CIMARRON RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Lake Meade State Park
Water Quality Impairment: Eutrophication Bundled with Dissolved Oxygen, pH, and Aquatic Plants

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Crooked

Counties: Meade & Seward

HUC 8: 11040007

HUC 11 (HUC 14)**: 050** (010 & 020)

Drainage Area: Approximately 91.3 square miles
(Primary contributing area = 15.9 square miles)

Conservation Pool: Area = 75 acres, Maximum Depth = 3.5 meters

Designated Uses: Primary & Secondary Contact Recreation; Special Aquatic Life Support; Food Procurement; Groundwater Recharge

1998 303d Listing: Table 4 - Water Quality Limited 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)).

pH less than 6.5 and greater than 8.5 (KAR 28-16-28e(c)(2)(C))

Dissolved Oxygen: 5 mg/L (KAR 28-16-28e(c)(2)(A))

Lake Meade TMDL Reference Map

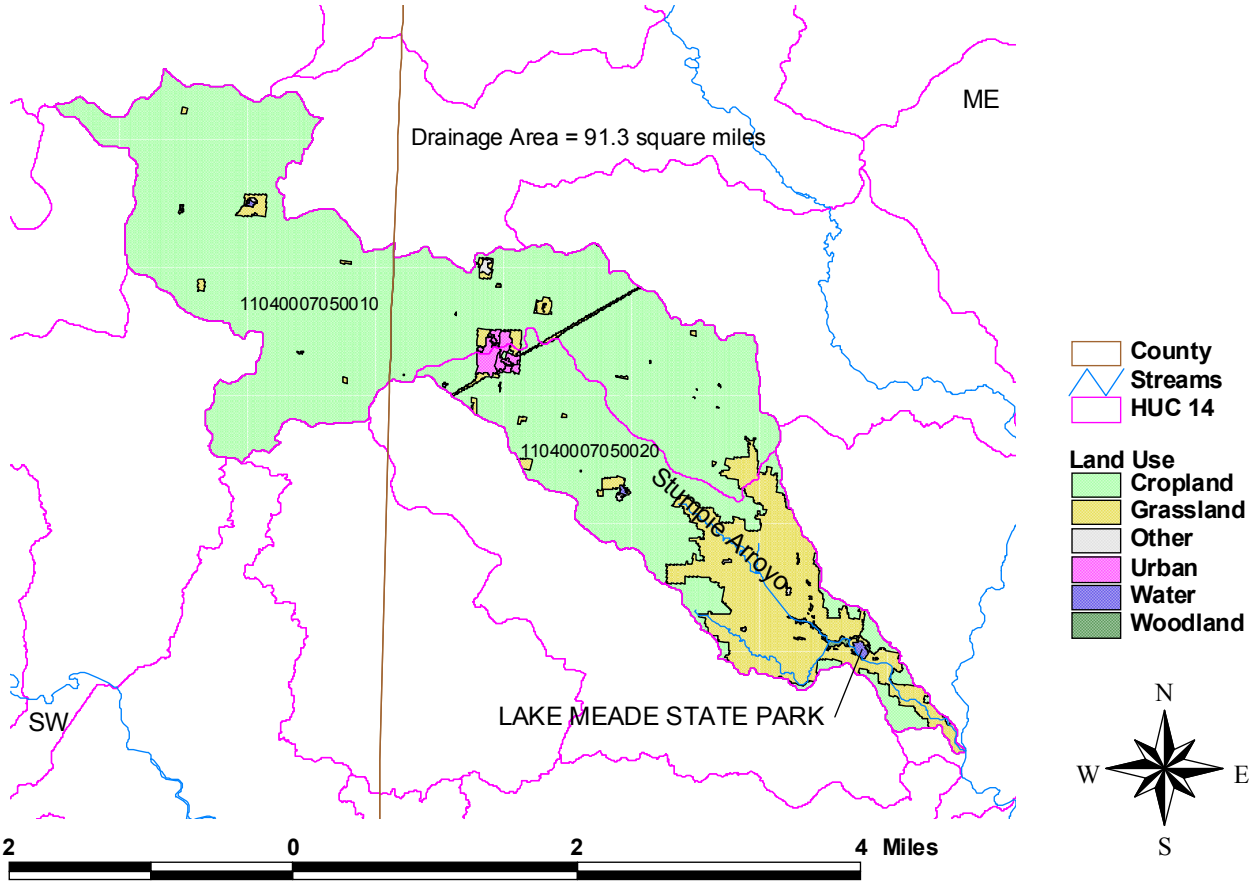

Figure 1

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Eutrophication: Hypereutrophic, Trophic State Index = 64.8

Monitoring Sites: Station 010601 in Lake Meade State Park.

Period of Record Used: Five surveys during 1975-1999. Special study during 1989.

Current Condition: Lake Meade consistently has elevated chlorophyll a concentrations; the average concentration is 32.7 ppb, related to a Trophic State Index of 64.8, indicating hypereutrophic conditions. The best conditions were seen in 1995 when chlorophyll a levels were 16.7 ppb with a TSI of 58.2 (eutrophic conditions). Prior to this, in 1989, the chlorophyll a concentrations averaged 42.1 ppb in June and 23.2 ppb in September. In the most recent survey, chlorophyll a concentrations were elevated with an average concentration of 49.0 ppb.

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 12 ug/l and hypereutrophy occurs at levels over 30 ug/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: ≥ 64

