MERCURY TOTAL MAXIMUM DAILY LOAD EVALUATION FOR THE STATE OF SOUTH DAKOTA

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Mercury Total Maximum Daily Load Summary for Bitter Lake

Entity IDs:	SD-BS-L-BITTER_01
Location:	HUC Code: 10170201
Size of Watershed:	27,241 acres
Waterbody Type:	Lake
303(d) Listing Parameter:	Mercury in fish flesh
Initial Listing date:	2004 IR
TMDL Priority Ranking:	1
Listed Lake Acres:	3228 acres
Designated Use of Concern:	Warmwater Permanent Fish Life Propagation
Analytical Approach:	Total source load from baseline year and reduction factor
Target:	1.0 mg/kg mercury in fish flesh
Indicators:	Total mercury atmospheric deposition
Load Allocation:	3.92 kg/day (1429.2 kg/yr)
Waste Load Allocation:	0 kg/day

Mercury Total Maximum Daily Load Summary for North Island Lake

Entity IDs:	SD-BS-L-ISLAND_N_01 (formerly SD-VM-L-ISLAND_N_01)
Location:	HUC Code: 10170203
Size of Watershed:	1,221.59 acres
Waterbody Type:	Lake
303(d) Listing Parameter:	Mercury in fish flesh
Initial Listing date:	2010 IR
TMDL Priority Ranking:	1
Listed Lake Acres:	375 acres
Designated Use of Concern:	Warmwater Semipermanent Fish Life Propagation
Analytical Approach:	Total source load from baseline year and reduction factor
Target:	1.0 mg/kg mercury in fish flesh
Indicators:	Total mercury atmospheric deposition
Load Allocation:	3.92 kg/day (1429.2 kg/yr)
Waste Load Allocation:	0 kg/day

Mercury Total Maximum Daily Load Summary for Twin Lakes/W. Hwy 81

Entity IDs:	SD-BS-L-TWIN_01
Location:	HUC Code: 10170202
Size of Watershed:	2,677.37 acres
Waterbody Type:	Lake
303(d) Listing Parameter:	Mercury in fish flesh
Initial Listing date:	2004 IR
TMDL Priority Ranking:	1
Listed Lake Acres:	303.14 acres
Designated Use of Concern:	Fish and Wildlife Propgation, Recreation, and Stock Watering
Analytical Approach:	Total source load from baseline year and reduction factor
Target:	1.0 mg/kg mercury in fish flesh
Indicators:	Total mercury atmospheric deposition
Load Allocation:	3.92 kg/day (1429.2 kg/yr)
Waste Load Allocation:	0 kg/day

Mercury Total Maximum Daily Load Summary for Twin Lake

Entity IDs:	SD-BS-L-TWIN_02
Location:	HUC Code: 10170203
Size of Watershed:	563.24 acres
Waterbody Type:	Lake
303(d) Listing Parameter:	Mercury in fish flesh
Initial Listing date:	2010 IR
TMDL Priority Ranking:	1
Listed Lake Acres:	287 acres
Designated Use of Concern:	Warmwater Permanent Fish Life Propagation
Analytical Approach:	Total source load from baseline year and reduction factor
Target:	1.0 mg/kg mercury in fish flesh
Indicators:	Total mercury atmospheric deposition
Load Allocation:	3.92 kg/day (1429.2 kg/yr)
Waste Load Allocation:	0 kg/day

Mercury Total Maximum Daily Load Summary for Pudwell Dam

Entity IDs:	SD-GR-L-PUDWELL_01
Location:	HUC Code: 10130303
Size of Watershed:	2,465.96 acres
Waterbody Type:	Lake
303(d) Listing Parameter:	Mercury in fish flesh
Initial Listing date:	2010 IR
TMDL Priority Ranking:	1
Listed Lake Acres:	105.01 acres
Designated Use of Concern:	Warmwater Permanent Fish Life Propagation
Analytical Approach:	Total source load from baseline year and reduction factor
Target:	1.0 mg/kg mercury in fish flesh
Indicators:	Total mercury atmospheric deposition
Load Allocation:	3.92 kg/day (1429.2 kg/yr)
Waste Load Allocation:	0 kg/day

Mercury Total Maximum Daily Load Summary for Lake Hurley

Entity IDs:	SD-MI-HURLEY_01
Location:	HUC Code: 10130105
Size of Watershed:	47,209.84 acres
Waterbody Type:	Lake
303(d) Listing Parameter:	Mercury in fish flesh
Initial Listing date:	2004 IR
TMDL Priority Ranking:	1
Listed Lake Acres:	105.9 acres
Designated Use of Concern:	Warmwater Permanent Fish Life Propagation
Analytical Approach:	Total source load from baseline year and reduction factor
Target:	1.0 mg/kg mercury in fish flesh
Indicators:	Total mercury atmospheric deposition
Load Allocation:	3.92 kg/day (1429.2 kg/yr)
Waste Load Allocation:	0 kg/day

