Escherichia coli Bacteria Total Maximum Daily Load (TMDL) for the Vermillion River Segment 3 Clay County, South Dakota

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Acronym List

Acronym	Definition
AUM	Animal Unit Month
ARSD	Administrative Rules of South Dakota
BMP	Best Management Practice
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations (U.S.)
cfs	Cubic Feet Per Second
CFU	Colony Forming Unit
CSP	Conservation Stewardship Program
CWA	Clean Water Act
DANR	Department of Agriculture & Natural Resources (South Dakota)
EPA	Environmental Protection Agency (U.S.)
EQIP	Environmental Quality Incentive Standards
GM	Geometric Mean
GFP	Game, Fish, & Parks (South Dakota)
GIS	Geographical Information System
HUC	Hydrologic Unit Code
ID	Identification
IR	Integrated Report (South Dakota's Water Quality Integrated Report)
LA	Load Allocation
mL	Milliliter
MOS	Margin of Safety
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
SSM	Single Sample Maximum
SWMP	Storm Water Management Program
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
VBWDD	Vermillion Basin Water Development District
WLA	Wasteload Allocation
WPP	Watershed Protection Program (South Dakota)
WQM	Water Quality Monitoring
WRP	Watershed Restoration Plan
WTF	Wastewater Treatment Facilities

Document Summary

EPA delegates authority to the South Dakota Department of Agriculture & Natural Resources (DANR) under the Clean Water Act to develop impaired waters lists and associated TMDLs (i.e. section 303(d)). Under this authority, DANR drafts TMDLs and EPA makes the final decision on the document. A TMDL serves as a planning document to characterize impairment and recommend measures to achieve compliance with water quality standards.

This document describes the *Escherichia coli* (*E. coli*) Total Maximum Daily Load (TMDL) and water quality improvement plan for SD-VM-R-Vermillion_03 or Vermillion River Segment 3 (**Figure 2-1)**. This document only addresses *E. coli* as a cause of impairment in segment 3 of the Vermillion River.

Vermillion River Segment 3 begins in Clay County, South Dakota from Baptist Creek to the confluence with the Missouri River. The Vermillion River Segment 3 watershed contains other smaller tributaries like Baptist Creek, Clay Creek Ditch, and Yankton Clay Ditch. The Vermillion River Segment 3 flows through Clay County, eastern Yankton County, extending up to the north of the lower sections of Turner and Hutchinson Counties. The watershed is approximately 112,988 hectares with a predominate land use of agriculture cropland. Majority of rangeland in the watershed is in the Clay Creek and Turkey Creek watershed.

E. coli **TMDL**

High concentrations of *E. coli* can put humans at risk for contracting water-borne illnesses. Elevated concentrations of *E. coli* can lead to impairment of the waterbody's designated beneficial uses. DANR's water quality assessment methods for *E. coli* impairment focus on the most sensitive recreation use to ensure protection. The TMDL was developed using the single sample maximum for immersion recreation. The selected criteria is protective of downstream use as immersion recreation is designated for the Missouri River and not Vermillion Segment 3.

This document summarizes *E. coli* production for all nonpoint sources such as human, agricultural and wildlife. All point sources of *E. coli* are identified, and waste load allocations are provided where appropriate. A margin of safety is applied to the TMDL to account for data uncertainty. MS4 waste load calculation for the city of Vermillion was developed using the Jurisdictional Area Method. All variables in the TMDL equation were calculated over five flow zones. A summary of state and federal programs that guide TMDL development as well as an implementation strategy to reduce *E. coli* concentrations is discussed.

Total Maximum Daily Load Summary

Vermillion River Segment 3 - SD-VM-R-Vermillion_03

Waterbody Type:	River/Stream
Reach Number:	SD-VM-R-Vermillion_03
303(d) Listing Parameter:	Pathogens (*Escherichia coli*)
Designated Uses of Concern:	Immersion Recreation Waters
Location:	Confluence of Baptist Creek and Vermillion River to the Missouri River in Clay County, SD (HUC 8 10170102)
Size of Impaired Waterbody:	SD-VM-R-VERMILLION_03 - Approximately 33.31 km
Size of Watershed:	Watershed size for Reach SD-VM-R-VERMILLION_03 – 112,988 hectares (ha)
Indicator(s):	Concentration of *Escherichia coli* (colony forming units per 100ml)
Analytical Approach:	Load Duration Curve Framework
TMDL Priority Ranking:	Priority 1 (2022 IR)
Target (Water Quality Standards):	*Escherichia coli* (*E. coli*) - Maximum daily concentration of ≤ 235 CFUs/100mL and a geometric mean of < 126 based on a minimum of five (5) samples obtained during separate 24-hour periods for any 30-day period.

TMDL Component	Vermillion River Segment 3 Flow Zones Expressed as (CFU/day)				
	High Flows	Moist Conditions	Mid-Range Conditions	Dry Conditions	Low Flows
	≥ 2463 cfs	2,462 - 463 cfs	462 - 167 cfs	166 - 86 cfs	≤ 85 cfs
LA	4.04E+13	1.15E+13	2.22E+12	8.00E+11	3.95E+11
MS4 - City of Vermillion	4.08E+11	1.16E+11	2.24E+10	8.08E+09	3.99E+09
WLA-City of Vermillion	3.56E+10	3.56E+10	3.56E+10	3.56E+10	3.56E+10
10% Explicit MOS (Low Implicit)	4.54E+12	1.29E+12	2.53E+11	9.37E+10	4.83E+10
TMDL @ 235 CFU/100mL	4.54E+13	1.29E+13	2.53E+12	9.37E+11	4.83E+11
Current Load	2.79E+14	8.58E+13	2.21E+12	7.15E+12	1.71E+11
Load Reduction	84%	85%	0%	87%	0%

1.0 TMDL Overview

The intent of this document is to clearly identify the components of the Total Maximum Daily Load (TMDL), support adequate public participation, and facilitate the United States Environmental Protection Agency (EPA) review. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by EPA. This TMDL document addresses the *E. coli* impairment for Assessment Unit **SD-VM-R-VERMILLION_03** or the Vermillion River Segment 3 (Baptist Creek to Missouri River) (**Figure 2-1**). This impairment has been assigned a priority category 1 (High-Priority) in the 2022 South Dakota 303(d) list and was first identified as impaired in the 2014 IR. Sufficient *E. coli* data was collected to determine that the beneficial use of limited contact recreation is not supported.

1.1 CWA Section 303(d)

In 1972, the U.S. Congress passed the Water Pollution Control Act, more commonly known as the Clean Water Act (CWA). The CWA's goal is to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." The CWA requires states to develop beneficial uses for waters and water quality standards to protect those uses.

Waterbodies in South Dakota are designated beneficial uses based on a use attainability assessment. South Dakota has established water quality standards and criteria to protect beneficial uses designated to waters of the state (ARSD 74:54:01). When a waterbody fails to comply with one or more water quality (WQ) standards the use(s) are considered not supporting or impaired. States are required to monitor water quality and assess beneficial use support and impairment status of all waters through the Integrated Report (IR) process.

South Dakota Department of Agriculture & Natural Resources (DANR) is required to submit an Integrated Report for Surface Water Quality Assessment to EPA by April 1st of every even year. The report provides a comprehensive account of the surface water quality in the state. In addition, the report contains the 303(d) list of impaired waterbodies that require TMDL development. A TMDL serves as a planning document directed to achieve and maintain water quality standards attainment.

1.2 Document Contents

This document addresses required components of a TMDL including an implementation and monitoring strategy. In addition to this introductory section, this document includes:

Section 2.0 Vermillion River Segment 3 Background: Provides background information, physical features and social profile of the Vermillion River Segment 3 watershed.

Section 3.0 South Dakota Water Quality Standards: Discusses the water quality standards that apply to the Vermillion River Segment 3.

Section 4.0 Impairment Assessment Methods: Documents the decision-making process to define whether water quality standards are met.

Section 5.0 Defining TMDLs and Their Components: Outlines the components of TMDLs and what water quality standard the Vermillion River Segment 3 will use to develop a numeric TMDL.

Section 6.0 Water Quality Data and Discharge Information: Discusses the collection of water quality data and measured discharges which will be used to calculate the TMDL for Vermillion River Segment 3.

Section 7.0 Vermillion River Segment 3 Source Assessment and Allocation: Identifies all bacteria sources in the watershed and provides a calculation of bacteria production from all sources.

Section 8.0 *Escherichia coli* (E. *coli*) TMDL for Vermillion River Segment 3: Includes:

(a) Development of a Load Duration Curve (LDC)
(b) TMDL Allocations and Margin of Safety
(c) Numeric TMDL and Flow Zones
(d) Seasonal Variation

Section 9.0 Water Quality Improvement Plan and Monitoring Strategy: Discusses water quality restoration objectives, a strategy to meet the identified objectives and TMDLs, and describes a water quality monitoring plan for evaluating the long-term effectiveness of implementation practices.

Section 10.0 Public Participation and Public Comment: Describes other agencies and stakeholders who were involved with the development of this plan, and the public participation process used to review the draft document. Addresses comments received during the public review period.

2.0 Vermillion River Segment 3 Background

This section provides a general description of the physical, ecological, and social characteristics of the Vermillion River Segment 3. This information provides context for the pollutant source assessment in **Section 7.0** and future implementation strategy in **Section 9**.**0**

2.1 Physical Characteristics

The following information describes the physical characteristics of the Project Area. This includes location, climate, topography, hydrology, land use, geology, and soils.

2.1.1 Location

The Vermillion River Segment 3 reach is located in southeastern South Dakota incorporates the lower portion of the Vermillion River. The segment measures approximately 33.31 km and starts at the junction of Baptist Creek and the Vermillion River four miles east of the intersection of South Dakota Highway 19 and 309th St. in Clay County, SD then ends at the converge with the Missouri River. The segment's watershed is comprised of several HUC 12 watersheds which extend from the southeastern corner of Hutchinson County to the western side of Union County. The size of Vermillion River Segment 3 watershed is approximately 112,988 hectares (ha). The length and size of the Vermillion River Segment 3 watershed was calculated using ARCMap geoprocessing tools.

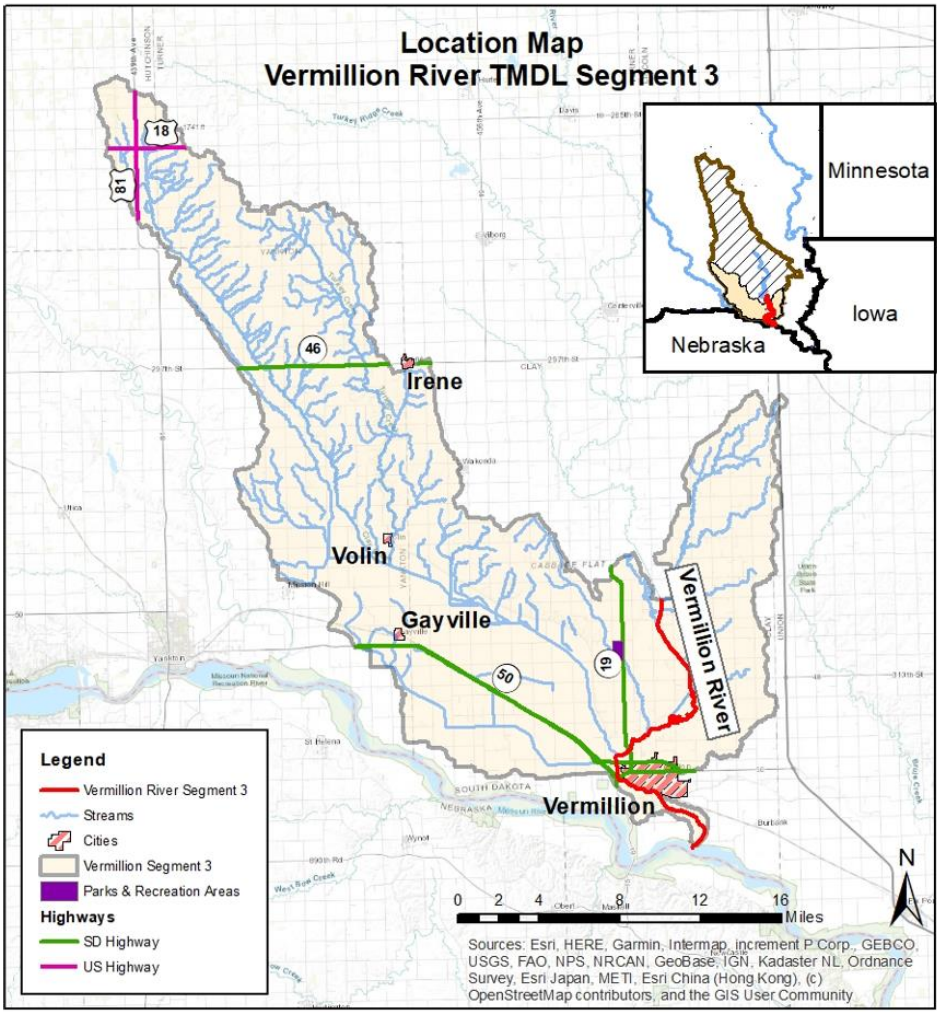

Figure 2-1. Location Map of Vermillion River Segment 3 Watershed.

2.1.2 Climate

Vermillion River's climate is influenced by the seasonal cycle and its location in the northern plains. The climate is characterized as a polar continental which means temperatures and precipitation amounts vary greatly throughout the year.

Climate data was retrieved from the National Climate Data Center. The data was measured by an Automated Surface Observing System (ASOS) in Vermillion. The watershed averages around fourty four inches of snowfall and over twenty six inches of total precipital water a year. Most rainfall occurs in the late spring and summer months due to the increase of low-level moisture and surface temperatures which aides in convective development. The transition of cold to warm weather in the spring causes the polar and subtropical jet stream(s) to retreat further north and position in a set-up that brings more active weather to the region. (Kuang et al., 2014)

Temperatures fluctuate with the change of seasons. Average low temperatures range from 0°-15°F in late December and January with high temperatures reaching the mid-80°Fs July through early August. Frostfree days typically occur from early May to the beginning of October.

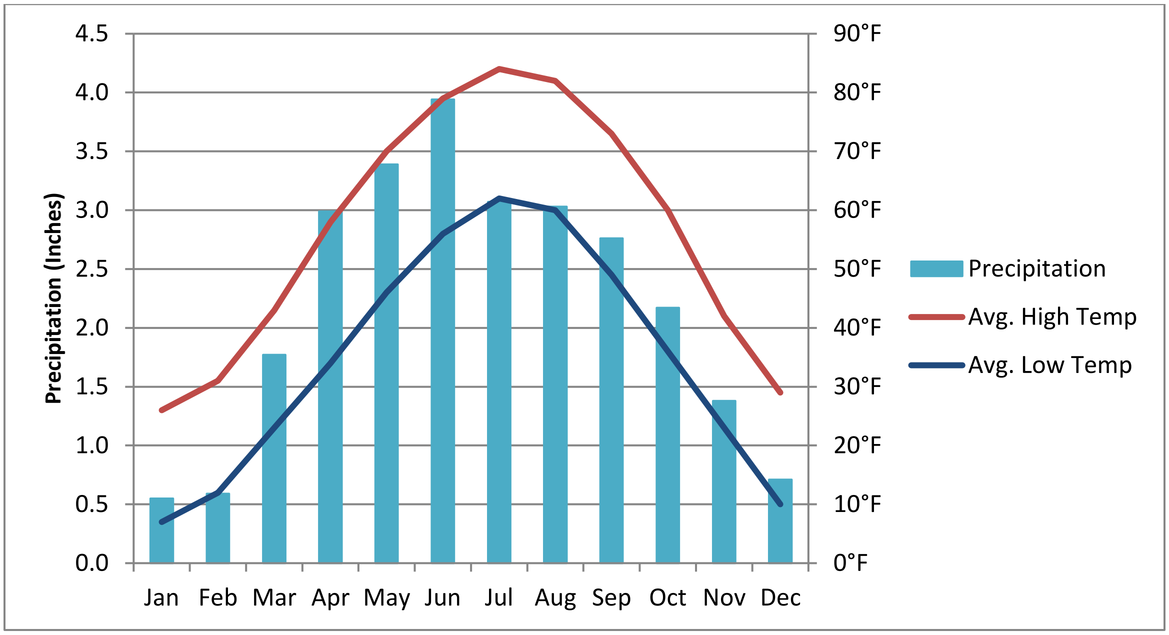

Figure 2-2. Average Annual Precipitation with High and Low Temperatures in Vermillion River Segment 3 Watershed.

The Vermillion River's watershed can also be influenced by other extreme weather phenomena like droughts, floods, and heatwaves. These extreme weather phenomena are an effect of upper level wind patterns and the cycles of the Southern Oscillation (Rauber et al., no date). The combination of extreme weather phenomena, seasonal temperatures and precipitation can affect the characteristics of the Vermillion River.

2.1.3 Hydrology

The drainage network in the Vermillion River Segment 3 watershed is characterized by the mainstem of the Vermillion River and several smaller tributaries, (**Figure 2-3)**. The watershed is broken into fifteen HUC 12 watersheds. The Vermillion River's major tributaries (Clay Creek, Yankton Clay Ditch, Turkey Creek, and Baptist Creek) are important hydrologically, but are not considered impaired for *E. coli*.

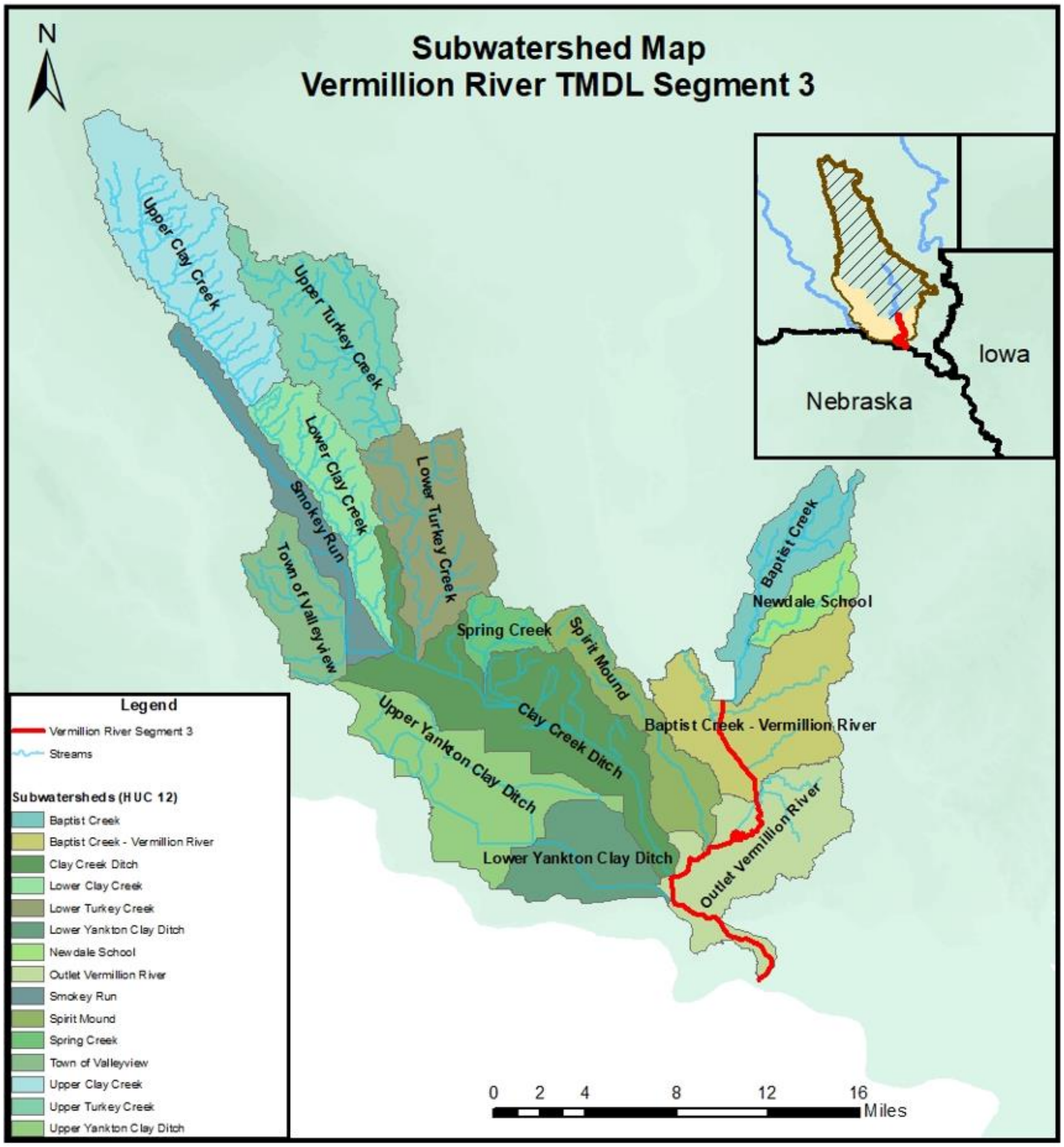

Figure 2-3. Subwatersheds of the Vermillion River Segment 3 Watershed

Tributary streamflow's generally follow seasonal changes for the region. The highest stream flows occur in the spring (March-May) due to increased runoff from snowmelt and precipitation events. Streamflow begins to decline in June, reaching minimum flow levels in the fall. Streamflow can fluctuate rapidly through the summer months due to thunderstorm activity. Baseflows are typically reached in the fall months as thunderstorm activity subsides and the weather pattern changes to drier and cooler conditions.

