TOTAL MAXIMUM DAILY LOADs (TMDLs)

For

Fecal Coliform

In

303(d) Listed Streams in The Altamaha River Basin

Big Cedar Creek - (Little Cedar Creek to Ohoopee River)
Jacks Creek - (U.S. Hwy 1 to Ohoopee River)
Little Ohoopee River - (Sardis Creek to Ohoopee River)
Milligan Creek - (Uvalda to Altamaha River)
Oconee Creek - (Headwaters to Cobb Creek)
Ohoopee River - (Dyers Creek to Big Cedar Creek)
Ohoopee River - (Little Ohoopee River to US Highway 292)
Ohoopee River - (Neels Creek to Little Ohoopee River)
Pendleton Creek - (Sand Hill Lake to Reedy Creek)
Pendleton Creek - (Wildwood Lake to Tiger Creek)
Rocky Creek - (Ga. Highway 130 to Little Rocky Creek)
Swift Creek - (Old Normantown Road to Pendleton Creek)
Tiger Creek - (Little Creek to Pendleton Creek)
Yam Grandy Creek - (Downstream of Crooked Creek)

Submitted to:

U.S. Environmental Protection Agency, Region 4

Prepared by:

Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

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LIST OF ABBREVIATIONS

BMP	Best Management Practices
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
DNR	Department of Natural Resources
DWPC	Division of Water Pollution Control
EPA	Environmental Protection Agency
EPD	Environmental Protection Division (State of Georgia)
GIS	Geographic Information System
HSPF	Hydrological Simulation Program - FORTRAN
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MRLC	Multi-Resolution Land Characteristic
NPDES	National Pollutant Discharge Elimination System
NPSM	Nonpoint Source Model
NRCS	Natural Resources Conservation Service
Rf3	Reach File 3*
RM	River Mile
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WCS	Watershed Characterization System
WLA	Waste Load Allocation

*Reach File 3= electronic file providing a detailed stream network from small to large streams and supports development of stream routing for modeling purposes.

SUMMARY
Total Maximum Daily Loads (TMDLs)
303(d) Listed Streams in Altamaha River Basin - HUC 03070106, and HUC 03070107

State: Georgia

Counties: Washington, Johnson, Emanuel, Laurens, Treutlen, Candler, Montgomery, Toombs, Tattnall, Jeff Davis, Appling, Wayne, Long, McIntosh and Glynn.

Major River Basin: Altamaha River

Constituent(s) of Concern: Fecal Coliform Bacteria

Summary of 303(d) Listed Waterbody Information and Allocation by Stream Segment

Stream Name	Segment Description	Hydrologic Unit(s)	Use Classification	Segment Length (miles)	Drainage Area (miles^2)	WLA (#/30 days)	LA (#/30 days)	MOS	TMDL (#/30 days)	Overall Reduction (percentage)
Big Cedar Creek	Little Cedar Creek to Ohoopee River	030701070104	Fishing	3	23.2	1.70E+11	6.60E+10	Implicit + 10% Explicit	2.36E+11	83.1
Doctors Creek	Upstream of Jones Creek	030701060405	Fishing	5	67.8	TBD	TBD	Implicit + 10% Explicit	TBD	TBD
Goose Creek	U/S Rd. S1922 to Little Goose Creek	030701060307 030701060308	Fishing	8	77.9	TBD	TBD	Implicit + 10% Explicit	TBD	TBD
Jacks Creek	U.S. Hwy 1 to Ohoopee River	030701070303	Fishing	9	61.7	N/A	3.61E+11	Implicit + 10% Explicit	3.61E+11	96.8
Little Ohoopee River	Sardis Creek to Ohoopee River	030701070205 030701070206	Fishing	18	62.3	N/A	1.16E+13	Implicit + 10% Explicit	1.16E+11	98.7
Milligan Creek	Uvalda to Altamaha river	030701060102	Fishing	11	45.2	N/A	1.63E+11	Implicit + 10% Explicit	1.63E+11	83.1

Stream Name	Segment Description	Hydrologic Unit(s)	Use Classification	Segment Length (miles)	Drainage Area ($miles^2$)	WLA (#/30 days)	LA (#/30 days)	MOS	TMDL (#/30 days)	Overall Reduction (percentage)
Oconee Creek	Headwaters to Cobb Creek	030701060104	Fishing	11	30.4	N/A	1.01E+11	Implicit + 10% Explicit	1.01 E+11	74.9
Ohoopee River	Dyers Creek to Big Cedar Creek	030701070102	Fishing	15	69.3	1.02E+11	2.53E+11	Implicit + 10% Explicit	3.56E+11	95.2
Ohoopee River	Little Ohoopee River to US Highway 292	030701070301 030701070304	Fishing	23	16.1	N/A	4.11E+14	Implicit + 10% Explicit	4.11E+14	98.6
Ohoopee River	Neels Creek to Little Ohoopee River	030701070107 030701070108	Fishing	18	47.6	N/A	5.92E+10	Implicit + 10% Explicit	5.92E+10	90.8
Pendleton Creek	Sand Hill Lake to Reedy Creek	030701070401 030701070402	Fishing	7	43.1	N/A	1.97E+12	Implicit + 10% Explicit	1.97E+12	99.8
Pendleton Creek	Wildwood Lake to Tiger Creek	030701070402	Fishing	12	102.8	N/A	2.05E+12	Implicit + 10% Explicit	2.05E+12	99.8
Rocky Creek	Ga. Hwy. 130 to Little Rocky Creek	030701070503	Fishing	10	35.1	N/A	1.17E+12	Implicit + 10% Explicit	1.17E+12	82.7
Swift Creek	Old Normantown Rd. to Pendleton Creek	030701070404	Fishing	5	51.8	5.80E+11	1.32E+11	Implicit + 10% Explicit	7.12E+11	78.3
Tiger Creek	Little Creek to Pendleton Creek	030701070403 030701070405	Fishing	16	63.7	N/A	7.63E+10	Implicit + 10% Explicit	7.63E+10	99.2
Yam Grandy Creek	D/s Crooked Creek	030701070302	Fishing	3	58.8	6.83E+11	9.77E+11	Implicit + 10% Explicit	1.66E+12	73.1

TBD: To Be Determined by EPA

Note: Current and future discharges shall be permitted at or below the water quality standard for fecal coliform bacteria of 200-counts/100 ml.

Applicable Water Quality Standard for Fishing use classification:

Section 391-3-6-.03 (6) of the *State of Georgia Rules and Regulations for Water Quality Control, Chapter 391-3-6 Revised, July, 2000:*

May through October - fecal coliform is not to exceed a geometric mean of 200 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. Should water quality and sanitary studies show fecal coliform levels from non-human sources exceed 200 per 100 ml (geometric mean) occasionally, then the allowable geometric mean fecal coliform shall not exceed 300 per 100 ml in lakes and reservoirs and 500 per 100 ml in free flowing freshwater streams.

November through April - fecal coliform is not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample. The geometric mean standard is the target value for the TMDLs

TMDL Development - Analysis/Modeling:

The Hydrologic Simulation Program Fortran (HSPF) watershed model was used to develop these TMDLs. An hourly time step was used to simulate hydrologic and water quality conditions with results expressed as daily averages. A simulation period of 10 years was used to assess the water quality standards for these TMDLs representing a range of hydrologic and meteorological conditions.

FECAL COLIFORM TOTAL MAXIMUM DAILY LOADS (TMDLs) for 303(d) listed stream segments in the ALTAMAHA RIVER BASIN

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions. This allows water quality based controls to be developed and implemented in an effort to reduce pollution, and restore and maintain compliance with water quality standards.

2.0 WATERSHED DESCRIPTION

The Altamaha River is formed by the confluence of the Ocmulgee and Oconee Rivers in Southeastern Georgia (Figure 1A), and flows in a southeastern direction to the Atlantic Ocean. The Altamaha River basin includes two United States Geologic Survey (USGS) eight-digit hydrologic units, HUC 03070107 (Ohoopee River watershed - Figure 1B), and HUC 03070106 (Altamaha River watershed - Figure 1C).

The Altamaha River basin falls within the Level III Southeastern Plains and Southern Coastal Plains ecoregions. The Ohoopee River watershed is located primarily in the Level IV Atlantic Southern Loam Plains subecoregion, with small portions of the headwaters extending up into the Coastal Plain Red Uplands subecoregion. The Altamaha River watershed is a multifaceted watershed with outlying portions of the watershed located in the Level IV Atlantic Southern Loam Plains and Sea Island Flatwoods subecoregions, and coastal portions (within approximately 15 miles of the coast) of the watershed located in the Sea Islands/Coastal Marsh subecoregion. There is also a corridor, running the length of the river in all non-coastal portions of the watershed and extending (approximately) one to three miles inland on each side of the river, which lies in the Southeastern Floodplains and Low Terraces and Floodplains and Low Terraces subecoregions. Typical characteristics for these subecoregions are as follows:

- Coastal Plain Red Uplands - this region contains mostly well drained soils composed of red sand and clay; the majority of the land is utilized as cropland or pasture.

- Atlantic Southern Loam Plains - this region contains soils ranging from poorly drained to excessively drained; longleaf pine, oak and some distinctive evergreen shrubs are common vegetation.

- Southeastern Floodplains and Low Terraces – this region contains large sluggish rivers and backwaters with ponds, swamps and oxbow lakes; terraces are typically covered by oak forests, while forests of bald cypress and water tupelo grow in the swamps and river areas.

- Sea Island Flatwoods – this region contains poorly drained, flat plains with spodosols and other wet soils common; loblolly and slash pine plantation land covers much of the region, with cypress, sweetgum, blackgum water oak and willow oak common in wet areas.

- Sea Islands/Coastal Marsh – this region contains the lowest elevations in Georgia and is a highly dynamic environment; organic, clayey soils often occur in the numerous freshwater, brackish and salt marshes; marshes are covered with various species of cordgrass, salt grass and rushes, while live oaks, red cypress, slash pines and cabbage palmettos cover the mainland areas.

- Floodplains and Low Terraces - this region contains floodplains and bottomland composed of stream alluvium and terrace deposits of sand, silt, clay and gravel, along with some organic muck and swamp deposits; large sluggish rivers and backwaters with ponds, swamps and oxbow lakes.

The Altamaha River basin contains approximately 6,250 miles of Rf3 level streams and drains a total area of approximately 2,744 square miles. Watershed land use distribution is based on the Multi-Resolution Land Characteristic (MRLC) databases derived from Landsat Thematic Mapper digital images from the period 1990-1994. Land use in the Altamaha River basin is summarized in Table 1, and shown in Figures 2A – 2B.

3.0 PROBLEM DEFINITION

EPA Region 4 approved Georgia's final 2000 303(d) list on August 28, 2000. This 303(d) list was then updated for the Altamaha, Ocmulgee, and Oconee River Basins and was finalized and approved by EPA Region 4 in June 2001. The list identified the waterbodies for the Altamaha River basin shown in Table 2, as either not supporting or partially supporting designated use classifications, due to exceedence of water quality standards for fecal coliform bacteria. Fecal coliform bacteria are used as an indicator of the potential presence of pathogens in a stream. The objective of this study is to develop fecal coliform TMDLs for 303(d) listed waterbodies in the Altamaha River basin.

4.0 TARGET IDENTIFICATION

Each of the 303(d) listed waterbodies in the Altamaha River basin for which a fecal coliform TMDL is being developed has a designated use classification of fishing. The fecal coliform water quality criteria for protection of the fishing use classification is established by the *State of Georgia Rules and Regulations for Water Quality Control, Chapter 391-3-6 Revised, July, 2000*, and will be used as the target level for fecal coliform TMDL development in the Altamaha River basin.

Section 391-3-6-.03 (6) of the *State of Georgia Rules and Regulations for Water Quality Control, Chapter 391-3-6 Revised, July, 2000,* states that during the months of May through October, when water contact recreation activities are expected to occur, fecal coliform is not to exceed a geometric mean of 200 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. Should water quality and sanitary studies show fecal coliform levels from non-human sources exceed 200/100 ml (geometric mean) occasionally, then the allowable geometric mean fecal coliform shall not exceed 300 per 100 ml in lakes and reservoirs and 500 per 100 ml in free flowing freshwater streams. For the months of November through April, fecal coliform is not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample. The geometric mean standard is the target for the TMDLs. An implicit and explicit MOS is applied to this standard during development of the TMDLs, as detailed in Section 8.3 of this report.

5.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

Compliance with the applicable fecal coliform water quality criteria was assessed for each of the current 303(d) listed streams, based on monitoring data collected from the monitoring stations listed in Table 3.

Water quality data collected during calendar year 1999 for the current 303(d) listed stream segments, which met the regulatory criteria for calculation of a valid geometric mean, are summarized in Table 4. A geometric mean in excess of 200 counts per 100 milliliters during the period May – October, or in excess of 1000 counts per 100 milliliters during the period November – April, provides a basis for adding a stream segment to the 303(d) listing. A single sample in excess of 4000 counts per 100 milliliters can also provide a basis for adding a stream segment to the 303(d) listing. Stream segments that do not have 1999 monitoring data exceeding the above geometric mean or single sample criteria, were placed on the 303(d) as a result of data collected prior to 1999. All water quality data collected during calendar year 1999 for the current 303(d) listed stream segments in the Altamaha River basin, including data which did not meet the regulatory criteria for calculation of a valid geometric mean, are provided in Table A-1, in Appendix A of this report.

6.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of fecal coliform bacteria in the watershed and the amount of loading contributed by each of these sources. Sources are broadly classified as either point or nonpoint sources.

A point source can be defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities discharging treated sanitary wastewater are considered primary point sources of fecal coliform bacteria.

Nonpoint sources of fecal coliform bacteria are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of fecal coliform bacteria on land surfaces and washoff as a result of storm events. Typical nonpoint sources of fecal coliform bacteria include:

- Wildlife
- Land application of agricultural manure
- Livestock grazing
- Leaking septic systems
- Urban development (including leaking sewer collection lines)
- Animals having access to streams

For nonpoint sources involving agricultural activities, the Natural Resources Conservation Service (NRCS) was consulted for information and parameters to be used to characterize agricultural activities represented in the water quality model.

6.1 Point Sources

There are a number of permitted point source discharges located in the drainage areas of the 303(d) listed stream segments. The average discharge flow and flow-weighted average fecal coliform loading for these facilities, as calculated from CY1999 Discharge Monitoring Report (DMR) data, are summarized in Table 5. Design flow, and fecal coliform loading based on monthly fecal coliform permit limits, are also provided in Table 5. The location of these point sources are presented in Appendix G.

A monthly average fecal coliform concentration of 200 counts per 100 milliliters was assumed for the purpose of calculating the flow-weighted average fecal coliform loading for facilities that did not have an existing fecal coliform permit limit, or for which no DMR data was available for the CY1999 period. Calibration of the water quality model was conducted using DMR data whenever available. In cases where no DMR data was available the fecal coliform loading rate was calculated using the design flow and assuming an average fecal coliform concentration equal to the lesser of 200 counts/ 100 ml and the existing fecal coliform permit limit.

6.2 Nonpoint Source Assessment

6.2.1 Wildlife

Wildlife deposit feces onto land surfaces where it can be transported during storm events to nearby streams. In the water quality model, the wildlife fecal coliform contribution is accounted for in the deer population. The deer population is estimated to be 30 to 45 animals per square mile in this area (Georgia WRD, 1999). The upper limit of 45 deer per square mile has been chosen to account for deer and all other wildlife present in the watershed. It is assumed that the wildlife population remains constant throughout the year, and that wildlife is uniformly distributed on all land classified in the MRLC database as forest, pasture, cropland, and wetlands.

6.2.2 Agricultural Animals

Agricultural animals are also a potential source of several types of fecal coliform loading to streams in the Altamaha River basin.

As with wildlife, agricultural livestock grazing on pastureland or forestland deposit their feces onto land surfaces where it can be transported during storm events to nearby streams. Animal access to pasture land varies monthly, resulting in varying fecal coliform loading rates throughout the year. Beef cattle spend all of their time in pasture, while dairy cattle and hogs are confined periodically. All manure from beef cattle is therefore assumed applied to pastureland. The percentage of feces deposited during grazing time is used to estimate the fecal coliform loading rates from pastureland.

Confined livestock operations also generate manure, which can be applied to pastureland and cropland as a fertilizer. Processed agricultural manure from confined hog, dairy cattle, and some poultry operations is generally collected in lagoons and applied to land surfaces during the growing season, at rates which often vary on a monthly basis. It is a basic assumption that the manure is evenly distributed over the land surfaces to which it is applied. Assumptions regarding manure management practices for specific agricultural livestock operations are as follows:

- Poultry litter is normally piled for a period before it is used for manure application. Within the Altamaha River basin it is estimated that approximately 100 percent of poultry litter is applied to pastureland, with only a negligible amount applied to cropland. It is assumed that the poultry litter is applied primarily during the period between March and October (inclusive), and that application rates vary monthly.

- Within the Altamaha River basin it is estimated that approximately 100 percent of broiler litter is applied to pastureland, with only a negligible amount applied to cropland. It is assumed that the broiler litter is applied year-round, but at variable monthly rates.

- Hog farms in the Altamaha River basin operate by confining the animals or allowing them to graze in small pastures or pens. It is assumed that all of the hog manure produced by either farming method is applied to available pastureland, with negligible amounts applied to cropland. Application rates of hog manure to pastureland vary monthly according to management practices. Applications are assumed to be made during the period between March and October (inclusive).

- On dairy farms, the cows are confined for a limited period each day during which time they are fed and milked. This is estimated to be four hours per day for each dairy cow. It is assumed that 100 percent of manure collected during confinement is applied to the available pastureland in the watershed. It is also assumed that the dairy cow manure is applied during the period between February and October (inclusive), as well as in November. Application rates vary monthly according to management practices.

- All manure from beef cattle is assumed applied to pastureland. The beef cow manure is assumed to be applied year-round, and at a constant monthly rate.

- Imported manure is used both on cropland and pastureland at proportions of 75 percent and 25 percent, respectively. It is assumed that the imported manure is applied during the period between February and October (inclusive), as well as in November. Application rates vary monthly.

Agricultural livestock and other unconfined animals (i.e., deer and other wildlife) also often have direct access to streams that pass through pastures, and as such can impact water quality. Feces deposited into these streams by grazing animals is included in the water quality model as a direct nonpoint source having constant flow and concentration. To calculate the amount of fecal coliform bacteria introduced into streams by cattle, it is assumed that only beef cow populations have access to the streams, and of those, approximately twelve percent will defecate in the stream (personal communication, EPA, Georgia Agribusiness Council, NRCS, University of Georgia, et. al.).

Livestock data for the listed streams in the Altamaha River basin are shown in Table 6. This data is based on the 1997 Census of Agriculture and is reported by county. The county data are assigned to the watersheds based on the percentage of agricultural area in each subwatershed classified as pasture/hay. Cattle numbers reported in the census data also represent other breeds of cattle and calves in addition to dairy and beef.

6.2.3 Leaking Septic Systems

Some fecal coliform loading in the Altamaha River basin may be attributed to failure of septic systems and illicit discharges of raw sewage. Estimates from county census data of people in each listed stream watershed utilizing septic systems are shown in Table 7. These estimates were updated based on a county-by-county survey conducted by EPD in April-May 2001. It is estimated that there are approximately 2.37 people per household on septic systems (EPA, personal communication). Based on the EPD survey, it is assumed that five percent of the septic systems in the watershed leak. Leaking septic systems are included in the water quality model as a direct nonpoint source having constant flow and concentration. The average fecal coliform concentration of the septic system wastewater reaching a stream was assumed to be 1×10^4 counts per 100 ml.

6.2.4 Urban Development

Fecal coliform loading from urban areas is potentially attributable to multiple sources including storm water runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. Urban runoff and storm water processes are not considered to be significant contributors to fecal coliform concentrations in the 303(d) listed segments for which a TMDL has been proposed in this report

To estimate the load of fecal coliform bacteria from leaking sewer collection lines, it was assumed (where applicable) up to five percent of the permitted design flow of a municipal water pollution control plant (WPCP) was lost through leaks. The average fecal coliform bacteria concentration in the untreated wastewater was assumed to be 1×10^6 counts/100 ml (EPA, "Protocol for Developing Pathogen TMDLs", 2001).

7.0 ANALYTICAL APPROACH

Establishing the relationship between in-stream water quality and source loading is an important component of TMDL development. It allows the determination of the relative contribution of sources to total pollutant loading and the evaluation of potential changes to water quality resulting from implementation of various management options. This relationship can be developed using a variety of techniques ranging from qualitative assumptions based on scientific principles to numerical computer modeling. In this section, the numerical modeling techniques developed to simulate fecal coliform bacteria fate and transport in the watershed are discussed.

7.1 Model Selection

A dynamic computer model was selected for fecal coliform analysis in order to: a) simulate the time varying nature of fecal coliform deposition on land surfaces and transport to receiving waters; b) incorporate seasonal effects on the production and fate of fecal coliform bacteria; and c) identify the critical condition for the TMDL analysis. Several computer based tools were also utilized to generate input data for the model.

The Nonpoint Source Model (NPSM) is a watershed model capable of simulating nonpoint source runoff and associated pollutant loadings, account for point source discharges, and performing flow and water quality routing through stream reaches. NPSM is based on the Hydrologic Simulation Program - Fortran (HSPF). In these TMDLs, NPSM was used to simulate point source discharges, simulate the deposition and transport of fecal coliform bacteria from land surfaces, and compute the resulting water quality response.

In addition to NPSM, the Watershed Characterization System (WCS), a geographic information system (GIS) tool, was used to display, analyze, and compile available information to support water quality model simulations for the Altamaha River basin. This information includes land use categories, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics. Results of the WCS characterization are input to a spreadsheet developed by Tetra Tech, Inc. to estimate NPSM input parameters associated with fecal coliform buildup (loading rates) and washoff from land surfaces. In addition, the spreadsheet can be used to estimate direct sources of fecal coliform loading to water bodies from leaking septic systems and animals having access to streams. Information from the WCS and spreadsheet tools were used as initial input for variables in the NPSM model.

7.2 Model Set Up

The Altamaha River basin was delineated into 88 subwatersheds in order to characterize relative fecal coliform bacteria contributions from significant contributing drainage areas (see Figures 3A and 3B).

Boundaries were constructed so that subwatershed "pour points" coincided, when possible, with water quality monitoring stations or USGS flow gages. Watershed delineation was based on the Reach File 3 (Rf3) stream coverage and Digital Elevation Model (DEM) data. This discretization allows management and load reduction alternatives to be varied by subwatershed. The structure of the watershed models for the subject stream segments of this report are presented in Appendix G.

An important factor influencing model results is the precipitation data contained in the meteorological data file used in the simulation. The pattern and intensity of rainfall affects the build-up and wash-off of fecal coliform bacteria from the land into the streams, as well as the dilution potential of the stream. Precipitation data from the EarthInfo CD set were used for simulations in all subwatersheds. Details regarding the methods and data sets are presented in Appendix B.

7.3 Model Calibration

Calibration of the watershed model included both hydrology and water quality components. The hydrology calibration was performed first and involved adjustment of the model parameters used to represent the hydrologic cycle until acceptable agreement was achieved between simulated flows and historic stream flow data from a USGS stream gaging station in the watershed for the same period of time. Model parameters adjusted include: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession, losses to the deep groundwater system, and interflow discharge. Details of hydrologic calibrations are presented in Appendix B. Hydrology calibrations are presented in Appendix C, along with USGS gages used for the flow calibrations. Calibrated models were then subjected to model validation to ensure that generated model streamflows for each of the impaired segments were acceptable. Model generated hydrographs for each of the impaired streams are presented in Appendix D.

The model was also calibrated for water quality. Appropriate model parameters were adjusted to obtain acceptable agreement between simulated instream fecal coliform concentrations and observed data collected at the sampling stations indicated in Table 3. Details of water quality calibrations are presented in Appendix B. Water quality calibrations are presented in Appendix E.

8.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), nonpoint source loads (Load Allocations), and an appropriate margin of safety (MOS) which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma \text{ WLAs} + \Sigma \text{ LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measure. For fecal coliform bacteria, the TMDLs are expressed as counts per 30 days.

8.1 Critical Conditions

The critical condition for nonpoint source fecal coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, fecal coliform bacteria builds up on the land surface, and is washed off by rainfall. The critical condition for point source loading occurs during periods of low stream flow when dilution is minimized. Both conditions are simulated in the water quality model.

A definitive time period was used to simulate a continuous 30-day geometric mean concentration to compare to the target. This time period contained a range of hydrological conditions that included both low and high stream flows from which critical conditions were identified and used to derive the TMDL values.

The simulated 30-day geometric mean concentrations for existing conditions are presented in Appendix F. From these figures, critical conditions can be determined. The 30-day critical period in the model is the period preceding the largest simulated violation of the geometric mean standard (EPA, 1991). During periods where the model predicted extremely low stream flows, the model often became unstable and exhibited extreme positive or negative spikes. These portions of the simulation were excluded from consideration of the critical period. Meeting water quality standards during this period ensures that water quality standards can be achieved throughout the reviewed time period. For the listed segments in the Altamaha River basin, the critical period used in development of the TMDLs is given in Table 8.

8.2 Existing Conditions

The existing fecal coliform load for each of the 303(d) listed waterbodies in the Altamaha River basin was determined in the following manner:

- The calibrated model, corresponding to the portion of the Altamaha River basin that is upstream of the pour point of the listed waterbody segment was run for a time period that included the critical condition. This critical time period is provided for each listed segment in Table 8.

- The existing fecal coliform load for each listed segment is represented as the sum of fecal coliform loads from NPDES permitted discharges, discharge loads of direct nonpoint sources (e.g. animal access to streams, illicit discharges of fecal coliform bacteria, failing septic systems, or leaking sewer collection lines), and the fecal coliform load indirectly going to surface waters from all land uses (e.g. surface runoff), cumulated over the 30 day critical period. The existing loading rates given in Table 8 considers a die-off and absorption by soil for fecal coliform applied to land (during accumulation and before transported to the stream), but does not consider fecal coliform decay (die-off) during transport to the stream. The existing in-stream fecal coliform concentration given in Table 8, includes in-stream decay of the fecal coliform.