Mercury Total Maximum Daily Load Summary for Roosevelt Lake

Entity IDs:	SD-MI-L-ROOSEVELT_01
Location:	HUC Code: 10130303
Size of Watershed:	7,045 acres
Waterbody Type:	Lake
303(d) Listing Parameter:	Mercury in fish flesh
Initial Listing date:	2006 IR
TMDL Priority Ranking:	1
Listed Lake Acres:	93.46 acres
Designated Use of Concern:	Warmwater Permanent Fish Life Propagation
Analytical Approach:	Total source load from baseline year and reduction factor
Target:	1.0 mg/kg mercury in fish flesh
Indicators:	Total mercury atmospheric deposition
Load Allocation:	3.92 kg/day (1429.2 kg/yr)
Waste Load Allocation:	0 kg/day

1.0 Introduction

A number of advisories for fish consumption due to elevated mercury concentrations in fish tissue have been given for a number of lakes in South Dakota and these lakes were listed as being impaired in the 2010 South Dakota Integrated Report. This prompted the South Dakota Department of Environment and Natural Resources (SDDENR) to acquire the services of Dr. James Stone from the South Dakota School of Mines and Technology (SDSM&T) to research the issue, identify sources of mercury, and provide the basis for establishing a Total Maximum Daily Load (TMDL) for mercury as it relates to mercury in fish tissue. The findings of his research can be found in Stone (2011).

The intent of this document is to clearly identify the components of the TMDL submittal, to support adequate public participation, and facilitate United States Environmental Protection Agency (USEPA) review and approval. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by EPA. This TMDL document addresses the mercury found in excessive concentrations in fish tissue in selected lakes in South Dakota.

1.1 Watershed Characteristics

1.1.1 Climate

South Dakota has a continental climate with cold winters and warm to hot summers. Temperatures average 48ºF in the south to 44ºF in the north and can vary from -20ºF during the winter to as much as 100ºF during the summer. Weather changes such as storms and rain are caused by passing cold fronts and low pressure areas moving eastward. The Black Hills region experiences increased moisture because of the effect of changing elevations in this area. An area just east of the Black Hills often has milder temperatures. Excluding the Black Hills, the eastern part of the state receives more moisture than the western half (Figure 1).

1.1.2 Geology/Soils

Although there are no known geologic formations in South Dakota that contain mercury, watershed attributes can influence mercury movement after mercury is deposited within a watershed. The geology of the state is varied (Figure 2) and matches up well with the land uses. The eastern portion of the state contains Pleistocene deposits of material formed by wind (loess), water (alluvium, silts, and clays), and glaciers (glacial drift). The geology in the western half of the state is of Mesozoic and Tertiary formations containing sandstones, clays, shale, silt, and chalk. The Black Hills are Precambrian formations of granites and metamorphic rocks.

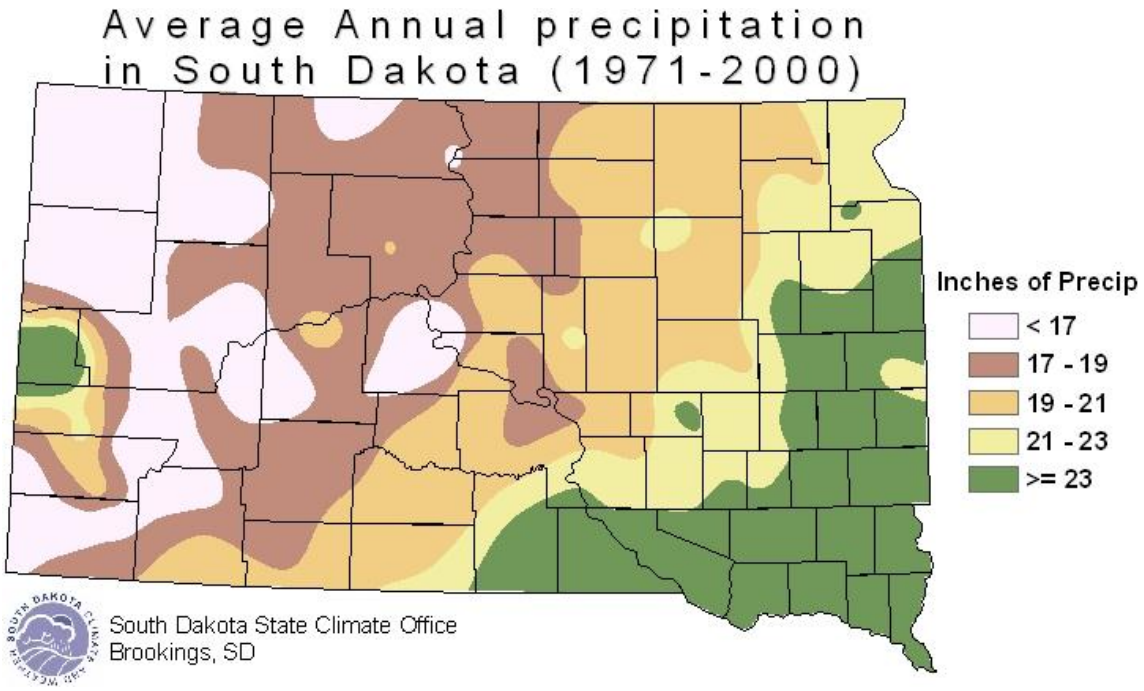

Figure 1. Average (1971-2000) Annual Precipitation for South Dakota.

