THE IMPACT OF DISCRETE POLLUTANT SOURCES ON THE WATER QUALITY OF LAKE LANIER

M. Timmerly York[1], Appiah Amirtharajah[2], Barbara Brouckaert[1]

AUTHORS: Graduate Student Assistant[1] and Professor[2], Environmental Engineering, School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, Georgia 30332.

REFERENCE: *Proceedings of the 1997 Georgia Water Resources Conference*, held March 20-22, 1997, at the University of Georgia, Kathryn J. Hatcher, Editor, Institute of Ecology, University of Georgia, Athens, Georgia 30602-2202.

Abstract. The potential discrete pollutant sources in the Lake Sidney Lanier watershed were identified and investigated. A sampling program was conducted to determine typical concentrations of pollutants from ten wastewater treatment facilities and from urban stormwater runoff into three streams. Average yearly pollutant loadings into the lake were calculated based on the results from the sampling program and the facilities' monitoring data. These calculations indicate that urban stormwater runoff is a significant portion of the total loading of biochemical oxygen demand (BOD_5) into the lake. The effluent from municipal wastewater treatment facilities com-prised the significant portion of nitrogen, ammonia, and total organic carbon (TOC) loading. The loading of phos-phorus was approximately equal from urban runoff and the municipal effluents. This investigation indicates that, of the sources investigated, municipal wastewater treat-ment facilities and urban runoff can provide significant loadings of pollutants into Lake Lanier. Synthesis of this research with that of nonpoint sources of pollution will provide the basis for sound watershed management of Lake Lanier.

INTRODUCTION

Lake Sidney Lanier in North Georgia is a 38,000 acre reservoir formed by Buford Dam. The impoundment, which is managed by the Army Corps of Engineers, has become an integral part of the economy of North Georgia. The primary purposes of the reservoir are flood control, navigation and hydropower. However, the lake has also become an important source of recreation, fisheries, municipal and industrial water supply and water quality via low flow augmentation (Hatcher, 1994). The outfall from Buford Dam is the Chattahoochee River which flows through Georgia, Alabama and Florida until it reaches Apalachicola Bay.

Because of the importance of Lake Lanier to the surrounding ecosystem, to the population of North Georgia, and to the inhabitants downstream of the dam, it is imperative that the lake's watershed be managed to ensure that the lake is healthy and viable. In order to properly manage a watershed it is necessary to identify the potential pollutant sources in the watershed and to determine the extent of pollution from these sources. A previous Lake Lanier Clean Lakes Study (Hatcher, 1994) assessed the current water quality of the lake and investigated some nonpoint source pollutant loadings into the lake. The purposes of the research presented here are to identify and investigate the discrete pollutant sources in the watershed and to calculate pollutant loadings from some of these sources and from urban stormwater runoff. There is currently no up-to-date information on these pollutant sources and loadings into Lake Lanier.

Under its Clean Lakes Program, the U.S. Environmental Protection Agency (EPA) gives grants for lake water quality management. The research presented here is a part of the Phase I Diagnostic/Feasibility Study of Lake Lanier to investigate the extent and sources of pollution into Lake Lanier. The results of this research will demonstrate the sources of pollution that are of critical importance to the well-being of the lake. This will be important in developing proper watershed management programs to protect the lake.

IDENTIFICATION OF POLLUTANT SOURCES

Lake Lanier's watershed consists of a large part of Forsyth, Habersham, Hall, Lumpkin and White counties and small sections of Dawson, Union and Gwinnett counties. There are many different potential sources of pollution in the watershed. Several of these potential pollutant sources were investigated. A summary of the results of the number of facilities in the watershed is presented in Table 1.

Table 1. Number of Facilities in the Watershed

Marinas	10	RCRA notifiers(1)	200
Municipal	13	CERCLA	6
PIDs	33	NPL	0
Industrial WWTP	8	HSI	0
Manufacturers (1)	360	LUST (1)	120
Landfills	8	Cemeteries (2)	30
Septic Tanks (2)	5,200		

(1) Number of facilities in counties surrounding Lake Lanier

(2) Estimates based on number within 300' (septic tanks) or 4000' (cemeteries) of lake

