Bacteria TMDLs for the Cannonball River in Grant, Morton, and Sioux Counties, North Dakota

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1.0 INTRODUCTION AND DESCRIPTION OF THE WATERSHED

The Cannonball River flows through five counties in southwest North Dakota, providing a recreational and agricultural water supply while it delineates county lines as it flows to Lake Oahe near the town of Cannonball, North Dakota. Originating in the northeast corner of Slope County, the Cannonball River winds its way in a southeasterly direction across Hettinger and Grant Counties where it confluences with Cedar Creek. At its confluence with Cedar Creek, the Cannonball River changes direction flowing northeast bisecting Sioux and Morton Counties and forming the northern border of the Standing Rock Indian Reservation (Figure 1). Encompassing two sub-basins, the Cannonball River watershed is part of the Missouri River Basin. General characteristics of the Cannonball River and its watershed are outlined in Table 1.

The Standing Rock Sioux Reservation is under the jurisdiction of the Standing Rock Sioux Tribe (SRST). The Reservation is thirty-four miles south of Mandan, North Dakota where the Cannonball River forms the boundary on the north side of the reservation. The reservation extends to the Perkins County, South Dakota line to the south, the Adams County, North Dakota line to the west and the Missouri River on its east side. The southern boundary of Standing Rock Reservation also forms the northern boundary of the Cheyenne River Reservation. The total land area of the Standing Rock Sioux Reservation is 2.3 million acres.

The segments of the Cannonball River listed on the State of North Dakota 2008 Section 303(d) list have a total length of 65.5 miles and approximately 516,761 acres of land drain to the three impaired segments. The three Section 303(d) listed stream segments (ND-10130206-027-S_00, ND-10130206-007-S_00, and ND-10130206-001-S_00) and their accompanying watersheds will be the focus of this TMDL report (Tables 2-4, Figures 2 and 3).

Table 1. General Characteristics of the Cannonball River and its Watershed.

Legal Name	Cannonball River
8-Digit HUC	10130204 and 10130206
Counties Traversed	Grant, Hettinger, Morton, Sioux, and Slope
Eco-region	Northwestern Great Plains (Level III) and Missouri Plateau (Level IV)
Watershed Area	1,619,734 acres
Head Waters	Northeast Slope County
Outlet	Lake Oahe
ND Highways Crossed	Hwy 21, Hwy 22, Hwy 8, Hwy 49, Hwy 31, Hwy 6, and Hwy 1806
Stream Class	Class II
Headwater Elevation	2,770 feet
Outlet Elevation	1,611 feet
River Length	346 miles
Annual Mean Stream Flow From USGS Station 06354000 for Years 2001-2002	162 cfs

Table 2. Cannonball River Section 303(d) Listing Information, Assessment Unit ND-10130206-027-S_00 (NDDoH, 2008).

Stream Name	Cannonball River
Assessment Unit ID	ND-10130206-027-S_00
Stream Description	Cannonball River from its confluence with Cedar Creek downstream to a tributary near Shields, ND
Size	23.52 miles
Impaired Designated Use	Recreation
Stream Class	Class II
Use Support	Fully Supporting, but Threatened
Impairment	Fecal Coliform Bacteria
TMDL Priority	High

Table 3. Cannonball River Section 303(d) Listing Information, Assessment Unit ND-10130206-007-S_00 (NDDoH, 2008).

Stream Name	Cannonball River
Assessment Unit ID	ND-10130206-007-S_00
Stream Description	Cannonball River from its confluence with a tributary watershed near Shields, ND (ND-10130206-028-S) downstream to its confluences with Dogtooth Creek
Size	21.15 miles
Impaired Designated Use	Recreation
Stream Class	Class II
Use Support	Fully Supporting, but Threatened
Impairment	Fecal Coliform Bacteria
TMDL Priority	High

Table 4. Cannonball River Section 303(d) Listing Information, Assessment Unit ND-10130206-001-S_00 (NDDoH, 2008).

Stream Name	Cannonball River
Assessment Unit ID	ND-10130206-001-S_00
Stream Description	Cannonball River from its confluence with Dogtooth Creek downstream to Lake Oahe
Size	20.83 miles
Impaired Designated Use	Recreation
Stream Class	Class II
Use Support	Fully Supporting, but Threatened
Impairment	Fecal Coliform Bacteria
TMDL Priority	High

1.1 Clean Water Act Section 303(d) Listing Information

Based on the 2008 Section 303(d) List of Impaired Waters Needing TMDLs (NDDoH, 2008), the North Dakota Department of Health has identified three segments on the Cannonball River as fully supporting, but threatened for recreational uses due to excessive fecal coliform and E. coli bacteria concentrations. These three segments include: (1) a 23.52 mile segment of the Cannonball River from Cedar Creek downstream to a tributary nears Shields, ND (ND-10130206-027-S_00, Table 2); (2) a 21.15 mile segment of the Cannonball River from its confluence with a tributary watershed near Shields, ND downstream to its confluence with Dogtooth Creek (ND-10130206-007-S_00, Table 3); and (3) a 20.83 mile segment of the Cannonball River from its confluence with Dogtooth Creek downstream to Lake Oahe (ND-10130206-001-S_00, Table 4). While listed in the 2008 Section 303(d) list as fully supporting, but threatened for recreational uses, additional data from site 380067 shows that segment ND-10130206-007-S_00 should be assessed as not supporting recreational uses (Table 6).

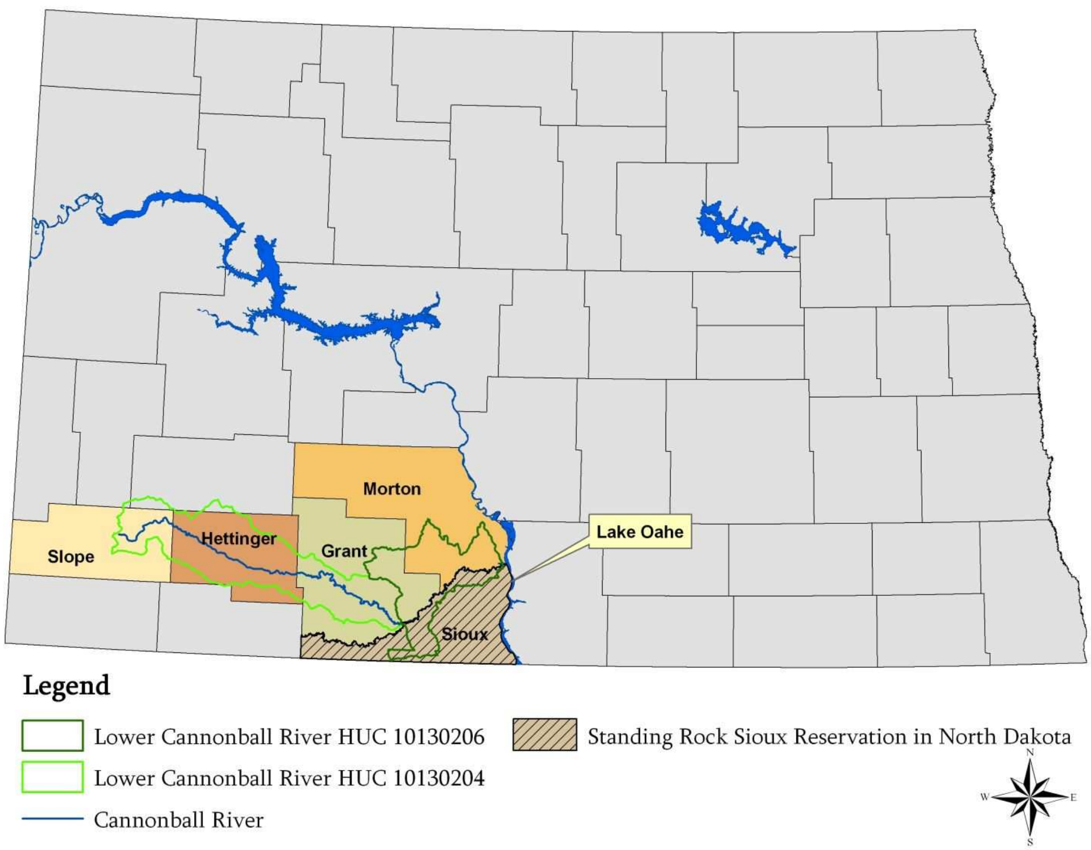

Figure 1. Cannonball River in North Dakota.

1.2 Topography

The Section 303(d) listed segments of the Cannonball River highlighted in this TMDL are located in Grant, Morton, and Sioux Counties (Figure 2). Topography of this area consists of short grass prairie rolling plains with prominent sandstone buttes. Elevation of the area ranges between 1,800 feet (MSL) near Shields, North Dakota to 2,700 feet (MSL) at the top of Coffin Butte south of New Leipzig. Glaciation has had little to no effect on the topography of the area leaving original soils in place and a complex drainage system.

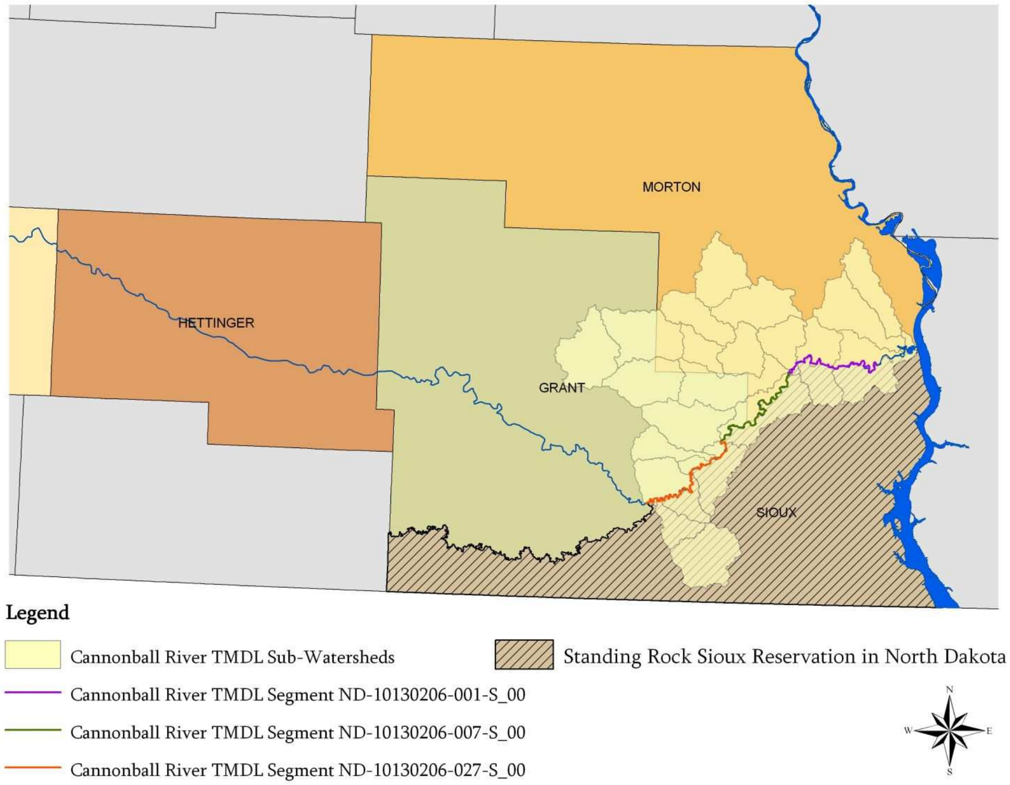

Figure 2. Location of the Cannonball River TMDL Segments and Watershed.

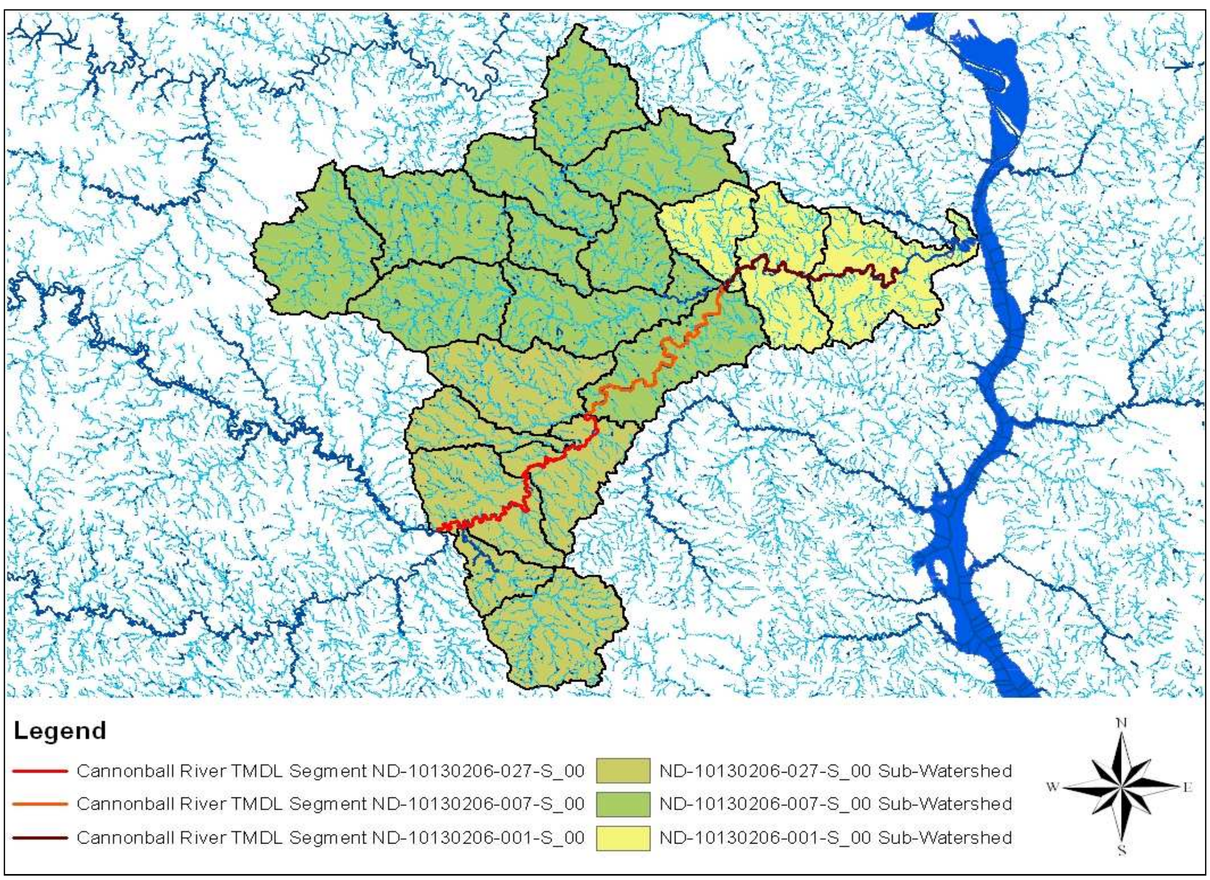

Figure 3. Cannonball River TMDL Sub-Watersheds.

1.3 Land Use/Land Cover

Land use in the three combined TMDL listed watersheds is primarily agriculture (Figure 4). Overall, seventy percent of the sub-watersheds are pasture/rangeland and grassland (Table 5), with the primary agricultural practice being livestock production. Thin top soil of siltstone, sandstone, and shale minimize crop production leaving pasture and rangelands consisting of short grass prairie, forbs, and a wide variety of forage ideal for beef production. Crop production consists of small grain crops such as spring and winter wheat, oats, and barley accounting for approximately 19 percent of the land use. With the advent of no-till and minimum tillage technologies, the region is seeing an increase in higher water use crops such as corn, silage, flax, and sunflower. Other land uses include urban areas, water, barren ground, and woods. Individually, TMDL sub-watershed ND-10130206-027-S_00 consists of 83 percent pasture/rangeland and grassland and 10 percent small grains, TMDL sub-watershed ND-10130206-007-S_00 consists of 61.4 percent pasture/rangeland and grassland and 26 percent small grains, and TMDL sub-watershed ND-10130206-001-S_00 consists of 74 percent pasture/rangeland and grassland and 14 percent small grains.

Table 5. Land Use Acreage by TMDL Sub-Watersheds.

