UPDATE OF TOTAL SUSPENDED SOLIDS TOTAL MAXIMUM DAILY LOAD FOR THE BIG SIOUX RIVER MINNEHAHA COUNTY, SOUTH DAKOTA

TOPICAL REPORT RSI-2806

PREPARED FOR

South Dakota Department of Environment
and Natural Resources
523 East Capitol
Joe Foss Building
Pierre, South Dakota 57501

JUNE 2019

RESPEC

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JUL 15 2019

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JUL 19 2019
Dept. of Environment and Natural Resources Secretary's Office

Ref: 8WD-CWS

Mr. Steven M. Pirner
Secretary
South Dakota Department of Environment & Natural Resources
Joe Foss Building
523 East Capitol Ave
Pierre, South Dakota 57501-3181

Re: Approval of the Updated *Escherichia coli* Bacteria and Total Suspended Solids Total Maximum Daily Loads for Segments 8, 10, 11 and 12 of the Big Sioux River

Dear Mr. Pirner,

The U.S. Environmental Protection Agency (EPA) has completed review of the total maximum daily loads (TMDLs) submitted by your office on June 21, 2019. 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 TMDLs for segment 8, 10, 11 and 12 of the Big Sioux River. The EPA has determined that the separate elements of the TMDLs listed in the enclosures adequately address the pollutants of concern, are designed to attain and maintain applicable water quality standards, consider seasonal variation and include margins of safety. The EPA's rationale for this action is contained in the enclosures.

The EPA understands this submittal is intended to revise existing TMDLs established for these water quality limited segments that were approved on September 26, 2012 and December 6, 2012. The EPA supports the process South Dakota followed to update the TMDLs, including the public participation aspects. Today's action supersedes the previous action and the EPA now considers the 2012 TMDLs replaced by these 2019 TMDLs.

Thank you for submitting these TMDLs for our review and approval. If you have any questions, please contact Peter Brumm on my staff at 406-457-5029.

Sincerely,

Darcy O'Connor, Director
Water Division

EPA TOTAL MAXIMUM DAILY LOAD (TMDL) REVIEW SUMMARY

TMDL: Update of the TSS Total Maximum Daily Loads for Segments 8, 10, 11 and 12 of the Big Sioux River

ATTAINS TMDL ID: R8-SD-2019-02

LOCATION: Minnehaha County, South Dakota

IMPAIRMENTS/POLLUTANTS: The TMDL document addresses four river segments whose warmwater semipermanent fish life propagation uses are impaired due to high concentrations of TSS.

Waterbody/Pollutants Addressed in this TMDL Action

Assessment Unit ID	Waterbody Description	Pollutants Addressed
SD-BS-R-BIG_SIOUX_08	Big Sioux River (S2, T104N, R49W to I-90)	Total Suspended Solids (TSS)
SD-BS-R-BIG_SIOUX_10	Big Sioux River (I-90 to diversion return)	Total Suspended Solids (TSS)
SD-BS-R-BIG_SIOUX_11	Big Sioux River (Diversion return to Sioux Falls Wastewater Treatment Plant [WWTP])	Total Suspended Solids (TSS)
SD-BS-R-BIG_SIOUX_12	Big Sioux River (Sioux Falls Wastewater Treatment Plant [WWTP] to above Brandon)	Total Suspended Solids (TSS)

BACKGROUND: The South Dakota Department of Environment and Natural Resources (DENR) submitted to EPA the final Total Suspended Solid (TSS) TMDLs for the Big Sioux River segments 8, 10, 11 and 12 with a letter requesting review and approval dated June 21, 2019. This revises TSS TMDLs established for these waterbodies that were approved by EPA on December 6, 2012 (SD DENR. 2012). An update was necessary to account for population and industrial growth occurring in and around the City of Sioux Falls. Given the scope of the updates, DENR solicited public comment on the revised TMDLs and sought re-approval by EPA.

The submittal included:

- Letter requesting EPA's review and approval of the TMDLs
- Final TMDL document
- Original 2012 HSPF modeling report (RESPEC. 2012)
- Updated 2019 HSPF modeling memo (RESPEC. 2019)

APPROVAL RECOMMENDATIONS: Based on the review presented below, the reviewer recommends approval of the final revised Big Sioux River segments 8, 10, 11 and 12 TSS TMDLs. All the required elements of approvable TMDLs have been met.

TMDL Approval Summary	
Number of TMDLs Approved:	4
Number of Causes Addressed by TMDLs:	4

REVIEWERS: Peter Brumm, 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 TMDL REVIEW FOR REVISIONS TO THE BIG SIOUX RIVER SEGMENTS 8, 10, 11 AND 12 TSS TMDLS

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.*

Impaired waterbody segments subject to these TMDLs are located in south-eastern South Dakota and are part of the larger Missouri River basin. This TMDL document covers four listed segments of the Big Sioux River (HUC 10170203) including: 1) Big Sioux River from S2, T104N, R49W to I-90 (28.5 miles, SD-BS-R-BIG_SIOUX_08); 2) Big Sioux River from I-90 to the diversion return (15.8 miles, SD-BS-R-BIG_SIOUX_10); 3) Big Sioux River from diversion return to Sioux Falls wastewater treatment plant (WWTP) (4.7 miles, SD-BS-R-BIG_SIOUX_11); and 4) Big Sioux River from Sioux Falls WWTP to above Brandon, SD (4.2 miles, SD-BS-R-BIG_SIOUX_12). Figure 1-1 displays the project area that shows the general location of the Big Sioux River and major tributaries within the project area, including the impaired segments. These segments have an extensive 303(d) listing and TMDL history:

- 2004 – Segments 8, 9, 10, 11 and 12 first listed for fecal coliform impairments.
- 2008 – EPA approved a fecal coliform TMDL for segment 8 (SD-BS-R-BIG_SIOUX_08, from near Dell Rapids to below Baltic).
- 2010 – DENR re-defined segment boundaries by dissolving segment 9 into segments 8 and 10. Segment 8's description expanded to: S2, T104N, R49W to I-90. Segments 8, 10, 11 and 12 first listed for *E. coli* and TSS impairments.
- 2012 – EPA approved fecal coliform, *E. coli* and TSS TMDLs for segments 8, 10, 11 and 12. This action replaced segment 8's 2008 fecal coliform TMDL.
- 2019 – DENR submitted revised *E. coli* and TSS TMDLs for segments 8, 10, 11 and 12. Once approved, this action will replace the 2012 TMDLs.

None of these impairments were included on South Dakota's 2018 303(d) List nor were they given a priority ranking for TMDL development because they were assigned Integrated Reporting Category 4a – Water impaired but has an approved TMDL. Prior to initial TMDL development they were considered high priorities. This information is contained in Section 1.0 (Introduction) and Section 1.2 (Clean Water Act Section 303(d) Listing Information).

Table 1-1 characterizes land uses draining into impaired segments and Section 3.2 discusses nonpoint sources of TSS such as surface runoff, bed and bank erosion, cropland erosion, and construction erosion. The pie charts in Figures 3-3, 3-4, 3-5 and 3-6 summarize Hydrological Simulation Program - FORTRAN (HSPF) model results and show the relative contribution from existing TSS sources categorized as local or upstream Municipal Separate Storm Sewer System (MS4), Big Sioux boundary conditions, Skunk Creek, Slip-up Creek, local bed and bank erosion, and upstream bed and bank erosion.

Point sources are identified by facility name and permit number in Table 3-1. Additionally, Figure 3-1 shows the location of point sources within the project area including the MS4 boundary.

Assessment: EPA concludes that the DENR adequately identified the impaired waterbodies, 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 TMDLs.

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 2.0 (Water Quality Standards and Total Maximum Daily Load Targets) describes the water quality standards applicable to the impaired segments with citations to applicable South Dakota regulations. Segments 8, 10, 11, and 12 of the Big Sioux River are designated for the following beneficial uses:

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

In addition, segments 8 and 10 are assigned a domestic water supply beneficial use. TSS is preventing the warmwater semipermanent fish life propagation uses from being supported on all four segments.

Numeric TSS criteria associated with these uses are applied as water quality targets for the TMDL. Table 2-1 displays the numeric TSS criteria for the warmwater semipermanent fish life propagation use which is comprised of a 30-day average criterion and a daily maximum criterion. These criteria are applicable year-round. TMDLs were primarily developed using the 30-day average criterion of 90 mg/L, however, TMDLs based on the daily maximum criterion of 158 mg/L were also included in Appendix A.

Assessment: EPA concludes that the DENR adequately described the applicable water quality standards and numeric water quality target for these TMDLs.

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, USEPA. 2007a). 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.

DENR relied on two methods to establish the loading capacity for each impaired segment: the Hydrological Simulation Program - FORTRAN (HSPF) model and the load duration curve approach. HSPF is a computer model that simulates hydrologic processes on the land surface and subsurface as well as the associated in-stream water quality. TSS monitoring data collected primarily by DENR, the U.S. Geological Survey (USGS) and the City of Sioux Fall, plus continuous flow recorded by the USGS, were used to calibrate the model as described in the original HSPF modeling report (RESPEC. 2012). The model was updated for the 2019 TMDL revisions with new meteorological data, land cover information, and diversion representations among other updates as explained in the 2019 modeling memo (RESPEC. 2019). DENR used the model to link sources of TSS to existing water quality and to evaluate TMDL implementation options through various scenario runs. Additionally, HSPF-generated flows and predicted TSS concentrations from the updated model were used to characterize existing loading conditions and establish the load duration curves used to define the loading capacity for each segment.

A load duration curve is a graphic representation of pollutant loads across flow regimes and the approach helps correlate water quality to flow conditions and provides insight into the variability of source contributions. EPA has provided guidance on the use of duration curves for TMDL development (USEPA. 2007b) and the practice is well established. Using this approach, DENR developed TMDLs at five different flow zones (i.e., high, moist, midrange, dry, low) for each segment as listed in Tables 5-2, 5-3, 5-4 and 5-5. Load duration curves, and the loading capacities based on the curves, are shown visually in Figures 4-1, 4-2, 4-3 and 4-4. While loading capacities are defined for multiple flow conditions, critical conditions exist in terms of the greatest observed exceedances during the high flow zone. DENR attributes the higher TSS concentrations during these conditions to streambed resuspension and decreased bank stability.

Assessment: EPA concludes that the loading capacity was calculated using an acceptable approach, used water quality targets consistent with numeric 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 loads. 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 5.4 (Load Allocation), DENR established LAs for each river segment as the allowable load remaining after the WLA and explicit MOS have been accounted for (i.e., LA = TMDL – WLA – MOS). Tables 5-2, 5-3, 5-4 and 5-5 present LAs across five flow zones. These composite LAs represent all nonpoint source contributions, both human and natural, as one allocation, however, individual nonpoint source categories were characterized in greater depth in Section 3.0 (Significant 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).

Table 3-1 identifies the six permitted point sources located within the drainage area of the four river segments. These are the Dell Rapids Wastewater Treatment Plant (WWTP), the Baltic WWTP and L.G. Everist in segment 8; the Sioux Falls Municipal Separate Storm Sewer System (MS4) in segments 10 and 11; Smithfield Foods (previously the John Morrell & Company) in segment 11 and the Sioux Falls WWTP in segment 12. Multiple Concentrated Animal Feeding Operations (CAFOs) also exist within the drainage area but no portion of the loading capacity was assigned to them because the CAFOs are designed to be zero discharge facilities except during rare storm events. Construction and industrial stormwater activities were evaluated but not assigned WLAs after DENR determined the area impacted by these activities make up less than 1.5% of the total project area.

DENR established non-stormwater WLAs using TSS concentrations more stringent than South Dakota's warmwater semipermanent fish life propagation criteria because technology-based effluent limits (45 or 135 mg/L) are more protective than the applicable water quality-based effluent limits and already effective in permits. Table 5-1 displays the individual non-stormwater WLAs and Tables 5-2, 5-3, 5-4 and 5-5 present all the WLAs, including the MS4, across the five flow zones.

Additionally, a future industrial growth WLA was established for each segment based on a flow rate of 10 million gallons per day to account for projected loading from new or expanded industries. DENR's proposed process for tracking and assigning this reserve capacity in the future is outlined on page 23. When DENR permits a new point source, the permit's statement of basis will detail how much of the future growth WLA will be assigned to the new point source and how much of the WLA remains unassigned. This process includes an opportunity for public comments and will provide a means to track the WLA and avoid situations of overallocation. Expanding the total WLA to include a future growth WLA component was the primary reason DENR chose to revise the 2012 TMDLs in accordance with EPA recommendations (USEPA. 2012).

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 current and future 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 Big Sioux River TMDLs include explicit MOSs for each segment derived as 10% of the loading capacity (i.e., TMDL). The explicit MOSs are included in Tables 5-2, 5-3, 5-4 and 5-5 and vary by flow zone.

Assessment: EPA concludes that the TMDL incorporates an adequate explicit 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)).

DENR relied on two primary methods to account for seasonal variation in these TMDLs: the HSPF model and the load duration curve approach. These methods reviewed conditions throughout many years and across various influencing factors such as temperature, precipitation and flow. The monthly variability of the monitoring dataset was also reviewed in Section 6.0 (Seasonality). TSS concentrations are generally highest during June and July when short-duration, high-intensity rainstorms are common.

Localized summer storms can cause significant runoff, increased flows, and increased TSS concentrations for a relatively short period of time.

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.

As verified through the TMDL analysis, segments 8, 10, 11 and 12 of the Big Sioux River are impaired by both point and nonpoint sources of TSS therefore reasonable assurances must be provided. DENR has done so in Section 9.3 (Reasonable Assurance).

The City of Sioux Falls led the development of the Draft Central Big Sioux River Watershed Water Quality Master Plan (City of Sioux Falls. 2013) to guide implementation efforts after the 2012 TMDLs were written. It addresses all nine key elements of a watershed plan as described by EPA's CWA Section 319 guidance (USEPA. 2008b). Within this plan, a watershed-scale, decision-support framework based on cost optimization was developed to support government and local planning agencies as they considered watershed-scale investments to improve water quality. This decision-support framework assisted in developing a more detailed TMDL implementation plan, identifying management practices to achieve pollutant reductions under the MS4 stormwater permit, and developing a phased BMP installation plan that is optimized for both cost and water quality effectiveness.

Section 9.1 (Recent Implementation) summarizes the quantity, location and costs of all installed BMPs known to DENR at this time. These activities are grouped into categories of agricultural waste systems, bank stabilization, cropland BMPs, grazing management and riparian restoration/protection, and city BMPs. For example, over $2.5 million dollars have been spent on grazing management and riparian restoration/protection BMPs in the project area; over $139 thousand of that came from EPA CWA Section 319 grants. Reductions necessary to meet LAs are expected to occur through the continued implementation of BMPs as described in existing planning documents (City of Sioux Falls. 2013) and local partnerships that support voluntary actions to address nonpoint sources.

WLAs were established based on facilities meeting technology-based effluent limits which are more stringent than South Dakota's TSS water quality criteria. Existing NPDES permit requirements are sufficient to be consistent with WLAs in the TMDL. Concerning MS4 controls, five stormwater BMPs have been installed since 2012 and Table 9-8 lists the planned location and date of future stormwater BMPs extending out till 2026.

Lastly, DENR compared the potential reductions realized under various HSPF modeling scenarios to the total TMDL reductions in order to demonstrate that the reductions called for are possible. This comparison is summarized in Table 9-9.

Assessment: EPA considered the reasonable assurances contained in the TMDL submittal and concludes that they are adequate to meet the load reductions.

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, USEPA. 2008a) 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.

DENR recently initiated a rotating basin approach to revisit established ambient water quality monitoring stations on a regular basis. With help from local DENR partners, like the East Dakota Water Development District, the Big Sioux River Basin will experience a comprehensive monitoring campaign in 2019. One aspect of this larger strategy involves collecting additional TSS samples from stations on segments 8, 10, 11, and 12 of the Big Sioux River. This information, and data collected in future years, will help gage the success of restoration efforts and provide insight into what actions still need to occur.

Assessment: Monitoring plans are not a required element of EPA's TMDL review and decision-making process. The TMDLs submitted by DENR include a monitoring strategy (Section 8.0) written to encourage future monitoring to measure progress toward attainment of water quality standards. The rotating basin approach is not mentioned in the TMDL, but EPA was aware of the effort and thought it noteworthy to mention. 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.

Section 9.0 (Restoration Strategy) summarizes implementation activities that have already occurred, discusses future management scenarios simulated by the HSPF model and outlines DENR's adaptive approach to TMDL implementation. The locations of existing best management practices are shown on a map (Figure 9-1) and quantified by category in term of the number of practices and the money spent to implement them. The HSPF model was used to better understand what additional actions must occur in order to meet water quality standards in each river segment. DENR simulated the following scenarios:

1. Future land use (e.g., agricultural lands converted into residential),
2. Upstream boundary conditions meet local upstream criteria (e.g., Big Sioux River above segment 8 meets 90 mg/L TSS and Skunk Creek meets 150 mg/L TSS),
3. Upstream boundary conditions meet warmwater semipermanent fish life propagation criteria (e.g. Big Sioux River above segment 8 and Skunk Creek both meet 90 mg/L TSS),
4. Loading from agricultural lands above Sioux Falls reduced by 90%,
5. Loading from instream scour on the Big Sioux River and major tributaries within the project area reduced by 50%,
6. Loading from the MS4 reduced by 85%,
7. Combined scenarios 3, 4, 5 and 6.

Simulated load reductions are presented for each scenario and segment in Table 9-9 and compared to the load reductions called for by the TMDL. Scenario 7 is the only scenario shown to consistently meet TMDL reduction goals.

Lastly, DENR commits to an iterative implementation process that makes progress toward achieving water quality goals by using new data and information whenever available to reduce uncertainty and adjust implementation activities accordingly.

Assessment: Although not a required element of the TMDL approval, DENR discussed how information derived from the TMDL analysis process can be used to support implementation of the TMDLs. 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.*

Section 7.0 (Public Participation) revisits the public engagement process DENR followed for the original 2012 TMDLs and summarizes what occurred for the revisions. DENR held a public meeting at the City of Sioux Falls Environmental Office on November 26, 2018. Subsequently, a draft of the updated TMDL report was made available for download and public review on DENR's website from May 16 to June 17, 2019. The public review period was announced in several area newspapers published on May 13 including the Sioux Falls Argus Leader, the Madison Daily Leader, and the Moody County Enterprise. DENR received no public comments on the revised TMDLs.

Assessment: EPA has reviewed the state's public participation process and concludes that the state involved the public during the development of the TMDLs 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 DENR, dated June 21, 2019, and signed by Paul Lorenzen, Environmental Scientist Manager 1, Water Protection Program. Two technical reports further documenting how the HSPF model was applied to this project were also shared as attachments (RESPEC. 2012, RESPEC. 2019).

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

References

RESPEC. 2012. *Sioux Falls Total Maximum Daily Load Model Application, Development, Calibration, and Validation.* Topical Report RSI-2272. Prepared for SD DENR by RESPEC Consulting & Services, Rapid City, SD.

RESPEC. 2019. *External Memorandum: Sioux Falls 2018 Total Maximum Daily Load Update, Changes to HSPF Model Application and Total Maximum Daily Load Documents.* Prepared for SD DENR by RESPEC Consulting & Services, Rapid City, SD.

