

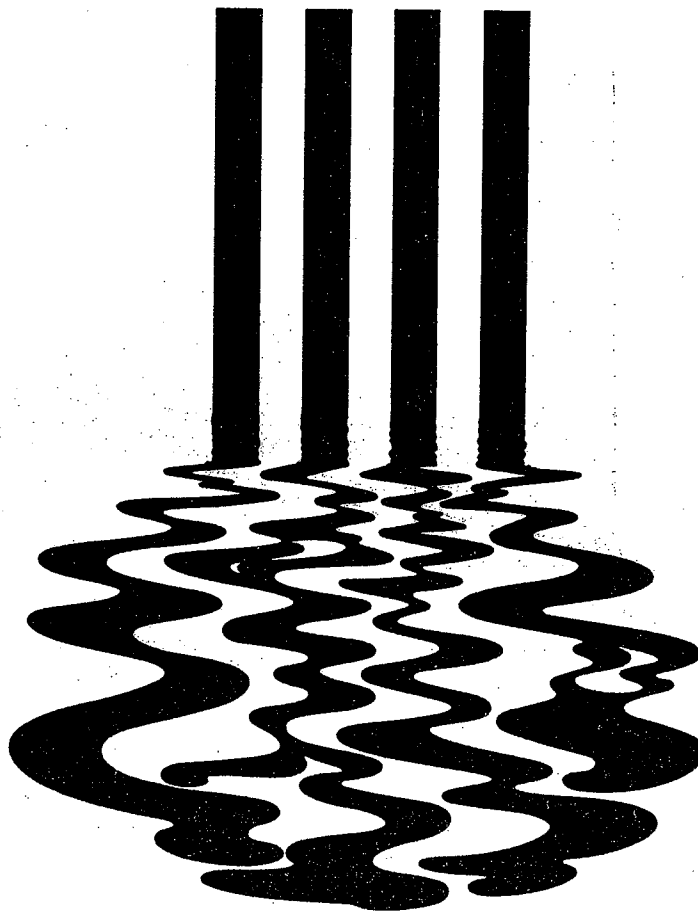
# Lake Maumelle Phase I

## Diagnostic / Feasibility Study

Prepared for the Arkansas Department  
of Pollution Control and Ecology



# FINAL REPORT



The University of Arkansas At Little Rock

Environmental Health Sciences Program

Department of Biology

Little Rock, Arkansas

LAKE MAUMELLE DIAGNOSTIC/FEASIBILITY STUDY  
FINAL REPORT

PREPARED FOR

THE ARKANSAS DEPARTMENT OF  
POLLUTION CONTROL AND ECOLOGY

AND

THE U.S. ENVIRONMENTAL PROTECTION AGENCY  
REGION VI OFFICE  
DALLAS, TEXAS

PREPARED BY

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**LAKE MAUMELLE DIAGNOSTIC/FEASIBILITY STUDY  
UNIVERSITY OF ARKANSAS AT LITTLE ROCK  
CARL R. STAPLETON, Ph.D., PROJECT DIRECTOR  
FINAL REPORT SUMMARY**

Arkansas contains over 204,453 surface hectares (ha) of lakes. Lakes of two ha or more in surface area represent a total of 2,462 lakes. This figure does not include the U.S. Corps of Engineers reservoirs, the U.S. Forest Service lakes, the Arkansas Department of Tourism lakes, and the Arkansas Game and Fish Commission lakes. These natural and constructed wildlife lakes fulfill demands for public water supplies, irrigation, habitat and flood control along with several other economic, environmental, and social benefits.

Based on present and forecasted needs, the demands on lake resources in Arkansas will increase significantly. These demands, as mentioned above, present conditions which can lead to serious direct and indirect impacts. It is evident that several lakes in Arkansas are experiencing accelerated water quality deterioration as a result of these stresses.