2.1.4 Topography

The topography is mapped below in **Figure 2-4.** Elevation ranges from 531 meters (1745 feet) to 340 meters (1115 feet) at the confluence with the Missouri River. The highest elevation in the Vermillion River Segment 3 watershed can be found in the upper parts of the Clay and Turkey Creek watersheds. This area consists of rolling hills with ravines and valleys. Moving towards the lower end of Clay Creek the land changes to a flat plain which makes up the Yankton Clay Ditch subwatershed.

The Yankton Clay Ditch subwatershed was previous flood plain ground of the Missouri River. This area is very flat ground with deep topsoil. The topography of the watershed greatly influences the agriculture land use that will be discussed in **Section 2.3.2.**

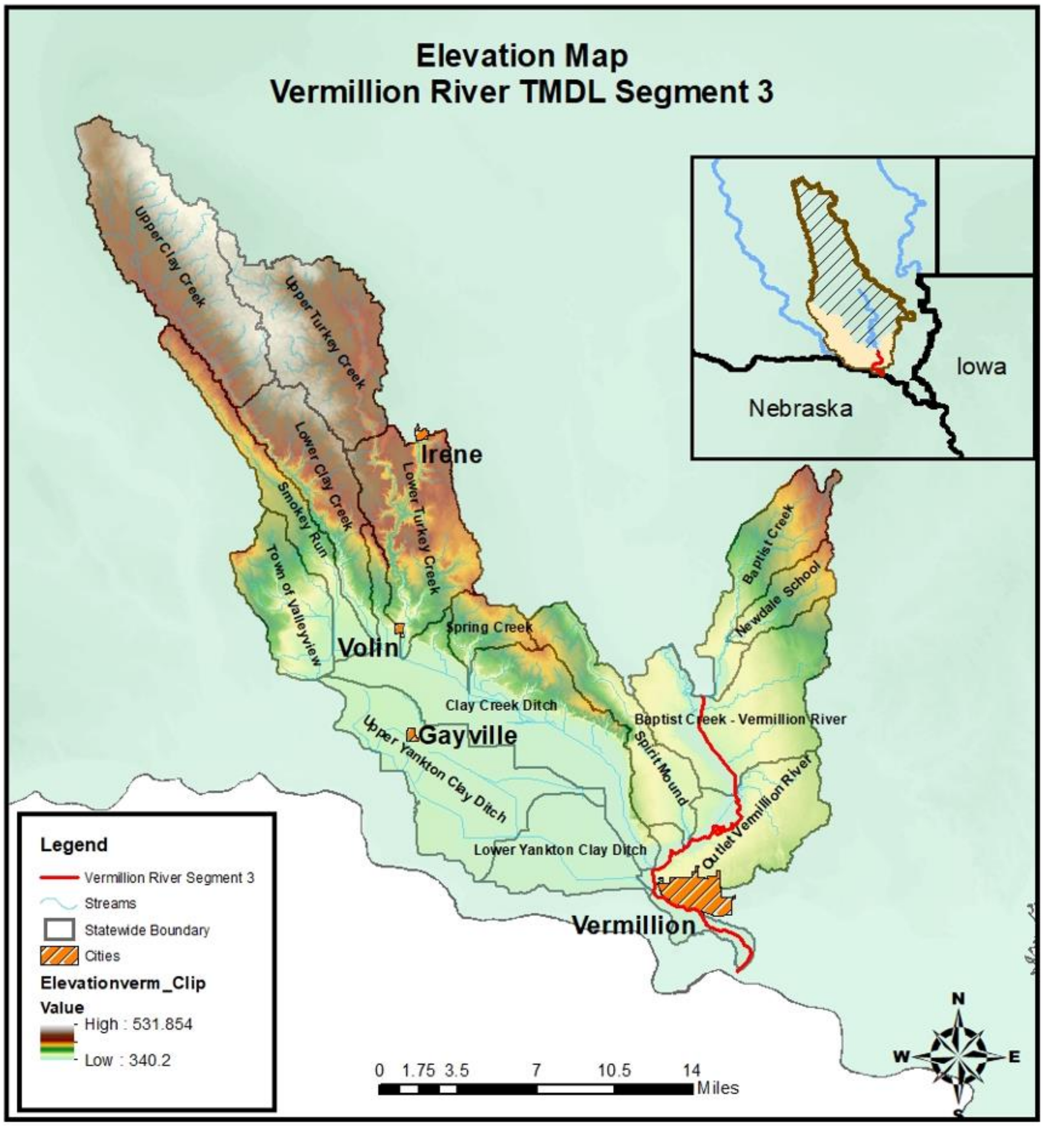

Figure 2-4. Topography of the Vermillion River Segment 3 Watershed

2.1.5 Ecoregions

Ecoregions are areas where ecosystems (the type, quality, and quantity of environmental resources) are generally similar. Ecoregions serve as a spatial framework for research assessment, management, and monitoring of ecosystems and their components. The ecoregion framework is derived from Omernik (1987) and from mapping done with multistate and federal agencies with the assistance from other North American countries. The Vermillion River Segment 3 watershed includes the James River Lowland (46n), Prairie Cateau (46k), and Missouri Alluvial Plain (47d) level four ecoregions (**Figure 2-5**).

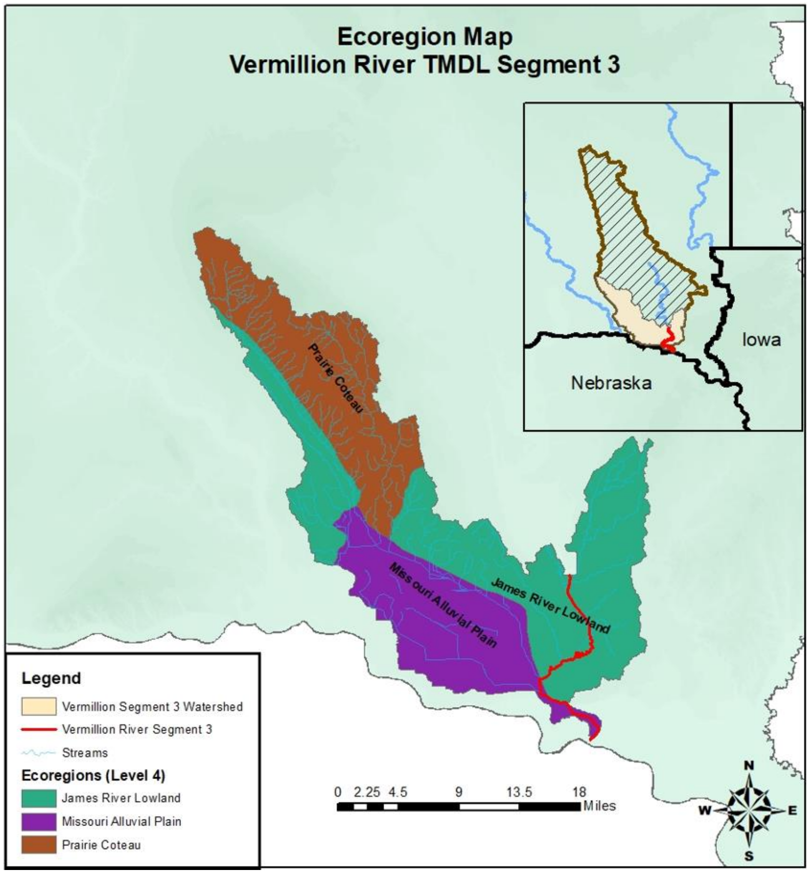

Figure 2-5. Level IV Ecoregions in the Vermillion River Segment 3 Watershed.

2.2 Social Profile

The following section describes the social characteristics of the Vermillion River Segment 3. This includes demographics and land use.

2.2.1 Demographics

Most of the population in Vermillion River Segment 3 is concentrated in municipalities. Small towns of Irene, Volin, and Gayville have populations around four hundred or less with Vermillion approaching eleven thousand. See **Table 1** below for the population estimates released by the U.S. Census Bureau in 2020.

Table 1. Municipality population in the Vermillion River Segment 3 Watershed

Municipality	Population (2020)
Irene	422
Volin	158
Gayville	382
Vermillion	11,695

There are several state and federal highways that run though the Vermillion River Segment 3 watershed. The main transportation corridors are SD Highway 50 that runs from Gayville to Vermillion and SD Highway 19 which heads north out of Vermillion. The segment area also contains a well-connected web of county and township roads. These roads can be found along a majority of the section lines in the segment area (**Figure 2-6**).

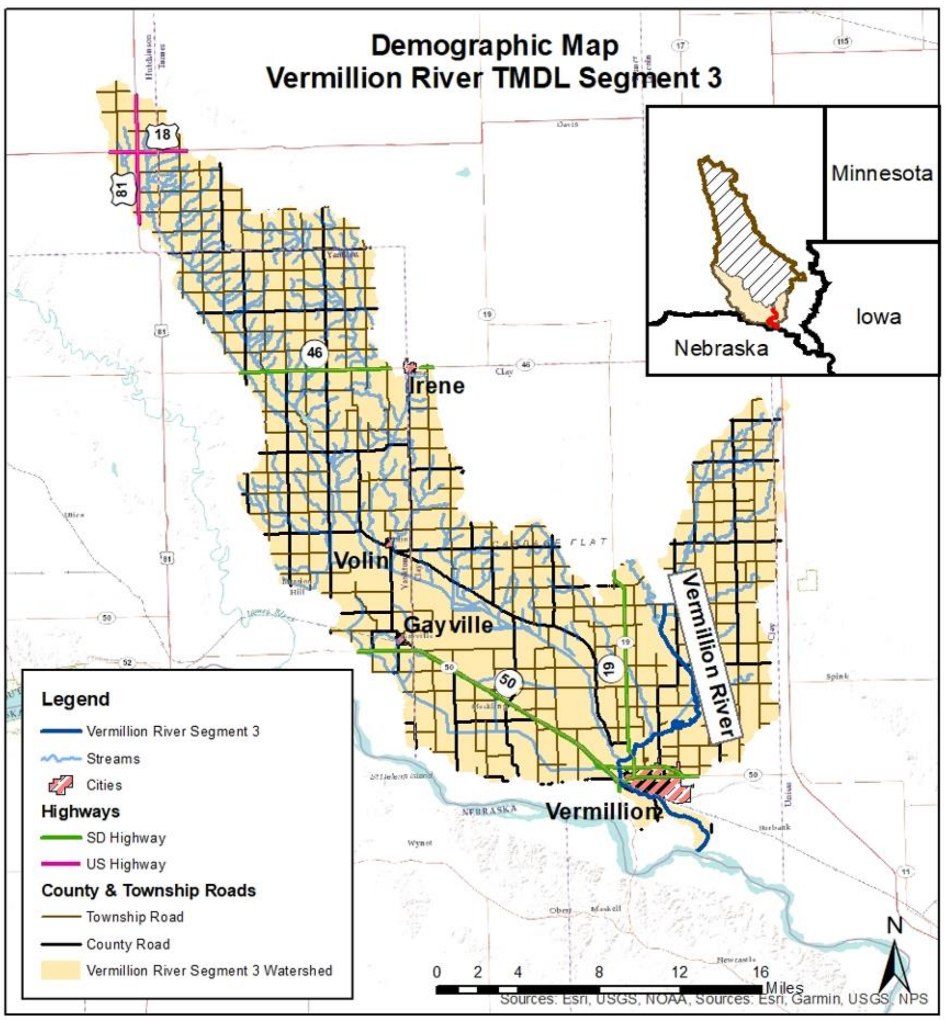

Figure 2-6. Demographic Map of the Vermillion River Segment 3 Watershed

2.2.2 Vermillion River Segment 3 Land Use

Land use in the Vermillion River Segment 3 watershed is primarily agriculture land with some developments in and around municipalities. A map of the land use can be found below in **Figure 2-7.** Much of the agriculture land use is cropland with corn and soybeans being the dominate crops planted with a mixture of different small grains scattered throughout the watershed. Grassland is mainly concentrated along or near waterways or on soils not suitable for cropland.

Heavy cropland coverage is located throughout the entire Baptist Creek watershed and through the Lower Vermillion River and Yankton Clay Ditch. Irrigated cropland is superior in the Yankton Clay Creek and lower half of the Clay Creek Ditch watershed. This area is very flat ground with deep topsoil. Moving up farther north through the Clay Creek and into the Turkey Creek watershed, cropland remains the common land use with grassland focused in drainageways and low-lying areas. Soil characteristics in these watersheds vary due to the topography changes that identified in **Figure 2-4**. Soils in the valleys and low-lying areas are not suitable for cropland. These areas are more suitable for grazing and haying.

Forest or woody vegetation is sporadic throughout the watershed and mainly made-up of tree belt establishments. More concentrated woody vegetation can be found along or near the Vermillion River and in the gulches of the Clay Creek and Turkey Creek watershed. Deciduous tree stands or more prevalent towards the bottom of the gulches while coniferous tree stands are common above and along the top slopes.

Urban development is predominant with municipalities found in the Vermillion Segment 3 watershed as discussed in **Section 2.3.1**. Other wildlife and state park grounds are in the Vermillion Segment 3 watershed. Game production areas are in the Clay Creek watershed and the Spirit Mound State Historic Prairie state park is found north of Vermillion along SD Highway 19.

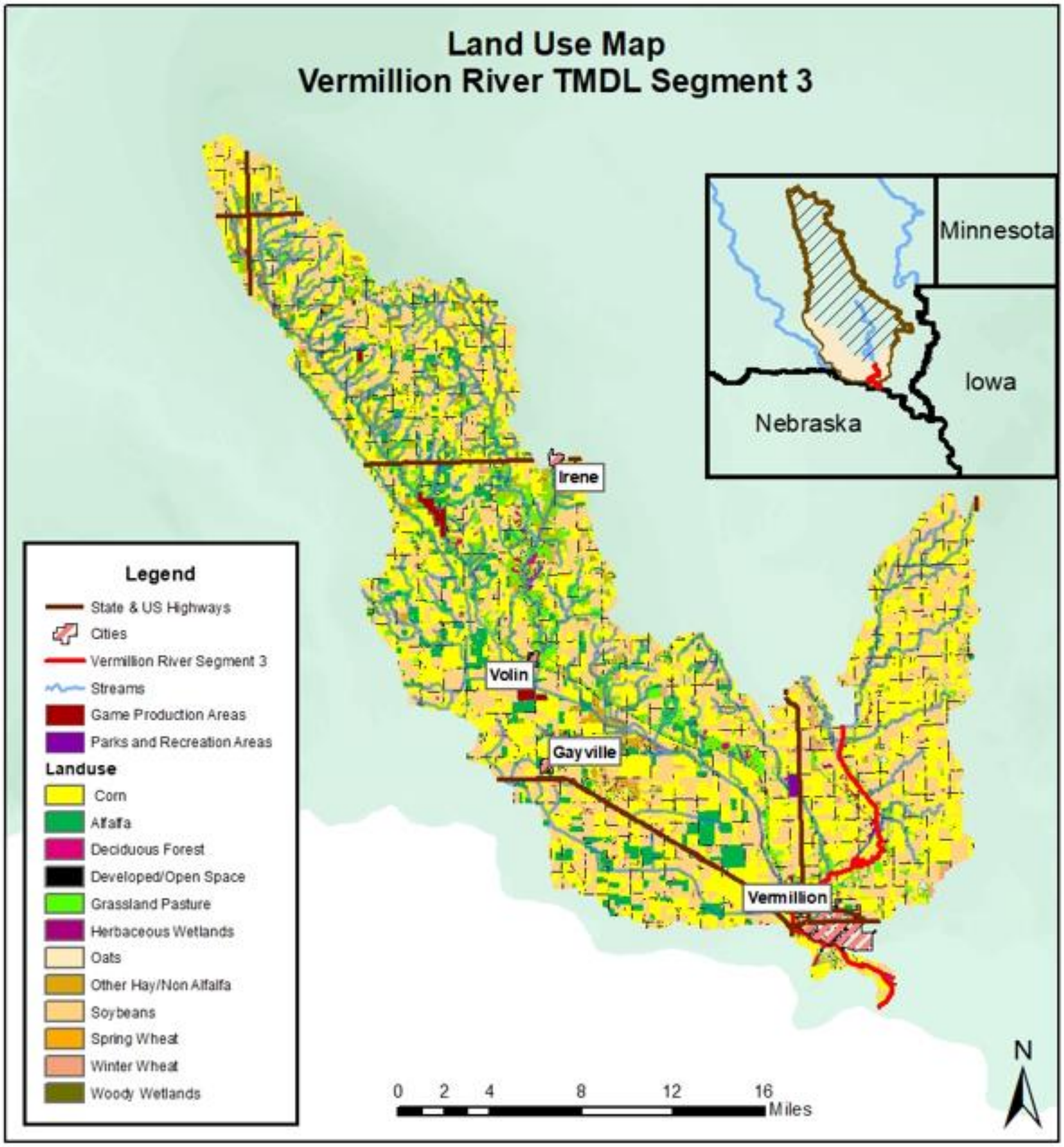

Figure 2-7. Land Use in the Vermillion River TMDL Segment 3 Watershed

3.0 South Dakota Water Quality Standards

Water quality standards are comprised of three main components as defined in the Federal Clean Water Act (33 U.S.C. §1251 et seq.) and Administrative Rules of South Dakota (ARSD) Chapter 74:51:01:

- Beneficial Uses – Functions or activities that reflect waterbody management goals
- Criteria – Numeric concentrations or narrative statements that represent the level of water quality required to support beneficial uses
- Antidegradation – Additional policies that protect high quality waters

3.1 Beneficial Uses

Waterbodies in South Dakota are designated beneficial uses. A list of South Dakota's beneficial uses can be **found** here: Beneficial Uses of Waters Established.

(1) Domestic water supply
(2) Coldwater permanent fish life propagation
(3) Coldwater marginal fish life propagation
(4) Warmwater permanent fish life propagation
(5) Warmwater semipermanent fish life propagation
(6) Warmwater marginal fish life propagation
(7) Immersion recreation
(8) Limited contact recreation
(9) Fish and wildlife propagation, recreation, and stock watering
(10) Irrigation
(11) Commerce and industry

All waters (both lakes and streams) within South Dakota are designated the use of fish and wildlife propagation, recreation, and stock watering (9). All streams are designated the uses of (9), and (10) irrigation. Additional uses are designated to waterbodies based on a beneficial use attainability assessment.

The Vermillion River segment 3 from the mouth of Baptist Creek to the confluence with the Missouri River has been designated the beneficial uses of: (5) Warmwater semipermanent fish life propagation, (8) Limited contact recreation, (9) Fish and wildlife propagation, recreation, and stock watering and (10) Irrigation waters.

3.2 Water Quality Criteria

Table 2 lists all the numeric criteria that must be met to support the beneficial uses designated for Vermillion River Segment 3. When multiple uses establish criteria for the same parameter, the most stringent criterion is used as indicated in the table with parentheses.

Table 2. South Dakota surface water quality criteria for Vermillion River Segment 3 in Clay County, South Dakota.

