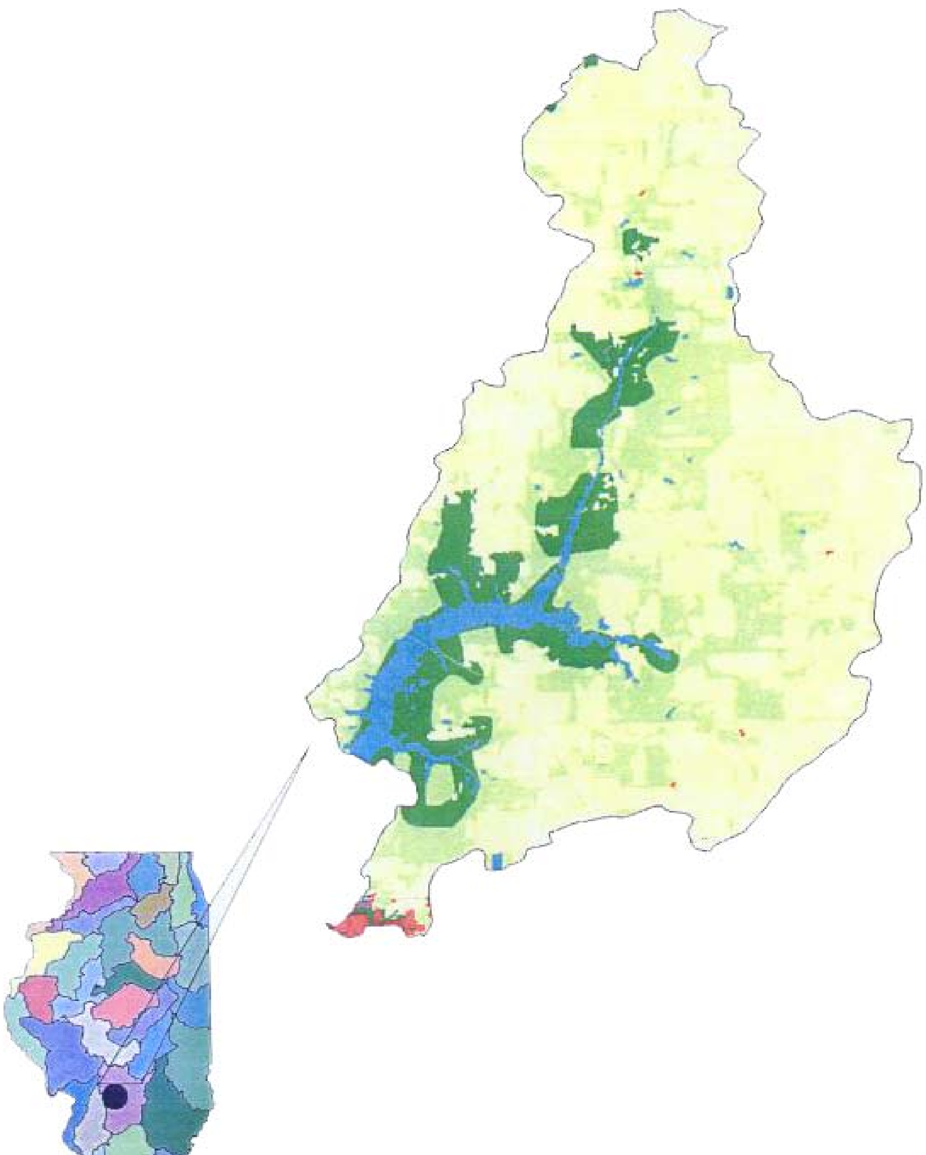
Illinois
Environmental
Protection Agency

Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

September 2002

IEPA/BOW/02-017

Governor Bond TMDL Report



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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

SEP 25 2002

REPLY TO THE ATTENTION OF:
WW-16J

Marcia T. Willhite, Chief
Bureau of Water
Illinois Environmental Protection Agency
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

RECEIVED
SEP 30 2002
BUREAU OF WATER

Dear Ms. Willhite:

The United States Environmental Protection Agency (U.S. EPA) has conducted a complete review of the final Total Maximum Daily Load (TMDL) submittal for Governor Bond Lake, which is located in Bond County, Illinois, including supporting documentation and information. Governor Bond Lake has been classified as impaired due to excess nutrients, siltation, suspended solids, and organic enrichment in the upper basin and for excess nutrients, siltation and suspended solids in the lower basin. The pollutants responsible for these causes of impairment are phosphorus, suspended solids and sedimentation (lake in-filling). TMDLs are based on a specific pollutant in a specific waterbody segment. In Governor Bond Lake there are three pollutants in each of two waterbody segments for a total of 6 TMDLs that address 7 impairments (4 in the upper basin and 3 in the lower basin). Based on this review, U.S. EPA has determined that Illinois' TMDLs for phosphorus, suspended solids and sedimentation meet the requirements of Section 303(d) of the Clean Water Act (CWA) and U.S. EPA's implementing regulations at 40 C.F.R. Part 130. Therefore, by this order, U.S. EPA hereby APPROVES Illinois' TMDLs for phosphorus, suspended solids and sedimentation in Governor Bond Lake, Illinois watershed ID numbers ILROP1 and ILROP2. These 6 TMDLs address all seven impairments for this lake found on Illinois' 1998 303(d) list. The statutory and regulatory requirements, and U.S. EPA's review of Illinois' compliance with each requirement, are described in the enclosed decision document.

We appreciate your hard work in this area and the submittal of the TMDLs as required. If you have any questions, please contact Mr. Kevin Pierard, Chief of the Watersheds and Wetlands Branch at 312-886-4448.

Sincerely yours,

Jo Lynn Traub,
Director, Water Division

Enclosure

GOVERNOR BOND LAKE

GREENVILLE, BOND COUNTY, ILLINOIS

TOTAL MAXIMUM DAILY LOAD REPORT

Doc. No: IEPA/BOW/02-017

Illinois Environmental Protection Agency

September 2002

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EXECUTIVE SUMMARY

Governor Bond Lake in Greenville, Illinois is listed as impaired for recreation, swimming and overall use. Main causes contributing to impairment are identified as nutrients, siltation, suspended solids, and excessive algal growth/chlorophyll-a. This TMDL addresses the nutrient and sediment reductions needed for Governor Bond Lake to comply with Illinois guidelines for nutrients, siltation, suspended solids, and chlorophyll-a concentrations. The specific problems and control action plans associated with nutrient and sediment loads are highlighted below.

Problem No. 1: Nutrients

Excessive nutrient loading to Governor Bond Lake has resulted in nuisance algal blooms, and consequently, impaired recreation and overall uses. Because there are no point source dischargers in the watershed, nutrient loads are coming from nonpoint sources, such as farming activities, feedlots, septic systems, streambank erosion, and natural processes. Elevated total phosphorus (TP) concentration, a surrogate for nutrients in general, has been measured in both the lake and associated tributaries. Internal cycling (re-release of previously settled out TP) is also implicated as a source of TP. Excessive chlorophyll-a, a surrogate measure of algal growth, has been measured in the lake. Several BMPs will result in nutrient load reductions and consequently, reduced algal growth. Some BMPS include: construction of multi-celled wetlands/extended sedimentation ponds, filter strips, tillage and nutrient management plans, construction erosion control permits, septic tank setback, sediment sealing, destratifiers, and/or aerators, to name a few. Additionally, continued and increased enrollment in CRP, stream bank stabilization projects, septic system maintenance, tillage and nutrient management education, feedlot management, and other on-going programs will further help reduce nutrient loads to Governor Bond Lake.

Problem No. 2: Sediment

Sediment loads to Governor Bond Lake have resulted in lake siltation (in-filling) and elevated non-volatile suspended solids (NVSS) concentrations. About one-half **(see Appendix C, comments #31 and #48, pages 12 and 15)** of the sediment load to Governor Bond Lake is from land surface erosion, and the rest is from shoreline and stream bank erosion. High sediment loads from tributaries and high NVSS in the lake have been measured. Practices that reduce erosion will reduce both sediment transport and NVSS concentrations. Most BMPs designed to reduce nutrient transport will also be effective at reducing sediment loads. Stream bank fencing, riprap, and aquascaping are some additional BMPs that can be used to reduce sediment transport to acceptable loads.

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act (CWA) provides authority for completing Total Maximum Daily Loads (TMDLs) to achieve state water quality standards and/or designated uses.

A TMDL is a calculation of the maximum amount of pollutant that a water body can receive and still meet water quality standards and/or designated uses. It is the sum of the loads of a single pollutant from all contributing point and nonpoint sources. TMDLs must include the following eight elements to be approved by the U.S. Environmental Protection Agency (EPA):

The TMDL must:

1. be designed to implement applicable water quality criteria,
2. include a total allowable load as well as individual waste load allocations,
3. consider the impacts of background pollutant contributions,
4. consider critical environmental conditions,
5. consider seasonal environmental variations,
6. include a margin of safety,
7. provide opportunity for public participation, and
8. have a reasonable assurance that the TMDL can be met.

In general, the TMDL is developed according to the following relationship:

$$TMDL = WLA + LA + MOS \qquad [1]$$

Where:

TMDL =	Total Maximum Daily Load (may be seasonal, for critical conditions, or other constraints)
WLA =	Waste Load Allocation (point source)
LA =	Load Allocation (nonpoint source)
MOS =	Margin of Safety (may be implicit and factored into conservative WLA and LA, or explicit)

This document provides the information used to develop TMDLs for Governor Bond Lake in Greenville, Illinois. The priority ranking for Governor Bond Lake TMDL development is No. 85 (1998 Illinois 303 (d) list).

Governor Bond Lake (Illinois water body ID numbers ILROP1-1998 and ILROP2-1998) was listed in the Illinois Water Quality Report 2000 (305(b) Report) as impaired for failure to meet its designated uses of recreation, swimming and overall use. Causes contributing to use impairment are nutrients (nitrogen and phosphorus), siltation, suspended solids, and algae growth. Causes contributing to impairment were determined using water quality standards (narrative and numeric) and Illinois Water Quality Report 2000 water quality criteria and guidelines. The applicable general use water quality standards are specified in Title 35 of the Illinois Administrative Code, Subtitle C, Part 302. The applicable listing guidelines developed by the Illinois EPA for narrative standards are specified in the Illinois Water Quality Report 2000 (IEPA/BOW/00-005). This TMDL document addresses all currently identified impairments to Governor Bond Lake.

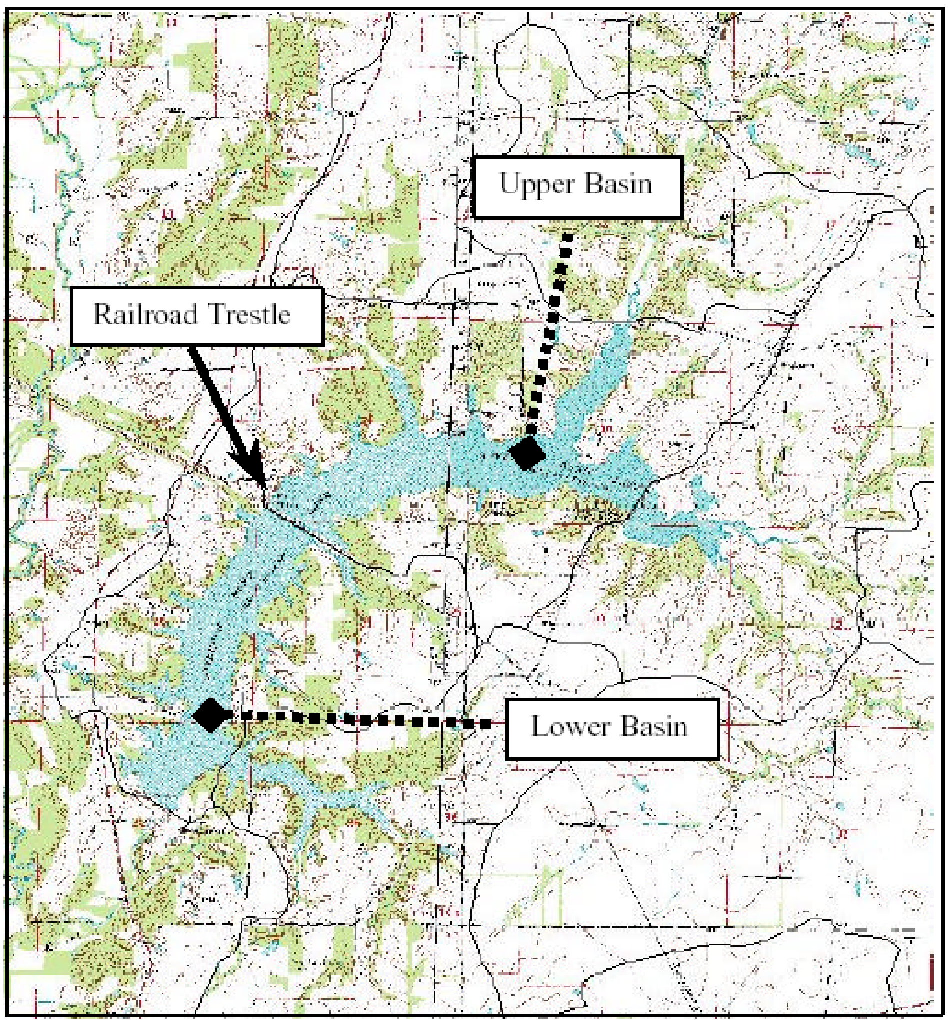
2.0 BACKGROUND INFORMATION

2.1 GENERAL CHARACTERISTICS

Governor Bond Lake was built in 1968 to 1970 as a water supply reservoir for the cities of Greenville, Mulberry Grove, Donnellson, and Smithboro. Currently, this lake also supports Royal Lakes and several rural customers for a total customer base of about 7,264 (IEPA, 2000a). The city of Greenville manages this reservoir and operates the surface water supply intake (Illinois Environmental Protection Agency [IEPA] #60096), which has three intake ports at varying depths. Governor Bond Lake is also heavily used for recreation. Permitted activities include fishing, boating, Scouts activities, and camping.

Governor Bond Lake has been effectively divided into two basins by a railroad trestle bisecting the lake (Figure 1-1). The two basins have significantly different physical and chemical properties that have affected recreational use and aquatic life support in each basin. TMDL assessment, however, is performed for whole lake systems.

Figure 1-1 Governor Bond Lake Basins



A partial shoreline survey completed in 1998 by Bond County indicates that shoreline erosion ranges from none (< 1 ft) to severe (up to 30-feet height of eroded bank), and highly eroded areas are associated with unprotected lake bank protrusions. Bank erosion was evident along approximately 1.25 miles of the surveyed shoreline.

Table 2-1 lists the general characteristics and Table 2-2 summarizes water quality characteristics of Governor Bond Lake as assessed in 1998 (based on 1996 data) and in 1999 (based on 1999 provisional Clean Lakes Program and IEPA data).

Table 2-1. General Governor Bond Lake Watershed Characteristics

Lake Surface Area	775 acres
Watershed Area	22,520 ac (re-projected SWAP geographic information system [GIS] data using in TMDL determinations); other organizations using different methods have measured slightly different areas (less than 2 percent difference)
Lake Depth	Mean depth = 13 ft (9 ft north basin, 20 ft south basin); Maximum depth = 24.5 ft
Lake Perimeter	31.39 miles
Lake Volume	9,900 acre-ft
Lake Retention Time	0.608 year
Major Inflows	Kingsbury Branch; Dry Branch
Major Outflows	Kingsbury Branch
Tributaries	8 miles of perennial, 5 miles of intermittent

SWAP = Source Water Assessment Program

Table 2-2. Governor Bond Lake Mean Concentration of Water Quality Constituents

Parameter	Upper Basin		Lower Basin	
	1996	1999	1996	1999
Chlorophyll-*a*, µg/L	36.3 (0.39)	90.2 (0.07)	19.7 (0.17)	78.0 (0.09)
Total Phosphorus, µg/L	208 (0.36)	149 (0.15)	115 (0.24)	84.2 (0.29)
Total Nitrogen, µg/L	1,446 (0.25)	731 (0.09)	1,248 (0.13)	828 (0.14)
Non-Volatile Suspended Solids, mg/L	38 (0.63)	21.8 (0.13)	27.1 (0.22)	13.0 (0.12)

Where:
µg/L = micrograms per liter = parts per billion
mg/L = milligrams per liter = parts per million
Value in parentheses = coefficient of variation

2.1.1 Lake Dissolved Oxygen Dynamics

Dissolved oxygen (DO) profiles show that anoxic (free oxygen depleted) conditions are observed at the bottom of both the lower basin and mid-basin sites sometime during the summer in all years monitored. Surface DO generally remains above six mg/L. The upper basin appears to be well mixed and DO remains at about six mg/L for all depths on most sampling dates. However, semi-monthly measurements would likely not detect episodic DO depletions. In 1993, DO fluctuated at the upper basin site, possibly attributable in part to July tributary inflows affecting lake mixing processes.

Lake mixing dynamics can greatly affect water quality in terms of chemical (nutrient) availability; the concentrations, location, and forms in which the chemical(s) are present. Phosphorus that settles out of the water column to the lake bottom is particulate-phosphorus and bound to the lake bottom sediment. This phosphorus generally is not available for aquatic plant growth and is not a water quality problem. However, if anoxic conditions occur at the lake bottom, it can result in re-release of the bound phosphorus. If there is no subsequent mixing of the water column, the dissolved phosphorus, resulting from the anoxic conditions, will remain at the lake bottom. If there is mixing (e.g., wind action or fish activity), this dissolved phosphorus is brought up to the surface where it is available for algal uptake and growth.

Anoxic conditions also can be created if there is highly active decomposition at the lake bottom in nutrient rich waters during warm weather, which accelerates decomposition rates. During active decomposition, DO is simply being used up faster than it can be replenished.

Anoxic conditions can also be created when lakes stratify. When a lake is stratified, new DO is prevented from being replenished because of lack of mixing. In typical midwestern lakes, lake stratification is a process based on formation of temperature differences in deep water bodies. Surface water gains (or loses) heat faster than wind action and temperature diffusion can mix the heat to lower depths. Warm water is less dense than cold water, so the warm surface layer "floats" on top of the colder, denser, deep water. Once this situation has occurred, the layers of water are essentially separated; there is a thermal resistance to mixing of water and chemicals. The surface layer is mixed, but does not mix with the lower, undisturbed layers. Over time, however, wind action and heat gain slowly catch up and the surface layer is slowly mixed deeper and deeper into the water column, until the thermal resistance to mixing the entire lake is removed. When this happens, the whole lake is able to mix again, resulting in "turnover." If this turnover happens during times of the year when aquatic plants such as algae are not actively growing (e.g., late fall), then the dissolved phosphorus released as a result of anoxic conditions does not contribute to water quality problems. If this happens during the active growing season, then the dissolved phosphorus can accelerate aquatic plant growth, resulting in nuisance algal blooms.

2.1.2 Limiting Nutrients

Total phosphorus (TP) is an essential, and often limiting, nutrient for plant growth. Therefore, TP often contributes to lake eutrophication (fertility) and algal blooms. Analysis of current and historical data shows that TP is slowly decreasing over time but it still exceeds both the Illinois Water Quality Standards (< 0.05 mg/L for reservoirs > 20 acres) and Illinois Water Quality Report 2000 guidelines (< 0.05 mg/L for non-impairment) at all sites.

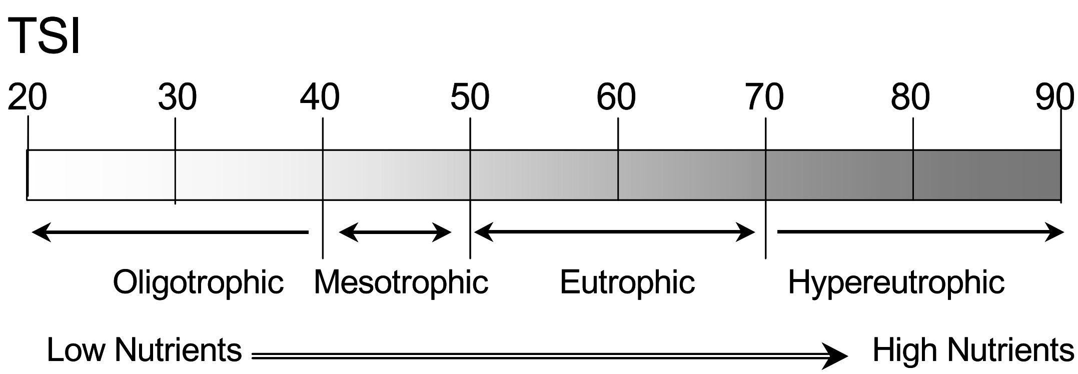
Nitrogen is another essential nutrient for plant growth; however, it is often so abundant that lack of nitrogen often does not limit algae growth, especially in water systems with low retention times (fast flowing systems). Some species of algae can also "fix" their own atmospheric nitrogen, so they do not need another source. With abundant nitrogen availability, any addition of the limiting nutrient (e.g., TP) results in rapid growth.

2.1.3 Trophic Status: Fertility Status

Trophic status often is used to describe the nutrient enrichment status of a lake ecosystem. Higher trophic status is equated with more nutrient availability and higher productivity. Generally, mesotrophic to eutrophic lakes are considered to be the best for supporting a variety of uses including fishing, aquatic life support, swimming, boating, and others. Excessive nutrient load to lakes can result in nuisance algal blooms and excessive turbidity. Very low nutrient status also can limit support of aquatic life by lack of a sufficient nutrient supply.

Carlson Trophic State Indexes (TSIs) use measured parameters as indicators of trophic status. These TSIs are based on TP concentration (TSI-TP), Chlorophyll-a concentration (TSI-Chla), or Secchi depth (TSI-SD). The individual indices are often averaged for an overall TSI. However, in general, TSI-TP is considered the best indicator of *potential* trophic status. The following diagram depicts the relationship between TSI, trophic status, and nutrient status according to IEPA guidelines.

Figure 2-1 Trophic State Index Relationship to Lake Fertility



Governor Bond Lake is considered to be eutrophic to hypereutrophic (fertile to highly fertile); Trophic State Indexes (TSI) are $\geq$ 50 < 70 for eutrophic lakes and $\geq$ 70 for hypereutrophic lakes. The 1998 Illinois 305(b) Report mean TSI-SD = 75.2, TSI-TP = 73.8, and TSI-Chla = 59.6, with the average TSI = 69.6. In 1999, these values were similar with TSI values as follows: TSI-SD = 73.7, TSI-TP = 67.6, and TSI-Chla = 72.4, with and overall TSI of 71.2.

2.1.4 Hydrology

Governor Bond Lake is a constructed reservoir on the Kingsbury Branch within the Shoal Creek Watershed HUC (07140203). As a Public Water Supply system, outflow is controlled by a rectangular dam (40 ft high and 1,200 ft long) with a gravity driven maximum discharge of 15,568 cfs. Normal reservoir storage as-built (original volume) is 9,900 acre-ft and maximum storage is 22,400 acre-ft (USEPA, 1999b.). Siltation of the reservoir has resulted in current storage volume of 6,324 acre-ft (Illinois State Natural History Survey, 1994) to 4,874 acre-ft (Bond County SWCD, 1999) or a reduction in storage capacity of 36 to 51 percent. Water supply withdrawals average 1.27 million gallons per day (MGD) (IEPA, 2000a). Withdrawals remain fairly constant throughout the monitoring season and are listed below (gallons):

Table 2-3. Monitoring Season Withdrawals from Governor Bond Lake

Month	Volume (gals)
Apr-99	37,506,000
May-99	41,231,000
Jun-99	38,234,000
Jul-99	41,059,000
Aug-99	41,781,000
Sep-99	40,435,000
Oct-99	41,783,000

Source: city of Greenville

No U.S. Geological Survey (USGS) gauging stations are located along this section of the Kingsbury Branch. However, because a low-head rectangular dam controls outflow, daily lake levels can be used to determine discharge rates with a broad-crested weir equation. Staff gage readings were recorded daily in 1999 as part of the Clean Lakes Program study and were used to approximate discharge rates using the weir equation. During dry conditions (mid to late summer and winter), no discharge occurs; water levels are below the dam height.

Bottom seepage rates are unknown and are therefore assumed to be negligible. Model analysis supports this assumption because no significant water balance residuals occurred implying seepage loss or gain.

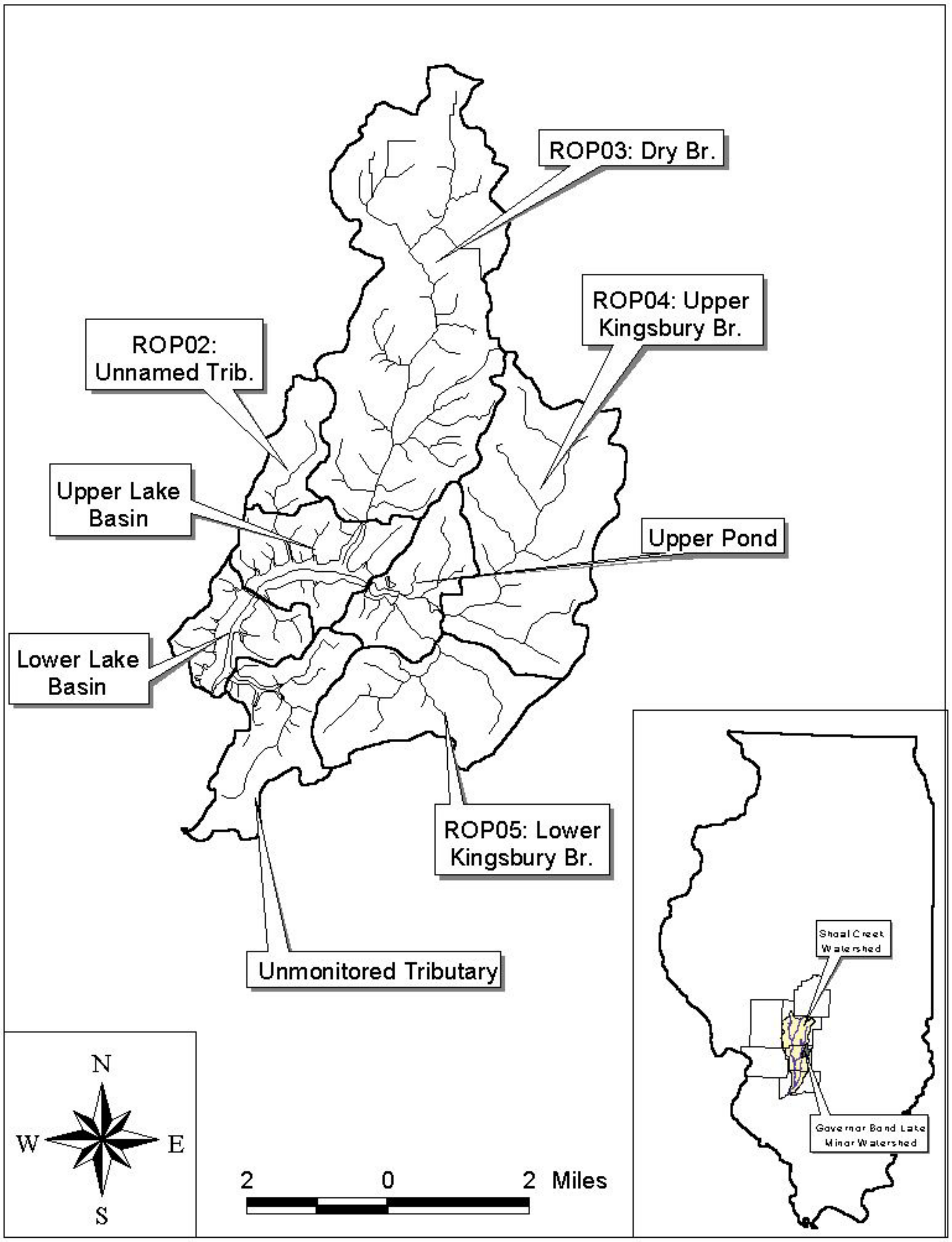
Average annual precipitation at the Greenville station (ID 113693) is approximately 39.2 inches (standard deviation 6.3 inches) for the past 13 years of record (1987 through 1999; there were some missing values in the years from 1989 through 1992). Most of the precipitation (55 percent) occurs between April and September (monitoring season) (Midwestern Regional Climate Center, 2000).

2.2 WATER BODY SETTING AND LAND USE

2.2.1 Water Body Setting: Watershed Characteristics

Governor Bond Lake is located approximately 1.5 miles north of the city of Greenville in Bond County, Illinois (Figure 2-2). Its outlet dam is located in Section 35 of LaGrange Township. The lake's watershed is located mainly within Bond County but also extends into the southeastern portion of Montgomery County.

Figure 2-2. Governor Bond Lake Location and Modeled Subwatersheds



Soils within the watershed are primarily silt loams formed under either native forest or prairie vegetation, in loess deposits overlying glacial tills. Forest soils are found on the uplands and on slopes with drainage characteristics depending upon landscape position. Prairie soils are generally somewhat poorly to poorly drained and are found in the low areas and depressions. The underlying glacial tills in this watershed tend to be less permeable and often create an impediment to downward drainage. Water infiltrating through the surface loess encounters the less permeable glacial till and either starts ponding there, if topography is fairly flat, or starts moving laterally along the interface towards streams and lakes, if topography is sloped. Upland soils in this watershed are generally poorly- to somewhat poorly-drained; however, flooding is rarely a problem, because landscape geomorphic processes have resulted in an extensive drainage network over time.

2.2.2 Land Use

Land use within the watershed is primarily row-crop agricultural followed by forest and pasture (GBL Committee, 1998; Illinois EPA, 2000a). The major row crops grown in this region are corn, soybeans and wheat. Some grain sorghum also is produced in this watershed. Much of the strongly sloping agricultural lands are planted to permanent vegetative cover, and forested lands occur along major streams and tributaries. About 2,800 acres of land in the watershed are enrolled in the Conservation Reserve Program (CRP), planted to a mixture of cool season grasses and legumes. This acreage is variable with new enrollments and turnover occurring each October.

Land use distribution used for modeling the watershed is summarized in Table 2-4. Land use used in modeling is a combination of land use data from NRCS data as presented in the Governor Bond Lake Resource Plan (Bond County SWCD, 1999a), GIS data from the Source Water Assessment Program (IEPA, 2000a), and GIS data from the BASINS model data set (USEPA, 1999b). Differences may exist between the total area used in modeling and those from other sources, because different methods were used to calculate land uses. These differences are minimal (less than 2 percent).

Table 2-4. Land Use Distribution Used for Modeling the Governor Bond Lake Watershed

Land Use	Acres	Percent of Total
Cropland	12,580	55.8 percent (15.7 percent of Cropland in CRP)
Grass/Pasture	6,270	27.8
Forest	2,250	10.0
Urban	80	0.4
Transportation	40	0.2
Water/Wetlands	1,300	5.8
Total	22,520	100

Nine farms in the watershed are feedlot or open pasture livestock operations. Six farms are approximately 100-head cattle (dairy and beef) operations, and three farms are approximately 300-head hog operations (GBL Committee, 1998).

2.3 POPULATION CHARACTERISTICS, WILDLIFE RESOURCES, AND OTHER RELEVANT INFORMATION

2.3.1 Population Characteristics

Current population of the city of Greenville and Bond County are 6,955 and 17,633, respectively (U.S. Census Bureau, 2001). There are 175 farms in the Governor Bond Lake watershed and farm sizes average 285 acres per farm. Although most of the area is in rural agriculture, 118 houses comprise lakeshore developments.

According to the Governor Bond Lake Resource Plan (GBL Committee, 1998), there are no documented sites of cultural significance in the Governor Bond Lake watershed. However, the Bond County area does have some recorded pre-historic and historically significant sites. Consequently, a potential remains for the existence of such sites in this watershed, especially since many historical sites are located close to watercourses.

2.3.2 Biotic Resources

2.3.2.1 Aquatic Vegetation

The Governor Bond Lake Resource Plan (GBL Committee, 1998) notes that Illinois Department of Natural Resources (IDNR) Fisheries Biologists report little aquatic vegetation in the northern end of the lake. Some cattails are found at the tributary inlets/backwater areas and some water willow grows very close to the edges (ZEIS, 2001). Because Governor Bond Lake is a reservoir, its steep sides inhibit aquatic macrophyte (rooted aquatic plants) growth, and consequently, results in reduced cover for young fish. The upper basin is shallower and has aquatic macrophytes growing within the tributary inlets that may somewhat compensate for the other negative fish habitat characteristics of the upper basin.

2.3.2.2. Fisheries

According to the IDNR, Governor Bond Lake historically has been an excellent channel catfish fishery that has been annually stocked by the state hatchery. A survey conducted in 1994 through 1995 noted that the population declined, resulting in fishing limits placed on harvesting of young and reproducing catfish. Since then, catfish population has improved and regulations on trotline and jugs have been removed. The city of Greenville took over channel catfish stocking in 2000. Bluegill population in Governor Bond Lake has been excellent since 1990. There was a decline in populations according to the 1996 survey, but current populations are within lake management plans goals. Largemouth bass population in Governor Bond Lake has been gradually increasing since 1986 and continued improvement is forecast. Largemouth Bass six to eight inches in size are stocked by the city of Greenville. White crappie population in Governor Bond Lake peaked in 1998 and should remain stable for several years. Current populations are well within Lake Management Plan goals. Gizzard shad population in Governor Bond Lake has been well within Lake Management Plan goals since 1992, except for 1994 when there was a slight reduction in populations. Goals for small and medium predators were exceeded by more than 10 times in 1999 and the majority of the population is within the size class available. Stocking of tiger muskie and hybrid striped bass has historically been unsuccessful, presumably due to high temperatures, high turbidity and low dissolved oxygen (IDNR, 2000).

2.3.2.3 Terrestrial Vegetation

As mentioned earlier, most of the vegetation in this watershed is row crop agriculture (corn and soybeans with some grain sorghum) and pasture/CRP (cool season grasses and legumes). Most of the forest land is confined to riparian areas and is composed of red, white and black oaks; shagbark hickory; American elm; silver, red, and sugar maples; box elder; sycamore; hackberry; and persimmon. Nearly 80 percent of the timber is owned by private parties and is immediately adjacent to the lake or its tributaries.

No threatened or endangered plant species have been identified in the Governor Bond Lake watershed, however several have been found in the overall Bond County area (ZEIS, 2001).

2.3.2.4 Terrestrial Fauna

The IDNR performed a Natural Heritage Database search for presence of endangered or threatened species, Illinois Natural Area Inventory sites, or dedicated Illinois Nature Preserves within the Governor Bond Lake watershed in 1998. A species record for the Black-Crowned Night Heron was found for the eastern end of the lake, which was recorded during an Atlas survey by IDNR in 1992. Therefore, any activities and methods recommended in the feasibility study for Phase II, and consequently for TMDL implementation, should avoid adverse impact to this species and its habitat.

As part of the Clean Lakes Program Phase I Study, a bird survey was conducted from July 18, 1999, through May 8, 2000 (ZEIS, 2001). Fourteen counts were acquired between July 18,1999, and November 11,1999, and seven counts were performed from April 3, 2000, through May 8, 2000. Seventeen species were identified with maximum number per day ranging from one (tern, osprey, and cattle egret) to over 50 (mallard and double crested cormorant). No Black-crowned night heron were identified.

About 1,600 hogs and cattle are present in the watershed, as well as some livestock sheep and exotic animals. The majority of hogs are raised in confined feedlot systems, however some are produced in a combination of feedlot and free-range systems. The cattle, sheep, and exotic animals are raised in mostly open-pasture and feedlot systems.

2.4 PRESENT AND FUTURE GROWTH TRENDS

Growth between 1990 and 1999 reflected a 33 percent increase in the city of Greenville population and 9 percent increase in Bond County population (GBL Committee 1999). If trends continue through 2010, the city of Greenville population will increase to 8,560.

The current rate of new housing development is about eight houses per year, reflecting a 33 percent increase in development rate since 1995[1]. Projected development around Governor Bond Lake for 2010 would be an additional 102 houses, bringing the total to 220, or 95 percent of full development. Maximum development (number of sites available for development) is 232 sites[2] and would be reached in less than 15 years.

[1] Personal communication, Mary Cross, City of Greenville, 2000.
[2] Personal communication, Crystal Lingley, Bond County Health Department, 2001.

No sediment or erosion control practices are currently part of the permitting process for construction activities[3]. Bare soil surfaces associated with construction can result in more than 20 tons per acre per year soil loss. This, coupled with development in close proximity to Governor Bond Lake, means that eroded soils are more likely to be discharged directly into Governor Bond Lake.

2.5 DESCRIPTION OF POINT AND NONPOINT SOURCES

This section provides an inventory and description of potential sources of pollutants associated with the water quality impairment, noted in the preceding section for both point and nonpoint sources within the watershed. Loads were determined through modeling efforts and analysis of monitored data.

2.5.1 Point Sources

There is only one minor point source discharger in the Governor Bond Lake watershed, the Gateway Retreat Center, which discharges into a roadway ditch leading to the lake. Flow rate for this discharger is 0.0160 MGD for 2 to 3 months each year. This discharger has no permitted limits and is only required to report quantities discharged.

Reported total potential point source load per year to Governor Bond Lake is 7.5 lbs of BOD (3.4 kg), 5.4 lbs of total suspended solids (2.5 kg), and 1.6 lbs of Ammonia (0.7 kg) (IEPA, 2000c).

2.5.2 Nonpoint Sources

The non-point source sediment and nutrient loads are from a variety of sources. Row-crop agriculture and upland stream bank erosion are major contributors. Other sources include pastures, construction sites, and shoreline and gully erosion. Nutrient load sources also include on-site septic systems and animal feedlots.

Watershed topography is fairly flat, but many soils are not very permeable. Low permeability results in water, nutrients, and fine sediment washing off of the surface into streams during storm events. Water that does not infiltrate will quickly reach the stream system. The resulting high-energy, sudden peak flows can severely erode stream banks and carry large sediment loads to the lake. Areas with topsoils that are permeable, on the other hand, often have an impermeable layer below. Consequently, excess nutrients may be washed into the soil and travel horizontally along the impermeable layer to lakes and streams. Due to these runoff and transport characteristics, both surface and subsurface nutrient contributions in this watershed can be high: modeled surface runoff concentration N is >8.0 mg/L and subsurface groundwater N is > 3.0 mg/L).

Areas around tributary inlets, in particular Dry Branch Creek, experience a large amount of backwater effect and may act similar to wetlands. While these quiet water areas can trap sediment and nutrients, periodic drying and flushing of these resources can also result in phosphorus re-release and flushing.

Fields that are cropped or pastured all the way to stream banks can contribute both sediment and nutrients to water bodies. Lack of buffer/filter strips results in inadequate trapping of particulates, uptake of dissolved nutrients, and infiltration of water and nutrients. Grazed pasturelands are often bisected by

[3] Personal communication, Dan Mueller, NRCS, 2000.

tributaries. Livestock passage through and within tributaries stirs up previously deposited sediment, destroys stream banks and riparian vegetation, and contributes to accelerated stream bank erosion.

Siltation of Governor Bond Lake has been significant due to both eroded sediment transport from upland streambank erosion and lakeshore erosion. As-built lake volume (1970) is reported as 9,900 acre-ft. Sediment/erosion surveys were conducted in 1990 by the Illinois Natural History Survey (INHS), in 1995 by the NRCS, and in 1999 by the Zahniser Institute for Environmental Studies (ZEIS, 2000). The INHS determined the lake volume to be 6,324 ac-ft, and the NRCS measured a lake volume of 5,026 acre-ft five years later. These volumes are not necessarily comparable due to different methods used, however, they do provide an estimate of lake in-filling since completion. Approximately one-third to one-half of the entire lake volume has been lost due to siltation. This is a large reduction in storage capacity that has affected aquatic life and recreation. However, it has not yet threatened the lake's designated use as a water supply. Eventually, decreasing storage volume may affect public water supply support, as local population increases.

Nonpoint source loads were determined by modeling watershed processes using measured and defined watershed characteristics. A suite of models were chosen for their ability to describe the system, model pollutants of concern, and make full use of available data while minimizing assumptions and default conditions. Details of this process are included in the associated document, Hydrologic and Water Quality Modeling of Governor Bond Lake (Appendix A).

The model FLUX (a stream loading computation model) was used to calculate annual flow-weighted average nutrient (total and dissolved nitrogen and phosphorus) and non-volatile suspended solids (NVSS) loads from each of four subwatersheds whose tributaries were sampled and monitored under the 1999 Clean Lakes Program water quality monitoring program. Resulting values were then used to calibrate the runoff and sediment nutrient concentrations of the watershed model, GWLF (Generalized Watershed Loading Function). GWLF incorporates watershed characteristic data (e.g., soils information, land use, cropping factors, septic systems, and others), Universal Soil Loss Equation (USLE) processes, and other processes to model sediment and nutrient transport for a watershed. GWLF is a steady-state model that uses daily climate data and provides monthly or annual loading rates. The model was run for 13 years (1987 though 1999) and loads were assessed for a dry year (1989), a wet year (1993), a normal year (1996), and the calibration year (1999). Table 2-5 lists the nonpoint source loads from each subwatershed for dry, wet, normal, and calibration year climatic conditions.

Table 2-5 Nonpoint Source Loads

Contributor	Nonpoint Source Load			Contributor	Nonpoint Source Load		
	TP	TN	Sediment		TP	TN	Sediment
	kg/yr	*kg/yr*	*Mg/yr*		*kg/yr*	*kg/yr*	*Mg/yr*
1989: Dry Year				**1996: Normal Year**			
Dry Br.	1,600	18,868	8,867	Dry Br.	3,139	26,552	11,762
Kingsbury Br.s	7,905	72,987	7,366	Kingsbury Br.s	11,429	99,455	9,771
Direct Watersheds	1,734	9,789	3,816	Direct Watersheds	2,840	13,283	8,617
Other	1,307	7,873	3,444	Other	1,860	9,989	4,565
Atmospheric	106	1,705	-	Atmospheric	106	1,705	-
Internal	2,353	-	-	Internal	17,730	-	-
Total	13,405	92,354	23,493	Total	33,965	124,432	34,715
1993: Wet Year				**1999: Wet-Normal Year**			
Dry Br.	2,876	29,061	10,984	Dry Br.	3,139	20,300	8,988
Kingsbury Br.s	12,405	106,597	9,125	Kingsbury Br.s	9,530	76,481	7,466
Direct Watersheds	2,848	13,491	10,065	Direct Watersheds	2,522	10,633	6,700
Other	2,177	12,036	4,263	Other	1,641	10,324	3,489
Atmospheric	106	1,705	-	Atmospheric	106	1,705	-
Internal	32,732	-	-	Internal	5,114	-	-
Total	50,268	133,829	34,437	Total	18,913	99,143	26,643

Where:
Other = two unnamed minor tributaries
Mg/yr = Megagrams per year or metric tons per year
TN = total nitrogen
TP = total phosphorus

Atmospheric deposition of nitrogen is 1705 kilograms per year (kg/yr) (Puckett, 1993) and phosphorus is 106.2 kg/yr (Litke, 1999). For model purposes, 50 percent of each pollutant was assumed to be in the dissolved form and 50 percent in the particulate form. No information was available on the exact proportion in each form for these pollutants; therefore it was assumed that they were in the same proportion as the model default parameters.

Decisions and assumptions in the modeling process were conservative to err on the side of caution. Because only four of the eight subwatersheds delineated for modeling were monitored, averages of the calibrated parameters were used for the remaining subwatersheds. It should also be noted that missing discharge measurements, movement of staff gages, and non-ideal conditions for tributary flow measurements result in differences between modeled and measured flow situations. However, because the GWLF watershed model is, to a large extent, process-based, loads will be reasonably modeled even without calibration.

For modeling septic systems, it was assumed that each system served three people for nutrient loading functions. The model does not separate drainfield versus aeration on-site septic systems, thus aeration systems were modeled as ponded systems. Ponded systems are handled by assuming surface discharge to the water body in the same month. Only septic systems surrounding Governor Bond Lake were included, since septic system contributions in other parts of the watershed will be accounted for in GWLF groundwater flow concentrations.

An additional 25,700 tons per year (23,310 megagrams per year) could be contributed by gully, ephemeral gully, and stream bank erosion (Bond County SCWD, 1998). An additional 404 tons/yr (366

Mg/yr) can be attributed to shoreline erosion (ZIES, 2001). These values effectively double the sediment load to Governor Bond Lake compared to sheet and rill erosion **(see Appendix C, comments #31 and #48, pages 12 and 15,)**.

2.6 DESCRIPTION OF NATURAL BACKGROUND LOADS FOR POLLUTANTS OF CONCERN

Certain levels of many constituents occur naturally in waters; these levels define background loads. Governor Bond Lake, however, is a constructed reservoir; physical modifications have changed watershed characteristics. Furthermore, background conditions would apply to a flowing stream, rather than the reservoir that is Governor Bond Lake. Assessment of all background loads separate from load allocations is not possible. Consequently, nonpoint source runoff background loads are included as part of the load allocations presented in Section 5.0.

Atmospheric deposition at a minimum can be considered background sources of the nutrients nitrogen and phosphorus. These deposition rates are 1,705 kg/yr total nitrogen (Puckett, 1993) and 106.2 kg/yr phosphorous (Litke, 1999).

2.7 ANALYTICAL BASIS FOR EXPRESSING THE TMDL THROUGH SURROGATE MEASURES

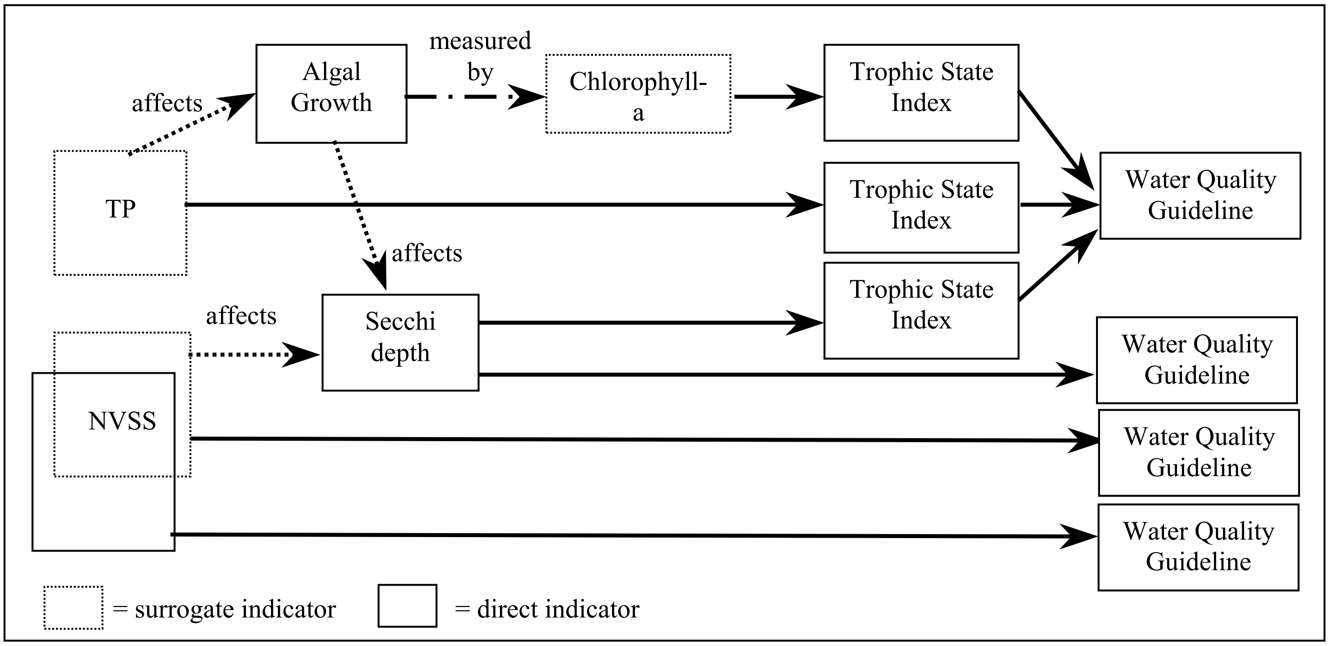
The use of surrogate measures as indicators of impairment is necessary in many cases because it is not possible or reasonable to directly assess the cause contributing to impairment. Specific causes considered to contribute to failure to meet these guidelines are nutrients, excessive algal growth, excessive sediment inputs, and siltation rate.

Algal growth is directly related to nutrient abundance and light availability for photosynthesis. For nutrients, algal growth was found to be dependent only on the nutrient phosphorus (TP) and not the nutrient nitrogen (TN) in Governor Bond Lake; in the lake eutrophication and nutrient cycling model, BATHTUB, algal growth was best simulated by the sub-model incorporating only TP, light, and reservoir flushing rate. Consequently, TP can be considered the surrogate indicator for the whole nutrient TMDL, as well as a surrogate indicator of algal growth. Chlorophyll-a is a plant pigment and its abundance in water is highly correlated with the amount of algae present.

Sediment is measured by determining all suspended solids in the water column and subtracting those that are volatile (organic material such as algal biomass). This suspended sediment is the Non-Volatile Suspended Solids (NVSS). NVSS and basin retention factors are used as surrogate measures for short-term lake siltation rates. Some of the sediment will settle out; the resulting NVSS will be only a fraction of what entered the lake. The estimated amount of sediment retained in the basin is a reasonable indicator of volume loss per year; however, detailed bathymetry measurements should be completed on a longer term (e.g., 5-year) basis in order to compare estimated siltation rates with actual lake volume loss.

Figure 2-3 depicts some of the relationships between indicators, surrogate indicators, and water quality guidelines.

Figure 2-3. Relationship Between Surrogate Indicators and Water Quality Guidelines



3.0 DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND NUMERIC WATER QUALITY TARGET GOALS

All waters of Illinois are assigned one of the following four designations: General Use Waters, Public and Food Processing Water Supplies, Lake Michigan, or Secondary Contact and Indigenous Aquatic Life Waters. Illinois waters must meet General Use water quality standards unless they are subject to another specific designation (Illinois Adm. Code 35, subtitle C Section 302.201). The General Use standards will protect the State's water for aquatic life (except as provided in Section 302.213), wildlife, agricultural use, secondary contact use, and most industrial uses, and ensure the aesthetic quality of the state's aquatic environment. Primary contact uses are protected for all General Use waters whose physical configuration permits such use. Public Water Supply standards are cumulative with the general use standards.

Impairment assessment is based on the guidelines outlined in the Illinois Water Quality Report 2000 (IEPA, 2000b) and water quality standards promulgated through Illinois Adm. Code 35, Subtitle C. TMDLs will be developed for all causes contributing to impairment.

Table 3-1. Governor Bond Lake Designated Use Impairments (305(b) list).

Designated Use	Support Status
Overall Use	Partial Support
Recreation	Partial Support
Aquatic Life	Full
Fish Consumption	Full
Swimming	Partial Support
Drinking Water Supply	Full

Source: Illinois Water Quality Report 2000

3.1 APPLICABLE ILLINOIS WATER QUALITY STANDARDS

Governor Bond Lake was assessed as not meeting its designated uses because it exceeds Secchi depth (lack of water clarity), TSI (Trophic State Index), siltation rate (lake storage volume loss), or NVSSs (suspended sediments) designated use guidelines, or for a combination of these factors. The applicable listing criteria developed by the Illinois EPA for narrative standards are specified in the Illinois Water Quality Report 2000 (IEPA/BOW/00-005). Applicable General Use water quality standards are specified in Title 35 of the Illinois Adm. Code, Subtitle C, Part 302. Quantitative standards are identified in the table below.

Table 3-2. Illinois Water Quality Standards for Causes Contributing to Impairment of Governor Bond Lake.

Parameter	Description of Water Quality Standards
Nitrogen	Total Ammonia-N shall in no case exceed 15 mg/L (standard). Unionized-Ammonia shall not exceed the acute and chronic standard provided in Section 302.212, Ill. Admin. Code (standard): Apr - Oct Acute 0.33 mg/L Chronic 0.057 mg/L Nov-Mar Acute 0.14 mg/L Chronic 0.025 mg/L For Drinking Water Supply, ≤ 20 percent of samples ≥ 10.0 ppm Nitrate-N with mean < 5.0 ppm (standard)
Phosphorus	Phosphorus as P shall not exceed 0.05 mg/L in any reservoir or lake with surface area of 8.1 hectares (20 acres) or more, or in any stream at the point where it enters any such reservoir or lake (standard).

3.2 OTHER APPLICABLE NUMERIC OR NARRATIVE WATER QUALITY STANDARDS, CRITERIA, AND GUIDELINES

Governor Bond Lake is impaired due to exceedance of narrative standards for nutrients (nitrogen and phosphorus), siltation, suspended solids, and excessive algal growth (Chlorophyll-a). The narrative standard states that:

Offensive Conditions: "Waters of the State shall be free from sludge or bottom deposits, floating debris, visible oil, plant or algal growth, color or turbidity of other than natural origin."

Criteria for determining impairment and guidances for water quality parameters values for non-impaired conditions are provided in the Illinois Water Quality Report 2000 (IEPA, 2000b). The following table lists water quality parameters for full support waters. Fecal coliform and macrophyte coverage are also considered to be potential causes contributing to impairment; however they were not measured or assessed and are therefore not included in this table.