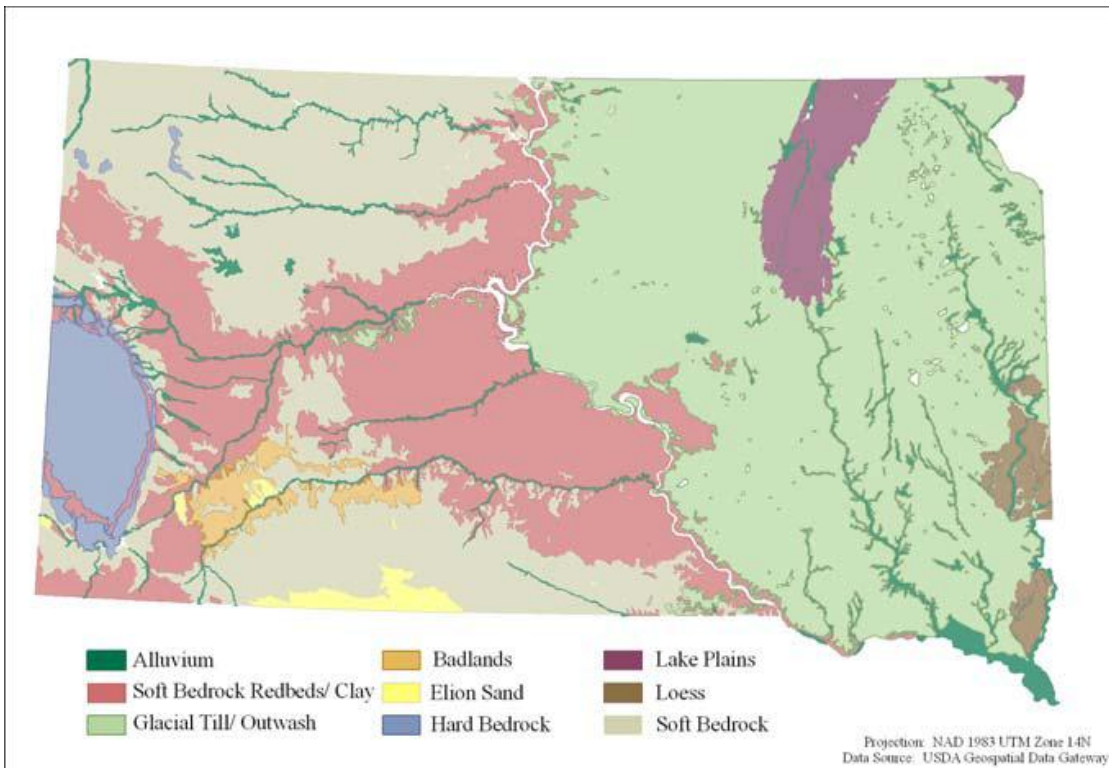

Figure 2. Geology of South Dakota.

1.1.3 Land Use

Land use in South Dakota is dominated by cropland in the eastern half of the state and by grazing lands in the western half (Figure 3). Approximately 50% of the cropland acres are planted in corn or soybeans. Other significant crops include winter and spring wheat, sunflowers, and hay production. Forestry is prevalent in the Black Hills of South Dakota with the Western Ponderosa Pine being the major tree harvested.

