SMOKY HILL/SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Lake Scott State Park
Water Quality Impairment: Eutrophication bundled with pH and Aquatic Plants

Subbasin: Ladder

County: Greeley, Logan, Scott, Wallace, and Wichita

HUC 8: 10260004

HUC 11 (HUC 14)**:** **010** (040, 050, 060, 070, 080)
020 (030, 040, 050, 060, 070, 080, 090)
050 (010, 020, 030, 040, 050, 060, 070, 080)

Ecoregion: Western High Plains, Flat to Rolling Cropland (25d)
Central Great Plains, Rolling Plains and Breaks (27b)

Drainage Area: Approximately 710 square miles

Conservation Pool: Area = 72.9 acres
Watershed Area: Lake Surface Area = 6,231:1
Maximum Depth = 4.5 meters (15 feet)
Mean Depth = 1.9 meters (6.2 feet)
Retention Time = 0.09 year (1 month)

Designated Uses: Primary and Secondary Contact Recreation, Special Aquatic Life Support, Food Procurement

Authority: State (Kansas Department of Wildlife and Parks)

2002 303(d) Listing: Smoky Hill/Saline River Basin Lakes

Impaired Use: All uses are impaired to a degree by eutrophication

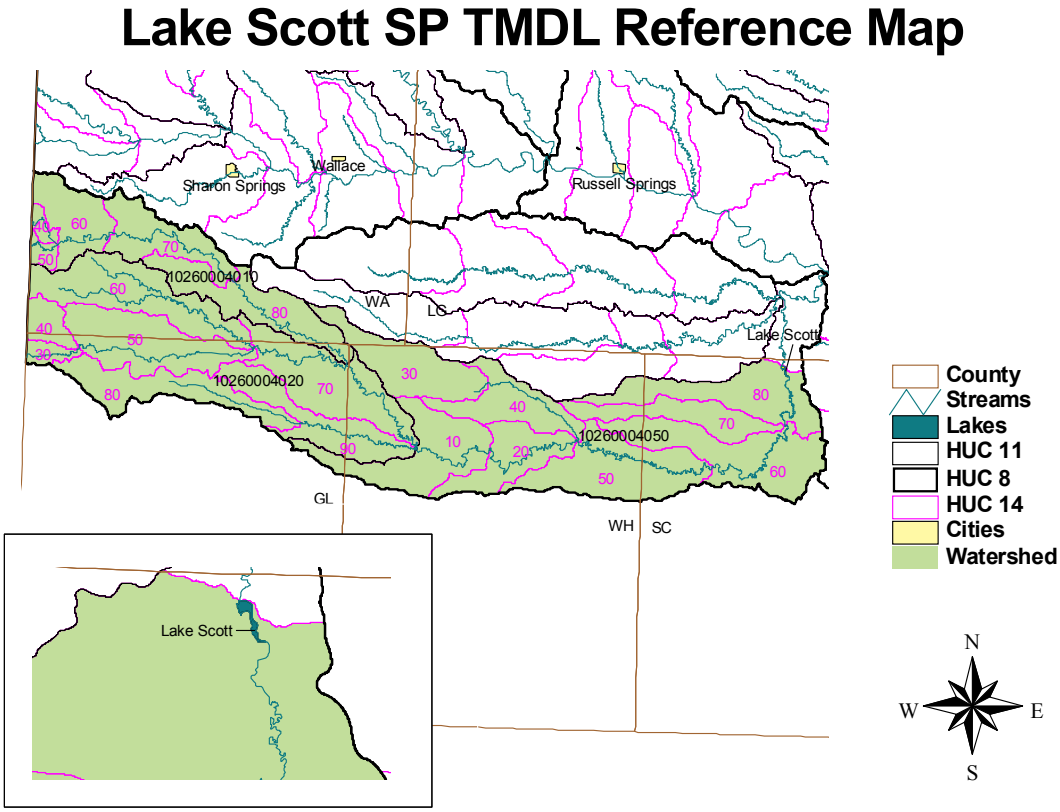
Water Quality Standard: Nutrients - Narrative: The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement of aquatic biota or the production of undesirable quantities or kinds of aquatic life. (KAR 28-16-28e(c)(2)(B)).