Parameter	Criteria	Beneficial Use
Alkalinity ($CaCO_3$)	≤ 750(1) mg/L	Fish and wildlife propagation, recreation, and stock watering
	≤ 1313(2) mg/L	
Dissolved oxygen (warmwater semipermanent)	≥ 5.0(3) mg/L	Warmwater semipermanent fish life propagation
Total ammonia nitrogen as N	Equal to or less than the result from Equations 2(2) or 3(1) in Appendix A of Surface Water Quality Standards	Warmwater semipermanent fish life propagation
E. coli (May 1 – September 30) (limited contact recreation)	*E. coli* ≤ 630(4) cfu/100 mL	Limited Contact Recreation
	E. coli ≤ 1,178(2) cfu/100 mL	Limited Contact Recreation
E. coli(6) (May 1 – September 30) (immersion recreation)	*E. coli* ≤ 126(4) cfu/100 mL	Immersion Recreation
	E. coli ≤ 235(2) cfu/100 mL	Immersion Recreation
Conductivity	≤ 2,500(1) micromhos/cm @ 25°C	Irrigation
	≤ 4,375(2) micromhos/cm @ 25°C	
pH (standard units)	≥ 6.5 and ≤ 9.0 units	Fish and wildlife propagation, recreation, and stock watering
Nitrates as N	≤ 88(2) mg/L	Fish and wildlife propagation, recreation, and stock watering
	≤ 50(1) mg/L	
Total suspended solids (warmwater semipermanent)	≤ 90(1) mg/L	Warmwater semipermanent fish life propagation
	≤ 158(2) mg/L	
Total dissolved solids	≤ 2,500(1) mg/L	Fish and wildlife propagation, recreation, and stock watering
	≤ 4,375(2) mg/L	
Temperature (warmwater semipermanent)	≤ 90 °F	Warmwater semipermanent fish life propagation
Undissociated hydrogen sulfide	≤ 0.002(2) mg/L	Warmwater semipermanent fish life propagation
Total petroleum hydrocarbon	≤ 10 mg/L	Fish and wildlife propagation, recreation, and stock watering
Oil and grease	≤ 10 mg/L	Fish and wildlife propagation, recreation, and stock watering
Microcystin (May 1st – Sep 30th)	< 8(5) µg/L	Limited Contact Recreation
Cylindrospermopsin (May 1st – Sep 30th)	< 15(5) µg/L	Limited Contact Recreation
Sodium adsorption ratio	≤ 10 ratio	Irrigation

(1) 30-day average as defined in ARSD 74:51:01:01(60); (2) daily maximum; (3) DO as measured anywhere in the water column of a non-stratified waterbody, or in the epilimnion of a stratified waterbody; (4) Geometric mean as defined in ARSD 74:51:01:01(24) and 74:51:01:50-51; (5) Not to be exceeded in more than three 10 day assessment periods over the course of the recreation season. (6) This use is not associated with Vermillion River Segment 3, but its downstream waterbody.

Additional "narrative" criteria that may apply can be found in ARSD 74:51:01:05; 06; 08; and 09. These rules contain language that generally prohibits the introduction of materials into waterbodies causing pollutants to form, visible pollutants, undesirable odors and nuisance aquatic life which can all interfere with the biological integrity of a waterbody.

3.2.1 *E. coli* Water Quality Criteria

South Dakota has adopted numeric *E. coli* criteria for the protection of (7) Immersion and (8) Limited contact recreation uses. Immersion recreation waters are to be maintained suitable for activities such as swimming, bathing, water skiing and other similar activities with a high degree of water contact that make bodily exposure and ingestion more likely. Limited contact recreation waters are to be maintained suitable for boating, fishing, and other water-related recreation other than immersion recreation.

Through the 1970's and 1980's EPA epidemiological studies identified *E. coli* as a good predictor of gastrointestinal illnesses in fresh waters (US EPA, 1986). *E. coli* is a class of bacteria naturally found in the intestinal tract of humans and warm-blooded animals. The presence and concentration of *E. coli* in surface waters, typically measured in colony forming units (cfu) or counts (#) per 100 ml, is used to identify fecal contamination and as an indicator for the likely presence of other pathogenic microorganisms. In 1986 EPA recommended states adopt *E. coli* criteria for immersion recreation based on a rate of 8 illnesses per 1,000 swimmers (US EPA, 1986). While it is generally understood that limited contact recreation is associated with a reduced illnesses risk and different routes of exposure, it is difficult to directly relate an illness rate to these activities from epidemiological studies based on immersion recreation. Therefore, to protect downstream uses and establish effluent limitations for limited contact recreation waters, EPA has suggested numeric criteria five times the immersion recreation values (US EPA, 2002). Because of the reduced risk, the multiplier was considered protective of the limited contact recreation use through the EPA and DANR water quality standards review and approval process.

The South Dakota *E. coli* criteria for the immersion recreation beneficial use requires that 1) no single sample maximum (SSM) exceed 235 cfu/100 ml and 2) during a 30-day period, the geometric mean (GM) of a minimum of 5 samples collected during separate 24-hr periods must not exceed 126 cfu/100 ml (ARSD 74:51:01:50). The *E. coli* criteria for the limited contact recreation beneficial use requires that 1) no single sample exceed 1,178 cfu/100 ml and 2) during a 30-day period, the geometric mean of a minimum of 5 samples collected during separate 24-hour periods must not exceed 630 cfu/100 ml (ARSD 74:51:01:51). *E. coli* criteria apply from May 1 through September 30, which is considered the recreation season. The numeric *E. coli* criteria applicable to the Vermillion River Segment 3 are values listed in **Table 2**.

TMDLs must also consider downstream water quality standards. In this case, Vermillion River Segment 3 flows into the Missouri River segment SD-MI-R-LEWIS_AND_CLARK_01 which has different designated beneficial uses than the Vermillion River and thus is subject to stricter criteria. Because of this agreement, the Vermillion River Segment 3 TMDL will be written to the immersion recreation beneficial use to be protective of downstream water quality standards.

3.3 Antidegradation

This TMDL document is consistent with South Dakota antidegradation policies (ARSD 74:51:01:34) because it provides recommendations and establishes pollutant limits at water quality levels necessary to meet criteria and fully support existing beneficial uses.

4.0 Impairment Assessment Methods

Assessment methods document the decision-making process used to define whether water quality standards are met. DANR evaluates monitoring data following these established procedures to determine if: 1) one or more beneficial use is not supported, 2) the waterbody is impaired, and 3) it should be placed on the next 303(d) list. Waterbodies impaired by pollutants require TMDLs and these assessment methods are commonly used again in the process sometime after TMDLs have been established and restoration efforts have been implemented. In select cases, attainment is judged instead by comparing current conditions to TMDL loading limits. For example, when certain characteristics of the pollutant (e.g., bioaccumulative) or waterbody (e.g., a reservoir filling with sediment) prioritize loading concerns.

When determining to list a waterbody for impairment, DANR allows a 10% or less exceedance frequency of both the SSM and GM. As long as the *E. coli* dataset meets other age and size requirements, a waterbody is considered impaired when greater than 10% of samples exceed either the SSM or GM. Water quality standards are considered met if the exceedance frequency of both the SSM and the GM are 10% or less. **Table 3** presents South Dakota's assessment method for *E. coli*, and describes what constitutes a minimum sample size and how an impairment decision is made.

Table 3. Assessment Methods for Determining Support Status for Section 303(d) (SD DANR 2022).

IR Assessment Methods		
Description	**Minimum Sample Size**	**Impairment Determination Approach**
FOR CONVENTIONAL PARAMETERS: • TSS • *E. coli* • pH • Temperature • Dissolved Oxygen	STREAMS: • Minimum of 20 samples (collected on separate days) for any one parameter are required within a waterbody reach. • Minimum of 10 chronic (calculated) results are required for chronic criteria (30-day averages and geomeans).	STREAMS: >10% exceedance for daily maximum criteria (acute) or >10% exceedance for 30-day average criteria OR when overwhelming evidence suggests nonsupport/support LAKES: Reference the lake listing methodology starting on page 31 of the 2022 IR..

	LAKES: Reference the lake listing methodology starting on page 31 of the 2022 IR.	

The assessment method mentions chronic and acute criteria. Although these terms do not directly relate to *E. coli* criteria (see **Section 3.2.1)**, the assessment method is organized together with other conventional parameters in the Integrated Report to show that a consistent approach is applied to many pollutants. In this limited definition, chronic refers to the GM and acute refers to the SSM *E. coli* criteria. Different assessment methods have been established for toxic parameters and mercury in fish tissue. **Section 6.0** will perform an assessment method to evaluate the Vermillion River Segment 3 data collection and monitoring results.

5.0 Framework for Developing TMDLs

A total maximum daily load (TMDL) is the maximum amount of a pollutant that a waterbody can receive from all sources and still meet water quality standards. The goal of the TMDL is to identify an approach to achieve and maintain water quality standards.

Pollutant sources are generally defined as two categories: point sources and nonpoint sources. Point sources are described as "any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack" (Hill, 1997). Pollutant loading sources that do not meet the definition of a point source are considered nonpoint sources. Nonpoint sources are associated with diffuse pollutant loading to a waterbody and are often linked to runoff from agricultural, urban, or forestry activities, as well as streambank erosion and groundwater seepage that can occur from these activities. Natural background loading and atmospheric deposition are both considered types of nonpoint sources.

As part of TMDL development, the allowable load is divided among all significant contributing point and nonpoint sources. For point sources, the allocated loads are called "wasteload allocations" (WLAs). For nonpoint sources, the allocated loads are called "load allocations" (LAs).

A TMDL is expressed by the equation: $TMDL = \Sigma WLA + \Sigma LA + MOS$, where:

> ΣWLA is the sum of the wasteload allocation(s) (point sources)
> ΣLA is the sum of the load allocation(s) (nonpoint sources)
> MOS = margin of safety

TMDL development must include a margin of safety (MOS), which can be explicitly incorporated into the above equation as shown. Alternatively, the MOS can be implicit in the TMDL, meaning that the explicit MOS in the above equation is equal to zero and can therefore be removed from the above equation. A TMDL must also ensure that the waterbody will be able to meet and maintain water quality standards for all applicable seasonal variations (e.g., pollutant loading or use protection).

Development of each TMDL has four major components:

- Determining water quality targets
- Quantifying pollutant sources
- Establishing the total allowable pollutant load
- Allocating the total allowable pollutant load to their sources

Although the way a TMDL is expressed can vary by pollutant, these four components are common to all TMDLs, regardless of pollutant. Each component is described in further detail below. The existing load can be compared to the allowable load to determine the amount of pollutant reduction needed.

5.1 Developing Numeric Targets for E. *coli*

TMDLs are required to identify a numeric target to measure whether the applicable water quality standard is attained. A maximum allowable load, or TMDL, is ultimately calculated by multiplying this target with a flow value and a unit conversion factor. Generally, the pollutant causing the impairment and the parameter expressed as a numeric water quality criteria are the same. In these cases, selecting a TMDL target is as simple as applying the numeric criteria.

As seen from **Table 2** there are two numeric *E. coli* criteria for TMDL target consideration. When multiple numeric criteria exist for a single parameter, the most stringent criterion is selected as the TMDL target. To judge whether one is more protective of the beneficial use, it is necessary to further elaborate how the criteria was derived.

South Dakota's *E. coli* criteria are based on EPA recommendations originally published in 1986 (USEPA, 1986). EPA issued slightly modified recommendations in 2012 that did not substantially change the underlying analysis or criteria values in South Dakota (USEPA, 2012). As recommended, SDDANR adopted *E. coli* criteria that contains two components: a geometric mean (GM) and a single sample maximum (SSM). The GM was established from epidemiological studies by comparing average summer exposure to an illness rate of 8:1,000. The SSM component was computed using the GM value and the corresponding variance observed in the epidemiological study dataset (i.e., log-standard deviation of 0.4). EPA provided four different SSM values corresponding to the 75^{th}, 82^{nd}, 90^{th}, and 95^{th} percentiles of the expected water quality sampling distribution around the GM to account for different recreational use intensities in **Figure 5-1** below. South Dakota adopted the most stringent recommendation, the 75th percentile, into state water quality standard regulations as the SSM protective of designated beaches.

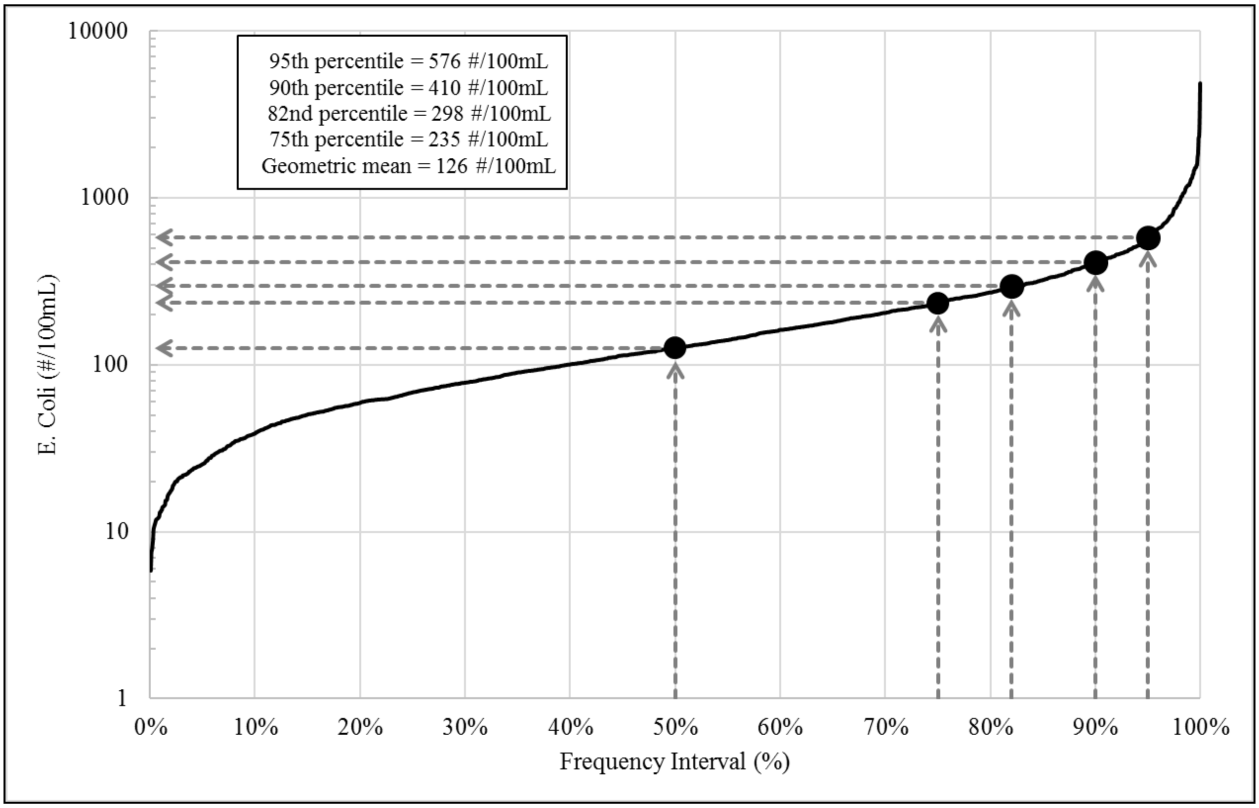

Figure 5-1. Log-Normal Frequency Distribution Used to Establish South Dakota's Immersion Recreation *E. coli* Criteria of 126 (GM) and 235 (SSM) #/100mL (EPA, 1986).

Dual criteria were established to balance the inherent variability of bacteria data and provide flexibility for handling different sampling routines. Together, the GM and SSM describe a water quality distribution expected to be protective of immersion contact recreation. The GM and SSM are equally protective of the beneficial use because they are based on the same illness rate and differ simply representing different statistical values and sampling timeframes. While this investigation has revealed the GM and SSM *E. coli* criteria to be equally protective of the immersion recreation use, a likewise conclusion can be made for the GM and SSM criteria associated with the limited contact recreation use since those values were simply derived as five times the immersion values.

As described in EPA's Protocol for Developing Pathogen TMDLs, the availability of data may dictate which criterion should be used as the TMDL target (EPA, 2001). When a geometric mean of the sampling dataset can be calculated as defined by South Dakota Administrative Rules (i.e., at least five samples separated by a minimum of 24-hours over a 30-day period) and compared to the GM criterion, DANR uses the GM criterion as the TMDL target. This establishes a smaller overall loading capacity and is considered a conservative approach to setting the TMDL.

When a proper GM cannot be calculated, as in this case for Vermillion River Segment 3 (SD-VM-R-VERMILLION_03), DANR uses the SSM as the TMDL target. This is permissible because the SSM is equally protective of the beneficial use as discussed above. Although this target selection leads to the establishment of a larger allowable load, in some respects it is more appropriate because timeframes align better (i.e., the SSM is associated with a single day and TMDLs establish daily loads, versus the 30-day GM). Additionally, certain aspects of DANR's *E. coli* assessment method, when combined with a SSM TMDL target, result in an expected dataset GM more protective than the GM criterion. DANR uses assessment methods to define how to interpret and apply water quality standards to 303(d) impairment decisions.

Returning to the original distribution used to establish South Dakota's Immersion Recreation *E. coli* criteria in **Figure 5-1** remember that SDDANR chose to adopt a SSM concentration based on the most stringent recommendation (75th percentile). According to assessment methods in South Dakota, however, the SSM concentration is treated as a 90th percentile (i.e., 10% exceedance frequency). Step #1 in **Figure 5-2** shows how doing so effectively moves the SSM point to the right. If the original log-normal frequency distribution with a log-standard deviation of 0.4 is subsequently re-fitted to this new 90th percentile point at 235 #/100mL (red dotted line), the corresponding 50th percentile (GM) is 72 #/100mL as shown in Step #2 of **Figure 5-2**.

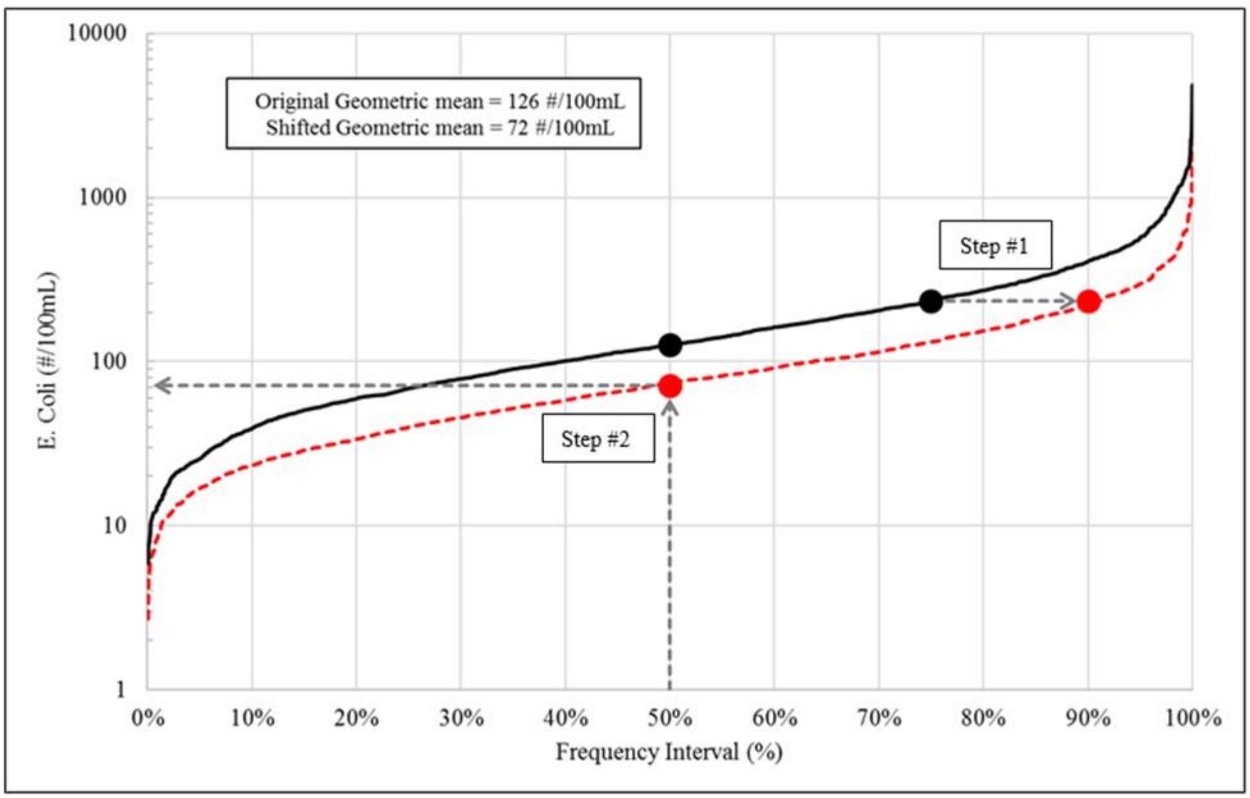

Figure 5-2. **The Effective Impact of South Dakota's *E. coli* Assessment Method on the Criteria's Original LogNormal Frequency Distribution (Black line = original; red dotted line = shifted)**

The GM associated with this shifted distribution is more stringent than the GM of the original distribution (126 #/100mL), thus this demonstrates that attaining a maximum daily SSM target in a TMDL will also achieve the 30-day GM criterion when following South Dakota's assessment method. A similar conclusion was determined by EPA in *An Approach for Using Load Duration Curves in the Development of TMDLs* (USEPA, 2007) using Michigan criteria as an example.