Model results indicate direct inputs of fecal coliform bacteria from "other sources" (i.e., animal access to streams, illicit discharges of fecal coliform bacteria, failing septic systems, and leaking sewer collection lines) have a significant impact on fecal coliform bacteria loading in the Altamaha River basin. Nonpoint sources from the various land uses within the watershed have a less significant impact on the fecal coliform loading in this watershed. Reductions in these loading rates reduce the in-stream fecal coliform bacteria levels. Loading rates from other nonpoint and direct sources, and the in-stream geometric mean concentration representing existing conditions during the critical period, are shown in Table 8.

In general, point source loads from NPDES facilities in the Altamaha River basin do not appear to significantly contribute to the impairment of the listed stream segments since discharges from these facilities are required to be treated to levels corresponding to instream water quality criteria. Table 5 provides point source loads from NPDES facilities for existing conditions based on DMRs, and loads for TMDL conditions based on permitted facility flows and limits. As shown in this table, most facilities for which data is available have existing (i.e. based on DMR reporting) loads that are significantly lower than the maximum load at the permit limits.

8.3 Margin of Safety

There are two methods for incorporating an MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In these TMDLs, an implicit MOS was incorporated through the use of conservative modeling assumptions and a continuous simulation that incorporates a range of meteorological events. Conservative modeling assumptions used include: septic systems discharging directly into the streams; development of the TMDL using loads based on the design flow and fecal coliform permit limits of NPDES facilities; and all land uses connected directly to streams. An explicit MOS of 10% was also included in the TMDLs by requiring the simulated geometric mean concentration to be 180 counts / 100 ml, rather than the standard of 200 counts / 100 ml.

8.4 Determination of TMDL, WLA, and LA

The TMDL is the total amount of pollutant that can be assimilated by a water body while maintaining water quality standards. Fecal coliform bacteria TMDLs are expressed as counts per 30-day period since this is how the water quality standard is expressed. The TMDL, therefore, represents the maximum fecal coliform bacteria load that can be assimilated by a stream during the critical 30-day period while maintaining the fecal coliform bacteria water quality standard of 200 counts / 100 ml. As previously stated, the TMDL is calculated using the equation:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

With MOS = 20 counts / 100 ml (i.e. a 10% explicit MOS), the TMDL, $\sum$WLA, & $\sum$LA were determined according to the following procedure:

- The calibrated model, corresponding to the portion of the watershed that is upstream of the pour point of the listed waterbody segment was run for a time period that included the critical condition as specified in Table 8.

- Existing NPDES permitted facilities and any known future facility discharges were assumed to discharge at design flows and the fecal coliform permit limit of 200 counts/100 ml.

- Fecal coliform land loading variables and the magnitude of loading from sources modeled as "other direct sources" were adjusted within reasonable range of known values until the resulting fecal coliform concentration at the pour point of the listed water body segment was less than or equal to 180 counts/100ml. (i.e. the water quality standard of 200 counts/100ml minus 20 counts/100ml [i.e. a 10% explicit MOS]).

- The $\sum$WLA is the load associated with the daily discharge loads of all modeled NPDES permitted facilities summed over the 30-day critical period. The discharge load for each facility represents the design flow at a fecal coliform concentration of 200 counts/100 ml (permitted limit).

- The $\sum$LA is the daily fecal coliform load indirectly going to surface waters from all modeled land use areas as a result of buildup/washoff processes plus the daily discharge load sources modeled as "other direct sources" and the result summed over the 30-day critical period.

- The TMDL for the 30 day critical period is $\sum$WLAs plus $\sum$LAs.

The TMDLs, WLAs, and LAs for the listed water bodies are summarized in Table 9.

8.4.1 Waste Load Allocations

There are 11 NPDES permitted facilities that discharge fecal coliform bacteria in the Altamaha River basin. Future facility permits will require end-of-pipe limits equivalent to the water quality standard of 200 counts /100 ml or less.

8.4.2 Load Allocations

There are two modes of transport for nonpoint source fecal coliform bacteria loading in the model. First, loading from failing septic systems, animals in the stream, and leaking sewer system collection lines are modeled as "other direct sources" to the stream and are independent of precipitation. The second mode involves loading resulting from fecal coliform accumulation on land surfaces and wash-off during storm events. Fecal coliform applied to land is subject to a die-off rate and an absorption rate before it is transported to the stream.

Model results were analyzed to determine which sources of fecal coliform have the greatest impact on the fecal coliform bacteria loadings in the Altamaha River basin. The results of this analysis are indicated in Table 10, for each of the 303(d) listed segments for which a TMDL was developed. Wasteload and Load allocation scenarios that would meet in-stream water quality standards for each of the 303(d) listed streams analyzed in the Altamaha River basin are provided in Table 10. Possible load reduction scenarios that would meet in-stream water quality standards for each of the 303(d) listed streams analyzed in the Altamaha River basin is provided in Table 11.

Best management practices (BMPs) that could be used to implement this TMDL include controlling pollution from agriculture and urban runoff, identification and elimination of illicit discharges and other unknown "direct sources" of fecal coliform bacteria to the streams, and repair of leaking sewer collection lines and failing septic systems. Loading from agricultural sources may be minimized by adoption of NRCS resource management practices. NRCS practices include measures such as covering manure stacks exposed to the environment; reducing animal access to streams; and applying manure to croplands (if applicable) at agronomic rates. Measures which can reduce urban contributions include: repair and renovation of leaking sewer collection systems; reduction of sewer overflows and surcharges by use of separate conduit systems for domestic wastewater and stormwater; encouragement of households and businesses to connect to public sewer systems and reduce the population using septic systems.

Additional monitoring and characterization of the watershed should be conducted to verify the various other direct sources of fecal coliform bacteria in the watershed.

8.4.3 Seasonal Variation

Seasonal variation was incorporated in the continuous simulation water quality model by using varying monthly loading rates and daily meteorological data.

9.0 RECOMMENDATIONS

The TMDL analysis was performed using the best data available to specify WLAs and LAs that will meet the water quality criteria for fecal coliform in the Altamaha River basin so as to support the use classification specified for each of the listed segments in Table 2. The following recommendations and strategies are targeted toward source identification, collection of data to support additional modeling and evaluation, and subsequent reduction in sources that cause water quality impairments.

9.1 Point Source Facilities

All discharges from point source facilities are required to be in compliance with the conditions of their NPDES permit at all times. All permitted facilities with the potential to discharge fecal coliform which do not currently have a fecal coliform limit will be given a fecal coliform limit of not more than 200 counts / 100 ml during the permit reissuance process.

9.2 Urban Sources of Fecal Coliform Loading

Urban area makes up only a small portion of the total Altamaha River basin. As such, fecal coliform bacteria loadings to the watershed from these are less significant than contributions from rural land uses. Urban sources of fecal coliform can best be addressed using a stategy which involves public participation and intergovernmental coordination to reduce the discharge of pollutants to the maximum extent practicable using management practices, control techniques, public education, and other appropriate methods and provisions.

9.3 Agricultural Sources of Fecal Coliform Loading

The Georgia Environmental Protection Division (EPD) should coordinate with the Georgia Soil and

Water Conservation Commission, and the Natural Resources Conservation Service (NRCS) to address issues concerning fecal coliform loading from agricultural lands in the Altamaha River basin. It is recommended that information (such as livestock populations by subwatershed, animal access to streams, manure application practices, etc.) be evaluated periodically so that watershed models can be updated to reflect current conditions. It is further recommended that BMPs be utilized to reduce the amount of fecal coliform bacteria transported to surface waters from agricultural sources to the maximum extent practicable.

9.4 Stream Monitoring

Further monitoring of the fecal coliform concentrations at current and additional water quality monitoring stations in the watershed is needed to characterize sources of fecal coliform bacteria and document future reduction of loading. Georgia's watershed management approach specifies a five-year cycle for planning and assessment. Watersheds will be examined (or re-examined) as appropriate, on a rotating basis.

9.5 Future Efforts

This TMDL represents the first phase of a long-term process to reduce fecal coliform loading to meet water quality standards in the Altamaha River basin. Implementation strategies will be reviewed and the TMDLs will be refined as necessary in the next phase (next five-year cycle). The phased approach will support progress toward water quality standards attainment in the future. In accordance with USEPA TMDL guidance, these TMDLs may be revised based on results of future monitoring and source characterization data efforts.

10.0 Public Participation

A thirty day public notice was provided for this TMDL document. During the public notice period, the availability of the TMDLs was public noticed, a copy of the TMDLs was provided as requested, and the public was invited to provide comments on the TMDLs.

11.0 Initial TMDL Implementation Plan

EPD has coordinated with EPA to prepare this Initial TMDL Implementation Plan for this TMDL. EPD has also established a plan and schedule for development of a more comprehensive implementation plan after this TMDL is established. EPD and EPA have executed a Memorandum of Understanding that documents the schedule for developing the more comprehensive plans. This Initial TMDL Implementation Plan includes a list of best management practices and provides for an initial implementation demonstration project to address one of the major sources of pollutants identified in this TMDL while State and/or local agencies work with local stakeholders to develop a revised TMDL implementation plan. It also includes a process whereby EPD and/or Regional Development Centers (RDCs) or other EPD contractors (hereinafter, "EPD Contractors") will develop expanded plans (hereinafter, "Revised TMDL Implementation Plans").

This Initial TMDL Implementation Plan, written by EPD and for which EPD and/or the EPD Contractor are responsible, contains the following elements.

1. EPA has identified a number of management strategies for the control of nonpoint sources of pollutants, representing some best management practices. The "Management Measure Selector

Table shown below identifies these management strategies by source category and pollutant. Nonpoint sources are the primary cause of excessive pollutant loading in most cases. Any wasteload allocations in this TMDL will be implemented in the form of water-quality based effluent limitations in NPDES permits issued under CWA Section 402. See 40 C.F.R. § 122.44(d)(1)(vii)(B). NPDES permit discharges are a secondary source of excessive pollutant loading, where they are a factor, in most cases.

2. EPD and the EPD Contractor will select and implement one or more best management practice (BMP) demonstration projects for each River Basin. The purpose of the demonstration projects will be to evaluate by River Basin and pollutant parameter the site-specific effectiveness of one or more of the BMPs chosen. EPD intends that the BMP demonstration project be completed before the Revised TMDL Implementation Plan is issued. The BMP demonstration project will address the major category of contribution of the pollutant(s) of concern for the respective River Basin as identified in the TMDLs of the watersheds in the River Basin. The demonstration project need not be of a large scale, and may consist of one or more measures from the Table or equivalent BMP measures proposed by the EPD Contractor and approved by EPD. Other such measures may include those found in EPA's "Best Management Practices Handbook", the "NRCS National Handbook of Conservation Practices, or any similar reference, or measures that the volunteers, etc., devise that EPD approves. If for any reason the EPD Contractor does not complete the BMP demonstration project, EPD will take responsibility for doing so.

3. As part of the Initial TMDL Implementation Plan the EPD brochure entitled "Watershed Wisdom -- Georgia's TMDL Program" will be distributed by EPD to the EPD Contractor for use with appropriate stakeholders for this TMDL, and a copy of the video of that same title will be provided to the EPD Contractor for its use in making presentations to appropriate stakeholders, on TMDL Implementation plan development.

4. If for any reason an EPD Contractor does not complete one or more elements of a Revised TMDL Implementation Plan, EPD will be responsible for getting that (those) element(s) completed, either directly or through another contractor.

5. The deadline for development of a Revised TMDL Implementation Plan, is the end of August, 2003.

6. The EPD Contractor helping to develop the Revised TMDL Implementation Plan, in coordination with EPD, will work on the following tasks involved in converting the Initial TMDL Implementation Plan to a Revised TMDL Implementation Plan:
   A. Generally characterize the watershed;
   B. Identify stakeholders;
   C. Verify the present problem to the extent feasible and appropriate, (e.g., local monitoring);
   D. Identify probable sources of pollutant(s);
   E. For the purpose of assisting in the implementation of the load allocations of this TMDL, identify potential regulatory or voluntary actions to control pollutant(s) from the relevant nonpoint sources;
   F. Determine measurable milestones of progress;
   G. Develop monitoring plan, taking into account available resources, to measure effectiveness; and
   H. Complete and submit to EPD the Revised TMDL Implementation Plan.

7. The public will be provided an opportunity to participate in the development of the Revised TMDL Implementation Plan and to comment on it before it is finalized.

The Revised TMDL Implementation Plan will supersede this Initial TMDL Implementation Plan when the Revised TMDL Implementation Plan is approved by EPD.

Management Measure Selector Table

Land Use	**Management Measures**	Fecal Coliform	Dissolved Oxygen	pH	Sediment	Temperature	*Toxicity*	*Mercury*	Metals (copper, lead, zinc, cadmium)	PCBs, toxaphene
Agriculture	1. Sediment & Erosion Control	_	_		_	_				
	2. Confined Animal Facilities	_	_							
	3. Nutrient Management	_	_							
	4. Pesticide Management		_							
	5. Livestock Grazing	_	_		_	_				
	6. Irrigation		_		_	_				
Forestry	1. Preharvest Planning				_	_				
	2. Streamside Management Areas	_	_		_	_				
	3. Road Construction &Reconstruction		_		_	_				
	4. Road Management		_		_	_				
	5. Timber Harvesting		_		_	_				
	6. Site Preparation & Forest Regeneration		_		_	_				
	7. Fire Management	_	_	_	_	_				
	8. Revegetation of Disturbed Areas	_	_	_	_	_				
	9. Forest Chemical Management		_			_				
	10. Wetlands Forest Management	_	_	_		_		_		

Land Use	**Management Measures**	Fecal Coliform	Dissolved Oxygen	pH	Sediment	Temperature	*Toxicity*	*Mercury*	Metals (copper, lead, zinc, cadmium)	PCBs, toxaphene
Urban	1. New Development	–	–		–	–			–	
	2. Watershed Protection & Site Development	–	–		–	–		–	–	
	3. Construction Site Erosion and Sediment Control		–		–	–				
	4. Construction Site Chemical Control		–							
	5. Existing Developments	–	–		–	–			–	
	6. Residential and Commercial Pollution Prevention	–	–							
Onsite Wastewater	1. New Onsite Wastewater Disposal Systems	–	–							
	2. Operating Existing Onsite Wastewater Disposal Systems	–	–							
Roads, Highways and Bridges	1. Siting New Roads, Highways & Bridges	–	–		–	–			–	
	2. Construction Projects for Roads, Highways and Bridges		–		–	–				
	3. Construction Site Chemical Control for Roads, Highways and Bridges		–							
	4. Operation and Maintenance-Roads, Highways and Bridges	–	–			–			–	

REFERENCES

American Society of Agricultural Engineers (ASAE), 1998. ASAE Standards, 45th Edition, Standards Engineering Practices Data.

Horner. *Water Quality Criteria/Pollutant Loading Estimation/Treatment Effectiveness Estimation*. In R.W. Beck and Associates, Covington Master Drainage Plan, King County Surface Water Management Division, Seattle, Washington, 1992.

Horsley & Witten, Inc., 1996. Identification and Evaluation of Nutrient Bacterial Loadings to Maquiot Bay, Brunswick and Freeport, Maine. Casco Bay Estuary Project.

Metcalf & Eddy, 1991. *Wastewater Engineering: Treatment, disposal, Reuse,* Third Edition, McGraw-Hill, Inc., New York.

NCSU, 1994. *Livestock Manure Production and Characterization in North Carolina*, North Carolina Cooperative Extension Service, North Carolina State University (NCSU) College of Agriculture and Life Sciences, Raleigh, January 1994.

Georgia EPD, 2000. *Final Georgia 2000 §303(d) / §305(b) List, August 2000 (As Revised April, 2001).* State of Georgia, Department of Natural Resources, Environmental Protection Division, Water Protection Branch.

Georgia EPD, 2000. *State of Georgia Rules and Regulations for Water Quality Control, Chapter 391-3-6 Revised, July, 2000.* State of Georgia, Department of Natural Resources, Environmental Protection Division, Water Protection Branch.

Georgia WRD, 1999. Personal Communications with a representative from the Wildlife Resources Division – Georgia Department of Natural Resources, 2070 U.S. Highway 278, SE, Social Circle, GA. November, 1999.

USDA, 2001. Personal Communications with Mr. Jimmy Bramblett, Water Resources Specialist, U.S. Department of Agriculture – NRCS, 355 East Hancock Ave., Athens, GA. March-May, 2001.

USEPA, 1991. *Guidance for Water Quality–based Decisions: The TMDL Process.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991.

USEPA, 2001. *Protocol for Developing Pathogen TMDLs, First Edition.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-841-R-00-002, January, 2001.

USEPA. 2000. *Draft Level III and IV Ecoregions of EPA Region IV*. U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Corvallis, Oregon.

USEPA, 1998. *Better Assessment Science Integrating Point and Nonpoint Sources (BASINS), Version 2.0 User's Manual*, U.S. Environmental Protection Agency, Office of Water, Washington D.C.

FIGURES

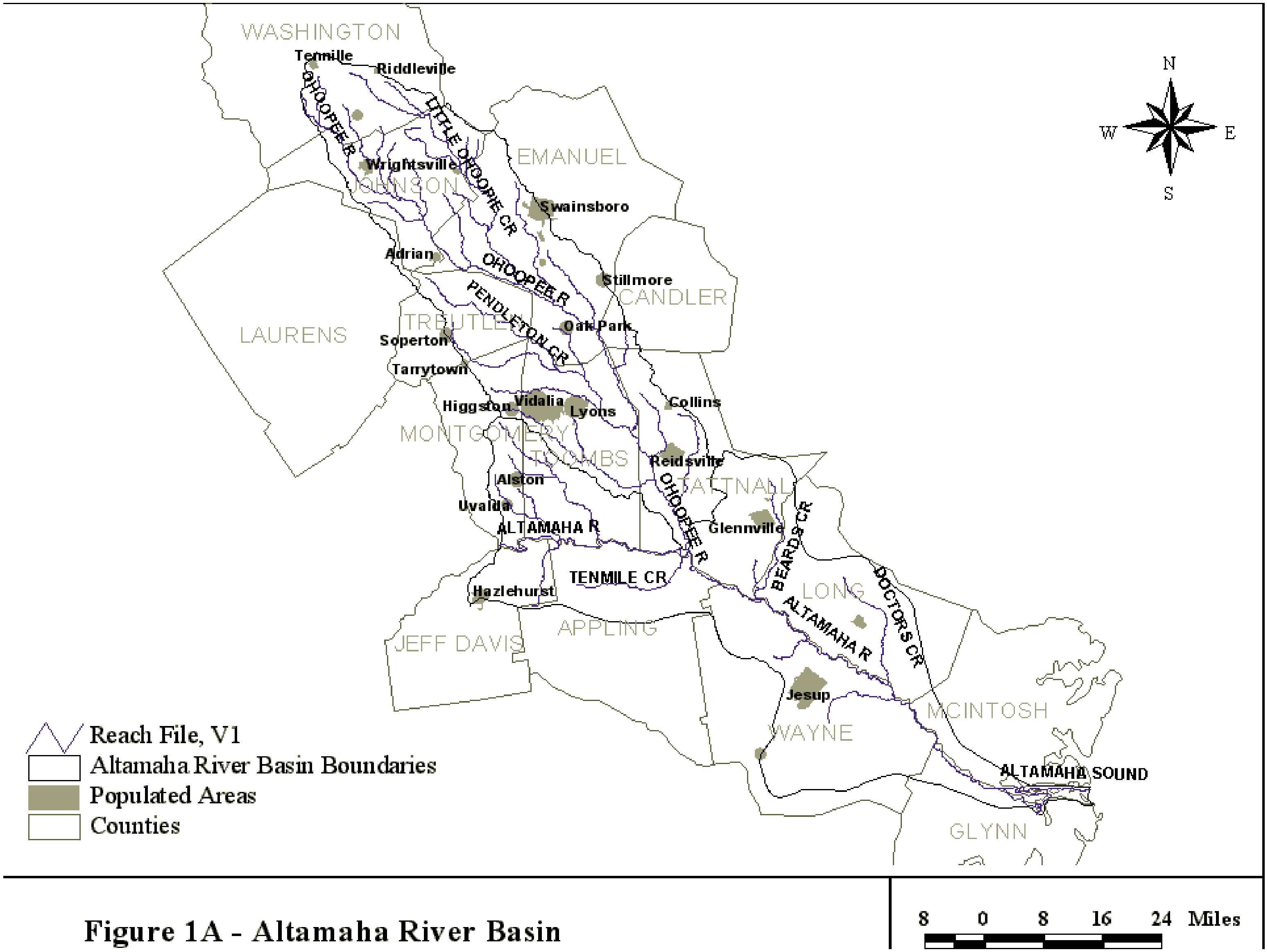


Figure 1A - Altamaha River Basin

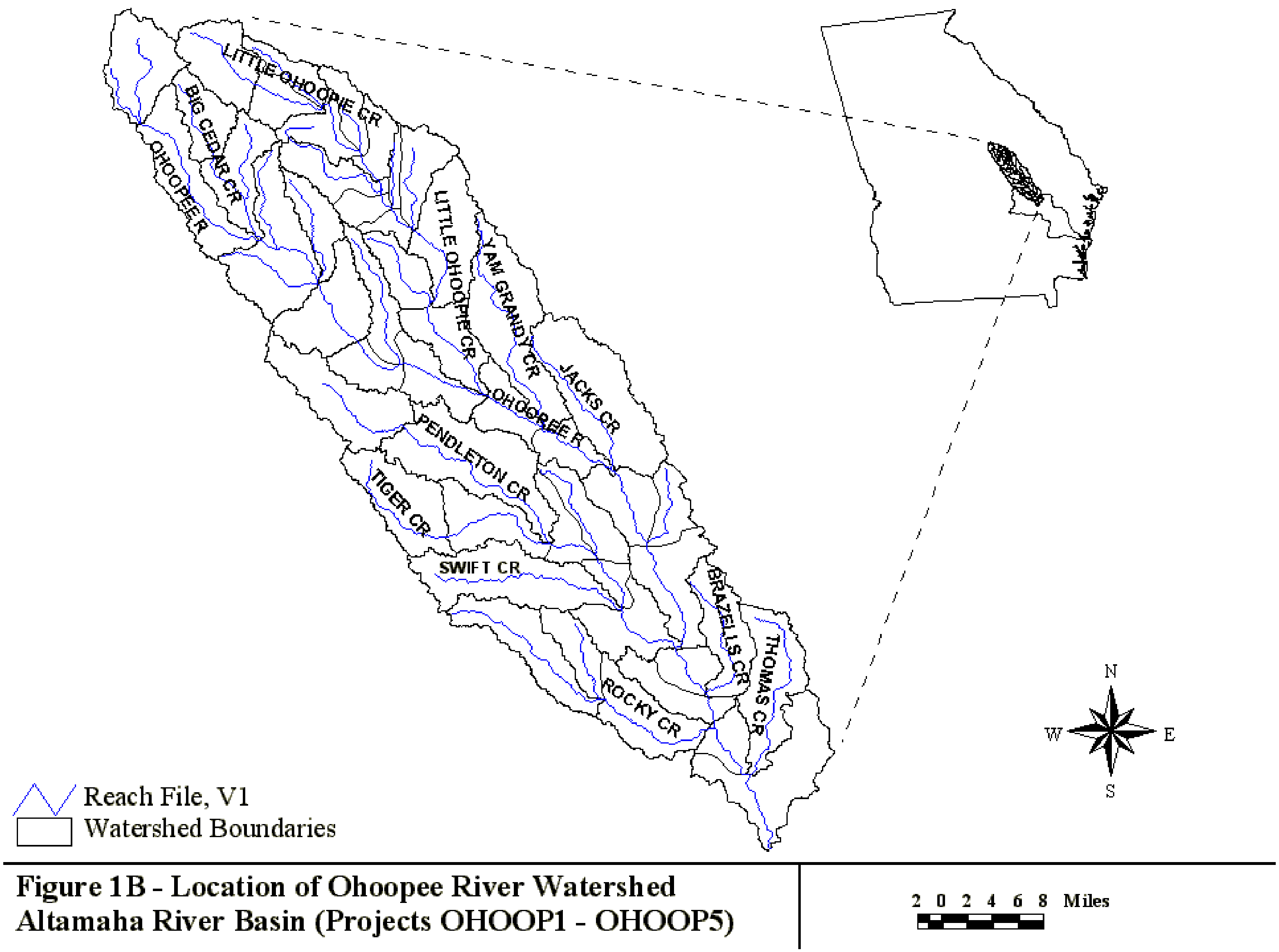


Figure 1B - Location of Ohoopee River Watershed Altamaha River Basin (Projects OHOOP1 - OHOOP5)

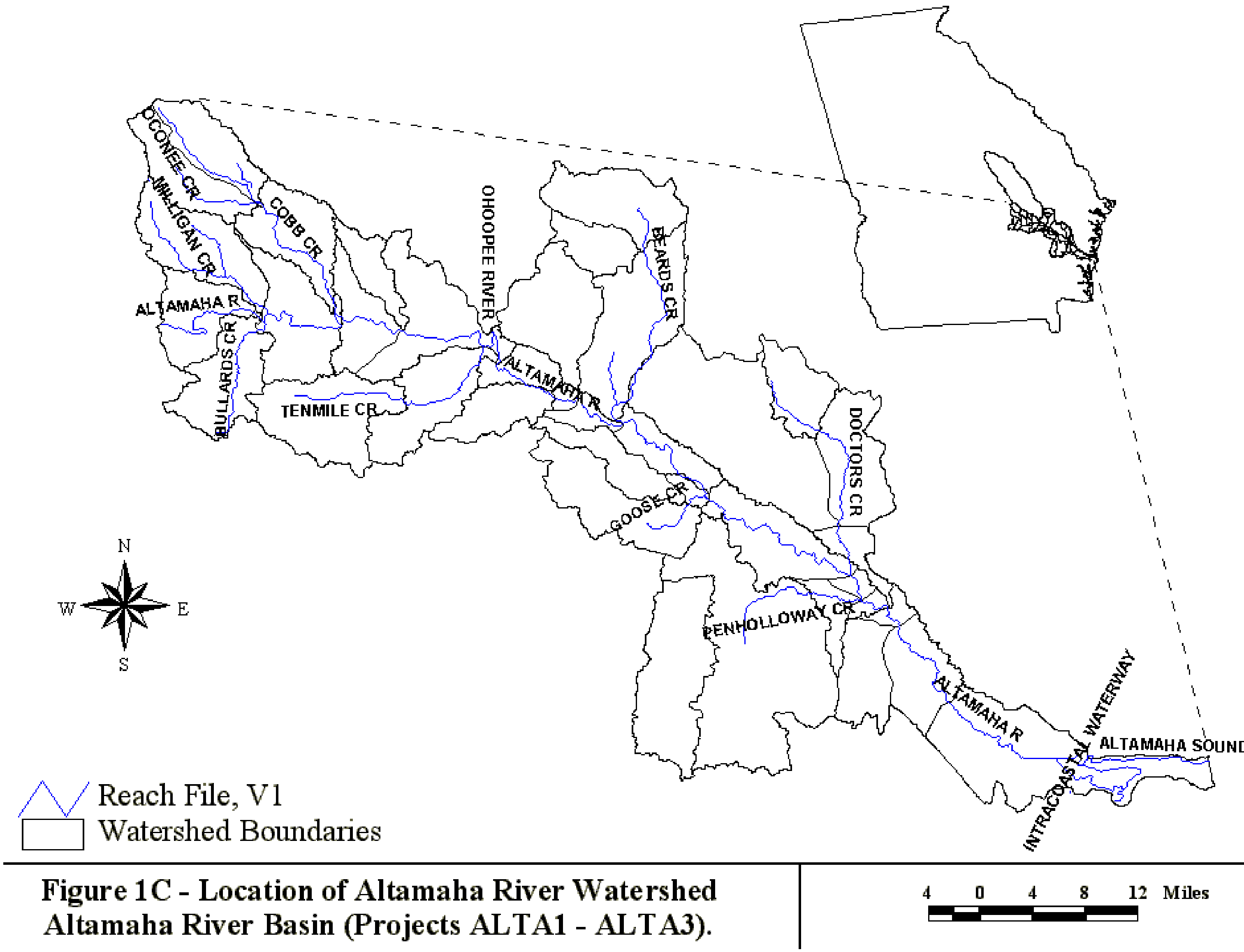


Figure 1C - Location of Altamaha River Watershed Altamaha River Basin (Projects ALTA1 - ALTA3).

