SMOKY HILL/SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Rimrock Park Lake
Water Quality Impairment: Eutrophication and Dissolved Oxygen

As listed on 1998 303(d) List **Subbasin:** Lower Smoky Hill (HUC 10260008)

As listed on 2002 303(d) List **Basin:** Kansas/Lower Republican

Subbasin: Lower Republican

County: Geary

HUC 8: 10250017 **HUC 11** (HUC 14)**:** **060** (090)

Ecoregion: Flint Hills (28)

Drainage Area: Approximately 0.55 square mile

Conservation Pool: Area = 2.3 acres
Watershed Area: Lake Surface Area = 152:1
Maximum Depth = 3.5 meters (11 feet)
Mean Depth = 1.5 meters (4.9 feet)
Retention Time = 0.20 year (2.4 months)

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

Authority: Junction City

2002 303(d) Listing: Kansas/Lower Republican River Basin Lakes

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

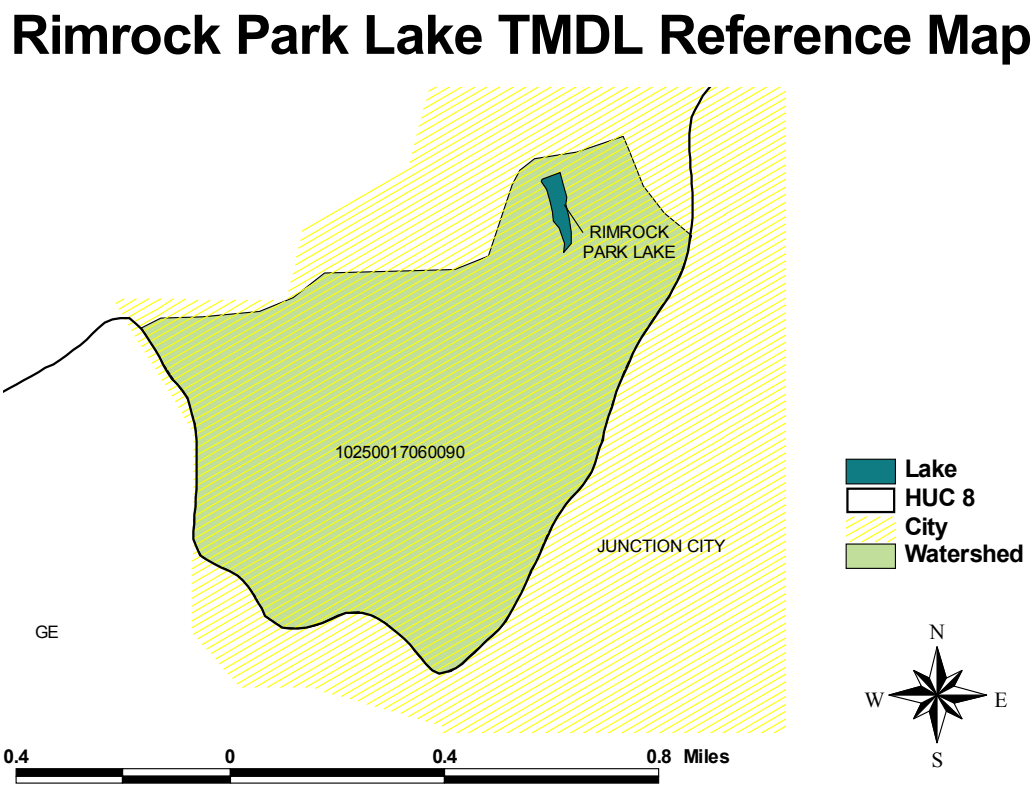
Water Quality Standard: Nutrients - Narrative: The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement of aquatic biota or the production of undesirable quantities or kinds of aquatic life. (KAR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

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

Figure 1



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Eutrophication: Hypereutrophic, Trophic State Index = 66.32

Monitoring Sites: Station 070501 in Rimrock Park Lake (Figure 1).

