E. coli Bacteria Total Maximum Daily Load (TMDL) for Six Mile Creek, Brookings and Deuel Counties, South Dakota

South Dakota Department of Agriculture and Natural Resources
Watershed Protection Program
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Acronym list

ARSD	Administrative Rules of South Dakota
BMP	Best management practice
CAFO	Concentrated Animal Feeding Operation
cfs	Cubic feet per second
CFU	Colony forming units
DMR	Discharge monitoring report
E. coli	*Escherichia coli*
EDWDD	East Dakota Water Development District
GM	Geometric mean
gpd	Gallons per day
HSPF	Hydrologic Simulation Program Fortran
IR	Integrated Report
LA	Load Allocation
MGD	million gallons per day
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NASS	National Agricultural Statistics Service
NHD	National Hydrography Dataset
NLCD	National Land Cover Database
NPDES	National Pollutant Discharge Elimination System
RB	Rotating basin
SDCL	South Dakota Codified Law
SDDANR	South Dakota Department of Agriculture and Natural Resources

SDSU	South Dakota State University
SSM	Single sample maximum
SWMM	Storm Water Management Model
SWMP	Storm Water Management Program
TMDL	Total Maximum Daily Load
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WLA	Waste Load Allocation
WPP	Watershed Protection Program
WWTF	Wastewater Treatment Facility

Six Mile Creek *E. coli* Total Maximum Daily Load Summary Table

Water Body Type:	River/Stream
Entity ID:	SD-BS-R-SIXMILE_01
Designated Use of Concern:	Limited Contact Recreation
303(d) Listing Parameter:	*E. coli* bacteria
Location:	HUC Code: 101702020601 (Upper Six Mile) and 101702020602 (Lower Six Mile)
Size of Watershed:	53,000 acres (83 sq. miles)
Size of Impaired Waterbody:	29 miles (46.2 km) out of 44.6 total miles (71.9 km) of Six Mile Creek.
Indicators:	*E. coli* bacteria, colony forming units (cfu)
Segment Description:	North Deer Creek to S30, T112N, R48W
Initial Listing Date:	2014 Integrated Report
TMDL Ranking Priority:	Priority 1 (2022 IR)
Analytical Approach:	Load Duration Curve Framework
Water Quality Target:	Meet limited contact recreation water quality standards ARSD 74:51:01:51. *E. coli*-maximum daily concentrations of ≤ 1,178 cfu/100ml and a monthly geometric mean of ≤630 *E. coli* cfu/100ml.

TMDL Component	Six Mile Creek Segment 1 Flow Zones Expressed as (CFU/day)			
	High Flows	Moist Conditions	Dry Conditions	Low Flows
	> 26.67 cfs	26.66 to 10.52 cfs	10.51 to 3.15 cfs	≤ 3.14 cfs
LA	2.22E+12	5.20E+11	1.77E+11	1.83E+10
WLA-City of White	5.76E+10	5.76E+10	5.76E+10	5.76E+10
WLA-Brookings MS4	2.69E+11	6.30E+10	2.14E+10	2.21E+09
10% Explicit MOS	2.83E+11	7.12E+10	2.84E+10	8.68E+09
TMDL @ 1178 CFU/100mL	2.83E+12	7.12E+11	2.84E+11	8.68E+10
Current Load	2.70E+13	1.24E+12	4.44E+11	6.37E+11
Load Reduction	90%	43%	36%	86%

1.0 Objective

This document provides an *Escherichia coli* (*E. coli*) Total Maximum Daily Load (TMDL) evaluation for Six Mile Creek segment 1 in Brookings and southern Deuel Counties, South Dakota. The intent of this document is to clearly identify the components of the TMDL, support adequate public participation, and facilitate the U.S. Environmental Protection Agency (US EPA) review. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by US EPA. This TMDL document addresses the *E. coli* impairment for assessment unit **SD-BS-R-SIXMILE_01** or Six Mile Creek segment 1 located in the Big Sioux River Basin from S30, T112N, R48W to the confluence with North Deer Creek. Six Mile Creek segment 1 was assessed as nonsupporting the limited contact recreation designated use due to high *E. coli* bacteria concentrations and was placed on the 303(d) list of impaired waters in South Dakota's 2022 Integrated Report (IR) for Surface Water Quality Assessment. This segment was initially placed on the 303(d) list during the 2014 IR cycle (SDDANR, 2014) and has been on the TMDL Vision Priority list since 2015.

2.0 Watershed Characteristics

Six Mile Creek is a small perennial prairie stream in the central Big Sioux River basin. The direct Six Mile Creek watershed covers approximately 53,000 acres in southern Deuel County and northeast Brookings County (Figure 1). The watershed lies in Level IV ecoregion 46m which has well-drained drainage network (Bryce, et al 1996). Elevations range from 483 to 608 meters above mean sea level. The headwaters of Six Mile Creek begin in Deuel County above the town of White continuing southwest to Brookings. The area has a humid continental climate with precipitation largely occurring in the spring and summer months. The average annual rainfall is roughly 24 inches with 36 inches of snowfall though considerable variability can exist during wet and dry cycles (NOAA, 2019). Streamflow in the Big Sioux basin has reportedly increased in recent years (Hoogenstraat and Stamm, 2015). Brookings has an average of 130 frost free days a year from May 14th to September 22nd (1895-2018) though the 30-year average has increased to 141 days (1988-2018).

South Dakota Department of Agriculture and Natural Resources (SDDANR) relies on United States Geological Survey (USGS) 1:100,000 medium resolution National Hydrography Dataset (NHD) to define stream segments and watershed hydrologic unit boundaries. This provides the state and EPA with a standardized identification approach to enable communication with regards to Clean Water Act activities including those associated with sections 304(a), 303(d) and 305(b). During the TMDL development process it was recognized that the NHD flow line for Six Mile Creek segment 1 is inconsistent with the actual flow pattern. The actual flow line is the result of flood control measures implemented to protect the city of Brookings. SD DANR and EPA are currently working with USGS to correct the Six Mile Creek segment 1 flow line and associated watershed boundary in the medium resolution NHD (1:100,000 scale) application. In the interim, it is the intention of this section to accurately describe Six Mile Creek segment 1 in accordance with proposed spatial corrections while maintaining consistency with the segment description defined in ARSD (https://sdlegislature.gov/Rules/Administrative/28368) for which this TMDL applies.

Figure 1 depicts a broad scale view of the Six Mile Creek segment 1 HUC 12 watershed boundary (purple) and flow line (blue) currently projected in medium resolution NHD. The corrected flow line (green) was drawn in conjunction with the NHD flow line to accurately represent Six Mile Creek segment 1 or SD-BS-

R-SIXMILE_01. In addition, monitoring stations used during various TMDL assessment projects and boundaries for the town of White and city of Brooking are also depicted to provide spatial perspective (Figure 1).

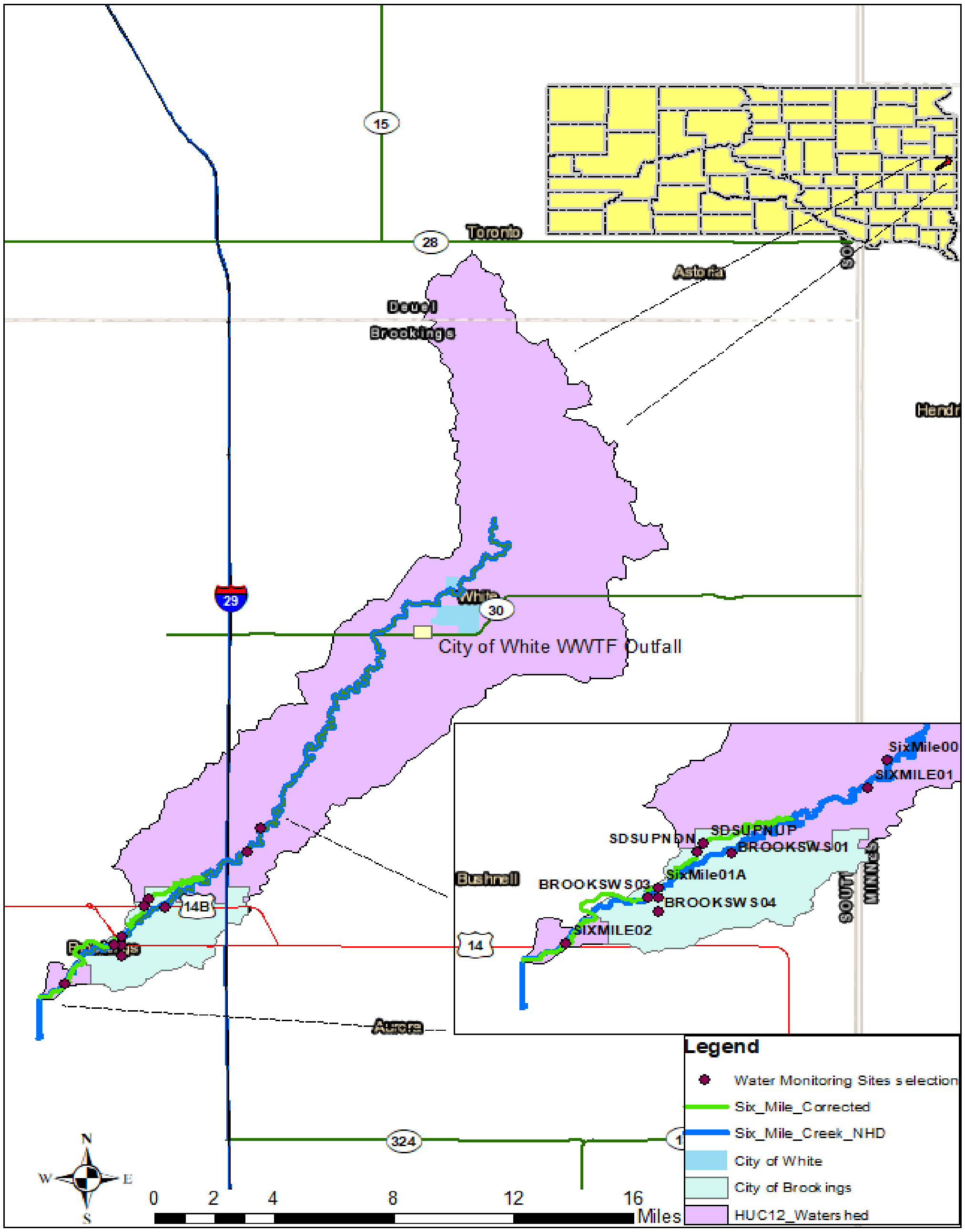

Figure 1: Six Mile Creek Segment 1 Watershed Depicting NHD (1:100,000) flow line, corrected flow line (ARSD), Monitoring Stations and Towns

A smaller spatial view of the lower Six Mile Creek watershed depicting the corrected flow line is provided to clarify identification of the impaired segment and facilitate discussion concerning flood control modifications surrounding Brookings (Figure 2). Modification to Six Mile Creek segment 1 starts roughly 1 mile upstream of Brookings. The new channel was re-routed to the north and diverted to a small impoundment (South Dakota State University [SDSU] pond) before crossing Highway 14 to the south and eventually entering the original channel near the northwest corner of Brookings. This modification was implemented to provide flood control for the northern tier of Brookings and SDSU.

Six Mile Creek segment 1 at the western edge of Brookings has been altered extensively beginning in 1973. Flood control for the municipal airport rerouted 3,950 feet of stream into a constructed channel. The channel was rerouted in 1991 then moved again in 1998. The current section briefly extends into the Lower Deer Creek HUC impacting the actual Six Mile Creek watershed boundary solely due to the alterations (Figure 2). This area is relatively small and will need to be corrected in NHD (1:100,000 scale) in concert with corrections to the flow line to achieve accuracy.

Six Mile Creek segment 1 merges with a channelized section of North Deer Creek also known as North Deer Ditch approximately 1.5 miles downstream of Brookings. The combined channelized section of Six Mile Creek and North Deer Ditch enter the Big Sioux River approximately one mile downstream according to current projection in NHD (1:100,000 scale). Six Mile Creek segment 1 actually ends at North Deer Creek (ARSD, DANR, 2022). The corrected Six Mile Creek segment 1 flow line was calculated at 28.72 miles. To conclude, the NHD (1:100,000 scale) spatial data associated with Six Mile Creek segment 1 or assessment unit SD-BS-R-SIXMILE_01 is currently inaccurate and requires corrective measures. In the interim, this TMDL recognizes the corrected Six Mile Creek segment 1 as depicted in Figures 1 and 2 consistent with ARSD (https://sdlegislature.gov/Rules/Administrative/28368) and is pending correction in medium resolution NHDPlus (1:100,000).

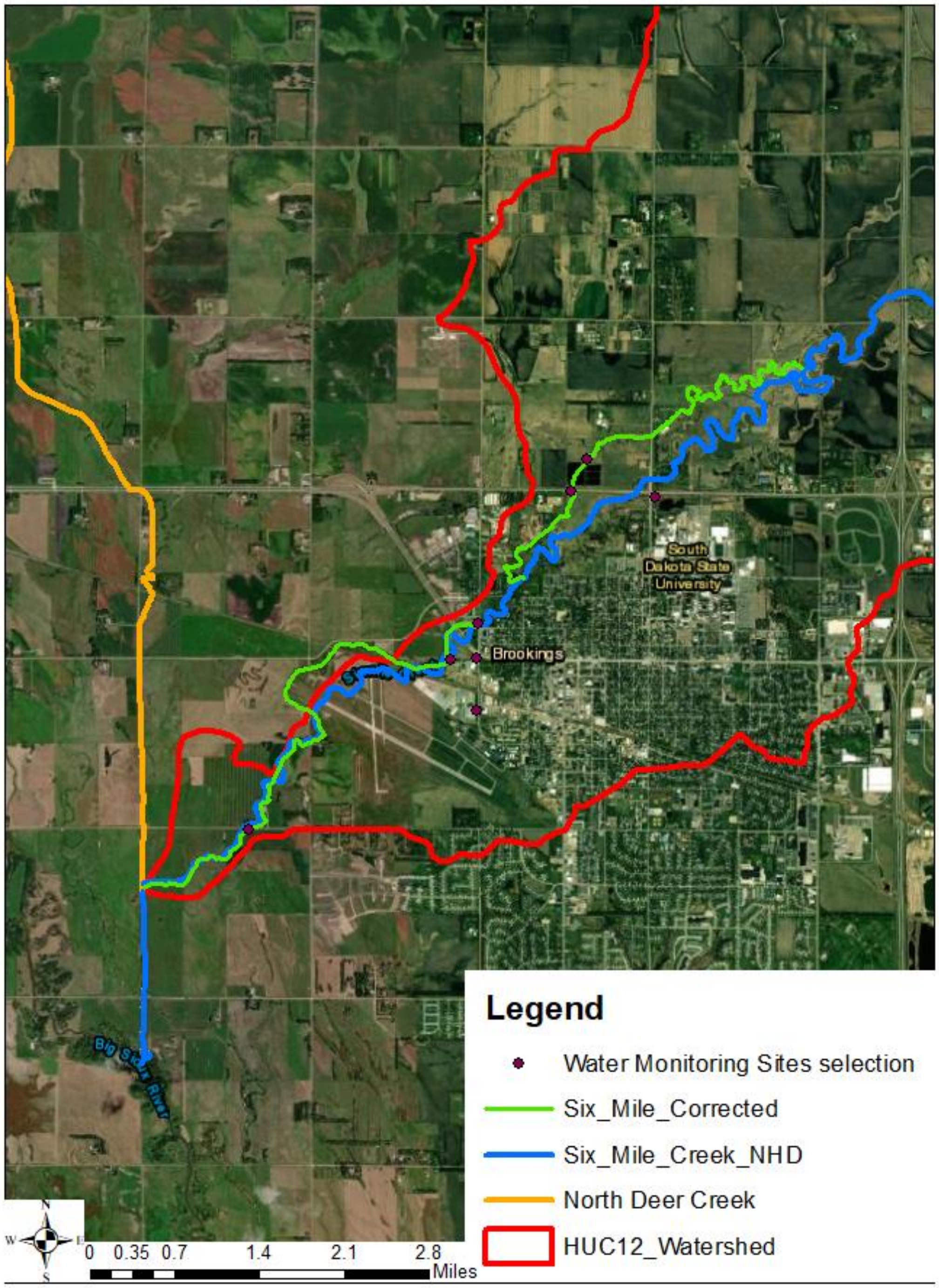

Figure 2. Six Mile Creek Segment 1 Lower Watershed Depicting NHD (1,00,000 scale) Flow Line and Corrected Flow Line (ARSD)

2.1 Geology and Soils

In pre-settlement days, the Six Mile Creek watershed was full of prairie pothole wetlands. The creek itself sits atop a shallow alluvial layer (Figure 3). Glacial outwash lays in the valley lower in the watershed and shallow sand and gravel layers sits atop Cretaceous Pierre shale (Bryce et al, 1996). Productive mollisols support crop production in the watershed.