Finally, while the SSM is associated with a single day of sampling and the GM is associated with 30 days of sampling, it is not technically appropriate to refer to them as "acute" and "chronic" criteria. Those terms distinguish timeframes over which harm-to-use impacts develop, not the sampling or averaging timeframe as with the SSM and GM. Acute refers to an effect that comes about rapidly over short periods of time. Chronic refers to an effect that can build up over longer periods, sometimes the lifetime of a subject. In the case of *E. coli*, gastrointestinal illness develops within a matter of hours to days. Both the SSM and GM are derived from this same timeframe and based on the same underlying illness rate, thus treating the SSM as an acute criterion and assuming it to be less stringent is incorrect. EPA recommends states use the GM and SSM together, rather than just the GM or just the SSM, to judge whether water quality is protective of recreational uses. DANR follows these guidelines and only relies on one criterion when forced by data availability.

The immersion recreation SSM *E. coli* criterion of 235 cfu/100mL was selected as the numeric TMDL target for the Vermillion River Segment 3 because a proper geometric mean could not be calculated from the available monitoring dataset. Refer to **Section 6.0** for a thorough review of the Vermillion River Segment 3 sampling and results.

6.0 Water Quality Data and Discharge Information

E. coli data was obtained from one monitoring station within the impaired segment from 2010 to 2020 during the recreational season. The associated daily flows were obtained from long-term flow records available from a DANR gage station located within the impaired segment.

All data collection conducted during this project followed methods in accordance with the South Dakota Standard Operating Procedures for Field Samplers developed by the DANR Watershed Protection Program. Water samples were sent to the State Health Laboratory in Pierre, SD for analysis. *E. coli* data collected during the recreation season was exclusively used to develop the TMDL. All measured flow and water quality data used for TMDL development can be found in **Appendix A** and **Appendix B**.

6.1 Flow Information and Data

A long-term flow record was constructed from DANR's stream gage station near Vermillion, SD. The gage is located at Water Quality Monitoring (WQM) station VERMILRWQM5 (WQM 5) approximately one mile west of Vermillion along SD Highway 50 (**Figure 6-1**). This station contains long-term water quality data and is located near the end of the impaired segment. The station captures all the drainage area in the Vermillion River Segment 3, including the upstream contribution from Vermillion River Segments 1 and 2, except the inflow from the Yankton Clay Ditch. The Yankton Clay Ditch is an intermittent waterway that typically flows in the spring due to snowmelt or during heavy rain events.

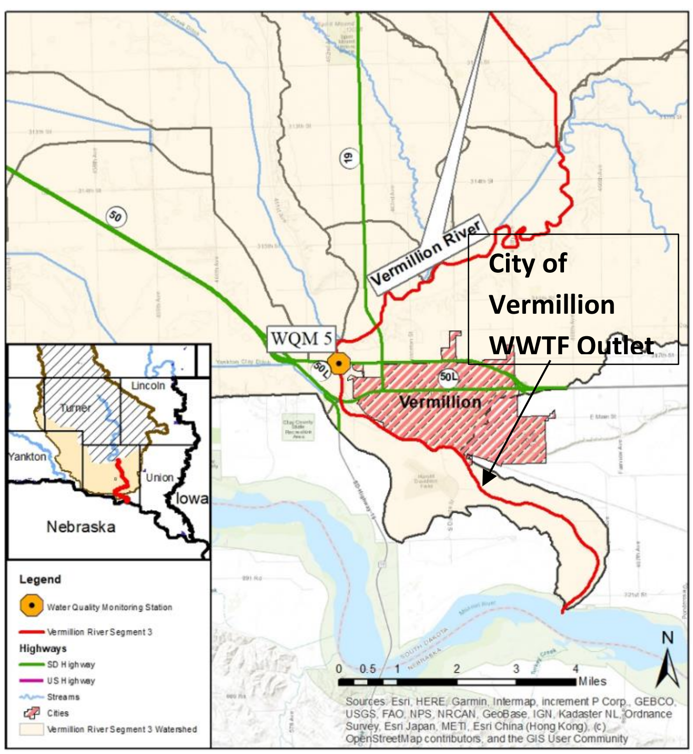

Figure 6-1: WQM 5 and City of Vermillion Waste Water Treatment Facility Location

Continuous gage height and periodic discharge measurements collected from April 2010 to August 2020 was used to development the flow record. The gage is programmed to record a stage every fifteen minutes on an annual basis. Over 270,000 gage measurements were recorded. The WQM 5 site was temporarily removed in the spring of 2013 due to the South Dakota Department of Transportation performing work on the bridge. The WQM 5 site was reinstalled in March of 2014 and the radar level sensor was surveyed at the same elevation prior to construction.

A stage-discharge rating curve was developed at WQM 5 for the period of record. The paired data best fit a curvilinear relationship resulting in a polynomial regression equation which was used to model flow for a given stage (**Figure 6-2**). Average daily flows from this timeframe were used to develop the Load Duration Curve (LDC) based TMDL in **Section 8.0.**

$$Y = -0.2567x^3 + 46.174x^2 - 2521.9x + 43502$$

$$R^2 = 0.957$$

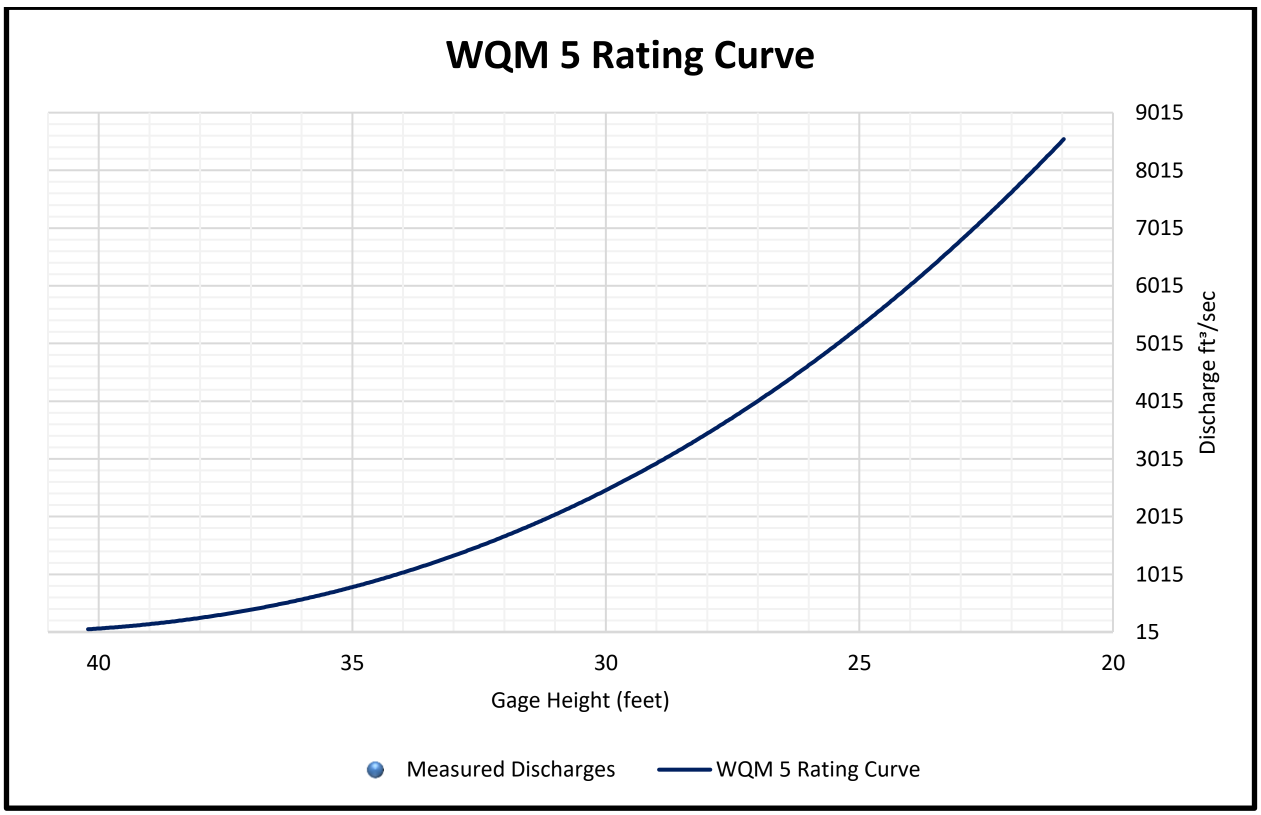

Figure 6-2: WQM 5 rating curve developed using a polynomial trendline.

6.2 *E. coli* Water Quality Data

All applicable *E. coli* data collected during the recreation season within the impaired segment was used for TMDL development. *E. coli* data was obtained from station WQM 5 a long-term monitoring site established as part of SD DANR's ambient water quality monitoring network. This monitoring station also provides a long-term dataset to evaluate compliance.

E. coli samples are collected monthly by DANR staff during the recreation season (May 1st to September 30th) at WQM 5. DANR started collecting *E. coli* samples at WQM5 in 2001. Since there was no DANR flow data available at WQM 5 prior to 2010, only *E. coli* samples from 2010 – 2020 were used for this TMDL. A total of 48 *E. coli* samples were collected from 2010-2020. These samples were split into three range groups. *E. coli* sample collection was not conducted at the frequency required to calculate a monthly GM. As a result, impairment was solely based on the SSM standard. The range values of *E. coli* concentration were from 10 cfu/100mL to 2,610 cfu/100mL. Eleven *E. coli* samples exceeded the single sample maximum (SSM) of immersion recreation beneficial use. A closer analysis was done to group the *E. coli* samples into three separate range of concentration groups.

A range group was created to show the percent exceedance of the single sample maximum (SSM) water quality standard for immersion recreation waters. Any *E. coli* sample equal to or greater than 235 cfu/100mL exceeds the SSM water quality standard. As a result, impairment was solely based on the SSM standard. A summary of the three *E. coli* concentration range groups is depicted in **Figure 6-3.**

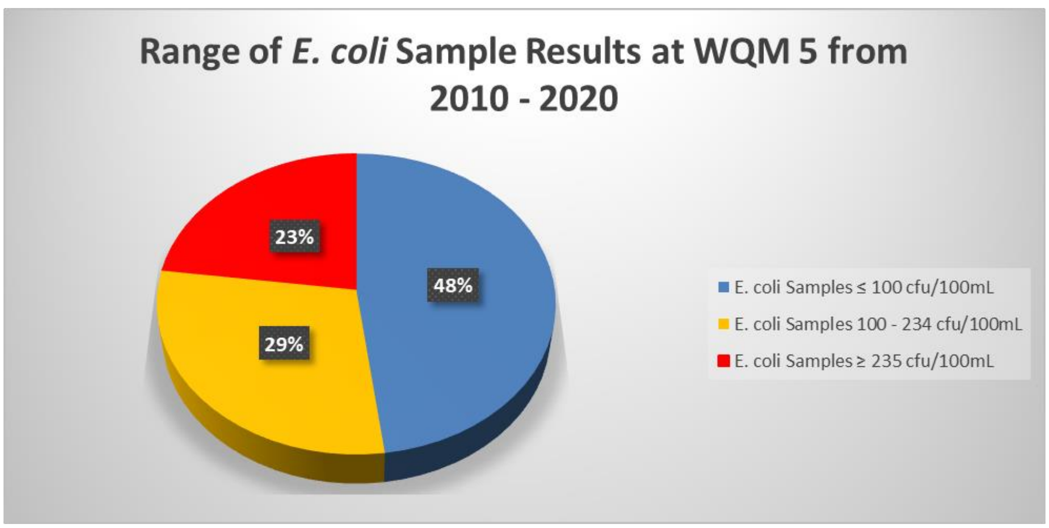

Figure 6-3. Range of E. coli sample results at WQM 5 from 2001 – 2020.

Approximately 23% of *E. coli* samples collected at WQM 5 from 2010 - 2020 exceeded the daily maximum criteria of the SSM. Almost half of the samples collected were at or less than 100 cfu/mL. These low *E. coli* results are significant when calculating a current *E. coli* load and determining the load reductions.

E. coli is a volatile pollutant which hinders performing in-depth analysis especially with a limited data set. Since WQM 5 is only sampled once per month, this puts restrictions when performing statistical analysis. Having a limited data affects the ability to perform a more in-depth statistical analysis or identify patterns of exceedances during the year. Increasing the frequency of sampling at WQM 5 would provide the resources to perform a more investigative analysis of *E. coli* at WQM 5.

7.0 Source Assessment and Allocations

This section provides an *E. coli* source assessment for the Vermillion River Segment 3 watershed. All point sources with a National Pollutant Discharge Elimination System (NPDES) permit are identified. Watershed scale nonpoint sources were also identified, and bacteria production was quantified using a population per area formula.

7.1 Point Sources

Point sources are described as "any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack" (Hill, 1997). Point sources are often linked to community wastewater treatment or industrial facilities with discernible, confined and discrete conveyances, such as pipes or ditches from which pollutants are being, or may be, discharged to a waterbody. Point sources of *E. coli* bacteria are documented here to provide a watershed scale account of the systems operational characteristics (discharge permits etc.), potential impact and Waste Load Allocation (WLA) consideration for TMDL development.

Town of Gayville (NPDES Permit# SDG822161) & Town of Volin (NPDES Permit# SDG820907)

Both of these municipalities Wastewater Treatment Facilities (WTF) are not permitted to discharge wastewater. These facilities have no direct impact on *E. coli* bacteria in the Vermillion River Segment 3 and were not assigned a WLA in the TMDL.

City of Irene (NPDES Permit# SD0022454)

The City of Irene has a wastewater treatment facility on the southwest side of the city. The facility has a design flow of 0.05 million gallons per day (MGD) with a maximum *E. coli* daily limit not to exceed 1,178 CFU/100mL. Discharges from the facility have only occurred 2-5 days annually and flow is directed to an unnamed tributary of Turkey Creek. Given the very limited annual non-direct discharge to the Vermillion River Segment 3, this facility was not assigned a WLA in the TMDL.

The City of Irene is proposing to construct Phase II of its water and wastewater utility project. This will address deficiencies in the water distribution system north of Main Street (Highway 46). The utilities in this area are in poor condition, largely made of cast iron pipe, and will be replaced with PVC.

Phase II will replace approximately 3,700 feet of 6-inch water main, 3,500 feet of 8-inch water main, and 4,000 feet of 1-inch water service line. This project will also include hydrants, valves, fittings, road surface replacement, and other necessary appurtenances.

Phase II sanitary and storm sewer utility improvements will replace approximately 7,200 feet of 8-inch sanitary sewer main, 1,400 feet of 4-inch sanitary sewer force main, and 3,400 feet of storm sewer of various sizes. This project will also include manholes, service lines, curb and gutter, road surface replacement, and other necessary appurtenances.

City of Vermillion (NPDES Permit# SD0020061)
The City of Vermillion has a wastewater treatment facility located on the southern side of the city. The facility has a design flow of 4 MGD with a daily *E. coli* max not exceeding 1,178 CFU/100mL. The facility discharges directly into the Vermillion River. The facility is also in the process of upgrading their UV treatment system.

In 2016 the city of Vermillion took out a loan to replace an existing lift station that is undersized for current flows and replace 2,400 feet downstream sanitary sewer that is undersized. Brick manholes will also be replaced under the loan agreement. A WLA was assigned to the TMDL for the City of Vermillion.

Lewis & Clark Regional Water System (NPDES Permit# SDG860054) & City of Vermillion Water Systems (SDG860011).

Both water treatment systems are permitted to discharge treated and untreated overflow water through specific outfalls to Vermillion River segment 3 during normal operation. *E. coli* effluent limits are not included in either permit because *E. coli* is not a pollutant of concern. Potential discharge from these facilities is not expected to impact the TMDL. A WLA was not assigned to either facility in the TMDL.

7.1.1 City of Vermillion MS4

Under EPA's Stormwater Phase II Rule, City of Vermillion is regulated as a small MS4 under a DEQ general permit (SDR41A001). The MS4 permit area corresponds to the City of Vermillion's storm sewer boundary which is approximately 1,064 ha. The purpose of the MS4 section in this document is to provide a bacteria source assessment in the City of Vermillion, calculate an allocation (WLA) for the City of Vermillion storm sewers, and review BMPs the city has taken to mitigate bacteria discharge into the Vermillion River.

City of Vermillion Storm Water Management Plan/BMPs
In 1999 the City of Vermillion was required by EPA to start adopting measures to reduce, or eliminate, pollutants and sediments entering the Vermillion River. Part of the requirement was accomplished when the city adopted a MS4 Storm Water Management Program (SWMP) in March 2015. Implementation activities in the plan included conveying information and education to the public. Brochures and educational presentations for the public and local students were

planned. Other BMPs included partnership opportunity and storm drainage stenciling. A list of possible partners was compiled by the city in 2016 and is updated annually. The goal of the partnership was to increase awareness and describe the purpose of the Storm Water Management Program. A map was developed, showing all stormwater drains in the community. All stormwater drains would be stenciled with “DO NOT DUMP – DRAINS DIRECTLY TO RIVER.” The BMP is expected to raise public awareness and reduce the discharge of pollutants.

Other BMPs the city has taken to mitigate bacteria discharge focus on bacteria sources and installing storm sewer pipe. The city has a designated dog park at Cotton Park with available clean-up bags at all city parks. In 2021 the city plans on installing approximately 2,556 yards of five-foot diameter storm sewer along the south ditch of SD Hwy. 50 from Dakota Avenue to Over Drive. The current ditch will remain, but the initial storm flow from the City will utilize the new pipe. The outflow of this pipe will discharge a quarter mile away from the Vermillion River. Any discharge from this pipe would flow in a grass ditch before entering the Vermillion River.

The City of Vermillion issues a MS4 Annual Report to DANR detailing the progress and current status of the city’s SWMP. The 2019 MS4 Annual Report references how the city handles illicit discharges. The City’s Code Compliance and Engineering Departments conducts inspections of complaints and construction projects during the year. If an issue is discovered Code Compliance Department contacts the entity responsible for the violation. If violation is not corrected, the city will charge the responsible party. The city is in the process of drafting a written plan to manage illicit discharges. The City of Vermillion should continue to follow their MS4 permit and SWMP to mitigate bacteria contributions to the Vermillion River.

City of Vermillion MS4 Bacteria Source Assessment

A map of the City of Vermillion’s storm sewer boundary and outlets can be found in Appendix C. The municipal boundary of the City of Vermillion makes up approximately 1% of the Vermillion River Segment 3 watershed. Not all the area of the storm sewer boundary is residential or urban area. Undeveloped areas and open sport areas (golf courses, baseball and football fields) would provide minimal to no bacteria contribution to the City of Vermillion’s storm sewer system. The bacteria source assessment focuses on areas that would see continual bacteria production.

Potential bacteria sources in the City of Vermillion are residential and city parks. Any run-off from residential lawns may provide bacteria contribution to the city’s storm sewer system. City parks present an increased risk for bacteria contribution due to pet feces. Park areas that may contribute bacteria are Barstow Park, Prentice Park and the dog park (Cotton Park). Local wildlife and bird migrations can also contribute bacteria to the cities storm sewer network.

Monitoring pollutant concentrations at the cities storm sewer outfalls is not a provision of the MS4 permit. It is recommended that the city consider monitoring *E. coli* from storm sewer outfalls as part of the SWMP. Determining *E. coli* concentrations from the storm sewer outfalls during storm events could provide several benefits. Monitoring results could be used to direct limited BMP resources to those areas with the greatest concentrations and loading. In addition, monitoring results could be used to determine BMP effectiveness. Maintaining *E. coli* concentrations in storm sewer outfalls at or below 235 cfu/100 ml (SSM) would comply with TMDL goals for Vermillion River segment 3 and ultimately protect the downstream immersion recreation use designated to the Missouri River.

7.1.2 CAFOs in the Vermillion River Segment 3 Watershed

There are seven permitted Concentrated Animal Feeding Operations (CAFOs) within the Vermillion River Segment 3 watershed. Each of the CAFO's facility name, type of operation, and permit number can be found in **Table 5**. All CAFO's are required to maintain compliance with provisions of the SD Water Pollution Control Act (SDCL 34A-2). SDCL 34A-2-36.2 requires each concentrated animal feeding operation, as defined by Title 40 Codified Federal Regulations Part 122.23 dated January 1, 2007, to operate under a general or individual water pollution control permit issued pursuant to 34A-2-36. The general permit ensures that all CAFO's in SD have permit coverage regardless of if they meet conditions for coverage under a NPDES permit.