Table 3-3. Illinois Water Quality Guidelines

Designated Use	Water Quality Guidelines		
Swimming	**TSI**	**Secchi Depth (m)**	
Full Support	< 55	> 0.6096	
Partial Impairment	≤ 75	< 0.6096	
Recreation	**TSI**	**NVSS (mg/L)**	
Full Support	< 60	< 3	
Full Support	≤ 55	< 7	
Aquatic Life	**TSI**	**NVSS (mg/L)**	
Full Support	< 85		
Full Support	< 90	< 20	
Additional Applicable Guidelines	**TP (mg/L)**	**Siltation (percent Orig. Vol.)**	**Chlorophyll-a (µg/L)**
Full Support	< 0.050	< 0.25	< 20
Partial Impaired	< 0.140	< 0.75	< 92
	NVSS (mg/L)		
Full Support	< 12		

Source: Illinois Water Quality Report 2000.

Evaluation of impairment is determined by both the magnitude of numeric criteria/standard/guidance exceedance and by the combined effect of all exceedances. Impairment is determined by:

1.) Assigning points for various levels of pollutants or indicators of water quality based on whether impairment caused by the particular environmental indicator is considered high, moderate, or slight (IEPA, 2000b)
2.) Summing points to obtain an overall use impairment rating for each designated use
3.) Assigning impairment support classifications and index based on total rating (full, partial, and non-support)
4.) Averaging all individual use impairment indices to obtain General Use assessment

Consequently, a water body can exceed a particular standard/criteria/guidance once but still be considered to fully support the designated use. If the magnitude of exceedance is within the ranges identified in the Illinois Water Quality Report 2000 (IEPA, 2000b) and if the combined effect of any other measures is within the ranges identified in the report, then the water body may still be considered to fully support its designated use.

3.3 TMDL ENDPOINTS

Based on the standards and guidelines presented above, target water quality values were chosen to reflect the conditions to be considered acceptable for the most sensitive designated uses. In order to meet all designated uses, the water body must meet the guidelines or standards identified for the most sensitive use. Consequently, the most stringent values will serve as the endpoints for the TMDL analysis. In this case, the Swimming use guidelines for TSI and Secchi depth, the Recreation guidelines for NVSS, and the additional applicable guidelines for chlorophyll-a, TP, and siltation rate will serve as TMDL endpoints. Compliance with the below target water quality values will result in assessment as 'full support' for all currently impaired designated uses:

Table 3-4. TMDL Endpoints

Parameter	**TMDL Endpoint**	**Surrogate or Direct Measurement for Water Quality Guideline?**
Trophic State Index (TSI)	< 55	Direct measure
Non-Volatile Suspended Solids (NVSS)	< 7 mg/L	Surrogate for siltation rate; direct measure for sediment
Secchi Depth	> 0.6096 m	Direct measure
Total Phosphorus (TP)	< 0.050 mg/L	Surrogate for nutrients
Chlorophyll-a	<0.020 mg/L	Surrogate for algal growth

4.0 LOADING CAPACITY - LINKING WATER QUALITY AND POLLUTANT SOURCES

Sediment and nutrient loads to Governor Bond Lake were modeled using the General Watershed Loading Functions (GWLF) model. GWLF is a moderately simple watershed-scale model developed for assessing point and nonpoint source sediment, nitrogen, and phosphorus loads from rural and urban watersheds. In addition to erosion and sediment transport modeling, this model can also assess loads from septic systems, an important consideration given the nature of soils in this region and the proximity of on-site septic systems to water bodies.

To model the effect of loads and load reductions on in-lake water quality, we used a eutrophication and nutrient cycling model, BATHTUB v. 5.4, developed by the US Army Corps of Engineers for modeling reservoirs. BATHTUB requires simple inputs and is suitable for modeling seasonal nutrient cycling processes, including algal growth (chlorophyll-a concentrations), Secchi depth, nutrient decay, and others. GWLF concentrations were input into BATHTUB for analysis of effects on water quality. Internal sub-models for nutrient cycling functions were selected based on calibration to 1999 water quality monitoring data (the most complete data set).

Table 4-1. Effect of Pollutant Loads on Lake Water Quality Modeled Using BATHTUB

Year/ Parameter	Current Value	Year/ Parameter	Current Value	Units
1989: Dry Year		**1996: Normal Year**		
TP Load: 13,400 kg/yr		**TP Load: 33,970 kg/yr**		
TN Load: 92,350 kg/yr		**TN Load: 124,430 kg/yr**		
TSI	82	TSI	70.8	
SD	0.36	SD	0.44	*m*
TP	129.4	TP	166.4	*ug/L*
TN	1757	TN	1340	*ug/L*
TN/TP	13.6	TN/TP	8.1	
Chla	117.9	Chla	28.9	*ug/L*
1993: Wet Year		**1999: Wet- NormalYear**		
TP Load: 50,270 kg/yr		**TP Load: 18,910 kg/yr**		
TN Load: 133,800 kg/yr		**TN Load: 99,140 kg/yr**		
TSI	77.6	TSI	73.7	
SD	0.38	SD	0.27	*m*
TP	188	TP	120.4	*ug/L*
TN	1252	TN	760	*ug/L*
TN/TP	6.7	TN/TP	6.3	
Chla	97.4	Chla	84.5	*ug/L*

TSI = mean of Chlorophyll-a and TP Trophic State Indexes
SD = Secchi Depth
TP = Total Phosphorus
TN = Total Nitrogen
Chla = Chlorophyll-a
TN/TP = TN to TP ratio; a measure of limiting nutrient
ug/L = parts per billion, or micrograms per liter

Cycling processes will not behave consistently during different climatic conditions due to temporal variability and loading history effects on water quality. Consequently, after the sub-model functions were chosen based on 1999 water quality monitoring data, their coefficients within BATHTUB were calibrated for three climate conditions (dry, wet, and normal precipitation years) where in-lake water quality data was also available. Following calibration for initial conditions, input values (nitrogen and phosphorus tributary concentrations) were adjusted to determine load reductions and corresponding nutrient concentrations that are needed to achieve the in-lake TMDL endpoints listed above (Section 3.0).

However, while BATHTUB can model nutrient cycling well, it is not as well suited for modeling sediment and siltation processes. For siltation processes, a spreadsheet model was used to determine the difference between modeled sediment concentrations in tributary inflows and sediment (NVSS) concentration in the lake water column. This difference is the amount of sediment retained in the lake. The amount of sediment retained in the lake expressed relative to inflow concentration provides the proportion of incoming sediment that is retained in the lake. The amount of sediment retained, expressed on a volume basis, provides an indication of volume loss, or siltation rate.

Table 4-2. Effect of Sediment on Lake Siltation

				Proportion of Sediment Retained in the Lake			As-Built Volume Loss				
Year	Climate Condition	Direct Inflow	Direct Inflow + Upstream	Sediment Concentration in Inflows	NVSS Concentration in the Lake	Proportion Retained*,**	Runoff Load in	Shoreline Erosion ****	Load Retained in Lake	Volume of Load Retained	As-Built Vol. Loss ***
			Hm3	*mg/L*	*mg/L*		*Mg*		*Mg*	*Acre-ft*	*%*
1989	Dry	17.7	26.3	0.923	0.030	0.87	22170	28300	44107	24.3	**0.246**
1993	Wet	36.3	53.6	0.560	0.021	0.82	27464	28300	45459	25.1	**0.253**
1996	Normal	36.3	53.6	0.600	0.027	0.73	29409	28300	42123	23.2	**0.235**
1999	Wet-Normal	37.2	54.4	0.452	0.019	0.78	22473	28300	39372	21.7	**0.219**

Where: Hm3 = 1,000,000 cubic meters
* Upper Pond sediment retention assumed to be 80%
** Upper Lake Basin assumed retention for years was the same as 1999 due to lack data for the previous years
***As-Built Volume = 9,900 Acre-ft
****From Zahniser Institute of Environmetal Studies 2001 Clean Lakes Program Report = estimate

Load reductions necessary to meet target NVSS goals are calculated by determining the percent reduction in in-lake concentration required to meet NVSS concentration endpoints (Table 4-3). These percent reductions are then applied to the total input load to determine the necessary load reductions. For example, for NVSS to be less than 3 mg/L in dry years, 90 percent (19,936 Mg) of the incoming load must be removed.

Table 4-3. Sediment Pollutant Load Reductions Necessary to Meet Various Target NVSS Concentrations.

		Measured			Load Reductions Necessary to Meet Target NVSS Ranges									
Year	**Climate**	**Input Load**	**Load Retained**	**In-Lake Concentration**	**NVSS < 3 mg/L**		**NVSS >=3 to 7 mg/L**		**NVSS >= 7 to 12 mg/L**		**NVSS >= 12 to 15 mg/L**		**NVSS >= 15 to 20 mg/L**	
		Mg	*Mg*	*mg/L*	*Load (Mg)*	*%*	*Load (Mg)*	*%*	*Load (Mg)*	*%*	*Load (Mg)*	*%*	*Load (Mg)*	*%*
1989	Dry	22170	20922	30	19936	90	16957	76	13233	60	10254	46	7275	33
1993	Wet	27464	25613	21	23566	86	18369	67	11873	43	6676	24	1479	5
1996	Normal	29409	26954	27	26179	89	21873	74	16489	56	12183	41	7876	27
1999	Wet-Normal	22473	20779	19	18911	84	14162	63	8225	37	3476	15	0	0

5.0 LOAD ALLOCATIONS (LA) AND WASTELOAD ALLOCATIONS (WLA)

5.1 REDUCTIONS NEEDED TO SATISFY THE TMDL

The assimilative capacity of the lake was established by determining the input stream loads or concentrations that will not result in violations of the applicable standards or guidelines during either wet, dry, or normal climate conditions. The concentrations were determined using the calibrated BATHTUB model. The percent load reductions from each source necessary to meet the TMDL endpoints were the same as the percentage reduction in concentrations.

Table 5-1. Initial Values for TMDL Endpoints and Final Values Following Load Reductions

Year/ Parameter	Initial Value	After Load Reduction	Year/ Parameter	Initial Value	After Load Reduction	Units
1989: Dry Year			**1996: Normal Year**			
TSI	82	54.5	TSI	70.8	54.5	
SD	0.36	1.04	SD	0.44	0.53	*m*
TP	129.4	24.9	TP	166.4	46.6	*ug/L*
TN	1757	1757	TN	1340	1340	*ug/L*
Chla	117.9	19.2	Chla	28.9	7.62	*ug/L*
1993: Wet Year			**1999: Wet- NormalYear**			
TSI	77.6	53.5	TSI	73.7	55.7	
SD	0.38	0.99	SD	0.27	0.37	*m*
TP	188	29.4	TP	120.4	27.9	*ug/L*
TN	1252	1236	TN	760	760	*ug/L*
Chla	97.4	11.06	Chla	84.5	18.9	*ug/L*

TSI = mean of Chlorophyll-a and TP Trophic State Indexes
SD = Secchi Depth
TP = Total Phosphorous
TN = Total Nitrogen
Chla = Chlorophyll-a
ug/L = part per billion, or micrograms per liter

Initial values for all parameters exceeded TMDL endpoints except Secchi depth (SD), which sets a minimum versus maximum value. Load reductions presented further on in Section 5.3 were sufficient to reduce all values to meet TMDL endpoints, except for a SD in 1996 and 1999. Average SD for all years, however, met TMDL endpoints (0.732 m).

Regardless of total load, percent load reduction necessary to reach TMDL endpoints were similar. The algal growth model that best simulated measured chlorophyll-a concentrations is based only on TP, turbidity, and flushing rate. This implies that nitrogen is not a limiting nutrient for algal growth. Consequently, reductions in TP are sufficient to reach nutrient affected TMDL endpoints.

Particulate forms of nutrients, or nutrient bound up in dead organic material often settle to the bottom of the lake. Internal cycling is the process where these nutrients are re-released and mixed into the water column rendering the phosphorus available for plant uptake and growth. No internal nitrogen cycling was discovered, however, internal P-cycling was evident in the Upper Lake Basin in three of the years modeled (1993, 1996, and 1999) and ranged from 30 to 65 percent of total load. During the dry year (1989), internal-P cycling did not occur in the Upper Lake Basin, but did occur in the Lower Lake Basin.

5.2 SOURCES OF POLLUTANT LOAD

The sources of pollutant load to Governor Bond Lake include nonpoint source runoff, atmospheric deposition, and septic systems. Septic system loads are relatively small compared to nonpoint source runoff, and are considered part of the overall nonpoint source load. Loads from the single point source were insignificant compared to any other loads (< 0.02 percent of allowable load) and there are no measurements for pertinent TMDL parameters. Therefore, this load is not included in the load allocation. Background loads due to nonpoint source runoff, as mentioned earlier, cannot be separated from the other nonpoint source loads due to lack of sufficient information and the significant physical and cultural changes to the watershed. Consequently, only atmospheric loads will be considered as background loads.

5.3 RATIONALE FOR LOAD ALLOCATIONS AND WASTELOAD ALLOCATIONS

The load allocation is based on the evaluation of the sources of pollutants entering the lake from the watershed. The pollutant loads, namely sediment and nutrient loads, have been linked to violations of applicable standards or guidelines in the lake. The magnitudes of the loads have been determined by a reliable quantitative procedure that is based on in-lake measurements for climate conditions that cover the range of expected precipitation conditions. The load reductions necessary are based on TMDL endpoints that have been determined sufficient to be compliant with Illinois water quality guidelines for full support of designated uses. Therefore, implementation of proposed load reductions, by means of appropriate Best Management Practices (BMPs), would be expected to bring the listed lake into compliance for all its designated uses.

TMDLs are expressed as a percent reduction in load because mass-based loads are highly variable and depend upon climatic conditions; yet, the proportion of load reduction necessary to meet in-lake TMDL endpoints remains fairly consistent. This situation is likely due to the situation that higher flow years, which generate larger loads, also result in greater flushing and dilution in the lake.

The Margins of Safety (MOSs) are calculated as the sum of both the statistical variation due to variable climate conditions assessed and those due to statistical error terms in internal model calculations. Using conservative values for model inputs adds an additional non-quantifiable, implicit MOS. See Section 6.0 for more detailed discussion of MOS.

Table 5-2 TMDLs

TMDL Parameter	WLA	LA*, % Reduction	MOS**	TMDL
Nutrients: Total Phosphorus	0	91%	3%	94%
Sediment NVSS Siltation	 0 0	 87% 20%	 2% 5%	 89% 25%

* LA includes both external and internal loads if applicable
**Sum of both coefficient of variation as a function of model calculations and variable climate conditions. Coefficient of variation = standard error/mean.

The following tables detail the load allocations for determining the TMDLs. Nonpoint source current and reduced loads are mean values for all climate condition modeled. High variation in actual loads renders these values suitable for general comparisons only, and TMDLs are therefore based on percent load reduction necessary to meet target water quality goals.

Table 5-3a: Nutrients: Total Phosphorus

Source	LA, % Reduction	Current Load, kg	Load Reduction, kg
Background (atmospheric)	0	106	0
Internal Cycling	100	10,840†	10,840†
Nonpoint Source	91	18,300†	16,550†

†Mean value for all climate conditions, current load ranges from 13,400 to 50,270 kg/yr.

Table 5-3b: NVSS

Source	LA, % Reduction	Current Load, Mg	Load Reduction, Mg
Background	NA	NA	NA
Shoreline & Gully	25	28,300	7075
Nonpoint Source	65	25,380†	14,680†

NA = Not applicable; no determined background load
†Mean value for all climate conditions, current load ranges from 22,170 to 29,410 Mg/yr.

Table 5-3c: Siltation

Source	LA, % Reduction	Current Load, Mg	Load Reduction, Mg
Background	NA	NA	NA
Shoreline & Gully	10	28,300	2,830
Nonpoint Source	15	25,380†	3,810†

NA = Not applicable; no determined background load
†Mean value for all climate conditions, current load ranges from 22,170 to 29,410 Mg/yr.

*Note: Refer to questions 31 and 48 in the Responsiveness Summary of this document for further discussion on estimated load allocations for Shoreline & Gully erosion, overland erosion and adjustments to the Cropping Factor (C) used in running the model.

6.0 MARGIN OF SAFETY

6.1 METHOD FOR CALCULATING MARGIN OF SAFETY (MOS)

The MOS is an additional factor included in the TMDL to account for scientific uncertainties, growth, and others such that applicable water quality standards/guidelines are achieved and maintained. The MOS can be included implicitly in the calculations of the WLA and LA or can be expressed explicitly as a separate value.

For the Governor Bond Lake TMDL, the MOS includes both implicit and explicit determination. Conservative input values (examples) were chosen for modeling purposes in order to implicitly include a MOS. The BATHTUB model calculated a measure of potential model error (coefficient of variation). This error term was used in combination with the coefficient of variation for percent load reductions in order to meet target water quality goals. The summation of these error terms was used to determine an additional explicit MOS. The coefficient of variation is a measure of variation in numbers relative to the mean value and can be expressed as either a fraction or percent of the mean.

6.2 RATIONALE FOR MOS

Potential sources of error are inherent in measured data, default values chosen for modeling, and model calculation procedures. The first two error sources are included in the implicit MOS, while the last error source is included in the explicit MOS.

1. Measured flow data had several potential errors; flows were determined based on staff gage depth of water flow, cross-section geometry, and float method stage-discharge relationships. Changing channel morphology during the growing season is highly likely. Stage-discharge relationships were measured at the end of the monitoring season, and are therefore only approximate for the monitored season. Bending of staff gages, limitations of float method, and changing channel morphology all contribute to measured flow errors.

2. Measured concentrations were from single grab samples, often following a precipitation event in order to capture high flow transport of pollutants. These samples may not accurately describe total loads during high flow conditions or base flow conditions. If samples happened to miss the peak loading times, loads may be under predicted. If samples were taken only during peak concentrations, loads may be over predicted.

3. Suspended sediment samples do not often characterize the entire water column, and the measurements often miss heavier particle fractions because they settle out before the subsample can be drawn out for laboratory analysis.

4. GIS analysis was used to minimize calculation errors, however, watershed characteristic data is based on several data sources, each containing inherent errors (e.g., soil survey polygons, soil survey k factors, land use type and area, etc.). A difference in calculated areas, when one data set is re-projected to be consistent with other data sets, is another source of error.

5. Model calculations use various regression and decay functions. Each submodel has errors associated with it. These are tabulated during the modeling process for an overall coefficient of variation.

7.0 SEASONAL VARIATION

It is often essential to account for seasonal variations in the concentrations of contaminants addressed in the TMDL. However, while seasonal variation is important for reservoir and lake systems, climate conditions and climate history can have a great effect on transport and transformation processes. Runoff and transport will be affected by previous year climate as well as current climate conditions. Flushing or storage in the reservoir will be affected by the climate (amount of precipitation and runoff) and amount of inputs.

Seasonal variation was addressed by using an averaging program, FLUX, to determine yearly flow-weighted average pollutant concentrations, which integrate the effects of seasonal variation and flow measured in-stream concentrations. This model can be adjusted to account for these effects by stratifying the data into related categories (e.g., early spring and late fall, high flow and low flow). The resulting average and associated error terms incorporate seasonal effects.

The Generalize Watershed Loading Function model was run for 13 continuous years, 1987 through 1999. This time frame was chosen in order to provide each simulated year (1989, 1993, 1996, and 1999) with at least three years of antecedent conditions for characterizing the build up of soil moisture, runoff, groundwater, and other transport factors.

Finally, the BATHTUB model was run for four climate conditions in order to bracket the effects of variations in climate. BATHTUB is a steady-state, equilibrium model that models both a single season or single year conditions and does not include build up and storage components. Simulations for changing watershed characteristics or climatic conditions were performed by first modeling the changed conditions in GWLF and using that program's output as input values for BATHTUB. Seasonal variation is modeled implicitly by including coefficients of variation for measured in-lake water quality parameters, which are descriptive of seasonal variations.

8.0 MONITORING PLAN

8.1 GOALS OF THE MONITORING PLAN

The goals of this monitoring plan are to assess the effectiveness of the Best Management Practices (BMPs) for attaining in-lake water quality TMDL endpoints and designated use full support. Governor Bond Lake will remain listed until it meets the standards/criteria/guidelines identified by the IEPA.

8.2 MONITORING ACTIVITIES, SCHEDULE, AND RESPONSIBILITIES

Governor Bond Lake should continue to be monitored by the Illinois EPA for in-lake water quality parameters on a three-year basis as a continuing part of the Ambient Lake Monitoring Program. Long-term trends analysis can be used to determine if water quality is improving and TMDL endpoints are being met.

Assuming implementation of the Clean Lakes Program Phase II, it is expected that additional monitoring would be part of this effort.

Tributary Monitoring. Attainment of TMDL endpoints may take time; the internal phosphorus load that may require long-term flushing to remove and BMPs within the watershed may require time to generate sufficient funds and education to implement. However, it is important to assess the effectiveness of the TMDL program in a timely manner and to make any adjustments or additions as needed. Accurate monitoring of loads entering Governor Bond Lake will provide intermediate assessment of load reduction strategies and help to identify priority areas. Stage-discharge relationships should be developed, and water quality monitoring should be conducted on the major tributaries (Dry Branch, Upper Kingsbury Branch, and Lower Kingsbury Branch) to accurately quantify BMP effects on load reductions. Previous stage discharge relationships are only approximate and apply only to the concurrently sampled water quality data.

BMPs Assessment. Monitoring studies should be conducted prior to implementation of structural BMPs and three years following implementation.

Bathymetry. Lake siltation should be assessed by detailed bathymetry according to similar methods used by the Zahniser Institute of Environmental Studies for the Clean Lakes Program Phase I efforts, (ZEIS, 2001). Differences in methodology used in previous bathymetry studies do not allow for comparison between years of lake volume changes, hence, siltation rates. New measurements should be completed in 2004-2005 to correlate lake siltation rates with surrogate measures and assess BMPs effectiveness.

A geographic information system (GIS) with updated land use, including CRP enrollment, should be developed to track quantity and effectiveness of agricultural BMPs in the watershed. This could be developed by the INHS or ZEIS in cooperation with the local NRCS.

9.0 IMPLEMENTATION ACTIVITIES

9.1 BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs) fall into two categories: cultural and structural. Cultural practices rely on changing human interactions with their environment and rely on incentives, education, and/or regulations to implement (e.g., conservation tillage, nutrient management plans). Structural practices are devices that are built or created to reduce pollutant transport (e.g., terracing, constructed wetlands). These are often more expensive up front, but can be easier to implement once funding has been obtained. Benefits of structural practices are often evident in a shorter time frame.

9.1.1 Cultural BMPs

Conservation Tillage and Conservation Reserve Program (CRP):

Conservation tillage minimizes soil structural damage and increases surface residue coverage, which in turn enhance soil infiltration and water holding properties and increase surface roughness. The combined effect is less sediment and chemical transport off the field. Conservation tillage is any tillage practice that leaves at least 30 percent of the surface covered with crop residues. Drawbacks to conservation tillage may include reduced crop yield and/or costs for retooling farm equipment.

The Conservation Reserve Program pays farmers to remove erosion susceptible land and plant it to a mixture of grass and legumes for 10 to 15 years. This allows land to recover structure and infiltration properties. Continuous enrollment is also an option for land set aside for grassed waterways, filter strips around creeks and ponds, windbreaks, riparian buffers (hardwood trees in bottom lands adjacent to streams and tributaries), and shallow water areas for wildlife. Drawbacks of CRP to the farmers are minimal, since potential CRP lands are likely in less productive areas to begin with. Reduced pasture or grazing land may be considered a drawback.

Table 9-1 examines the relative modeled effect of additional conservation tillage and/or CRP land on pollutant load reductions in the Governor Bond Lake watershed. An additional scenario considered is where all potential home sites around the lake are developed without additional BMPs (Full Build Out). Effects of these factors were incorporated into GWLF model input parameters.

Table 9-1. Percent Reduction in Loads Due to Conservation Tillage and CRP.

			Double CRP Acreage (31.4%)				Double Conservation Tillage (60%)			
Year	Climate	Initial Erosion	Erosion	Sediment	TN	TP	Erosion	Sediment	TN	TP
		tons/ac	tons/ac	%	%	%	tons/ac	%	%	%
1989	dry	5.64	4.68	13.2	8.0	5.6	4.37	22.7	16.6	10.6
1993	wet	6.99	5.79	15.2	9.7	5.6	5.42	19.3	11.8	2.7
1996	normal	7.48	6.20	16.7	11.5	6.5	5.80	24.0	18.1	8.8
1999	wet-norm	5.72	4.74	18.0	12.6	6.3	4.43	27.0	20.8	10.5

			Double CRP and Cons. Tillage				100% Conservation Tillage			
Year	Climate	Initial Erosion	Erosion	Sediment	TN	TP	Erosion	Sediment	TN	TP
		tons/ac	tons/ac	%	%	%	tons/ac	%	%	%
1989	dry	5.64	3.89	34.6	15.6	12.6	2.87	51.0	18.3	16.5
1993	wet	6.99	4.81	36.1	16.0	10.7	3.55	51.1	15.6	12.3
1996	normal	7.48	5.15	37.2	18.7	11.8	3.81	51.1	18.1	13.0
1999	wet-norm	5.72	3.94	38.2	19.5	10.6	2.91	51.1	17.7	10.8

			Full Build Out			
Year	Climate	Initial Erosion	Erosion	Sediment	TN	TP
		tons/ac	tons/ac	%	%	%
1989	dry	5.64	5.708	0.0	-1.2	-1.0
1993	wet	6.99	7.070	0.0	-0.9	-0.7
1996	normal	7.48	7.571	0.0	-1.1	-0.8
1999	wet-norm	5.72	5.785	0.0	-1.6	-1.0

Conservation Tillage = No-till

Conservation tillage and CRP programs, alone, are insufficient to meet TMDL goals. Other BMPs will need to be implemented. However, effectiveness of some BMPs described below will be dependent upon maintenance (e.g., pond in-filling, clogging of filter strips with eroded sediment, etc.). Therefore, conservation tillage and CRP will greatly assist in longevity and functional efficiency of these other BMPs and should be considered a necessary part of the load reduction strategy.

Full Build Out show slightly (< 0.1 percent) negative pollutant reductions are possible due to an actual increase in nutrient pollution from the additional septic systems.

Nutrient Management:

The high surface and subsurface runoff potential makes nutrient management important in the Governor Bond Lake watershed. Nutrient management involves managing the source, rate, form, timing, and placement of nutrients. Nutrient management is a component of a conservation management system that can be used in conjunction with filter strips to reduce the amount of nutrient loads to Governor Bond Lake.

The objectives of nutrient management are to effectively and efficiently use nutrient resources (e.g., manure, commercial fertilizers) to supply plants with sufficient resources to produce food, forage, fiber, and cover while minimizing environmental degradation. Nutrient management is applicable to all lands where plant nutrients and soil amendments are applied.

Typical nutrient management components of conservation plans may include the following information:

- Field map and soil map
- Crop rotation or sequence
- Results of soil, water, plant, and organic material samples analyses
- Expected yield
- Source and form of nutrients to be applied
- Nutrient budget, including credits of nutrients available
- Recommended nutrient rates, form, timing, and method of application
- Location of designated sensitive areas
- Guidelines for operation and maintenance

General nutrient management considerations for water quality protection may include the following:

- Test soil, plants, water and organic material for nutrient content
- Set realistic yield goals
- Apply nutrients according to soil test recommendations
- Account for nutrient credits from all sources (e.g., manure, atmospheric nitrogen fixation, carry over from previous applications, etc.)
- Consider effects of drought or excess moisture on quantities of available nutrients
- Use a water budget to guide timing of nutrient applications
- Use cover and green manure crops, where possible, to recover and retain residual nitrogen and other nutrients between cropping periods
- Use split applications of nitrogen fertilizer for greater nutrient efficiency
- Incorporate nutrients to minimize losses.

Guidelines for operation and maintenance include the following:

- Review nutrient management component of the conservation plan annually and make adjustments when needed
- Calibrate application equipment to ensure uniform distribution and accurate application rates.
- Protect nutrient storage areas from weather to minimize runoff and leakage
- Observe setbacks for nutrient applications adjacent to water bodies, drainage ways, and other sensitive areas
- Maintain records of nutrient applications
- Clean up residual material from equipment and dispose of properly

A nutrient management plan also includes an assessment of the site-specific potential environmental risks. For example, a nutrient management plan should include an assessment of the potential risk for nitrogen and phosphorus to contribute to water quality impairment. Areas that might have high levels of produced or applied nutrients that may contribute to environmental degradation must be evaluated and appropriate conservation practices and management techniques must be implemented to mitigate any unacceptable risks. Areas in filter strips in the Conservation Reserve Program are not allowed to be hayed or grazed unless released by the Secretary of Agriculture. The actual size of the buffer strips is based on the slope at the specific site (refer to Table 9-2). For land enrolled in the Conservation Reserve Program, use of buffer strips is fully sanctioned.

Filter/Buffer Strips:

Filter strips, which are areas of grass or other permanent vegetation, can be used to maintain or improve water quality by reducing sediment, organics, nutrients, pesticides, and other contaminants from runoff. Filter strips are recommended because of their effectiveness in reducing dissolved contaminants in areas situated between cropland and water bodies. In several instances, filter strips are listed as one of the most effective BMPs in reducing ammonia and nitrogen transport to water bodies. The following case studies illustrate the effectiveness of using filter strips (NRCS, 1999):

- In Arkansas, two studies concluded that sediment and nutrient runoff (including nitrogen and phosphorus) from poultry and swine manured fields were significantly reduced in the first 10 feet of a tall fescue grass filter grown on a Captina silt loam soil. Further lengthening of the filter strip beyond 30 feet did not significantly reduce the contaminant load of the runoff water.

- In Montana, the trapping efficiency and nutrient uptake of four grasses were measured to treat dairy manure runoff in a filter strip. Orchardgrass and meadow bromegrass were effective at both entrapping the nutrients in the runoff and absorbing the nitrogen into the plant biomass within the upper 20 feet of the filter.

In addition to reducing the amount of nutrients, filter strips have the following benefits:

- Permanent vegetation along watercourses and drainage ways helps stabilize the adjacent area. The width of filter strips provides a distance from the edge of the watercourse so equipment does not damage the area.

- Companion legumes in filter strips have value and can be harvested or used. Alfalfa can be the companion legume and be harvested for commercial hay or used for on-site livestock.

The effectiveness of filter strips depends on many parameters; the key ones include flow velocity, vegetation, and width. For preliminary design purposes, the width required for different field slopes may be estimated from Table 9-2.

Table 9-2. Filter Strip Width on Land Slopes to Achieve Minimum Flow Through Times of 15 and 30 Minutes, Respectively, for a 0.5-inch Rainfall.

	Filter Strip Width (feet)					
Percent Slope	**0.5%**	**1.0%**	**2.0%**	**3.0%**	**4.0%**	**$\geq$ 5.0%**
15-min Flow Through	36	54	72	90	108	117
30-min Flow Through	72	108	144	180	216	234

Source: NRCS, 1999

Lawn management:

Homeowners surrounding the lake can impact lake water quality by lawn care management practices. Mowing to the shore edge reduces native aquatic vegetation that is often helpful in providing fish habitat and shoreline stabilization. Incorrect application of pesticides and fertilizers can wash off lawns and enter directly into the lake. Timing, amount, and form of fertilizer can be adjusted to minimize potential loss to the lake.

9.1.2 Structural BMPs

Shoreline Stabilization and Aquascaping:

Governor Bond Lake is a reservoir, with naturally steep banks and high flow rates, and consequently shoreline stabilization is a difficult process. The city of Greenville has begun an extensive rip-rap and embankment program to control shoreline erosion in the lower basin. Alternative rip-rap components and energy dissipaters (e.g., native material bank revetment, deflectors) should be explored to maximize effectiveness. Regrading bank slopes to a more stable angle and establishment of vegetation can also be effective at reducing bank erosion.

There are currently no no-wake restrictions (no-wake zones) in the lower basin. No-wake zones can reduce impacts of boating on shoreline erosion by reducing the wave action that erodes shorelines.

Aquascaping, or shoreline vegetation and land management, can be effective in establishing conditions conducive to aquatic life support, reduced nutrient transport, and shoreline stabilization. Aquascaping includes planting or allowing natural aquatic macrophyte (rooted aquatic plants) growth and establishment near lakeshores. These plants acts as filter strips to remove nutrients and help dissipate erosive energy of the flowing water.

Construction Permitting:

There are no construction BMPs required as part of the permitting process; however, recently the Public Health Department established minimum lot sizes for new on-site septic systems. Minimum lot sizes provide for more area through which wastewater can infiltrate and be cleaned prior to discharge into shallow groundwater. These design requirements, however, are for human health protection and not for water quality protection. Typically, erosion control measures for new construction permits and setbacks for septic fields from water bodies are often required.

A recent city of Greenville inspection showed that most on-site septic systems (100/108) are functioning appropriately and new systems being built are primarily aeration systems (GBL Committee, 1998). Aeration systems generally include a holding tank that is periodically pumped, an aeration chamber that supplies compressed air and mixes waste material to increase decomposition, and a clarifying chamber to remove particulates (Doley and Kerns, 1996). Systems surveyed included all privately owned septic systems in subdivisions around Governor Bond Lake. Recommendations for remediation were provided to owners of failed systems.

Septic Systems:

Septic systems near the lake and tributaries can contribute nutrient and fecal coliform pollution. Like livestock manure, human effluent is rich in nutrients, oxygen-demanding waste materials, and fecal coliforms. Typical septic systems include a settling chamber where the large solids settle out and a drainfield, where liquid waste is dispersed over a large area and slowly percolates through soil. The settling tanks need to be pumped periodically (every three to five years, depending on size and load) or they will contribute to failure of the system. Drainfields can also get clogged over time, which prevents effective polishing of the liquid waste.

Septic systems should be sited far enough away from the lakeshore to allow for sufficient filtering of nutrients and fecals by soil and for uptake of nutrients by plants, prior to discharge into the lake. In areas where soils are not sufficient for septic systems (e.g., shallow depth to groundwater, infiltration too slow), aeration or mounded systems can be installed. Aeration systems generally discharge the liquid effluent at the surface, therefore, discharge should be at a point sufficiently far from the lakeshore such that there is plenty of time for nutrients to infiltrate into the ground and be taken up by plants. All systems need to be maintained; failed systems short-circuit or bypass the treatment processes and contribute to water quality pollution.

Feedlot Runoff Containment and Wetlands

Feedlot and manure application regulations for protection of water quality are found in Title 35 of the Illinois Administrative Code, Subtitle E, Part 501. BMPs for manure spreading and feedlot runoff containment or diversion will help reduce loads from feedlots. Assessment of compliance with current regulations is important in minimizing feedlot impacts on water quality. Standard BMPs include lagoon, pit, diversion, manure spreading, and other practices. Slaked lime or alum manure amendments can also be added to animal manure to bind dissolved P and reduce its solubility, hence, availability for plant growth and runoff (Sharpley et al, 1999).

For smaller feedlots and other animal operations not covered under the Illinois Adm. Code, Subtitle E, feedlot wetlands may also be helpful in reducing water quality pollution.

Wetland and Extended Detention Pond Systems to Reduce Nutrient and Sediment Loads.

Construction of multi-celled extended detention ponds or wetlands can present an opportunity to improve the quality of runoff from the nonpoint sources, provided that the drainage system in the vicinity of the wetlands is modified to direct and detain the runoff in the wetland complex. The Upper Pond area, several inlets with current backwater effects, small feedlot and other animal operation drainage areas, and additional sites in the upland areas are all potential locations for this type of BMP. In particular, siting these systems in areas with animal waste runoff (e.g., the equestrian farms on the Upper Kingsbury Branch) and watershed drainage in the upper Kingsbury Branch would be most effective, since pollutant loads from this watershed are the greatest.

Nutrient removal in wetland systems occurs through settling and by biological uptake. Most aquatic and wetland plants take nutrients from the sediments through their root system rather that from the water column through the leaves. Removal rates may be quite variable throughout the year with high removal rates in the spring and summer. Removal rates, however, are sometimes low in the fall and winter because of floating, dead plant material released from the basin and complex nutrient cycling patterns often associated with wetlands. Healthy wetland detention systems can have sediment removal rates from 60 percent to 100 percent and removal rates of nutrients in the range 20 percent to 80 percent. A discussion of using wetlands to control non-point sources is presented in *Technical Memorandum,* *Literature Review-Wetlands as a Nonpoint Source Pollution Control Measure* (USEPA, 1993). Detailed procedures for constructing wetlands or enhancing existing wetlands will not be presented here, as these are site specific.

The feasibility of implementing this BMP will depend to a great extent on the cooperation of the city of Greenville and agreement from the owners of the property and adjacent properties (potential flood zone effect). The Illinois Department of Transportation may also need to be involved because of the potential effect of modified drainage patterns on highway culvert crossings and roadside ditches within IDOT's right-of-way. IDOT approval for proposed construction activity within the IDOT right-of-way will be needed.

Livestock Fencing:

Animal traffic into and out of streams contributes to bank erosion, re-suspension and mixing of settled materials, direct deposition of waste products into the waterway, and destruction of bank vegetation that is important in filtering out runoff nutrients and sediment. Fencing livestock out of these streams and providing fenced stream crossings, if necessary, are effective at reducing bank erosion and maintaining vegetative buffers along the tributaries. Areas with pastures leading right up to the stream bank should be targeted for fencing BMPs.

Internal Load Reduction BMPs:

Aeration

Internal nutrient cycling generally occurs due to re-release of previously settled out phosphorus bound to particles. Anoxic (lack of free oxygen) conditions convert bound phosphorus to dissolved phosphorus. Subsequent lake mixing can cause this dissolved phosphorus to be brought back up to the surface and made available for plant (algal) growth. Aeration systems can keep oxygen conditions from being depleted on the lake bottom and therefore very effective at preventing re-release of bound phosphorus.

Destratifiers

Destratifiers enhance lake mixing at depths in order to prevent formation of thermal stratification in deep lakes (> 15 foot depth). Thermal stratification sets up the lake with a thermal resistance to mixing, effectively separating the warmer, lighter, well-mixed surface water from the colder, denser, undisturbed deep water. If phosphorus re-release is occurring due to anoxic conditions enhanced by lake stratification, this technique reduce phosphorus re-release by keeping the lake mixed and new oxygen replenishing the depleted supplies. In shallow lakes, however, where anoxic conditions are due to episodic events (sudden senescence of a large amount of aquatic plants) or re-suspension by wind and fish, this technique will not be effective.

Sediment Sealing

Sediment sealing effectiveness tends to last about 10 years, depending upon lake and sediment chemistry and costs approximately $700/ha (1993) (Cooke et al, 1986). The process works by binding dissolved (plant-available) phosphorus to Alum or another metal oxide that holds phosphorus tightly bound even during depleted oxygen (anoxic) conditions. Similar to public waste water and water supply treatment processes, Alum picks up the phosphorus, binds it, and settles to the bottom of the lake where the phosphorus is rendered unavailable. It is a simple and effective process, provided that the lake chemistry and physical characteristics are appropriate. Amount of sediment and water column iron, pH, and phosphorus, in addition to more detailed lake mixing information and other characteristics need to be determined prior to considering this a viable option. A diagnostic feasibility study should be completed prior to choosing this method.

Dredging

Dredging is an effective, but very costly method for reducing internal nutrient cycling (18-65 percent TP for Governor Bond Lake). Dredging to a 1-m depth can cost $20,000/ha (Welch and Cook, 1995). Effectiveness of this nutrient removal process is 100 percent and will last for at least 50 years.

Structural BMPs Summary

The following table summarizes the pollutant removal efficiencies of some structural BMPs. The values presented are averages and in most cases there is a wide range due to BMP design, siting, and watershed characteristics.

Table 9-3 Summary of Structural BMP Average Effectiveness for Pollutant Removal

BMP	Load Reductions			Comments	Source
	TSS	TP	TN		
	%	%	%		
Extended Detention Wet Pond	80	65	55	Extended wet detention ponds are effective for sediment and nutrient removal but must be sized to hold 2.5 inches of runoff in the permanent pool (26 to 160 acre-ft for Governor Bond Lake subwatersheds).	USEPA 1993
Constructed Wetland	80	65	55	Constructed wetlands must be 1 to 3% of the watershed area to be effective (3.6 to 96 acres for Governor Bond Lake subwatersheds).	USEPA 1993
Multi-cell Detention Ponds or Wetlands	>80	>65	>55	Incremental increases in removal over Constructed Wetlands or Extended Detention Wet Ponds depending on size, number, and configuration of additional cells	USEPA 1993
Filter/Buffer Strips	75	70	60	Reports of over 90% TP removal with 60-ft buffer strips	USEPA 1993
Feedlot Wetlands	75	85	70	The upper subwatershed of the Kingsbury Branch (ROP04) is the largest nutrient contributor to Governor Bond Lake. High loads may be associated with dairy cattle operations that may be mitigated by this BMP	Simeral 1998
Stream Fencing	Considered High but No Quantification			An important BMP for filterstrip/buffer BMPs, protection and general stream bank stabilization.	
Lake Bank Stabilization	No Quantification			Rip-rap, vegetative cover, etc. will help reduce continued slumping.	

Lake Shore Aquascaping and Set-backs	No Quantification			Lakeshore setbacks for houses and septic systems, natural aquatic plants, buffers, and filter strips all are effective at reducing bank erosion.	
Aeration System		up to 90% internal		Testing necessary to determine cause of internal cycling and best locations. Must be maintained.	
Sediment Sealing		up to 96% internal		Temporary depending upon sediment type and other conditions, one to 10 years	Welch and Cook 1995, 1999
Dredging		up to 90% internal		Long term (>10 yrs), but costly	Welch and Cook 1995, 1999

9.1.3 Existing BMPs

Riparian Buffers and Conservation Reserve Program (CRP) Land. The Governor Bond Lake watershed landscape is flat with steeply rolling land next to the tributaries. The most prevalent BMPs currently being used are filter strips and other land enrolled in the CRP program. These lands are typically removed from production agriculture and planted to a mixture of grasses and legumes for 10 to 15 years, and then returned to production. Continuous enrollment is also an option for land set aside for grassed waterways, filter strips around creeks and ponds, windbreaks, riparian buffers (hardwood trees in bottom lands adjacent to streams and tributaries), and shallow water areas for wildlife. Much of the upland soils in the Governor Bond Lake watershed are considered a "good" candidate for shallow water areas, while the lower lands near streams are "good" candidates for hardwood trees (riparian buffers) (NRCS 1983). Most of the soils are considered restricted for grassed waterways due to erosion potential, slow percolation, and high wetness. All of the soils are suitable for grass and legume establishment and growth.

A tax abatement option is available for buffer strips of at least 66-foot width next to a water body. Much of the land immediately adjacent to tributaries is steeply sloping or very wet and not suitable for row crops and is consequently used for pasture or left as wooded riparian buffers. Some pasturelands continue right up to the tributary banks.

Conservation Tillage. Conservation tillage, primarily no-till, is also practiced in the county on approximately 31 percent of the cropped acreage (IDOA, 2000).

Education. A newsletter produced by the University of Illinois Bond County Cooperative Extension Service is used for public education on such issues as conservation tillage, efficient application rates, filter strip program, and other practices for protecting Governor Bond Lake.

Feedlots. Feedlot and manure application regulations for protection of water quality are found in Title 35 of the Illinois Administrative Code, Subtitle E, Part 501. In spring 2001, a diary feedlot operation in the Dry Branch subwatershed completed installation of a livestock waste handling facility. In compliance with state regulations, this facility was approved by the Illinois Department of Agriculture.

Shoreline Stabilization. The city of Greenville and associated stakeholders has already rip rapped 27,800 feet of shoreline and reconstructed approximately 700 feet of eroded shoreline banks.

Except for the CRP estimate in the land use section (15.7 percent of cropland) and shoreline stabilization, effectiveness, exact acreage, and amount of each BMP are not known at this time.

9.1.4 BMP Recommendations:

Combinations of cultural and structural BMPs are possible to reduce loads to target levels (94 percent reduction in nutrients, 89 percent reduction in NVSS). It is important to include cultural BMPs in implementation, such as conservation tillage and/or CRP, because longevity and effectiveness of structural BMPs will be enhanced by cultural BMPs, even though total reductions may not be as significant.

These removal rates are based on average effectiveness of these BMPs. In this watershed, however, average rates may not be practically attainable. Consequently, additional BMPs are recommended to maximize the possibility of TMDL goal attainment. Other combinations are also possible, and exact reduction rates will depend on BMP design, siting, and other watershed characteristics.

Nutrient BMPs

The combination of the following BMPs results in a reduction of 94.6 percent of TP load to the lake

- 33.5 percent reduction through aeration, sediment sealing, or system flushing (90 percent of internal load)
- 20 percent reduction of external load due to cultural practices (primarily through CRP and tillage and nutrient management practices)
- 70 percent reduction of external load due to buffer strips
- 65 percent reduction of external load due to ponds or wetlands

Additional recommended BMPs

- Septic system maintenance and design. Include sufficiently large drainfield, assure that soil filtration properties are sufficient, and add setback requirements of at least 75 feet from the shoreline to construction permits. Replace failed systems with systems that comply with new requirements.

- Lawn management. Develop lawn chemical management guidelines for homeowners near the lake. Educate homeowners on proper use of lawn chemicals and their effects on water quality.

Sediment/NVSS BMPs

The above combination of BMPs will also result in a 92 percent reduction in sediment/NVSS

- 20 percent reduction due to cultural practices
- 75 percent reduction due to buffer strips
- 80 percent reduction due to ponds or wetlands

Additional recommended BMPs

- Shoreline stabilization. Continue with rip-rap and bank stabilization. Target highly eroded areas noted in the Clean Lakes Program Phase I Study Report (ZEIS, 2001). Explore other stabilization materials and options.

- No-wake zones. Establish boating “No-wake” zones near the most eroded segments of the shoreline to minimize wave action impact on these susceptible areas.

Overall additional BMPs.

- Stream bank fencing. Keeping livestock out of tributaries will reduce both nutrient and sediment pollution.

- Construction erosion control. Include construction erosion control plans, for sites located near water bodies, in the permitting process. Reduced sediment transport will also reduce transport of associated pollutants. Although contributions from construction sites are expected to be small, their proximity to water bodies results in immediate impacts.

- Promote aquascaping and natural aquatic vegetation to reduce shoreline erosion and increase nutrient uptake.

9.2 IMPLEMENTATION APPROACHES

Section 9.1 above describes various BMPs and their potential for achieving the proposed target phosphorus, sediment, and NVSS load reductions. This section describes the manner in which the proposed BMPs could be implemented. Appendix B describes potential funding sources for implementing these BMPs. This section does not constitute a plan for implementing BMPs. Rather, this section simply documents that institutional structures are in place to support BMP implementation. The major BMPs and their implementation approaches are as follows:

Cultural BMPs (e.g., conservation tillage, nutrient management plans, lawn care management, CRP, and others)

According to the NRCS,[4] 15.7 percent of the land is already enrolled in CRP. The NRCS and the University of Illinois Bond County Extension Service have already begun a program for educating watershed residents on nutrient and tillage management, septic system maintenance, and other water quality issues (GBL Committee, 1998). Additional education measures are recommended and assistance given for preparing tillage and nutrient management plans. Because they are currently being implemented, there is no initial phase-in period needed to establish programs.

Structural BMPs (e.g., constructed wetlands, stormwater detention ponds, filter/buffer strips, others)

As part of the Clean Lakes Program Phase II efforts, multi-celled wetlands and/or detention ponds could be sited at several locations within the watershed.

According to the NRCS[5], through CRP, filter and buffer strips are already established along some

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[4] Personal communication, Dan Mueller, NRCS, 2000.
[5] Personal communication, Dan Mueller, NRCS, 2000.

tributaries. There is currently a property tax abatement offered to land owners who leave at least 66 ft of riparian buffer next to tributaries. It is recommended that these programs be expanded to include all land adjacent to tributaries.

The city of Greenville has already begun a shoreline stabilization program. This program should continue and be expanded to include eroded and undercut banks as identified in the Clean Lake Program Diagnostic Feasibility Study, Governor Bond Lake (ZEIS, 2001).

10. REASONABLE ASSURANCES

10.1 EVIDENCE OF BMP IMPLEMENTABILITY

The proposed BMPs are acceptable to watershed stakeholders for implementation. These BMPs are consistent with those recommended in the IEPA Clean Lakes Program Phase I Diagnostic Feasibility Study, Governor Bond Lake (ZEIS, 2001) and the Governor Bond Lake Resource Plan (Bond County SWCD, 1999a).

Load reduction goals for nutrients (phosphorus) are high, but not unreasonable; studies have shown reduction rates due to proposed BMPs are reasonable. Continued monitoring following TMDL implementation will determine if TMDL endpoints are being met. BMPs could be expanded to include greater areas and/or treatment if TMDL endpoints are not being met.

10.2 DESCRIPTION OF NON-REGULATORY, REGULATORY, OR INCENTIVE-BASED APPROACHES

The Federal Clean Water Act, the Illinois Environmental Protection Act, the Illinois Water Pollution Discharge Act, and regulations and guidance implementing those statutes do not provide authority for the direct regulation of nonpoint sources of pollution to surface waters. As a result, control of nonpoint sources of pollutants and sediment must be addressed through nonregulatory measures, such as economic assistance and education, or through local ordinances and permitting processes. Section 9.1 describes a number of BMPs that will result in reduction of nutrients and sediment load to Governor Bond Lake. Many of these BMPs are being implemented through voluntary and incentive-based approaches. Furthermore, Appendix B describes funding sources that could be used to further expand the BMP applications.

11. PUBLIC PARTICIPATION

IEPA policy requires full and meaningful public participation in the TMDL development process. Illinois provides for public participation consistent with its own continuing planning process and public participation requirement provided in 40 CFR § 130.7 (c) (1) (ii). Furthermore, Illinois provides for meaningful public involvement in the TMDL through a series of two public meetings and one public hearing, which allow for public comment the draft TMDL.

11.1 DESCRIPTION OF PUBLIC PARTICIPATION PROCESS

Illinois EPA published a notice of the commencement of its solicitation of comments from the public on the proposed TMDL on June 28, 2001. The public comment period ran from June 28 through August 30, 2001, and included the public hearing held in Greenville on July 31, 2001. A copy of the draft TMDL was maintained for public viewing in Greenville at the Greenville Public Library, at the IEPA offices at 1021 North Grand Ave. East, Springfield, IL, and on the IEPA website at http://www.epa.state.il.us.

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GOVERNOR BOND LAKE TMDL

APPENDIX A

HYDROLOGIC AND WATER QUALITY MODELING OF GOVERNOR BOND LAKE

A. MODELING PURPOSE

To quantify nutrient and sediment loads entering Governor Bond Lake and to determine load reductions necessary to meet water quality standards and criteria or guidelines.

Governor Bond Lake has minimal time sequence data and no continuous data; therefore, not enough data exists to support dynamic modeling. Based on the contributing causes to designated use impairments that have been identified for Governor Bond Lake (primarily nutrients, sediments, and algae), the chosen model(s) must do three things:

1. Model sediment loads to the lake
2. Model nutrient loads to the lake, including septic systems
3. Model internal eutrophication/nutrient cycling

B. GENERAL MODEL DESCRIPTIONS AND APPROACH

To model sediment and nutrient loads to Governor Bond Lake, the Generalized Watershed Loading Function (GWLF v 2.0, 1992) model was used. This is a moderately simple watershed-scale model developed for assessing point and nonpoint source nitrogen and phosphorous loads from rural, urban, and mixed watersheds. In addition to erosion and sediment transport modeling, this model can also assess loads due to septic systems, an important consideration given the nature of soils in this region and the proximity of on-site septic systems to water bodies.

Once inputs into the lake were modeled using GWLF, we used BATHTUB v. 5.4 (1998), developed by the US Army Corps of Engineers to model internal reservoir processes. BATHTUB requires fairly simple inputs and can model inflow/outflows, nutrient cycling, chlorophyll-a (a measure of algal growth), Secchi depth, and oxygen demand.

Supporting models used for calibrating and determining input parameters for GWLF and BATHTUB were FLUX v. 4.5 (1995), a stream load computations model, and PROFILE v 5.0 (1998), a model for determining oxygen demand based on in-lake dissolved oxygen (DO) and temperature (T) profiles.