The introduction of plant nutrients into surface waters designated for primary or secondary contact recreational use shall be controlled to prevent the development of objectionable concentrations of algae or

algal by-products or nuisance growths of submersed, floating, or emergent aquatic vegetation. (KAR 28-16-28e(c)(7)(A)).

Artificial sources of pollution shall not cause the pH of any surface water outside of a zone of initial dilution to be below 6.5 and above 8.5 (KAR 28-16-28e(c)(2)(C))

Figure 1



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Eutrophication: Hypereutrophic, Trophic State Index = 80.56

Monitoring Sites: Station 011201 in Lake Scott (Figure 1).

Period of Record Used: Four surveys during 1989 - 2002.

Current Condition: The water in Lake Scott comes primarily from spring flow and secondarily from precipitation and flow from Ladder Creek. Variations in nutrient and chlorophyll a concentrations are most likely due to fluctuations in water level.

Over the period of record, Lake Scott had chlorophyll a concentrations averaging 163.3 μg/L, a Total Phosphorus concentration of 332 μg/L, a Total Kjeldahl Nitrogen concentration of 2.79 mg/L, a nitrate concentration of 0.04 mg/L, and nitrite concentrations below the detection limit (Appendix A). The Secchi disc depth averaged 0.57 meter. Light was indicated to be the primary limiting factor due to zooplankton grazing (Appendix B). Nitrogen may be a secondary limiting factor. The chlorophyll a to total phosphorus yield was high.

The Trophic State Index is derived from the chlorophyll a concentration. Trophic state assessments of potential algal productivity were made based on chlorophyll a concentrations, nutrient levels and values of the Carlson Trophic State Index (TSI). Generally, some degree of eutrophic conditions is seen with chlorophyll a concentrations over 7 μg/l and hypereutrophy occurs at levels over 30 μg/l. The Carlson TSI, derives from the chlorophyll concentrations and scales the trophic state as follows:

1. Oligotrophic TSI < 40
2. Mesotrophic TSI: 40 - 49.99
3. Slightly Eutrophic TSI: 50 - 54.99
4. Fully Eutrophic TSI: 55 - 59.99
5. Very Eutrophic TSI: 60 - 63.99
6. Hypereutrophic TSI: $\geq$ 64

The pH levels have exceeded the criteria 100% of the time and average 8.8. High pH problems relate directly to the high trophic state and large macrophyte community.

According to the 1995, 1999, and 2002 surveys, 84% of Lake Scott is covered with aquatic plants. Nuisance growth of aquatic plants (for recreation use) is defined as greater than 70% cover. The macrophyte community (submersed and floating-leaved aquatic plants) consists of the following during the three surveys:

Aquatic Plant Survey Results

Survey Year	% Total Cover	% Species Cover*	Scientific Name	Common Name
1995	87%	87%	*Myriophyllum spicatum*	Parrot Feather
		87%	*Ceratophyllum demersum*	Coontail
1999	80%	80%	*Myriophyllum sp.*	Parrot Feather
		7%	*Potamogeton crispus*	Pondweed
2002	85%	85%	*Myriophyllum spicatum*	Parrot Feather

*Due to the overlap in species cover, the percent of community composition does not equal 100%.

Interim Endpoints of Water Quality (Implied Load Capacity) at Lake Scott over 2008 - 2012:
In order to improve the trophic condition of the lake from its current Hypereutrophic status, the desired endpoint will be to maintain summer chlorophyll a concentrations below 12 μg/L. Achievement of this endpoint should also result in pH levels between 6.5 and 8.5 and reduction in the abundance of aquatic plants.

Total Nitrogen concentration in the lake should be maintained below 0.62 mg/L. A regression of 2000 - 2001 lake data and 1997 - 2000 wetland data was used to determine the current, in-lake nitrogen concentration and to calculate how much of a nutrient reduction was need to meet water quality standards.