SD DENR. 2012. *Total Suspended Solids Total Maximum Daily Load for the Big Sioux River, Minnehaha County South Dakota.* Topical Report RSI-2182. Prepared for SD DENR by RESPEC Consulting & Services, Rapid City, SD.

USEPA. 1991. *Guidance for water quality-based decisions: The TMDL process.* EPA 440-4-91-001. Office of Water, Assessment and Watershed Protection Division and Office of Wetlands, Oceans, and Watersheds, U.S. Environmental Protection Agency, Washington, DC.

USEPA. 1997. *New policies for establishing and implementing Total Maximum Daily Loads (TMDLs)*. Office of Water, U.S. Environmental Protection Agency, Washington, DC.

USEPA. 2006a. *Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit.* Office of Water, Office of Wetlands, Oceans, and Watersheds, U.S. Environmental Protection Agency, Washington, DC.

USEPA. 2006b. *Clarification Regarding "Phased" Total Maximum Daily Loads.* Office of Water, Office of Wetlands, Oceans, and Watersheds, U.S. Environmental Protection Agency, Washington, DC.

USEPA. 2007a. *Options for Expressing Daily Loads in TMDLs - DRAFT.* Office of Water, Office of Wetlands, Oceans, and Watersheds, U.S. Environmental Protection Agency, Washington, DC.

USEPA. 2007b. *An Approach for Using Load Duration Curves in the Development of TMDLs.* EPA-841-B-07-006. Office of Water, Office of Wetlands, Oceans and Watersheds, U.S. Environmental Protection Agency, Washington, DC.

USEPA. 2008a. *Handbook for Developing Watershed TMDLs – DRAFT.* Office of Water, Office of Wetlands, Oceans, and Watersheds, U.S. Environmental Protection Agency, Washington, DC.

USEPA. 2008b. *Handbook for Developing Watershed Plans to Restore and Protect our Waters.* EPA-841-B-08-002. Office of Water, Environmental Protection Agency, Washington, DC.

USEPA. 2010. *National Pollutant Discharge Elimination System (NPDES) Permit Writers' Manual, Chapter 6, Water Quality-Based Effluent Limitations.* EPA-833-K-10-001. Office of Water, Office of Wastewater Management, Water Permits Division, Washington, DC.

USEPA. 2012. *Considerations for Revising and Withdrawing TMDLs – DRAFT.* Office of Water, Office of Wetlands, Oceans, and Watersheds, U.S. Environmental Protection Agency, Washington, DC.

USEPA. 2014. *Water Quality Standards Handbook: Chapter 1: General Provisions.* EPA-820-B-14-008. EPA Office of Water, Office of Science and Technology, Washington, DC.

USEPA. 2017. *Water Quality Standards Handbook: Chapter 3: Water Quality Criteria.* EPA-823-B-17-001. EPA Office of Water, Office of Science and Technology, Washington, DC.

Total Maximum Daily Load Summary	
Waterbody Name/Description	Big Sioux River (S2, T104N, R49W to I-90)
Assessment Unit I.D.	SD-BS-R-BIG_SIOUX_08
Waterbody Type	River
Size of Impaired Waterbody	28.5 miles (45.8 kilometers)
Size of Watershed (Incremental)	79.0 square miles (204.7 square kilometers)
Location	12-digit Hydrologic Unit Code (HUC): 101702030604, 101702030605, and 101702031201
Impaired Designated Use(s)	Warm-water Semipermanent Fish Life
303(d) Listing Parameter	Total Suspended Solids (TSS)
Cycle Most Recently Listed	2018 South Dakota Integrated Report
TMDL Priority Ranking	N/A
TMDL Criteria Threshold Values	Indicator Name: TSS Threshold Values: Maximum daily concentration of ≤ 158 milligrams per liter (mg/L) and a 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period of ≤ 90 mg/L.
Analytical Approach	Load-duration curves and HSPF modeling
High-Flow Zone LA	245.14 tons/day
High-Flow Zone PS WLA	9.91 tons/day
High-Flow Zone MS4 WLA	0 tons/day
High-Flow Zone MOS	28.34 tons/day
High-Flow Zone TMDL	283.39 tons/day

Total Maximum Daily Load Summary	
Waterbody Name/Description	Big Sioux River (I-90 to diversion return)
Assessment Unit I.D.	SD-BS-R-BIG_SIOUX_10
Waterbody Type	River
Size of Impaired Waterbody	15.8 miles (25.4 kilometers)
Size of Watershed (Incremental)	40.9 square miles (106.0 square kilometers)
Location	12-Digit Hydrologic Unit Code (HUC): 101702031203
Impaired Designated Use(s)	Warm-water Semipermanent Fish Life
303(d) Listing Parameter	TSS
Cycle Most Recently Listed	2018 South Dakota Integrated Report
TMDL Priority Ranking	N/A
TMDL Criteria Threshold Values	Indicator Name: TSS Threshold Values: Maximum daily concentration of $\leq$ 158 milligrams per liter (mg/L) and a 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period of $\leq$ 90 mg/L.
Analytical Approach	Load-duration curves and HSPF modeling
High-Flow Zone LA	77.60 tons/day
High-Flow Zone PS WLA	5.63 tons/day
High-Flow Zone MS4 WLA	16.65 tons/day
High-Flow Zone MOS	11.10 tons/day
High-Flow Zone TMDL	110.97 tons/day

Total Maximum Daily Load Summary	
Waterbody Name/Description	Big Sioux River (Diversion return to Sioux Falls Wastewater Treatment Plant)
Assessment Unit I.D.	SD-BS-R-BIG_SIOUX_11
Waterbody Type	River
Size of Impaired Waterbody	4.7 miles (7.5 kilometers)
Size of Watershed (Incremental)	49.0 square miles (127.0 square kilometers)
Location	12-digit Hydrologic Unit Code (HUC): 101702031705
Impaired Designated Use(s)	Warm-water Semipermanent Fish Life
303(d) Listing Parameter	TSS
Cycle Most Recently Listed	2018 South Dakota Integrated Report
TMDL Priority Ranking	N/A
TMDL Criteria Threshold Values	Indicator Name: TSS Threshold Values: Maximum daily concentration of ≤ 158 milligrams per liter (mg/L) and a 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period of ≤ 90 mg/L.
Analytical Approach	Load-duration curves and HSPF modeling
High-Flow Zone LA	292.09 tons/day
High-Flow Zone PS WLA	7.01 tons/day
High-Flow Zone MS4 WLA	13.91 tons/day
High-Flow Zone MOS	34.78 tons/day
High-Flow Zone TMDL	347.80 tons/day

Total Maximum Daily Load Summary	
Waterbody Name/Description	Big Sioux River (Sioux Falls Wastewater Treatment Plant to above Brandon)
Assessment Unit I.D.	SD-BS-R-BIG_SIOUX_12
Waterbody Type	River
Size of Impaired Waterbody	4.2 miles (6.8 kilometers)
Size of Watershed (Incremental)	45.3 square miles (117.4 square kilometers)
Location	12-digit Hydrologic Unit Code (HUC): 101702031705
Impaired Designated Use(s)	Warm-water Semipermanent Fish Life
303(d) Listing Parameter	TSS
Cycle Most Recently Listed	2018 South Dakota Integrated Report
TMDL Priority Ranking	N/A
TMDL Criteria Threshold Values	Indicator Name: TSS Threshold Values: Maximum daily concentration of $\leq$ 158 milligrams per liter (mg/L) and a 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period of $\leq$ 90 mg/L.
Analytical Approach	Load-duration curves and HSPF modeling
High-Flow Zone LA	310.61 tons/day
High-Flow Zone PS WLA	16.33 tons/day
High-Flow Zone MS4 WLA	0 tons/day
High-Flow Zone MOS	36.33 tons/day
High-Flow Zone TMDL	363.27 tons/day

EXECUTIVE SUMMARY

This Total Maximum Daily Load (TMDL) assessment was completed as an update to an existing TMDL assessment for Big Sioux River impaired waterbodies near the city of Sioux Falls. The assessment addresses *E. coli* impairments in four river and stream reaches. A second TMDL assessment and TMDL assessment update was completed in the same four river and stream reaches for total suspended solids impairments. The goal of these TMDL updates was to quantify the pollutant reductions needed to meet the state water quality standards for *E. coli* and TSS in more recent years (i.e., 2013–2017). Reserve capacity was also added to the point source portion of the wasteload allocations to accommodate inevitable growth within the city of Sioux Falls. Because the point sources currently contribute less than one percent of the overall *E. coli* and TSS load, the point-source concentrations must remain below the water quality standards, and the point-source allocations are generally less than the margin of safety; thereby, the increased point-source allocations are not a water quality concern.

TMDLs described herein were derived from output of an HSPF model and observed data collected from 2013–2017. This model was calibrated to available flows (2005–2017), monitored water quality, and the latest National Land Cover Database and City of Sioux Falls Parcel Data. HSPF-estimated runoff and pollutant characterizations were employed to assess TMDLs for stream *E. coli* and TSS. HSPF-generated flows and outputs were used to establish load-duration curves for the *E. coli* and TSS impairments with wasteload allocations and load allocations established for five flow duration curve categories: high, moist, mid, low, and dry conditions. Reductions required to achieve state bacteria standards range from 0 percent to 96 percent by TMDL duration curve category. The reductions that are required to achieve state TSS standards range from 0 percent to 63 percent by TMDL duration curve category.

Restoring water quality will continue to be aided by the interdependent and cooperative efforts of the local communities, counties, state, and federal partners via leveraged management actions phased over budgetary cycles regarding the largest pollutant sources. Of the best management practices (BMPs), widespread adoption of buffers and streambank stabilization should proceed as a high priority and will assist in reducing bacteria and TSS. Knowing dominant bacteria and TSS sources to each impaired stream will help prioritize and guide implementation with agricultural producers and municipal storm sewer system areas. The findings from this TMDL study will assist in selecting implementation and monitoring activities.

The high flow zone distribution of the *E. coli* and TSS TMDL allocations for each reach are illustrated in figures ES-1 and ES-2, respectively.

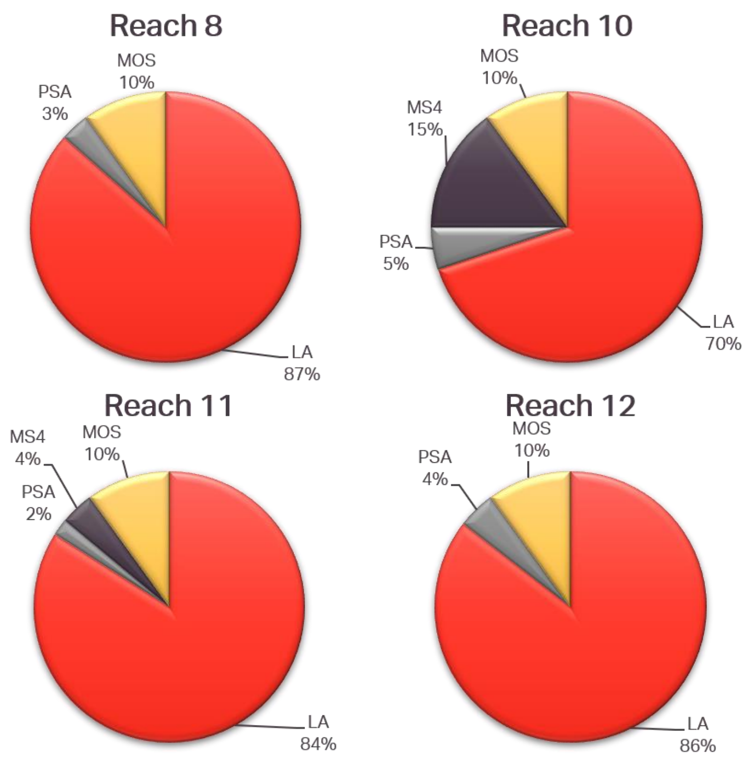

Figure ES-1. Total Suspended Solids High Flow Zone Total Maximum Daily Load Distribution.

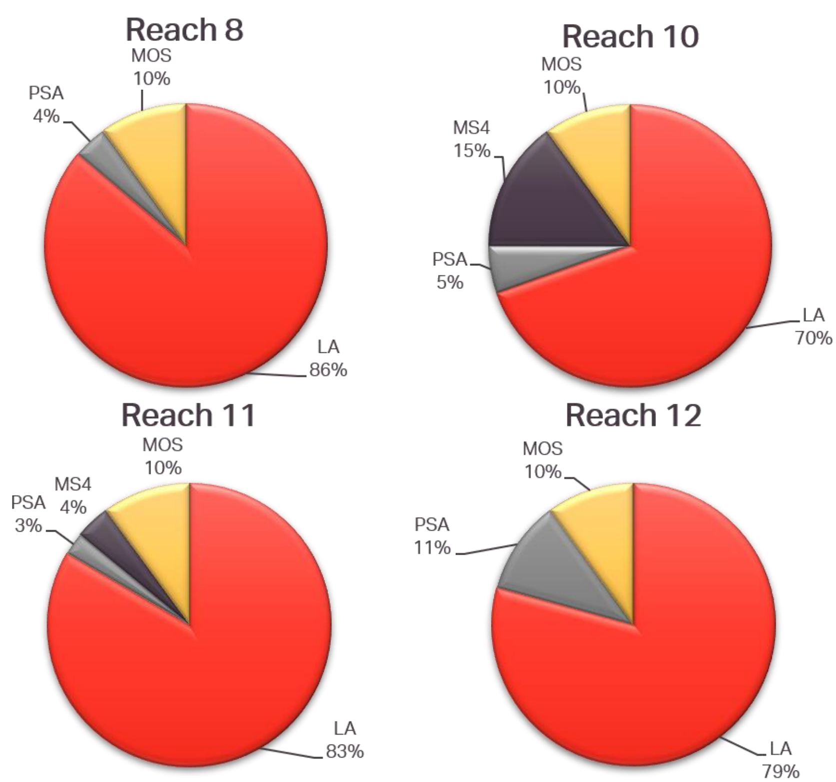

Figure ES-2. *E. coli* High Flow Zone Total Maximum Daily Load Distribution.

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1.0 INTRODUCTION

This document is to clearly identify the components of a set of Total Maximum Daily Loads (TMDLs), support adequate public participation, and facilitate the US Environmental Protection Agency (EPA) review. This document is an update to the TMDLs that were finalized in 2012, which have been developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by the EPA. A revision to the 2012 TMDLs was deemed necessary to account for the inevitable population and industrial growth occurring in and around the city of Sioux Falls, as Census data indicate that the population of Sioux Falls has increased nearly 15 percent since the previous TMDLs were written. The revision utilized updated land cover datasets and newly collected ambient water quality data. This TMDL document addresses total suspended solids (TSS) impairments on the Big Sioux River within the Lower Big Sioux River Watershed local to the city of Sioux Falls. The impaired reaches (SD-BS-R-BIG_SIOUX_08 [Reach 8], SD-BS-R-BIG_SIOUX_10 [Reach 10], SD-BS-R-BIG_SIOUX_11 [Reach 11], SD-BS-R-BIG_SIOUX_12 [Reach 12]) were assigned to priority category 1 (high priority) in the 2010 impaired waterbodies list [South Dakota Department of Natural Resources, 2010], but were removed from priority category 1 when they were approved by the EPA in 2012.

From 2008 to 2010, South Dakota Department of Environment and Natural Resources (SD DENR) integrated SD-BS-R-BIG_SIOUX_09 (Reach 09) into the upstream and downstream reaches because of differences in beneficial use designations and TMDL development. None of the newly listed reaches were listed as impaired for TSS in the 2008 impaired waterbodies list [SD DENR, 2008]. The 2018 integrated report lists the four reaches as impaired for TSS in EPA category 4A (water impaired with an approved TMDL).

1.1 WATERSHED CHARACTERISTICS

The Big Sioux River Watershed above the project area outlet is primarily located in eastern South Dakota and drains approximately 5,598 square miles in South Dakota, Minnesota, and Iowa. The Sioux Falls TMDL assessment project area lies within the Lower Big Sioux River Watershed, which includes the city of Sioux Falls (South Dakota's largest city). The project area drains approximately 216 square miles within the state of South Dakota.

Figure 1-1 shows the impaired (Section 303(d) listed) reaches on the Lower Big Sioux River that are located within the project area [SD DENR, 2018a]. Reach 8 begins near Dell Rapids at the Moody/Minnehaha County line and ends at Interstate-90 (I-90). In the 2008 integrated report, Reach 8 was defined as extending from near Dell Rapids to below Baltic [SD DENR, 2008]. In the 2010 integrated report, Reach 8 was expanded to include the portion of Reach 9 above the diversion split or at I-29 [SD DENR, 2010]. The remainder of Reach 9 below the diversion to Skunk Creek was incorporated into Reach 10 in the 2010 report [SD DENR, 2010]. Reach 10 now begins at I-90 and ends at the diversion return; Reach11 begins at the diversion return and ends at the Sioux Falls Wastewater Treatment Plant (WWTP); and Reach12 begins at the Sioux Falls WWTP and ends above Brandon, South Dakota [SD DENR, 2018a]. These TMDLs represent the contiguous Reaches 8 through 12.

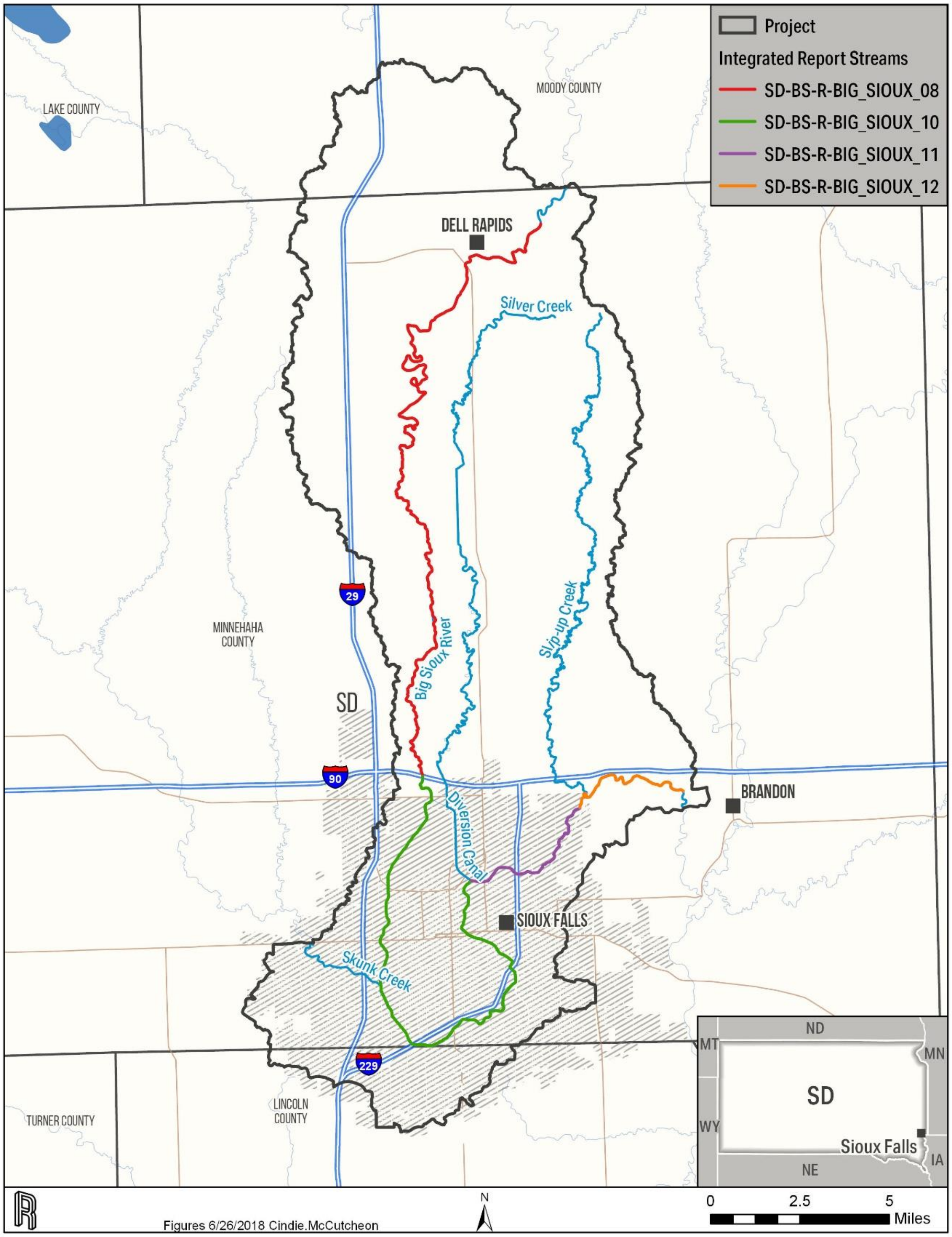

Figure 1-1. Project Area Watershed and Total Suspended Solids Impaired Reaches.