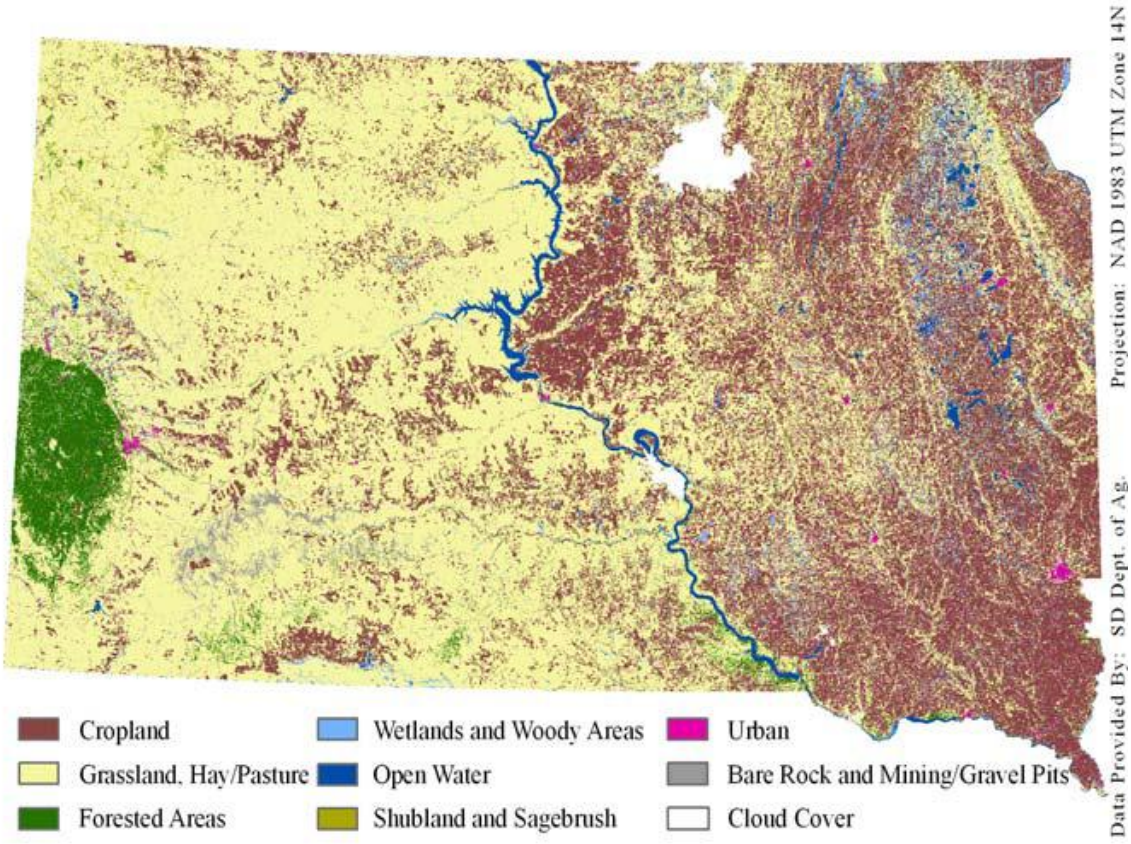

Figure 3. Land Use in South Dakota.

1.2 Impairments and Waterbody Listings

Eight lakes and impoundments are listed in the South Dakota 2010 Integrated Report as being impaired because of mercury in fish flesh. These listings are based on an advisory level of 1.0 mg/kg mercury in fish flesh and include Bitter Lake, Lake Hurley, Lake Isabel, North Island Lake, Pudwell Dam, Roosevelt Lake, Twin Lake (Minnehaha

County), and the Twin Lakes/Highway 81 Lakes complex (Kingsbury County) (Figure 4).

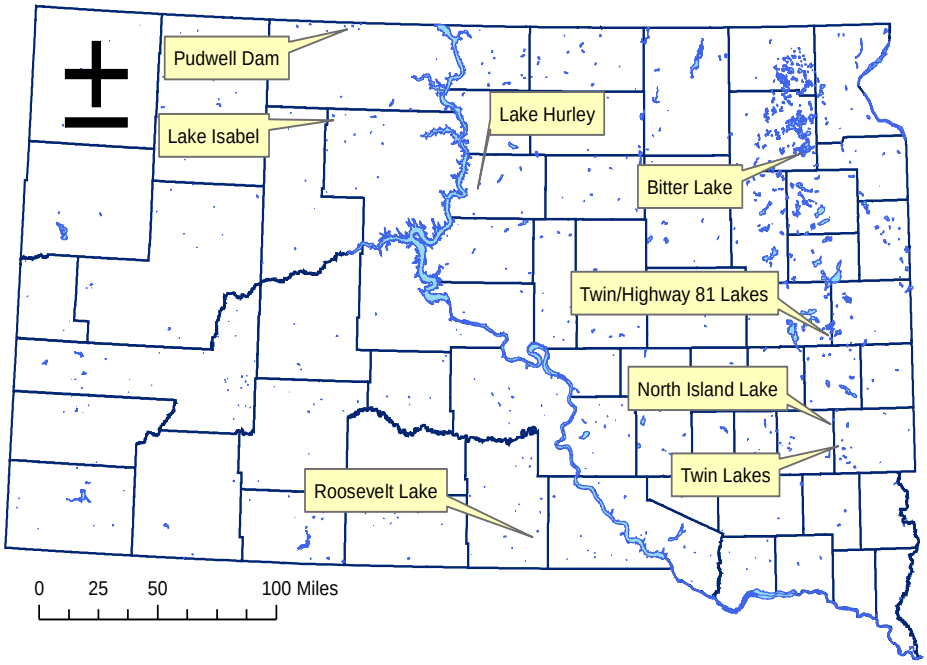

Figure 4. Lakes and impoundments in South Dakota that are listed in the 2010 Integrated Report for mercury in fish flesh.

2.0 Water Quality Standards and Fish Consumption Advisory Level

South Dakota has water quality standards for total recoverable mercury set at 0.05 ug/l for human health, 1.4 ug/l for acute freshwater aquatic life, and 0.77 ug/l for chronic freshwater aquatic life. Additional "narrative" standards that may apply can be found in the "Administrative Rules of South Dakota: Articles 74:51:01:05; 06; 08; 09; and 12". These contain language that generally prohibits the presence of materials causing pollutants to form, visible pollutants, nuisance aquatic life, and biological integrity. South Dakota also has a fish consumption advisory level for mercury in fish tissue, which is currently set at the FDA action level of 1.0 mg/kg.

