the fecal coliform criteria are in effect from May 1 to September 30, as defined by the recreation season in North Dakota.

***Comments**: No comments.*

5. Public Participation

EPA regulations require that the establishment of TMDLs be conducted in a process open to the public, and that the public be afforded an opportunity to participate. To meaningfully participate in the TMDL process it is necessary that stakeholders, including members of the general public, be able to understand the problem and the proposed solution. TMDL documents should include language that explains the issues to the general public in understandable terms, as well as provides additional detailed technical information for the scientific community. Notifications or solicitations for comments regarding the TMDL should be made available to the general public, widely circulated, and clearly identify the product as a TMDL and the fact that it will be submitted to EPA for review. When the final TMDL is submitted to EPA for approval, a copy of the comments received by the state and the state responses to those comments should be included with the document.

Review Elements:

☒ The TMDL must include a description of the public participation process used during the development of the TMDL (40 C.F.R. §130.7(c)(1)(ii)).

☐ TMDLs submitted to EPA for review and approval should include a summary of significant comments and the State's/Tribe's responses to those comments.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

***Summary**: The TMDL document includes a summary of the public participation process that has occurred. It describes the opportunities the public had to be involved in the TMDL development process. Letters notifying stakeholders of the availability of the draft TMDL document were mailed to stakeholders in the watershed during public comment. Also, the draft TMDL document was posted on NDoDH's Water Quality Division website, and a public notice for comment was published in local newspapers.*

***Comments**: No comments.*

6. Monitoring Strategy

TMDLs may have significant uncertainty associated with the selection of appropriate numeric targets and estimates of source loadings and assimilative capacity. In these cases, a phased TMDL approach may be necessary. For Phased TMDLs, it is EPA's expectation that a monitoring plan will be included as a component of the TMDL document to articulate the means by which the TMDL will be evaluated in the field, and to provide for future supplemental data that will address any uncertainties that may exist when the document is prepared.

Review Elements:

☐ When a TMDL involves both NPDES permitted point source(s) and nonpoint source(s) allocations, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring.

☐ Under certain circumstances, a phased TMDL approach may be utilized when limited existing data are relied upon to develop a TMDL, and the State believes that the use of additional data or data based on better analytical techniques would likely increase the accuracy of the TMDL load calculation and merit development of a second phase TMDL. EPA recommends that a phased TMDL document or its implementation plan include a monitoring plan and a scheduled timeframe for revision of the TMDL. These elements would not be an intrinsic part of the TMDL and would not be approved by EPA, but may be necessary to support a rationale for approving the TMDL. http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.pdf

Recommendation:

☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *Once a watershed restoration plan (e.g., Section 319 PIP) is developed and implemented, monitoring will be conducted in the stream beginning two years after implementation and extending five years after the implementation project is complete.*

Comments: *No comments.*

7. Restoration Strategy

The overall purpose of the TMDL analysis is to determine what actions are necessary to ensure that the pollutant load in a waterbody does not result in water quality impairment. Adding additional detail regarding the proposed approach for the restoration of water quality is not currently a regulatory requirement, but is considered a value added component of a TMDL document. During the TMDL analytical process, information is often gained that may serve to point restoration efforts in the right direction and help ensure that resources are spent in the most efficient manner possible. For example, watershed models used to analyze the linkage between the pollutant loading rates and resultant water quality impacts might also be used to conduct "what if" scenarios to help direct BMP installations to locations that provide the greatest pollutant reductions. Once a TMDL has been written and approved, it is often the responsibility of other water quality programs to see that it is implemented. The level of quality and detail provided in the restoration strategy will greatly influence the future success in achieving the needed pollutant load reductions.

Review Elements:

☐ EPA is not required to and does not approve TMDL implementation plans. However, in cases where a WLA is dependent upon the achievement of a LA, "reasonable assurance" is required to demonstrate the necessary LA called for in the document is practicable). A discussion of the BMPs (or other load reduction measures) that are to be relied upon to achieve the LA(s), and programs and funding sources that will be relied upon to implement the load reductions called for in the document, may be included in the implementation/restoration section of the TMDL document to support a demonstration of "reasonable assurance".

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *Implementation of these TMDLs are dependent upon the availability of Section 319 NPS funds or other watershed restoration programs (e.g. USDA EQIP), as well as securing a local project sponsor and the required matching funds. Provided these three requirements are in place, a project implementation plan (PIP) will be developed in accordance with the TMDL and submitted to the North Dakota 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 dependent on the ability of the local project sponsor to find cooperating producers.*

Comments: *No comments.*

8. Daily Loading Expression

The goal of a TMDL analysis is to determine what actions are necessary to attain and maintain WQS. The appropriate averaging period that corresponds to this goal will vary depending on the pollutant and the nature of the waterbody under analysis. When selecting an appropriate averaging period for a TMDL analysis, primary concern should be given to the nature of the pollutant in question and the achievement of the underlying WQS. However, recent federal appeals court decisions have pointed out that the title TMDL implies a "daily" loading rate. While the most appropriate averaging period to be used for developing a TMDL analysis may vary according to the pollutant, a daily loading rate can provide a more practical indication of whether or not the overall needed load reductions are being achieved. When limited monitoring resources are available, a daily loading target that takes into account the natural variability of the system can serve as a useful indicator for whether or not the overall load reductions are likely to be met. Therefore, a daily expression of the required pollutant loading rate is a required element in all TMDLs, in addition to any other load averaging periods that may have been used to conduct the TMDL analysis. The level of effort spent to develop the daily load indicator should be based on the overall utility it can provide as an indicator for the total load reductions needed.

Review Elements:

☒ The document should include an expression of the TMDL in terms of a daily load. However, the TMDL may also be expressed in temporal terms other than daily (e.g., an annual or monthly load). If the document expresses the TMDL in additional "non-daily" terms the document should explain why it is appropriate or advantageous to express the TMDL in the additional unit of measurement chosen.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The Sheyenne River E. coli TMDL document includes daily loads expressed as colony forming units per day for the three listed stream segments in the watershed. The daily TMDL loads for each segment are included in TMDL section (Section 7.0) of the document.*

Comments: *No comments.*

Appendix E
NDDoH Response to Comments

US EPA Region 8 Comment: The first sentence of Section 1.3, Land Use, cites NASS 2007 land cover data. However, the description of Figure 4, Land Use in the Upper Sheyenne River Watershed, cites NASS 2006 data. Please revise as necessary to include the correct year of the land use dataset.

NDDoH Response: Reference to NASS change to reflect 2007 data in Figure 4.