The Sioux Falls project area receives 73 percent of its average annual precipitation (24.7 inches) during the growing season of April through September [South Dakota State University, 2008]. The average annual precipitation in the project area is shown in Figure 1-2. Local storms with short durations often produce heavy rainfall and can elevate to severe thunderstorms and occasionally produce tornados. The average seasonal snowfall is 41.1 inches per year [US Department of Commerce National Climatic Data Center, 2004]. Land use in the entire area draining to the impaired reaches is predominantly cropland and pasture. A complete list of watershed land uses and percent areas is shown in Table 1-1.

1.2 CLEAN WATER ACT SECTION 303(D) LISTING INFORMATION

Four Big Sioux River reaches (8 through 12) within the project area were listed as impaired in South Dakota's 2018 303(d) list because of sample concentrations of TSS that exceeded the criteria for protecting warm-water, semipermanent fish life propagation. The Big Sioux River reaches within the Sioux Falls project area were not listed as impaired for TSS in South Dakota before 2010 [SD DENR, 2018a].

1.3 AVAILABLE WATER QUALITY AND WATER-QUANTITY DATA

Data have been collected throughout the project area by the SD DENR, the US Geological Survey (USGS), and by the City of Sioux Falls throughout the years. A summary of older water quality data, which included a specific summary of the baseflow samples versus the stormflow samples, is included in the previous version of this updated TMDL [McCutcheon et al., 2012]. Data summarized for this updated TMDL were collected between 2013 and 2017. Water quality data monitoring locations are shown in Figure 1-3 and listed in Table 1-2. Table 1-3 contains data summaries for each site from 2013 through 2017 including concentration ranges, percent exceedance of the daily maximum standard, and percent exceedance of the 30-day average standard. Data were used to create boxplots (Figure 1-4), that show the range of TSS concentrations [milligrams/Liter (mg/L)] at each site.

The most downstream monitoring site in each reach was used for load-duration curve development. The most downstream monitoring sites include BSR020 in Reach 8, BSR070 in Reach 10, BSR090 in Reach 11, and BSR105 in Reach 12. In Reach 8, BSR020 is the most downstream monitoring site in Reach 8, is the first mainstem site below the diversion above Skunk Creek into the city., is above Skunk Creek, and is below the diversion. In Reach 10, BSR070 is the most downstream monitoring site in Reach 10, includes flows from much the city and Skunk Creek, and but does not include diversion flows. Approximately half-way down Reach 11, BSR090 is the most downstream monitoring site in Reach 11, includes flows from the entire city, Skunk Creek, and the diversion, but not flows from Slip-up Creek. Approximately half-way down Reach 12, BSR105 includes flows from the entire city, Skunk Creek, the diversion, and Slip-up Creek. At all locations, exceedances of the 30-day average criteria were far more prevalent than exceedances of the daily maximum criteria; therefore, these TMDLs are developed using the 30-day average concentrations and criteria.

Monitoring was completed in 2009 on three key tributaries (Skunk Creek, Slip-up Creek, and Silver Creek); on the diversion canal, which sends flow around the Sioux Falls area; at multiple sites along the Big Sioux River; and throughout the city's storm drainage network. More information about these sites is

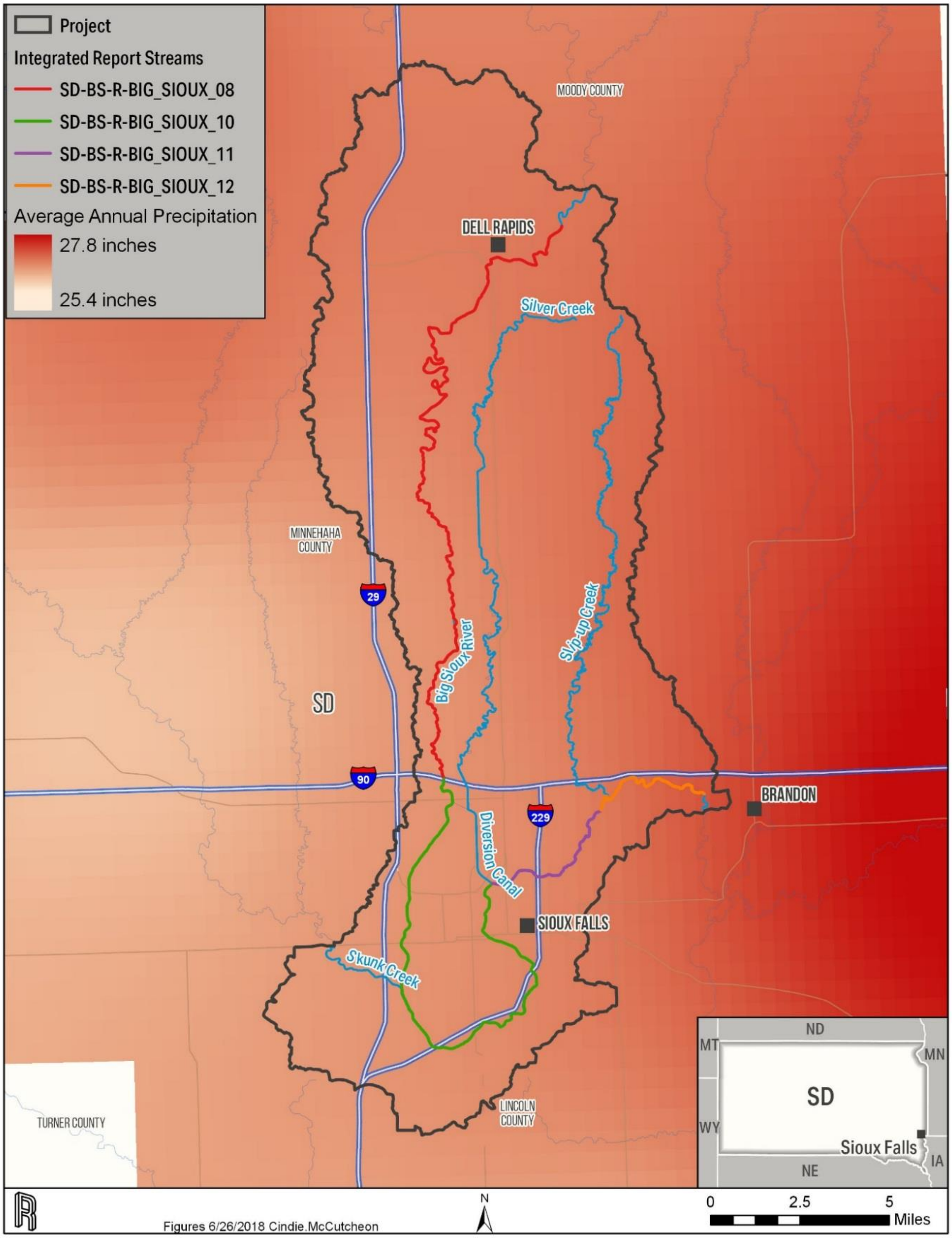

Figure 1-2. PRISM Average Annual Precipitation From 1981 to 2010.

Table 1-1. Land Use at Total Maximum Daily Load Reach Endpoints

Land Use	Reach 8 Land-Use Drainage Area (mi^2)	Percent at TMDL Reach 8 Endpoint[a]	Reach 10 Land-Use Drainage Area (mi^2)	Percent at TMDL Reach 10 Endpoint[a]	Reach 11 Land-Use Drainage Area (mi^2)	Percent at TMDL Reach 11 Endpoint[a]	Reach 12 Land-Use Drainage Area (mi^2)	Percent at TMDL Reach 12 Endpoint[a]
Cultivated Crops	2,601.9	54	3,002.2	55	3,023.7	55	3052.2	55
Grassland/Herbaceous	930.7	19	967.7	18	969.6	17	972.5	17
Pasture/Hay	467.3	10	571.7	10	582.4	11	593.4	11
Open Water	457.3	9	483.3	9	483.6	9	483.9	9
Developed	229.1	5	297.9	5	309.5	6	318.9	6
Wetlands	126.6	3	137.9	3	138.2	2	138.6	2
Forest	26.3	1	31.1	1	32.4	1	33.1	1
Shrub/Scrub	2.3	0	2.4	0	2.5	0	2.5	0
Barren Land	2.0	0	2.5	0	2.7	0	2.7	0
Total Drainage Area (mi^2)	**4,843.4**		**5,496.7**		**5,544.6**		**5,597.7**	

(a) See Figure 1-1; National Land Cover 2002 (Total Project Area = 214 mi^2).

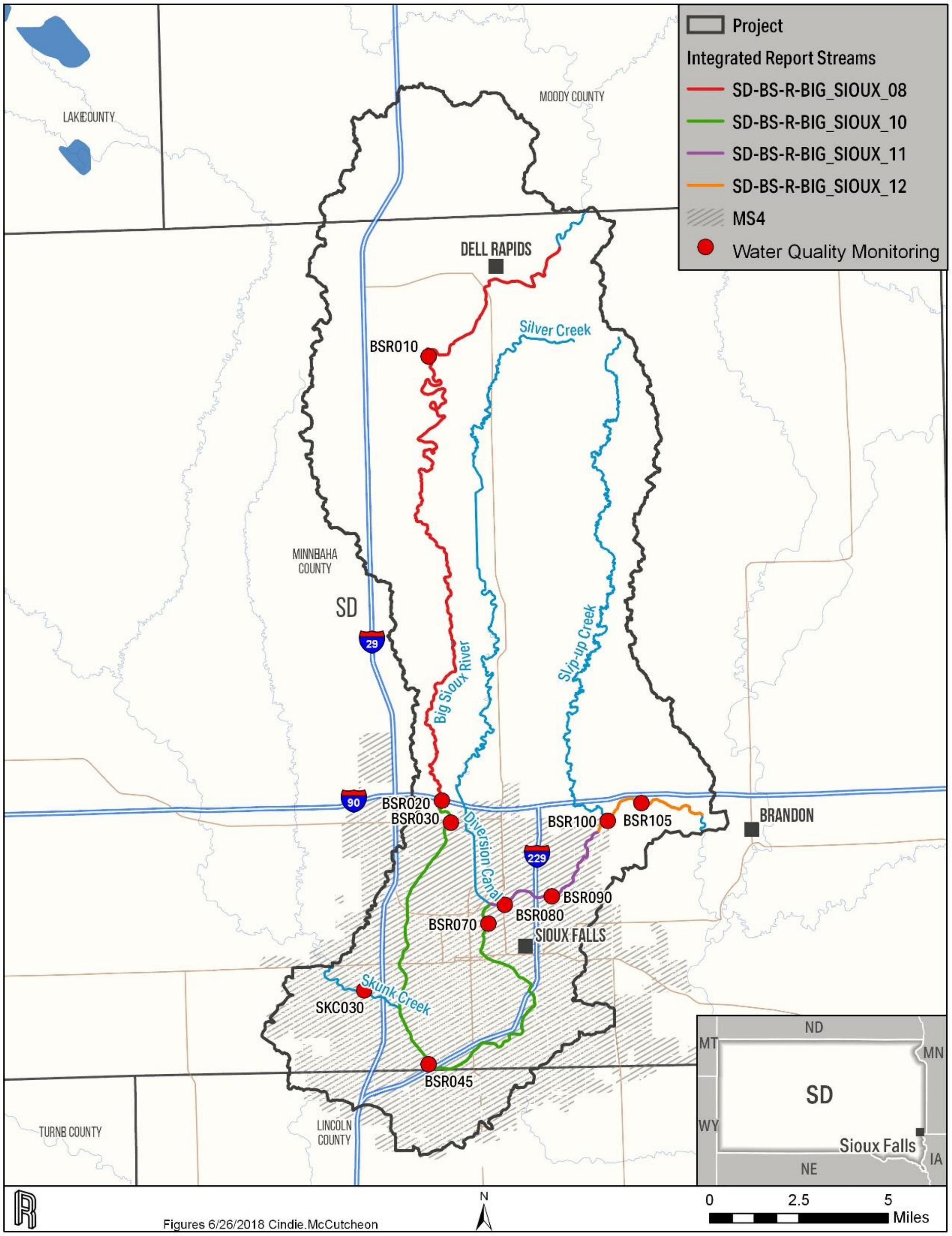

Figure 1-3. Monitoring Sites With 2013–2017 Total Suspended Solids Data.

included in the previous version of this TMDL [McCutcheon et al., 2012]. This monitoring increased the understanding of the flows and associated TSS concentrations throughout the watershed, as well as the flows being diverted around the city of Sioux Falls for the watershed model, which were ultimately used for the TMDLs.

Table 1-2. Data Available Between 2013 and 2017

Observed Monitoring Stations	Site Identification	Reach	Number of Samples
Big Sioux River Minnehaha Co. Line to Below Baltic[(a)]	BSR010	SD-BS-R-BIG_SIOUX_08	109
Big Sioux River I-90 Bridge upstream of Sioux Falls	**BSR020**	**SD-BS-R-BIG_SIOUX_08**	**351**
Big Sioux River at Silver Creek[(a)]	BSR030	SD-BS-R-BIG_SIOUX_10	16
Skunk Creek at Marion Road Bridge at Sioux Falls [(a)]	SKC030	NA	351
Big Sioux River at I-229 Bridge[(a)]	BSR045	SD-BS-R-BIG_SIOUX_10	62
Big Sioux River From Skunk Creek to Diversion Return	**BSR070**	**SD-BS-R-BIG_SIOUX_10**	**353**
Big Sioux River at North Cliff at Sioux Falls[(a)]	BSR080	SD-BS-R-BIG_SIOUX_11	19
Big Sioux River at Bahnson Ave. Bridge	**BSR090**	**SD-BS-R-BIG_SIOUX_11**	**408**
Big Sioux River at Bridge Downstream of Slip-up Creek[(a)]	BSR100	SD-BS-R-BIG_SIOUX_12	417
Big Sioux River (26B) at Hwy 21	**BSR105**	**SD-BS-R-BIG_SIOUX_12**	**315**

(a) Not used in the development of TMDL tables and load duration curves (LDCs).
(b) Sites shown in bold were used for LDCs and TMDL tables.

Skunk Creek contributes a significant flow volume (40 to over 60 percent) to the Big Sioux River, as illustrated in Figure 1-5. This significant flow is related to the diversion of much of the Big Sioux River around the city of Sioux Falls via canal (see Figure 1-1 for the canal location). Runoff from the city of Sioux Falls and flow from Skunk Creek accounts for much of the Big Sioux River flow. The median concentration at Skunk Creek is slightly lower than that in the Big Sioux River, so the larger flows from Skunk Creek may dilute TSS concentrations in the impaired reaches.

The Municipal Separate Storm Sewer Systems (MS4) permit is a municipal stormwater discharge permit that authorizes stormwater discharge from the MS4. For the Sioux Falls TMDLs, the permit refers to stormwater runoff from the city of Sioux Falls into the Big Sioux River and its tributaries. The level of stormwater quality control is defined in federal regulations in terms of maximum extent practicable (MEP). MEP considers the practicality and/or economics in treating low-frequency, very large events, and it recognizes that the majority of stormwater loadings are generated by the frequent, smaller events.

The 2009 stormwater portion of the monitoring showed the average median concentrations in stormwater from the city to be 26.6 mg/L, which is lower than the TSS criteria in the project area. The 2009 monitoring also showed that the existing Best Management Practices (BMPs) within the project area (e.g., detention ponds and constructed wetlands) tend to decrease the Big Sioux River TSS concentrations within the project area [McCutcheon et al., 2012].

Table 1-3. Percent Exceedance of Total Suspended Solids Concentration Criteria and Ranges for Water Quality Monitoring Sites With Data Between 2013 and 2017

Observed Monitoring Stations	Site Identification	Total Number of Samples	Daily Maximum Exceedances	Daily Maximum Percent Exceedance	Daily Maximum Concentration Range (mg/L)[a]	Median Concentration (mg/L)[a]	30-Day Average[b] Values	30-Day Average[b] Exceedances	30-Day Average Percent Exceedance	30-Day Average[b] Concentration Range (mg/L)[a]
Big Sioux River Minnehaha Co. Line to Below Baltic	BSR010	109	7	6	3–220	64	14	8	57	28–124.5
Big Sioux River I-90 Bridge Upstream of Sioux Falls	**BSR020**	**351**	**25**	**7**	**3–677**	**60**	**45**	**11**	**24**	**6.7–224**
Big Sioux River at Silver Creek[c]	BSR030	16	0	0	3–148	51	0	NA	NA	NA
Skunk Creek at Marion Road Bridge at Sioux Falls	SKC030	351	15	4	3–602	39	51	4	8	4.5–219.6
Big Sioux River at I-229 Bridge	BSR045	62	4	6	8–380	59.5	4	4	100	97.7–116
Big Sioux River From Skunk Creek to Diversion Return	**BSR070**	**353**	**18**	**5**	**1.8–484**	**44**	**47**	**11**	**23**	**3.8–190.7**
Big Sioux River at North Cliff at Sioux Falls[c]	BSR080	19	1	5	6–340	45	0	NA	NA	NA
Big Sioux River at Bahnson Ave. Bridge	**BSR090**	**408**	**25**	**6**	**2.3–492**	**52**	**57**	**12**	**21**	**4.2–234.9**
Big Sioux River at Bridge Downstream of Slip-up Creek	BSR100	417	21	5	1.3–432	46	58	12	21	5.8–205.9
Big Sioux River (26B) at Hwy 21	**BSR105**	**315**	**16**	**5**	**1.3–432**	**46**	**48**	**9**	**19**	**6.2–205.9**

(a) mg/L = milligrams per liter.

(b) The 30-day average concentration is calculated for each month. South Dakota criteria require at least three samples in a 30-day period to calculate a 30-day average. Therefore, months with less than three samples were not considered.

