Addendum to the Total Maximum Daily Load Evaluation of pH for Reservoirs in the Black Hills Plateau Ecoregion of Custer and Pennington Counties, South Dakota

Introduction

This addendum addresses an addition to the Total Maximum Daily Load Evaluation of pH for Reservoirs in the Black Hills Plateau Ecoregion of Custer and Pennington Counties, South Dakota. Completed in November 2010, it is referred to as the "Ecoregion based TMDL" throughout this document. The addition consists of linking the pH impairment in Sylvan Lake to an existing nutrient TMDL developed for Sylvan Lake. The nutrient TMDL (Phase 1 Watershed Assessment Final Report and TMDL Sylvan Lake Watershed Custer County, South Dakota completed in November 2005) will be referenced as "Sylvan Lake TMDL" throughout this document. This document does not modify any aspect of the original TMDLs, which may be accessed on South Dakota DENR's TMDL web page: http://denr.sd.gov/dfta/wp/tmdlpage.aspx.

Sylvan Lake (AUID=SD-CH-L-SYLVAN_01) is located in Custer County, South Dakota. It was initially included in the 1998 South Dakota 303(d) list as impaired due to excessive chlorophyll *a* concentrations. The Sylvan Lake TMDL addressing the necessary nutrient reductions was approved by EPA in 2005. This addendum addresses pH impairments found during data analysis in 2016. It serves as the linkage between the reductions in the Sylvan Lake TMDL and the Ecoregion based TMDL approved by EPA for the Black Hills in 2010. The Ecoregion based TMDL was developed to address pH impairments in reservoirs found in Ecoregion 17b of the Black Hills. It found the correlation between chlorophyll *a* and pH impairments and indicated that a reduction in nutrient loadings would result in lower pH levels.

The majority of the information contained within this addendum is reprinted from the previously mentioned documents. The exceptions to this include the water quality standards and the TMDL expression. Since the Sylvan Lake TMDL was published, the water quality standards for permanent coldwater fisheries have been modified. Specifically, the range of acceptable pH values was adjusted from the previous standard of **6.6-8.6** su to the current standard of **6.5-9.0** su. The expression of the TMDL in the Sylvan Lake TMDL was in the form of an annual load. Since its publishing, requirements for expressing a TMDL have changed and now must include that it be expressed as a daily load. In the case of Sylvan Lake, the long term or annual loading is more important to the attainment of the TMDL. However, to comply with the daily expression requirement, the annual load has been converted to a daily load through the use of EPA's Technical Support Document (TSD) method.

Common Name	Sylvan Lake
County	Custer County
Waterbody Type:	Lake (Impoundment)
AUID	SD-CH-L-SYLVAN_01
Size of Impaired Waterbody:	18 acres
Size of Watershed:	565 acres
Water Quality Standards:	Narrative and Numeric
Analytical Approach:	Models including BATHTUB and FLUX
Location:	HUC Code: 10120109
Goal:	75% reduction of phosphorus load
Target:	Phsophorus TSI = 45 or concentration = 0.02 mg/L
Long Term Average Load	4.9 Kg/year Total Phosphorus
Total Maximum Daily Load:	0.026 Kg/day Total Phosphorus

Watershed Description

Sylvan Lake is an 18-acre impoundment located in the Spring Creek Basin in northern Custer County, South Dakota (Figure 1). The lake reaches a maximum depth of 34 feet (10.5 m) and holds a total water volume of 214 acre-ft (at spillway elevation). Two unnamed inlets are located on the south and east sides of the lake. Portions of the lake exhibit thermal stratification during spring and summer months. The 2004 South Dakota 303(d) Waterbody List identified Sylvan Lake for TMDL development due to elevated trophic state index (TSI) values. Information supporting this listing was derived from statewide lake assessment data.

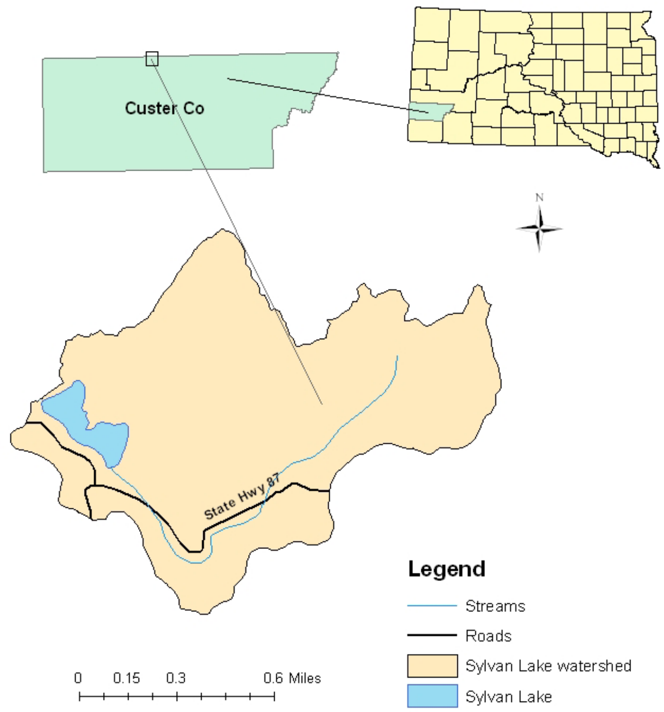

Figure 1. Location of the Sylvan Lake Watershed and Sylvan Lake, Custer County, South Dakota

Wetzel (2001) defines 'trophy' of a lake as "the rate at which organic matter is supplied by or to a lake per unit time." Trophic state is often measured as the amount of algal production in a lake, one source of organic material. Determinations of trophic state can be made from several different measures including oxygen levels, species composition of lake biota, concentrations of nutrients, and various measures of biomass or production. An index incorporating several of these parameters is best suited to determine trophic state.

Carlson's (1977) Trophic State Index (TSI) was used to determine the approximate trophic state of Sylvan Lake. This index incorporates measures of Secchi disk transparency, chlorophyll a, and total phosphorus into scores ranging from 0 to 100 with each 10-unit increase representing a doubling in algal biomass. TSI values were calculated for each of the index parameters individually (i.e. Secchi TSI, chlorophyll a TSI and TP TSI) and also combined into overall mean TSI value. In the 2005 Sylvan Lake TMDL, both the index value and phosphorus concentrations were used as TMDL targets and are considered numeric representations of the State's narrative biological integrity and nuisance aquatic life standards (ARSD 74:51:01:09 and 12).

The unnamed streams to Sylvan Lake Dam drain a watershed of 565 acres that predominantly consists of evergreen forest and state park camping areas. The streams carry sediment and nutrient loads, which degrade water quality in the lake and have caused increased eutrophication. An estimated 12.4 kg/year of phosphorus enter Sylvan Lake from watershed runoff.

The source of nonpoint source pollution loading from the Sylvan Lake watershed is likely a combination of recreational uses, forest management, as well as background sources (i.e. wildlife, natural weathering, etc.). However, degraded water quality in Sylvan Lake is primarily attributed to recreational activity within the watershed. According to (Wierenga & Payne, 1987), 5% of the total watershed area has been converted to commercial or developed recreational use. Approximately 90% of the watershed land area is managed by the SD Department of Game, Fish and Parks (Custer State Park), while the remaining 10% is managed by the US Forest Service. Although much of the watershed remains in its natural state, the intense usage of recreational facilities within Custer State Park has degraded the watershed condition. Sylvan Lake also experiences considerable internal phosphorus loading from lake-bottom sediment. An estimated 7.3 kg/yr of total phosphorus is delivered from the lake sediment.

