EFFECT OF THE RESTRICTED USE OF PHOSPHATE DETERGENT AND UPGRADED WASTEWATER-TREATMENT FACILITIES OF WATER QUALITY IN THE CHATTAHOOCHEE RIVER NEAR ATLANTA, GEORGIA

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U.S. GEOLOGICAL SURVEY
Open File Report 94-99

NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

Atlanta, Georgia
1994

U.S. DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

Multiply	by	to obtain
foot (ft)	0.3048	meter
square mile (mi^2)	2.590	square kilometer
million gallons per day (Mgal/d)	0.0438	cubic meter per second
ton (short)	0.9072	megagram

ACRONYMS

ACF	Apalachicola-Chattahoochee-Flint River basin
GDNR-EPD	Georgia Department of Natural Resources Environmental Protection Division
NAWQA	National Water-Quality Assessment Program
WWTF	Wastewater Treatment Facilities
USGS	U.S. Geological Survey

U.S. DEPARTMENT OF THE INTERIOR, U.S. GEOLOGICAL SURVEY
NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

Effect of the Restricted Use of Phosphate Detergent and Upgraded Wastewater-Treatment Facilities on Water Quality in the Chattahoochee River near Atlanta, Georgia

ABSTRACT

Data compiled for the six largest wastewater-treatment facilities (WWTF) in Metropolitan Atlanta, Ga., indicate about an 83-percent reduction in the phosphorus load discharged to the Chattahoochee River from 1988 to 1993 because of restricted use of phosphate detergents and upgraded treatment of municipal wastewater. This reduction resulted in about a 54-percent decrease in the phosphorus load in the Chattahoochee River downstream of Atlanta during this time period. Phosphorus loads in animal manure and fertilizers applied to the land (nonpoint sources) are greater than loads discharged to the Chattahoochee River from WWTF (point sources). However, only a fraction of the phosphorus applied to the land enters the surface waters and is bioavailable. Even though nonpoint sources of land-applied phosphorus potentially are important sources to surface waters, point-source inputs from wastewater effluent are far greater. Phosphorus concentrations in wastewater effluent from three city of Atlanta WWTF need to be reduced by about an additional 31 percent by 1996 to comply with Georgia Department of Natural Resources, Environmental Protection Division regulations.

BACKGROUND

In 1991, the U.S. Geological Survey (USGS) began full-scale implementation of the National Water-Quality Assessment (NAWQA) program. The three major objectives of the program are to provide a consistent description of current water-quality conditions for a large part of the Nation's water resources; define long-term trends (or lack thereof); and identify, describe, and explain the major factors that affect observed water-quality conditions and trends. The NAWQA program, when fully implemented, will include investigations of hydrologic systems in 60 study units that include parts of most major river basins and aquifer systems in the United States. Study units range in size from 1,200 to about 65,000 square miles (mi^2), and incorporate 60 to 70 percent of the Nation's water use and population served by public water-supply systems. The Apalachicola-Chattahoochee-Flint (ACF) River basin (fig. 1) was among the first 20 NAWQA study units selected for study under the full-scale implementation plan.