(c) The 30-day average based on at least three samples was not available.

(d) Sites shown in bold were used for LCDs and TMDL tables

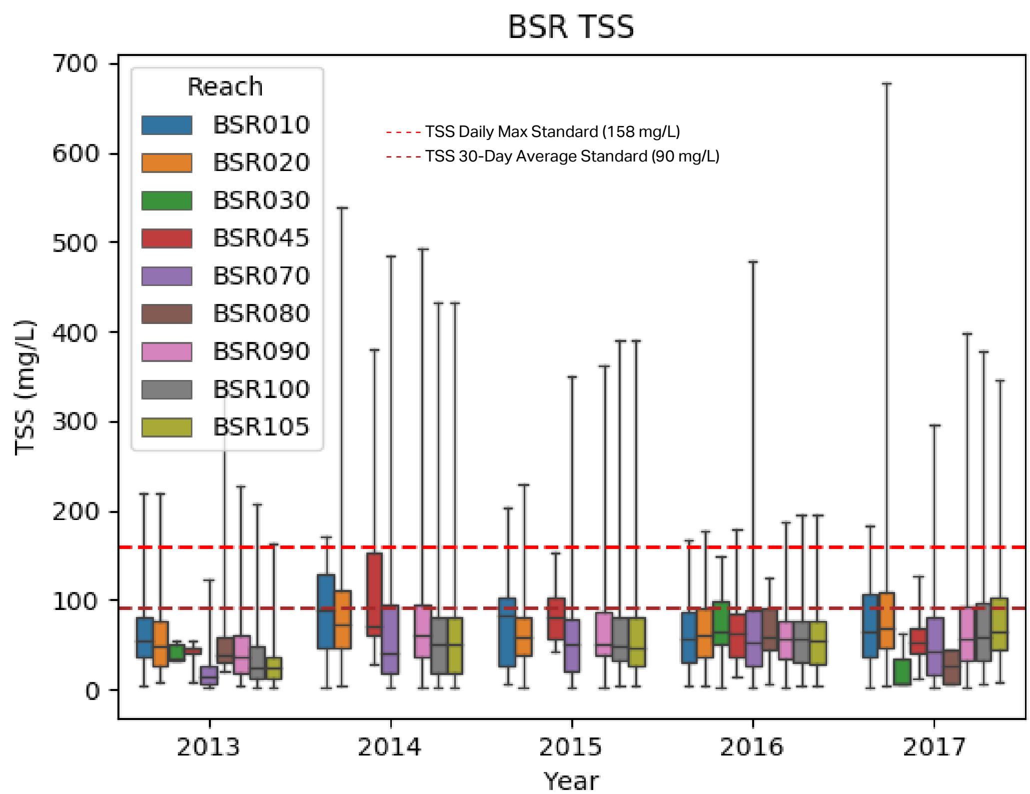

Figure 1-4. Big Sioux River Total Suspended Solids Boxplots for the Mainstem Sampling Sites With 2013–2017 Data.

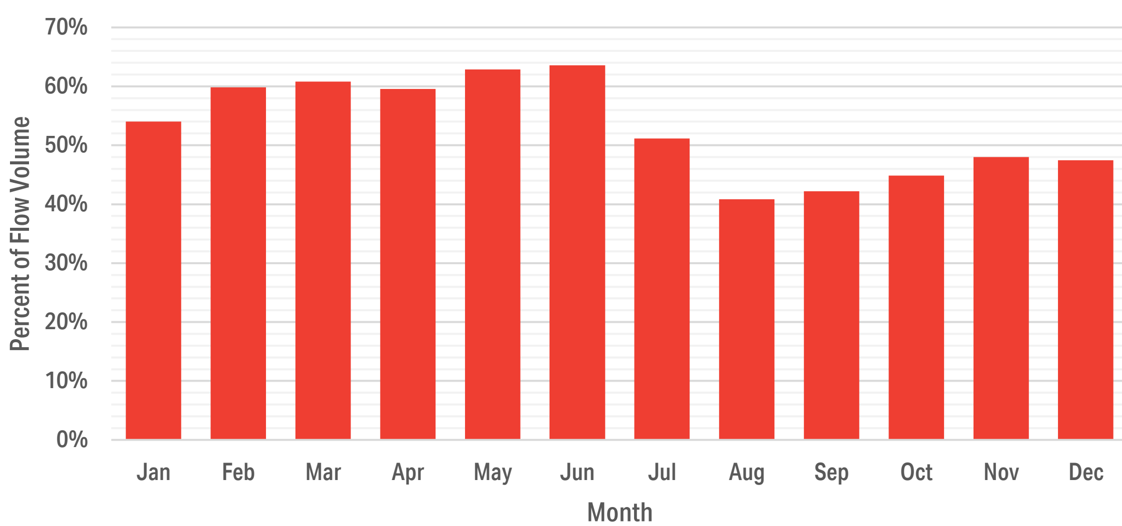

Figure 1-5. Skunk Creek Monthly Flow Volume Contribution Percentage to the Big Sioux River Directly Downstream of Skunk Creek (2013–2017).

The USGS monitors long-term stream flow on the Big Sioux River at USGS 06481000 (Big Sioux River near Dell Rapids), USGS 06482000 (Big Sioux River at Sioux Falls), USGS 06482020 (Big Sioux River at Cliff Avenue at Sioux Falls), and Skunk Creek at USGS 06481500 (Skunk Creek at Sioux Falls). These stream flow gages are shown in Figure 1-6. Two additional stream flow gages also existed (BSR020 at the I-90 Bridge upstream of Sioux Falls and BSR110 near Brandon), but they did not have continuous flow data. Additional flow data were collected as a part of the 2009 monitoring effort. All flow data from 2005 to 2017 were used to calibrate the hydrology portion of the watershed model.

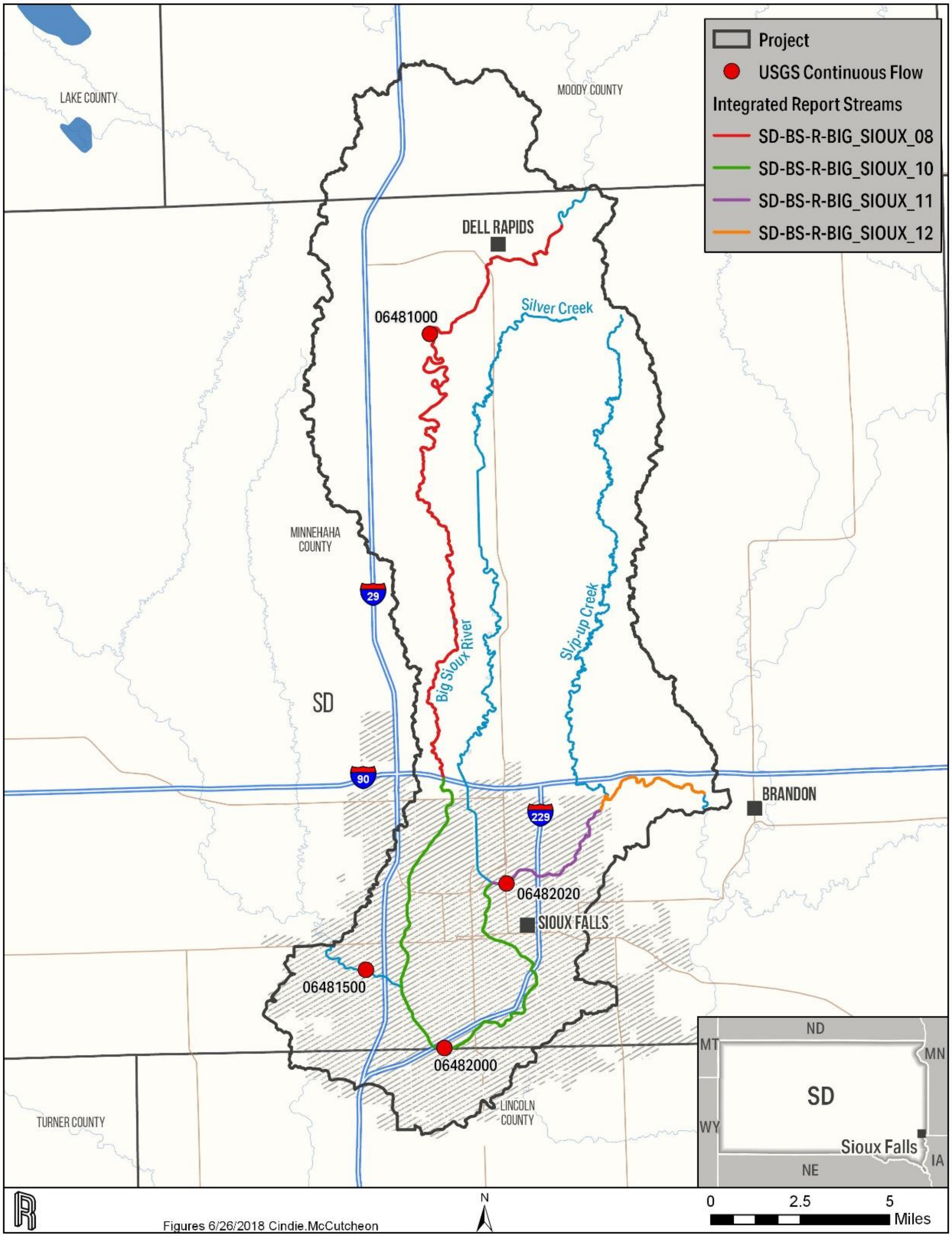

Figure 1-6. Long-Term US Geological Survey Stream Flow Gages on the Big Sioux River and Skunk Creek.

2.0 WATER QUALITY STANDARDS AND TOTAL MAXIMUM DAILY LOAD TARGETS

Each waterbody within South Dakota is assigned beneficial uses. All waters (both lakes and streams) are designated with the use of fish and wildlife propagation, recreation, and stock watering, and all streams are assigned the use of irrigation. Additional uses may be assigned by the state based on a beneficial use analysis of each waterbody. Water quality standards are defined in South Dakota state statutes to support these uses and consist of suites of criteria that provide physical and chemical benchmarks from which management decisions can be developed (Administrative Rules of South Dakota [ARSD] 74:51:01–74:51:03) [ARSD, 2010].

Additional applicable standards can be found in ARSD Articles 74:51:01:05; 06; 0; 09; and 12 [ARSD, 2010]. These articles contain language that generally prohibits materials causing the formation of pollutants, visible pollutants, nuisance aquatic life, and pollutants that impact biological integrity.

The Big Sioux River Reaches 8 and 10 have been assigned the following beneficial uses: domestic water supply, fish and wildlife propagation, immersion recreation, irrigation waters, limited contact recreation, and warm-water semipermanent fish life. The Big Sioux River Reaches 11 and 12 were assigned the same beneficial uses with exception to domestic water supply, which is not a beneficial use in these downstream reaches. Table 2-1 lists the TSS water quality criteria that must be met to support the beneficial uses currently assigned to the Big Sioux River within the city of Sioux Falls. Greater than 10 percent of the samples must exceed water quality criteria for that parameter to be included as a cause of impairment on the 303(d) Impaired Waters List. For a parameter to be considered representative of actual conditions, at least 20 samples are required; however, the sample threshold is reduced to ten samples if three or more samples exceed daily maximum water quality standards.

Table 2-1. State Total Suspended Solids Surface Water Quality Standards for the Big Sioux River in the City of Sioux Falls

Parameter	Criteria	Unit of Measure	Special Conditions
TSS[(a)]	≤ 90	mg/L	30-day average
	≤ 158	mg/L	Daily maximum

(a) Criteria for warm-water semipermanent fish life propagation use.

Current TSS criteria for the warm-water semipermanent fish life propagation (Big Sioux River) beneficial use requires that no sample exceeds 158 mg/L and the 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period must not exceed 90 mg/L. Current TSS criteria for the warm-water marginal fish life propagation (Skunk Creek) beneficial use requires that no sample exceeds 263 mg/L and the 30-day average of at least three consecutive grab or composite samples taken on separate weeks in a 30-day period must not exceed 150 mg/L.

According to ARSD Article 74:51:01:04, if pollutants are discharged into a reach and the criteria for that reach's designated beneficial use are not exceeded, but the waters flow into another reach whose designated beneficial use requires a more stringent parameter criterion, the pollutants may not cause the more stringent criterion to be exceeded.

3.0 SIGNIFICANT SOURCES

3.1 POINT SOURCES

Multiple permitted point-source discharges are in the project area, illustrated in Figure 3-1 and listed in Table 3-1. These permitted point sources include the L.G. Everest in Reach 8, Dell Rapids Wastewater Treatment Plant (WWTP) in Reach 8, Baltic WWTP in Reach 8, Sioux Falls MS4 permit in Reaches 10 and 11, Smithfield Foods in Reach 11, and Sioux Falls WWTP in Reach 12. The TSS daily maximum effluent limits for these facilities are listed in Table 3-1. The Baltic WWTP and the Dell Rapids WWTP are lagoons. According to the discharge monitoring report data, the Baltic WWTP has not discharged in over 10 years, and the Dell Rapids WWTP typically discharges in May and December each year. When the previous version of this TMDL document was written, Smithfield Foods was John Morrell. The permit area covered by the MS4 permit includes "all areas within the corporate boundary of the city of Sioux Falls served by, or otherwise contributing to, discharges to state waters from municipal separate storm sewers owned or operated by the city of Sioux Falls and interstate highways operated by South Dakota Department of Transportation" [SD DENR, 1999]. Multiple concentrated animal feeding operations (CAFOs) are located in Minnehaha County. Note, however, that all of these permitted CAFOs have zero discharge except in the rare case of a precipitation event that produces a volume of water greater than the facility's design capacity. In this case, the permittee is required to notify the SD DENR and develop a plan of action to remediate the problem. CAFOs were therefore not given WLAs.

3.2 NONPOINT SOURCES

Nonpoint-source pollution of TSS generally comes from surface runoff, bed and bank erosion, cropland erosion, and construction erosion. Analysis of sediment concentrations from upstream to downstream shows no obvious trends. TSS loadings for the model were estimated using the simulated hydrologic response of each modeled land use and the corresponding Event Mean Concentrations (EMCs) that were derived from 2009 sample data based on representative land use draining to particular sampling sites. For example, one sampling site was predominantly residential, so the concentrations observed from that site were used as the EMC for all residential land. The multiple sampling sites had a targeted representative land use. To account for spatial variability in the watershed and to align with downstream sampling measurements, the EMCs in some cases were adjusted through the calibration process within the range of concentrations that were observed for the land use.

3.3 SOURCE ASSESSMENT MODELING RESULTS

The watershed modeling package selected for this assessment was the EPA HSPF model. HSPF is a comprehensive watershed model of hydrology and water quality that includes modeling both land surface and subsurface hydrologic and water quality processes that are linked and closely integrated with corresponding stream and reservoir processes. HSPF is considered a premier, high-level model among those currently available for comprehensive watershed assessments.

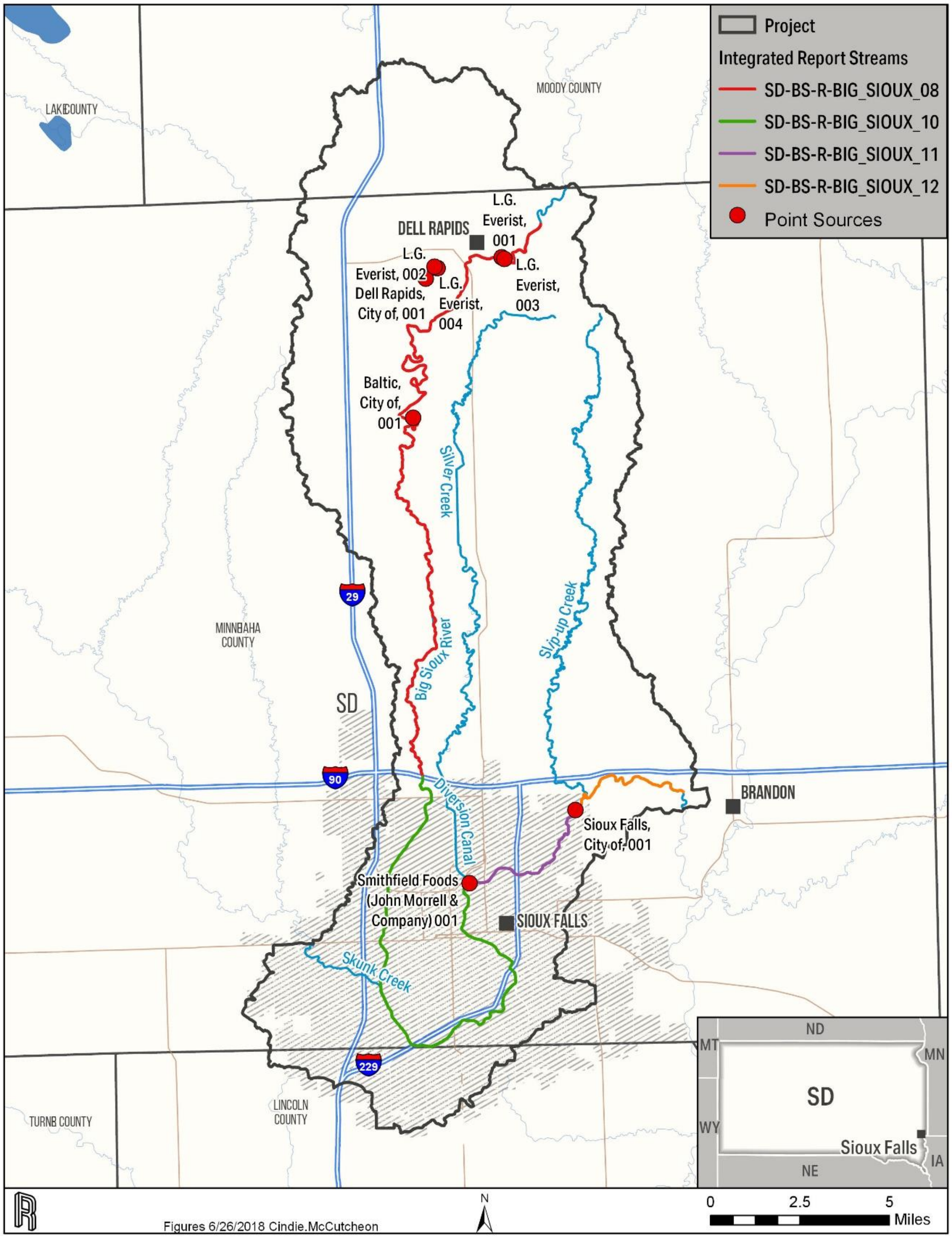

Figure 3-1. Point Sources Including the Municipal Separate Storm Sewer Systems.