3.0 Technical Analysis

This TMDL is primarily based on the work done by Dr. James Stone and his graduate students Cindie McCutcheon and Hailemelekot Betemariam from the South Dakota School of Mines and Technology. The "Phase I Data Collection and Assessment for Mercury TMDL Development" project contained six major elements and provided for 1) a comprehensive literature review of mercury fate and transport within air, water, and soil mediums; 2) a dissemination of the results from the atmospheric deposition monitoring; 3) an establishment of sediment mercury behavior for selected South Dakota lakes and impoundments; 4) an establishment of impacts of various watershed attributes on movement of mercury; 5) a determination of the relationships between existing water quality parameters and fish tissue mercury concentrations for selected lakes and impoundments in South Dakota; and 6) an establishment of relationships between physiochemical and watershed characteristics for mercury concentrations in South Dakota walleye.

3.1 Data Collection Methods

3.1.1 Atmospheric Deposition of Mercury

Ten bulk mercury passive samplers were constructed and deployed by the SDSM&T at ten locations throughout South Dakota and surrounding states. Details of the sampler design and sampling protocols can be found in Stone (2011). Samples were collected monthly and sent to Frontier Geosciences for mercury analysis. Additional data for atmospheric deposition of mercury were obtained from the Mercury Deposition Network (MDN, http://nadp.sws.uiuc.edu/MDN/), which had limited data for South Dakota.

The data provided the state with an updated estimate of atmospheric mercury deposition and were compared against various watershed, physical and chemical attributes from selected lakes and impoundments.

3.1.2 Surface Water Quality and Fish Flesh

Water quality data used for the assessment were obtained from SDDENR, who followed standard sampling protocols for sampling surface waters (SDDENR, 2005). The assessment used alkalinity, pH, dissolved oxygen (DO), dissolved orthophosphate as P (DP), total phosphorus (TP), total dissolved phosphorus, Secchi disc depth, specific conductance, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), turbidity, trophic state index for phosphorus and Secchi disc, sulfate, and dissolved organic carbon (DOC) data. Fish tissue mercury concentrations were obtained from SDDENR, who collaborated with the South Dakota Game, Fish & Parks Department (SDGF&P) and the South Dakota Department of Health to monitor mercury in fish tissue from selected lakes and impoundments each year. The samples were analyzed for

mercury by the South Dakota Health Laboratory. McCutcheon (2009) used these data to explore relationships between mercury concentrations in fish tissue and water quality variables.

3.1.3 Sediment Analyses

Sediment cores were collected from ten lakes and impoundments during the winter of 2009 (Stone, 2011). Lakes having fish consumption advisories as well as lakes without advisories were chosen. The sampling protocols, sample processing and analytical procedures are discussed in Betemariam (2010) and Stone (2011). Analyses included sediment dating, elemental analysis sulfur, iron, and organic matter), loss of ignition, and mercury concentration. These data were compared to the mercury concentrations in advisory versus non-advisory lakes to see whether these factors were influencing mercury concentrations in the sediments.

3.2 Source Analysis

3.2.1 Point Sources

Few point sources for mercury air emissions exist in South Dakota. The largest is the Big Stone coal fired power plant located in the northeastern corner of the state which emits approximately 200 pounds mercury per year. This facility does not appear to impact South Dakota because of its location and prevailing winds. The second largest point source of mercury air emissions is GCC Dacotah's cement plant in Rapid City which emits approximately 125 pounds mercury per year. Other sources of mercury air emissions include mining operations in the northern Black Hills; operations that burn coal such as Pete Lien and Sons' lime plant and Black Hills Power's Ben French electric coal-fired power plant in Rapid City and South Dakota State University in Brookings; and other minor sources. These other sources are not considered significant mercury sources.

Mercury discharges to South Dakota surface waters are insignificant. National Pollution Discharge Elimination System (NPDES) permits are administered by SDDENR. Permits containing language about mercury are required for those sources deemed having a reasonable probability of discharging mercury. But the permittees have not had significant amounts of mercury in their discharges and the analysis of those waters for mercury mostly results in a "non-detect" for mercury.

3.2.2 Non-point Sources

The primary non-point source of mercury is the atmosphere and it is thought that this mercury is coming from industries located in other states or countries. No significant non-point sources of mercury have been identified in South Dakota.

4.0 TMDL and Allocations

This TMDL was based on the total source load (TSL) and a reduction factor (RF) needed to reduce the current concentration of mercury in fish tissue to the 1.0 mg/kg target.