All facilities with a general permit number that starts with SDG-01* are covered under the 2003 General Water Pollution Control Permit for Concentrated Animal Feeding Operations. These permits require housed lots to have no discharge of solid or liquid manure to waters of the state, and allows open lots to only have a discharge of manure or process wastewaters from properly designed, constructed, operated and maintained manure management systems in the event of 25-years, 24-hour or 100-year, 24-hour storm event if they meet the permit conditions. The general permit was reissued and became effective on April 15, 2017. All CAFO's with coverage under the 2003 general permit have a deadline to apply for coverage under the 2017 general permit.

All facilities with a general permit number that starts with SDG-1* are covered under the 2017 General Water Pollution Control Permit for Concentrated Animal Feeding Operations. The 2017 general permit allows no discharge of manure or process wastewater from operations with state permit coverage or NPDES permit coverage for new source swine, poultry, and veal operations, and other housed lots with covered manure containment systems. Operations also have the option to apply for a state issued NPDES permit. Operations covered by the 2017 general permit or NPDES permit for open or housed lots with uncovered manure containment systems can only discharge manure or process wastewater from properly designed, constructed, operated and maintained manure management systems in the event of 25-year, 24-hour storm event if they meet the permit conditions.

Table 5. CAFOs in the Vermillion River Segment 3 Watershed

Name of Facility	Type of Operations	SD General Permit #
Cameron Colony	multiple animals (housed lot)	SDG-0100408
Fickbohm Swine	grower swine (housed lot)	SDG-0100513
Jensen Hogs	finisher swine (housed lot)	SDG-100316
John Lindstrom Swine Operation	finisher swine (housed lot)	SDG-0100503
Peterson Swine, LLC	finisher swine (housed lot)	SDG-0100381
Petrik Finishing Facility	finisher swine (housed lot)	SDG-0100294
Preheim Feedlot, LLC	dairy cattle (housed lot)	SDG-0100525

Both the 2003 and 2017 general permits have nutrient management planning requirements based on EPA's regulations and the South Dakota Natural Resources Conservation Services 590 Nutrient Management Technical Standard to ensure the nutrients are applied at agronomic rates with management practices to minimize the runoff of nutrients. Additionally, the general permits include design standards, operation, maintenance, inspections, record keeping, and reporting requirements.

For more information about South Dakota's CAFO requirements and general permits visit: DANR Concentrated Animal Feeding Operations. As long as these facilities comply with the general CAFO permit requirements ensuring their discharges are unlikely and indirect loading events, the TMDL assumes their *E. coli* contribution is minimal, and unless found otherwise, no additional permit conditions are required by this TMDL.

7.2 *E. coli* Nonpoint Sources and Assessment

This bacteria assessment is for areas directly contributing to the Vermillion River Segment 3 at the Baptist Creek confluence to the Missouri River. Bacteria loadings and assessments found upstream of the Vermillion River Segment 3 watershed will be calculated in future TMDLs.

Nonpoint sources of *E. coli* in the Vermillion River Segment 3 basin originate primarily from agricultural sources. Data from the 2019 National Agricultural Statistic Survey (NASS) (USDA, 2019) and the 2002 South Dakota Game Fish and Parks (SDGFP) county wildlife assessment (Huxoll, 2002), were utilized for livestock and wildlife densities within the segment. Animal density information was used to estimate relative source contributions of bacteria. The 2019 agriculture data reflects the "on the ground" conditions exhibited in the water quality data collected during the watershed assessment. The 2002 SDGFP Wildlife data was the most current available for each county within the State of South Dakota.

Total production of *E. coli* bacteria in the watershed is estimated at 2.66 E+15 colony forming units/acre/day. A summary of bacteria production estimates from agriculture, wildlife, and humans can be found in **Table 6.** *E. coli* production estimates are referenced from EPA's Bacteria Indicator Tool and indicate the major nonpoint source contributors of bacteria in the watershed.

The estimated production of bacteria per acre is 9.53 E+09. The source assessment can be used to guide future watershed implementation activities. A more in-depth implementation discussion is provided in **Section 9.0.**

Table 6. Vermillion River Segment 3 *E .coli* Nonpoint Source Bacteria Production

Species	#/acre watershed	Bacteria/Animal/Day	Bacteria/Acre/Day	Percent
Dairy cow[2]	1.0E-03	1.0E+11	1.0E+08	1.0%
Beef[2]	8.2E-02	1.0E+11	8.5E+09	89.5%
Hog[2]	6.6E-02	1.1E+10	7.1E+08	7.5%
Sheep[2]	6.0E-03	1.2E+10	7.2E+07	0.8%
Human[2]	4.7E-02	2.0E+09	9.4E+07	1.0%
All Wildlife	**Sum of all wildlife**		1.9E+07	0.2%
Turkey (Wild)[1]	3.0E-03	9.3E+07	3.5E+04	
Goose[2]	4.0E-02	4.9E+10	1.6E+07	
Deer[2]	7.0E-03	5.0E+08	6.3E+05	
Beaver[2]	5.0E-03	2.5E+08	4.6E+04	
Raccoon[2]	8.0E-03	1.3E+08	2.3E+05	
Coyote/Fox[3]	3.0E-03	4.1E+09	1.3E+06	
Muskrat[4]	1.1E-02	1.3E+08	5.8E+05	
Opossom[4]	2.0E-03	1.3E+08	4.6E+03	
Mink[4]	4.0E-03	1.3E+08	2.9E+04	
Skunk[4]	5.0E-03	1.3E+08	9.3E+04	
Badger[4]	2.0E-04	1.3E+08	2.0E+04	
Rabbits[4]	2.5E-02	1.3E+08	5.2E+05	
(1) USEPA 2001				
(2) Bacteria Indicator Tool Worksheet				
(3) Best Professional Judgment based off of Dogs				
(4) FC/Animal/Day copied from Raccoon to provide a more conservative estimate of background effects of wildlife				

7.2.1 Natural Background Sources

Wildlife within the watershed is a natural background source of bacteria. Wildlife population density estimates were obtained from the South Dakota Department of Game, Fish, and Parks. The approximate contribution of bacteria from wildlife in the Vermillion River Segment 3 watershed was very minimal in comparison to the livestock production. The main producers of bacteria from natural sources were geese and ducks.

7.2.2 Human Sources

A calculation of bacteria from human population in the Vermillion River Segment 3 watershed was performed by using population estimates from the United States Census Bureau. Approximately 16,700 people reside in the watershed with most of the population located in the city of Vermillion. Residents that are not located in municipalities with WTF are assumed to have septic systems as their primary disposal source. **Table 6** includes all human produced *E. coli* and does not include expected reductions as a result of delivery to a septic system. Human bacteria production is estimated at 1.95E+09 (Yagow et al. 2001). When included as a total load, the population produced loads accounting for about 1% of all bacteria in the watershed. No bacteria should be entering the segment if all bacteria are delivered to a proper functioning septic system.

7.2.3 Agricultural Sources

Manure from livestock is a potential source of *E. coli* to the river. They may contribute *E. coli* directly by wading in or near waterbodies. Manure on rangelands or in feeding areas can be vulnerable to runoff from precipitation events and end up in streams. Looking at **Figure 2-7**, most of the pasture and grassland in the Vermillion River Segment 3 watershed are in the Turkey Creek and Clay Creek watersheds.

A calculation of bacteria produced by livestock in the Vermillion River Segment 3 watershed was conducted. Livestock numbers were gathered using USDA Agriculture Statistics database. The most current data for county livestock population were used. These county population numbers included livestock located in CAFO facilities even though CAFO facilities shouldn't contribute to bacteria loading if working properly. A watershed population for each livestock animal was calculated by the percentage of the watershed in each county multiplied by the county livestock population. Individual county livestock population data were added up then multiplied by the Vermillion River Segment 3 watershed area to provide a density value (**Table 6).**

Most of the bacteria produced by livestock in the watershed are predominantly beef cattle. Beef cattle produce approximately 89.5% of the bacteria per acre in the Vermillion River Segment 3 watershed. Total livestock bacteria contribution in the watershed is approximately 98.8%. Future implementation practices should focus on mitigating bacteria runoff and contributions from livestock sources outside of CAFO facilities.

Limited implementation focus should be given to CAFO facilities because if functioning properly, the facility should be not contributing to bacteria loading. All CAFO's permitted in the Vermillion Segment 3 watershed are held to conditions to have a licit discharge based on their permit.

8.0 *Escherichia coli* (*E. coli*) TMDL for Vermillion River Segment 3

The Load Duration Curve (LDC) for the Vermillion River Segment 3 was developed using the rating curve and *E. coli* data that was discussed in **Section 6.0.** For Vermillion River Segment 3, **Figures 8-1** shows violations occurring within three of the five flow zones. The LDC approach was deemed an appropriate method for identifying possible bacteria loading based on the flow zone.

When incorporating the water quality criteria, the LDC is a dynamic expression of the allowable load for any given day. To aid in interpretation and implementation of the TMDL, the LDC flow intervals were grouped into five flow zones representing high flows (0–10 percent), moist conditions (10-40 percent), mid-range flows (40–70 percent), dry conditions (70–90percent), and low flows (90-100 percent). This flow zone breakout follows the recommendation of EPA's An Approach for Using Load Duration Curves in the Development of TMDLs (USEPA, 2007).

Section 5.1 discussed why the immersion recreation SSM *E. coli* criterion of 235 cfu/100mL was selected as the numeric TMDL target for the Vermillion River Segment 3. The SSM was used in developing an *E. coli* allowable daily load by using the formula below:

$$E.coli\ Load\ \frac{CFU}{Day} = Average\ Daily\ Flow\ \left(\frac{ft^3}{sec}\right)\ X\ 235\ \frac{CFU}{mL}\ X\ \frac{86{,}400\ sec}{Day}\ X\ \frac{28316.8\ mL}{ft^3}$$

The *E. coli* loads were then plotted with their paired percentage values to produce the LDC in **Figure 8-1**. The load duration curve represents the TMDL across the entire flow regime.

E. coli observations were also plotted on the LDC graph by using the equation above. The SSM and average daily flow variables were substituted with the measured *E. coli* observation and the average daily flow value of the *E. coli* sample date. These observations represent an instantaneous single day load. The plotted *E. coli* observations follow a generally similar parallel slope with the LDC.

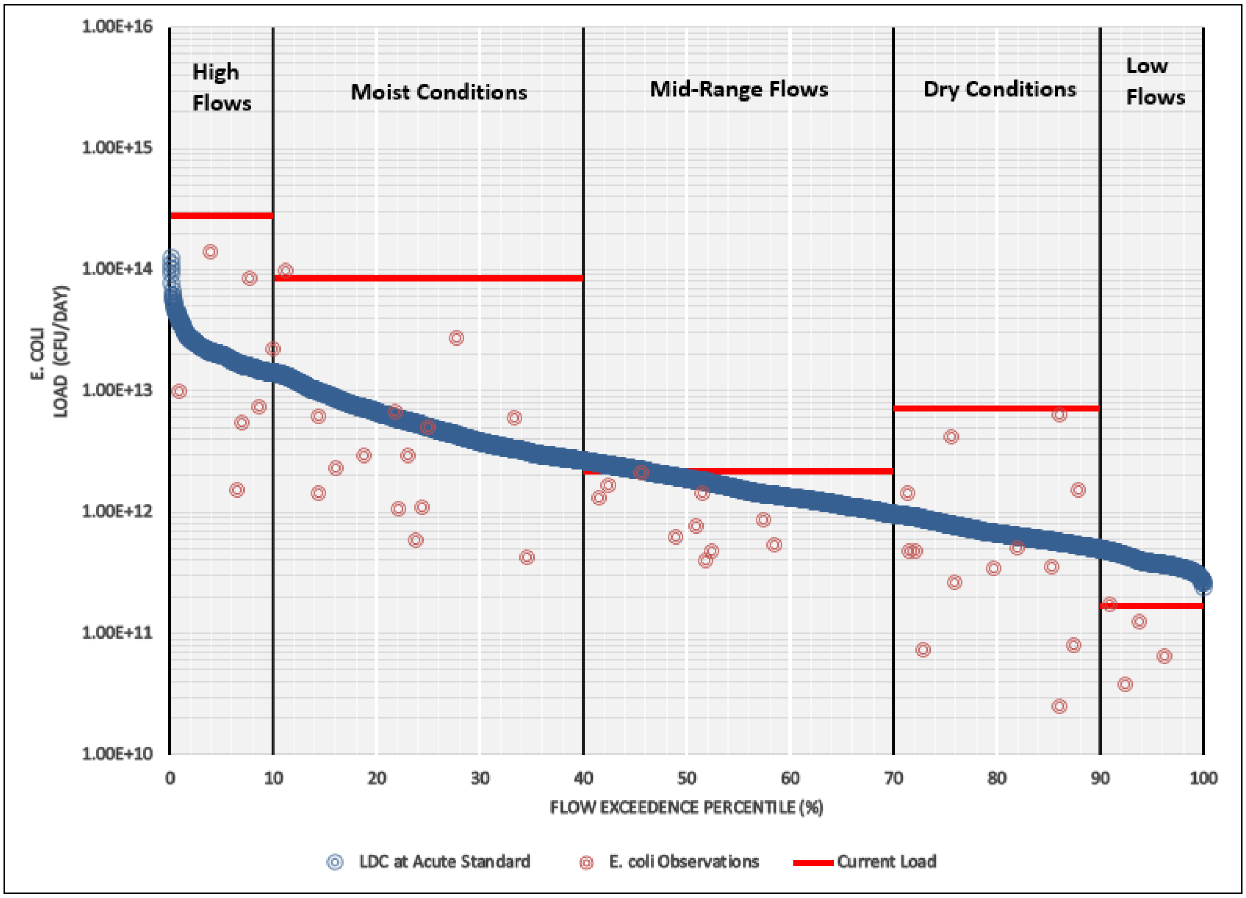

Figure 8-1: *E. coli* Load Duration Curve for Vermillion River Segment 3

When the *E. coli* observations are plotted on the LDC, characteristics of the water quality impairment are shown. *E. coli* observations that plot above the curve are exceeding the TMDL, while those below the curve are in compliance. As the plot shows, *E. coli* samples collected from Vermillion River Segment 3 exceed the TMDL in three flow zones. Loads exceeding the criteria in the high flow zones imply storm runoff from nonpoint sources. Exceedances in the low flow zone typically indicate point sources or nonpoint sources in or near the Vermillion River.

Current loads were calculated based off the 95th percentile flow and *E. coli* concentrations for all flow zones. These loads provide a representation of *E. coli* loading in each flow zone relative to the LDC. If the current load in a particular flow zone is above the LDC, a reduction is required to meet the TMDL target. When the current load in a particular flow zone is below the LDC it implies TMDL attainment. **Section 8.2** will go into more detail about the flow zones and reductions needed to meet the TMDL target.

8.1 TMDL Allocations and Margin of Safety

As discussed in **Section 5.0**, the *E. coli* TMDL consists of the sum of load allocations (LA), waste load allocations (WLA), and a margin of safety (MOS). Each of these components are discussed in this section.

8.1.1 Waste Load Allocations (WLA)

All NPDES permitted point sources within the Vermillion River Segment 3 watershed were identified and reviewed for WLA consideration in **Section 7.1**. The only direct NPDES point source discharge to Vermillion River Segment 3 occurs from the City of Vermillion's WTF. The facilities current permit (SD0020061) is written to the limited contact standards. To protect downstream water quality beneficial uses, DANR agreed the permit will be revised to immersion recreation beneficial uses with standards of 126 #/100mL 30-day geometric mean and 235 #/100mL daily maximum.

The WLA calculated from the City of Vermillion WTF for this TMDL will use the immersion recreation standard due to the expectation of the permit renewal. As a result, the City of Vermillion was assigned a WLA of 3.56E+10 cfu/day in the TMDL. The WLA calculation was based on the *E. coli* SSM standard, multiplied by the effluent flow (4.00 MGD) and a conversion factor. The normal operation of this municipal facility would typically result in only a portion of the calculated daily amounts being discharged.

***E. coli* Equations** - *K.G. 5/15/2019*

$$\text{Daily Maximum E. Coli WLA}\left(\frac{\#}{day}\right) = \text{"Daily Max E. coli Limit x"}\left(\frac{\#}{100\ mL}\right) \times \text{"Effluent Flow y"}\left(\frac{MG}{D}\right) \times \left(\frac{10^6\ G}{MG}\right) \times \left(\frac{10^3\ mL}{L}\right) \times \left(\frac{3.785\ L}{G}\right)$$

The remaining NPDES permitted facilities were not assigned a WLA in the TMDL based on two main factors; 1) no discharge facility in accordance with provisions of the NPDES permit and; (2) discharge is indirect and greater than ten miles from Vermillion River Segment 3. It is important to note that any facility discharging directly to the Vermillion River must, at a minimum, meet the water quality standards associated with the beneficial uses that are assigned in the South Dakota 2022 Integrated Report. All point sources and WLA considerations for this TMDL are documented in **Table 7**

The WLA established in this TMDL is not intended to add load limits to the NPDES permit. The permit is deemed consistent with the assumptions and requirements of the WLAs by adhering to permit requirements, primarily by meeting end-of-pipe *E. coli* concentrations consistent with the applicable water quality criteria and concentration-based TMDL target. As long as wastewater discharges from Vermillion's WTF does not exceed peak design flows and *E. coli* effluent limits, any variable flow rates from this facility are not expected to impact the TMDL. The TMDL allocations (i.e., WLAs) would need to be adjusted in the future if the facility increases peak flow capacity (expansion) or a new waste load(s) is added to the stream segment and there is insufficient remaining WLA to assign to the new source.

City of Vermillion MS4 Allocation
A brief climate overview of the Vermillion River Segment 3 watershed was discussed in **Section 2.1.2.** The area averages about forty-four inches of snow and twenty-six inches of precipitation a year with most of the precipitation occurring in the spring and summer months. Discharges from the city of Vermillion's storm sewer would be most common with precipitation events in the spring and early summer due to the incidence of snow melt and rain events.

E. coli loading from the city of Vermillion's stormwater sewer outfalls (MS4 area) is considered a direct point source to Vermillion River Segment 3. Discharge and *E. coli* concentration data was not available to develop a quantified *E. coli* load from the cities storm sewer outfalls. *E. coli* loads are expected to vary significantly annually and daily depending on precipitation. A jurisdictional area approach was used to develop an *E. coli* WLA to account for the MS4 load in the TMDL based on the following equation:

$$MS4\ Allocation = (TMDL - \sum WLA - MOS) \times Percent\ Area\ in\ Segment\ 3\ Watershed$$

TMDL = Total Maximum Daily Load (Flow Zone)
WLA = Waste Load Allocation
MOS = Margin of Safety (10% of TMDL Flow Zone)
Percent Area = 1%

The MS4 allocation calculation was applied proportionate to each flow zone. The MS4 allocation accounts for a minimal portion of the TMDL in all flow zones, which is reasonable given the MS4 area only accounts for 1% of the entire Vermillion River Segment 3 watershed. The MS4 allocation (WLA) is applicable to the TMDL based on current area and infrastructure of the storm sewer system in the City of Vermillion. Significant change to the MS4 area would impact the MS4 allocations requiring a revision to the TMDL.

8.1.2 Load Allocations (LA)

Most of the bacteria produced in the Vermillion River Segment 3 watershed is from agriculture nonpoint sources. A list of bacteria producers and their daily bacteria production per acre can be found in **Table 6.** Livestock produce the most bacteria in the watershed with humans and wildlife contributing a small percentage.

Reducing bacteria concentrations below the SSM standard in each flow zone provides assurance that both the SSM and GM standards will be met. To achieve the specified reductions, primary focus should be placed on reducing bacteria inputs from livestock grazing and feeding areas. Implementation practices to achieve this task are discussed in **Section 9.0.**

8.1.3 Margin of Safety

In accordance with regulations, a margin of safety (MOS) was established to account for uncertainty in the data analyses. A margin of safety may be provided (1) by using conservative assumptions in the calculation of the loading capacity of the waterbody and (2) by establishing allocations that in total are lower than the defined loading capacity. This document used the second method to establish a safety margin for the *E. coli* TMDL.

A 10% explicit MOS was calculated within the load duration curve framework to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc.). This 10% explicit MOS was calculated from the TMDL within each flow zone. The remaining assimilative capacity was attributed to nonpoint sources (LA) or point sources (WLA).