Period of Record Used: Twelve surveys during 1994

Current Condition: In 1994, the chlorophyll a concentrations were low in the spring (10.8 μg/L) and climbed as the season progressed. The highest reading was seen in September with an average chlorophyll a concentration of 76.4 μg/L. The total phosphorus levels in Rimrock Park Lake fluctuated over the season, ranging from 50 to 130 μg/L. (See the below table).

Average Concentrations in Rimrock Park Lake over Time

Date	Kjeldahl Nitrogen (mg/L)	Secchi Disc Depth (m)	Chlorophyll a (mg/L)	Phosphorus (μg/L)
4/4/94	2.26	0.3	10.8	70
4/26/94	1.59	0.3	15.6	100
6/1/94	1.94	0.3	29.8	50
6/20/94	1.09	0.5	18.8	80
7/11/94	1.40	0.7	31.0	70
8/1/94	1.59	0.5	36.2	60
8/22/94	0.63	0.3	58.3	130
9/12/94	1.05	0.4	76.4	70
10/3/94	0.49	0.4	67.4	120
10/25/94	1.98	0.2		100
11/28/94	0.38	0.3		70
12/19/94	1.95	0.2		100

Based on the twelve monitoring visits, Rimrock Park Lake had average chlorophyll a concentration of 38.2 μg/L, a Total Phosphorus concentration of 82 μg/L, a Total Kjeldahl Nitrogen concentration of 1.3 mg/L, and nitrate and nitrite were often below the detection limit (Appendix A). The Secchi disc depth averaged 0.36 meter. Nitrogen was the primary limiting factor. Light was indicated to be secondary factor due to clay turbidity (Appendix B). 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

Dissolved Oxygen Samples (mg/L) by Depth from Rimrock Park Lake

Date	0.0 meter	0.5 meter	1.0 meter	1.5 meter	2.0 meter	2.5 meter
4/4/94		8.7				
4/26/94	6.7	6.7	6.7			
6/1/94	9.5	9.5	9.5	9.0		
6/20/94	8.2	8.0	7.0	**0.4**	**0.2**	**0.2**
7/11/94	8.7	8.7	8.2	**3.4**	**0.2**	**0.2**
8/1/94	9.4	9.4	7.2	**1.8**	**0.2**	**0.2**
8/22/94	9.1	9.1	8.4	**4.0**	**0.2**	**0.2**
9/12/94	7.5	7.4	7.2	6.8	**1.6**	
Average	8.4	8.4	7.7	4.2	0.5	0.2

Decomposition of plant material contributes to the decreases dissolved oxygen levels. The dissolved oxygen concentrations decreased with increased depth. (See above table). At the surface, the average concentration was 8.4 mg/L, a sufficient amount of dissolved oxygen for aquatic life support. At 2.5 meters, the average concentration drops to 0.2 mg/L.

Interim Endpoints of Water Quality (Implied Load Capacity) at Rimrock Park Lake 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.

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 Rimrock Park Lake

Parameter	Current Condition	TMDL	Percent Reduction
Total Phosphorus Load (lb/year)	323.7	59.4	82 %
Total Phosphorus Concentration (μg/L)	82	32	61 %
Chlorophyll a (μg/L)	38.2	< 12	69 %
Total Nitrogen Concentration (mg/L)	1.3	< 0.62	52 %

