NEOSHO RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Gridley City Lake
Water Quality Impairment: Eutrophication Bundled with Dissolved Oxygen

Subbasin: Upper Neosho

County: Coffey

HUC 8: 11070204

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

Ecoregion: Central Irregular Plains/Osage Cuestas (40b)

Drainage Area: Approximately 1.1 square miles.

Conservation Pool: Area = 32.5 acres
Maximum Depth = 3.0 meters (9.8 feet)
Mean Depth = 1.3 meters (4.3 feet)
Retention Time = 0.09 years (1 month)

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

Authority: City of Gridley

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)).

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

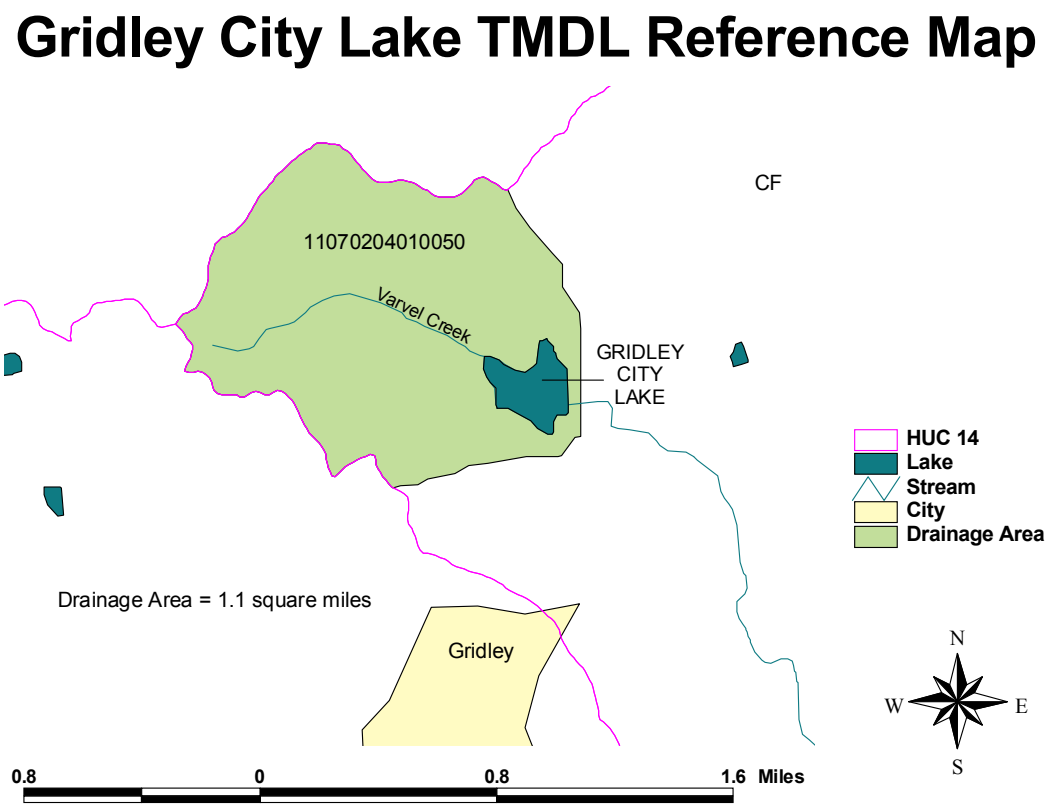
2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Eutrophication: Very Eutrophic, Trophic State Index = 61.35

Monitoring Sites: Station 045601 in Gridley City Lake (Figure 1).

Period of Record Used: Four surveys during 1986 - 2001.

Figure 1



Current Condition: In 1991, the average chlorophyll a concentration was 22.6 ppb. (See the below table and Appendix A). In 1996, Gridley City Lake was drained. The bottom sediment was moved to the sides and shore of the lake, and an aeration system was installed. The chlorophyll a concentration seen in the following year dropped dramatically to 2.5 ppb. The Total Phosphorus concentration and clarity of the lake improved as well. However, by the 2001 sampling period, the chlorophyll a and Total Phosphorus concentrations returned to the pre-drainage condition.

Average Concentration of Samples Taken by the KDHE Lake Monitoring Program

Date	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ppb)	Secchi Disc Depth
09/03/86		0.048	42.7	
08/19/91		0.063	22.6	0.60
06/09/97	0.466	0.025	2.5	1.90
07/10/01	0.100	0.080	24.5	0.62

The chlorophyll a to total phosphorus yield is moderate. Light is the primary limiting factor, and nitrogen is the secondary limiting factor (Appendix B). The Total Kjeldahl Nitrogen concentrations average 0.344 mg/L; nitrate and nitrite were often below the detection limit.

