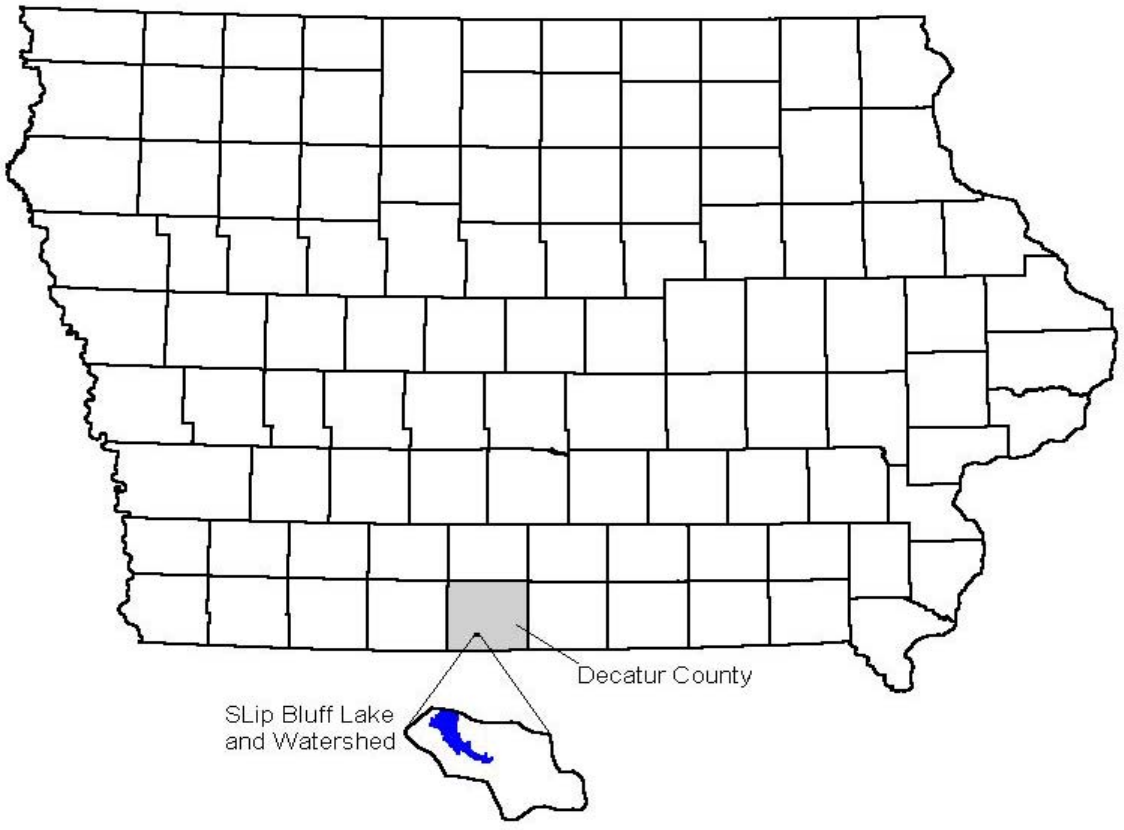
Total Maximum Daily Load
For Siltation
Slip Bluff Lake
Decatur County, Iowa

July 2001

Iowa Department of Natural Resources
Water Resources Section

TMDL for Siltation
Slip Bluff Lake
Decatur County, Iowa

Waterbody Name:	Slip Bluff Lake
IDNR Waterbody ID:	IA 05-THO-00120-L
Hydrologic Unit Code:	HUC11 10280102050
Location:	Sec. 28 T68N R26W
Latitude:	40 Deg. 39 Min. N
Longitude:	93 Deg. 51 Min W
Use Designation Class:	A (primary contact recreation) B(LW) (aquatic life)
Watershed Area:	240 acres
Lake Area:	16 acres
Major River Basin:	Southern Iowa River Basin
Receiving Water Body:	Thompson River
Pollutant:	Siltation
Pollutant Sources:	Gully and Streambank Erosion
Impaired Use:	Aquatic life (habitat)
1998 303(d) Priority:	Medium/Low



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1. Description of Waterbody and Watershed

Slip Bluff Lake was built in 1970 and is located in south central Iowa about 2 miles northwest of Davis City, Iowa. In 1994, the lake had a surface area of 16 acres, a mean depth of 12 feet, a maximum depth of 24 feet, a storage volume of 198 acre-feet, and a shoreline of 1.3 miles.