Land Use Type	TMDL Sub-Watersheds						Total Acres	Total (%)
	ND-10130206-027-S_00		ND-10130206-007-S_00		ND-10130206-001-S_00			
	Acres	Percent	Acres	Percent	Acres	Percent		
Pasture/Rangeland	84,187	56.6	117,224	41.7	23,262	26.8	224,673	43.5
Grassland	38,498	25.9	55,366	19.7	41,376	47.6	135,240	26.2
Alfalfa	615	0.4	556	0.2	124	0.1	1,295	0.3
Fallow/Idle Cropland/CRP	5,836	3.9	15,327	5.4	3,941	4.5	25,104	4.8
Small Grains (wheat, oats, & barley)	14,395	9.7	73,414	26.1	11,872	13.7	99,681	19.3
Row Crops (corn & sunflowers)	610	0.4	6,274	2.2	1,109	1.3	7,993	1.5
Other Crops (soybeans, canola, flaxseed, peas, sorghum, & dry edible beans)	0	0	716	0.3	70	0.1	786	0.2
Wetlands/Water	2,228	1.5	4,100	1.4	2,919	3.4	9,247	1.8
Woods	818	0.6	1,328	0.5	1,010	1.1	3,156	0.6
Urban	1,118	0.8	6,283	2.2	986	1.1	8,387	1.6
Barren Ground	196	0.1	247	0.1	144	0.2	587	0.1
No Data	120	0.1	453	0.2	39	0.1	612	0.1
Total	**148,621**	**28.8**	**281,288**	**54.4**	**86,852**	**16.8**	**516,761**	**100**

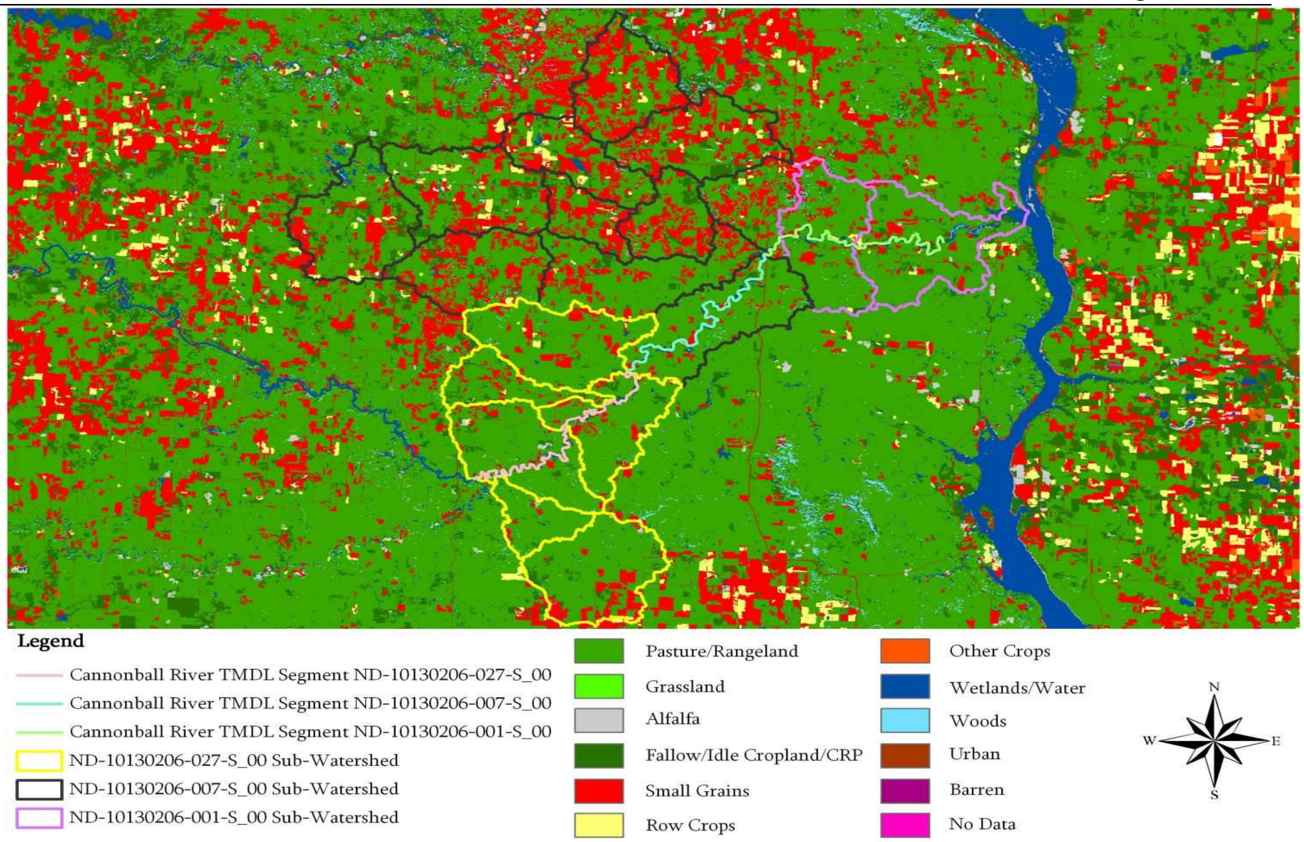

Figure 4. Land Use in the TMDL Sub-Watersheds (NASS, 2006).

1.4 Climate and Precipitation

The climate of the region varies significantly depending on the season. Climate data from the period of 1948 through 2004 was obtained from the High Plains Regional Climate Center for the Breien, ND monitoring station (380067). The average daily temperature is 42.7° F, with an average of 71.2° F in July and 10.8° F in January. The average rainfall is 16-17 inches during the summer season. The growing season lasts three months, June to August. The snow fall averages from moderate to heavy for winter weather. The temperature in the winter ranges from 30 degrees below zero to 17 degrees above zero and will range from 69 degrees to 110 degrees from June to August. The area suffers from occasional drought in the summer and severe blizzard in the winter.

1.5 Available Stream Water Quality Data

Fecal coliform bacteria and E. coli bacteria samples have been collected at three locations within the TMDL listed segments (Figure 5). Monitoring station 385138 is located on the Cannonball River near the town of Shields, upstream from monitoring stations 380067 and 385139. In addition to fecal coliform bacteria, E. coli bacteria was collected in 2001 and 2002. Monitoring station 380067 is located on the Cannonball River 0.5 miles south of Breien, ND at the Highway 6 Bridge, upstream from monitoring station 385139. It is a NDDoH ambient monitoring station that has been regularly monitored since 1994. This site is also collocated with a United States Geological Survey (USGS) gauging station (06354000). This station was monitored for fecal coliform bacteria from 1994 to 2007 and for E. coli bacteria from 2001 to 2007. Monitoring station 385139 is located on the Cannonball River at the town of Solen and was monitored for fecal coliform bacteria and E. coli bacteria in 2001 and 2002. In support of TMDL development at each site, sampling frequency was increased to twice per week during the 2001 and 2002 recreation seasons. The recreation season in North Dakota is May 1 to September 30 (NDDoH, 2006)

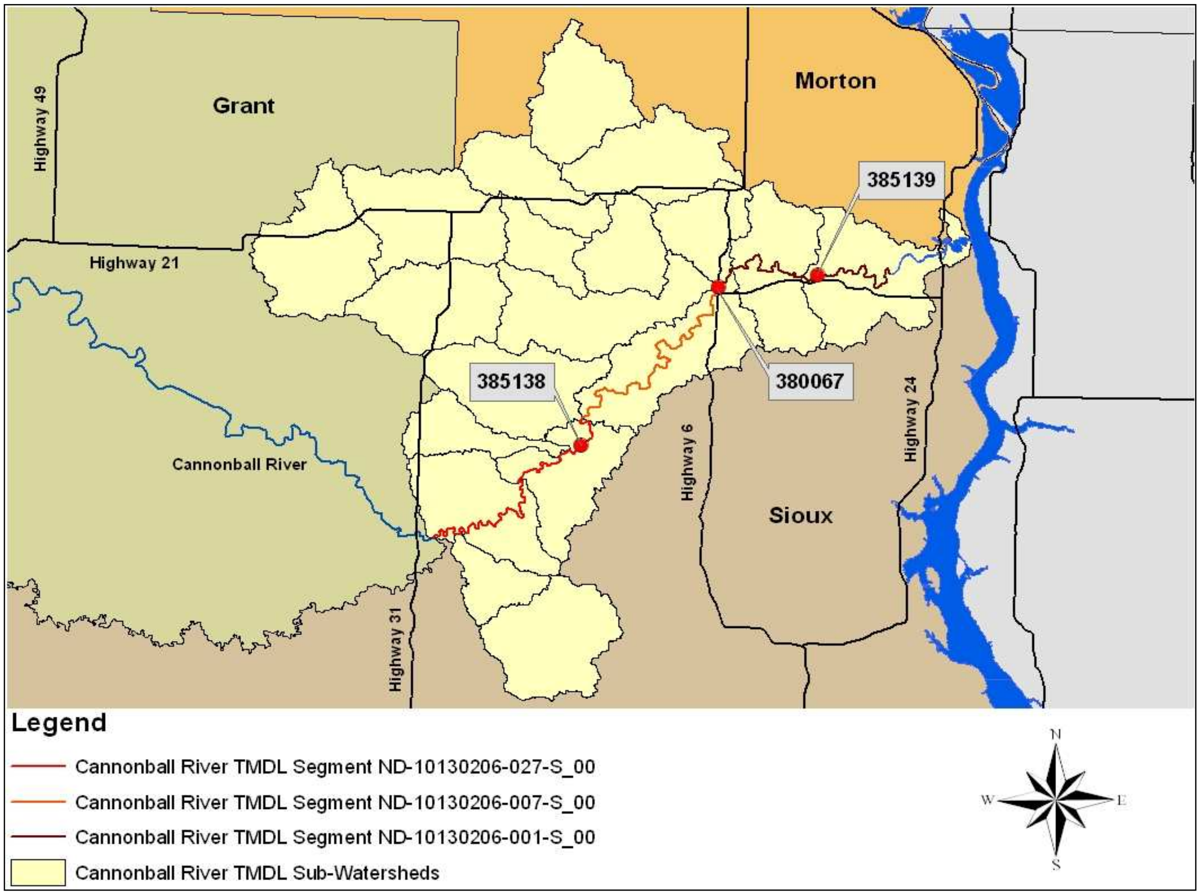

Figure 5. Water Quality Monitoring Station Locations on TMDL Listed Segments.

Table 6. General Statistics for Fecal Coliform Bacteria Data and Monitoring Station Descriptions on the Cannonball River.

Station Number	Location Description	Number of Samples Collected / Years Collected	Max. (CFU/100 mL)	Min. (CFU/100 mL)	Geometric Mean (CFU/100 mL)	Percent Greater than 400 CFU/100 mL	Percent Greater than 200 CFU/100 mL Standard
385138	Cannonball River, 1 miles S. and 0.5 miles E. of Shields, ND	40 2001-2002	12,000*	10	143	20	29
380067	Cannonball River, 0.5 miles S. of Breien on Hwy 6 bridge	80 1994-2007	3,400*	10	253	39	53
		44 2001-2002	1,600*	10	274	43	56
385139	Cannonball River, at Solen, ND	38 2001-2002	5,600*	10	171	28	36

* Some of the samples returned results of "too numerous to count," a value of 1600 was used in these situations.

Location descriptions and statistics for fecal coliform bacteria data for each monitoring station are shown in Table 6. Station 385139 is the furthest downstream site and had 36 percent of the samples from 2001 and 2002 exceed the 200 colony forming units (CFU) per 100 milliliters (mL) water quality standard. Station 380067 is located upstream from 385139 and had 53 percent of the samples collected at this site exceed the water quality standard from 1994-2007 and 56 percent exceed the water quality standard from 2001and 2002. Station 385138 is located upstream from 380067 and had 29 percent of the samples collected at this site exceed the water quality standard from 2001 and 2002. The maximum fecal coliform bacteria concentrations at stations 385138, 380067, and 385139 were 12,000 CFU/100 mL, 3,400 CFU/100 mL, and 5,600 CFU/100 mL, respectively. The minimum fecal coliform bacteria concentrations at all three stations was 10 CFU/100 mL.

Table 7. General Statistics for E. Coli Bacteria Data and Monitoring Station Descriptions on the Cannonball River.

Station Number	Location Description	Number of Samples Collected Years Collected	Max. (CFU/100 mL)	Min. (CFU/100 mL)	Geometric Mean (CFU/100 mL)	Percent Greater than 409 CFU/100 mL	Percent Greater than 126 CFU/100 mL Standard
385138	Cannonball River, 1 miles S. and 0.5 miles E. of Shields, ND	38 2001-2002	11,000*	10	124	21	33
380067	Cannonball River, 0.5 miles S. of Breien on Hwy 6 bridge	16 2003-2007	3,400*	30	372	56	NA
		44 2001-2002	1,600*	5	229	30	71
385139	Cannonball River, at Solen, ND	38 2001-2002	5,500*	20	156	21	57

* Some of the samples returned results of “too numerous to count,” a value of 1600 was used in these situations.

Location descriptions and statistics for E. coli bacteria data collected for each monitoring station are shown in Table 7. Station 385139 is the furthest downstream site and had 57 percent of the samples exceed the 126 CFU/100 mL water quality standard. Station 380067 is located upstream from 385139 and had 71 percent of the samples collected at this site exceed the water quality standard. Station 385138 is located upstream from 380067 and had 33 percent of the samples collected at this site exceed the water quality standard. The maximum E. coli bacteria concentrations at stations 385138, 380067, and 385139 were 11,000 CFU/100 mL, 3,400 CFU/100 mL, and 5,500 CFU/100 mL, respectively. Data collected at station 380067 during 2003-2007 were part of the ambient river monitoring program. Samples are collected at a six week interval during the recreation season (May 1 – September 30), so there is insufficient data to determine the 30-day geometric mean of samples exceeding the 126 CFU/100 mL standard. It should be noted that a value of 1,600 CFU/100 mL was used when a bacteria sample returned a result of “too numerous to count” and represents the maximum colonies the Department of Laboratory Services will count for a sample at a dilution rate of 10:1. While a value of 1,600 CFU/100 mL may be a significant underestimation in the cases of “too numerous to count,” there is no other defensible value that can be used for these cases. Ten percent of the samples returned results of “too numerous to count”.

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 nonpoint 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 (i.e., nutrients, dissolved oxygen). While these TMDLs are listed in the Section 303(d) list as a total fecal coliform impairment, this is considered a bacteria TMDL and both the fecal coliform and E. coli standards will be considered. As a border water with the SRST, the state must also consider water quality standards for the SRST. Since the SRST does not have US EPA approved water quality standards for it’s waters, EPA’s current E. coli criteria will be applied to tribal waters (Table 8). This is the same E. coli standard as the state’s E. coli standard.

2.1 Narrative 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, 2006).

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

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

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

In addition to the narrative standards, the NDDoH has set a biological goal for all surface waters in the state. The goal states “the biological condition of surface waters shall be similar to that of sites or waterbodies determined by the department to be regional reference sites” (NDDoH, 2006).

2.2 Numeric Stream Water Quality Standards

The Cannonball River is a Class II stream (NDDoH, 2006). As a Class II stream, “the quality of the waters in this class shall be suitable for the propagation and/or protection of resident fish species and other aquatic biota and for swimming, boating, and other water recreation. The quality of the waters shall be for irrigation, stock watering, and wildlife without injurious effects. After treatment consisting of coagulation, settling, filtration, and chlorination, or equivalent treatment processes, the water quality shall meet the bacteriological, physical, and chemical requirements of the department for municipal or domestic use. Additional treatment for municipal use may be required to meet the drinking water requirements of the Department. Streams in this classification may be intermittent in nature, which would make these waters of limited value for beneficial uses such as municipal water, fish life, or irrigation. Numeric criteria have been developed for Class II streams for both fecal coliform and E. coli bacteria (Table 7). Both bacteria standards apply only during the recreation season from May 1 to September 30. (NDDoH, 2006).

Table 8. North Dakota Fecal Coliform and E. Coli Bacteria Standards for Class II Streams.

	Standard	
Parameter	**Geometric Mean[1]**	**Maximum[2]**
Fecal Coliform Bacteria	200 CFU/100 mL	400 CFU/100 mL
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 Cannonball River is based on the NDDoH water quality standard for fecal coliform and NDDoH and EPA water quality criteria for E. coli bacteria.

TMDL targets have been set for the Cannonball River in order to restore its recreation uses to fully supporting status. The measure of achievement will be the restoration and maintenance of total fecal coliform and E. coli bacteria concentrations below the state water quality standards and EPA criteria.

3.1 Cannonball River Bacteria Targets

The Cannonball River is either not supporting or fully supporting, but threatened because of total bacteria (fecal coliform and/or E. coli) counts exceeding the North Dakota water quality standard. The North Dakota water quality standard for total fecal coliform bacteria is a 30-day geometric mean of 200 CFU/100 mL and no more than 10 percent of the samples collected within the 30-day period may exceed 400 CFU/100 mL. In addition, the North Dakota water quality standard and EPA criteria for E. coli bacteria is a 30-day geometric mean of 126 CFU/100 mL and no more than 10 percent of the samples collected within the 30-day period may exceed 409 CFU/100 mL. Both standards will apply to this TMDL and the most restrictive load reduction will be used for setting the TMDL targets for each listed waterbody.

4.0 SIGNIFICANT SOURCES

4.1 Point Sources

There is one point source located in the Cannonball River watershed. Solen, North Dakota (Population 86) utilizes a secondary treatment system. While the City of Solen (North Dakota Pollutant Discharge Elimination System (NDPDES) permit number NDND0022110) does discharge into the Cannonball River, in the last ten years it has only discharged twice. In August 1999 the City of Solen discharged 1.8 million gallons over a two week period and in June of 2003 2.3 million gallons were discharged over a six day period. The only fecal coliform testing was completed during the 2003 discharge and returned a concentration of 50 CFU/100 mL. Due to the intermittent nature of its discharge and the presumed low concentration of bacteria, it is assumed, therefore, that fecal coliform and E. coli loadings to the Cannonball River are negligible from this point source. No NDDoH permitted Concentrated Animal Feeding Operations (CAFOs) of 1000 animals or greater are located in the three TMDL sub-watersheds.

4.2 Nonpoint Sources

According to the 2006 National Agricultural Statistics Service (NASS) land use/land cover data, the dominant land use/land cover within an estimated 250 meter riparian buffer around the three TMDL segments of the Cannonball River is pasture/rangeland and grassland at 95 percent. The watershed is almost entirely rural with 70 percent of the land classified as pasture/rangeland and grassland, while agricultural crop production accounts for 21 percent. The remainder of the watershed is fallow/idle cropland/CRP, wetlands/water, woods, urban, barren ground, and areas with no data (Figure 4, Table 5). With agriculture being the predominant land use, farms and ranches are located throughout the watershed. Livestock production is a dominant agricultural practice in Grant, Morton, and Sioux Counties. Grant County ranked 4th, Morton County ranked 1st, and Sioux County ranked 22nd out of 53 counties in North Dakota with an estimated livestock production of 63,000 in Grant County, 104,000 in Morton County, and 38,000 in Sioux County (NDASS, 2007).