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

Decomposition of plant material has lowered the dissolved oxygen concentrations in the lake. The dissolved oxygen concentrations decreased with increased depth. (See the table below). At the surface, the average concentration was 7.3 mg/L, a sufficient amount of dissolved oxygen for aquatic life support. However, toward the bottom of the lake, the concentration drops below the water quality standard to an average of 2.9 mg/L.

Interim Endpoints of Water Quality (Implied Load Capacity) at Gridley City Lake over 2007 - 2011:

The desired endpoint will be to maintain summer chlorophyll a concentrations at or below 12 μg/L. Achievement of this endpoint should also result in dissolved oxygen concentrations above 5 mg/L. Refined endpoints will be developed in 2007 to reflect additional sampling and artificial source assessment and confirmation of impaired status of lake.

The 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.

Dissolved Oxygen Samples Taken by the KDHE Lake Monitoring Program

Date	Depth (feet)	Dissolved Oxygen (mg/L)
9/3/86	0.00	9.30
9/3/86	1.64	9.30
9/3/86	3.28	9.20
9/3/86	6.56	9.20
9/3/86	8.20	9.20
8/19/91	0.00	7.80
8/19/91	1.64	7.60
8/19/91	3.28	7.00
8/19/91	6.56	6.60
8/19/91	9.84	**0.90**
6/9/97	0.00	5.70
6/9/97	1.64	5.40
6/9/97	3.28	5.40
6/9/97	6.56	5.20
6/9/97	9.84	**0.20**
7/10/01	0.00	6.40
7/10/01	1.64	6.40
7/10/01	3.28	5.60
7/10/01	6.56	**2.40**
7/10/01	9.84	**1.20**
7/10/01	11.48	**0.30**

3. SOURCE INVENTORY AND ASSESSMENT

Land Use: The watershed around Gridley City Lake has moderate potential for nonpoint source pollutants. An annual phosphorus load of 496 pounds per year is necessary to correspond to the concentrations seen in the lake.

Nitrogen and phosphorus from animal waste are a contributing factor. Eighty-five percent of land around the lake is grassland; the grazing density of livestock is medium in winter and summer.

One source of phosphorus and nitrogen within Gridley City Lake is probably runoff from agricultural lands where nutrients have been applied. Land use coverage analysis indicates that 9.9% of the watershed is cropland (Figure 2).

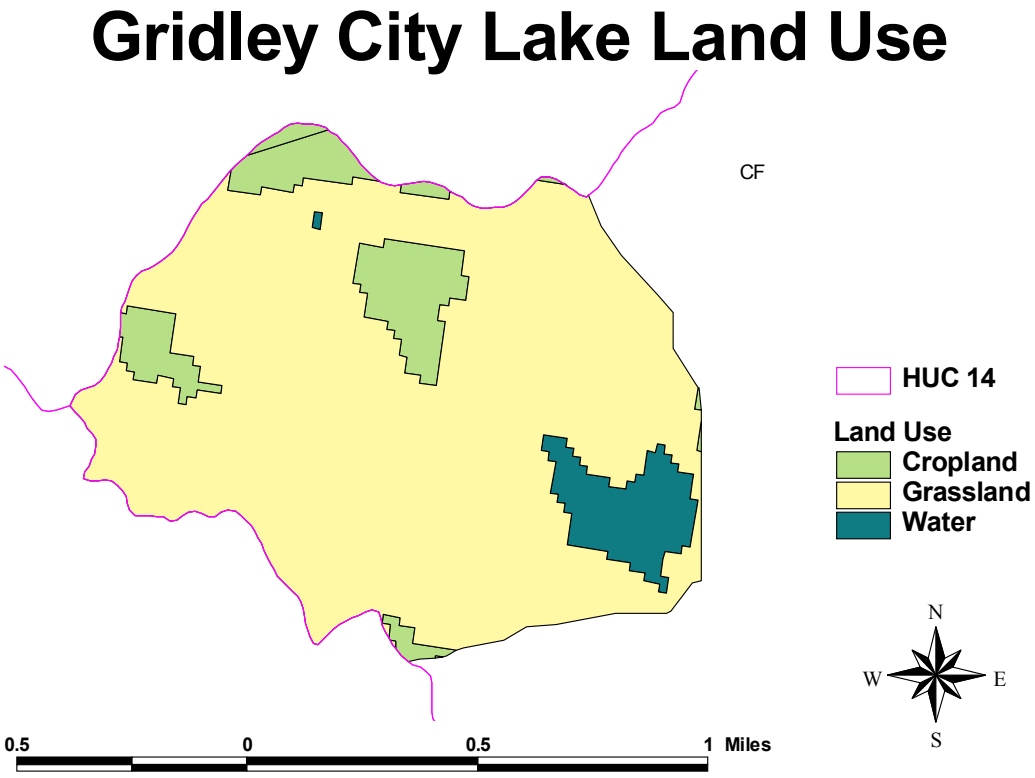
The population density is 8.5 people per square mile. The population of Gridley is expected to increase 8.0% through 2020.