Slip Bluff Lake is entirely within the approximately 310 acre Slip Bluff Lake County Park, owned and managed by the Decatur County Conservation Board. The lake provides facilities for boating, fishing, camping, picnicking and hiking. Park use is approximately 5,000 visits per year.

The Slip Bluff Lake watershed has an area of approximately 240 acres and has a watershed to lake ratio of 16:1. Approximately 185 acres (including the lake) of the 310 acre park are located within the Slip Bluff Lake watershed. The park consists primarily of timber and some restored prairie areas. The landuse and associated areas for the watershed are shown in Table 1.

Table 1. 2001 Landuse in Slip Bluff Lake watershed.

Landuse	Area in Acres	Percent of Total Area
Slip Bluff Park	168	71
Pasture	33	13
Conservation Reserve	22	8
Timber	16	6
Roads, etc.	1	2
Total	240	100

Topography of the watershed varies from gently sloping to steep (2-25%). Soils of the watershed are primarily forest-derived developed from pre-Wisconsin till or loess and prairie-derived soils from alluvium and include Lindley, Keswick, Armstrong, and Gara soils. These soils are generally composed of 10-60% clay. Permeability of these soils is slow to moderate and runoff is very rapid. These soils typically have low to very low amounts of available phosphorous (UDSA-NRCS, 1990)

Average rainfall in the area is 35 inches/year, with the greatest monthly amount (5.5 inches) occurring in June.

2. Applicable Water Quality Standards

The *Iowa Water Quality Standards* (Iowa, 1996) list the designated uses for Slip Bluff Lake as Primary Contact Recreation (Class A) and Aquatic Life (Class B(LW)). Slip Bluff Lake also has general uses of secondary contact recreation, agricultural uses, domestic uses, and livestock watering.

The State of Iowa does not have numeric water quality criteria for siltation that apply to Slip Bluff Lake. Slip Bluff Lake was included on the list of Iowa impaired waters based on the best professional judgment of DNR field staff regarding the water quality. The 1998 Iowa 305(b) report assessed the Class B(LW) uses of Slip Bluff Lake as “partially supporting” due to siltation primarily from natural sources. Slip Bluff Lake was erroneously listed as impaired by nutrients on the 1998 303(d) list: there does not appear to be an impairment to Slip Bluff Lake due to excess nutrients. The lake does not have problems with algae blooms or algae-related fishkills. Excess sediment is impairing the Class B(LW) designated use by altering the physical and chemical characteristics of the lake so that a balanced community normally associated with

lake-like conditions is not maintained (IAC 567-61.3(1)b(7)). The altering of the physical and chemical characteristics are causing impairments of the following beneficial uses: 1) aquatic habitat; 2) spawning, reproduction and development; and, 3) sport fishing. In addition, siltation reduces food supplies by smothering benthic macroinvertebrates.

3. Water Quality Conditions

Water quality studies have been completed on Slip Bluff Lake by Iowa State University for the Clean Lakes Classification Study (1980, 1990) and the Iowa Lakes Survey (2000-present).

Secchi disk reading is a measurement of the depth of visibility or transparency of a water body. Secchi disk readings in 1979 ranged from 2.2 to 2.8 meters with an average (N=3) of 2.4 meters (Bachmann, 1980). In 1990, a study of Iowa's lakes by Bachmann (Bachmann, et al., 1994) indicated a Secchi depth range of 0.4 to 0.9 meters with a mean (N=3) of 0.7 meters. Secchi disk readings in 2000 ranged from 0.5 to 2.1 meters, with an average (N=3) of 1.2 meters (Downing and Ramstack, 2001).

Table 2. Data collected in 1979 by Iowa State University (Bachmann, et al., 1980).