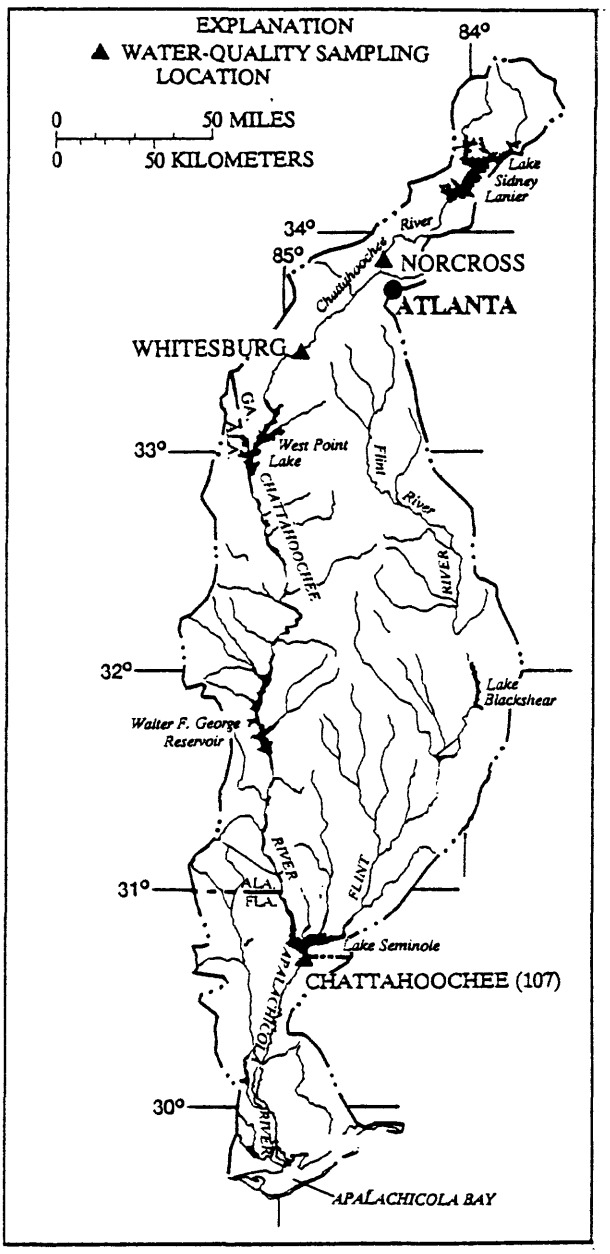

Figure 1. Location of the Apalachicola-Chattahoochee-Flint River basin, Georgia, Alabama, and Florida.

The NAWQA program will provide an improved scientific basis for evaluating the effectiveness of water-quality management programs and for predicting the likely effects of changes in land- and water-management practices on water quality. One of the initial tasks of the NAWQA program is to compile and evaluate existing data from individual study units. These data will help to establish priorities and formulate

plans for studying each river basin. In addition, the data will provide the basis for national-synthesis investigations.

In February 1989, the Georgia Environmental Protection Division issued an Administrative Order requiring all major WWTF (larger than 1 Mgal/d) between Lake Sidney Lanier (upstream of Atlanta) and West Point Reservoir (downstream of Atlanta) to reduce the average concentration of phosphorus in effluent to 0.75 mg/L or less. Nine municipal and one industrial WWTF are in compliance as of 1993 (David Kamps, Georgia Environmental Protection Division, oral commun., 1994). The three remaining WWTF in this reach of the Chattahoochee River are owned by the city of Atlanta, which negotiated an extension until July 4, 1996, in exchange for having to meet a more restrictive limit of 0.64 mg/L average phosphorus concentration. The data base that has been compiled by NAWQA for the ACF River basin includes average monthly discharge and phosphorus concentration data from WWTF. A summary and evaluation of those data indicates that legislated restrictions on the use of phosphate detergents and upgraded wastewater-treatment facilities resulted in substantial reductions in concentrations of phosphorus in wastewater effluent. This report describes the effectiveness of the legislated restrictions and WWTF upgrades in reducing phosphorus loads from Atlanta, Ga., and the effect of that reduction on the water-quality of the Chattahoochee River. It also compares the magnitude of point- and nonpoint-source phosphorus loads for Atlanta and the ACF River basin.

DESCRIPTION OF AVAILABLE DATA

Primary sources of inputs of phosphorus to the Chattahoochee River are WWTF effluent, animal manure, and fertilizer. About 130 municipal WWTF discharge treated wastewater effluent directly into surface waters within the ACF River basin. The total volume of effluent discharged from these point sources during 1990, a year for which consistent data are available, was about 360 million gallons per day (Mgal/d) (modified from Marella and others, 1993). About 60 percent, or 217 Mgal/d, was discharged to the Chattahoochee River from six major WWTF in Metropolitan Atlanta. The Georgia Department of Natural Resources, Environmental Protection Division (DNR-EPD) and each of the six facilities were able to provide effluent discharge and average phosphorus-concentration data for much of the period 1980-93. Data from the six largest WWTF in Metropolitan Atlanta were used to estimate annual phosphorus loads in wastewater effluent.

Animal manure, as used in this study, include manure generated by poultry, cows, and pigs. The amount of animal manure generated within each county in 1990 was estimated on the basis of the number of animals per county, the average weight of the animals, and the amount of manure generated by an animal unit (1,000 pounds live weight; Alabama, Florida, and Georgia Agricultural Statistics Service, 1990). Estimates of the nutrient content of the manure (Kay and others, 1985) were then made for each county, aggregated by subbasin, and totaled to represent input to the ACF River basin for 1990.

Phosphorus inputs from fertilizers were estimated for 1990 using agricultural sales data by county (J.T. Berry, Tennessee Valley Authority, written commun., 1993). Estimated phosphorus inputs to agricultural lands were then summed to estimate the total input to the ACF River basin. Fertilizer applications can also be substantial in urban and suburban areas. However, few data are available from which to estimate nutrient inputs from these sources. Fertilizer estimates described above were based on sales tonnages reported by fertilizer dealers and farm expenditures for fertilizer. It is assumed that these estimates do not include data from nurseries and retail stores in urban areas. The amounts of nutrients in fertilizers applied to all land uses in Cobb County, Ga., have been estimated on the basis of estimated land area and recommended application rates. Cobb County is one of several counties that is part of Metropolitan Atlanta. Because several assumptions needed to be made to derive these estimates, and because the data are not provided at the county level for all counties, estimates for urban and suburban areas were not included as part of the total nutrient input shown in this report. A conservative estimate of phosphorus inputs from fertilizer in urban and suburban areas could potentially increase the total nutrient nonpoint input by about 10 percent.