Beneficial Uses and Water Quality Standards

South Dakota water quality standards establish 11 beneficial uses which are assigned to individual waters based on their characteristics. All waters (both lakes and streams) are assigned the beneficial use of fish and wildlife propagation, recreation, and stock watering (Use #9). All streams are assigned the beneficial use of irrigation (Use #10). Additional uses are assigned by the state based on a beneficial use analysis of each water body. Each beneficial use has a set of water quality standards to protect those uses. The Administrative Rules of South Dakota (ARSD) contain the water quality standards in Chapter 74:51. In instances where two beneficial uses have different requirements for a common standard, the more restrictive standard is applicable. Sylvan Lake has been assigned the beneficial uses of:

- Coldwater Permanent Fish Life Propagation (pH standard 6.5-9.0)
- Immersion Recreation (no pH standard)
- Limited Contact Recreation (no pH standard)
- Fish and Wildlife propagation, recreation, and stock watering (pH standard 6.0-9.5)

The pH standard for the coldwater permanent fish life propagation standard is the more restrictive and therefore the most applicable. It should be noted, that the coldwater fishery standard for pH has changed since the Sylvan Lake TMDL was written. The standard currently in use is the same as the standard which formed the basis for the Ecoregion based TMDL.

In addition to the numeric criteria established for pH, South Dakota has narrative criteria addressing acids and alkalis. South Dakota Administrative Rule 74:51:01:07 states “No materials may be discharged or caused to be discharged which affect the pH of the receiving waters by more than 0.5 pH unit. This does not apply to pH fluctuations of more than 0.5 pH unit contributable to natural influences.” Attainment of the more stringent numeric criteria will also result in the narrative criteria being attained.

Technical Analysis

pH Assessment Results

Data collected as a part of routine lake assessments during 2010 and 2015 indicated portions of the Sylvan Lake water column had elevated pH levels. Listed in Table 1, 27 of the 110 (25%) measurements were found to be above 9.0 su. Because greater than 10% of the pH measurements exceeded South Dakotas Integrated Report assessment methodology, a pH TMDL is required for Sylvan Lake. Elevated pH values were found near the surface of the water column (less than 2.5 meters of depth). Impairments were also tied to data collected later in the recreation season (July-August) while samples collected during June were found to fully support the standard.

Table 1. pH Data for Sylvan Lake

Date	StationID	Depth (m)	R_Depth	pH	Date	StationID	Depth (m)	R_Depth	pH
06/16/2010	SWLAZZZ2111A	0.4	Surface	7.56	06/23/2015	SWLAZZZ2111A	0.4	SURFACE	8.23
06/16/2010	SWLAZZZ2111A	1.1	Midwater	7.55	06/23/2015	SWLAZZZ2111A	1.5	MIDWATER	8.28
06/16/2010	SWLAZZZ2111A	2.1	Midwater	7.35	06/23/2015	SWLAZZZ2111A	2.4	MIDWATER	8.1
06/16/2010	SWLAZZZ2111A	2.5	Midwater	7.26	06/23/2015	SWLAZZZ2111A	3.5	MIDWATER	7.83
06/16/2010	SWLAZZZ2111A	3.2	Midwater	6.96	06/23/2015	SWLAZZZ2111A	3.5	MIDWATER	7.77
06/16/2010	SWLAZZZ2111A	3.6	Midwater	6.8	06/23/2015	SWLAZZZ2111A	4.3	MIDWATER	7.55
06/16/2010	SWLAZZZ2111A	4.1	Midwater	6.73	06/23/2015	SWLAZZZ2111A	5.4	MIDWATER	7.25
06/16/2010	SWLAZZZ2111A	5.0	Midwater	6.72	06/23/2015	SWLAZZZ2111A	6.4	MIDWATER	7.1
06/16/2010	SWLAZZZ2111A	6.0	Midwater	6.77	06/23/2015	SWLAZZZ2111A	7.4	MIDWATER	7.01
06/16/2010	SWLAZZZ2111A	7.0	Midwater	6.86	06/23/2015	SWLAZZZ2111A	7.7	BOTTOM	6.99
06/16/2010	SWLAZZZ2111A	7.2	Bottom	6.91	06/23/2015	SWLAZZZ2111B	0.3	SURFACE	8.2
06/16/2010	SWLAZZZ2111B	0.3	Surface	7.56	06/23/2015	SWLAZZZ2111B	1.3	MIDWATER	8.18
06/16/2010	SWLAZZZ2111B	1.1	Midwater	7.57	06/23/2015	SWLAZZZ2111B	2.4	MIDWATER	8.09
06/16/2010	SWLAZZZ2111B	1.6	Midwater	7.57	06/23/2015	SWLAZZZ2111B	3.3	MIDWATER	7.72
06/16/2010	SWLAZZZ2111B	2.0	Midwater	7.55	06/23/2015	SWLAZZZ2111B	4.3	MIDWATER	7.41
06/16/2010	SWLAZZZ2111B	2.6	Midwater	7.46	06/23/2015	SWLAZZZ2111B	5.0	BOTTOM	7.28
06/16/2010	SWLAZZZ2111B	3.0	Midwater	7.03	06/23/2015	SWLAZZZ2111C	0.4	SURFACE	8.31
06/16/2010	SWLAZZZ2111B	3.5	Midwater	6.81	06/23/2015	SWLAZZZ2111C	1.3	MIDWATER	8.21
06/16/2010	SWLAZZZ2111B	4.0	Midwater	6.78	06/23/2015	SWLAZZZ2111C	2.4	MIDWATER	8.02
06/16/2010	SWLAZZZ2111B	4.4	Bottom	6.77	06/23/2015	SWLAZZZ2111C	2.7	BOTTOM	7.73
06/16/2010	SWLAZZZ2111C	0.2	Surface	7.58					
06/16/2010	SWLAZZZ2111C	1.1	Midwater	7.56					
06/16/2010	SWLAZZZ2111C	1.5	Midwater	7.53					
06/16/2010	SWLAZZZ2111C	2.1	Bottom	7.55					
07/26/2010	SWLAZZZ2111A	0.5	Surface	9.1	08/04/2015	SWLAZZZ2111A	0.3	SURFACE	9.03
07/26/2010	SWLAZZZ2111A	0.5	Midwater	9.13	08/04/2015	SWLAZZZ2111A	0.9	MIDWATER	9.05
07/26/2010	SWLAZZZ2111A	1.0	Midwater	9.15	08/04/2015	SWLAZZZ2111A	1.4	MIDWATER	9.04
07/26/2010	SWLAZZZ2111A	1.5	Midwater	9.05	08/04/2015	SWLAZZZ2111A	2.1	MIDWATER	9.02
07/26/2010	SWLAZZZ2111A	2.1	Midwater	8.75	08/04/2015	SWLAZZZ2111A	2.5	MIDWATER	8.85
07/26/2010	SWLAZZZ2111A	2.5	Midwater	8.02	08/04/2015	SWLAZZZ2111A	3.0	MIDWATER	8.78
07/26/2010	SWLAZZZ2111A	3.0	Midwater	7.81	08/04/2015	SWLAZZZ2111A	3.5	MIDWATER	8.38
07/26/2010	SWLAZZZ2111A	3.5	Midwater	7.57	08/04/2015	SWLAZZZ2111A	4.0	MIDWATER	8.08
07/26/2010	SWLAZZZ2111A	4.1	Midwater	7.32	08/04/2015	SWLAZZZ2111A	4.5	MIDWATER	7.9
07/26/2010	SWLAZZZ2111A	4.6	Midwater	7.2	08/04/2015	SWLAZZZ2111A	5.1	MIDWATER	7.7
07/26/2010	SWLAZZZ2111A	5.1	Midwater	7.14	08/04/2015	SWLAZZZ2111A	5.5	MIDWATER	7.53
07/26/2010	SWLAZZZ2111A	5.5	Midwater	7.08	08/04/2015	SWLAZZZ2111A	6.1	MIDWATER	7.43
07/26/2010	SWLAZZZ2111A	6.0	Midwater	6.98	08/04/2015	SWLAZZZ2111A	6.5	MIDWATER	7.36
07/26/2010	SWLAZZZ2111A	6.6	Midwater	6.93	08/04/2015	SWLAZZZ2111A	7.1	MIDWATER	7.31
07/26/2010	SWLAZZZ2111A	7.0	Midwater	6.94	08/04/2015	SWLAZZZ2111A	7.6	MIDWATER	7.28
07/26/2010	SWLAZZZ2111A	7.0	Bottom	6.93	08/04/2015	SWLAZZZ2111A	8.0	BOTTOM	7.28
07/26/2010	SWLAZZZ2111B	0.5	Surface	9.06	08/04/2015	SWLAZZZ2111B	0.3	SURFACE	9.11
07/26/2010	SWLAZZZ2111B	1.0	Midwater	9.17	08/04/2015	SWLAZZZ2111B	0.9	MIDWATER	9.1
07/26/2010	SWLAZZZ2111B	1.6	Midwater	9.15	08/04/2015	SWLAZZZ2111B	1.4	MIDWATER	9.08
07/26/2010	SWLAZZZ2111B	2.1	Midwater	9.15	08/04/2015	SWLAZZZ2111B	1.9	MIDWATER	9.04
07/26/2010	SWLAZZZ2111B	2.5	Midwater	9.08	08/04/2015	SWLAZZZ2111B	2.4	MIDWATER	8.81
07/26/2010	SWLAZZZ2111B	2.6	Midwater	9.04	08/04/2015	SWLAZZZ2111B	3.0	MIDWATER	8.5
07/26/2010	SWLAZZZ2111B	2.7	Midwater	8.86	08/04/2015	SWLAZZZ2111B	3.5	MIDWATER	8.23
07/26/2010	SWLAZZZ2111B	3.1	Midwater	8.15	08/04/2015	SWLAZZZ2111B	4.1	MIDWATER	8.01
07/26/2010	SWLAZZZ2111B	3.5	Midwater	7.79	08/04/2015	SWLAZZZ2111B	4.5	MIDWATER	7.84
07/26/2010	SWLAZZZ2111B	4.0	Midwater	7.6	08/04/2015	SWLAZZZ2111B	5.0	MIDWATER	7.72
07/26/2010	SWLAZZZ2111B	4.5	Midwater	7.28	08/04/2015	SWLAZZZ2111B	5.9	BOTTOM	7.63
07/26/2010	SWLAZZZ2111B	5.2	Bottom	7.21	08/04/2015	SWLAZZZ2111C	0.3	SURFACE	9.11
07/26/2010	SWLAZZZ2111C	0.5	Surface	9.18	08/04/2015	SWLAZZZ2111C	1.3	MIDWATER	9.15
07/26/2010	SWLAZZZ2111C	1.1	Midwater	9.19	08/04/2015	SWLAZZZ2111C	2.0	MIDWATER	8.8
07/26/2010	SWLAZZZ2111C	1.6	Midwater	9.2	08/04/2015	SWLAZZZ2111C	2.7	BOTTOM	8.54
07/26/2010	SWLAZZZ2111C	2.1	Midwater	9.2					
07/26/2010	SWLAZZZ2111C	2.5	Midwater	9.17					
07/26/2010	SWLAZZZ2111C	2.5	Midwater	9.17					
07/26/2010	SWLAZZZ2111C	2.5	Bottom	9.16					