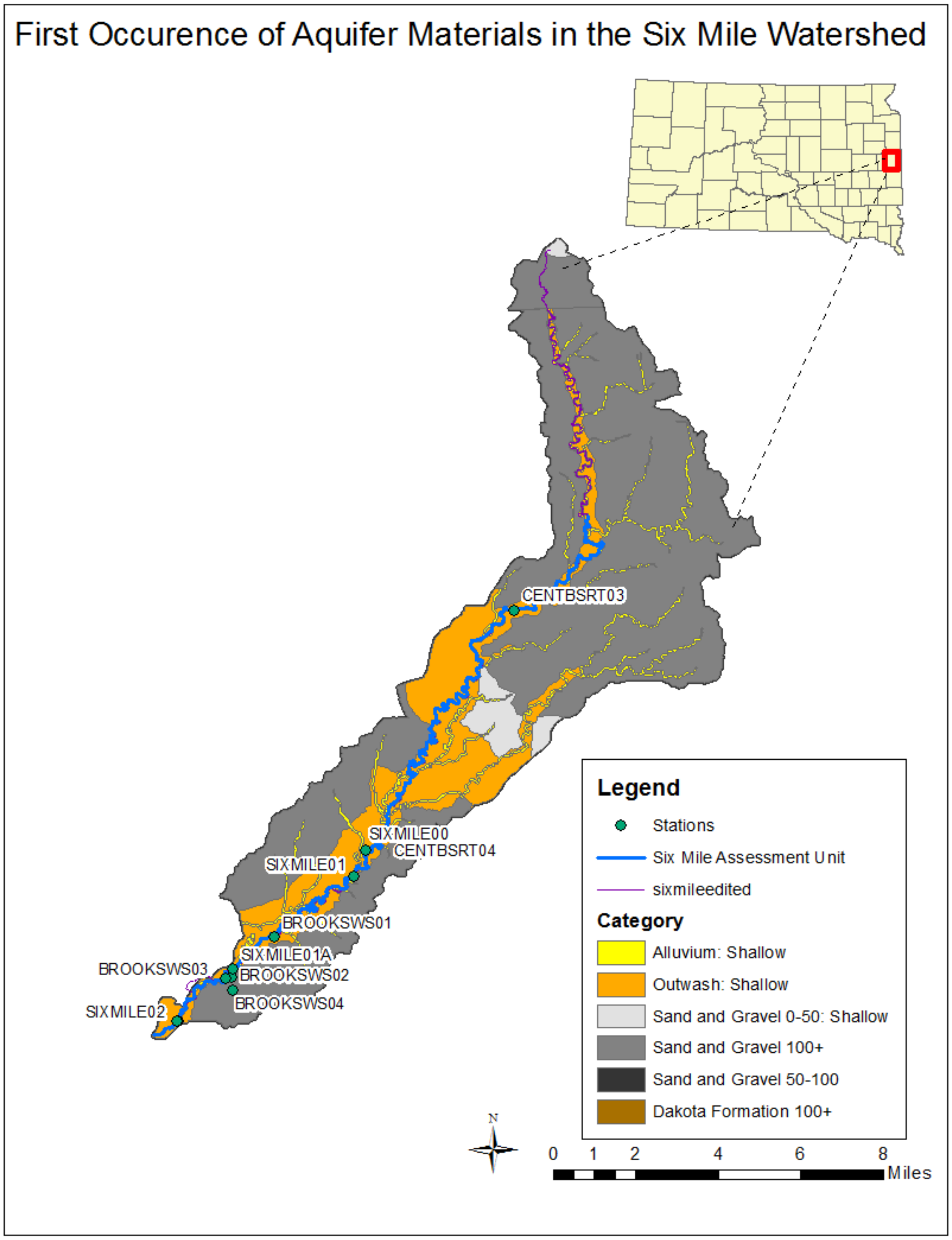

Figure 3: First Occurrence of Aquifer Materials in the Six Mile Watershed

Except two small hillside areas, most of the watershed area is not highly erodible (Figure 4). Loamy soils on till plains include the Barnes and Svea Associations and silty Estelline soils in the upper watershed. Badger and Tonka series are clayey alluvial soils common in poorly drained areas with Maryland soils in the floodplains which are poorly drained loamy alluvium.

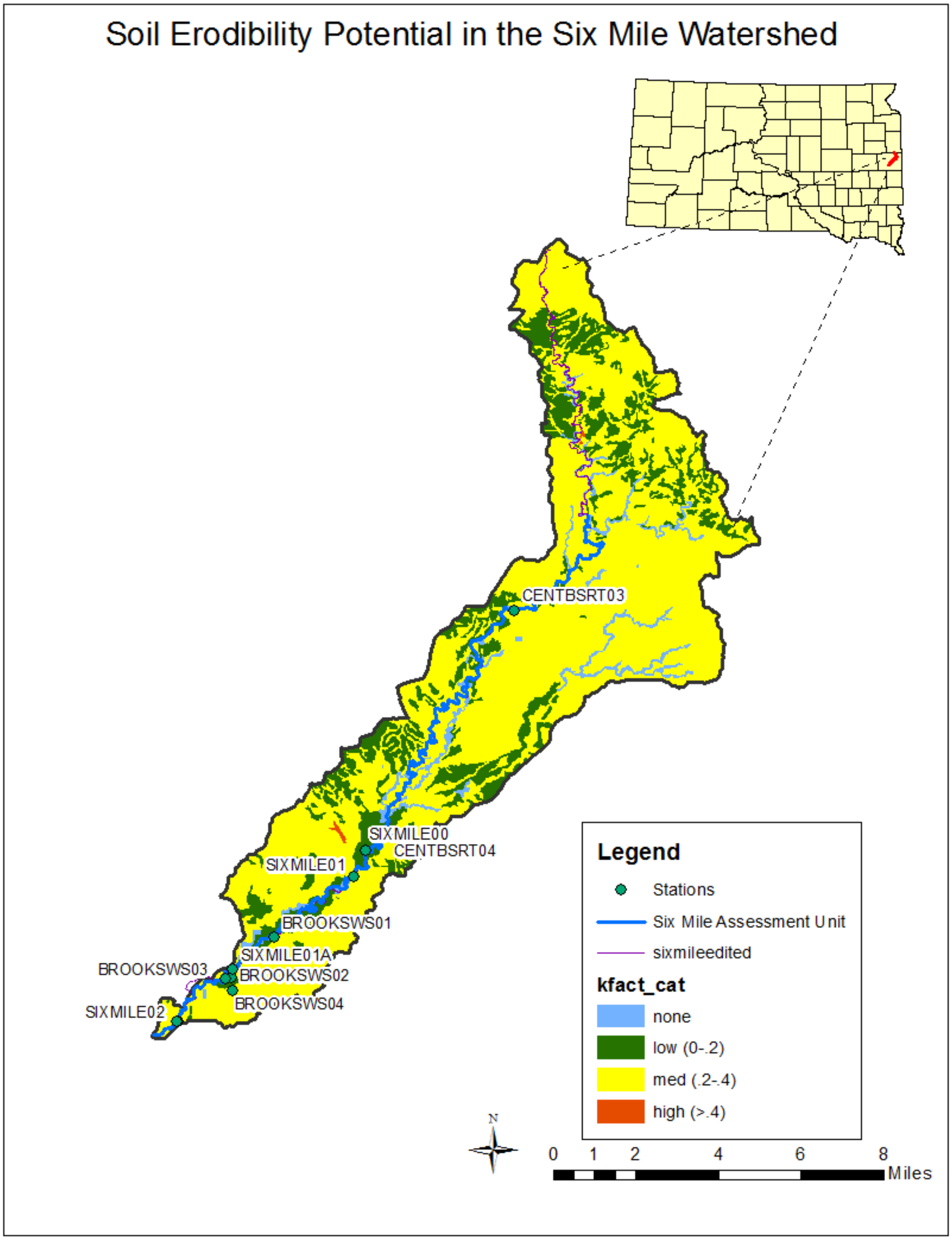

Figure 4: Soil Erodibility in Six Mile Watershed

2.2 Land Use and Population

The watershed is used extensively for agriculture, which comprised 89% of land area in 2017 and is approximately 10% developed. Wetlands and forested areas have decreased since 2006. Changes in land use from 2006 to 2017 are shown in Table 1. The grassland area is mainly used for grazing. Much of the grazing takes place in the remaining riparian areas adjacent to streams. The hydrology has been altered in recent years, with many remnants of prairie potholes that have been drained but are still visible in the imagery. Tile drainage is extensive in the area which also alters the hydrology, increasing flow within Six Mile Creek and throughout the Big Sioux basin (SDDANR 2004). Tallgrass prairie with big and little bluestem, switchgrass and Indian grass are the native species, however little intact tallgrass prairie remains. Riparian vegetation includes willows and cordgrass with other hardwood forest, however those too have been greatly reduced (Bryce et al., 1996). The most current (2017) land use map is shown in Figure 5.

Table 1: Land Use in Six Mile Creek according to the National Land Cover Dataset (NLCD)

Six Mile Summary Land Use Percentages		
Classes	NLCD 2006	NLCD 2017
barren	10.05	0.07
developed	11.91	9.95
forest	0.73	0.54
grassland	13.30	17.21
hay	3.62	5.68
row crops	52.06	64.12
small grain	2.73	1.99
water	0.29	0.06
wetlands	5.31	0.38

The population of Brookings County was estimated at 4,965 in 1880. The population of Brookings County in 2020 was 34,375 according to the U.S. Census Bureau. Two communities reside in the Six Mile Creek watershed. The largest of the two communities, Brookings is located at the lower end of the watershed and has a population of 23,377 (2020 census). The town of White is located in the upper portion of the watershed and has a population of 518 (2020 census).

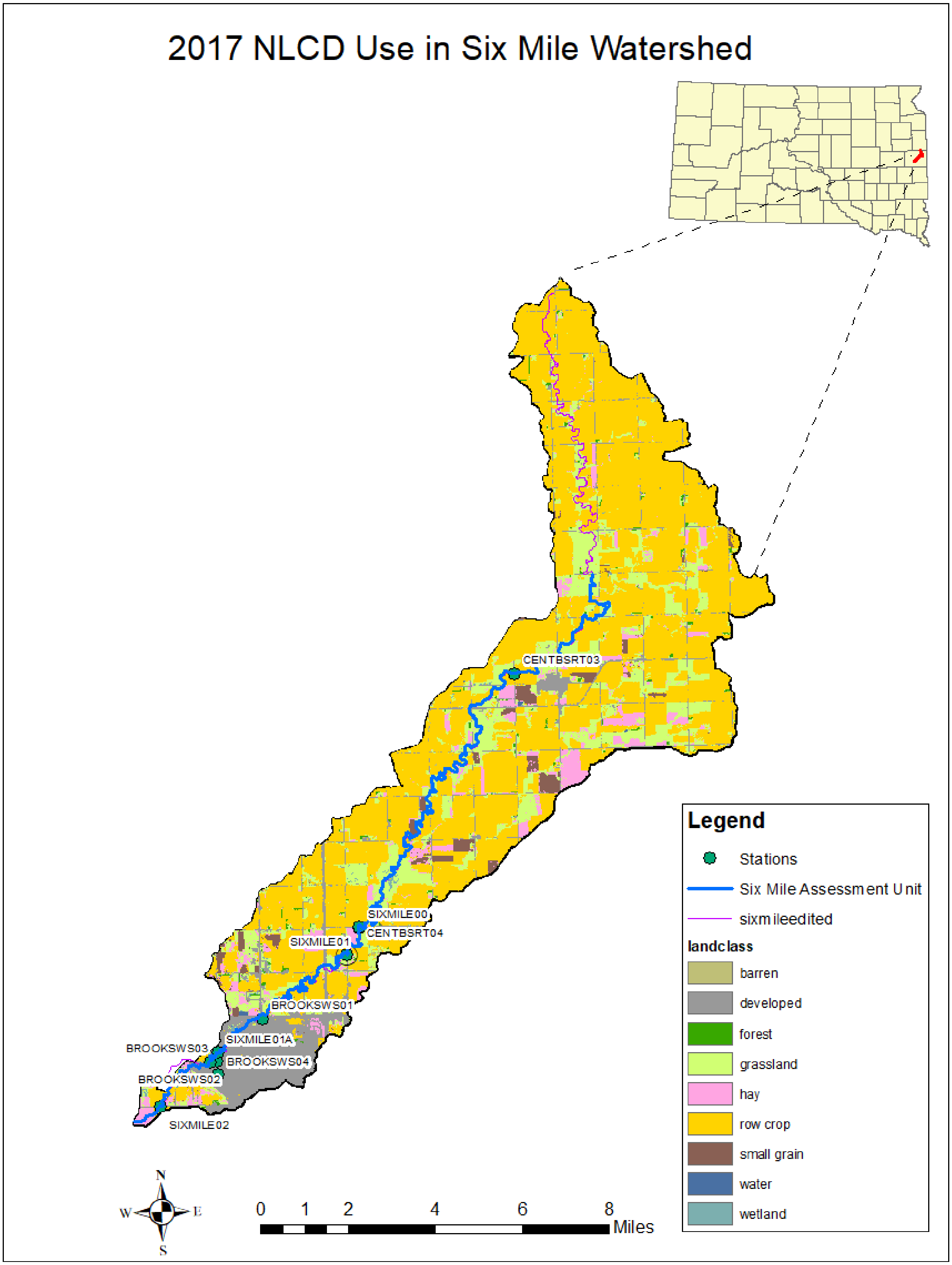

Figure 5: Land Use in Six Mile Creek Watershed.

3.0 South Dakota Water Quality Standards

Water quality standards are comprised of three main parts 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

Each individual waterbody within South Dakota is designated one or more of the following beneficial uses:

(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 have the designated uses of (9) fish and wildlife propagation, recreation and stock watering and (10) irrigation. Additional uses are designated by the state based on a waterbody specific use attainability assessment.

Six Mile Creek is designated the beneficial uses of warmwater marginal fish life propagation (6), limited contact recreation (8), fish and wildlife propagation, recreation, and stock watering (9) and irrigation waters (10).

3.2 Water Quality Criteria

Water quality criteria have been defined in South Dakota state statutes in support of all beneficial uses. The standards consist of suites of numeric criteria that provide physical and chemical benchmarks from which support determinations and impairment decisions can be identified. Table 2 lists numeric criteria that must be met to support the beneficial uses designated to SD-BS-R-SIXMILE_01. When multiple uses establish criteria for the same parameter, the most stringent criterion is used for regulatory purposes as indicated in the table with parentheses. Limited contact recreation includes activities such as fishing, boating and other water-related activities other than immersion recreation where a person's water contact would be limited to the extent that infections of eyes, ears, respiratory or digestive systems or urogenital areas would normally be avoided (ARSD 74:51:01:01). The beneficial uses (6, 8, 9 and 10) and associated criteria designated to Six Mile Creek are presented in Table 2.

Table 2: Beneficial Uses and Water Quality Criteria for Six Mile Creek

Parameters	Criteria	Unit of Measure	Beneficial Use
Total Ammonia nitrogen as N	Equal to or less than the result from Equation 3 in Appendix A of Surface Water Quality Standards	mg/L (30 day average March 1 to Oct 31)	Warmwater Marginal Fish Life Propagation
	Equal to or less than the result from Equation 2 in Appendix A of Surface Water Quality Standards	mg/L (30 day average Nov 1 to Feb 29)	
	Equal to or less than the result from Equation 2 in Appendix A of Surface Water Quality Standards	mg/L Daily Maximum	
Dissolved Oxygen	≥ 4.0	mg/L daily minimum October 1-April 30	Warmwater Marginal Fish Life Propagation
	≥ 5.0	mg/L daily minimum May 1-September 30	
Total Suspended Solids	≤150 (30d average) and ≤263 (single sample)	mg/L	Warmwater Marginal Fish Life Propagation
Temperature	≤90	°F	Warmwater Marginal Fish Life Propagation
Escherichia coli Bacteria (May 1- Sept 30)	≤630 (geometric mean) and ≤1178 (single sample)	count/100mL	Limited Contact Recreation
Alkalinity (CaCO3)	≤750 (30d average) and ≤ 1,313 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
Conductivity	≤2,500 (30d average) and ≤4,375 (single sample)	µmhos/cm @ 25° C	Irrigation Waters
Nitrogen, nitrate as N	≤50 (30d average) and ≤88 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
pH (standard units)	≥6.0 to ≤9.0	standard units	Warmwater Marginal Fish Life Propagation
Solids, Total dissolved	≤2,500 (30d average) and ≤4,375 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
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
Sodium Adsorption Ratio	<10	ratio	Irrigation Waters
Microcystin	< 8	µg/L	Limited Contact Recreation
Cylindrospermopsin	<15	µg/L	Limited Contact Recreation
Undissociated Hydrogen Sulfide	< 0.002	mg/L	Warmwater Marginal Fish Life Propagation

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.

3.3 *E. coli* Water Quality Criteria

South Dakota has adopted numeric *E. coli* criteria for the protection of the immersion (7) and limited contact recreation uses (8). Immersion recreation waters are to maintain suitability 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 maintain suitability 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 (USEPA, 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 100ml, 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 (USEPA, 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 (USEPA, 2002). Because of the reduced risk, the multiplier was considered protective of the limited contact recreation use through the EPA and SDDANR 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 exceed 235 cfu/100 ml and 2) during a 30-day period, the geometric mean 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). As noted, these limited contact criteria are five times the corresponding immersion criteria. *E. coli* criteria apply from May 1 through September 30, which is considered the recreation season. The numeric *E. coli* criteria applicable to Six Mile Creek (SD-BS-R-SIXMILE_01) are the limited contact recreation values listed in Table 2. While not explicitly described within the state’s water quality standards, geometric mean criteria, including geometric means and 30-day averages, are applied to a calendar month. This method is documented in the listing methodology of South Dakota’s most recent (2022) IR for Surface Water Quality Assessment and is used in National Pollutant Discharge Elimination System (NPDES)/Surface Water Discharge permits.