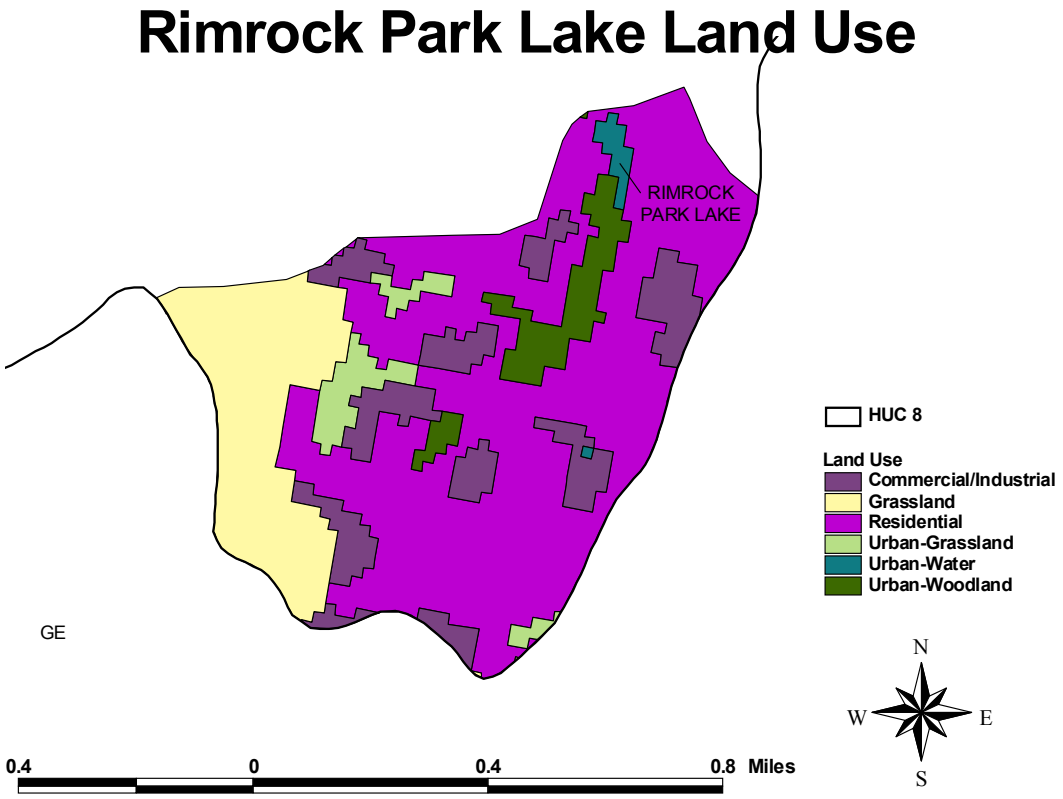
3. SOURCE INVENTORY AND ASSESSMENT

Land Use: The watershed around Rimrock Park Lake has a moderate potential for nonpoint source pollutants. An annual phosphorus load of 323.7 pounds per year is necessary to correspond to the concentrations seen in the lake.

Part of Junction City is located within the watershed. The Junction City anticipates a 7.2% population increase by the year 2020. The average population density in the watershed is 4,386 people per square mile. The watershed is urban consisting of 58.1% residential properties, 13.6% commercial properties, 5.5% urban woodland, 3.8% urban grassland, 1.0% urban water, and 17.9% grassland (Figure 2). Fertilizer applications to lawns and animal waste are primary contributors to the nutrient load.

A potential source may be septic systems located around the lake. Failing septic systems can be a significant source of nutrients. The Geary County has 1,202 septic systems, accounting for 10% of the sewage systems present in the county.

Figure 2



Background Levels: The atmospheric phosphorus and geological formations (i.e., soil and bedrock) may contribute to phosphorus loads. Nutrients from wildlife waste are another contributing factor. One percent of the watershed is woodland; leaf litter may be adding to the nutrient load.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

While nitrogen is the limiting factor in Rimrock Park Lake, 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 59.4 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.