Table 3-1. Point-Source Flows, Concentrations, and Waste Load Allocations

Point Sources	Permit Number	Reach	Flow (mgd)[a]	TSS Limit (mg/L)	TSS WLA (tons/day)
L. G. Everist	SD-0000051	8	5.08	45	0.95
Dell Rapids WWTP	SD-0022101	8	4.38	135[b]	2.47
Baltic WWTP	SD-0022284	8	4.56	45[b]	0.86
Sioux Falls NPDES MS4	SDS-000001	10, 11	N/A	N/A	N/A
Smithfield Foods[a]	SD-0000078	11	5.25	1.38 tons per day	1.38
Sioux Falls WWTP	SD-0022128	12	57	45[b]	10.70
Future Industrial Growth Reserve Capacity	NA	8, 10, 11, 12	10	135	5.63

The HSPF model was used to determine the contribution of TSS from identified sources in the Big Sioux River Watershed and evaluate the implementation of BMPs to control these sources. The Big Sioux River drainage basin was represented in the model by using 24 subwatersheds and two boundary conditions that represent Skunk Creek and the Big Sioux River at Dell Rapids. As mentioned earlier, nonpoint-source TSS loadings for HSPF were estimated using the EMCs for each land use, which were derived from the intensive 2009 sample data based on representative land uses draining to particular sampling sites. For example, one sampling site was predominantly residential, so the concentrations from that site were used as the EMCs for all residential land. EMCs were applied throughout the watershed. Point-source data provided by SD DENR for facilities discharging below the Big Sioux River boundary condition were represented in the model at the time step provided (30-day average).

Source assessment modeling results were summarized according to the following categories: nonpoint sources, local MS4, upstream MS4, Big Sioux River boundary conditions, Skunk Creek, Slip-up Creek, and bed and bank (local and upstream). Figure 3-2 is a schematic of the sources listed above. The nonpoint-source category includes all areas north of the Sioux Falls MS4 except the Slip-up Creek Watershed (local Big Sioux River from Reach 8), and Silver Creek. A time series of average daily loads by source occurring on each date from 2013 through 2017 was created. Pie charts, shown in Figures 3-3 through 3-6, were then produced for each of the four TMDL endpoints for each source. Point sources contributing to the Big Sioux River above the boundary condition at the USGS flow gage (L.G. Everist, Dell Rapids WWTP, and Baltic WWTP) were not explicitly modeled and are included in the boundary condition. Primary source contributions to Reach 8 included in the pie charts were from the Big Sioux River upstream of the boundary conditions and bed and bank. Reach 10 loads were primarily from Skunk Creek, the Big Sioux River upstream of the boundary conditions, local MS4, and local bed and bank. Reach 11 loads were primarily a combination of the Big Sioux River upstream of the boundary conditions, the local MS4, upstream bed and bank, and Skunk Creek. Finally, Reach 12 loads were primarily attributed to the Big Sioux River upstream of the boundary conditions, upstream MS4, upstream bed and bank, and Skunk Creek.

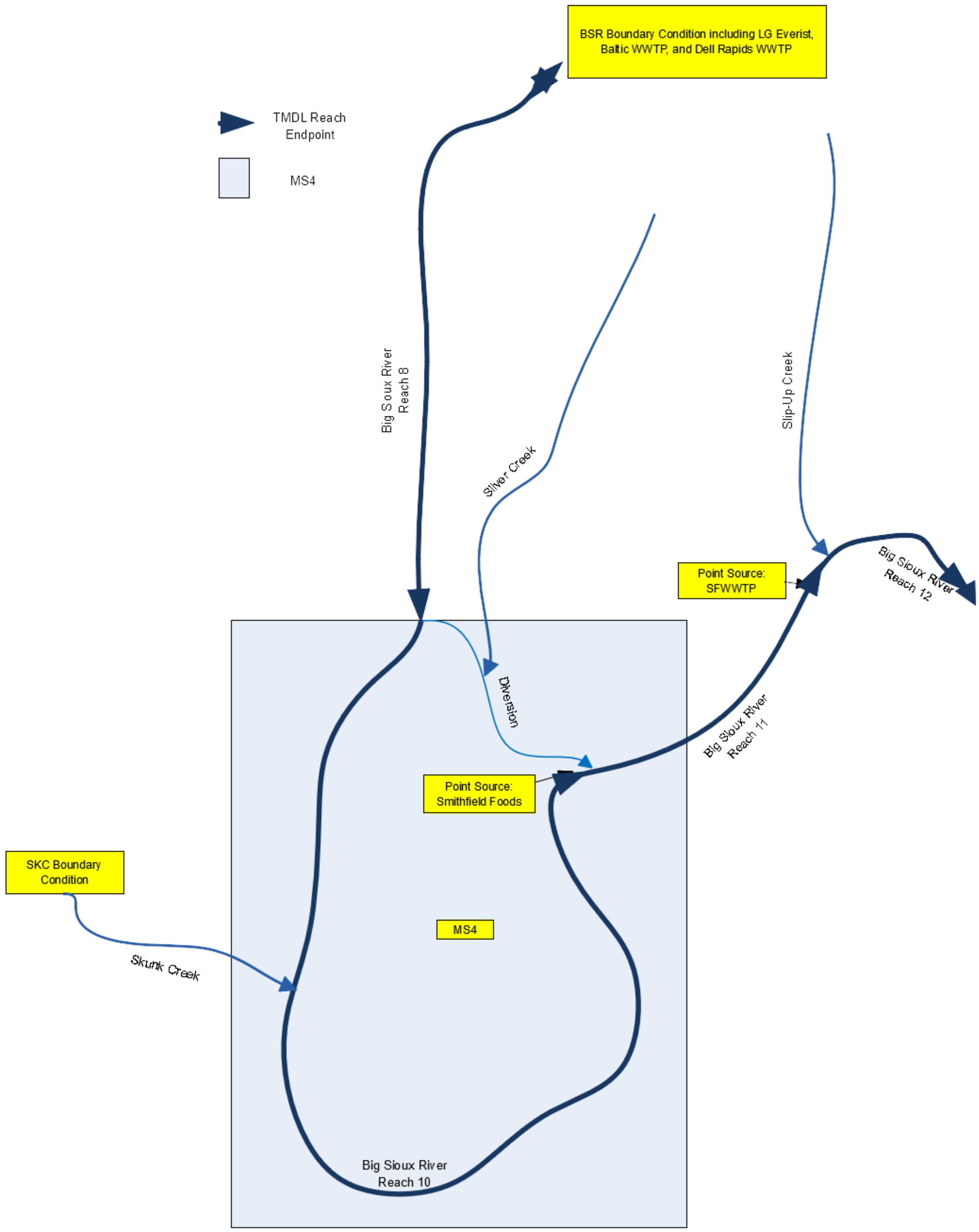

Figure 3-2. Diagram of Sources Used in Source Assessment Pie Charts.

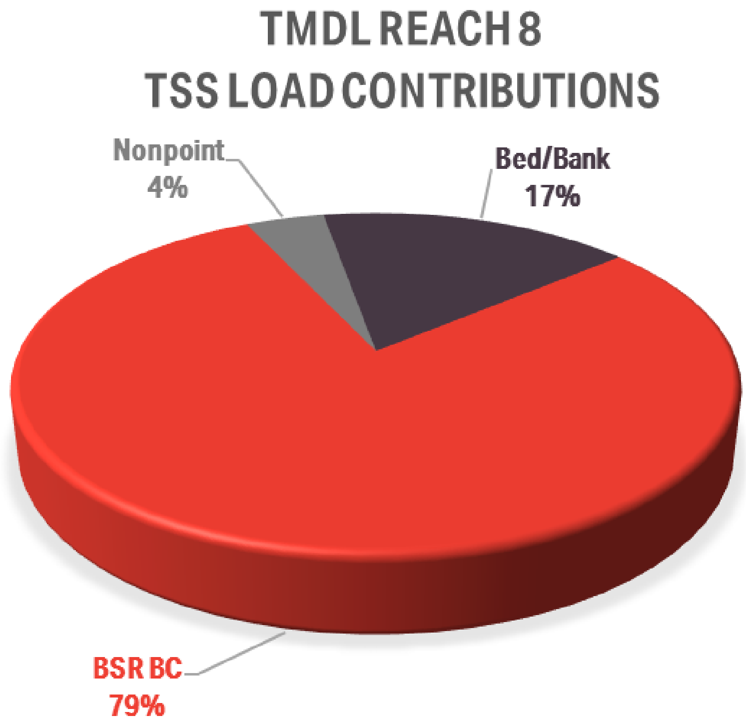

Figure 3-3. Source Assessment Modeling Results for Total Maximum Daily Load Reach 8.

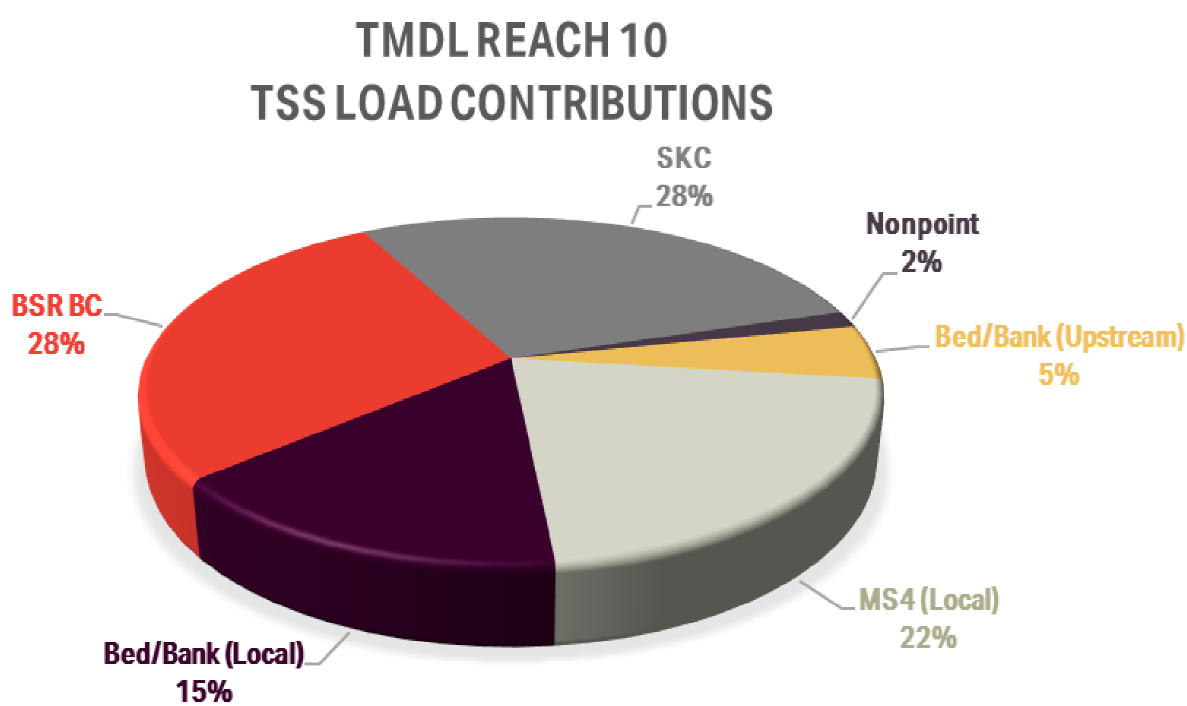

Figure 3-4. Source Assessment Modeling Results for Total Maximum Daily Load Reach 10.

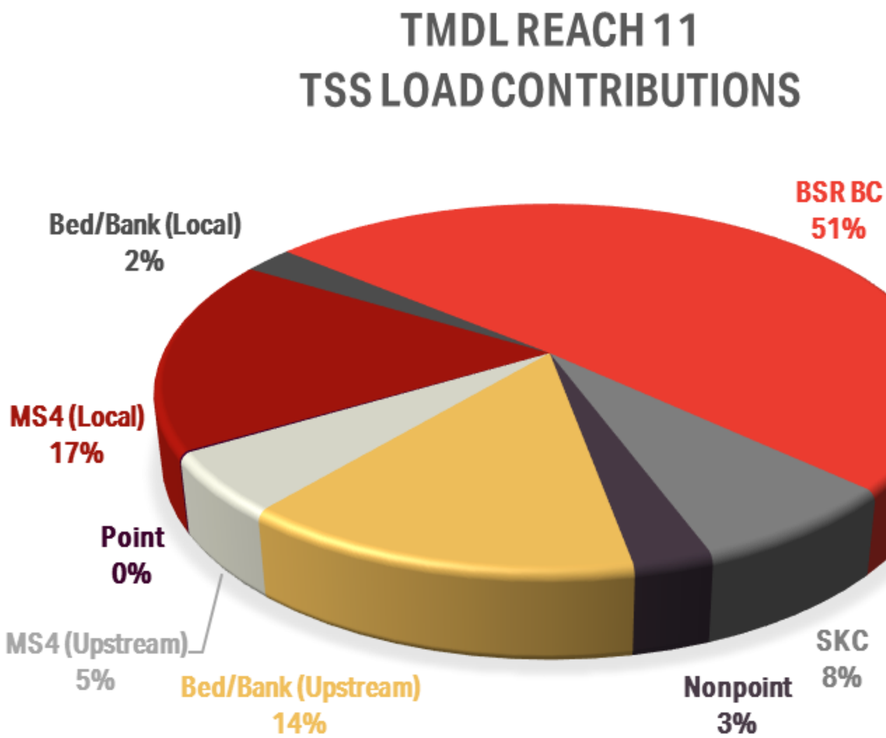

Figure 3-5. Source Assessment Modeling Results for Total Maximum Daily Load Reach 11.

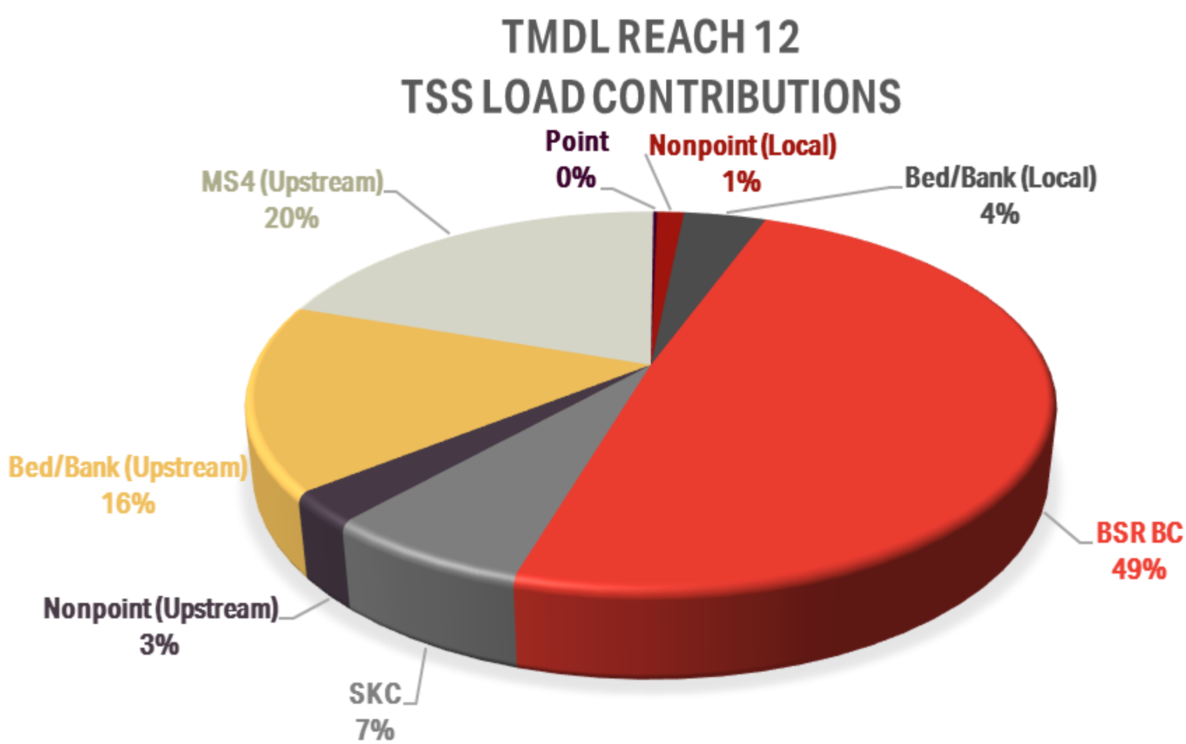

Figure 3-6. Source Assessment Modeling Results for Total Maximum Daily Load Reach 12.

4.0 TECHNICAL ANALYSES

The TMDL was developed using the load-duration curve (LDC) approach, which resulted in a flow-variable target that considers the entire flow regime. The LDC is a dynamic expression of the allowable daily load for any given flow. To aid in interpreting and implementing the TMDL, the LDC flow intervals were grouped into five flow zones: high flows (0–10 percent), moist conditions (10–40 percent), midrange flows (40–60 percent), dry conditions (60–90 percent), and low flows (90–100 percent) according to the EPA [2007]. When TSS loads are higher during higher flow conditions, it generally reflects potential indirect source contributions from stormwater runoff [EPA, 2007]. Loads exceeding the criteria more often in the low-flow zone would indicate potential direct-source load contributions or sources in close proximity to the stream, such as failing septic systems or livestock in the stream channel [EPA, 2007].

Both 30-day average loads and daily maximum loads calculated using simulated flow and observed concentrations are shown on the LDCs. The locations of the water quality monitoring sites where observed data were collected on the Big Sioux River are provided in Figure 1-3. Observed TSS data collected between 2013 and 2017 were applied to the LDC of the reach in which they were collected. In LDCs, the daily maximum loads should be compared to the daily maximum criteria curve and the 30-day average loads should be compared to the 30-day average criteria curve. The LDCs in Figures 4-1 through 4-4 show that exceedance of criterion occurred during the higher flow conditions in all four TMDL reaches.

For this report, critical criteria were defined as the criteria with the highest percent exceedance. The percent exceedance of the 30-day average criteria was higher than the daily maximum in all impaired reaches. Both conditions will be addressed by reducing 30-day average loads throughout the watershed.

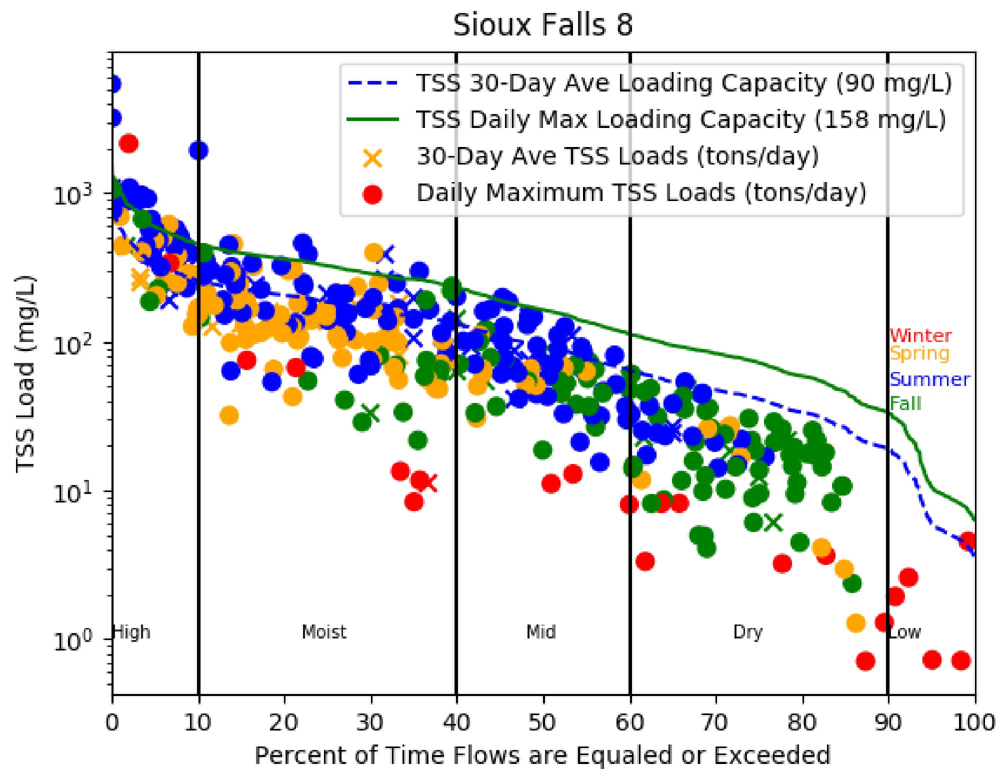

Figure 4-1. Reach 8 Load-Duration Curve Generated With Observed Total Suspended Solids (BSR020) and Simulated Flow.