The reduction factor was based on the 1.0 mg/kg target and the 90th percentile of mercury concentration in fish flesh in standard length predator fish in South Dakota. Stone's (2011) analysis found that the current fish tissue mercury concentrations differed between walleye (0.858 mg/kg) and northern pike (1.003 mg/kg). For this TMDL, the 1.003 mg/kg mercury in northern pike was used because this would produce a larger reduction factor and result in a TMDL that is protective of both fish. The reduction factor was calculated to be 1.003 mg/kg – 1.00 mg/kg = .003 mg/kg.

The total source load was calculated from the state's area (199,742.5 km²) times the average atmospheric mercury deposition rate (0.0072 kg/km²/yr) obtained from baseline 2009 data (Stone, 2011). This resulted is a total source load of 1430.2 kg/yr for the state.

The TMDL is calculated from the equation:

TMDL = TSL – (1- (RF/100))
Where TSL is the total source load and RF is the reduction factor.

Therefore:
TMDL = 1430.2 kg/yr – (1 – (.003/100)) = 1,429.2 kg/yr (**3.92 kg/day**)

This TMDL is based on the 1.0 mg/kg advisory level rather than the 0.3 mg/kg level that Stone (2011) used. Although Stone (2011) received guidance from the state and was working under the assumption the state might adopt the more conservative advisory level, the state decided to use the level currently in use for this TMDL. The TMDL value, however, is the same regardless of which advisory level is used in the TMDL calculation.

This TMDL applies to seven of the eight waterbodies listed as impaired due to excessive mercury in fish flesh. SDDENR previously relinquished the responsibility of preparing TMDLs for waterbodies in the Grand and Moreau River basins to the USEPA and Lake Isabel, located in the Grand River basin, is not included in this TMDL. It is the responsibility of the USEPA to deal with the mercury TMDL for Lake Isabel.

4.1 Load Allocations (LAs)

The load allocation from non-point sources was assumed to originate from the atmosphere and was estimated from existing data as well as the mercury atmospheric deposition data obtained from Stone's (2011) assessment. A baseline year of 2009 was

used to estimate the mercury deposition rates and the load allocation was estimated to be 3.92 kg/day, the same as the TMDL.

4.2 Wasteload Allocations (WLAs)

Given the location and prevailing winds near the Big Stone coal fired power plant it is unlikely that this facility contributes to atmospheric deposition mercury in South Dakota. And other small sources are considered insignificant relative to the overall total deposition of mercury. In addition, water samples taken from permitted dischargers do not contain appreciable amounts of mercury and are considered insignificant. Therefore, the wasteload allocation was considered zero for this TMDL.

5.0 Margin of Safety (MOS), Seasonality, and Other Factors

5.1 Margin of Safety

The State of South Dakota currently has a target advisory level of 1.0 mg/kg mercury in fish for consumptive use. This advisory is the FDA action level that is set at approximately ten times lower than the lowest levels associated with adverse effects. SDDENR feels this provides an adequate margin of safety and any TMDL based on this level will protect those who eat fish in quantities given in the fish consumption advisories.

5.2 Seasonality

The mercury TMDL assessment study indicated that spring and summer precipitation events result in higher bulk atmospheric mercury deposition (Stone, 2011). These are also the seasons when most of the nutrient and sediment loading to lakes and impoundments occur. It is thought that mercury in fish tissue is influenced by forces that are similar to those associated with lake and impoundment productivity. These might be erosion, increased runoff, or other factors and so the spring and summer seasons are critical for mercury migration into these waterbodies. Controlling mercury migration from the watershed should recognize and key in on the spring runoff and on intense precipitation events that lead to isolated runoff events.

5.3 Relations between Water Quality and Fish Flesh Mercury

Statistical analyses relating mercury in fish tissue to a number of water quality variables suggested that variables often associated with lake productivity (alkalinity, phosphorus, pH, and total solids) were significantly related to mercury in fish tissue of walleye and northern pike (McCutcheon, 2009). The relationships between mercury in fish tissue and the water quality variables were not necessarily the same for lakes versus impoundments but the broad conclusion of this study is that eutrophication or factors affecting eutrophication, can enhance mercury migration to these waterbodies and ultimately into fish tissue. Thus, implementation activities within a watershed that decrease eutrophication, such as implementation of Best Management Practices, might also decrease mercury migration to lakes and impoundments and ultimately into fish tissue.

5.4 Mercury in Lake Sediments

A study of mercury in ten lakes and impoundments was conducted by Hailemelekot Betemariam (2010). Sediment core samples were collected from the waterbodies and analyzed for mercury and other chemical constituents. For the mercury advisory lakes, mercury was found to be negatively correlated with aluminum, iron, potassium, and magnesium. Mercury was not correlated with aluminum in non-advisory lakes. The advisory lakes had greater sediment mercury concentrations than the non-advisory lakes. And the lower total sulfur and sulfide concentrations in the advisory lakes compared to the non-advisory lakes illustrates the impact of these factors on facilitating mercury methylation. Organic matter in the sediment was higher in the advisory lakes and because organic matter is an energy source in methylation, this material also plays an important role in the mercury cycle. This supports the idea that more productive waterbodies provide for conditions that favor mercury transformations and eventual accumulation in fish, and that decreasing lake productivity (decreasing organic matter) might help decrease mercury accumulation in fish. The high mercury levels have also been found to be related to increased lake surface area where mercury deposited in adjacent terrestrial soils have recently become flooded (Selch et al., 2007; Snodgrass et al., 2000). There is evidence that lesser slopes in lake shorelines may result in higher methylation rates within nearshore sediments prone to flooding (Snodgrass et al., 2000), providing fresh reserves of organic matter for the mercury methylation process.