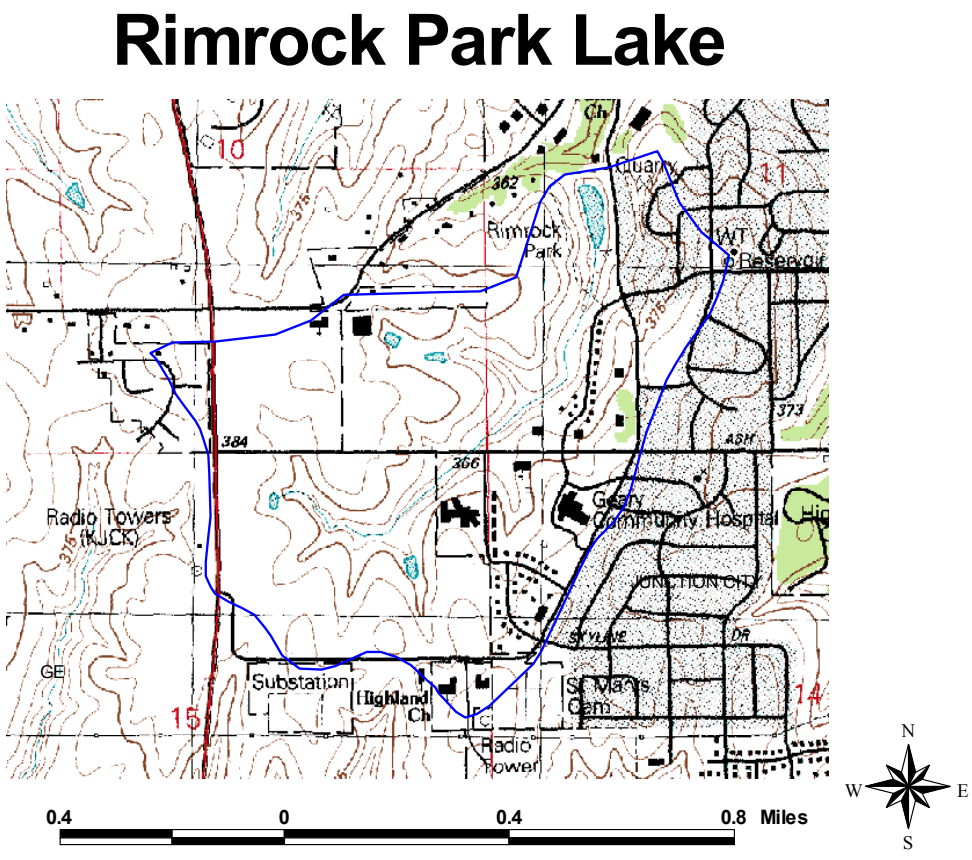
Point Sources: A current Wasteload Allocation of zero is established by this TMDL because of the lack of point sources in the watershed. Should future point sources be proposed in the

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.

Nonpoint Sources: Water quality violations are partially due to nonpoint source pollutants. Background levels may be attributed to atmospheric deposition and geological sources. The assessment suggests that urban runoff contributes to the elevated total phosphorus concentrations in the lake. Generally a Load Allocation of 53.4 pounds of total phosphorus per year, leading to an 82% reduction, is necessary to reach the endpoint. A proportional decrease of 47% 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 5.9 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 5% reduction in nitrogen to ensure that the endpoint is reached.

Figure 3



State Water Plan Implementation Priority: Because Junction City has been actively working to improve the water quality in Rimrock Park Lake, this TMDL will be a Medium Priority for implementation.

Unified Watershed Assessment Priority Ranking: Rimrock Park Lake lies within the Lower Republican (HUC 8: 10250017) with a priority ranking of 11 (High Priority for restoration).

Priority HUC 11s: The HUC 11 (060) encompasses the entire watershed and thus should take priority.

5. IMPLEMENTATION

Desired Implementation Activities

Because the lake is located in an urban area and the watershed is small, the amount and type of best management practices are limited. The best option is to dredge and alter the structure of the lake. In response to the 1994 Clean Lakes Program, Junction City recently made these upgrades to Rimrock Park Lake. The lake was dredged; the depth was increased; and the surface area of the lake was decreased.

Residents in the watershed should be encouraged to do soil sampling so that they apply the appropriate amount of fertilizer to lawns and planting beds.

Implementation Programs Guidance

Nonpoint Source Pollution Technical Assistance - KDHE

a. Provide technical assistance on nutrient management in vicinity of the lakes.
b. Develop a Watershed Restoration and Protection Strategy for HUC 10250017.