3.4 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 (SDDANR, 2022). SDDANR 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. 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: 303(d) Assessment Methods for Determining Support Status (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). LAKES: Reference the lake listing methodology starting on page 31 of the 2022 IR.	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..

The assessment method mentions chronic and acute criteria. Although these terms do not directly relate to *E. coli* criteria for reasons previously discussed, 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 geomean (GM) and acute refers to the singles sample maximum (SSM) *E. coli* criteria. Different assessment methods have been established for toxic parameters and mercury in fish tissue. In Section 6.0, data collection activities are summarized and monitoring results are evaluated using this assessment method.

5.0 Numeric TMDL Targets

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. Occasionally, impairment is caused by narrative water quality criteria violations or by parameters that cannot be easily expressed as a load. When this occurs, the narrative criteria must be translated into a numeric TMDL target (e.g., nuisance aquatic life translated into a total phosphorus target) or a surrogate target established (e.g., a pH cause addressed through a total nitrogen target) and a demonstration should show how the chosen target is protective of water quality standards.

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 were 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 contain two components: a GM and a 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 75th, 82nd, 90th, and 95th percentiles of the expected water quality sampling distribution around the GM to account for different recreational use intensities (Figure 6). South Dakota adopted the most stringent recommendation, the 75th percentile, into state water quality standard regulations as the SSM protective of designated beaches.

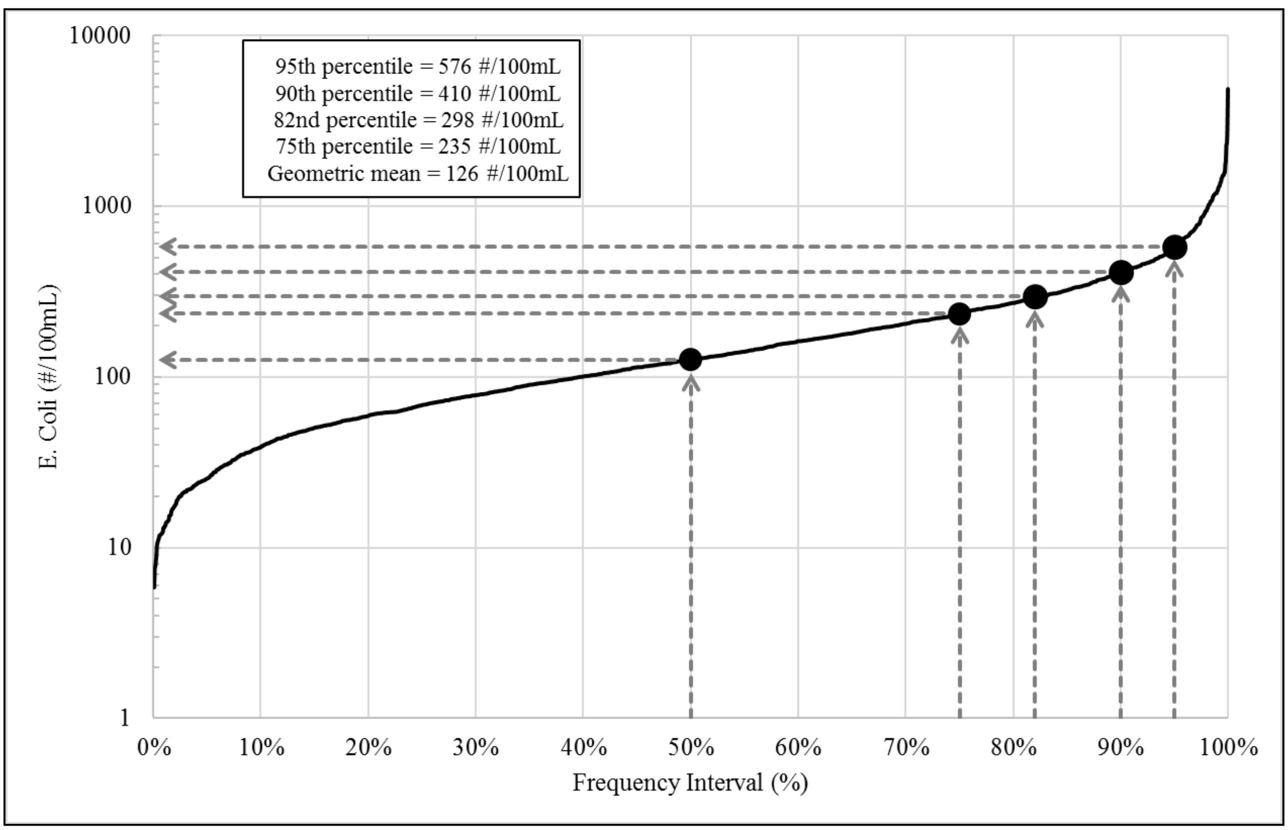

Figure 6: Log-Normal Frequency Distribution Used to Establish South Dakota's Immersion Recreation *E. coli* Criteria of 126 (GM) and 235 (SSM) #/100mL (EPA, 1986).

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, SDDANR may use 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 Six Mile Creek (SD-BS-R-SIXMILE_01), SDDANR 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 SDDANR's *E. coli* assessment method, when combined with a SSM TMDL target, result in an expected dataset GM more protective than the GM criterion. SDDANR uses assessment methods to define how to interpret and apply water quality standards to 303(d) impairment decisions. These methods are further discussed in Section 4.0, however for this discussion, it is important to note that SDDANR allows a 10% exceedance frequency of both the SSM and GM. In other words, as long as the *E. coli* dataset meets other age and size requirements, a waterbody is considered impaired (i.e., not meeting water quality standards) when greater than 10% of samples exceed either the SSM or GM. Water quality standards are met if the exceedance frequency is 10% or less.

Returning to the original distribution used to establish South Dakota's Immersion Recreation *E. coli* criteria in Figure 6, 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 7 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 7.

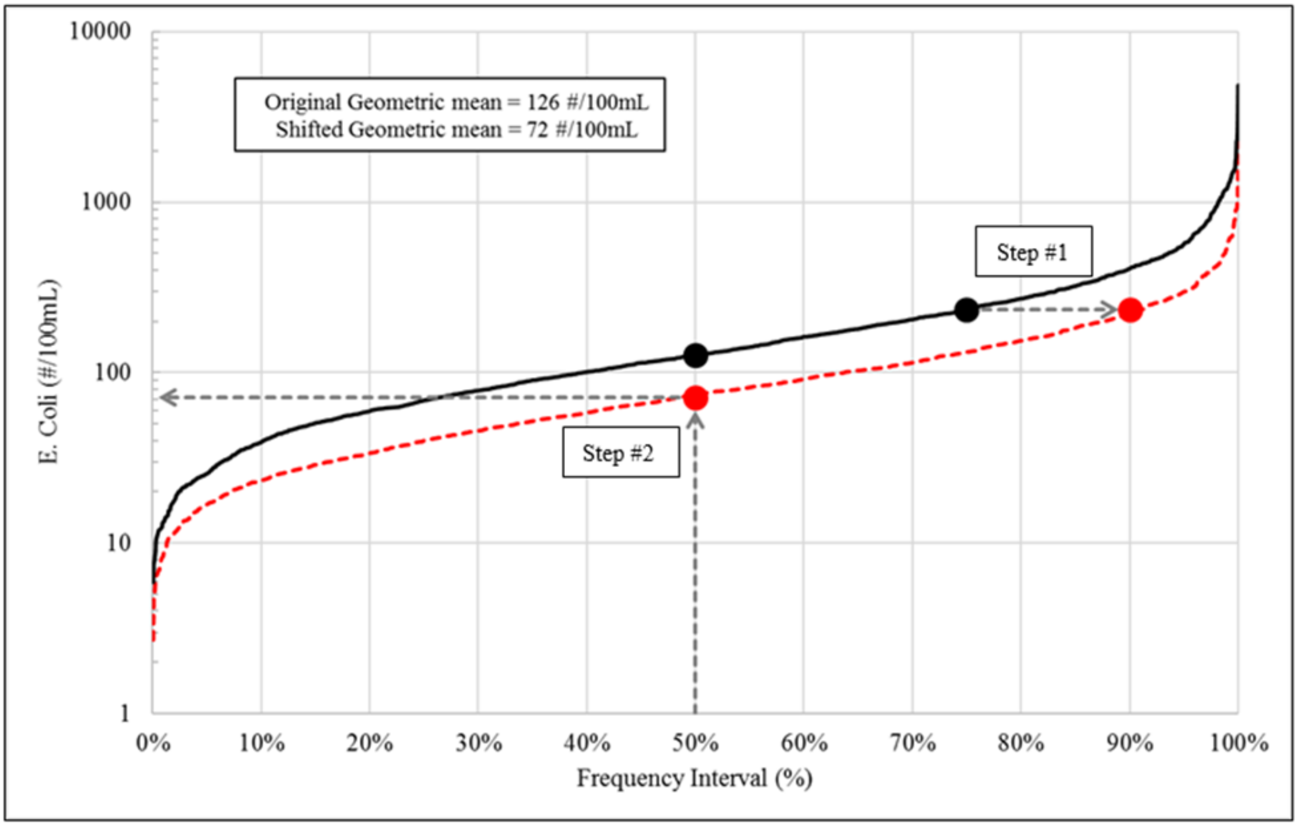

Figure 7: The Effective Impact of South Dakota's *E. coli* Assessment Method on the Criteria's Original Log-Normal Frequency Distribution (Black line = original; red dotted line = shifted)

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. Once again, this outcome holds true for South Dakota's limited contact recreation *E. coli* criteria since they were simply derived as five times the immersion values.

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 as long as 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. SDDANR follows these guidelines and only relies on one criterion when forced by data availability.

The limited contact recreation SSM *E. coli* criterion of 1,178 cfu/100mL was selected as the numeric TMDL target for Six Mile Creek because a proper geometric mean could not be calculated from the available monitoring dataset.

6.0 Data Collection and Results

6.1 Water Quality Data

The impaired segment of Six Mile Creek was part of four separate assessment projects conducted over the last 20 years. All assessment efforts associated with Six Mile Creek were conducted by Water Resource Technicians from East Dakota Water Development District (EDWDD) in Brookings, SD through a partnership with DANR. Six Mile Creek was first assessed during the Central Big Sioux River Assessment project in 2000. *E. coli* samples were not collected during this project though results of the assessment indicated that Six Mile Creek had elevated levels of fecal coliform. This project established monitoring sites that would be used in subsequent assessment projects; CENBSRTR03 (SIXMILE01), CENBSRTR04 (SIXMILE 00) and CENBSRTR05 (SIXMILE02) (Figure 1).

The North Central Big Sioux River Assessment project (2005-2007) constituted the second assessment. Water quality samples were collected at the same locations on Six Mile Creek as in the previous project. Results of the sampling indicated Six Mile Creek was not supporting the limited contact recreation use due to elevated levels of fecal coliform. Six Mile Creek was placed on the 303(d) list of impaired waters in the 2010 Integrated Report. A limited number of *E. coli* samples were collected during the second assessment.

The third assessment (2012-2013) focused directly on the impaired segment of Six Mile Creek to address bacteria as part of the TMDL development process. The focus of this assessment shifted to *E. coli*, which replaced fecal coliform as the bacterial indicator to protect the recreation beneficial uses in 2009 (ARSD 74:51:01). This project established monitoring sites in the city of Brookings to evaluate *E. coli* loading from the storm sewer system with direct discharge to Six Mile Creek (BROOKSWS01, BROOKSWS02, BROOKSWS03 and BROOKSWS04, Figure 1). Sampling was conducted at SIXMILE01 (above Brookings) and SIXMILE02 (below Brookings) in conjunction with storm sewer monitoring following precipitation events (Figure 8). Monitoring sites were also established upstream (SDSUPNUP) and downstream (SDSUPNDN) of the SDSU impoundment (Figures 1 and 2). Six Mile Creek was identified as impaired for *E. coli* in the 2014 IR from data collected during this assessment effort (SDDANR, 2014).

The fourth assessment (2015) expanded on previous efforts and established new monitoring stations to better characterize *E. coli* loading above the city of Brookings. In addition, site SIXMILE01A was established in the City of Brookings (Figure 1). *E. coli* monitoring at SIXMILE01 and SIXMILE02 continued during the 2018 field season as part of EDWDDs water quality assessment program. *E. coli* data collected within the recreation season during the third, fourth and 2018 assessments were used to develop the TMDL for the impaired segment of Six Mile Creek (Appendix A).

All applicable *E. coli* data collected from 2012 to 2018 at monitoring stations established on the impaired segment of Six Mile Creek were evaluated against the SSM standard (1,178 cfu/100 mL) for limited contact recreation waters. A total of 152 *E. coli* samples were available for the evaluation. Thirty-three samples exceeded the SSM standard. *E. coli* concentrations exceeded the SSM standard in 24 of 60 independent sample dates. *E. coli* concentrations from SIXMILE01 exhibited the highest exceedance rate of all mainstem sites (Table 4, Figure 8). Increased *E. coli* concentrations at SIXMILE01 may be the result of local influence from a small livestock feeding area located in close proximity to the site.

E. coli concentrations in Six Mile Creek segment 1 increase within the city of Brookings. *E. coli* concentrations in the upper portion of Six Mile Creek segment 1 are significantly reduced before entering Brookings due to the influence of the SDSU pond. None of the *E. coli* samples collected at SDSUPNDN exceeded the SSM standard (Table 4). *E. coli* concentrations increase as Six Mile Creek flows along the northwestern tier of Brookings. This is first indicated by at 20% exceedance rate at SIXMILE01A (Table 4). *E. coli* samples from the four off channel storm sewer sites display relatively high concentrations and exceedance rates. *E. coli* samples collected at the furthest downstream site (SIXMILE02) displayed a 12% exceedance rate. *E. coli* concentrations from this site represent the cumulative loading from the entire segment. On dates where the storm sewers exceeded the bacteria standards, 50% percent (3 out of 6) of samples downstream at SIXMILE02 exceeded the SSM standard. Overall *E. coli* concentrations are higher upstream than at the lowest downstream site (Figure 9). *E. coli* reductions are warranted from the Brookings stormwater sewer outfalls to ensure compliance with Six Mile Creek segment 1 water quality criteria downstream of Brookings. In addition, implementing nonpoint source best management practices to reduce *E. coli* loading to Six Mile Creek using a holistic watershed approach is warranted to ensure compliance with water quality criteria above Brookings. *E. coli* sample collection was not conducted at the frequency required to calculate a monthly geometric mean (GM).

Table 4: Data Summary by Site from Upstream to Downstream

Data Summary	# samples	samples exceeding	percent exceeding	stormwater sample	stormwater exceeding	percent stormwater exceeding	bimonthly sampling	stormflow mean cfu	baseflow mean cfu
SIXMILE00	10	1	10%	1	0	0%	10	24.71	9.09
SIXMILE01	61	23	38%	16	5	31%	45	38.61	7.62
SDSUPNUP	10	1	10%	1	0	0%	9	24.71	9.09
SDSUPNDN	10	0	0%	1	0	0%	9	24.71	9.09
*BROOKSWS01**	8	5	63%	4	3	75%	4	49.79	6.85
SIXMILE01A	10	2	20%	1	0	0%	9	24.6	9.09
*BROOKSWS02**	6	5	83%	3	2	67%	3	74.95	8.64
*BROOKSWS03**	7	7	100%	4	4	100%	3	57.3	8.64
*BROOKSWS04**	7	5	71%	4	2	50%	3	44.23	8.64
SIXMILE02	51	6	12%	16	2	13%	35	38.32	9.37

*Green= above Brookings, blue= within city limits, red= downstream of Brookings * On storm sewer, or off mainstem Six Mile Creek*