For purposes of this TMDL, AFOs are considered a nonpoint source. Sub-watershed ND-10130206-027-S_00 has ten known Animal Feeding Operations (AFOs) of 100 to 1000, sub-watershed ND-10130206-007-S_00 has six AFOs of 100 to 1000 and three 0 to 100, and sub-watershed ND-10130206-001-S_00 has seven AFOs of 100 to 1000 that are located in the riparian area or in a location where pollution from livestock waste is likely (Espe, 2005). There may be other AFOs in the TMDL sub-watersheds, however their location and size are unknown.

Failing septic systems or direct discharge sewage systems could be located within the watershed. Single-family dwellings and farmsteads are located throughout the watershed. While it has not been documented, land application of septic sludge may be another source of contamination.

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 pollutants (in this case total fecal coliform and E. coli bacteria) to determine the load reduction needed to meet the target. To determine the cause-and-effect relationship between the water quality target and the identified source, the "load duration curve" methodology was used. The loading capacity or TMDL is the amount of pollutant a waterbody can receive and still meet and maintain water quality standards and beneficial uses. The following technical analysis addresses the total fecal coliform and E. coli bacteria load allocation and the load allocation reductions necessary to achieve the water quality standard for fecal coliform bacteria target of 200 CFU/100 mL and the E. coli target of 126 CFU/100mL plus a margin of safety.

5.1 Mean Daily Stream Flows

In south-central North Dakota, rain events are variable and can be sporadic and heavy or light, occurring over a short duration or over several days. 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 duration and/or magnitude that do not contribute to runoff.

Mean daily flows from December 18, 1987 through December 18, 2007 were used in the development of the flow duration curve and load duration curve for site 380067 (0.5 miles south of Breien, ND). Flows for monitoring station 380067 were obtained from the discharge record at the United States Geological Survey (USGS) gauge station (06354000) co-located with station 380067. There is no daily flow record for sites 385138 and 385139, therefore the mean daily flow record used in flow duration curve development and in the development of the load duration curve was synthesized using the daily flow record for the USGS site (06354000) times a correction factor developed for each site. This correction factor is based on the contributing watershed area for each site expressed as a percentage of the watershed area for site 380067 (USGS site 0635400). The correction factors are 101.8 and 87 percent for sites 385138 and 385139, respectively (Table 9).

Table 9. Estimated Contributing Watershed Area and Percentage of Watershed Estimated.

Site	Contributing Watershed Area (Acres)	Watershed Area as a Percentage of Site 380067
380067	2,620,911	100.0
385138	2,669,577	101.8
385139	2,281,182	87.0

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. Low flows are exceeded most of the time, while flood flows are exceeded infrequently (USEPA, 2007).

A basic flow duration curve runs from high to low (0 to 100 percent) along the x-axis with the corresponding flow value on the y-axis (Figure 6). 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 6, a flow duration interval of fifty (50) percent, associated with a stream flow of 26 cfs, implies that 50 percent of all observed mean daily discharge values equal or exceed 26 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 (fecal coliform and E. coli bacteria in this case) (USEPA, 2007). As depicted in Figure 6, the flow duration curve was divided into three zones, one representing high flows (0-10 percent), another for moderate flows (10-80 percent), and one for low flows (80-100 percent). Based on the flow duration curve analysis, no flow occurred 2 percent of the time (98-100 percent). These flow 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 (Figure 6). A secondary factor in determining the flow intervals used in the analysis is the number of fecal coliform or E. coli observations available for each flow interval. Based on the analysis of the flow duration curve developed for each site, three flow regimes were also defined for sites 385138 and 385139. These flow regimes were used in the development of the TMDLs for each site (Appendices C and D).

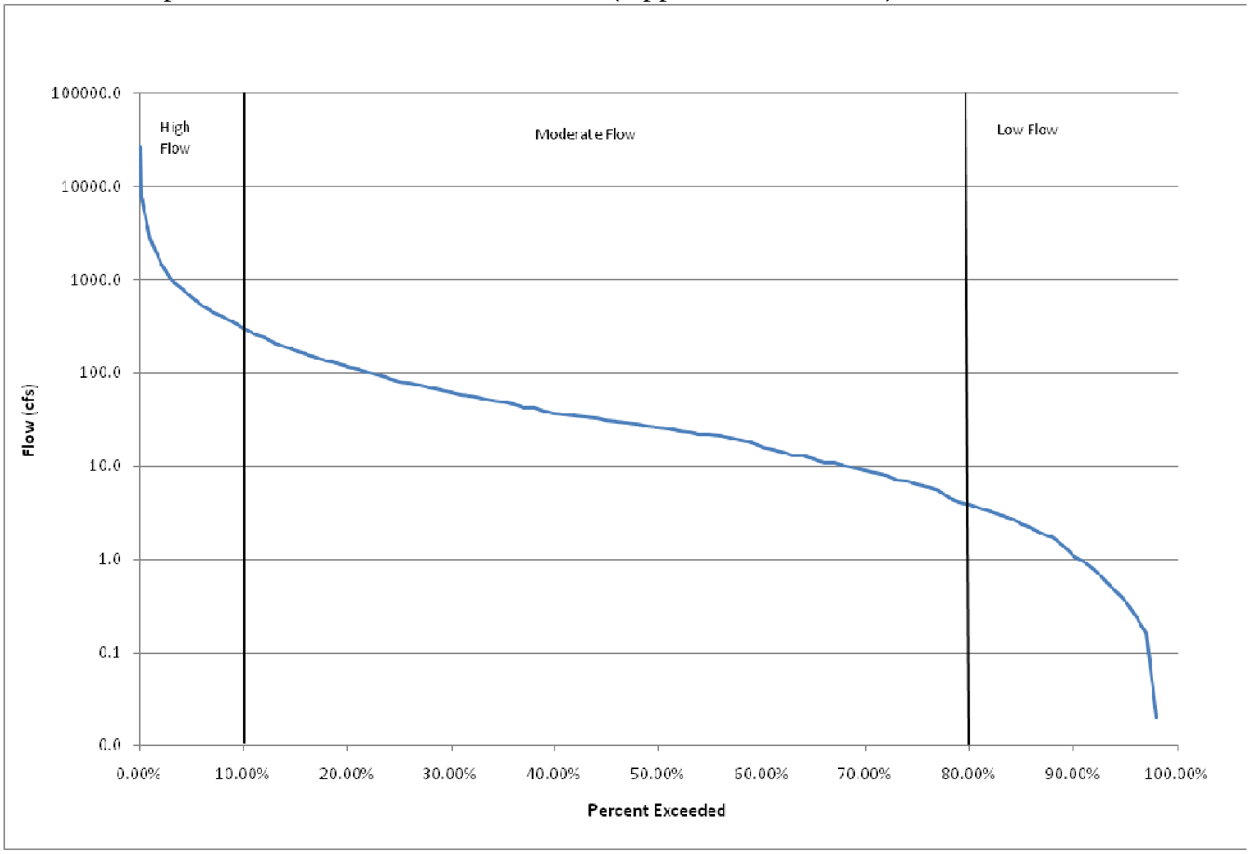

Figure 6. Cannonball River Flow Duration Curve at Monitoring Station 380067 ; Co-located with USGS Station 06354000 at Breien, ND (The curve reflects flows collected from 1987-2007)

5.3 Load Duration Curve Analysis

An important factor in determining nonpoint source pollution loads is variability in stream flows and loads associated with high, moderate, and low flow. To better correlate the relationship between the pollutants of concern and the hydrology of the Section 303(d) listed waterbodies, a fecal coliform and E. coli bacteria load duration curve was developed for each site representing the waterbody. The load duration curves were derived using the TMDL target (i.e., state water quality standards for fecal coliform and E. coli), the daily flow record obtained or synthesized for each site (see Section 5.1), and the bacteria data collected at each site from May 1-Spetember 30.

Observed in-stream fecal coliform and E. coli bacteria concentrations from monitoring sites 380067, 385138, and 385139 were converted to pollutant loads by multiplying bacteria concentrations by the daily flow on the date the sample was collected and a conversion factor. These loads are plotted against the percent exceeded of the flow on the day of sample collection (Figure 7). Points plotted above the TMDL target curve exceed the TMDL target (Figure 7). Points plotted below the curve are meeting the water quality target of 200 CFU/100 mL for fecal coliform bacteria and 126 CFUs/100 mL for E. coli bacteria.

For each flow interval or zone (i.e., high, moderate, low) and each site, a regression relationship was developed between the samples above the TMDL target curve and the corresponding percent exceeded flow. The fecal coliform load duration curve for site 380067 depicting the linear relationship for each flow regime is provided in Figure 7. Load duration curves for fecal coliform and E. coli at the remaining sites are provided in Appendices C and D, respectively. The regression line for each flow interval was then used with the midpoint of the percent exceeded flow for that interval to calculate the existing total fecal coliform or E. coli bacteria load for that flow interval. For example, in the example provided in Figure 7, the regression relationship between observed fecal coliform bacteria loading and percent exceeded flow for the high flow interval (0-10 percent) is:

Fecal coliform load (expressed as 10^7 CFUs/day) = antilog (6.72 + (-9.72*Percent Exceeded Flow))

Where the midpoint of the flow interval from 0 to 10 percent is 5 percent, the existing fecal coliform load is:

Fecal coliform load (10^7 CFUs/day) = antilog (6.72 + (-9.72*0.05))
= 1,713,957

The midpoint for the flow interval is also used to estimate the TMDL target load. In the case of the previous example, the TMDL target load for the midpoint or 5 percent exceeded flow derived from the 200 CFU/100 mL TMDL target curve is 318,464 x 10^7 CFUs/day (Figure 7).

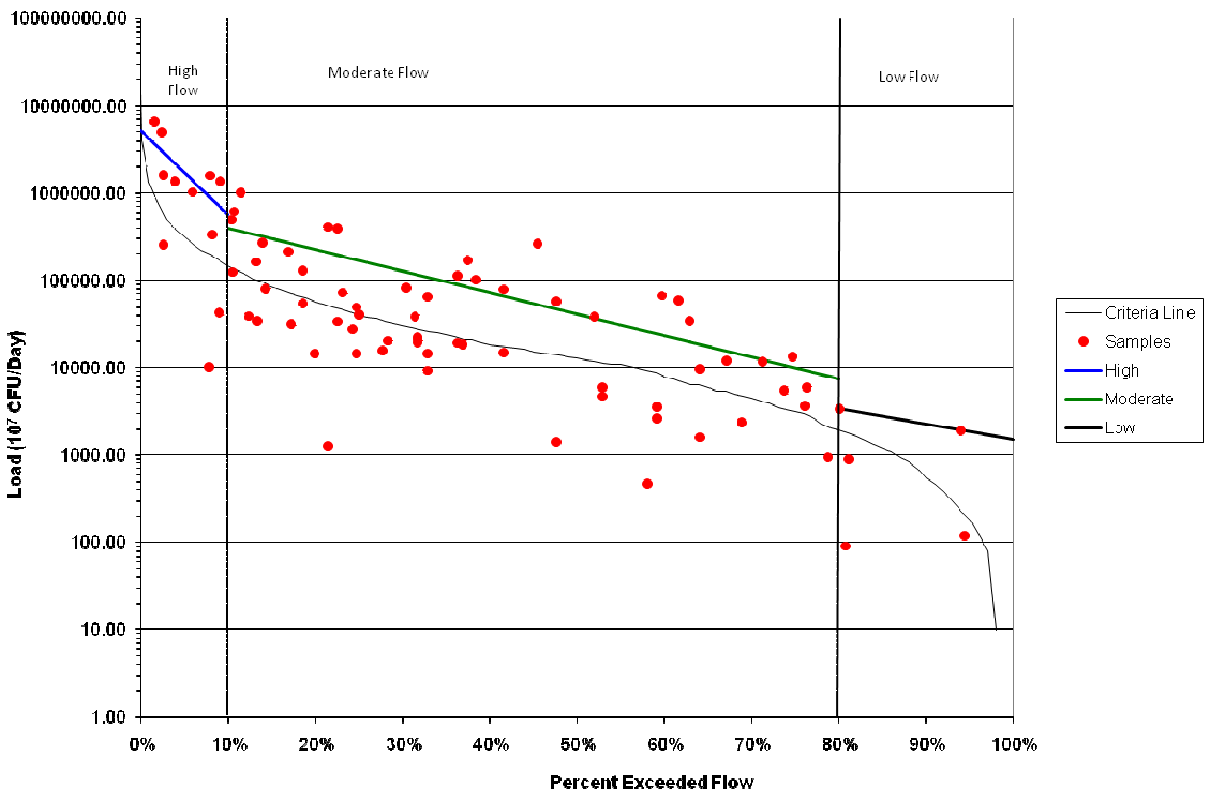

Figure 7. Cannonball River Load Duration Curve at Monitoring Station 380067 ; Co-located with USGS Station 06354000 at Breien, ND (The curve reflects flows collected from 1987-2007)

5.4 Loading Sources

In Section 4.0, significant sources of total fecal coliform loading were defined as non-point source pollution originating from livestock. One of the more important concerns regarding non-point sources is variability in stream flows. Variable stream flows often cause different source areas and loading mechanisms to dominate (Cleland, 2003). As previously described, three flow regimes (i.e., high, moderate, and low) were selected to represent the hydrology of the watershed (Figure 6).

By relating runoff characteristics to each flow regime one can infer which sources are most likely to contribute to fecal coliform loading. Animals grazing in the riparian area contribute total fecal coliform and 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, medium and low flows (Table 10). 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 moderate flows (Table 10). 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 bacteria contamination.
Since there are no significant point sources believed to be impacting bacteria loading in the watershed, loading sources exceeding the target curve in the medium flow regime and those occurring in the high flow regime indicate non-point source pollution. Specific non-point sources of pollution and their potential to contribute to fecal coliform and E. coli bacteria loads under high, medium and low flow regimes in the Cannonball River watershed are described in Table 10.

Table 10. Non-Point Sources of Pollution and Their Potential to Pollute at a Given Flow Regime.

Non-point Sources	Flow Regime		
	High Flow	Medium Flow	Low Flow
Riparian Area Grazing (Livestock)	H[1]	H	H
Animal Feeding Operations	H	M[1]	L[1]
Manure Application to Crop and Range Land	H	M	L
Intensive Upland Grazing (Livestock)	H	M	L

[1]Potential importance of non-point source area to contribute fecal coliform bacteria loads under a given flow regime rated as H: High; M: Medium; and 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 as a separate component of the TMDL (explicit).

To account for the uncertainty associated with known sources and the load reductions necessary to reach the water quality target of 200 CFU/100 mL and the E. coli water quality target of 126

CFU/100mL, a 10 percent explicit margin of safety was used for these TMDLs. The MOS was calculated as 10 percent of the TMDL. In other words 10 percent of the TMDL is set aside from the load allocation as a MOS. The 10 percent MOS was derived by taking 10 percent of the TMDL for each pollutant (fecal coliform or E. coli) for each waterbody for each flow regime.

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 Cannonball River TMDL addresses seasonality because the flow duration curve was developed using 20 years of USGS gauge data encompassing all twelve 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 bacteria loads during the seasons covered by the water quality standards.

7.0 TMDL

Table 11 provides an outline of the critical elements for each of the three waterbody specific bacteria TMDLs located within the Cannonball River watershed. TMDLs for waterbodies ND-10130206-027-S_00, ND-10130206-007-S_00, and ND-10130206-001-S_00 are presented in Tables 12, 13 and 14, respectively. It should be noted that while these segments are listed as impaired for fecal coliform bacteria, this is a bacteria TMDL, therefore both fecal coliform and E. coli will be considered. Since both standards will be applied, the most restrictive load reduction will be used for setting the TMDL. Each TMDL summary provides an estimate of the existing daily load, an estimate of the average daily loads necessary to meet water quality target (i.e. TMDL load). This TMDL load includes a load allocation from known non-point 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 11. TMDL Summary for the Three Segments on the Cannonball River.

Category	Description	Explanation
Beneficial Use Impaired	Recreation	Contact Recreation (i.e. swimming and fishing)
Pollutant	Fecal coliform and E. coli Bacteria	See Section 2.1
TMDL Target Fecal coliform E. coli	 200 CFU/100 mL 126CFU/100 mL	Based on North Dakota Water Quality Standards
Significant Sources	Non-Point Sources	No Significant Point Sources in Sub-Watersheds
Margin of Safety (MOS)	Explicit	10%

The TMDL can be generically described by the following equation:

$$TMDL = WLA + LA + MOS$$

Where:

TMDL = Total Maximum Daily Load, or the maximum 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; and

MOS = Margin of safety, or an accounting of 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 12. Fecal Coliform and E. Coli Bacteria TMDL (10^7 CFU/Day) for Cannonball River Waterbody ND-10130206-027-S_00 as Represented by Site 385138.

	Flow Regime					
	High Flow		Moderate Flow		Low Flow	
	Fecal	E. Coli	Fecal	E. Coli	Fecal	E. Coli
Existing Load	885,637	800,876	44,274	22,743	NA[1]	NA[2]
TMDL	277,064	174,550	13,199	8,315	NA	NA
WLA	0	0	0	0	NA	NA
LA	249,358	157,095	11,879	7,483	NA	NA
MOS	27,706	17,455	1,320	832	NA	NA

[1] Existing load could not be calculated due to the lack of two or more samples in this flow interval above the TMDL target curve of 200 CFUs/100 mL.
[2] Existing load could not be calculated due to the lack of two or more samples in this flow interval above the TMDL target curve of 126 CFUs/100 mL.