The primary focus of this report's analysis is a summary review of relevant sections found in the original TMDLs. Comprised of 90% state and 10% federal, land ownership in the watershed remained the same since the initial assessment. The watershed does not have any point sources of pollution. The primary remediation activity intended to address nutrient impairments in the lake is limited to the installation of a water circulating device in November of 2000. At this time, data is insufficient to determine the impacts this device may have had on the lake. Based on this information, it is expected that the assumptions made in the original Sylvan Lake TMDL during 2005 continue to hold true.

Linking Nutrients to pH

Phosphorus and nitrogen are nutrients that are essential to plant growth. While not directly linked to elevated pH concentrations, increased concentrations of either nutrient can result in excessive macrophyte and algae growth in the waterbody. Increased respiration from excessive macrophyte and algae growth results in processes that elevate the pH.

The ratio of nitrogen to phosphorus (N:P) considered optimal for plant growth is commonly accepted to be approximately 10:1. The ecoregion 17b reservoirs had an average N:P ratio of 17:1, suggesting that the limiting nutrient is phosphorus. Reducing the phosphorus entering the reservoirs is expected to result in a reduction of aquatic biomass.

Chlorophyll *a* is an indicator of primary production. Unlike many prairie lakes in South Dakota, reservoirs in the Black Hills tend to be phosphorus limited systems. The limiting nutrients section of Sylvan Lake TMDL found this to be true for Sylvan Lake with almost 90% of the samples collected indicating phosphorus limitation. As such, the most effective method for controlling primary production (chlorophyll *a* concentrations) is by reducing the available phosphorus load.

Section 4.0 pages 19-27 of the Ecoregion based TMDL address in greater depth the linkage between nutrients, chlorophyll *a*, and elevated pH concentrations. To summarize this linkage, the analysis found that there was a correlation between increasing chlorophyll *a* concentrations and rising pH levels for lakes in ecoregion 17b. Due to variability in the data, a range of concentrations were developed that were likely to meet the standard. That range suggests if chlorophyll *a* levels were kept at or below 9-12.5 ppb, pH levels should remain below the water quality standard of 9.0 su in at least 90% of the samples (i.e. factoring in the criterion's maximum 10% allowable exceedance rate).

Phosphorus

Sylvan Lake's chemistry is discussed in greater detail from pages 34-54 of the Sylvan Lake TMDL. The only new phosphorus data collected since the 2005 TMDL was written, includes 2 samples from 2015 (Figure 2). Although lower than many of the historic data points, they remained above the target in lake concentration of 0.02 mg/L total phosphorus identified in the 2005 Sylvan Lake TMDL. Considering variability observed in previous sampling seasons, little weight should be given to these two data points at this time. Phosphorus levels do appear to be lower in the 2000's than the 1980's. This may be due in part to the installation of a circulator which is discussed on pages 60-62 of the Sylvan Lake TMDL.