6.0 Public Participation

STATE AGENCIES

SDDENR was the primary state agency involved in completion of the TMDL assessment. SDDENR provided technical support, funding, and project administration throughout the course of the project.

FEDERAL AGENCIES

Environmental Protection Agency (EPA) provided the primary source of funds for the completion of the project.

LOCAL GOVERNMENT, INDUSTRY, ENVIRONMENTAL, AND OTHER GROUPS, AND PUBLIC AT LARGE

The primary local sponsor for this project was the South Dakota School of Mines of Technology, who also provided in-kind services as part of the project. Dr. Stone and his graduate students completed the project and presented their findings to the public through various efforts which included:

Presentations

1. Stone, J.J., Stetler, L., McCutcheon, C., Betemariam, H., and Chipps, S. Mercury TMDL Development for South Dakota. Presented at the joint meeting of the Rocky Mountain Section, Geologic Society of America 62nd Annual Meeting and the 2010 Western South Dakota Hydrology Conference , Rapid City, SD, April 2010.

2. Betemariam, H., Stone, J.J., Stetler, L., McCutcheon, C., Chipps, S., Desutter, T., Penn, M., Urban, N., Sediment mercury behavior in South Dakota lakes and impoundments. Presented at the joint meeting of the Rocky Mountain Section, Geologic Society of America 62nd Annual Meeting and the 2010 Western South Dakota Hydrology Conference, Rapid City, SD, April 2010.

3. Betemariam, H., Stone, J.J., Stetler, L., McCutcheon, C., Chipps, S., Desutter, T., Penn, M., Urban, N., Sediment mercury behavior in South Dakota lakes and impoundments. Presented at the 22nd Annual Environmental and Ground Water Quality Conference, Pierre, SD, March 2010.

4. Stone, J.J., Penn, M., Desutter, T., Chipps, S., Stetler, L.D., A multimodal approach to develop a TMDL for mercury impaired lakes and impoundments in South Dakota. Presented at the 2009 American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America International Annual Meetings, Pittsburg, PA, November 2009.

5. Betemariam, H., Stone, J., Stetler, L., McCutcheon, C., Chipps, S., Desutter, T., Penn, M. Sediment mercury concentration profiles in South Dakota lakes and impoundments. Presented at the 2009 Eastern South Dakota Water Conference, Brookings, SD, November 2009.

6. McCutcheon, C., Stone, J., Stetler, L., Chipps, S. Relations between water quality and mercury fish tissue concentrations for natural lakes and impoundments in South Dakota. Presented at the 2009 Eastern South Dakota Water Conference, Brookings, SD, November 2009.

7. Hayer, C.A., Chipps, S., Stone, J.J., Relationship of physiochemical and watershed characteristics to mercury concentration in walleye tissue. Presented at the 139th American Fisheries Society annual meeting, Nashville, TN, August 2009.

8. Betemarian, H., Stone J.J., Stetler, L.D., McCutcheon, C., Chipps, S., Desutter, T., Penn, M., Sediment mercury concentration profiles in South Dakota lakes and impoundments. Presented at 2009 Western South Dakota Hydrology Conference, Rapid City, SD, April 2009.

9. McCutcheon, C., Stone, J.J., Stetler, L.D., Chipps, S., Relationships between water quality and mercury fish tissue concentrations for natural lakes and impoundments in South Dakota. Presented at 2009 Western South Dakota Hydrology Conference, Rapid City, SD, April 2009.

10. Stone, J.J., Stetler, L.D., McCutcheon, C., Betemariam, H., Chipps, S., Desutter, T., Penn, M., Relationships between water quality and mercury fish tissue concentrations for lakes and impoundments in South Dakota. Presented at the 21st Annual Environmental and Ground Water Quality Conference, Pierre, SD, March 2009.

11. McCutcheon, C., Stetler, L.D., Chipps, S., Stone, J.J., Relationships between water quality and mercury fish tissue concentrations for natural lakes and impoundments in South Dakota. Presented at the 2008 Eastern South Dakota Water Conference, Brookings, SD, October 2008.

12. Stone, J.J., Stetler, L.D., Sundareshwar, P., Chipps, S., Penn, M., Development of a mercury TMDL for South Dakota lakes and reservoirs. Presented at the 2008 Western South Dakota Hydrology Conference, Rapid City, SD, April 2008.