Contributing Runoff: The watershed's average soil permeability is 0.6 inches/hour according to NRCS STATSGO database. About 99.9% 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 48.6% of this watershed, chiefly along the stream channels.

Background Levels: The atmospheric phosphorus and geological formations (i.e., soil and bedrock) may contribute to phosphorus loads. Nitrogen loads may be contributed from the atmosphere. Carp may cause some resuspension of sediment.

Figure 2



4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

While light is the limiting factors in Gridley City Lake, Total Phosphorus is also allocated under this TMDL, because a phosphorus reduction will have a large effect on the managing the algal community. The Load Capacity is 226 pounds per year of phosphorus. 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 the average Total Kjeldahl

concentration is below the desired endpoint, a proportional decrease in nitrogen between the current condition and the desired endpoint will not be required at this time.

Point Sources: A current Wasteload Allocation of zero is established by this TMDL because of the lack of discharging, 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 predominantly due to nonpoint source pollutants. Background levels may be attributed to atmospheric and geological sources. The assessment suggests that cropland and animal waste contribute to the elevated total phosphorus and nitrogen concentrations in the lake. Generally a Load Allocation of 204 pounds of total phosphorus per year, leading to a 54.4% reduction, is necessary to reach the endpoint. A proportional decrease of 0% 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 and the chlorophyll a endpoint. Therefore, the margin of safety will be 23 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 0% reduction in nitrogen to ensure that the endpoint is reached.

State Water Plan Implementation Priority: Because Gridley City Lake has multiple impairments and a complex watershed, this TMDL will be a Medium Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Upper Neosho (HUC 8: 11070205) with a priority ranking of 20 (High Priority for restoration).

Priority HUC 11s: The watershed is within HUC 11 (010).

5. IMPLEMENTATION

Desired Implementation Activities

There is good potential that agricultural best management practices will improve water quality in Gridley City Lake. 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

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 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. 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 nutrients.

Time Frame for Implementation: Water quality improvement activities are encouraged at the local level prior to 2007. Funding for installing pollution reduction practices should be allocated within the lake drainage after the year 2007. Evaluation of nutrient sources to lake and identification of potential management techniques should occur prior to 2007.

Targeted Participants: Primary participants for implementation will be agricultural producers within the drainage of the lake. Initial work in 2007 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 2007: The year 2007 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from Gridley City 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 the City of Gridley, 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 Neosho 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: 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 2007. Further sampling and evaluation should occur once before 2007 and once between 2007 and 2011.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Neosho Basin were held January 9, 2002 in Burlington and March 4, 2002 in Council Grove. 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 Neosho Basin.

Public Hearing: Public Hearings on the TMDLs of the Neosho Basin were held in Burlington and Parsons on June 3, 2002.

Basin Advisory Committee: The Neosho Basin Advisory Committee met to discuss the TMDLs in the basin on October 2, 2001, January 9, March 4, and June 3, 2002.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:
Kansas Farm Bureau: February 26 in Parsons and February 27 in Council Grove

Milestone Evaluation: In 2007, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of Gridley City Lake. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

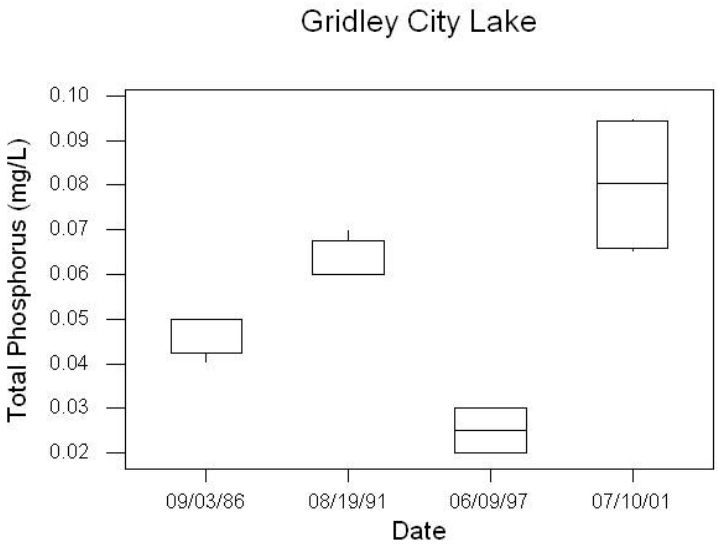
Consideration for 303(d) Delisting: The lake will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2007-2011. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