The entire watershed was subdivided into 10 subwatersheds based on 1999 Clean Lakes Program tributary sampling sites and additional discrete units; however, for modeling purposes they were combined into one unit. Monitored data was available for four subwatersheds (ROP02 - Unnamed Tributary, ROP03 - Dry Branch, ROP04 - Upper Kingsbury Branch, and ROP05 - Lower Kingsbury Branch) that were used to calibrate the models for determining contributions from the rest of the subwatersheds. The following diagram depicts the flow paths, subwatersheds, and inflow device (basin) modeled:

Figure B-1. Governor Bond Lake Model Flow Net

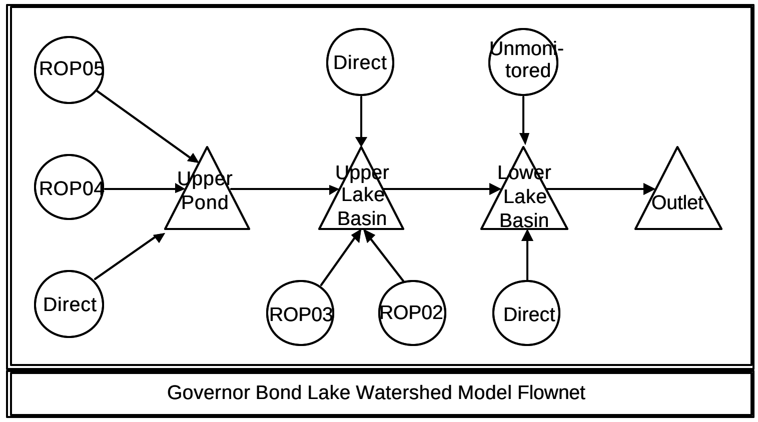
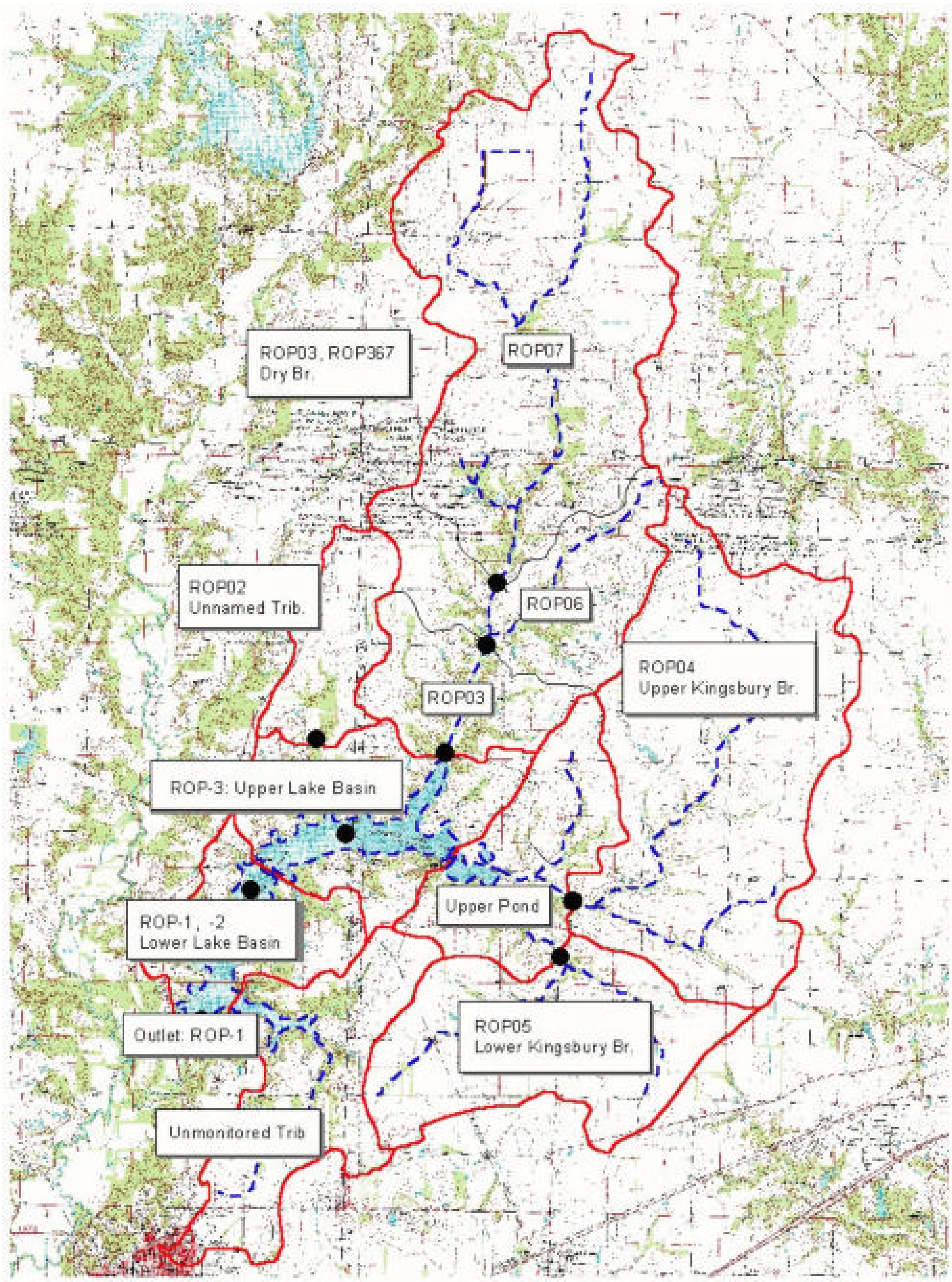


Figure B-2. Governor Bond Lake Subwatersheds and Modeled Clean Lakes Program Monitoring Sites *(red boundaries delineate modeled subwatersheds)*



C. MODELING ASSUMPTIONS AND COEFFICIENTS DETERMINATION

C.1 FLUX

FLUX was used to determine subwatershed specific flow-weighted average concentrations and loads. Daily flow data and measured concentrations from the 1999 Clean Lakes Program monitoring program (ZEIS, 2001) were fitted to various model regressions to determine yearly average load and concentrations. Yearly in-stream FLUX concentrations were then used to calibrate the GWLF model. By using FLUX, instead of simple mean values, variations in concentration as a function of flow and season are taken into consideration, resulting in a single yearly value that most appropriately describes the system. FLUX was also used to determine flow-weighted concentrations for the lake outflow, assuming outflow concentrations were the same as in-lake measured concentrations at site ROP-1.

Input Values

Minimum input values included daily flow and at least four water quality samples for determining flow-weighted concentrations using FLUX. Model utilities can be used to determine if sampling frequency and timing is sufficient for rigorous analysis; however, 10 samples and daily flow for an entire year are usually sufficient for reasonable (coefficient of variation < 0.3) results.

Flow Computations

In the fall of 1999, approximately 10 different flow velocity versus stream depth values were measured at Clean Lakes Program (CLP) stream sites ROP02, ROP06, ROP04, and ROP05 (ZEIS, 2001). Flow velocity was measured by recording the travel time of a floating object. A correction factor of 0.85 was applied to each velocity to account for the fact that surface flows have generally higher velocities than the whole cross-section. Prior to initiation of measurements (Spring 1999) stream cross-sections were surveyed at each sampling location. Rating curves (depth of flow versus discharge) were established for sites ROP02, ROP04, ROP05, and ROP06.

Flow was intermittent for site ROP06 during the monitoring season, consequently, the downstream site, ROP03, was used for modeling purposes. To determine flow at site ROP03, Manning's Equation was used to estimate flows at both ROP03 and ROP06. Then, flows at ROP03 were adjusted according to the relationship between Manning's predicted flow at site ROP06 and measured flow at site ROP06. Because of this artifact in calculating flows for ROP03, ROP03 flows were only used for determining yearly average in-stream concentrations and not for determining 1999 annual loads.

The 1999 monitoring program included seven tributary sites with water quality information and stream gauging. Rating curve measurements were gathered for only four sites and at the end of the monitoring season - one of these sites being an intermittent stream. Therefore water quantity calculations will be approximate at best. The tributary streambeds do not appear to be very stable; old sediment is scoured out and new sediment deposited during storm events, debris is deposited or moved downstream, livestock and other animals wander in and out of the streambed, and other processes can occur. These will result in changed channel morphology and roughness and therefore flow properties will change. Flows based on velocity times cross-sectional areas will be approximate at best and established rating curves at the end of the monitoring season may not accurately reflect flows during the monitoring season. Finally, since flows were gauged using daily stream depth, backwater effects cannot be determined.

Outflow values were determined using the broad-crested weir equation for flow and monitored water quality in the lake at site ROP-1 (near the outflow). The dam length is 1200 ft, however, due to the nature of the structure (three sides of a square v. straight dam) and restricted flow around 1/3 of the length (near shore), a length of 800 ft was used for calculating actual flows.

Mannings n Equation

$$Q = \frac{1.49R^{2/3}S^{1/2}}{n} A$$

Weir Equation: Broadcrested Weir

$$Q = CLH^N$$

Where:

Q = Discharge or Flow, cfs
R = Staff Gage Height or Stream Depth, ft
S = Water Surface Slope, unitless
n = Manning's Roughness Coefficient, unitless
A = Cross-sectional Area, ft^2
C = Weir Coefficient = 0.59 for depth of flow v. weir height relationship
H = Staff Gage Height or Stream Depth, ft
L = Weir Length, ft
N = 1.5 for Broadcrested Weirs

Table C-1 Stage-discharge Relationships for Sites With Measured Flow

Table C-1lists the resulting stage-discharge relationships where Q = discharge (cfs) and H = stage height (ft).

Site	Relationship	r^2*
ROP02	$Q = 0.05068\ H^{4.803}$	0.8872
ROP04	$Q = 0.0339\ H^{5.5577}$	0.9337
ROP05	$Q = 0.269\ H^{3.1962}$	0.9977
ROP06	$Q = 11.124\ H^{2.5045}$	0.9231

FLUX Regression Model Selection

Six regression models are evaluated through FLUX for determining flow-weighted concentrations. The most appropriate regression is chosen based on balancing the following factors: low coefficients of variation (cv), lack of relationship to date or flow (no slope significance for residuals v. date or residuals v. flow), and robustness of the regression. If good fits are not possible, flow or date stratification is applied to improve the fits. Flow-weighted concentration from the best fitting regression is then used for calibrating the GWLF model. FLUX output files list the chosen regression in the header information and means and cvs for all other regressions are listed in the body.

Ortho-Phosphorous Values

Insufficient orthophosphorous (OP) values were available for FLUX flow weighted averages, therefore, the relationship between OP and Total Phosphorous (TP) (OP:TP ratio) was used to determine flow weighted average OP concentrations and loads based on FLUX TP modeled concentrations.

Table C-2. Ortho-Phosphorous to Total Phosphorous Ratios Used for Determining OP Concentrations

Site	OP:TP ratio	Comments
R0P01: Lake Outlet	0.349	Measured
R0P02: Unnamed Tributary	0.832	
R0P03: Dry Br.	0.717	
R0P04: Upper Kingsbury Br.	0.566	
R0P05: Lower Kingsbury Br.	0.643	
R0P06: Dry Br. - upper	0.717	Assume same as ROP03
R0P07: Dry Br. - upper	0.717	
Unmonitored: Unmonitored Trib.	0.643	Use ROP05, adjacent neighbor
Pond: Upper Pond	0.566	Downstream ROP04, use ROP04
Upper: Upper Lake Basin	0.650	Semi-mean ratio
Lower: Lower Lake Basin	0.650	

Annual flows are calculated and presented in Hm3 (cubic hectameters or 1,000,000 cubic meters).

Table C-3. FLUX Concentrations Summary

Site	Flow	OP:TP	TP	OP	TN	DisN	NVSS	SedN	SedP
monitored season									
			Concentration: ppb						
ROP2		0.863	343.2	296.2	3,725	3,162	175,992		
ROP367		0.717	227.8	163.3	1,250	639	29,415		
ROP4		0.566	718.4	406.6	7,855	2,702	362,791		
ROP5		0.643	536.7	345.1	1,527	721	120,384		
	Hm3		*Load: kg/ monitored season*					*mg/kg*	*mg/kg*
ROP2	0.59	0.863	203.1	175.3	2,194	1,862	104,154	3,186	267
ROP367*	23.54	0.717	5,361.0	3,843.8	29,410	15,028	692,281	20,775	2,192
ROP4	4.74	0.566	3,356.6	1,899.8	37,220	12,804	1,719,133	14,203	847
ROP5	0.22	0.643	116.5	74.9	342	264	26,955	2,901	1,543

*No velocity measurements: Manning's flow adjusted for upstream site relationship

TP = Total Phosphorous
OP = Ortho Phosphorous, calcuated based on OP:TP ratios
TN = Total N
DisN = Dissolved N (NO2N+NO3N)
NVSS = Non-Volatile Suspended Solids (sediment)
SedN = Sediment N concentration = (TN-DisN)/NVSS
SedP = Sediment P concentration = (TP-DisP)/NVSS

Where:
ppb = parts per billion, or ug/L
Hm3 = cubic hectameters, or 10000000 cubic meters
kg = kilograms, or 1000 grams

C.2 GWLF

GWLF was used to model potential sediment and nutrient transport into the lake from each of the eight subwatersheds. Geographic Information System (GIS) layers were obtained from various agency sources and combined for calculating area-weighted parameters for each subwatershed. Soils information included mapping unit, hydrologic group, K-factor (erodibility), and LS (slope-length factor). Soils information was combined with land use layers to calculate area-weighted average Universal Soil Loss Equation KLSCP factor and Curve Number (CN) - two input parameters governing water and erosional transport processes in GWLF.

Table C-4 GWLF Input Parameters Overview

Parameter	Method/Value	Source
Areas	GIS Digitized TTEMI delineated topographs	BASINS data set (USEPA, 1999), Illinois Natural History Survey datasets converted to UTM NAD 1927
Land use	GIS; BASINS, and SWAP (Source Water Assessment Program) data sets were converted to same projection and intersected to form a combined land use layer. This increases the resolution of the BASINS layer yet separated wooded from grass/pasture of the SWAP layer. Data included cropland, grass/pasture, forest, urban, commercial, and transportation land uses and associated area for each subwatershed.	BASINS data set, Source Water Assessment Program data set (Illinois EPA, 2000)
Cropping Factors (C)	Cropland = 0.43 (row crop agriculture) Grass/Pasture = 0.01 (CRP, grassland/pasture: permanent pasture, idle land, 80% groundcover as grass) Forest = 0.004 (Managed, woodland, 40-75% tree canopy) **(See Appendix C, Comments #31 and #48, pages 12 and 15)**	GWLF tables Illinois Transect Survey (IDOA, 2000)
Soils	Soil survey was digitized for Bond County and attributed with values from the soil survey. Montgomery County missing data was assumed to be include soils in the same proportion as the Bond County data. Data included soil mapping unit and area for each subwatershed.	Bond County Soil Survey (NRCS, 1983) TTEMI digitizing TTEMI attributing
Soil Erodibility Factor (K)	Soil survey data for the surface soil; proportion weighted averages for soil associations.	Bond County Soil Survey
Conservation Practice Factor (P)	No conservation practices were modeled since CRP is the primary practice and is accounted for in the land use categories (considered delineated as grassland/pasture)	NA
Slope-Length Factor (LS)	LS factors measured by NRCS for each soil mapping unit: Area weighted average for each subwatershed using GIS	NRCS
Hydrologic Group	Soil Survey data for each soil mapping unit	Bond County Soil Survey
Curve Number (CN)	Curve number is based on land use and hydrologic group. Intersected soils and land use data was used to determine CN for each intersected area. A weighted average CN was calculated for each land use type in each subwatershed.	Tables from GWLF manual for Hydrologic Group - Land use relationship numbers

Soil Loss and Transport Factor (KLSCP)	Area weighted average for the entire subwatershed determined by intersecting land use and soils data sets using GIS.	GIS Calculated
Groundwater Recession (r)	GWLF calibrated to monitored stream flows for ROP02, ROP04, and ROP05; estimated for other watersheds based. Original estimate based on the following formula during hydrograph regression: r = ln[flowt$_1$/flowt$_2$]/(t$_2$ - t$_1$) (t$_2$>t$_1$)/day	GWLF - monitored data calibrated
Rainfall Erosivity	Average of Zone 16 and Zone 19, Figure B-1 GWLF Manual since the watershed is near the boundary. Cool season (November though April) = 0.13 Warm season (May through October) = 0.28	GWLF Manual: (Wischmeier and Smith, 1978)
Evapotranspiration (ET)	Default ET coefficient for land use area and Bond County Agric. Statistics cropping practices used to determine weighted average ET for each subwatershed.	GWLF Manual
Climate	Daily Temperature and Precipitation from 1987 through 1999 were reformatted for use in GWLF. Leap year February 29 values were deleted because the model could only run 365-day years. The model was calibrated to 1999 data and simulated for a 13-year run. Greenville station data was used except where values were missing. In this case, neighboring station averages (Vandalia, Carlyle Reservoir, and Hillsboro) were used (all temperature and 1988 through 1992 precipitation)	Regional Climate Data Center (MRCC, 2000)
Nutrient Export Coefficients	FLUX calibrated for subwatersheds ROP02, ROP03, ROP04, and ROP05. Averages values from these used for the rest. Grass/Pasture was assumed to have the same nutrient concentrations as Cropland since these individual land uses could not be separated out. See text for more discussion.	GWLF/FLUX Calibrated
Nutrient Washoff Coefficients and Accum. Rates	Default GWLF values for urban land uses.	GWLF Manual.
Daylight Hours	Average of Table B-9 values (GWLF Manual; Mills et. al, 1985) for 38 and 40^{o} N (Greenville = 38^{o} 53')	GWLF Manual
Growing season	Assumed April through October	
Sediment Delivery Ratio	Table values from GWLF manual based on size of watershed.	GWLF Manual

Septic Systems	118 septic systems are located around Governor Bond Lake. These were assumed to serve an average of 3 people per system, and exist in proportion to area of each directly contributing watershed. Of the 118 septic systems, 8 systems were considered failed. Ponded systems are used to describe systems that use surface discharge and where discharge will enter the lake within a month. In this case, aeration systems were considered ponded due to the surface discharge characteristics.	Personal Communication with City of Greenville and Bond County Health Dept.
Septic System Nutrients	Default values from GWLF were used. They were similar to literature values encountered.	GWLF Manual
Sediment Nutrients	GWLF values were calibrated using FLUX (total nutrient concentrations - dissolved concentration)/suspended sediment concentration.	GWLF/FLUX calibrated

General Modeling Conventions

For modeling purposes, all land use areas and septic loads were multiplied by 100 in order to increase model output resolution. Consequently, all output loads (quantities, not concentrations) must be reduced by a factor of 100 for actual values.

Model simulations spanned 13 continuous years (1987 through 1999) to reduce potential errors due to artifact antecedent conditions and to capture watershed responses to variable climate.

The growing season was assumed to be April through September and large bodies of water (Upper Pond, Upper Lake Basin, and Lower Lake Basin) were not included in the subwatershed analysis.

Calibration

GLWF input parameters were then calibrated to 1999 monitored data adjusted for nutrient transport using FLUX output. In addition to monitored tributary subwatersheds, subwatersheds included directly draining area to the northwest Upper Pond, the Upper Lake Basin, and the Lower Lake Basin, and the Unmonitored tributary in the southeast area of the watershed. GWLF loads from septic systems, groundwater interflow, and surface runoff were simulated for the years 1987 through 1999. Running model simulations for a number of years reduces potential artifacts due to antecedent conditions. GWLF derived annual loads were then used as input values for BATHTUB to model in-lake nutrient cycling processes.

Inputs

Cropping Factor

The original C factor used in calculations for Cropland was 0.51. Further information obtained from the 2000 Illinois Soil Conservation Transect Survey provided more detailed cropping practices for Bond County and was used to proportionally adjust the GIS calculated weighted average. Cropland land use KSLCP for each watershed using the revised C-factor is provided in Table C-6 (i.e., 0.43/0.51x original Cropland KLSCP) **(see Appendix C, Comments #31 and #48, pages 12 and 15)**.

Table C-5. Land use Parameters Used in GIS Subwatershed Weighted Averages

Cropping Factor and Curve Number Relationships to Landuse

		Hydrologic Group Curve Number		
Landuse	**C-factor**	**1 (D)**	**2 (C)**	**3 (B)**
Cropland	0.43	91	88	81
Commercial		91	89	85
Forest	0.004	82	76	65
Grassland/Pasture	0.01	73	65	48
Transportation		98	98	98
Urban		82	76	65
Water/Wetland		98	98	98

Source: Bond County Soil Survey (NRCS, 1983)
Note: No Hydrologic Group A soils are present in the watershed.

Table C-6. Bond County Cropping Practice Averages: Used to Adjust Subwatershed KLSCP

	Conventional			**Mulch**			**No-till**			**Total**		
	Acres	%	C	Acres	%	C	Acres	%	C	Acres	%	wt.avg C
Corn	72538	97	0.54	424	1	0.38	1697	2	0.20	74658	44.6	0.532
Soybean	36481	64	0.48	2121	4	0.40	18240	32	0.22	56842	33.9	0.394
Small Grain	11453	32	0.38	3818	11	0.32	20786	58	0.20	36057	21.5	0.273
Totals/Means										167557	100	**0.430**

Source:
2000 Illinois Soil Conservation Transect Survey Summary, Illinois Department of Agriculture, Bureau of Land and Water Resources, Springfield, IL. September 2000. **(See Appendix C, Comments #31 and #48, pages 12 and 15)**

Table C-7. Soil Mapping Units and Associated Parameters From Bond County NRCS and the Bond County Soil Survey

Soil Factors Used for Determining Subwatershed Weighted Average Curve Numbers (CN) and KLSCP

Soil Mapping Unit	Hydrologic Group	K-factor	LS- factor
2	1	0.37	0.16
3A	2	0.32	0.2
3B	2	0.32	0.34
3B2	2	0.43	0.46
4B	2	0.32	0.49
4C2	2	0.32	1.39
7C3	1	0.32	0.9
8F	2	0.37	5
12	1	0.43	0.13
13A	1	0.43	0.2
13B	1	0.43	0.34
13B2	1	0.43	0.47
14B	2	0.43	0.34
14C2	2	0.43	1.3
15C2	3	0.37	1.68
48	1.5	0.37	0.13
50	2	0.28	0.16
113B2	2	0.32	0.47
120	1	0.43	0.13
218	2	0.37	0.16
242B	3	0.37	0.11
287A	2	0.37	0.25
333	2	0.37	0.16
451	2	0.32	0.12
474	1	0.37	0.16
581B2	1	0.43	0.34
583B	3	0.37	0.34
585D	3	0.32	2.4
620A	1	0.43	0.16
620B3	1	0.43	0.34
802			
862			
912A	1.55	0.3695	0.25
912B2	1.55	0.3695	0.47
914C3	0.9	0.308	0.9
946D3	1.4	0.313	2.5
991	1	0.397	0.16
DAM			

Hydrologic Groups were assigned numbers: A=4; B=3; C=2; D=1
Hydrologic Groups for associations were determined by proportion weighted average

Septic Systems

Septic system data was estimated based on near-lake housing and development information obtained from the city of Greenville[1], and failure rates from a 1999 survey (GBL Committee, 1998). Failed systems were assumed to operate as ponded systems (surface discharge that reaches the water body within a month of discharge) within the GWLF model. Aeration systems were also considered to respond as ponded systems since they discharge to the surface. Each household near the lake was assumed to have three people served by one septic system. The following table summarizes the per capita septic systems for both the Upper and Lower Lake Basins.

Table C-8. Estimated Number of People Served by Septic Systems Around Governor Bond Lake.

	Current	**Maximum level based on number of sites available (Full Build-Out)**
Total		
Ponded	225 (63.4%)	441
Normal	130 (36.6%)	255
Upper Basin (45% of houses)		
Ponded	101	222.5
Normal	58	128.5
Lower Basin (55% of houses)		
Ponded	124	219
Normal	72	126

Default (GWLF manual) nutrient concentrations in effluent were used and were consistent with other reported literature values: TN = 12 mg/L, Dissolved N = 2.5 mg/L, TP = 1.6 mg/L, and Dissolved P = 0.4 mg/L

Groundwater

Initial groundwater concentrations were estimated from baseflow in-stream concentrations (8/2 and 10/21 or 10/22 1999 Clean Water Partnership Monitoring Program). Groundwater concentrations were adjusted during calibration only if necessary to obtain model results consistent with in-stream water quality results.

[1] Personal communication. 2001. Crystal Lingley, Director of Environmental Health, City of Greenville

Table C-9. Pre-Calibration GWLF Groundwater Concentrations

	Groundwater Concentration	
Site	**Dis-N**	**Dis-P**
	mg/L	*mg/L*
R0P02	4.650	0.1240
R0P03	0.155	0.1880
R0P04	0.075	0.2220
R0P05	0.135	0.0993
R0P06	0.640	0.1320
R0P07	1.950	0.0584

Evapotranspiration Coefficients

Weighted average evapotranspiration (ET) coefficients for each subwatershed were determined based on default values in the GWLF manual. ET is used to adjust potential evaporation for effects of growing plants/crops. The following tables show chosen values and resultant weighted average coefficients. Land use and Cropland type proportion was used to determine monthly evapotranspiration.

Table C-10. Proportion-weighted Evapotranspiration Coefficients Governor Bond Lake Watershed Cropland

Evapotranspiration Factor for Agriculatural Crops (Cropland)						
% of Growing Season	**Corn**	**Sorghum**	**Beans**	**All**	**Growing Season Months**	**Month**
%	fraction of pan evaporation					
0	0.45	0.30	0.30	0.37	0.37	Nov-Apr
10	0.51	0.40	0.35	0.44		
20	0.58	0.65	0.58	0.60	0.52	May
30	0.66	0.90	1.05	0.83		
40	0.75	1.10	1.07	0.94	0.88	June
50	0.85	1.20	0.94	0.99	0.96	July
60	0.96	1.10	0.80	0.97		
70	1.08	0.95	0.66	0.95	0.96	Aug
80	1.20	0.80	0.53	0.92		
90	1.08	0.65	0.43	0.79	0.86	Sep
100	0.70	0.50	0.36	0.56		
				0.37	0.46	Oct

Calculated using 2000 Illinois Soil Conservation Transect Survey Summary for Bond County where 44.6 percent is corn, 33.9% is soybean and 21.5% of acreage is small grains. Values used for sorghum were from small grains as a close fit.

Table C-11. Overall Monthly ET for Governor Bond Lake Watershed

	Landuse ET Factor				Area Weighted ET Factor				Area Weighted ET Factor			
Month	Crop	Pasture	Forest	Water/ Wetland	ROP2	ROP3,6,7	ROP4	ROP5	Unmon	Pond	Upper	Lower
Jan	0.37	1.16	0.3	0.75	0.46	0.65	0.55	0.56	0.66	0.69	0.66	0.73
Feb	0.37	1.23	0.3	0.75	0.47	0.68	0.56	0.58	0.68	0.72	0.69	0.75
Mar	0.37	1.19	0.3	0.75	0.46	0.66	0.55	0.57	0.67	0.70	0.68	0.74
Apr	0.44	1.09	0.6	0.75	0.54	0.70	0.59	0.60	0.73	0.72	0.75	0.78
May	0.52	0.95	0.8	0.75	0.61	0.72	0.62	0.63	0.75	0.73	0.78	0.79
Jun	0.88	0.83	0.9	0.75	0.88	0.86	0.87	0.87	0.86	0.85	0.87	0.83
Jul	0.96	0.79	0.9	0.75	0.93	0.89	0.92	0.92	0.87	0.87	0.87	0.83
Aug	0.96	0.8	0.8	0.75	0.92	0.88	0.92	0.92	0.85	0.87	0.84	0.81
Sep	0.86	0.91	0.5	0.75	0.82	0.83	0.87	0.87	0.79	0.83	0.76	0.77
Oct	0.46	0.91	0.2	0.75	0.48	0.59	0.56	0.57	0.58	0.63	0.56	0.64
Nov	0.37	0.83	0.2	0.75	0.41	0.52	0.47	0.48	0.52	0.56	0.50	0.60
Dec	0.37	0.69	0.3	0.75	0.40	0.49	0.44	0.45	0.49	0.52	0.48	0.58

Daylight length and regional erodibility factors used are also included in GWLF analysis. Default values used for the region are listed in the table below (GWLF manual):

Table C-12. Daylight Hours and Erodibility GWLF Input Values for Governor Bond Lake Watershed

Month	Daylight Hours	Erodibility
Jan	9.6	0.13
Feb	10.6	0.13
Mar	11.8	0.13
Apr	13.0	0.28
May	14.0	0.28
Jun	14.6	0.28
Jul	14.5	0.28
Aug	13.5	0.28
Sep	12.2	0.28
Oct	11.0	0.13
Nov	9.9	0.13
Dec	9.3	0.13

Runoff Nutrient Concentrations

Urban, Forest, and Transportation land uses were assumed to have default runoff nutrient concentrations (GWLF Manual) and atmospheric deposition rates for waterbodies. Table C-13 lists values used.

Table C-13. Default Runoff Nutrient Concentrations

Land use	Dissolved N	Dissolved P
	mg/L	*mg/L*
Forest	0.19	0.006
Urban	0.0173	0.002
Transportation	0.101	0.0019
Water	0.0184	0.00184

Source: GWLF Users Manual

Runoff nutrient concentration from Cropland and Grass/Pasture runoff was determined by calibrating GWLF output to measured in-stream concentrations for the 1999 monitoring season, where some in-stream measured data was available. Cropland and Grass/Pasture land uses dominated the subwatersheds and were assumed to have equal nutrient runoff concentrations in lieu of better data and the inability to separate nutrient concentrations associated with each land use type. Literature for grassland or fallow lands shows that nutrient concentrations in runoff from these lands are similar to or greater than concentrations in runoff from cropland. Grassland and pasture, however, have much less runoff, so although the nutrient concentrations in runoff are the same compared to cropland, the amount of load from grassland/pasture will be much less. Actual transport rates and loads from the two different land uses will be reflected in different runoff and sediment transport properties associated with them. Runoff concentrations from cropland and grassland/pasture were adjusted until output concentrations for the monitored period were equivalent to measured concentrations (< 1 percent difference). If necessary, original groundwater concentrations were also adjusted during this calibration process. For non-monitored subwatersheds, average values were used. Table C-14 lists final nutrient values used.

Table C-14. Runoff Nutrient Concentrations Used in Calibrated GWLF Models.

GWLF Coefficients for unmonitored subwatersheds: Velocity Based Q Relationship Calibrated Concentrations

Cropland/Pasture							
Stream Site	**Sed N**	**Sed P**	**GW N**	**GW P**	**Dis N**	**Dis P**	**Comments**
	mg/kg	mg/kg	mg/L	mg/L	mg/L	mg/L	
ROP2	800	80	3.5	0.24	1.4	0.55	calibrated to measured instream values
ROP3	800	90	0.155	0.188	2.9	0.075	calibrated to measured instream values
ROP4	7500	450	0.155	0.222	8.9	0.816	calibrated to measured instream values
ROP5	100	1	0.135	0.0993	2.4	0.93	calibrated to measured instream values
Unmonitored	100	1	0.135	0.0993	2.4	0.93	same as 5 (neighbor)
Pond	800	85	0.148	0.187	2.233	0.593	average of 2, 3, 4, 5 - outliers
Upper Basin	800	85	0.148	0.187	2.233	0.593	average of 2, 3, 4, 5 - outliers
Lower Basin	800	85	0.148	0.187	2.233	0.593	average of 2, 3, 4, 5 - outliers

GW N = Groundwater Nitrogen
GW P = Groundwater Phosphorus
Sed N = Sediment-associated Nitrogen
Sed P = Sediment-associated Phosphorus
Dis N = Dissolved N in runoff
Dis P = Dissolved P in runoff

Table C-15. Summaries Annual GWLF Output for Each Subwatershed

ROP02: Unnamed Tributary

				Ha	359.6		
	PRECIP	**PRECIP**	**PRECIP**	**EVAPOTRANS**	**GR.WAT.FLO**	**RUNOFF**	**STREAMFLOW**
	m	Hm3	Hm3	Hm3	Hm3	Hm3	Hm3
1989	0.913	0.108	3.283	1.683	1.169	0.629	1.798
1993	1.294	0.252	4.653	1.518	1.766	1.054	2.819
1996	1.078	0.360	3.876	1.435	1.334	0.867	2.201
1999	1.047	0.467	3.765	1.496	1.780	0.644	2.424

		EROSION	**EROSION**	**SEDIMENT**	**DIS.NITR**	**TOT.NITR**	**DIS.PHOS**	**TOT.PHOS**
		tons/ha	tons/ac	g/L	mg/L	mg/L	mg/L	
1989	dry	0.03	4.78	0.721	2.737	3.315	0.336	0.393
1993	wet	0.08	5.93	0.569	2.683	3.139	0.341	0.387
1996	nomal	0.11	6.35	0.781	2.637	3.264	0.346	0.409
1999	cal	0.15	4.85	0.542	2.921	3.356	0.313	0.357

ROP03: Dry Branch

				Ha	3175		
	PRECIP	**PRECIP**	**PRECIP**	**EVAPOTRANS**	**GR.WAT.FLO**	**RUNOFF**	**STREAMFLOW**
	m	Hm3	Hm3	Hm3	Hm3	Hm3	Hm3
1989	0.913	28.988	28.988	15.780	2.635	4.477	7.112
1993	1.294	41.085	41.085	13.875	7.303	7.525	14.827
1996	1.078	34.227	34.227	13.176	8.827	6.223	15.018
1999	1.047	33.242	33.242	14.034	10.700	4.509	15.240

		EROSION	**EROSION**	**SEDIMENT**	**DIS.NITR**	**TOT.NITR**	**DIS.PHOS**	**TOT.PHOS**
		tonnes/ha	tons/ac	g/L	mg/L	mg/L	mg/L	
1989	dry	18.62	7.42	1.247	1.631	2.653	0.110	0.225
1993	wet	23.06	9.19	0.741	1.351	1.960	0.126	0.194
1996	nomal	24.70	9.84	0.783	1.128	1.768	0.137	0.209
1999	cal	18.87	7.52	0.590	0.847	1.332	0.151	0.206

ROP04: Kingsbury Branch

				Ha	1925		
	PRECIP	**PRECIP**	**PRECIP**	**EVAPOTRANS**	**GR.WAT.FLO**	**RUNOFF**	**STREAMFLOW**
	m	Hm3	Hm3	Hm3	Hm3	Hm3	Hm3
1989	0.913	17.575	17.575	9.240	1.444	3.484	4.928
1993	1.294	24.910	24.910	8.297	3.966	5.871	9.856
1996	1.078	20.752	20.752	7.854	4.851	4.870	9.702
1999	1.047	20.155	20.155	8.162	5.910	3.658	9.567

		EROSION	**EROSION**	**SEDIMENT**	**DIS.NITR**	**TOT.NITR**	**DIS.PHOS**	**TOT.PHOS**
		tonnes/ha	tons/ac	g/L	mg/L	mg/L	mg/L	
1989	dry	12.12	4.83	0.947	6.268	13.371	0.636	1.062
1993	wet	15.01	5.98	0.586	5.307	9.707	0.570	0.834
1996	nomal	16.07	6.40	0.638	4.486	9.272	0.515	0.802
1999	cal	12.28	4.89	0.494	3.446	7.154	0.444	0.667

ROP05: Lower Kingsbury Branch

				Ha	996		
	PRECIP	**PRECIP**	**PRECIP**	**EVAPOTRANS**	**GR.WAT.FLO**	**RUNOFF**	**STREAMFLOW**
	m	Hm3	Hm3	Hm3	Hm3	Hm3	Hm3
1989	0.913	9.093	9.093	4.771	0.767	1.713	2.480
1993	1.294	12.888	12.888	4.303	2.112	2.888	5.000
1996	1.078	10.737	10.737	4.074	2.570	2.390	4.970
1999	1.047	10.428	10.428	4.233	3.137	1.783	4.920

		EROSION	**EROSION**	**SEDIMENT**	**DIS.NITR**	**TOT.NITR**	**DIS.PHOS**	**TOT.PHOS**
		tonnes/ha	tons/ac	g/L	mg/L	mg/L	mg/L	
1989	dry	10.85	4.32	1.089	1.602	2.861	0.631	1.077
1993	wet	13.44	5.35	0.669	1.362	2.185	0.544	0.837
1996	nomal	14.39	5.73	0.721	1.158	1.911	0.470	0.734
1999	cal	11.00	4.38	0.556	0.905	1.634	0.379	0.640

Unmonitored Tributary

Ha 787.9

	PRECIP	PRECIP	PRECIP	EVAPOTRANS	GR.WAT.FLO	RUNOFF	STREAMFLOW
	m	Hm3	Hm3	Hm3	Hm3	Hm3	Hm3
1989	0.913	7.194	7.194	3.908	0.465	1.040	1.505
1993	1.294	10.195	10.195	3.412	1.363	1.749	3.112
1996	1.078	8.494	8.494	3.238	1.741	1.450	3.191
1999	1.047	8.249	8.249	3.451	2.175	1.087	3.262

		EROSION	EROSION	SEDIMENT	DIS.NITR	TOT.NITR	DIS.PHOS	TOT.PHOS
		tonnes/ha	tons/ac	g/L	mg/L	mg/L	mg/L	
1989	dry	10.48	4.17	1.426	0.968	1.271	0.385	0.399
1993	wet	12.98	5.17	0.854	0.834	1.024	0.340	0.349
1996	nomal	13.90	5.53	0.892	0.700	0.879	0.293	0.301
1999	cal	10.62	4.23	0.667	0.521	0.671	0.231	0.238

Pond: Upper Pond

Ha 564.7

	PRECIP	PRECIP	PRECIP	EVAPOTRANS	GR.WAT.FLO	RUNOFF	STREAMFLOW
	m	Hm3	Hm3	Hm3	Hm3	Hm3	Hm3
1989	0.913	5.156	5.156	2.840	0.491	0.678	1.169
1993	1.294	7.307	7.307	2.468	1.350	1.163	2.513
1996	1.078	6.087	6.087	2.344	1.638	0.960	2.603
1999	1.047	5.912	5.912	2.502	1.993	0.689	2.682

		EROSION	EROSION	SEDIMENT	DIS.NITR	TOT.NITR	DIS.PHOS	TOT.PHOS
		tonnes/ha	tons/ac	g/L	mg/L	mg/L	mg/L	
1989	dry	16.50	6.57	2.389	1.286	3.198	0.402	0.605
1993	wet	20.43	8.14	1.377	1.055	2.156	0.358	0.475
1996	nomal	21.88	8.71	1.424	0.870	2.009	0.323	0.444
1999	cal	16.72	6.66	1.056	0.660	1.504	0.284	0.374

Upper: Upper Lake Basin

Ha 564.1

	PRECIP	PRECIP	PRECIP	EVAPOTRANS	GR.WAT.FLO	RUNOFF	STREAMFLOW
	m	Hm3	Hm3	Hm3	Hm3	Hm3	Hm3
1989	0.913	5.150	5.150	2.821	0.530	0.536	1.066
1993	1.294	7.299	7.299	2.443	1.450	0.931	2.381
1996	1.078	6.081	6.081	2.324	1.760	0.778	2.533
1999	1.047	5.906	5.906	2.476	2.132	0.530	2.657

		EROSION	EROSION	SEDIMENT	DIS.NITR	TOT.NITR	DIS.PHOS	TOT.PHOS
		tonnes/ha	tons/ac	g/L	mg/L	mg/L	mg/L	
1989	dry	10.24	4.08	1.625	1.547	2.892	0.399	0.546
1993	wet	12.69	5.05	0.902	1.042	1.790	0.326	0.408
1996	nomal	13.58	5.41	0.908	0.897	1.646	0.302	0.384
1999	cal	10.38	4.13	0.661	0.731	1.281	0.277	0.338

Lower: Lower Lake Basin

Ha 349.3

	PRECIP	PRECIP	PRECIP	EVAPOTRANS	GR.WAT.FLO	RUNOFF	STREAMFLOW
	m	Hm3	Hm3	Hm3	Hm3	Hm3	Hm3
1989	0.913	3.189	3.189	1.778	0.339	0.272	0.611
1993	1.294	4.520	4.520	1.502	0.933	0.482	1.411
1996	1.078	3.765	3.765	1.432	1.132	0.402	1.533
1999	1.047	3.657	3.657	1.530	1.369	0.265	1.635

		EROSION	EROSION	SEDIMENT	DIS.NITR	TOT.NITR	DIS.PHOS	TOT.PHOS
		tonnes/ha	tons/ac	g/L	mg/L	mg/L	mg/L	mg/L
1989	dry	19.88	7.92	3.408	2.001	4.857	0.434	0.728
1993	wet	24.62	9.81	1.828	1.162	2.701	0.327	0.484
1996	nomal	26.37	10.50	1.802	1.030	2.534	0.308	0.464
1999	cal	20.15	8.03	1.291	0.864	1.954	0.284	0.396

Concentrations and flows adjusted for calculated loads 100 times greater than actual due to 100 multiplier used to increase model resolution.

BMPs

Since most of the conservation tillage in Bond County appears to be no-till, analysis of increased conservation tillage as a BMP assumed conversion of conventional till to no-till. Resulting C-factors were used to proportionally adjust original area-weighted Cropland KSLCP. Table C-16 shows the multiplier necessary for KLSCP factor to account for increased conservation tillage.

Table C-16. KLSCP Multipliers to Adjust Conservation Tillage Management Increases

Bond County Averages: Transect Survey 2000

Crop	Acres	Wt. C	Proportion of Conventional Tillage	Conventional Tillage C	No-Till C	Assume 40% NT	Assume 60% NT	Assume 100% NT
corn	74658	0.532	0.97	0.54	0.2	30162	25085	14932
soybeans	56842	0.394	0.64	0.48	0.22	21373	18417	12505
small grains	36057	0.273	0.32	0.38	0.2	9844	9844	7211
Fraction in conservation tillage:			0.28					
Wt. Composite C				0.43		0.3663	0.3184	0.2068
mean factor for converting initial KLSCP						0.7183	0.6243	0.4055

C.3 BATHTUB

BATHTUB is an equilibrium, in-lake eutrophication and nutrient cycling model. Input values consist of monitored tributary flow and concentrations or non-point source land use fractions and export coefficients, in-lake water quality concentrations, and some global parameters. Internal cycling can be considered the residual between predicted in-lake concentration and measured values. Several internal sub-models are available to describe in-lake processes and coefficients can be calibrated for site-specific applications.

Although analysis of lake impairment and load reductions must be completed for the entire lake, in order to more accurately model the system and understand the processes, Governor Bond Lake was divided into three portions: the Upper Pond, Upper Lake Basin, and Lower Lake Basin. Each basin had associated tributary inputs.

Tributary output from GWLF was used as input values for BATHTUB. Directly contributing watersheds were also modeled as monitored tributaries in order to remain consistent with GWLF calculations and to simplify modeling potential BMP effects. The model was built using 1999 data; internal nutrient cycling and eutrophication models were chosen to best simulate 1999 conditions, since data was the most complete for this year.

Upper and Lower Lake Basin in-lake concentration means and coefficients of variation (cvs) were determined by analysis of STORET (1989, 1993, 1996) and 1999 IEPA and Clean Lakes Program provisional data. Two sites were available for long-term analysis of the Lower Lake Basin (ROP-1 and ROP-2). Concentrations at these sites were averaged to determine overall Lower Lake Basin water quality parameters. Upper Lake Basin values were used for the Upper Pond conditions, since additional data was not available. Outflow concentrations were assumed to be the same as lake site ROP-1.

Because reservoirs and lakes are often highly responsive to current and previous year weather and transport conditions (retention and storage history), it is often difficult to validate models such as BATHTUB. Therefore, BATHTUB was calibrated for variable weather conditions that bracket potential climatic situations. For Governor Bond Lake, chosen conditions included a dry year (1989), wet year (1993), and near normal year (1996). These specific years were chosen to represent variable climatic conditions due to precipitation amounts and availability of in-lake water quality monitoring data. 1999 was used for calibration and additional information, but was not chosen to represent the Normal year, even though annual precipitation was closer to normal in 1999 than 1996. The preceding year climate for 1999 was much wetter than preceding years for 1989, 1993, and 1996. This wetter history influences both transport and cycling processes, and therefore, 1999 is not as comparable to 1989 and 1993 as is 1996.

GWLF modeled output for each condition year was used for BATHTUB tributary concentrations and flows. First, coefficients for Upper Pond water quality models were calibrated to match in-lake concentrations. Next, residual mass balance differences for Total Phosphorous (TP) or Total Nitrogen (TN) in the downstream basins (Upper Lake Basin and Lower Lake Basin) were used to determine internal cycling load (modeled concentration less than measured) or storage/retention load (modeled concentration greater than measured).

Input Parameters

Global Parameters

The Diagnostic Feasibility Study for Governor Bond Lake (ZEIS, 2001) values for atmospheric nitrogen and phosphorous loads (497 kg/km^2/yr and30.9 kg/km^2/yr, respectively) were used in BATHTUB models. One-half of total load was assumed to be in the dissolved fraction, which is consistent with default proportions in the BATHTUB model. Yearly evaporation (0.812 m/yr) and corresponding cv (0.031) was calculated from average monthly pan evaporation (Midwestern Regional Climate Center website). Generally, evaporation from a lake surface can be assumed to be 0.75 * pan evaporation.

Climate

Precipitation for each year was calculated from climate data (Midwestern Regional Climate Center, 2000). For 1989, 1993, and 1996, climate conditions (dry year, wet year, normal year) were preceded by a dry year (less than 0.95 m rainfall). Preceding year for 1999 (wet-normal rainfall), however, was a normal to wet year (greater than 1.0 m rainfall). BATHTUB modeled continuous conditions from 1987 through 1999 and consequently, includes antecedent conditions history in the analysis.

In-Lake Concentrations

STORET and 1999 Clean Lakes Program monitoring data was used to determine mean in-lake concentrations for both Upper and Lower Lake Basins and their coefficients of variation (cv). No data was available for the Upper Pond, therefore in-lake concentrations were assumed to be the same as the Upper Lake Basin. Two long term monitoring sites had associated data for the Lower Lake Basin and were averaged for an overall Lower Lake Basin value. Mixed layer depth, hypolimnetic oxygen demand (HOD), and metalimnion oxygen demand (MOD) were determined using the model PROFILE described at the end of this section.

The following tables show input in-lake concentrations used for modeling Governor Bond Lake Upper Pond, Upper Lake Basin, and Lower Lake Basin, respectively.

Table C-17a: Upper Pond Characteristics In-Lake Concentrations (assumed same as Upper Lake Basin)

Site:	POND	Year:	1989
Area, km2			0.127
Mean Depth, m			1.27
Mixed Layer, m			0
Hypolimnetic Depth, m			0
Length, km			0.711

Parameter	Mean	cv
	ug/L	
TP	138	na
TN	1725	na
Chl-a	128.9	na
SD	0.3912	na
OrgN	1432	na
TP-OP	108.4	na
HOD	na	na
MOD	na	na

Site:	POND	Year:	1993
Area, km2			0.127
Mean Depth, m			1.27
Mixed Layer, m			0
Hypolimnetic Depth, m			0
Length, km			0.711

Parameter	Mean	cv
	ug/L	
TP	255.6	na
TN	1376	na
Chl-a	120.1	na
SD	0.4039	na
OrgN	1006	na
TP-OP	149	na
HOD	na	na
MOD	na	na

Site:	POND	Year:	1996
Area, km2			0.127
Mean Depth, m			1.27
Mixed Layer, m			0
Hypolimnetic Depth, m			0
Length, km			0.711

Parameter	Mean	cv
	ug/L	
TP	208.4	na
TN	1446	na
Chl-a	36.26	na
SD	0.4597	na
OrgN	1156	na
TP-OP	147.8	na
HOD	na	na
MOD	na	na

Site:	POND	Year:	1999
Area, km2			0.127
Mean Depth, m			1.27
Mixed Layer, m			0
Hypolimnetic Depth, m			0
Length, km			0.711

Parameter	Mean	cv
	ug/L	
TP	149.2	na
TN	730.7	na
Chl-a	90.18	na
SD	0.2426	na
OrgN	433.9	na
TP-OP	55.25	na
HOD	na	na
MOD	na	na

Table C-17b: Upper Lake Basin Characteristics and In-Lake Concentrations

Site:	UPPER BASIN	Year:	1989
Area, km2			1.867
Mean Depth, m			2.744
Mixed Layer, m			0.8
Hypolimnetic Depth, m			1.6
Length, km			2.42
Parameter	**Mean**	**cv**	
	ug/L		
TP	138	0.103	
TN	1725	0.112	
Chl-a	128.9	0.178	
SD	0.3912	0.062	
OrgN	1432	0.123	
TP-OP	108.4	0.013	
HOD	66.67	na	
MOD	36.63	na	

Site:	UPPER BASIN	Year:	1993
Area, km2			1.867
Mean Depth, m			2.744
Mixed Layer, m			0.4
Hypolimnetic Depth, m			1.5
Length, km			2.42
Parameter	**Mean**	**cv**	
	ug/L		
TP	255.6	0.168	
TN	1376	0.228	
Chl-a	120.1	0.229	
SD	0.4039	0.088	
OrgN	1006	0.215	
TP-OP	149	0.144	
HOD	123.4	na	
MOD	100.7	na	

Site:	UPPER BASIN	Year:	1996
Area, km2			1.867
Mean Depth, m			2.744
Mixed Layer, m			0.3
Hypolimnetic Depth, m			1.7
Length, km			2.42
Parameter	**Mean**	**cv**	
	ug/L		
TP	208.4	0.355	
TN	1446	0.267	
Chl-a	36.26	0.39	
SD	0.4597	0.125	
OrgN	1156	0.16	
TP-OP	147.8	0.303	
HOD	44	na	
MOD	15.78	na	

Site:	UPPER BASIN	Year:	1999
Area, km2			1.867
Mean Depth, m			2.744
Mixed Layer, m			1
Hypolimnetic Depth, m			1.6
Length, km			2.42
Parameter	**Mean**	**cv**	
	ug/L		
TP	149.2	0.145	
TN	730.7	0.094	
Chl-a	90.18	0.068	
SD	0.2426	0.125	
OrgN	433.9	0.14	
TP-OP	55.25	0.142	
HOD	148.6	na	
MOD	210.6	na	

Table C-17c: Lower Lake Basin Characteristics and In-Lake Concentrations

Site:	LOWER BASIN	Year:	1989
Area, km2			1.571
Mean Depth, m			6.098
Mixed Layer, m			3.45
Hypolimnetic Depth, m			5.35
Length, km			2.54
Parameter	**Mean**	**cv**	
	ug/L		
TP	120.7	0.102	
TN	1863	0.046	
Chl-a	105.4	0.11	
SD	0.3115	0.227	
OrgN	1524	0.047	
TP-OP	91.53	0.056	
HOD	39.52	na	
MOD	101.1	na	

Site:	LOWER BASIN	Year:	1993
Area, km2			1.571
Mean Depth, m			6.098
Mixed Layer, m			1.3
Hypolimnetic Depth, m			2.8
Length, km			2.54
Parameter	**Mean**	**cv**	
	ug/L		
TP	102.3	0.075	
TN	1195	0.127	
Chl-a	68.58	0.138	
SD	0.3522	0.231	
OrgN	839.3	0.1	
TP-OP	73.73	0.062	
HOD	117.5	na	
MOD	77.04	na	

Site:	LOWER BASIN	Year:	1996
Area, km2			1.571
Mean Depth, m			6.098
Mixed Layer, m			1.45
Hypolimnetic Depth, m			2.8
Length, km			2.54
Parameter	**Mean**	**cv**	
	ug/L		
TP	115.5	0.238	
TN	1248	0.129	
Chl-a	19.7	172	
SD	0.425	172	
OrgN	787.3	0.273	
TP-OP	77.73	0.04	
HOD	107.1	0.176	
MOD	56.06	na	

Site:	LOWER BASIN	Year:	1999
Area, km2			1.571
Mean Depth, m			6.098
Mixed Layer, m			2.58
Hypolimnetic Depth, m			3.55
Length, km			2.54
Parameter	**Mean**	**cv**	
	ug/L		
TP	84.2	0.288	
TN	828.5	0.142	
Chl-a	78.03	0.078	
SD	0.3025	0.118	
OrgN	383.2	0.104	
TP-OP	28.8	0.131	
HOD	215.8	na	
MOD	218.3	na	

Tributary Concentrations

Tributary concentrations and flow data were derived from GWLF model output. Directly contributing watersheds were also modeled as tributaries for ease in manipulation. Following submodel calibration, for BMPs assessment, concentrations were reduced until BATHTUB predicted in-lake concentrations complied with target water quality guidelines. The following table lists initial input values for all tributaries for each year modeled.

Table C-18. BATHTUB Initial Tributary Inputs From GWLF Models

Site/ Year	Dissolved Nitrogen	Total Nitrogen	Dissolved Phosphorous	Total Phosphorous	Streamflow
	mg/L				*Hm3*
ROP02: Unnamed Tributary					
1989	2.737	3.315	0.336	0.393	1.80
1993	2.683	3.139	0.341	0.387	2.82
1996	2.637	3.264	0.346	0.409	2.20
1999	2.921	3.356	0.313	0.357	2.42
ROP03: Dry Branch					
1989	1.631	2.653	0.110	0.225	7.11
1993	1.351	1.960	0.126	0.194	14.83
1996	1.128	1.768	0.137	0.209	15.02
1999	0.847	1.332	0.151	0.206	15.24
ROP04: Kingsbury Branch					
1989	6.268	13.371	0.636	1.062	4.93
1993	5.307	9.707	0.570	0.834	9.86
1996	4.486	9.272	0.515	0.802	9.70
1999	3.446	7.154	0.444	0.667	9.57
ROP05: Lower Kingsbury Branch					
1989	1.602	2.861	0.631	1.077	2.48
1993	1.362	2.185	0.544	0.837	5.00
1996	1.158	1.911	0.470	0.734	4.97
1999	0.905	1.634	0.379	0.640	4.92
Unmonitored Tributary					
1989	0.968	1.271	0.385	0.399	1.50
1993	0.834	1.024	0.340	0.349	3.11
1996	0.700	0.879	0.293	0.301	3.19
1999	0.521	0.671	0.231	0.238	3.26
Pond: Upper Pond					
1989	1.286	3.198	0.402	0.605	1.17
1993	1.055	2.156	0.358	0.475	2.51
1996	0.870	2.009	0.323	0.444	2.60
1999	0.660	1.504	0.284	0.374	2.68
Upper: Upper Lake Basin					
1989	1.547	2.892	0.399	0.546	1.07
1993	1.042	1.790	0.326	0.408	2.38
1996	0.897	1.646	0.302	0.384	2.53
1999	0.731	1.281	0.277	0.338	2.66
Lower: Lower Lake Basin					
1989	2.001	4.857	0.434	0.728	0.61
1993	1.162	2.701	0.327	0.484	1.41
1996	1.030	2.534	0.308	0.464	1.53
1999	0.864	1.954	0.284	0.396	1.63

Internal Submodel Selection

The most complete water quality data set existed for 1999, including GWLF output calibrated to measured concentrations. Therefore, 1999 data was used to determine suitable internal models and processes for the Governor Bond Lake system. 1999 conditions also reflect load and response during consistently wet climate patterns.