Date Collected	7/18/79	8/21/79	9/26/79
Secchi (meters)	2.2	2.8	2.3
Total Phosphorus (mg/L)	0.08	0.07	0.05
Total K Nitrogen (mg/L)		0.370	0.440
Chlorophyll-a (ug/L) corr.	4.4	2.5	6.6

Table 3. Data collected in 1990 by Iowa State University (Bachmann, et al., 1994).

Date Collected	6/7/90	7/6/90	8/4/90
Secchi (meters)	0.4	0.7	0.9
Total Phosphorus (mg/L)	0.093	0.071	0.059
Total Nitrogen (mg/L)	1.1	1.4	0.8
Chlorophyll-a (mg/m3)	9.9	7.9	9.9
Suspended Solids* (mg/L)`	45.8	36.3	26.9

*Suspended solids value is the average of three total water column composite samples.

Table 4. Data collected in 2000 by Iowa State University (Downing and Ramstack, 2001).

Date Collected	6/29/00	7/25/00	8/22/00
Secchi (meters)	0.5	1.0	2.1
Total Phosphorus (mg/L)	0.170	0.071	0.069
Total Nitrogen (mg/L)	0.80	0.82	0.45
Chlorophyll-a	3	2	2
Suspended Solids (mg/L)`	19.5	5.9	3.3

Secchi disk depths for lakes in general are expected to be the lowest during July and August due to both sediment and algae growth. The readings at Slip Bluff Lake were taken during those seasons and therefore are likely to represent the most critical seasonal conditions. Over the long term, summer Secchi depths have remained relatively constant for the last 22 years.

4. Desired Endpoint

The listing of Slip Bluff Lake is based on narrative criteria. There are no numeric criteria for siltation applicable to Slip Bluff Lake or its sources in Chapter 61 of the *Iowa Water Quality Standards* (Iowa, 1996). Therefore, an appropriate endpoint needs to be determined. The endpoint needs to include both sediment load to the lake as well as a measurement of the aquatic life within the lake. This TMDL will incorporate an endpoint for sediment delivery to the lake, and an endpoint for the fishery of the lake.

The first endpoint will address the deposition of sediment delivered to the lake. A direct measure of the sediment load is difficult to make, given seasonal variability and actual measurement tools. Acceptable estimates using established soil loss equations can be made to predict the erosion rates in the watershed, and subsequent delivery to the lake. An estimate of the gross erosion and sediment delivery to Slip Bluff Lake based on current watershed conditions was calculated using the Field Office Technical Guide (USDA-NRCS, 1998) and the Revised Universal Soil Loss Equation (RUSLE) (USDA-NRCS, 1998). The Field Office Technical Guide was used to determine erosion form gullies, while RUSLE was used to estimate the sheet and rill erosion from the areas of grass and CRP. The potential gross erosion in the Slip Bluff Lake watershed based on current landuse and practices is estimated at 1,816 tons/year. This yields an estimated sediment delivery to the reservoir of 1,258 tons/year. Supporting calculations are in Tables 5 and 6 in Appendix I.

The first endpoint for this TMDL is to reduce sediment delivery to Slip Bluff Lake by 50%. Reducing the sediment delivery to watershed is expected to result in the protection of aquatic life by eliminating the adverse effects of excessive sediment loading to the lake. This target load reduction is a reasonable initial estimate of needed reductions because it will result in an average rate of deposition in the lake low enough to minimize the impact on aquatic life. This reduction would result in 629 tons/year delivered to Slip Bluff Lake. Therefore, the first endpoint is to reduce the sediment delivery to Slip Bluff Lake to 629 tons/year.

The second endpoint for this TMDL will be achieved when the fishery of Slip Bluff Lake is determined to be fully supporting the Class B aquatic life uses. This determination will be accomplished through an assessment conducted by the DNR Fisheries Bureau by 2003. This assessment will be in accordance with the Statewide Biological Sampling Plan protocol (Larscheid, 2001). This protocol is currently being used to develop benchmarks for the fishery of Iowa's lakes. The results from the Slip Bluff Lake assessment will be compared with the benchmarks being developed. These assessments will include age, growth, size structure, body condition, relative abundance, and species.