Current Condition and Reductions for Lake Scott

Parameter	Current Condition	TMDL	Percent Reduction
Total Phosphorus Load (lb/year)	56,908	5,989	89 %
Total Phosphorus Concentration (μg/L)	332	31	91 %
Chlorophyll a (μg/L)	163	< 12	93 %
Total Nitrogen Concentration (mg/L)	2.83	< 0.62	78 %
pH	8.8	> 6.5, < 8.5	3 %
Aquatic Plants (%)	84	< 70	17 %

3. SOURCE INVENTORY AND ASSESSMENT

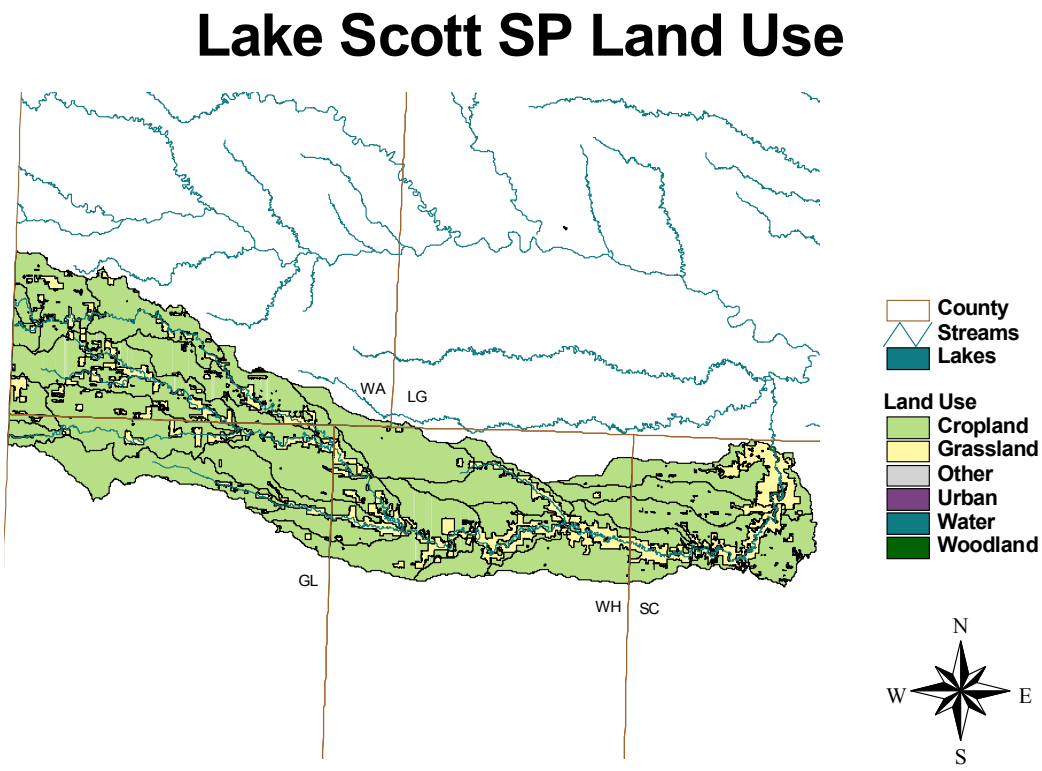
Land Use: The watershed around Lake Scott has a high potential for nonpoint source pollutants. An annual phosphorus load of 56,908 pounds per year is necessary to correspond to the concentrations seen in the lake.

One source of phosphorus and nitrogen within Lake Scott is probably runoff from agricultural lands where phosphorus and nitrogen have been applied. Land use coverage analysis indicates that 83.7% of the watershed is cropland (Figure 2).