Total phosphorus data are varied, but tend to be elevated in the lake, averaging 82.5 ppb. Thirty-eight percent of the samples taken from the lake were over 100 ppb. Phosphorus appears to be of primary importance, but nitrogen may play a secondary role. Levels of nitrate were below the detectable limit in 1989. However, the average concentration of nitrates was 63.3 ppb in 1995 and 1999. The amount of ammonia in the lake has consistently been below the detectable limit. Light plays no limiting role, but macrophytes may exert an influence on algal growth in the water column. The chlorophyll a to total phosphorus yield is high.

Station	Date	Depth (ft)	Dissolved Oxygen (mg/L)	pH (at 0 ft)
Lake Meade				
010601	22-May-78	0	7.800	8.500
010601	22-May-78	3	8.000	8.500
010601	22-May-78	6	8.200	8.500
010601	22-May-78	9	8.500	8.600
010601	22-May-78	13	8.000	8.500
010601	21-Jun-89	0	7.500	8.650
010601	21-Jun-89	1.64	7.200	8.450
010601	21-Jun-89	3.28	6.600	
010601	21-Jun-89	6.56	6.400	
010601	21-Jun-89	9.84	5.800	
010601	21-Jun-89	13.12	3.800	
010601	11-Jul-95	0	7.000	8.410
010601	11-Jul-95	1.64	7.000	8.520
010601	11-Jul-95	3.28	7.000	
010601	11-Jul-95	4.92	6.600	
010601	11-Jul-95	6.56	1.800	
010601	29-Jun-99	0	7.000	8.320
010601	29-Jun-99	1.64	7.000	8.355
010601	29-Jun-99	3.28	6.800	8.189
010601	29-Jun-99	6.56	5.200	8.272
010601	29-Jun-99	9.84	3.400	
010601	29-Jun-99	11.48	0.300	

The availability of dissolved oxygen has declined over time. In 1978, the concentration of dissolved oxygen remained constant throughout the water column. In 1989, 1995, and 1999, the dissolved oxygen concentrations decreased with increased depth. (See above table). At the surface, the average concentration was 7.3 mg/L, a sufficient amount of dissolved oxygen for aquatic life support. However, near the bottom of the lake, the average concentration dropped to 3.5 mg/L. The low dissolved oxygen problems relate to conditions within the macrophyte stands (although still within the upper 3.0 meters of the water column).