Invited Lectures

1. National Parks Service Northern Great Plains Technical Committee Meeting, Rapid City, SD. "Assessment of atmospheric mercury deposition at select Northern Great Plains National Parks." January 2010.

2. EPA Region 8 TMDL training workshop, Rapid City, SD. "South Dakota mercury TMDL development." March, 2009.

3. National Parks Service Northern Great Plains Technical Committee Meeting, Rapid City, SD. "South Dakota mercury TMDL project." December 2008.

Graduate Theses

1. Betemarian, H., 2010. Sediment mercury geochemical behavior and watershed influences for South Dakota lakes and impoundments M.S. Thesis. Thesis Committee: Stetler, L., Davis, A., Sawyer, F., Geology and Geological Engineering, SDSM&T.

2. McCutcheon, C., 2009. Relations between water quality and mercury fish tissue concentrations in South Dakota lakes and impoundments. M.S. Thesis. Thesis Committee: Mott, H., Civil and Environmental Engineering, Stetler, L., Geology and Geological Engineering, SDSM&T.

Refereed Journal Articles

1. Stone, J.J., McCutcheon, C., Stetler, L., Chipps, S. Interrelationships between fish tissue mercury concentrations and water quality for South Dakota natural lakes and impoundment. *Water, Air and Soil Pollution*. In press. http://dx.doi.org/10.1007/s11270-011-0828-3

2. Hayer, C., Chipps, S., Stone, J.J., 2011. Influence of physiochemical and watershed characteristics on mercury concentration in walleye, *Sander vitreus, M. Bulletin of Environmental Contamination and Toxicology*. 86(2): 163-167. http://dx.doi.org/10.1007/s00128-010-0166-y

Reports

1. Stone, J.J. 2011. Final Report: Phase I data collection and assessment for South Dakota mercury TMDL development. Report No. CEE 05-11. Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology. Prepared for South Dakota Division of Environment and Natural Resources, Pierre, SD.

This TMDL was placed on public notice during June 2011 in the following newspapers:

Aberdeen American News,
Brookings Register,
Gettysburg Potter C. News,
Huron Plainsmen,
Mitchell Daily Republic,
Pierre Capital Journal,
Rapid City Journal,
Sioux Falls Argus Leader,
Vermillion Plain Talk,
Watertown Public Opinion,
Webster Reporter & Farmer, and
Winner Advocate.

The document was made available on the DENR website and advertised on its home page during the same time period.

7.0 Monitoring Strategy

The Department may adjust the load and/or wasteload allocations in this TMDL to account for new information or circumstances that are developed or come to light during the implementation of the TMDL and a review of the new information or circumstances indicate that such adjustments are appropriate. Adjustment of the load and waste load allocation will only be made following an opportunity for public participation. The Department will propose adjustments only in the event that any adjusted LA or WLA will not result in a change to the loading capacity; the adjusted TMDL, including its WLAs and LAs, will be set at a level necessary to implement the applicable water quality standards; and any adjusted WLA will be supported by a demonstration that load allocations are practicable. The Department will notify EPA of any adjustments to this TMDL within 30 days of their adoption.

The state will continue to review data from the Mercury Deposition Network (MDN, http://nadp.sws.uiuc.edu/MDN/). Stone's (2011) work provided a baseline for mercury atmospheric deposition in the state but additional comprehensive monitoring is not currently scheduled. For surface waters, monitoring for mercury is done by the permittees of those facilities having a reasonable probability of mercury discharges and

the SDDENR periodically reviews their data. The state will also continue its effort to monitor mercury in fish flesh annually and post fish consumption advisories as needed.

8.0 Implementation Plan

Because the atmospheric load allocation for mercury in South Dakota is primarily due to emissions from other states or even other countries, the state supports efforts to control mercury emissions through national or international programs. For mercury sources within the state of South Dakota the SDDENR will continue to use the permit process to control mercury wastes and/or mercury emissions.

It is also possible the state will adopt the USEPA fish consumption advisory level of 0.3 mg/kg for mercury in fish. If or when this happens, even more lakes and impoundments will be listed as impaired due to elevated concentrations of mercury in fish flesh and fish consumption advisories will be posted at these waterbodies as needed.

In addition, the research done by Dr. Stone and his graduate students indicate there is a relationship between mercury in fish tissue and water quality variables associated with lake and impoundment productivity. The SDDENR has a very active non-point source pollution control program that provides financial and technical assistance to local sponsors. These sponsors manage projects that implement various Best Management Practices, which are designed to control nutrient and sediment inputs to these waterbodies and decrease eutrophication. These activities would help in the effort to control mercury in fish tissue and consequently decrease the number of fish consumption advisories in the states lakes and impoundments. There are currently non-point source implementation projects that include some of the listed lakes and these are:

Northeast Glacial Lakes Watershed Improvement and Protection Project (Bitter Lake);
Lewis and Clark Watershed Implementation Project (Roosevelt Lake); and
Central Big Sioux River Watershed Project (Twin Lake, North Island Lake, and the Twin Lake/Highway 81 lake complex).

9.0 Literature Cited

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