The goal of a lake resources program should be "to protect and maintain the physical, chemical, and biological integrity of lake resources through the application of the best available technical and management methodologies". Prevention is a key component for successful attainment of this goal. Policies focusing on good planning and anticipation of problems as opposed to treatment and/or restoration alternatives are required. It is also important that a lake's watershed be recognized as an integral part of lake resources management.

## STUDY OBJECTIVES

In response to the needs identified above, a grant application was submitted to the U.S. Environmental Protection Agency for a Diagnostic/Feasibility Study of Lake Maumelle, Pulaski County, Arkansas. Funding was approved under the Clean Lakes Program, Section 314 of the Clean Water Act as Amended in 1977 (PL92-500). This study was completed by the University of Arkansas at Little Rock under contract to the Arkansas Department of Pollution Control and Ecology.

Phase I of the Clean Lakes Program provides support for a Diagnostic/Feasibility Study. The Diagnostic portion included an assessment of current and future water quality conditions in Lake Maumelle and the influence of its watershed on water quality. In the Feasibility portion, technical and management recommendations were made in response to problems identified in the Diagnostic portion of the study. Also, funding and organizational mechanisms for implementation of the study recommendations were presented in the Feasibility section. Based on the outcome of the Phase I, Diagnostic/Feasibility Study, a Phase II application can be made to the U.S.EPA for partial funding to implement the recommendations presented in Phase I.

Specific objectives of the Lake Maumelle, Phase I Diagnostic/Feasibility Study, were as follows:

- o To provide a description of Lake Maumelle, its basin, and the economic characteristics of the current and potential user population as compared to other lakes in the region.
- o To determine historical, current and projected water quality conditions in Lake Maumelle including physical, chemical and biological characteristics.

- o To identify point and nonpoint pollutant sources in the Lake Maumelle basin and determine their current and projected impacts on Lake Maumelle.
- o To develop technical and/or management recommendations which will respond to current or anticipated water quality problems in Lake Maumelle and its watershed.
- o To determine benefits, potential funding, permit requirements, environment impacts, monitoring requirements, and a work schedule required for implementation (Phase II) of the recommendations presented in the Feasibility section of Phase I.
- o To develop, implement and report on methods used to insure public participation throughout the duration of the Lake Maumelle, Phase I Diagnostic/Feasibility Study.

#### **STUDY SITE DESCRIPTION**

Lake Maumelle is located approximately nineteen (19) km northwest of the City of Little Rock in Pulaski County, Arkansas. This water supply reservoir was completed in 1958 and supplies approximately sixty percent of the Little Rock Metropolitan area water needs with over 315,000 users.

A total of 3,603 surface ha are contained in Lake Maumelle. The lake is nineteen (19) km long with one hundred thirteen (113) km of shoreline. Primary inflow into Lake Maumelle is provided by the Big Maumelle River which drains a watershed of approximately 354.8 km<sup>2</sup>. The majority of land use in the watershed consists of forestland (87 percent). Silvicultural activities are commonplace in the watershed with forty-three (43) percent of the total watershed acreage owned by private timber companies.

Lake Maumelle exhibits characteristics associated with a warm monomictic lake. The lake stratifies directly in the summer with a Fall turnover and free circulation during the winter.

Water depths in Lake Maumelle vary from 2.5 meters in the western end compared to 13.7 meters near the old Maumelle River channel off the south shore of Big Island. An average depth of approximately 7.5 meters exists in Lake Maumelle.

### **Geology, Soils and Topography**

The Lake Maumelle basin is composed primarily of two consolidated rock types separated by an east-west trending fault which enters the basin in the east approximately 2.1 km (T3N R15 Sec. 1) north of Lunsford Corner, on the north side of Lake Maumelle. The fault continues westerly, and exits the basin near Flatside Pinnacle which is located in T3N R18W Sec. 27. The area to the north of "Y" City is classified as Atoka Formation, which consist generally of fifty percent shale and fifty percent sandstone. The Lake Maumelle watershed is located in an area of generally eastwest trending mountains ranging in elevation from 121.9 meters near the spillway to over 457.2 meters in the west side near North Fork Pinnacle and Flatside Pinnacle. Slopes within the watershed range anywhere from three to sixty percent.