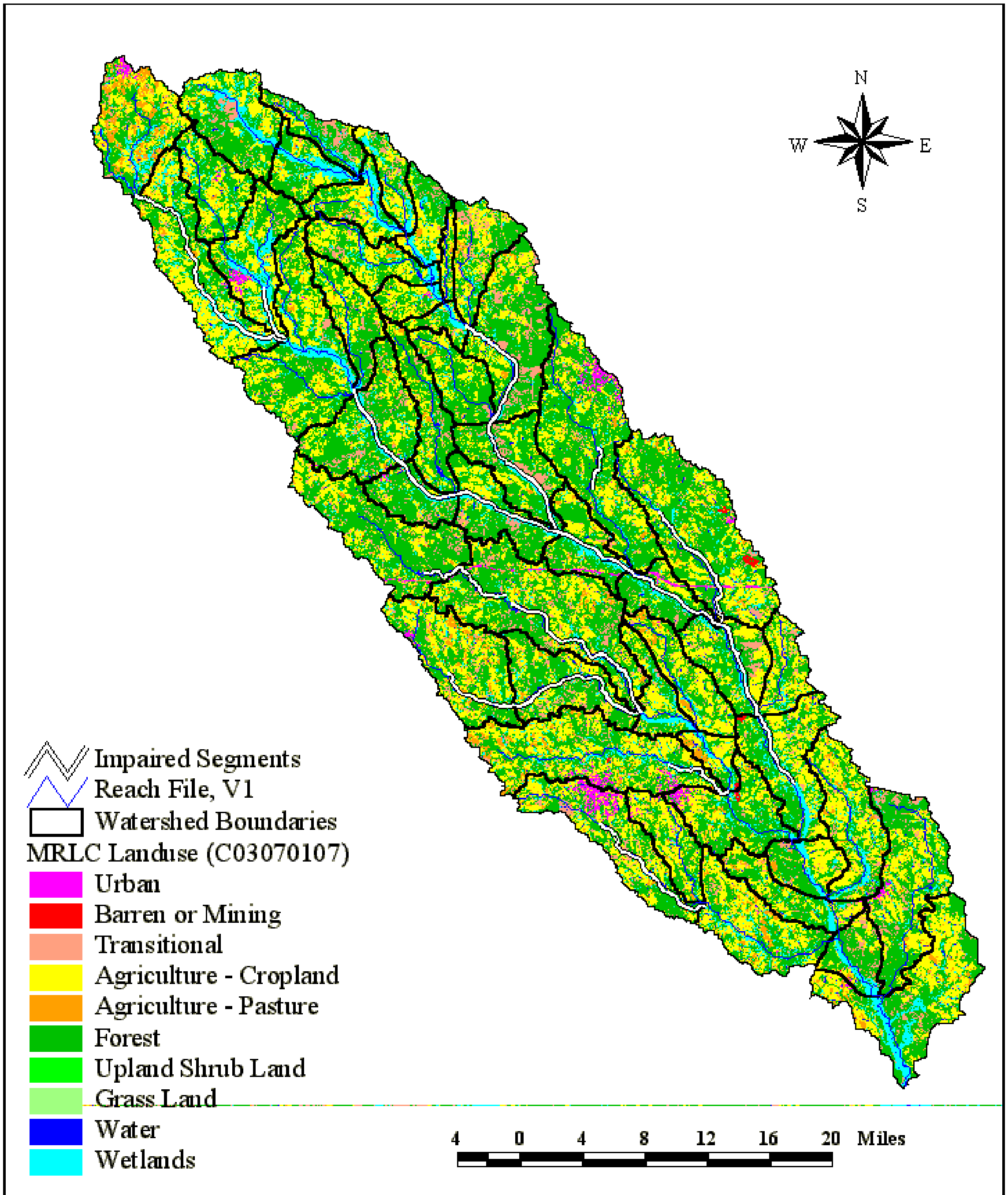


Figure 2A - Land Use Distribution.
Ohoopee River Watershed
Altamaha River Basin (Projects OHOOP1 - OHOOP5)

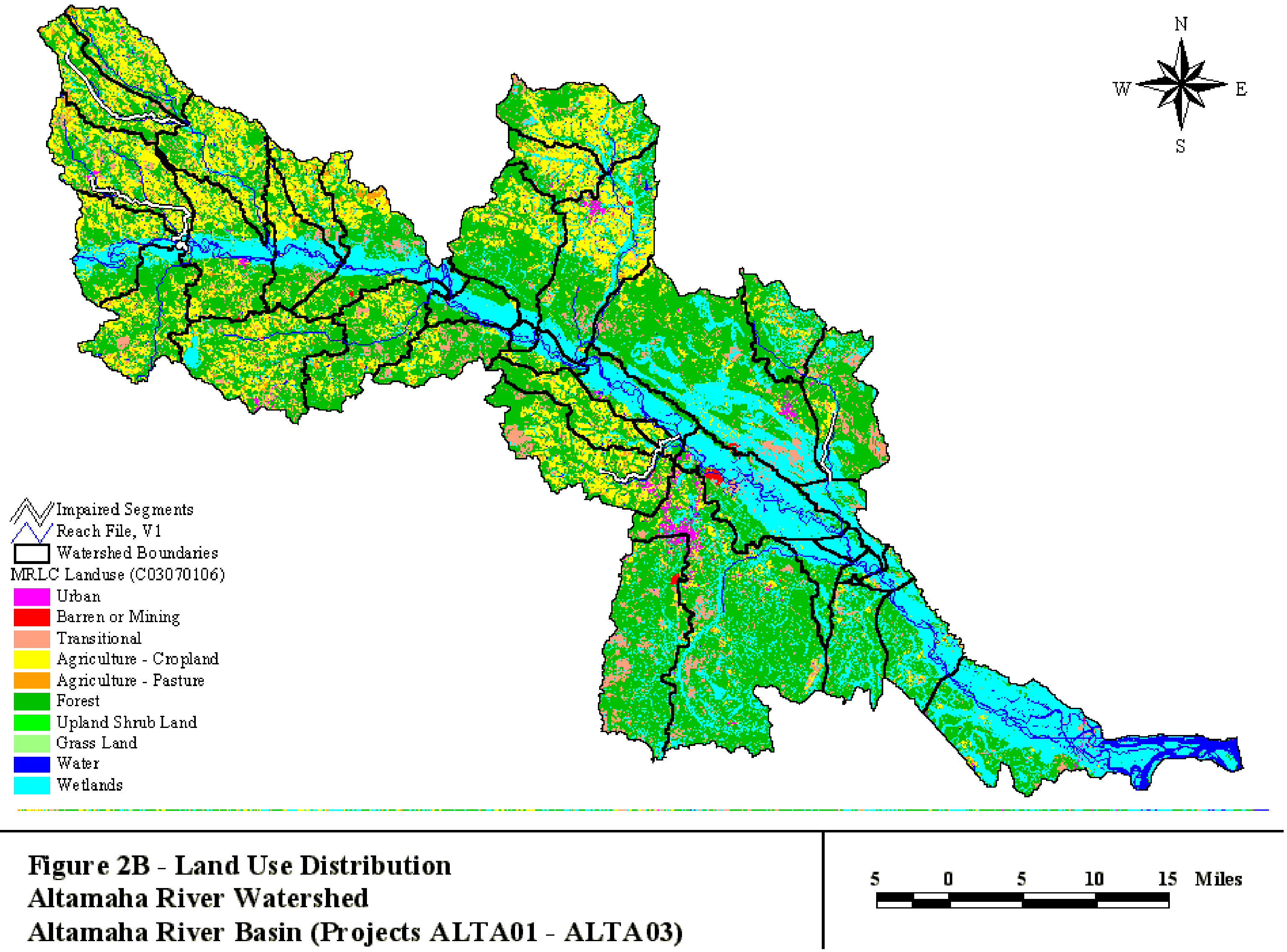


Figure 2B - Land Use Distribution
Altamaha River Watershed
Altamaha River Basin (Projects ALTA01 - ALTA03)

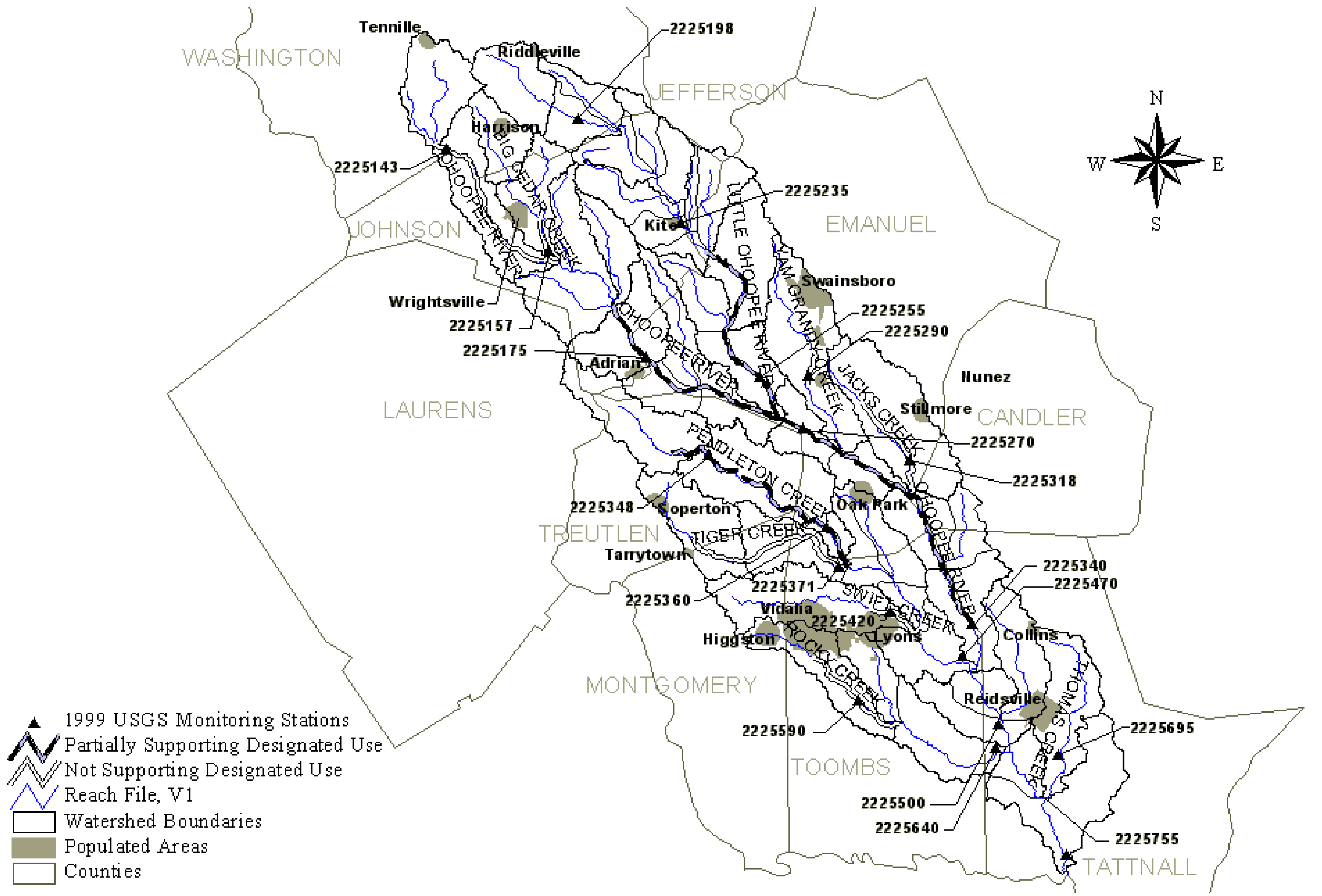
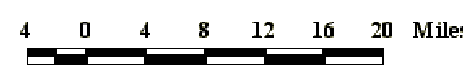


Figure 3A - Ohoopee River Watershed
Altamaha River Basin (Projects OHOOP1 - OHOOP5).



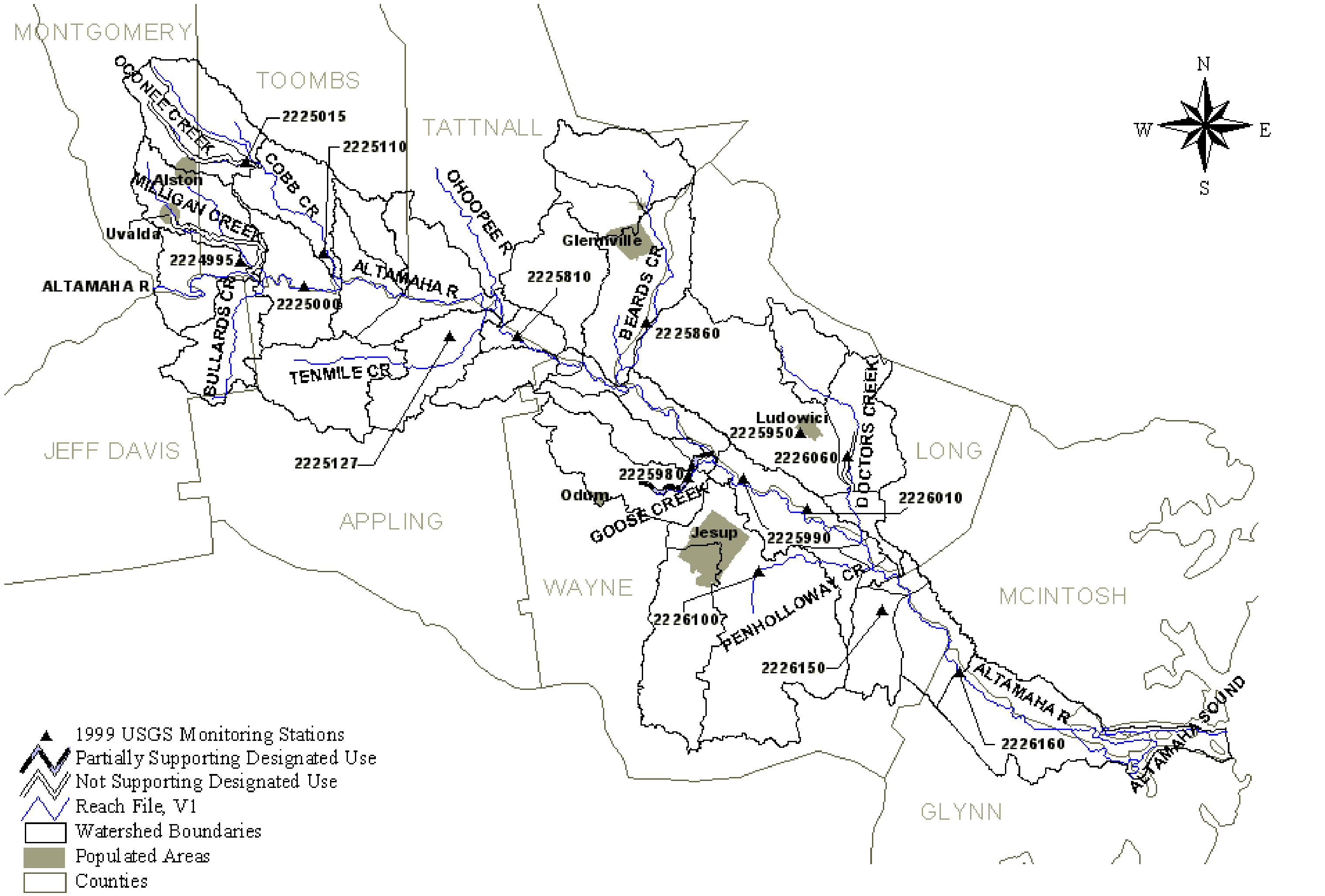


Figure 3B - Altamaha River Watershed
Altamaha River Basin (Projects ALTA01 - ALTA03)

TABLES

Table 1 Land Use Distribution for the Altamaha River Basin

Stream/Segment	Land Use Categories - in units of acres (percent)																
	Bare Rock/Sand/Clay	Deciduous Forest	Emergent Herbaceous Wetlands	Evergreen Forest	High Intensity Commercial/Industrial/Transportation	Low Intensity Commercial/Industrial/Transportation	High Intensity Residential	Low Intensity Residential	Mixed Forest	Open Water	Other Grasses Urban/Recreational	Pasture/Hay	Quarries/Strip Mines/Gravel Pits	Row Crops	Transitional	Woody Wetlands	Unclassified
Big Cedar Creek (Little Cedar Creek to Ohoopee River)	22 (0.1)	4083 (12.7)	6 (0.0)	6518 (20.2)	219 (0.7)	0 (0.0)	88 (0.3)	310 (1.0)	2748 (8.5)	178 (0.6)	54 (0.2)	860 (2.7)	0 (0.0)	11402 (35.4)	997 (3.1)	4713 (14.6)	0 (0.0)
Doctors Creek (Upstream of Jones Creek)	13 (0.0)	1444 (3.3)	87 (0.2)	21267 (49.0)	4 (0.0)	0 (0.0)	6 (0.0)	96 (0.2)	3353 (7.7)	28 (0.1)	1 (0.0)	954 (2.2)	14 (0.0)	3127 (7.2)	4820 (11.1)	8195 (18.9)	0 (0.0)
Goose Creek (U/S Rd. S1922 to Little Goose Creek)	35 (0.1)	3100 (6.2)	17 (0.0)	18338 (36.8)	86 (0.2)	0 (0.0)	16 (0.0)	322 (0.6)	4773 (9.6)	343 (0.7)	35 (0.1)	1711 (3.4)	105 (0.2)	15299 (30.7)	3545 (7.1)	2149 (4.3)	0 (0.0)
Jacks Creek (U.S. Hwy 1 to Ohoopee River)	22 (0.1)	4370 (10.4)	6 (0.0)	14246 (34.0)	333 (0.8)	0 (0.0)	4 (0.0)	68 (0.2)	4020 (9.6)	380 (0.9)	12 (0.0)	1424 (3.4)	364 (0.9)	12315 (29.4)	2292 (5.5)	2013 (4.8)	0 (0.0)
Little Ohoopee River (Sardis Creek to Ohoopee River)	77 (0.0)	16193 (10.1)	119 (0.1)	48886 (30.6)	38 (0.0)	0 (0.0)	8 (0.0)	69 (0.0)	13205 (8.3)	687 (0.4)	834 (0.5)	4548 (2.8)	7 (0.0)	43731 (27.3)	12902 (8.1)	18597 (11.6)	0 (0.0)

Stream/Segment	Land Use Categories - in units of acres (percent)																
	Bare Rock/Sand/Clay	Deciduous Forest	Emergent Herbaceous Wetlands	Evergreen Forest	High Intensity Commercial/Industrial/Transportation	Low Intensity Commercial/Industrial/Transportation	High Intensity Residential	Low Intensity Residential	Mixed Forest	Open Water	Other Grasses Urban/Recreational	Pasture/Hay	Quarries/Strip Mines/Gravel Pits	Row Crops	Transitional	Woody Wetlands	Unclassified
Milligan Creek (Uvalda to Altamaha River)	25 (0.1)	2890 (10.0)	9 (0.0)	6513 (22.5)	58 (0.2)	0 (0.0)	2 (0.0)	125 (0.4)	1940 (6.7)	205 (0.7)	16 (0.1)	1292 (4.5)	0 (0.0)	11887 (41.1)	2562 (8.9)	1384 (4.8)	0 (0.0)
Oconee Creek (Headwaters to Cobb Creek)	30 (0.1)	4223 (10.9)	11 (0.0)	9855 (25.4)	11 (0.0)	0 (0.0)	4 (0.0)	59 (0.2)	3218 (8.3)	285 (0.7)	16 (0.0)	1690 (4.4)	1 (0.0)	14742 (38.0)	2643 (6.8)	1991 (5.1)	0 (0.0)
Ohoopee River (Dyers Creek to Big Cedar Creek)	73 (0.1)	7154 (14.2)	12 (0.0)	7880 (15.6)	137 (0.3)	0 (0.0)	98 (0.2)	318 (0.6)	3725 (7.4)	236 (0.5)	81 (0.2)	4675 (9.2)	0 (0.0)	17909 (35.4)	2273 (4.5)	5972 (11.8)	0 (0.0)
Ohoopee River (Little Ohoopee River to US Highway 292)	325 (0.1)	54265 (10.9)	172 (0.0)	149701 (30.0)	1738 (0.3)	0 (0.0)	402 (0.1)	1637 (0.3)	43186 (8.6)	2938 (0.6)	2153 (0.4)	17080 (3.4)	575 (0.1)	141879 (28.4)	31685 (6.3)	51954 (10.4)	0 (0.0)
Ohoopee River (Neels Creek to Little Ohoopee River)	163 (0.1)	21594 (11.3)	29 (0.0)	54117 (28.4)	417 (0.2)	0 (0.0)	200 (0.1)	783 (0.4)	16311 (8.6)	1069 (0.6)	1193 (0.6)	8555 (4.5)	0 (0.0)	55730 (29.3)	9764 (5.1)	20510 (10.8)	0 (0.0)
Pendleton Creek (Sand Hill Lake to Reedy Creek)	34 (0.1)	2616 (9.2)	4 (0.0)	12609 (44.1)	174 (0.6)	0 (0.0)	0 (0.0)	48 (0.2)	2328 (8.1)	314 (1.1)	10 (0.0)	644 (2.3)	0 (0.0)	6899 (24.1)	2222 (7.8)	684 (2.4)	0 (0.0)

Stream/Segment	**Land Use Categories - in units of acres (percent)**																
	Bare Rock/Sand/Clay	**Deciduous Forest**	**Emergent Herbaceous Wetlands**	**Evergreen Forest**	**High Intensity Commercial/Industrial/Transportation**	**Low Intensity Commercial/Industrial/Transportation**	**High Intensity Residential**	**Low Intensity Residential**	**Mixed Forest**	**Open Water**	**Other Grasses Urban/Recreational**	**Pasture/Hay**	**Quarries/Strip Mines/Gravel Pits**	**Row Crops**	**Transitional**	**Woody Wetlands**	**Unclassified**
Pendleton Creek (Wildwood Lake to Tiger Creek)	31 (0.1)	3763 (9.2)	6 (0.0)	14501 (35.4)	296 (0.7)	0 (0.0)	1 (0.0)	26 (0.1)	3419 (8.3)	267 (0.7)	4 (0.0)	1681 (4.1)	4 (0.0)	10699 (26.1)	3758 (9.2)	2500 (6.1)	0 (0.0)
Rocky Creek (Ga. Hwy. 130 to Little Rocky Creek)	34 (0.1)	1939 (8.1)	13 (0.1)	6261 (26.3)	589 (2.5)	0 (0.0)	221 (0.9)	719 (3.0)	1752 (7.4)	271 (1.1)	170 (0.7)	836 (3.5)	7 (0.0)	7965 (33.4)	1948 (8.2)	1090 (4.6)	0 (0.0)
Swift Creek (Old Normantown Rd. to Pendleton Creek)	36 (0.1)	3361 (9.4)	4 (0.0)	8407 (23.4)	324 (0.9)	0 (0.0)	165 (0.5)	689 (1.9)	2820 (7.9)	227 (0.6)	60 (0.2)	2577 (7.2)	42 (0.1)	12731 (35.5)	1909 (5.3)	2538 (7.1)	0 (0.0)
Tiger Creek (Little Creek to Pendleton Creek)	97 (0.1)	9789 (8.7)	16 (0.0)	41641 (36.9)	585 (0.5)	0 (0.0)	30 (0.0)	235 (0.2)	8966 (7.9)	786 (0.7)	43 (0.0)	4956 (4.4)	9 (0.0)	31127 (27.6)	9018 (8.0)	5499 (4.9)	0 (0.0)
Yam Grandy Creek (D/s Crooked Creek)	26 (0.1)	4267 (10.8)	1 (0.0)	15126 (38.1)	399 (1.0)	0 (0.0)	189 (0.5)	716 (1.8)	3996 (10.1)	328 (0.8)	113 (0.3)	1113 (2.8)	53 (0.1)	9372 (23.6)	2236 (5.6)	1723 (4.3)	0 (0.0)