Extension Outreach and Technical Assistance - Kansas State University

a. Encourage annual soil testing to determine capacity of soil to hold phosphorus.

Time Frame for Implementation: Water quality improvement activities are encouraged at the local level prior to 2008. Funding for installing lake pollution reduction practices should be allocated within the lake drainage after the year 2008. Evaluation of nutrient sources to lake and identification of potential management techniques should occur prior to 2008.

Targeted Participants: Primary participants for implementation will be residents within the drainage of the lake. A detailed assessment of sources will be conducted by KDHE over 2003-2008.

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 Rimrock Park Lake should indicate probable sources of nutrients and plans in place to initiate implementation.

Delivery Agents: The primary delivery agents for program participation will be Junction City. 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 Medium Priority consideration.

Effectiveness: The key to success will be utilization of nutrient management within the watershed cited in this TMDL.

6. MONITORING

Additional data, to determine the effectiveness of the dredging and restructuring of the lake, 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 Rimrock Park Lake. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

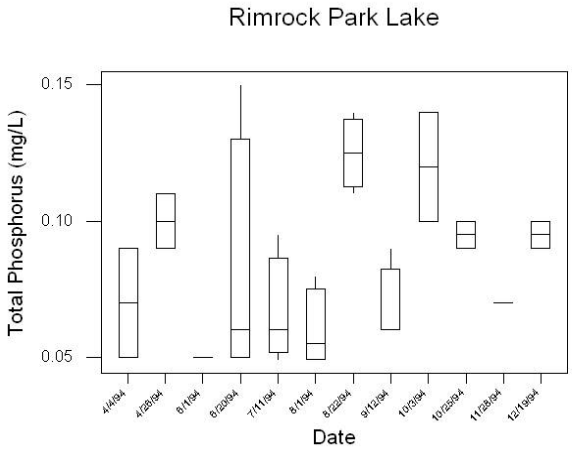
Consideration for 303(d) Delisting: The lake will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2008-2012. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water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

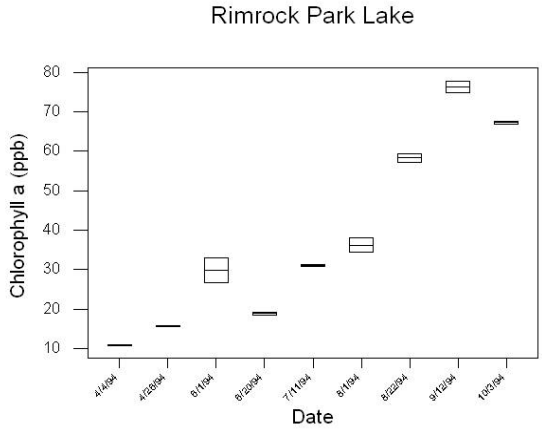
Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2004 which will emphasize revision of the Water Quality Management Plan. At that 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.

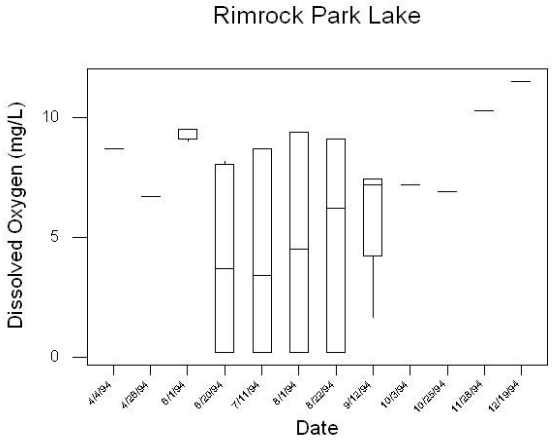
Bibliography

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].