Ten major soil series with twenty-one differing soil types exist in the Lake Maumelle watershed. The most predominate soil series within the basin is the Carnasaw Series. Remaining soil series identified in the basin are as follow: Amy, Leadvale, Linker, Rexor, Sallisaw, and Sherwood.

### **Population Demographics and Economic Structure**

The 15 county central Arkansas area, of which the study is part, had a 1980 population of 838,846 persons and a land area of 28,116.9 km<sup>2</sup> yielding a population density of 29.8 persons per

km<sup>2</sup>. At the county level, population densities ranged from a low of 13 persons per km<sup>2</sup> in the sparsely populated areas of Perry County to a high of 445.2 persons per km<sup>2</sup> in Pulaski County, the most densely populated county in the State. The resident population within the 80 km study area is 671,835 or 80 percent of the 15 county area.

The personal income of the central Arkansas area was reported to be \$6,023,234,000 in 1979 and the per capita personal income was \$7,586. As might be expected, both the highest personal income and per capita personal income were found in Pulaski County and totaled \$2,906,084,000 and \$8,856, respectively. The economy of the central area provides a diversity of employment opportunity and is essentially based on the wholesale-retail trade, manufacturing, government and services.

#### **Population Impacted by Lake Degradation**

Because Lake Maumelle serves as the primary water source for the Little Rock-North Little Metropolitan Area, recreational uses of the lake are of only secondary importance. Consequently, the greatest and most immediate impact of degradation of Lake Maumelle would be its effect on its current user population. The Little Rock Water Works Department estimates that approximately 316,000 persons currently depend upon Lake Maumelle to meet their daily water requirements. This represents approximately 93 percent of Pulaski County's population and affects every segment of the community.

#### **SAMPLE COLLECTION METHODOLOGIES**

Six sampling stations were located on Lake Maumelle to

assess current physical, biological and chemical water quality conditions. Station 1 was selected due to its isolation from the main body of the lake and reflection of water quality inflow from the Big Maumelle River. Station 3 provides an assessment of conditions in a typical cove area. The remaining stations were purposively located to assess conditions in the main body of Lake Maumelle. Stations 2, 5 and 6 were all located near the old Big Maumelle River channel.

Samples were collected over a twelve (12) month period. The frequency of sampling was two times per month during June, July and August and once per month for the remainder of the year. An increase in sampling frequency during the summer months was necessary to assess lake productivity and the impacts of stratification.

Physical, Chemical and Biological samples were collected at each station. In-situ analyses were performed using a Hydrolab unit for measurement of temperature, dissolved oxygen, and conductivity. A Kemmer Bottle sampling instrument was used to collect vertical discrete samples representing the lake column at each station. These samples were analyzed for solids, turbidity and nutrients. A Secchi Disc was used to determine the transparency of the water which relates to the level of solids or plankton organisms present. Benthic organisms in the bottom sediments were collected using an Eckman Dredge. Additional grab samples were collected from the surface for biochemical oxygen demand (BOD<sub>5</sub>), coliform bacteria, and chlorophyll a determination.

All sample collection, transportation and analysis was conducted in accordance with U.S.EPA protocol and an approved quality assurance project plan.

### **RESULTS AND CONCLUSIONS**

A summary of results and conclusions related to the water quality of Lake Maumelle is presented below. For a more detailed discussion of each topic area, consult the full report.

#### **Projected Population and Land Use**

The data shows that population is expected to increase to a total of 1,994 by the year 2005, which represents an addition of 756 residents in the watershed. It is anticipated that half of this projected growth will consist of movement into the watershed from the Little Rock metropolitan area and other surrounding communities. Based upon the projection, the following land use changes are expected: (1) residential land use will increase by 191 ha (2) agriculture use will experience an increase of 243 ha; (3) other urban, commercial and transportation related uses will increase by 74 ha; and (4) forested areas will decrease by 508 ha to fulfill land use demands identified above.