Table 2 Waterbodies Listed for Fecal Coliform Bacteria in the Altamaha River Basin

Stream Name	Segment Description	Segment Length (miles)	Designated Use Classification	Partially Supporting Designated Uses	Not Supporting Designated Uses
Big Cedar Creek	Little Cedar Creek to Ohoopee River	3	Fishing		X
Doctors Creek	Upstream of Jones Creek	5	Fishing		X
Goose Creek	U/S Rd. S1922 to Little Goose Creek	8	Fishing	X	
Jacks Creek	U.S. Hwy 1 to Ohoopee River	9	Fishing		X
Little Ohoopee River	Sardis Creek to Ohoopee River	18	Fishing	X	
Milligan Creek	Uvalda to Altamaha River	11	Fishing		X
Oconee Creek	Headwaters to Cobb Creek	11	Fishing		X
Ohoopee River	Dyers Creek to Big Cedar Creek	15	Fishing		X
Ohoopee River	Little Ohoopee River to US Highway 292	23	Fishing	X	
Ohoopee River	Neels Creek to Little Ohoopee River	18	Fishing	X	
Pendleton Creek	Sand Hill Lake to Reedy Cree	7	Fishing	X	
Pendleton Creek	Wildwood Lake to Tiger Creek	12	Fishing	X	
Rocky Creek	Ga. Hwy. 130 to Little Rocky Creek	10	Fishing		X
Swift Creek	Old Normantown Rd. to Pendleton Creek	5	Fishing		X
Tiger Creek	Little Creek to Pendleton Creek	16	Fishing		X
Yam Grandy Creek	D/s Crooked Creek	3	Fishing		X

Table 3   1999 Water Quality Monitoring Stations

Stream Name	Segment Description	USGS Monitoring Station No.	Monitoring Station Description
Big Cedar Creek	Little Cedar Creek to Ohoopee River	02225157	Big Cedar Creek at Liberty Church Road (County Road 175) near Wrightsville, Georgia
Doctors Creek	Upstream of Jones Creek	02226060	Doctors Creek at State Road 99 near Ludowici, Georgia
Goose Creek	U/S Rd. S1922 to Little Goose Creek	02225980	Goose Creek at Woods Road (County Road 30) near Jesup, Georgia
Jacks Creek	U.S. Hwy 1 to Ohoopee River	02225318	Jacks Creek at State Road 46 near Stillmore, Georgia
Little Ohoopee River	Sardis Creek to Ohoopee River	02225255	Little Ohoopee River at State Road 56 near Covena, Georgia
Milligan Creek	Uvalda to Altamaha River	02224995	Milligan Creek at Old River Road (County Road 1125) near Baxley, Georgia
Oconee Creek	Headwaters to Cobb Creek	02225015	Oconee Creek at Vidalia Road (County Road 78) near Vidalia, Georgia
Ohoopee River	Dyers Creek to Big Cedar Creek	02225143	Ohoopee River at Harts Ford Road (County Road 239) near Harrison, Georgia
Ohoopee River	Little Ohoopee River to US Highway 292	02225270 02225340	Ohoopee River at State Road 297 near Swainsboro, Georgia and Ohoopee River at State Road 292 near Lyons, Georgia
Ohoopee River	Neels Creek to Little Ohoopee River	02225175	Ohoopee River at U.S. Highway 80 near Adrian, Georgia
Pendleton Creek	Sand Hill Lake to Reedy Creek	02225348	Pendleton Creek at U.S. Highway 221 near Soperton, Georgia
Pendleton Creek	Wildwood Lake to Tiger Creek	02225360	Pendleton Creek at Blackston Road near Normantown, Georgia
Rocky Creek	Ga. Hwy. 130 to Little Rocky Creek	02225590	Rocky Creek at State Road 4 near Lyons, Georgia
Swift Creek	Old Normantown Rd. to Pendleton Creek	02225420	Swift Creek at State Road 152 near Lyons, Georgia
Tiger Creek	Little Creek to Pendleton Creek	02225371	Tiger Creek at Victory Drive near Normantown, Georgia
Yam Grandy Creek	D/s Crooked Creek	02225290	Yam Grandy Creek at Levilligar Pond Road (County Road 198) near Nunez, Georgia

Table 4 CY 1999 Water Quality Monitoring Data

Stream/Segment	Sample Period	Geometric Mean (#/100 ml.)	Sample Period	Geometric Mean (#/100 ml.)	Sample Period	Geometric Mean (#/100 ml.)	Sample Period	Geometric Mean (#/100 ml.)
Big Cedar Creek (Little Cedar Creek to Ohoopee River)	01/27/1999 02/10/1999 02/17/1999 02/24/1999	79	05/12/1999 05/19/1999 06/02/1999 06/09/1999	922	08/18/1999 08/25/1999 09/01/1999 09/15/1999	164	11/17/1999 12/01/1999 12/08/1999 12/15/1999	48
Doctors Creek (Upstream of Jones Creek)	01/20/1999 02/02/1999 02/09/1999 02/17/1999	110	03/23/1999 04/13/1999 04/21/1999 04/22/1999	42	06/23/1999 06/30/1999 07/14/1999 04/21/1999	162	09/22/1999 09/29/1999 10/06/1999 10/20/1999	238
Goose Creek (U/S Rd. S1922 to Little Goose Creek)	03/30/1999 04/12/1999 04/19/1999 04/27/1999	121	05/17/1999 05/24/1999 06/07/1999 06/14/1999	75	07/26/1999 08/09/1999 08/16/1999 08/23/1999	291	11/15/1999 11/29/1999 12/06/1999 12/13/1999	155
Jacks Creek (U.S. Hwy 1 to Ohoopee River)	01/21/1999 02/03/1999 02/10/1999 02/18/1999	390	03/24/1999 04/08/1999 04/14/1999 04/19/1999	36	06/21/1999 06/28/1999 07/12/1999 07/19/1999	291		
Little Ohoopee River (Sardis Creek to Ohoopee River)	01/21/1999 02/03/1999 02/10/1999 02/18/1999	406	03/24/1999 04/08/1999 04/14/1999 04/19/1999	109	06/21/1999 06/28/1999 07/12/1999 07/19/1999	421	09/20/1999 09/27/1999 10/04/1999 10/18/1999	271
Milligan Creek (Uvalda to Altamaha River)	03/31/1999 04/07/1999 04/13/1999 04/20/1999	89	05/18/1999 06/01/1999 06/08/1999 06/15/1999	372	07/27/1999 08/10/1999 08/17/1999 08/24/1999	451	11/16/1999 11/30/1999 12/07/1999 12/14/1999	256
Oconee Creek (Headwaters to Cobb Creek)	03/31/1999 04/07/1999 04/13/1999 04/20/1999	68	05/18/1999 06/01/1999 06/08/1999 06/15/1999	1502	11/16/1999 11/30/1999 12/07/1999 12/14/1999	193		
Ohoopee River (Dyers Creek to Big Cedar Creek)	01/27/1999 02/10/1999 02/17/1999 02/24/1999	191	05/12/1999 05/19/1999 06/02/1999 06/09/1999	443	08/18/1999 08/25/1999 09/01/1999 09/15/1999	269	11/17/1999 12/01/1999 12/08/1999 12/15/1999	70

Stream/Segment	Sample Period	Geometric Mean (#/100 ml.)	Sample Period	Geometric Mean (#/100 ml.)	Sample Period	Geometric Mean (#/100 ml.)	Sample Period	Geometric Mean (#/100 ml.)
Ohoopee River (Little Ohoopee River to US Highway 292)	01/21/1999 02/03/1999 02/10/1999 02/18/1999	309	05/24/1999 06/08/1999 06/14/1999 06/19/1999	191	06/21/1999 06/28/1999 07/12/1999 07/19/1999	171	09/20/1999 09/27/1999 10/04/1999 10/18/1999	262
Ohoopee River (Neels Creek to Little Ohoopee River)	01/21/1999 02/03/1999 02/10/1999 02/18/1999	749	03/24/1999 04/08/1999 04/14/1999 04/19/1999	191	06/21/1999 06/28/1999 07/12/1999 07/19/1999	66		
Pendleton Creek (Sand Hill Lake to Reedy Creek)	01/21/1999 02/03/1999 02/10/1999 02/18/1999	281	03/24/1999 04/08/1999 04/14/1999 04/19/1999	233				
Pendleton Creek (Wildwood Lake to Tiger Creek)	01/21/1999 02/03/1999 02/10/1999 02/18/1999	203	03/24/1999 04/08/1999 04/14/1999 04/19/1999	46				
Rocky Creek (Ga. Hwy. 130 to Little Rocky Creek)	03/31/1999 04/07/1999 04/13/1999 04/20/1999	215	05/18/1999 06/01/1999 06/08/1999 06/15/1999	4918	07/27/1999 08/10/1999 08/17/1999 08/24/1999	450	11/16/1999 11/30/1999 12/07/1999 12/14/1999	234
Swift Creek (Old Normantown Rd. to Pendleton Creek)	03/31/1999 04/07/1999 04/13/1999 04/20/1999	61	05/18/1999 06/01/1999 06/08/1999 06/15/1999	2196	07/27/1999 08/10/1999 08/17/1999 08/24/1999	281	11/16/1999 11/30/1999 12/07/1999 12/14/1999	83
Tiger Creek (Little Creek to Pendleton Creek)	01/21/1999 02/03/1999 02/10/1999 02/18/1999	263	03/24/1999 04/08/1999 04/14/1999 04/19/1999	102	06/21/1999 06/28/1999 07/12/1999 07/19/1999	662		
Yam Grandy Creek (D/s Crooked Creek)	01/21/1999 02/03/1999 02/10/1999 02/18/1999	137	03/24/1999 04/08/1999 04/14/1999 04/19/1999	25				

Table 5 NPDES Facilities Discharging Fecal Coliform in the Altamaha River Basin

Facility Name	NPDES Permit No.	1999 Discharge Monitoring Reports		NPDES Permit Limits	
		Avg. Flow (MGD)	Avg. Fecal Coliform Loading[a] (counts/hr)	Avg. Flow (MGD)	Avg. Fecal Coliform Loading[b] (counts/hr)
DOC-Rogers Correctional Institute	GA0022900	0.64	4.39E+07	0.85	2.69E+08
Georgia Power Hatch	GA0004120	No data available		43.4	1.37E+10
Glenville WPCP	GA0031836	No data available		0.88	2.78E+08
Jessup WPCP	GA0026000	No data available		2.50	7.90E+08
Lyons Pond #1	GA0033405	0.36	2.10E+07	0.67	2.12E+08
Lyons North WPCP #2	GA0033391	No data available		0.67	2.12E+08
Rayonier Inc., Jessup	GA0003620	No data available		67.00	2.12E+10
Santa Claus Pond	GA0050059	No data available		0.01	3.16E+06
Tennille Pond	GA0049956	No data available		0.45	1.42E+08
Vidalia WPCP	GA0025488	0.64	3.79E+06	1.88	5.94E+08
Wrightsville Pond	GA0032395	No data available		0.745	2.35E+08

a Loadings based on CY 1999 average fecal coliform concentration and mean flow reported on DMRs.
b Loadings based on Monthly Average fecal coliform permit limit at monthly average permitted flow (design flow used for facilities without a permitted monthly flow limit). A fecal coliform loading of 200 counts/100 mL was assumed for facilities without a fecal coliform bacteria permit limit.

Table 6 Livestock Distribution In Altamaha River Basin

Stream/Segment	Livestock						
	Beef Cow	Milk Cow	Cattle	Chicken Layers	Chickens-Broilers Sold	Hogs	Sheep
Big Cedar Creek - (Little Cedar Creek to Ohoopee River)	419	26	796	28	0	357	0
Doctors Creek - (Upstream of Jones Creek)	221	0	416	0	677637	9	0
Goose Creek - (U/S Rd. S1922 to Little Goose Creek)	460	94	962	54	0	677	66
Jacks Creek - (U.S. Hwy 1 to Ohoopee River)	503	9	1375	0	0	686	14
Little Ohoopee River - (Sardis Creek to Ohoopee River)	2086	80	4209	92	0	1981	19
Milligan Creek - (Uvalda to Altamaha River)	348	6	858	0	0	400	0
Oconee Creek - (Headwaters to Cobb Creek)	426	7	1008	0	0	498	0
Ohoopee River - (Dyers Creek to Big Cedar Creek)	2597	265	5211	180	0	677	0
Ohoopee River - (Little Ohoopee River to US Highway 292)	7883	434	16600	20658	1917056	7191	62
Ohoopee River - (Neels Creek to Little Ohoopee River)	4255	312	8445	263	0	2590	9
Pendleton Creek - (Sand Hill Lake to Reedy Creek)	93	3	320	3	0	115	0
Pendleton Creek - (Wildwood Lake to Tiger Creek)	356	8	1303	3	0	315	7
Rocky Creek - (Ga. Hwy. 130 to Little Rocky Creek)	257	5	687	0	0	289	0
Swift Creek - (Old Normantown Rd. to Pendleton Creek)	666	10	1601	0	0	774	0
Tiger Creek - (Little Creek to Pendleton Creek)	555	11	2327	3	0	599	7
Yam Grandy Creek - (D/s Crooked Creek)	481	8	1145	0	0	283	14

Table 7 Estimated Number of Septic Systems In Altamaha River Basin

Stream/Segment	Population on Septic Systems
Big Cedar Creek - (Little Cedar Creek to Ohoopee River)	1965
Doctors Creek - (Upstream of Jones Creek)	1210
Goose Creek - (U/S Rd. S1922 to Little Goose Creek)	1683
Jacks Creek - (U.S. Hwy 1 to Ohoopee River)	2152
Little Ohoopee River - (Sardis Creek to Ohoopee River)	6520
Milligan Creek - (Uvalda to Altamaha River)	1295
Oconee Creek - (Headwaters to Cobb Creek)	870
Ohoopee River - (Dyers Creek to Big Cedar Creek)	2010
Ohoopee River - (Little Ohoopee River to US Highway 292)	22886
Ohoopee River - (Neels Creek to Little Ohoopee River)	8870
Pendleton Creek - (Sand Hill Lake to Reedy Creek)	1050
Pendleton Creek - (Wildwood Lake to Tiger Creek)	1484
Rocky Creek - (Ga. Hwy. 130 to Little Rocky Creek)	1895
Swift Creek - (Old Normantown Rd. to Pendleton Creek)	2170
Tiger Creek - (Little Creek to Pendleton Creek)	4289
Yam Grandy Creek - (D/s Crooked Creek)	2081

Table 8 Loading Rates and Instream Fecal Coliform Concentrations for Existing Conditions During Critical Period

Stream/Segment	Critical Conditions Period	Loading from NPDES Discharges (counts/30 days)	Loading from Other Direct Sources (counts/30 days)	Loading from Surface Runoff (counts/30 days)	Geometric Mean In-stream Fecal Coliform Concentration (counts/100 ml)
Big Cedar Creek - (Little Cedar Creek to Ohoopee River)	9/11/93 - 10/10/93	1.70E+11	1.21E+12	1.29E+10	4,553.3
Doctors Creek - (Upstream of Jones Creek)	TBD	TBD	TBD	TBD	TBD
Goose Creek - (U/S Rd. S1922 to Little Goose Creek)	TBD	TBD	TBD	TBD	TBD
Jacks Creek - (U.S. Hwy 1 to Ohoopee River)	11/5/91 - 12/4/91	N/A	9.21E+11	1.05E+13	1,599.8
Little Ohoopee River - (Sardis Creek to Ohoopee River)	12/21/93 - 1/19/94	N/A	7.87E+11	8.64E+14	1,021.2
Milligan Creek - (Uvalda to Altamaha River)	9/8/95 - 10/7/95	N/A	9.43E+11	2.20E+10	822.0
Oconee Creek - (Headwaters to Cobb Creek)	9/17/95 - 10/16/95	N/A	3.95E+11	8.47E+09	592.0
Ohoopee River - (Dyers Creek to Big Cedar Creek)	9/1/98 – 9/30/98	1.02E+11	4.26E+12	3.03E+12	1,216.3
Ohoopee River - (Little Ohoopee River to US Highway 292)	1/23/95 – 2/21/95	N/A	1.87E+11	2.8E+16	723.1
Ohoopee River - (Neels Creek to Little Ohoopee River)	11/25/98 – 12/24/98	N/A	5.92E+11	5.27E+10	2,914.0
Pendleton Creek - (Sand Hill Lake to Reedy Creek)	5/16/95 – 6/14/95	N/A	1.96E+11	9.56E+14	649.5
Pendleton Creek - (Wildwood Lake to Tiger Creek)	11/6/91 – 12/5/91	N/A	6.91E+11	9.75E+14	1,464.6
Rocky Creek - (Ga. Hwy. 130 to Little Rocky Creek)	5/31/98 – 6/29/98	N/A	5.02E+11	6.22E+12	1,174.3
Swift Creek - (Old Normantown Rd. to Pendleton Creek)	6/7/93 – 7/6/93	5.80E+11	2.63E+12	6.84E+10	1,611.5
Tiger Creek - (Little Creek to Pendleton Creek)	11/6/91 – 12/5/91	N/A	4.0E+11	8.85E+12	1,137.1
Yam Grandy Creek - (D/s Crooked Creek)	11/5/91 – 12/4/91	N/A	8.82E+11	8.38E+12	1,584.2

TBD: **To Be Determined**

Table 9 TMDL Components

Stream/Segment	WLAs (counts/30 days)	LAs (counts/30 days)	Margin of Safety	TMDL (counts/30 days)
Big Cedar Creek - (Little Cedar Creek to Ohoopee River)	1.70E+11	6.60E+10	Implicit + 10% Explicit	2.36E+11
Doctors Creek - (Upstream of Jones Creek)	TBD	TBD	Implicit + 10% Explicit	TBD
Goose Creek - (U/S Rd. S1922 to Little Goose Creek)	TBD	TBD	Implicit + 10% Explicit	TBD
Jacks Creek - (U.S. Hwy 1 to Ohoopee River)	N/A	3.61E+11	Implicit + 10% Explicit	3.61E+11
Little Ohoopee River - (Sardis Creek to Ohoopee River)	N/A	1.16E+13	Implicit + 10% Explicit	1.16E+13
Milligan Creek - (Uvalda to Altamaha River)	N/A	1.63E+11	Implicit + 10% Explicit	1.63E+11
Oconee Creek - (Headwaters to Cobb Creek)	N/A	1.01E+11	Implicit + 10% Explicit	1.01E+11
Ohoopee River - (Dyers Creek to Big Cedar Creek)	1.02E+11	2.53E+11	Implicit + 10% Explicit	3.56E+11
Ohoopee River - (Little Ohoopee River to US Highway 292)	N/A	4.11E+14	Implicit + 10% Explicit	4.11E+14
Ohoopee River - (Neels Creek to Little Ohoopee River)	N/A	5.92E+10	Implicit + 10% Explicit	5.92E+10
Pendleton Creek - (Sand Hill Lake to Reedy Creek)	N/A	1.97E+12	Implicit + 10% Explicit	1.97E+12
Pendleton Creek - (Wildwood Lake to Tiger Creek)	N/A	2.05E+12	Implicit + 10% Explicit	2.05E+12
Rocky Creek - (Ga. Hwy. 130 to Little Rocky Creek)	N/A	1.17E+12	Implicit + 10% Explicit	1.17^{E}+12
Swift Creek - (Old Normantown Rd. to Pendleton Creek)	5.80E+11	1.32E+11	Implicit + 10% Explicit	7.12E+11
Tiger Creek - (Little Creek to Pendleton Creek)	N/A	7.63E+10	Implicit + 10% Explicit	7.63E+10
Yam Grandy Creek - (D/s Crooked Creek)	N/A	3.28E+11	Implicit + 10% Explicit	3.28E+11

TBD: **To Be Determined**

Table 10 Load Allocations for Altamaha River Basin

Stream/Segment	Most Significant Impact(s)	Loading from Point Sources (counts/30 days)	Non-point Sources		Overall Loading (counts/30 days)
			Loading from Other Direct Sources (counts/30 days)	Loading from Surface Runoff (counts/30 days)	
Big Cedar Creek (Little Cedar Creek to Ohoopee River)	Agricultural runoff	1.70E+11	6.59E+10	6.84E+07	2.36E+11
Doctors Creek (Upstream of Jones Creek)	TBD	TBD	TBD	TBD	TBD
Goose Creek (U/S Rd. S1922 to Little Goose Creek)	TBD	TBD	TBD	TBD	TBD
Jacks Creek (U.S. Hwy 1 to Ohoopee River)	Agricultural runoff	N/A	1.84E+11	1.77E+11	3.61E+11
Little Ohoopee River (Sardis Creek to Ohoopee River)	Agricultural runoff	N/A	2.34E+11	1.14E+13	1.16E+13
Milligan Creek (Uvalda to Altamaha River)	Agricultural runoff	N/A	1.41E+11	2.20E+10	1.63E+11
Oconee Creek (Headwaters to Cobb Creek)	Agricultural runoff	N/A	9.27E+10	8.47E+09	1.01E+11
Ohoopee River (Dyers Creek to Big Cedar Creek)	Agricultural runoff	1.02E+11	2.46E+11	7.26E+09	3.56E+11
Ohoopee River (Little Ohoopee River to US Highway 292)	Agricultural runoff	N/A	1.78E+11	4.11E+14	4.11E+14
Ohoopee River (Neels Creek to Little Ohoopee River)	Agricultural runoff	N/A	5.58E+10	3.35E+09	5.92E+10
Pendleton Creek (Sand Hill Lake to Reedy Creek)	Agricultural runoff	N/A	1.96E+10	1.95E+12	1.97E+12
Pendleton Creek (Wildwood Lake to Tiger Creek)	Agricultural runoff	N/A	6.91E+10	1.98E+12	2.05E+12
Rocky Creek (Ga. Hwy. 130 to Little Rocky Creek)	Agricultural runoff	N/A	5.02E+10	1.12E+12	1.17E+12

Stream/Segment	Most Significant Impact(s)	Loading from Point Sources (counts/30 days)	Non-point Sources		Overall Loading (counts/30 days)
			Loading from Other Direct Sources (counts/30 days)	Loading from Surface Runoff (counts/30 days)	
Swift Creek (Old Normantown Rd. to Pendleton Creek)	Agricultural runoff	5.80E+11	1.32E+11	2.12E+08	7.12E+11
Tiger Creek (Little Creek to Pendleton Creek)	Agricultural runoff	N/A	4.0E+10	3.63E+10	7.63E+10
Yam Grandy Creek (D/s Crooked Creek)	Agricultural runoff	N/A	1.76E+11	1.52E+11	3.28E+11

TBD: To Be Determined

Table 11 Possible Load Reduction Scenarios for the Altamaha River Basin

Stream/Segment	Reduction from Point Sources (percentage)	Non-point Sources		Overall Reduction (percentage)
		Reduction from Other Direct Sources (percentage)	Reduction from Surface Runoff (percentage)	
Big Cedar Creek - (Little Cedar Creek to Ohoopee River)	0.0	94.6	99.5	83.10
Doctors Creek - (Upstream of Jones Creek)	TBD	TBD	TBD	TBD
Goose Creek - (U/S Rd. S1922 to Little Goose Creek)	TBD	TBD	TBD	TBD
Jacks Creek - (U.S. Hwy 1 to Ohoopee River)	N/A	80.0	98.3	96.8
Little Ohoopee River - (Sardis Creek to Ohoopee River)	N/A	70.3	98.7	98.7
Milligan Creek - (Uvalda to Altamaha River)	N/A	85.0	*0.0	83.1
Oconee Creek - (Headwaters to Cobb Creek)	N/A	76.5	*0.0	74.9
Ohoopee River - (Dyers Creek to Big Cedar Creek)	0.0	94.3	99.8	95.2
Ohoopee River - (Little Ohoopee River to US Highway 292)	N/A	5.0	98.6	98.6
Ohoopee River - (Neels Creek to Little Ohoopee River)	N/A	90.6	93.7	90.8
Pendleton Creek - (Sand Hill Lake to Reedy Creek)	N/A	90.0	99.8	99.8
Pendleton Creek - (Wildwood Lake to Tiger Creek)	N/A	90.0	99.8	99.8
Rocky Creek - (Ga. Hwy. 130 to Little Rocky Creek)	N/A	90.0	82.1	82.7
Swift Creek - (Old Normantown Rd. to Pendleton Creek)	0	95.0	99.7	78.3
Tiger Creek - (Little Creek to Pendleton Creek)	N/A	90.0	99.6	99.2
Yam Grandy Creek - (D/s Crooked Creek)	N/A	80.0	98.2	96.5

TBD: To Be Determined

***** Runoff impacts were not measurable due to lack of precipitation in the critical condition period.

APPENDIX A:

WATER QUALITY MONITORING DATA

Altamaha River Basin

Stream/Segment	Sample Dates	Fecal Coliform Bacteria (MPN/100 ml.)	Geometric Mean (#/100 ml.)	Sample Dates	Fecal Coliform Bacteria (MPN/100 ml.)	Geometric Mean (#/100 ml.)	Sample Dates	Fecal Coliform Bacteria (MPN/100 ml.)	Geometric Mean (#/100 ml.)	Sample Dates	Fecal Coliform Bacteria (MPN/100 ml.)	Geometric Mean (#/100 ml.)
Big Cedar Creek (Little Cedar Creek to Ohoopee River)	01/27/1999	65	79	05/12/1999	790	922	08/18/1999	270	164	11/17/1999	20	48
	02/10/1999	230		05/19/1999	490		08/25/1999	790		12/01/1999	40	
	02/17/1999	20		06/02/1999	1100		09/01/1999	20		12/08/1999	50	
	02/24/1999	130		06/09/1999	1700		09/15/1999	170		12/15/1999	130	
	04/21/1999	490		07/14/1999	270							
Doctors Creek (Upstream of Jones Creek)	01/20/1999	50	110	03/23/1999	<20	42	06/23/1999	490	162	09/22/1999	490	238
	02/02/1999	330		04/13/1999	20		06/30/1999	790		09/29/1999	1100	
	02/09/1999	80		04/21/1999	150		07/14/1999	90		10/06/1999	120	
	02/17/1999	110		04/22/1999	50		04/21/1999	<20		10/20/1999	50	
Goose Creek (U/S Rd. S1922 to Little Goose Creek)	03/30/1999	220	121	05/17/1999	120	75	07/26/1999	110	291	11/15/1999	1300	155
	04/12/1999	20		05/24/1999	40		08/09/1999	490		11/29/1999	110	
	04/19/1999	70		06/07/1999	<20		08/16/1999	270		12/06/1999	<20	
	04/27/1999	700		06/14/1999	330		08/23/1999	490		12/13/1999	200	
Jacks Creek (U.S. Hwy 1 to Ohoopee River)	01/21/1999	330	390	03/24/1999	110	36	06/21/1999	330	291			
	02/03/1999	490		04/08/1999	20		06/28/1999	90		10/04/1999	330	
	02/10/1999	130		04/14/1999	20		07/12/1999	490		10/18/1999	270	
	02/18/1999	1100		04/19/1999	40		07/19/1999	490				
Little Ohoopee River (Sardis Creek to Ohoopee River)	01/21/1999	490	406	03/24/1999	80	109	06/21/1999	80	421	09/20/1999	230	271
	02/03/1999	490		04/08/1999	170		06/28/1999	3500		09/27/1999	790	
	02/10/1999	230		04/14/1999	80		07/12/1999	230		10/04/1999	230	
	02/18/1999	490		04/19/1999	130		07/19/1999	490		10/18/1999	130	
Milligan Creek (Uvalda to Altamaha river)	03/31/1999	20	89	05/18/1999	600	372	07/27/1999	490	451	11/16/1999	230	256
	04/07/1999	170		06/01/1999	50		08/10/1999	2400		11/30/1999	140	
	04/13/1999	80		06/08/1999	490		08/17/1999	130		12/07/1999	170	
	04/20/1999	230		06/15/1999	1300		08/24/1999	270		12/14/1999	790	
Oconee Creek (Headwaters to Cobb Creek)	03/31/1999	50	68	05/18/1999	170	1502	11/16/1999	460	193			
	04/07/1999	170		06/01/1999	16000		11/30/1999	140		07/27/1999	790	
	04/13/1999	50		06/08/1999	1100		12/07/1999	70		08/10/1999	270	
	04/20/1999	50		06/15/1999	1700		12/14/1999	310				
Ohoopee River (Dyers Creek to Big Cedar Creek)	01/27/1999	170	191	05/12/1999	700	443	08/18/1999	700	269	11/17/1999	80	70
	02/10/1999	330		05/19/1999	490		08/25/1999	220		12/01/1999	140	
	02/17/1999	70		06/02/1999	490		09/01/1999	110		12/08/1999	20	
	02/24/1999	340		06/09/1999	230		09/15/1999	310		12/15/1999	110	
	04/21/1999	330		07/14/1999	220							
Ohoopee River (Little Ohoopee River to US Highway 292)	01/21/1999	330	309	05/24/1999	230	191	06/21/1999	460	171	09/20/1999	460	262
	02/03/1999	490		06/08/1999	210		06/28/1999	170		09/27/1999	460	
	02/10/1999	170		06/14/1999	60		07/12/1999	50		10/04/1999	130	
	02/18/1999	330		06/19/1999	460		07/19/1999	220		10/18/1999	170	
Ohoopee River (Neels Creek to Little Ohoopee River)	01/21/1999	1500	749	03/24/1999	80	191	06/21/1999	20	66	09/27/1999	3500	
	02/03/1999	490		04/08/1999	110		06/28/1999	50		10/04/1999	130	
	02/10/1999	330		04/14/1999	460		07/12/1999	130		10/18/1999	490	
	02/18/1999	1300		04/19/1999	330		07/19/1999	150				
Pendleton Creek (Sand Hill Lake to Reedy Creek)	01/21/1999	330	281	03/24/1999	170	233	06/21/1999	790				
	02/03/1999	790		04/08/1999	330		07/19/1999	310				
	02/10/1999	170		04/14/1999	170		10/04/1999	490				
	02/18/1999	140		04/19/1999	310		10/18/1999	220				
Pendleton Creek (Wildwood Lake to	01/21/1999	460	203	03/24/1999	40	46	07/12/1999	5400		10/04/1999	110	
	02/03/1999	330		04/08/1999	50		07/19/1999	270		10/08/1999	170	

Table A1 – Water Quality Monitoring Data, Altamaha River Basin

Stream/Segment	Sample Dates	Fecal Coliform Bacteria (MPN/100 ml.)	Geometric Mean (#/100 ml.)	Sample Dates	Fecal Coliform Bacteria (MPN/100 ml.)	Geometric Mean (#/100 ml.)	Sample Dates	Fecal Coliform Bacteria (MPN/100 ml.)	Geometric Mean (#/100 ml.)	Sample Dates	Fecal Coliform Bacteria (MPN/100 ml.)	Geometric Mean (#/100 ml.)
Tiger Creek)	02/10/1999 02/18/1999	80 140		04/14/1999 04/19/1999	110 <20		09/27/1999	1400				
Rocky Creek (Ga. Hwy. 130 to Little Rocky Creek)	03/31/1999 04/07/1999 04/13/1999 04/20/1999	80 110 220 1100	215	05/18/1999 06/01/1999 06/08/1999 06/15/1999	2300 3500 9200 7900	4918	07/27/1999 08/10/1999 08/17/1999 08/24/1999	1000 490 700 120	450	11/16/1999 11/30/1999 12/07/1999 12/14/1999	230 50 790 330	234
Swift Creek (Old Normantown Rd. to Pendleton Creek)	03/31/1999 04/07/1999 04/13/1999 04/20/1999	170 <20 50 80	61	05/18/1999 06/01/1999 06/08/1999 06/15/1999	1700 1700 3500 2300	2196	07/27/1999 08/10/1999 08/17/1999 08/24/1999	2300 1700 <20 80	281	11/16/1999 11/30/1999 12/07/1999 12/14/1999	70 50 80 170	83
Tiger Creek (Little Creek to Pendleton Creek)	01/21/1999 02/03/1999 02/10/1999 02/18/1999	330 790 230 80	263	03/24/1999 04/08/1999 04/14/1999 04/19/1999	50 170 20 630	263	06/21/1999 06/28/1999 07/12/1999 07/19/1999	170 490 7000 330	662	09/27/1999 10/04/1999 04/18/1999	11000 1700 110	
Yam Grandy Creek (D/s Crooked Creek)	01/21/1999 02/03/1999 02/10/1999 02/18/1999	20 170 800 130	137	03/24/1999 04/08/1999 04/14/1999 04/19/1999	50 20 <20 20	25	07/19/1999 08/27/1999 10/04/1999 10/08/1999	490 790 80 70				

APPENDIX B:

MODEL DEVELOPMENT AND CALIBRATION

B.1 Model Selection

The Hydrological Simulation Program Fortran (HSPF) - Version 12.0 was selected to represent the hydrological conditions for the Altamaha River Basin. The watershed modeling provided a consistent hydrology and modeling framework for TMDL development in 2001. The Nonpoint Source Model Program (NPSM), a detailed graphical user interface (GUI), was used as the link between the user and HSPF.

B.2 Model Development

The watershed model represents the variability of nonpoint source contributions through dynamic representation of hydrology and land practices. The watershed model includes all point and nonpoint source contributions within the Altamaha River Basin. Key components of the watershed modeling included:

- Watershed segmentation
- Meteorological data
- Simulation period
- Land use representation
- Hydrological representation
- USGS Flow Data

B.2.1 Watershed Segmentation

In order to evaluate the sources contributing to an impaired waterbody and to represent the spatial variability of these sources within the watershed model, the contributing drainage area was represented by a series of subwatersheds. These subwatersheds were represented using the Georgia 12-digit watershed data layer. In some situations, the 12-digit data layer required further subdivision for appropriate hydrological connectivity and representation.

Boundaries were constructed so that subwatershed "pour points" coincided, when possible, with water quality monitoring stations or USGS flow gages. Watershed delineation was based on the Rf3 stream coverage and Digital Elevation Model (DEM) data. This discretization allows management and load reduction alternatives to be varied by subwatershed. Initial input for model variables was developed using WCS and the associated spreadsheet tools.

B.2.2 Meteorological Data

An important factor influencing model results is the precipitation data contained in the meteorological data file used in the simulation. The pattern and intensity of rainfall affects the build-up and wash-off of fecal coliform bacteria from the land into the streams, as well as the dilution potential of the stream. Hourly data from weather stations within the boundaries of or in close proximity to the subwatersheds were applied to the watershed model. These data include precipitation, air temperature, dew point temperature, wind speed, cloud cover, evaporation, and solar radiation. These data are used directly, or calculated from the observed data.

Hourly precipitation data for numerous stations in and adjacent to the Altamaha River Basin were extracted from the EarthInfo CD set. After review of precipitation data and graphs, 5 precipitation stations were chosen for inclusion. This information was processed and patched, to construct a continuous period of record. The stations used are shown in Table B1. The 5 precipitation stations are shown in Figure B1.

Meteorological data, other than precipitation, was used from two stations in or near to the project study watershed area. The data from these meteorological stations were assigned, using engineering judgment, to each of the 5 precipitation stations. The data from meteorological stations area applied to the precipitation stations are shown in Table B2. The two meteorological stations are shown in Figure B1 as HUSWO and SAMSON sites.

Cloud cover data was incomplete for the period 1996 to 1999. The solution for this missing data was to evaluate the annual total rainfall values for the period of record of the meteorological stations. It was assumed that the cloud cover data from a prior year with a similar annual rainfall value would be representative.

Figure B1 – Location of Precipitation and Meteorological Stations

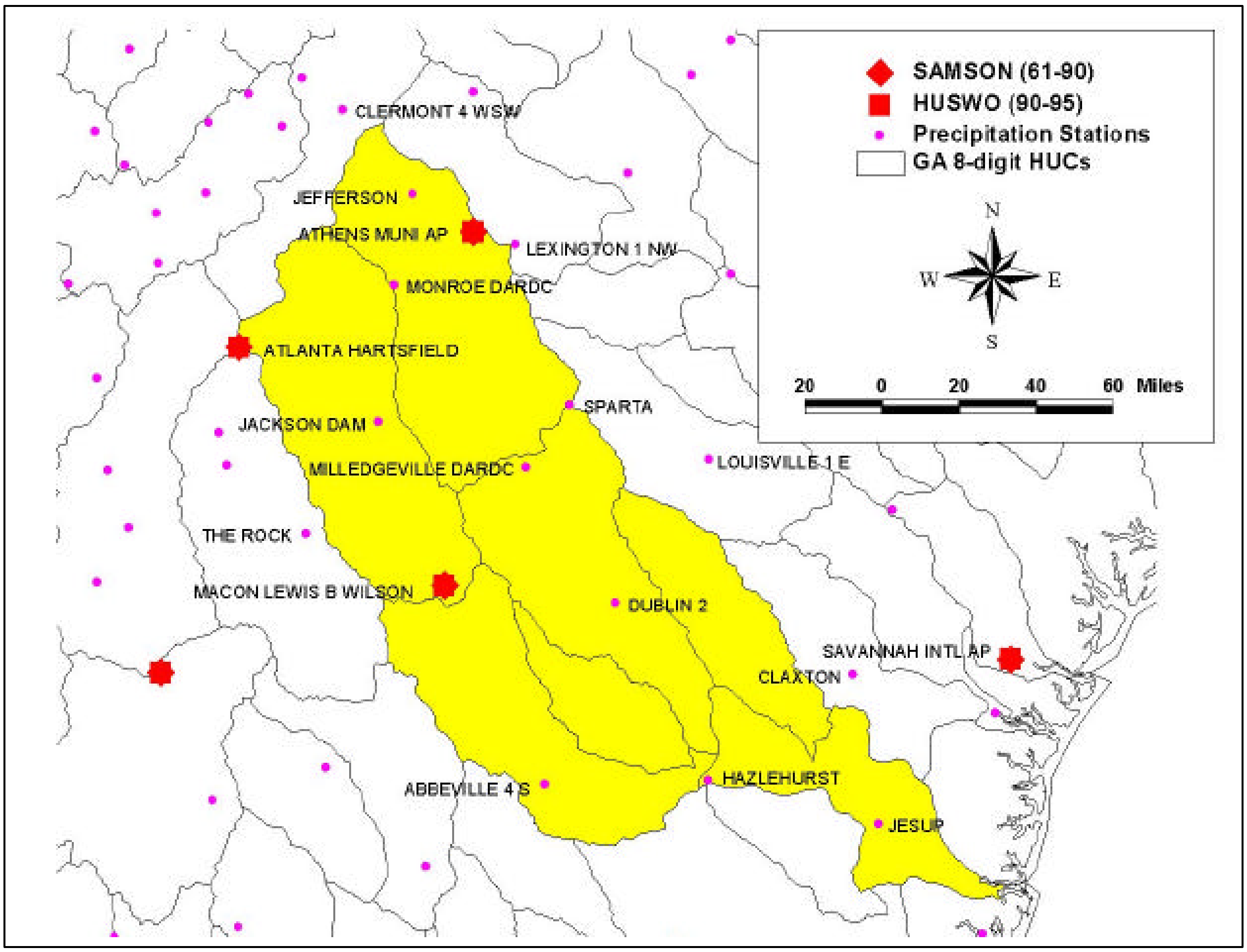


Table B1 - Precipitation Stations and Associated Patching Stations

WDM File Station Number	Description	Station ID	Stations Used to Patch the WDM File Station
03	Claxton	GA1973	GA4204, GA4671, GA8517
06	Hazelhurst	GA4204	GA0010, GA2844, GA4671
08	Jesup	GA4671	GA1340, GA1973, GA4204
10	Louisville 1 E	GA5314	GA2844, GA8223, GA8517
14	Savannah Intl AP	GA7847	GA1973, GA7468, GA8517

Table B2 – Meteorological Stations Used at Each Precipitation Station

WDM File Station Number	Description	Station ID	Station Used for Meteorological Data at the WDM File Precipitation Stations
03	Claxton	GA1973	GA7847, Savannah Intl AP
06	Hazelhurst	GA4204	GA7847, Savannah Intl AP
08	Jesup	GA4671	GA7847, Savannah Intl AP
10	Louisville 1 E	GA5314	GA5443, Macon Lewis B Wilson
14	Savannah Intl AP	GA7847	GA7847, Savannah Intl AP

B.2.3 Simulation Period

EPA recommends looking at an extended time period for hydrology calibrations. This is due to the fact that over an extended period, a variety of hydrological conditions will exist, and a model that is calibrated over this time period will have a greater chance of success in predicting future hydrological conditions. The hydrological models were calibrated from October 1, 1994 through December 31, 1999. In 1999, there was a comprehensive water quality data set that was collected for the Altamaha River Basin.

B.2.4 Land Use Representation

The watershed model uses land use data as the basis for representing hydrology and nonpoint source loading. Land use categories for modeling were selected based on the USGS Multi-Resolution Landuse Classification (MRLC) data set, and included built-up, forest, cropland, pasture, and wetlands. The USGS data represents conditions in the early to middle 1990's. The modeling categories and their corresponding USGS classifications are presented in Table B3.

The HSPF model requires division of land uses in each subwatershed into separate pervious and impervious land units. For each land use, this division can be made based on typical imperviousness percentages from individual land use categories, such as those used in the Soil Conservation Service's TR-55 method. For modeling purposes, the percent imperviousness of a given land category can be calculated as an area-weighted average of land use classes encompassing the modeling land category.

Table B3 – Land Use Representation

Land Categories Represented in the Model	MRLC Land Use Code	MRLC Land Use Classes	% Impervious
Built-up	21	Low Intensity Residential	19
	22	High Intensity Residential	65
	23	High Intensity Comm./Ind./Trans.	80
	33	Transitional	10
	31	Bare Rock/Sand/Clay	0
Forest	32	Quarries/Strip Mines/Gravel Pits	0
	41	Deciduous Forest	0
	42	Evergreen Forest	0
Forest	43	Mixed Forest	0
	51	Deciduous Shrubland	0
	52	Evergreen Shrubland	0
	53	Mixed Shrubland	0
	71	Grassland/Herbaceous	0
	85	Other Grasses	0
Wetland	91	Woody Wetlands	0
	92	Emergent Herbaceous Wetlands	0
Cropland	61	Planted/Cultivated	0
	82	Row Crops	0
	83	Small Grains	0
	84	Bare Soil	0
Pasture	81	Pasture/Hay	0

B.2.5 Hydrological Representation

Watershed hydrology plays an important role in the determination of nonpoint source flow and ultimately nonpoint source loadings to a waterbody. The watershed model must appropriately represent the spatial and temporal variability of hydrological characteristics within a watershed. Key hydrological characteristics include interception storage capacities, infiltration properties, evaporation and transpiration rates, and watershed slope and roughness. The HSPF modules used to represent watershed hydrology for TMDL development included PWATER (water budget simulation for pervious land units) and IWATER (water budget simulation for impervious land units).

During the hydrologic calibration process, model parameters were adjusted within reasonable constraints until an acceptable agreement was achieved between simulated and observed stream flow. Model parameters adjusted included: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession rates, losses to the deep groundwater system, and interflow discharge.

B.2.6 USGS Flow Data

There are four historical USGS flow stations in the Altamaha River Basin that contained complete flow data from January 1, 1990 through December 31, 1999. Of those 4, one station was used for model calibration and 4 stations were used for model validation (Refer to Table C1 in Appendix C).

B.3 Model Organization

The main division within the modeling schematic for the Altamaha River Basin is the 8-digit HUC number. The Altamaha River Basin is comprised of two HUCs, 03070106 (Altamaha) and 03070107 (Ohoopee). Within each of these HUCs, individual projects were created that identify and appropriately model the subwatersheds within each HUC. There are 3 projects within the Altamaha HUC and 5 projects within the Ohoopee HUC.

The development of the modeling schematic for each HUC in the Altamaha River Basin is provided in Appendix G. The information included for each HUC includes:

- Tables of 303(d) Listed Segments located within each 8-digit HUC for Fecal Coliform and their associated project names,
- Modeling schematic of each 8-digit HUC,
- Location of Projects within each 8-digit HUC,
- Subwatershed ID Numbering for each of the Projects,
- Location of the Active Point Sources that were included within each 8-digit HUC,
- Location of the 1999 Monitoring Stations that were included within each 8-digit HUC,
- Project Summary Sheets.

There is one project summary sheet for each project contained in the 8-digit HUC. These sheets contain all of the information about each of the subwatersheds contained within each individual project.

B.4 Model Calibration

The calibration of the NPSM watershed model involves both hydrology and water quality components. The model must be calibrated to appropriately represent hydrologic response in the watershed before subsequent calibrations and reasonable water quality simulations can be performed.

B.4.1 Hydrologic Calibration

The hydrology calibration of the watershed model involved comparing simulated stream flows to historic stream flow data from a USGS stream gaging station for the same period of time.

Initial values for hydrological variables were taken from an EPA developed default data set. During the calibration process, model parameters were adjusted within reasonable constraints until acceptable agreement was achieved between simulated and observed stream flow. Model parameters adjusted include: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession, losses to the deep groundwater system, and interflow discharge. Measures which can reduce urban contributions include: repair and renovation of leaking sewer collection systems; reduction of sewer overflows and surcharges by use of separate conduit systems for domestic wastewater and stormwater; encouraging households and businesses to connect to public sewer systems and reduce the population using septic systems.

Calibrated models were then subjected to model validation to ensure that generated model streamflows for each of the impaired segments were acceptable. Model generated hydrographs for each of the impaired streams are presented in Appendix D.

Within the Coastal Plain, the hydrological parameters were calibrated using the USGS flow gage 02225500 – Ohoopee River near Reidsville, GA, which is located in the Altamaha River Basin (Refer to Table C1 in Appendix C). The calibration of the hydrological parameters below the fall line was from January 1, 1990 through December 31, 1999.

B.4.2 Model Validation

An important step of the modeling process is model validation. Model validation is the process of taking the hydrological parameters that have been calibrated, applying those parameters to other watersheds, and comparing the simulated flow to measured flow from a USGS stream gaging station for the same period of time. Model validation is sometimes called model verification, as essentially you are validating or verifying that hydrological parameters calibrated in one watershed will produce acceptable results in another watershed. It is important that when selecting watersheds to perform validations, those watersheds represent a wide variety of landuses as well as drainage areas. This will help to ensure that the hydrological parameters that were calibrated apply to a wide range of conditions. Every validation was carried over an extended multi-year period (Refer to Appendix D).

For the hydrological parameters calibrated below the fall line, validations were performed at 4 other watersheds. Table C1 (Appendix C) summarizes the calibration station and validation stations for below the fall line.

B.5 Water Quality Calibration

Altamaha River Basin data, generated by WCS, was processed through the spreadsheet applications developed by Tetra Tech, Inc. to generate fecal coliform loading data for use as initial input to the NPSM model.

The figures presented in Appendix F show the resulting 30-day geometric mean results for the existing and TMDL conditions for the modeled 10-year period. The existing conditions results provided the basis for selection of the 30-day critical conditions period for the TMDL modeling.

B.5.1 Point Sources

For existing conditions, NPDES facilities located in modeled subwatersheds are represented as point sources of constant flow and concentration based on the facility’s average flow and effluent fecal coliform concentration as reported on DMRs (see Table 6).

A.5.2 Nonpoint Sources

A number of nonpoint source categories are not associated with land loading processes and are represented as direct, instream source contributions in the model. These may include, but are not limited to, failing septic systems, leaking sewer lines, animals in streams, direct discharge of raw sewage, and undefined sources. All other nonpoint sources involve land loading of fecal coliform bacteria and washoff as a result of storm events. Only a portion of the load from these sources are actually delivered to streams due to the mechanisms of washoff (efficiency), decay, and incorporation into soil (adsorption, absorption, filtering) before being transported to the stream. Therefore, land loading nonpoint sources are represented as indirect contributions to the stream. Buildup, washoff, and die-off rates are dependent on seasonal and hydrologic processes.

Initial input for nonpoint sources of fecal coliform loading in the water quality model was developed using watershed information generated with WCS and the Tetra Tech loading calculation spreadsheets.

B.5.2.1 Wildlife

Fecal coliform loading from wildlife is considered to be uniformly distributed to forest, pasture, cropland, and wetland areas in the modeled subwatersheds. A loading rate of 5.0×10^8 counts/animal/day for deer is based on best professional judgment (BPJ) of EPA. An animal density of 45 animals/square mile is used to account for deer and all other wildlife. The resulting fecal coliform loading is 2.5×10^6 counts/acre/day and is considered background.

B.5.2.2 Land Application of Agricultural Manure

In the water quality model, county livestock populations (see Table 7) are distributed to subwatersheds based on the percentage of agricultural area in each subwatershed classified as pasture/hay. Fecal coliform loading rates were calculated from livestock populations based on manure application rates, literature values for bacteria concentrations in livestock manure, and the following assumptions:

- Fecal content in manure was adjusted to account for die-off due to known treatment/storage methods.
- Manure application rates from the various animal sources vary monthly according to management practices. Hog manure and chicken litter are applied from March through October; beef cattle manure is applied throughout the year; dairy cow manure is applied from February through October as well as in December.
- The fraction of manure available for runoff is dependent on the method of manure application. In the water quality model, the fraction available is estimated based on incorporation into the soil.
- In Georgia, manure is generally not applied to cropland, only pastureland.
- Fecal coliform production rates used in the model are 1.04×10^{11} counts/day/dairy cow, 1.22×10^{10} counts/day/sheep, 1.98×10^8 counts/day/chicken layer, and 2.4×10^8 counts/day/chicken (Metcalf and Eddy, 1991).

Since manure is not applied to cropland in the Altamaha River Basin, the only source of fecal coliform bacteria from cropland is from wildlife that deposits feces on the land surface. The in-stream loading from cropland is considered background.

B.5.2.3 Grazing Animals

Cattle spend time grazing on pastureland and deposit feces onto the land. During storm events, a portion of this material containing fecal coliform bacteria is transported to streams. Beef cattle are assumed to spend all their time in pasture. The percentage of feces deposited during grazing time is used to estimate fecal coliform loading rates from pastureland. Because there is no assumed monthly variation in animal access to pastures, the fecal loading rate does not vary significantly throughout the year. Therefore, the loading rate to pastureland from grazing animals used in the model is assumed to be constant. Contributions of fecal coliform from wildlife (as noted in Section B.5.2.1) are also included in these rates.

B.5.2.4 Urban Development

Urban land use represented in the MRLC database includes areas classified as: high intensity commercial, industrial, transportation, low intensity residential, high intensity residential, and transitional. Associated with each of these classifications a percent of the land area that is impervious. A single, area-weighted loading rate from urban areas is used in the model and is based on the percentage of each urban land use type in the watershed and build-up and accumulation rates referenced in Horner (1992). In the water quality calibrated model, this rate varies from 7.5×10^9 to 2.5×10^{10} counts/acre-day and is assumed constant throughout the year.

B.5.2.5 Other Sources

As previously stated, there are a number of nonpoint sources of fecal coliform bacteria that are not associated with land loading and washoff processes. These include animal access to streams, failing septic systems, leaking sewer lines, illicit discharges, and other undefined sources. In each subwatershed, all of these miscellaneous sources have been grouped together and modeled as a point source of constant flow and fecal coliform concentration. The initial baseline values of flow and concentration were estimated using the Tetra Tech, Inc. developed spreadsheets and the following assumptions:

- The load attributed to animals having access to streams is initially based on the beef cow population in the watershed. It was assumed that 50% have access to streams and, of those, 25% defecate in or near the stream banks during a short portion of the day. The resulting percentage of time fecal coliform bacteria is discharged into the streams from grazing cattle is 0.025%. Literature values were used to estimate the fecal coliform bacteria concentration in beef cow manure.