Table 13. Fecal Coliform and E. Coli Bacteria TMDL (10^7 CFU/Day) for Cannonball River Waterbody ND- ND-10130206-007-S_00 as Represented by Site 380067.

	Flow Regime					
	High Flow		Moderate Flow		Low Flow	
	Fecal	E. Coli	Fecal	E. Coli	Fecal	E. Coli
Existing Load	1,713,957	1,737,782	54,476	35,602	2,243	NA[1]
TMDL	318,464	200,632	15,171	9,558	538	NA
WLA	0	0	0	0	NA	NA
LA	286,618	180,569	13,654	8,602	484	NA
MOS	31,846	20,063	1,517	956	54	NA

[1] Existing load could not be calculated due to the lack of two or more samples in this flow interval above the TMDL target curve of 126 CFUs/100 mL.

Table 14. Fecal Coliform and E. Coli Bacteria TMDL (10^7 CFU/Day) for Cannonball River Waterbody ND- ND-10130206-001-S_00 as Represented by Site 385139.

	Flow Regime					
	High Flow		Moderate Flow		Low Flow	
	Fecal	E. Coli	Fecal	E. Coli	Fecal	E. Coli
Existing Load	1,450,753	1,432,983	37,073	24,027	NA[1]	NA[2]
TMDL	324,196	204,244	15,444	9,730	NA	NA
WLA	0	0	0	0	NA	NA
LA	291,776	183,820	13,900	8,757	NA	NA
MOS	32,420	20,424	1,544	973	NA	NA

[1] Existing load could not be calculated due to the lack of two or more samples in this flow interval above the TMDL target curve of 200 CFUs/100 mL.
[2] Existing load could not be calculated due to the lack of two or more samples in this flow range above the TMDL target curve of 126 CFUs/100 mL.

8.0 ALLOCATION

There are no known point sources impacting the watershed, therefore, the entire total bacteria load for this TMDL was allocated to nonpoint sources in the watershed. The entire nonpoint source load is allocated as a single load because there is not enough detailed source data to allocate the load to individual uses (i.e. animal feeding, septic systems, riparian grazing, upland grazing). To achieve the TMDL targets identified in the report will require the wide spread support and voluntary participation of landowners and residents in the immediate watershed as well as those living upstream. 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 non-point source pollution control needs,” (USEPA, 2001). This TMDL plan is put forth as recommendations for what needs to be accomplished for the Cannonball River, its tributaries and associated watershed to restore and maintain its recreational uses. Water quality monitoring should continue, in order to measure BMP effectiveness and determine through adaptive management if loading allocation recommendations need to be adjusted.

Non-point source pollution is the sole contributor to elevated total fecal coliform and E. coli bacteria levels in the Cannonball River. Three flow regimes (high flows, medium flows, low flows) have been identified for the TMDL. Each flow regime has the capacity to deliver pollutant loads from different sources in the watershed at varying magnitudes. To reduce NPS pollution for each flow regime, specific BMPs are described in Section 8.1 that will mitigate the affects of total bacteria loading to the impaired reach. Table 15 illustrates specific BMPs, that when implemented in the watershed and based on specific hydrologic conditions, will result in reducing fecal coliform and E. coli bacteria loading necessary to meet the water quality targets.

Table 15. Management Practices and Flow Regimes Affected by the Implementation of BMPs.

Management Practice	Flow Regime and Expected Reduction		
	High Flow-78 %	Medium Flow-69 %	Low Flow-60 %
Livestock Exclusion From Riparian Area	X	X	X
Water Well & Tank Development	X	X	X
Prescribed Grazing	X	X	X
Waste Management System	X	X	
Vegetative Filter Strip		X	
Septic System Repair		X	X

Note: X Denotes potential of management practice to contribute to reduction needed under defined flow regime.

Controlling non-point sources is an immense undertaking requiring extensive financial and technical support. Provided that technical and financial assistance is available to landowners and livestock producers in the Cannonball River sub-watersheds, these BMPs have the potential to significantly reduce fecal coliform bacteria loads. The following describe in detail those BMPs listed in Table 15 that will reduce fecal coliform bacteria levels in the Cannonball River.

8.1 Livestock Management Recommendations

Livestock management BMPs are designed to promote healthy water quality and riparian areas through management of livestock and associated grazing land. Fecal matter from livestock and erosion from poorly managed grazing land and riparian areas can be a significant source of fecal coliform 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 non-point 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 non-point 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 – When fencing off animals from stream access an alternative water source is required. 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 into adjacent fields. Grazing with a specified rotation minimizes overgrazing and resulting erosion. The Natural Resources 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 subsurface water for plant growth, better manure distribution, and increased rate of decomposition (NRCS, 1998). In a study by Tiedemann et al. (1998), as presented by USEPA (1993), the effects of four grazing strategies on bacteria levels in thirteen watersheds in Oregon were studied during the summer of 1984. Results of the study (Table 16) 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 fecal coliform bacteria loading originating from confined animal feeding areas (Table 17). A waste management system is made up of various components designed to control non-point 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 are designed to be adaptive to environmental, soil, and plant conditions to minimize the probability of contamination of surface water.

Table 16. Bacterial Water Quality Response to Four Grazing Strategies in Oregon (Tiedemann et al., 1998).

Grazing Strategy		Geometric Mean Fecal Coliform Bacteria Count
Strategy A:	Ungrazed	40/Liter
Strategy B:	Grazing without management for livestock distribution; 20.3 ac/AUM.	150/Liter
Strategy C:	Grazing with management for livestock distribution: fencing and water developments; 19.0 ac/AUM.	90/Liter
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/Liter

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, fecal coliform bacteria to streams. The effectiveness of filter strips and other BMPs in reducing fecal coliform bacteria can be quite successful. Results from a study by Pennsylvania State University (1992) as presented by USEPA (1993), suggest that vegetative filter strips are capable of removing up to 55 percent of fecal coliform bacteria loading to rivers and streams (Table 17). The ability of the filter strip to reduce 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

Table 17. Relative Gross Effectiveness[a] of Confined Livestock Control Measures (Pennsylvania State University, 1992).

Practice[b] Category	Runoff[c] Volume	Total[d] Phosphorus Percent	Total[d] Nitrogen Percent	Sediment Percent	Fecal Coliform Bacteria Percent
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, and waste treatment lagoons.

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 coliform bacteria. Land application of septic system sludge, although unlikely, may also be a source of contamination.

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

9.0 PUBLIC PARTICIPATION

To satisfy the public participation requirement of this TMDL, a hard copy of the TMDL for the three segments of the Cannonball River and a request for comment was mailed to participating agencies, partners, and to those who request a copy. As a multi-jurisdictional TMDL, the SRST was afforded an opportunity for public comment in addition to other interested stakeholders. Those who were provided a copy of the TMDL report either by mail or email are as follows:

- Cedar (Sioux County) Soil Conservation District
- Grant County Soil Conservation District
- Morton County Soil Conservation District
- Grant County Water Resource Board
- Sioux County Water Resource Board
- Morton County Water Resource Board
- Natural Resources Conservation Service (State Office)

- U.S. Environmental Protection Agency, Region VIII
- Standing Rock Sioux Tribe, Department of Water Resources

In addition to mailing copies of this report for the three TMDL segments of the Cannonball River to interested parties, the TMDL report was posted on the North Dakota Department of Health, Division of Water Quality web site at: **http://www.health.state.nd.us/WQ/sw/Z2_TMDL/TMDLs_Under_PublicComment/B_Under_Public_Comment.htm**. A 30 day public notice soliciting comment and participation was also published in the following newspapers:

- Mandan News
- Carson Press
- Grant County News

Comments were only received from US EPA Region 8, which were provided as part of their normal public notice review (Appendix E). The NDDoH's response to these comments are provided in Appendix F.

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.

To ensure that the best management practices (BMPs) and technical assistance that are implemented as part of any Section 319 watershed restoration project are successful in reducing fecal coliform and E. coli bacteria loadings to levels prescribed in this TMDL, water quality monitoring is conducted in accordance with an approved Quality Assurance Project Plan (QAPP).

11.0 TMDL IMPLEMENTATION STRATEGY

Implementation of TMDLs is dependent upon the availability of Section 319 NPS funds and/or other watershed restoration programs (e.g. USDA Environmental Quality Incentive Program), 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 ND Nonpoint Source Pollution Task Force and the US EPA for approval. The implementation of the BMPs contained in the NPS pollution PIP is voluntary. Therefore, success of any TMDL implementation project is ultimately dependent upon the producers in the watershed to voluntarily implement BMPs needed to meet the TMDL goal.

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
Fecal Coliform and E. coli Bacteria Data Collected in the Cannonball River Watershed (1994-2007)

Storet	Location	Description	Date	Analyte	Bacteria	Result
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/4/2001	33120	E Coli MF	40
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/6/2001	33120	E Coli MF	130
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/10/2001	33120	E Coli MF	450
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/13/2001	33120	E Coli MF	80
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/18/2001	33120	E Coli MF	140
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/20/2001	33120	E Coli MF	830
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/24/2001	33120	E Coli MF	30
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/27/2001	33120	E Coli MF	60
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/1/2001	33120	E Coli MF	170
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/9/2001	33120	E Coli MF	140
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/11/2001	33120	E Coli MF	70
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/16/2001	33120	E Coli MF	330
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/18/2001	33120	E Coli MF	1600
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/23/2001	33120	E Coli MF	560
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/25/2001	33120	E Coli MF	1600
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/30/2001	33120	E Coli MF	710
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/1/2001	33120	E Coli MF	320
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/6/2001	33120	E Coli MF	140
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/8/2001	33120	E Coli MF	50
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/13/2001	33120	E Coli MF	80
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/15/2001	33120	E Coli MF	90
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/20/2001	33120	E Coli MF	20
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	9/5/2001	33120	E Coli MF	50
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	9/11/2001	33120	E Coli MF	40
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	9/19/2001	33120	E Coli MF	60
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	9/26/2001	33120	E Coli MF	20
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/3/2002	33120	E Coli MF	60
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/10/2002	33120	E Coli MF	30
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/17/2002	33120	E Coli MF	210
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/24/2002	33120	E Coli MF	70
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/1/2002	33120	E Coli MF	210
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/8/2002	33120	E Coli MF	1200
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/15/2002	33120	E Coli MF	40
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/22/2002	33120	E Coli MF	11000
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/30/2002	33120	E Coli MF	60
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/5/2002	33120	E Coli MF	10
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/12/2002	33120	E Coli MF	60
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/19/2002	33120	E Coli MF	20
380067	Cannonball River	0.5 Mi S Of Breien	5/8/2001	33120	E Coli MF	50
380067	Cannonball River	0.5 Mi S Of Breien	6/4/2001	33120	E Coli MF	150
380067	Cannonball River	0.5 Mi S Of Breien	6/6/2001	33120	E Coli MF	130
380067	Cannonball River	0.5 Mi S Of Breien	6/10/2001	33120	E Coli MF	130
380067	Cannonball River	0.5 Mi S Of Breien	6/13/2001	33120	E Coli MF	240
380067	Cannonball River	0.5 Mi S Of Breien	6/18/2001	33120	E Coli MF	70
380067	Cannonball River	0.5 Mi S Of Breien	6/19/2001	33120	E Coli MF	320
380067	Cannonball River	0.5 Mi S Of Breien	6/20/2001	33120	E Coli MF	1600
380067	Cannonball River	0.5 Mi S Of Breien	6/24/2001	33120	E Coli MF	310
380067	Cannonball River	0.5 Mi S Of Breien	6/27/2001	33120	E Coli MF	90
380067	Cannonball River	0.5 Mi S Of Breien	7/1/2001	33120	E Coli MF	150
380067	Cannonball River	0.5 Mi S Of Breien	7/9/2001	33120	E Coli MF	260
380067	Cannonball River	0.5 Mi S Of Breien	7/11/2001	33120	E Coli MF	160
380067	Cannonball River	0.5 Mi S Of Breien	7/16/2001	33120	E Coli MF	480
380067	Cannonball River	0.5 Mi S Of Breien	7/18/2001	33120	E Coli MF	1600
380067	Cannonball River	0.5 Mi S Of Breien	7/23/2001	33120	E Coli MF	1600

380067	Cannonball River	0.5 Mi S Of Breien	7/25/2001	33120	E Coli MF	1600
380067	Cannonball River	0.5 Mi S Of Breien	7/30/2001	33120	E Coli MF	1600
380067	Cannonball River	0.5 Mi S Of Breien	7/31/2001	33120	E Coli MF	1600
380067	Cannonball River	0.5 Mi S Of Breien	8/1/2001	33120	E Coli MF	490
380067	Cannonball River	0.5 Mi S Of Breien	8/6/2001	33120	E Coli MF	110
380067	Cannonball River	0.5 Mi S Of Breien	8/8/2001	33120	E Coli MF	60
380067	Cannonball River	0.5 Mi S Of Breien	8/13/2001	33120	E Coli MF	5
380067	Cannonball River	0.5 Mi S Of Breien	8/15/2001	33120	E Coli MF	60
380067	Cannonball River	0.5 Mi S Of Breien	8/20/2001	33120	E Coli MF	150
380067	Cannonball River	0.5 Mi S Of Breien	9/5/2001	33120	E Coli MF	80
380067	Cannonball River	0.5 Mi S Of Breien	9/11/2001	33120	E Coli MF	40
380067	Cannonball River	0.5 Mi S Of Breien	9/19/2001	33120	E Coli MF	20
380067	Cannonball River	0.5 Mi S Of Breien	9/26/2001	33120	E Coli MF	100
380067	Cannonball River	0.5 Mi S Of Breien	5/21/2002	33120	E Coli MF	170
380067	Cannonball River	0.5 Mi S Of Breien	6/3/2002	33120	E Coli MF	60
380067	Cannonball River	0.5 Mi S Of Breien	6/10/2002	33120	E Coli MF	370
380067	Cannonball River	0.5 Mi S Of Breien	6/17/2002	33120	E Coli MF	310
380067	Cannonball River	0.5 Mi S Of Breien	6/24/2002	33120	E Coli MF	800
380067	Cannonball River	0.5 Mi S Of Breien	6/25/2002	33120	E Coli MF	180
380067	Cannonball River	0.5 Mi S Of Breien	6/25/2002	33120	E Coli MF	460
380067	Cannonball River	0.5 Mi S Of Breien	7/8/2002	33120	E Coli MF	1600
380067	Cannonball River	0.5 Mi S Of Breien	7/15/2002	33120	E Coli MF	400
380067	Cannonball River	0.5 Mi S Of Breien	7/22/2002	33120	E Coli MF	1600
380067	Cannonball River	0.5 Mi S Of Breien	7/30/2002	33120	E Coli MF	300
380067	Cannonball River	0.5 Mi S Of Breien	7/30/2002	33120	E Coli MF	700
380067	Cannonball River	0.5 Mi S Of Breien	8/5/2002	33120	E Coli MF	400
380067	Cannonball River	0.5 Mi S Of Breien	8/12/2002	33120	E Coli MF	40
380067	Cannonball River	0.5 Mi S Of Breien	8/19/2002	33120	E Coli MF	310
380067	Cannonball River	0.5 Mi S Of Breien	5/19/2003	33120	E Coli MF	970
380067	Cannonball River	0.5 Mi S Of Breien	6/24/2003	33120	E Coli MF	1600
380067	Cannonball River	0.5 Mi S Of Breien	5/4/2004	33120	E Coli MF	30
380067	Cannonball River	0.5 Mi S Of Breien	6/22/2004	33120	E Coli MF	110
380067	Cannonball River	0.5 Mi S Of Breien	7/27/2004	33120	E Coli MF	470
380067	Cannonball River	0.5 Mi S Of Breien	5/12/2005	33120	E Coli MF	1000
380067	Cannonball River	0.5 Mi S Of Breien	6/29/2005	33120	E Coli MF	1600
380067	Cannonball River	0.5 Mi S Of Breien	8/9/2005	33120	E Coli MF	150
380067	Cannonball River	0.5 Mi S Of Breien	9/28/2005	33120	E Coli MF	90
380067	Cannonball River	0.5 Mi S Of Breien	5/18/2006	33120	E Coli MF	90
380067	Cannonball River	0.5 Mi S Of Breien	6/27/2006	33120	E Coli MF	730
380067	Cannonball River	0.5 Mi S Of Breien	9/19/2006	33120	E Coli MF	90
380067	Cannonball River	0.5 Mi S Of Breien	5/9/2007	33120	E Coli MF	3400
380067	Cannonball River	0.5 Mi S Of Breien	6/13/2007	33120	E Coli MF	490
380067	Cannonball River	0.5 Mi S Of Breien	7/16/2007	33120	E Coli MF	170
380067	Cannonball River	0.5 Mi S Of Breien	8/21/2007	33120	E Coli MF	1600
385139	Cannonball River	At Solen, ND	6/4/2001	33120	E Coli MF	60
385139	Cannonball River	At Solen, ND	6/6/2001	33120	E Coli MF	230
385139	Cannonball River	At Solen, ND	6/10/2001	33120	E Coli MF	80
385139	Cannonball River	At Solen, ND	6/13/2001	33120	E Coli MF	210
385139	Cannonball River	At Solen, ND	6/18/2001	33120	E Coli MF	580
385139	Cannonball River	At Solen, ND	6/20/2001	33120	E Coli MF	180
385139	Cannonball River	At Solen, ND	6/24/2001	33120	E Coli MF	90
385139	Cannonball River	At Solen, ND	6/27/2001	33120	E Coli MF	120
385139	Cannonball River	At Solen, ND	7/1/2001	33120	E Coli MF	100
385139	Cannonball River	At Solen, ND	7/9/2001	33120	E Coli MF	90
385139	Cannonball River	At Solen, ND	7/11/2001	33120	E Coli MF	130