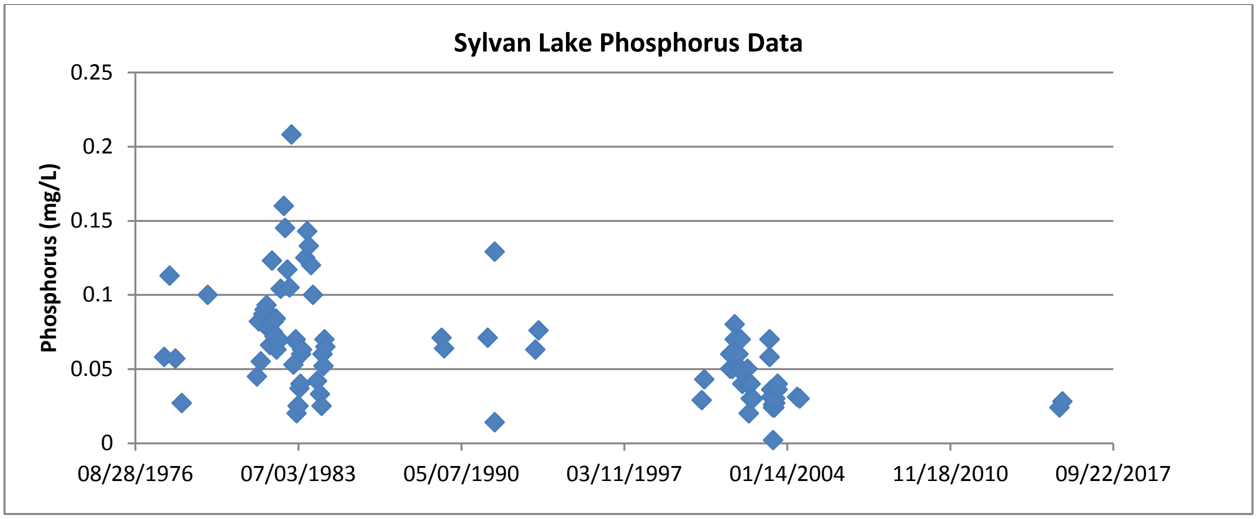

Figure 2. Sylvan Lake Phosphorus Data

Reduction Response Model

As part of the 2005 nutrient TMDL, reduction response modeling was conducted for external loading sources using BATHTUB, a eutrophication response model designed by the United States Army Corps of Engineers (USACE, 1999). The model predicts changes in water quality parameters related to eutrophication (phosphorus, nitrogen, chlorophyll *a*, and transparency) using empirical relationships previously developed and tested for reservoir applications. Lake and tributary sample data were used to calculate existing conditions in Sylvan Lake. Tributary loading data was obtained from the FLUX model output. Inlet phosphorus and nitrogen concentrations were reduced in increments of 10% and modeled to generate an in lake reduction curve.

The results of BATHTUB analysis for external nutrient source reductions are available in Figure 3. The ecoregion target called for a minimum chlorophyll *a* concentration of 9ppb, which translates into a TSI-Chlorophyll *a* value of 53. The targets from both the Ecoregion based TMDL and the Sylvan Lake TMDL are included in the graph. Achieving the 2005 TMDL goal of a TSI-TP of 45 or less required a greater than 90% reduction in nutrient loadings. In contrast, to achieve the 2010 ecoregion pH target, a much lower reduction of less than 40% is required. As a result, the more extensive reductions required to achieve the nutrient TMDL will be protective of the pH targets for the reservoir.

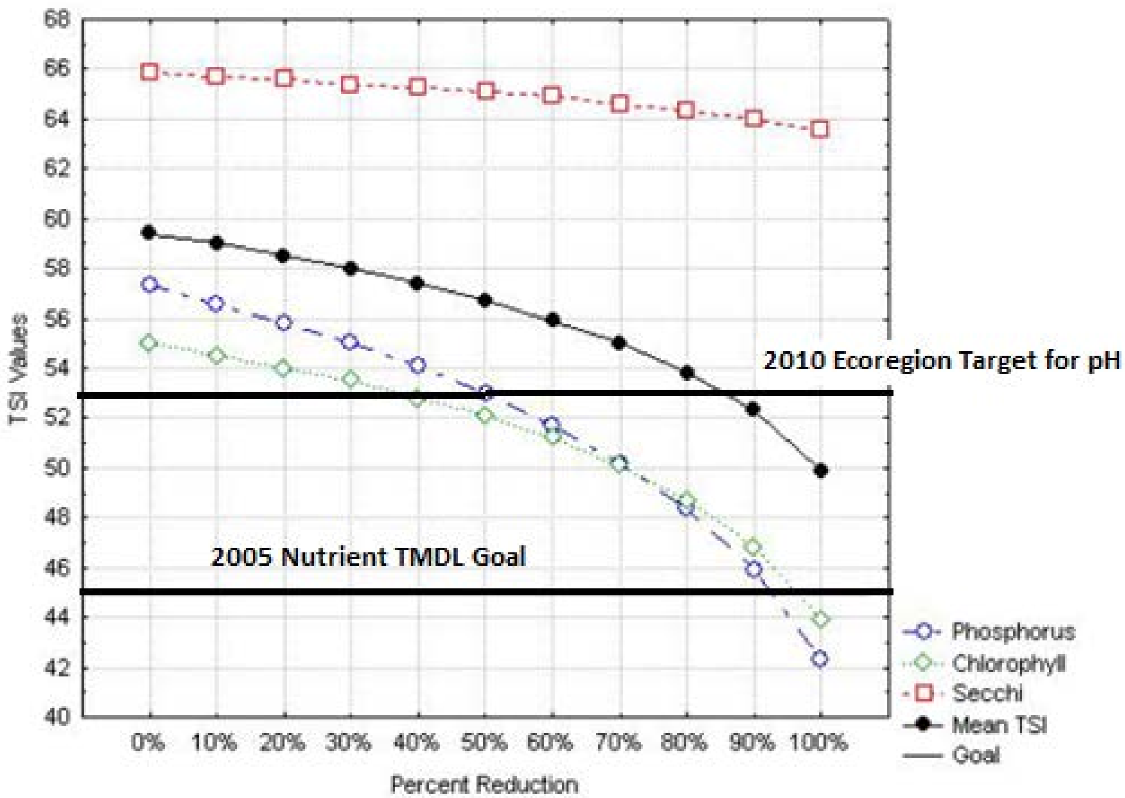

Figure 3. Sylvan Lake Reduction Response Modeling based on External Load Reductions and TMDL targets

Technical Analysis Summary

A summary of the conclusions of the various sections includes:

- Elevated pH concentrations in Black Hills reservoirs can be linked to eutrophication.
- Reducing eutrophication measured as chlorophyll *a* concentrations to less than 9ppb is expected to mitigate pH violations.
- Sylvan Lake is phosphorus limited, thus the most appropriate method for controlling eutrophication is phosphorus load reductions.
- Reduction response modeling indicated that a 92% reduction in external phosphorus loading could achieve a TSI-TP of 45.

Figure 4. 2005 Sylvan Lake Reduction Response BATHTUB Modeling Results

Percent Reduction	Total Phosphorus (ppb)	Total Nitrogen (ppb)	Predicted Phosphorus TSI value	Predicted Chlorophyll TSI value	Predicted Secchi Depth TSI value	Predicted Mean TSI value
0%	39.9	393.0	57.3	55.0	65.9	59.4
10%	38.0	386.6	56.6	54.5	65.7	59.0
20%	36.1	380.1	55.8	54.0	65.6	58.5
30%	34.0	373.6	55.0	53.5	65.4	58.0
40%	31.9	366.9	54.1	52.8	65.3	57.4
50%	29.6	360.1	53.0	52.1	65.1	56.7
60%	27.1	353.2	51.7	51.2	64.9	55.9
70%	24.4	346.2	50.2	50.1	64.6	55.0
80%	21.5	339.9	48.4	48.7	64.3	53.8
90%	18.1	331.8	45.9	46.8	64.0	52.3
100%	14.1	324.4	42.3	43.9	63.6	49.9

The Sylvan Lake TMDL called for a load of 4.9 kg/yr TP, which the BATHTUB model indicated would result in the TMDL goal of an in lake phosphorus concentration of 0.02mg/L (18.1 ppb) TP and a TSI-TP of 45. As shown above in Figure 4, the Sylvan Lake TMDL predicted that when the TSI-TP is reduced to 45, the TSI-chlorophyll *a* will fall below 46.8. Converting the TSI-Chlorophyll *a* to its base chlorophyll *a* concentration yields 5.2 ppb. Section 4.5 of the Ecoregion based TMDL found that maintaining chlorophyll *a* concentrations of less than 9-12.5 ppb would be adequate to meet pH criterion for the fishery. Since the 5.2 ppb chlorophyll *a* concentration is more conservative than the Ecoregion based TMDL, the Sylvan Lake TMDL expressed as a total phosphorus limit of 4.9 kg/yr will result in full attainment of the pH standard in Sylvan Lake.