Slip Bluff Lake will not be considered restored until the second endpoint is achieved. If the aquatic life endpoint is achieved prior to the sediment delivery endpoint, then the level of land practices may be maintained at a level at or above those in place at the time of the assessment. If however, after a reasonable time following the completion of the sediment delivery practices the aquatic life has not been restored, then further study and practices may be necessary.

5. Loading Capacity

The State of Iowa does not have numeric water quality criteria for siltation that apply to Slip Bluff Lake. Slip Bluff Lake was included on the list of Iowa impaired waters based on the best professional judgment of DNR field staff regarding the water quality. Excess sediment is impairing the Class B(LW) designated use by altering the physical and chemical characteristics of the lake so that a balanced community normally associated with lake-like conditions is not

maintained (IAC 567-61.3(1)b(7)). A general reduction in sediment delivery to the lake is needed to restore the aquatic life uses. The lack of a water quality standard for siltation results in an adequate endpoint needing to be determined. A 50% reduction in sediment delivery should restore the aquatic life uses in Slip Bluff Lake. Therefore, the load capacity established for Slip Bluff Lake is 629 tons/year of sediment delivered to the lake.

6. Pollutant Sources

Water quality in Slip Bluff Lake is influenced only by nonpoint sources. There are no point source discharges in the watershed. Field investigations to determine landuses, conservation practices, livestock operations, and gully erosion were made in June 2000 and spring 2001 by DNR staff and the Decatur County Conservation Board.

Nonpoint source pollution is caused by materials transported to the lake with runoff from the watershed. Gully, streambank, streambed, and shoreline erosion can be a significant contributor to poor water quality and lake degradation. Although all land within a watershed contributes runoff containing sediment, the main source of this pollutant in the Slip Bluff Lake watershed is naturally occurring gully and streambank erosion within the forested areas of the watershed. Almost all soil eroded by these methods ends up as siltation within the lake.

Shoreline erosion is also present at Slip Bluff Lake. Rip-rap along the shoreline is minimal, as is established vegetation. The exposed shoreline allows continuing erosion and resuspension of sediment by wind and wave action.

It is clear from observations made that the most significant sediment delivery problem in the Slip Bluff Lake watershed is from gully erosion. There are currently no structures or practices in place within the timbered areas of the watershed to reduce sediment delivery from gully erosion.

7. Pollutant Allocation

7.1 Point Sources

There are no point source discharges within the Slip Bluff Lake watershed. Therefore, the Wasteload Allocation established under this TMDL is zero.

7.2 Non-Point Sources

The watershed of Slip Bluff Lake is comprised entirely of timber or grassland (prairie, pasture, CRP). There is no land used for row crops in the Slip Bluff Lake watershed. Nonpoint source gully and streambank erosion accounts for almost all sediment entering the lake and the resulting siltation of the lake.

Soil loss estimates for gully and streambank erosion were determined by using the Field Office Technical Guide (USDA-NRCS, 1998), and estimates for sheet and rill erosion were determined using RUSLE. The estimated soil loss from the Slip Bluff Lake watershed due to gully erosion is 1,764 tons/year. The estimated sheet and rill erosion from the watershed is 52 tons/year. These soil loss estimates result in sediment delivery of 1,235 tons/year due to gully erosion, and 23 tons/year for sheet and rill erosion. The total sediment delivery to Slip Bluff Lake is estimated at 1,258 tons/year. See Appendix I for supporting calculations.

The current sediment delivery to Slip Bluff Lake is estimated to be 1,258 tons/year. The Load Capacity established to support the endpoint of this TMDL, is 629 tons/year of sediment delivered to Slip Bluff Lake.

7.3 Load Allocation and Margin of Safety

The margin of safety for this TMDL is implicit. The dual endpoints for this TMDL assures that that the aquatic life uses will be restored regardless of the accuracy of the sediment delivery endpoint. Failure to achieve water quality standards will result in review of the TMDL, allocations, and/or sediment management approaches and probable revision. In addition, calculations were made using conservative estimates. RUSLE uses conservative calculations to calculate the gross erosion. A delivery rate of 70% was used for gullies, while the accepted range is 60-80% (USDA-NRCS, 1998). A trap efficiency of 80% was used in the calculations to determine sediment delivery reductions from sediment basins. The trap efficiency is typically 80-95% for these types of structures (USDA-NRCS, 1998). These conservative estimates provide an additional implicit margin of safety.