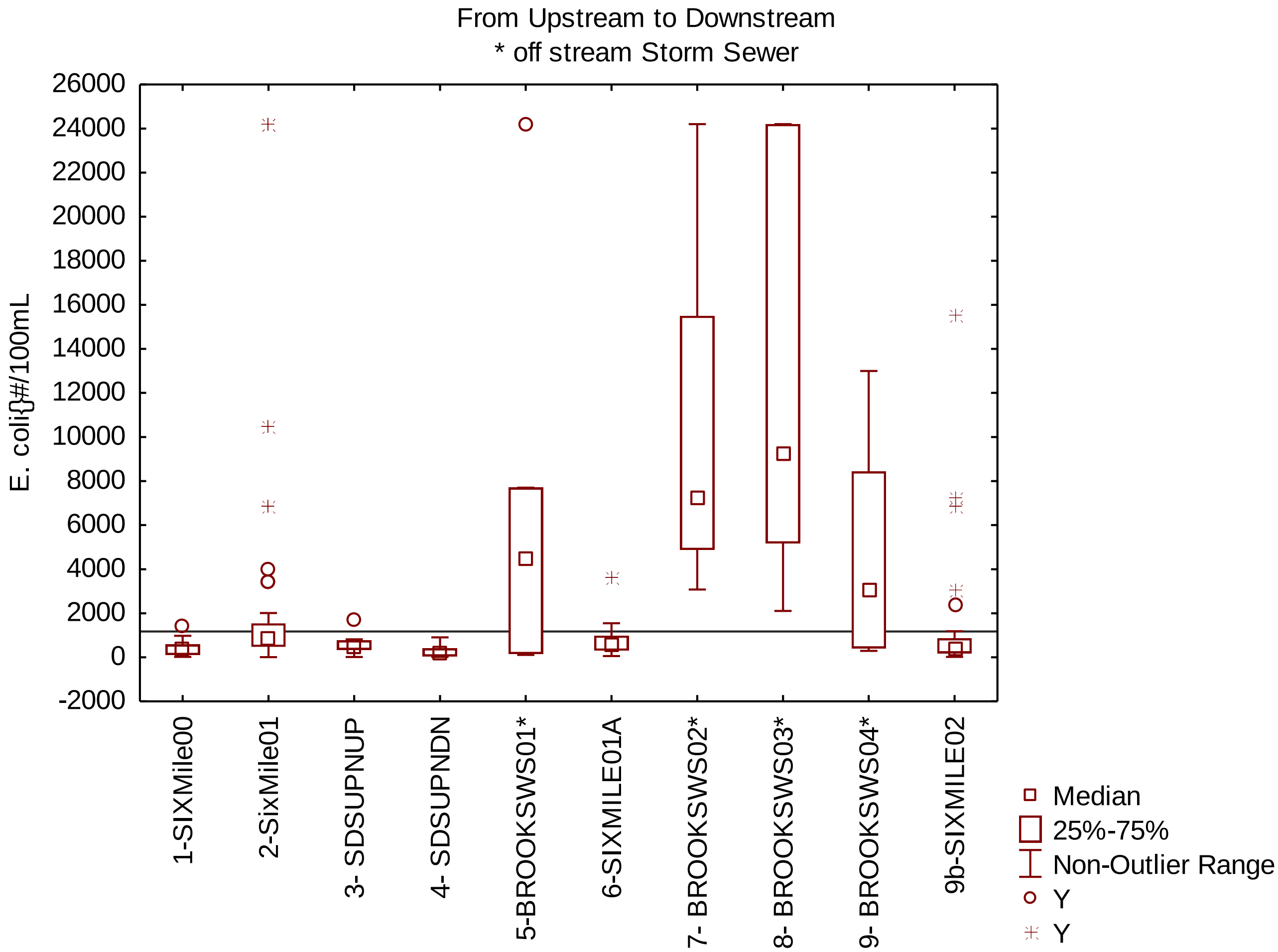

Figure 8: *E. coli* Results by Station 2012-2018

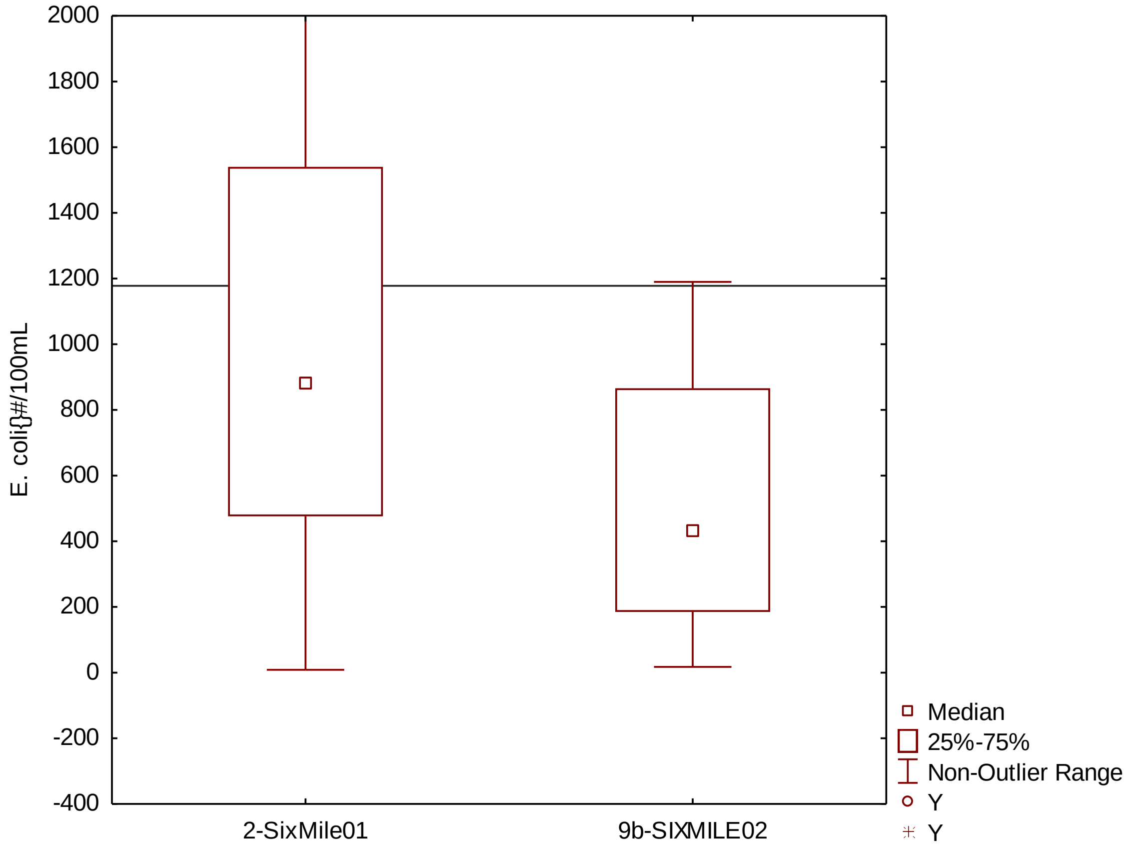

Figure 9: SIXMILE01 and SIXMILE02 *E. coli* Samples 2012-2018

6.2 Flow Information

Minimal focus was placed on quantifying continuous stream flow for Six Mile Creek during the water quality assessments. As a result, a continuous flow record was developed using available flow information. In 2018, a permanent stream level gage was installed at SIXMILE00 as part of DANRs Statewide Stream Flow Monitoring project https://danr.sd.gov/Conservation/WatershedProtection/Projects/StreamflowMonitoringNetwork.aspx. Periodic flow measurements were collected in 2018 at various stream levels (stage) to develop a stage/discharge relationship (i.e., rating curve). The average daily stage derived flows generated at SIXMILE00 (Stage 2018 Six Mile Q) were related to average daily flows available from the nearest USGS streamflow station (6480000) located on the Big Sioux River 10 miles downstream from the confluence of North Deer Creek. The relationship resulted in an average daily flow record (SIXMILE00 Adjust Q) for the period of record for which sample data was available (i.e., 2012 to 2018), where SIXMILE00 Adjust Q = 4.1537*(0.12*USGS 6480000 $_{Q}$ +2 days) (-2.29128).

Periodic flow measurements collected at SIXMILE00 in 2018 (Direct Six Mile Q) were used to validate the SIXMILE00 Adjust Q flows for the period of record (2012-2018). The physical flow measurements related well with flows estimated by the SIXMILE00 Adjust Q model (R^2=0.92), despite underestimating high flows (Figure 10). Daily flows generated from the SIXMILE00 Adjust Q model were used to develop the load duration curve based TMDL for the impaired segment of Six Mile Creek.

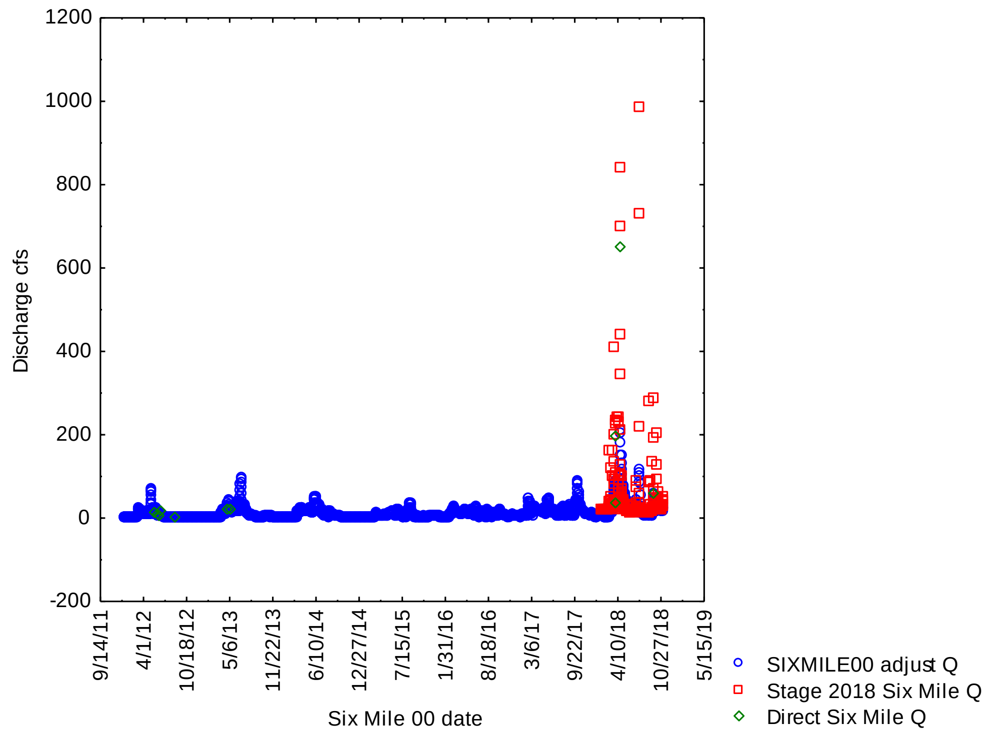

Figure 10: SIXMILE00 Adjust Q flows, Direct Six Mile Flows and Stage 2018 Six Mile Flow

7.0 Source Assessment and Allocations

This section provides an *E. coli* source assessment for the Six Mile Creek segment 1 watershed. All point sources with permit coverage are identified. Watershed scale nonpoint sources were also identified, and bacteria production was quantified using a population per area formula.

7.1 Point Source Assessment

7.1.1 NPDES Permitted Facilities

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.

There are documented point sources within the Six Mile Creek watershed. This includes NPDES permitted facilities that may directly contribute *E. coli* to the impaired segment of Six Mile Creek. In addition, the city of Brookings holds a phase II MS4 permit. All potential point sources of *E. coli* bacteria are documented here to provide a watershed scale account of the entity's operational characteristics (discharge permits etc.), potential impact and Waste Load Allocation (WLA) consideration for TMDL development.

Dacotah Bank (NPDES Permit# SD0028568), SDSU Swimming Pool (NPDES Permit# SD0026832) and Brookings Municipal Utilities Water Distribution System (NPDES Permit# SDG860083):

Dacotah Bank and the SDSU swimming pool are permitted to discharge to a portion of the Brookings stormwater sewer system (MS4) that drains directly to Six Mile Creek segment 1. Neither facilities NDPES permit contain *E. coli* effluent limits because bacteria is not a pollutant of concern. A WLA was not provided for either facility in the TMDL. Brookings Municipal Utilities is permitted to discharge overflow water from the water distribution system which could potentially reach Six Mile Creek. The permit does not contain effluent limits for *E. coli* because it is not a pollutant of concern. As a result, a WLA was not provided in the TMDL.

City of White Waste Water Treatment Facility (NPDES Permit# SD0021636) and Water Distribution System (NPDES Permit# SDG860010):

The city of White is approximately 11 miles northeast of Brookings in the upper part of the Six Mile Creek segment 1 watershed. The city's wastewater treatment facility (WWTF) is located one mile southwest of the city of White (Figure 1). Wastewater is discharged to an unnamed tributary approximately 1.5 miles upstream from the confluence of Six Mile Creek. The facility is a gravity flow collection system with a three-cell stabilization pond. The system serves 518 people (2020 census) and has a peak design flow of 27,900 gallons per day (gpd). The facility has commonly discharged on a monthly basis for brief periods (days to weeks) since late 2014.

A WLA of 5.76E+10 cfu/day was allocated for this facility in the TMDL. The WLA was calculated by multiplying the permitted effluent limit or SSM *E. coli* standard for limited contact recreation (1,178 cfu/100 ml) by the 80^{th} percentile of daily maximum flows (1.29 million gallons per day [MGD]=2.0 cubic feet per second [cfs]) acquired from Discharge Monitoring Reports (DMRs), times a conversion factor (24465715). The normal operation of this municipal facility would typically result in only a portion of the calculated daily amounts being discharged.

The City of White is permitted to discharge overflow water from the water distribution system which could potentially reach Six Mile Creek. The permit does not contain effluent limits for *E. coli* because it is not a pollutant of concern. As a result, a WLA was not provided in the TMDL.

7.1.2 Brookings MS4

Stormwater runoff from the city of Brookings is transported through a municipal storm water sewer system. The cumulative stormwater contribution is directly conveyed to a modified section of Six Mile Creek designed to provide flood control. The modified section serves to increase flow capacity and provides a diversion around the regional airport and area roadways before connecting with the natural channel. The modified channel spans a distance of 3,950 linear feet. The channel is 50 feet wide and approximately 5 feet deep with a storage capacity of 987,500 cubic feet capable of discharges to 750 cfs.

Pollution control from the Brookings stormwater sewer system is regulated by a Phase II Municipal Separate Storm Sewer System (MS4) permit (# SDR41A003) issued by DANR. A Phase II MS4 permit is federally required of cities with a population size of 10,000 to 100,000. Provisions of the MS4 permit are implemented by the Brookings stormwater management program (SWMP). The cumulative MS4 area encompasses roughly 8,500 acres. The direct drainage area to Six Mile Creek was estimated at 3,999.5 acres according to the SWMP plan developed in 2015. The remaining MS4 drainage area associated with

Brookings drains directly and indirectly to the Big Sioux River. A Storm Water Management Model (SWMM) was completed by Banner and Associates in 2008 as part of the Brookings Master Drainage Plan. Impervious area by basin was calculated to produce runoff amounts. The model assumes Type B soils with moderate infiltration rates. Areas 3, 4, 5, 6, 20, 21, 22, 23, 24, 25, 26 and 27 outlined in red drain to Six Mile Creek (Figure 11). Percent impervious area (Ia) was calculated from NLCD and matched up well with the results from SWMM based on current Brookings zoning categories (Figure 12).

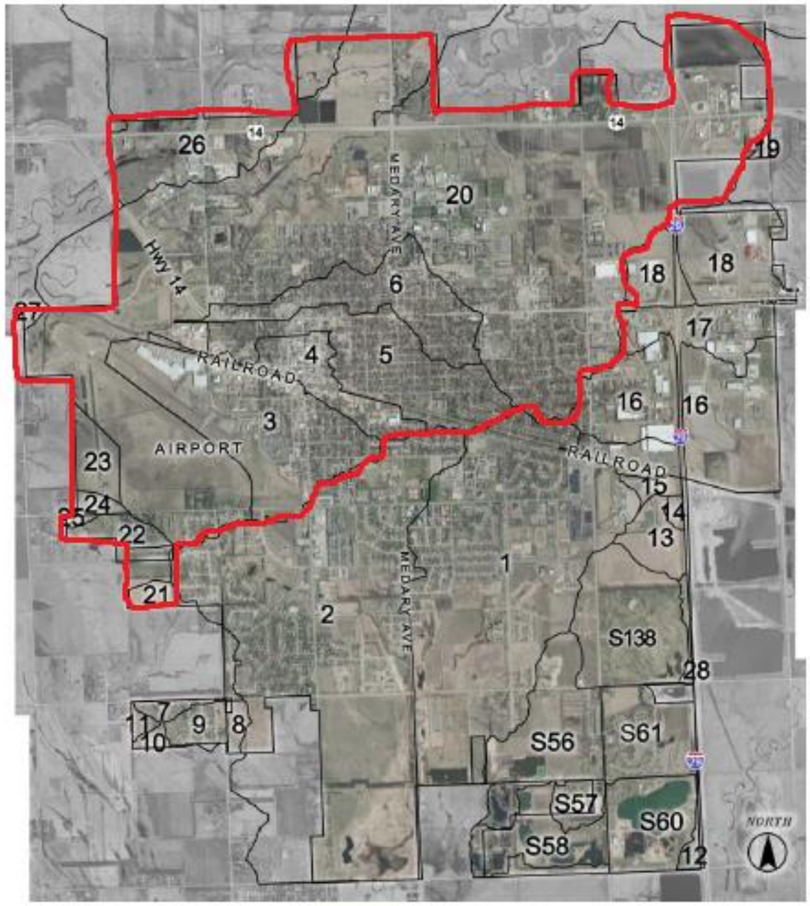

Figure 11: Brookings Drainage Areas

The Brookings stormwater sewer system (MS4 area) is considered a point source for *E. coli* bacteria loading to the impaired segment of Six Mile Creek. *E. coli* concentrations collected from the four main outfalls (BROOKSWS01, BROOKSWS02, BROOKSWS03 and BROOKSWS04) were examined to determine the significance of each source. The MS4 permit does not set pollutant effluent limits for stormwater discharges. *E. coli* concentrations were compared to the SSM *E. coli* criterion (1,178 CFU/100mL) for limited contact recreation designated to the downstream impaired segment of Six Mile Creek. A total of 28 *E. coli* samples were collected at the 4 outfall stations and 22 of those exceeded the criterion (Appendix A).

An *E. coli* load per acre was estimated for each of the four outfall stations using available concentration data, runoff (based on impervious surface) and drainage estimates. Station SWS02 had the highest load/acre (Table 5). This may be attributed to the relatively high percentage of impervious surface in respect to the small drainage area. Station SWS04 has similar drainage characteristics though the *E. coli* load per acre was less than half that from SWS02. Increasing water infiltration capacity and/or decreasing impervious surfaces would help reduce urban stormwater runoff. Focusing BMPs in the SWS02 drainage is warranted to effectively reduce overall bacteria loading in the MS4 area.