River-flow and nutrient-concentration data are available from data bases maintained by the U.S. Geological Survey and the U.S. Environmental Protection Agency. These data were used to estimate annual phosphorus loads for locations upstream and downstream of Atlanta for the period 1980-93.

EVALUATION OF DATA

During the period 1980-93, Metropolitan Atlanta's population (Atlanta Regional Commission, written commun., 1994) grew by about 43 percent, from about 1,845,000 in 1980 to about 2,635,000 in 1993 (much of Atlanta is within the Chattahoochee River basin). As a result, the

volume of treated wastewater discharged to the Chattahoochee River increased by about 50 percent. Figure 2 shows the increase in discharge from the six WWTF in Metropolitan Atlanta, the corresponding increase in the phosphorus load prior to 1989, and the decrease following legislated restrictions on the use of phosphate detergents and wastewater- treatment plant upgrades. Phosphorus loads decreased by about 83 percent from 1988-93 even though the volume of effluent increased by about 9 percent. To comply with the Georgia DNR-EPD phosphorus standard for the three city of Atlanta WWTF (concentration of 0.64 mg/L), the 1993 average concentration of 0.93 mg/L will have to be reduced by about 31 percent in the next 2 1/2 years.

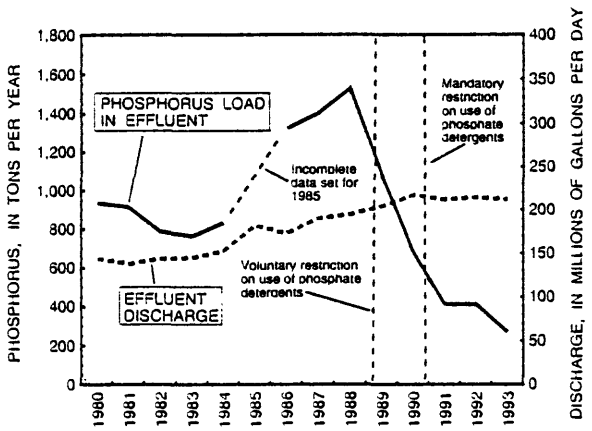

Figure 2. Phosphorus load and effluent discharged from six wastewater-treatment facilities (WWTF) to the Chattahoochee River, Atlanta, Ga., 1980-93.

The annual phosphorus load at monitoring sites on the Chattahoochee River near Norcross (upstream of Atlanta) and near Whitesburg (downstream of Atlanta) are shown in figure 3. Phosphorus loads downstream of Atlanta reflect point-source inputs from WWTF and other discharge points, and nonpoint-source inputs from fertilizer, animal manure, and atmospheric sources upstream of the Whitesburg site. However, the phosphorus load from WWTF is a major part of the total phosphorus load transported by the river at the Whitesburg site. The difference between the two curves in figure 3 indicates the effect of point- and nonpoint-source discharges from Atlanta on the phosphorus load in the river. It also shows about a 54-percent decrease in the phosphorus load in the river following reductions in phosphorus loads from WWTF.

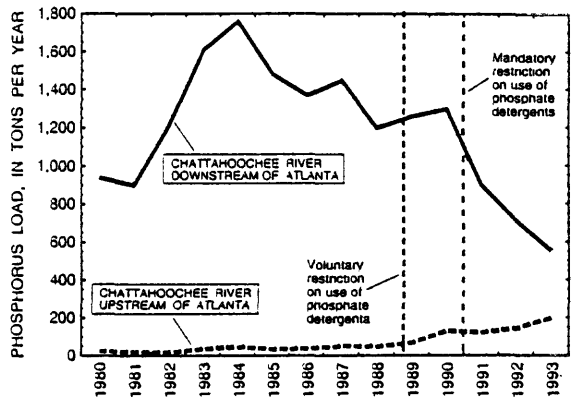

Figure 3. Phosphorus loads in Chattahoochee River upstream and downstream of Atlanta, Ga., 1980-93.

Nonpoint-source inputs of phosphorus applied to the land (as manure and fertilizer) in the Chattahoochee, Flint, and Apalachicola River basins, and the point-source inputs of phosphorus to the Chattahoochee River (as wastewater effluent) are shown in figure 4. However, the data are not directly comparable because only a fraction of the nonpoint-source inputs of phosphorus applied to land enters surface waters. Only about one third of the nonpoint-source phosphorus entering the surface water is bioavailable. Point-source inputs, on the other hand, are discharged directly into surface waters and nearly all of the phosphorus from point-source discharges is bioavailable.