Internal Cycling

In all cases, Upper Pond values were assumed to be the same as Upper Lake Basin concentrations. Model coefficients were locally calibrated for the Upper Pond, and then residual TP or TN was used to account for internal cycling, if necessary. Predicted in-lake TP less than measured TP reflects potential internal cycling effects. After addition of internal cycling component, all local internal submodel coefficients were calibrated to reflect each situation (dry year, normal year, or wet year). Calibrated models can then be used to assess load reduction impacts on in-lake water quality (e.g., Chlorophyll-a, Total Phosphorous - TP, Trophic State Index -TSI) parameters.

Retention

The Upper Pond likely acts as a sediment and nutrient trap for water entering from Kingsbury Branches and direct contributions. Assuming an 80 percent trapping efficiency for sediment (National Urban Runoff Program [NURP] pond standards), sediment transport from the Upper Pond to the Upper Lake Basin can be assumed from GWLF in-stream sediment loads. Differences between tributary and upstream NVSS loads were used to determine trapping efficiency, sedimentation, and load reductions necessary to reach target NVSS values.

Model Application

Models were adjusted to determine load reductions necessary to meet target water quality conditions, based on Illinois EPA guidelines for Governor Bond Lake causes contributing to impairment as listed in the 2000 Illinois Water Quality Report. Target water quality values were chosen to reflect the range of conditions considered acceptable for various designated uses. Compliance with the below target water quality values will result in assessment as non-impaired for all currently impaired designated uses:

- Trophic State Index (TSI) of < 55
- Non-Volatile Suspended Solids (NVSS) ranging from < 7
- Secchi Depth > 0.6096 m
- Total Phosphorous < 0.050 mg/L
- Chlorophyll-a < 0.020 mg/L

The following table lists some Water Quality Report 2000 Guidelines. Fecal coliform and macrophyte coverage are also considered potential causes contributing to impairment; however they were not measured or assessed and are therefore not included in this table.

Table C-19. Water Quality Parameter Guidelines for Meeting Designated Uses

Designated Use	**Water Quality Guidelines**		
Swimming	**TSI**	**Secchi Depth (m)**	
Full Support	< 55> 0.6096		
Partial Impairment	< 75< 0.6096		
Recreation	**TSI**	**NVSS (mg/L)**	
Full Support	< 60	< 3	
Full Support	< 55	< 7	
Aquatic Life	**TSI**	**NVSS (mg/L)**	
Full Support	< 85		
Full Support	< 90	< 20	
Additional Applicable Guidelines	**TP (mg/L)**	**Siltation (% Orig. Vol.)**	**Chlorophyll-a (mg/L)**
Full Support	< 0.050	< 0.25	< 20
Partial Impaired	< 0.140	< 0.75	< 92
	NVSS (mg/L)		
Full Support	< 12		

Input values for calibrated BATHTUB models for each year condition (dry, wet, normal, wet-normal) were adjusted to determine what load reductions and corresponding nutrient concentrations are necessary to achieve in-lake water quality target goals listed above.

Non-Volatile Suspended Solids (NVSS) and Siltation

Non-volatile suspended solids (NVSS) and siltation are considered causes contributing to recreation and overall use impairment. GWLF modeled tributary sediment concentrations were used to determine sediment loads and flow weighted concentrations for the Upper Pond, Upper Lake Basin, and the Lower Lake Basin. GWLF concentrations were compared with measured in-lake concentrations to determine retention factors (proportion of sediment that settles out) and total load retained in each portion of the lake. For the Upper Pond area, no in-lake data was available, consequently a well designed NURP (National Urban Runoff Program) Pond retention factor of 80 percent removal rate was assumed. The following table summarizes GWLF modeled sediment transport to Governor Bond Lake and the individual basins. From this data, load reductions to meet target goals can be determined.

Table C-20. GWLF Modeled Sediment Transport for the Governor Bond Lake Watershed

Climate Condition	Direct Inflow	Direct Inflow + Upstream	Sediment Flow-Weighted Concentration	NVSS In-Lake Concentration	Proportion of Sediment Retained	Runoff Load in	Shoreline and Gulley Erosion ****	Load Retained	Volume of Load	As-Built Vol. Loss ***
	Hm3	*Hm3*	*mg/L*	*mg/L*		*Mg*		*Mg*	*Acre-ft*	*%*
Upper Pond *										
1989	8.6	8.6	1.184	0.948	0.8	10159		8127	4.5	
1993	17.4	17.4	0.725	0.580	0.8	12586		10069	5.5	
1996	17.3	17.3	0.780	0.624	0.8	13478		10782	5.9	
1999	17.2	17.2	0.600	0.480	0.8	10298		8238	4.5	
Upper Lake Basin **										
1989	10.0	18.6	1.079	0.043	0.96	20023		19222	10.6	
1993	20.0	37.4	0.663	0.027	0.96	24805		23813	13.1	
1996	19.8	37.0	0.717	0.029	0.96	26562		25500	14.1	
1999	20.3	37.5	0.541	0.022	0.96	20297		19473	10.7	
Lower Lake Basin										
1989	16.3	26.3	0.082	0.017	0.79	2147		1700	0.9	
1993	33.6	53.6	0.050	0.016	0.68	2659		1801	1.0	
1996	33.8	53.6	0.053	0.026	0.51	2847		1454	0.8	
1999	34.0	54.4	0.040	0.016	0.60	2176		1306	0.7	
Wet	17.7	26.3	0.923	0.030	0.87	22170	28300	44107	24.3	**0.246**
Dry	36.3	53.6	0.560	0.021	0.82	27464	28300	45459	25.1	**0.253**
Normal	36.3	53.6	0.600	0.027	0.73	29409	28300	42123	23.2	**0.235**
Wet-Normal	37.2	54.4	0.452	0.019	0.78	22473	28300	39372	21.7	**0.219**

* Upper Pond sediment retention assumed to be 80%
** Upper Lake Basin assumed retnetion of all years if the same as 1999 due to lack of previous year measured data
***As-Built Volume = 9,900 Acre-ft
****From Zahniser Institute of Environmetal Studies 2001 Clean Lakes Program Report = estimate

Gully and Streambank Erosion

Measured in-stream NVSS can be assumed to represent sediment transported to tributaries that will eventually reach the lake. However, NVSS does not account for bedload transport and sediment that is deposited within tributary systems. NVSS is therefore likely to under-represent actual sediment transport. Because predicted (modeled) sediment concentrations are consistently higher than measured NVSS concentrations, contributions due to streambank or gully erosion cannot be accounted for. A previous report by the Bond County Soil and Water Conservation District (Bond County SWCD, 1999a) estimated that these sediment sources could add another 14 percent sheet and rill erosion rates with a sediment delivery ratio of 0.40 (proportion of eroded sediment reaching the lake). Total gully and streambank erosion would increase lake siltation rates by 0.13 percent original volume loss per year.

Table C-21. Modeled Current Conditions Target Water Quality Parameters

Year/ Parameter	Current Value	Year/ Parameter	Current Value	Units
1989: Dry Year		**1996: Normal Year**		
TP Load: 13,400 kg/yr		**TP Load: 33,970 kg/yr**		
TN Load: 92,350 kg/yr		**TN Load: 124,430 kg/yr**		
TSI	75.9	TSI	70.8	
SD	0.36	SD	0.44	*m*
TP	130	TP	166	*ug/L*
TN	1757	TN	1340	*ug/L*
TN/TP	13.5	TN/TP	8.1	
Chla	117.9	Chla	29	*ug/L*
1993: Wet Year		**1999: Wet- NormalYear**		
TP Load: 50,270 kg/yr		**TP Load: 18,910 kg/yr**		
TN Load: 133,800 kg/yr		**TN Load: 99,140 kg/yr**		
TSI	77.6	TSI	73.7	
SD	0.38	SD	0.27	*m*
TP	188	TP	120	*ug/L*
TN	1236	TN	760	*ug/L*
TN/TP	6.6	TN/TP	6.3	
Chla	97.2	Chla	84.5	*ug/L*

TSI = mean of Chlorophyll-a and TP Trophic State Indexes
SD = Secchi Depth
TP = Total Phosphorous
TN = Total Nitrogen
Chla = Chlorophyll-a
TN/TP = TN to TP ratio; a measure of limiting nutrient
ug/L = part per billion, or micrograms per liter

Trophic State Index (TSI), Total Phosphorous (TP), Total Nitrogen (TN), Secchi Depth (SD), and Chlorophyll-a (Chla)

Total Phosphorous was the limiting nutrient for eutrophication (nutrient enrichment) processes. Using BATHTUB, chlorophyll-a concentrations were best explained by a submodel using only TP, light, and flushing rate. Submodels based on using TN in combination with other parameters did not predict chlorophyll-a concentrations very well. Consequently, reductions in TP will have the greatest effect on reducing lake TSI and Chla, and in increasing SD.

Nutrient load reductions result in reduced TSI, increased SD, and lower Chla concentrations; the exact effect depends upon the type of weather condition (dry, wet, normal, or wet-normal years) and resulting internal submodel coefficients. The following table allocates current pollutant loads within the watershed.

Table C-22. Governor Bond Lake Load Allocations For Various Climate Conditions

Contributor	Nonpoint Source Load			Contributor	Nonpoint Source Load		
	TP	TN	Sediment		TP	TN	Sediment
	kg/yr	kg/yr	Mg/yr		kg/yr	kg/yr	Mg/yr
1989: Dry Year				**1996: Normal Year**			
Dry Br.	1,600	18,868	8,867	Dry Br.	3,139	26,552	11,762
Kingsbury Br.s	7,905	72,987	7,366	Kingsbury Br.s	11,429	99,455	9,771
Direct Watersheds	1,734	9,789	3,816	Direct Watersheds	2,840	13,283	8,617
Other	1,307	7,873	3,444	Other	1,860	9,989	4,565
Atmospheric	106	1,705	-	Atmospheric	106	1,705	-
Internal	2,353	-	-	Internal	17,730	-	-
Total	13,405	92,354	23,493	Total	33,965	124,432	34,715
1993: Wet Year				**1999: Wet-Normal Year**			
Dry Br.	2,876	29,061	10,984	Dry Br.	3,139	20,300	8,988
Kingsbury Br.s	12,405	106,597	9,125	Kingsbury Br.s	9,530	76,481	7,466
Direct Watersheds	2,848	13,491	10,065	Direct Watersheds	2,522	10,633	6,700
Other	2,177	12,036	4,263	Other	1,641	10,324	3,489
Atmospheric	106	1,705	-	Atmospheric	106	1,705	-
Internal	32,732	-	-	Internal	5,114	-	-
Total	50,268	133,829	34,437	Total	18,913	99,143	26,643

Internal cycling is calculated as the residual (difference) between predicted (modeled) in-lake concentration and measured concentration. No nitrogen internal cycling was noted (i.e., predicted concentrations were not less than measured concentration indicating an internal source of nitrogen necessary to make up the difference). Internal cycling of phosphorous occurred mostly in the Upper Lake Basin and ranged from 27 to 65 percent. Due to the shallow nature of this basin, it is likely that internal cycling was more a result of re-suspension of settled and re-dissolved TP. Re-suspension, as opposed to lake turnover processes (convection), is more likely to occur in shallower lakes and under higher flow conditions (wet and normal years). In 1999, wet conditions during the previous year may have partially flushed some previously deposited TP resulting in less TP available for re-suspension during 1999.

Best Management Practices (BMPs)

Best Management Practices to reduce pollutant loads were assessed by either modeling effects on watershed characteristics, or by applying known pollutant reduction rates to modeled watershed loads.

Effects of the following scenarios were evaluated by adjusting GWLF model input parameters to determine effects on load reduction (reduced pollutant concentrations). In addition to evaluating the effect of various agricultural BMPs, the effect of full build-out for developments surrounding the lake was assessed for septic system contributions.

Table C-23. Modeled Cultural Agricultural BMPs

BMP	Assumptions	Model Process
Double CRP Acreage (2xCRP)	Assume 31.4% of cropland in grass/pasture (original CRP 15.7% of cropland)	Move 15.7% of original cropland to grass/pasture land use for each subwatershed
Double Conservation Tillage Acreage (60% CT)	Assume 60% No-till (2000 Illinois Soil Conservation Transect Survey Summary, currently 29% CT, most in No-till)	Adjust KLSCP factor in each subwatershed by proportional reduction in C factor
Double Conservation Tillage and CRP Acreage (2xCRP + 60% CT)	Combination of above	Combination of above
100% Conservation Tillage (100% CT)	Assume 100% No-till	Adjust KLSCP factor in each subwatershed by proportional reduction in C factor
Full Development (FD)	Assume all lots developed and on septic systems	Add additional septic units to Lower and Upper Lake Basin subwatersheds

Construction of less than 12 houses per year (last 10 years trend; City of Greenville, 1998) around Governor Bond Lake implies that only approximately one acre will remain bare soil for an entire year. This is equivalent to 0.1 percent of the subwatershed area directly surrounding the lake. Contributions from this source are negligible (< 0.15 percent) in comparison to other sources, however; due to proximity to the lake, construction BMPs should not be neglected if large load reductions are necessary.

Other BMPs considered for application to modeled loads include:

- Extended detention wet ponds
- Constructed wetlands
- Filter/buffer strips
- Reduced inputs
- Feedlot runoff wetlands
- Stream fencing
- Lakeshore aquascaping
- Lake bank stabilization

C.4 PROFILE

Profile is a model that calculates oxygen depletion rates based on dissolved oxygen and/or temperature profiles in a lake. Mixed layer depth (top of the metalimneon) and bottom layer depth (top of the hypolimneon) are read from PROFILE graphical displays. These rates and values can be used in BATHTUB to describe in-lake conditions for comparison with modeled data.

At least two profiles must be chosen to analyze depletion rates that must not include limiting oxygen conditions (anoxic; without oxygen) or turnover situations (complete mixing), but must show evidence of stratification (changing temperature/concentration as a function of depth). Consequently, in most cases only two profiles in early spring satisfied these criteria.

In addition to concentrations and/or temperature as a function of date and depth, lake basin physical characteristics are required. The following table lists the basin characteristics used for PROFILE. Values were calculated from digitized 1995 NRCS Bathymetry maps.

Table C-24. Depth - Area Relationships for Hypsographic Curves

Site and Depth	Length	Area	ElevationZ
	(m)	(Ha)	(m)
Upper Basin	3616.7		
0 m		186.7	925
3 m		161.7	922
5 m		126.6	920
10 m		45.5	915
Lower Basin	2419.2		
0 m		157.1	925
3 m		147.2	922
5 m		136.7	920
10 m		125.8	915
15 m		97.4	910
20 m		42.3	905
25 m		1.5	900
Pond	711.4	12.67	925

D. INPUT AND OUTPUT FILES FOR MODELS

D.1 MEASURED STAGE-DISCHARGE RELATIONSHIP DATA

ROP02: Unnamed Tributary

Gaged Stage	Corrected Stage	Measured Velocity	Area	Discharge
ft	*ft*	*ft/s*	*ft2*	*cfs*
1.98	2.39	0.1	15.25	1.52
2.10	2.51	0.11	16.42	1.81
2.18	2.59	0.1	17.23	1.72
2.28	2.69	0.08	18.25	1.46
2.70	3.11	0.45	22.87	10.29
2.92	3.33	0.49	25.49	12.49
2.94	3.35	0.55	25.73	14.15
3.10	3.51	0.35	27.72	9.70
3.38	3.79	0.47	31.37	14.74
3.72	4.13	0.55	36.08	19.84

ROP05: Lower Kingsbury Branch

Gaged Stage	Corrected Stage	Measured Velocity	Area	Discharge
ft	*ft*	*ft/s*	*ft2*	*cfs*
1.82	1.88	0.12	14.16	1.70
1.92	1.98	0.15	15.02	2.25
2.58	2.64	0.25	20.90	5.22
3.18	3.24	0.46	26.61	12.24
3.38	3.44	0.47	28.60	13.44
3.48	3.54	0.49	29.61	14.51
3.60	3.66	0.54	30.83	16.65
3.86	3.92	0.6	33.53	20.12
3.96	4.02	0.61	34.58	21.10
6.60	6.66	1.63	66.04	107.64

ROP04: Upper Kingsbury Branch

Gaged Stage	Corrected Stage	Measured Velocity	Area	Discharge
ft	*ft*	*ft/s*	*ft2*	*cfs*
2.24	2.69	0.11	53.18	5.85
2.30	2.75	0.05	54.94	2.80
2.40	2.85	0.03	57.93	1.97
2.66	3.11	0.13	66.02	8.58
3.54	3.99	0.63	96.91	61.05
3.80	4.25	0.56	107.06	59.95
3.90	4.35	0.64	111.09	71.10
4.46	4.91	0.85	134.95	114.71
4.50	4.95	0.89	136.74	121.70

ROP06: Dry Branch Above Site ROP03

Gaged Stage	Corrected Stage	Measured Velocity	Area	Discharge
ft	*ft*	*ft/s*	*ft2*	*cfs*
0.86	2.02	0.1	30.47	3.05
0.94	2.10	0.29	32.53	9.43
1.10	2.26	0.33	36.81	12.15
1.10	2.26	0.65	36.81	23.93
1.22	2.38	0.73	40.15	29.31
1.30	2.46	0.71	42.44	30.13
2.60	3.76	1.67	84.86	141.71
3.38	4.54	1.6	113.41	181.45
3.40	4.56	1.78	114.15	203.19
3.56	4.72	2.24	120.14	269.11

Corrected Stage adjusts for datum

D.2 FLUX OUTPUT

ROP-1: Lake Outlet

```
 rop01 new weir                   VAR=NOxN      METHOD= 6 REG-3
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR        NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1        183   5   5 100.0       37.202       35.541        .120   .474
***        183   5   5 100.0       37.202       35.541

 FLOW STATISTICS
```

```
FLOW DURATION =     183.0 DAYS  =   .501 YEARS
MEAN FLOW RATE =    37.202 HM3/YR
TOTAL FLOW VOLUME =      18.64 HM3
FLOW DATE RANGE   = 980501 TO 981030
SAMPLE DATE RANGE = 980531 TO 980706
```

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	311.8	622.3	.6247E+05	16.73	.402
2 Q WTD C	326.3	651.3	.9938E+05	17.51	.484
3 IJC	299.7	598.2	.1025E+06	16.08	.535
4 REG-1	328.1	654.9	.1910E+06	17.61	.667
5 REG-2	433.2	864.7	.8220E+06	23.24	1.048
6 REG-3	443.5	885.3	.2507E+06	23.80	.566

```
rop01 new weir                  VAR=NOxN      METHOD= 6 REG-3
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =     -.0908  SLOPE              =      .0000
 R-SQUARED          =      .0000  MEAN SQUARED ERROR =      .0789
 STD ERROR OF SLOPE =      .1462  DEGREES OF FREEDOM =          3
 T STATISTIC        =      .0000  PROBABILITY(>|T|)  =      .9955
 Y MEAN             =     -.0908  Y STD DEVIATION    =      .2432
 X MEAN             =     1.0354  X STD DEVIATION    =      .9602
RESIDUALS ANALYSIS:
 RUNS TEST Z        =    -2.0731  PROBABILITY (>|Z|) =      .0191
 LAG-1 AUTOCORREL.  =      .1741  PROBABILITY (>|R|) =      .3485
 EFFECTIVE SAMPLES  =          3  SLOPE SIGNIFICANCE =      .9955


rop01 new weir                  VAR=NOxN      METHOD= 6 REG-3
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =  -403.0598  SLOPE              =     4.0928
 R-SQUARED          =      .6489  MEAN SQUARED ERROR =      .0277
 STD ERROR OF SLOPE =     1.7381  DEGREES OF FREEDOM =          3
 T STATISTIC        =     2.3547  PROBABILITY(>|T|)  =      .0991
 Y MEAN             =     -.0908  Y STD DEVIATION    =      .2432
 X MEAN             =    98.4589  X STD DEVIATION    =      .0479
RESIDUALS ANALYSIS:
 RUNS TEST Z        =      .1091  PROBABILITY (>|Z|) =      .4565
 LAG-1 AUTOCORREL.  =     -.3058  PROBABILITY (>|R|) =      .2471
 EFFECTIVE SAMPLES  =          5  SLOPE SIGNIFICANCE =      .0991


rop01 new weir                  VAR=TN        METHOD= 6 REG-3

TABULATION OF MISSING DAILY FLOWS:

Flow File =qrop01m.dat                    ,   Station =FLOW
Daily Flows from 980501 to 981030

Summary:
Reported Flows =  183
```

```
Missing Flows =     0
Zero Flows =      109
Positive Flows =   74

rop01 new weir                    VAR=TN        METHOD= 6 REG-3
COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
 1       183   5   5 100.0       37.202       35.541       -.087   .251
***      183   5   5 100.0       37.202       35.541

FLOW STATISTICS
FLOW DURATION =     183.0 DAYS  =   .501 YEARS
MEAN FLOW RATE =    37.202 HM3/YR
TOTAL FLOW VOLUME =      18.64 HM3
FLOW DATE RANGE   = 980501 TO 981030
SAMPLE DATE RANGE = 980531 TO 980706

METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
1 AV LOAD         8699.4        17363.2      .5360E+08     466.73    .422
2 Q WTD C         9106.0        18174.7      .2828E+08     488.55    .293
3 IJC             8708.9        17382.2      .3456E+08     467.24    .338
4 REG-1           9070.0        18102.9      .2668E+08     486.62    .285
5 REG-2           7125.8        14222.4      .5991E+08     382.31    .544
6 REG-3           9728.2        19416.6      .2057E+08     521.93    .234


rop01 new weir                    VAR=TN        METHOD= 6 REG-3
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      -.0158  SLOPE                =       .0000
 R-SQUARED          =       .0000  MEAN SQUARED ERROR =       .0137
 STD ERROR OF SLOPE =       .0610  DEGREES OF FREEDOM =           3
 T STATISTIC        =       .0000  PROBABILITY(>|T|)  =       .9955
 Y MEAN             =      -.0158  Y STD DEVIATION    =       .1015
 X MEAN             =      1.0354  X STD DEVIATION    =       .9602
RESIDUALS ANALYSIS:
 RUNS TEST Z        =       .1091  PROBABILITY (>|Z|) =       .4565
 LAG-1 AUTOCORREL.  =      -.3452  PROBABILITY (>|R|) =       .2201
 EFFECTIVE SAMPLES  =           5  SLOPE SIGNIFICANCE =       .9955


rop01 new weir                    VAR=TN        METHOD= 6 REG-3
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =   -138.3164  SLOPE                =      1.4047
 R-SQUARED          =       .4385  MEAN SQUARED ERROR =       .0077
 STD ERROR OF SLOPE =       .9176  DEGREES OF FREEDOM =           3
 T STATISTIC        =      1.5307  PROBABILITY(>|T|)  =       .2231
 Y MEAN             =      -.0158  Y STD DEVIATION    =       .1015
 X MEAN             =     98.4589  X STD DEVIATION    =       .0479
RESIDUALS ANALYSIS:
 RUNS TEST Z        =       .1091  PROBABILITY (>|Z|) =       .4565
 LAG-1 AUTOCORREL.  =      -.6236  PROBABILITY (>|R|) =       .0816
 EFFECTIVE SAMPLES  =           5  SLOPE SIGNIFICANCE =       .2231
```

rop01 new weir VAR=TP METHOD= 4 REG-1

COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS

STR	NQ	NC	NE	VOL%	TOTAL FLOW	SAMPLED FLOW	C/Q SLOPE	SIGNIF
1	183	5	5	100.0	37.202	35.541	.042	.593
***	183	5	5	100.0	37.202	35.541		

FLOW STATISTICS
FLOW DURATION = 183.0 DAYS = .501 YEARS
MEAN FLOW RATE = 37.202 HM3/YR
TOTAL FLOW VOLUME = 18.64 HM3
FLOW DATE RANGE = 980501 TO 981030
SAMPLE DATE RANGE = 980531 TO 980706

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	927.8	1851.8	.9561E+06	49.78	.528
2 Q WTD C	971.2	1938.3	.2077E+05	52.10	.074
3 IJC	980.3	1956.5	.9770E+04	52.59	.051
4 REG-1	973.0	1942.1	.1922E+05	52.20	.071
5 REG-2	1080.3	2156.1	.2506E+06	57.96	.232
6 REG-3	998.6	1993.1	.7453E+05	53.58	.137

rop01 new weir VAR=TP METHOD= 4 REG-1
X =S FLOW , Y =RESIDUAL

BIVARIATE REGRESSION: Y VS. X

INTERCEPT	=	-.0211	SLOPE	=	.0000
R-SQUARED	=	.0000	MEAN SQUARED ERROR	=	.0183
STD ERROR OF SLOPE	=	.0704	DEGREES OF FREEDOM	=	3
T STATISTIC	=	.0000	PROBABILITY(>|T|)	=	.9955
Y MEAN	=	-.0211	Y STD DEVIATION	=	.1171
X MEAN	=	1.0354	X STD DEVIATION	=	.9602

RESIDUALS ANALYSIS:

RUNS TEST Z	=	1.2002	PROBABILITY (>|Z|)	=	.1150
LAG-1 AUTOCORREL.	=	-.4932	PROBABILITY (>|R|)	=	.1350
EFFECTIVE SAMPLES	=	5	SLOPE SIGNIFICANCE	=	.9955

rop01 new weir VAR=TP METHOD= 4 REG-1
X =DATE , Y =RESIDUAL

BIVARIATE REGRESSION: Y VS. X

INTERCEPT	=	85.7549	SLOPE	=	-.8712
R-SQUARED	=	.1267	MEAN SQUARED ERROR	=	.0160
STD ERROR OF SLOPE	=	1.3205	DEGREES OF FREEDOM	=	3
T STATISTIC	=	-.6597	PROBABILITY(>|T|)	=	.5586
Y MEAN	=	-.0211	Y STD DEVIATION	=	.1171
X MEAN	=	98.4589	X STD DEVIATION	=	.0479

RESIDUALS ANALYSIS:

RUNS TEST Z	=	1.2002	PROBABILITY (>|Z|)	=	.1150
LAG-1 AUTOCORREL.	=	-.7624	PROBABILITY (>|R|)	=	.0441
EFFECTIVE SAMPLES	=	5	SLOPE SIGNIFICANCE	=	.5586

```
rop01 new weir                    VAR=NVSS      METHOD= 4 REG-1
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR        NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1        183   4   4 100.0       37.202       37.739        .430   .101
***        183   4   4 100.0       37.202       37.739

 FLOW STATISTICS
 FLOW DURATION =     183.0 DAYS  =   .501 YEARS
 MEAN FLOW RATE =    37.202 HM3/YR
 TOTAL FLOW VOLUME =      18.64 HM3
 FLOW DATE RANGE   = 980501 TO 981030
 SAMPLE DATE RANGE = 980531 TO 980701

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD      1213002.0      2421033.0      .2611E+13   65078.81    .667
 2 Q WTD C      1195737.0      2386573.0      .2236E+12   64152.50    .198
 3 IJC          1225168.0      2445315.0      .2298E+12   65731.50    .196
 4 REG-1        1188392.0      2371914.0      .2405E+12   63758.44    .207
 5 REG-2        2435850.0      4861717.0      .1082E+13  130685.80    .214
 6 REG-3        1624947.0      3243234.0      .2539E+13   87180.04    .491


 rop01 new weir                    VAR=NVSS      METHOD= 4 REG-1
 X =S FLOW  , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =      -.0883  SLOPE               =       .0000
  R-SQUARED          =       .0000  MEAN SQUARED ERROR =       .0767
  STD ERROR OF SLOPE =       .1481  DEGREES OF FREEDOM =           2
  T STATISTIC        =       .0000  PROBABILITY(>|T|)  =       .9955
  Y MEAN             =      -.0883  Y STD DEVIATION    =       .2261
  X MEAN             =       .9374  X STD DEVIATION    =      1.0795
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =       .0000  PROBABILITY (>|Z|) =       .5000
  LAG-1 AUTOCORREL.  =      -.4323  PROBABILITY (>|R|) =       .1936
  EFFECTIVE SAMPLES  =           4  SLOPE SIGNIFICANCE =       .9955



 rop01 new weir                    VAR=NVSS      METHOD= 4 REG-1
 X =DATE    , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =    137.8064  SLOPE               =    -1.4007
  R-SQUARED          =       .0516  MEAN SQUARED ERROR =       .0727
  STD ERROR OF SLOPE =      4.2443  DEGREES OF FREEDOM =           2
  T STATISTIC        =      -.3300  PROBABILITY(>|T|)  =       .7657
  Y MEAN             =      -.0883  Y STD DEVIATION    =       .2261
  X MEAN             =     98.4459  X STD DEVIATION    =       .0367
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =       .6124  PROBABILITY (>|Z|) =       .2701
  LAG-1 AUTOCORREL.  =      -.6399  PROBABILITY (>|R|) =       .1003
  EFFECTIVE SAMPLES  =           4  SLOPE SIGNIFICANCE =       .7657
```

ROP02: Unnamed Tributary

```
ROP02 VELOCITY BASED Q          VAR=NOxN      METHOD= 6 REG-3
COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
 1        31   3   3  21.9        1.525        1.064       1.263   .217
 2       151   8   8  77.7        1.112        1.139        .533   .411
***      182  11  11  99.5        1.182        1.119
EXCLU      1   0   0    .5        1.037         .000

FLOW STATISTICS
FLOW DURATION =     182.0 DAYS  =   .498 YEARS
MEAN FLOW RATE =     1.182 HM3/YR
TOTAL FLOW VOLUME =       .59 HM3
FLOW DATE RANGE   = 980501 TO 981030
SAMPLE DATE RANGE = 980503 TO 981021

METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
1 AV LOAD         1774.1         3560.3      .6082E+06    3012.12    .219
2 Q WTD C         1812.3         3637.1      .3475E+06    3077.07    .162
3 IJC             1824.2         3660.9      .3604E+06    3097.24    .164
4 REG-1           1939.0         3891.4      .4096E+06    3292.22    .164
5 REG-2           3566.1         7156.6      .1672E+08    6054.69    .571
6 REG-3           1862.3         3737.5      .3231E+06    3161.99    .152
```

```
ROP02 VELOCITY BASED Q          VAR=NOxN      METHOD= 6 REG-3
X =S FLOW   , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      -.0326  SLOPE              =      -.0129
 R-SQUARED          =       .0001  MEAN SQUARED ERROR =       .0268
 STD ERROR OF SLOPE =       .4881  DEGREES OF FREEDOM =           9
 T STATISTIC        =      -.0264  PROBABILITY(>|T|)  =       .9778
 Y MEAN             =      -.0331  Y STD DEVIATION    =       .1553
 X MEAN             =       .0367  X STD DEVIATION    =       .1060
RESIDUALS ANALYSIS:
 RUNS TEST Z        =       .9764  PROBABILITY (>|Z|) =       .1644
 LAG-1 AUTOCORREL.  =      -.1824  PROBABILITY (>|R|) =       .2726
 EFFECTIVE SAMPLES  =          11  SLOPE SIGNIFICANCE =       .9778
```

```
ROP02 VELOCITY BASED Q          VAR=NOxN      METHOD= 6 REG-3
X =DATE     , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =    -14.3434  SLOPE              =       .1452
 R-SQUARED          =       .0200  MEAN SQUARED ERROR =       .0263
 STD ERROR OF SLOPE =       .3392  DEGREES OF FREEDOM =           9
 T STATISTIC        =       .4282  PROBABILITY(>|T|)  =       .6803
 Y MEAN             =      -.0331  Y STD DEVIATION    =       .1553
 X MEAN             =     98.5222  X STD DEVIATION    =       .1511
RESIDUALS ANALYSIS:
 RUNS TEST Z        =       .6707  PROBABILITY (>|Z|) =       .2512
```

```
 LAG-1 AUTOCORREL.  =      -.1642  PROBABILITY (>|R|) =       .2930
 EFFECTIVE SAMPLES  =          11  SLOPE SIGNIFICANCE =       .6803


ROP02 VELOCITY BASED Q            VAR=TN        METHOD= 6 REG-3
COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
 1        31   3   3  21.9        1.525        1.064       -.572   .752
 2       151   8   8  77.7        1.112        1.139        .309   .475
***      182  11  11  99.5        1.182        1.119
EXCLU      1   0   0    .5        1.037         .000

FLOW STATISTICS
FLOW DURATION =     182.0 DAYS  =   .498 YEARS
MEAN FLOW RATE =     1.182 HM3/YR
TOTAL FLOW VOLUME =        .59 HM3
FLOW DATE RANGE   = 980501 TO 981030
SAMPLE DATE RANGE = 980503 TO 981021

METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
1 AV LOAD         2188.5         4392.1      .5680E+06    3715.81    .172
2 Q WTD C         2239.4         4494.2      .2669E+06    3802.23    .115
3 IJC             2247.2         4509.9      .2768E+06    3815.52    .117
4 REG-1           2164.1         4343.0      .4710E+06    3674.28    .158
5 REG-2           2055.5         4125.2      .5024E+07    3490.02    .543
6 REG-3           2194.1         4403.3      .2511E+06    3725.29    .114


ROP02 VELOCITY BASED Q            VAR=TN        METHOD= 6 REG-3
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      -.0160  SLOPE              =      -.0043
 R-SQUARED          =       .0000  MEAN SQUARED ERROR =       .0123
 STD ERROR OF SLOPE =       .3309  DEGREES OF FREEDOM =           9
 T STATISTIC        =      -.0130  PROBABILITY(>|T|)  =       .9867
 Y MEAN             =      -.0162  Y STD DEVIATION    =       .1053
 X MEAN             =       .0367  X STD DEVIATION    =       .1060
RESIDUALS ANALYSIS:
 RUNS TEST Z        =       .6707  PROBABILITY (>|Z|) =       .2512
 LAG-1 AUTOCORREL.  =      -.0898  PROBABILITY (>|R|) =       .3829
 EFFECTIVE SAMPLES  =          11  SLOPE SIGNIFICANCE =       .9867


ROP02 VELOCITY BASED Q            VAR=TN        METHOD= 6 REG-3
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =    -13.5185  SLOPE              =       .1370
 R-SQUARED          =       .0387  MEAN SQUARED ERROR =       .0118
 STD ERROR OF SLOPE =       .2278  DEGREES OF FREEDOM =           9
 T STATISTIC        =       .6017  PROBABILITY(>|T|)  =       .5676
 Y MEAN             =      -.0162  Y STD DEVIATION    =       .1053
 X MEAN             =     98.5222  X STD DEVIATION    =       .1511
RESIDUALS ANALYSIS:
 RUNS TEST Z        =       .6707  PROBABILITY (>|Z|) =       .2512
 LAG-1 AUTOCORREL.  =      -.0444  PROBABILITY (>|R|) =       .4414
 EFFECTIVE SAMPLES  =          11  SLOPE SIGNIFICANCE =       .5676
```

```
 ROP02 VELOCITY BASED Q            VAR=TP        METHOD= 6 REG-3
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       183  11  11 100.0        1.181        1.119       -.638   .624
***       183  11  11 100.0        1.181        1.119

 FLOW STATISTICS
 FLOW DURATION =     183.0 DAYS  =   .501 YEARS
 MEAN FLOW RATE =     1.181 HM3/YR
 TOTAL FLOW VOLUME =        .59 HM3
 FLOW DATE RANGE   = 980501 TO 981030
 SAMPLE DATE RANGE = 980503 TO 981021

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD          177.4          354.2      .9899E+04     299.83    .281
 2 Q WTD C          187.4          373.9      .1133E+05     316.57    .285
 3 IJC              186.5          372.3      .1103E+05     315.17    .282
 4 REG-1            181.0          361.2      .1171E+05     305.80    .300
 5 REG-2            164.4          328.2      .9661E+04     277.87    .299
 6 REG-3            203.1          405.3      .2021E+05     343.15    .351


 ROP02 VELOCITY BASED Q            VAR=TP        METHOD= 6 REG-3
 X =S FLOW   , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =      -.1990  SLOPE                =       .0000
  R-SQUARED          =       .0000  MEAN SQUARED ERROR =       .1728
  STD ERROR OF SLOPE =      1.2396  DEGREES OF FREEDOM =           9
  T STATISTIC        =       .0000  PROBABILITY(>|T|)  =       .9955
  Y MEAN             =      -.1990  Y STD DEVIATION    =       .3944
  X MEAN             =       .0367  X STD DEVIATION    =       .1060
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =       .2835  PROBABILITY (>|Z|) =       .3884
  LAG-1 AUTOCORREL.  =      -.1298  PROBABILITY (>|R|) =       .3333
  EFFECTIVE SAMPLES  =          11  SLOPE SIGNIFICANCE =       .9955


 ROP02 VELOCITY BASED Q            VAR=TP        METHOD= 6 REG-3
 X =DATE     , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =    -49.7393  SLOPE                =       .5028
  R-SQUARED          =       .0371  MEAN SQUARED ERROR =       .1664
  STD ERROR OF SLOPE =       .8539  DEGREES OF FREEDOM =           9
  T STATISTIC        =       .5889  PROBABILITY(>|T|)  =       .5757
  Y MEAN             =      -.1990  Y STD DEVIATION    =       .3944
  X MEAN             =     98.5222  X STD DEVIATION    =       .1511
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =       .2835  PROBABILITY (>|Z|) =       .3884
  LAG-1 AUTOCORREL.  =      -.1588  PROBABILITY (>|R|) =       .2991
  EFFECTIVE SAMPLES  =          11  SLOPE SIGNIFICANCE =       .5757


 ROP02 VELOCITY BASED Q           VAR=NVSS       METHOD= 6 REG-3
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       183  11  11 100.0        1.181        1.119      -4.840   .060
```

```
***       183  11  11 100.0        1.181        1.119

 FLOW STATISTICS
 FLOW DURATION =     183.0 DAYS  =   .501 YEARS
 MEAN FLOW RATE =     1.181 HM3/YR
 TOTAL FLOW VOLUME =        .59 HM3
 FLOW DATE RANGE   = 980501 TO 981030
 SAMPLE DATE RANGE = 980503 TO 981021
```

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	87271.9	174186.2	.1113E+11	147465.70	.606
2 Q WTD C	92143.4	183909.2	.1345E+11	155697.20	.631
3 IJC	90256.6	180143.4	.1302E+11	152509.00	.633
4 REG-1	70843.2	141396.1	.8166E+10	119705.70	.639
5 REG-2	391899.0	782191.9	.3128E+12	662202.00	.715
6 REG-3	104154.0	207881.1	.2242E+11	175991.70	.720

```
 ROP02 VELOCITY BASED Q            VAR=NVSS      METHOD= 6 REG-3
 X =S FLOW   , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =      -.6716  SLOPE              =       .0000
  R-SQUARED          =       .0000  MEAN SQUARED ERROR =       .5834
  STD ERROR OF SLOPE =      2.2776  DEGREES OF FREEDOM =           9
  T STATISTIC        =       .0000  PROBABILITY(>|T|)  =       .9955
  Y MEAN             =      -.6716  Y STD DEVIATION    =       .7246
  X MEAN             =       .0367  X STD DEVIATION    =       .1060
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =     -1.1024  PROBABILITY (>|Z|) =       .1351
  LAG-1 AUTOCORREL.  =      -.2416  PROBABILITY (>|R|) =       .2115
  EFFECTIVE SAMPLES  =          11  SLOPE SIGNIFICANCE =       .9955


 ROP02 VELOCITY BASED Q            VAR=NVSS      METHOD= 6 REG-3
 X =DATE     , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =    -68.0335  SLOPE              =       .6837
  R-SQUARED          =       .0203  MEAN SQUARED ERROR =       .5715
  STD ERROR OF SLOPE =      1.5824  DEGREES OF FREEDOM =           9
  T STATISTIC        =       .4321  PROBABILITY(>|T|)  =       .6778
  Y MEAN             =      -.6716  Y STD DEVIATION    =       .7246
  X MEAN             =     98.5222  X STD DEVIATION    =       .1511
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =     -1.1024  PROBABILITY (>|Z|) =       .1351
  LAG-1 AUTOCORREL.  =      -.2552  PROBABILITY (>|R|) =       .1987

  EFFECTIVE SAMPLES  =          11  SLOPE SIGNIFICANCE =       .6778
```

ROP03: Dry Branch

```
 rop03 new flows                   VAR=NOxN      METHOD= 5 REG-2
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       183  11  11 100.0       46.974       46.143       2.715   .005
```

```
***       183  11  11 100.0       46.974       46.143

 FLOW STATISTICS
 FLOW DURATION =     183.0 DAYS  =   .501 YEARS
 MEAN FLOW RATE =    46.974 HM3/YR
 TOTAL FLOW VOLUME =      23.54 HM3
 FLOW DATE RANGE   = 980501 TO 981030
 SAMPLE DATE RANGE = 980531 TO 981022

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD        13868.4        27679.9      .6634E+08     589.26    .294
 2 Q WTD C        14118.2        28178.6      .3291E+08     599.88    .204
 3 IJC            14342.5        28626.3      .3191E+08     609.41    .197
 4 REG-1          14819.6        29578.5      .9765E+08     629.68    .334
 5 REG-2          15027.9        29994.2      .2426E+08     638.53    .164
 6 REG-3          22725.3        45357.4      .2025E+09     965.59    .314


 rop03 new flows                   VAR=NOxN      METHOD= 5 REG-2
 X =S FLOW  , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =      -.4001  SLOPE              =       .0000
  R-SQUARED          =       .0000  MEAN SQUARED ERROR =       .3475
  STD ERROR OF SLOPE =       .7360  DEGREES OF FREEDOM =           9
  T STATISTIC        =       .0000  PROBABILITY(>|T|)  =       .9955
  Y MEAN             =      -.4000  Y STD DEVIATION    =       .5592
  X MEAN             =      1.6147  X STD DEVIATION    =       .2533
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =     -2.3637  PROBABILITY (>|Z|) =       .0090
  LAG-1 AUTOCORREL.  =       .5227  PROBABILITY (>|R|) =       .0415
  EFFECTIVE SAMPLES  =           3  SLOPE SIGNIFICANCE =       .9955



 rop03 new flows                   VAR=NOxN      METHOD= 5 REG-2
 X =DATE    , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =    230.8744  SLOPE              =     -2.3455
  R-SQUARED          =       .4091  MEAN SQUARED ERROR =       .2053
  STD ERROR OF SLOPE =       .9396  DEGREES OF FREEDOM =           9
  T STATISTIC        =     -2.4963  PROBABILITY(>|T|)  =       .0327
  Y MEAN             =      -.4000  Y STD DEVIATION    =       .5592
  X MEAN             =     98.6041  X STD DEVIATION    =       .1525
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =     -1.1024  PROBABILITY (>|Z|) =       .1351
  LAG-1 AUTOCORREL.  =       .4006  PROBABILITY (>|R|) =       .0919
  EFFECTIVE SAMPLES  =           5  SLOPE SIGNIFICANCE =       .1906


 rop03 new flows                   VAR=TN        METHOD= 6 REG-3
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1        92   5   5  67.7       63.240       62.101       2.069   .175
  2        91   6   6  32.3       30.529       32.843        .265   .398
***       183  11  11 100.0       46.974       46.143

 FLOW STATISTICS
```

```
FLOW DURATION =      183.0 DAYS  =   .501 YEARS
MEAN FLOW RATE =    46.974 HM3/YR
TOTAL FLOW VOLUME =      23.54 HM3
FLOW DATE RANGE   = 980501 TO 981030
SAMPLE DATE RANGE = 980531 TO 981022
```

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	28721.4	57325.1	.4591E+08	1220.36	.118
2 Q WTD C	28885.7	57653.0	.2967E+08	1227.34	.094
3 IJC	28982.1	57845.4	.3168E+08	1231.44	.097
4 REG-1	29774.3	59426.5	.1690E+09	1265.10	.219
5 REG-2	30594.6	61063.7	.1328E+09	1299.95	.189
6 REG-3	29410.5	58700.4	.7511E+08	1249.64	.148

```
rop03 new flows                   VAR=TN        METHOD= 6 REG-3
X =S FLOW   , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      -.0766  SLOPE              =       .0352
 R-SQUARED          =       .0063  MEAN SQUARED ERROR =       .0139
 STD ERROR OF SLOPE =       .1471  DEGREES OF FREEDOM =           9
 T STATISTIC        =       .2396  PROBABILITY(>|T|)  =       .8102
 Y MEAN             =      -.0197  Y STD DEVIATION    =       .1121
 X MEAN             =      1.6147  X STD DEVIATION    =       .2533
RESIDUALS ANALYSIS:
 RUNS TEST Z        =       .9764  PROBABILITY (>|Z|) =       .1644
 LAG-1 AUTOCORREL.  =       .1691  PROBABILITY (>|R|) =       .2874
 EFFECTIVE SAMPLES  =           8  SLOPE SIGNIFICANCE =       .8383
```

```
rop03 new flows                   VAR=TN        METHOD= 6 REG-3
X =DATE     , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =     27.2866  SLOPE              =      -.2769
 R-SQUARED          =       .1418  MEAN SQUARED ERROR =       .0120
 STD ERROR OF SLOPE =       .2271  DEGREES OF FREEDOM =           9
 T STATISTIC        =     -1.2196  PROBABILITY(>|T|)  =       .2528
 Y MEAN             =      -.0197  Y STD DEVIATION    =       .1121
 X MEAN             =     98.6041  X STD DEVIATION    =       .1525
RESIDUALS ANALYSIS:
 RUNS TEST Z        =       .6707  PROBABILITY (>|Z|) =       .2512
 LAG-1 AUTOCORREL.  =       .0408  PROBABILITY (>|R|) =       .4461
 EFFECTIVE SAMPLES  =          10  SLOPE SIGNIFICANCE =       .2783
```

```
rop03 new flows                   VAR=TN        METHOD= 6 REG-3
```

FLUX Breakdown by Stratum:

ST	NS	NE	FREQ DAYS	FLOW HM3/YR	FLUX KG/YR	VOLUME HM3	MASS KG	CONC PPB	CV -
1	5	5	92.0	63.24	101982.2	15.93	25687.5	1612.6	.168
2	6	6	91.0	30.53	14943.0	7.61	3723.0	489.5	.156
***	11	11	183.0	46.97	58700.4	23.54	29410.5	1249.6	.148

Optimal Sample Allocation:

ST	NS	NE	NE%	NEOPT%	FREQ%	VOL%	MASS%	VAR%	VARIANCE	CV
1	5	5	45.5	87.1	50.3	67.7	87.3	98.2	.7376E+08	.168
2	6	6	54.5	12.9	49.7	32.3	12.7	1.8	.1350E+07	.156
***	11	11	100.0	100.0	100.0	100.0	100.0	100.0	.7511E+08	.148

Optimal Allocation of 11 Sampled Events Across Strata (According to NEOPT%)
Would Reduce CV of FLUX Estimate from .148 to .113

rop03 new flows VAR=TP METHOD= 6 REG-3
COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS

STR	NQ	NC	NE	VOL%	TOTAL FLOW	SAMPLED FLOW	C/Q SLOPE	SIGNIF
1	183	11	11	100.0	46.974	46.143	.220	.064
***	183	11	11	100.0	46.974	46.143		

FLOW STATISTICS
FLOW DURATION = 183.0 DAYS = .501 YEARS
MEAN FLOW RATE = 46.974 HM3/YR
TOTAL FLOW VOLUME = 23.54 HM3
FLOW DATE RANGE = 980501 TO 981030
SAMPLE DATE RANGE = 980531 TO 981022

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	5212.9	10404.4	.2210E+07	221.49	.143
2 Q WTD C	5306.8	10591.9	.4341E+06	225.48	.062
3 IJC	5314.2	10606.6	.4406E+06	225.80	.063
4 REG-1	5327.7	10633.5	.4615E+06	226.37	.064
5 REG-2	5331.1	10640.4	.4417E+06	226.52	.062
6 REG-3	5361.0	10700.0	.4713E+06	227.79	.064

rop03 new flows VAR=TP METHOD= 6 REG-3
X =S FLOW , Y =RESIDUAL

BIVARIATE REGRESSION: Y VS. X

INTERCEPT	=	-.0081	SLOPE	=	.0000
R-SQUARED	=	.0000	MEAN SQUARED ERROR	=	.0071
STD ERROR OF SLOPE	=	.1049	DEGREES OF FREEDOM	=	9
T STATISTIC	=	.0000	PROBABILITY(>|T|)	=	.9955
Y MEAN	=	-.0081	Y STD DEVIATION	=	.0797
X MEAN	=	1.6147	X STD DEVIATION	=	.2533

RESIDUALS ANALYSIS:

RUNS TEST Z	=	-.6124	PROBABILITY (>|Z|)	=	.2701
LAG-1 AUTOCORREL.	=	-.2097	PROBABILITY (>|R|)	=	.2433
EFFECTIVE SAMPLES	=	11	SLOPE SIGNIFICANCE	=	.9955

rop03 new flows VAR=TP METHOD= 6 REG-3
X =DATE , Y =RESIDUAL

BIVARIATE REGRESSION: Y VS. X

INTERCEPT	=	-9.7268	SLOPE	=	.0986
R-SQUARED	=	.0356	MEAN SQUARED ERROR	=	.0068
STD ERROR OF SLOPE	=	.1710	DEGREES OF FREEDOM	=	9
T STATISTIC	=	.5762	PROBABILITY(>|T|)	=	.5837

```
 Y MEAN            =      -.0081  Y STD DEVIATION    =       .0797
 X MEAN            =     98.6041  X STD DEVIATION    =       .1525
RESIDUALS ANALYSIS:
 RUNS TEST Z       =      -.6124  PROBABILITY (>|Z|) =       .2701
 LAG-1 AUTOCORREL.  =     -.2010  PROBABILITY (>|R|) =       .2525
 EFFECTIVE SAMPLES  =         11  SLOPE SIGNIFICANCE =       .5837
```

```
rop03 new flows                  VAR=NVSS      METHOD= 6 REG-3
COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
 1       183  11  11 100.0       46.974       46.143         .197   .427
***      183  11  11 100.0       46.974       46.143

FLOW STATISTICS
FLOW DURATION =     183.0 DAYS  =   .501 YEARS
MEAN FLOW RATE =    46.974 HM3/YR
TOTAL FLOW VOLUME =      23.54 HM3
FLOW DATE RANGE   = 980501 TO 981030
SAMPLE DATE RANGE = 980531 TO 981022

METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
1 AV LOAD       686056.4      1369301.0      .7808E+11   29150.27    .204
2 Q WTD C       698416.9      1393971.0      .2990E+11   29675.46    .124
3 IJC           702862.0      1402843.0      .2983E+11   29864.33    .123
4 REG-1         700872.3      1398872.0      .3237E+11   29779.79    .129
5 REG-2         701271.6      1399669.0      .2750E+11   29796.76    .118
6 REG-3         692280.6      1381724.0      .2878E+11   29414.73    .123
```

```
rop03 new flows                  VAR=NVSS      METHOD= 6 REG-3
X =S FLOW   , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT         =      -.0403  SLOPE              =       .0000
 R-SQUARED         =       .0000  MEAN SQUARED ERROR =       .0351
 STD ERROR OF SLOPE =      .2338  DEGREES OF FREEDOM =           9
 T STATISTIC       =       .0000  PROBABILITY(>|T|)  =       .9954
 Y MEAN            =      -.0404  Y STD DEVIATION    =       .1776
 X MEAN            =      1.6147  X STD DEVIATION    =       .2533
RESIDUALS ANALYSIS:
 RUNS TEST Z       =     -1.1024  PROBABILITY (>|Z|) =       .1351
 LAG-1 AUTOCORREL.  =     -.0687  PROBABILITY (>|R|) =       .4098
 EFFECTIVE SAMPLES  =         11  SLOPE SIGNIFICANCE =       .9954
```

```
rop03 new flows                  VAR=NVSS      METHOD= 6 REG-3
X =DATE     , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT         =     49.2348  SLOPE              =      -.4997
 R-SQUARED         =       .1840  MEAN SQUARED ERROR =       .0286
 STD ERROR OF SLOPE =      .3507  DEGREES OF FREEDOM =           9
 T STATISTIC       =     -1.4248  PROBABILITY(>|T|)  =       .1860
 Y MEAN            =      -.0404  Y STD DEVIATION    =       .1776
 X MEAN            =     98.6041  X STD DEVIATION    =       .1525
RESIDUALS ANALYSIS:
```

```
RUNS TEST Z        =     .6707  PROBABILITY (>|Z|) =      .2512
LAG-1 AUTOCORREL.  =    -.2167  PROBABILITY (>|R|) =      .2361
EFFECTIVE SAMPLES  =        11  SLOPE SIGNIFICANCE =      .1860
```