Phosphorus and nitrogen from animal waste are a potential contributing factor. Animal waste, from livestock waste management systems, may add to the phosphorus and nitrogen loads going into the lake (Figure 3). However, given the controls for the systems, animal waste coming from grazing areas is a more likely contributor. Sixteen percent of land around the lake is grassland. There are 25 beef, 2 swine, and 2 dairy animal feeding operations in the watershed. Nineteen of these facilities are NPDES permitted, non-discharging facilities with 298,840 animal units. All permitted livestock

facilities have waste management systems designed to minimize runoff entering their operations or detaining runoff emanating from their areas. Such systems are designed to retain the 25 year, 24 hour rainfall/runoff event, as well as an anticipated two weeks of normal wastewater from their operations. Such a rainfall event typically coincides with stream flows which are exceeded 1-5 percent of the time. Therefore, events of this type, infrequent and of short duration, are not likely to add to chronic impairment of the designated uses of the waters in this watershed. Requirements for maintaining the water level of the waste lagoons a certain distance below the lagoon berms ensure retention of the runoff from the intense, local storms events. In Scott County, where many of the facilities are relatively close to the river, such an event would generate 4.5 inches of rain, yielding 3.4 to 4.2 inches of runoff in a day. Permit compliance data was examined, and no evidence of spills was detected. Potential animal units for all facilities in the watershed total 303,900 (active: 295,260 animal units; inactive: 8,640 animal units). The actual number of animal units on site is variable, but typically less than potential numbers.