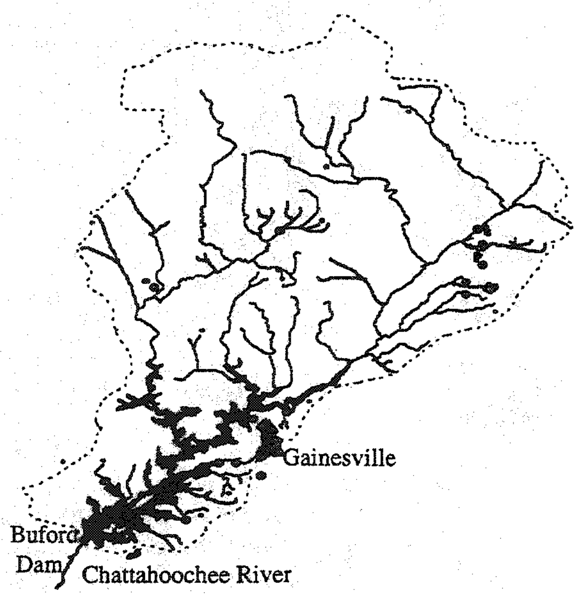

Figure 1. Lake Lanier Watershed with sampling locations marked.

The National Pollutant Discharge Elimination System facilities include the municipal wastewater treatment plants (WWTPs), PIDs (Private Industrial Developments), and industrial WWTPs.

The hazardous waste sites include Resource Conservation and Recovery Act (RCRA) sites, Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites, the National Priorities List (NPL, "Superfund") sites, and Georgia's Hazardous Site Index (HSI) sites. There are no known major hazardous waste sites of significant concern in the watershed.

The landfills and Leaking Underground Storage Tanks (LUST) information was obtained from file review at the EPD. Of the eight known landfills, five are closed and one is in the process of obtaining authorization to close.

The estimated number of septic tanks and cemeteries in close proximity to the lake was determined by enumeration from United States Geological Survey 7.5 minute quadrangle maps.

Each of these sources was investigated to determine the current and potential contribution of pollutants to the lake. It is beyond the scope of this paper to present the results of this analysis.

SAMPLING PROGRAM

In an effort to obtain more accurate information about the contributions of point source pollution and urban runoff into the lake, a sampling program was employed. Out of the potential pollutant sources mentioned previously, only wastewater treatment plants (WWTPs) and urban runoff were considered in the sampling program. The reasons for this are two fold. First, the relative amounts of pollution contributed by WWTPs and urban runoff are reasonably assumed to be much greater than that from marinas, landfills, septic tanks, USTs and cemeteries. Second, it is difficult to conduct comprehensive sampling from these latter sources (in addition to the WWTPs and urban runoff) in a timely and cost efficient manner. The sampling program included wastewater treatment effluents and urban stormwater runoff sampling.

Table 2. Wastewater Effluent Concentrations

Parameter	Min	Max	Avg
CBOD5 (mg/L)	2	85	20
Fecal Coliform	< 1	1000	137
NH3 (mg N/L)	< 0.1	47.4	6
NO3- (mg N/L)	0.5	300	21
NO2- (mg N/L)	< 0.01	3.86	0.37
P (mg P/L)	0.01	8.9	2.9
TSS (mg/L)	1	185	20.5
Conductivity (umohs/cm)	139	1271	486
Mercury (ug/L)		< 0.2	
TOC (mg/L)	3	43	9
Turbidity (NTU)	1	120	21

Wastewater Sampling

Grab samples of the effluents from municipal and industrial wastewater treatment plants were collected and analyzed over a period of nine months in 1995 and 1996. The effluent sampling was planned in two tiers. Tier one facilities were considered to have the greatest impact on the lake and were sampled twelve to fourteen times. The tier two facilities, considered to have a lesser impact, were sampled three times each.

The effluent samples were analyzed for the following water quality parameters: $CBOD_5$, total and fecal coliforms, conductivity, mercury, ammonia, nitrite, nitrate, total phosphorus, total inorganic phosphorus, total organic carbon (TOC), total suspended solids (TSS), turbidity, and a scan of trace metals including arsenic and selenium. According to the analyses conducted for this project, most facilities are meeting their permit requirements. A summary of the results is shown in Table 2. For more information on the trace metals analyses see Brouckaert et al. (1997).