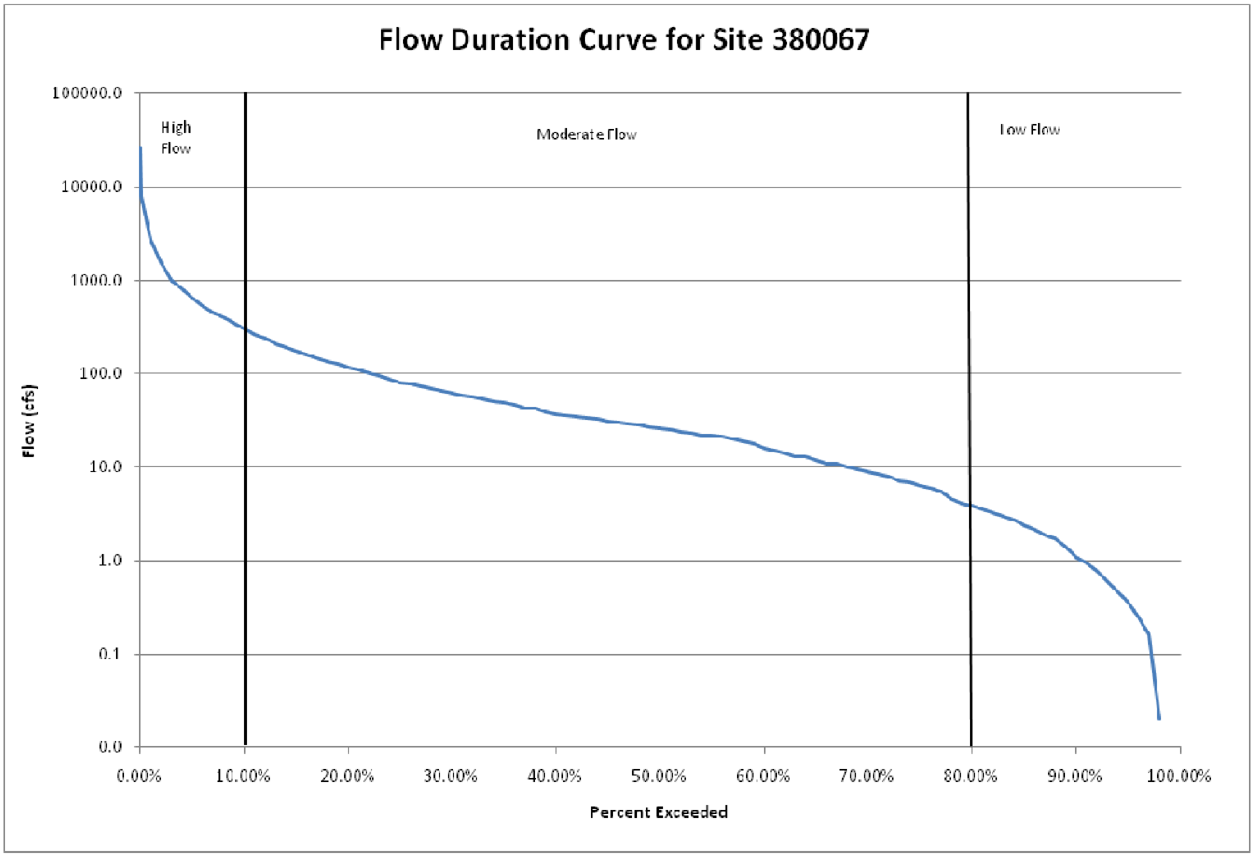
385139	Cannonball River	At Solen, ND	7/16/2001	33120	E Coli MF	430
385139	Cannonball River	At Solen, ND	7/18/2001	33120	E Coli MF	1600
385139	Cannonball River	At Solen, ND	7/23/2001	33120	E Coli MF	270
385139	Cannonball River	At Solen, ND	7/25/2001	33120	E Coli MF	1600
385139	Cannonball River	At Solen, ND	7/30/2001	33120	E Coli MF	1600
385139	Cannonball River	At Solen, ND	8/1/2001	33120	E Coli MF	470
385139	Cannonball River	At Solen, ND	8/6/2001	33120	E Coli MF	120
385139	Cannonball River	At Solen, ND	8/8/2001	33120	E Coli MF	160
385139	Cannonball River	At Solen, ND	8/13/2001	33120	E Coli MF	50
385139	Cannonball River	At Solen, ND	8/15/2001	33120	E Coli MF	40
385139	Cannonball River	At Solen, ND	8/20/2001	33120	E Coli MF	20
385139	Cannonball River	At Solen, ND	9/5/2001	33120	E Coli MF	20
385139	Cannonball River	At Solen, ND	9/11/2001	33120	E Coli MF	20
385139	Cannonball River	At Solen, ND	9/19/2001	33120	E Coli MF	30
385139	Cannonball River	At Solen, ND	9/26/2001	33120	E Coli MF	40
385139	Cannonball River	At Solen, ND	6/3/2002	33120	E Coli MF	170
385139	Cannonball River	At Solen, ND	6/10/2002	33120	E Coli MF	260
385139	Cannonball River	At Solen, ND	6/17/2002	33120	E Coli MF	160
385139	Cannonball River	At Solen, ND	6/24/2002	33120	E Coli MF	130
385139	Cannonball River	At Solen, ND	7/1/2002	33120	E Coli MF	310
385139	Cannonball River	At Solen, ND	7/8/2002	33120	E Coli MF	1600
385139	Cannonball River	At Solen, ND	7/15/2002	33120	E Coli MF	110
385139	Cannonball River	At Solen, ND	7/22/2002	33120	E Coli MF	5500
385139	Cannonball River	At Solen, ND	7/30/2002	33120	E Coli MF	120
385139	Cannonball River	At Solen, ND	8/5/2002	33120	E Coli MF	40
385139	Cannonball River	At Solen, ND	8/12/2002	33120	E Coli MF	110
385139	Cannonball River	At Solen, ND	8/19/2002	33120	E Coli MF	60
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/4/2001	33080	F Col MemF	40
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/6/2001	33080	F Col MemF	140
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/10/2001	33080	F Col MemF	480
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/13/2001	33080	F Col MemF	80
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/18/2001	33080	F Col MemF	140
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/20/2001	33080	F Col MemF	1600
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/24/2001	33080	F Col MemF	40
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/27/2001	33080	F Col MemF	60
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/1/2001	33080	F Col MemF	170
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/5/2001	33080	F Col MemF	90
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/9/2001	33080	F Col MemF	140
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/11/2001	33080	F Col MemF	70
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/16/2001	33080	F Col MemF	360
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/18/2001	33080	F Col MemF	1600
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/23/2001	33080	F Col MemF	1600
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/25/2001	33080	F Col MemF	1600
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/30/2001	33080	F Col MemF	710
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/1/2001	33080	F Col MemF	380
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/6/2001	33080	F Col MemF	160
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/8/2001	33080	F Col MemF	50
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/13/2001	33080	F Col MemF	110
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/15/2001	33080	F Col MemF	90
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/20/2001	33080	F Col MemF	120
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/30/2001	33080	F Col MemF	50
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	9/5/2001	33080	F Col MemF	60
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	9/11/2001	33080	F Col MemF	40
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	9/19/2001	33080	F Col MemF	60
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	9/26/2001	33080	F Col MemF	20

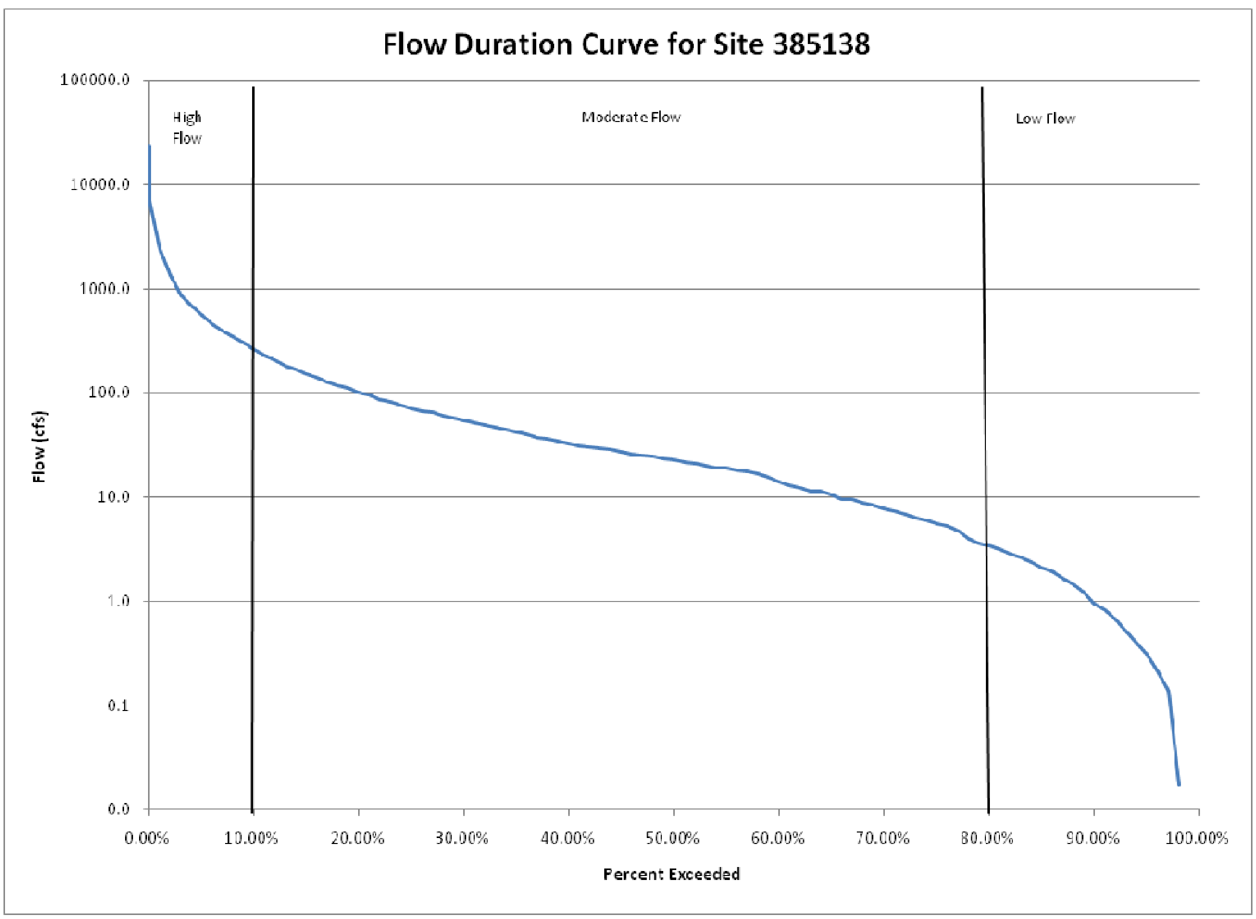
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/3/2002	33080	F Col MemF	60
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/10/2002	33080	F Col MemF	30
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/17/2002	33080	F Col MemF	310
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	6/24/2002	33080	F Col MemF	100
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/1/2002	33080	F Col MemF	240
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/8/2002	33080	F Col MemF	1300
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/15/2002	33080	F Col MemF	50
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/22/2002	33080	F Col MemF	12000
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	7/30/2002	33080	F Col MemF	60
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/5/2002	33080	F Col MemF	10
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/12/2002	33080	F Col MemF	80
385138	Cannonball River	1 Mi S And 0.5 Mi E Of Sheilds	8/19/2002	33080	F Col MemF	30
380067	Cannonball River	0.5 Mi S Of Breien	6/13/1994	33080	F Col MemF	1400
380067	Cannonball River	0.5 Mi S Of Breien	9/6/1994	33080	F Col MemF	350
380067	Cannonball River	0.5 Mi S Of Breien	5/1/1995	33080	F Col MemF	50
380067	Cannonball River	0.5 Mi S Of Breien	7/31/1995	33080	F Col MemF	200
380067	Cannonball River	0.5 Mi S Of Breien	9/5/1995	33080	F Col MemF	700
380067	Cannonball River	0.5 Mi S Of Breien	6/10/1996	33080	F Col MemF	320
380067	Cannonball River	0.5 Mi S Of Breien	7/23/1996	33080	F Col MemF	320
380067	Cannonball River	0.5 Mi S Of Breien	6/2/1997	33080	F Col MemF	70
380067	Cannonball River	0.5 Mi S Of Breien	7/8/1997	33080	F Col MemF	580
380067	Cannonball River	0.5 Mi S Of Breien	8/19/1997	33080	F Col MemF	90
380067	Cannonball River	0.5 Mi S Of Breien	9/29/1997	33080	F Col MemF	70
380067	Cannonball River	0.5 Mi S Of Breien	5/19/1998	33080	F Col MemF	160
380067	Cannonball River	0.5 Mi S Of Breien	6/29/1998	33080	F Col MemF	770
380067	Cannonball River	0.5 Mi S Of Breien	8/11/1998	33080	F Col MemF	80
380067	Cannonball River	0.5 Mi S Of Breien	9/22/1998	33080	F Col MemF	10
380067	Cannonball River	0.5 Mi S Of Breien	5/25/1999	33080	F Col MemF	10
380067	Cannonball River	0.5 Mi S Of Breien	8/17/1999	33080	F Col MemF	340
380067	Cannonball River	0.5 Mi S Of Breien	8/15/2000	33080	F Col MemF	100
380067	Cannonball River	0.5 Mi S Of Breien	9/26/2000	33080	F Col MemF	100
380067	Cannonball River	0.5 Mi S Of Breien	5/8/2001	33080	F Col MemF	50
380067	Cannonball River	0.5 Mi S Of Breien	6/4/2001	33080	F Col MemF	140
380067	Cannonball River	0.5 Mi S Of Breien	6/6/2001	33080	F Col MemF	120
380067	Cannonball River	0.5 Mi S Of Breien	6/10/2001	33080	F Col MemF	130
380067	Cannonball River	0.5 Mi S Of Breien	6/13/2001	33080	F Col MemF	240
380067	Cannonball River	0.5 Mi S Of Breien	6/18/2001	33080	F Col MemF	170
380067	Cannonball River	0.5 Mi S Of Breien	6/19/2001	33080	F Col MemF	900
380067	Cannonball River	0.5 Mi S Of Breien	6/20/2001	33080	F Col MemF	1600
380067	Cannonball River	0.5 Mi S Of Breien	6/24/2001	33080	F Col MemF	560
380067	Cannonball River	0.5 Mi S Of Breien	6/27/2001	33080	F Col MemF	90
380067	Cannonball River	0.5 Mi S Of Breien	7/1/2001	33080	F Col MemF	170
380067	Cannonball River	0.5 Mi S Of Breien	7/9/2001	33080	F Col MemF	270
380067	Cannonball River	0.5 Mi S Of Breien	7/11/2001	33080	F Col MemF	170
380067	Cannonball River	0.5 Mi S Of Breien	7/16/2001	33080	F Col MemF	490
380067	Cannonball River	0.5 Mi S Of Breien	7/18/2001	33080	F Col MemF	1600
380067	Cannonball River	0.5 Mi S Of Breien	7/23/2001	33080	F Col MemF	1600
380067	Cannonball River	0.5 Mi S Of Breien	7/25/2001	33080	F Col MemF	1600
380067	Cannonball River	0.5 Mi S Of Breien	7/30/2001	33080	F Col MemF	1600
380067	Cannonball River	0.5 Mi S Of Breien	7/31/2001	33080	F Col MemF	1600
380067	Cannonball River	0.5 Mi S Of Breien	8/1/2001	33080	F Col MemF	550
380067	Cannonball River	0.5 Mi S Of Breien	8/6/2001	33080	F Col MemF	180
380067	Cannonball River	0.5 Mi S Of Breien	8/8/2001	33080	F Col MemF	70
380067	Cannonball River	0.5 Mi S Of Breien	8/13/2001	33080	F Col MemF	5
380067	Cannonball River	0.5 Mi S Of Breien	8/15/2001	33080	F Col MemF	70