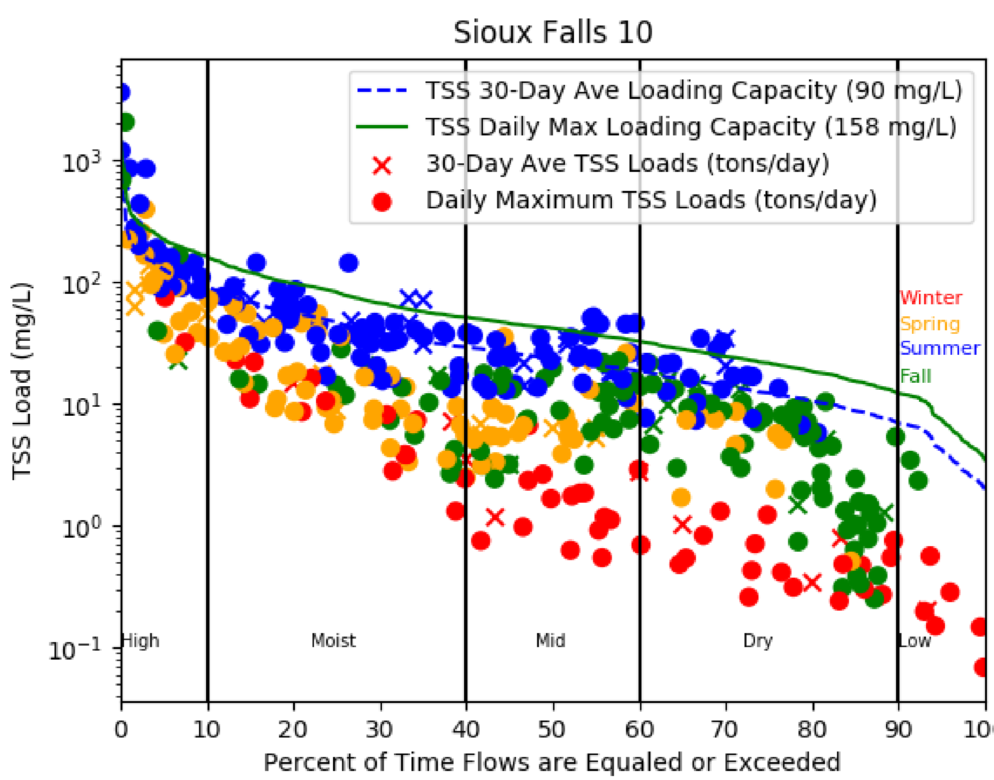

Figure 4-2. Reach 10 Load-Duration Curve Generated With Observed Total Suspended Solids (BSR070) and Simulated Flow.

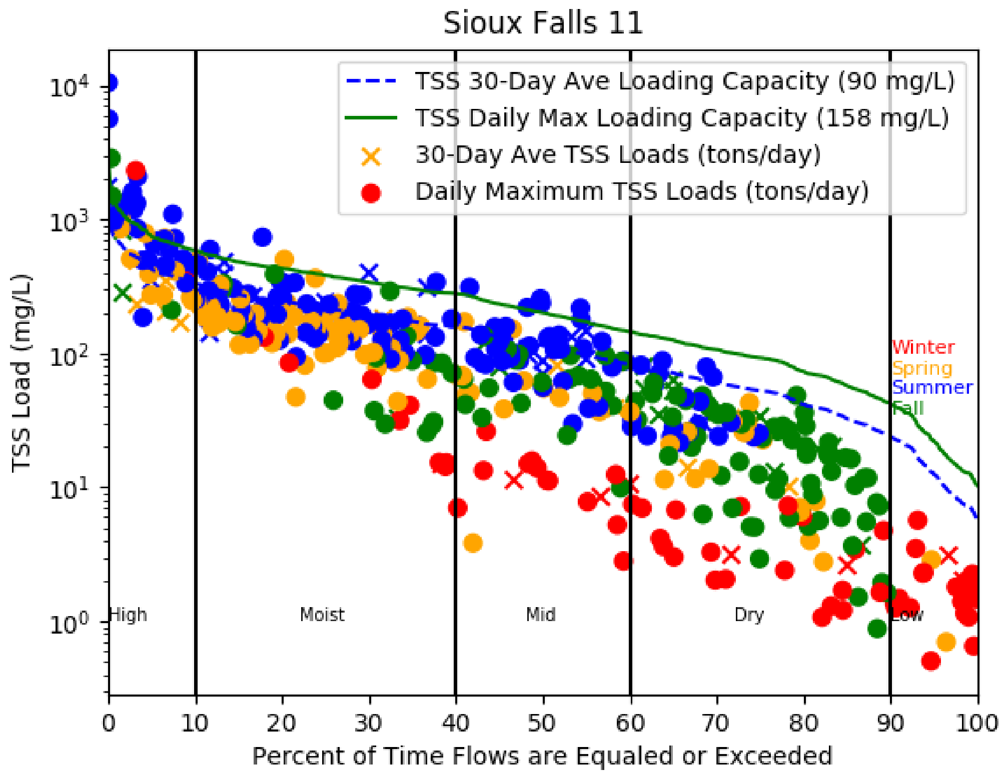

Figure 4-3. Reach 11 Load-Duration Curve Generated With Observed Total Suspended Solids (BSR090) and Simulated Flow.

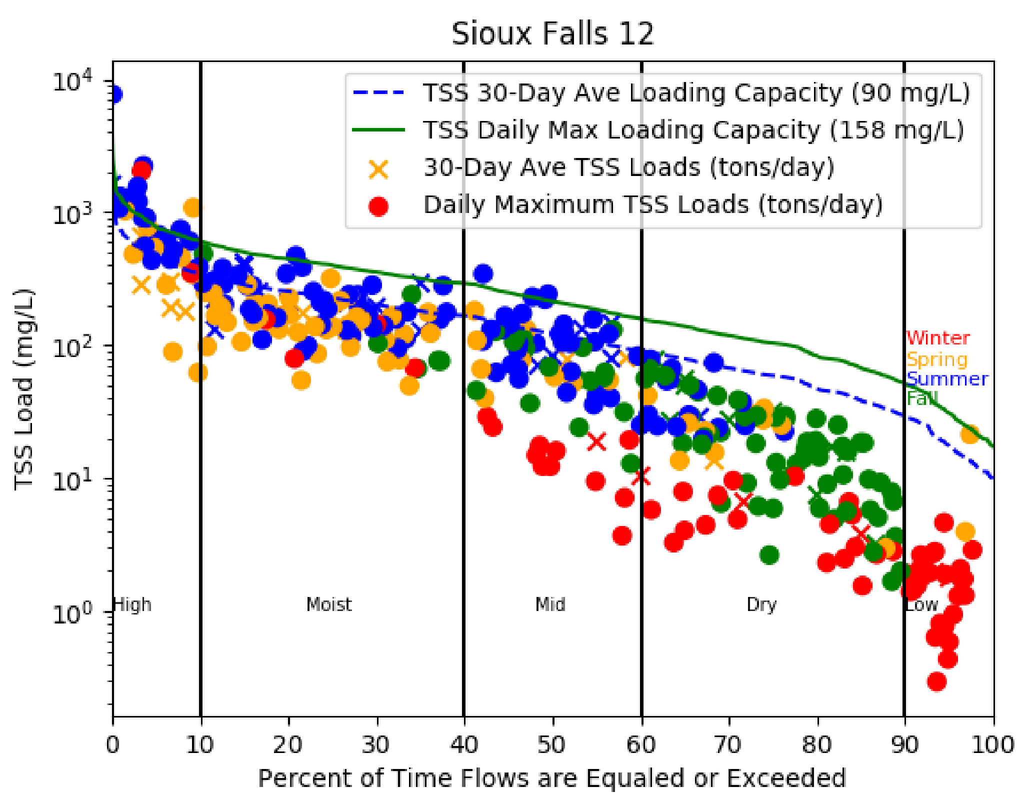

Figure 4-4. Reach 12 Load-Duration Curve Generated With Observed Total Suspended Solids (BSR105) and Simulated Flow.

5.0 TOTAL MAXIMUM DAILY LOAD AND ALLOCATIONS

To ensure that all applicable TSS criteria are met and to aid in the TMDL implementation, load allocations were calculated for the five flow zones (high flows [0–10 percent], moist conditions [10–40 percent], midrange flows [40–60 percent], dry conditions [60–90 percent], and low flows [90–100 percent]) using both the daily maximum and 30-day average criteria. The critical criteria for this TMDL are the 30-day average criteria because exceedances of this criteria were higher in all four impaired reaches. Thus, the TMDL tables are focused on the reduction required to meet the 30-day average TSS criteria. TMDL tables were constructed using simulated TSS concentrations and flows at the outlet of each impaired reach. Daily maximum-based TMDL tables calculated with simulated flow and single-sample observed data (2013–2017) are available in Appendix A.

5.1 LOADING CAPACITY

The TMDL (loading capacity) is the sum of the load allocation (LA), the waste load allocations (WLA), and margin of safety (MOS). In Reaches 10, 11, and 12 for each of the five flow zones, the 30-day average loading capacity was calculated using median monthly average flow, the 30-day average TSS criteria (90 mg/L), and a conversion factor at each reach endpoint. In Reach 8, the dry and low-flow zones were combined, and the remainder of the calculations were consistent with all other reaches. No reductions were required in the flow zones where this method was used.

5.2 WASTELOAD ALLOCATION

Multiple point sources of TSS discharge directly into the impaired reaches of the Big Sioux River within the Sioux Falls project area. Point-source discharges also exist upstream of the impaired reaches. These discharges are indirectly accounted for by using boundary condition loads. TSS loads from these facilities do not likely have a large impact on the impaired reaches of the Big Sioux River because of relatively small facility loads. These facilities should not cause exceedance of those standards because TSS limits are generally set at or below the water quality standard. Multiple CAFOs are located in Minnehaha County. The CAFOs in the project area are not allowed to discharge except in the rare case of a precipitation event that produces a volume of water greater than the facility's design capacity, and they were therefore not given WLAs.

The WLA for the Sioux Falls TMDL is the sum of the point-source allocations (PSAs) within each reach and the MS4 loads. The PSAs were derived in tons per day by SD DENR staff using the product of the effluent flow, the TSS concentration limit, and a conversion factor of 0.004172. Flows and concentrations used are shown in Table 3-1. For Baltic and Dell Rapids, the effluent flow did not change from the 2012 TMDL and was based on each facility's storage capacity and estimated effluent volume during a discharge event one week in duration. For L.G. Everest, the effluent flow was set at twice the 2012 inspection average flow. The city of Sioux Falls effluent flow was set at the future peak flow to allow for future domestic municipal wastewater growth. The effluent flow for Smithfield Foods was set at the 25 percent above the current peak to allow for future growth. A future industrial growth PSA (calculated using 10 MGD) was added to each reach. The future growth WLA was based on the projected loading from potential new industries. As new industries that discharge these pollutants are permitted, there will be a paragraph in the statement of basis for the permit explaining how much of the future growth WLA will be assigned to that permit and how much is still available for future permits. The permit and statement of basis will be public noticed for 30 days before the permit is issued. The EPA is notified of all permits that we public notice and issue. Point sources currently make up less than one percent of the load contributions in the impaired reaches. Additionally, the permit limits for each facility are such that they cannot discharge at concentrations above the daily maximum water quality standards. The allowable load from the point sources makes up a small percent of the total allowable loads, and concentrations used to calculate PSAs were based on daily maximum permit limits where possible so that the facilities can be evaluated on a daily time step. The MS4 allocation was based upon the modeled MS4 flow contribution percentage at the outlet of each impaired reach (Table 5-1). The MS4 flow contribution was calibrated in the HSPF model based upon data collected at various outfalls throughout the MS4 area. Construction and industrial stormwater activities were evaluated using the percentage of estimated impacted acres area weighted by county. Construction and industrial stormwater made up less than 1.5 percent of the total area and, therefore, they were not given a WLA for these TMDLs. In Reaches 8 and 10, when five flow zones were used, the WLA exceeded the loading capacity; therefore, the Reaches 8 and 10 dry and low-flow zones were combined into one flow zone, but reductions were not required before or after combining in either flow zone.

Table 5-1. Big Sioux River Total Suspended Solids Wasteload Allocations and Municipal Separate Storm Sewer Systems Percentage

Reach	PSA	TSS PSA (tons/day)	Reach PSA Sum (tons/day)	MS4 Percent (TMDL–PSA)
SD-BS-R-BIG_SIOUX_08	L. G. Everest	0.95	9.91	0
	Dell Rapids WWTP	2.47		
	Baltic WWTP	0.86		
	Future Industrial Growth	5.63		
SD-BS-R-BIG_SIOUX_10	Future Industrial Growth	5.63	5.63	15
SD-BS-R-BIG_SIOUX_11	Smithfield Foods	1.38	7.01	4
	Future Industrial Growth	5.63		
SD-BS-R-BIG_SIOUX_12	Sioux Falls WWTP	10.70	16.33	0
	Future Industrial Growth	5.63		

5.3 MARGIN OF SAFETY

An explicit MOS, identified by using a duration curve framework, is an unallocated assimilative capacity that is intended to account for uncertainty (e.g., loads from tributary streams and effectiveness of controls). An explicit MOS was calculated as 10 percent of the loading capacity. This method is appropriate because the TMDL is based upon the 90th percentile concentration (i.e., an impaired reach exceeds the standard more than 10 percent of the time).

5.4 LOAD ALLOCATION

To develop the TSS LA for each of the four TMDL reaches, the loading capacity was first determined using the data sources specified. Portions of the loading capacity were allocated to the MOS to account for uncertainty in the calculations, and portions of the loading capacity were allocated to the WLA. The LA was calculated as the TMDL minus the WLA and the MOS.

5.5 BASELINE CONDITIONS

Simulated TSS concentrations and simulated flow were used to estimate current daily loads (tons/day) by calculating the product of the 90th percentile of the 30-day average TSS concentrations (tons/100 mL), the median of the monthly average simulated flows (cubic feet per second [cfs]), and a unit conversion factor (0.002697). Tables 5-2 through 5-5 present LAs for Reaches 8 through 12 based on the 30-day average criterion for each flow zone. The PSAs from each table are described in Table 5-1. The tables indicate that load reductions are required for the upper two to three flow zones in all of the reaches. High flows tend to lead to higher sediment because of resuspension and decreased bank stability.

Table 5-2. Big Sioux River Total Suspended Solids Total Maximum Daily Load Based on the 30-Day Average Criterion for Reach 8

TMDL Component (Tons/Day)		Flow Zone							
		High		Moist		Midrange		Dry/Low Combined	
TMDL		283.39		192.30		97.75		62.89	
MOS		28.34		19.23		9.78		3.29	
PSA	WLA	9.91	9.91	9.91	9.91	9.91	9.91	9.91	9.91
MS4		0		0		0		0	
LA		245.14		163.16		78.06		19.69	
Current Load		595.13		251.05		124.87		23.11	
Load Reduction		52%		23%		22%		0%	

Table 5-3. Big Sioux River Total Suspended Solids Total Maximum Daily Load Based on the 30-Day Average Criterion for Reach 10

TMDL Component (Tons/Day)		Flow Zone							
		High		Moist		Midrange		Dry/Low Combined	
TMDL		110.97		47.26		27.17		62.89	
MOS		11.10		4.73		2.72		3.29	
PSA	WLA	5.63	22.28	5.63	12.72	5.63	9.71	5.63	7.41
MS4		16.65		0		0		16.65	
LA		77.59		29.81		14.74		3.24	
Current Load		234.75		51.33		43.39		9.75	
Load Reduction		53%		8%		37%		0%	

Table 5-4. Big Sioux River Total Suspended Solids Total Maximum Daily Load Based on the 30-Day Average Criterion for Reach 11

TMDL Component (Tons/Day)		Flow Zone									
		High		Moist		Midrange		Dry		Low	
TMDL		347.80		211.11		122.90		53.40		13.15	
MOS		34.78		21.11		12.29		5.34		1.32	
PSA	WLA	7.01	20.93	7.01	15.46	7.01	11.93	4.45	9.15	7.01	7.54
MS4		13.91		8.44		4.92		2.14		0.53	
LA		292.09		174.54		98.68		38.91		4.29	
Current Load		941.97		233.32		171.46		32.75		3.30	
Load Reduction		63%		10%		28%		0%		0%	

Table 5-5. Big Sioux River Total Suspended Solids Total Maximum Daily Load Based on the 30-Day Average Criterion for Reach 12

TMDL Component (Tons/Day)		Flow Zone									
		High		Moist		Midrange		Dry		Low	
TMDL		363.27		217.77		130.48		59.76		18.20	
MOS		36.33		21.78		13.05		5.98		1.82	
PSA	WLA	16.33	16.33	16.33	16.33	16.33	16.33	16.33	16.33	16.33	16.33
MS4		0		0		0		0		0	
LA		310.61		179.66		101.10		37.45		0.05	
Current Load		911.05		243.22		133.23		33.01		1.72	
Load Reduction		60%		10%		2%		0%		0%	

The flow-weighted percent reductions required for all combined flow zones to meet the TMDL based on the 30-day average water quality criteria were 30 percent in Reach 8, 31 percent in Reach 10, 33 percent in Reach 11, and 27 percent in Reach 12.

6.0 SEASONALITY

Stream flows and TSS concentrations in the Big Sioux River showed seasonal variation. TSS data at the most downstream location of each reach (2013–2017) were used to generate boxplots of TSS concentrations throughout the project area. Figure 6-1 depicts higher TSS concentrations during the summer. Monthly median flows were calculated for the four local USGS sites and are shown in Figure 6-2. Flows were typically highest during spring and early summer and lowest during fall and winter.