8. Seasonal Variation

This TMDL accounts for seasonal variation by recognizing that (1) sediment loading varies substantially by season and between years, and (2) sediment impacts are felt over multi-year timeframes. Sediment loading and transport are predictable only over long timeframes. Moreover, in contrast to pollutants which cause short-term beneficial use impacts and are thus sensitive to seasonal variation and critical conditions, the sediment impacts in this watershed occur over much longer time scales. For these reasons, the longer time frames (tons per year) used in this TMDL is appropriate.

It is expected that the majority of all erosion occurring in the Slip Bluff Lake watershed occurs in the spring and early summer during periods of higher rainfall.

9. Implementation

The Iowa Department of Natural Resources recognizes that an implementation plan is not a required component of a Total Maximum Daily Load. However, the IDNR offers the following implementation strategy as a guide to improve water quality at Slip Bluff Lake.

This TMDL is being designed as a Phased TMDL. In Phase One, the amount of sediment delivered to the lake will be reduced so that the TMDL is met. The fishery of the lake will be reassessed during Phase Two to determine if aquatic life (Class B(LW)) impairments continue to exist.

Phase One of the TMDL will be accomplished by constructing sediment basins and placing rip-rap along the shoreline of Slip Bluff Lake. Eleven sediment control structures are proposed for the Slip Bluff Lake watershed. It is expected that Phase One will be completed by December 2002.

The Decatur County Soil and Water Conservation District and Decatur County Conservation Board have received grant funds from the Iowa Department of Land Stewardship, Division of Soil Conservation, Water Protection Funds and EPA Section 319 grant funds. The Water Protection Funds will be used to construct two large structures in the watershed to stop sediment delivery to the lake. In addition, EPA 319 grant funds will be used to construct nine other structures in the watershed to reduce sediment delivery form other portions of the watershed. Section 319 grants are subject to the provisions of the Endangered Species Act. Any projects within the watershed will consider any endangered species.

When these structures are completed it is estimated the sediment delivery will be reduced to 562 tons/year. Delivery rates of 70% for gullies and 45% for sheet and rill were used to

calculate delivery rates (USDA-NRCS, 1998). A trap efficiency of 80% was used for the sediment control structures (USDA-NRCS, 1998). See Tables 7 and 8 in Appendix I for supporting calculations.

There is some shoreline erosion at Slip Bluff Lake. The Decatur County Soil and Water Conservation District and Decatur County Conservation Board have received grant funds from the Iowa Department of Land Stewardship, Division of Soil Conservation, Water Protection Funds to address at least some of this erosion. Rip-rap will be placed along the shore and attempts made to establish shoreline vegetation. The Decatur County Conservation Board is working with the Iowa Department of Transportation to place rip-rap below the newly constructed visitor center.

Phase Two of the TMDL will monitor the lake water quality and assess the fishery of the lake. The Fisheries Bureau of the Iowa Department of Natural Resources will survey the fishery at Slip Bluff Lake by December 2003 to assess the Class B uses. Bathymetric mapping of Slip Bluff Lake will be completed by December 2002. This mapping will show the original lake bottom and the depth of sediment that has been deposited in the lake. Slip Bluff Lake is part of the Iowa Lakes Survey, which conducts in lake water quality sampling three times per year for each of the field seasons 2000 – 2004.

10. Public Participation

A public meeting was held regarding the Slip Bluff Lake TMDL in Des Moines and Lamoni on January 17 and January 22, 2001, respectively. A public meeting to discuss the final draft TMDL was held in Lamoni on June 13, 2001. Any comments received will be reviewed and given consideration and, where appropriate, incorporated into the TMDL.

11. Literature Cited

Bachmann, R.W., T.A. Hoyman, L.K. Hatch, and B.P. Hutchins. 1994. A classification of Iowa's lakes for restoration. Department of Animal Ecology, Iowa State University, Ames, Iowa. 517 p.