Table 5: Urban runoff areas

Station	Imperviousness (Ia)	Drainage area (ac)	Load/acre
SWS01	0.2382	972.7	1.10E+08
SWS02	0.5414	215.9	4.19E+08
SWS03	0.3849	2595.9	3.11E+08
SWS04	0.5524	284.2	1.72E+08

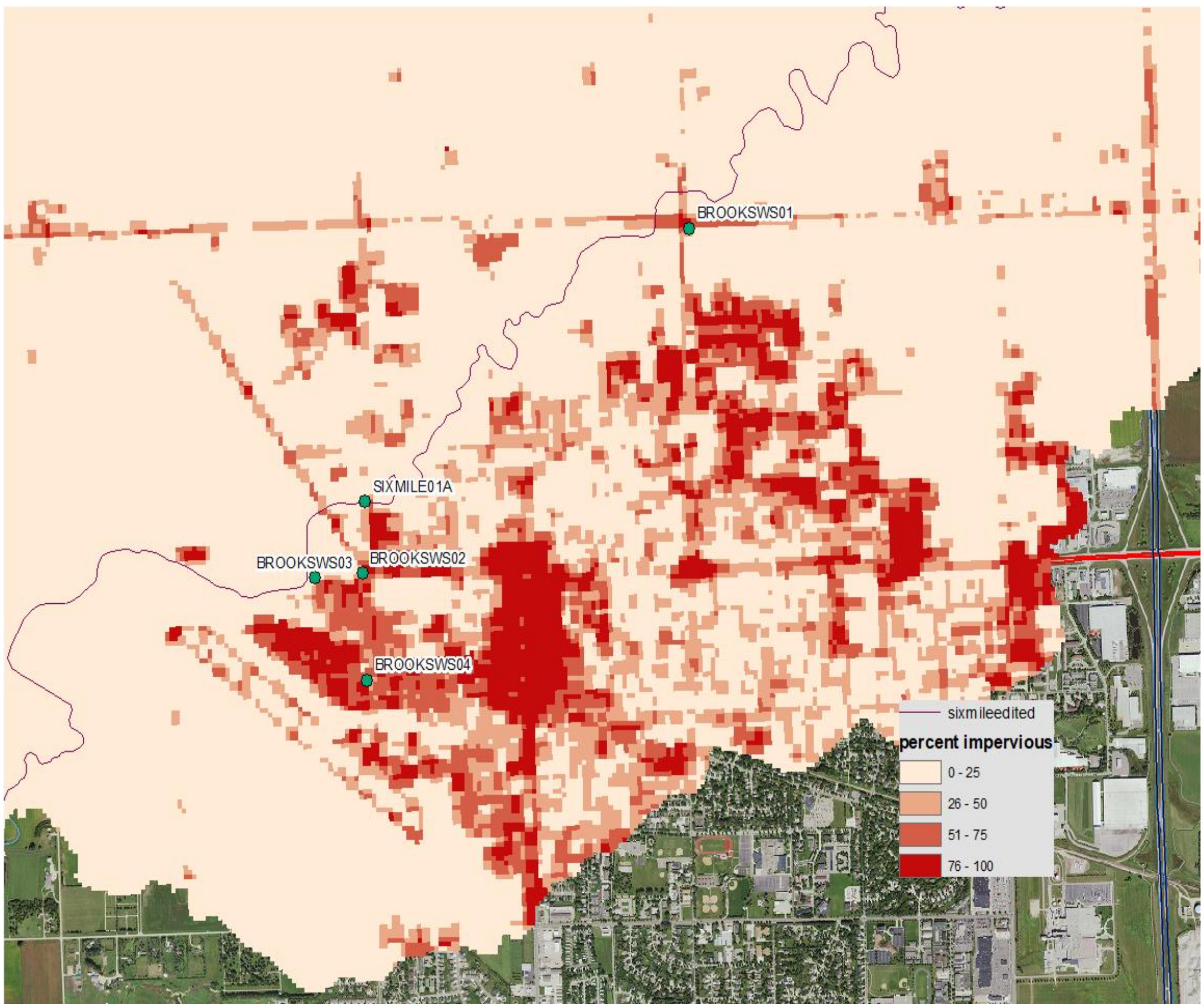

Figure 12: Urban Impervious Cover (NLCD 2011)

The Simple Method was used to quantity the cumulative *E. coli* load from the MS4 drainage area (Scheuler, 1987). *E. coli* concentrations collected from storm sewer outfall locations in 2012, 2013 and 2018 were used in the load calculations (Appendix A). It should be noted that *E. coli* concentrations used to generate loadings are limited and may not accurately depict the variable nature of *E. coli* (i.e., decay rate) in annual or daily load estimates (Scheuler, 1987). In addition, several assumptions are factored into the Simple Method calculations which ultimately impact accuracy of the *E. coli* loading results. The calculated loads simply represent estimates to glean insight into the *E. coli* loading within the MS4 area using the information available. The equations and loading results are documented in Appendix B. Load estimates were also derived from the SSM *E. coli* standard (1,178 cfu/100mL) to provide a sense of perspective. A substantial reduction in MS4 load is noted to meet the cumulative load at the SSM standard.

The WLA for the MS4 component was calculated by using a jurisdictional area approach. After the $WLA_{White,}$ and MOS were subtracted from the TMDL, the remainder was multiplied by the ratio of MS4 acres to the acres draining to SIXMILE00 where the flow calculation was based. The MS4 area was estimated at 10.8% of the watershed. Area-based jurisdictional bacteria load allocations are a common way to calculate WLAs in TMDLs.

MS4 allocation = (TMDL- MOS- WLA) * (3999.5/36694 acres)

The Brookings MS4 permit requires the city to implement Best Management Practices (BMP) that control pollutant run-off from stormwater outfalls during run-off events documented in the SWMP plan. Monitoring pollutant concentrations at the city's 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 plan. 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. Achieving *E. coli* concentrations in storm sewer outfalls at or below 1,178 cfu/100 ml (SSM) would protect the downstream limited contact recreation use designated to Six Mile Creek and help meet TMDL goals.

7.1.3 Permitted CAFOs

Large scale Concentrated Animal Feeding Operations (CAFOs) are considered point sources (SDDANR, 2017). All CAFO's are required to maintain compliance with provisions of the SD Water Pollution Control Act (South Dakota Codified Law [SDCL] 34A-2). Provision 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, if they meet conditions for coverage under a federal NPDES permit. For more information about South Dakota's CAFO requirements and general permits visit
https://danr.sd.gov/Agriculture/Livestock/FeedlotPermit/default.aspx.

As long as CAFOs comply with the general 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. There were no CAFOs identified in the watershed of the impaired segment of Six Mile Creek during TMDL development.

7.2 Nonpoint Source Assessment

A comprehensive assessment of the total *E. coli* production from nonpoint sources was conducted for the Six Mile Creek segment 1 watershed. Nonpoint sources of *E. coli* in the Six Mile Creek segment 1 watershed originate primarily from wildlife (i.e., natural background), agriculture and humans. Due to a lack of literature values for *E. coli* production of many livestock and wildlife species, source loading calculations were based on fecal coliform (Table 6). This is an acceptable surrogate to source characterization because *E. coli* is a bacterium within the fecal coliform group. Further, fecal coliform source contributions are considered synonymous with *E. coli* based on the close statewide paired bacteria data relationship documented in the bacteria translation TMDL https://danr.sd.gov/Conservation/WatershedProtection/TMDL/docs/TableDocs/tmdl_statewidetranslation_ecoli.pdf.

Data from the National Agricultural Statistic Survey (NASS) and the most recent South Dakota Game Fish and Parks County wildlife survey were used to estimate livestock and wildlife densities, respectively (USDA, 2017; Huxoll, 2002). Animal density information was used to estimate relative source contributions of bacteria for the Six Mile Creek segment 1 watershed (Table 6). Approximately 90% of the Six Mile Creek segment 1 watershed resides in Brookings County. Therefore, animal density estimates were based exclusively on the NASS estimates from Brookings County. The total number of animals in Brookings County was divided proportional to the number of acres in the watershed. The same procedure was also used for human and wildlife. E. coli production estimates for livestock, humans and some wildlife species are referenced from EPA's Bacteria Indicator Tool (USEPA, 2020). Bacteria production in the Six Mile Creek segment 1 watershed was estimated at 1.78E+09 cfu/acre/day (Table 6).

Table 6: Six mile Creek Watershed *E. coli* sources

Species	#/acre watershed	Bacteria/Animal/Day	Bacteria/Acre	Percent
Dairy cow3	3.29E-03	1.01E+11	3.33E+08	18.6%
Beef3	1.23E-02	1.04E+11	1.28E+09	71.8%
Hog3	1.31E-02	1.08E+10	1.42E+08	7.9%
Sheep3	1.27E-03	1.20E+10	1.52E+07	0.9%
Horse3	1.71E-04	4.20E+08	7.19E+04	0.004%
All Wildlife	**Sum of all wildlife**		1.07E+07	0.6%
Human3	1.594E-03	1.950E+09	3.11E+06	0.17%
Turkey (Wild)2	8.88E-06	9.30E+07	8.26E+02	
Goose3	1.78E-04	4.90E+10	8.70E+06	
Deer3	4.84E-04	5.00E+08	2.42E+05	
Beaver3	2.66E-04	2.50E+08	6.66E+04	
Raccoon3	1.78E-03	1.25E+08	2.22E+05	
Coyote/Fox4	1.86E-04	4.09E+09	7.63E+05	
Muskrat2	1.15E-03	1.25E+08	1.44E+05	
Opossom5	5.33E-04	1.25E+08	6.66E+04	
Mink5	3.55E-04	1.25E+08	4.44E+04	
Skunk5	9.77E-04	1.25E+08	1.22E+05	
Badger5	7.10E-05	1.25E+08	8.88E+03	
Jackrabbit5	4.44E-04	1.25E+08	5.55E+04	
Cottontail5	1.78E-03	1.25E+08	2.22E+05	
Squirrel5	1.78E-04	1.25E+08	2.22E+04	

2 USEPA 2001
3 Bacteria Indicator Tool Worksheet
4 Best Professional Judgment based off of Dogs
5 FC/Animal/Day copied from Raccoon to provide a more conservative estimate of background effects of wildlife

7.2.1 Agriculture

Manure from livestock is the main source of *E. coli* bacteria in the Six Mile Creek segment 1 watershed (99.23%). Most of the bacteria produced by livestock originates from beef and dairy cattle. Livestock can contribute *E. coli* directly to waterbodies when wading or watering in the steam channel. Livestock also contribute *E. coli* to waterbodies by defecating while in feeding areas and grazing on rangelands that get washed off during precipitation events. Livestock distribution on the landscape was separated in feedlots and rangeland. Feedlot numbers were calculated as the sum of all dairy, hog, and the NASS estimate of beef in feeding areas. All remaining livestock were assumed to be on grass. Roughly 50% of livestock in the Six Mile Creek segment 1 watershed were estimated to reside in feedlots and rangeland, respectively (Table 7).

Table 7: Bacteria contributions from livestock in Six Mile Creek watershed.

Source	Percent contribution
Livestock in Feedlots	49.96 %
Livestock on grass	49.27 %
Total Livestock	99.23 %

7.2.2 Human Sources

Septic systems are assumed to be the primary human source of bacteria for the rural population in Brookings County (approximately 8,974) or those not connected to Brookings or White wastewater treatment facilities. A majority of the rural population reside on acreages or farmsteads in the watershed. Daily human fecal production was estimated at 1.95E+9 (Yagow et al., 2001). The rural population was estimated to contribute 0.17% of all *E. coli* production in the watershed. Human bacteria production should all be delivered to a septic system, which if functioning correctly, would result in no bacteria entering Six Mile Creek. Septic system failure was not identified as a source of concern during watershed assessment projects.

7.2.3 Natural Background

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 estimated contribution of bacteria from wildlife in the Six Mile Creek segment 1 watershed was estimated at 0.6%. The largest contributor of bacteria from natural sources was geese. Livestock (agriculture source) is by far the largest contributor of bacteria in the Six Mile Creek segment 1 watershed (Table 8).

Table 8: Nonpoint Sources of E. coli

Source	Percent contribution
Livestock	99.23 %
Wildlife	0.6 %
Human	0.17 %

8.0 TMDL Load Duration Curve

A load duration curve framework provides the essential components for TMDL development. The flow frequency curve component is a measure of the frequency of occurrence of all daily mean flows in the record expressed as a percentage. Zero percent corresponds to the highest stream flow in the record and 100% to the lowest (EPA, 2007). The flow frequency curve serves as the foundation for development of a load duration curve. A load duration curve is developed by multiplying daily stream flow by the numeric water quality target and a conversion factor for the pollutant of concern. Hence, the load duration curve serves as the TMDL.

A load duration curve was generated for Six Mile Creek segment 1 to facilitate TMDL development. The load duration curve was based on the flow frequency (SIXMILE00 Adjust Q) and the SSM water quality criteria (1,178 CFU/100 ml) assigned to protect the limited contact recreation designated use for Six Mile Creek segment 1. All applicable (May-September) *E. coli* data available from the mainstem Six Mile Creek monitoring stations was plotted over the load duration curve (n=152 samples) to represent the current or actual loadings at individual flows along the flow frequency curve (Figure 13).

The load duration curve generated for Six Mile Creek segment 1 was separated into four flow zones (Figure 13). Flow zones were defined according to the flow regime structure and distribution of *E. coli* concentrations following guidance recommended by EPA (USEPA 2007). Four flow zones were established to facilitate interpretation of the hydrologic condition and patterns associated with the impairment. The zones were segmented by high flows (0-10 percent), moist conditions (10-40 percent), dry conditions (40-80 percent) and low flows (80-100 percent).

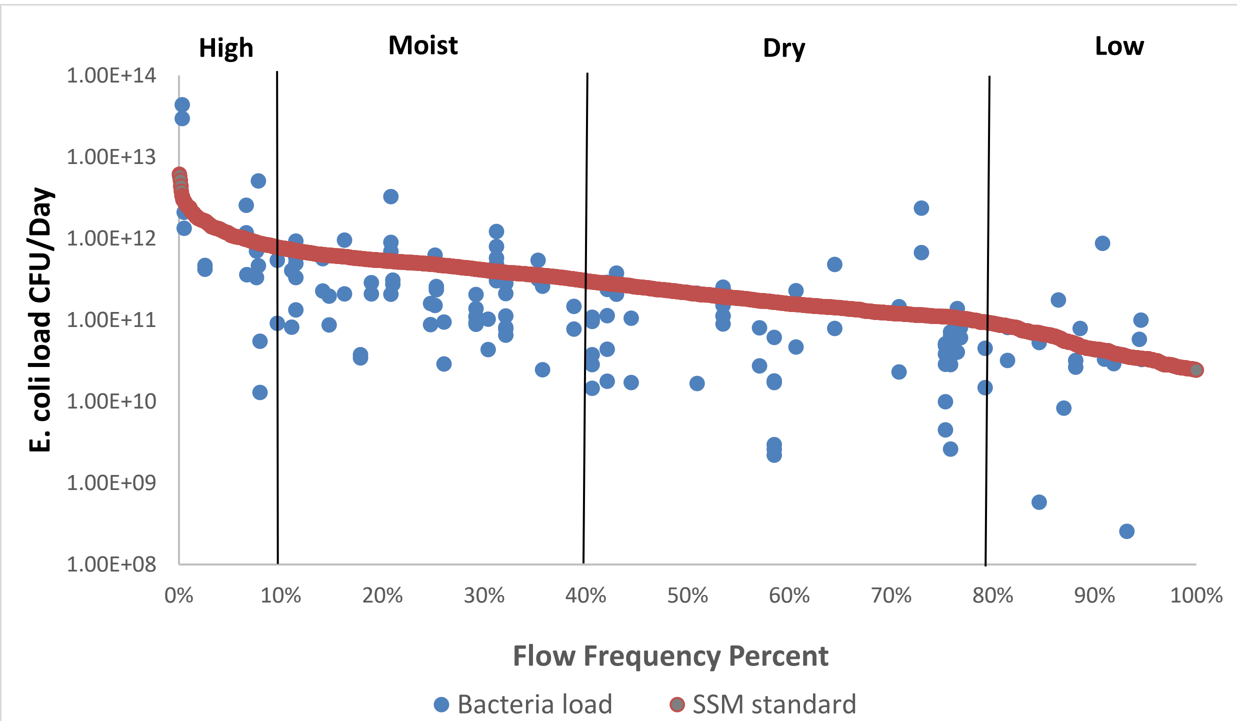

Figure 13: Six Mile Load Duration Curve

8.1 TMDL Loading Analysis

All TMDL components including numeric calculations for each flow zone associated with Six Mile Creek segment 1 are presented in Table 9. The load capacity or TMDL was calculated by multiplying the 95th percentile flow and SSM *E. coli* (1,178 cfu/ml) criterion for each flow zone. The current loads for all flow zones were calculated by multiplying the 95th percentile flow and concentration. Reduction calculations were based on reducing the current load to the TMDL within each flow zone to assure compliance with SSM criterion (1,178 CFU/100ml) for limited contact recreation waters. In addition to the daily load, the geometric mean criterion must be attained on a longer (i.e., monthly) basis. A WLA was provided for the town of White and Brookings MS4. A description for the margin of safety (MOS) used for the TMDL is provided in a subsequent section.