Figure 2

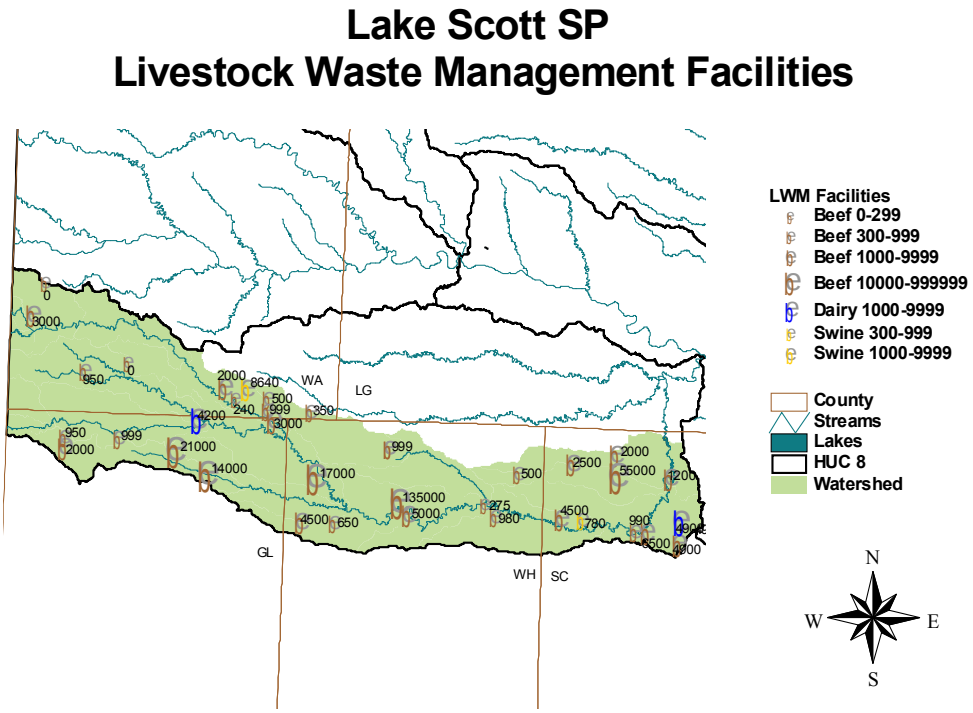


Permitted Livestock Waste Management Systems in the Lake Scott Watershed

Permit Number	Livestock Waste Management Facility	Wasteload Allocation
A-SHWA-C005	Purvis Feedlot	0 lbs/day
A-SHGL-C002	Young Cattle Company #1	0 lbs/day
A-SHSC-C008	Wiechman Feedyard, LP	0 lbs/day
A-SHSC-C006	Owen Unruh Cattle Co Inc	0 lbs/day
A-SHSC-C007	Decker Brothers Livestock	0 lbs/day
A-SHGL-C001	Ox Town Cattle Feeders, LLC	0 lbs/day
A-SHWH-C003	* Caprock Industries III	0 lbs/day
A-SHSC-C011	Cutler Cattle Company	0 lbs/day
A-SHWH-C007	CSA Cattle Co.	0 lbs/day
A-SHSC-D001	West Plains Dairy	0 lbs/day
A-SHSC-C010	Nightengale Cattle Co.	0 lbs/day
A-SHGL-D001	Ladder Creek Dairy	0 lbs/day
A-SHGL-C004	Young Cattle Company #3	0 lbs/day
300	Maple Creek Farms, Llc - Coolidge Site	0 lbs/day
A-SHWA-C002	Howard C. Wilson Trust	0 lbs/day
A-SHWH-C006	Wedel Feedlot	0 lbs/day
A-SHSC-C005	Royal Beef, Division Of Irsik & Doll	0 lbs/day
A-SHSC-C009	Griffith Ranch	0 lbs/day
A-SHWH-C004	Kan Sun Beef, Inc.	0 lbs/day

* The facility is not in compliance with the existing permit. Corrective actions are being taken by the KDHE Livestock Management Program.

Figure 3



No towns and thus no municipal wastewater treatment plants are located within the Lake Scott watershed. The average population density in the watershed is 1.1 people per square mile. A 19.1% decline in population is anticipated in the county outside of Scott City. A potential source is septic systems located around the lake. Failing septic systems can be a significant source of nutrients. The Scott County has 606 septic systems, accounting for 26% of the sewage systems present in the county.

Contributing Runoff: The watershed's average soil permeability is 1.4 inches/hour according to NRCS STATSGO database. About 92.0% of the watershed produces runoff even under relatively low (1.5''/hr) potential runoff conditions. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.5"/hr of rain will generate runoff from 5.9% of this watershed, chiefly along the stream channels.

Background Levels: Lake Scott is a shallow lake with a mean depth of 1.9 meters. Therefore, recycling contributes to the high nutrient concentrations within the lake. The atmospheric phosphorus and geological formations (i.e., soil and bedrock) may contribute to phosphorus loads. Nutrients from wildlife waste are another contributing factor.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

While light is the limiting factor in Lake Scott, Total Phosphorus is allocated under this TMDL, because a phosphorus reduction will have a large effect on the managing the algal community. The Load Capacity is 5,989 pounds per year of phosphorus and was calculated using the CNET model. More detailed assessment of sources and confirmation of the trophic state of the lake must be completed before detailed allocations can be made. The general inventory of sources within the drainage does provide some guidance as to areas of load reduction. Because of atmospheric deposition, initial allocations of nitrogen will be based on a proportional decrease in nitrogen between the current condition and the desired endpoint.

Point Sources: A current Wasteload Allocation of zero is established by this TMDL because of the lack of point sources in the watershed. Should future point sources be proposed in the watershed and discharge into the impaired segments, the current wasteload allocation will be revised by adjusting current load allocations to account for the presence and impact of these new point source dischargers. As previously noted in the inventory and assessment section, sources such as non-discharging permitted livestock waste management systems located within the watershed do not discharge with sufficient frequency or duration to add to an impairment in the lake.

Nonpoint Sources: Water quality violations are partially due to nonpoint source pollutants. Background levels may be attributed to wildlife waste, atmospheric deposition, and geological sources. The assessment suggests that cropland and animal waste contribute to the elevated total phosphorus concentrations in the lake. Generally a Load Allocation of 5,390 pounds of total

phosphorus per year, leading to an 89% reduction, is necessary to reach the endpoint. A proportional decrease of 70% in nitrogen loading will allow the total nitrogen endpoint to be achieved.

Defined Margin of Safety: The margin of safety provides some hedge against the uncertainty of variable annual total phosphorus load and the chlorophyll a endpoint. Therefore, the margin of safety will be 599 pounds per year of total phosphorus taken from the load capacity subtracted to compensate for the lack of knowledge about the relationship between the allocated loadings and the resulting water quality. For nitrogen, the margin of safety will be an additional 8% reduction in nitrogen to ensure that the endpoint is reached.