TMDL Allocations

Wasteload Allocation

There are no point sources of pollutants of concern in this watershed. Therefore, the “wasteload allocation” component of this TMDL is considered a zero value. The TMDL is considered wholly included within the “load allocation” component.

Load Allocation (LA)

The 2005 Sylvan Lake TMDL estimated that 12.4 kg total phosphorus is currently being contributed into the lake annually from external sources while another 7.3 kg is being contributed annually from internal sources, such as lake sediments. As shown in Figure 3 above, if only external phosphorus loads originating from the watershed are managed, a 92% reduction would be required to meet the TSI-TP of 45 and the equivalent total phosphorus concentration of 0.02 mg/mL, both identified as TMDL targets. DENR estimates that a 90% reduction in external loading is possible through the construction of artificial wetlands. The remaining reduction necessary may come from internal sources. DENR estimates that in-lake management (i.e. alum treatment) could provide a 50% reduction of the lake’s internal phosphorus load. A combination of the 90% reduction from the external load (from 12.4 to 1.2 kg/year) and the 50% reduction from the internal load (from 7.3 to 3.7 kg/yr) will provide approximately 75% reduction of the total load (from 19.7 to 4.9 kg/yr). Because there are no point sources, the entire 4.9 kg/yr total phosphorus loading capacity is allocated to the LA.

Table 2. Load allocation (kg/yr) summary for Sylvan Lake.

Load source	Current Load	BMP	Reduction	TMDL
External	12.4	Artificial wetlands	0.9	1.2
Internal	7.3	Alum Treatment	0.5	3.7
Total	19.7		0.75	4.9

To identify a maximum daily limit, a method from EPA’s “Technical Support Document For Water Quality-Based Toxics Control,” referred to as the TSD method, was used. This method, which is based on a long-term average load that considers variation in a dataset, is a recommended method in EPA’s technical guidance “Options for expressing Daily Loads in TMDLs” (USEPA, 2007). The TSD method is represented by the following equation:

$MDL = LTA * e^{[z\sigma - 0.5\sigma^2]}$
where,
MDL = maximum daily limit
LTA = long-term average
z = z statistic of the probability of occurrence
$\sigma^2 = \ln(CV^2+1)$
CV = coefficient of variation

The daily load expression is identified as a static daily maximum load. A static daily load expression was deemed suitable because of the small watershed size, relatively constant loadings from nonpoint sources (e.g., septics, roads, in-stream sources), and the fact that a steady-state analysis was used. Assuming a probability of occurrence of 95% and a CV of 0.5 (assumed since the CV data used for modeling was not reported), the maximum daily load corresponding to an average annual load of 4.9 kg/yr is 0.026 kg/day.

Seasonal Variation

Different seasons of the year can yield differences in water quality due to changes in precipitation and landuse. To determine seasonal differences, Sylvan Lake sample data was graphed by month to facilitate viewing seasonal differences. Nearly all parameters assessed in this study displayed seasonal variation. For example, lake total phosphorus concentrations are highest in the early spring and late fall. Because much of the biologically available phosphorus is assimilated by algae, concentrations decrease during the early part of the growing season. Concentrations increase in the fall as algae assimilation decreases. Seasonal hydrologic loadings from the Sylvan Lake watershed were also calculated. Seasonality in the hydrologic loads appeared to vary by location. Approximately one-third of the hydrologic load from subwatershed SLT-4 occurred during the fall months, while approximately one-third of the hydrologic load from SLT-3 subwatershed occurred during the spring (see page 13 of the assessment report for seasonal hydrologic budget).

Margin of Safety

The margin of safety is implicit based on conservative estimations of lake model coefficients and a conservative estimation of the percent reduction of total phosphorus achieved with the alum treatment.

Critical Conditions

The impairments to Sylvan Lake are most severe during late summer. This is the result of warm water temperatures and peak algal growth. The TMDL load represents a measured load and may not represent the long term average load due to recent drought conditions.

Public Participation

A number of things were done to gain public education, review, and comment during development of the TMDL and included:

Public Notice sent to:

Sioux Falls Argus Leader – published April 20, 2016
Native Sun News in Rapid City – published April 20-26, 2016
Custer County Chronicle – published April 20, 2016
Pierre Capitol Journal – published April 20, 2016
Aberdeen American News – published April 18, 2016

The formal 30-day period went from April 20, 2016 to May 20, 2016.

Other organizations receiving the Public Notice included:

East Dakota Water Development District
James River Water Development District
South Central Water Development District
Central Plains Water Development District

Vermillion Basin Water Development District
West River Water Development District
West Dakota Water Development District
U.S. Bureau of Reclamation
U.S. Forest Service
U.S. Geological Survey
South Dakota Department of Agriculture
South Dakota Department of Game, Fish & Parks
South Dakota Wildlife Federation

The Public Notice was also placed on DENR's Website for the April 20 to May 20, 2016 Public Notice comment period. No comments were received from those organizations sent the Public Notice nor were any comments received from those seeing the Public Notice and Addendums on DENR's Website.

Works Cited

Carlson, R.E. 1977. A trophic state index for lakes. Limnology and Oceanography. 22(2):361-369.

USACE. (1999). *Simplified Procedures for Eutrophication Assessment and Prediction.* User Manual, US Army Corps of Engineers.

USEPA. (2007). *Options for Expressing Daily Loads in TMDLs.* United States Environmental Protection Agency, Washington D.C.

Wierenga, G., & Payne, F. (1987). *Sylvan Lake Restoration Project Final Report.* South Dakota Department of Water and Natural Resources, Pierre, SD.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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AUG 18 2016

Ref: 8EPR-EP

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 Addendum to the Total Maximum Daily Load Evaluation of pH for Reservoirs in the Black Hills Plateau Ecoregion of Custer and Pennington Counties, South Dakota

Dear Mr. Pirner,

The U.S. Environmental Protection Agency (EPA) has completed review of the total maximum daily load (TMDL) submitted by your office on August 1, 2016. In accordance with the Clean Water Act (33 U.S.C. §1251 *et. seq.*), the EPA approves all aspects of the TMDL referenced in the Enclosure 1, summary table developed for a water quality limited segment as described in Section 303(d)(1). Based on our review, the EPA finds the separate elements of the TMDL developed for Sylvan Lake (SD-CH-L-SYLVAN_01) adequately address the pH impairment, taking into consideration seasonal variation and a margin of safety. Because setting daily loads for pH is impractical, EPA agrees with the approach to adopt Sylvan Lake's existing total phosphorus TMDL as a surrogate to a pH TMDL. EPA understands that the original TMDL approved on March 24, 2011 remains in effect unchanged. A full discussion of the EPA's review is contained in the Enclosure 2, decision document.