ROP04: Upper Kingsbury Branch

```
ROP04 Velocity Based Q            VAR=TN       METHOD= 4 REG-1
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       183  13  13 100.0        9.458       58.924        .107   .056
***       183  13  13 100.0        9.458       58.924

 FLOW STATISTICS
 FLOW DURATION =     183.0 DAYS  =   .501 YEARS
 MEAN FLOW RATE =     9.458 HM3/YR
 TOTAL FLOW VOLUME =       4.74 HM3
 FLOW DATE RANGE   = 980501 TO 981030
 SAMPLE DATE RANGE = 980503 TO 981022

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD        96985.4       193573.3      .3655E+11   20466.97    .988
 2 Q WTD C        15567.1        31070.4      .2394E+09    3285.15    .498
 3 IJC            15678.9        31293.5      .2524E+09    3308.73    .508
 4 REG-1          12803.8        25555.0      .6149E+08    2702.00    .307
 5 REG-2          37220.0        74287.4      .6009E+08    7854.58    .104
 6 REG-3          16257.6        32448.5      .7931E+08    3430.86    .274

 ROP04 Velocity Based Q            VAR=TN        METHOD= 5 REG-2
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       183  13  13 100.0        9.458       58.924        .107   .056
***       183  13  13 100.0        9.458       58.924

 FLOW STATISTICS
 FLOW DURATION =     183.0 DAYS  =   .501 YEARS
 MEAN FLOW RATE =     9.458 HM3/YR
 TOTAL FLOW VOLUME =       4.74 HM3
 FLOW DATE RANGE   = 980501 TO 981030
 SAMPLE DATE RANGE = 980503 TO 981022

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD        96985.4       193573.3      .3655E+11   20466.97    .988
 2 Q WTD C        15567.1        31070.4      .2394E+09    3285.15    .498
 3 IJC            15678.9        31293.5      .2524E+09    3308.73    .508
 4 REG-1          12803.8        25555.0      .6149E+08    2702.00    .307
 5 REG-2          37220.0        74287.4      .6009E+08    7854.58    .104
 6 REG-3          16257.6        32448.5      .7931E+08    3430.86    .274

 ROP04 Velocity Based Q            VAR=TN        METHOD= 5 REG-2
 X =S FLOW   , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =      -.0650  SLOPE                =       .0000
  R-SQUARED          =       .0000  MEAN SQUARED ERROR =       .0564
  STD ERROR OF SLOPE =       .0505  DEGREES OF FREEDOM =          11
  T STATISTIC        =       .0000  PROBABILITY(>|T|)  =       .9955
  Y MEAN             =      -.0650  Y STD DEVIATION    =       .2274
  X MEAN             =      -.2139  X STD DEVIATION    =      1.3574
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =     -2.2475  PROBABILITY (>|Z|) =       .0123
```

```
 LAG-1 AUTOCORREL.  =       .4130  PROBABILITY (>|R|) =       .0682
 EFFECTIVE SAMPLES  =           5  SLOPE SIGNIFICANCE =       .9955


ROP04 Velocity Based Q            VAR=TN        METHOD= 5 REG-2
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =    -31.3956  SLOPE              =       .3179
 R-SQUARED          =       .0574  MEAN SQUARED ERROR =       .0532
 STD ERROR OF SLOPE =       .3885  DEGREES OF FREEDOM =          11
 T STATISTIC        =       .8181  PROBABILITY(>|T|)  =       .4356
 Y MEAN             =      -.0650  Y STD DEVIATION    =       .2274
 X MEAN             =     98.5630  X STD DEVIATION    =       .1713
RESIDUALS ANALYSIS:
 RUNS TEST Z        =     -1.7270  PROBABILITY (>|Z|) =       .0421
 LAG-1 AUTOCORREL.  =       .3958  PROBABILITY (>|R|) =       .0768
 EFFECTIVE SAMPLES  =           6  SLOPE SIGNIFICANCE =       .6103


ROP04 Velocity Based Q            VAR=TP        METHOD= 4 REG-1
COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
 1       183  13  13 100.0        9.458       58.924        .118   .035
***      183  13  13 100.0        9.458       58.924

FLOW STATISTICS
FLOW DURATION =     183.0 DAYS  =   .501 YEARS
MEAN FLOW RATE =     9.458 HM3/YR
TOTAL FLOW VOLUME =       4.74 HM3
FLOW DATE RANGE   = 980501 TO 981030
SAMPLE DATE RANGE = 980503 TO 981022

METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
1 AV LOAD        25966.1        51825.8      .2591E+10    5479.67    .982
2 Q WTD C         4167.8         8318.6      .6620E+07     879.54    .309
3 IJC             4186.5         8355.8      .5532E+07     883.48    .281
4 REG-1           3356.6         6699.5      .1979E+06     708.35    .066
5 REG-2          10177.8        20313.9      .8267E+08    2147.84    .448
6 REG-3           4236.8         8456.1      .6584E+07     894.09    .303

 ROP04 Velocity Based Q            VAR=TP        METHOD= 4 REG-1
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      -.0634  SLOPE              =       .0000
 R-SQUARED          =       .0000  MEAN SQUARED ERROR =       .0551
 STD ERROR OF SLOPE =       .0499  DEGREES OF FREEDOM =          11
 T STATISTIC        =       .0000  PROBABILITY(>|T|)  =       .9955
 Y MEAN             =      -.0634  Y STD DEVIATION    =       .2247
 X MEAN             =      -.2139  X STD DEVIATION    =      1.3574
RESIDUALS ANALYSIS:
 RUNS TEST Z        =       .0224  PROBABILITY (>|Z|) =       .4910
 LAG-1 AUTOCORREL.  =       .0455  PROBABILITY (>|R|) =       .4348
 EFFECTIVE SAMPLES  =          11  SLOPE SIGNIFICANCE =       .9955


ROP04 Velocity Based Q            VAR=NVSS      METHOD= 3 IJC
COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
```

STR	NQ	NC	NE	VOL%	TOTAL FLOW	SAMPLED FLOW	C/Q SLOPE	SIGNIF
1	183	13	13	100.0	9.458	58.924	.201	.074
***	183	13	13	100.0	9.458	58.924		

FLOW STATISTICS
FLOW DURATION = 183.0 DAYS = .501 YEARS
MEAN FLOW RATE = 9.458 HM3/YR
TOTAL FLOW VOLUME = 4.74 HM3
FLOW DATE RANGE = 980501 TO 981030
SAMPLE DATE RANGE = 980503 TO 981022

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	10670500.0	21297260.0	.4363E+15	2251811.00	.981
2 Q WTD C	1712720.0	3418421.0	.7813E+12	361437.90	.259
3 IJC	1719133.0	3431220.0	.5842E+12	362791.10	.223
4 REG-1	1186429.0	2367995.0	.9534E+12	250373.80	.412
5 REG-2	4394480.0	8770949.0	.1336E+15	927373.60	1.318
6 REG-3	2274354.0	4539387.0	.6669E+13	479960.30	.569

ROP04 Velocity Based Q VAR=NVSS METHOD= 3 IJC
X =S FLOW , Y =RESIDUAL

BIVARIATE REGRESSION: Y VS. X

INTERCEPT	=	-.6882	SLOPE	=	.2007
R-SQUARED	=	.2584	MEAN SQUARED ERROR	=	.2323
STD ERROR OF SLOPE	=	.1025	DEGREES OF FREEDOM	=	11
T STATISTIC	=	1.9578	PROBABILITY(>|T|)	=	.0736
Y MEAN	=	-.7311	Y STD DEVIATION	=	.5359
X MEAN	=	-.2139	X STD DEVIATION	=	1.3574

RESIDUALS ANALYSIS:

RUNS TEST Z	=	.2129	PROBABILITY (>|Z|)	=	.4157
LAG-1 AUTOCORREL.	=	-.1380	PROBABILITY (>|R|)	=	.3094
EFFECTIVE SAMPLES	=	13	SLOPE SIGNIFICANCE	=	.0736

ROP04 Velocity Based Q VAR=NVSS METHOD= 3 IJC
X =DATE , Y =RESIDUAL

BIVARIATE REGRESSION: Y VS. X

INTERCEPT	=	62.2240	SLOPE	=	-.6387
R-SQUARED	=	.0417	MEAN SQUARED ERROR	=	.3002
STD ERROR OF SLOPE	=	.9231	DEGREES OF FREEDOM	=	11
T STATISTIC	=	-.6919	PROBABILITY(>|T|)	=	.5092
Y MEAN	=	-.7311	Y STD DEVIATION	=	.5359
X MEAN	=	98.5630	X STD DEVIATION	=	.1713

RESIDUALS ANALYSIS:

RUNS TEST Z	=	.8280	PROBABILITY (>|Z|)	=	.2038
LAG-1 AUTOCORREL.	=	-.3184	PROBABILITY (>|R|)	=	.1254
EFFECTIVE SAMPLES	=	13	SLOPE SIGNIFICANCE	=	.5092

ROP05: Lower Kingsbury Branch

ROP05 Velocity Based q VAR=NOxN METHOD= 4 REG-1
COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS

```
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       183  11  11 100.0         .447         .716        .069   .863
***       183  11  11 100.0         .447         .716

 FLOW STATISTICS
 FLOW DURATION =     183.0 DAYS  =   .501 YEARS
 MEAN FLOW RATE =      .447 HM3/YR
 TOTAL FLOW VOLUME =        .22 HM3
 FLOW DATE RANGE   = 980501 TO 981030
 SAMPLE DATE RANGE = 980503 TO 981021

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD          267.2          533.4      .6994E+05    1193.54    .496
 2 Q WTD C          166.9          333.0      .2143E+05     745.20    .440
 3 IJC              166.5          332.3      .2306E+05     743.56    .457
 4 REG-1            161.5          322.3      .1700E+05     721.21    .405
 5 REG-2            184.3          367.8      .7841E+05     823.08    .761
 6 REG-3            263.6          526.1      .1624E+06    1177.27    .766


 ROP05 Velocity Based q           VAR=NOxN      METHOD= 4 REG-1
 X =S FLOW  , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =      -.6280  SLOPE                =       .0000
  R-SQUARED          =       .0000  MEAN SQUARED ERROR =       .5455
  STD ERROR OF SLOPE =       .4110  DEGREES OF FREEDOM =           9
  T STATISTIC        =       .0000  PROBABILITY(>|T|)  =       .9955
  Y MEAN             =      -.6280  Y STD DEVIATION    =       .7007
  X MEAN             =      -.3955  X STD DEVIATION    =       .5682
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =       .2835  PROBABILITY (>|Z|) =       .3884
  LAG-1 AUTOCORREL.  =       .0755  PROBABILITY (>|R|) =       .4010
  EFFECTIVE SAMPLES  =           9  SLOPE SIGNIFICANCE =       .9955


 ROP05 Velocity Based q           VAR=NOxN      METHOD= 4 REG-1
 X =DATE    , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =   -138.8324  SLOPE                =      1.4027
  R-SQUARED          =       .1019  MEAN SQUARED ERROR =       .4899
  STD ERROR OF SLOPE =      1.3880  DEGREES OF FREEDOM =           9
  T STATISTIC        =      1.0106  PROBABILITY(>|T|)  =       .3403
  Y MEAN             =      -.6280  Y STD DEVIATION    =       .7007
  X MEAN             =     98.5247  X STD DEVIATION    =       .1595
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =       .2835  PROBABILITY (>|Z|) =       .3884
  LAG-1 AUTOCORREL.  =       .0245  PROBABILITY (>|R|) =       .4675
  EFFECTIVE SAMPLES  =          10  SLOPE SIGNIFICANCE =       .3659

 GBL TMDL ROP05: Monitored         VAR=TN        METHOD= 4 REG-1
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       183  12  12 100.0       23.900       29.514        .144   .453
***       183  12  12 100.0       23.900       29.514

 FLOW STATISTICS
 FLOW DURATION =     183.0 DAYS  =   .501 YEARS
```

```
MEAN FLOW RATE =    23.900 HM3/YR
TOTAL FLOW VOLUME =      11.97 HM3
FLOW DATE RANGE   = 980501 TO 981030
SAMPLE DATE RANGE = 980503 TO 981021
```

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	21949.6	43809.2	.1299E+09	1832.99	.260
2 Q WTD C	17774.4	35476.0	.5969E+08	1484.33	.218
3 IJC	17750.5	35428.3	.5734E+08	1482.33	.214
4 REG-1	17241.1	34411.6	.5204E+08	1439.79	.210
5 REG-2	17407.2	34743.1	.5426E+08	1453.66	.212
6 REG-3	17196.8	34323.1	.5546E+08	1436.09	.217

```
GBL TMDL ROP05: Monitored         VAR=TN        METHOD= 4 REG-1
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      -.0584  SLOPE               =       .0000
 R-SQUARED          =       .0000  MEAN SQUARED ERROR =       .0507
 STD ERROR OF SLOPE =       .1829  DEGREES OF FREEDOM =          10
 T STATISTIC        =       .0000  PROBABILITY(>|T|)  =       .9954
 Y MEAN             =      -.0584  Y STD DEVIATION    =       .2148
 X MEAN             =      1.3725  X STD DEVIATION    =       .3714
RESIDUALS ANALYSIS:
 RUNS TEST Z        =     -1.4574  PROBABILITY (>|Z|) =       .0725
 LAG-1 AUTOCORREL.  =       .1581  PROBABILITY (>|R|) =       .2919
 EFFECTIVE SAMPLES  =           8  SLOPE SIGNIFICANCE =       .9955


GBL TMDL ROP05: Monitored         VAR=TN        METHOD= 4 REG-1
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =    -15.9825  SLOPE               =       .1616
 R-SQUARED          =       .0154  MEAN SQUARED ERROR =       .0500
 STD ERROR OF SLOPE =       .4085  DEGREES OF FREEDOM =          10
 T STATISTIC        =       .3956  PROBABILITY(>|T|)  =       .7014
 Y MEAN             =      -.0584  Y STD DEVIATION    =       .2148
 X MEAN             =     98.5427  X STD DEVIATION    =       .1650
RESIDUALS ANALYSIS:
 RUNS TEST Z        =     -1.5138  PROBABILITY (>|Z|) =       .0650
 LAG-1 AUTOCORREL.  =       .1637  PROBABILITY (>|R|) =       .2853
 EFFECTIVE SAMPLES  =           8  SLOPE SIGNIFICANCE =       .7541


ROP05 Velocity Based q            VAR=TP        METHOD= 6 REG-3
COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
```

STR	NQ	NC	NE	VOL%	TOTAL FLOW	SAMPLED FLOW	C/Q SLOPE	SIGNIF
1	31	3	3	45.8	1.207	1.257	.717	.416
2	151	8	8	51.2	.277	.513	.595	.003
***	182	11	11	97.0	.436	.716		
EXCLU	1	0	0	3.0	2.493	.000		

```
FLOW STATISTICS
FLOW DURATION =     182.0 DAYS  =   .498 YEARS
MEAN FLOW RATE =      .436 HM3/YR
TOTAL FLOW VOLUME =        .22 HM3
FLOW DATE RANGE   = 980501 TO 981030
SAMPLE DATE RANGE = 980503 TO 981021
```

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	198.9	399.2	.5108E+05	916.38	.566
2 Q WTD C	119.9	240.7	.4326E+04	552.50	.273
3 IJC	127.7	256.3	.5966E+04	588.33	.301
4 REG-1	91.0	182.7	.6715E+03	419.38	.142
5 REG-2	139.0	278.9	.1786E+05	640.12	.479
6 REG-3	116.5	233.8	.1731E+04	536.71	.178

```
ROP05 Velocity Based q          VAR=TP        METHOD= 6 REG-3
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      -.0277  SLOPE              =       .0067
 R-SQUARED          =       .0007  MEAN SQUARED ERROR =       .0219
 STD ERROR OF SLOPE =       .0823  DEGREES OF FREEDOM =           9
 T STATISTIC        =       .0819  PROBABILITY(>|T|)  =       .9344
 Y MEAN             =      -.0303  Y STD DEVIATION    =       .1404
 X MEAN             =      -.3955  X STD DEVIATION    =       .5682
RESIDUALS ANALYSIS:
 RUNS TEST Z        =      1.3122  PROBABILITY (>|Z|) =       .0947
 LAG-1 AUTOCORREL.  =      -.4375  PROBABILITY (>|R|) =       .0734
 EFFECTIVE SAMPLES  =          11  SLOPE SIGNIFICANCE =       .9344


ROP05 Velocity Based q          VAR=TP        METHOD= 6 REG-3
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      6.3120  SLOPE              =      -.0644
 R-SQUARED          =       .0053  MEAN SQUARED ERROR =       .0218
 STD ERROR OF SLOPE =       .2926  DEGREES OF FREEDOM =           9
 T STATISTIC        =      -.2200  PROBABILITY(>|T|)  =       .8247
 Y MEAN             =      -.0303  Y STD DEVIATION    =       .1404
 X MEAN             =     98.5247  X STD DEVIATION    =       .1595
RESIDUALS ANALYSIS:
 RUNS TEST Z        =      1.3122  PROBABILITY (>|Z|) =       .0947
 LAG-1 AUTOCORREL.  =      -.4339  PROBABILITY (>|R|) =       .0750
 EFFECTIVE SAMPLES  =          11  SLOPE SIGNIFICANCE =       .8247

ROP05 Velocity Based q          VAR=NVSS      METHOD= 4 REG-1
COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
 1       183  11  11 100.0         .447         .716        .017   .961
***      183  11  11 100.0         .447         .716

FLOW STATISTICS
FLOW DURATION =     183.0 DAYS  =   .501 YEARS
MEAN FLOW RATE =      .447 HM3/YR
TOTAL FLOW VOLUME =        .22 HM3
FLOW DATE RANGE   = 980501 TO 981030
SAMPLE DATE RANGE = 980503 TO 981021
```

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	43516.5	86854.6	.2112E+10	194349.70	.529
2 Q WTD C	27169.9	54228.4	.7787E+09	121343.90	.515
3 IJC	27146.3	54181.4	.9577E+09	121238.70	.571
4 REG-1	26954.8	53799.2	.5331E+09	120383.50	.429

```
5 REG-2          27857.8        55601.4      .3471E+10  124416.20   1.060
6 REG-3          27576.2        55039.3      .1571E+10  123158.40    .720

ROP05 Velocity Based q           VAR=NVSS      METHOD= 4 REG-1
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT         =     -.4438  SLOPE                =       .0000
 R-SQUARED         =      .0000  MEAN SQUARED ERROR =       .3855
 STD ERROR OF SLOPE =     .3455  DEGREES OF FREEDOM =           9
 T STATISTIC       =      .0000  PROBABILITY(>|T|)  =       .9955
 Y MEAN            =     -.4438  Y STD DEVIATION    =       .5890
 X MEAN            =     -.3955  X STD DEVIATION    =       .5682
RESIDUALS ANALYSIS:
 RUNS TEST Z       =     -.6124  PROBABILITY (>|Z|) =       .2701
 LAG-1 AUTOCORREL.  =    -.1840  PROBABILITY (>|R|) =       .2709
 EFFECTIVE SAMPLES  =        11  SLOPE SIGNIFICANCE =       .9955


ROP05 Velocity Based q           VAR=NVSS      METHOD= 4 REG-1
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT         =    36.1996  SLOPE                =      -.3719
 R-SQUARED         =      .0101  MEAN SQUARED ERROR =       .3816
 STD ERROR OF SLOPE =    1.2250  DEGREES OF FREEDOM =           9
 T STATISTIC       =     -.3036  PROBABILITY(>|T|)  =       .7647
 Y MEAN            =     -.4438  Y STD DEVIATION    =       .5890
 X MEAN            =    98.5247  X STD DEVIATION    =       .1595
RESIDUALS ANALYSIS:
 RUNS TEST Z       =     -.6124  PROBABILITY (>|Z|) =       .2701
 LAG-1 AUTOCORREL.  =    -.2299  PROBABILITY (>|R|) =       .2229
 EFFECTIVE SAMPLES  =        11  SLOPE SIGNIFICANCE =       .7647
```

D.3 WATER QUALITY STATISTICAL ANALYSIS

Statistical analysis of STORET and Clean Lakes Program in-lake water quality measurements for each year was performed using JMP 3.2.1 statistical software (SAS Institute, Inc). Both Lower Lake Basin sites (ROP-1 and ROP-2) were combined for a total Lower Lake Basin value. Coefficient of variation (cv) was determined by:

cv = Std Err Mean/Mean.

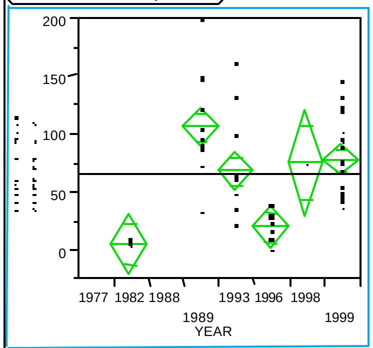
Results were used in BATHTUB models for calibration and comparison of predicted versus actual concentrations

Where:

CHLRPHYL A	= Chlorophyll-a Concentration, ug/L
PHOS-TOT	= Total Phosphorous, mg/L
TOT KJEL N	= Total Kjeldahl Nitrogen, mg/L
DISP	= Dissolved Phosphorous, mg/L
NO2&NO3 N-TOTAL	= Total Nitrate + Nitrite Nitrogen, mg/L
COD-LL	= Chemical Oxygen Demand, mg/L
TP-OP	= Total Phosphorous - Ortho(dissolved) Phosphorous or Particulate Phosphorous, mg/L
TN	= Total Nitrogen, mg/L
OrgN	= Organic N, mg/L = TOT KJEL N + NO2&NO3 N-TOTAL
NVSS	= Non-Volatile Suspended Solids
?	= No data
Std Err Mean	= Standard Area of Mean

LOWER LAKE BASIN: ROP-1 + ROP-2

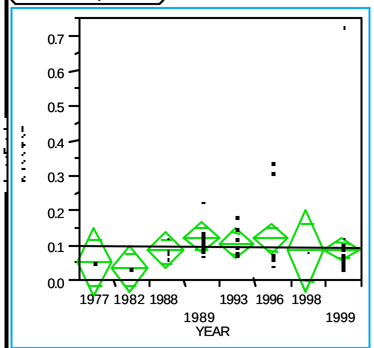
CHLRPHYL A UG/L By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	6	5.482	1.6682	0.681
1988	0	?	?	?
1989	15	105.394	45.0115	11.622
1993	15	68.580	36.8087	9.504
1996	12	19.703	11.7133	3.381
1998	2	75.430	0.0000	0.000
1999	22	78.030	32.3636	6.900

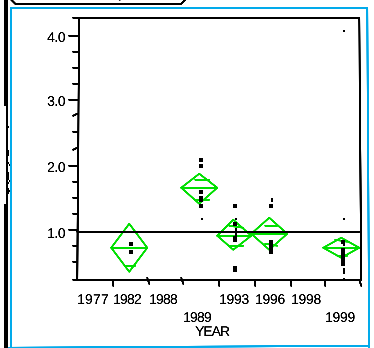
PHOS-TOT By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	3	0.050000	0.000000	0.00000
1982	6	0.029833	0.000753	0.00031
1988	10	0.082600	0.025136	0.00795
1989	15	0.120667	0.047500	0.01226
1993	15	0.102333	0.029717	0.00767
1996	15	0.115533	0.106454	0.02749
1998	2	0.080000	0.000000	0.00000
1999	28	0.084214	0.128140	0.02422

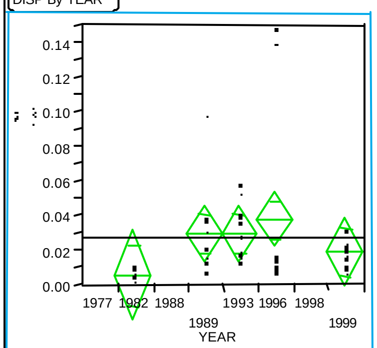
TOT KJEL N By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	6	0.73333	0.051640	0.02108
1988	0	?	?	?
1989	15	1.62667	0.281493	0.07268
1993	15	0.92067	0.295719	0.07635
1996	15	0.92467	0.287672	0.07428
1998	0	?	?	?
1999	31	0.73355	0.647871	0.11636

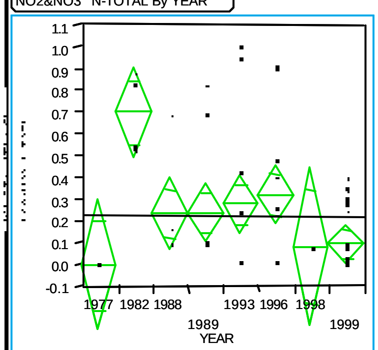
DISP By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	6	0.005500	0.003146	0.00128
1988	0	?	?	?
1989	15	0.029133	0.030016	0.00775
1993	15	0.028600	0.015620	0.00403
1996	15	0.037800	0.054061	0.01396
1998	0	?	?	?
1999	10	0.018700	0.006929	0.00219

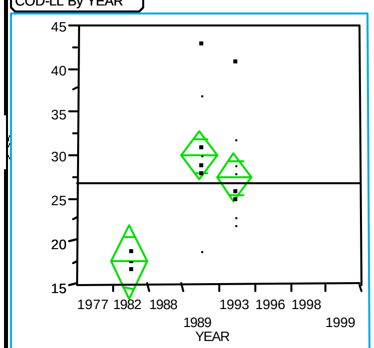
NO2&NO3 N-TOTAL By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	3	0.000000	0.000000	0.00000
1982	6	0.698333	0.181705	0.07418
1988	10	0.232000	0.243073	0.07687
1989	15	0.236667	0.284572	0.07348
1993	15	0.274000	0.388013	0.10018
1996	15	0.323333	0.347844	0.08981
1998	2	0.080000	0.000000	0.00000
1999	31	0.094968	0.133724	0.02402

COD-LL By YEAR

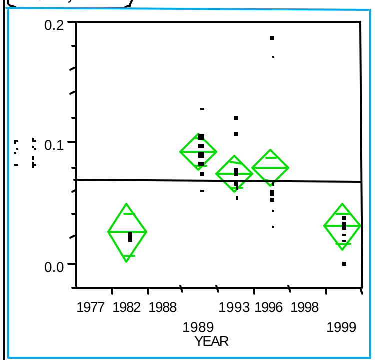


Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	6	17.6667	0.81650	0.3333
1988	0	?	?	?
1989	15	29.8667	6.12800	1.5822
1993	15	27.4667	4.94060	1.2757
1996	0	?	?	?
1998	0	?	?	?
1999	0	?	?	?

LOWER BASIN CONTINUED: ROP-1 + ROP-2

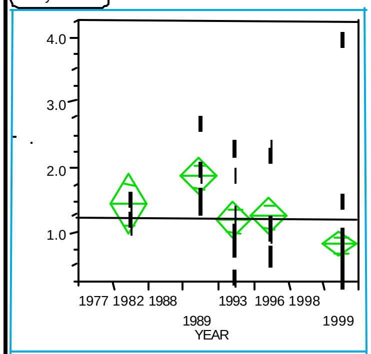
TP-OP By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	6	0.024333	0.002422	0.00099
1988	0	?	?	?
1989	15	0.091533	0.020042	0.00517
1993	15	0.073733	0.018305	0.00473
1996	15	0.077733	0.053019	0.01369
1998	0	?	?	?
1999	10	0.028800	0.011942	0.00378

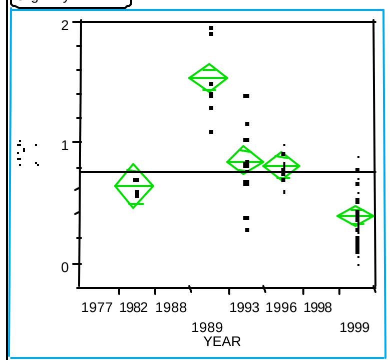
TN By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	6	1.43167	0.186056	0.07596
1988	0	?	?	?
1989	15	1.86333	0.333352	0.08607
1993	15	1.19467	0.588762	0.15202
1996	15	1.24800	0.624376	0.16121
1998	0	?	?	?
1999	31	0.82852	0.655220	0.11768

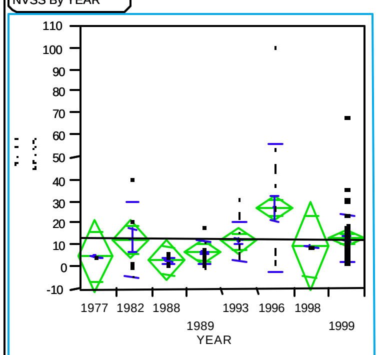
OrgN By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	6	0.62333	0.060882	0.02486
1988	0	?	?	?
1989	15	1.52400	0.276839	0.07148
1993	15	0.83933	0.325235	0.08398
1996	15	0.78733	0.122560	0.03164
1998	0	?	?	?
1999	31	0.38316	0.221362	0.03976

NVSS By YEAR

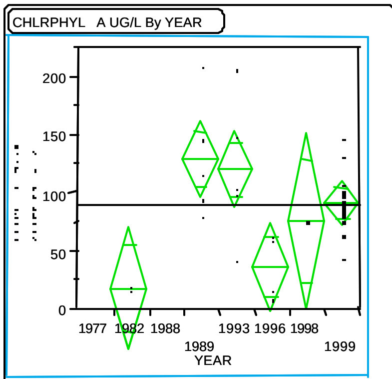


Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	3	5.0000	0.0000	0.0000
1982	10	12.2000	17.0542	5.3930
1988	10	3.0000	1.8856	0.5963
1989	25	6.9200	5.1228	1.0246
1993	25	11.9600	8.9976	1.7995
1996	23	27.1304	29.2346	6.0958
1998	2	9.0000	0.0000	0.0000
1999	47	12.9574	10.9206	1.5929

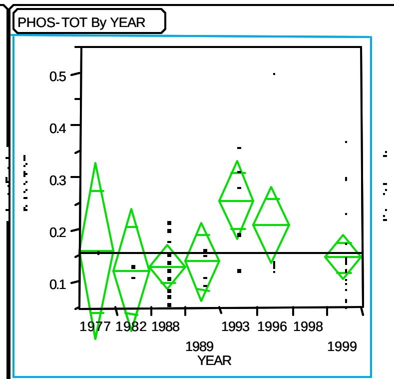
Means Comparisons

UPPER LAKE BASIN: ROP-3



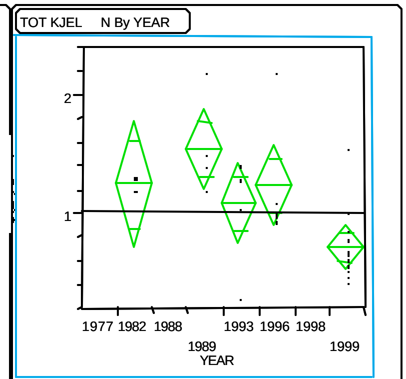
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	2	17.425	2.5385	1.795
1988	0	?	?	?
1989	5	128.900	51.2578	22.923
1993	5	120.108	61.5738	27.537
1996	4	36.257	28.2915	14.146
1998	1	75.430	?	?
1999	16	90.178	24.4859	6.121



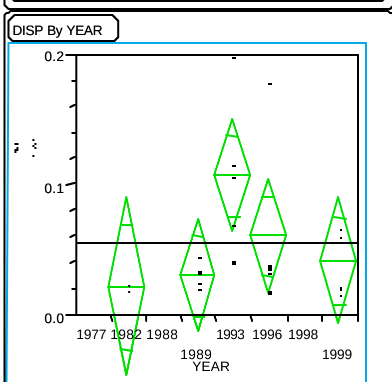
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	1	0.160000	?	?
1982	2	0.122000	0.014142	0.01000
1988	15	0.127867	0.049756	0.01285
1989	5	0.138000	0.031757	0.01420
1993	5	0.255600	0.095960	0.04291
1996	5	0.208400	0.165449	0.07399
1998	0	?	?	?
1999	16	0.149188	0.086746	0.02169



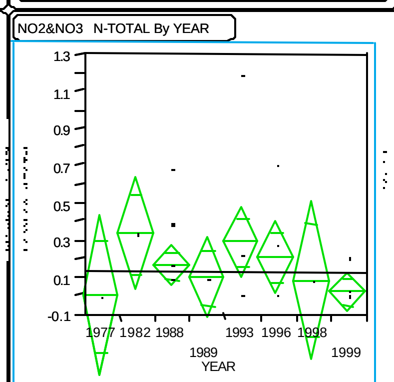
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	2	1.25000	0.070711	0.05000
1988	0	?	?	?
1989	5	1.54000	0.384708	0.17205
1993	5	1.08600	0.469287	0.20987
1996	5	1.24200	0.539092	0.24109
1998	0	?	?	?
1999	15	0.71000	0.275474	0.07113



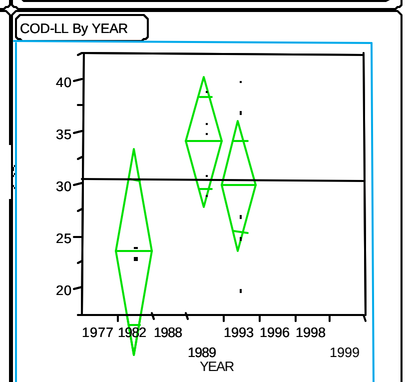
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	2	0.022000	0.002828	0.00200
1988	0	?	?	?
1989	5	0.029600	0.010597	0.00474
1993	5	0.106600	0.059066	0.02642
1996	5	0.060600	0.066097	0.02956
1998	0	?	?	?
1999	4	0.041500	0.026211	0.01311



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	1	0.000000	?	?
1982	2	0.335000	0.007071	0.00500
1988	15	0.163333	0.164085	0.04237
1989	4	0.100000	0.000000	0.00000
1993	5	0.290000	0.516769	0.23111
1996	5	0.204000	0.306072	0.13688
1998	1	0.080000	?	?
1999	16	0.019500	0.051678	0.01292

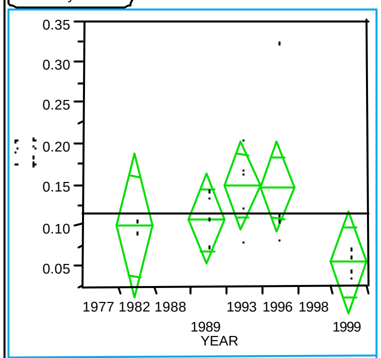


Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	2	23.5000	0.70711	0.5000
1988	0	?	?	?
1989	5	34.0000	4.00000	1.7889
1993	5	29.8000	8.40833	3.7603
1996	0	?	?	?
1998	0	?	?	?
1999	0	?	?	?

UPPER LAKE BASIN CONTINUED: ROP-3

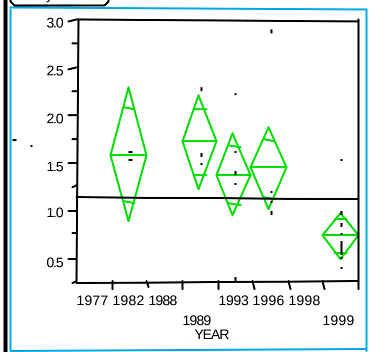
TP-OP By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	2	0.100000	0.011314	0.00800
1988	0	?	?	?
1989	5	0.108400	0.031895	0.01426
1993	5	0.149000	0.047838	0.02139
1996	5	0.147800	0.100291	0.04485
1998	0	?	?	?
1999	4	0.055250	0.015714	0.00786

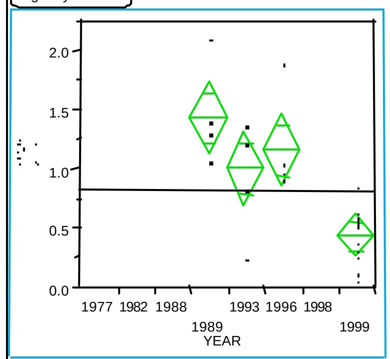
TN By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	2	1.58500	0.063640	0.04500
1988	0	?	?	?
1989	4	1.72500	0.386221	0.19311
1993	5	1.37600	0.702802	0.31430
1996	5	1.44600	0.823092	0.36810
1998	0	?	?	?
1999	15	0.73067	0.266058	0.06870

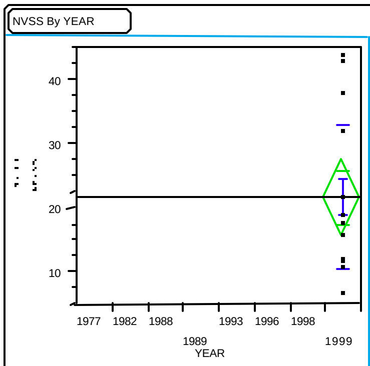
OrgN By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	0	?	?	?
1988	0	?	?	?
1989	5	1.43200	0.393853	0.17614
1993	5	1.00600	0.484644	0.21674
1996	5	1.15600	0.413376	0.18487
1998	0	?	?	?
1999	15	0.43387	0.234640	0.06058

NVSS By YEAR



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
1977	0	?	?	?
1982	0	?	?	?
1988	0	?	?	?
1989	0	?	?	?
1993	0	?	?	?
1996	0	?	?	?
1998	0	?	?	?
1999	16	21.7500	11.2931	2.8233

D.4 PROFILE MODEL INPUT

<u>ROP-1 and ROP-2: Lower Basin 1989</u>

```
Governor Bond Lake Lower Basin; CLP, IEPA Data
2.42                    *** length   (kilometers)
-9.                     *** missing value code
.305                    *** elevation conversion to m
.01                     *** area conversion to km2
1.0                     *** rkm conversion to km
.305                    *** depth unit conversion factor to m
1.                      *** date fuzz factor
elev--->area--->         ** hypsiographic curve in increasing order ft,acres
 899.        0.
 900.       .86
 905.     24.66
 910.     56.78
 915.     73.29
 920.     79.63
 922.     85.79
 925.     91.53
00
id label   <---><---><---><---><---><--->
01 temp     5.   10.  15.  20.  25.  30.
02 oxygen   2.   4.   6.   8.   10.  12.
00
st code--->elev--->rkm---->weight-> seg description---->
01 STA 2       925.      .2     .40  02 RR trestle
02 STA 1       925.     2.4     .60  03 Dam Outlet
00                                                      *** date key
date--selev--->
890425   925.
890608   924.5
890711   923.5
890815   923.
891003   925.
00                                                      *** profile data
st date-- depth temp   o2
01 890616    0 24.8 11.2
01 890616    1 24.7 11.0
01 890616    3 24.6 10.9
01 890616    5 24.4 10.8
01 890616    7 24.1 9.6
01 890616    9 23.9 9.0
01 890616   11 23.7 6.8
01 890616   13 22.9 1.7
01 890616   15 22.0 0.2
01 890616   16 21.5 0.0
02 890425    0 17.7 11.5
02 890425    1 17.7 11.5
02 890425    3 17.5 11.2
```

```
02 890425    5 16.1 9.5
02 890425    7 15.6 8.9
02 890425    9 15.1 8.1
02 890425   11 14.6 7.3
02 890425   13 13.9 6.2
02 890425   15 13.4 6.3
02 890425   17 13.0 5.8
02 890425   19 12.8 5.4
02 890425   21 12.6 4.2
02 890425   23 12.3 1.6
00
```

ROP-3: Upper Basin 1989

```
Governor Bond Lake Lower Basin; CLP, IEPA Data
3.617                    *** length   (kilometers)
-9.                     *** missing value code
.305                    *** elevation conversion to m
.01                     *** area conversion to km2
1.0                     *** rkm conversion to km
.305                    *** depth unit conversion factor to m
1.                      *** date fuzz factor
elev--->area--->        ** hypsiographic curve in increasing order ft,acres
 914.5       0.
 915.     25.68
 920.     76.39
 922.     97.64
 925.     112.8
00
id label   <---><---><---><---><---><--->
01 temp     5.   10.  15.  20.  25.  30.
02 oxygen   2.   4.   6.   8.   10.  12.
00
st code--->elev--->rkm---->weight-> seg description---->
01 STA 1       925.      .2     1.0  01 Upper Basin
00                                                        *** date key
date--selev--->
890425   925.5
890606   925.5
890711   925.5
890815   924.0
891003   925.0
00                                                        *** profile data
st date-- depth temp   o2
01 890606    0 25.2 10.9
01 890606    1 25.3 10.8
01 890606    3 25.1 10.6
01 890606    5 24.3 7.3
00
```

ROP-1 and ROP-2: Lower Basin 1993

```
Governor Bond Lake Lower Basin; CLP, IEPA Data
2.42                    *** length   (kilometers)
-9.                     *** missing value code
```

```
.305                     *** elevation conversion to m
.01                      *** area conversion to km2
1.0                      *** rkm conversion to km
.305                     *** depth unit conversion factor to m
1.                       *** date fuzz factor
elev--->area--->         ** hypsiographic curve in increasing order ft,acres
 899.        0.
 900.       .86
 905.     24.66
 910.     56.78
 915.     73.29
 920.     79.63
 922.     85.79
 925.     91.53
00
ic label   <---><---><---><---><---><--->
01 temp     5.   10.  15.  20.  25.  30.
02 oxygen   2.   4.   6.   8.   10.  12.
00
st code--->elev--->rkm---->weight-> seg description---->
01 STA 2       925.      .2     .40  02 RR trestle
02 STA 1       925.     2.4     .60  03 Dam Outlet
00                                                         *** date key
date--selev--->
930407   924.0
930623   925.0
930720   924.0
930824   924.5
931019   924.0
00                                                         *** profile data
st date-- depth temp   o2
01 930407    0 9.9  13.1
01 930407    1 9.9  13.0
01 930407    3 9.8  12.9
01 930407    5 9.8  12.7
01 930407    7 8.8  11.8
01 930407    9 8.4  11.4
01 930407   11 8.0  10.7
01 930407   13 7.9  10.4
01 930407   14 7.9  9.6
02 930720    0 32.9 15.7
02 930720    1 32.9 15.8
02 930720    3 32.1 16.4
02 930720    5 30.7 14.1
02 930720    7 30.4 12.6
02 930720    9 29.3 6.4
02 930720   11 27.8 0.4
02 930720   13 27.2 0.3
02 930720   15 26.2 0.1
02 930720   17 24.3 0.0
02 930720   19 21.4 0.0
02 930720   21 19.9 0.0
00
```

ROP-3: Upper Basin 1993

```
Governor Bond Lake Lower Basin; CLP, IEPA Data
```

```
3.617                     *** length   (kilometers)
-9.                      *** missing value code
.305                     *** elevation conversion to m
.01                      *** area conversion to km2
1.0                      *** rkm conversion to km
.305                     *** depth unit conversion factor to m
1.                       *** date fuzz factor
elev--->area--->         ** hypsiographic curve in increasing order ft,acres
 914.5       0.
 915.     25.68
 920.     76.39
 922.     97.64
 925.     112.8
00
ic label   <---><---><---><---><---><--->
01 temp     5.   10.  15.  20.  25.  30.
02 oxygen   2.   4.   6.   8.   10.  12.
00
st code--->elev--->rkm---->weight-> seg description---->
01 STA 1       925.      .2     1.0  01 Upper Basin
00                                                         *** date key
date--selev--->
930407   924.5
930602   924.5
930623   924.5
930720   925.0
930824   924.5
931019   924.5
00                                                         *** profile data
st date-- depth temp   o2
01 930623    0 28.5 7.2
01 930623    1 28.4 6.9
01 930623    3 27.1 2.4
01 930623    5 26.7 0.9
00
```

ROP-1 and ROP-2: Lower Basin 1996

```
Governor Bond Lake Lower Basin; CLP, IEPA Data
2.42                     *** length   (kilometers)
-9.                      *** missing value code
.305                     *** elevation conversion to m
.01                      *** area conversion to km2
1.0                      *** rkm conversion to km
.305                     *** depth unit conversion factor to m
1.                       *** date fuzz factor
elev--->area--->         ** hypsiographic curve in increasing order ft,acres
 899.        0.
 900.       .86
 905.     24.66
 910.     56.78
 915.     73.29
 920.     79.63
 922.     85.79
 925.     91.53
00
ic label   <---><---><---><---><---><--->
```

```
01 temp     5.   10.  15.  20.  25.  30.
02 oxygen   2.   4.   6.   8.   10.  12.
00
st code--->elev--->rkm---->weight-> seg description---->
01 STA 2       925.      .2     .40  02 RR trestle
02 STA 1       925.     2.4     .60  03 Dam Outlet
00                                                          *** date key
date--selev--->
960509   925.0
960620   925.0
960712   923.5
960729   925.0
960823   923.5
00                                                          *** profile data
st date-- depth temp   o2
01 960509    0 17.4 6.9
01 960509    1 17.3 6.8
01 960509    3 17.2 6.7
01 960509    5 17.2 6.7
01 960509    7 17.2 6.7
01 960509    9 17.2 6.7
01 960509   11 17.1 6.6
01 960509   13 15.6 4.5
01 960509   15 15.5 3.8
02 960509    0 16.5 6.6
02 960509    1 16.2 6.4
02 960509    3 15.9 6.4
02 960509    5 15.8 6.3
02 960509    7 15.8 6.3
02 960509    9 15.6 6.2
02 960509   11 15.4 6.0
02 960509   13 15.1 5.7
02 960509   15 14.7 5.3
02 960509   17 14.0 4.4
02 960509   19 13.2 3.0
02 960509   21 12.7 1.3
02 960509   22 12.6 0.7
00
```

ROP-3: Upper Basin 1996

```
Governor Bond Lake Lower Basin; CLP, IEPA Data
3.617                    *** length   (kilometers)
-9.                     *** missing value code
.305                    *** elevation conversion to m
.01                     *** area conversion to km2
1.0                     *** rkm conversion to km
.305                    *** depth unit conversion factor to m
1.                      *** date fuzz factor
elev--->area--->        ** hypsiographic curve in increasing order ft,acres
 914.5        0.
 915.     25.68
 920.     76.39
 922.     97.64
 925.     112.8
00
ic label   <---><---><---><---><---><--->
```

```
01 temp     5.   10.  15.  20.  25.  30.
02 oxygen   2.   4.   6.   8.   10.  12.
00
st code--->elev--->rkm---->weight-> seg description---->
01 STA 1       925.      .2     1.0  01 Upper Basin
00                                                        *** date key
date--selev--->
960509   925.0
960620   923.5
960729   924.0
960823   924.0
961004   924.0
00                                                        *** profile data
st date-- depth temp   o2
01 960620    0 30.3 8.0
01 960620    1 29.9 8.2
01 960620    3 28.1 7.6
01 960620    5 27.2 5.8
00
```

ROP-1 and ROP-2: Lower Basin 1999

```
Governor Bond Lake Lower Basin; CLP, IEPA Data
2.42                     *** length   (kilometers)
-9.                      *** missing value code
.305                     *** elevation conversion to m
.01                      *** area conversion to km2
1.0                      *** rkm conversion to km
.305                     *** depth unit conversion factor to m
1.                       *** date fuzz factor
elev--->area--->         ** hypsiographic curve in increasing order ft,acres
 899.        0.
 900.       .86
 905.     24.66
 910.     56.78
 915.     73.29
 920.     79.63
 922.     85.79
 925.     91.53
00
ic label   <---><---><---><---><---><--->
01 temp     5.   10.  15.  20.  25.  30.
02 oxygen   2.   4.   6.   8.   10.  12.
00
st code--->elev--->rkm---->weight-> seg description---->
01 STA 2       925.      .2     .40  02 RR trestle
02 STA 1       925.     2.4     .60  03 Dam Outlet
00                                                        *** date key
date--selev--->
990715   925.14
990814   924.73
990916   924.35
991016   924.16
991116   924.12
00                                                        *** profile data
st date-- depth temp   o2
01 990503    0 19.9 14.0
```

01	990503	1	19.8	14.9
01	990503	3	19.8	15.1
01	990503	5	19.3	15.1
01	990503	7	19.2	15.2
01	990503	9	18.5	14.5
01	990503	11	16.8	12.4
01	990503	13	15.7	9.7
01	990503	14	15.3	9.4
01	990518	0	22.8	8.0
01	990518	1	22.8	8.2
01	990518	3	22.8	8.1
01	990518	5	21.6	6.2
01	990518	7	21.1	5.5
01	990518	9	20.9	4.9
01	990518	11	20.6	4.5
01	990518	13	20.0	2.5
01	990607	0	27.0	11.1
01	990607	1	26.9	11.1
01	990607	3	26.8	11.1
01	990607	5	26.7	11.1
01	990607	7	26.6	10.9
01	990607	9	26.5	10.7
01	990607	11	26.3	9.5
01	990607	13	22.4	3.6
01	990607	14	21.7	0.3
01	990614	1	27.5	5.5
01	990614	0	27.5	6.4
01	990614	3	26.9	5.0
01	990614	5	25.8	2.2
01	990614	7	25.6	1.5
01	990614	9	25.5	1.0
01	990614	11	25.0	0.4
01	990614	13	22.5	0.0
01	990614	15	22.0	0.0
01	990706	0	29.8	11.1
01	990706	1	29.8	11.2
01	990706	3	29.7	10.9
01	990706	5	30.0	10.7
01	990706	7	29.2	8.4
01	990706	9	27.6	2.4
01	990706	11	26.7	1.0
01	990706	13	26.1	0.3
01	990706	14	25.9	0.2
01	990707	0	30.3	12.2
01	990707	1	30.3	12.3
01	990707	3	30.2	12.3
01	990707	5	29.9	8.8
01	990707	7	28.9	8.6
01	990707	9	28.4	8.3
01	990707	11	26.6	1.4
01	990707	13	26.0	0.8
01	990707	14	25.7	0.2

02	990503	0	18.6	12.9
02	990503	1	18.6	12.9
02	990503	3	18.5	12.7
02	990503	5	17.7	12.4
02	990503	7	16.5	10.5
02	990503	9	16.0	9.0

```
02 990503   11 15.7 8.1
02 990503   13 15.6 7.9
02 990503   15 15.4 7.4
02 990503   17 15.3 7.2
02 990503   19 15.2 6.8
02 990503   21 15.2 6.7
02 990519    1 24.5 11.5
02 990519    3 23.4 12.4
02 990519    5 21.1 8.9
02 990519    7 21.4 6.9
02 990519    9 21.1 5.5
02 990519   11 20.7 3.8
02 990519   13 20.2 2.9
02 990519   15 20.0 2.5
02 990519   17 18.8 0.9
02 990519   19 17.8 0.1
02 990519   20 17.4 0.1
02 990607    0 25.4 8.1
02 990607    1 25.3 8.1
02 990607    3 24.6 7.3
02 990607    5 24.5 6.4
02 990607    7 24.3 5.2
02 990607    9 24.1 4.5
02 990607   11 23.8 3.5
02 990607   13 22.9 1.9
02 990607   15 22.2 0.1
02 990607   17 20.4 0.6
02 990607   19 19.5 0.5
02 990607   20 18.9 0.5
02 990614    0 23.6 10.3
02 990614    1 27.2 8.7
02 990614    3 27.1 8.3
02 990614    5 27.0 7.7
02 990614    7 26.9 7.4
02 990614    9 26.8 6.9
02 990614   11 26.5 6.0
02 990614   13 26.3 5.6
02 990614   15 26.1 5.1
02 990614   17 21.9 0.1
02 990614   19 20.2 0.1
02 990614   20 19.6 0.1
02 990706    0 29.6 10.4
02 990706    1 29.5 10.5
02 990706    3 29.2 10.8
02 990706    5 28.7 9.8
02 990706    7 28.0 7.9
02 990706    9 27.3 4.9
02 990706   11 26.9 3.2
02 990706   13 25.8 0.9
02 990706   15 25.0 0.2
02 990706   17 23.3 0.1
02 990706   19 21.3 0.1
02 990706   20 20.6 0.0
02 990706    0 28.7 9.7
02 990706    1 28.7 9.8
02 990706    3 28.6 9.5
02 990706    5 28.4 8.8
02 990706    7 28.2 8.2
02 990706    9 27.4 4.7
```

```
02 990706   11 26.9 3.4
02 990706   13 25.8 0.1
02 990706   15 24.0 0.0
02 990706   17 22.5 0.0
02 990706   19 20.8 0.0
02 990706   20 20.3 0.0
02 990719    0 29.2 12.7
02 990719    1 29.7 12.6
02 990719    3 28.4 6.6
02 990719    5 28.1 4.5
02 990719    7 27.6 2.4
02 990719    9 27.3 1.2
02 990719   11 27.0 0.5
02 990719   13 26.9 0.2
02 990719   15 26.1 0.1
02 990719   17 24.6 0.1
02 990719   19 21.3 0.1
02 990719   20 20.5 0.1
00
```