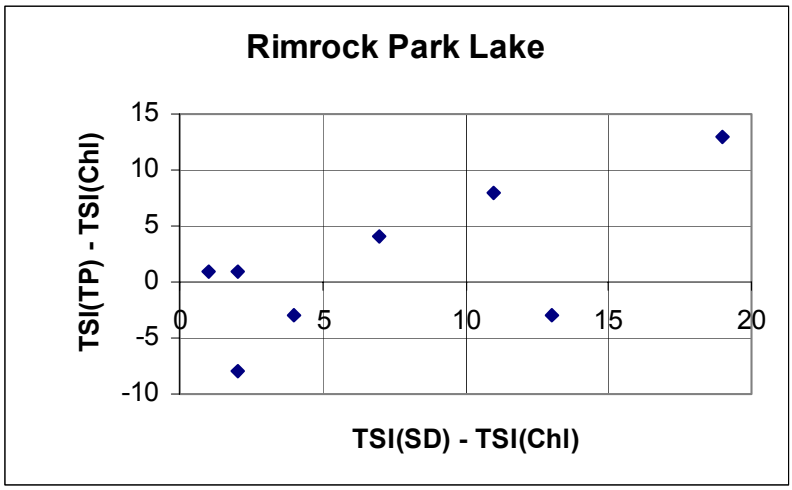
Appendix A - Boxplots

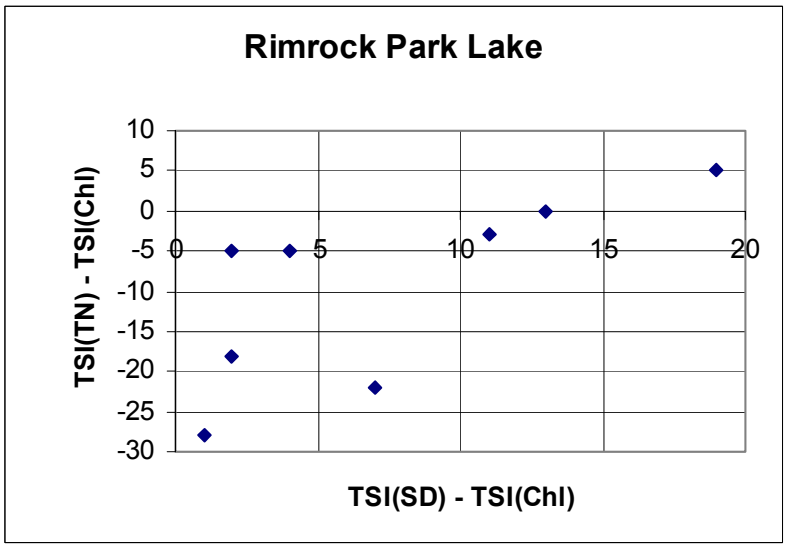






Appendix B - Trophic State Index Plots





The relationship between the TSI(SD) - TSI(Chl) and TSI(TN)-TSI(Chl) indicates that nitrogen is the primary limiting factor. The deviation of chlorophyll from the sediment load indicates the degree of light penetration, while the difference between chlorophyll and nitrogen indicates the level of nitrogen limitation. Therefore, if the final plot is in the fourth quadrant, it shows that nitrogen limits algae growth. The Trophic State Index plots indicate that light is the secondary limiting factor, due to clay turbidity.

Appendix C - Input for CNET Model

Parameter	Value Input into CNET Model
Drainage Area (km^2)	1.4
Precipitation (m/yr)	0.75
Evaporation (m/yr)	1.33
Unit Runoff (m/yr)	0.12
Surface Area (km^2)	0.009
Mean Depth (m)	1.47
Depth of Mixed Layer (m)	1.4
Depth of Hypolimnion (m)	0.4
Observed Phosphorus (ppb)	82.0
Observed Chlorophyl-a (ppb)	38.2
Observed Secchi Disc Depth (m)	0.4

Output from CNET Model

Parameter	Output from CNET Model
Load Capacity (LC)*	**59.4 lb/yr**
Waste Load Allocation (WLA)	**0 lb/yr**
Load Allocation (LA)	**53.4 lb/yr**
Margin of Safety (MOS)	**5.9 lb/yr**

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

Approved Aug. 7, 2003