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

Sincerely,

Martin Hestmark
Assistant Regional Administrator
Office of Ecosystems Protection
and Remediation

Enclosures
1. Sylvan Lake pH TMDL Addendum, Summary Table
2. Sylvan Lake pH TMDL Addendum, Review Form and Decision Document

Waterbody Description	Waterbody ID	Cause of Impairment[1]	Pollutant Addressed by Total Maximum Daily Load (TMDL)	EPA Action	TMDL End Point		Wasteload Allocation (WLA)[2]		Load Allocation (LA)[3]		Margin of Safety	TMDL (kg/day)
					Indicator	Threshold Value	WLA Source	WLA (kg/day)	LA Source	LA (kg/day)		
Sylvan Lake – Custer County	SD-CH-L-SYLVAN_01	pH (high)	Total Phosphorus	TMDL Approved	Phosphorus Trophic State Index	≤ 45	N/A	0	Natural Background & Nonpoint Sources	0.026	Implicit	0.026
					Total Phosphorus Concentration	≤ 0.02 mg/L						
		Water Temperature	NA	No Action (Future TMDL Project)	NA	NA	NA	NA	NA	NA	NA	NA
		Trophic State Index	NA	No Action (Previous TMDL Project)	NA	NA	NA	NA	NA	NA	NA	NA

[1]Identified from South Dakota's 2014 Integrated Report, except for the pH cause which was identified in 2016
[2]There are no point sources in the Sylvan Lake watershed therefore DENR established a WLA of zero
[3]DENR established a composite LA attributed to all nonpoint sources and natural background combined

ENCLOSURE 2

EPA REGION 8 TMDL REVIEW FORM AND DECISION DOCUMENT

TMDL Document Info:

Document Name:	Addendum to the Total Maximum Daily Load Evaluation of pH for Reservoirs in the Black Hills Plateau Ecoregion of Custer and Pennington Counties, South Dakota
Submitted by:	South Dakota Department of Environment and Natural Resources
Date Received:	August 1, 2016
Review Date:	August 2, 2016
Reviewer:	Peter Brumm
Rough Draft / Public Notice / Final Draft?	Final
Notes:	

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

- [x] Approve
- [ ] Partial Approval
- [ ] Disapprove
- [ ] Insufficient Information

Approval Notes to the Administrator: *Based on the review presented below, I recommend approval of a surrogate phosphorus TMDL to address Sylvan Lake's pH impairment as submitted in this document. A surrogate TMDL is acceptable because setting a pH load limit is impractical. The original Ecoregion pH TMDL addressing pH impairments for other regional lakes, approved on March 24, 2011, remains in effect unchanged.*

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

1. Problem Description
   - 1.1. TMDL Document Submittal
   - 1.2. Identification of the Waterbody, Impairments, and Study Boundaries
   - 1.3. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   - 4.1. Data Set Description
   - 4.2. Waste Load Allocations (WLA)
   - 4.3. Load Allocations (LA)
   - 4.4. Margin of Safety (MOS)
   - 4.5. Seasonality and variations in assimilative capacity
5. Public Participation

6. Monitoring Strategy
7. Restoration Strategy
8. Daily Loading Expression

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

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

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

1. Problem Description

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

1.1 TMDL Document Submittal

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

Review Elements:

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

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

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

Summary: The South Dakota Department of Environment and Natural Resources (DENR) submitted the *Addendum to the Total Maximum Daily Load Evaluation of pH for Reservoirs in the Black Hills Plateau Ecoregion of Custer and Pennington Counties, South Dakota* to EPA via email on May 26, 2016. An accompanying submittal letter clearly requested EPA approval of the final TMDL under Section 303(d) of the Clean Water Act. The May 26th version erroneously omitted a summary of the public participation procedures DENR followed while developing this TMDL. DENR resent the Addendum for final EPA review and approval on August 1, 2016 updated with all relevant information included in the Public Participation Section.

Comments: None.

1.2 Identification of the Waterbody, Impairments, and Study Boundaries

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

Review Elements:

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

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

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

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

Summary: This TMDL was written to address a pH impairment for Sylvan Lake (SD-CH-L-SYLVAN_01) and presented as an addendum to a previous DENR TMDL effort that addressed multiple pH impairments in the same Ecoregion (*Total Maximum Daily Load Evaluation of pH for Reservoirs in the Black Hills Plateau Ecoregion of Custer and Pennington Counties, South Dakota*) subsequently referred to as the 2011 Ecoregion pH TMDL. Due to a link between pH and nutrients explained later in this review form, the Addendum also relies on information contained within an individual phosphorus TMDL developed for Sylvan Lake (*Phase I Watershed Assessment Final Report and TMDL Sylvan Lake Watershed Custer County, South Dakota*) subsequently referred to as the 2005 Sylvan Lake nutrient TMDL.

The introduction section of the Addendum details Sylvan Lake's 303(d) listing and TMDL history. In short, DENR originally listed Sylvan Lake as impaired by chlorophyll-*a* in 1998, developed a total phosphorus TMDL to address the chlorophyll-*a* impairment in 2005, and recently identified the lake as impaired by elevated pH in 2016. The Addendum's watershed description section briefly describes the physical attributes of the lake and surrounding land use, while a more detailed watershed description, including a discussion of the area climate and geology, is contained in the 2005 Sylvan Lake nutrient TMDL. Figure 1 of the Addendum depicts the general location and watershed of Sylvan Lake.

Comments: None.

1.3 Water Quality Standards

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

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

Review Elements:

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

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

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

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

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

Summary: The beneficial uses and water quality standards section of the Addendum provides a primer to water quality standards and references state regulations that establish beneficial uses and criteria in South Dakota (ARSD 74:51). The following table associates Sylvan Lake's beneficial uses with applicable pH criteria:

Table DD-1. Sylvan Lake pH Water Quality Standards

Beneficial Use	pH Criteria
Coldwater Permanent Fish Propagation	Acceptable pH range = 6.5-9.0 standard units
Fish and Wildlife Propagation, Recreation, and Stock Watering	Acceptable pH range = 6.0-9.5 standard units
Limited Contact Recreation	See narrative
Immersion Recreation	See narrative
Narrative Criterion Applicable to All Uses	No materials may be discharged or caused to be discharged which affect the pH of the receiving waters by more than 0.5 pH unit (ARSD 74:51:01:07)

Additional narrative standards contain language that prohibit the presence of material causing pollutants to form, visible pollutants, odor, and nuisance aquatic life (ARSD 74:51:01:05; 06; 08; and 09). The TMDL is based on attaining the more restrictive Coldwater Permanent Fish Propagation criterion of 6.5-9.0 standard units. DENR notes in the Addendum that the existing numeric pH criterion for Coldwater Permanent Fish Propagation has been updated since the 2005 Sylvan Lake nutrient TMDL when the applicable pH criterion was 6.6-8.6 standard units, but matches the pH criterion used to develop the 2011 Ecoregion pH TMDL. This newer criterion also matches EPA's nationally recommended Clean Water Act Section 304(a) Criterion for freshwater aquatic life experiencing chronic exposure. An important factor in chemical and biological systems, pH is a measure of hydrogen ion activity in water. The purpose of the criterion is to protect fish from direct adverse physiological effects outside this range due to low pH (acidic) or high pH (alkaline) waters. In addition, the toxicity and solubility of many compounds are affected by pH extremes. The detrimental effects of elevated pH on fish is discussed further in the 2011 Ecoregion pH TMDL (see page 20).

Following DENR's assessment methodology, pH is impairing aquatic life uses in Sylvan Lake because pH exceeds the upper criterion limit (9.0 standard units) in more than 10% of the collected samples. No samples in the assessment database have violated the lower criterion limit (6.5 standard units).

Comments: None.

2. Water Quality Targets

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

Review Elements:

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

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

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

Summary: While pH water quality standards attainment is best determined directly by comparing monitoring data to the numeric pH criteria following DENR's assessment method, in this case attainment will also be measured against numeric phosphorus targets because the pH impairment has been addressed though a surrogate phosphorus TMDL. The Addendum relies heavily on the analyses performed in the 2005 Sylvan Lake nutrient TMDL and the 2011 Ecoregion pH TMDL to adopt TMDL targets that are protective of Sylvan Lake's pH criteria and beneficial uses. The Addendum and 2011 Ecoregion pH TMDL both describe the mechanisms by which elevated pH in lakes can result from excessive nutrients. To summarize, loading of elevated nutrients to a system can lead to a rapid increase in primary production and algal or macrophytic growth. This growth, paired with higher rates of photosynthesis, can drive a rise in pH as photosynthesis removes CO_2 and other forms of inorganic carbon from the water column. In these waters the effects of photosynthesis outcompete the opposing processes of respiration and decomposition, which lower pH by releasing CO_2, carbonic acid, and other forms of inorganic carbon.