ROP-3: Upper Basin 1999

```
Governor Bond Lake Lower Basin; CLP, IEPA Data
3.617                    *** length   (kilometers)
-9.                     *** missing value code
.305                    *** elevation conversion to m
.01                     *** area conversion to km2
1.0                     *** rkm conversion to km
.305                    *** depth unit conversion factor to m
1.                      *** date fuzz factor
elev--->area--->        ** hypsiographic curve in increasing order ft,acres
 914.5       0.
 915.     25.68
 920.     76.39
 922.     97.64
 925.     112.8
00
ic label   <---><---><---><---><---><--->
01 temp     5.   10.  15.  20.  25.  30.
02 oxygen   2.   4.   6.   8.   10.  12.
00
st code--->elev--->rkm---->weight-> seg description---->
01 STA 1      925.      .2     1.0  01 Upper Basin
00                                                       *** date key
date--selev--->
990715   925.14
990814   924.73
990916   924.35
991016   924.16
991116   924.12
00                                                       *** profile data
st date-- depth temp   o2
01 990503    0 19.9 12.7
01 990503    1 19.9 13.0
01 990503    3 19.7 13.1
01 990503    5 18.3 12.3
01 990519    0 24.2 9.5
```

```
01 990519    1 22.7 8.2
01 990519    3 22.2 7.3
01 990519    5 21.9 7.0
01 990607    0 28.4 9.6
01 990607    1 28.3 9.6
01 990607    3 28.2 9.2
01 990607    5 27.8 7.8
01 990615    0 26.2 7.9
01 990615    1 26.0 7.6
01 990615    3 25.8 6.8
01 990615    5 25.7 6.7
01 990615    6 25.7 6.6
01 990706    0 31.3 10.3
01 990706    1 31.3 10.3
01 990706    3 31.2 8.8
01 990706    5 30.9 8.7
01 990706    0 32.3 13.0
01 990706    1 32.0 12.5
01 990706    3 31.4 10.5
01 990706    5 30.8 8.4
01 990719    0 30.6 10.7
01 990719    1 30.5 9.8
01 990719    3 30.1 7.8
01 990719    5 29.6 4.9
00
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D.5 BATHTUB OUTPUT: DIAGNOSTICS

INITIAL CONDITIONS

CASE: 1989 INITIAL CONDITIONS

CASE: GovBondL Initial

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 1 Pond

VARIABLE		----- VALUES ----- OBSERVED	ESTIMATED	--- RANKS (%) ---- OBSERVED	ESTIMATED
TOTAL P	MG/M3	138.00	137.68	88.0	88.0
TOTAL N	MG/M3	1725.00	1712.54	80.2	79.9
C.NUTRIENT	MG/M3	95.10	94.60	89.0	88.8
CHL-A	MG/M3	128.90	128.64	100.0	100.0
SECCHI	M	.39	.39	9.1	9.1
ORGANIC N	MG/M3	1432.00	3126.17	98.5	100.0
TP-ORTHO-P	MG/M3	108.40	236.27	91.2	98.5
ANTILOG PC-1		4452.03	5862.93	98.7	99.2
ANTILOG PC-2		19.24	21.85	98.1	99.0
(N - 150) / P		11.41	11.35	27.9	27.6
INORGANIC N / P		9.90	1.00	13.4	.0
TURBIDITY	1/M	.48	.48	39.4	39.4

ZMIX * TURBIDITY	.61	.61	1.7	1.7
ZMIX / SECCHI	3.25	3.24	25.4	25.3
CHL-A * SECCHI	50.43	50.41	98.8	98.8
CHL-A / TOTAL P	.93	.93	99.3	99.3
FREQ(CHL-a>10) %	99.99	99.99	.0	.0
FREQ(CHL-a>20) %	99.65	99.64	.0	.0
FREQ(CHL-a>30) %	97.94	97.92	.0	.0
FREQ(CHL-a>40) %	94.27	94.23	.0	.0
FREQ(CHL-a>50) %	88.83	88.77	.0	.0
FREQ(CHL-a>60) %	82.21	82.13	.0	.0
CARLSON TSI-P	75.20	75.17	.0	.0
CARLSON TSI-CHLA	78.27	78.25	.0	.0
CARLSON TSI-SEC	73.52	73.50	.0	.0

SEGMENT: 2 Upper Basin

VARIABLE	----- VALUES ----- OBSERVED	ESTIMATED	--- RANKS (%) ---- OBSERVED	ESTIMATED
TOTAL P MG/M3	138.00	137.03	88.0	87.9
TOTAL N MG/M3	1725.00	1697.74	80.2	79.5
C.NUTRIENT MG/M3	95.10	93.92	89.0	88.7
CHL-A MG/M3	128.90	128.08	100.0	100.0
SECCHI M	.39	.39	9.1	9.2
ORGANIC N MG/M3	1432.00	3113.51	98.5	100.0
TP-ORTHO-P MG/M3	108.40	235.29	91.2	98.5
HOD-V MG/M3-DAY	66.67	1628.85	42.3	100.0
MOD-V MG/M3-DAY	36.63	778.94	19.2	100.0
ANTILOG PC-1	4452.03	5806.13	98.7	99.2
ANTILOG PC-2	19.24	21.85	98.1	99.0
(N - 150) / P	11.41	11.29	27.9	27.4
INORGANIC N / P	9.90	1.00	13.4	.0
TURBIDITY 1/M	.48	.48	39.4	39.4
ZMIX * TURBIDITY	.38	.38	.3	.3
ZMIX / SECCHI	2.04	2.03	7.3	7.2
CHL-A * SECCHI	50.43	50.37	98.8	98.8
CHL-A / TOTAL P	.93	.93	99.3	99.3
FREQ(CHL-a>10) %	99.99	99.99	.0	.0
FREQ(CHL-a>20) %	99.65	99.64	.0	.0
FREQ(CHL-a>30) %	97.94	97.89	.0	.0
FREQ(CHL-a>40) %	94.27	94.15	.0	.0
FREQ(CHL-a>50) %	88.83	88.63	.0	.0
FREQ(CHL-a>60) %	82.21	81.94	.0	.0
CARLSON TSI-P	75.20	75.10	.0	.0
CARLSON TSI-CHLA	78.27	78.20	.0	.0
CARLSON TSI-SEC	73.52	73.45	.0	.0

SEGMENT: 3 Lower Basin

VARIABLE	----- VALUES ----- OBSERVED	ESTIMATED	--- RANKS (%) ---- OBSERVED	ESTIMATED
TOTAL P MG/M3	120.67	119.54	84.8	84.5
TOTAL N MG/M3	1863.00	1830.61	83.4	82.7
C.NUTRIENT MG/M3	92.16	90.92	88.2	87.9
CHL-A MG/M3	105.40	104.97	99.9	99.9
SECCHI M	.31	.31	5.1	5.1
ORGANIC N MG/M3	1524.00	2664.28	98.9	100.0
TP-ORTHO-P MG/M3	91.53	218.61	88.0	98.2

HOD-V MG/M3-DAY	39.52	487.13	18.5	99.3
MOD-V MG/M3-DAY	101.10	368.54	71.2	99.1
ANTILOG PC-1	4454.12	5382.87	98.7	99.1
ANTILOG PC-2	14.60	16.00	94.0	95.8
(N - 150) / P	14.20	14.06	39.6	39.0
INORGANIC N / P	11.63	1.00	17.3	.0
TURBIDITY 1/M	1.51	1.51	85.0	85.0
ZMIX * TURBIDITY	5.22	5.22	74.3	74.3
ZMIX / SECCHI	11.08	11.05	92.6	92.6
CHL-A * SECCHI	32.83	32.77	95.1	95.0
CHL-A / TOTAL P	.87	.88	99.1	99.1
FREQ(CHL-a>10) %	99.98	99.97	.0	.0
FREQ(CHL-a>20) %	99.11	99.10	.0	.0
FREQ(CHL-a>30) %	95.70	95.64	.0	.0
FREQ(CHL-a>40) %	89.49	89.37	.0	.0
FREQ(CHL-a>50) %	81.41	81.23	.0	.0
FREQ(CHL-a>60) %	72.54	72.32	.0	.0
CARLSON TSI-P	73.27	73.13	.0	.0
CARLSON TSI-CHLA	76.29	76.25	.0	.0
CARLSON TSI-SEC	76.81	76.78	.0	.0

SEGMENT: 4 AREA-WTD MEAN

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	130.36	129.35	86.7	86.5
TOTAL N MG/M3	1785.81	1756.82	81.7	81.0
C.NUTRIENT MG/M3	93.80	92.62	88.6	88.3
CHL-A MG/M3	118.54	117.92	100.0	99.9
SECCHI M	.36	.36	7.2	7.3
ORGANIC N MG/M3	1472.54	2916.00	98.7	100.0
TP-ORTHO-P MG/M3	100.97	227.97	89.9	98.4
HOD-V MG/M3-DAY	54.26	1107.14	31.9	100.0
MOD-V MG/M3-DAY	66.09	591.41	48.4	99.9
ANTILOG PC-1	4452.88	5621.89	98.7	99.2
ANTILOG PC-2	17.17	19.21	96.9	98.1
(N - 150) / P	12.55	12.42	32.8	32.2
INORGANIC N / P	10.66	1.00	15.1	.0
TURBIDITY 1/M	.94	.94	68.7	68.7
ZMIX * TURBIDITY	1.86	1.86	24.8	24.8
ZMIX / SECCHI	5.57	5.55	60.5	60.3
CHL-A * SECCHI	42.21	42.15	97.8	97.7
CHL-A / TOTAL P	.91	.91	99.2	99.2
FREQ(CHL-a>10) %	99.99	99.99	.0	.0
FREQ(CHL-a>20) %	99.48	99.46	.0	.0
FREQ(CHL-a>30) %	97.17	97.11	.0	.0
FREQ(CHL-a>40) %	92.54	92.42	.0	.0
FREQ(CHL-a>50) %	86.05	85.86	.0	.0
FREQ(CHL-a>60) %	78.48	78.23	.0	.0
CARLSON TSI-P	74.38	74.27	.0	.0
CARLSON TSI-CHLA	77.45	77.39	.0	.0
CARLSON TSI-SEC	74.88	74.82	.0	.0

CASE: 1993 INITIAL CONDITIONS

CASE: GovBondL Initial

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 1 Pond

VARIABLE	VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
TOTAL P MG/M3	255.60	255.32	96.9	96.9
TOTAL N MG/M3	137.60	136.76	.1	.1
C.NUTRIENT MG/M3	.83	.83	.0	.0
CHL-A MG/M3	120.10	120.06	100.0	100.0
SECCHI M	.40	.40	9.8	9.8
ORGANIC N MG/M3	1006.00	2935.27	93.0	100.0
TP-ORTHO-P MG/M3	149.00	222.46	95.4	98.3
ANTILOG PC-1	234.67	344.58	48.7	60.3
ANTILOG PC-2	46.70	55.54	100.0	100.0
(N - 150) / P	.04	.04	.0	.0
INORGANIC N / P	.01	.03	.0	.0
TURBIDITY 1/M	.54	.54	44.7	44.7
ZMIX * TURBIDITY	.69	.69	2.5	2.5
ZMIX / SECCHI	3.14	3.14	23.7	23.7
CHL-A * SECCHI	48.51	48.51	98.6	98.6
CHL-A / TOTAL P	.47	.47	91.5	91.6
FREQ(CHL-a>10) %	99.99	99.99	.0	.0
FREQ(CHL-a>20) %	99.51	99.51	.0	.0
FREQ(CHL-a>30) %	97.30	97.30	.0	.0
FREQ(CHL-a>40) %	92.83	92.83	.0	.0
FREQ(CHL-a>50) %	86.51	86.50	.0	.0
FREQ(CHL-a>60) %	79.09	79.07	.0	.0
CARLSON TSI-P	84.09	84.07	.0	.0
CARLSON TSI-CHLA	77.57	77.57	.0	.0
CARLSON TSI-SEC	73.06	73.06	.0	.0

SEGMENT: 2 Upper Basin

VARIABLE	VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
TOTAL P MG/M3	255.60	255.25	96.9	96.8
TOTAL N MG/M3	1376.00	1359.09	69.0	68.3
C.NUTRIENT MG/M3	94.87	93.72	88.9	88.6
CHL-A MG/M3	120.10	119.81	100.0	100.0
SECCHI M	.40	.40	9.8	9.8
ORGANIC N MG/M3	1006.00	2929.39	93.0	100.0
TP-ORTHO-P MG/M3	149.00	222.00	95.4	98.2
HOD-V MG/M3-DAY	123.40	1577.20	73.7	100.0
MOD-V MG/M3-DAY	100.70	735.97	71.0	100.0
ANTILOG PC-1	3709.27	5393.34	98.1	99.1
ANTILOG PC-2	17.69	21.08	97.3	98.8
(N - 150) / P	4.80	4.74	3.2	3.0
INORGANIC N / P	3.47	.03	1.5	.0
TURBIDITY 1/M	.54	.54	44.7	44.7
ZMIX * TURBIDITY	.22	.22	.0	.0
ZMIX / SECCHI	.99	.99	.3	.3
CHL-A * SECCHI	48.51	48.48	98.6	98.6
CHL-A / TOTAL P	.47	.47	91.5	91.5

FREQ(CHL-a>10) %	99.99	99.99	.0	.0
FREQ(CHL-a>20) %	99.51	99.50	.0	.0
FREQ(CHL-a>30) %	97.30	97.28	.0	.0
FREQ(CHL-a>40) %	92.83	92.78	.0	.0
FREQ(CHL-a>50) %	86.51	86.42	.0	.0
FREQ(CHL-a>60) %	79.09	78.97	.0	.0
CARLSON TSI-P	84.09	84.07	.0	.0
CARLSON TSI-CHLA	77.57	77.55	.0	.0
CARLSON TSI-SEC	73.06	73.04	.0	.0

SEGMENT: 3 Lower Basin

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	102.33	102.12	80.1	80.0
TOTAL N MG/M3	1195.00	1179.00	60.8	60.0
C.NUTRIENT MG/M3	66.32	65.67	78.1	77.7
CHL-A MG/M3	68.58	68.42	99.5	99.5
SECCHI M	.35	.35	7.0	7.0
ORGANIC N MG/M3	839.30	1847.66	86.9	99.6
TP-ORTHO-P MG/M3	73.73	158.81	82.8	96.0
HOD-V MG/M3-DAY	117.50	844.93	71.5	99.9
MOD-V MG/M3-DAY	77.04	499.81	57.0	99.8
ANTILOG PC-1	2206.88	2907.85	95.3	97.1
ANTILOG PC-2	11.46	13.03	86.4	91.0
(N - 150) / P	10.21	10.08	22.7	22.1
INORGANIC N / P	12.44	1.00	19.1	.0
TURBIDITY 1/M	1.74	1.74	88.3	88.3
ZMIX * TURBIDITY	2.26	2.26	33.3	33.3
ZMIX / SECCHI	3.69	3.69	33.0	32.9
CHL-A * SECCHI	24.15	24.12	88.8	88.8
CHL-A / TOTAL P	.67	.67	97.3	97.3
FREQ(CHL-a>10) %	99.74	99.74	.0	.0
FREQ(CHL-a>20) %	95.33	95.29	.0	.0
FREQ(CHL-a>30) %	84.70	84.61	.0	.0
FREQ(CHL-a>40) %	71.21	71.09	.0	.0
FREQ(CHL-a>50) %	57.92	57.77	.0	.0
FREQ(CHL-a>60) %	46.23	46.08	.0	.0
CARLSON TSI-P	70.89	70.86	.0	.0
CARLSON TSI-CHLA	72.08	72.05	.0	.0
CARLSON TSI-SEC	75.04	75.02	.0	.0

SEGMENT: 4 AREA-WTD MEAN

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	188.06	187.77	93.6	93.5
TOTAL N MG/M3	1252.12	1236.19	63.6	62.9
C.NUTRIENT MG/M3	78.94	78.05	83.9	83.6
CHL-A MG/M3	97.40	97.17	99.9	99.9
SECCHI M	.38	.38	8.5	8.6
ORGANIC N MG/M3	932.54	2452.91	90.8	99.9
TP-ORTHO-P MG/M3	115.83	194.17	92.3	97.5
HOD-V MG/M3-DAY	120.70	1242.59	72.7	100.0
MOD-V MG/M3-DAY	89.89	628.06	65.3	99.9
ANTILOG PC-1	2967.97	4164.14	97.2	98.5
ANTILOG PC-2	15.10	17.69	94.8	97.3

(N - 150) / P	5.86	5.78	5.9	5.7
INORGANIC N / P	4.42	1.00	2.8	.0
TURBIDITY 1/M	1.07	1.07	73.8	73.8
ZMIX * TURBIDITY	.88	.88	5.1	5.1
ZMIX / SECCHI	2.17	2.17	8.8	8.8
CHL-A * SECCHI	37.12	37.09	96.6	96.6
CHL-A / TOTAL P	.52	.52	93.7	93.7
FREQ(CHL-a>10) %	99.96	99.96	.0	.0
FREQ(CHL-a>20) %	98.76	98.74	.0	.0
FREQ(CHL-a>30) %	94.40	94.36	.0	.0
FREQ(CHL-a>40) %	86.98	86.90	.0	.0
FREQ(CHL-a>50) %	77.80	77.69	.0	.0
FREQ(CHL-a>60) %	68.14	68.00	.0	.0
CARLSON TSI-P	79.66	79.64	.0	.0
CARLSON TSI-CHLA	75.52	75.50	.0	.0
CARLSON TSI-SEC	73.90	73.88	.0	.0

CASE: 1996 INITIAL CONDITIONS

CASE: GovBondL Initial

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 1 Pond

	VALUES		RANKS (%)	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	208.40	208.09	94.9	94.9
TOTAL N MG/M3	1446.00	1436.39	71.7	71.3
C.NUTRIENT MG/M3	95.89	95.30	89.2	89.0
CHL-A MG/M3	36.26	36.23	96.0	96.0
SECCHI M	.46	.46	13.1	13.1
ORGANIC N MG/M3	1156.00	1102.88	96.0	95.1
TP-ORTHO-P MG/M3	147.80	98.11	95.3	89.4
ANTILOG PC-1	1900.56	1860.94	94.1	93.9
ANTILOG PC-2	8.63	8.58	71.2	70.8
(N - 150) / P	6.22	6.18	7.0	6.9
INORGANIC N / P	4.79	3.03	3.3	1.1
TURBIDITY 1/M	1.59	1.59	86.3	86.3
ZMIX * TURBIDITY	2.02	2.02	28.4	28.4
ZMIX / SECCHI	2.76	2.76	17.4	17.4
CHL-A * SECCHI	16.67	16.66	75.6	75.6
CHL-A / TOTAL P	.17	.17	42.6	42.6
FREQ(CHL-a>10) %	96.14	96.13	.0	.0
FREQ(CHL-a>20) %	74.21	74.16	.0	.0
FREQ(CHL-a>30) %	49.82	49.77	.0	.0
FREQ(CHL-a>40) %	31.97	31.92	.0	.0
FREQ(CHL-a>50) %	20.37	20.34	.0	.0
FREQ(CHL-a>60) %	13.08	13.05	.0	.0
CARLSON TSI-P	81.15	81.12	.0	.0
CARLSON TSI-CHLA	65.82	65.82	.0	.0
CARLSON TSI-SEC	71.20	71.20	.0	.0

SEGMENT: 2 Upper Basin

VARIABLE	----- VALUES ----- OBSERVED	ESTIMATED	--- RANKS (%) ---- OBSERVED	ESTIMATED
TOTAL P MG/M3	208.40	206.60	94.9	94.8
TOTAL N MG/M3	1446.00	1426.55	71.7	71.0
C.NUTRIENT MG/M3	95.89	94.58	89.2	88.8
CHL-A MG/M3	36.26	36.17	96.0	96.0
SECCHI M	.46	.46	13.1	13.1
ORGANIC N MG/M3	1156.00	1101.60	96.0	95.1
TP-ORTHO-P MG/M3	147.80	98.01	95.3	89.4
HOD-V MG/M3-DAY	44.00	758.86	22.6	99.9
MOD-V MG/M3-DAY	15.78	371.36	2.0	99.2
ANTILOG PC-1	1900.56	1850.02	94.1	93.9
ANTILOG PC-2	8.63	8.58	71.2	70.8
(N - 150) / P	6.22	6.18	7.0	6.9
INORGANIC N / P	4.79	2.99	3.3	1.0
TURBIDITY 1/M	1.59	1.59	86.3	86.3
ZMIX * TURBIDITY	.48	.48	.8	.8
ZMIX / SECCHI	.65	.65	.0	.0
CHL-A * SECCHI	16.67	16.64	75.6	75.5
CHL-A / TOTAL P	.17	.18	42.6	43.0
FREQ(CHL-a>10) %	96.14	96.11	.0	.0
FREQ(CHL-a>20) %	74.21	74.08	.0	.0
FREQ(CHL-a>30) %	49.82	49.67	.0	.0
FREQ(CHL-a>40) %	31.97	31.84	.0	.0
FREQ(CHL-a>50) %	20.37	20.26	.0	.0
FREQ(CHL-a>60) %	13.08	13.00	.0	.0
CARLSON TSI-P	81.15	81.02	.0	.0
CARLSON TSI-CHLA	65.82	65.80	.0	.0
CARLSON TSI-SEC	71.20	71.19	.0	.0

SEGMENT: 3 Lower Basin

VARIABLE	----- VALUES ----- OBSERVED	ESTIMATED	--- RANKS (%) ---- OBSERVED	ESTIMATED
TOTAL P MG/M3	115.53	115.19	83.6	83.5
TOTAL N MG/M3	1248.00	1230.17	63.4	62.6
C.NUTRIENT MG/M3	71.73	70.93	80.8	80.5
CHL-A MG/M3	19.70	19.65	83.2	83.1
SECCHI M	.43	.43	11.0	11.0
ORGANIC N MG/M3	787.30	758.30	84.0	82.2
TP-ORTHO-P MG/M3	77.73	79.12	84.2	84.6
HOD-V MG/M3-DAY	107.10	460.74	67.1	99.2
MOD-V MG/M3-DAY	56.06	272.54	39.3	97.5
ANTILOG PC-1	1034.81	1012.67	86.4	86.1
ANTILOG PC-2	5.36	5.33	36.5	36.1
(N - 150) / P	9.50	9.38	19.7	19.1
INORGANIC N / P	12.19	13.09	18.5	20.5
TURBIDITY 1/M	2.04	2.04	91.5	91.5
ZMIX * TURBIDITY	2.95	2.95	46.7	46.7
ZMIX / SECCHI	3.41	3.41	28.2	28.2
CHL-A * SECCHI	8.37	8.35	39.0	38.9
CHL-A / TOTAL P	.17	.17	41.3	41.4
FREQ(CHL-a>10) %	78.34	78.22	.0	.0
FREQ(CHL-a>20) %	36.90	36.74	.0	.0
FREQ(CHL-a>30) %	16.15	16.04	.0	.0
FREQ(CHL-a>40) %	7.32	7.26	.0	.0

FREQ(CHL-a>50) %	3.50	3.47	.0	.0
FREQ(CHL-a>60) %	1.76	1.74	.0	.0
CARLSON TSI-P	72.64	72.60	.0	.0
CARLSON TSI-CHLA	59.84	59.81	.0	.0
CARLSON TSI-SEC	72.33	72.33	.0	.0

SEGMENT: 4 AREA-WTD MEAN

VARIABLE	----- VALUES -----		--- RANKS (%) ----	
	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	167.47	166.37	91.8	91.7
TOTAL N MG/M3	1358.75	1340.36	68.3	67.5
C.NUTRIENT MG/M3	85.24	84.18	86.2	85.8
CHL-A MG/M3	28.96	28.89	92.8	92.8
SECCHI M	.44	.44	12.1	12.1
ORGANIC N MG/M3	993.52	950.36	92.7	91.4
TP-ORTHO-P MG/M3	116.92	89.69	92.4	87.6
HOD-V MG/M3-DAY	72.83	622.64	47.0	99.7
MOD-V MG/M3-DAY	34.19	326.21	16.6	98.6
ANTILOG PC-1	1507.88	1470.94	91.7	91.4
ANTILOG PC-2	7.23	7.18	58.8	58.3
(N - 150) / P	7.22	7.15	10.4	10.2
INORGANIC N / P	7.22	5.09	7.7	3.8
TURBIDITY 1/M	1.79	1.79	88.9	88.9
ZMIX * TURBIDITY	1.50	1.50	17.0	17.0
ZMIX / SECCHI	1.89	1.89	5.6	5.6
CHL-A * SECCHI	12.87	12.85	62.9	62.8
CHL-A / TOTAL P	.17	.17	42.2	42.5
FREQ(CHL-a>10) %	92.00	91.95	.0	.0
FREQ(CHL-a>20) %	61.31	61.16	.0	.0
FREQ(CHL-a>30) %	35.68	35.54	.0	.0
FREQ(CHL-a>40) %	20.30	20.19	.0	.0
FREQ(CHL-a>50) %	11.69	11.61	.0	.0
FREQ(CHL-a>60) %	6.88	6.83	.0	.0
CARLSON TSI-P	77.99	77.90	.0	.0
CARLSON TSI-CHLA	63.62	63.60	.0	.0
CARLSON TSI-SEC	71.69	71.68	.0	.0

CASE: 1999 INITIAL CONDITIONS

CASE: GovBondL Initial

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 1 Pond

VARIABLE	----- VALUES -----		--- RANKS (%) ----	
	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	149.20	148.84	89.7	89.6
TOTAL N MG/M3	730.70	723.66	31.1	30.6
C.NUTRIENT MG/M3	46.03	45.52	62.5	61.9
CHL-A MG/M3	90.18	89.97	99.8	99.8

SECCHI M	.24	.24	2.5	2.5
ORGANIC N MG/M3	433.90	2409.37	43.1	99.9
TP-ORTHO-P MG/M3	55.25	219.33	74.0	98.2
ANTILOG PC-1	1954.67	3587.32	94.4	98.0
ANTILOG PC-2	10.41	13.76	82.0	92.6
(N - 150) / P	3.89	3.85	1.5	1.5
INORGANIC N / P	3.16	1.00	1.2	.0
TURBIDITY 1/M	2.67	2.67	95.3	95.3
ZMIX * TURBIDITY	3.39	3.39	53.8	53.8
ZMIX / SECCHI	5.23	5.23	56.4	56.3
CHL-A * SECCHI	21.88	21.84	85.9	85.9
CHL-A / TOTAL P	.60	.60	96.2	96.2
FREQ(CHL-a>10) %	99.94	99.94	.0	.0
FREQ(CHL-a>20) %	98.30	98.28	.0	.0
FREQ(CHL-a>30) %	92.86	92.81	.0	.0
FREQ(CHL-a>40) %	84.17	84.07	.0	.0
FREQ(CHL-a>50) %	73.94	73.81	.0	.0
FREQ(CHL-a>60) %	63.58	63.44	.0	.0
CARLSON TSI-P	76.33	76.29	.0	.0
CARLSON TSI-CHLA	74.76	74.74	.0	.0
CARLSON TSI-SEC	80.41	80.40	.0	.0

SEGMENT: 2 Upper Basin

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	149.20	149.21	89.7	89.7
TOTAL N MG/M3	730.70	717.62	31.1	30.1
C.NUTRIENT MG/M3	46.03	45.09	62.5	61.5
CHL-A MG/M3	90.18	89.82	99.8	99.8
SECCHI M	.24	.24	2.5	2.5
ORGANIC N MG/M3	433.90	2406.05	43.1	99.9
TP-ORTHO-P MG/M3	55.25	219.07	74.0	98.2
HOD-V MG/M3-DAY	148.60	1378.94	81.1	100.0
MOD-V MG/M3-DAY	210.60	659.43	94.4	99.9
ANTILOG PC-1	1954.67	3561.83	94.4	97.9
ANTILOG PC-2	10.41	13.78	82.0	92.6
(N - 150) / P	3.89	3.80	1.5	1.4
INORGANIC N / P	3.16	1.00	1.2	.0
TURBIDITY 1/M	2.67	2.67	95.3	95.3
ZMIX * TURBIDITY	2.67	2.67	41.6	41.6
ZMIX / SECCHI	4.12	4.12	40.1	40.0
CHL-A * SECCHI	21.88	21.82	85.9	85.9
CHL-A / TOTAL P	.60	.60	96.2	96.1
FREQ(CHL-a>10) %	99.94	99.94	.0	.0
FREQ(CHL-a>20) %	98.30	98.27	.0	.0
FREQ(CHL-a>30) %	92.86	92.77	.0	.0
FREQ(CHL-a>40) %	84.17	84.01	.0	.0
FREQ(CHL-a>50) %	73.94	73.73	.0	.0
FREQ(CHL-a>60) %	63.58	63.34	.0	.0
CARLSON TSI-P	76.33	76.33	.0	.0
CARLSON TSI-CHLA	74.76	74.72	.0	.0
CARLSON TSI-SEC	80.41	80.39	.0	.0

SEGMENT: 3 Lower Basin

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED

TOTAL P MG/M3	84.21	83.77	73.5	73.3
TOTAL N MG/M3	828.50	812.79	38.3	37.2
C.NUTRIENT MG/M3	46.94	46.11	63.4	62.6
CHL-A MG/M3	78.03	77.75	99.7	99.7
SECCHI M	.30	.30	4.7	4.7
ORGANIC N MG/M3	383.20	2084.08	33.8	99.8
TP-ORTHO-P MG/M3	28.80	182.87	48.3	97.1
HOD-V MG/M3-DAY	215.80	855.16	91.7	99.9
MOD-V MG/M3-DAY	218.30	490.37	95.0	99.7
ANTILOG PC-1	1571.88	2849.73	92.2	96.9
ANTILOG PC-2	10.68	14.08	83.3	93.2
(N - 150) / P	8.06	7.91	13.6	13.1
INORGANIC N / P	8.04	1.00	9.4	.0
TURBIDITY 1/M	2.05	2.05	91.6	91.6
ZMIX * TURBIDITY	7.28	7.28	86.0	86.0
ZMIX / SECCHI	11.74	11.72	93.9	93.9
CHL-A * SECCHI	23.60	23.55	88.2	88.1
CHL-A / TOTAL P	.93	.93	99.3	99.3
FREQ(CHL-a>10) %	99.87	99.86	.0	.0
FREQ(CHL-a>20) %	97.03	96.99	.0	.0
FREQ(CHL-a>30) %	89.10	88.99	.0	.0
FREQ(CHL-a>40) %	77.87	77.70	.0	.0
FREQ(CHL-a>50) %	65.84	65.62	.0	.0
FREQ(CHL-a>60) %	54.54	54.31	.0	.0
CARLSON TSI-P	68.08	68.00	.0	.0
CARLSON TSI-CHLA	73.34	73.31	.0	.0
CARLSON TSI-SEC	77.23	77.21	.0	.0

SEGMENT: 4 AREA-WTD MEAN

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	120.56	120.36	84.7	84.7
TOTAL N MG/M3	773.80	759.78	34.3	33.3
C.NUTRIENT MG/M3	46.43	45.56	62.9	62.0
CHL-A MG/M3	84.83	84.51	99.8	99.8
SECCHI M	.27	.27	3.4	3.4
ORGANIC N MG/M3	411.56	2264.29	39.1	99.9
TP-ORTHO-P MG/M3	43.59	203.13	65.3	97.8
HOD-V MG/M3-DAY	179.31	1139.59	87.2	100.0
MOD-V MG/M3-DAY	214.12	582.18	94.7	99.9
ANTILOG PC-1	1774.36	3227.58	93.5	97.5
ANTILOG PC-2	10.60	14.00	82.9	93.0
(N - 150) / P	5.17	5.07	4.0	3.8
INORGANIC N / P	4.71	1.00	3.2	.0
TURBIDITY 1/M	2.40	2.40	94.0	94.0
ZMIX * TURBIDITY	5.11	5.11	73.4	73.4
ZMIX / SECCHI	7.93	7.92	80.9	80.8
CHL-A * SECCHI	22.82	22.76	87.2	87.2
CHL-A / TOTAL P	.70	.70	97.8	97.8
FREQ(CHL-a>10) %	99.91	99.91	.0	.0
FREQ(CHL-a>20) %	97.83	97.80	.0	.0
FREQ(CHL-a>30) %	91.41	91.32	.0	.0
FREQ(CHL-a>40) %	81.66	81.50	.0	.0
FREQ(CHL-a>50) %	70.63	70.42	.0	.0
FREQ(CHL-a>60) %	59.82	59.59	.0	.0
CARLSON TSI-P	73.25	73.23	.0	.0

CARLSON TSI-CHLA	74.16	74.13	.0	.0
CARLSON TSI-SEC	78.92	78.90	.0	.0

LOAD REDUCTION ASSESSMENT FOR COMPLIANCE WITH TARGET WATER QUALITY GUIDELINES

CASE: 1989 93% EXTERNAL + 95% INTERNAL LOAD REDUCTIONS

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 1 Pond

VARIABLE	VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
TOTAL P MG/M3	138.00	15.14	88.0	10.0
TOTAL N MG/M3	1725.00	1712.54	80.2	79.9
C.NUTRIENT MG/M3	95.10	15.04	89.0	14.0
CHL-A MG/M3	128.90	8.39	100.0	44.2
SECCHI M	.39	1.62	9.1	70.4
ORGANIC N MG/M3	1432.00	384.43	98.5	34.1
TP-ORTHO-P MG/M3	108.40	22.23	91.2	37.6
ANTILOG PC-1	4452.03	106.22	98.7	26.2
ANTILOG PC-2	19.24	9.04	98.1	74.1
(N - 150) / P	11.41	103.20	27.9	99.6
INORGANIC N / P	9.90	1328.11	13.4	100.0
TURBIDITY 1/M	.48	.48	39.4	39.4
ZMIX * TURBIDITY	.61	.61	1.7	1.7
ZMIX / SECCHI	3.25	.78	25.4	.1
CHL-A * SECCHI	50.43	13.62	98.8	65.8
CHL-A / TOTAL P	.93	.55	99.3	94.9
FREQ(CHL-a>10) %	99.99	27.63	.0	.0
FREQ(CHL-a>20) %	99.65	4.35	.0	.0
FREQ(CHL-a>30) %	97.94	.90	.0	.0
FREQ(CHL-a>40) %	94.27	.23	.0	.0
FREQ(CHL-a>50) %	88.83	.07	.0	.0
FREQ(CHL-a>60) %	82.21	.02	.0	.0
CARLSON TSI-P	75.20	43.34	.0	.0
CARLSON TSI-CHLA	78.27	51.46	.0	.0
CARLSON TSI-SEC	73.52	53.02	.0	.0

SEGMENT: 2 Upper Basin

VARIABLE	VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
TOTAL P MG/M3	138.00	26.30	88.0	25.3
TOTAL N MG/M3	1725.00	1697.74	80.2	79.5
C.NUTRIENT MG/M3	95.10	25.77	89.0	34.2

CHL-A MG/M3	128.90	14.08	100.0	70.1
SECCHI M	.39	1.41	9.1	63.8
ORGANIC N MG/M3	1432.00	514.25	98.5	56.4
TP-ORTHO-P MG/M3	108.40	32.36	91.2	53.2
HOD-V MG/M3-DAY	66.67	671.05	42.3	99.8
MOD-V MG/M3-DAY	36.63	320.91	19.2	98.6
ANTILOG PC-1	4452.03	229.71	98.7	48.0
ANTILOG PC-2	19.24	11.04	98.1	84.8
(N - 150) / P	11.41	58.84	27.9	96.6
INORGANIC N / P	9.90	1183.48	13.4	100.0
TURBIDITY 1/M	.48	.48	39.4	39.4
ZMIX * TURBIDITY	.38	.38	.3	.3
ZMIX / SECCHI	2.04	.57	7.3	.0
CHL-A * SECCHI	50.43	19.90	98.8	82.7
CHL-A / TOTAL P	.93	.54	99.3	94.3
FREQ(CHL-a>10) %	99.99	59.57	.0	.0
FREQ(CHL-a>20) %	99.65	19.05	.0	.0
FREQ(CHL-a>30) %	97.94	6.30	.0	.0
FREQ(CHL-a>40) %	94.27	2.31	.0	.0
FREQ(CHL-a>50) %	88.83	.93	.0	.0
FREQ(CHL-a>60) %	82.21	.41	.0	.0
CARLSON TSI-P	75.20	51.30	.0	.0
CARLSON TSI-CHLA	78.27	56.55	.0	.0
CARLSON TSI-SEC	73.52	55.02	.0	.0

SEGMENT: 3 Lower Basin

VARIABLE	----- VALUES ----- OBSERVED	ESTIMATED	--- RANKS (%) ---- OBSERVED	ESTIMATED
TOTAL P MG/M3	120.67	26.08	84.8	25.0
TOTAL N MG/M3	1863.00	1830.61	83.4	82.7
C.NUTRIENT MG/M3	92.16	25.64	88.2	34.0
CHL-A MG/M3	105.40	28.01	99.9	92.2
SECCHI M	.31	.51	5.1	16.1
ORGANIC N MG/M3	1524.00	909.47	98.9	89.9
TP-ORTHO-P MG/M3	91.53	81.62	88.0	85.4
HOD-V MG/M3-DAY	39.52	200.69	18.5	90.1
MOD-V MG/M3-DAY	101.10	151.83	71.2	87.1
ANTILOG PC-1	4454.12	667.37	98.7	77.8
ANTILOG PC-2	14.60	9.76	94.0	78.6
(N - 150) / P	14.20	64.43	39.6	97.5
INORGANIC N / P	11.63	921.13	17.3	100.0
TURBIDITY 1/M	1.51	1.51	85.0	85.0
ZMIX * TURBIDITY	5.22	5.22	74.3	74.3
ZMIX / SECCHI	11.08	6.78	92.6	72.7
CHL-A * SECCHI	32.83	14.26	95.1	68.2
CHL-A / TOTAL P	.87	1.07	99.1	99.6
FREQ(CHL-a>10) %	99.98	91.17	.0	.0
FREQ(CHL-a>20) %	99.11	59.22	.0	.0
FREQ(CHL-a>30) %	95.70	33.68	.0	.0
FREQ(CHL-a>40) %	89.49	18.80	.0	.0
FREQ(CHL-a>50) %	81.41	10.66	.0	.0
FREQ(CHL-a>60) %	72.54	6.19	.0	.0
CARLSON TSI-P	73.27	51.18	.0	.0
CARLSON TSI-CHLA	76.29	63.29	.0	.0
CARLSON TSI-SEC	76.81	69.73	.0	.0

SEGMENT: 4 AREA-WTD MEAN

VARIABLE	VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
TOTAL P MG/M3	130.36	25.81	86.7	24.6
TOTAL N MG/M3	1785.81	1756.82	81.7	81.0
C.NUTRIENT MG/M3	93.80	25.33	88.6	33.4
CHL-A MG/M3	118.54	20.01	100.0	83.7
SECCHI M	.36	1.02	7.2	47.1
ORGANIC N MG/M3	1472.54	683.79	98.7	76.4
TP-ORTHO-P MG/M3	100.97	53.71	89.9	73.0
HOD-V MG/M3-DAY	54.26	456.12	31.9	99.2
MOD-V MG/M3-DAY	66.09	243.65	48.4	96.4
ANTILOG PC-1	4452.88	356.86	98.7	61.3
ANTILOG PC-2	17.17	11.87	96.9	87.8
(N - 150) / P	12.55	62.26	32.8	97.2
INORGANIC N / P	10.66	1073.03	15.1	100.0
TURBIDITY 1/M	.94	.94	68.7	68.7
ZMIX * TURBIDITY	1.86	1.86	24.8	24.8
ZMIX / SECCHI	5.57	1.94	60.5	6.1
CHL-A * SECCHI	42.21	20.46	97.8	83.7
CHL-A / TOTAL P	.91	.78	99.2	98.5
FREQ(CHL-a>10) %	99.99	79.08	.0	.0
FREQ(CHL-a>20) %	99.48	37.86	.0	.0
FREQ(CHL-a>30) %	97.17	16.78	.0	.0
FREQ(CHL-a>40) %	92.54	7.68	.0	.0
FREQ(CHL-a>50) %	86.05	3.70	.0	.0
FREQ(CHL-a>60) %	78.48	1.87	.0	.0
CARLSON TSI-P	74.38	51.03	.0	.0
CARLSON TSI-CHLA	77.45	59.99	.0	.0
CARLSON TSI-SEC	74.88	59.68	.0	.0

CASE: 1993 94% EXTERNAL + 95% INTERNAL LOAD REDUCTIONS

CASE: GovBondL TP Reductions

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 1 Pond

VARIABLE	VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
TOTAL P MG/M3	255.60	27.82	96.9	27.3
TOTAL N MG/M3	137.60	136.76	.1	.1
C.NUTRIENT MG/M3	.83	.83	.0	.0
CHL-A MG/M3	120.10	11.54	100.0	60.6
SECCHI M	.40	1.37	9.8	62.4
ORGANIC N MG/M3	1006.00	460.96	93.0	47.8
TP-ORTHO-P MG/M3	149.00	29.29	95.4	49.0
ANTILOG PC-1	234.67	27.11	48.7	4.6
ANTILOG PC-2	46.70	18.74	100.0	97.9
(N - 150) / P	.04	.36	.0	.0
INORGANIC N / P	.01	1.00	.0	.0

TURBIDITY 1/M	.54	.54	44.7	44.7
ZMIX * TURBIDITY	.69	.69	2.5	2.5
ZMIX / SECCHI	3.14	.92	23.7	.2
CHL-A * SECCHI	48.51	15.85	98.6	73.3
CHL-A / TOTAL P	.47	.41	91.5	88.1
FREQ(CHL-a>10) %	99.99	46.85	.0	.0
FREQ(CHL-a>20) %	99.51	11.56	.0	.0
FREQ(CHL-a>30) %	97.30	3.21	.0	.0
FREQ(CHL-a>40) %	92.83	1.03	.0	.0
FREQ(CHL-a>50) %	86.51	.37	.0	.0
FREQ(CHL-a>60) %	79.09	.15	.0	.0
CARLSON TSI-P	84.09	52.11	.0	.0
CARLSON TSI-CHLA	77.57	54.59	.0	.0
CARLSON TSI-SEC	73.06	55.43	.0	.0

SEGMENT: 2 Upper Basin

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	255.60	38.47	96.9	40.4
TOTAL N MG/M3	1376.00	1359.09	69.0	68.3
C.NUTRIENT MG/M3	94.87	35.94	88.9	50.3
CHL-A MG/M3	120.10	12.26	100.0	63.5
SECCHI M	.40	1.35	9.8	61.6
ORGANIC N MG/M3	1006.00	477.34	93.0	50.6
TP-ORTHO-P MG/M3	149.00	30.57	95.4	50.8
HOD-V MG/M3-DAY	123.40	532.69	73.7	99.5
MOD-V MG/M3-DAY	100.70	248.57	71.0	96.6
ANTILOG PC-1	3709.27	256.74	98.1	51.4
ANTILOG PC-2	17.69	8.99	97.3	73.8
(N - 150) / P	4.80	31.43	3.2	81.7
INORGANIC N / P	3.47	111.72	1.5	90.9
TURBIDITY 1/M	.54	.54	44.7	44.7
ZMIX * TURBIDITY	.22	.22	.0	.0
ZMIX / SECCHI	.99	.30	.3	.0
CHL-A * SECCHI	48.51	16.57	98.6	75.4
CHL-A / TOTAL P	.47	.32	91.5	77.8
FREQ(CHL-a>10) %	99.99	50.75	.0	.0
FREQ(CHL-a>20) %	99.51	13.58	.0	.0
FREQ(CHL-a>30) %	97.30	3.98	.0	.0
FREQ(CHL-a>40) %	92.83	1.33	.0	.0
FREQ(CHL-a>50) %	86.51	.50	.0	.0
FREQ(CHL-a>60) %	79.09	.20	.0	.0
CARLSON TSI-P	84.09	56.78	.0	.0
CARLSON TSI-CHLA	77.57	55.19	.0	.0
CARLSON TSI-SEC	73.06	55.65	.0	.0

SEGMENT: 3 Lower Basin

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	102.33	18.91	80.1	15.1
TOTAL N MG/M3	1195.00	1179.00	60.8	60.0
C.NUTRIENT MG/M3	66.32	18.47	78.1	20.5
CHL-A MG/M3	68.58	9.65	99.5	51.4
SECCHI M	.35	.53	7.0	17.4
ORGANIC N MG/M3	839.30	507.71	86.9	55.4

TP-ORTHO-P MG/M3	73.73	54.20	82.8	73.3
HOD-V MG/M3-DAY	117.50	285.37	71.5	96.1
MOD-V MG/M3-DAY	77.04	168.81	57.0	90.0
ANTILOG PC-1	2206.88	243.34	95.3	49.8
ANTILOG PC-2	11.46	4.68	86.4	27.3
(N - 150) / P	10.21	54.41	22.7	95.6
INORGANIC N / P	12.44	671.29	19.1	99.9
TURBIDITY 1/M	1.74	1.74	88.3	88.3
ZMIX * TURBIDITY	2.26	2.26	33.3	33.3
ZMIX / SECCHI	3.69	2.46	33.0	12.7
CHL-A * SECCHI	24.15	5.11	88.8	16.4
CHL-A / TOTAL P	.67	.51	97.3	93.4
FREQ(CHL-a>10) %	99.74	35.67	.0	.0
FREQ(CHL-a>20) %	95.33	6.87	.0	.0
FREQ(CHL-a>30) %	84.70	1.62	.0	.0
FREQ(CHL-a>40) %	71.21	.46	.0	.0
FREQ(CHL-a>50) %	57.92	.15	.0	.0
FREQ(CHL-a>60) %	46.23	.06	.0	.0
CARLSON TSI-P	70.89	46.54	.0	.0
CARLSON TSI-CHLA	72.08	52.84	.0	.0
CARLSON TSI-SEC	75.04	69.18	.0	.0

SEGMENT: 4 AREA-WTD MEAN

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	188.06	29.47	93.6	29.5
TOTAL N MG/M3	1252.12	1236.19	63.6	62.9
C.NUTRIENT MG/M3	78.94	26.99	83.9	36.3
CHL-A MG/M3	97.40	11.08	99.9	58.5
SECCHI M	.38	.99	8.5	45.4
ORGANIC N MG/M3	932.54	490.14	90.8	52.6
TP-ORTHO-P MG/M3	115.83	40.94	92.3	62.8
HOD-V MG/M3-DAY	120.70	419.68	72.7	98.9
MOD-V MG/M3-DAY	89.89	212.12	65.3	94.5
ANTILOG PC-1	2967.97	240.44	97.2	49.4
ANTILOG PC-2	15.10	7.23	94.8	58.9
(N - 150) / P	5.86	36.86	5.9	87.2
INORGANIC N / P	4.42	746.05	2.8	99.9
TURBIDITY 1/M	1.07	1.07	73.8	73.8
ZMIX * TURBIDITY	.88	.88	5.1	5.1
ZMIX / SECCHI	2.17	.84	8.8	.1
CHL-A * SECCHI	37.12	10.97	96.6	54.1
CHL-A / TOTAL P	.52	.38	93.7	84.7
FREQ(CHL-a>10) %	99.96	44.27	.0	.0
FREQ(CHL-a>20) %	98.76	10.35	.0	.0
FREQ(CHL-a>30) %	94.40	2.77	.0	.0
FREQ(CHL-a>40) %	86.98	.87	.0	.0
FREQ(CHL-a>50) %	77.80	.31	.0	.0
FREQ(CHL-a>60) %	68.14	.12	.0	.0
CARLSON TSI-P	79.66	52.94	.0	.0
CARLSON TSI-CHLA	75.52	54.20	.0	.0
CARLSON TSI-SEC	73.90	60.14	.0	.0

CASE: 1996 89% EXTERNAL + 85% INTERNAL LOAD REDUCTIONS

CASE: GovBondL TP Reductions

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 1 Pond

VARIABLE	VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
TOTAL P MG/M3	208.40	39.44	94.9	41.5
TOTAL N MG/M3	1446.00	1436.39	71.7	71.3
C.NUTRIENT MG/M3	95.89	37.02	89.2	51.8
CHL-A MG/M3	36.26	7.45	96.0	38.2
SECCHI M	.46	.58	13.1	20.9
ORGANIC N MG/M3	1156.00	446.81	96.0	45.4
TP-ORTHO-P MG/M3	147.80	46.89	95.3	68.1
ANTILOG PC-1	1900.56	288.22	94.1	54.9
ANTILOG PC-2	8.63	3.56	71.2	13.0
(N - 150) / P	6.22	32.61	7.0	83.1
INORGANIC N / P	4.79	989.58	3.3	100.0
TURBIDITY 1/M	1.59	1.59	86.3	86.3
ZMIX * TURBIDITY	2.02	2.02	28.4	28.4
ZMIX / SECCHI	2.76	2.17	17.4	8.8
CHL-A * SECCHI	16.67	4.36	75.6	11.5
CHL-A / TOTAL P	.17	.19	42.6	47.7
FREQ(CHL-a>10) %	96.14	21.65	.0	.0
FREQ(CHL-a>20) %	74.21	2.86	.0	.0
FREQ(CHL-a>30) %	49.82	.53	.0	.0
FREQ(CHL-a>40) %	31.97	.13	.0	.0
FREQ(CHL-a>50) %	20.37	.04	.0	.0
FREQ(CHL-a>60) %	13.08	.01	.0	.0
CARLSON TSI-P	81.15	57.14	.0	.0
CARLSON TSI-CHLA	65.82	50.31	.0	.0
CARLSON TSI-SEC	71.20	67.74	.0	.0

SEGMENT: 2 Upper Basin

VARIABLE	VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
TOTAL P MG/M3	208.40	55.95	94.9	56.9
TOTAL N MG/M3	1446.00	1426.55	71.7	71.0
C.NUTRIENT MG/M3	95.89	49.52	89.2	65.9
CHL-A MG/M3	36.26	9.15	96.0	48.6
SECCHI M	.46	.58	13.1	20.3
ORGANIC N MG/M3	1156.00	485.39	96.0	51.9
TP-ORTHO-P MG/M3	147.80	49.90	95.3	70.4
HOD-V MG/M3-DAY	44.00	389.51	22.6	98.5
MOD-V MG/M3-DAY	15.78	190.61	2.0	92.7
ANTILOG PC-1	1900.56	397.00	94.1	64.4
ANTILOG PC-2	8.63	3.87	71.2	16.7
(N - 150) / P	6.22	22.82	7.0	66.7
INORGANIC N / P	4.79	155.56	3.3	95.2
TURBIDITY 1/M	1.59	1.59	86.3	86.3

ZMIX * TURBIDITY	.48	.48	.8	.8
ZMIX / SECCHI	.65	.52	.0	.0
CHL-A * SECCHI	16.67	5.26	75.6	17.5
CHL-A / TOTAL P	.17	.16	42.6	38.8
FREQ(CHL-a>10) %	96.14	32.49	.0	.0
FREQ(CHL-a>20) %	74.21	5.80	.0	.0
FREQ(CHL-a>30) %	49.82	1.30	.0	.0
FREQ(CHL-a>40) %	31.97	.36	.0	.0
FREQ(CHL-a>50) %	20.37	.11	.0	.0
FREQ(CHL-a>60) %	13.08	.04	.0	.0
CARLSON TSI-P	81.15	62.18	.0	.0
CARLSON TSI-CHLA	65.82	52.31	.0	.0
CARLSON TSI-SEC	71.20	67.97	.0	.0

SEGMENT: 3 Lower Basin

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	115.53	35.97	83.6	37.5
TOTAL N MG/M3	1248.00	1230.17	63.4	62.6
C.NUTRIENT MG/M3	71.73	33.40	80.8	46.7
CHL-A MG/M3	19.70	5.80	83.2	26.6
SECCHI M	.43	.47	11.0	13.7
ORGANIC N MG/M3	787.30	442.56	84.0	44.6
TP-ORTHO-P MG/M3	77.73	54.47	84.2	73.5
HOD-V MG/M3-DAY	107.10	236.49	67.1	93.4
MOD-V MG/M3-DAY	56.06	139.89	39.3	84.5
ANTILOG PC-1	1034.81	261.09	86.4	51.9
ANTILOG PC-2	5.36	2.63	36.5	4.5
(N - 150) / P	9.50	30.03	19.7	79.8
INORGANIC N / P	12.19	787.62	18.5	100.0
TURBIDITY 1/M	2.04	2.04	91.5	91.5
ZMIX * TURBIDITY	2.95	2.95	46.7	46.7
ZMIX / SECCHI	3.41	3.09	28.2	22.7
CHL-A * SECCHI	8.37	2.72	39.0	3.1
CHL-A / TOTAL P	.17	.16	41.3	38.0
FREQ(CHL-a>10) %	78.34	11.73	.0	.0
FREQ(CHL-a>20) %	36.90	1.06	.0	.0
FREQ(CHL-a>30) %	16.15	.15	.0	.0
FREQ(CHL-a>40) %	7.32	.03	.0	.0
FREQ(CHL-a>50) %	3.50	.01	.0	.0
FREQ(CHL-a>60) %	1.76	.00	.0	.0
CARLSON TSI-P	72.64	55.81	.0	.0
CARLSON TSI-CHLA	59.84	47.85	.0	.0
CARLSON TSI-SEC	72.33	70.89	.0	.0

SEGMENT: 4 AREA-WTD MEAN

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	167.47	46.56	91.8	48.7
TOTAL N MG/M3	1358.75	1340.36	68.3	67.5
C.NUTRIENT MG/M3	85.24	41.97	86.2	58.0
CHL-A MG/M3	28.96	7.61	92.8	39.3
SECCHI M	.44	.53	12.1	17.4
ORGANIC N MG/M3	993.52	465.14	92.7	48.5
TP-ORTHO-P MG/M3	116.92	51.81	92.4	71.7

HOD-V MG/M3-DAY	72.83	319.58	47.0	97.2
MOD-V MG/M3-DAY	34.19	167.43	16.6	89.8
ANTILOG PC-1	1507.88	333.65	91.7	59.3
ANTILOG PC-2	7.23	3.31	58.8	10.3
(N - 150) / P	7.22	25.57	10.4	72.6
INORGANIC N / P	7.22	875.22	7.7	100.0
TURBIDITY 1/M	1.79	1.79	88.9	88.9
ZMIX * TURBIDITY	1.50	1.50	17.0	17.0
ZMIX / SECCHI	1.89	1.59	5.6	3.0
CHL-A * SECCHI	12.87	4.03	62.9	9.5
CHL-A / TOTAL P	.17	.16	42.2	38.8
FREQ(CHL-a>10) %	92.00	22.66	.0	.0
FREQ(CHL-a>20) %	61.31	3.09	.0	.0
FREQ(CHL-a>30) %	35.68	.58	.0	.0
FREQ(CHL-a>40) %	20.30	.14	.0	.0
FREQ(CHL-a>50) %	11.69	.04	.0	.0
FREQ(CHL-a>60) %	6.88	.01	.0	.0
CARLSON TSI-P	77.99	59.53	.0	.0
CARLSON TSI-CHLA	63.62	50.51	.0	.0
CARLSON TSI-SEC	71.69	69.18	.0	.0

CASE: 1999 89% EXTERNAL + 90% INTERNAL LOAD REDUCTIONS

CASE: GovBondL TP Reductions

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 1 Pond

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	149.20	24.22	89.7	22.4
TOTAL N MG/M3	730.70	723.66	31.1	30.6
C.NUTRIENT MG/M3	46.03	21.60	62.5	26.5
CHL-A MG/M3	90.18	12.64	99.8	65.0
SECCHI M	.24	.35	2.5	6.8
ORGANIC N MG/M3	433.90	646.16	43.1	72.8
TP-ORTHO-P MG/M3	55.25	81.67	74.0	85.4
ANTILOG PC-1	1954.67	411.64	94.4	65.4
ANTILOG PC-2	10.41	4.27	82.0	21.9
(N - 150) / P	3.89	23.69	1.5	68.7
INORGANIC N / P	3.16	77.50	1.2	83.3
TURBIDITY 1/M	2.67	2.67	95.3	95.3
ZMIX * TURBIDITY	3.39	3.39	53.8	53.8
ZMIX / SECCHI	5.23	3.65	56.4	32.3
CHL-A * SECCHI	21.88	4.40	85.9	11.7
CHL-A / TOTAL P	.60	.52	96.2	93.8
FREQ(CHL-a>10) %	99.94	52.69	.0	.0
FREQ(CHL-a>20) %	98.30	14.67	.0	.0
FREQ(CHL-a>30) %	92.86	4.41	.0	.0
FREQ(CHL-a>40) %	84.17	1.51	.0	.0
FREQ(CHL-a>50) %	73.94	.57	.0	.0
FREQ(CHL-a>60) %	63.58	.24	.0	.0

CARLSON TSI-P	76.33	50.11	.0	.0
CARLSON TSI-CHLA	74.76	55.48	.0	.0
CARLSON TSI-SEC	80.41	75.21	.0	.0

SEGMENT: 2 Upper Basin

VARIABLE	----- VALUES ----- OBSERVED	ESTIMATED	--- RANKS (%) ---- OBSERVED	ESTIMATED
TOTAL P MG/M3	149.20	33.58	89.7	34.7
TOTAL N MG/M3	730.70	717.62	31.1	30.1
C.NUTRIENT MG/M3	46.03	27.38	62.5	37.0
CHL-A MG/M3	90.18	17.58	99.8	79.2
SECCHI M	.24	.34	2.5	6.3
ORGANIC N MG/M3	433.90	758.96	43.1	82.2
TP-ORTHO-P MG/M3	55.25	90.48	74.0	87.7
HOD-V MG/M3-DAY	148.60	648.92	81.1	99.8
MOD-V MG/M3-DAY	210.60	310.32	94.4	98.4
ANTILOG PC-1	1954.67	609.20	94.4	75.7
ANTILOG PC-2	10.41	5.15	82.0	33.7
(N - 150) / P	3.89	16.90	1.5	49.7
INORGANIC N / P	3.16	1.00	1.2	.0
TURBIDITY 1/M	2.67	2.67	95.3	95.3
ZMIX * TURBIDITY	2.67	2.67	41.6	41.6
ZMIX / SECCHI	4.12	2.95	40.1	20.5
CHL-A * SECCHI	21.88	5.95	85.9	22.3
CHL-A / TOTAL P	.60	.52	96.2	93.9
FREQ(CHL-a>10) %	99.94	72.59	.0	.0
FREQ(CHL-a>20) %	98.30	30.23	.0	.0
FREQ(CHL-a>30) %	92.86	12.06	.0	.0
FREQ(CHL-a>40) %	84.17	5.09	.0	.0
FREQ(CHL-a>50) %	73.94	2.30	.0	.0
FREQ(CHL-a>60) %	63.58	1.10	.0	.0
CARLSON TSI-P	76.33	54.82	.0	.0
CARLSON TSI-CHLA	74.76	58.72	.0	.0
CARLSON TSI-SEC	80.41	75.60	.0	.0

SEGMENT: 3 Lower Basin

VARIABLE	----- VALUES ----- OBSERVED	ESTIMATED	--- RANKS (%) ---- OBSERVED	ESTIMATED
TOTAL P MG/M3	84.21	21.07	73.5	18.1
TOTAL N MG/M3	828.50	812.79	38.3	37.2
C.NUTRIENT MG/M3	46.94	19.69	63.4	22.8
CHL-A MG/M3	78.03	20.55	99.7	84.6
SECCHI M	.30	.42	4.7	10.7
ORGANIC N MG/M3	383.20	779.92	33.8	83.6
TP-ORTHO-P MG/M3	28.80	81.06	48.3	85.2
HOD-V MG/M3-DAY	215.80	402.43	91.7	98.7
MOD-V MG/M3-DAY	218.30	230.76	95.0	95.7
ANTILOG PC-1	1571.88	499.57	92.2	70.7
ANTILOG PC-2	10.68	7.13	83.3	57.8
(N - 150) / P	8.06	31.46	13.6	81.7
INORGANIC N / P	8.04	32.88	9.4	54.1
TURBIDITY 1/M	2.05	2.05	91.6	91.6
ZMIX * TURBIDITY	7.28	7.28	86.0	86.0
ZMIX / SECCHI	11.74	8.45	93.9	83.7
CHL-A * SECCHI	23.60	8.63	88.2	40.7

CHL-A / TOTAL P	.93	.98	99.3	99.4
FREQ(CHL-a>10) %	99.87	80.29	.0	.0
FREQ(CHL-a>20) %	97.03	39.50	.0	.0
FREQ(CHL-a>30) %	89.10	17.87	.0	.0
FREQ(CHL-a>40) %	77.87	8.31	.0	.0
FREQ(CHL-a>50) %	65.84	4.06	.0	.0
FREQ(CHL-a>60) %	54.54	2.08	.0	.0
CARLSON TSI-P	68.08	48.10	.0	.0
CARLSON TSI-CHLA	73.34	60.26	.0	.0
CARLSON TSI-SEC	77.23	72.50	.0	.0

SEGMENT: 4 AREA-WTD MEAN

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	120.56	27.74	84.7	27.2
TOTAL N MG/M3	773.80	759.78	34.3	33.3
C.NUTRIENT MG/M3	46.43	23.79	62.9	30.6
CHL-A MG/M3	84.83	18.72	99.8	81.5
SECCHI M	.27	.37	3.4	8.2
ORGANIC N MG/M3	411.56	764.18	39.1	82.6
TP-ORTHO-P MG/M3	43.59	86.01	65.3	86.6
HOD-V MG/M3-DAY	179.31	536.28	87.2	99.5
MOD-V MG/M3-DAY	214.12	273.97	94.7	97.5
ANTILOG PC-1	1774.36	554.94	93.5	73.4
ANTILOG PC-2	10.60	5.93	82.9	43.9
(N - 150) / P	5.17	21.99	4.0	64.7
INORGANIC N / P	4.71	1.00	3.2	.0
TURBIDITY 1/M	2.40	2.40	94.0	94.0
ZMIX * TURBIDITY	5.11	5.11	73.4	73.4
ZMIX / SECCHI	7.93	5.69	80.9	61.9
CHL-A * SECCHI	22.82	7.02	87.2	29.9
CHL-A / TOTAL P	.70	.67	97.8	97.4
FREQ(CHL-a>10) %	99.91	75.83	.0	.0
FREQ(CHL-a>20) %	97.83	33.83	.0	.0
FREQ(CHL-a>30) %	91.41	14.20	.0	.0
FREQ(CHL-a>40) %	81.66	6.24	.0	.0
FREQ(CHL-a>50) %	70.63	2.90	.0	.0
FREQ(CHL-a>60) %	59.82	1.43	.0	.0
CARLSON TSI-P	73.25	52.06	.0	.0
CARLSON TSI-CHLA	74.16	59.34	.0	.0
CARLSON TSI-SEC	78.92	74.14	.0	.0

D.6 BATHTUB OUTPUT: BALANCES

BALANCES: INITIAL CONDITIONS

CASE: GOVERNOR BOND LAKE 1989 INITIAL CONDITIONS

GROSS WATER BALANCE:

		DRAINAGE AREA	---- FLOW (HM3/YR) ----			RUNOFF
ID	T LOCATION	KM2	MEAN	VARIANCE	CV	M/YR

1	1	ROP02	3.596	1.798	.000E+00	.000	.500
2	1	ROP03	31.750	7.112	.000E+00	.000	.224
3	1	ROP04	19.250	4.928	.000E+00	.000	.256
4	1	ROP05	9.961	2.480	.000E+00	.000	.249
5	1	Unmonitored	7.879	1.505	.000E+00	.000	.191
6	1	DirPond	5.647	1.169	.000E+00	.000	.207
7	1	DirUpper	5.641	1.066	.000E+00	.000	.189
8	1	DirLower	3.493	.611	.000E+00	.000	.175
9	4	Withdrawl	.000	1.830	.000E+00	.000	.000
10	4	Outflow	.000	37.200	.000E+00	.000	.000
PRECIPITATION			3.565	3.255	.424E+00	.200	.913
TRIBUTARY INFLOW			87.217	20.669	.000E+00	.000	.237
***TOTAL INFLOW			90.782	23.924	.424E+00	.027	.264
GAUGED OUTFLOW			.000	39.030	.000E+00	.000	.000
ADVECTIVE OUTFLOW			90.782	-17.999	.432E+00	.036	-.198
***TOTAL OUTFLOW			90.782	21.031	.432E+00	.031	.232
***EVAPORATION			.000	2.893	.779E-02	.030	.000

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL P

			----- LOADING ----		--- VARIANCE ---			CONC	EXPORT
ID	T	LOCATION	KG/YR	%(I)	KG/YR**2	%(I)	CV	MG/M3	KG/KM2
1	1	ROP02	706.6	4.6	.000E+00	.0	.000	393.0	196.5
2	1	ROP03	1600.2	10.5	.000E+00	.0	.000	225.0	50.4
3	1	ROP04	5233.5	34.4	.000E+00	.0	.000	1062.0	271.9
4	1	ROP05	2671.0	17.6	.000E+00	.0	.000	1077.0	268.1
5	1	Unmonitored	600.5	3.9	.000E+00	.0	.000	399.0	76.2
6	1	DirPond	707.2	4.6	.000E+00	.0	.000	605.0	125.2
7	1	DirUpper	582.0	3.8	.000E+00	.0	.000	546.0	103.2
8	1	DirLower	444.8	2.9	.000E+00	.0	.000	728.0	127.3
9	4	Withdrawl	220.3	1.4	.990E+04	40.4	.452	120.4	.0
10	4	Outflow	4478.0	29.4	.409E+07	16688.0	.452	120.4	.0
PRECIPITATION			313.1	2.1	.245E+05	100.0	.500	96.2	87.8
INTERNAL LOAD			2352.6	15.5	.000E+00	.0	.000	.0	.0
TRIBUTARY INFLOW			12545.9	82.5	.000E+00	.0	.000	607.0	143.8
***TOTAL INFLOW			15211.6	100.0	.245E+05	100.0	.010	635.8	167.6
GAUGED OUTFLOW			4698.3	30.9	.450E+07	18370.2	.452	120.4	.0
ADVECTIVE OUTFLOW			-2166.7	-14.2	.965E+06	3938.6	.453	120.4	-23.9
***TOTAL OUTFLOW			2531.6	16.6	.131E+07	5351.8	.452	120.4	27.9
***RETENTION			12680.0	83.4	.133E+07	5434.5	.091	.0	.0

	HYDRAULIC	--------------	TOTAL P	--------------	
OVERFLOW	RESIDENCE	POOL	RESIDENCE	TURNOVER	RETENTION
RATE	TIME	CONC	TIME	RATIO	COEF
M/YR	YRS	MG/M3	YRS	-	-
5.90	.7068	130.4	.1274	7.8501	.8336

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL N

			----- LOADING ----		--- VARIANCE ---			CONC	EXPORT
ID	T	LOCATION	KG/YR	%(I)	KG/YR**2	%(I)	CV	MG/M3	KG/KM2
1	1	ROP02	5960.4	5.2	.000E+00	.0	.000	3315.0	1657.5

2	1	ROP03	18868.1	16.5	.000E+00	.0	.000	2653.0	594.3
3	1	ROP04	65892.3	57.5	.000E+00	.0	.000	13371.0	3423.0
4	1	ROP05	7095.3	6.2	.000E+00	.0	.000	2861.0	712.3
5	1	Unmonitored	1912.9	1.7	.000E+00	.0	.000	1271.0	242.8
6	1	DirPond	3738.5	3.3	.000E+00	.0	.000	3198.0	662.0
7	1	DirUpper	3082.9	2.7	.000E+00	.0	.000	2892.0	546.5
8	1	DirLower	2967.6	2.6	.000E+00	.0	.000	4857.0	849.6
9	4	Withdrawl	3408.9	3.0	.353E+07	55.9	.551	1862.8	.0
10	4	Outflow	69295.4	60.5	.146E+10	23105.4	.551	1862.8	.0
PRECIPITATION			5021.7	4.4	.630E+07	100.0	.500	1542.8	1408.6
TRIBUTARY INFLOW			109517.9	95.6	.000E+00	.0	.000	5298.7	1255.7
***TOTAL INFLOW			114539.5	100.0	.630E+07	100.0	.022	4787.7	1261.7
GAUGED OUTFLOW			72704.3	63.5	.160E+10	25434.7	.551	1862.8	.0
ADVECTIVE OUTFLOW			-33528.5	-29.3	.343E+09	5444.6	.553	1862.8	-369.3
***TOTAL OUTFLOW			39175.8	34.2	.466E+09	7394.8	.551	1862.8	431.5
***RETENTION			75363.7	65.8	.470E+09	7453.5	.288	.0	.0

	HYDRAULIC	-------------- TOTAL N	--------------		
OVERFLOW	RESIDENCE	POOL	RESIDENCE	TURNOVER	RETENTION
RATE	TIME	CONC	TIME	RATIO	COEF
M/YR	YRS	MG/M3	YRS	-	-
5.90	.7068	1785.8	.2318	4.3149	.6580

CASE: GOVERNOR BOND LAKE 1993 INITIAL CONDITIONS

GROSS WATER BALANCE:

ID	T	LOCATION	DRAINAGE AREA KM2	---- FLOW (HM3/YR) ---- MEAN	VARIANCE	CV	RUNOFF M/YR
1	1	ROP02	3.596	2.424	.000E+00	.000	.674
2	1	ROP03	31.750	15.240	.000E+00	.000	.480
3	1	ROP04	19.250	9.567	.000E+00	.000	.497
4	1	ROP05	9.961	4.920	.000E+00	.000	.494
5	1	UNMon	7.879	3.262	.000E+00	.000	.414
6	1	DirPond	5.647	2.682	.000E+00	.000	.475
7	1	DirUpper	5.641	2.657	.000E+00	.000	.471
8	1	DirLower	3.493	1.635	.000E+00	.000	.468
9	4	Withdrawl	.000	1.830	.000E+00	.000	.000
10	4	Outflow	.000	37.200	.000E+00	.000	.000
PRECIPITATION			3.565	3.708	.550E+00	.200	1.040
TRIBUTARY INFLOW			87.217	42.387	.000E+00	.000	.486
***TOTAL INFLOW			90.782	46.095	.550E+00	.016	.508
GAUGED OUTFLOW			.000	39.030	.000E+00	.000	.000
ADVECTIVE OUTFLOW			90.782	4.172	.558E+00	.179	.046
***TOTAL OUTFLOW			90.782	43.202	.558E+00	.017	.476
***EVAPORATION			.000	2.893	.779E-02	.030	.000

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS

COMPONENT: TOTAL P

ID	T	LOCATION	----- LOADING ---- KG/YR	%(I)	--- VARIANCE --- KG/YR**2	%(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	ROP02	865.4	3.9	.000E+00	.0	.000	357.0	240.6
2	1	ROP03	3139.4	14.1	.000E+00	.0	.000	206.0	98.9
3	1	ROP04	6381.2	28.7	.000E+00	.0	.000	667.0	331.5

4	1	ROP05	3148.8	14.1	.000E+00	.0	.000	640.0	316.1
5	1	UNMon	776.4	3.5	.000E+00	.0	.000	238.0	98.5
6	1	DirPond	976.2	4.4	.000E+00	.0	.000	364.0	172.9
7	1	DirUpper	898.1	4.0	.000E+00	.0	.000	338.0	159.2
8	1	DirLower	647.5	2.9	.000E+00	.0	.000	396.0	185.4
9	4	Withdrawl	154.1	.7	.483E+04	19.7	.451	84.2	.0
10	4	Outflow	3132.6	14.1	.200E+07	8149.9	.451	84.2	.0
PRECIPITATION			313.1	1.4	.245E+05	100.0	.500	84.5	87.8
INTERNAL LOAD			5114.4	23.0	.000E+00	.0	.000	.0	.0
TRIBUTARY INFLOW			16832.9	75.6	.000E+00	.0	.000	397.1	193.0
***TOTAL INFLOW			22260.5	100.0	.245E+05	100.0	.007	482.9	245.2
GAUGED OUTFLOW			3286.7	14.8	.220E+07	8971.5	.451	84.2	.0
ADVECTIVE OUTFLOW			351.3	1.6	.289E+05	117.9	.484	84.2	3.9
***TOTAL OUTFLOW			3638.0	16.3	.270E+07	11000.4	.451	84.2	40.1
***RETENTION			18622.4	83.7	.272E+07	11081.7	.088	.0	.0

OVERFLOW RATE M/YR	HYDRAULIC RESIDENCE TIME YRS	TOTAL P POOL CONC MG/M3	RESIDENCE TIME YRS	TURNOVER RATIO -	RETENTION COEF -
12.12	.3441	120.6	.0805	12.4218	.8366

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL N

ID	T	LOCATION	LOADING KG/YR	LOADING %(I)	VARIANCE KG/YR**2	VARIANCE %(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	ROP02	8134.9	6.6	.000E+00	.0	.000	3356.0	2262.2
2	1	ROP03	20299.7	16.5	.000E+00	.0	.000	1332.0	639.4
3	1	ROP04	68442.3	55.8	.000E+00	.0	.000	7154.0	3555.4
4	1	ROP05	8039.3	6.5	.000E+00	.0	.000	1634.0	807.1
5	1	UNMon	2188.8	1.8	.000E+00	.0	.000	671.0	277.8
6	1	DirPond	4033.7	3.3	.000E+00	.0	.000	1504.0	714.3
7	1	DirUpper	3403.6	2.8	.000E+00	.0	.000	1281.0	603.4
8	1	DirLower	3194.8	2.6	.000E+00	.0	.000	1954.0	914.6
9	4	Withdrawl	1515.5	1.2	.696E+06	11.0	.550	828.1	.0
10	4	Outflow	30806.1	25.1	.287E+09	4559.5	.550	828.1	.0
PRECIPITATION			5021.7	4.1	.630E+07	100.0	.500	1354.4	1408.6
TRIBUTARY INFLOW			117737.2	95.9	.000E+00	.0	.000	2777.7	1349.9
***TOTAL INFLOW			122758.8	100.0	.630E+07	100.0	.020	2663.2	1352.2
GAUGED OUTFLOW			32321.5	26.3	.316E+09	5019.1	.550	828.1	.0
ADVECTIVE OUTFLOW			3454.6	2.8	.396E+07	62.8	.576	828.1	38.1
***TOTAL OUTFLOW			35776.1	29.1	.388E+09	6149.8	.550	828.1	394.1
***RETENTION			86982.7	70.9	.391E+09	6209.3	.227	.0	.0

OVERFLOW RATE M/YR	HYDRAULIC RESIDENCE TIME YRS	TOTAL N POOL CONC MG/M3	RESIDENCE TIME YRS	TURNOVER RATIO -	RETENTION COEF -
12.12	.3441	773.8	.0937	10.6729	.7086

CASE: GOVERNOR BOND LAKE 1996 INITIAL CONDITIONS

GROSS WATER BALANCE:

DRAINAGE AREA ---- FLOW (HM3/YR) ---- RUNOFF

ID	T	LOCATION	KM2	MEAN	VARIANCE	CV	M/YR
1	1	ROP02	3.596	2.201	.000E+00	.000	.612
2	1	ROP03	31.750	15.018	.000E+00	.000	.473
3	1	ROP04	19.250	9.702	.000E+00	.000	.504
4	1	ROP05	9.961	4.970	.000E+00	.000	.499
5	1	Unmonitored	7.879	3.191	.000E+00	.000	.405
6	1	DirPond	5.647	2.603	.000E+00	.000	.461
7	1	DirUpper	5.641	2.533	.000E+00	.000	.449
8	1	DirLower	3.493	1.533	.000E+00	.000	.439
9	4	Withdrawl	.000	1.830	.000E+00	.000	.000
10	4	Outflow	.000	37.200	.000E+00	.000	.000
PRECIPITATION			3.565	3.843	.591E+00	.200	1.078
TRIBUTARY INFLOW			87.217	41.751	.000E+00	.000	.479
***TOTAL INFLOW			90.782	45.594	.591E+00	.017	.502
GAUGED OUTFLOW			.000	39.030	.000E+00	.000	.000