State Water Plan Implementation Priority: Because Lake Scott is a state managed fishing lake and an important regional recreation facility, this TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: Lake Scott lies within the Ladder (HUC 8: 10260004) with a priority ranking of 65 (Low Priority for restoration).

Priority HUC 11s: Lake Scott is located in HUC 11 (10260004 050). Since the majority of runoff will come off of land adjacent to the lake, this HUC should take priority.

5. IMPLEMENTATION

Desired Implementation Activities

There is potential that agricultural best management practices will improve the water quality in Lake Scott. Some of the recommended agricultural practices are as follows:

1. Implement soil sampling to recommend appropriate fertilizer applications on cropland.
2. Maintain conservation tillage and contour farming to minimize cropland erosion.
3. Install grass buffer strips along streams.
4. Reduce activities within riparian areas.
5. Implement nutrient management plans to manage manure application to land.

Implementation Programs Guidance

Fisheries Management - KDWP

a. Assist evaluation in-lake or near-lake potential sources of nutrients to lake.

b. Advise county on applicable lake management techniques which may reduce nutrient loading and cycling in lake.

c. Evaluate alternative ways to remove nutrient accumulation in Lake Scott

Nonpoint Source Pollution Technical Assistance - KDHE

a. Support Section 319 demonstration projects for reduction of sediment runoff from agricultural activities as well as nutrient management

b. Provide technical assistance on practices geared to establishment of vegetative buffer strips.

c. Provide technical assistance on nutrient management in vicinity of streams.

d. Update and implement nutrient and sediment abatement strategies.

e. Develop a Watershed Restoration and Protection Strategy for HUC 10260004.

Livestock Waste Management - KDHE

a. Take corrective actions to ensure that facilities comply with existing permits.

Water Resource Cost Share Nonpoint Source Pollution Control Program - SCC

a. Apply conservation farming practices, including terraces and waterways, sediment control basins, and constructed wetlands.

b. Provide sediment control practices to minimize erosion and sediment and nutrient transport.

Riparian Protection Program - SCC

a. Establish or reestablish natural riparian systems, including vegetative filter strips and streambank vegetation.

b. Develop riparian restoration projects.

c. Promote wetland construction to assimilate nutrient loadings.

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams.

b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

a. Continue to educate residents and landowners about nonpoint source pollution.

b. Educate agricultural producers on sediment, nutrient, and pasture management.

c. Educate livestock producers on livestock waste management and manure applications and nutrient management planning.

d. Provide technical assistance on livestock waste management systems and nutrient management plans.

e. Provide technical assistance on buffer strip design and minimizing cropland runoff.

f. Encourage annual soil testing to determine capacity of field to hold phosphorus.

Time Frame for Implementation: Pollutant reduction practices should be installed within the priority subwatersheds during the years 2003-2008, with minor followup implementation, including other subwatersheds over 2008-2012.

Targeted Participants: Primary participants for implementation will be agricultural producers within the drainage of the lake. Initial work in 2003 should include local assessments by conservation district personnel and county extension agents to locate within the lake drainage:

1. Total row crop acreage
2. Cultivation alongside lake
3. Drainage alongside or through animal feeding lots
4. Livestock use of riparian areas
5. Fields with manure applications

Milestone for 2008: The year 2008 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from Lake Scott should indicate evidence of reduced phosphorus and nitrogen levels in the conservation pool elevations relative to the conditions seen in 2000.

Delivery Agents: The primary delivery agents for program participation will be the Kansas Department of Wildlife and Parks. Producer outreach and awareness will be delivered by Kansas State Extension.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollutants.

1. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

2. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

3. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.

4. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

5. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan.*

6. The *Kansas Water Plan* and the Smoky Hill/Saline Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a High Priority consideration.