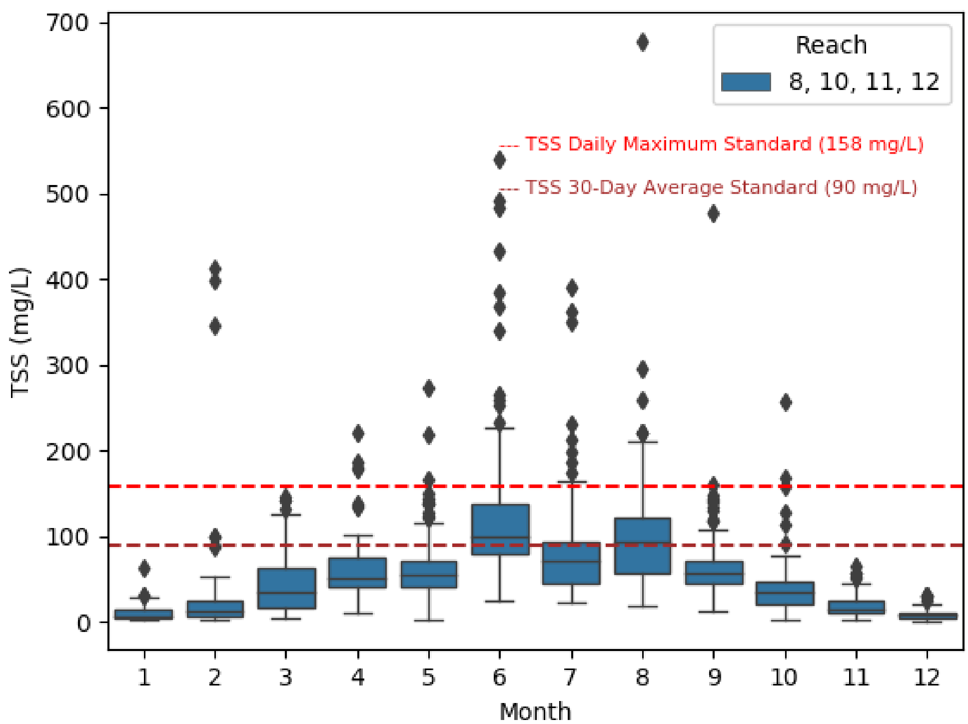

Figure 6-1. Total Suspended Solids Concentration Boxplots (BSR020, BSR070, BSR090, and BSR105 From 2013 Through 2017).

The highest TSS concentrations generally occurred during the summer months of June and July when short-duration, high-intensity rainstorms are common. Localized summer storms can cause significant runoff, increased flows, and increased TSS concentrations for a relatively short period of time. Using the LDC approach to develop the TMDL allocations, seasonal variability in flow and TSS loads are considered, because stream flow and TSS delivery to the stream are related to seasonal changes in precipitation

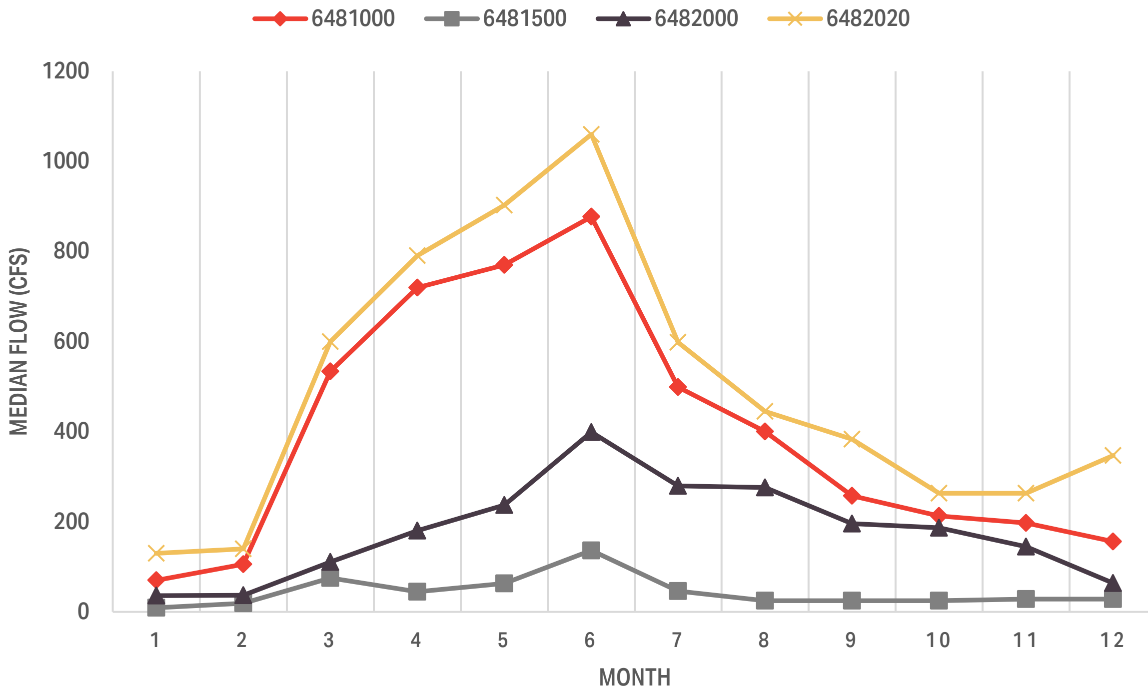

Figure 6-2. Monthly Median Flows From Local US Geological Survey Data (2013–2017).

7.0 PUBLIC PARTICIPATION

During the development of the previous version of Big Sioux River TSS TMDL, efforts focused on public education, review, and comment. The findings of the assessment were provided to local groups in the watershed, and a 30-day public notice period was provided for public review and comment. The results of these public meetings and comments were considered when developing the TMDLs. The public notice was published in the *Sioux Falls Argus Leader* and the *Dell Rapids Tribun*e, and the document was made available through the SD DENR's website. The public notice of this updated version of the TMDL was also published in the *Sioux Falls Argus Leader* and the *Dell Rapids Tribune* , and the updated document was also made available through the SD DENR's website.

Several meetings were held and presentations were provided for the Steering Committee regarding the previous versions of the TMDLs: one in March 2009, one in April 2009 regarding Sioux Falls land use, one in November 2009 regarding monitoring, and one in October 2010 regarding modeling. Steering Committee members include Mr. Robert Kappel and Mr. Andy Berg (City of Sioux Falls), Mr. John Meyer (Smithfield Foods - previously John Morrell and Co.), Ms. Deb Springman (East Dakota Water Development District [EDWDD]), and Mr. Rich Hanson and Ms. Kelli Buscher (SD DENR). Regular updates were provided for the Public Works Department, the City of Sioux Falls, EDWDD, Smithfield Foods (previously John Morrell & Company), and the SD DENR. Two public meetings were held at the Kuehn Community Center in Sioux Falls (May 2009 and November 2009), and one public meeting was held at the Sioux Falls Main Public Library (November 2010). Additionally, presentations on the different aspects of the project were provided at the annual Western South Dakota Hydrology Conference and the Eastern South Dakota Water Conference. Scientists and engineers from the Midwest who work in the area of water quality and stream health regularly attend these conferences as well as many local stakeholders. These conferences allowed the project team to provide updates to the professional and stakeholder communities and receive feedback on the technical aspects of the project. A Sioux Falls TMDL website was made available during the development of the original version of this TMDL and an EPA MS4 workshop was held in July 2009. A TMDL public education video was also available on the city of Sioux Falls website. For the TMDL updates, a public meeting was held at the City of Sioux Falls Environmental Office on November 26, 2018. The draft TMDL report was made available for download on the SD DENR website from May 16 to June 17, 2019, for public review. The notice for the public review period was published on May 13 in the *Sioux Falls Argus Leader*, the *Madison Daily Leader*, and the *Moody County Enterprise*. No comments were received during the comment period.

8.0 MONITORING STRATEGY

During and after the implementation of management practices, monitoring will be necessary to ensure attainment of the TMDLs. Stream water quality monitoring will be accomplished through SD DENR's ambient water quality monitoring stations on the Big Sioux River and through the City of Sioux Falls monitoring program. Additional monitoring should continue to be used to implement effective BMPs and to evaluate existing BMPs. Monitoring locations should be based on the location and the type of BMPs installed. In 2017, two BMPs (the Galway BMP and the Swift Park Extended Detention Basin) within the city of Sioux Falls were monitored for effectiveness. The results of the Galaway BMP were inclusive, but the Swift Park Extended Detention Basin reduced TSS concentrations by 67 percent during storm flows and by 45 percent during baseflows.

The SD DENR may adjust the load and/or wasteload allocations in this TMDL to account for new information or circumstances that develop during the TMDL's implementation phase. New information generated during TMDL implementation may include monitoring data, BMP effectiveness information, and land-use information. The SD DENR will propose adjustments only in the event that (1) any adjusted LA or WLA will not result in a change to the loading capacity; (2) the adjusted TMDL, including the WLAs and LAs, will be set at a level necessary to implement the applicable water quality standards; and (3) any adjusted WLA will be supported by demonstrating that LAs are practical. The SD DENR will notify the EPA of any adjustments to this TMDL within 30 days of their adoption. The LA and WLA will only be adjusted after an opportunity for public participation.

9.0 RESTORATION STRATEGY

The watershed area affecting the Big Sioux River from near the Brookings/Moody County line to the Sioux Fall's WWTP has had several BMPs implemented since the previous version of the Sioux Falls Big Sioux River TMDLs was approved. These practices were installed through several 319 Implementation Projects, Environmental Quality Incentives Program, National Water Quality Initiative (NWQI), and other participating programs. The focus of these BMPs is to reduce nutrient, sediment, and bacteria loading to impaired streams in the area and make progress in achieving existing TMDLs. The implemented BMPs ranged from riparian area protection buffers to Agricultural Waste Management Systems to cattle grazing management systems. Funding were from a variety of sources such as local producers as well as cities, state, and federal agencies.

The SD DENR has distributed funding for BMP installation and technical guidance to implementation projects in this area over several years. A large part of this funding is from the EPA Section 319 grants. The following Section 319-funded Implementation Projects have operated in the area:

- 303(d) Watershed Planning and Assistance Project (March 2003–June 2010)
- Central Big Sioux River Watershed Project Segment 1 (August 2005–September 2010)
- Central Big Sioux River Interim Project (December 2010–September 2011)
- Central Big Sioux Implementation Project Segment 2 (July 2011–July 2015)
- Big Sioux River Implementation Project Segment 3 (July 2015–Current)
- Grassland Management & Planning Project (July 2008–December 2009)
- Grassland Management Planning & Assistance Project Segment 3 (June 2010–July 2013)
- Grassland Management Planning & Assistance Project Segment 4 (July 2013–July 2017).

9.1 RECENT IMPLEMENTATION

Many BMPs have been installed throughout and above the project area in recent years that are expected to improve the conditions of the Big Sioux River within the project area. Each practice that was installed through a 319 Implementation Project was required to estimate load reductions. The Spreadsheet Tool for Estimating Pollutant Load (STEPL) Model, developed for the EPA Office of Water Grants Reporting and Tracking System by Tetra Tech, was the model used to estimate these load reductions. These load reductions were entered into the SD DENR internet-based tracker system along with a location for BMP placement. The combination of the aforementioned projects has led to significant load reductions in the area over the years.

A map of BMP locations installed with assistance from 319 Implementation Projects in the area is shown in Figure 9-1. This map also shows the different types of BMPs that have been put in place. Each type of BMP in the STEPL model can have several supporting BMPs that collectively make up the same load reductions. Because multiple supporting BMPs could also be covered under the same project expenses, separating specific load reductions and actual cost of individual supporting practices can be difficult.

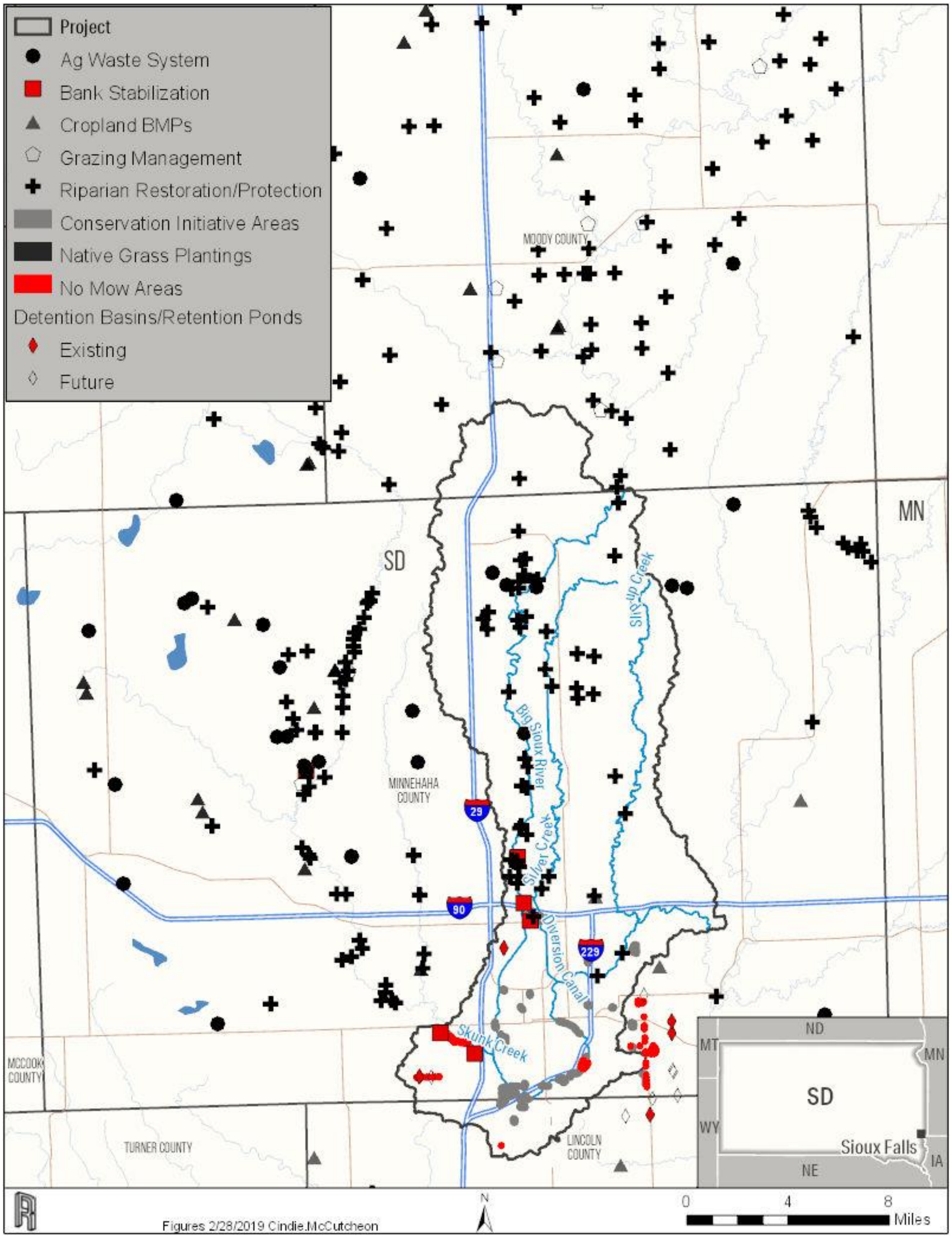

Figure 9-1. Best Management Practices Installed Within and Upstream of the Project Area.

The BMP summary in Table 9-1 shows the quantity of supporting BMPs and the total funds used to install those BMPs. Each of these BMPs is discussed in the following sections.

Table 9-1. STEPL Load Reductions Realized by Best Management Practice Type

Type of BMP	Sediment (Tons/Year)	Phosphorus (Pounds/Year)	Nitrogen (Pounds/Year)
Agricultural Waste System	584	23,496	93,091
Bank Stabilization	49,028	26,354	68,458
Cropland	2,647	3,773	10,222
Grazing Management	70	118	637
Riparian Restoration/Protection	8,982	20,810	74,232
Total	61,311	74,551	246,640

9.1.1 AGRICULTURAL WASTE SYSTEMS

Sixteen Agricultural Waste Management Systems have been installed in the Big Sioux River Watershed in conjunction with 319 Implementation Projects. Each system also included a nutrient management plan to apply manure from the system to local cropland. Many of these systems were installed at facilities along or very near an impaired stream.

Table 9-2 provides a summary of individual Agricultural Waste Management Systems supporting practices that were installed or completed for the area. More engineering has been completed than systems installed because system installation is ongoing.

Table 9-2. Agricultural Waste Management System Supporting Best Management Practices

BMP	Quantity Implemented
Engineering	21
Livestock Feedlot Relocation	2
Nutrient Management	17
Waste Facility Cover	3
Waste Storage Facility	19

Installing an Agricultural Waste Management System has been very costly in the past and has increased in price over the years. Table 9-3 provides a summary of funds that have been used to construct Agricultural Waste Management Systems in the area. Most of the cost for installing these systems has come from the producer, as seen in the in this summary for the local contribution.

Table 9-3. Agricultural Waste System Cost Summary

US Department of Agriculture	319	State	EDWDD	City	Local	Total
$2,323,817	$209,969	$47,103	$101,608	$613,941	$4,968,062	$8,264,500

9.1.2 BANK STABILIZATION

Several homes are located along high eroding banks of Skunk Creek in Sioux Falls. The City of Sioux Falls was concerned with erosion that may affect these homes. Therefore, the City of Sioux Falls employed Mussetter Engineering, Inc.(Fort Collins, CO) to developed recommendations and preliminary designs for stabilizing approximately 10,000 feet along Skunk and Silver Creek near Dunham Park to reduce this erosion. Stockwell Engineers, Inc. (Sioux Falls, SD) prepared construction plans and specifications from the recommendations and designs for these areas. Construction was completed during the winter of 2006 and 2007. The cost for this stabilization was paid entirely from Sioux Falls State Revolving Fund Nonpoint-Source (SRF-NPS) loans in the amount of $1,609,000.

The Agricultural Research Service completed a study of bank stability on the Big Sioux River from Sioux Falls to Watertown during January 2009. Several areas were identified as having high amounts of erosion. The City of Sioux Falls decided to design bank stabilization for several of the sites between Sioux Falls and Baltic that had greater than 5 feet per year of lateral recession. Large sod blocks could be found at many of these sites. Sites were ranked and divided into four phases with the first two phases constructed during the winter of 2009 and 2010 and the remaining sites constructed during the winter of 2010 and 2011.

The total cost for Big Sioux River stabilization was approximately $1,989,000. Funds were spent on engineering, construction, tree planting, fencing, and placing alternate water along the river where cattle were present. The stabilization installation required landowners to provide at least a 15-foot buffer and planting trees on top of the bank. Most of these sites have greater than 15-foot buffers and great stands of grass and trees. Installing stabilization in many cases has led to involving other riparian BMP practices (e.g., Seasonal Riparian Area Management (SRAM) and grazing management). Stabilization along the Big Sioux is estimated to be 27,735 linear-feet with more stabilization expected in the future.

9.1.3 CROPLAND BEST MANAGEMENT PRACTICES

Practices placed on cropland were not funded for most of the 319 Implementation Projects but were strongly recommended with assistance from other US Department of Agriculture (USDA) programs. Table 9-4 is a summary of supporting practices for cropland BMPs. This list may not represent all that have been installed throughout the years because only practices with direct implementation project involvement were reported.

Table 9-4. Cropland Supporting Best Management Practices

BMP	Quantity Implemented
Conservation Reserve Program	139.74 acres
Conservation Tillage	1,301.9 acres
Continuous Conservation Reserve Program-Buffers	47.5 acres
Filter Strip	33.1 acres
Grassed Waterway	2,841 acres
Terrace	13,794 feet
Terrace Restoration	1,080 feet
Wetland Restoration	170.5 acres

Several of the cropland BMPs in the area were completed using USDA funds with only a few implementation project funds. Table 9-5 shows is a summary of funds used for cropland BMPs.