Table 9: E. coli TMDL, reductions needed and zone allocations for Six Mile Creek.

TMDL Component	Six Mile Creek Segment 1 Flow Zones Expressed as (CFU/day)			
	High Flows	Moist Conditions	Dry Conditions	Low Flows
	> 26.67 cfs	26.66 to 10.52 cfs	10.51 to 3.15 cfs	≤ 3.14 cfs
LA	2.22E+12	5.20E+11	1.77E+11	1.83E+10
WLA-City of White	5.76E+10	5.76E+10	5.76E+10	5.76E+10
WLA-Brookings MS4	2.69E+11	6.30E+10	2.14E+10	2.21E+09
10% Explicit MOS	2.83E+11	7.12E+10	2.84E+10	8.68E+09
TMDL @ 1178 CFU/100mL	2.83E+12	7.12E+11	2.84E+11	8.68E+10
Current Load	2.70E+13	1.24E+12	4.44E+11	6.37E+11
Load Reduction	90%	43%	36%	86%

8.1.1 High Flows (0-10%)

The high flow zone represents flows in the upper range that account for 10% or less of the flow frequency. The flow rate for this zone was variable ranging from 213 cfs to 26.67 cfs. Flows represented in this zone occur during significant run-off events that can occur during the spring and early summer. High flows are commonly the product of spring snowmelt events but may also be generated by intense rain events. Bacteria sources across the watershed have the potential to be conveyed to the stream channel during high flow conditions. The 95th percentile bacteria concentration and flow (current load) was calculated at 11,250 cfu/100 ml., and 98.2 cfs, respectively. An *E. coli* load reduction of 90% is required to achieve compliance with the single sample maximum criterion (i.e., TMDL target). In addition to the daily load, the geometric mean criterion must be attained on a monthly basis.

8.1.2 Moist Conditions (10-40%)

Moist conditions or the moderate flow zone represents the portion of the flow regime that occurs following moderate storm events. Flows in this zone varied from 26.66 cfs to 10.52 cfs. The flows in this zone occur in early to mid-summer near the peak of the recreation season, which provides for the optimal recreational opportunity. Bacteria sources from this zone are expected to be closer to the channel and easier to mitigate than that of the high flow zone. The 95th percentile bacteria concentration and flow (current load) was calculated at 2,048 cfu/100ml and 24.71 cfs, respectively. An *E. coli* load reduction of 43% is required to achieve compliance with the single sample maximum criterion (i.e., TMDL target). In addition to the daily load, the geometric mean criterion must be attained on a monthly basis.

8.1.3 Dry Conditions (40-80%)

Dry conditions represent flow rates between 10.51 cfs and 3.15 cfs. Dry condition flows are best characterized as base flow conditions that are influenced by ground water sources. Bacteria sources from this zone likely originate in the stream channel during dry flow conditions. The 95th percentile bacteria concentration and flow (current load) was calculated at 1,842 cfu/100m and 9.86 cfs, respectively. An *E. coli* load reduction of 36% is required to achieve compliance with the single sample maximum criterion (i.e., TMDL target). In addition to the daily load, the geometric mean criterion must be attained on a monthly basis.

8.1.4 Low Flows (80-100%)

The low flow zone accounts for flow rates at or below 3.14 cfs. Bacteria sources from this zone originate in the stream channel during low flow conditions. The 95th percentile bacteria concentration and flow (current load) was calculated at 8,652 cfu/100ml and 3.01 cfs, respectively. An *E. coli* load reduction of 86% is required to achieve compliance with the single sample maximum criterion (i.e., TMDL target). In addition to the daily load, the geometric mean criterion must be attained on a monthly basis.

9.0 TMDL Allocations

9.1 Waste Load Allocations (WLAs)

All NPDES permitted point sources within the Six Mile Creek segment 1 watershed were identified and reviewed for WLA consideration. A WLA was provided for the town of White WWTF in the TMDL (5.76E+10) by multiplying the permitted effluent limit or SSM *E. coli* standard for limited contact recreation (1,178 cfu/100 ml) by the 80th percentile of daily maximum effluent flows (2.0 cfs) times a unit conversion factor (24465715). The normal operation of this municipal facility would typically result in only a portion of the calculated daily amounts being discharged. Based on review of available data, the existing load from the city of White, which discharges to a tributary to Six Mile Creek, is not contributing to the bacteria impairment.

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 White's WWTF 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.

E. coli loading from the city of Brookings stormwater sewer outfalls (MS4 area) is considered a direct point source to Six Mile Creek segment 1. Discharge and *E. coli* concentration data were limited and not used to develop a WLA for the cities storm sewer outfalls. *E. coli* loads are expected to vary significantly depending on precipitation. A jurisdictional area approach was used to develop a WLA for the MS4 load in the TMDL.

The MS4 waste load was allocated proportionately in each flow zone based on watershed area (TMDL-WLA_{White}-MOS) *0.108). 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 10.8% of the Six Mile Creek segment 1 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 Brookings. Significant change to the MS4 area would impact the MS4 allocations requiring a revision to the TMDL.

The Brooking MS4 area is clearly contributing to the *E. coli* impairment of Six Mile Creek (Appendix B). It is recommended that the city consider monitoring *E. coli* from storm sewer outfalls as part of the SWMP plan. Achieving *E. coli* concentrations in storm sewer outfalls at or below 1,178 cfu/100 ml (SSM) would protect the downstream limited contact recreation use designated to Six Mile Creek and help meet TMDL goals.

9.2 Load Allocations (LAs)

The majority of bacteria production in the Six Mile Creek segment 1 watershed (99.23%) originates from livestock sources. Human and wildlife bacteria production in both watersheds is considered negligible. The majority of *E. coli* bacteria produced by livestock can be attributed to beef and dairy cattle. Livestock were estimated to be evenly distributed between rangeland/pasture and in feedlots. Reducing *E. coli* concentrations at or below the SSM standard in each flow zone provides assurance that both the SSM (TMDL target) and GM criteria will be achieved. To achieve compliance, a 90% reduction in *E. coli* bacteria is required in the high flow zone. A 43% reduction is required in moist conditions. A 36% and 86% reduction in *E. coli* bacteria is required in the dry and low flow zones, respectively. To achieve the specified reductions, primary focus should be placed on nonpoint source load allocation by reducing bacteria inputs from livestock grazing and feeding areas.

9.3 Margin of Safety

A margin of safety (MOS) is a required component of TMDL development. A margin of safety (MOS) was established to account for uncertainty. A margin of safety may be provided by (1) 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. The latter approach was used to establish a MOS in the 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.). The MOS was calculated from the TMDL within each flow zone. The remaining assimilative capacity was attributed to nonpoint sources (LA) or point sources (WLA).

10.0 Seasonal Variation

Seasonality is an important factor when considering patterns associated with bacteria contamination. Bacteria samples used in the TMDL analysis were collected from May to September to cover seasonal differences and satisfy the criterion associated with the standards for limited contact recreation waters. Seasonal variation is also a component of the load duration curve framework through the establishment of individual flow zones and associated TMDL load allocations. Daily bacteria loads exceed the single sample maximum TMDL threshold consistently throughout the flow regimes of Six Mile Creek segment 1. The implications of this pattern suggest bacteria contamination is continual. Bacteria conveyance in the spring and early summer is likely to occur watershed wide during high and moist range flows. Bacteria contamination is more likely to be localized to the riparian zone and direct stream channels in the summer and fall during dry and low flow conditions. Focusing restoration efforts to account for these seasonal patterns is warranted to achieve TMDL goals.

11.0 Critical Conditions

Remediation efforts focused on reducing *E. coli* loading in the Six Mile Creek watershed should account for critical conditions. *E. coli* concentrations and loading are greatest at high flows resulting from snow-melt 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 flow conditions is essential to meet reduction goals. *E. coli* concentrations also exceed water quality criteria in low flow 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.

12.0 Adaptive Management and Monitoring Strategy

The Department (or EPA) may adjust the load and/or wasteload allocations in this TMDL to account for new information or circumstances identified during the implementation of the TMDL. If a review of the new information or circumstances indicates that an adjustment to the LA and WLA is appropriate, then the TMDL will be updated following SDDANR programmatic steps including public participation. The Department will propose adjustments only if any adjusted LA or WLA will not result in a change to the loading capacity and will reflect the water quality standards found in the ARSD. The Department will notify EPA of any adjustments to this TMDL within 30 days of their adoption. The Department will follow EPA guidance for revising or withdrawing TMDLs in accordance with considerations documented in EPA's 2012 draft memo before taking action (http://www.epa.gov/sites/production/files/2015-10/documents/draft-tmdl_32212.pdf).

Long-term water quality monitoring will continue at site SIXMILE02 (furthest downstream site) on a monthly basis through DANR's Ambient Water Quality Monitoring Program. East Dakota Water Development District also collects *E. coli* samples bimonthly during the recreation season at the aforementioned site as part of the district's routine monitoring efforts. Sampling is expected to continue indefinitely depending on resource availability. Additional monitoring at SIXMILE02 will also be conducted as part of DANRs Rotating Basin (RB) Project. Details about the RB project will be available on DANRs Watershed Protection Program web site in 2022
https://danr.sd.gov/Conservation/WatershedProtection/default.aspx.

Watershed Protection Program staff will continue to maintain a long-term stream gage at SIXMILE02 as part of the statewide stream flow monitoring network.
https://danr.sd.gov/Conservation/WatershedProtection/Projects/StreamflowMonitoringNetwork.aspx.
Data collected as part of these monitoring efforts will be used to determine beneficial use support in accordance with 303(d) listing methods, evaluate TMDL effectiveness following BMP implementation and to make potential future adjustments to the TMDLs, if necessary.

The Big Sioux River Implementation project provides another potential avenue for future monitoring. In addition, future monitoring or assessment plans implemented by DANR and partners should include Six

Mile Creek segment 1. Bacteria monitoring should be conducted at SIXMILE02 or other stations established during TMDL development to maintain consistency.

13.0 Public Participation

SD DANRs Watershed Protection Program (WPP) partnered with East Dakota Water Development District (EDWDD) to assess beneficial use support and acquire data and information necessary to develop the *E. coli* TMDL for Six Mile Creek segment 1. *E. coli* data collected during the project was supplemented with *E. coli* data available from SD DANR's ambient surface water quality monitoring program.

Field staff from WPP and EDWDD communicated with interested landowners and residents in the watershed during the field collection process to gain information about potential sources of *E. coli*. This also provided a pathway to inform interested parties of the project scope and activities being conducted to assess the impairment and address concerns.

A 30-day public comment period was issued for the draft TMDL. A public notice letter was published in the Brookings Register and Tri City Star. 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 August 11, 2022 and ended September 12, 2022. No public comments were received during the 30-day comment period.

14.0 Reasonable Assurance

Six Mile Creek (SD-BS-R-SIXMILE_01) 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 the 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 Segment 1 of Six Mile Creek will require a comprehensive approach that addresses:

- Wastewater discharges under NPDES permits,
- Stormwater discharges regulated by a Phase II MS4 permit,
- Non-point source pollution,
- Existing and potential future sources, and
- Regulatory and voluntary approaches.

There is reasonable assurance that the goals of the TMDL established for Six Mile Creek 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 City of White WWTF.

Point Sources

Combined point sources contribute less than 12% of the loading to Six Mile Creek. The City of White WWTF is located in the Six Mile Creek watershed and discharges to a tributary of Six Mile Creek. It is always imperative that the facility operate in compliance with their NPDES permits and WLAs set forth in the TMDL. Below are some recommendations for the facility to consider to ensure high operational effectiveness of wastewater treatment.

City of White WWTF

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

The city of Brookings Phase II MS4 also contributes bacteria loads to Six Mile Creek. Sampling indicates that urban runoff exceeds standards for the Creek during storm events. Brookings should continue to follow its Storm Water Management Program and continue implementing BMPs to reduce bacteria loads to Six Mile Creek, especially in the SWS02 area and impervious areas on the west side of Brookings. Green spaces around the creek and detention ponds help to mitigate some of the runoff from less pervious surfaces.

Nonpoint Source

Nonpoint sources contribute most of the bacteria to Six Mile Creek, livestock being the largest component. There are several entities that provide watershed stewardship and have an interest in improving the watershed. The Big Sioux River Watershed Implementation Project, which includes the Six Mile Creek watershed, includes the various municipalities within the river basin including the cities of Brookings and White. The various county conservation districts, Natural Resource Conservation Service, and East Dakota Water Development District will also be involved in any kind of restoration project that involves Six Mile Creek.

This ongoing project provides reasonable assurance that bacteria loading from nonpoint sources will be targeted through measures outlined in Section 15.0 Implementation Strategy. More information can be found here: https://eastdakota.org/protection

15.0 Watershed Improvement Plan: Implementation Strategy

SD DANR recommends reducing runoff and bacteria sources to reduce bacteria in Six Mile Creek. As livestock is the primary contributor to bacteria in Six Mile Creek, the following practices are recommended to reduce bacteria-laden runoff:

- Relocate livestock feeding and grazing areas away from streams especially sloped areas near streams.
- Protect the riparian corridors and keep permanent vegetation along creek. Unstable banks should be protected to improve erosion control. Restoring vegetation and limiting streambank use will allow these areas to recover.
- Maintain vegetated buffer between stream and cropland or pastureland.
- Limit cattle access to streams and provide alternative water sources
- Control livestock manure runoff and use best practices to contain manure from animal feeding areas.
- Improve manure application to crop fields and maintain a buffer near streams.
- Preliminary evidence suggests that slowing flow by ponding water may have beneficial effects in reducing bacteria. Practices that increase infiltration and reduce runoff are beneficial.
- Conserving wetlands and sloughs slows runoff and improves water quality.

Some best management practices to reduce urban stormwater and septic loads include:

- Utilize best management practices including detention and retention to reduce storm water runoff and sequester bacteria.
- Find, repair and replace failing septic systems.

Working with ongoing 319 implementation projects such as the Big Sioux River Implementation Project is recommended to find solutions for reducing bacteria in Six Mile Creek.

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APPENDIX A: Water Quality Data

Sample Date	StationID	Waterbody	*E. coli*{}#/100mL	USGS 6480000 flow	SIXMILE00adjQ	flow exceedance at SIXMILE00	runoffconversion	modeledReach8 HSPFflow	flowexceedanceReach8HSPFflow
10/03/2013	BROOKSWS01	Brookings Storm Sewer	148	96.7	3.49	0.78	1.85	1.53	0.88
10/03/2013	BROOKSWS02	Brookings Storm Sewer	4880	96.7	3.49	0.78	1.85	1.53	0.88
10/03/2013	BROOKSWS03	Brookings Storm Sewer	5170	96.7	3.49	0.78	1.85	1.53	0.88
10/03/2013	BROOKSWS04	Brookings Storm Sewer	1520	96.7	3.49	0.78	1.85	1.53	0.88
05/10/2012	SIXMILE01	Six Mile Creek	437	1150	33.92	0.07	1.03	78.25	0.04
05/10/2012	SIXMILE02	Six Mile Creek	435	1150	33.92	0.07	1.85	78.25	0.04
05/17/2012	SIXMILE01	Six Mile Creek	545	358	11.04	0.39	1.85	15.03	0.24
05/17/2012	SIXMILE02	Six Mile Creek	288	358	11.04	0.39	1.85	15.03	0.24
05/24/2012	SIXMILE01	Six Mile Creek	1530	556	16.76	0.25	1.85	19.16	0.19
05/24/2012	SIXMILE02	Six Mile Creek	369	556	16.76	0.25	1.85	19.16	0.19
05/30/2012	SIXMILE01	Six Mile Creek	1050	737	21.99	0.14	1.85	24.75	0.15
05/30/2012	SIXMILE02	Six Mile Creek	422	737	21.99	0.14	1.85	24.75	0.15
05/31/2012	SIXMILE01	Six Mile Creek	1890	696	20.81	0.16	1.85	27.69	0.13
05/31/2012	SIXMILE02	Six Mile Creek	412	696	20.81	0.16	1.85	27.69	0.13
06/07/2012	SIXMILE01	Six Mile Creek	1620	306	9.54	0.43	1.85	11.13	0.32
06/07/2012	SIXMILE02	Six Mile Creek	888	306	9.54	0.43	1.85	11.13	0.32
06/14/2012	SIXMILE01	Six Mile Creek	1380	207	6.68	0.54	1.85	7.39	0.45
06/14/2012	SIXMILE02	Six Mile Creek	1190	207	6.68	0.54	1.85	7.39	0.45
06/28/2012	SIXMILE01	Six Mile Creek	1730	163	5.41	0.61	1.85	7.86	0.43
06/28/2012	SIXMILE02	Six Mile Creek	354	163	5.41	0.61	1.85	7.86	0.43
07/05/2012	SIXMILE01	Six Mile Creek	1530	104	3.71	0.76	1.85	3.77	0.66
07/05/2012	SIXMILE02	Six Mile Creek	448	104	3.71	0.76	1.85	3.77	0.66
07/12/2012	SIXMILE01	Six Mile Creek	1140	76.8	2.92	0.81	1.85	2.5	0.77
07/12/2012	SIXMILE02	Six Mile Creek	448	76.8	2.92	0.81	1.85	2.5	0.77