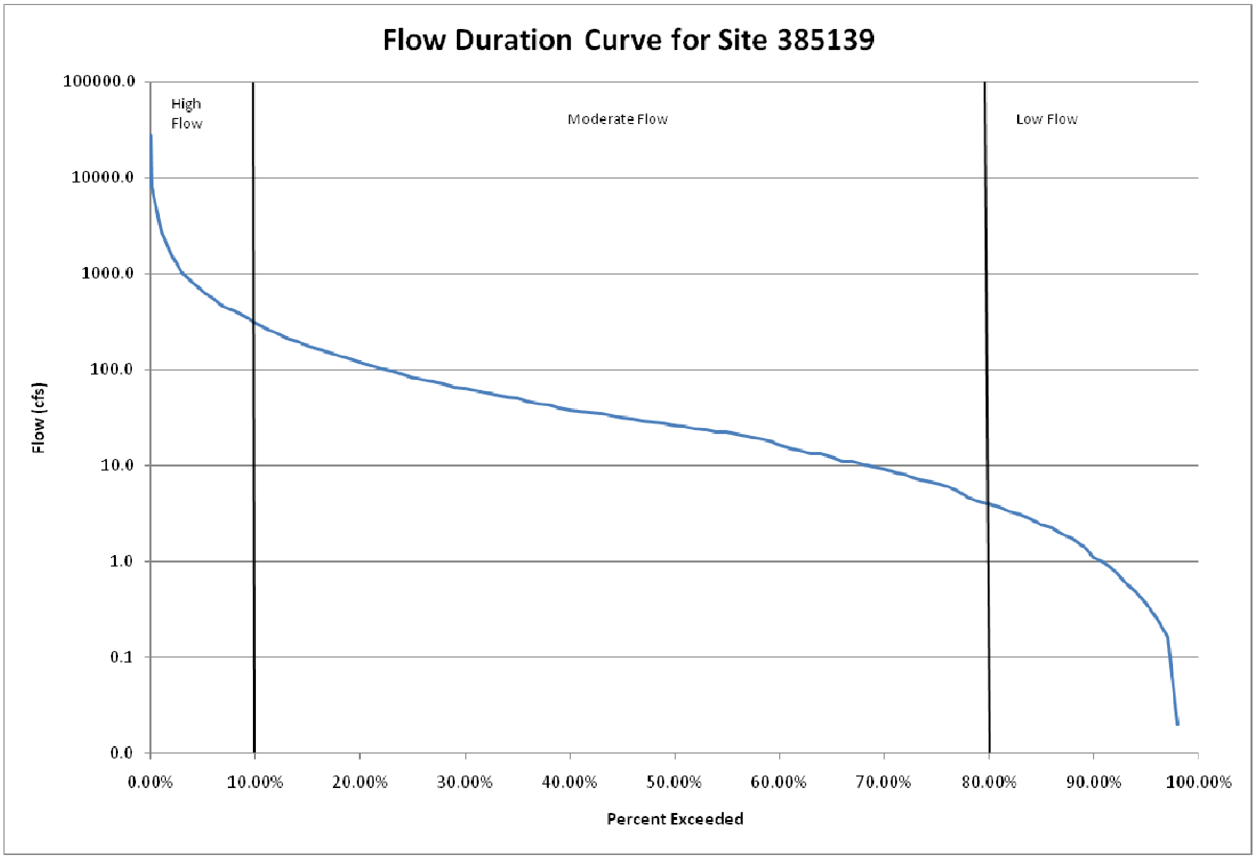
380067	Cannonball River	0.5 Mi S Of Breien	8/20/2001	33080	F Col MemF	150
380067	Cannonball River	0.5 Mi S Of Breien	8/30/2001	33080	F Col MemF	620
380067	Cannonball River	0.5 Mi S Of Breien	9/5/2001	33080	F Col MemF	80
380067	Cannonball River	0.5 Mi S Of Breien	9/11/2001	33080	F Col MemF	50
380067	Cannonball River	0.5 Mi S Of Breien	9/19/2001	33080	F Col MemF	20
380067	Cannonball River	0.5 Mi S Of Breien	9/26/2001	33080	F Col MemF	100
380067	Cannonball River	0.5 Mi S Of Breien	5/21/2002	33080	F Col MemF	170
380067	Cannonball River	0.5 Mi S Of Breien	6/3/2002	33080	F Col MemF	60
380067	Cannonball River	0.5 Mi S Of Breien	6/10/2002	33080	F Col MemF	440
380067	Cannonball River	0.5 Mi S Of Breien	6/17/2002	33080	F Col MemF	560
380067	Cannonball River	0.5 Mi S Of Breien	6/24/2002	33080	F Col MemF	830
380067	Cannonball River	0.5 Mi S Of Breien	6/25/2002	33080	F Col MemF	250
380067	Cannonball River	0.5 Mi S Of Breien	6/25/2002	33080	F Col MemF	1010
380067	Cannonball River	0.5 Mi S Of Breien	7/8/2002	33080	F Col MemF	1600
380067	Cannonball River	0.5 Mi S Of Breien	7/15/2002	33080	F Col MemF	400
380067	Cannonball River	0.5 Mi S Of Breien	7/22/2002	33080	F Col MemF	1600
380067	Cannonball River	0.5 Mi S Of Breien	7/30/2002	33080	F Col MemF	300
380067	Cannonball River	0.5 Mi S Of Breien	7/30/2002	33080	F Col MemF	800
380067	Cannonball River	0.5 Mi S Of Breien	8/5/2002	33080	F Col MemF	410
380067	Cannonball River	0.5 Mi S Of Breien	8/12/2002	33080	F Col MemF	140
380067	Cannonball River	0.5 Mi S Of Breien	8/19/2002	33080	F Col MemF	310
380067	Cannonball River	0.5 Mi S Of Breien	5/19/2003	33080	F Col MemF	1000
380067	Cannonball River	0.5 Mi S Of Breien	6/24/2003	33080	F Col MemF	1600
380067	Cannonball River	0.5 Mi S Of Breien	5/4/2004	33080	F Col MemF	10
380067	Cannonball River	0.5 Mi S Of Breien	6/22/2004	33080	F Col MemF	110
380067	Cannonball River	0.5 Mi S Of Breien	7/27/2004	33080	F Col MemF	540
380067	Cannonball River	0.5 Mi S Of Breien	5/12/2005	33080	F Col MemF	1000
380067	Cannonball River	0.5 Mi S Of Breien	6/29/2005	33080	F Col MemF	1600
380067	Cannonball River	0.5 Mi S Of Breien	8/9/2005	33080	F Col MemF	170
380067	Cannonball River	0.5 Mi S Of Breien	9/28/2005	33080	F Col MemF	90
380067	Cannonball River	0.5 Mi S Of Breien	5/18/2006	33080	F Col MemF	110
380067	Cannonball River	0.5 Mi S Of Breien	6/27/2006	33080	F Col MemF	890
380067	Cannonball River	0.5 Mi S Of Breien	9/19/2006	33080	F Col MemF	90
380067	Cannonball River	0.5 Mi S Of Breien	5/9/2007	33080	F Col MemF	3400
380067	Cannonball River	0.5 Mi S Of Breien	6/13/2007	33080	F Col MemF	680
380067	Cannonball River	0.5 Mi S Of Breien	7/16/2007	33080	F Col MemF	170
380067	Cannonball River	0.5 Mi S Of Breien	8/21/2007	33080	F Col MemF	1600
385139	Cannonball River	At Solen, ND	6/4/2001	33080	F Col MemF	70
385139	Cannonball River	At Solen, ND	6/6/2001	33080	F Col MemF	450
385139	Cannonball River	At Solen, ND	6/10/2001	33080	F Col MemF	100
385139	Cannonball River	At Solen, ND	6/13/2001	33080	F Col MemF	230
385139	Cannonball River	At Solen, ND	6/18/2001	33080	F Col MemF	600
385139	Cannonball River	At Solen, ND	6/20/2001	33080	F Col MemF	1600
385139	Cannonball River	At Solen, ND	6/24/2001	33080	F Col MemF	90
385139	Cannonball River	At Solen, ND	6/27/2001	33080	F Col MemF	120
385139	Cannonball River	At Solen, ND	7/1/2001	33080	F Col MemF	110
385139	Cannonball River	At Solen, ND	7/9/2001	33080	F Col MemF	90
385139	Cannonball River	At Solen, ND	7/11/2001	33080	F Col MemF	130
385139	Cannonball River	At Solen, ND	7/16/2001	33080	F Col MemF	480
385139	Cannonball River	At Solen, ND	7/18/2001	33080	F Col MemF	1600
385139	Cannonball River	At Solen, ND	7/23/2001	33080	F Col MemF	330
385139	Cannonball River	At Solen, ND	7/25/2001	33080	F Col MemF	1600
385139	Cannonball River	At Solen, ND	7/30/2001	33080	F Col MemF	1600
385139	Cannonball River	At Solen, ND	8/1/2001	33080	F Col MemF	480
385139	Cannonball River	At Solen, ND	8/6/2001	33080	F Col MemF	140

385139	Cannonball River	At Solen, ND	8/8/2001	33080	F Col MemF	170
385139	Cannonball River	At Solen, ND	8/13/2001	33080	F Col MemF	90
385139	Cannonball River	At Solen, ND	8/15/2001	33080	F Col MemF	40
385139	Cannonball River	At Solen, ND	8/20/2001	33080	F Col MemF	20
385139	Cannonball River	At Solen, ND	8/30/2001	33080	F Col MemF	50
385139	Cannonball River	At Solen, ND	9/5/2001	33080	F Col MemF	110
385139	Cannonball River	At Solen, ND	9/11/2001	33080	F Col MemF	10
385139	Cannonball River	At Solen, ND	9/19/2001	33080	F Col MemF	30
385139	Cannonball River	At Solen, ND	9/26/2001	33080	F Col MemF	40
385139	Cannonball River	At Solen, ND	6/3/2002	33080	F Col MemF	170
385139	Cannonball River	At Solen, ND	6/10/2002	33080	F Col MemF	240
385139	Cannonball River	At Solen, ND	6/17/2002	33080	F Col MemF	190
385139	Cannonball River	At Solen, ND	6/24/2002	33080	F Col MemF	130
385139	Cannonball River	At Solen, ND	7/1/2002	33080	F Col MemF	1040
385139	Cannonball River	At Solen, ND	7/8/2002	33080	F Col MemF	1600
385139	Cannonball River	At Solen, ND	7/15/2002	33080	F Col MemF	120
385139	Cannonball River	At Solen, ND	7/22/2002	33080	F Col MemF	5600
385139	Cannonball River	At Solen, ND	7/30/2002	33080	F Col MemF	120
385139	Cannonball River	At Solen, ND	8/5/2002	33080	F Col MemF	40
385139	Cannonball River	At Solen, ND	8/12/2002	33080	F Col MemF	110
385139	Cannonball River	At Solen, ND	8/19/2002	33080	F Col MemF	60

Appendix B
Flow Duration Curves for Sites 380067, 385138, and 385139


Flow Duration Curve for Site 380067
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
0.0
High Flow
Moderate Flow
Low Flow
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 Exceeded


Flow Duration Curve for Site 385138
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
0.0
High Flow
Moderate Flow
Low Flow
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 Exceeded



Flow Duration Curve for Site 385139
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
0.0
Flow (cfs)
High Flow
Moderate Flow
Low Flow
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
Percent Exceeded

Appendix C
Load Duration Curves, Estimated Existing Loads, TMDL Targets and Percentage of Reduction Required for Fecal Coliform at sites 380067, 385138, and 385139

Existing Loads, TMDL Targets and Percentage of Reduction Required

Storet 380067

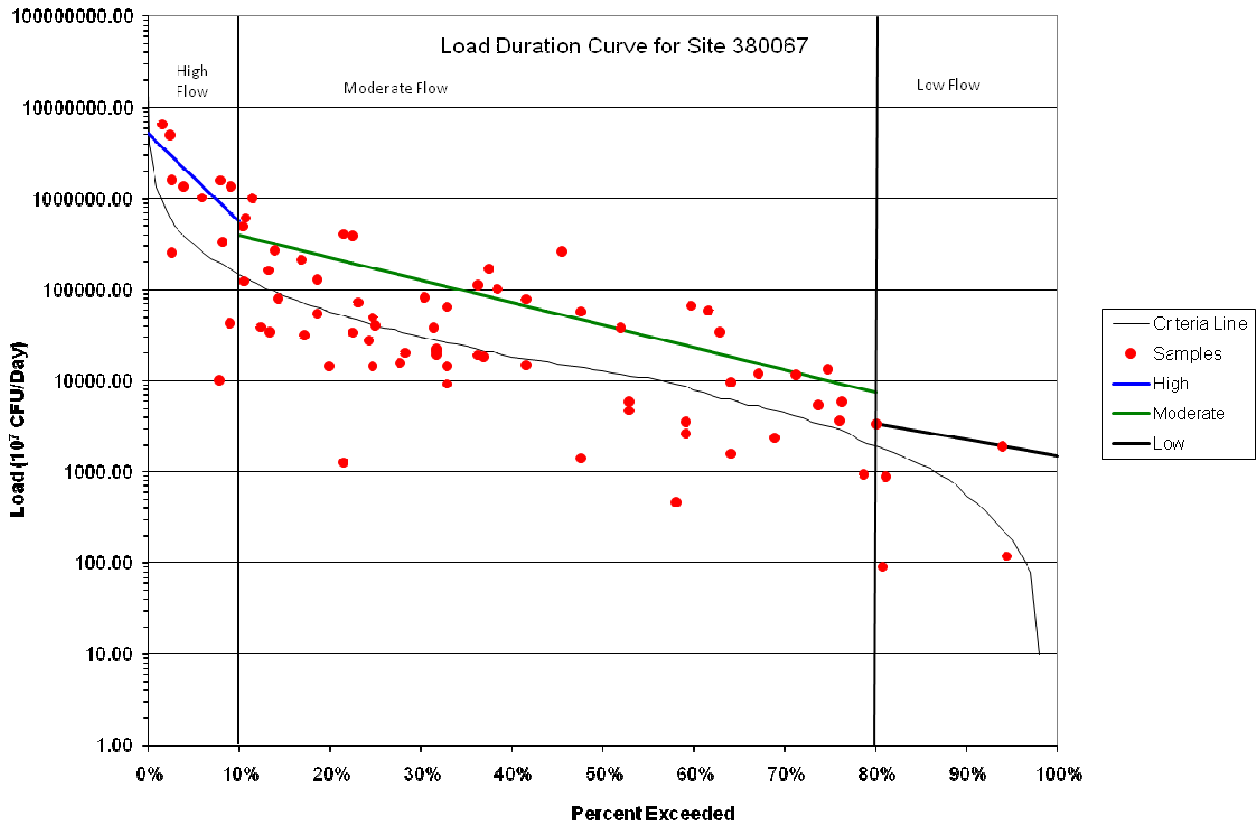
	Load (10^7 CFU/Day)				Load (10^7 CFU/Period)		
	Median Percentile	Existing	TMDL	Days	Existing	TMDL	Percent Reduction
High	5.00%	1713957.31	318463.88	36.50	62376845.04	11623931.58	81.36%
Moderate	45.01%	54475.72	15170.77	255.46	13916557.10	3875578.66	72.15%
Low	90.01%	2243.37	538.32	72.96	163684.42	39277.55	76.00%
			Total	365	76457087	15538788	79.68%

Storet 385138

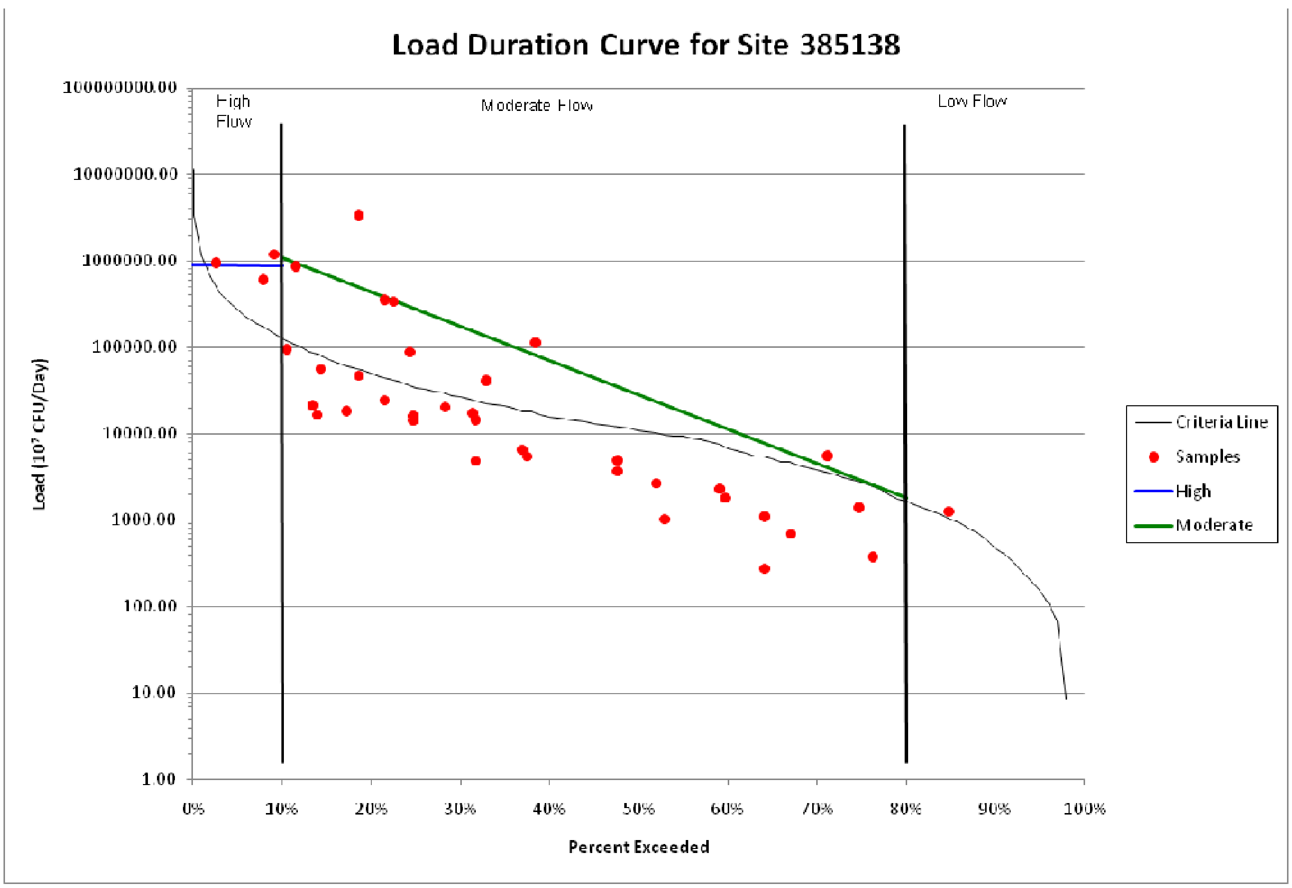
	Load (10^7 CFU/Day)				Load (10^7 CFU/Period)		
	Median Percentile	Existing	TMDL	Days	Existing	TMDL	Percent Reduction
High	5.00%	885636.77	277063.57	36.50	32325742.27	10112820.47	68.72%
Moderate	45.01%	44274.55	13198.57	255.46	11310532.54	3371753.43	70.19%
			Total	292	43636275	13484574	69.10%