The Addendum states "elevated pH values were found near the surface of the water column" and the sampling data contained in Table 1 supports this finding. Given that pH exceedances were most often located in the water column where sunlight is most prevalent and photosynthesis rates are highest, and given the documented history of excessive nutrient issues in Sylvan Lake, EPA believes it reasonable to conclude that elevated pH is related to nutrients, and controls on nutrient loading is needed to address the pH impairment.

The 2005 Sylvan Lake nutrient TMDL found phosphorus to be the limiting nutrient controlling primary production and chlorophyll-*a* concentrations in the lake (see page 48). Consequently, DENR chose to address the chlorophyll-*a* impairment in 2005 through a total phosphorus TMDL with phosphorus TMDL targets. The 2011 Ecoregion pH TMDL compiled information from multiple Ecoregion 17b lakes to compare a variety of parameters related to nutrients and pH such as: phosphorus, nitrogen, hydroxide, alkalinity and chlorophyll-*a*. After reviewing nearly 100 paired chlorophyll-*a* and pH values, DENR determined that a chlorophyll-*a* range of 9-12.5 ppb corresponded to a pH value of less than 9.0 standard units in 90% of the data (see page 27). Considering DENR's assessment method allows up to a 10% exceedance frequency of the pH criterion, a waterbody meeting the criterion in 90% of the samples is attaining pH water quality standards.

Nutrient loading delivered to Sylvan Lake was simulated in the 2005 Sylvan Lake nutrient TMDL using monitoring data and the FLUX model. FLUX output files were then fed into a BATHTUB eutrophication response model to predict in-lake changes to water quality parameters given successive 10% reductions in loading. Both models are well established in TMDL practice and designed by the U.S. Army Corps of Engineers. Figures 3 and 4 of the Addendum display BATHTUB modeling results. The original TMDLs and the Sylvan Lake BATHTUB model reported results as Trophic State Index (TSI), which is a measure of eutrophication scored independently for phosphorus, Secchi depth, and chlorophyll-*a*.

The 2005 Sylvan Lake nutrient TMDL established TMDL targets for total phosphorus (TP) TSI (≤ 45) and total phosphorus concentration (≤ 0.02 mg/L) to address the chlorophyll-*a* impairment. As shown in Figure 4 of the Addendum, BATHTUB estimated that these targets will be met following a 92% reduction in external nutrient loading. At that point the predicted chlorophyll-*a* TSI value will be slightly less than 46.8 which corresponds to chlorophyll-*a* concentration of 5.2 ppb. Because this chlorophyll-*a* concentration is more stringent than the chlorophyll-*a* range (9-12.5 ppb) shown in the 2011 Ecoregion pH TMDL to meet pH water quality standards and support the Coldwater Permanent Fish Propagation use, EPA believes the 2005 Sylvan Lake nutrient TMDL targets (TP TSI ≤ 45 and TP concentration $\leq$ 0.02 mg/L) are adequate for addressing the pH impairment. Indeed a sufficient level of protection is afforded by using these targets over the 2011 Ecoregion pH TMDL targets which only require a 40% reduction to meet a chlorophyll-*a* range of 9-12.5 ppb. Even though Sylvan Lake's pH impairment has been addressed using TMDL targets originating from the 2005 Sylvan Lake nutrient TMDL, DENR chose to publish this TMDL as an addendum to the 2011 Ecoregion pH TMDL so all regional pH TMDLs are organized under one document.

Comments: EPA notes the term *photosynthesis* should replace the term *respiration* in the Addendum sentence, "Increased *respiration* from excessive macrophyte and algae growth results in processes that elevate the pH" (emphasis added). EPA understands the term was used in error (i.e., respiration lowers pH, photosynthesis raises pH) but the underlying concept linking pH and nutrients is accurate.

3. Pollutant Source Analysis

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

Review Elements:

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

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

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

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

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

Summary: The Addendum's brief watershed description, discussed in more detail in the 2005 Sylvan Lake nutrient TMDL, describes a small basin less than one square mile in size dominated by evergreen forests and granite outcrops. Approximately 90% of the watershed is managed by the South Dakota Department of Game, Fish and Parks (Custer State Park) with the remaining 10% administered by the U.S. Forest Service (Black Hills National Forest). In addition to forested lands, patches of low to medium intensity development and roads support an extremely popular local recreation economy that involves boating, swimming, fishing, hiking, and rock climbing. Through a screening level analysis of present sources and current land uses, DENR identified the following sources of nutrient loading: natural background, recreation, septic systems, roads, and forest management. The 2005 Sylvan Lake nutrient TMDL states, "degraded water quality in Sylvan Lake is primarily attributed to recreational activity within the watershed" (see page 3). Land use and ownership remains similar to the 2005 characterization thus DENR assumes the original pollutant source analysis is still accurate and appropriate for use in the Addendum.

The Addendum relied on the original Sylvan Lake BATHTUB and FLUX model results to estimate loading from internal sources such as lakebed sediments and external sources such as tributary contributions. Table 2 of the Addendum lists the annual phosphorus load as 7.3 kg from internal sources and 12.4 kg from external sources under existing conditions. The Addendum source analysis and final allocation process used a composite LA to represent all nonpoint sources instead of breaking out unique land use categories or identifying natural background. There are no point sources permitted under the National Pollutant Discharge Elimination System (NPDES) in the watershed nor are there any known unpermitted point sources. Given the relatively simple source scenario for Sylvan Lake (i.e., small watershed, few unique sources, no point sources, two landowners, etc.) and the flexibility allowed by regulation to estimate gross LA allotments (40 C.F.R. §130.2(g)), EPA finds the source analysis provided in the Addendum is justified.

Comments: None.

4. TMDL Technical Analysis

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

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

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

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

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

Where:

TMDL = Total Maximum Daily Load (also called the Loading Capacity)

LAs = Load Allocations

WLAs = Wasteload Allocations

MOS = Margin Of Safety

Review Elements:

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

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

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

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

- the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
- the distribution of land use in the watershed (e.g., urban, forested, agriculture);
- a presentation of relevant information affecting the characterization of the pollutant of concern and its allocation to sources such as population characteristics, wildlife resources, industrial activities etc…;
- present and future growth trends, if taken into consideration in determining the TMDL and preparing the TMDL document (e.g., the TMDL could include the design capacity of an existing or planned wastewater treatment facility);
- an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments; chlorophyll-*a* and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

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

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

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

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

Summary: Because setting daily loads for pH is impractical, DENR adopted Sylvan Lake's existing total phosphorus TMDL with phosphorus based targets as a surrogate to a pH TMDL. See discussion in Section 2.0 of this review form regarding the linkage and derivation of phosphorus targets to address the pH impairment. The BATHTUB model predicted the 0.02 mg/L in-lake total phosphorus target will be met when the external phosphorus load is reduced by 92%. DENR relied on phosphorus removal studies, including a local Sylvan Lake report[1], to demonstrate that a 90% reduction of external phosphorus loading could be expected with the installation of artificial wetlands and the remaining load reduction needed could be achieved by reducing the internal phosphorus load using alum treatments. As shown in Table 2 of the Addendum, DENR established a TMDL of 4.9 kg/yr total phosphorus by combining these treatments for an overall 75% reduction from the existing total phosphorus load of 19.7 kg/yr. Because a 92% reduction applied to external loading alone would have resulted in an overall load limit of 8.29 kg/yr (i.e., 12.4 x (1 - 0.92) + 7.3), EPA determines the 4.9 kg/yr TMDL established in the Addendum is sufficiently protective and achievable with the application of proper restoration activities. For more detail on treatment alternatives see pages 62-65 of the 2005 Sylvan Lake nutrient TMDL.