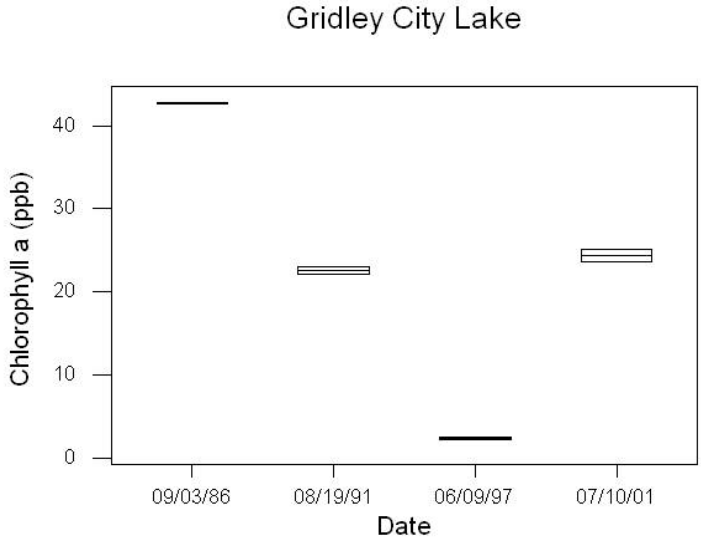
Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2003 which will emphasize revision of the Water Quality Management Plan. At that 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 2003-2007.

Bibliography

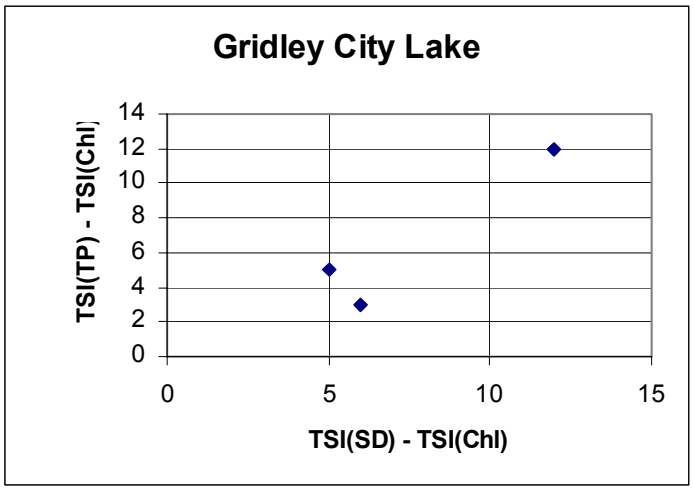
Liscek, Bonnie C. Methodology Used in Kansas Lake TMDLs [web page] Jul. 2001; http://www.kdhe.state.ks.us/tmdl/eutro.htm [Accessed 17 May 2002].

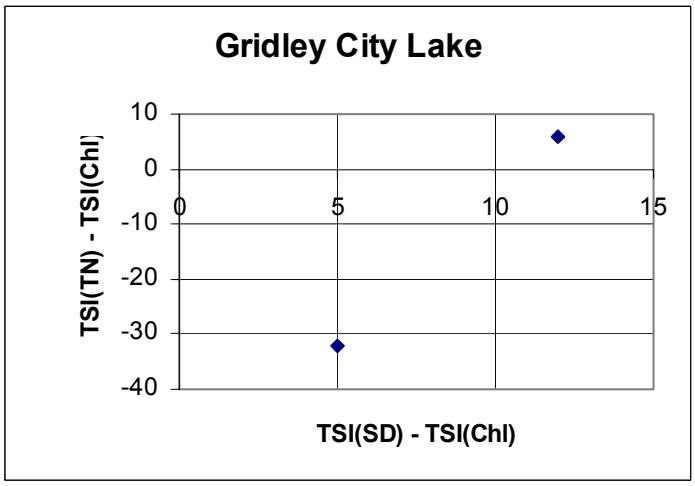
Appendix A - Boxplots





Appendix B - Trophic State Index Plots





The Trophic State Index Plots indicate that light, due to clay turbidity, is the limiting factor. Nitrogen is a secondary limiting nutrient.

Appendix C - Input for CNET Model

Parameter	Value Input into CNET Model
Drainage Area (km^2)	2.82
Precipitation (m/yr)	0.9
Evaporation (m/yr)	1.30
Unit Runoff (m/yr)	0.23
Surface Area (km^2)	0.13
Mean Depth (m)	1.3
Depth of Mixed Layer (m)	1.23
Depth of Hypolimnion (m)	0.34
Observed Phosphorus (ppb)	53.80
Observed Chlorophyl-a (ppb)	23.04
Observed Secchi Disc Depth (m)	1.04

Approved September 30, 2002