Table 9-5. Cropland Cost Summary

USDA	319	Local	Total
$102,797.00	$894.15	$5,779.05	$109,470.20

9.1.4 GRAZING MANAGEMENT AND RIPARIAN RESTORATION/PROTECTION

Producers that grazed or farmed along rivers, creeks, and other bodies of water in this area were encouraged to install fence to keep cattle out of the water and create riparian buffers. These practices included alternative sources of water or placing a buffer between the water and farming. Grazing BMPs were often part of riparian protection because cattle often graze along bodies of water. For this reason, the two BMP categories were combined in this section.

Supporting BMPs practices used to protect riparian areas are shown in Table 9-6. The SRAM was a BMP developed by the Central Big Sioux Implementation Project that has had great success in the area, and several producers along Skunk Creek have taken advantage of this program. Water quality monitoring was also ongoing in this area as part of the NWQI program that demonstrated SRAM effectiveness.

Table 9-6. Grazing Management and Riparian Restoration/Protection Supporting Best Management Practices

BMP	Quantity Implemented
Alternative Water Sources	24
BMP Installation	101
BMP Plans	128
Conservation Easements	16.8 AC
Conservation Reserve Program	220.6 AC
Cropland Riparian Buffer	48.7 AC
Easement–30 Years/Permanent	16 AC
Fence	49,047 FT
Grass Seeding	183 AC
Grazing Planned Systems	1,172.7 AC
Grazing System	12
Livestock Pipeline	23,921 FT
Riparian Area Management	70.53 AC
Rock Crossing	1
SRAM	1,687.63 AC
Stream Exclusion With Grazing Land Management	235,952 FT
Streambank and Shoreline Protection	9,716 FT
Tank/Trough	11

Most of the funding for these BMPs came from the City of Sioux Falls SRF-NPS loans with assistance from other programs. Table 9-7 is a summary of the funds used in the area for Grazing Management and Riparian Restoration/Protection.

Table 9-7. Grazing Management and Riparian Restoration/Protection Cost Summary

USDA	319	EDWDD	City	Local	Total
$164,630.83	$139,085.91	$30,633.29	$2,091,687.28	$110,678.28	$2,536,715.35

9.1.5 CITY BEST MANAGEMENT PRACTICES

The City of Sioux Falls has also working to implement BMPs to improve the *E. coli* and sediment concentrations in the impaired reaches. Table 9-8 and Figure 9-1 provide the locations of all the BMPs installed since 2011 as well as the planned BMPs through 2026. All of these BMPS are extended detention basin designs except identifcations7-5, 303-4, and 400W, which are retention pond designs. Additionally, the city has been planting areas with native grasses and implanting a "no-mow" policy in certain areas shown in Figure 9-1. In 2018, the governor of South Dakota approved an $8,829,000 million state revolving fund loan for Sioux Falls storm sewer and nonpoint-source projects in the city [SD DENR, 2018b].

Table 9-8. Locations of Installed and Planned Best Management Practices

Year	Identification	Location
2011	89	Benson and Westport
2014	13	41st and Ellis
2016	17-5	69th & Hwy 11
2017	303-4	Arrowhead & Six Mile Rd
2017	25-3	10th and Six Mile Rd
2018	25-1W	Powderhouse and Madison
2019	7-4	69th and Sycamore
2020	25-1E	Powderhouse and Madison
2021	51-1	85th and Cliff
2022	400W	SE of 41st and Six Mile
2023	401-2	½ Mile SE of 57th and Hwy 11
2024	400E	SE of 41st and Six Mile
2025	13-1	41st and Grinnell
2026	401-1	½ Mile East of 57th and Six Mile

9.2 SIMULATED MANAGEMENT SCENARIOS

A variety of BMPs could be considered when developing a water quality management implementation plan in the project area. While several types of control measures are available for reducing TSS loads, the practical control measures listed and discussed in the following table are recommended to address the identified sources in the Sioux Falls area.

Because the HSPF model application calibration was updated to represent more recent years, it is assumed that the updated version represents the BMPs implemented throughout the watershed. Therefore, scenarios for the restoration strategy aim to meet load reductions that are required in this updated TMDL. Modeled load reduction results are presented for each of the TMDL reach endpoints in Table 9-9. Percent load reductions represent 30-day averages.

The management scenarios that were simulated for each TSS-impaired reach using the HSPF model include incorporating the following

- Future land use
- Big Sioux River upstream of Dell Rapids and Skunk Creek compliance with current 30-day average TSS criteria (90 mg/L for the Big Sioux River and 150 mg/L for Skunk Creek)
- Big Sioux River upstream of Dell Rapids and Skunk Creek compliance with the 30-day average warm-water semipermanent TSS criteria (90 mg/L)
- A 90 percent load reduction on agricultural land within the project area boundary north of Sioux Falls local to the Big Sioux River and Silver Creek
- A 50 percent reduction of instream scour on the Big Sioux River and major tributaries within the project area
- An 85 percent load reduction on the MS4 within the project area boundary
- Scenarios 3, 4, 5, and 6 combined.

Implementing future Sioux Falls land use (Scenario 1) was completed using expected build out information from the city of Sioux Falls. The future growth WLA was not included in this scenario. Scenario 1 would result in no load reduction in Reach 8, an increase of 2 percent in Reach 10, an increase of 1 percent in Reach 11, and an increase of 2 percent in Reach 12.

If the Big Sioux River above the project area and Skunk Creek were capped at the current 30-day average TSS criteria (90 mg/L for the Big Sioux River and 150 mg/L for Skunk Creek) (Scenario 2), load reductions would be 16, 8, 11, and 9 percent in Reaches 8, 10, 11, and 12, respectively.

Currently, Skunk Creek has a daily maximum and 30-day average TSS criteria of 263 mg/L and 150 mg/L, respectively, which are higher than the daily maximum criteria and 30-day average criteria of 158 mg/L and 90 mg/L in the impaired Big Sioux River reaches. Skunk Creek also contributes significant volume to Reaches 10, 11, and 12, which significantly influences water quality on the Big Sioux River. The project team is working closely with SD DENR to determine if Skunk Creek should be reassigned a more stringent standard. If the Big Sioux River above the project area and Skunk Creek were both capped at the 30-day average warm-water semipermanent TSS criteria (90 mg/L) (Scenario 3), load reductions would be 16,11,12,and 10 percent in Reaches 8, 10, 11, and 12 respectively.

An 85 percent reduction of loads from agricultural land within the project area (Scenario 4) would be expected to reduce the load by 0, 1, 1, and 1 percent in Reaches 8, 10, 11, and 12, respectively.

A 50 percent reduction of loads from instream scour on the Big Sioux and its major tributaries within the watershed (Scenario 5) would be expected to reduce the load by 15, 16, 21, and 25 percent in

Table 9-9. Big Sioux River Best Management Practice Modeled Percent Exceedance of the 30-Day Average Criterion and Best Management Practice Reduction

Scenario	Scenario Description	Percent Load Reduction			
		Reach 8	Reach 10	Reach 11	Reach 12
1	Future Land Use	0	−2	−1	−2
2	Big Sioux River and Skunk Creek Capped at Current TSS Criteria	16	8	11	9
3	Big Sioux River and Skunk Creek Capped at Warm-Water Semipermanent Criteria	16	11	12	10
4	90% Load Reduction on Agriculture Land[a]	0	1	1	1
5	50% Reduction of Instream Scour on Big Sioux River and Major Tributaries Within the Project Area	15	16	21	25
6	85% Load Reduction on All MS4 Land	0	10	3	3
7	Cumulative Scenario (Scenarios 3 - 6)	31	38	36	39
TMDL Load Reduction Needed		30	31	33	27

Reaches 8, 10, 11, and 12, respectively. This scenario simulates streambank protection measures within the project area.

An 85 percent reduction of loads from the MS4 within the project area (Scenario 6) would be expected to reduce the load by 0, 10, 3, and 3 percent in Reaches 8, 10, 11, and 12, respectively.

A cumulative scenario (Scenario 7) was run with the goal of meeting the 30-day average TMDL reductions needed in each reach. The cumulative scenario was the combination of Scenarios 3 through 6. The cumulative scenario achieved the goal of meeting the necessary TMDL reductions with a 31, 38, 36, and 39 percent reduction in Reaches 8, 10, 11, and 12, respectively. Therefore, reasonable assurance is given that the cumulative implementation of Scenarios 3 through 6 would be an effective method for achieving the TSS TMDLs in the Big Sioux River throughout the project area.

In addition to evaluating load reductions for each scenario, the change in percent exceedance was also calculated. From the cumulative scenario, the modeled 30-day average percent exceedance was reduced from 27 to 2 percent in Reach 8, from 17 to 2 percent in Reach 10, from 28 to 5 percent in Reach 11, and from 32 to 10 percent in Reach 12.

The City of Sioux Falls led the development of the Central Big Sioux River Watershed Implementation Plan. Within this plan, a watershed-scale, decision-support framework based on cost optimization was developed to support government and local planning agencies as they considered watershed-scale investments to improve water quality. This decision-support framework assisted in developing the TMDL implementation plan, identifying management practices to achieve pollutant reductions under an MS4 stormwater permit, and developing a phased BMP installation plan that is optimized for both cost and water quality effectiveness.

Achieving the load reductions necessary to meet the TMDLs will require proper planning between state and local regulatory agencies, organizations, and stakeholders; BMP implementation; and access to adequate financial resources. Funds to implement watershed water quality improvements can be obtained through the SD DENR and the USDA. Specifically, the SD DENR administers three major funding programs that provide low-interest loans and grants for projects that protect and improve water quality in South Dakota. These programs include the Consolidated Water Facilities Construction Program, the Clean Water State Revolving Fund Program, and the Section 319 Nonpoint-Source Program. If the preferred concentrations cannot be met with the implementation of recommended BMPs, pollutant trading should be considered for the Sioux Falls Big Sioux River project area

9.3 REASONABLE ASSURANCE

When a TMDL is developed for waters that are impaired by both point and nonpoint sources and the WLA is based on an assumption that nonpoint-source load reductions will occur, the EPA states that the TMDL should provide reasonable assurances that nonpoint-source control measures will achieve expected load reductions. The Big Sioux River Reaches 8, 10, 11, and 12 are impaired by nonpoint sources and permitted point sources (including the MS4); therefore, the requirement to provide reasonable assurances applies to the TSS TMDLs for these reaches.

The WLAs for the non-MS4 point sources are calculated based on the TSS water quality criterion and discharge volumes estimated by the SD DENR for each point source. The concentration used in these calculations is equal to or less than the TMDL target. Modeling demonstrates that the non-MS4 point sources at these WLAs contribute less than 1 percent of the TSS load in these reaches. Therefore, further reductions in the WLAs for the non-MS4 point sources is not likely to be effective in meeting the TSS water quality criteria in these reaches. Baltic WWTP did not discharge during the modeling period. The Dell Rapids WWTP did not exceed their TSS permit limits between 2005 and 2018. L.G. Everist exceeded their 30-day average permit limit (25 mg/L) in 12 of 202 samples (6 percent) and exceeded their daily maximum permit limit (45 mg/L) in 4 of 202 samples (2 percent) between 2005 and 2018. The Sioux Falls WWTP did not exceed their TSS permit limits (45 mg/L) between 2005 and 2018. Smithfield foods does not have a concentration based WLA, but they exceeded the daily maximum water quality standard (158 mg/L) in 4 of 44 samples (9 percent).

The following elements provide assurances that nonpoint-source control measures can be feasibly designed to reduce the TSS loading in these reaches, are likely to be effective, and have a reasonably high probability of successful implementation in the Big Sioux River project area:

/ Continued cooperation among stakeholders will facilitate implementing BMPs. The water quality assessment work and the TMDL development for these reaches were performed as a cooperative project among the City of Sioux Falls, USGS, the EDWDD, RESPEC, and SD DENR. The cooperation among local stakeholders, state and local regulatory agencies, and organizations is expected to continue through the implementation phase, which will increase the probability of success.

/ Simulation of management scenarios indicates that they are likely to be effective. Potential BMP scenarios of the four reaches have been conceptually developed, and the HSPF model was used to predict the effectiveness of individual and cumulative scenarios. The HSPF model predicts that implementing the cumulative scenario will achieve the required load reductions needed in all four impaired reaches.

/ The percent reductions in nonpoint-source loading required to meet the TMDL are the difference between the baseline loading and the TMDL. The baseline loading value chosen for the four reaches was calculated using the 90^{th} percentile of the monthly average TSS concentration for each flow zone with the median of the monthly average discharge. This method conservatively calculates of the necessary loading reductions.

/ A TMDL implementation plan has been written, resources have been committed, and work has been completed on a watershed-scale decision-support framework. The cost-effective framework supports government and local planning agencies in coordinating investments to achieve required load reductions. This decision-support framework outlines strategies with the best probability of success and milestones for implementation. BMP implementation strategies have already been developed within the city of Sioux Falls MS4 permit and the Central Big Sioux River Implementation Plan.

9.4 ADAPTIVE IMPLEMENTATION APPROACH

An adaptive implementation approach will be followed for this TMDL. The EPA defines "adaptive implementation [as] an iterative implementation process that makes progress toward achieving water quality goals while using any new data and information to reduce uncertainty and adjust implementation activities" [EPA, 2006]. Using an adaptive implementation approach for this TMDL is based on the uncertainty in developing the loading sources. The source assessment presented in Chapter 3.0 of this TMDL is based on relatively general sources of load contributions. To effectively achieve TSS reduction in the Big Sioux River, further understanding of specific sources of TSS to the impaired reaches is needed. To obtain a better understanding of the sources, a relatively intensive monitoring network, that consists of spatially distributed sampling locations should be established within the project area. A possible benefit of this monitoring would be the ability to further isolate and investigate portions of the watershed with elevated suspended sediment levels for potential source areas and remedial actions. As noted in Chapter 8.0, the SD DENR will notify the EPA of any adjustments to this TMDL within 30 days of their adoption.

10.0 REFERENCES

Administrative Rules of South Dakota, 2010. "ASRD: 74:51:01:30," *legis.state.sd.us*, retrieved February 23, 2010, from *http://legis.state.sd.us/rules/DisplayRule.aspx?Rule=74:51:01:30*

Buscher, K., 2010. Personal communication between K. Buscher, South Dakota Department of Environment and Natural Resources, Pierre, SD, and C. McCutcheon, RESPEC, Rapid City, SD, November 9.

McCutcheon, C. M., J. K. Oswald, J. T. Love, and J. P. Lambert, 2012. *Total Suspended Solids Total Maximum Daily Load for The Big Sioux River, Minnehaha County, South Dakota,* RSI-2182, prepared by RESPEC, Rapid City, SD, for the South Dakota Department of Environment and Natural Resources, Pierre, SD.

South Dakota Department of Environment and Natural Resources, 1999. *Authorization to Discharge Under the Surface Water Discharge System SDS-000001*, prepared by the South Dakota Department of Environment and Natural Resources, Pierre, SD.

South Dakota Department of Environment and Natural Resources, 2008. *The 2008 South Dakota Integrated Report for Surface Water Quality Assessment*, prepared by the South Dakota Department of Environment and Natural Resources, Pierre, SD.

South Dakota Department of Environment and Natural Resources, 2018a. *The 2018 South Dakota Integrated Report for Surface Water Quality Assessment*, prepared by the South Dakota Department of Environment and Natural Resources, Pierre, SD.

South Dakota Department of Environment and Natural Resources, 2018b. *Gov. Daugaard Announces $8.829 Million Loan for Sioux Falls Storm Sewer and Nonpoint Source Projects*, external news release from M. Perkovich, South Dakota Department of Environment and Natural Resources, Pierre, SD, January 4.

South Dakota Department of Environment and Natural Resources, 2010. *The 2010 South Dakota Integrated Report for Surface Water Quality Assessment*, prepared by the South Dakota Department of Environment and Natural Resources, Pierre, SD.

South Dakota State University, 2008. "South Dakota Climate and Weather," *sdstate.edu*, retrieved September 1, 2008, from *http://climate.sdstate.edu/climate_site/ climate.htm*

US Department of Commerce National Climatic Data Center, 2004. "Snowfall-Average Totals in Inches," *noaa.gov*, retrieved September 1, 2008, from *http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/snowfall.html*

US Environmental Protection Agency, 2006. "Clarification Regarding "Phased" Total Maximum Daily Loads," *epa.gov*, retrieved July 1, 2010, from *http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/tmdl_clarification_letter.cfm*

US Environmental Protection Agency, 2007. *An Approach for Using Load Duration Curves in the Development of TMDLs*, US Environmental Protection Agency, Office of Water, Washington, DC.

APPENDIX A

DAILY MAXIMUM CRITERIA TOTAL MAXIMUM DAILY LOAD TABLES

TMDLs in the daily maximum TMDL tables were developed using the median simulated daily average flow and the daily maximum criteria in each flow zone. Current loads in the daily maximum TMDL tables were developed using the 90th percentile observed daily average concentration and the median simulated daily average flow in each flow zone.

Table A-1. Total Suspended Solids Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach 8

TMDL Component (Tons/Day)		Flow Zone							
		High		Moist		Midrange		Dry/Low Combined	
TMDL		596.64		324.88		164.25		58.87	
MOS		59.66		32.49		16.42		5.89	
PSA	WLA	9.91	9.91	9.91	9.91	9.91	9.91	9.91	9.91
MS4		0		0		0		0	
LA		527.07		282.48		137.92		43.07	
Current Load		789.99		283.47		126.20		24.21	
Load Reduction		24%		0%		0%		0%	

Table A-2. Total Suspended Solids Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach 10

TMDL Component (tons/day)		Flow Zone							
		High		Moist		Midrange		Dry/Low Combined	
TMDL		223.13		82.16		41.72		18.43	
MOS		22.31		8.22		4.17		1.84	
PSA	WLA	5.63	39.10	5.63	17.96	5.63	11.89	5.63	8.40
MS4		33.47		12.32		6.26		2.76	
LA		161.72		55.98		25.66		8.19	
Current Load		344.30		55.38		32.85		10.88	
Load Reduction		35%		0%		0%		0%	

Table A-3. Total Suspended Solids Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach 11

TMDL Component (Tons/Day)		Flow Zone									
		High		Moist		Midrange		Dry		Low	
TMDL		750.64		382.60		200.27		92.51		22.07	
MOS		75.06		38.26		20.03		9.25		2.21	
PSA	WLA	7.01	37.04	7.01	22.32	7.01	15.02	7.01	10.71	7.01	7.90
MS4		30.03		15.30		8.01		3.70		0.88	
LA		638.54		322.02		165.22		72.55		11.96	
Current Load		1260.88		286.71		138.67		36.89		4.14	
Load Reduction		40%		0%		0%		0%		0%	

Table A-4. Total Suspended Solids Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach 12

TMDL Component (Tons/Day)		Flow Zone									
		High		Moist		Midrange		Dry		Low	
TMDL		779.14		399.46		213.35		103.89		30.90	
MOS		77.91		39.95		21.34		10.39		3.09	
PSA	WLA	16.33	16.33	16.33	16.33	16.33	16.33	16.33	16.33	16.33	16.33
MS4		0		0		0		0		0	
LA		684.90		343.18		175.68		77.17		11.48	
Current Load		1351.17		264.20		150.16		35.77		4.11	
Load Reduction		42%		0%		0%		0%		0%	