ADVECTIVE OUTFLOW			90.782	3.671	.599E+00	.211	.040
***TOTAL OUTFLOW			90.782	42.701	.599E+00	.018	.470
***EVAPORATION			.000	2.893	.779E-02	.030	.000

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL P

ID	T	LOCATION	LOADING KG/YR	LOADING %(I)	VARIANCE KG/YR**2	VARIANCE %(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	ROP02	900.2	2.4	.000E+00	.0	.000	409.0	250.3
2	1	ROP03	3138.8	8.4	.000E+00	.0	.000	209.0	98.9
3	1	ROP04	7781.0	20.9	.000E+00	.0	.000	802.0	404.2
4	1	ROP05	3648.0	9.8	.000E+00	.0	.000	734.0	366.2
5	1	Unmonitored	960.5	2.6	.000E+00	.0	.000	301.0	121.9
6	1	DirPond	1155.7	3.1	.000E+00	.0	.000	444.0	204.7
7	1	DirUpper	972.7	2.6	.000E+00	.0	.000	384.0	172.4
8	1	DirLower	711.3	1.9	.000E+00	.0	.000	464.0	203.6
9	4	Withdrawl	211.4	.6	.914E+04	37.3	.452	115.5	.0
10	4	Outflow	4297.7	11.5	.378E+07	15421.1	.452	115.5	.0
PRECIPITATION			313.1	.8	.245E+05	100.1	.500	81.5	87.8
INTERNAL LOAD			17730.0	47.5	.000E+00	.0	.000	.0	.0
TRIBUTARY INFLOW			19268.2	51.6	.000E+00	.0	.000	461.5	220.9
***TOTAL INFLOW			37311.2	100.0	.245E+05	100.0	.004	818.3	411.0
GAUGED OUTFLOW			4509.1	12.1	.416E+07	16975.8	.452	115.5	.0
ADVECTIVE OUTFLOW			424.1	1.1	.445E+05	181.9	.498	115.5	4.7
***TOTAL OUTFLOW			4933.3	13.2	.498E+07	20341.4	.452	115.5	54.3
***RETENTION			32378.0	86.8	.500E+07	20427.3	.069	.0	.0

OVERFLOW RATE M/YR	HYDRAULIC RESIDENCE TIME YRS	TOTAL P POOL CONC MG/M3	TOTAL P RESIDENCE TIME YRS	TOTAL P TURNOVER RATIO -	TOTAL P RETENTION COEF -
11.98	.3481	167.5	.0667	14.9881	.8678

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL N

ID	T	LOCATION	LOADING KG/YR	LOADING %(I)	VARIANCE KG/YR**2	VARIANCE %(I)	CV	CONC MG/M3	EXPORT KG/KM2

1 1 ROP02	7184.1	4.7	.000E+00	.0	.000	3264.0	1997.8
2 1 ROP03	26551.8	17.2	.000E+00	.0	.000	1768.0	836.3
3 1 ROP04	89956.9	58.3	.000E+00	.0	.000	9272.0	4673.1
4 1 ROP05	9497.7	6.2	.000E+00	.0	.000	1911.0	953.5
5 1 Unmonitored	2804.9	1.8	.000E+00	.0	.000	879.0	356.0
6 1 DirPond	5229.4	3.4	.000E+00	.0	.000	2009.0	926.1
7 1 DirUpper	4169.3	2.7	.000E+00	.0	.000	1646.0	739.1
8 1 DirLower	3884.6	2.5	.000E+00	.0	.000	2534.0	1112.1
9 4 Withdrawl	2283.8	1.5	.158E+07	25.1	.550	1248.0	.0
10 4 Outflow	46424.9	30.1	.653E+09	10352.7	.550	1248.0	.0
PRECIPITATION	5021.7	3.3	.630E+07	100.0	.500	1306.7	1408.6
TRIBUTARY INFLOW	149278.8	96.7	.000E+00	.0	.000	3575.5	1711.6
***TOTAL INFLOW	154300.4	100.0	.630E+07	100.0	.016	3384.2	1699.7
GAUGED OUTFLOW	48708.7	31.6	.719E+09	11396.4	.550	1248.0	.0
ADVECTIVE OUTFLOW	4581.4	3.0	.722E+07	114.5	.586	1248.0	50.5
***TOTAL OUTFLOW	53290.1	34.5	.860E+09	13643.2	.550	1248.0	587.0
***RETENTION	101010.3	65.5	.864E+09	13696.7	.291	.0	.0

	HYDRAULIC	-------------- TOTAL N	--------------		
OVERFLOW	RESIDENCE	POOL	RESIDENCE	TURNOVER	RETENTION
RATE	TIME	CONC	TIME	RATIO	COEF
M/YR	YRS	MG/M3	YRS	-	-
11.98	.3481	1358.7	.1309	7.6398	.6546

CASE: GOVERNOR BOND LAKE 1999 INITIAL CONDITIONS

GROSS WATER BALANCE:

ID T LOCATION	DRAINAGE AREA KM2	---- FLOW (HM3/YR) ---- MEAN	VARIANCE	CV	RUNOFF M/YR
1 1 ROP02	3.596	2.424	.000E+00	.000	.674
2 1 ROP03	31.750	15.240	.000E+00	.000	.480
3 1 ROP04	19.250	9.567	.000E+00	.000	.497
4 1 ROP05	9.961	4.920	.000E+00	.000	.494
5 1 UNMon	7.879	3.262	.000E+00	.000	.414
6 1 DirPond	5.647	2.682	.000E+00	.000	.475
7 1 DirUpper	5.641	2.657	.000E+00	.000	.471
8 1 DirLower	3.493	1.635	.000E+00	.000	.468
9 4 Withdrawl	.000	1.830	.000E+00	.000	.000
10 4 Outflow	.000	37.200	.000E+00	.000	.000
PRECIPITATION	3.565	3.708	.550E+00	.200	1.040
TRIBUTARY INFLOW	87.217	42.387	.000E+00	.000	.486
***TOTAL INFLOW	90.782	46.095	.550E+00	.016	.508
GAUGED OUTFLOW	.000	39.030	.000E+00	.000	.000
ADVECTIVE OUTFLOW	90.782	4.172	.558E+00	.179	.046
***TOTAL OUTFLOW	90.782	43.202	.558E+00	.017	.476
***EVAPORATION	.000	2.893	.779E-02	.030	.000

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS

COMPONENT: TOTAL P

ID T LOCATION	----- LOADING ---- KG/YR	%(I)	--- VARIANCE --- KG/YR**2	%(I)	CV	CONC MG/M3	EXPORT KG/KM2
1 1 ROP02	865.4	3.9	.000E+00	.0	.000	357.0	240.6
2 1 ROP03	3139.4	14.1	.000E+00	.0	.000	206.0	98.9

3 1 ROP04	6381.2	28.7	.000E+00	.0	.000	667.0	331.5
4 1 ROP05	3148.8	14.1	.000E+00	.0	.000	640.0	316.1
5 1 UNMon	776.4	3.5	.000E+00	.0	.000	238.0	98.5
6 1 DirPond	976.2	4.4	.000E+00	.0	.000	364.0	172.9
7 1 DirUpper	898.1	4.0	.000E+00	.0	.000	338.0	159.2
8 1 DirLower	647.5	2.9	.000E+00	.0	.000	396.0	185.4
9 4 Withdrawl	154.1	.7	.483E+04	19.7	.451	84.2	.0
10 4 Outflow	3132.6	14.1	.200E+07	8149.9	.451	84.2	.0
PRECIPITATION	313.1	1.4	.245E+05	100.0	.500	84.5	87.8
INTERNAL LOAD	5114.4	23.0	.000E+00	.0	.000	.0	.0
TRIBUTARY INFLOW	16832.9	75.6	.000E+00	.0	.000	397.1	193.0
***TOTAL INFLOW	22260.5	100.0	.245E+05	100.0	.007	482.9	245.2
GAUGED OUTFLOW	3286.7	14.8	.220E+07	8971.5	.451	84.2	.0
ADVECTIVE OUTFLOW	351.3	1.6	.289E+05	117.9	.484	84.2	3.9
***TOTAL OUTFLOW	3638.0	16.3	.270E+07	11000.4	.451	84.2	40.1
***RETENTION	18622.4	83.7	.272E+07	11081.7	.088	.0	.0

HYDRAULIC		TOTAL P			
OVERFLOW RATE	RESIDENCE TIME	POOL CONC	RESIDENCE TIME	TURNOVER RATIO	RETENTION COEF
M/YR	YRS	MG/M3	YRS	-	-
12.12	.3441	120.6	.0805	12.4218	.8366

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL N

	LOADING		VARIANCE			CONC	EXPORT
ID T LOCATION	KG/YR	%(I)	KG/YR**2	%(I)	CV	MG/M3	KG/KM2
1 1 ROP02	8134.9	6.6	.000E+00	.0	.000	3356.0	2262.2
2 1 ROP03	20299.7	16.5	.000E+00	.0	.000	1332.0	639.4
3 1 ROP04	68442.3	55.8	.000E+00	.0	.000	7154.0	3555.4
4 1 ROP05	8039.3	6.5	.000E+00	.0	.000	1634.0	807.1
5 1 UNMon	2188.8	1.8	.000E+00	.0	.000	671.0	277.8
6 1 DirPond	4033.7	3.3	.000E+00	.0	.000	1504.0	714.3
7 1 DirUpper	3403.6	2.8	.000E+00	.0	.000	1281.0	603.4
8 1 DirLower	3194.8	2.6	.000E+00	.0	.000	1954.0	914.6
9 4 Withdrawl	1515.5	1.2	.696E+06	11.0	.550	828.1	.0
10 4 Outflow	30806.1	25.1	.287E+09	4559.5	.550	828.1	.0
PRECIPITATION	5021.7	4.1	.630E+07	100.0	.500	1354.4	1408.6
TRIBUTARY INFLOW	117737.2	95.9	.000E+00	.0	.000	2777.7	1349.9
***TOTAL INFLOW	122758.8	100.0	.630E+07	100.0	.020	2663.2	1352.2
GAUGED OUTFLOW	32321.5	26.3	.316E+09	5019.1	.550	828.1	.0
ADVECTIVE OUTFLOW	3454.6	2.8	.396E+07	62.8	.576	828.1	38.1
***TOTAL OUTFLOW	35776.1	29.1	.388E+09	6149.8	.550	828.1	394.1
***RETENTION	86982.7	70.9	.391E+09	6209.3	.227	.0	.0

HYDRAULIC		TOTAL N			
OVERFLOW RATE	RESIDENCE TIME	POOL CONC	RESIDENCE TIME	TURNOVER RATIO	RETENTION COEF
M/YR	YRS	MG/M3	YRS	-	-
12.12	.3441	773.8	.0937	10.6729	.7086

LOAD REDUCTIONS FOR COMPLIANCE WITH TARGET WATER QUALITY GUIDELINES BALANCES

CASE: GOVERNOR BOND LAKE 1989 95% EXTERNAL + 95% INTERNAL LOAD REDUCTIONS

GROSS WATER BALANCE:

ID	T	LOCATION	DRAINAGE AREA KM2	FLOW (HM3/YR) MEAN	FLOW (HM3/YR) VARIANCE	FLOW (HM3/YR) CV	RUNOFF M/YR
1	1	ROP02	3.596	1.798	.000E+00	.000	.500
2	1	ROP03	31.750	7.112	.000E+00	.000	.224
3	1	ROP04	19.250	4.928	.000E+00	.000	.256
4	1	ROP05	9.961	2.480	.000E+00	.000	.249
5	1	Unmonitored	7.879	1.505	.000E+00	.000	.191
6	1	DirPond	5.647	1.169	.000E+00	.000	.207
7	1	DirUpper	5.641	1.066	.000E+00	.000	.189
8	1	DirLower	3.493	.611	.000E+00	.000	.175
9	4	Withdrawl	.000	1.830	.000E+00	.000	.000
10	4	Outflow	.000	37.200	.000E+00	.000	.000
		PRECIPITATION	3.565	3.255	.424E+00	.200	.913
		TRIBUTARY INFLOW	87.217	20.669	.000E+00	.000	.237
		***TOTAL INFLOW	90.782	23.924	.424E+00	.027	.264
		GAUGED OUTFLOW	.000	39.030	.000E+00	.000	.000
		ADVECTIVE OUTFLOW	90.782	-17.999	.432E+00	.036	-.198
		***TOTAL OUTFLOW	90.782	21.031	.432E+00	.031	.232
		***EVAPORATION	.000	2.893	.779E-02	.030	.000

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS

COMPONENT: TOTAL P

ID	T	LOCATION	LOADING KG/YR	LOADING %(I)	VARIANCE KG/YR**2	VARIANCE %(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	ROP02	48.5	4.4	.000E+00	.0	.000	27.0	13.5
2	1	ROP03	112.4	10.2	.000E+00	.0	.000	15.8	3.5
3	1	ROP04	364.7	33.3	.000E+00	.0	.000	74.0	18.9
4	1	ROP05	186.0	17.0	.000E+00	.0	.000	75.0	18.7
5	1	Unmonitored	42.0	3.8	.000E+00	.0	.000	27.9	5.3
6	1	DirPond	49.1	4.5	.000E+00	.0	.000	42.0	8.7
7	1	DirUpper	40.5	3.7	.000E+00	.0	.000	38.0	7.2
8	1	DirLower	31.2	2.8	.000E+00	.0	.000	51.0	8.9
9	4	Withdrawl	47.7	4.4	.465E+03	15.3	.452	26.1	.0
10	4	Outflow	970.3	88.5	.192E+06	6332.3	.452	26.1	.0
		PRECIPITATION	110.2	10.0	.303E+04	100.0	.500	33.8	30.9
		INTERNAL LOAD	111.9	10.2	.000E+00	.0	.000	.0	.0
		TRIBUTARY INFLOW	874.3	79.7	.000E+00	.0	.000	42.3	10.0
		***TOTAL INFLOW	1096.4	100.0	.303E+04	100.0	.050	45.8	12.1
		GAUGED OUTFLOW	1018.0	92.9	.211E+06	6970.7	.452	26.1	.0
		ADVECTIVE OUTFLOW	-469.5	-42.8	.455E+05	1500.4	.454	26.1	-5.2
		***TOTAL OUTFLOW	548.6	50.0	.614E+05	2023.9	.452	26.1	6.0
		***RETENTION	547.8	50.0	.623E+05	2052.8	.456	.0	.0

OVERFLOW RATE	HYDRAULIC RESIDENCE TIME	TOTAL P POOL CONC	TOTAL P RESIDENCE TIME	TOTAL P TURNOVER RATIO	TOTAL P RETENTION COEF

M/YR	YRS	MG/M3	YRS	-	-
5.90	.7068	130.4	1.7674	.5658	.4997

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL N

ID	T	LOCATION	LOADING KG/YR	LOADING %(I)	VARIANCE KG/YR**2	VARIANCE %(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	ROP02	5960.4	5.4	.000E+00	.0	.000	3315.0	1657.5
2	1	ROP03	18868.1	17.0	.000E+00	.0	.000	2653.0	594.3
3	1	ROP04	65892.3	59.2	.000E+00	.0	.000	13371.0	3423.0
4	1	ROP05	7095.3	6.4	.000E+00	.0	.000	2861.0	712.3
5	1	Unmonitored	1912.9	1.7	.000E+00	.0	.000	1271.0	242.8
6	1	DirPond	3738.5	3.4	.000E+00	.0	.000	3198.0	662.0
7	1	DirUpper	3082.9	2.8	.000E+00	.0	.000	2892.0	546.5
8	1	DirLower	2967.6	2.7	.000E+00	.0	.000	4857.0	849.6
9	4	Withdrawl	3350.0	3.0	.340E+07	433.6	.551	1830.6	.0
10	4	Outflow	68098.5	61.2	.141E+10	*******	.551	1830.6	.0
		PRECIPITATION	1771.8	1.6	.785E+06	100.0	.500	544.4	497.0
		TRIBUTARY INFLOW	109517.9	98.4	.000E+00	.0	.000	5298.7	1255.7
		***TOTAL INFLOW	111289.7	100.0	.785E+06	100.0	.008	4651.8	1225.9
		GAUGED OUTFLOW	71448.5	64.2	.155E+10	*******	.551	1830.6	.0
		ADVECTIVE OUTFLOW	-32949.4	-29.6	.331E+09	42220.4	.552	1830.6	-363.0
		***TOTAL OUTFLOW	38499.2	34.6	.450E+09	57339.6	.551	1830.6	424.1
		***RETENTION	72790.5	65.4	.451E+09	57397.7	.292	.0	.0

OVERFLOW RATE M/YR	HYDRAULIC RESIDENCE TIME YRS	TOTAL N POOL CONC MG/M3	TOTAL N RESIDENCE TIME YRS	TOTAL N TURNOVER RATIO -	TOTAL N RETENTION COEF -
5.90	.7068	1785.8	.2385	4.1925	.6541

CASE: GOVERNOR BOND LAKE 1993 95% EXTERNAL + 95% INTERNAL LOAD REDUCTIONS
GROSS WATER BALANCE:

ID	T	LOCATION	DRAINAGE AREA KM2	FLOW (HM3/YR) MEAN	FLOW VARIANCE	CV	RUNOFF M/YR
1	1	ROP02	3.596	2.819	.000E+00	.000	.784
2	1	ROP03	31.750	14.827	.000E+00	.000	.467
3	1	ROP04	19.250	9.856	.000E+00	.000	.512
4	1	ROP05	9.961	5.000	.000E+00	.000	.502
5	1	Unmonitored	7.879	3.112	.000E+00	.000	.395
6	1	DirPond	5.647	2.513	.000E+00	.000	.445
7	1	DirUpper	5.641	2.381	.000E+00	.000	.422
8	1	DirLower	3.493	1.411	.000E+00	.000	.404
9	4	Withdrawl	.000	1.830	.000E+00	.000	.000
10	4	Outflow	.000	37.200	.000E+00	.000	.000
		PRECIPITATION	3.565	4.613	.851E+00	.200	1.294
		TRIBUTARY INFLOW	87.217	41.919	.000E+00	.000	.481
		***TOTAL INFLOW	90.782	46.532	.851E+00	.020	.513
		GAUGED OUTFLOW	.000	39.030	.000E+00	.000	.000
		ADVECTIVE OUTFLOW	90.782	4.609	.859E+00	.201	.051
		***TOTAL OUTFLOW	90.782	43.639	.859E+00	.021	.481
		***EVAPORATION	.000	2.893	.779E-02	.030	.000

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL P

ID	T	LOCATION	LOADING KG/YR	LOADING %(I)	VARIANCE KG/YR**2	VARIANCE %(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	ROP02	65.5	2.2	.000E+00	.0	.000	23.2	18.2
2	1	ROP03	172.0	5.8	.000E+00	.0	.000	11.6	5.4
3	1	ROP04	493.8	16.7	.000E+00	.0	.000	50.1	25.7
4	1	ROP05	251.0	8.5	.000E+00	.0	.000	50.2	25.2
5	1	Unmonitored	65.0	2.2	.000E+00	.0	.000	20.9	8.3
6	1	DirPond	71.6	2.4	.000E+00	.0	.000	28.5	12.7
7	1	DirUpper	58.3	2.0	.000E+00	.0	.000	24.5	10.3
8	1	DirLower	40.9	1.4	.000E+00	.0	.000	29.0	11.7
9	4	Withdrawl	34.6	1.2	.243E+03	8.0	.450	18.9	.0
10	4	Outflow	703.5	23.7	.100E+06	3309.7	.450	18.9	.0
PRECIPITATION			110.2	3.7	.303E+04	100.0	.500	23.9	30.9
INTERNAL LOAD			1636.6	55.2	.000E+00	.0	.000	.0	.0
TRIBUTARY INFLOW			1218.2	41.1	.000E+00	.0	.000	29.1	14.0
***TOTAL INFLOW			2964.9	100.0	.303E+04	100.0	.019	63.7	32.7
GAUGED OUTFLOW			738.1	24.9	.111E+06	3643.4	.450	18.9	.0
ADVECTIVE OUTFLOW			87.2	2.9	.181E+04	59.8	.488	18.9	1.0
***TOTAL OUTFLOW			825.3	27.8	.138E+06	4553.9	.450	18.9	9.1
***RETENTION			2139.6	72.2	.140E+06	4613.2	.175	.0	.0

OVERFLOW RATE M/YR	HYDRAULIC RESIDENCE TIME YRS	TOTAL P POOL CONC MG/M3	TOTAL P RESIDENCE TIME YRS	TOTAL P TURNOVER RATIO -	TOTAL P RETENTION COEF -
12.24	.3406	188.1	.9428	1.0607	.7216

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL N

ID	T	LOCATION	LOADING KG/YR	LOADING %(I)	VARIANCE KG/YR**2	VARIANCE %(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	ROP02	8848.8	5.4	.000E+00	.0	.000	3139.0	2460.7
2	1	ROP03	29060.9	17.8	.000E+00	.0	.000	1960.0	915.3
3	1	ROP04	95672.2	58.7	.000E+00	.0	.000	9707.0	4970.0
4	1	ROP05	10925.0	6.7	.000E+00	.0	.000	2185.0	1096.8
5	1	Unmonitored	3186.7	2.0	.000E+00	.0	.000	1024.0	404.5
6	1	DirPond	5418.0	3.3	.000E+00	.0	.000	2156.0	959.5
7	1	DirUpper	4262.0	2.6	.000E+00	.0	.000	1790.0	755.5
8	1	DirLower	3811.1	2.3	.000E+00	.0	.000	2701.0	1091.1
9	4	Withdrawl	2157.6	1.3	.141E+07	179.7	.550	1179.0	.0
10	4	Outflow	43858.7	26.9	.582E+09	74247.3	.550	1179.0	.0
PRECIPITATION			1771.8	1.1	.785E+06	100.1	.500	384.1	497.0
TRIBUTARY INFLOW			161184.8	98.9	.000E+00	.0	.000	3845.1	1848.1
***TOTAL INFLOW			162956.6	100.0	.784E+06	100.0	.005	3502.0	1795.0
GAUGED OUTFLOW			46016.3	28.2	.641E+09	81732.0	.550	1179.0	.0
ADVECTIVE OUTFLOW			5434.1	3.3	.100E+08	1278.1	.583	1179.0	59.9
***TOTAL OUTFLOW			51450.4	31.6	.802E+09	*******	.550	1179.0	566.7
***RETENTION			111506.1	68.4	.802E+09	*******	.254	.0	.0

HYDRAULIC -------------- TOTAL N --------------

OVERFLOW RATE M/YR	RESIDENCE TIME YRS	POOL CONC MG/M3	RESIDENCE TIME YRS	TURNOVER RATIO -	RETENTION COEF -
12.24	.3406	1252.1	.1142	8.7555	.6843

CASE: GOVERNOR BOND LAKE 1996 90% EXTERNAL + 85% INTERNAL LOAD REDUCTIONS

GROSS WATER BALANCE:

ID	T	LOCATION	DRAINAGE AREA KM2	---- FLOW (HM3/YR) ---- MEAN	VARIANCE	CV	RUNOFF M/YR
1	1	ROP02	3.596	2.201	.000E+00	.000	.612
2	1	ROP03	31.750	15.018	.000E+00	.000	.473
3	1	ROP04	19.250	9.702	.000E+00	.000	.504
4	1	ROP05	9.961	4.970	.000E+00	.000	.499
5	1	Unmonitored	7.879	3.191	.000E+00	.000	.405
6	1	DirPond	5.647	2.603	.000E+00	.000	.461
7	1	DirUpper	5.641	2.533	.000E+00	.000	.449
8	1	DirLower	3.493	1.533	.000E+00	.000	.439
9	4	Withdrawl	.000	1.830	.000E+00	.000	.000
10	4	Outflow	.000	37.200	.000E+00	.000	.000
PRECIPITATION			3.565	3.843	.591E+00	.200	1.078
TRIBUTARY INFLOW			87.217	41.751	.000E+00	.000	.479
***TOTAL INFLOW			90.782	45.594	.591E+00	.017	.502
GAUGED OUTFLOW			.000	39.030	.000E+00	.000	.000
ADVECTIVE OUTFLOW			90.782	3.671	.599E+00	.211	.040
***TOTAL OUTFLOW			90.782	42.701	.599E+00	.018	.470
***EVAPORATION			.000	2.893	.779E-02	.030	.000

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS

COMPONENT: TOTAL P

ID	T	LOCATION	----- LOADING ---- KG/YR	%(I)	--- VARIANCE --- KG/YR**2	%(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	ROP02	99.0	2.0	.000E+00	.0	.000	45.0	27.5
2	1	ROP03	345.4	7.1	.000E+00	.0	.000	23.0	10.9
3	1	ROP04	855.7	17.6	.000E+00	.0	.000	88.2	44.5
4	1	ROP05	401.1	8.2	.000E+00	.0	.000	80.7	40.3
5	1	Unmonitored	105.6	2.2	.000E+00	.0	.000	33.1	13.4
6	1	DirPond	127.3	2.6	.000E+00	.0	.000	48.9	22.5
7	1	DirUpper	94.2	1.9	.000E+00	.0	.000	37.2	16.7
8	1	DirLower	78.2	1.6	.000E+00	.0	.000	51.0	22.4
9	4	Withdrawl	65.8	1.3	.878E+03	29.3	.450	36.0	.0
10	4	Outflow	1338.0	27.4	.363E+06	12120.1	.450	36.0	.0
PRECIPITATION			109.4	2.2	.299E+04	100.0	.500	28.5	30.7
INTERNAL LOAD			2659.5	54.5	.000E+00	.0	.000	.0	.0
TRIBUTARY INFLOW			2106.6	43.2	.000E+00	.0	.000	50.5	24.2
***TOTAL INFLOW			4875.5	100.0	.299E+04	100.0	.011	106.9	53.7
GAUGED OUTFLOW			1403.8	28.8	.399E+06	13341.9	.450	36.0	.0
ADVECTIVE OUTFLOW			132.0	2.7	.425E+04	141.8	.494	36.0	1.5
***TOTAL OUTFLOW			1535.8	31.5	.478E+06	15972.1	.450	36.0	16.9
***RETENTION			3339.7	68.5	.480E+06	16028.7	.207	.0	.0

HYDRAULIC -------------- TOTAL P --------------

OVERFLOW RATE M/YR	RESIDENCE TIME YRS	POOL CONC MG/M3	RESIDENCE TIME YRS	TURNOVER RATIO -	RETENTION COEF -
11.98	.3481	167.5	.5106	1.9585	.6850

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL N

ID	T	LOCATION	----- LOADING ---- KG/YR	%(I)	--- VARIANCE --- KG/YR**2	%(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	ROP02	7184.1	4.8	.000E+00	.0	.000	3264.0	1997.8
2	1	ROP03	26551.8	17.6	.000E+00	.0	.000	1768.0	836.3
3	1	ROP04	89956.9	59.6	.000E+00	.0	.000	9272.0	4673.1
4	1	ROP05	9497.7	6.3	.000E+00	.0	.000	1911.0	953.5
5	1	Unmonitored	2804.9	1.9	.000E+00	.0	.000	879.0	356.0
6	1	DirPond	5229.4	3.5	.000E+00	.0	.000	2009.0	926.1
7	1	DirUpper	4169.3	2.8	.000E+00	.0	.000	1646.0	739.1
8	1	DirLower	3884.6	2.6	.000E+00	.0	.000	2534.0	1112.1
9	4	Withdrawl	2251.2	1.5	.153E+07	195.6	.550	1230.2	.0
10	4	Outflow	45762.4	30.3	.634E+09	80826.2	.550	1230.2	.0
		PRECIPITATION	1771.8	1.2	.785E+06	100.1	.500	461.0	497.0
		TRIBUTARY INFLOW	149278.8	98.8	.000E+00	.0	.000	3575.5	1711.6
		***TOTAL INFLOW	151050.6	100.0	.784E+06	100.0	.006	3312.9	1663.9
		GAUGED OUTFLOW	48013.6	31.8	.698E+09	88974.3	.550	1230.2	.0
		ADVECTIVE OUTFLOW	4516.0	3.0	.701E+07	893.9	.586	1230.2	49.7
		***TOTAL OUTFLOW	52529.7	34.8	.836E+09	*******	.550	1230.2	578.6
		***RETENTION	98520.9	65.2	.836E+09	*******	.293	.0	.0

HYDRAULIC OVERFLOW RATE M/YR	HYDRAULIC RESIDENCE TIME YRS	TOTAL N POOL CONC MG/M3	TOTAL N RESIDENCE TIME YRS	TOTAL N TURNOVER RATIO -	TOTAL N RETENTION COEF -
11.98	.3481	1358.7	.1337	7.4789	.6522

CASE: GOVERNOR BOND LAKE 1999 90% EXTERNAL + 90% INTERNAL LOAD REDUCTION

GROSS WATER BALANCE:

ID	T	LOCATION	DRAINAGE AREA KM2	---- FLOW (HM3/YR) ---- MEAN	VARIANCE	CV	RUNOFF M/YR
1	1	ROP02	3.596	2.424	.000E+00	.000	.674
2	1	ROP03	31.750	15.240	.000E+00	.000	.480
3	1	ROP04	19.250	9.567	.000E+00	.000	.497
4	1	ROP05	9.961	4.920	.000E+00	.000	.494
5	1	UNMon	7.879	3.262	.000E+00	.000	.414
6	1	DirPond	5.647	2.682	.000E+00	.000	.475
7	1	DirUpper	5.641	2.657	.000E+00	.000	.471
8	1	DirLower	3.493	1.635	.000E+00	.000	.468
9	4	Withdrawl	.000	1.830	.000E+00	.000	.000
10	4	Outflow	.000	37.200	.000E+00	.000	.000
		PRECIPITATION	3.565	3.708	.550E+00	.200	1.040
		TRIBUTARY INFLOW	87.217	42.387	.000E+00	.000	.486
		***TOTAL INFLOW	90.782	46.095	.550E+00	.016	.508
		GAUGED OUTFLOW	.000	39.030	.000E+00	.000	.000
		ADVECTIVE OUTFLOW	90.782	4.172	.558E+00	.179	.046
		***TOTAL OUTFLOW	90.782	43.202	.558E+00	.017	.476

***EVAPORATION	.000	2.893	.779E-02	.030	.000	

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL P

ID	T	LOCATION	LOADING KG/YR	LOADING %(I)	VARIANCE KG/YR**2	VARIANCE %(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	ROP02	95.3	3.8	.000E+00	.0	.000	39.3	26.5
2	1	ROP03	344.4	13.9	.000E+00	.0	.000	22.6	10.8
3	1	ROP04	702.2	28.4	.000E+00	.0	.000	73.4	36.5
4	1	ROP05	346.4	14.0	.000E+00	.0	.000	70.4	34.8
5	1	UNMon	85.5	3.5	.000E+00	.0	.000	26.2	10.8
6	1	DirPond	110.2	4.5	.000E+00	.0	.000	41.1	19.5
7	1	DirUpper	98.8	4.0	.000E+00	.0	.000	37.2	17.5
8	1	DirLower	71.3	2.9	.000E+00	.0	.000	43.6	20.4
9	4	Withdrawl	38.6	1.6	.302E+03	9.9	.450	21.1	.0
10	4	Outflow	783.8	31.7	.125E+06	4108.6	.450	21.1	.0
PRECIPITATION			110.2	4.4	.303E+04	100.0	.500	29.7	30.9
INTERNAL LOAD			511.4	20.7	.000E+00	.0	.000	.0	.0
TRIBUTARY INFLOW			1854.1	74.9	.000E+00	.0	.000	43.7	21.3
***TOTAL INFLOW			2475.7	100.0	.303E+04	100.0	.022	53.7	27.3
GAUGED OUTFLOW			822.4	33.2	.137E+06	4522.8	.450	21.1	.0
ADVECTIVE OUTFLOW			87.9	3.6	.179E+04	58.9	.481	21.1	1.0
***TOTAL OUTFLOW			910.3	36.8	.168E+06	5540.3	.450	21.1	10.0
***RETENTION			1565.4	63.2	.169E+06	5585.3	.263	.0	.0

OVERFLOW RATE M/YR	HYDRAULIC RESIDENCE TIME YRS	TOTAL P POOL CONC MG/M3	TOTAL P RESIDENCE TIME YRS	TOTAL P TURNOVER RATIO -	TOTAL P RETENTION COEF -
12.12	.3441	120.6	.7239	1.3815	.6323

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL N

ID	T	LOCATION	LOADING KG/YR	LOADING %(I)	VARIANCE KG/YR**2	VARIANCE %(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	ROP02	8134.9	6.8	.000E+00	.0	.000	3356.0	2262.2
2	1	ROP03	20299.7	17.0	.000E+00	.0	.000	1332.0	639.4
3	1	ROP04	68442.3	57.3	.000E+00	.0	.000	7154.0	3555.4
4	1	ROP05	8039.3	6.7	.000E+00	.0	.000	1634.0	807.1
5	1	UNMon	2188.8	1.8	.000E+00	.0	.000	671.0	277.8
6	1	DirPond	4033.7	3.4	.000E+00	.0	.000	1504.0	714.3
7	1	DirUpper	3403.6	2.8	.000E+00	.0	.000	1281.0	603.4
8	1	DirLower	3194.8	2.7	.000E+00	.0	.000	1954.0	914.6
9	4	Withdrawl	1487.4	1.2	.670E+06	85.3	.550	812.8	.0
10	4	Outflow	30236.0	25.3	.277E+09	35259.1	.550	812.8	.0
PRECIPITATION			1771.8	1.5	.785E+06	100.0	.500	477.9	497.0
TRIBUTARY INFLOW			117737.2	98.5	.000E+00	.0	.000	2777.7	1349.9
***TOTAL INFLOW			119509.0	100.0	.785E+06	100.0	.007	2592.7	1316.4
GAUGED OUTFLOW			31723.4	26.5	.305E+09	38813.5	.550	812.8	.0
ADVECTIVE OUTFLOW			3390.7	2.8	.381E+07	486.0	.576	812.8	37.3
***TOTAL OUTFLOW			35114.0	29.4	.373E+09	47557.0	.550	812.8	386.8
***RETENTION			84394.9	70.6	.374E+09	47616.1	.229	.0	.0

	HYDRAULIC	TOTAL N			
OVERFLOW	RESIDENCE	POOL	RESIDENCE	TURNOVER	RETENTION
RATE	TIME	CONC	TIME	RATIO	COEF
M/YR	YRS	MG/M3	YRS	-	-
12.12	.3441	773.8	.0962	10.3903	.7062

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APPENDIX B

FEDERAL FUNDING SOURCES

A variety of funding sources are available to support implementation of the Best Management Practices and other management measures addressed in the TMDL document. The following table provides a brief overview of several of these sources available at the Federal level. Additional information on these sources is available from the U.S. Environmental Protection Agency publication, *Catalog of Federal Funding Sources for Watershed Protection,* EPA 841-B-99-003. The publication presents information on 69 federal funding sources (grants and loans) that may be used to fund a variety of watershed protection projects. The information on funding sources is organized into categories including coastal waters, conservation, economic development, education, environmental justice, fisheries, forestry, Indian tribes, mining, pollution prevention and wetlands. More information is also available at http://www.epa.gov/owow/watershed/funding.html/.

PROGRAM	OVERVIEW	ELIGIBILITY	ASSISTANCE PROVIDED
U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA) - PROGRAM GRANTS TO STATES Watersheds and Nonpoint Source Programs Branch, U.S. EPA Region 5			
Nonpoint Source Implementation Grants (319)	The 319 program provides formula grants to the States to implement nonpoint source projects and programs in accordance with Section 319 of the Clean Water Act.	States and Indian Tribes	Grants are awarded to a lead state agency. States and local organizations receiving 319 grants are required to provide 40 percent of program cost.
Water Quality Cooperative Agreements (104 (b)(3))	Grants are provided to support new approaches to meeting storm water, combined sewer outflows, sludge, and pretreatment requirements as well as enhancing State capabilities. Eligible projects usually include research, investigations, experiments, training, environmental technology demonstrations, surveys, and studies related to the causes, effects, extent, and prevention of pollution.	State water pollution control agencies, interstate agencies, local public agencies, Indian Tribes, nonprofit institutions, organizations, and individuals	Grants are awarded; matching is encouraged.

PROGRAM	OVERVIEW	ELIGIBILITY	ASSISTANCE PROVIDED
Water Quality Management Planning (205 (J))	Formula grants are awarded to State water quality management agencies to carry out water quality planning. States are required to allocate at least 40 percent of funds to eligible Regional Public Comprehensive Planning Agencies (RPCPO) and Interstate Organizations (IO).	States	States are required to allocate at least 40 percent of funds to eligible RPCPOs and IOs.
State Revolving Funds (SRF)	EPA awards grant money to States to establish SRFs. Under the SRF program, Illinois has created revolving loan funds to provide independent and permanent sources of low-cost financing for a range of water quality infrastructure projects. States set loan terms, repayment periods, and other loan features. SRFs are available to fund a wide variety of water quality projects including all types of nonpoint source and estuary management projects, as well as more traditional wastewater treatment projects.	States	Grants are awarded to a lead agency. Loans are provided to eligible participants.
Capitalization Grants for State Revolving Funds	EPA awards grants to States to capitalize their Clean Water State Resolving Funds (SRF). The States, through the SRF, make loans for high priority water quality activities. Loans are used for water quality management activities.	States, Tribes, Puerto Rico, Territories, and DC	Grants are awarded to a lead agency. Loans are provided by the state to eligible participants. States are required to provide a 20 percent match
Capitalization Grants for Drinking Water State Revolving Funds	EPA awards grant money to Illinois for Drinking Water State Revolving Funds (DWSRF) creation. Illinois, through its DWSRF, provides loans for drinking water supply-related projects. Although the majority of loan money is intended for upgrades of infrastructure (public or private drinking water supplies), Illinois also has the option to use some of the DWSRF funds for source water protection, capacity development, drinking water programs, and operator certification programs. DWSRF emphasizes preventing contamination and enhancing water systems management.	States, Territories, U.S. possessions, and Indian Tribes.	Grants and loans are awarded to drinking water suppliers. A 20 percent match from the State is required.

PROGRAM	OVERVIEW	ELIGIBILITY	ASSISTANCE PROVIDED
Water Pollution Control Program Grants (Section 106)	This program authorizes EPA to provide assistance to States and interstate agencies to establish and implement ongoing water pollution control programs. Prevention and control measures supported include permitting, pollution control activities, surveillance, monitoring, and enforcement; advice and assistance to local agencies; and the provision of training and public information. The Section 106 programs help foster a watershed approach at the State level by looking at water quality problems holistically.	States, interstate agencies, and Indian Tribes	Funds are allotted among the State and Interstate Water Pollution Control agencies on the basis of the extent of water pollution problems in the respective States.
EPA - PROJECT GRANTS Watersheds and Nonpoint Source Programs Branch, U.S. EPA Region 5			
Great Lakes Program	EPA's Great Lakes Program issues awards assistance to projects affecting the Great Lakes Basin or in support of the U.S.-Canada Great Lakes Water Quality Agreement. Such activities include surveillance and monitoring of Great Lakes water quality and land use activities.	State water pollution control agencies, interstate agencies, other public or nonprofit agencies, institutions, organizations, and individuals	Project grants, use of property and equipment, provision of specialized services, and dissemination of technical information are the forms of assistance provided.
Pollution Prevention Grants Program	This program provides project grants to States to implement pollution prevention projects. The grant program is focused on institutionalizing multimedia pollution prevention (air, water, land).	States and Indian Tribes	Individual grants are awarded based on requests. States are required to provide at least 50 percent of total project costs
Wetlands Protection Development Grants Program	This program provides financial assistance to States, Indian Tribes, and local governments to support wetlands development or augmentation and enhancement of existing programs. Projects must clearly demonstrate a direct link to an increase in the group's ability to protect its wetland resources.	States, Indian Tribes, Interstate/Intertribal agencies, local governments	Project grants are used to fund individual projects. States or Tribes must provide a 25 percent match of the total project cost

PROGRAM	OVERVIEW	ELIGIBILITY	ASSISTANCE PROVIDED
NATURAL RESOURCES CONSERVATION SERVICE (NRCS)			
Environmental Quality Incentives Program (EQIP)	EQIP provides technical, financial, and educational assistance, half of it targeted to livestock-related natural resource concerns and the other half to more general conservation priorities. EQIP is available primarily in priority areas where there are significant natural resource concerns and objectives.	Non-federal landowners engaged in livestock operations or agricultural productions. Eligible land includes cropland, rangeland, pasture, forest land, and other farm and ranch lands	EQIP can provide up to 75 percent of costs of certain conservation practices. Incentive payments can be up to 100 percent for 3 years, paid at a flat rate. The maximum is $10,000 per person per year and $50,000 over the length of the contract.
Forestry Incentives Program (FIP)	FIP supports good forest management practices on privately owned, nonindustrial forest lands nationwide. FIP is designed to benefit the environment while meeting future demands for wood products. Eligible practices are tree planting, timber stand improvement, site preparation for natural regeneration, and other related activities. FIP’s forest maintenance and reforestation provides numerous natural resource benefits, including reduced soil erosion and enhanced water quality and wildlife habitat. Land must be suitable for conversion from nonforest to forest land, for reforestation, or for improved forest management and be capable of producing marketable timber crops.	Private landowner of at least 10 acres and no more than 1,000 acres of nonindustrial forest or other suitable land. Individuals, groups, Indian Tribes, and corporations whose stocks are not publicly traded might be eligible provided they are not primarily manufacturing forest products or providing public utility services.	FIP provides no more than 65 percent of the total costs, with a maximum of $10,000 per person per year.
Small Watershed Program	This program works through local government sponsors and helps participants solve natural resource and related economic problems on a watershed basis. Projects include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in watersheds of 250,000 or fewer acres. Technical and financial assistance is available for installation of works of improvement to protect, develop, and utilize the land and water resources in small watersheds.	Local or State agency, county, municipality, town or township, soil and water conservation district, flood prevention or flood control district, Indian Tribe or Tribal organization, or nonprofit agency with authority to carry out, maintain, and operate watershed improvement works	Assistance can cover 100 percent of flood prevention construction costs; 50 percent of construction costs related to agricultural water management, recreation and fish and wildlife; and none of the costs for other municipal and industrial water management. Technical assistance and counseling may also be provided.

PROGRAM	OVERVIEW	ELIGIBILITY	ASSISTANCE PROVIDED
Wetlands Reserve Program (WRP)	The Wetlands Reserve Program (WRP) is a voluntary program to restore and protect wetlands on private property. WRP provides landowners with financial incentives to enhance wetlands in exchange for retiring marginal agricultural land. Landowners may sell a conservation easement or enter into a cost-share restoration agreement. Landowners voluntarily limit future use of the land, yet retain private ownership. Landowners and the NRCS develop a plan for the restoration and maintenance of the wetland.	The easement participant must have owned the land for at least 1 year. An owner can be an individual, partnership, association, corporation, estate, trust, business or other legal entities, a State (when applicable), political subdivision of a State, or any agency thereof owning private land. Land must be restorable and suitable for wildlife benefits.	WRP provides three options to the landowner: *Permanent Easement*: USDA purchases easement (price is lesser of land value or payment cap.) USDA pays 100 percent of restoration costs. *30-year Easement*: Payment will be 75 percent of what would be paid for a permanent easement. USDA pays 75 percent of restoration costs. *Restoration Cost Share Agreement*: Agreement (min. 10 yr.) to restore degraded wetland habitat. USDA pays 75 percent of restoration costs.
Wildlife Habitat Incentives Program (WHIP)	WHIP is a voluntary program for people who want to develop and improve wildlife habitat on private land. It provides both technical assistance and cost sharing to help establish and improve fish and wildlife habitat. A wildlife habitat plan is developed that describes the landowner's goals for improving wildlife habitat, includes a list of practices and schedule for installing them, and details the steps necessary for maintenance.	Individuals must own or have control of the land under consideration, and cannot have the land already enrolled in programs that have a wildlife focus, such as the WRP, or use the land for mitigation.	USDA will pay up to 75 percent of installation costs and will provide technical assistance for successfully establishing habitat development projects.
Resource Conservation and Development Program (RC&D)	RC & D provides a way for local residents to work together and plan how they can actively solve environmental, economic, and social problems facing their communities. Assistance is available for planning and installation of approved projects specified in RC&D area plans, for land conservation, water management, community development, and environmental enhancement.	Must be an RC&D area authorized by the Secretary of Agriculture for assistance	Technical assistance Grants (as funding allows) up to 25 percent of total cost not to exceed $50,000. Financial assistance has not been available in recent years due to budget constraints. Local or State government must provide 10 percent of total cost and are also responsible for operation and maintenance.

PROGRAM	OVERVIEW	ELIGIBILITY	ASSISTANCE PROVIDED
Watershed Surveys and Planning	This program provides planning assistance to Federal, State and local agencies for the development of coordinated water and related land resources programs in watershed and river basins. Special priority is given to projects helping to solve problems of upstream rural community flooding, water quality improvement coming from agricultural nonpoint sources, wetland preservation, and drought management for agricultural and rural communities.	State, Federal, Indian tribes, or local agencies	Technical assistance is provided. Each cooperating agency is expected to fund its own participation.
Emergency Watershed Protection (EWP) Program	The EWP Program was set up to respond to emergencies created by natural disasters. All EWP work must reduce threats to life and property. It must be economically and environmentally defensible. EWP work can include a wide variety of measures ranging from reshaping and protecting eroded banks to reseeding damaged areas.	Public and private landowners are eligible for assistance but must be represented by a project sponsor who must be a public agency.	NRCS can fund up to 75 percent of total cost.
U.S. FOREST SERVICE			
Cooperative Forestry Assistance	Cooperative Forestry Assistance helps State Foresters or equivalent agencies with forest stewardship programs on private, State, local, and other non-Federal forest and rural lands, plus rural communities and urban areas. This assistance is provided through the following programs: Forest Stewardship Program, Stewardship Incentive Program, Economic Action Programs, Urban and Community Forestry Program, Cooperative Lands Forest Health Protection Program, and Cooperative Lands Fire Protection Program. These programs help to achieve ecosystem health and sustainability by improving wildlife habitat, conserving forest land, reforestation, improving soil and water quality, preventing and suppressing damaging insects and diseases, wildfire protection, expanding economies of rural communities, and improving urban environments.	State Forester or equivalent State agency can receive moneys. State agencies can provide these moneys to owners of non-Federal lands, rural communities, urban/municipal governments, nonprofit organizations, and State, local, and private agencies acting through State Foresters or equivalent.	Formula grants, project grants, and cost share programs are available as well as use of property and facilities.

PROGRAM	OVERVIEW	ELIGIBILITY	ASSISTANCE PROVIDED
Stewardship Incentive Program	The Stewardship Incentive Program provides technical and financial assistance to encourage nonindustrial private forest landowners to keep their lands and natural resources productive and healthy. Qualifying land includes rural lands with existing tree cover or land suitable for growing trees and which is owned by a private individual, group, association, corporation, Indian tribe, or other legal private entity.	Eligible landowners must have an approved Forest Stewardship Plan and own 1,000 or fewer acres of qualifying land. Authorizations may be obtained for exceptions of up to 5,000 acres.	Technical or financial assistance can be provided.
U.S. FISH AND WILDLIFE SERVICE			
Coastal Wetlands Planning, Protection, and Restoration Act	This program provides funds to assist States in pursuing coastal wetland conservation projects. Funds can be used for acquisition of interests in coastal lands or waters, and for restoration, enhancement, or management of coastal wetland ecosystems on a competitive basis with all coastal states.	All States bordering the Atlantic, Gulf and Pacific coasts, Great Lakes and other U.S. coastal territories	Project grants. Federal share of costs not to exceed 50 percent; Federal share may be increased to 75 percent if a coastal State has established a fund (1) for the acquisition of coastal wetlands, other natural areas, or open spaces, or (2) derived from a dedicated recurring source of moneys.
Partners for Wildlife Habitat Restoration Program	The Partners for Wildlife Program provides technical and financial assistance to private landowners through voluntary cooperative agreements in order to restore formerly degraded wetlands, native grasslands, riparian areas, and other habitats to conditions as natural as feasible. Under cooperative agreements, private landowners agree to maintain restoration projects as specified in the agreement but otherwise retain full control of the land. To date, the Partners for Wildlife Program has restored over 360,000 acres of wetlands, 128,000 acres of prairie grassland, 930 miles of riparian habitat, and 90 miles of in-stream aquatic habitat.	Private landowners (must enter into a cooperative agreement for a fixed term of at least 10 years)	Project grants (cooperative agreements) are provided. Program's goal is that no more than 60 percent of project cost is paid by Federal moneys (the program seeks remainder of cost share from landowners and nationally-based and local entities).

PROGRAM	OVERVIEW	ELIGIBILITY	ASSISTANCE PROVIDED
Wildlife Conservation and Appreciation Program	The Wildlife Conservation and Appreciation Program provide grants to fund projects that bring together USFWS, State agencies, and private organizations and individuals. Projects include identification of significant problems that can adversely affect fish and wildlife and their habitats; actions to conserve species and their habitats; actions that will provide opportunities for the public to use and enjoy fish and wildlife through nonconsumptive activities; monitoring of species; and identification of significant habitats.	State fish and wildlife agencies	Project grants are provided.
North American Wetlands Conservation Act (NAWCA) Grant Program	The NAWCA grant program promotes long-term conservation of North American wetland ecosystems. Principal conservation actions supported by NAWCA are acquisition, enhancement and restoration of wetlands and wetlands-associated habitat.	Public or private, profit or nonprofit entities or individuals establishing public-private sector partnerships	Project grants (cooperative agreements and contracts) are provided. Cost-share partners must at least match grant funds 1:1 with U.S. non-federal dollars.
U.S. ARMY CORPS OF ENGINEERS			
Planning Assistance to States Program	The USACE to assist States, Indian Tribes local governments, and other non-Federal entities in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources under this program. The program can encompass many types of studies dealing with water resources issues. Typical studies are only planning level of detail. Types of studies conducted in recent years include water quality studies, flood plain management, environmental conservation, and many others.	States, Indian Tribes local governments, and other non-Federal entities	Federal allotments for each State or Tribe from the nation-wide appropriation are limited to $500,000 annually.

GOVERNOR BOND LAKE TMDL

APPENDIX C

RESPONSIVENESS SUMMARY

Governor Bond Lake

TABLE OF CONTENTS

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
(Illinois EPA)

IN THE MATTER OF:

GOVERNOR BOND LAKE IN CLINTON COUNTY
TOTAL MAXIMUM DAILY LOAD DLC# 331-01

RESPONSIVENESS SUMMARY

This responsiveness summary responds to substantive questions and comments received during the public comment period from June 28, 2001, through August 30, 2001 (postmarked) including those from the July 31 public hearing.

WHAT IS A TMDL?

A Total Maximum Daily Load (TMDL) is the sum of the allowable amount of a single pollutant (nutrients, siltation, etc.) that a water body can receive from all contributing sources and still meet water quality standards or designated uses. The Governor Bond TMDL report contains a plan that detailing the actions necessary to reduce pollutant loads to Governor Bond Lake and ensure compliance with applicable water quality standards. The Illinois EPA implements the TMDL program in accordance with Section 303(d) of the federal Clean Water Act and the regulations thereunder.

BACKGROUND

The 775 acre Governor Bond Lake is a water supply reservoir for the towns of Greenville, Mulberry Grove, Donnellson, Smithboro, and Royal Lakes. It is listed as impaired for recreation, swimming, and overall use. The main causes contributing to impairment are identified as nutrients, siltation, suspended solids, and chlorophyll-a concentrations. The U.S. EPA contracted Tetra Tech EM Inc., Chicago, Illinois, to prepare a TMDL report for Illinois EPA on this waterbody.

PUBLIC MEETINGS/ HEARING

Public meetings were held in the city of Greeneville on October 24, 2000, and January 17, 2001. A public hearing on the proposed plan was held on Tuesday, July 31, 2001 in the Bradford Room at 107 Main Street, Greenville, Illinois. The Illinois EPA provided public notice for the hearing by placing boxed display ads in the *Greenville Advocate* on June 28, July 5, and July 12, 2001. These three notices gave the date, time, location, and purpose of the hearing. The notices also provided references to obtain additional information about this specific site, the TMDL Program, and other related issues, as well as the name, address, and phone number of the IEPA hearing officer. Approximately 75 individuals and organizations were also sent the public notice by first class mail. The mailing list is contained in the Agency file DLC #331-01. The Draft TMDL Report was available for review in the reference area of the Greenville Public Library and also at the Agency's web page at http://www.epa.state.il.us.