Table 3. Urban Runoff Concentrations

Parameter	Min	Max	Avg
NH3 (mg N/L)	0.37	3.55	1
NO3- (mg N/L)	0.19	8.24	3.8
NO2-)mg N/L)	<0.01	0.19	0.03
P (mg P/L)	0.04	1.15	0.45
TSS (mg/L)	8	444	96
Conductivity (umohs/cm)	82	311	168
Mercury (ug/L)		< 0.2	< 0.2
Turbidity	33	198	79
Carbaryl (ug/L)		< 1	< 1
Diazinon (ug/L)		< 0.5	< 0.5
Dursban (ug/L)		< 0.5	< 0.5
Malathion (ug/L)		< 1.4	< 1.4

Table 4. Average Annual Pollutant Loading Ranges (1000 kg/yr)

	BOD	TO	N	NH3	P
Municipal	143	100	450	110	24
PID	3	5	9	5	1
Industrial WWTP	8	9	3	1	1
Septic Tanks	2	--	44	11	1
Urban Runoff	570	--	220	45	25
TOTAL	726	114	726	172	52

Urban Runoff Sampling

Gainesville is the only city of significant size in the watershed. Because it lies alongside the lake, there are unlimited areas for stormwater runoff. However, runoff from urbanized areas of Gainesville flow into two streams, South Flat Creek and Limestone Creek. These creeks and Six Mile Creek (which has had a history of problems) were chosen to be sampled for stormwater runoff. They were sampled three to four times during the study. The analyses included: conductivity, mercury, ammonia, nitrite, nitrate, total phosphorus, total suspended solids, turbidity, a scan of trace metals, and insecticides. A summary of the results is presented in Table 3.

POLLUTANT LOADING CALCULATIONS

Several different analyses were conducted to determine the average annual loading of various pollutants into Lake Lanier. The loadings of BOD_5, TOC, nitrogen, ammonia, and phosphorus were calculated based on historical monitoring data and the results from the current sampling program. The loadings of these pollutants were calculated for five different potential pollutant sources: municipal WWTPs, urban runoff, industrial WWTPs, PIDs and septic tanks.

Monitoring Data

The available monitoring data for the NPDES facilities were analyzed to determine pollutant loading values. For facilities and pollutants that were permitted and had monitoring data available, loadings were calculated based on the flow-weighted average concentrations and flows.

Sampling Data

Wastewater Effluent Data. Because the monitoring data were not complete, not always up-to-date, and subject to analysis bias, loadings were calculated from the sampling data. Again, flow-weighted averages of the parameter concentration and flows were used to calculate the average annual loadings. For the facilities that were not sampled, the loadings calculated based on monitoring data were used.

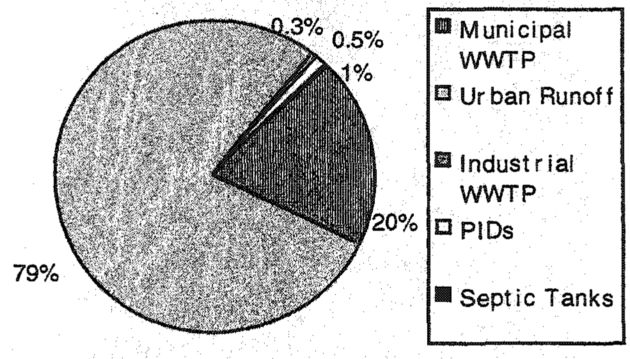

Figure 2. BOD5 loadings from specific discrete pollutant sources.

Stormwater Values. The loadings for urban runoff into the three streams studied were computed using the flow-weighted average concentrations, precipitation information and land use information. The runoff volume was computed based on the Soil Conservation Service (SCS) Method for Abstractions (Chow, 1988).

Septic Tank Calculations

Loadings of BOD, nitrogen and phosphorus from the septic tanks within 300 feet of Lake Lanier were calculated using several different methods (Kaplan, 1991; Reckhow, 1980; USEPA *National Eutrophication Study*). Loading calculations were not determined for ammonia and TOC due to lack of information.

Results

The annual pollutant loadings calculated from the monitoring data and the sampling data showed good correspondence. The loadings from the sampling analyses were used to estimate an expected pollutant loading range and an average. A summary of this average annual loading data by pollutant and source is presented in Table 4. The average annual loadings of pollutants were also compared on a percent basis. Figures 2 through 4 display the BOD5, nitrogen and phosphorus results graphically. The TOC results are

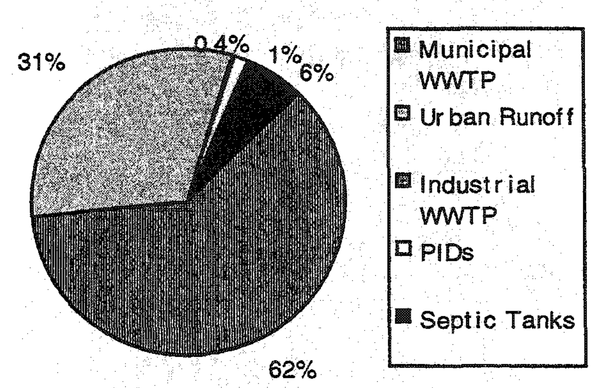

Figure 3. Nitrogen loadings from specific discrete pollutant sources.