8.2 Numeric TMDL and Flow Zones

The TMDL and allocations for each flow zone are presented in **Table 7.** Direct point sources exist in the impaired segment but make up a small portion of the TMDL. This requires most reductions to come from nonpoint sources.

Table 7. ***E. coli*** **TMDL and Flow Zone Allocations for Vermillion River Segment 3**

TMDL Component	Vermillion River Segment 3 Flow Zones Expressed as (CFU/day)				
	High Flows	Moist Conditions	Mid-Range Conditions	Dry Conditions	Low Flows
	≥ 2463 cfs	2,462 - 463 cfs	462 - 167 cfs	166 - 86 cfs	≤ 85 cfs
LA	4.04E+13	1.15E+13	2.22E+12	8.00E+11	3.95E+11
MS4 - City of Vermillion	4.08E+11	1.16E+11	2.24E+10	8.08E+09	3.99E+09
WLA-City of Vermillion	3.56E+10	3.56E+10	3.56E+10	3.56E+10	3.56E+10
10% Explicit MOS (Low Implicit)	4.54E+12	1.29E+12	2.53E+11	9.37E+10	4.83E+10
TMDL @ 235 CFU/100mL	4.54E+13	1.29E+13	2.53E+12	9.37E+11	4.83E+11
Current Load	2.79E+14	8.58E+13	2.21E+12	7.15E+12	1.71E+11
Load Reduction	84%	85%	0%	87%	0%

8.2.1 High Flows (0-10%)

The high flow zone represents moderate to significant flooding events in the Vermillion River Segment 3 watershed. The rate of flow for this zone is categorized with flows greater than or equal to 2,463 cfs. This flow magnitude occurs on an infrequent basis and is characteristic of significant run-off events typical during the spring and summer. High flows are commonly the product of a rapid spring snowmelt but may also be generated by intense rainfall events. Bacteria sources across the watershed have the potential to be conveyed into the stream channel during high flow conditions. The 95th percentile bacteria concentration and flow was calculated at 1,444 counts/100 ml and 7,893 cfs. An *E. coli* load reduction of 84% is required to achieve compliance with the single sample maximum threshold of the immersion recreation beneficial use.

Prolonged high flow events occurred in the summer of 2010 and 2018 with historic flooding occurring for most of 2019. In 2010 and 2018 high flows fluctuated for durations of a week to more than month during the summer and early fall. Causes for these high flows was multiple rounds of thunderstorm producing heavy rainfall over saturated soils. The year of 2019 was a historic year for precipitation in the watershed. An active weather pattern brought above average precipitation starting in the winter and continued until the mid-fall when water levels started to return to above average levels. These above average levels are represented in the moist conditions zone.

8.2.2 Moist Conditions (10-40%)

The moist condition flows represent above average flow to moderate flooding events. This portion of the flow regime occurs following snow melt and moderate rainfall events. Flows in this zone range from 2,462 cfs to 463 cfs. The flows in this zone occur in the spring and possibly through the summer months. Bacteria sources from this zone are expected to be from runoff events and sources near the stream. The 95th percentile bacteria concentration and flow was calculated at 1,558 counts/100ml and 2,250 cfs. An *E. coli* load reduction of 85% is required to achieve compliance with the single sample maximum threshold of the immersion recreation beneficial use.

8.2.3 Mid-Range Conditions (40-70%)

Mid-range conditions represent flow rates between 462 cfs and 167 cfs. Mid-range flows are best characterized as base flow conditions which is streamflow that is sustained between precipitation events. Bacteria sources from this zone likely originate in or near the stream channel with occasional runoff events. The 95th percentile bacteria concentration and flow was calculated at 205 counts/100ml and 440 cfs. An *E. coli* load reduction of 0% is required to achieve compliance with the single sample maximum threshold of the immersion recreation beneficial use.

8.2.4 Dry Conditions (70-90%)

The dry flow zone represents flow rates that are between 166 and 86 cfs. This zone is best characterized as below average base flow conditions. Flows from this zone occur during the winter months or periods of abnormal dryness. Bacteria sources from this zone likely originate from in or near stream sources. The 95th percentile bacteria concentration and flow was calculated at 1794 counts/100ml and 163 cfs An *E. coli* load reduction of 87% is required to achieve compliance with the single sample maximum threshold of the immersion recreation beneficial use.

8.2.5 Low Flows (90-100%)

The low flow zone represents flow rates that are less than or equal to 85 cfs. This zone represents shallow water levels resulting in very below normal flow conditions. Flows from this zone occur during the winter months and drought conditions. Bacteria sources from this zone likely originate from in or near stream sources. The 95th percentile bacteria concentration and flow was calculated at 83 counts/100ml and 84 cfs. An *E. coli* load reduction of 0% is required to achieve compliance with the single sample maximum threshold of the immersion recreation beneficial use.

8.3 Seasonal Variation & Critical Conditions

Seasonality is important when considering bacteria contamination. Sample data was collected from May through September when the recreation standards apply. Seasonal variation is also a component of the load duration curve framework through the establishment of individual flow zones and associated TMDL allocations. Daily bacteria loads exceed the single sample maximum TMDL threshold consistently through the first two flow regimes (high flows and moist conditions). The implications of this pattern suggest bacteria contamination is mostly in the spring and early summer when it is watershed wide. Focusing on seasonal patterns is warranted to achieve TMDL attainment goals of the immersion recreation beneficial use.

Remediation efforts focused on reducing *E. coli* loading in the Vermillion Segment 3 watershed should account for critical conditions. The critical condition can be thought of as the "worst case" scenario of environmental conditions (e.g., stream flow, temperature, loads) in the waterbody in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards.

E. coli concentrations and loading are greatest at high to moderate flows resulting from snowmelt and heavy precipitation events encountered in the spring and early summer. Implementing watershed-scale best management practices designed to reduce manure transport potential during high to moderate flow conditions is essential to meet reduction goals. *E. coli* concentrations also exceed water quality criteria during dry conditions when livestock have direct access to the stream. Implementing practices to reduce livestock access to the stream corridor and channel during this critical condition is also necessary to meet reduction goals.

9.0 Water Quality Improvement Plan and Monitoring Strategy

This section describes an overall strategy designed to achieve beneficial use support and *E. coli* standards attainment for the Vermillion River Segment 3.

9.1 Improvement and Monitoring Strategy Overview

The monitoring strategy includes general measures for reducing loads from identified nonpoint sources of *E. coli* as well as approaches to further evaluate *E. coli* conditions in the Vermillion River Segment 3 watershed. Effective monitoring is integral for evaluating conservation practices and provides a basis for an adaptive management approach. Having a successful monitoring strategy in place allows for feedback on:

- The effectiveness of restoration activities
- pollutant load reductions
- the status of TMDL target attainment
- Identifying all significant sources of *E. coli*
- providing technical justification to modify restoration strategies, targets, or allocations if appropriate.

9.2 Role of DANR and Stakeholders

DANR administers the 319 nonpoint source grant for South Dakota. Funds from the grant are primarily awarded to projects that focus on implementing watershed-scale BMPs to improve and protect water quality. Nonpoint source implementation projects generally focus on impaired waterbodies and are designed to address TMDL goals. Successful implementation of TMDL pollutant-reduction projects often requires collaboration among private landowners, land management agencies, and other stakeholders. More information on DANR's Section 319 Nonpoint Source Management Program is discussed in **Section 9.9.1**.

DANR works with interested participants to use TMDLs as a basis for developing locally driven projects that aim at improving or protecting waterbodies. Because most nonpoint source pollution reductions rely on voluntary measures, it is important that local landowners, watershed organizations, and resource managers work collaboratively with local and state agencies to achieve water quality restoration goals and meet TMDL targets.

9.3 Adaptive Management Process

DANR is entrusted to assess the waters for which TMDLs have been completed and restoration measures or BMPs have been applied to determine whether compliance with water quality standards has been attained, water quality is improving, or if revisions to current goals are necessary. This aligns with an adaptive management approach.

Adaptive management is a systematic approach for improving resource management by learning from management outcomes and allows for flexible decision making. There is an inherent amount of uncertainty involved in the TMDL process, such as quantifying source contributions (e.g., determining natural background) and characterizing spatial and seasonal loading conditions. Use of an adaptive management approach based on continued monitoring of project implementation helps manage resource commitments and achieve success in meeting the water quality standards and supporting water quality beneficial uses. This approach further allows for adjustments to restoration goals and/or allocations, as necessary.

Figure 9-1 below is a visual explanation of the iterative process of adaptive management (Williams et al., 2009).

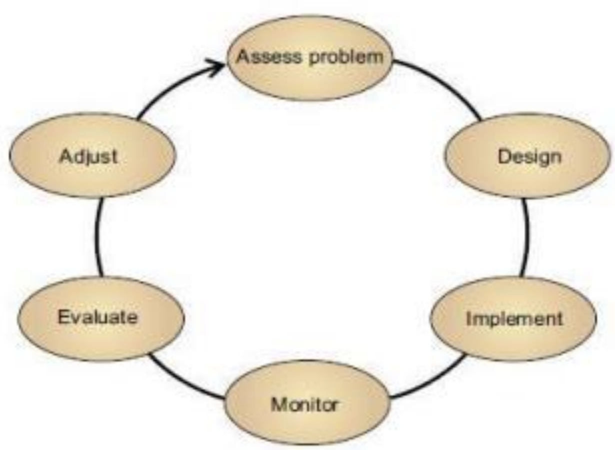

Figure 9-1. Diagram of the Adaptive Management Process

9.4 Water Quality Restoration Objectives

The water quality restoration objective is to reduce *E. coli* loads to meet the water quality standards (TMDL targets) for recovery of beneficial uses for Vermillion River Segment 3. Based on the assessment provided in this document, the TMDL can be achieved through implementation of appropriate nonpoint sources BMPs.

Specific objectives for watershed restoration activities could be identified by local stakeholders through the development of a watershed restoration plan (WRP) or similar approach. A WRP can provide a strategy for water quality restoration and monitoring in the Vermillion River Segment 3 watershed, focusing on how to achieve the TMDL, as well as other water quality issues of interest to the local community and stakeholders. A WRP serves as a locally organized "road map" for watershed activities, prioritizing projects, and identifying funding and technical resources for achieving local watershed goals, including water quality improvements by implementation. The WRP can be revised based on new information related to restoration effectiveness, monitoring results, and stakeholder priorities.

The EPA requires nine minimum elements for a WRP (listed below). A complete description can be found here: Handbook for Developing Watershed Plans to Restore and Protect our Waters

1. Identification of the causes and sources of pollutants
2. Estimated load reductions expected based on implemented management measures
3. Description of needed nonpoint source management measures
4. Estimate of the amounts of technical and financial assistance needed
5. An information/education component
6. Schedule for implementing the nonpoint source management measures
7. Description of interim, measurable milestones
8. Set of criteria that can be used to determine whether loading reductions are being achieved over time
9. A monitoring component to evaluate effectiveness of the implementation efforts over time

The Clean Water Act Section 319 (nonpoint source management programs) provides authority for congressional funding to South Dakota. 319 funds for nonpoint source projects may be used to implement WRPs.

9.5 Reasonable Assurance

The Vermillion River Segment 3 receives *E. coli* loadings from both point and non-point sources. When a TMDL is developed for impaired waters that receive pollutant loadings from both point and nonpoint sources and the WLA is based on an assumption that nonpoint source load reductions will occur, the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions. Reasonable assurance ensures that a TMDL's WLA and load allocations are properly calibrated to meet the applicable water quality standards.

Reasonable assurance of the TMDL established for the Vermillion River Segment 3 will require a comprehensive approach that addresses:

- Wastewater discharges under NPDES permits.
- Storm Sewer Discharges under MS4 SWMP.
- Non-point source pollution.
- Existing and potential future sources.
- Regulatory and voluntary approaches.

There is reasonable assurance that the goals of the TMDL established for Vermillion River Segment 3 can be met with proper planning between state and local regulatory agencies, stakeholders, BMP implementation, and access to adequate financial resources. The waste load allocations used in the TMDL were obtained from regulations defined in the NPDES permits administratively assigned to the different communities and facilities within the watershed. **Sections 9.6** to **Section 9.9** will provide specific projects and efforts that will provide reasonable assurance that bacteria loading from both point and nonpoint sources will be reduced and monitored.

9.6 *E. coli* Restoration Approach

Cattle grazing in riparian area and manure runoff are identified as the most likely cause of elevated *E. coli* loading to Vermillion River Segment 3. General recommendations for the management of grazing management and septic systems and other sources of human caused *E. coli* loading to Vermillion River Segment 3 are outlined below.

A WRP developed by local stakeholders would contain more detailed information on restoration priorities, milestones and specific BMP recommendations to address key pollutant sources. Monitoring is an important part of the restoration process and for evaluating BMP effectiveness. Specific monitoring recommendations are outlined in **Section 9.7** and **Section 9.8.**

9.6.1 Grazing and Manure Management

In watersheds that contain livestock, the goal of the *E. coli* restoration strategy is to reduce source input to stream channels by increasing the filtering and uptake capacity of riparian vegetation areas, decreasing the amount of bare ground, limiting the transport of *E. coli* (from manure on rangeland and cropland) to waterbodies. Specific BMPs include grazing management to improve riparian health by reducing livestock direct access to waterbodies and installing buffer strips. Grazing management that intends to increase vegetative post-grazing ground cover should be considered when the goal is to decrease *E. coli* loading from rangelands.

9.6.2 Residential Sources

It is imperative that all facilities with a water treatment facility operate in compliance with their NPDES permits and WLA’s set forth in the TMDL. Below are some recommendations for the facilities to consider ensuring high operational effectiveness of wastewater treatment.

City of Vermillion WTF

- Continue scheduled sanitary sewer lines and storm sewer replacement and repairs.
- Continue upgrading treatment system as new technologies become available.
- Continued maintenance of the existing facility.
- Continue *E. coli* monitoring to assure compliance with water quality standards.
- Encourage WTF Personnel to attend annual wastewater training courses sponsored by the state.
-

City of Irene WTF

- Continue scheduled replacement of sanitary pumps, replacing riprap, and repairing inter-pond valves.
- Continue scheduled sanitary sewer lines and storm sewer replacement and repairs.
- Continued maintenance of the existing facility.
- Continue upgrading treatment system as new technologies become available.
- Encourage WTF Personnel to attend annual wastewater training courses sponsored by the state.

Towns of Volin and Gayville

- Continue scheduled replacement of sanitary pumps, replacing riprap, and repairing inter-pond valves.
- Continue scheduled sanitary sewer lines and storm sewer replacement and repairs.
- Encourage WTF Personnel to attend annual wastewater training courses sponsored by the state.

The City of Vermillion issues a MS4 Annual Report to DANR detailing the progress and status of the city's SWMP. The plan serves as a guide to the city in implementing BMPs to reduce and mitigate bacteria loading in the city's storm sewers. The city is also in the process of updating a section of their sewer system infrastructure as stated in **Section 7.1**.

9.7 Strengthening Source Assessment and Available Data

In order to better understand conditions contributing to *E. coli* loading, it is recommended that *E. coli* sampling be continued in areas where elevated *E. coli* concentrations were observed, and to note specific land uses and conditions at the time of sampling that could be contributing to elevated instream concentrations. *E. coli* sampling timeframes should only take place in the recreation season when water quality is most susceptible to impacts from *E. coli* contributions.

More frequent sampling is recommended to take place along tributaries in the Vermillion River Segment 3 watershed. This TMDL identified potential areas for *E. coli* nonpoint sources in the Turkey Creek and Clay Creek watersheds. Additional monitoring sites and prolonged sampling in these watersheds is recommended to get a better representation of *E. coli* loadings from these locations. Water quality data from these sites would also benefit future implementation projects in this area to notice any changes in *E. coli* concentrations. The following monitoring would help improve the understanding of *E. coli* loading in the Vermillion River Segment 3:

- Additional monitoring of *E. coli* of Clay Creek Ditch at Station ID: VERMILRVRT04 including additional locations upstream, to span multiple field seasons.
- Additional monitoring of E. *coli* near the mouth of Baptist Creek for multiple field seasons.
- Monthly sampling at Station ID: VERMILRVRT34 at Volin on Turkey Creek. A majority of rangeland and pasture ground is in the Turkey Creek watershed. Any monitoring will yield a better understanding of sources located throughout the watershed.
- Continue monthly sampling at WQM5 by Vermillion.

Below is information that could help strengthen the source assessment and help guide monitoring activities.

- Thorough analysis of the number of septic systems in the watershed, their proximity to surface water and their state of repair.
- A more detailed understanding and location of grazing and manure management practices within the watershed.

9.8 Consistent Data Collection and Methodologies

DANR uses water quality data from several stakeholders to conduct beneficial use support and impairment assessments as part of the IR process. Water quality data collected by other stakeholders can be used to evaluate overall progress of restoration efforts.

It is recommended that future water quality monitoring efforts conducted by local stakeholders follow quality assurance plans and standard operating procedures developed by the DANR Watershed Protection Program. These plans and procedures maintain consistency with data collection and analysis used to develop this TMDL.

DANR Watershed Protection Program and the South Dakota Discovery Center jointly operate the South Dakota Volunteer Water Quality Monitoring Program. The goal of the program is to increase public interest and engagement for water quality in South Dakota. The Watershed Protection Program trains volunteer monitors on water quality sampling techniques and procedures. Further expansion of volunteer monitors in the Vermillion River Segment 3 watershed would benefit the monitoring portion of the adaptive management process. Consistent additional data collection can allow DANR to evaluate overall implementation effectiveness and make recommended adjustments to local implementation.

9.9 Implementation Strategy

Funding support and technical assistance for implementing watershed-scale nonpoint source projects can be obtained through DANR. Funding programs provided by DANR administer financial support for projects that protect and improve water quality in South Dakota. These programs are the Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (CWSRF) program, and the Section 319 Nonpoint Source Management Program.

9.9.1 Section 319 Nonpoint Source Management Program

The Section 319 Nonpoint Source Management Program provides the means for states, tribes and territories to receive federal funds to address nonpoint source pollution. Applications for Section 319 grant funds are submitted to DANR to be presented at the annual Non-Point Source Task Force Meeting. The task force then reviews and submits a grant funding recommendation to the Board of Water & Natural Resources for grant approval. Watershed projects awarded 319 funds are the primary channel for reducing nonpoint source pollution in South Dakota by implementing water-quality BMPs.

The South Central Watershed Implementation Project is a 319-funded project that is targeting bacteria pollutant sources within the Vermillion River Basin. The project's objectives are to restore and protect the water quality of impaired watersheds.

Multiple types of BMPs have been considered in the development of a water quality management implementation plan for the impaired segments of the Vermillion River Basin including Vermillion River Segment 3. **Section 8.2** provides the LDC and indicate reductions are required in five flow zones. Because of the rural area and the lack of point sources most of the implementation measures should focus on the following:

- Livestock access to streams should be reduced, and livestock should be provided sources of water away from streams.
- Riparian buffer strips should be installed along streams bordering cropland and pastureland.
- Animal confinement facilities should implement proper animal waste management systems.
- An assessment of progress will be part of every Section 319 implementation segment, and revisions to the plan will be made as appropriate in cooperation with basin stakeholders.

10.0 Public Participation

The Vermillion River Segment 3 was assessed as part of a larger watershed assessment project that occurred from 2004 to 2006. Some of the data and information gained during this effort was incorporated into the report. More recent (2010-2020) data and information was used to develop most aspects of the report and TMDL. The assessment project integrated measures to inform stakeholders about the assessment project and future TMDL development.

Efforts taken to gain public awareness and education:

1. Monthly meetings were held during the assessment phase (2004-2006) through the Vermillion Basin Water Development District (VBWDD) which was the local sponsor of the assessment project. Meetings minutes are available upon request.
2. A webpage was developed and used during the course of the assessment.
3. Findings of the assessment were conveyed to local interest groups.

A 30-day public comment period was issued for the draft TMDL. A public notice letter was published in the following local newspapers: Vermillion Plain Talk, Centerville Journal, Lennox Independent and New Era. The draft TMDL document and ability to comment was made available on DANRs One-Stop Public Notice Page at: https://danr.sd.gov/public/default.aspx. The public comment period began May 20, 2022 and ended June 21, 2022. No public comments were received during the 30-day comment period.