The hearing started at 6:33 P.M. on Tuesday, July 31, 2001. It was attended by approximately 40 people and concluded at 7:46 P.M. with the hearing record remaining open until midnight August 30, 2001. A total of six exhibits were received either during the hearing or within the public comment period. A court reporter prepared a transcript of the public hearing.

QUESTIONS AND COMMENTS

1. The City of Greenville was told, based on the tests done by Zahniser Institute, that siltation has been reduced considerably and is no longer a major problem. This seems to conflict with some of the TMDL findings. Please clarify.

   Response: Zahniser Institute did a bathymetry study to map the elevation/contour of the bottom of the lake. The elevations they obtained indicate that Governor Bond Lake has filled in over time. Those who investigated lake siltation for previous studies over the years used different technologies and methods for each study, making the results difficult to use for comparison. If the Zahniser Institute does another study using the same methods, data obtained will be comparable and would be considered more valid.

   The analysis done for this TMDL looked strictly at what quantity of sediment was coming into the lake, and then what remained in the water. The difference was assumed to have settled out of the water, allowing for the calculation of a siltation rate. If additional studies indicate differently, the siltation rate can be adjusted.

2. The City of Greenville was told by the Zahniser Institute that shoreline erosion is a major source of siltation, contributing as much as half of what is coming into the lake. The rest of the siltation appears to be entering from the watershed sources. Is that what the TMDL report finds also?

   Response: Please see the response to question #48.

3. How critical is it to develop a watershed program (with the filter strips, etc.) with or without a complimentary shoreline erosion program?

   Response: We believe it is important to develop a program to deal with both. In addition, practices to reduce erosion are not 100 percent effective, indicating that multiple source controls should be attempted.

4. The City of Greenville and its residents feel water quality is possibly our number one concern because it may be our greatest resource. However, the City was told that the expected life of the lake with no action is 75 to 100 years. Can we leave the lake as it is for now and in the meantime develop other methods of finding a solution for the water supply, whether it be an alternate reservoir or wells or whatever?

   Response: The TMDL study did not specifically look at the expected life of the lake if no actions are taken. Siltation and the rate of siltation were evaluated but an estimate of how long the lake would exist was not calculated. The TMDL process was tasked to look at the lakes "designated uses", such as swimming, fishing, and the lake's continued use as a public water supply. The Illinois EPA determined before the TMDL study started that the public water supply designated use was already meeting its objectives.

5. In order to find and develop the resources necessary to do the things recommended, can the community adopt a remedy that phases in over 10, 20, or 30 years or is an immediate action needed? What time frame does the TMDL program assume? Could the Agency elaborate on when a timeline would be developed and how members of the public would be able to help develop the timeline?

   Response: The TMDL program does not have a specified timetable. After the Agency submits a final TMDL to USEPA, partners within the watershed will be identified and contacted to conduct the needed tasks. IEPA and those partners will work together to find funding and develop a timetable.

   The timeline would be different for each Best Manageme nt Practices (BMPs) project, depending on who the partners are. IEPA will identify these partners, what budgets and priorities get established, and what role the public has. Potential BMPs in the upper watershed will vary more depending on what type of projects can be worked out with local landowners and whether or not efforts form team approaches with partners like the Natural Resources Conservation Service, local soil and water conservation districts, or others.

6. One of the reasons for being concerned about the siltation in the lake was because if the lake is filling up, there will continue to be less water in the lake. If industry were pursued, a sufficient and reliable water supply would be necessary. One of the methods suggested involves raising the level of the lake. That puts more water in the lake but it also might harm the landowners around the lake depending on what they might have in the lake, such as piers, boat docks, etc. Is raising the level of the lake a reasonable solution to any of the problems?

   Response: The TMDL study did not consider raising the lake as a viable option to solve sources of impairment. Raising the level of the lake would not reduce siltation and nutrient input. This is a short-term solution. There needs to be a sustained effort in the watershed for water quality improvement. Streambank erosion, for example, should be remedied because it will continue no matter what is done at the lake. If the pool elevation of the lake is increased, some of the eroded areas will be covered but other erosion problems that do not currently exist may be created.

7. If the requirements listed in the TMDL were prioritized, what would be the first priority or action, the second, etc. or does it all have to be done together?

   Response: The first priority would most likely be finding the right partners needed to get things done in the watershed. That may be working with the City of Greenville for certain BMPs. It also means getting in touch with local landowners in the watershed. In both cases evaluating the need for additional data on locations and severity of conditions is a high priority. Phasing in appropriate BMPs based on the data will be important. In fact some of this work has begun. On March 13, 2002, a Section 319 grant of $235,221 was awarded to the Zahniser Institute to create three rural wetlands on tributaries of the lake. The total project fund is $400,00, with the local share of $164,779. Illinois EPA is providing $300,000 to the city of Greenville under an Illinois Cle an Lakes grant. These funds will be used for hypolimnetic aeration, construction of certain BMPs, septic tank inspection, NRCS conservation program projects, and streambank stabilization. These projects and program elements are described in the ZEIS Diagnostic Feasibility Study for Governor Bond Lake of December 2001. In the future, more data will be needed to determine streambank and field erosion rates. This will allow us to identify appropriate control practices and funding sources for these BMPs.

8. One of the things that the City may be able to do rather soon is shoreline stabilization on the land owned by the City, and then implement other stabilization projects for landowners. The City of Greenville has already looked into various grants that are available for such activities. Is the City mandated to maintain a certain water quality in the lake? If so, what is the current water quality and how far away is the city from not meeting water quality standards?

   Response: The City of Greenville is mandated as a community water supply to meet certain standards for the water in the reservoir itself in order to use the lake as a source of drinking water. The City must also meet separate standards for the quality of the water supplied to its customers. The City is not, however, considered the sole responsible party for maintaining water quality in the lake. With the City owning and managing a great deal of property at the lake, the City could play a major role in achieving compliance with the designated uses.

   It is possible the City would contribute funds to the remedies. These are the types of things that need to be worked out with partners once the TMDL has been approved. Refer to Response #7 for information on the ongoing grants.

9. Is the IEPA mandating that the community do what you recommend?

   Response: No. The IEPA is strongly recommending some BMPs. We are also recommending a phased approach. Nonpoint source control will, in any event, be a voluntary program.

10. In addition to looking at raising the level of the lake, the City also looked at dredging. The last report of Zahniser Institute indicated the siltation on the bottom of the lake was not dangerous and could be taken out of the lake for use most anywhere. Is this a reasonable solution? Do you have any input about the pros or cons of dredging?

    Response: Dredging is included as one of the potential BMPs that either the City or a homeowners association could consider but would only be feasible in conjunction with a program that controls sediment delivery from the watershed. Dredging projects can be expensive. Dredging is relatively simple once the details are worked out, and can be very effective, for example, in reducing lake based sources of certain nutrients. However, it is often difficult to find adequate disposal sites.

11. Do you anticipate a timeline will be included further on down the road for other TMDLs, not just here on Governor Bond? Will you be including that in the future on round two?

    Response: Yes. This happens to be the first TMDL public hearing for Illinois. This one is a little different than some of the others in that it is being done in partnership with USEPA. They have been a party to all the discussions that have gone on. There is a good chance with this TMDL that all the parties will be able to progress quickly. Some of the other TMDLs may proceed more slowly and an implementation plan may be developed to estimate the cost and implementation timeframe for the particular landowners, city, or whoever happens to be a partner in establishing BMPs.

12. Does the TMDL report consider using bridge embankment where they're tearing out the concrete for shoreline stabilization to reduce the cost of hauling other types of rock?

    Response: No specific projects, or sources of material, have been considered at this time.

13. Could there be a requirement for construction activities that within 30 days of when they clear land they get grass and straw on that property?

    Response: Construction-related BMPs and model ordinances for erosion control can be part of the implementation plan.

14. Would the city consider giving a tax credit or reduction of some kind to homeowners that make shoreline stabilization improvements?

    Response: Illinois EPA cannot speak for the City of Greenville but this question will be forwarded to the city as an option for them to consider. Examples like this are useful in securing landowners to participate in BMPs.

15. How many lakes are participating in the TMDL program as of today?

    Response: There are 201 lakes or watersheds on the TMDL list out of the 741 total water bodies identified as impaired in the state of Illinois. Of the 201 on the TMDL list, 6 have been studied in the same manner as Governor Bond Lake and two of those six have completed draft reports and have held meetings to receive comments from the public and other organizations.

    These are the lakes we are currently doing TMDLs on: (current as of June 2002)

- **Washington County Lake**
- **Kincaid Lake**
- **Dutchman Lake**
- **Altamont Reservoir**
- **Vandalia Lake**
- **Borah Lake**
- **Olney East Fork Lake**

16. How many water bodies have done a report and study like the Zahniser report around the state?

    Response: There are approximately 43 reports completed statewide under the Federal and State Clean Lakes Program. These studies are called Phase I in the Clean Lakes Program and are designed to evaluate water quality problems identified for these lakes.

17. Have any of the Clean Lakes Program Reports resulted in work projects being conducted?

    Response: There are eighteen lakes in Phase II. Implementation of work projects occurs in Phase II of the Clean Lakes Program.

18. Could the community get a list of those who have done work, so we could talk to them and see what they've done and how they've done it?

Response: The eighteen lakes currently under Phase II in the Clean Lakes Program and their contacts are as follows:

LAKE NAME	PREPARED FOR	PREPARED BY	PHONE #
Baumann Park/Cherry Valley	Village of Cherry Valley	Hanson Engineers-Roger Anderson	217/788-2450
Channel Lake, Lake Catherine	Fox Waterway Agency	Cochran & Wilken	217/585-8300
Chicago Botanic Garden Lagoons	Chicago Horticultural Society-Bob Kirschner	NIPC-Holly Hudson	312/454-0401 Ext.302
Herrick Lake	Forest Preserve District of DuPage Co.	NIPC-Holly Hudson	312/454-0401 Ext.302
Indian Lake	Chicago Zoological Society	NIPC-Holly Hudson	312/454-0401 Ext.302
Johnson Sauk Trail	IDOC	ISWS-Shundar Lin	309/671-3196
Lake George	Village of Richton Park	NIPC-Holly Hudson	312/454-0401 Ext.302
Lake Le-Aqua-Na	IDOC	ISWS-Shundar Lin	309/671-3196
Lake Lou Yaeger	City of Litchfield	CMT	217/787-8050
Lake Springfield	CWLP	CWLP-Michelle Bodamer	217/757-8660 Ext.125
Lake Storey	City of Galesburg	Cochran & Wilken	217/585-8300
Lake-Of-The-Woods		Champaign County Forest Preserve District-Don Humphrey	217/595-5432
Meadow Lake	Morton Arboretum-Kris Bachtell*	Harza Engineering	*630/968-0074
Otter Lake	ADGPTV(Otter Lake)Water Commission-Dennis Ross	ISWS-Shundar Lin	309/671-3196
Paris Twin Lakes	City of Paris	Cochran & Wilken	217/585-8300
Sherman Park Lagoon	Chicago Park District	Chicago Park District	312/742-7529
Stephen A. Forbes		Cochran & Wilken	217/585-8300
Woods Creek Lake(Lake-In-The-Hills)	Village of Lake-In-The-Hills	Devery Eng. Inc.-Robert Devery	847/548-6774

* Phone number is for Morton Arboretum contact, not Harza Engineering.

19. Does the EPA give the City of Greenville the authority to put a nine-mile drainage district on our lake by a City ordinance?

Response: The Illinois EPA cannot authorize the City to establish a drainage district within the watershed. Drainage districts generally do not function to improve water quality but rather to improve conveyance, the movement of water from one location to another. A watershed planning group or committee could be formed by the City to provide for overall planning, set up projects and demonstrations, and seek funding.

20. What kind of time frame does the USEPA have for approving or not approving the TMDL?

    Response: Illinois EPA submits the report to USEPA who must approve or disapprove the TMDL within 30 days.

    The Illinois EPA anticipates that because USEPA is aware of all the steps that have been taken for this TMDL, this will allow matters to proceed quickly and with more certainty of approval than would otherwise.

21. When does the Illinois EPA plan to submit the TMDL to USEPA?

    Response: After the record was closed on August 30th, this responsiveness summary was developed and the TMDL was revised to produce a final draft. This Responsiveness Summary and the revised TMDL Report will be submitted to USEPA for approval in September 2002.

22. There were a couple of references to the term "impaired for designated uses". What is that based on? Does that involve health or safety issues for recreational use or swimming?

    Response: Designated uses were established by the Illinois Pollution Control Board and are documented in the water pollution regulations of 35 Ill. Adm. Code Subtitle C. Designated uses and the water quality standards form the basis against which impairment is determined. Those determinations are published biannually in the Illinois Water Quality Report (also called the Section 305(b) Report). The designated uses for Illinois waters are: drinking water, aquatic life, swimming, secondary contact (boating) and fish consumption.

    When a water body is listed for a certain use, there are parameters used to measure whether it is impaired according to the guidelines published in the Illinois Water Quality Report. Illinois EPA did not review recreational or swimming because there were not enough data to evaluate whether it is impaired. The Zahniser Institute identified fecal coliform results were high in some areas of the lake, which would be a human health issue. The issues that affect swimming use in the TMDL report are clarity of the water and algal growth.

23. Regarding the statement that a shoreline survey was performed and the erosion ranged from none to severe, please indicate the location and amount of shoreline actually surveyed.

    Response: The Zahniser Institute completed a shoreline survey in 2000. Information on the survey was drawn from the Draft Governor Bond Lake Resource Management Plan, which was provided by the Institute. The Resource Management Plan is available from the Institute.

24. Please confirm the units used in table 2.2 measuring both total phosphorus (TP) and total nitrogen (TN).

    Response: The TP and TN units and significant figures were provided in the original data sets. The customary unit for those parameters is mg/L. The data units could be converted to any units desired. Refer to pages 21through 24 in Appendix A of the TMDL for the text and tables presenting this information.

25. Is the assumption of no seepage through the bottom of the lake valid, especially since the model uses this assumption to calculate other parameters?

Response: The model did not initially assume any seepage through the lake. Because seepage data were not available for the lake, a water balance approach was employed to assess the significance of the seepage. An assessment of the available discharge data for outflows from and inflows into the lake was made. This assessment found no residuals left in the lake (i.e., outflows were found to be greater than inflows). As a result, no seepage loss through the bottom of the lake was assumed.

26. Has the draft TMDL report, specifically the last sentence on page 7, correctly identified the infiltration of water around the lake?

Response: We believe this was addressed adequately using the Universal Soil Loss Equation (USLE) approach employed in this analysis. Under this approach, land use and soil characteristics govern water infiltration around the lake.

27. Does the draft TMDL describe the runoff/erosion process and the nutrients carried by the same while considering the influence of field tiles and other subsurface drains based on observation or were calculations based on general assumptions?

Response: The influence of specific field tiles or subsurface drains was not assessed. Furthermore, the modeling approach does not directly simulate subsurface drains. Instead, the ground water components of the model incorporate subsurface drainage, whether through drains or ground water discharge. The ground water recession rate is determined through separation of the unit hydrograph for tributaries to the lake. Ground water and surface water components of the model were adjusted to reflect in-stream, measured conditions as best as practical.

28. In section 2.5.2, Nonpoint Sources, please further define the term "high" in relation to the Nitrate-N levels described. Please also provide the frame of reference and context for the statements concerning total nitrogen and phosphorus deposition rates.

Response: The Illinois EPA guideline for listing lakes as impaired from high nitrate levels is a measurement exceeding 2.2 mg/L at least once during the monitoring year. Observed values of 8.0 mg/L and 3.0 mg/L were deemed "high" in comparison to this guideline. This guideline is based on the 85th percentile for all similar samples collected statewide. These values also represent direct contributions to the lake.

29. Where has the approximately 4,300 acre-feet of sediment come from that is not accounted for when comparing the sediment survey's 4,900 acre-feet of reduced lake volume to the almost 600 acre-feet generated by the model?

Response: The values provided in the question represent a comparison between early bathymetric studies of Governor Bond Lake and more recent bathymetric studies conducted by the Zahniser Institute. This discrepancy is addressed in the Zahniser Institute final report cited above, and essentially results from differences in techniques. Nonetheless, these values do indicate a contribution of sediment load to the lake from lake and streambank erosion.

30. It appears that only about 10% of the lakes sediment load is accounted for in the calculations for 1990 through 1995. Does the model used in the draft TMDL properly address the lakes sediment load, specifically during that time period?

    Response: The model uses in-lake, measured non-volatile suspended solid (NVSS) data and modeled erosion rates. The NVSS values are not directly correlated to sedimentation rates. As a result, the conclusion that "about 10% of the sediment load is accounted for" is not supported. Furthermore, the table values cited are for one year alone, not a five-year period.

31. Can a further explanation be given of how the Cropping factor (C) and Conservation Practice factor (P) were calculated/derived, including a justification of why values of 0.43 and 1.0, respectively, were used instead of values closer to 0.20 and 0.70 respectively?

    Response: The C factor of 0.43, and the P Factor of 1.0 were derived using default values as found in the GWLF model. The C factor of 0.43 was derived by averaging the tillage practices within Bond County (Table C-6 in Appendix A) as identified in the 2000 Illinois Soil Conservation Transect Survey Summary (IDA). Upon further review, an average C factor of 0.43 was determined to be too high. Please refer to Response #48 for further discussion on this issue.

    A P factor of 1.0 was used because specific information does not exist to quantify the specific practices that may exist in the watershed. The use of a P factor of 1.0 adds to the implicit margin of safety for the TMDL.

32. How has historical field practice and crop rotation/selection affected the accuracy of sedimentation data collected? How does this further affect the predictive accuracy of the model for the TMDL recommendations?

    Response: It is difficult to compare the impact of historical field practices because of the problems inherent in the bathymetric data gathered in the past (refer to Response 1). The Zahniser Institute has conducted new studies and these provide a more accurate baseline for future comparisons. The TMDL model used in-lake measurements and erosion factors based on current land uses. Therefore, the model is appropriate for assessing the impact of changes in current land management practices.

33. Wouldn't a 10-25% reduction goal for sediment (NVSS) be more realistic to start with? Couldn't further reductions then be phased in over time with continued data collection to verify the intended results?

    Response: The original reduction goal proposed in the TMDL will be met on a gradual basis. Monitoring and sampling will determine how the watershed is progressing towards meeting the goal(s) and whether the goal(s) need to be adjusted. Illinois EPA intends to use an "adaptive management" approach, in which certain actions (BMPs), identified in the TMDL, will be implemented and monitored so that subsequent actions (more or other BMPs) can be adjusted.

34. During 1977-1999, what were the frequency, schedule, and condition by which samples were collected?

Response: Samples were collected during periods of non-threatening weather.

Samples were taken one time a month for:
- **1977-June**
- **1982- May and August**
- **1989, 1993, 1996- April or May, June, July, August, and October**

Samples were taken up to two times a month for volunteer data from 1982-88, transparency only: 1988 WQ.

For 1999:
- **3 times in May**
- **5 times in June**
- **3 times in July**
- **4 times in August**
- **2 times in September**
- **3 times in October**
- **2 times in November**

35. Were all the samples collected simultaneously for all parameters?

Response: Yes.

36. Were samples collected during the types of flows and events the TMDL analysis modeled?

Response: The model looked at whole month or whole season averages for periods covered by the monitoring data. The single event monitoring data were converted to monthly or seasonal values by applying flow-weighted values using the FLUX model.

37. Were the water quality data and the flow of the lake correlated?

Response: Refer to Response 36. Water quality data and flow data were used to develop monthly or seasonal load values using the FLUX model.

38. How many pending 401 certifications are located in the Governor Bond Lake watershed and how will future requests be addressed?

Response: There are no pending 401 certifications in the watershed. Agency engineers will follow standard procedures in assessing future requests. Since projects requiring 401 are largely voluntary, load reductions from these projects cannot be relied upon as a significant means to address impairment.

39. How many National Pollution Discharge Elimination System (NPDES) permits are located in the Governor Bond Lake watershed and how will future requests be addressed?

    Response: There is currently one NPDES permit located in the watershed. That discharge is from a seasonally used camp. Under 303(d) of the Clean Water Act, Illinois EPA cannot allow the addition or expansion of a point source that would contribute to the impairment. At the time this response is being written (June 2002), the Illinois EPA has initiated enforcement against a livestock facility in the watershed. As part of that case, the Agency is seeking to have the facility permitted under the NPDES system. Current livestock regulations prohibit surface water discharges by livestock facilities. It is unlikely the adoption of the TMDL will affect or be affected by this facility, once permitted.

40. What 319 funds are available for implementation of BMPs and/or voluntary non-point source controls? Will any USDA funds be available for the same?

    Response: If the annual federal appropriation for Illinois' Section 319 is comparable to the FY2002 appropriation, IEPA estimates that approximately six million dollars will be available for developing TMDLs and for implementation of voluntary nonpoint source BMPs for federal fiscal year 2003.

    USDA offers a wide variety of programs that provide technical and financial assistance and encourage land stewardship: Environmental Quality Incentive Program (EQIP), Wildlife Habitat Incentive Program (WHIP), Wetlands Reserve Program (WRP), Conservation Security Program (CSP), and Conservation Reserve Program (CRP). These programs are summarized on the USDA website at www.usda.gov.

41. How many of the onsite wastewater systems have been inspected and what percentage are meeting appropriate discharge effluent standards? How many are surface discharges? How many have NPDES permits?

    Response: Approximately 108 septic systems were inspected at residences near the lake. Of these, 100 were functioning appropriately. These septic systems are not designed to have discharge to surface water and are therefore not permitted under the NPDES system.

42. Are there any voluntary agreements, memos of understanding, resolutions, ordinances, contracts, or any other devices already in place, or being discussed, that the Agency believes will be utilized in order to attain the TMDL goals and objectives?

    Response: The Illinois EPA is funding both a Section 319 grant and a Clean Lakes project through the City and Zahniser Institute. See Response #7.

43. Many in the community look forward to working with the Illinois EPA and for the Agency to provide leadership for the stakeholders such as the City and agricultural community. Perhaps a memorandum of understanding between agencies, NRCS, et cetera, as well as additional funding, programs examining zoning around the lake and working with the public health department will occur in the near future. We look forward to the leadership we expect from the Agency and thank you for your time.

    Response: Thank you for the suggestions and comments.

44. The TMDL report would be much more useful to the general public and to the various commenters if it visually indicated where information was gathered and what the results of the surveys found. Examples of the information that could be added would be maps, charts, and graphs that show land-use features more precisely, where riparian corridors exist, and specifics about the "lay of the land".

Response: Noted. Thank you for the suggestions and comments.

45. The water quality monitoring plan needs to provide much more detail, specifically what type of monitoring will be done, what frequency of monitoring, what parameters will be checked, and predicted locations where the monitoring will occur. The Agency also needs to describe who is responsible for collection, analysis, and interpretation of the data. It seems prudent for the Agency to also consider including biological monitoring components, similar in scope to other Agency programs.

Response: The monitoring of the lake will continue through the Agency's normal ambient (ALMP) and volunteer lake monitoring program (VLMP). The ALMP will continue to sample the lake five times a year, every three years. The VLMP will sample up to 12 times every year. In addition to the traditional VLMP the volunteers will also be collecting monthly and storm event suspended solids and nutrient samples at major tributary inflows for approximately the next four years. Once all the BMPs and in-lake projects are concluded, a one-year intensive monitoring program will begin. This will include, at a minimum, two in-lake and tributary samples per month (April through October) and one sample a month during the non-growing season. It will also include up to 18 storm event samples for each of the tributaries. For each of the programs listed, parameters include nutrients, suspended solids, pH and alkalinity collections. Biological sampling will consist of chlorophyll *a*, *b* and *c*, phenophytin and dissolved oxygen sampling. For consistency, all monitoring will occur at the three historically sampled lake sites and at the tributary sites established during the Illinois Clean Lakes Program Phase I study.

46. The TMDL is very difficult to read and evaluate because it does not include the water quality data for Governor Bond Lake and its tributary streams. That data was the basis for placing the stream on the 303(d) list and was used in calibrating the watershed-loading model.

Response: The data on which the decision to list the lake as impaired are available through the federal database system, STORET, at www.epe.gov/storet. We published a synopsis in the TMDL, similar to the information we publish in the 305(b) Report. We believe that the majority of those reviewing the TMDL will find a synopsis more meaningful.

47. Frequently, the TMDL does not present critical values used in the model, such as sediment delivery ratio, but refers the reader to the user's manual for the model, which is not readily available to the lay reader.

Response: Table C-4 in Appendix A of the TMDL contains sources for all critical values. The TMDL was organized in this manner to allow those who are interested in the modeling details to refer to the appendix, while allowing other readers to focus on the key issues and results described in the TMDL document. Specifically, the sediment delivery ratio is on page 33 in the GWLF Manual published in 1992 by Haith et. al.

48. Perhaps the most obvious and significant technical error in the TMDL is the use of grossly incorrect C-factors in calculating soil losses from cropland within the watershed. Using the assumptions presented in the TMDL, errors may result in overestimating cropland erosion rates by as much as 90 percent. If not corrected

the TMDL may significantly underestimate the effectiveness of conservation tillage systems in reducing soil erosion.

Response: Upon further consultation with NRCS, IDA, UIUC, USEPA, Tetra Tech, and Illinois EPA, a consensus was reached concerning an average C factor for the watershed. C factors used in Appendix A, page 11, Tables C-5 and C-6 were considered to be too high because they were based on C factors found in the GWLF model which were generalized values of cover and management factor (C) for field crops east of the Rocky Mountains (Stewart et al., 1975), and were not C factors specific to Illinois. Based on discussion among the above-mentioned group, it was determined that using C factors representative of Illinois would result in an average C factor approximately half (0.23) that stated in the TMDL. Based on this, it was determined that the sediment loads from sheet and rill erosion stated in the TMDL would be approximately half that listed. Consequently, one third of the sediment load is expected to come from sheet and rill erosion, with two thirds of the load coming from gully, ephemeral gully, stream bank and shoreline erosion.

49. On page 28, the TMDL seems to reflect an over-reliance on modeled predictions and a disregard of local knowledge that could have been evaluated rather easily by surveying the condition of the streams.

    Response: In developing the TMDL, researchers at the Zahniser Institute at Greenville College and the local Natural Resources Conservation Service and Soil and Water Conservation District office were consulted. It was thought that those individuals had the best local knowledge of the Governor Bond Lake watershed.

50. The TMDL also ignores the potentially significant contribution of sediment and phosphorus to the lake as a result of streambank or gully erosion. The TMDL noted but did not use a report by the Bond County Soil and Water Conservation District that estimated gully and streambank erosion could account for a significant proportion of the sediment reaching the lake. The TMDL states, "gully and streambank erosion would increase lake siltation rates by 0.13 percent original volume loss per year." We believe that this statement would more appropriately be rephrased to: "Total gully and streambank erosion could account for more than 50 percent of the siltation in the lake." Streambank erosion may also be a significant source of phosphorus to the lake. Scientists at the Illinois State Water Survey and the Illinois Natural History Survey have estimated that about 30 percent of the nutrient yield from a watershed in western Illinois was the result of streambank erosion.

    Response: The estimates for gully and streambank erosion were based on the Zahniser Institute of Environmental Studies 2001 Clean Lakes Program Report for this watershed. We believe these sources of erosion could be much higher and have modified the TMDL to reflect this higher rate.(refer to Appendix A, page 29). Site-specific erosion values will be necessary as part of an effective implementation plan.

51. The TMDL is based on unrealistic water quality endpoints that are not feasible. The Illinois water quality standard for total phosphorus in lakes and reservoirs is 0.05 milligrams per liter, but we question whether that standard is appropriate for an impounded stream draining a watershed underlain by fertile, but erosive soils. The load allocation for total phosphorus in the TMDL is equivalent for the average year to about three ounces of phosphorus per year from each acre of the watershed. In southern Illinois, only two watersheds have a smaller phosphorus yield, and one of those is in Shawnee National Forest. We also believe that the water quality endpoint for non-volatile suspended solids (NVSSs) is not achievable. One of the primary functions of a stream is to carry sediment. Even if the entire watershed were converted to no-till systems or

other cover, it is very possible that the reduction in sediment load from the watershed would result in an increase in streambank erosion.

Response: The phosphorus water quality standard for lakes was established by the Pollution Control Board and has been appropriately applied in this instance. However, the Illinois EPA is currently reviewing information related to phosphorus in preparation for drafting proposed nutrient standards. Should the phosphorus standard for lakes be adjusted as a result, the phased implementation of the BMPs in this watershed (by which we intend to approach compliance) should allow the Agency and stakeholders flexibility. Scouring of streambed and banks may occur under the circumstances you describe (conversion to no-till or other cover crops). This assumes, however, that other BMPs were not adopted to account for in-stream sources of sediment. This statement also appears to attribute most of the NVSS load to upland sources, which has since been revised.

52. The TMDL is confusing in its presentation of data on the relative proportion of particulate and dissolved phosphorus in water quality samples from the influent streams. However, Table C-18 in Appendix A indicates that 60 to 80 percent of the total phosphorus entering the lake is in the dissolved form. Most of the best management programs recommended in the TMDL will not reduce loadings of dissolved phosphorus. Recently, a group of scientists from the University of Illinois and state and federal agencies gathered to evaluate the effectiveness of various cultural and structural management practices in reducing movement of sediment and nutrients to surface waters. It was the consensus of that group, based on peer-reviewed research, including studies conducted in Illinois, that conservation tillage systems increase losses of dissolved phosphorus and that riparian buffers and wetlands will have little, if any, effect on dissolved phosphorus loadings to lakes and streams. Therefore, we do not believe that a 94 percent reduction in total phosphorus loadings is feasible.

    Response: The TMDL recommends the use of a number of BMPs in combination to achieve reductions in sediment and nutrient load. Those BMPs are consistent with those recommended by the Zahniser Institute as part of their Clean Lakes Program study. In addition, the TMDL document recommends the use of in-lake BMPs to reduce in-lake cycling of phosphorus, which is a significant source of the dissolved form of the nutrient.

    Your evaluation of BMPs has been noted. A compendium of BMP effectiveness published by USEPA (*Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*, Jan. 1993) indicates significant ranges in nutrient reduction in case studies nationwide.

53. As presented, the TMDL for Governor Bond Lake fails to meet the criteria of using sound science and requiring that the solutions be justified and feasible and should be re-evaluated.

    Response: In the process of revising this draft TMDL, with input from several sources in the agricultural community, we have adjusted and modified several model inputs and assumptions. As a result, we believe the science supporting the TMDL has been improved. Moreover, by adopting a phased approach to further investigation, monitoring and BMP installation, solutions can and will be justified. Solutions will rely on voluntary measures. Impractical and infeasible ones should be eliminated at the start.

54. A concern was expressed by a lakefront resident that the recent removal of horsepower limits on the lake is "a major cause of lake soil erosion" citing that they had lost two feet worth of shoreline and the riprap had

dropped away making it ineffective. They would like the city to consider again placing the horsepower restrictions on the lake as one or part of the solutions to soil erosion into the lake.

Response: We note this and will convey this information to the City, which controls limits on horsepower on the lake.

55. The TMDL report should be resubmitted with more careful considerations of sediment sources, using more available data, and after additional necessary data have been obtained. Without such a re-working of the document, the decisions and recommendations made by the report are likely to be flawed. The decisions of the report are too important, expensive, and life-changing for the citizens living and working on the watershed to allow faulty results.

    Response: Given the importance of determining sediment sources, attributing appropriate loads and assigning BMPs properly, we will conduct further evaluations of streambank and bed erosion <u>prior to</u> taking any action toward upland soil erosion.

56. Best management practices and other steps to reduce pollutant loadings are listed in the TMDL report, but no specifics are provided as to how the measures will actually be implemented. By failing to identify the partners, resources, and time frames needed to accomplish the stated goals of the TMDL report, there is no assurance that there will be real water quality improvements.

    Response: This TMDL was funded directly by USEPA. At the time, Congress prohibited USEPA from conducting TMDLs under regulations that would have allowed for consideration of the implementation factors cited in this question. (Other TMDLs now under development will contain comprehensive implementation plans). The implementation of BMPs and further study of specific issues will be carried out with the city, NRCS, the county soil and water conservation district, Zahniser Institute, and others.

GLOSSARY AND ACRONYMS

BMPs	Best Management Practices. These are practices that have been determined to be effective and practical means of preventing or reducing pollution from nonpoint sources.
C-factor	C is the cover-management factor. The C-factor is used to reflect the effect of cropping and management practices on erosion rates. It is the factor used most often to compare the relative impacts of management options on conservation plans.
IEPA	The Illinois Environmental Protection Agency (also referred to as the Agency or Illinois EPA)
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NVSS	Non-volatile suspended solids
P-factor	P is the support practice factor. P-factor reflects the impact of support practices on the average annual erosion rate. It is the ratio of soil loss with contouring and/or strip cropping to that with straight row farming up-and-down slope.
STORET	Storage and Retrieval of Water Quality Control
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USLE	Universal Soil Loss Equation. A method of estimating the average soil loss from sheet and rill erosion that might be expected to occur over an extended period under specified conditions of soils, vegetation, climate, cultural operation, and conservation measures.

* *

DISTRIBUTION OF RESPONSIVENESS SUMMARY

Copies of this responsiveness summary were mailed in October 2002, to all who registered at the hearing, to all who sent in written comments and to anyone who requested a copy. Additional copies of this responsiveness summary are available from Mark Britton, Illinois EPA Office of Community Relations, phone 217-524-7342 or e-mail Mark.Britton@epa.state.il.us.

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Questions regarding the public hearing record and access to the exhibits should be directed to Hearing Officer Bill Seltzer, 217-782-5544.

The public hearing notice, the hearing transcript and the responsiveness summary are available on the Illinois EPA website: www.epa.state.il.us

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