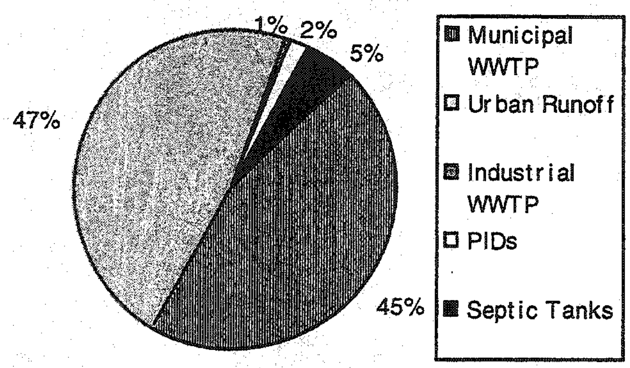

Figure 4. Phosphorus loadings from specific discrete pollutant sources.

not shown because loadings were not calculated from the septic tanks and urban runoff. Results from ammonia loadings are also not shown graphically because the percent contributions of nitrogen and ammonia from the sources are comparable. It should be noted that "urban runoff" is only for the three streams analyzed and that the sources shown are not the only sources that contribute these pollutants to the lake.

DISCUSSION

From the loading calculations it is apparent that the municipal dischargers contribute the largest percent of pollutant loadings into the lake of the sources analyzed. Based on the loading calculations it can be deduced that nitrogen, ammonia, and TOC loadings are mainly from the municipal WWTPs, BOD from urban runoff, and phosphorus from municipal WWTPs and urban runoff. It is important to note that the urban runoff shown is only from three streams. Thus, it does not represent the contribution of all urban runoff in the watershed. However, it does give a good indication of trends. If only a small percentage of urban runoff is represented, then the effect of all urban runoff must be larger than is represented in this paper. Thus, urban runoff can comprise a significant portion of the pollutant loading into Lake Lanier. It is recommended that further studies be conducted to determine pollutant loadings from all types of stormwater runoff (such as, agricultural, urban, and forested) in the watershed.

SUMMARY AND RECOMMENDATIONS

Several potential pollutant sources (marinas, municipal WWTPs, industrial WWTPs, landfills, septic tanks, hazardous waste sites, USTs and cemeteries) in the Lake Lanier watershed were identified and investigated. A sampling program was conducted to determine the contribution of pollutants from the wastewater treatment facilities and urban runoff. The investigations of the potential pollutant sources and the sampling program results led to determinations of average annual pollutant loadings of various pollutants (BOD5, TOC, nitrogen, ammonia, phosphorus) from specific sources (municipal WWTPs, PIDs, industrial WWTPs, septic tanks and urban runoff). These analyses show that municipal WWTPs and urban runoff contribute the greatest quantity of the pollutants from the sources investigated.

The information gained from this research is valuable in determining the contribution of discrete pollutant sources into the lake. The next step is to combine this data with information on other sources of pollution into the lake (such as agricultural runoff and atmospheric deposition) to determine the overall loadings into the lake. Once the "big picture" is examined, it will be possible to determine which sources contribute the most to the degradation of the lake and which can be most feasibly controlled. This holistic approach furthers appropriate management of the watershed for the preservation of Lake Lanier.

ACKNOWLEDGMENTS

This work was partially funded by the Georgia Department of National Resources through The University of Georgia.

LITERATURE CITED

Brouckaert, Barbara, A. Amirtharajah, Guangxuan Zhu, M. Timmerly York. 1997. Heavy metal loading to Lake Lanier from point sources of pollution and urban runoff. *Proceeding of the 1997 Georgia Water Resources Conference.*

Chow, Ven Te, David R. Maidment, and Larry W. Mays. 1988. *Applied Hydrology*. New York: McGraw-Hill.

Hatcher, Kathryn et al. 1994. "Diagnostic/Feasibility Study of Lake Sidney Lanier, Georgia." Project Completion Report prepared for Georgia Environmental Protection Division.

Kaplan, O. Benjamin. 1991. *Septic Systems Handbook.* 2nd ed. Michigan: Lewis Publishers.

Reckhow, K. H. and J. T. Simpson. 1980. A Procedure Using Modeling and Error Analysis for the Prediction of Lake Phosphorus Concentration from Land Use Information. *Canadian Journal of Fishing and Aquatic Sciences*. 37:1439-1448.

U. S. Environmental Protection Agency. *National Eutrophication Survey: Working Paper Series.* Pacific Northwest Environmental Research Laboratory. PB 248/886.