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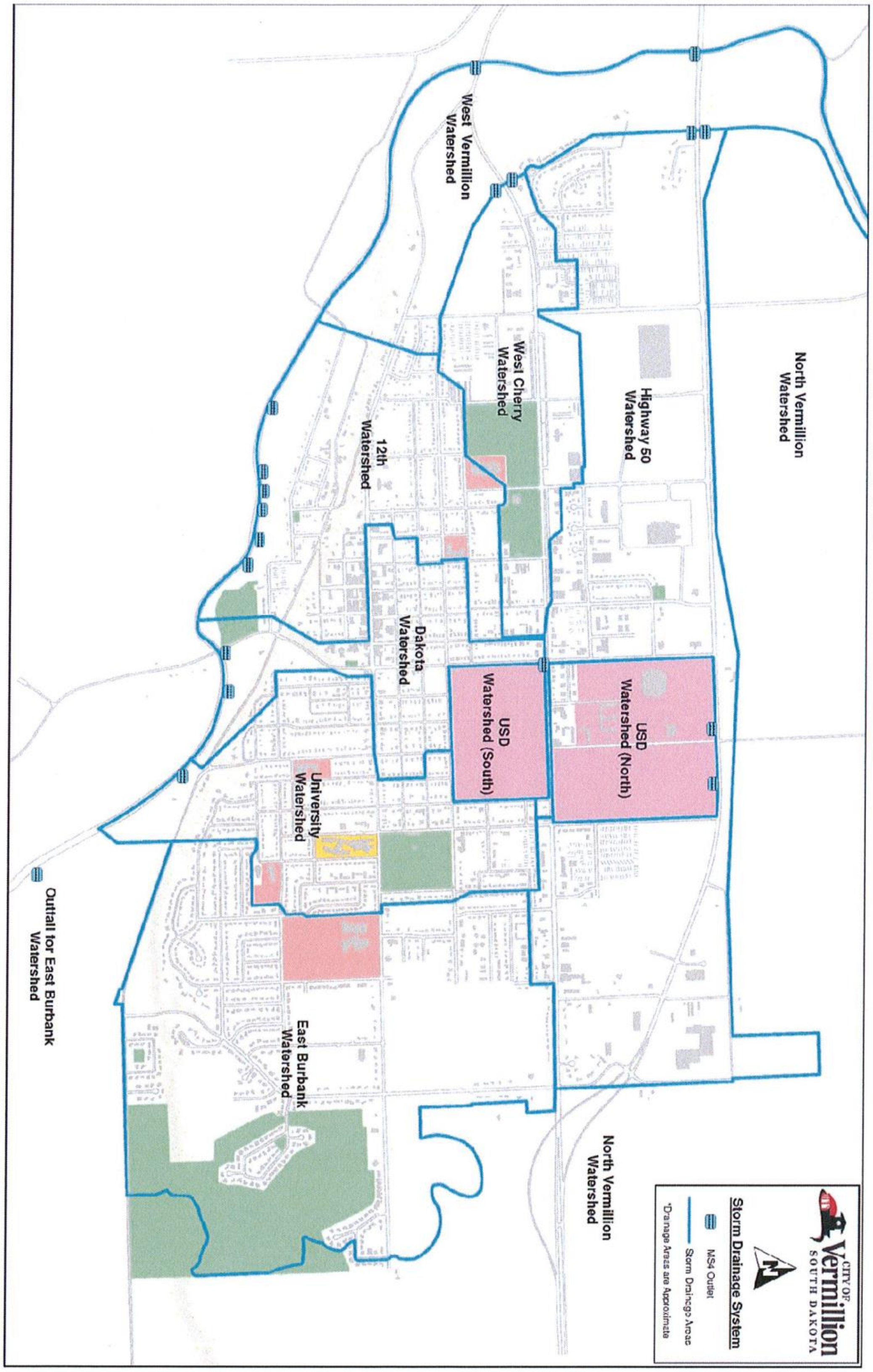
Appendix A – Measured Discharge Data at WQM 5

Date	Time CST	Total Measured Discharge (cfs)	Gage Height (ft)	Discharge Error (%)	Grade
06/15/2010	15:00	3011.67	27.54	4.26	Good
06/22/2010	10:45	2840.5	27.72	3.79	Good
07/06/2010	13:15	2247.92	30.9	4.43	Good
07/21/2010	12:15	554.72	35.89	0.57	Excellent
08/03/2010	12:30	7333.97	24.78	2.33	Good
08/16/2010	11:45	2746.66	29.03	3.29	Good
08/30/2010	11:45	506.96	35.82	3.69	Good
09/20/2010	13:00	601.36	35.74	3.56	Good
10/06/2010	11:45	2445.25	29.48	3.89	Good
10/20/2010	11:30	520.24	35.83	3.89	Good
05/18/2011	11:40	1203.31	33.22	1.91	Excellent
06/07/2011	11:30	1886.9	30.16	5.06	Fair
06/24/2011	11:30	2168.91	28.06	0.19	Excellent
09/27/2011	11:45	162.04	35.94	2.41	Good
10/12/2011	12:10	170.34	38.14	3.96	Good
04/10/2012	11:15	137.84	38.72	4.06	Good
07/02/2012	11:30	71.75	39.5	5.54	Fair
08/28/2012	10:15	19.35	40.02	3.58	Good
10/10/2012	11:45	15.23	40.21	7.94	Fair
06/05/2013	12:00	896.28	35.6	1.01	Excellent
05/31/2017	12:45	697.57	36.35	1.47	Poor
05/15/2018	17:20	1151.56	34.39	1.32	Excellent
06/25/2018	8:30	4345	26.12	3.17	Good
06/26/2018	18:30	5748	24.44	1.02	Fair
06/27/2018	16:30	7773	20.97	3.73	Good
07/02/2018	12:00	6717	22.86	3.84	Fair
07/03/2018	7:45	6174	23.62	0.46	Good
07/05/2018	9:30	5500	25.79	1.22	Fair
05/02/2019	14:15	3579.96	29	1.54	Excellent
05/31/2019	8:35	8274.23	21.87	1	
08/09/2019	11:00	1118.84	34.22	2.23	
10/04/2019	10:30	2510.06	31.19	3.85	
11/05/2019	13:30	1201.5	33.87	1.79	
05/21/2020	11:45	683.79	36.47	U/A	Fair
06/23/2020	16:30	1521.4	33.61	U/A	Good
07/15/2020	12:33	306.31	38.15	U/A	Excellent
08/11/2020	12:17	176.72	38.88	U/A	Excellent

Appendix B – Measured E. coli WQM 5 Data 2010 - 2020

Site	Date	E. coli #/100m	Stage Gag	Flow(cfs)	Percent
WQM5	05/17/2010	49.5	34.53	906.46	24.40
WQM5	06/14/2010	1540	27.66	3640.56	4.00
WQM5	07/12/2010	94.8	33.27	1254.74	18.80
WQM5	08/16/2010	21	29	2938.58	6.50
WQM5	09/07/2010	25.6	34.42	934.35	23.80
WQM5	05/09/2011	33.6	31.91	1703.99	14.40
WQM5	06/13/2011	368	30.03	2457.38	10.00
WQM5	07/11/2011	79.2	29.23	2826.80	7.00
WQM5	08/01/2011	116	29.74	2587.85	8.60
WQM5	09/12/2011	42.2	34.11	1015.50	22.20
WQM5	05/07/2012	63.4	37.68	301.06	52.40
WQM5	06/05/2012	52	37.61	310.63	51.80
WQM5	07/02/2012	183	39.49	110.30	82.00
WQM5	08/06/2012	41	40.2	64.18	96.20
WQM5	09/10/2012	74	40.12	68.60	93.90
WQM5	05/13/2013	19.4	38.99	152.28	72.90
WQM5	05/05/2014	10.4	39.66	97.83	86.10
WQM5	06/02/2014	2610	39.66	97.83	86.10
WQM5	07/14/2014	185	37.6	312.02	51.60
WQM5	08/11/2014	78.2	39.19	134.53	75.90
WQM5	09/08/2014	90.4	38.16	239.89	58.50
WQM5	06/01/2015	118	39.4	117.27	79.70
WQM5	07/06/2015	1250	39.17	136.25	75.70
WQM5	08/10/2015	20	40	75.60	92.50
WQM5	09/08/2015	34.4	39.72	93.65	87.40
WQM5	05/09/2016	63	32.55	1482.86	16.10
WQM5	06/13/2016	221	37.11	383.97	45.70
WQM5	07/11/2016	121	38.92	158.80	72.10
WQM5	08/08/2016	84	39.88	83.04	90.90
WQM5	09/06/2016	669	39.74	92.28	87.90
WQM5	05/03/2017	1720	30.36	2313.64	11.20
WQM5	06/06/2017	97	37.55	318.98	50.90
WQM5	07/11/2017	121	38.9	160.69	71.60
WQM5	08/08/2017	143	39.62	100.69	85.30
WQM5	05/15/2018	121	34.29	967.91	23.10
WQM5	06/05/2018	158	36.84	427.22	42.40
WQM5	07/19/2018	243	33.71	1125.86	21.90
WQM5	08/07/2018	422	36.01	576.56	33.30
WQM5	09/18/2018	122	36.78	437.18	41.60
WQM5	05/09/2019	1220	29.38	2755.25	7.70
WQM5	06/04/2019	63	23.53	6382.24	1.00
WQM5	07/23/2019	146	31.92	1700.40	14.40
WQM5	08/13/2019	233	34.66	874.12	25.00
WQM5	09/11/2019	1470	35.21	744.53	27.70
WQM5	05/11/2020	31	36.15	549.61	34.50
WQM5	06/09/2020	74	37.39	341.83	48.90
WQM5	07/15/2020	142	38.12	244.69	57.50
WQM5	08/11/2020	361	38.89	161.64	71.40

Appendix C – City of Vermillion Storm Sewer Drainage Locations



Appendix D – EPA Approval Letter and Decisions Document

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
Denver, CO 80202-1129
Phone 800-227-8917
www.epa.gov/region08

June 30, 2022

Ref: 8WD-CWS

SENT VIA EMAIL

Hunter Roberts, Secretary
South Dakota Department of Agriculture and Natural Resources
Hunter.Roberts@state.sd.us

Re: Approval of *Escherichia coli* Bacteria Total Maximum Daily Load (TMDL) for the Vermillion River Segment 3, Clay County, South Dakota

Dear Mr. Roberts,

The U.S. Environmental Protection Agency (EPA) has completed review of the total maximum daily load (TMDL) submitted by your office on June 23, 2022. In accordance with the Clean Water Act (33 U.S.C. §1251 *et. seq*.) and the EPA's implementing regulations at 40 C.F.R. Part 130, the EPA hereby approves South Dakota's TMDL for segment 3 of the Vermillion River. The EPA has determined that the separate elements of the TMDL listed in the enclosure adequately address the pollutant of concern, are designed to attain and maintain applicable water quality standards, consider seasonal variation and include a margin of safety. The EPA's rationale for this action is contained in the enclosure.

Thank you for submitting this TMDL for our review and approval. If you have any questions, please contact Amy King on my staff at (303) 312-6708.

Sincerely,

Judy Bloom, Manager
Clean Water Branch

Enclosure:
EPA Decision Rationale – Vermillion River Segment 3 *E. coli* TMDL

Cc: Barry McLaury, Watershed Protection Program Administrator, South Dakota DANR
Paul Lorenzen, Environmental Scientist Manager – TMDL Team Leader, South Dakota DANR

EPA TOTAL MAXIMUM DAILY LOAD (TMDL) DECISION RATIONALE

TMDL: *Escherichia coli* Bacteria Total Maximum Daily Load (TMDL) for the Vermillion River Segment 3, Clay County, South Dakota

ATTAINS TMDL ID: R8-SD-2022-03

LOCATION: Clay, Hutchinson, Yankton, Turner, and Union counties, South Dakota

IMPAIRMENTS/POLLUTANTS: The TMDL submittal addresses one river segment with a recreation use that is impaired due to elevated levels of *Escherichia coli* (*E. coli*) bacteria.

Waterbody/Pollutant Addressed in this TMDL Action

Assessment Unit ID	Waterbody Description	Pollutant Addressed
SD-VM-R-VERMILLION_03	Vermillion River Segment 3 (Baptist Creek to mouth)	*E. coli*

BACKGROUND: The South Dakota Department of Agriculture and Natural Resources (DANR) submitted to EPA the *E. coli* TMDL for segment 3 of the Vermillion River with a letter requesting review and approval dated June 23, 2022. The TMDL report was subsequently withdrawn that same day due to a typographical error associated with percent contributions in the source assessment. The errors were fixed by DANR and the TMDL report was resubmitted for final EPA review and approval on June 23, 2022 before EPA began review of the final TMDL. EPA previously reviewed and provided staff comments on draft versions of the report but did not submit comments during the subsequent public comment period (May 20, 2022 to June 21, 2022).

The submittal included:

- Letter requesting EPA's review and approval of the TMDL
- Final TMDL report
- Data appendices

APPROVAL RECOMMENDATIONS: Based on the review presented below, the reviewer recommends approval of the final Vermillion River segment 3 *E. coli* TMDL. All the required elements of an approvable TMDL have been met.

TMDL Approval Summary	
Number of TMDLs Approved:	1
Number of Causes Addressed by TMDLs:	1

REVIEWER: Amy King, EPA

The following review summary explains how the TMDL submission meets the statutory and regulatory requirements of TMDLs in accordance with Section 303(d) of the Clean Water Act (CWA), and EPA's implementing regulations in 40 C.F.R. Part 130.

EPA REVIEW OF THE VERMILLION RIVER SEGMENT 3 *E. COLI* TMDL

This TMDL review document includes EPA's guidelines that summarize the currently effective statutory and regulatory requirements relating to TMDLs (CWA Section 303(d) and 40 C.F.R. Part 130). These TMDL review guidelines are not themselves regulations. Any differences between these guidelines and EPA's regulations should be resolved in favor of the regulations themselves. The italicized sections of this document describe the information generally necessary for EPA to determine if a TMDL submittal fulfills the legal requirements for approval. The sections in regular type reflect EPA's analysis of the state's compliance with these requirements. Use of the verb "must" below denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation.

1. Identification of Waterbody, Pollutant of Concern, Pollutant Sources, and Priority Ranking

The TMDL submittal must clearly identify (40 C.F.R. §130.7(c)(1)):

- *the waterbody as it appears on the State's/Tribe's 303(d) list;*
- *the pollutant for which the TMDL is being established; and*
- *the priority ranking of the waterbody.*

The TMDL submittal must include (40 C.F.R. §130.7(c)(1); 40 C.F.R. §130.2):

- *an identification of the point and nonpoint sources of the pollutant of concern, including location of the source(s) and the quantity of the loading (e.g., lbs. per day);*
- *facility names and NPDES permit numbers for point sources within the watershed; and*
- *a description of the natural background sources, and the magnitude and location of the sources, where it is possible to separate natural background from nonpoint sources.*

This information is necessary for EPA's review of the load and wasteload allocations, which are required by regulation.

The TMDL submittal should also contain a description of any important assumptions made in developing the TMDL, such as:

- *the spatial extent of the watershed in which the impaired waterbody is located;*
- *the assumed distribution of land use in the watershed (e.g., urban, forested, agriculture);*
- *population characteristics, wildlife resources, and other relevant information affecting the characterization of the pollutant of concern and its allocation to sources;*
- *present and future growth trends, if taken into consideration in preparing the TMDL (e.g., the TMDL could include the design capacity of a wastewater treatment facility); and*
- *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.*

Segment 3 of the Vermillion River is located in southeastern South Dakota and is the most downstream segment of the larger Vermillion River Basin (Figure 2-1). Segment 3 extends from Baptist Creek 20.7 miles to the Missouri River and is identified as SD-VM-R-VERMILLION_03. The entire drainage area is over 279,000 acres in fifteen different HUC12 watersheds (Figure 2-3) with four major tributaries: Clay, Turkey, and Baptist creeks and Yankton Clay Ditch. Most of the drainage is located in Clay and Yankton counties with headwaters for the various tributaries located in Hutchinson, Turner, and Union counties. Figure 2-1 displays the general location of the Vermillion River segment 3 watershed with the impaired segment, cities, and major highways.

Segment 3 was first identified as impaired by *E. coli* and placed on South Dakota's 303(d) list in 2014 and remained as impairments on subsequent list cycles. It was assigned a high priority (i.e., 1) for TMDL development on the most recent EPA-approved 303(d) list in 2022. This priority ranking information is contained on page 6, which summarizes the TMDL components. This segment is also impaired for total suspended solids causing nonattainment the warmwater semipermanent fish life propagation use; a TMDL has been in place to address this impairment since 2011 (Action ID # 40439).

Section 2.0 (*Vermillion River Segment 3 Background*) describes watershed characteristics. The headwaters of the Clay and Turkey Creek watersheds consist of rolling hills with ravines and valleys, which transition to flat plains including the historic floodplains of the Missouri River (Figure 2-4, Section 2.1.4). Figure 2-7 illustrates the land use distribution draining into the impaired segment, which is predominantly agriculture (cropland of corn and soybeans as well as a mix of other small grains) with grasslands near waterways as soils in the valleys and low-lying areas are more suitable for grazing and haying. Urban development includes several small towns (Irene, Volin, and Gayville) in the western portion of the watershed as well as and the city of Vermillion (population less than 12,000) located near the river mouth.

Section 7.2 (*Nonpoint Sources and Assessment*) characterizes the nonpoint sources into categories of agriculture, human (i.e., septic systems), and natural background/wildlife (particularly geese and ducks). DANR quantified *E. coli* production from these sources using population estimates, geographic information system (GIS) analysis, and the Bacterial Indicator Tool (EPA, 2000) with information provided by U.S. Department of Agriculture, South Dakota Game Fish and Parks, and local municipalities (Table 6). Agriculture, including manure from livestock, was the dominant source of bacteria production (98.8 percent).

Section 7.1 (*Point Sources*) describes the permitted point sources by facility name, permit number, and discharge characteristics. The city of Vermillion operates a wastewater treatment facility (WWTF; SD0020061) that discharges *E. coli* directly to the Vermillion River (outfall location illustrated in Figure 6-1). This permit includes effluent limits for *E. coli* consistent with the single sample maximum and geometric mean criteria for the limited contact recreation use. The facility is upgrading their UV treatment system and conducted additional upgrades in 2016. The three most recent inspection reports (2018, 2020, and 2021) note no fecal or total coliform exceedances.

The city of Vermillion is also regulated as a small municipal separate storm sewer system (MS4) under a general permit (SDR21A001; Section 7.1.1 and Appendix C). DANR discusses the bacteria source assessment and storm water management program (SWMP) including best management practices (BMPs) that the city has implemented. While monitoring for *E. coli* is not required as part of their MS4 permit, the city has identified potential sources of bacteria and DANR recommends future outfall monitoring to evaluate stormwater conditions. DANR also notes several additional permits in the watershed that are not expected to contribute *E. coli* to the watershed and do not receive WLAs, including water distribution permits, no discharge WWTFs, and the city of Irene's WWTF that is several tributary connections away from the Vermillion River and discharges infrequently.

Seven permitted Concentrated Animal Feeding Operations (CAFOs) are located in the watershed (Section 7.1.2 and Table 5). DANR discusses the CAFO permit requirements, including design standards, operation maintenance, inspections, and records/reporting requirements. DANR notes that *E. coli* contributions are unlikely if facilities are in compliance with their permit requirements; therefore, they were not assigned an allocation within the document and, thus, are given a WLA of zero.

Assessment: EPA concludes that DANR adequately identified the impaired waterbody, the pollutant of concern, the priority ranking, the identification, location and magnitude of the pollutant sources, and the important assumptions and information used to develop the TMDL.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

The TMDL submittal 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 antidegradation policy (40 C.F.R. §130.7(c)(1)); and*
- *a numeric water quality target for each TMDL. If the TMDL is based on a target other than a numeric water quality criterion, then a numeric expression must be developed from a narrative criterion and a description of the process used to derive the target must be included in the submittal (40 C.F.R. §130.2(i)).*

EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation.

Section 3.0 (*South Dakota Water Quality Standards*) describes the water quality standards applicable to the impaired segments with citations to relevant South Dakota regulations. SD-VM-R-VERMILLION_03 is designated the following beneficial uses:

- warmwater semipermanent fish life propagation,
- limited contact recreation,
- fish and wildlife propagation, recreation, and stock watering,
- irrigation waters.