During 1990, the manure generated by approximately 250 million chickens, 500,000 cows, and 225,000 pigs in the ACF River basin was estimated to contain about 28,000 tons of phosphorus. Poultry manure represented nearly 90 percent of the load. Approximately 20,000 tons of phosphorus were applied as fertilizer to agricultural lands in the ACF River basin. Animal manure, and much of the fertilizer applied within the basin, are associated with agricultural land uses. However, part of the fertilizer applied in the basin is in urban and suburban areas. In general, agricultural land use in the upper part of the basin (particularly in the Chattahoochee headwaters upstream of Atlanta) is predominantly pasture land used for grazing cattle and for disposal of poultry manure. In the lower half of the basin (particularly in the middle and lower Flint River basin), the agricultural land use is row-crop agriculture. Therefore, most of the phosphorus load from manure is distributed in the upper part of the Chattahoochee River basin, and most of the load from fertilizer is distributed in the Flint River basin.

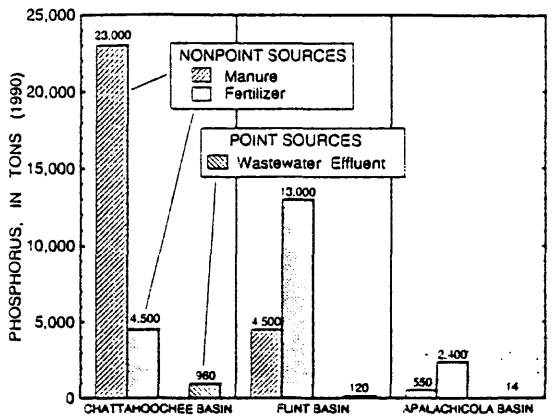

Figure 4. Point- and nonpoint-source phosphorus inputs to major river basins within the Apalachicola-Chattahoochee-Flint River basin, 1990

Nonpoint-source phosphorus inputs and outputs for various land-use types being studied within small river basins as a part of the ACF River basin NAWQA are shown in figure 5. To compare river basins of different sizes, the annual phosphorus load estimated for each basin was divided by the drainage area to provide an estimate of phosphorus yield in pounds per square mile. In general, even though some land uses have very large nonpoint-source inputs, little nonpoint-source phosphorus enters the surface water compared to the amount of point-source inputs. Even so, nonpoint sources of phosphorus can be significant. Because their effect on the aquatic system is not well understood, best-management practices need to continue to be implemented.

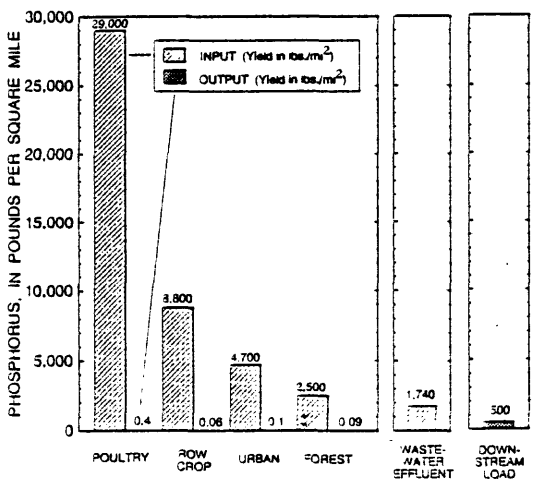

Figure 5. Phosphorus input and output yield for nonpoint sources in various land uses and from wastewater-effluent discharges to the Chattahoochee River.

SUMMARY

A Georgia Environmental Protection Division Administrative Order required all major WWTF (larger than 1 Mgal/d) between Lake Sidney Lanier (upstream of Atlanta) and West Point Reservoir (downstream of Atlanta) reduce the average concentration of phosphorus in effluent to 0.75 mg/L or less. The city of Atlanta negotiated an extension for it's three WWTF in exchange for a more restrictive limit of 0.64 mg/L average phosphorus concentration. The 1993 average concentration (0.93 mg/L) for these three WWTF will have to be reduced by about 31 percent in the next 2 1/2 years to be in compliance with the new standard. Therefore, even though reductions of about 83 percent in point-source phosphorus loads from 1988-93 have been documented, and phosphorus loads in the river downstream of Atlanta have declined by about 54 percent, phosphorus loads discharged to the Chattahoochee River from wastewater-treatment facilities in Atlanta need to be further reduced to comply with State mandated limits.

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Reports and data related to the NAWQA program can be obtained from:

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Open-File Report 94-99

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