Effectiveness: Nutrient control has been proven effective through conservation tillage, contour farming and use of grass waterways and buffer strips. The key to success will be widespread utilization of conservation farming and installation of buffer strips within the watersheds cited in this TMDL.

6. MONITORING

Additional data, to further determine source loading and mean summer lake trophic condition, would be of value prior to 2008. Further sampling and evaluation should occur once before 2008 and once between 2008 and 2012.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Smoky Hill/Saline Basin were held January 7 and March 5, 2003 in Hays. An active Internet Web site was established at http://www.kdhe.state.ks.us/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Smoky Hill/Saline Basin.

Public Hearing: A Public Hearing on the TMDLs of the Smoky Hill/Saline Basin was held in Hays on June 2, 2003.

Basin Advisory Committee: The Smoky Hill/Saline Basin Advisory Committee met to discuss the TMDLs in the basin on October 3, 2002, January 7, March 5, and June 2, 2003.

Milestone Evaluation: In 2008, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of Lake Scott. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

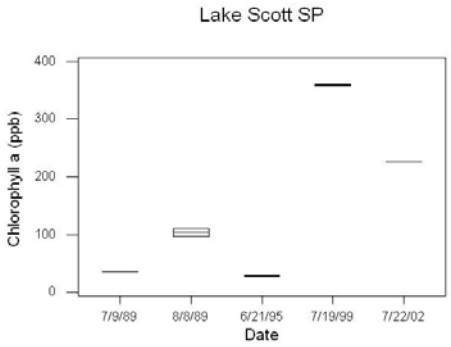
Consideration for 303(d) Delisting: The lake will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2008-2012. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

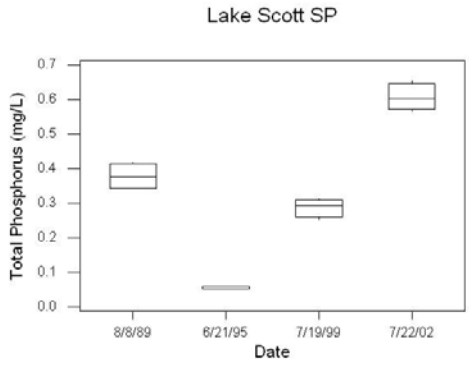
Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2004 which will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2004-2008.

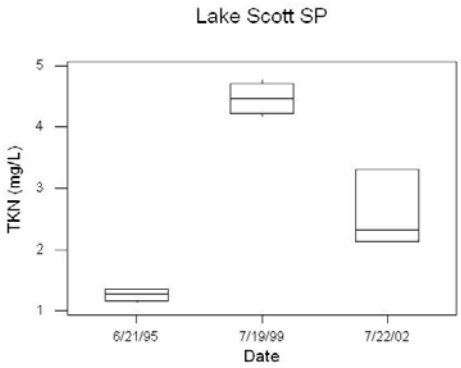
Bibliography

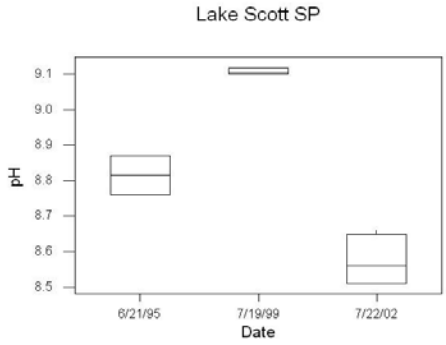
Liscek, Bonnie C. Methodology Used in Kansas Lake TMDLs [web page] Jul. 2001; http://www.kdhe.state.ks.us/tmdl/eutro.htm [Accessed 30 September 2002].