From 1975 to 1999, the pH was high 33 percent of the time. The average pH was 8.34 ranging from 8.19 to 9.70. The high summer pH occurrences are related to periods of large macrophyte productivity.

The macrophyte community is excessive in that it is both abundant and composed mostly of *Myriophyllum* sp., a common nuisance macrophyte in North America. Beyond the nuisance to fishing, this lake has been the site of swimmers' itch outbreaks which macrophytes tend to be associated with (through acting as habitat for snails).

Interim Endpoints of Water Quality (Implied Load Capacity) at Lake Meade over 2005 - 2010:

In order to improve the trophic condition of the lake from its current hypereutrophic status, the desired endpoint will be summer chlorophyll a concentrations at or below 12 ug/l, corresponding to a trophic state of eutrophic conditions by 2009. Achievement of this endpoint should also

result in higher concentrations of dissolved oxygen (>5 mg/L) in the water column of the lake as well as manageable coverage of macrophytes and pH values between 6.5 and 8.5. Refined endpoints will be developed in 2005 to reflect additional sampling and artificial source assessment and confirmation of impaired status of lake.

3. SOURCE INVENTORY AND ASSESSMENT

Point Source: A fish hatchery is located to the northwest of Lake Meade and discharges into an unnamed stream that flows into the Stumpie Arroyo and then into the lake. This hatchery contributes to the nitrogen and phosphorus load by draining the contents of its ponds (including feed and fish feces) where primarily Black Bass were produced. Two to 18 ponds are kept full each year.

Land Use: The primary source of phosphorus within Lake Meade is probably runoff from agricultural lands where phosphorus has been applied. Land use coverage analysis indicates that 83.3% of the watershed is cropland. An annual phosphorus load of 132 pounds per year is necessary to correspond to the concentrations seen in the lake.

Phosphorus from animal waste is a minor contributing factor. Fifteen percent of land around the lake is grassland; the grazing density of livestock is low in the summer and average in the winter. The majority of the rangeland in the Lake Meade watershed is native grass. Because of this, the watershed may provide for additional pollutant trapping, beyond what might normally be expected.

The City of Plains is within the watershed and includes 480 acres of urban area (0.8 % of the watershed). The city is sparsely populated (994 people) and anticipating a ten percent growth in population.

Contributing Runoff: The soils in this area are of the Harney-Spearville association, which is described as clayey and possessing moderately slow permeability. The watershed has an average soil permeability of 1.7 inches/hour according to NRCS STATSGO data base. Runoff would be produced from storms one to two hours in duration, having a recurrence interval up to twenty five years and storms of three hours in duration, having a recurrence interval of twenty-five years. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. Generally, 46 percent of the watershed would generate runoff under dryer conditions or smaller storms. Moderate or wet conditions or larger storms would see runoff contributed from most of the watershed .

Background Levels: A large population of geese (1,500 to 7,000) lives in and around Lake Meade. Their waste, as well as waste from numerous other types of wildlife, increases the levels of nitrogen and phosphorus in the lake. One hundred twelve acres of woodland (primarily cottonwood) surround Lake Meade; leaf litter may be adding to the nutrient load. Nutrient recycling from the sediments in the lake is likely contributing available phosphorus to the lake

for algal uptake. Geological formations contain small amounts of phosphorus (up to 0.5% of total weight), and may contribute to phosphorus loads.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

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.

Point Sources: The discharge from the fish hatchery is a minor contributor of nutrients. A Waste Load Allocation of 0.8 pounds per year is necessary to reach the end point.

Nonpoint Sources: Water quality violations are predominantly due to nonpoint source pollutants. Background levels may be attributed to wildlife waste and leaf litter. The assessment suggests that cropland throughout the watershed contribute to the hypereutrophic state of the lake. Generally a Load Allocation of 34.9 pounds per year, leading to a 70% reduction in available phosphorus is necessary to reach the endpoint.