Storet 385139

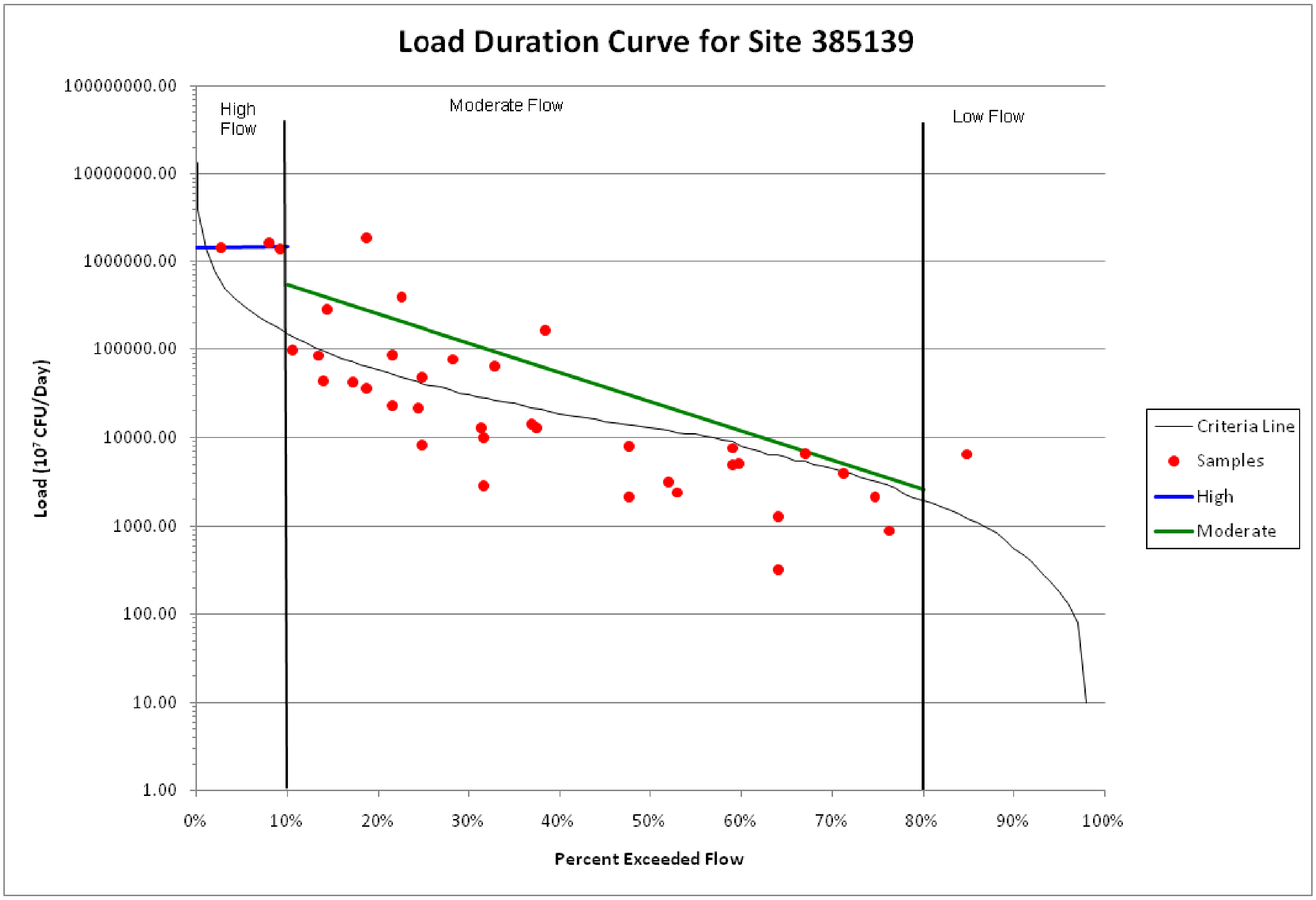
	Load (10^7 CFU/Day)				Load (10^7 CFU/Period)		
	Median Percentile	Existing	TMDL	Days	Existing	TMDL	Percent Reduction
High	5.00%	1450753.14	324196.23	36.50	52952489.58	11833162.35	77.65%
Moderate	45.01%	37072.84	15443.85	255.46	9470757.58	3945339.07	58.34%
			Total	292	62423247	15778501	74.72%



Load Duration Curve for Site 380067
High Flow
Moderate Flow
Low Flow
Load (10^7 CFU/Day)
100000000.00
10000000.00
1000000.00
100000.00
10000.00
1000.00
100.00
10.00
1.00
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent Exceeded
Criteria Line
Samples
High
Moderate
Low



Load Duration Curve for Site 385138
High Flow
Moderate Flow
Low Flow
Load (10^7 CFU/Day)
100000000.00
10000000.00
1000000.00
100000.00
10000.00
1000.00
100.00
10.00
1.00
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent Exceeded
Criteria Line
Samples
High
Moderate



Load Duration Curve for Site 385139
100000000.00
10000000.00
1000000.00
100000.00
10000.00
1000.00
100.00
10.00
1.00
High Flow
Moderate Flow
Low Flow
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent Exceeded Flow
Load (10^7 CFU/Day)
Criteria Line
Samples
High
Moderate

Appendix D
Load Duration Curves, Estimated Existing Loads, TMDL Targets and Percentage of Reduction Required for E. Coli at sites 380067, 385138, and 385139

Existing Loads, TMDL Targets and Percentage of Reduction Required

Storet 380067

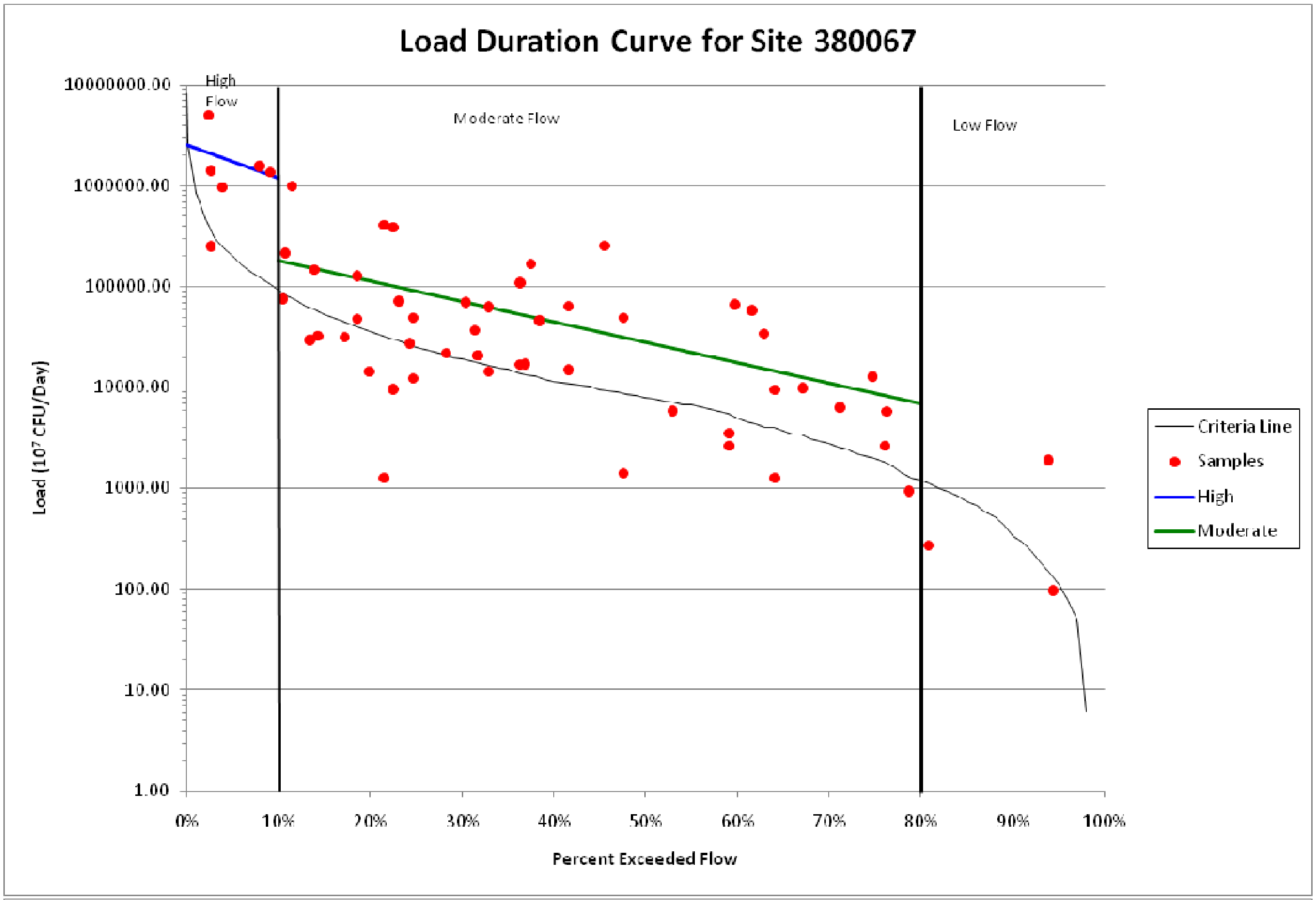
	Load (10^7 CFU/Day)				Load (10^7 CFU/Period)		
	Median Percentile	Existing	TMDL	Days	Existing	TMDL	Percent Reduction
High	5.00%	1737781.88	200632.24	36.50	63429038.64	7323076.89	88.45%
Moderate	45.01%	35601.66	9557.59	255.46	9094925.06	2441614.55	73.15%
			Total	292	72523964	9764691	86.54%

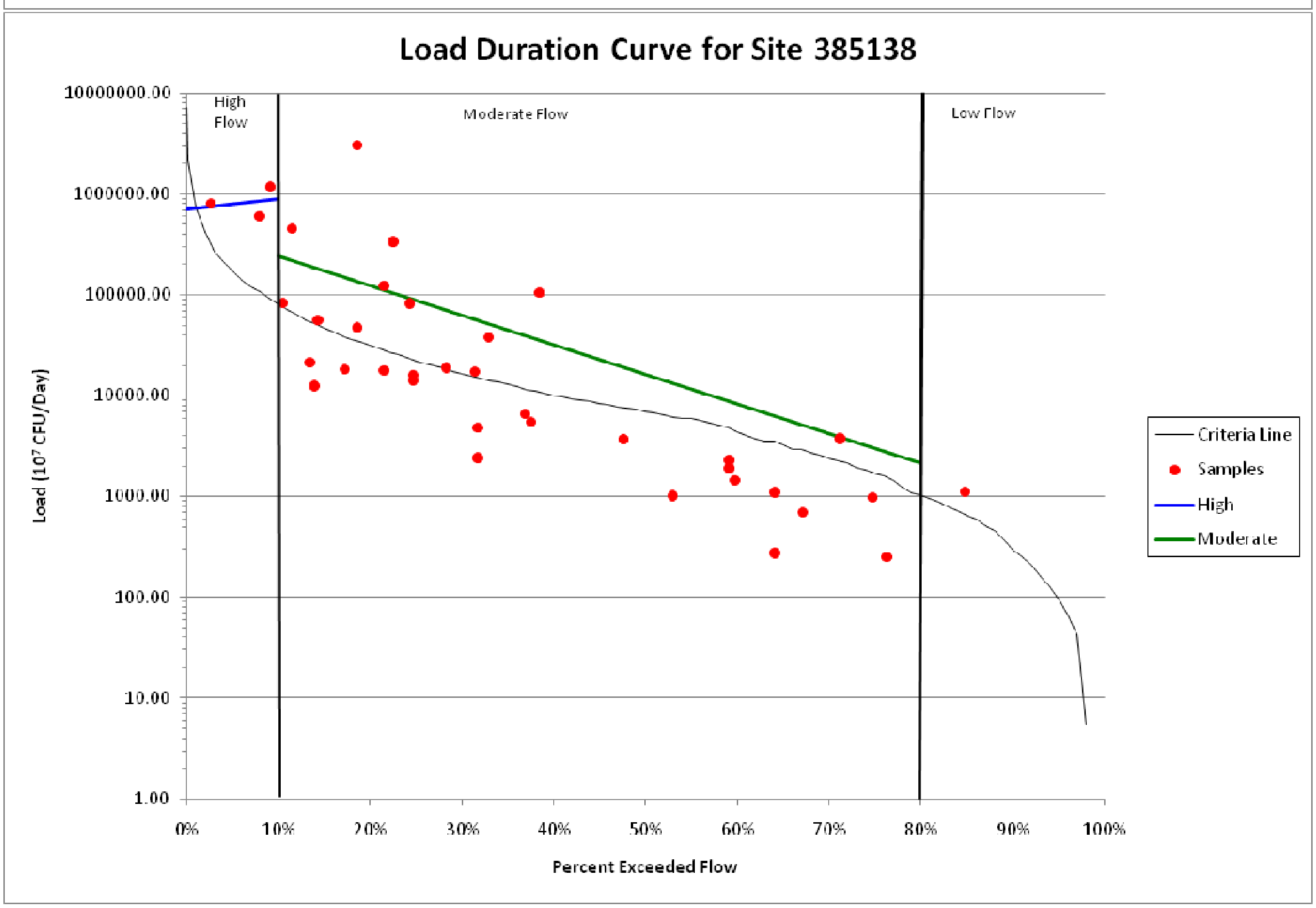
Storet 385138

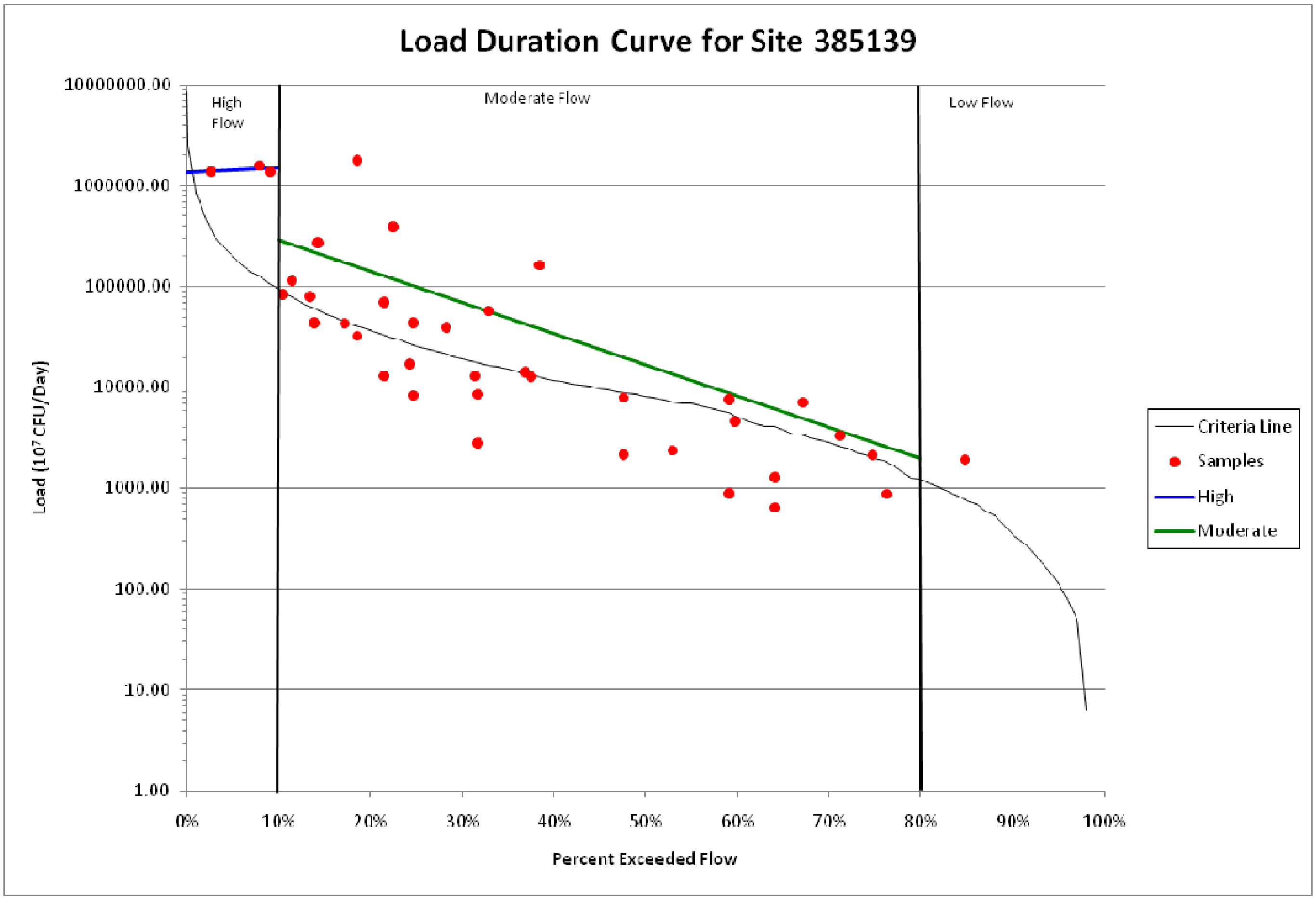
	Load (10^7 CFU/Day)				Load (10^7 CFU/Period)		
	Median Percentile	Existing	TMDL	Days	Existing	TMDL	Percent Reduction
High	5.00%	800875.73	174550.05	36.50	29231964.22	6371076.90	78.21%
Moderate	45.01%	22743.18	8315.10	255.46	5810052.99	2124204.66	63.44%
			Total	292	35042017	8495282	75.76%

