WATER QUALITY MODELING FOR THE ACT AND ACF RIVER BASINS USING BASINS AND HEC-5Q

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Abstract. This paper describes a joint effort between the U.S. Army Corps of Engineers (Corps) and U.S. Environmental Protection Agency (USEPA), and various contractors to assess the impacts of water allocation on the water quality of the Alabama-Coosa-Tallapoosa (ACT) and Apalachicola-Chattahoochee-Flint (ACF) River Basins. The BASINS and HEC-5Q water quality models were used to assess water quality effects on a basinwide approach for these two large river basins. These analyses are being conducted to support preparation of the environmental impact statements (EISs) for each basin.

INTRODUCTION

The water quality within the major stream of the Alabama-Coosa-Tallapoosa (ACT) and Apalachicola-Chattahoochee-Flint (ACF) River Basins is dependent on the natural characteristics of these basins (climate, precipitation, geology, vegetation, topography, etc.) as well as societally influenced effects (impoundments, point and nonpoint releases, development, etc.). Water quality in the ACT and ACF basins, particularly as it relates to the ongoing water allocation formula development process, is of interest to the many people who live in these basins and use its water resources. Surface water is a drinking water source and thus its quality is of utmost importance. The ACT and ACF basins have widely ranging land uses, which have significant effects on water quality. Although the quality of treated wastewater discharges in the basin has improved since the 1970s with the adoption of improved wastewater treatment processes, water quality continues to be a concern from both point sources and unregulated nonpoint sources. Nonpoint source pollution includes suspended sediment, bacteria, pesticides, fertilizer, metals, oils, grease, and a variety of other pollutants that are washed into surface waters from urban and rural runoff.

WATER QUALITY ANALYSIS MODELS

In order to assess water quality on a basinwide approach, a combination of water quality models were used for the Draft Environmental Impact Statements (Draft EISs) for Water Allocation in the ACT and ACF River Basins (Corps 1998a and 1998b). These models address both point and nonpoint discharges to the surface waters of these basins. Model results were used to assess the impacts of the no action and action alternative flow scenarios on water quality.

The BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) Nonpoint Source Model was used to estimate current levels of nonpoint source pollution in the basin (USEPA 1996). The Corps HEC conducted one-dimensional modeling of the rivers and reservoirs in the ACT and ACF basins using the HEC-5Q model (Corps 1986).

Point source discharges of treated wastewater affect the quantity, as well as quality, of water in the ACT and ACF basins. Point source discharges are regulated under the National Pollutant Discharge Elimination System (NPDES) and include both municipal and industrial discharges. Wastewater discharges in the ACT and ACF basins were identified for the HEC-5Q modeling. Municipal wastewater discharges are a major source of potential nutrient loading in the basin. Industrial wastewater discharges are also significant point sources regulated under the NPDES program. However, only a small number of the industrial discharges include significant amounts of flow. Industrial discharges can consist of organic heavy oxygen-demanding waste loads from facilities such as pulp and paper mills and large quantities of non-contact cooling water.

BASINS Model Summary

The BASINS Nonpoint Source Model was used to estimate current levels of nonpoint source pollution in the basin. Nonpoint source pollution includes suspended sediment, bacteria, pesticides, fertilizer, metals, oils, grease, and a variety of other pollutants that are washed into surface waters from urban and rural runoff. The BASINS modeling was conducted by Tetra Tech, Inc. under the direction of USEPA and the Corps. The purpose of the BASINS modeling was to assess nonpoint sources and to provide nonpoint source flows and pollutants as inputs to the HEC-5Q models for each basin. BASINS used locations of tributary inflow points designated in the HEC-5Q model and major control points

designated in the HEC-5 model. The BASINS model uses meteorological data, detailed land use data, and future growth projections to evaluate nonpoint source runoff in the basin. The BASINS model was also used to predict loadings for 1995, 2020, and 2050 land uses. Five key parameters were looked at in the BASINS modeling – flow, BOD, total nitrogen, total phosphorus, and fecal coliform bacteria.