Defined Margin of Safety: The margin of safety provides some hedge against the uncertainty of variable annual total phosphorus loads and the chlorophyll a endpoint. Therefore, the margin of safety will be 4.0 pounds per year of total phosphorus taken from the load capacity to ensure that adequate load reduction occurs to meet the endpoint.

State Water Plan Implementation Priority: Because Lake Meade is a lake under state jurisdiction and represents a major water body in surface water scarce Southwest Kansas, this TMDL will be a High Priority for implementation

Unified Watershed Assessment Priority Ranking: This watershed lies within the Crooked Subbasin (HUC 8: 11040007) with a priority ranking of 29 (Medium Priority for restoration work).

Priority HUC 11s: The entire watershed is within HUC 11 (050).

5. IMPLEMENTATION

Desired Implementation Activities

Some potential exists for reducing the level of nutrient pollutants coming into Lake Meade. 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.

Opportunities for lake resource management could also help reduce nutrient cycling within the lake. Generally, reducing the macrophyte cover to under 25% of the lake area would be beneficial. Improving the hydrology could have the most lasting impact on lake water quality and use support. Maintaining the historic water depth of about 5.0 meters would restrict the amount of macrophyte biomass through shading, improve trophic state to some degree, and allow fuller support of beneficial uses. Given the decline in water levels in the basin, such increases in water depth can only come about through retention from sporatic runoff events.

Implementation Programs Guidance

Fishery Management - KDWP

a. Evaluate in-lake or near-lake potential sources of nutrients to lake.
b. Apply lake management techniques which may reduce nutrient loading and cycling in lake, particularly macrophyte control

Water Quality Monitoring and Assessment - KDHE

a. Assist KDWP with assessing the condition and sources of nutrients in Lake Meade.

NPDES Program - KDHE

a. Evaluate possible reductions through permit limits assigned to the hatchery.

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.

Water Resource Cost Share Program - SCC

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

Nonpoint Source Pollution Control Program - SCC

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

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

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

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

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

Time Frame for Implementation: Pollution reduction practices should be installed within the lake drainage after evaluation of nutrient sources to lake and identification of potential management techniques and should occur prior to 2005.

Targeted Participants: Primary participants for implementation will be state fisheries managers for Lake Meade and agricultural producers within the drainage of the lake. Lake source assessment and control implementation would occur over 2000-2005. Initial work should include local assessments by conservation district personnel and county extension agents to locate within the lake drainage:

1. Total rowcrop 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 2005: The year 2005 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sources should have been assessed and implementation measures should be underway to targeted sources.

Delivery Agents: The primary delivery agents for program participation will be the Kansas Department of Wildlife and Parks, conservation districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. 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 Cimarron 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.

7. K.S.A. 32-807 authorizes the Kansas Department of Wildlife and Parks to manage lake resources.

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 within the watersheds cited in this TMDL.

6. MONITORING

Additional data, to establish nutrient ratios, source loading and further determine mean summer lake trophic condition, would be of value prior to 2005. Further sampling and evaluation should occur in once before 2005 and twice between 2005 and 2010.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Cimarron Basin were held March 8 and April 25 in Meade. 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 Cimarron Basin.

Public Hearing: A Public Hearing on the TMDLs of the Cimarron Basin was held in Meade on May 30, 2000.

Basin Advisory Committee: The Upper Arkansas Basin Advisory Committee met to discuss the TMDLs in the basin on October 6, 1999; January 11 and 24, 2000; March 8, 2000.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:
Agriculture: February 28, 2000

Milestone Evaluation: By 2005, evaluation will be made as to the sources of impairment which has occurred within the drainage and current condition of Meade Lake with subsequent decisions made regarding implementation approach and follow up assessments of source contribution and possible management techniques.

Consideration for 303d Delisting: Meade Lake will be evaluated for delisting under Section 303d, based on the monitoring data over the period 2005-2009. Therefore, the decision for delisting will come about in the preparation of the 2010 303d list. Should modifications be made to the applicable nutrient criterion 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 2002 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 during Fiscal Years 2001-2005.

Approved September 11, 2000.