- The initial baseline loads attributable to leaking septic systems is based on an assumed failure rate of 5 percent. This rate was selected based on a survey conducted by EPD that included all counties within the Altamaha and Ohoopee River watersheds that had septic system failure data.

These flow and concentration variables were adjusted during water quality calibration to alter simulated instream fecal concentrations during dry weather conditions.

B.5.3 Water Quality Calibration Results

During water quality calibration, model parameters were adjusted within reasonable limits until acceptable agreement between simulation output and instream observed data was achieved. Model variables adjusted include:

- Rate of fecal coliform bacteria accumulation

- Maximum storage of fecal coliform bacteria

- Rate of surface runoff that will remove 90% of stored fecal coliform bacteria

- Concentration of fecal coliform bacteria in interflow

- Concentration of fecal coliform bacteria in groundwater

- Concentration of fecal coliform bacteria and rate of flow of “other direct sources” described in Section B.5.2.5

The portion of the each impaired stream segment modeled for each water quality calibration represented the drainage area upstream of the monitoring station. A comparison of simulated and observed daily fecal coliform concentrations at sampling stations in the 303(d) listed streams are presented in Appendix E. Results show that the model adequately simulates peaks in fecal coliform bacteria in response to rainfall events. Often a high observed value is not simulated in the model due to lack of rainfall at the meteorological station as compared to the rainfall occurring in the watershed, or is the result of an unknown source that is not included in the model.

APPENDIX C:

HYDROLOGY CALIBRATIONS

Table C1 - Calibration and Validation Stations for Hydrological Parameters Below the GA Fall Line (Coastal Plain).

Station Number	**Station Name**	**Type**	**Drainage Area (acres)**	**Reference WDM station**
02225500	Ohoopee River near Reidsville, GA	Calibration	735216	Dublin
02215500	Ocmulgee River at Lumber City, GA	Validation	3366386	Abbeville
02223500	Oconee River at Dublin, GA	Validation	2804097	Milledgeville
02225000	Altamaha River near Baxley, GA	Validation	7414025	Hazlehurst
02226000	Altamaha River at Doctortown, GA	Validation	8738182	Jesup

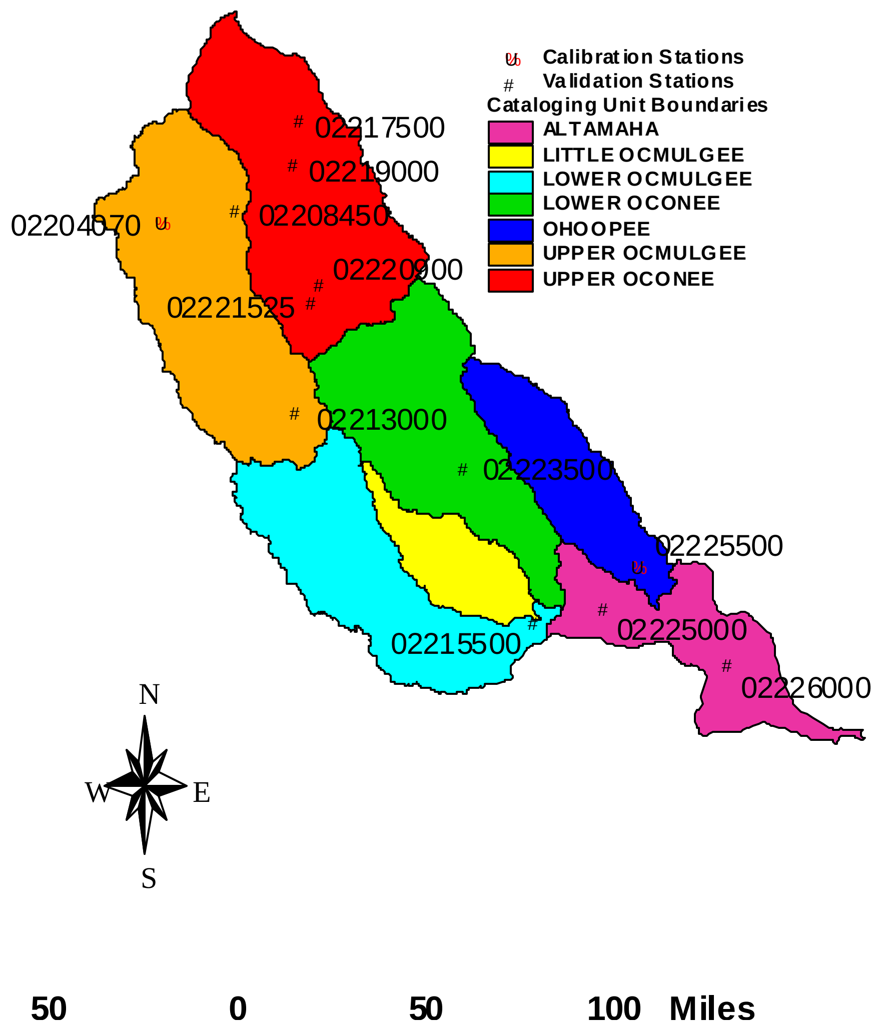
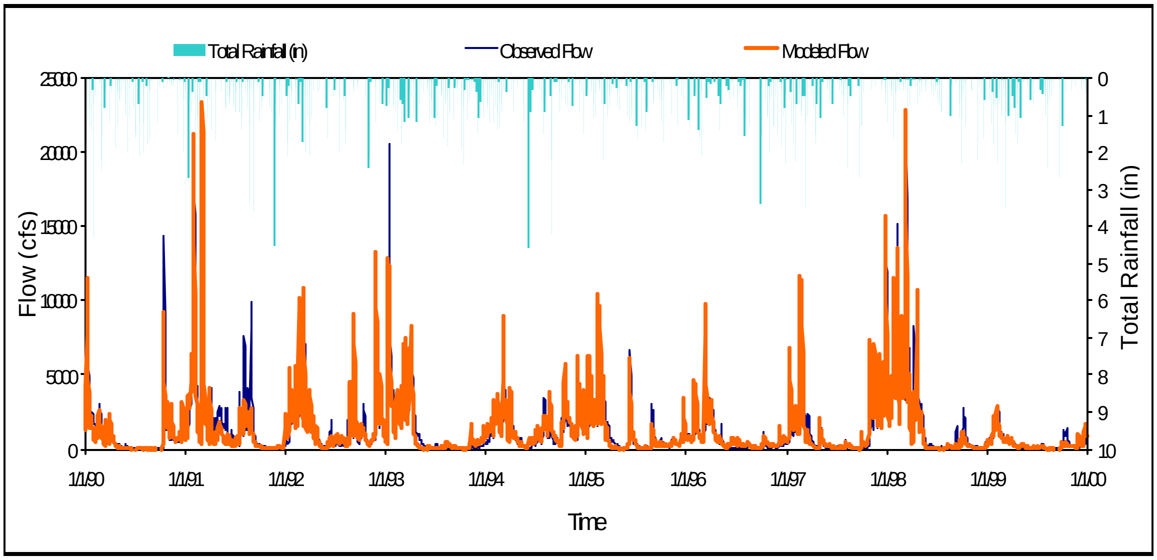


Figure C.1. Location of Hydrology Calibration and Validation Stations

Figure C.2. 10-Year Calibration (Daily Flow) at 02225500 – Ohoopee River near



Reidsville, GA.

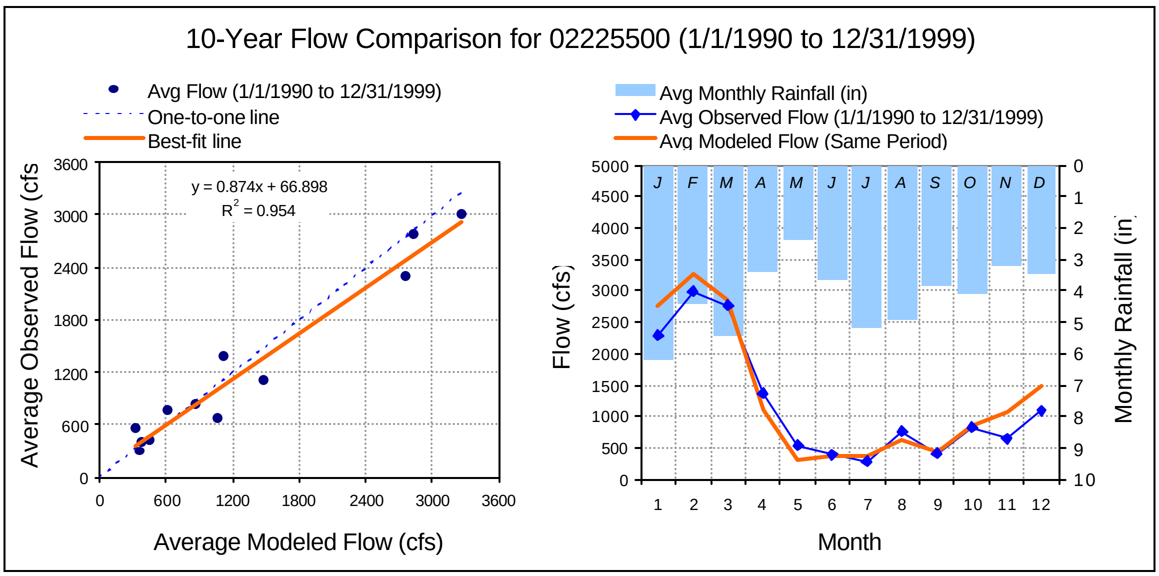


Figure C.3. 10-Year Calibration (Monthly Average) at 02225500 – Ohoopee River near Reidsville, GA.

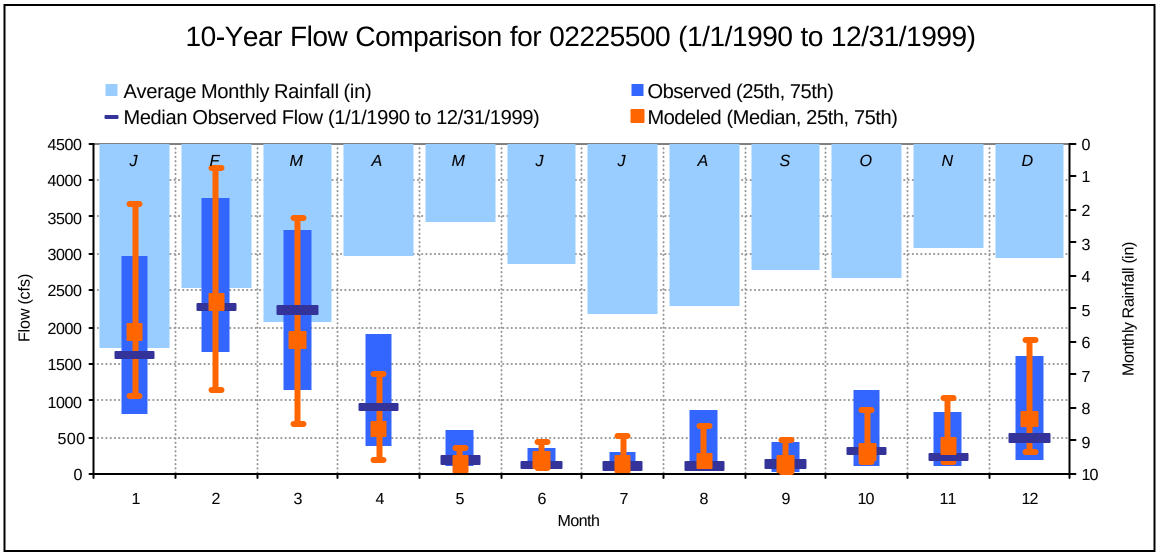


Figure C.4. 10-Year Calibration (Monthly Medians) at 02225500 – Ohoopee River near Reidsville, GA.

Simulation Name:	02225500	**Simulation Period:**	
		Watershed Area (ac):	730428.00
Period for Flow Analysis			
Begin Date:	**01/01/90**	**Baseflow PERCENTILE:**	2.5
End Date:	**12/31/99**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**153.74**	Total Observed In-stream Flow:	**142.28**
Total of highest 10% flows:	**76.16**	Total of Observed highest 10% flows:	**63.14**
Total of lowest 50% flows:	**9.69**	Total of Observed Lowest 50% flows:	**9.59**
Simulated Summer Flow Volume (months 7-9):	**14.54**	Observed Summer Flow Volume (7-9):	**14.79**
Simulated Fall Flow Volume (months 10-12):	**34.37**	Observed Fall Flow Volume (10-12):	**26.02**
Simulated Winter Flow Volume (months 1-3):	**86.76**	Observed Winter Flow Volume (1-3):	**78.63**
Simulated Spring Flow Volume (months 4-6):	**18.07**	Observed Spring Flow Volume (4-6):	**22.84**
Total Simulated Storm Volume:	**153.40**	Total Observed Storm Volume:	**138.34**
Simulated Summer Storm Volume (7-9):	**14.46**	Observed Summer Storm Volume (7-9):	**13.80**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**7.45**	10	
Error in 50% lowest flows:	**1.04**	10	
Error in 10% highest flows:	**17.10**	15	
Seasonal volume error - Summer:	**-1.72**	30	
Seasonal volume error - Fall:	**24.29**	30	
Seasonal volume error - Winter:	**9.36**	30	
Seasonal volume error - Spring:	**-26.38**	30	
Error in storm volumes:	**9.81**	20	
Error in summer storm volumes:	**4.52**	50	

Figure C.5. 10-Year Calibration Statistics at 02225500 – Ohoopee River near Reidsville, GA.

Figure C.6. Calendar Year 1999 (Daily Flow) at 02225500 – Ohoopee River near Reidsville, GA.

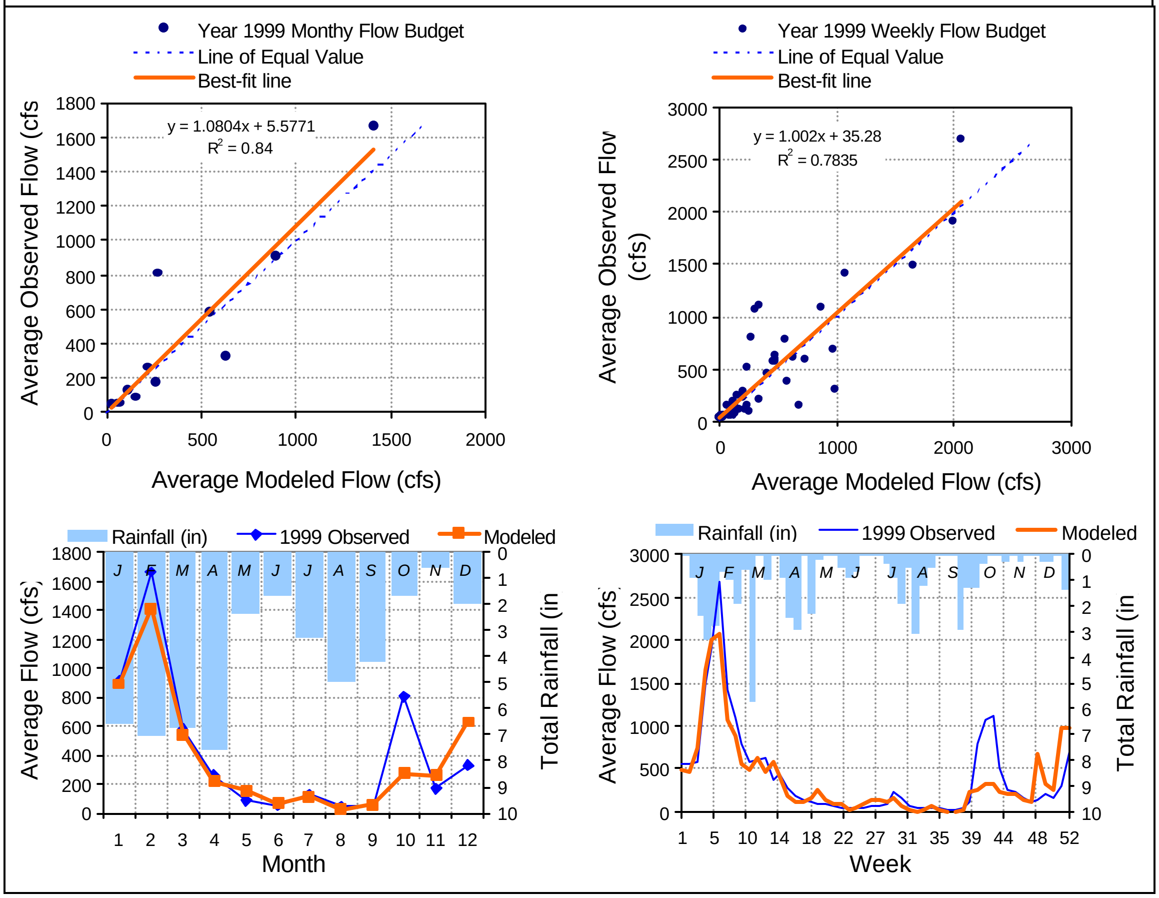


Figure C.7. Calendar Year 1999 (Monthly and Weekly) at 02225500 – Ohoopee River near Reidsville, GA.

Simulation Name:	02225500	**Simulation Period:**	
		Watershed Area (ac):	730428.00
Selected a Year for Flow Analysis:	**1999**		
Type of Year (1=Calendar, 2=Water Year)	**1**	**Baseflow PERCENTILE:**	2.5
Calendar Year 1999:		*Usually 1%-5%*	
1/1/1999 to 12/31/1999			
Total Simulated In-stream Flow:	**4.54**	Total Observed In-stream Flow:	**4.96**
Total of highest 10% flows:	**1.95**	Total of Observed highest 10% flows:	**2.08**
Total of lowest 50% flows:	**0.50**	Total of Observed Lowest 50% flows:	**0.47**
Simulated Summer Flow Volume (months 7-9):	**0.20**	Observed Summer Flow Volume (7-9):	**0.23**
Simulated Fall Flow Volume (months 10-12):	**1.17**	Observed Fall Flow Volume (10-12):	**1.32**
Simulated Winter Flow Volume (months 1-3):	**2.74**	Observed Winter Flow Volume (1-3):	**3.02**
Simulated Spring Flow Volume (months 4-6):	**0.44**	Observed Spring Flow Volume (4-6):	**0.39**
Total Simulated Storm Volume:	**4.52**	Total Observed Storm Volume:	**4.60**
Simulated Summer Storm Volume (7-9):	**0.20**	Observed Summer Storm Volume (7-9):	**0.14**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**-9.32**	10	
Error in 50% lowest flows:	**5.09**	10	
Error in 10% highest flows:	**-6.78**	15	
Seasonal volume error - Summer:	**-16.27**	30	
Seasonal volume error - Fall:	**-13.02**	30	
Seasonal volume error - Winter:	**-10.35**	30	
Seasonal volume error - Spring:	**10.12**	30	
Error in storm volumes:	**-1.56**	20	
Error in summer storm volumes:	**28.69**	50	

Figure C.8. Calendar Year 1999 Statistics at 02225500 – Ohoopee River near Reidsville, GA.

Figure C.9. 10-Year Validation (Daily Flow) at 02215500 – Ocmulgee River at Lumber City, GA.

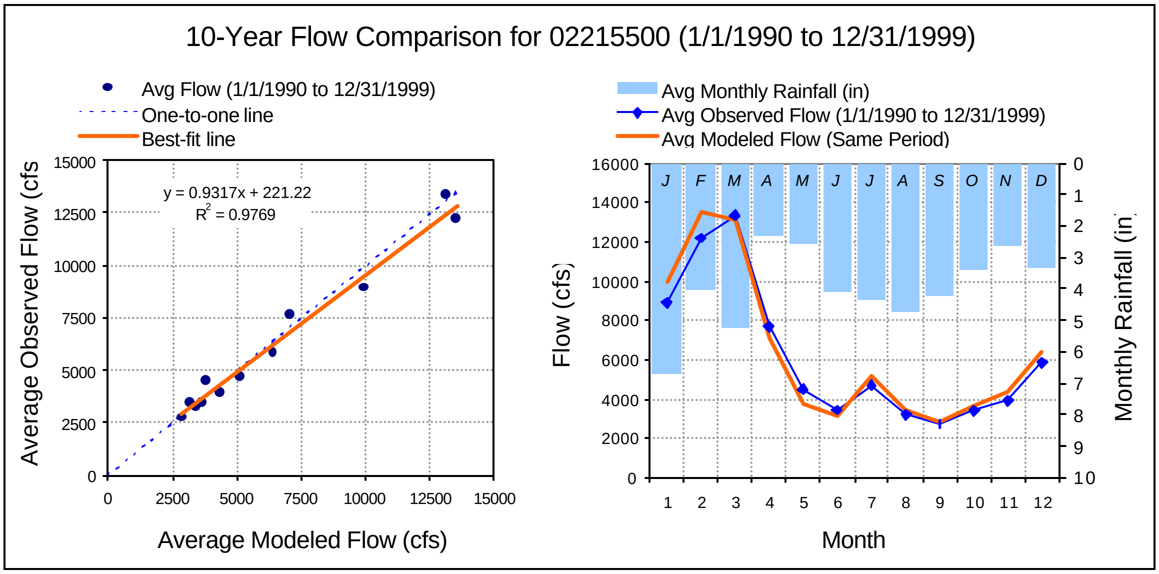


Figure C.10. 10-Year Validation (Monthly Average) at 02215500 – Ocmulgee River at Lumber City, GA.

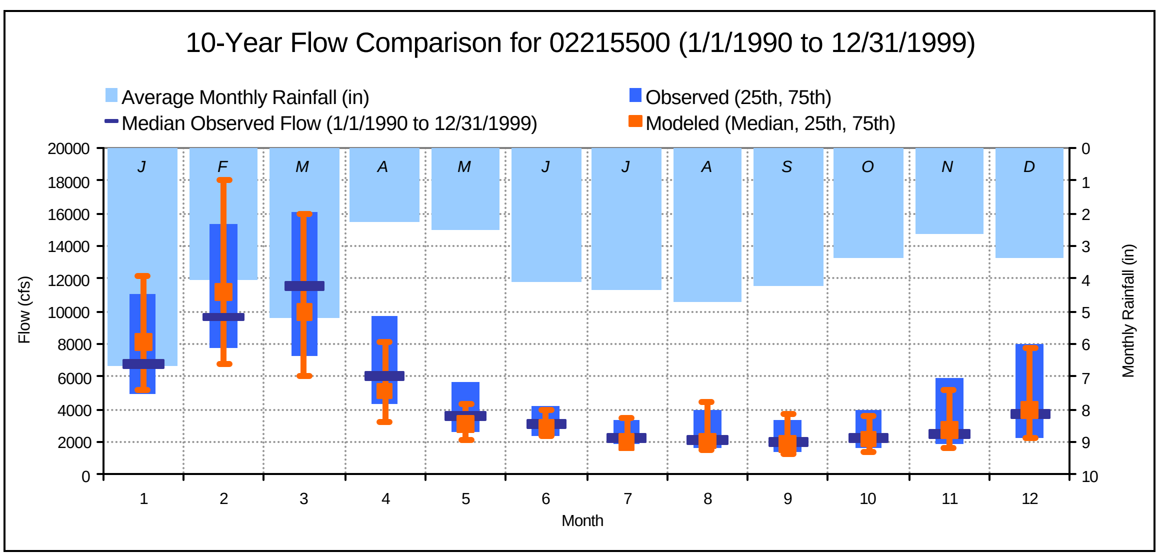


Figure C.11. 10-Year Validation (Monthly Medians) at 02215500 – Ocmulgee River at Lumber City, GA.

Simulation Name:	02215500	**Simulation Period:**	
		Watershed Area (ac):	3366386
Period for Flow Analysis			
Begin Date:	**01/01/90**	**Baseflow PERCENTILE:**	2.5
End Date:	**12/31/99**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**163.87**	Total Observed In-stream Flow:	**158.47**
Total of highest 10% flows:	**61.83**	Total of Observed highest 10% flows:	**53.58**
Total of lowest 50% flows:	**27.34**	Total of Observed Lowest 50% flows:	**30.16**
Simulated Summer Flow Volume (months 7-9):	**24.86**	Observed Summer Flow Volume (7-9):	**23.16**
Simulated Fall Flow Volume (months 10-12):	**31.41**	Observed Fall Flow Volume (10-12):	**28.73**
Simulated Winter Flow Volume (months 1-3):	**77.60**	Observed Winter Flow Volume (1-3):	**73.13**
Simulated Spring Flow Volume (months 4-6):	**29.99**	Observed Spring Flow Volume (4-6):	**33.45**
Total Simulated Storm Volume:	**136.76**	Total Observed Storm Volume:	**126.78**
Simulated Summer Storm Volume (7-9):	**18.11**	Observed Summer Storm Volume (7-9):	**15.23**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**3.29**	10	
Error in 50% lowest flows:	**-10.33**	10	
Error in 10% highest flows:	**13.35**	15	
Seasonal volume error - Summer:	**6.84**	30	
Seasonal volume error - Fall:	**8.53**	30	
Seasonal volume error - Winter:	**5.76**	30	
Seasonal volume error - Spring:	**-11.51**	30	
Error in storm volumes:	**7.29**	20	
Error in summer storm volumes:	**15.93**	50	

Figure C.12. 10-Year Validation Statistics at 02215500 – Ocmulgee River at Lumber City, GA.