[1]Fischer, D.J., K.B. Goyer, D. Lipp, and G. Sanchez. 2004. Phosphorus Accumulation and Techniques for Removal in Sylvan Lake; Black Hills, South Dakota. South Dakota School of Mines and Technology, Department of Civil and Environmental Engineering: Senior Design Project Final Report.

Comments: None.

4.1 Data Set Description

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

Review Elements:

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

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

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

Summary: Table 1 of the Addendum provides the raw pH dataset used to determine Sylvan Lake's impaired status. The Addendum also characterizes the phosphorus dataset and summarizes the BATHTUB and FLUX model results, all of which are provided in more detail in the 2005 Sylvan Lake nutrient TMDL.

Comments: None.

4.2 Waste Load Allocations (WLA):

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

Review Elements:

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

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

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

Summary: There are no point sources in the Sylvan Lake watershed therefore DENR established a WLA of zero.

Comments: None.

4.3 Load Allocations (LA):

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

Review Elements:

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

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

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

Summary: The Addendum established a composite load allocation of 4.9 kg/yr total phosphorus attributed to all nonpoint sources and natural background combined. Because the WLA component is zero, the entire TMDL is allocated to the LA. The existing 19.7 kg/yr total phosphorus load contribution from all sources identified using the BATHTUB and FLUX models requires a 75% reduction to meet the 4.9 kg/yr LA and TMDL. Given the relatively simple source scenario for Sylvan Lake (i.e., small watershed, few unique sources, no point sources, two landowners, etc.) and the flexibility allowed by regulation to estimate gross LA allotments (40 C.F.R. §130.2(g)), EPA finds the composite LA provided in the Addendum appropriate.

Comments: None.

4.4 Margin of Safety (MOS):

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

Review Elements:

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

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

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

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

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

Summary: DENR stated in the Addendum, "The margin of safety is implicit based on conservative estimations of lake model coefficients and a conservative estimation of the percent reduction of total phosphorus achieved with the alum treatment" (i.e., 50%). Additionally, DENR chose to use the phosphorus targets established in the 2005 Sylvan Lake nutrient TMDL, which correspond to a 5.2 ppb chlorophyll-*a* concentration that is more stringent than the 9-12.5 ppb range demonstrated by the 2011 Ecoregion pH TMDL as sufficient to meet pH water quality standards and support the Coldwater Permanent Fish Propagation use. As a result the TMDL based on the chosen targets may be more conservative than minimally necessary to address the pH impairment.

Comments: None.

4.5 Seasonality and variations in assimilative capacity:

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

Review Elements:

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

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

Summary: The Addendum references the review of sampling data and loading by month presented in the 2005 Sylvan Lake nutrient TMDL as evidence that seasonal variation was considered while developing the original TMDL now adopted by the Addendum. This investigation found nearly all monitoring parameters displayed seasonal variation with total phosphorus concentrations peaking in the early spring and late fall. The mid-summer decrease was attributed to algae actively uptaking and removing phosphorus from the water column. Monthly pH measurements are graphed in Figure 24 of the 2005 Sylvan Lake nutrient TMDL and indicate samples above the criteria have occurred during June, July, August, and September. Finally, the Addendum addresses seasonality concerns by providing an annual loading limit in addition to the daily limit to capture growing season variability.

Comments: None.

5.0 Public Participation

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

Review Elements:

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

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

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

Summary: The public participation process followed for the Addendum is summarized in the document. The *Addendum to the Total Maximum Daily Load Evaluation of pH for Reservoirs in the Black Hills Plateau Ecoregion of Custer and Pennington Counties, South Dakota* was released for public comment from April 20, 2016 to May 20, 2016. The opportunity for public comment and review was posted on DENR's website and announced in five newspapers: Sioux Falls Argus Leader, Native Sun News in Rapid City, Custer County Chronicle, Pierre Capitol Journal, and Aberdeen American News. Additionally, DENR directly notified a number of stakeholders by email. No comments were received.

Comments: None.

6. Monitoring Strategy

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

Review Elements:

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

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

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

Summary: The monitoring strategy developed for the 2005 Sylvan Lake nutrient TMDL also applies to this pH Addendum. Future monitoring will focus on effectiveness of Best Management Practice (BMP) implementation. Long term trend data will also continue to be collected on Sylvan Lake though DENR's established statewide lake assessment program. Data collected in 2010 and 2015 triggered the pH listing, however, the listing action should not be interpreted as a drastic decline in water quality conditions over the past decade because the 2005 Sylvan Lake nutrient TMDL reported an 8% exceedance frequency of the upper pH criterion, nearing the 10% maximum allowed by the State's assessment methodology (see page 38). No BMPs or restoration activities have taken place since 2005.

Comments: None.

7. Restoration Strategy

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

Review Elements:

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

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

Summary: DENR relied on phosphorus removal studies to demonstrate the reduction goal is realistic and achievable with the application of proper restoration activities. DENR estimated that external phosphorus loading could be reduced 90% from 12.4 to 1.2 kg/yr if artificial wetlands are constructed near stream inlets. This reduction estimate was based on a South Dakota School of Mines and Technology Senior Design Study[1] conducted on Sylvan Lake. DENR cites other studies to support the assumption that internal phosphorus loading could be reduced 50% from 7.3 to 3.7 kg/yr following aluminum sulfate (alum) treatment. Combined, these activities could account for the 75% total reduction required by the TMDL to reduce the phosphorus load from 19.7 to 4.9 kg/yr. For more detail on treatment alternatives see pages 62-65 of the 2005 Sylvan Lake nutrient TMDL.

The 2005 Sylvan Lake nutrient TMDL also discussed a historic restoration project initiated in 1979 to combat erosion and sedimentation issues caused by heavy recreation occurring in the area. Lakebed sediments were dredged, parking lots and roads were paved, riparian vegetation was planted, and sediment control structures were constructed near the lake inlet (see page 59). Lake assessments conducted after five years showed no noticeable improvement, however, Figure 2 of the Addendum shows phosphorus concentrations today have markedly dropped since the 1980's potentially aided by these efforts. The other notable restoration activity to date has been the installation of floating circulator in 2000 to disrupt stratification, improve dissolved oxygen concentrations, and control algal blooms in the lake. The circulator has improved dissolved oxygen conditions throughout the lake's water column but more restoration activities are clearly needed for Sylvan Lake to fully support its designated uses. No additional BMPs or restoration activities have taken place since 2005, and land use changes have been negligible, therefore the assumptions and existing conditions derived in the 2005 Sylvan Lake nutrient TMDL are still valid and appropriate for use by this Addendum.

[1]Fischer, D.J., K.B. Goyer, D. Lipp, and G. Sanchez. 2004. Phosphorus Accumulation and Techniques for Removal in Sylvan Lake; Black Hills, South Dakota. South Dakota School of Mines and Technology, Department of Civil and Environmental Engineering: Senior Design Project Final Report.

Comments: None.

8. Daily Loading Expression

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

Review Elements:

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

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

Summary: DENR converted the annual total phosphorus limit of 4.9 kg to a daily limit of 0.026 kg following the TSD method[2] for lognormally distributed data. Use of this statistical approach to identify maximum daily loads is endorsed by EPA[3].

[2]Technical Support Document for Water Quality-Based Toxics Control, EPA, 1991: *https://www3.epa.gov/npdes/pubs/owm0264.pdf*

[3]Draft Options for Expressing Daily Loads in TMDLs, EPA, 2007:
https://www.epa.gov/tmdl/draft-options-expression-daily-loads-tmdls

Comments: EPA notes a formatting error in the Addendum's TSD equation and definitions, however, the resulting daily load is calculated correctly. All three instances of the number "2" in the Addendum's TSD equation and definitions should be treated as an exponent squaring the neighboring variables.