Appendix A - Boxplots

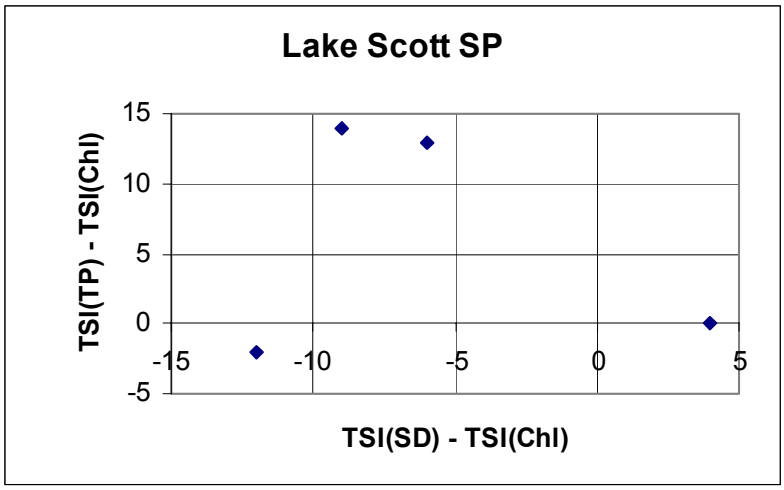


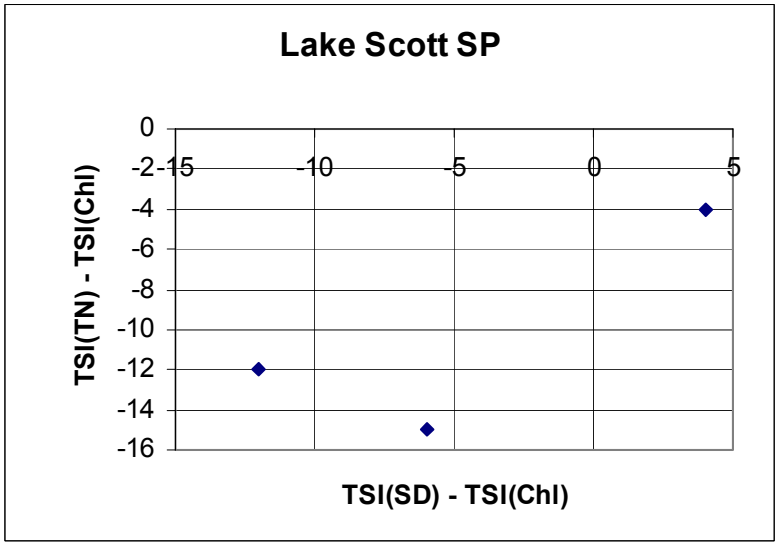






Appendix B - Trophic State Index Plots





The Trophic State Index plots indicate that zooplankton grazing is the primary limiting factor. This is inferred by examining the relationship between the TSI(SD) - TSI(Chl) and TSI(TP)-TSI(Chl) or TSI(TN)-TSI(Chl). The deviation of chlorophyll from the sediment load indicates the degree of light penetration, while the difference between chlorophyll and phosphorus, or chlorophyll and nitrogen indicates the level of phosphorus or nitrogen limitation. Therefore, if the final plot is in the fourth quadrant, it shows that the transparency of the water is impaired due to the presence of large particles, such as blue-green algae, and that phosphorus does not limit algae growth. The relationship between the TSI(SD) - TSI(Chl) and TSI(TN)-TSI(Chl) indicates that nitrogen may be a secondary limiting factor.

Appendix C - Input for CNET Model

Parameter	Value Input into CNET Model
Drainage Area (km^2)	1838.9
Precipitation (m/yr)	0.46
Evaporation (m/yr)	1.66
Unit Runoff (m/yr)	0.01
Surface Area (km^2)	0.295
Mean Depth (m)	1.9
Depth of Mixed Layer (m)	1.9
Depth of Hypolimnion (m)	1.8
Observed Phosphorus (ppb)	332
Observed Chlorophyl-a (ppb)	163
Observed Secchi Disc Depth (m)	0.57

Output from CNET Model

Parameter	Output from CNET Model
Load Capacity (LC)*	**5,989 lb/yr**
Waste Load Allocation (WLA)	**0 lb/yr**
Load Allocation (LA)	**5390 lb/yr**
Margin of Safety (MOS)	**599 lb/yr**

***LC = WLA + LA + MOS**

Approved Aug. 7, 2003