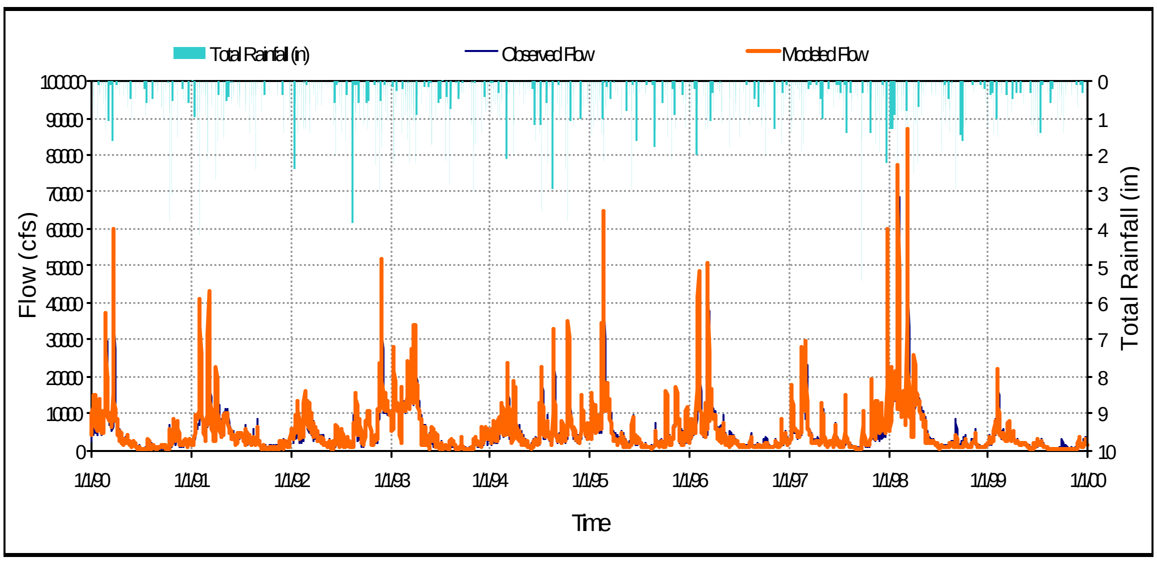


Figure C.13. 10-Year Validation (Daily Flow) at 02223500 – Oconee River at Dublin, GA.

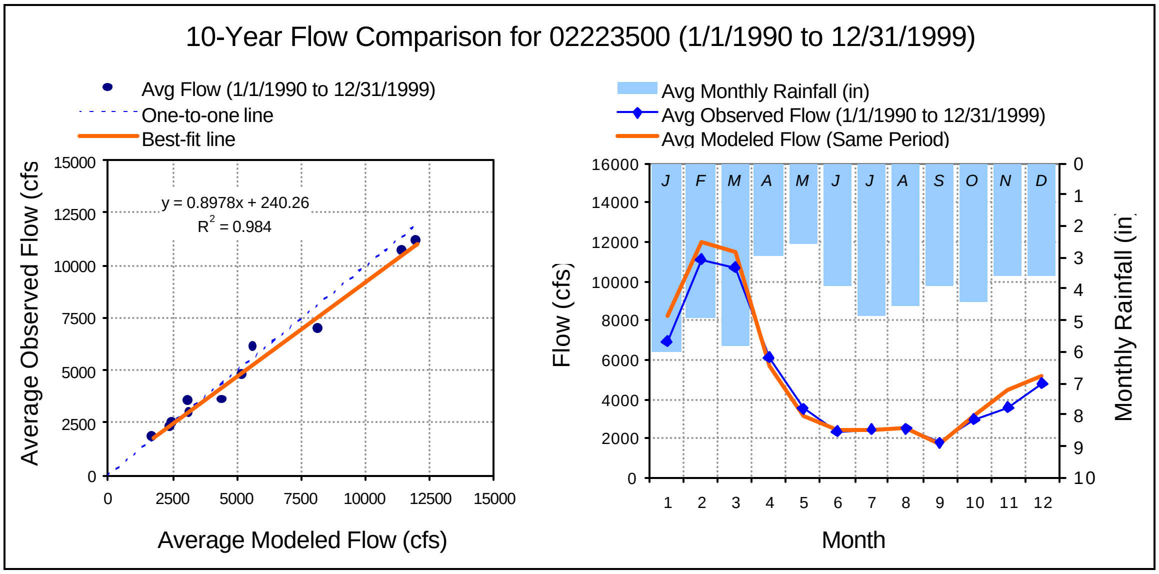


Figure C.14 10-Year Validation (Monthly Average) at 02223500 – Oconee River at Dublin, GA.

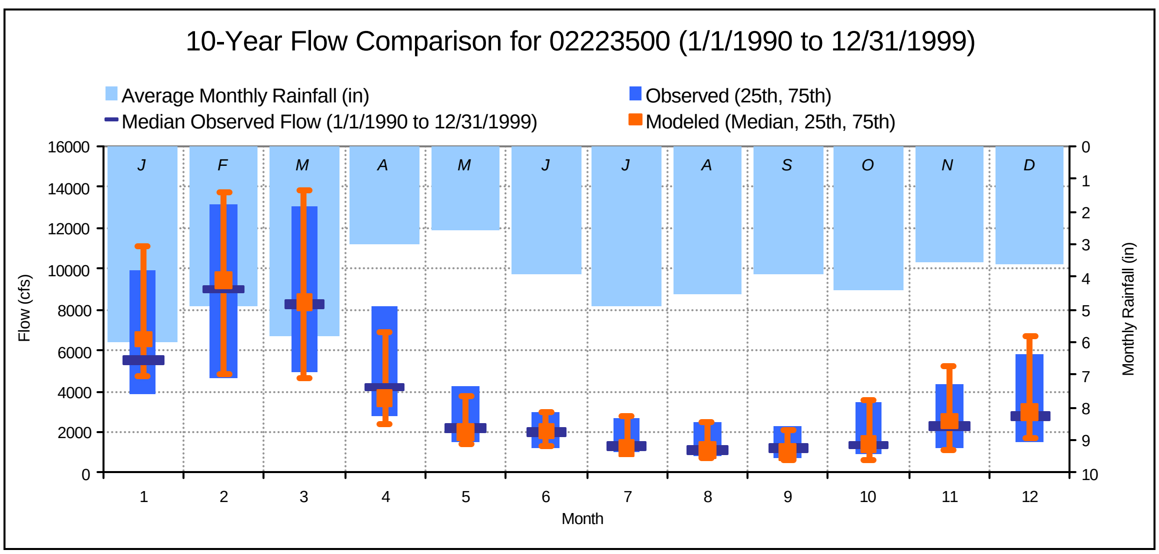


Figure C.15. 10-Year Validation (Monthly Medians) at 02223500 – Oconee River at Dublin, GA.

Simulation Name:	02223500	**Simulation Period:**	
		Watershed Area (ac):	2804097
Period for Flow Analysis			
Begin Date:	**01/01/90**	**Baseflow PERCENTILE:**	2.5
End Date:	**12/31/99**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**159.89**	Total Observed In-stream Flow:	**150.96**
Total of highest 10% flows:	**63.23**	Total of Observed highest 10% flows:	**56.09**
Total of lowest 50% flows:	**21.46**	Total of Observed Lowest 50% flows:	**22.45**
Simulated Summer Flow Volume (months 7-9):	**17.58**	Observed Summer Flow Volume (7-9):	**17.62**
Simulated Fall Flow Volume (months 10-12):	**33.23**	Observed Fall Flow Volume (10-12):	**29.53**
Simulated Winter Flow Volume (months 1-3):	**80.43**	Observed Winter Flow Volume (1-3):	**73.00**
Simulated Spring Flow Volume (months 4-6):	**28.64**	Observed Spring Flow Volume (4-6):	**30.81**
Total Simulated Storm Volume:	**145.27**	Total Observed Storm Volume:	**132.05**
Simulated Summer Storm Volume (7-9):	**13.93**	Observed Summer Storm Volume (7-9):	**12.90**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**5.59**	10	
Error in 50% lowest flows:	**-4.62**	10	
Error in 10% highest flows:	**11.30**	15	
Seasonal volume error - Summer:	**-0.22**	30	
Seasonal volume error - Fall:	**11.13**	30	
Seasonal volume error - Winter:	**9.24**	30	
Seasonal volume error - Spring:	**-7.55**	30	
Error in storm volumes:	**9.10**	20	
Error in summer storm volumes:	**7.39**	50	

Figure C.16. 10-Year Validation Statistics at 02223500 – Oconee River at Dublin, GA.

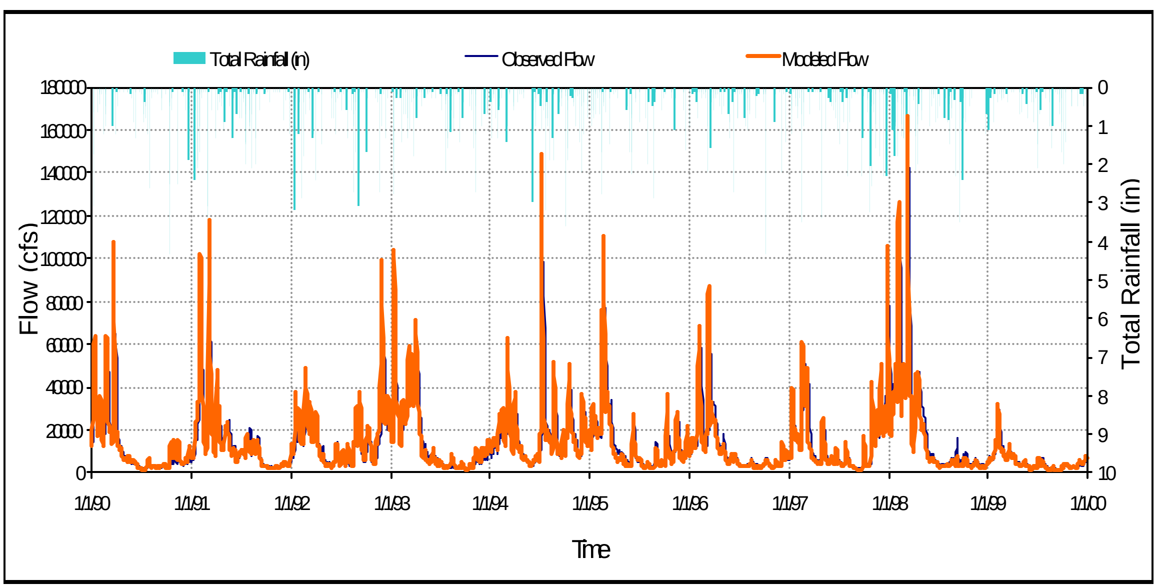


Figure C.17. 10-Year Validation (Daily Flow) at 02225000 – Altamaha River near Baxley, GA.

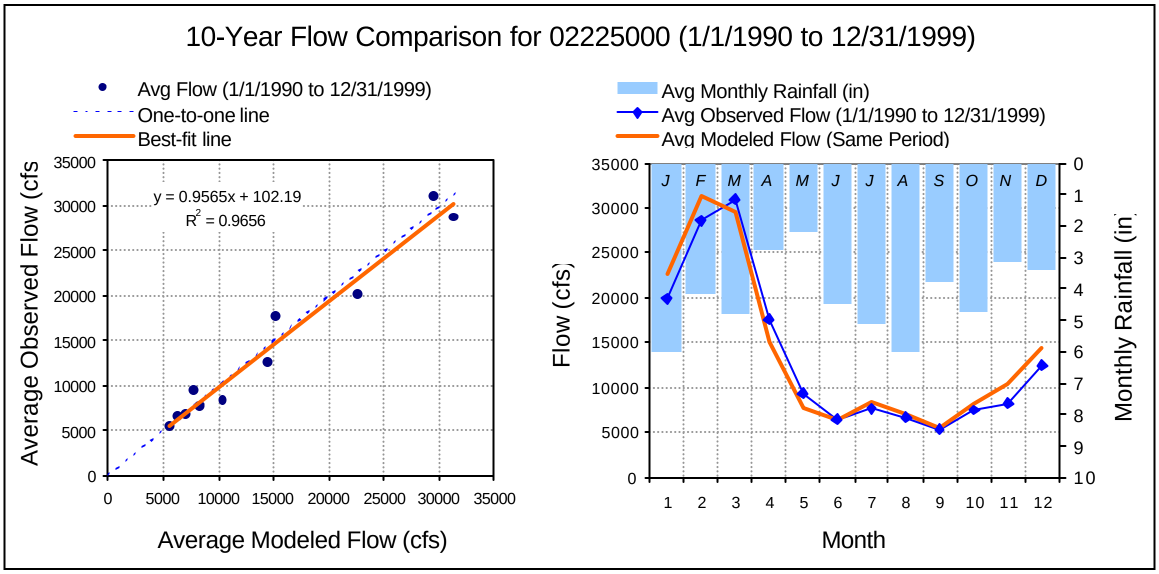


Figure C.18. 10-Year Validation (Monthly Average) at 02225000 – Altamaha River near Baxley, GA.

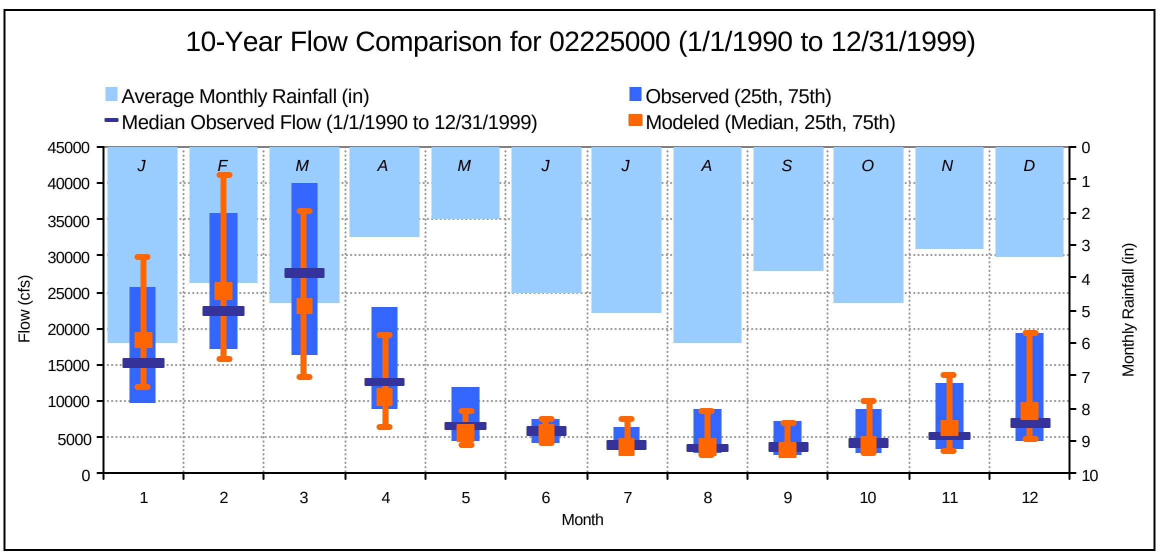


Figure C.19. 10-Year Validation (Monthly Medians) at 02225000 – Altamaha River near Baxley, GA.

Simulation Name:	02225000	**Simulation Period:**	
		Watershed Area (ac):	7414025
Period for Flow Analysis			
Begin Date:	**01/01/90**	**Baseflow PERCENTILE:**	2.5
End Date:	**12/31/99**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**162.30**	Total Observed In-stream Flow:	**156.52**
Total of highest 10% flows:	**61.54**	Total of Observed highest 10% flows:	**55.32**
Total of lowest 50% flows:	**24.30**	Total of Observed Lowest 50% flows:	**25.45**
Simulated Summer Flow Volume (months 7-9):	**20.78**	Observed Summer Flow Volume (7-9):	**19.53**
Simulated Fall Flow Volume (months 10-12):	**32.68**	Observed Fall Flow Volume (10-12):	**27.94**
Simulated Winter Flow Volume (months 1-3):	**80.39**	Observed Winter Flow Volume (1-3):	**76.56**
Simulated Spring Flow Volume (months 4-6):	**28.45**	Observed Spring Flow Volume (4-6):	**32.50**
Total Simulated Storm Volume:	**141.79**	Total Observed Storm Volume:	**132.50**
Simulated Summer Storm Volume (7-9):	**15.67**	Observed Summer Storm Volume (7-9):	**13.53**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**3.56**	10	
Error in 50% lowest flows:	**-4.72**	10	
Error in 10% highest flows:	**10.10**	15	
Seasonal volume error - Summer:	**6.06**	30	
Seasonal volume error - Fall:	**14.50**	30	
Seasonal volume error - Winter:	**4.77**	30	
Seasonal volume error - Spring:	**-14.24**	30	
Error in storm volumes:	**6.56**	20	
Error in summer storm volumes:	**13.68**	50	

Figure C.20. 10-Year Validation Statistics at 02225000 – Altamaha River near Baxley, GA.

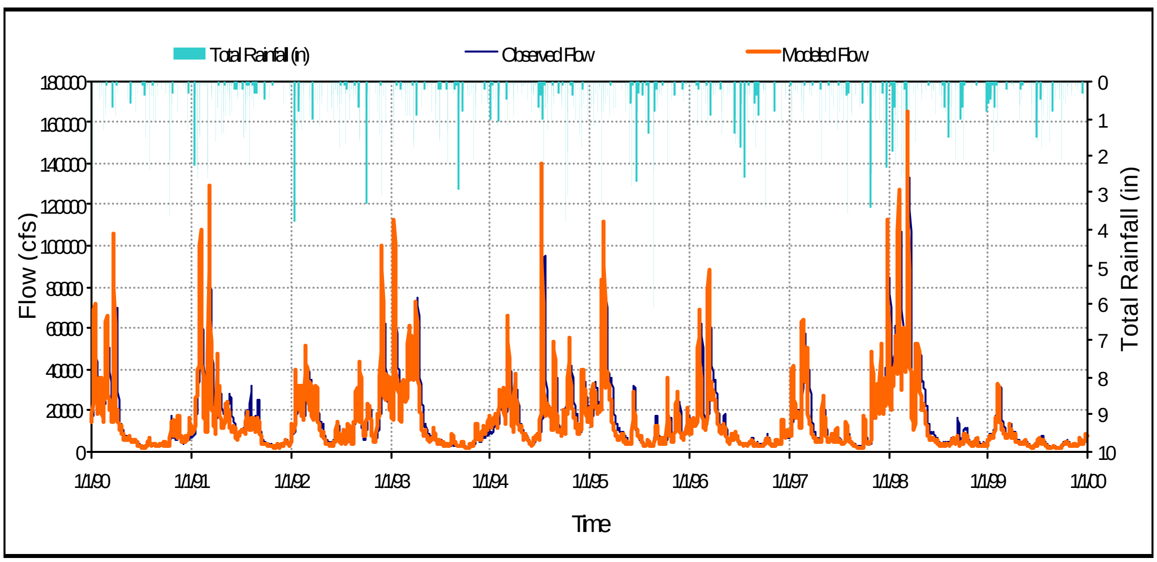


Figure C.21. 10-Year Validation (Daily Flow) at 02226000 – Altamaha River at Doctortown, GA.

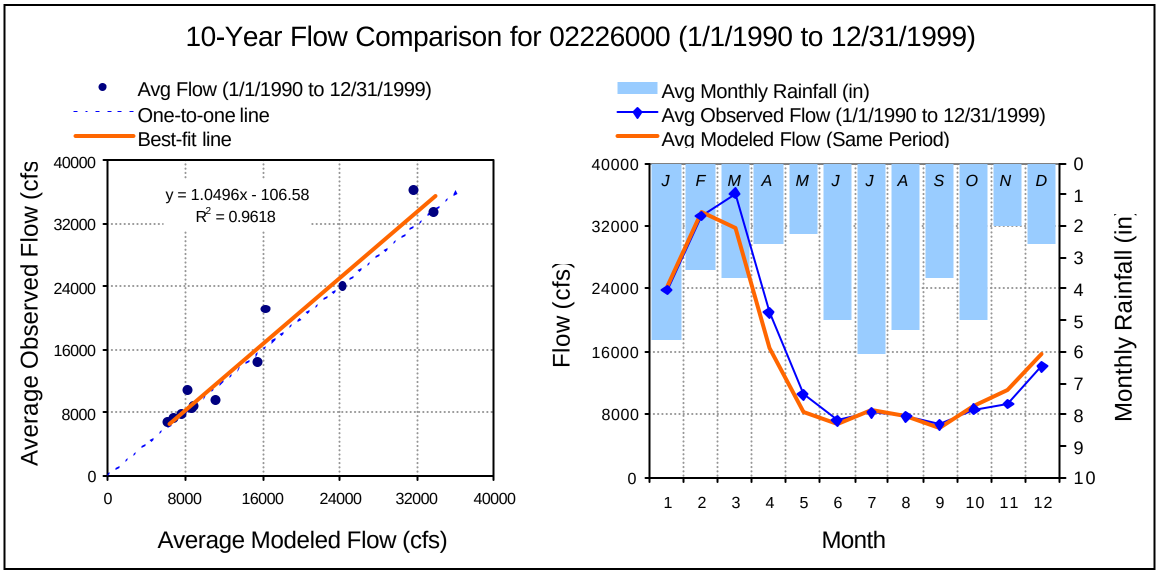


Figure C.22. 10-Year Validation (Monthly Average) at 02226000 – Altamaha River at Doctortown, GA.

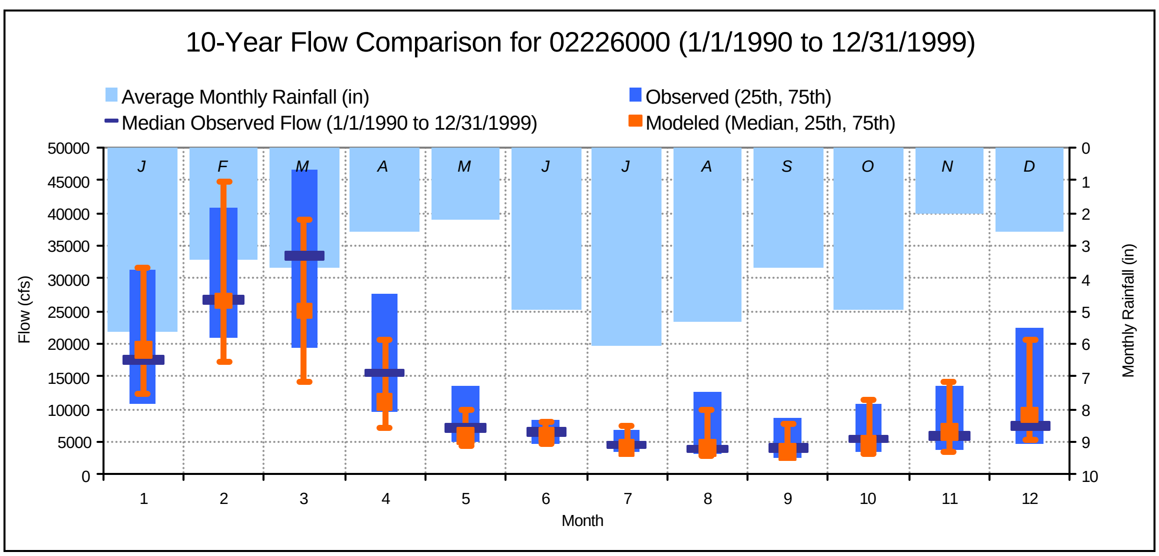


Figure C.23. 10-Year Validation (Monthly Medians) at 02226000 – Altamaha River at Doctortown, GA.

Simulation Name:	02226000	**Simulation Period:**	
		Watershed Area (ac):	8738182
Period for Flow Analysis			
Begin Date:	**01/01/90**	**Baseflow PERCENTILE:**	2.5
End Date:	**12/31/99**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**148.01**	Total Observed In-stream Flow:	**154.40**
Total of highest 10% flows:	**55.97**	Total of Observed highest 10% flows:	**54.45**
Total of lowest 50% flows:	**22.16**	Total of Observed Lowest 50% flows:	**23.94**
Simulated Summer Flow Volume (months 7-9):	**18.93**	Observed Summer Flow Volume (7-9):	**19.10**
Simulated Fall Flow Volume (months 10-12):	**29.89**	Observed Fall Flow Volume (10-12):	**26.97**
Simulated Winter Flow Volume (months 1-3):	**73.27**	Observed Winter Flow Volume (1-3):	**76.27**
Simulated Spring Flow Volume (months 4-6):	**25.92**	Observed Spring Flow Volume (4-6):	**32.06**
Total Simulated Storm Volume:	**128.79**	Total Observed Storm Volume:	**132.15**
Simulated Summer Storm Volume (7-9):	**14.13**	Observed Summer Storm Volume (7-9):	**13.53**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**-4.32**	10	
Error in 50% lowest flows:	**-8.01**	10	
Error in 10% highest flows:	**2.72**	15	
Seasonal volume error - Summer:	**-0.90**	30	
Seasonal volume error - Fall:	**9.77**	30	
Seasonal volume error - Winter:	**-4.09**	30	
Seasonal volume error - Spring:	**-23.71**	30	
Error in storm volumes:	**-2.61**	20	
Error in summer storm volumes:	**4.26**	50	

Figure C.24. 10-Year Validation Statistics at 02226000 – Altamaha River at Doctortown, GA.