Sample Date	StationID	Waterbody	*E. coli*{}#/100mL	USGS 6480000 flow	SIXMILE00adjQ	flow exceedance at SIXMILE00	runoffconversion	modeledReach8 HSPFflow	flowexceedanceReach8HSPFflow
07/19/2012	SIXMILE01	Six Mile Creek	10	58.2	2.38	0.85	1.85	2.21	0.79
07/19/2012	SIXMILE02	Six Mile Creek	909	58.2	2.38	0.85	1.85	2.21	0.79
07/26/2012	SIXMILE01	Six Mile Creek	176	42.7	1.93	0.87	1.85	1.55	0.88
08/02/2012	SIXMILE01	Six Mile Creek	3450	48.4	2.1	0.86	1.85	1.06	0.92
08/09/2012	SIXMILE01	Six Mile Creek	620	36.4	1.75	0.88	1.85	2.31	0.78
08/09/2012	SIXMILE02	Six Mile Creek	749	36.4	1.75	0.88	1.85	2.31	0.78
08/16/2012	SIXMILE01	Six Mile Creek	1940	33.5	1.67	0.89	1.85	1.85	0.83
08/23/2012	SIXMILE01	Six Mile Creek	933	26.3	1.46	0.91	1.85	1.15	0.91
08/28/2012	SIXMILE01	Six Mile Creek	24200	27.1	1.48	0.91	1.85	1.05	0.92
08/30/2012	SIXMILE01	Six Mile Creek	884	22.7	1.36	0.92	1.85	1.17	0.91
09/06/2012	SIXMILE01	Six Mile Creek	8.4	18.9	1.25	0.93	1.85	0.72	0.94
09/13/2012	SIXMILE01	Six Mile Creek	1140	16.4	1.18	0.95	1.85	0.36	0.97
09/20/2012	SIXMILE01	Six Mile Creek	3470	16.5	1.18	0.95	1.85	0.29	0.98
09/27/2012	SIXMILE01	Six Mile Creek	2010	16.8	1.19	0.94	1.85	0.15	0.99
05/02/2013	SIXMILE01	Six Mile Creek	74.3	1020	30.17	0.08	1.85	27.67	0.13
05/02/2013	SIXMILE02	Six Mile Creek	17.5	1020	30.17	0.08	1.85	27.67	0.13
05/08/2013	SIXMILE01	Six Mile Creek	816	919	27.25	0.1	1.85	22.13	0.17
05/08/2013	SIXMILE02	Six Mile Creek	137	919	27.25	0.1	1.85	22.13	0.17
05/16/2013	SIXMILE01	Six Mile Creek	240	536	16.19	0.26	1.85	17.06	0.21
05/16/2013	SIXMILE02	Six Mile Creek	73.3	536	16.19	0.26	1.85	17.06	0.21
05/23/2013	SIXMILE01	Six Mile Creek	77.6	660	19.77	0.18	1.85	27.36	0.13
05/23/2013	SIXMILE02	Six Mile Creek	71.2	660	19.77	0.18	1.85	27.36	0.13
05/30/2013	SIXMILE01	Six Mile Creek	6870	1030	30.46	0.08	1.85	81.47	0.03
05/30/2013	SIXMILE02	Six Mile Creek	626	1030	30.46	0.08	1.85	81.47	0.03
06/06/2013	SIXMILE01	Six Mile Creek	388	561	16.91	0.25	1.85	35.77	0.1
06/06/2013	SIXMILE02	Six Mile Creek	213	561	16.91	0.25	1.85	35.77	0.1
06/13/2013	SIXMILE01	Six Mile Creek	921	1060	31.32	0.08	1.85	119.72	0.02

Sample Date	StationID	Waterbody	*E. coli*{}#/100mL	USGS 6480000 flow	SIXMILE00adjQ	flow exceedance at SIXMILE00	runoffconversion	modeledReach8 HSPFflow	flowexceedanceReach8HSPFflow
06/13/2013	SIXMILE02	Six Mile Creek	435	1060	31.32	0.08	1.85	119.72	0.02
06/20/2013	SIXMILE01	Six Mile Creek	690	608	18.27	0.21	1.85	37.04	0.1
06/20/2013	SIXMILE02	Six Mile Creek	615	608	18.27	0.21	1.85	37.04	0.1
06/27/2013	SIXMILE01	Six Mile Creek	870	3410	99.22	0.01	1.85	178.56	0.01
06/27/2013	SIXMILE02	Six Mile Creek	551	3410	99.22	0.01	1.85	178.56	0.01
07/11/2013	SIXMILE01	Six Mile Creek	615	638	19.13	0.19	1.85	22.29	0.17
07/11/2013	SIXMILE02	Six Mile Creek	449	638	19.13	0.19	1.85	22.29	0.17
07/18/2013	SIXMILE01	Six Mile Creek	370	726	21.68	0.15	1.85	27.18	0.13
07/18/2013	SIXMILE02	Six Mile Creek	165	726	21.68	0.15	1.85	27.18	0.13
07/25/2013	SIXMILE01	Six Mile Creek	870	398	12.2	0.36	1.85	12.95	0.28
07/25/2013	SIXMILE02	Six Mile Creek	82.6	398	12.2	0.36	1.85	12.95	0.28
08/01/2013	SIXMILE01	Six Mile Creek	476	291	9.11	0.44	1.85	7.83	0.43
08/01/2013	SIXMILE02	Six Mile Creek	76.8	291	9.11	0.44	1.85	7.83	0.43
08/15/2013	SIXMILE01	Six Mile Creek	1200	228	7.29	0.51	1.85	5.85	0.54
08/15/2013	SIXMILE02	Six Mile Creek	93.3	228	7.29	0.51	1.85	5.85	0.54
08/22/2013	SIXMILE01	Six Mile Creek	551	183	5.99	0.57	1.85	4.35	0.63
08/22/2013	SIXMILE02	Six Mile Creek	187	183	5.99	0.57	1.85	4.35	0.63
08/29/2013	SIXMILE01	Six Mile Creek	3970	147	4.95	0.64	1.85	3.4	0.69
08/29/2013	SIXMILE02	Six Mile Creek	651	147	4.95	0.64	1.85	3.4	0.69
09/05/2013	SIXMILE01	Six Mile Creek	1440	120	4.17	0.71	1.85	2.51	0.77
09/05/2013	SIXMILE02	Six Mile Creek	226	120	4.17	0.71	1.85	2.51	0.77
09/12/2013	SIXMILE01	Six Mile Creek	914	101	3.62	0.77	1.85	1.9	0.82
09/12/2013	SIXMILE02	Six Mile Creek	690	101	3.62	0.77	1.85	1.9	0.82
09/19/2013	SIXMILE01	Six Mile Creek	24200	114	3.99	0.73	1.85	1.78	0.85
09/19/2013	SIXMILE02	Six Mile Creek	6870	114	3.99	0.73	1.85	1.78	0.85
09/26/2013	SIXMILE01	Six Mile Creek	563	89.1	3.28	0.79	1.85	1.5	0.88
09/26/2013	SIXMILE02	Six Mile Creek	185	89.1	3.28	0.79	1.85	1.5	0.88

Sample Date	StationID	Waterbody	*E. coli*{}#/100mL	USGS 6480000 flow	SIXMILE00adjQ	flow exceedance at SIXMILE00	runoffconversion	modeledReach8 HSPFflow	flowexceedanceReach8HSPFflow
05/04/2015	SDSUPNDN	Six Mile Creek	21.1	175	5.76	0.58	1.85	0.86	0.93
05/04/2015	SDSUPNUP	Six Mile Creek	15.6	175	5.76	0.58	1.85	0.86	0.93
05/04/2015	SIXMILE00	Six Mile Creek	18.5	175	5.76	0.58	1.85	0.86	0.93
05/04/2015	SIXMILE01	Six Mile Creek	128	175	5.76	0.58	1.85	0.86	0.93
05/04/2015	SIXMILE01A	Six Mile Creek	435	175	5.76	0.58	1.85	0.86	0.93
05/04/2015	SIXMILE02	Six Mile Creek	122	175	5.76	0.58	1.85	0.86	0.93
05/18/2015	SDSUPNDN	Six Mile Creek	250	437	13.33	0.32	1.85	10.08	0.35
05/18/2015	SDSUPNUP	Six Mile Creek	345	437	13.33	0.32	1.85	10.08	0.35
05/18/2015	SIXMILE00	Six Mile Creek	201	437	13.33	0.32	1.85	10.08	0.35
05/18/2015	SIXMILE01	Six Mile Creek	238	437	13.33	0.32	1.85	10.08	0.35
05/18/2015	SIXMILE01A	Six Mile Creek	649	437	13.33	0.32	1.85	10.08	0.35
05/18/2015	SIXMILE02	Six Mile Creek	866	437	13.33	0.32	1.85	10.08	0.35
06/01/2015	SDSUPNDN	Six Mile Creek	308	481	14.6	0.29	1.85	22.2	0.17
06/01/2015	SDSUPNUP	Six Mile Creek	308	481	14.6	0.29	1.85	22.2	0.17
06/01/2015	SIXMILE00	Six Mile Creek	579	481	14.6	0.29	1.85	22.2	0.17
06/01/2015	SIXMILE01	Six Mile Creek	387	481	14.6	0.29	1.85	22.2	0.17
06/01/2015	SIXMILE01A	Six Mile Creek	248	481	14.6	0.29	1.85	22.2	0.17
06/01/2015	SIXMILE02	Six Mile Creek	260	481	14.6	0.29	1.85	22.2	0.17
06/15/2015	SDSUPNDN	Six Mile Creek	548	208	6.71	0.53	1.85	6.71	0.49
06/15/2015	SDSUPNUP	Six Mile Creek	687	208	6.71	0.53	1.85	6.71	0.49
06/15/2015	SIXMILE00	Six Mile Creek	980	208	6.71	0.53	1.85	6.71	0.49
06/15/2015	SIXMILE01	Six Mile Creek	687	208	6.71	0.53	1.85	6.71	0.49
06/15/2015	SIXMILE01A	Six Mile Creek	1550	208	6.71	0.53	1.85	6.71	0.49
06/15/2015	SIXMILE02	Six Mile Creek	921	208	6.71	0.53	1.85	6.71	0.49
07/06/2015	SDSUPNDN	Six Mile Creek	906	450	13.7	0.31	1.85	14.05	0.26
07/06/2015	SDSUPNUP	Six Mile Creek	1720	450	13.7	0.31	1.85	14.05	0.26
07/06/2015	SIXMILE00	Six Mile Creek	1450	450	13.7	0.31	1.85	14.05	0.26

Sample Date	StationID	Waterbody	*E. coli*{}#/100mL	USGS 6480000 flow	SIXMILE00adjQ	flow exceedance at SIXMILE00	runoffconversion	modeledReach8 HSPFflow	flowexceedanceReach8HSPFflow
07/06/2015	SIXMILE01	Six Mile Creek	985	450	13.7	0.31	1.85	14.05	0.26
07/06/2015	SIXMILE01A	Six Mile Creek	3650	450	13.7	0.31	1.85	14.05	0.26
07/06/2015	SIXMILE02	Six Mile Creek	2380	450	13.7	0.31	1.85	14.05	0.26
07/27/2015	SDSUPNDN	Six Mile Creek	183	316	9.83	0.42	1.85	7.05	0.47
07/27/2015	SDSUPNUP	Six Mile Creek	472	316	9.83	0.42	1.85	7.05	0.47
07/27/2015	SIXMILE00	Six Mile Creek	74	316	9.83	0.42	1.85	7.05	0.47
07/27/2015	SIXMILE01	Six Mile Creek	1210	316	9.83	0.42	1.85	7.05	0.47
07/27/2015	SIXMILE01A	Six Mile Creek	987	316	9.83	0.42	1.85	7.05	0.47
07/27/2015	SIXMILE02	Six Mile Creek	1040	316	9.83	0.42	1.85	7.05	0.47
08/17/2015	SDSUPNDN	Six Mile Creek	220	831	24.71	0.11	1.85	33.03	0.11
08/17/2015	SDSUPNUP	Six Mile Creek	821	831	24.71	0.11	1.85	33.03	0.11
08/17/2015	SIXMILE00	Six Mile Creek	551	831	24.71	0.11	1.85	33.03	0.11
08/17/2015	SIXMILE01	Six Mile Creek	1540	831	24.71	0.11	1.85	33.03	0.11
08/17/2015	SIXMILE01A	Six Mile Creek	977	831	24.71	0.11	1.85	33.03	0.11
08/17/2015	SIXMILE02	Six Mile Creek	977	831	24.71	0.11	1.85	33.03	0.11
08/31/2015	SDSUPNDN	Six Mile Creek	409	330	10.23	0.41	1.85	14.71	0.25
08/31/2015	SDSUPNUP	Six Mile Creek	435	330	10.23	0.41	1.85	14.71	0.25
08/31/2015	SIXMILE00	Six Mile Creek	150	330	10.23	0.41	1.85	14.71	0.25
08/31/2015	SIXMILE01	Six Mile Creek	387	330	10.23	0.41	1.85	14.71	0.25
08/31/2015	SIXMILE01A	Six Mile Creek	58.5	330	10.23	0.41	1.85	14.71	0.25
08/31/2015	SIXMILE02	Six Mile Creek	114	330	10.23	0.41	1.85	14.71	0.25
09/15/2015	SDSUPNDN	Six Mile Creek	48	108	3.82	0.75	1.85	5.3	0.57
09/15/2015	SDSUPNUP	Six Mile Creek	411	108	3.82	0.75	1.85	5.3	0.57
09/15/2015	SIXMILE00	Six Mile Creek	107	108	3.82	0.75	1.85	5.3	0.57
09/15/2015	SIXMILE01	Six Mile Creek	548	108	3.82	0.75	1.85	5.3	0.57
09/15/2015	SIXMILE01A	Six Mile Creek	517	108	3.82	0.75	1.85	5.3	0.57
09/15/2015	SIXMILE02	Six Mile Creek	308	108	3.82	0.75	1.85	5.3	0.57

Sample Date	StationID	Waterbody	*E. coli*{}#/100mL	USGS 6480000 flow	SIXMILE00adjQ	flow exceedance at SIXMILE00	runoffconversion	modeledReach8 HSPFflow	flowexceedanceReach8HSPFflow
09/28/2015	SDSUPNDN	Six Mile Creek	28.1	107	3.79	0.76	1.85	5.46	0.56
09/28/2015	SDSUPNUP	Six Mile Creek	770	107	3.79	0.76	1.85	5.46	0.56
09/28/2015	SIXMILE00	Six Mile Creek	579	107	3.79	0.76	1.85	5.46	0.56
09/28/2015	SIXMILE01	Six Mile Creek	687	107	3.79	0.76	1.85	5.46	0.56
09/28/2015	SIXMILE01A	Six Mile Creek	308	107	3.79	0.76	1.85	5.46	0.56
09/28/2015	SIXMILE02	Six Mile Creek	387	107	3.79	0.76	1.85	5.46	0.56
05/29/2018	SIXMILE01	Six Mile Creek	649	858	25.49	0.11	1.85	11.08	0.32
05/29/2018	SIXMILE02	Six Mile Creek	131	858	25.49	0.11	1.85	11.08	0.32
06/11/2018	SIXMILE01	Six Mile Creek	1550	614	18.44	0.21	1.85	10.81	0.33
06/11/2018	SIXMILE01	Six Mile Creek	1990	614	18.44	0.21	1.85	10.81	0.33
06/11/2018	SIXMILE02	Six Mile Creek	7270	614	18.44	0.21	1.85	10.81	0.33
06/11/2018	SIXMILE02	Six Mile Creek	461	614	18.44	0.21	1.85	10.81	0.33
06/21/2018	SIXMILE01	Six Mile Creek	1410	1160	34.21	0.07	1.85	26.85	0.14
06/21/2018	SIXMILE02	Six Mile Creek	3080	1160	34.21	0.07	1.85	26.85	0.14
07/10/2018	SIXMILE01	Six Mile Creek	576	555	16.74	0.25	1.85	37.4	0.1
07/10/2018	SIXMILE02	Six Mile Creek	633	555	16.74	0.25	1.85	37.4	0.1
07/19/2018	SIXMILE01	Six Mile Creek	10500	3980	115.68	0	1.85	689.13	0
07/19/2018	SIXMILE02	Six Mile Creek	15500	3980	115.68	0	1.85	689.13	0
07/23/2018	SIXMILE01	Six Mile Creek	336	1960	57.33	0.03	1.85	92.81	0.03
07/23/2018	SIXMILE02	Six Mile Creek	301	1960	57.33	0.03	1.85	92.81	0.03
08/06/2018	SIXMILE01	Six Mile Creek	298	462	14.05	0.3	1.85	13.9	0.27
08/06/2018	SIXMILE02	Six Mile Creek	127	462	14.05	0.3	1.85	13.9	0.27
08/20/2018	SIXMILE01	Six Mile Creek	1790	404	12.37	0.35	1.85	14.03	0.26
08/20/2018	SIXMILE02	Six Mile Creek	1050	404	12.37	0.35	1.85	14.03	0.26
05/30/2012	BROOKSWS01	Storm Sewer	109	737	21.99	0.14	1.85	24.75	0.15
05/30/2012	BROOKSWS02	Storm Sewer	292	737	21.99	0.14	1.85	24.75	0.15
05/30/2012	BROOKSWS03	Storm Sewer	2110	737	21.99	0.14	1.85	24.75	0.15