Numeric criteria applicable to these uses are presented in Table 2. DANR determined that *E. coli* is preventing the river's limited contact recreation use from being fully supported. Numeric *E. coli* criteria established to protect this recreation use are comprised of a 30-day mean criterion (≤ 630 colony forming units per 100 milliliters [CFU/100mL]) and a single sample maximum criterion (≤ 1,178 CFU/100mL) (Table 2 and E. coli *Water Quality Criteria* [Section 3.2.1]). These criteria are seasonally applicable from May 1 to September 30. In addition, the TMDL considers downstream uses for the Missouri River (SD-MI-R-LEWIS_AND_CLARK_01). This segment is subject to stricter criteria as it has a beneficial use of immersion recreation. *E. coli* water quality criteria for immersion recreation are also included in Table 2 (≤ 126 CFU/100mL as a 30-day criterion and ≤ 235 CFU/100mL as a single sample maximum).

The numeric *E. coli* criteria for immersion recreation waters are applied directly as water quality targets for these TMDLs to be protective of downstream uses (Section 5.1 [*Developing Numeric Targets for* E. coli]). DANR expects that meeting the numeric *E. coli* criteria will lead to conditions necessary to support any relevant narrative criteria. The TMDL numeric target applicable to the impaired segment is based on the immersion recreation single sample maximum criterion (235 CFU/100mL) as monitoring is not of sufficient frequency to assess compliance with the geometric mean criterion. DANR demonstrates in Section 5.1 (*Developing Numeric Targets for* E. coli) that attaining the single sample maximum target will also achieve the geometric mean criterion.

The TMDLs are consistent with South Dakota antidegradation policies because they provide recommendations and establish pollutant limits at water quality levels necessary to meet criteria and fully support existing beneficial uses, including more stringent downstream uses.

Assessment: EPA concludes that DANR adequately described the applicable water quality standards and numeric water quality target for this TMDL.

3. Loading Capacity - Linking Water Quality and Pollutant Sources

The TMDL submittal must include the loading capacity for each waterbody and pollutant of concern. 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 TMDL submittal must:

- *describe the method used to establish 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;*
- *contain documentation supporting the TMDL analysis, including the basis for any assumptions; a discussion of strengths and weaknesses in the analytical process; and results from any water quality modeling; and*
- *include a description and summary of the water quality data used for the TMDL analysis.*

EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation (40 C.F.R. §130.2).

The full water quality dataset should be made available as an appendix to the TMDL or as a separate electronic file. Other datasets used (e.g., land use, flow), if not included within the TMDL submittal, should be referenced by source and year. The TMDL analysis should make use of all readily available data for the waterbody unless the TMDL writer determines that the data are not relevant or appropriate.

The pollutant loadings may be expressed as either mass-per-time, toxicity or other appropriate measure (40 C.F.R. §130.2(i)). Most TMDLs should be expressed as daily loads (USEPA. 2006a). If the TMDL is expressed in terms other than a daily load (e.g., annual load), the submittal should explain why it is appropriate to express the TMDL in the unit of measurement chosen.

The TMDL submittal must describe the critical conditions and related physical conditions in the waterbody as part of the analysis of loading capacity (40 C.F.R. §130.7(c)(1)). The critical condition can be thought of as the "worst case" scenario of environmental conditions (e.g., stream flow, temperature, loads) in the waterbody in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. TMDLs should define the applicable critical conditions and describe the approach used to estimate both point and nonpoint source loads under such critical conditions.

DANR relied on the load duration curve approach to define the *E. coli* loading capacity for Vermillion River segment 3. A load duration curve is a graphical representation of pollutant loads across various flows. The approach correlates water quality conditions with stream flow and provides insight into the variability of source contributions. EPA has published guidance on the use of duration curves for TMDL development (USEPA, 2007) and the practice is well established.

Using this approach, DANR set the TMDL equivalent to the loading capacity, which is the sum of the load allocations, wasteload allocations, and margin of safety (MOS is 10% of the total loading capacity), and expressed the TMDL in CFUs per day at different flow zones (i.e., high, moist, mid-range, dry, and low). The TMDL is not expressed as a load or mass, but instead as a number of organisms per day due to the nature of the pollutant. This approach is consistent with EPA guidance and the flexibility offered in 40 CFR §130.3(i) to express TMDLs in other appropriate, non-mass-based measures (USEPA, 2001).

The load duration curve is shown visually in Figure 8-1, including the loading capacity, calculated with the numeric TMDL target and estimated flow compared to instantaneous loads calculated from the monitoring dataset. The monitoring data used to develop the load duration curve and calculate existing loads are summarized in Section 6.0 (*Water Quality Data and Discharge Information*) and provided fully in Appendices A and B. Table 7 summarizes the 95th percentile existing loads and loading capacity by flow regime for Vermillion River segment 3. DANR described conditions associated with each flow regime in sub-sections below this table.

DANR demonstrated the cause-and-effect relationship between sources and the water quality target at various flow conditions by supplementing the pattern of observed exceedances in each flow zone with known characteristics of various source categories as investigated and described in Section 7.0 (*Source Assessment and Allocations*). Loading sources were characterized and quantified using multiple approaches. Two National Pollutant Discharge Elimination System (NPDES) permitted facilities were identified as sources to segment 3 and their contributions were estimated using effluent limits and design flow (city of Vermillion WWTF) and jurisdictional area (city of Vermillion MS4) (Section 8.1.1 [*Waste Load Allocations*]; Table 7). DANR estimated relative nonpoint source contributions, including agricultural livestock, wildlife (natural background), and human sources, using bacteria production rates from the Bacterial Indicator Tool (EPA, 2000; Table 6). Livestock grazing was identified as the main source of bacteria loading in the watershed (Section 7.2.3 [*Agricultural Sources*]).

While the loading capacity is defined for multiple stream flow conditions, DANR described the critical conditions when bacteria loading to segment 3 of the Vermillion River are greatest as periods of high to moist flows (Section 8.3 [*Seasonal Variation & Critical Conditions*]). These flow conditions are typically associated with snowmelt and heavy precipitation in the spring and early summer. However, high *E. coli* concentrations have also been observed during dry conditions when livestock have direct access to the stream.

Assessment: EPA concludes that the loading capacity was calculated using an acceptable approach, used a water quality target consistent with water quality criteria, and has been appropriately set at a level necessary to attain and maintain the applicable water quality standards. The pollutant loads have been expressed as daily limits. The critical conditions were described and factored into the calculations and were based on a reasonable approach to establish the relationship between the target and pollutant sources.

4. Load Allocation

The TMDL submittal must include load allocations (LAs). EPA regulations define LAs as the portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution and to natural background sources. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Where possible, separate LAs should be provided for natural background and for nonpoint sources.

In the rare instance that a TMDL concludes that there are no nonpoint sources or natural background for a pollutant, the load allocation must be expressed as zero and the TMDL should include a discussion of the reasoning behind this decision.

As described in Section 8.1.2 (*Load Allocations*), DANR established a single LA as the allowable load remaining after accounting for the WLAs and explicit MOS (i.e., LA = TMDL – MOS – WLA). Table 7 presents the LA across the TMDL's different flow regimes in CFUs per day. This composite LA represents all nonpoint source contributions, both human and natural, as one allocation; however, individual nonpoint source categories, including agriculture, human, and wildlife, were characterized in greater depth in Section 7.2 (*Nonpoint Sources and Assessment*) and Table 6.

Assessment: EPA concludes that the LAs provided in the TMDL are reasonable and will result in attainment of the water quality standards.

5. Wasteload Allocations

The TMDL submittal must include wasteload allocations (WLAs). EPA regulations define WLAs as the portion of a receiving water's loading capacity that is allocated to existing and future point sources (40 C.F.R. §130.2(h)). If no point sources are present or if the TMDL recommends a zero WLA for point sources, the WLA must be expressed as zero. If the TMDL recommends a zero WLA after considering all pollutant sources, there must be a discussion of the reasoning behind this decision, since a zero WLA implies an allocation only to nonpoint sources and natural background will result in attainment of the applicable water quality standards, and all point sources have no measurable contribution.

The individual WLAs may take the form of uniform percentage reductions or individual mass based limitations for dischargers where it can be shown that this solution meets WQSs and does not result in localized impairments. In some cases, WLAs may cover more than one discharger (e.g., if the source is contained within a general permit).

Wasteload allocations are established for two NPDES-regulated permits discharging to Vermillion River segment 3, the city of Vermillion WWTF (SD0020061) and the city's MS4 (SDR41A001). These WLAs are identified in Table 7 and discussed in Section 8.1.1 (*Waste Load Allocations*) and Section 7.1 (*Point Sources*). WLAs for both facilities are given in CFUs per day. The WWTF WLA is set at a constant load throughout all five flow regimes (Table 7). The current effluent limits are written to protect the limited contact recreation use; however, the permit will be revised to include effluent limits consistent with the downstream immersion recreation use (≤ 126 CFU/100mL as a 30-day criterion and ≤ 235 CFU/100mL as a single sample maximum limit). The WLA was calculated using the design flow of 4.0 million gallons per day and the immersion recreation single sample maximum concentration. Normal operations of the facility would typically result in discharge of only a portion of the allowable daily load. DANR notes that all discharges are required to meet the immersion recreation single sample maximum and geometric mean water quality criteria (Section 8.1.1, *Waste Load Allocations*).

The WLA allocation analysis associated with the MS4 discharge is discussed in Section 8.1.1 (*Waste Load Allocations*). *E. coli* loads are expected to vary depending on precipitation; therefore, a jurisdictional area approach was used to develop an *E. coli* WLA by flow regime. The MS4 area is one percent of the total watershed area; therefore, the WLA for each flow regime was calculated as one percent of the remaining allowable load after the margin of safety (MOS) and WWTF WLA were subtracted from the loading capacity.

Concentrated Animal Feeding Operations (CAFOs) were discussed in Section 7.1.2 and seven CAFOs were identified in the watershed. These CAFOs are not expected to contribute to *E. coli* loads if they are in compliance with their permit requirements; therefore, they were not assigned an allocation within the document and, thus, are given a WLA of zero. No additional permit conditions are required by the TMDL. Several other permits were identified in the report (Section 7.1) but are not contributing sources of *E. coli* and no wasteload allocations were established for these facilities.

Assessment: EPA concludes that the WLAs provided in the TMDL are reasonable, will result in the attainment of the water quality standards and will not cause localized impairments. The TMDL accounts for all point sources contributing loads to impaired segments, upstream segments, and tributaries in the watershed.

6. Margin of Safety

The TMDL submittal must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load allocations, wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). The MOS may be ***implicit*** *or* ***explicit****.*

If the MOS is ***implicit****, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is* ***explicit****, the loading set aside for the MOS must be identified.*

The TMDL for Vermillion River segment 3 includes an explicit MOS derived as 10% of the loading capacity (Section 8.1.3 [*Margin of Safety*]). The explicit MOS is included as a separate allocation in Table 7 and varies by flow regime.

Assessment: EPA concludes that the TMDL incorporates an adequate margin of safety.

7. Seasonal Variation

The TMDL submittal must be established with consideration of seasonal variations. The method chosen for including seasonal variations in the TMDL must be described (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

The variability of measured stream flows and monitored *E. coli* concentrations are summarized in Section 8.3 (*Seasonal Variation & Critical Conditions*). The load duration curve method used to establish the TMDL incorporates variations in stream flow, which in turn, is influenced by other climatic and human factors that change throughout the year. To account for these variations, DANR developed the TMDL at different flow zones as listed in Table 7. In addition to these flow and water quality patterns, the immersion recreation water quality criteria have a seasonal component as they apply during the recreation season (May through September).

DANR noted that bacteria concentrations exceed the TMDL targets during several different flow regimes, suggesting that bacteria contamination can occur throughout much of the recreation season. The greatest *E. coli* loads are observed during the high and moist flow zones and are associated with watershed-wide spring snowmelt or intense rainfall events. DANR also notes that bacteria contamination during dry conditions are likely to be more localized in the riparian zone and direct to the stream channel. Restoration efforts should account for seasonal patterns to achieve TMDL goals.

Assessment: EPA concludes that seasonal variations were adequately described and considered to ensure the TMDL allocations will be protective of the applicable water quality standards throughout any given year.

8. Reasonable Assurances

When a TMDL is developed for waters impaired by both point and nonpoint sources, EPA guidance (USEPA. 1991) and court decisions say that the TMDL must provide reasonable assurances that nonpoint source control measures will achieve expected load reductions in order for the TMDL to be approvable. This information is necessary for EPA to determine that the TMDL, including the load and wasteload allocations, has been established at a level necessary to implement the applicable water quality standards (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

EPA guidance (USEPA. 1997) also directs Regions to work with States to achieve TMDL load allocations in waters impaired only by nonpoint sources. However, EPA cannot disapprove a TMDL for nonpoint source-only impaired waters, which do not have a demonstration of reasonable assurance that LAs will be achieved, because such a showing is not required by current regulations.

The TMDL for Vermillion River segment 3 is developed for an assessment unit impaired by both point and nonpoint sources, thus reasonable assurances must be provided (see Section 9.5 [*Reasonable Assurance*]). Reasonable assurance justifications are provided for both point and nonpoint sources.

For point sources, the WLAs established for the city of Vermillion WWTF are based on an *E. coli* effluent concentration at the TMDL target, which is lower than the current effluent limit, and facility discharge rates. Achieving these WLAs, which will be implemented through the NPDES permitting process, is critical to implementation success. DANR provided recommendations in Section 9.6.2 to ensure high operational effectiveness including continuing with scheduled sewer repair, upgrading treatment systems with new technologies, and monitoring *E. coli* to assess compliance. Similar recommendations are provided for the city of Irene and the towns of Volin and Gayville that did not receive WLAs because they are not anticipated to be a source of *E. coli*; however, these implementation measures are helpful to prevent any future water quality degradation. DANR also provided information on BMP implementation for the city of Vermillion MS4 in Sections 9.6.2 and 7.1, consistent with their SWMP, as well as the city's plans to update some MS4 infrastructure, all of which will reduce bacteria loading from the storm sewers.

Nonregulatory, voluntary-based reasonable assurances are provided for the LAs where the submittal discusses DANR's monitoring strategy to gage TMDL effectiveness in the future (Sections 9.1 [*Improvement and Monitoring Strategy Overview*] and 9.7 [*Strengthening Source Assessment and Available Data*]) and the core aspects of a TMDL implementation strategy (Sections 9.6.1 [*Grazing and Manure Management*] and 9.9 [*Implementation Strategy*]). These assurances include the watershed stewardship and interest from the Vermillion Basin Water Development District, building off their involvement in the previous watershed assessment project, and the continued implementation of the South Central Watershed Implementation Project. DANR notes several implementation measures that focus on bacteria monitoring and nonpoint source bacteria load reduction relevant to Vermillion River segment 3 sources described in the TMDL source assessment and load duration curve results. In particular, projects for future implementation include reduced livestock access to streams, installation of riparian buffer strips, implementation of proper animal waste management systems, and an iterative assessment of progress and revision to the project plan, when needed.

Assessment: EPA considered the reasonable assurances contained in the TMDL submittal and concludes that they are adequate to meet the load reductions. Nonpoint source load reductions are expected to occur through the implementation of best management practices ongoing and planned to begin in the future. Point sources with NPDES permits require that effluent limits are consistent with assumptions and requirements of WLAs for the discharges in the TMDL.

9. Monitoring Plan

The TMDL submittal should include a monitoring plan for all:

- *Phased TMDLs; and*
- *TMDLs with both WLA(s) and LA(s) where reasonable assurances are provided.*

Under certain circumstances, a phased TMDL should be developed when there is significant uncertainty associated with the selection of appropriate numeric targets, estimates of source loadings, assimilative capacity, allocations or when limited existing data are relied upon to develop a TMDL. EPA guidance (USEPA. 2006b) recommends that a phased TMDL submittal, or a separate document (e.g., implementation plan), include a monitoring plan, an explanation of how the supplemental data will be used to address any uncertainties that may exist when the phased TMDL is prepared and a scheduled timeframe for revision of the TMDL.

For TMDLs that need to provide reasonable assurances, the monitoring plan should describe the additional data to be collected to determine if the load reductions included in the TMDL are occurring and leading to attainment of water quality standards.

EPA guidance (USEPA. 1991) recommends post-implementation monitoring for all TMDLs to determine the success of the implementation efforts. Monitoring plans are not a required part of the TMDL and are not approved by EPA but may be necessary to support the decision rationale for approval of the TMDL.

In Sections 9.1 (*Improvement and Monitoring Strategy Overview*), 9.7 (*Strengthening Source Assessment and Available Data*), and 9.8 (*Consistent Data Collection and Methodologies*) DANR presents recommendations for future water quality monitoring efforts, including effectiveness assessment, loading analyses, and source assessment. In particular, they identify specific monitoring locations, including continued sampling at WQM5 and additional sampling at tributaries, to assess changes in *E. coli* concentrations over time. DANR also discusses expansion of stakeholder- and volunteer-led monitoring programs including training by DANR to support and evaluate local implementation activities. This submittal is not considered a phased TMDL, however, DANR maintains the ability to modify the TMDL and allocations as new data become available using an adaptive management approach (Section 9.3 [*Adaptive Management Process*]) in accordance with EPA's TMDL revision process.

Assessment: Monitoring plans are not a required element of EPA's TMDL review and decision-making process. The TMDL submitted by DANR includes a commitment to monitor progress toward attainment of water quality standards. EPA is taking no action on the monitoring strategy included in the TMDL submittal.

10. Implementation

EPA policy (USEPA. 1997) encourages Regions to work in partnership with States/Tribes to achieve nonpoint source load allocations established for 303(d)-listed waters impaired by nonpoint sources. Regions may assist States/Tribes in developing implementation plans that include reasonable assurances that nonpoint source LAs established in TMDLs for waters impaired solely or primarily by nonpoint sources will in fact be achieved. The policy recognizes that other relevant watershed management processes may be used in the TMDL process. EPA is not required to and does not approve TMDL implementation plans.

EPA encourages States/Tribes to include restoration recommendations (e.g., framework) in all TMDLs for stakeholder and public use to guide future implementation planning. This could include identification of a range of potential management measures and practices that might be feasible for addressing the main loading sources in the watershed (see USEPA. 2008b, Chapter 10). Implementation plans are not a required part of the TMDL and are not approved by EPA but may be necessary to support the decision rationale for approval of the TMDL.

In Sections 9.4 (*Water Quality Restoration Objectives*) and 9.9 (*Implementation Strategy*), DANR describes requirements of a 9-element watershed restoration plan that could be developed by local stakeholders to identify implementation activities and the Section 319 Nonpoint Source Management Program that can provide funding for BMPs. The South Central Watershed Implementation Project is a 319-funded project to address bacteria pollutant sources in the Vermillion River basin and describes BMPs that have been considered for the basin, including to address sources identified in the TMDL for segment 3. In Section 9.6 (E. coli *Restoration Approach*), DANR further describes potential implementation activities to reduce bacteria loading associated with grazing and manure management and point source loadings from WWTFs and MS4s.

Assessment: Although not a required element of the TMDL approval, DANR discussed how information derived from the TMDL analysis process can be used to support implementation of the TMDL. EPA is taking no action on the implementation portion of the TMDL submittal.

11. Public Participation

EPA policy is that there must be full and meaningful public participation in the TMDL development process. Each State/Tribe must, therefore, provide for public participation consistent with its own continuing planning process and public participation requirements (40 C.F.R. §25.3 and §130.7(c)(1)(ii)).

The final TMDL submittal must describe the State/Tribe's public participation process, including a summary of significant comments and the State/Tribe's responses to those comments (40 C.F.R. §25.3 and §25.8). Inadequate public participation could be a basis for disapproving a TMDL; however, where EPA determines that a State/Tribe has not provided adequate public participation, EPA may defer its approval action until adequate public participation has been provided for, either by the State/Tribe or by EPA.

Public Participation (Section 10.0) explains the public engagement process DANR followed during development of the TMDL. A draft TMDL report was released for public comment from May 20, 2022 to June 21, 2022. The opportunity for public review and comment was posted on DANR's website and announced in several area newspapers: the Vermillion Plain Talk, Centerville Journal, Lennox Independent, and New Era. No public comments were submitted.

Assessment: EPA has reviewed DANR's public participation process and concludes that DANR involved the public during the development of the TMDL and provided adequate opportunities for the public to comment on the draft report.

12. Submittal Letter

The final TMDL submittal must 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 (40 C.F.R. §130.7(d)(1)). The final submittal letter should contain such identifying information as the waterbody name, location, assessment unit number and the pollutant(s) of concern.

A transmittal letter with the appropriate information was included with the final TMDL report submission from DANR, dated June 23, 2022 and signed by Paul Lorenzen, Environmental Scientist Manager – TMDL Team Leader, Watershed Protection Program.

Assessment: EPA concludes that the state's submittal package clearly and unambiguously requested EPA to act on the TMDL in accordance with the Clean Water Act and the submittal contained all necessary supporting information.

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