#### **Hydrological Budget**

Calculations show a residence time of 1.72 years or 628 days which translates into a lake flushing rate of .58/year, with a lake outflow of 21 million gallons per day (MGD). However, seasonal spillway overflows yielded a seasonal flushing rate of .14/year. The hydrological budget indicates a relatively slow movement of water through Lake Maumelle. A flushing rate between .14/year and .58/year increases the vulnerability of the lake to pollutant loading.

## **Nutrient Budget**

Total phosphorus inputs in 1985 were 10, 696.5 kg/yr. Total phosphorus outflows during this same period were 2,636.4 kg/yr which consisted of 1,364.1 kg/yr and 1,272.3 kg/yr attributed to water supply demand and spillways overflows, respectively.

## **Existing and Projected Water Quality**

A comparison of total nitrogen (TN) to total phosphorus (TP) yielded a TN to TP ratio of 19:1. This indicates that Lake Maumelle is phosphorus limited. Therefore, the primary basis for calculating an existing trophic state and projected water quality trends will be average in-lake TP concentrations.

An average TP concentration of .028mg/l was measured in Lake Maumelle for the months of June through August, 1982. Secchi disc depth averaged 2.5 in during this period with chlorophyll a averaging 6.05 ug/l. Using the above values, Carlson's Trophic State Index values were 46.8, 48.3 and 52.2 for Secchi disc, chlorophyll a, and total phosphorus. The average index value of 49.1 indicates Lake Maumelle is mesotrophic. However, the index value for TP is 52.2 which is very close to a eutrophic state.

## **Vulnerability**

A vulnerability index shows the sensitivity of Lake Maumelle to pollutant loadings. The vulnerability index analysis indicates a high rating of 2.6 (based on a maximum of 3.0). Therefore, Lake Maumelle has morphometric characteristics which increases its vulnerability to pollutant loading from its watershed.

## **Conclusions**

Carlson's average Trophic State Index for Lake Maumelle is

49.1 which indicates the lake is mesotrophic. However, the index value for total phosphorus is 52.2 which is very close to a eutrophic state. The maintenance of good water quality conditions in Lake Maumelle has been aided by the sediment and nutrient removal capabilities of the western end of the lake above the Highway 10 bridge. The existing calculated areal phosphorus loading for 1985 (most likely) of  $.297 \text{ g/m}^2\text{-yr}$  far exceeds the dangerous loading levels for Lake Maumelle's average depth of 7.3m. Algal populations are mostly identified with mesotrophic lakes, but the periodic dominance of algal genera more associated with eutrophic lakes indicates a possible transitional status.

In order to protect and maintain Lake Maumelle's water quality, it will be necessary to reduce phosphorus loadings. This will necessitate an effective watershed management strategy and monitoring program.

#### RECOMMENDATIONS

Based on water quality data presented in this report, the following recommendations were presented:

1. Development of a "Central Management System" in the Lake Maumelle Watershed. This system will monitor the operation and maintenance of on-site sewage disposal systems. The "Central Management System" can be established under a special authority or be incorporated within the structure of the "Watershed Management Commission" as presented in Task IIB 1.0 of the full report.
2. Continued water quality monitoring of Lake Maumelle and its watershed.
3. Increase shoreline and tributary buffers (except the Big Maumelle River) through county zoning authorities.
4. Provide special provisions for management of development and pollution practices along the Big Maumelle River.

5. Designate zones where urban and silvicultural activities would be monitored to minimize erosion and other pollution problems.
6. Dredge the western most section of Lake Maumelle (west of the Highway 10 bridge) to improve the effectiveness of its sediment trapping capabilities.
7. Develop a Watershed Management Commission composed of: two Little Rock Water Works representatives, one member from each of the three county quorum courts, one Arkansas Department of Pollution Control and Ecology Commission representative, one Arkansas Forestry Commission representative, one local industry representative, and one local land owner. The committee is to be supported by representatives from the U.S. Forest Service and the Soil Conservation Service of the U.S. Department of Agriculture.