As a result of the BASINS modeling, the estimated annual pollutant loadings for 1995 from nonpoint sources in the ACT basin are listed below:

- Average flow: 24,702 cfs
- BOD: 13,608 tons
- Total nitrogen: 8,330 tons
- Total phosphorus: 2,447 tons
- Fecal coliform: 2.6 E+17 counts

According to the BASINS model, the greatest contributions to nonpoint source loadings in the ACT basin came from the lower Coosa River basin and the Alabama River. The BASINS modeling estimated the annual pollutant loadings for 1995 from nonpoint sources in the ACF basin are as follows:

- Average flow: 20,920 cfs
- BOD: 16,727 tons
- Total nitrogen: 8,028 tons
- Total phosphorus: 2,296 tons
- Fecal coliform: 2.3 E+17 counts

According to the BASINS model, the greatest contributions to nonpoint source loadings in the ACF basin came from the Flint River basin. The lowest contributions were from the upper Chattahoochee basin above Atlanta.

HEC-5Q Model Summary

The Corps HEC (and subcontractor Resource Management Associates, Inc.) conducted the HEC-5Q modeling of the ACT and ACF basins. HEC-5Q used data generated by the HEC-5 hydrologic model, point source load projection spreadsheets developed by EPA as part of the Comprehensive Study, and the BASINS model of nonpoint source runoff to predict average concentrations of critical parameters in streams and reservoirs. The objective of the HEC-5Q models was to evaluate various system operation alternatives in a basinwide fashion. This model is a generalized computer program designed to simulate flow and water quality within a branched stream and reservoir system. All stream and reservoir components are simulated sequentially within a single run, thus allowing for a basinwide analysis. The model represents components of the system one dimensionally providing computed vertical or longitudinal profiles of water quality in reservoirs and longitudinal water quality in stream sections. A key advantage to use of this systemwide model is its direct linkage with the HEC-5 hydrologic model, the detailed surface water quantity model proposed for use in evaluation of various water allocation formulas.

HEC and RMA, Inc. selected a critical period of analysis to run the HEC-5Q model to determine water quality impacts of the no action and alternative flow scenarios. The years 1984 through 1988 were selected for the analysis. HEC calibrated the HEC-5Q model to water quality data for these periods. This 5-year period includes two major droughts (1986 and 1988). Under drought conditions, water quality is critically affected, with higher temperatures and lower flows causing decreases in dissolved oxygen concentrations and increases in concentrations of other pollutants. Thus, this analysis focuses on the impacts under worst-case conditions in the basin. Under typical or normal conditions, the impacts to water quality would be less pronounced.

The HEC-5Q analysis results are presented in Appendix D of each river basin Draft EIS for select stream reaches in the basin. The stream reaches were chosen where impacts were most likely to occur, due to either natural or unnatural conditions (i.e., wastewater discharges or water withdrawals). One of the key parameters modeled on stream water quality in the basins was dissolved oxygen (DO). Other parameters included BOD_5 and nutrients. The HEC-5Q model predicted the number of days per year that the river at a given point would be below certain dissolved oxygen levels.

In the reservoirs in the basin, the modeling effort focused on chlorophyll *a* concentrations, nutrient loading in the reservoirs, reservoir retention time, and tailwater DO concentrations. The Corps and EPA chose these parameters in consultation with the Corps water quality modelers as being good indicators of water quality trends in the basin's reservoirs.

Although the initial development and calibration of the HEC-5Q model was accomplished for hydrologic conditions from 1984 to 1988, subsequent simulations for the 1995, 2020, and 2050 water demand levels were also performed using the 1984 to 1988 hydrologic data. The majority of impacts here are presented for the average summer period for the 5-year model simulation. In general, 1986 conditions proved to be most critical within this time frame. During 1986, the southeast was facing a serious drought, which lowered stream flows and water quality in many parts of the basin.

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