Storet 385139

	Load (10^7 CFU/Day)				Load (10^7 CFU/Period)		
	Median Percentile	Existing	TMDL	Days	Existing	TMDL	Percent Reduction
High	5.00%	1432982.83	204243.62	36.50	52303873.23	7454892.28	85.75%
Moderate	45.01%	24027.12	9729.62	255.46	6138052.87	2485563.62	59.51%
			Total	292	58441926	9940456	82.99%


Load Duration Curve for Site 380067
High Flow
Moderate Flow
Low Flow
Load (10^7 CFU/Day)
10000000.00
1000000.00
100000.00
10000.00
1000.00
100.00
10.00
1.00
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent Exceeded Flow
Criteria Line
Samples
High
Moderate


Load Duration Curve for Site 385138
High Flow
Moderate Flow
Low Flow
Load (10^7 CFU/Day)
10000000.00
1000000.00
100000.00
10000.00
1000.00
100.00
10.00
1.00
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent Exceeded Flow
Criteria Line
Samples
High
Moderate



Load Duration Curve for Site 385139
High Flow
Moderate Flow
Low Flow
10000000.00
1000000.00
100000.00
10000.00
1000.00
100.00
10.00
1.00
Load (10⁷ CFU/Day)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent Exceeded Flow
Criteria Line
Samples
High
Moderate

Appendix E
US EPA Region 8 Public Notice Review and Comments

EPA REGION VIII TMDL REVIEW

TMDL Document Info:

Document Name:	**Bacteria TMDL for the Cannonball River in Grant, Morton and Sioux Counties, North Dakota**
Submitted by:	**Mike Ell, North Dakota Department of Health**
Date Received:	**August 4, 2009**
Review Date:	**August 31, 2009**
Reviewer:	**Vern Berry, EPA**
Rough Draft / Public Notice / Final?	**Public Notice Draft**
Notes:	

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

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

Approval Notes to 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 minimum submission requirements and TMDL elements identified in the following 8 sections:

1. Problem Description
   1.1. TMDL Document Submittal Letter
   1.2. Identification of the Waterbody, Impairments, and Study Boundaries
   1.3. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   4.1. Data Set Description
   4.2. Waste Load Allocations (WLA)
   4.3. Load Allocations (LA)
   4.4. Margin of Safety (MOS)
   4.5. 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 minimum submission requirements 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 the minimum submission requirements 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 template 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 Letter

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

Minimum Submission Requirements.

☒ A TMDL submittal letter should be included with each TMDL document submitted to EPA requesting a formal review.

☒ The submittal letter should specify whether the TMDL document is being submitted for initial review and comments, public review and comments, or final review and approval.

☐ 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

SUMMARY: The public notice draft Cannonball River fecal coliform TMDL was submitted to EPA for review during the public notice period via an email from Mike Ell, NDDoH on August 4, 2009. The email included the draft TMDL document and a public notice announcement requesting review and comment.

COMMENTS: None

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.

Minimum Submission Requirements:

☒ 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: The Cannonball River flows through five counties in southwest North Dakota. The three Cannonball River segments on the 303(d) list begin at the confluence with Cedar Creek (i.e., Grant County), and continue flowing along the border between Grant and Sioux counties, then Morton and Sioux counties, where it ends when it flows into Lake Oahe. The Cannonball River is part of the larger Missouri River basin in the Lower Cannonball sub-basin (HUC 10130206). The three listed segments of the Cannonball River flow approximately 65.5 miles, and drain a total area of approximately 516,761 acres. The 303(d) listed segments of the Cannonball River include: 1) Cannonball River from its confluence with Cedar Creek downstream to a tributary near Shields, ND (ND-10130206-027-S_00); 2) Cannonball River from its confluence with a tributary watershed near Shields, ND downstream to its confluence with Dogtooth Creek (ND-10130206-007-S_00); and 3) Cannonball River from its confluence with Dogtooth Creek downstream to Lake Oahe (ND-10130206-001-S_00). All three segments are listed as high priority for TMDL development.

The Standing Rock Sioux Reservation is under the jurisdiction of the Standing Rock Sioux Tribe (SRST). The Reservation is thirty-four miles south of Mandan, North Dakota where the Cannonball River forms the boundary on the north side of the reservation. The reservation extends to the Perkins County, South Dakota line to the south, the Adams County, North Dakota line to the west and the Missouri River on its east side. The southern boundary of Standing Rock Reservation also forms the northern boundary of the Cheyenne River Reservation. The total land area of the Standing Rock Sioux Reservation is 2.3 million acres.

The designated use for the listed segments of the Cannonball River and its tributaries are based on the Class II stream classification in the ND water quality standards (NDCC 33-15-02.1-09). The segments were included on the ND 2008 303(d) list for fecal coliform bacteria which is impairing primary contact recreation uses.

COMMENTS: One or more of the maps in Figure 1, 2 or 3 should include a label and shading that shows the Standing Rock Sioux Tribal boundary and land area.

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).

Minimum Submission Requirements:

☒ 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 significant sources. Therefore, all TMDL documents must be written to meet the existing water quality standards 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 Cannonball River segments addressed by these TMDLs are impaired based on fecal coliform concentrations for primary contact recreational uses. Cannonball River and its tributaries are Class II streams. Numeric criteria have been developed for Class II streams for fecal coliform bacteria. Fecal coliform bacteria standards have been established and are shown in Table 8 below. North Dakota also has E. coli standards, and E.coli data was collected during the Cannonball River assessment. While the Cannonball River segments are listed in the Section 303(d) list as a total fecal coliform impairment, the TMDL document is considered a bacteria TMDL and both the fecal coliform and E. coli standards will be addressed. As a border water with the SRST, the state must also consider water quality standards for the SRST. Since the SRST does not have US EPA approved water quality standards for its waters, EPA's current E. coli criteria will be applied to tribal waters (Table 8). This is the same E. coli standard as the state's E. coli standard.

Discussion of additional applicable water quality standards for Cannonball River can be found on pages 9 and 10 of the TMDL.

Table 8. North Dakota Fecal Coliform and E. Coli Bacteria Standards for Class II Streams.

Parameter	Standard	
	Geometric Mean[1]	Maximum[2]
Fecal Coliform Bacteria	200 CFU/100 mL	400 CFU/100 mL
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: None.

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, embeddeness, stream morphology, up-slope conditions and a measure of biota).

Minimum Submission Requirements:

☒ 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 this TMDL are based on the numeric water quality standards for fecal coliform and E.coli bacteria as shown in Table 8 of the TMDL. These standards are based on the primary contact recreational beneficial use for the three listed segments of the Cannonball River. The North Dakota water quality standard for total fecal coliform bacteria is a 30-day geometric mean of 200 CFU/100 mL and no more than 10 percent of the samples collected within the 30-day period may exceed 400 CFU/100 mL. In addition, the North Dakota water quality standard and EPA criteria for E. coli bacteria is a 30-day geometric mean of 126 CFU/100 mL and no more than 10 percent of the samples collected within the 30-day period may exceed 409 CFU/100 mL. Both standards will apply to this TMDL and the most restrictive load reduction will be used for setting the TMDL targets for each listed waterbody.

COMMENTS: None.

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 significant source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each significant source (or source category) should be identified and quantified to the maximum practical extent. 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.

Minimum Submission Requirements:

☒ The TMDL should include an identification of all potentially significant 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 all significant anthropogenic sources of the pollutant of concern have been identified, characterized, and properly 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 following landuse breakdown in the watershed: 70 percent pasture/rangeland, and 21 percent cropland. The nonpoint source assessment identifies the significant contributor of the fecal coliform load in the watershed as primarily coming from the landuses where livestock grazing and feeding operations are located in the watershed. The estimated livestock production numbers for each of the counties in the watershed are: 104,000 in Morton County, 63,000 in Grant County and 38,000 in Sioux County.

There is one point source located in the Cannonball River watershed which is from the city of Solen's wastewater treatment facility (WWTF). Solen's discharge is from a population of 86, and has only discharged twice in the past ten years. Due to the small size and infrequent nature of the discharge it is considered a negligible source of fecal coliform and E. coli loading to the river. There are no permitted concentrated animal feeding operations located in the three TMDL sub-watersheds.

Failing septic systems or direct discharge sewage systems could be located within the watershed. Single-family dwellings and farmsteads are located throughout the watershed. While it has not been documented, land application of septic sludge may be another source of contamination. These sources are potential contributors of bacteria to the Cannonball River segments that have not been investigated.

COMMENTS: None.

4. TMDL Technical Analysis

TMDL determinations should be supported by a robust 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:

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

Where:

TMDL = Total Pollutant Loading Capacity of the waterbody

LAs = Pollutant Load Allocations

WLAs = Pollutant Wasteload Allocations

MOS = The portion of the Load Capacity allocated to the Margin of safety.

Minimum Submission Requirements:

☒ 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:

(1) the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
(2) the distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) 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…;

(4) 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);
(5) 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 Cannonball River watershed TMDL describes how the fecal coliform 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 the Section 303(d) listed waterbody, a LDC was developed for each monitoring site within the three listed segments. All LDCs were derived using the 200 CFU/100 mL TMDL target (i.e., state water quality standard), the daily flow record obtained or synthesized for each site, and the observed fecal coliform data collected from the three water quality monitoring stations (see Figure 5 of the TMDL document) from 2001 - 2002.

Mean daily flows for the period December 18, 1987 through December 18, 2007 were used in the development of the flow duration curve and LDC for site 380067 (0.5 miles south of Breien, ND). This data was obtained from the collocated USGS gauge site (0635400). For sites 385138 and 385139 the mean daily flow record used in flow duration curve development and in the development of the load duration curve was synthesized using the daily flow record for the USGS site (06354000) times a correction factor developed for each site. This correction factor is based on the contributing watershed area for each site expressed as a percentage of the watershed area for site 380067 (USGS site 0635400). The correction factors are 101.8 and 87 percent for sites 385138 and 385139, respectively (see Table 9 in the TMDL document).

Each LDC was divided into 3 distinct flow regimes. The resulting curves represent a flow-variable TMDL target across the flow regimes shown in the TMDL document. For each Cannonball River segment covered by the TMDL document, the LDC is a dynamic expression of the allowable load for any given daily flow. Loading capacities were derived from this approach for each segment at each flow regime. Tables 12, 13, and 14 show the loading capacity loads (or TMDL loads) for each listed segment of the Cannonball River.

COMMENTS: It is not clear why 3 flow zones were used in the LDCs for these TMDLs. Page 12 of the document explains ***how*** the flow regimes were defined for each site, but no explanation is given for ***why*** 3 zones were used. A brief explanation of why 3 flow zones were used (e.g., based on the shape of the curve, no flow at low end of curve, etc) should be added to the document.

From the information provided on pages 12 and 13 of the document, it is not clear how the linear regression line is used in determining the required percent reductions needed for LDC. NDDoH is asked to clarify the information and include a description as to how the percent reduction calculation is made using the linear regression line.

Also, we understand that loads cannot be derived at the low flow regime for the three listed segments. However, the "NA" shown at low flow in Tables 12, 13 and 14 do not adequately express this. We recommend adding a footnote to these tables explaining the reason and meaning of the NAs in the tables.

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…).

Minimum Submission Requirements:

☒ 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 Cannonball River TMDL data description and summary are included tables throughout the document for all three listed segments. The recent water quality monitoring was conducted over the period from January 2001 to December 2002 and included a total of 122 fecal coliform samples. The data set also includes the 20 years of flow record on the Cannonball River from the USGS gauging site near Breien, ND. The flow data was used to develop load duration curves for the Cannonball River segments

COMMENTS: None.

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.

Minimum Submission Requirements:

☒ EPA regulations require that a TMDL include WLAs for all significant and/or NPDES permitted point sources of the pollutant. TMDLs must identify the portion of the loading capacity allocated to individual existing and/or 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: There is one point source located in the Cannonball River watershed which is from the city of Solen's wastewater treatment facility (WWTF). Solen's discharge is from a population of 86, and has only discharged twice in the past ten years. Due to the small size and infrequent nature of the discharge it is considered a negligible source of fecal coliform and E. coli loading to the river. There are no permitted concentrated animal feeding operations located in the three TMDL sub-watersheds. Therefore, the WLAs for these TMDLs are zero.

COMMENTS: None.

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.

Minimum Submission Requirements:

☒ 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 all significant 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 following landuse breakdown in the watershed: 70 percent pasture/rangeland, and 21 percent cropland. The nonpoint source assessment identifies the significant contributor of the fecal coliform load in the watershed as primarily coming from the landuses where livestock grazing and feeding operations are located in the watershed. The estimated livestock production numbers for each of the counties in the watershed are: 104,000 in Morton County, 63,000 in Grant County and 38,000 in Sioux County. Tables 12, 13 and 14 show the load allocations for each listed segment of the Cannonball River at 3 different flow regimes. Specific non-point sources of pollution and their potential to contribute total fecal coliform bacteria loads under high, medium and low flow regimes in the Cannonball River watershed are described in Table 10 of the TMDL document.

COMMENTS: None.

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).

Minimum Submission Requirements:

☒ 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 Cannonball River TMDL includes explicit MOSs for each listed segment derived by calculating 10 percent of the loading capacity. The explicit MOSs for the listed segments of the Cannonball River watershed are included in Tables 12, 13 and 14.

COMMENTS: None.

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.

Minimum Submission Requirements:

☒ 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. Highest steam flows typically occur during late spring, and the lowest stream flows occur during the winter months. Also, the TMDL is seasonal since the fecal coliform criteria are in effect from May 1 to September 30, therefore the TMDLs are only applicable during that period.

COMMENTS: None.

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.

Minimum Submission Requirements:

☒ 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. As a multi-jurisdictional TMDL, the SRST was afforded the opportunity for public comment in addition to other interested stakeholders. Copies 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 three newspapers.

COMMENTS: None.

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.

Minimum Submission Requirements:

☒ 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: Implementation of TMDLs is dependent upon the availability of Section 319 NPS funds and/or other watershed restoration programs (e.g. USDA Environmental Quality Incentive Program), 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. Monitoring is a 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.

COMMENTS: None.

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.

Minimum Submission Requirements:

☒ 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 TMDLs is dependent upon the availability of Section 319 NPS funds and/or other watershed restoration programs (e.g. USDA Environmental Quality Incentive Program), 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. As data are gathered and analyzed, watershed restoration tasks are adapted to place BMPs where they will have the greatest benefit to water quality.

COMMENTS: None.

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.

Minimum Submission Requirements:

☒ 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 Cannonball River TMDL document includes daily loads expressed as fecal coliform and E. coli colonies per day for the three listed segments in the watershed. The daily TMDL loads are included in TMDL section (Section 7.0) of the document.

COMMENTS: None.

Appendix F
NDDoH's Response to Comments Received from the US EPA Region 8

EPA Region 8 Comment: One or more of the maps in Figure 1, 2 or 3 should include a label and shading that shows the Standing Rock Sioux Tribal boundary and land area.

NDDoH Response: Figures 1 and 2 have been revised with additional detail defining the location of the Standing Rock Sioux Reservation in North Dakota.

EPA Region 8 Comment: It is not clear why 3 flow zones were used in the LDCs for these TMDLs. Page 12 of the document explains ***how*** the flow regimes were defined for each site, but no explanation is given for ***why*** 3 zones were used. A brief explanation of why 3 flow zones were used (e.g., based on the shape of the curve, no flow at low end of curve, etc) should be added to the document.

From the information provided on pages 12 and 13 of the document, it is not clear how the linear regression line is used in determining the required percent reductions needed for LDC. NDDoH is asked to clarify the information and include a description as to how the percent reduction calculation is made using the linear regression line.

Also, we understand that loads cannot be derived at the low flow regime for the three listed segments. However, the "NA" shown at low flow in Tables 12, 13 and 14 do not adequately express this. We recommend adding a footnote to these tables explaining the reason and meaning of the NAs in the tables.

NDDoH Response: An additional section was added to Section 5.0, Technical Analysis. This new section, added as Section 5.2, describes the flow duration curve analysis, which is a precursor to the load duration curve analysis. This new section describes how the flow intervals used in the load duration curve are selected.

Additional language was also added to the "Load Duration Curve Analysis" section, now 5.3, which describes with an example of how the existing and TMDL loads are calculated from the regression line and the TMDL target curve. This section also describes how the midpoint for the flow interval is selected.

A footnote has been added to Tables 12, 13 and 14 describing what the "NA" means and why loads could not be calculated for the low flow regime for each listed segment.