Bachmann, R.W., M.R. Johnson, M.V. Moore, and T.A. Noonan. 1980. Clean lakes classification study of Iowa's lakes for restoration. Iowa Cooperative Fisheries Research Unit and Department of Animal Ecology, Iowa State University, Ames, Iowa. 715 p.

Downing, John A., and Joy M. Ramstack. 2001. Iowa Lakes Survey – Summer 2000 Data. Iowa Sate University, Department of Animal Ecology. January 2001.

Iowa. 1996. *Iowa Administrative Code 567, Chapter 61, Iowa Water Quality Standards.*

Larscheid, Joe. Statewide Biological Sampling Plan, July 2001.

Parsons, Jerry. Soil Conservation Technician, Natural Resource Conservation Service, Decatur County. Personal Communication, May 2000.

USDA-NRCS. 1998. Field Office Technical Guide Notice No. IA-198. “Erosion and Sediment Delivery Procedure”, Section I, Erosion Protection.

USDA-NRCS. 1990. United States Department of Agriculture, Soil Conservation Service. March 1990. Soil Survey of Decatur County, Iowa.

12. Appendix I

Current Gross Erosion from the Slip Bluff Lake Watershed

Gully Erosion (for gully sloughing) (USDA-NRCS, 1998)

$$\frac{\text{2 sides x depth x length x average annual rate of sloughing x soil unit weight}}{\text{2000 lbs/ton}} = \text{tons/year}$$

$$\frac{\text{2 sides x 5' depth x 8300' length x .5' annual rate x 85 lbs/ft}^3}{\text{2000 lbs/ton}} = 1{,}764 \text{ tons/year}$$

Sheet and Rill Erosion (determined using RUSLE (USDA-NRCS, 1998))

Rainfall x Soil Erodability x Length-Slope x Conservation Practice x Practice Factor = Soil Loss

Pasture
180 x .28 x 1.97 x 1.0 x .038 = 3.7 tons/acre/year x 8 acres = 30 tons/year

Grass and CRP
180 x .28 x 2.15 x 1.0 x .004 = 0.4 tons/acre/year x 55 acres = 22 tons/year

Table 5. Current Sediment Delivery from the Slip Bluff Lake Watershed

Sediment Delivery = (Gross Erosion x Sediment Delivery Ratio)

Gully Erosion	1,764 tons/year x 70%	=	1,235 tons/year delivered
Sheet and Rill Erosion	52 tons/year x 45%	=	23 tons/year delivered
Current Sediment Delivery			1,258 tons/year

Gross Erosion after structures are implemented

Gully Erosion (gross erosion)

Gullies protected by structures

$$\frac{\text{2 sides x 5' depth x 5700' length x .5' annual rate x 85 lbs/ft}^3}{\text{2000 lbs/ton}} = 1{,}211 \text{ tons/year}$$

Gullies not protected

$$\frac{\text{2 sides x 5' depth x 2600' length x .5' annual rate x 85 lbs/ft}^3}{\text{2000 lbs/ton}} = 553 \text{ tons/year}$$

Sheet and Rill Erosion (gross erosion)

Pasture, Grass and CRP = 52 tons/year

Table 6. Sediment Delivery after structures are implemented

Sediment Delivery (Gross Erosion x Sediment Delivery Ratio x Trap Efficiency)

Gullies protected	1,211 tons/year x 70% x 20% (80% trap efficiency)	= 170 tons/year
Gullies not protected	553 tons/year x 70%	= 387 tons/year
Sheet and Rill	52 tons/year x 45% x 20% (80% trap efficiency)	= 5 tons/year
Total Sediment Delivery after structures		562 tons/year

RUSLE calculations and Gully Erosion estimates were obtained from the local NRCS office in Leon, IA.

The Sediment Delivery Ratio (SDR) was obtained from the Erosion and Sediment Delivery Worksheet (USDA-NRCS, 1998). The SDR for gullies is based on the type of drainage and channel characteristics, and for sheet and rill is based on the drainage area of the watershed, watershed shape, topography, channel density, channel characteristics, and type of drainage.

Location of proposed structures in the Slip Bluff Lake watershed.