Sample Date	StationID	Waterbody	*E. coli*{}#/100mL	USGS 6480000 flow	SIXMILE00adjQ	flow exceedance at SIXMILE00	runoffconversion	modeledReach8 HSPFflow	flowexceedanceReach8HSPFflow
05/30/2012	BROOKSWS04	Storm Sewer	364	737	21.99	0.14	1.85	24.75	0.15
08/28/2012	BROOKSWS01	Storm Sewer	158	27.1	1.48	0.91	1.85	1.05	0.92
08/28/2012	BROOKSWS03	Storm Sewer	24200	27.1	1.48	0.91	1.85	1.05	0.92
05/08/2013	BROOKSWS01	Storm Sewer	2830	919	27.25	0.1	1.85	22.13	0.17
05/08/2013	BROOKSWS04	Storm Sewer	445	919	27.25	0.1	1.85	22.13	0.17
09/19/2013	BROOKSWS01	Storm Sewer	24200	114	3.99	0.73	1.85	1.78	0.85
09/19/2013	BROOKSWS02	Storm Sewer	7270	114	3.99	0.73	1.85	1.78	0.85
09/19/2013	BROOKSWS03	Storm Sewer	9210	114	3.99	0.73	1.85	1.78	0.85
09/19/2013	BROOKSWS04	Storm Sewer	9610	114	3.99	0.73	1.85	1.78	0.85
06/11/2018	BROOKSWS01	Storm Sewer	6130	614	18.44	0.21	1.85	10.81	0.33
06/11/2018	BROOKSWS02	Storm Sewer	15500	614	18.44	0.21	1.85	10.81	0.33
06/11/2018	BROOKSWS03	Storm Sewer	12000	614	18.44	0.21	1.85	10.81	0.33
06/11/2018	BROOKSWS04	Storm Sewer	13000	614	18.44	0.21	1.85	10.81	0.33
06/21/2018	BROOKSWS01	Storm Sewer	7700	1160	34.21	0.07	1.85	26.85	0.14
06/21/2018	BROOKSWS02	Storm Sewer	3080	1160	34.21	0.07	1.85	26.85	0.14
06/21/2018	BROOKSWS03	Storm Sewer	5480	1160	34.21	0.07	1.85	26.85	0.14
06/21/2018	BROOKSWS04	Storm Sewer	7270	1160	34.21	0.07	1.85	26.85	0.14
07/19/2018	BROOKSWS01	Storm Sewer	7700	3980	115.68	0	1.85	689.13	0
07/19/2018	BROOKSWS02	Storm Sewer	24200	3980	115.68	0	1.85	689.13	0
07/19/2018	BROOKSWS03	Storm Sewer	24200	3980	115.68	0	1.85	689.13	0
07/19/2018	BROOKSWS04	Storm Sewer	4610	3980	115.68	0	1.85	689.13	0

APPENDIX B: MS4 Simple Method

L (annual load) = R(Annual runoff)* C(Pollution concentration in cfu/L)* Area(acres)* conversion factor (102789.7)

R (Annual runoff in inches) = P (Annual rainfall)*Pj (fraction of rainfall events that produce runoff~.9)*Rv (runoff coefficient)

Rv (Runoff coefficient)= .05+.9Ia where Ia is percent impervious area

Annual Load (L) was then divided by 365 to calculate a daily load.

City of Brookings MS4 that drains to Six Mile Creek

L=x*R*C*A	2012	2013	2018	average year
where L=annual load (cfu)	2.18E+14	1.97E+14	5.38E+14	3.18E+14
R=Annual runoff(inches)	8.241283	8.403798	11.98995	
C=Pollutant concentration(cfu/L)	64488.75	57131.67	109058.3	
A=Area(acres)	3999.5	3999.5	3999.5	
x	102789.7	102789.7	102789.7	
L daily (divide annual by 365)	5.99E+11	5.41E+11	1.47E+12	8.71E+11
L allowed (if LC standard met)	1.09E+11	1.12E+11	1.59E+11	1.27E+11
decrease in load needed	81.73%	79.30%	89.18%	85.46%

APPENDIX C: EPA Decision Document and Approval Letter

EPA TOTAL MAXIMUM DAILY LOAD (TMDL) DECISION RATIONALE

TMDL: *E. coli* Bacteria Total Maximum Daily Load (TMDL) for the Six Mile Creek, Brookings and Deuel Counties, South Dakota

ATTAINS TMDL ID: R8-SD-2022-08

LOCATION: Brookings and Deuel 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-BS-R-SIXMILE_01	Six Mile Creek segment 01 (North Deer Creek to S30, T112N, R48W)	*E. coli*

BACKGROUND: The South Dakota Department of Agriculture and Natural Resources (DANR) submitted to EPA the *E. coli* TMDL for Six Mile Creek with a letter requesting review and approval dated September 14, 2022. EPA previously reviewed and provided staff comments on draft versions of the report but did not submit comments during the subsequent public comment period (August 11, 2022 to September 12, 2022).

The submittal included:
- Letter requesting EPA's review and approval of the TMDL
- Final TMDL report

APPROVAL RECOMMENDATIONS: Based on the review presented below, the reviewer recommends approval of the final Six Mile Creek *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 SIX MILE CREEK SEGMENT 1 *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 1 of Six Mile Creek is a perennial prairie stream in eastern South Dakota and is part of the larger Big Sioux River Basin (Figure 1). Six Mile Creek (SD-BS-R-SIXMILE_01) extends from southern Deuel county (S30, T112N, R48W) into Brookings county. It passes through the cites of White and Brookings before its confluence with North Deer Creek. The entire drainage area is over 53,000 acres and includes two different HUC12 watersheds plus a small portion of a third HUC12 watershed just west of the Brookings Municipal Airport. Figure 1 displays the general location of the Six Mile Creek watershed with the impaired segment, cities, and major highways.

During TMDL development it was recognized that the National Hydrography Dataset (NHD) flow line for Six Mile Creek segment 1 is inconsistent with the actual flow pattern. The actual flow line is the result of flood control measures implemented to protect the city of Brookings including South Dakota State University (SDSU). DANR and EPA are working with the U.S. Geological Survey (USGS) to correct the Six Mile Creek segment 1 flow line and associated watershed boundary in the medium resolution NHD. South Dakota's geospatial files will be updated during the 2024 list cycle with the updated flow layer to correctly display segment 1. Figures 1 and 2 illustrate the current NHD layer as well as the corrected flow line (in green). The TMDL is written for the segment description defined in ATTAINS, which extends from S30, T112N, R48W to North Deer Creek; this description is consistent with the corrected flow line.

Six Mile Creek was first identified as impaired by *E. coli* and placed on South Dakota's 303(d) list in 2014 and remained as an impairment 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 7, which summarizes the TMDL components. This segment is also impaired for dissolved oxygen causing nonattainment the limited contact recreation waters use and is slated for TMDL development by 2035.

Section 2.0 (*Watershed Characteristics*) describes watershed characteristics, including a detailed discussion of the stream routing for flood control around Brookings, South Dakota. The watershed historically contained prairie pothole wetlands (Section 2.1; *Geology and Soils*), many of which have been drained. Based on 2017 land use data, 89 percent of the watershed is used for agriculture and 10 percent is developed. Wetlands and forested areas have decreased since 2006 and agricultural uses have increased (Table 1). Little intact tallgrass prairie remains in the watershed. Figure 5 illustrates the land use distribution draining into the impaired segment, which is predominantly agriculture (row crops, hay, and small grain) with grasslands near waterways. Urban development includes the town of White (population over 500) in the center of the watershed and the city of Brookings (population over 23,000) located near the creek mouth (Section 2.2; *Land Use and Population*).

Section 7.2 (*Nonpoint Source Assessment*) characterizes the nonpoint sources into categories of agriculture, human (i.e., septic systems), and natural background/wildlife (particularly geese). DANR quantified *E. coli* production from these sources using population estimates, geographic information system (GIS) analysis, and the Bacterial Indicator Tool (USEPA, 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 (99 percent). Livestock in the watershed are evenly split between feedlots and rangeland (Section 7.2.1, *Agriculture*).

Section 7.1 (*Point Source Assessment*) describes the permitted point sources by facility name, permit number, and discharge characteristics. The city of White operates a wastewater treatment facility (WWTF; SD0021636) that discharges *E. coli* to an unnamed tributary approximately 1.5 miles from Six Mile Creek (outfall location illustrated in Figure 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. No exceedances were observed in the discharge monitoring report data since 2017.

The city of Brookings is regulated as a Phase II municipal separate storm sewer system (MS4) under permit SDR41A003 (Section 7.1.2, *Brookings MS4,* and Appendix B). DANR discusses the portion of the MS4 that drains to Six Mile Creek (nearly 4,000 acres, which is about half of the MS4 area; Figure 11) and the storm water management program (SWMP) including a Storm Water Management Model (SWMM) and *E. coli* load estimates. While the MS4 permit does not include *E. coli* effluent limits for stormwater discharges, the city has conducted a monitoring study and compared the concentrations to the *E. coli* targets. Twenty-two out of 28 samples at four outfall stations exceeded the criterion. DANR recommends ongoing outfall monitoring to evaluate stormwater conditions.

DANR also identified four additional permits in the watershed that are not expected to contribute *E. coli* to the watershed and do not receive WLAs, including two water distribution permits and the Dacotah Bank and SDSU Swimming Pool permits (Section 7.1, *Point Source Assessment*). No Concentrated Animal Feeding Operations (CAFOs) are permitted in the watershed (Section 7.1.3, *Permitted CAFOs*) therefore, CAFOs are not included in the allocations. If CAFOs are permitted in the future, DANR notes that *E. coli* contributions are unlikely if facilities comply with their permit requirements.

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 segment with citations to relevant South Dakota regulations. SD-BS-R-SIXMILE_01 is designated the following beneficial uses:

- warmwater marginal 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 creek'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 3.3). These criteria are seasonally applicable from May 1 to September 30.

The numeric *E. coli* criteria for limited contact recreation waters are applied directly as water quality targets for this TMDL (Section 5.0, *Numeric TMDL Targets*). 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 limited contact recreation single sample maximum criterion (1,178 CFU/100mL) as monitoring is not of sufficient frequency to assess compliance with the geometric mean criterion. DANR demonstrates that attaining the single sample maximum target will also achieve the geometric mean criterion (Section 5.0, *Numeric TMDL Targets*).

The TMDL is consistent with South Dakota antidegradation policies because it provides recommendations and establishes pollutant limits at water quality levels necessary to meet criteria and fully support existing beneficial 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 Six Mile Creek segment 1. 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), and expressed the TMDL in CFUs per day at different flow zones (i.e., high, moist, 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 13, 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 (*Data Collection and Results*) and provided fully in Appendix A. Table 9 summarizes the 95th percentile existing loads and loading capacity by flow regime for Six Mile Creek segment 1 (note: only mainstem stations were used to calculate existing loads). 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 1 and their contributions were estimated using effluent limits and the 80th percentile daily maximum flow (city of White WWTF) and jurisdictional area (city of Brookings MS4) (Section 9.1, *Waste Load Allocations*; Table 9). DANR estimated relative nonpoint source contributions, including agricultural, wildlife (natural background), and human sources, using bacteria production rates from the Bacterial Indicator Tool (USEPA, 2000; Table 6). Livestock was identified as the main source of bacteria loading in the watershed (Section 7.2.1, *Agriculture*).

While the loading capacity is defined for multiple stream flow conditions, DANR described the critical conditions when bacteria loading to segment 1 are greatest as periods of high flows (Section 11.0, *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 low flow 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 9.2 (*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 9 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 Section 7.2 (*Nonpoint Source Assessment*) and Table 6. Human and wildlife sources were considered negligible as nearly all of the bacteria production is associated with agriculture (livestock sources).

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 Six Mile Creek segment 1, the city of White WWTF (SD0021636) and the city of Brookings MS4 (SDR41A003). These WLAs are identified in Table 9 and discussed in Sections 9.1 (*Waste Load Allocations*) and 7.1 (*Point Source Assessment*). WLAs for both facilities are given in CFUs per day. The WWTF WLA is set at a constant load throughout all four flow regimes (Table 9). The current permit effluent limits are written to protect the limited contact recreation use (≤ 630 CFU/100mL as a 30-day criterion and ≤ 1,178

CFU/100mL as a single sample maximum limit) and are consistent with the numeric TMDL targets. The WLA was calculated using the 80th percentile daily maximum flow (2.0 cubic feet per second) and the limited contact recreation single sample maximum criterion. Normal operations of the facility would typically result in discharge of only a portion of its allowable daily load. DANR notes that as long as discharges from the WWTF do not exceed peak design flow and *E. coli* effluent limits, any variable flow rates from the facility are not expected to impact the TMDL (Section 9.1, *Waste Load Allocations*).

The WLA analysis associated with the MS4 discharge is discussed in Sections 9.1 (*Waste Load Allocations*) and 7.1 (*Point Source Assessment*). *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 10.8 percent of the total watershed area; therefore, the WLA for each flow regime was calculated as 10.8 percent of the remaining allowable load after the MOS and WWTF WLA were subtracted from the loading capacity. DANR notes that significant change to the MS4 area would impact the WLA, requiring a revision to the TMDL. Appendix B demonstrates that the MS4 area is contributing *E. coli* to Six Mile Creek segment 1. Achieving *E. coli* concentrations in storm sewer outfalls at or below 1,178 CFU/100 mL would protect the downstream limited contact recreation use designated to Six Mile Creek.

Several other permits were identified in the report (Section 7.1, *Point Source Assessment*) 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 Six Mile Creek includes an explicit MOS derived as 10% of the loading capacity (Section 9.3, *Margin of Safety*). The explicit MOS is included as a separate allocation in Table 9 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 10.0 (*Seasonal Variation*). 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 for the different flow zones listed in Table 9. In addition to these flow and water quality patterns, the limited contact 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 throughout the flow regimes, suggesting that bacteria contamination can occur throughout 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 and low flow 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 Six Mile Creek segment 1 is developed for an assessment unit impaired by both point and nonpoint sources, thus reasonable assurances must be provided (see Section 14.0, *Reasonable Assurance*). Reasonable assurance justifications are provided for both point and nonpoint sources.

For point sources, the WLA established for the city of White WWTF is based on an *E. coli* effluent concentration at the numeric TMDL target and the 80th percentile maximum daily discharge rate. Achieving this WLA, which will be implemented through the NPDES permitting process, is critical to implementation success. DANR provided recommendations in Section 14.0 to ensure high operational effectiveness including continuing with scheduled sewer repair, upgrading treatment systems with new technologies, and monitoring *E. coli* to assess compliance. The WWTF discharges to a tributary of Six Mile Creek and is not anticipated to contribute to the *E. coli* impairment under current conditions. DANR also noted that the city of Brookings MS4 exceeds standards during storm events. DANR indicated the city should follow its SWMP and continue implementing BMPs to reduce bacteria loads, especially in the SWS02 area and impervious areas on the west side of the city. They also note that green infrastructure and detention ponds may mitigate runoff from impervious areas.

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 (Section 12.0, *Adaptive Management and Monitoring Strategy*) and the core aspects of a TMDL implementation strategy (Section 15.0, *Watershed Improvement Plan: Implementation Strategy*). These assurances include the watershed stewardship and interest from the East Dakota Water Development District and the continued implementation of the Big Sioux River Watershed Implementation Project. DANR notes several implementation measures that focus on bacteria monitoring and nonpoint source bacteria load reduction relevant to livestock sources described in the TMDL source assessment. In particular, projects for future implementation include reduced livestock access to streams, installation of riparian buffer strips, implementation of proper animal waste management systems, improved manure application to crop fields, increased infiltration, and wetlands conservation to slow runoff.

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 Section 12.0 (*Adaptive Management and Monitoring Strategy*), 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 by both DANR and the East Dakota Water Development District at SIXMILE02 to assess changes in *E.*

coli concentrations over time. DANR also discusses potential expansion of the Big Sioux River Implementation Plan to include sampling on Six Mile Creek segment 1. 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 12.0, *Adaptive Management and Monitoring Strategy*) 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 Section 15.0 (*Watershed Improvement Plan: Implementation Strategy*), DANR recommends collaboration with the ongoing 319 implementation projects as well as livestock-specific management activities. The Big Sioux River Watershed Implementation Project is a 319-funded project that can be expanded to address bacteria pollutant sources in the Six Mile Creek portion of the basin. DANR also describes potential implementation activities to reduce bacteria loading associated with grazing and manure management. These management measures include, but are not limited to, reduced livestock access to streams, installation of riparian buffer strips, implementation of proper animal waste management systems, improved manure application to crop fields, increased infiltration, and wetlands conservation to slow runoff.

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 13.0) explains the public engagement process DANR followed during development of the TMDL. A draft TMDL report was released for public comment from August 11, 2022 to September 12, 2022. The opportunity for public review and comment was posted on DANR's website and announced in several area newspapers: the Brookings Register and Tri City Star. 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 September 14, 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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September 20, 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 *E. coli* Bacteria Total Maximum Daily Load (TMDL) for the Six Mile Creek, Brookings and Deuel Counties, 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 September 14, 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 Six Mile Creek. 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
Digitally signed by JUDY BLOOM
Date: 2022.09.20 22:42:44 -06'00'

Judy Bloom, Manager
Clean Water Branch

Enclosure:
EPA Decision Rationale – Six Mile Creek *E. coli* TMDL

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