APPENDIX D:

SIMULATION PERIOD HYDROGRAPHS

FIGURE D-1
OHOOPEE RIVER - DYERS CREEK TO BIG CEDAR CREEK
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

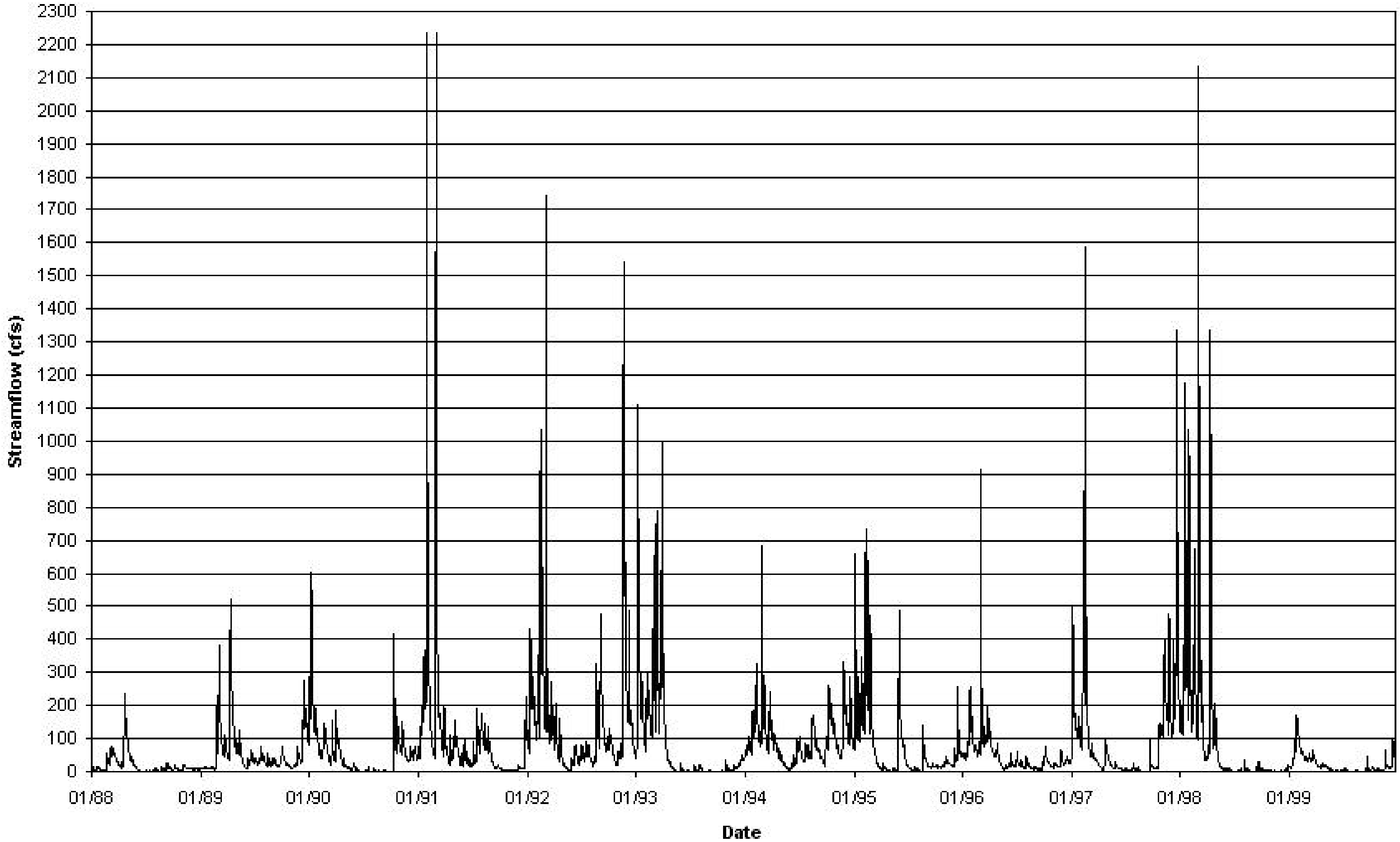


FIGURE D-2
BIG CEDAR CREEK - LITTLE CEDAR CREEK TO OHOOPEE RIVER
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

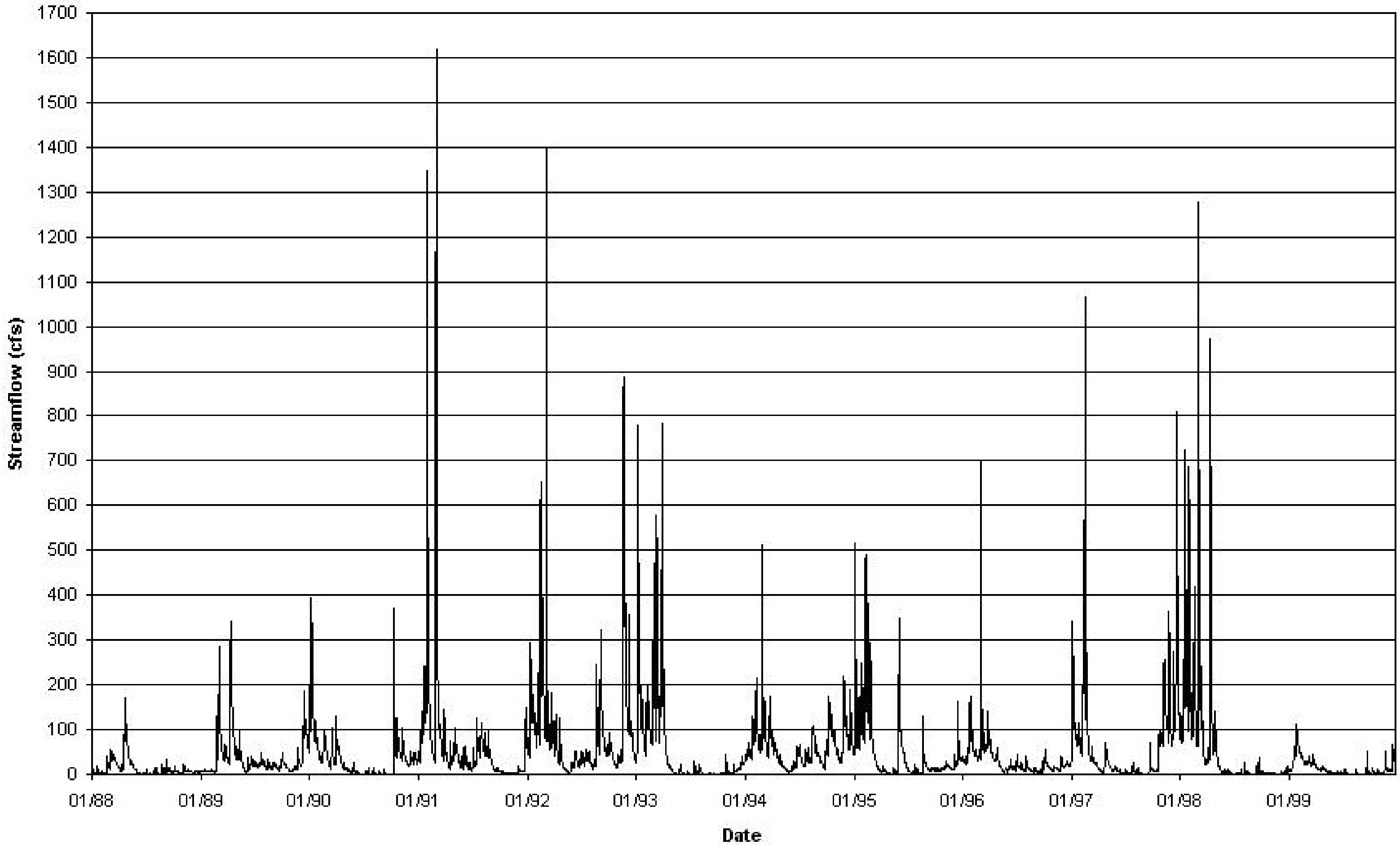


FIGURE D-3
OHOOPEE RIVER - NEELS CREEK TO LITTLE OHOOPEE RIVER
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

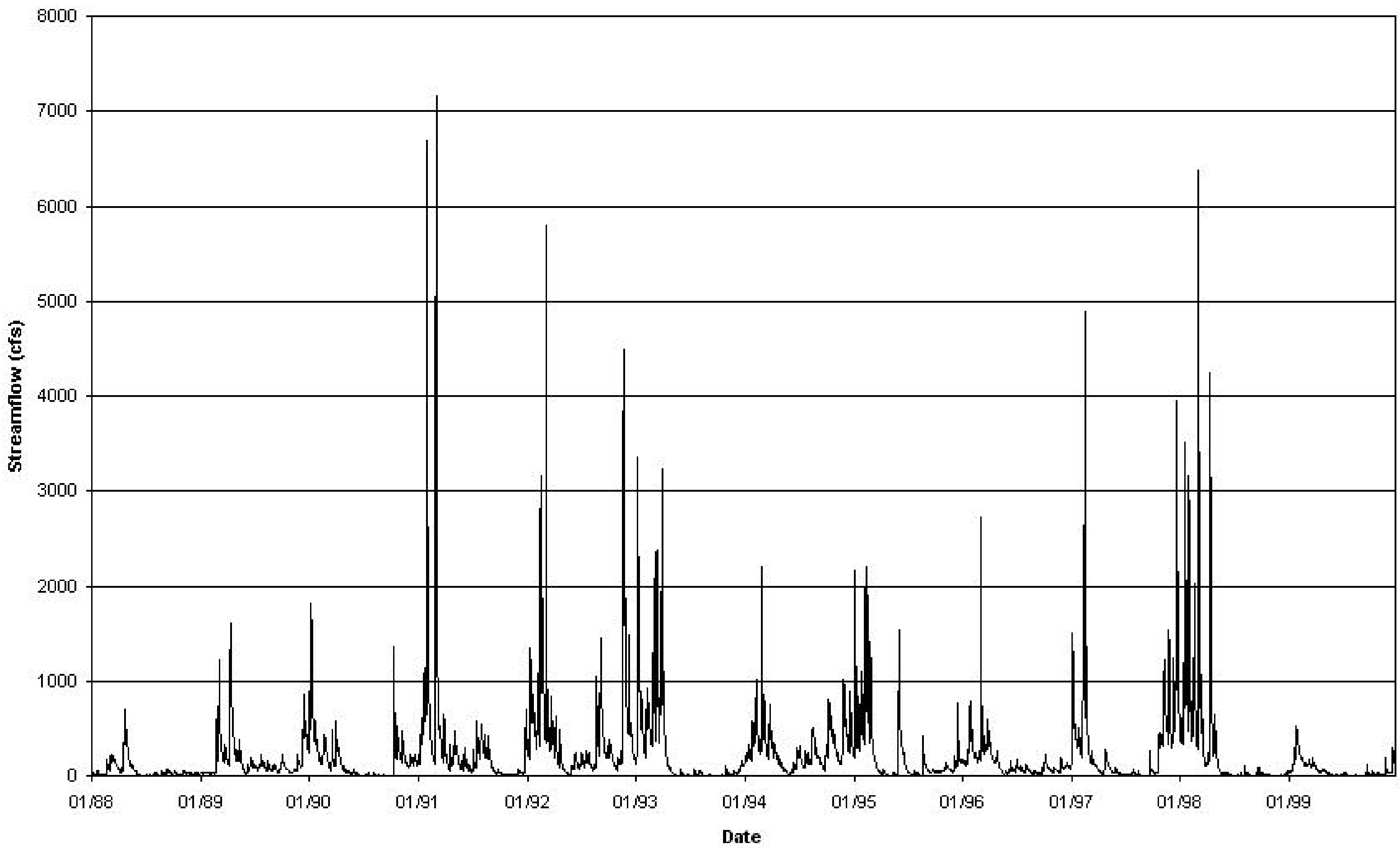


FIGURE D-4
LITTLE OHOOPEE RIVER - SARDIS CREEK TO OHOOPEE RIVER
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

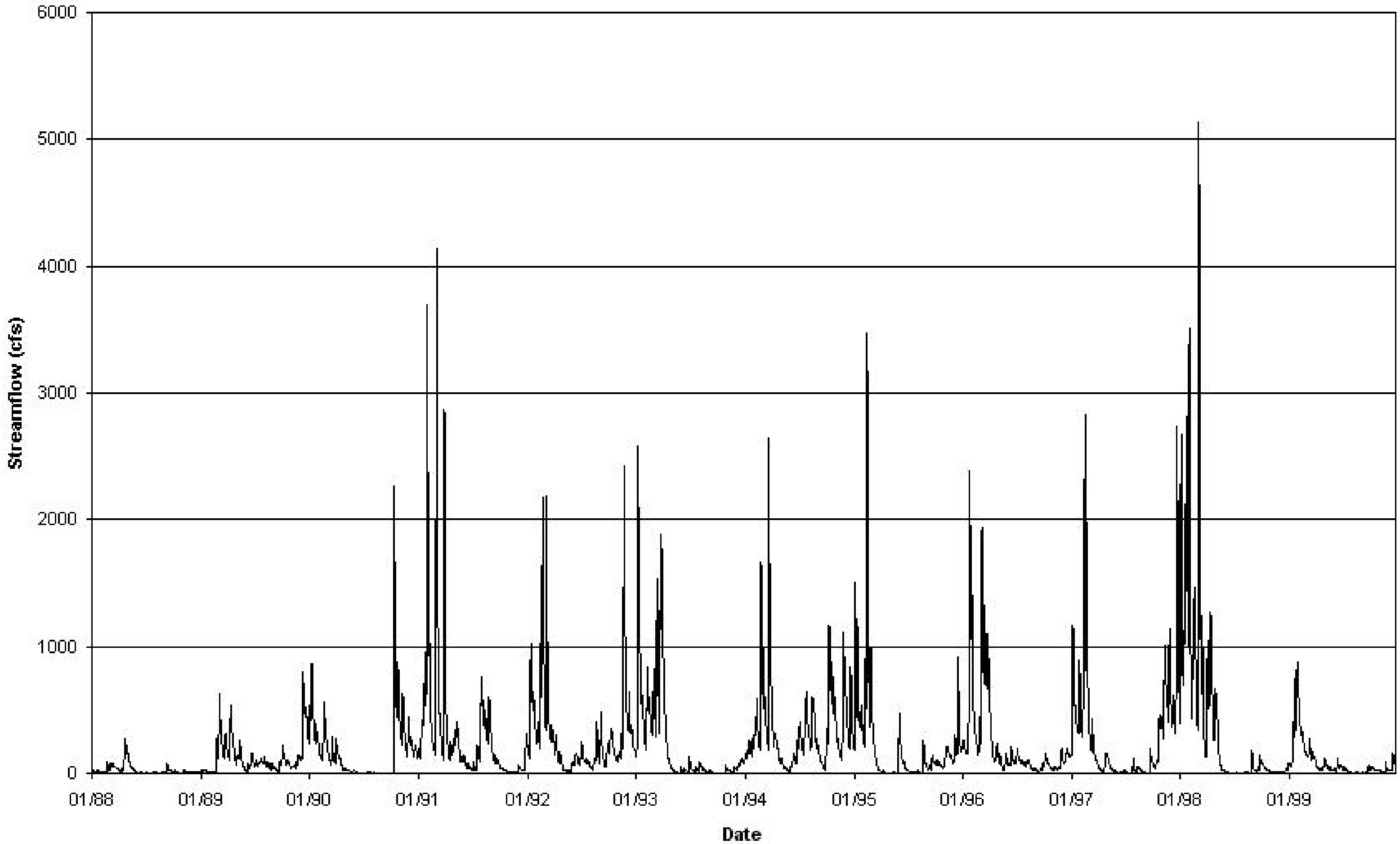


FIGURE D-5
YAM GRANDY CREEK - DOWNSTREAM OF CROOKED CREEK
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

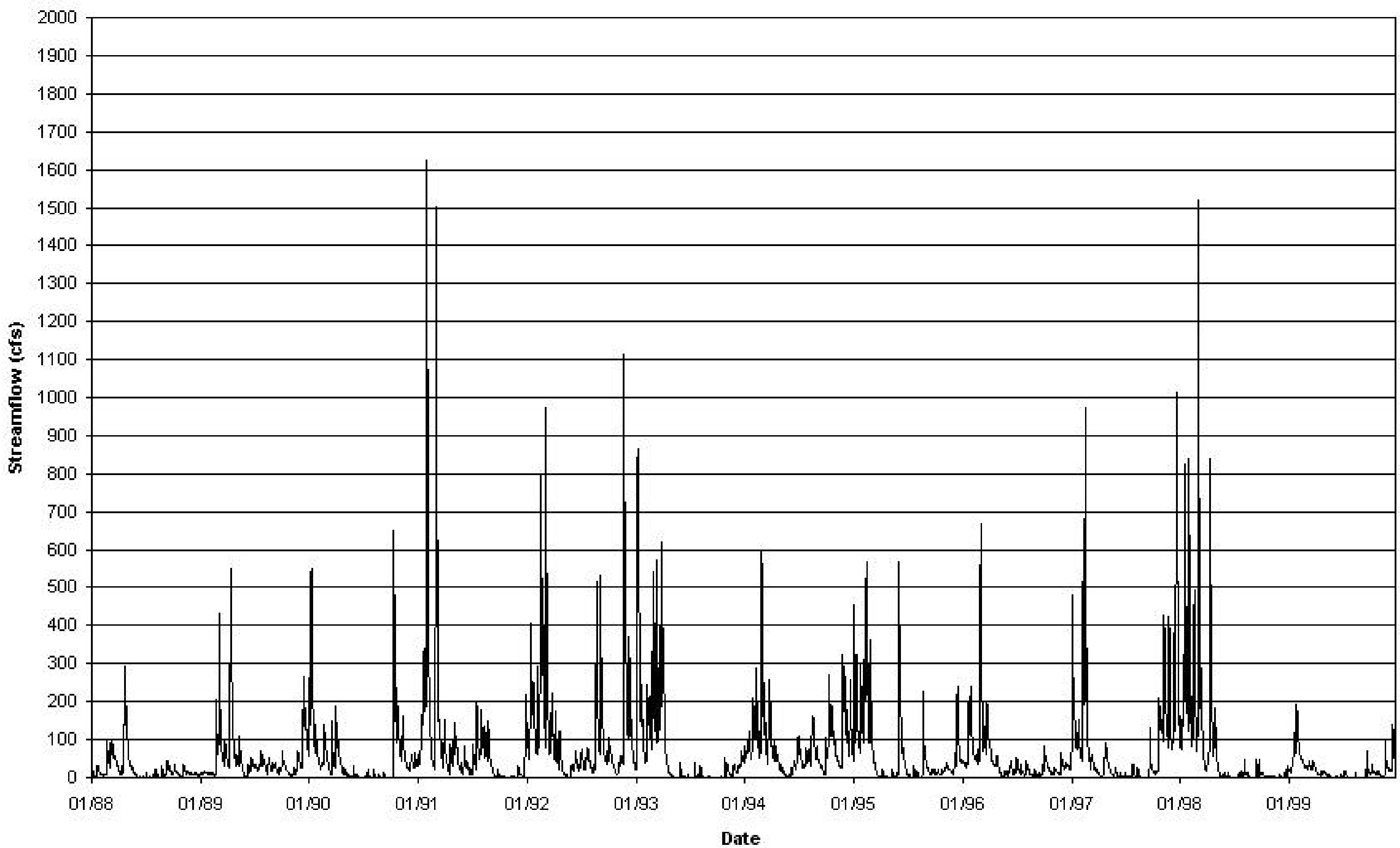


FIGURE D-6
JACKS CREEK - U. S. HIGHWAY 1 TO OHOOPEE RIVER
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

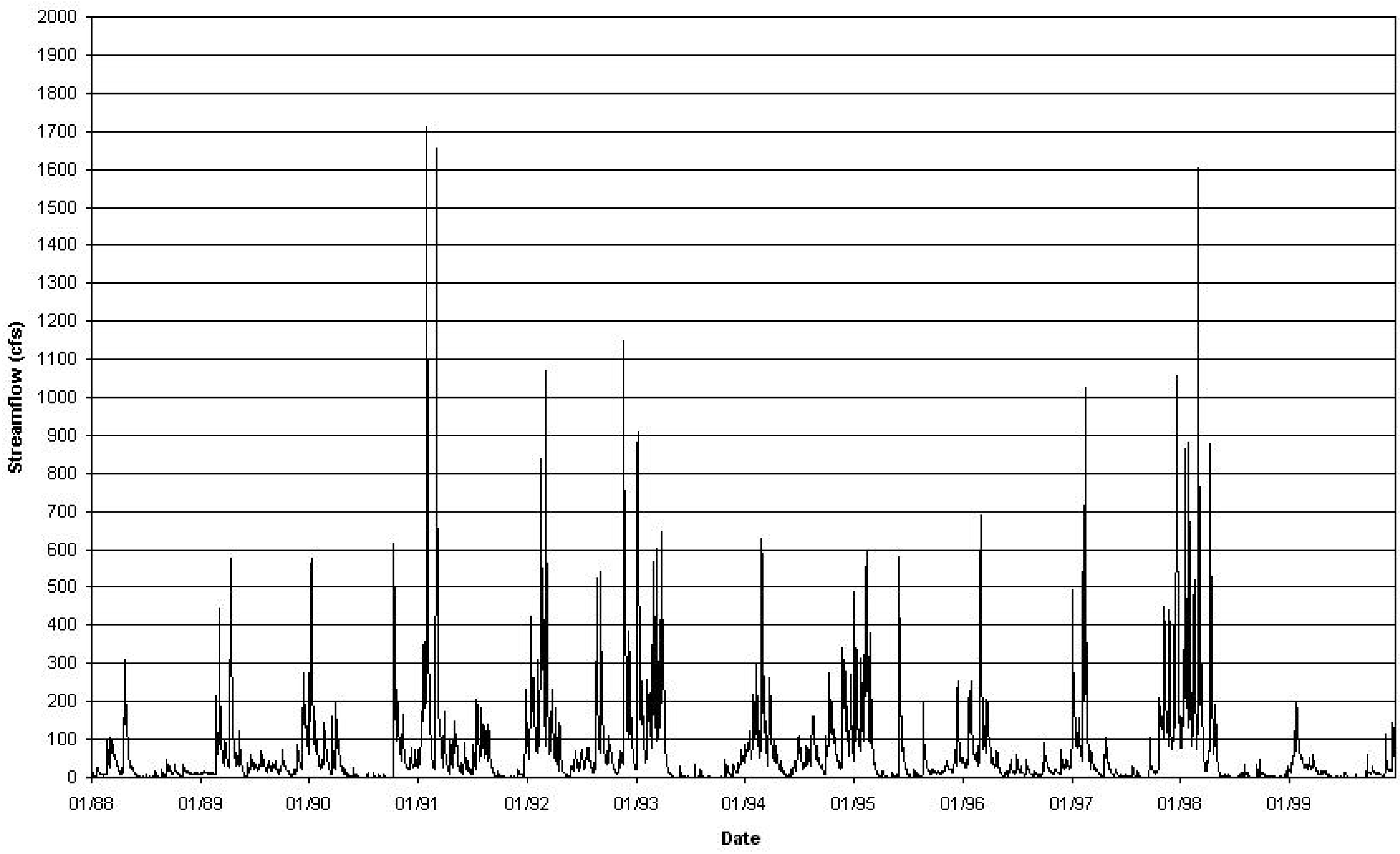


FIGURE D-7
OHOOPEE RIVER - LITTLE OHOOPEE RIVER TO U.S. HIGHWAY 292
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

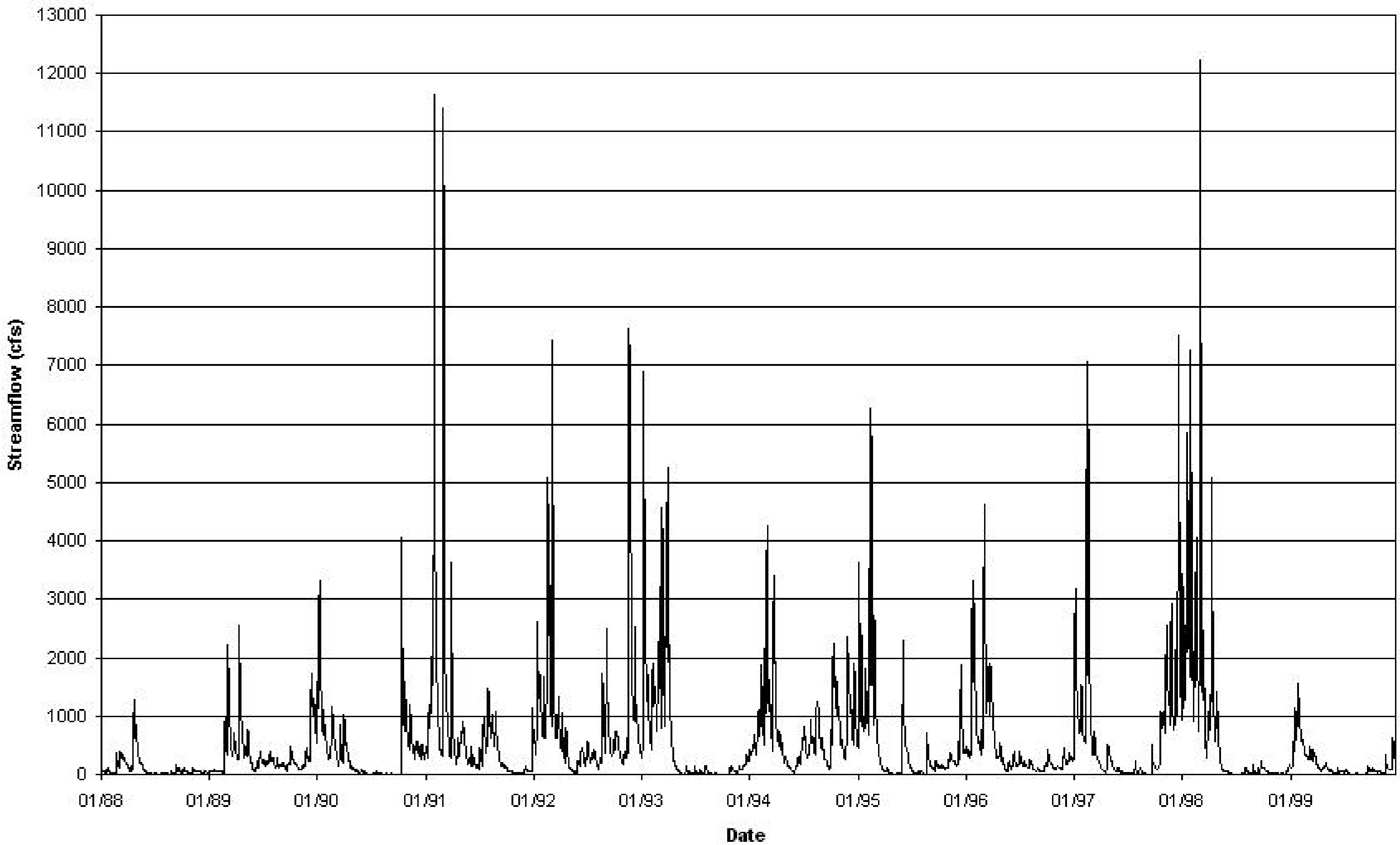


FIGURE D-8
SWIFT CREEK - OLD NORMANTOWN ROAD TO PENDLETON CREEK
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

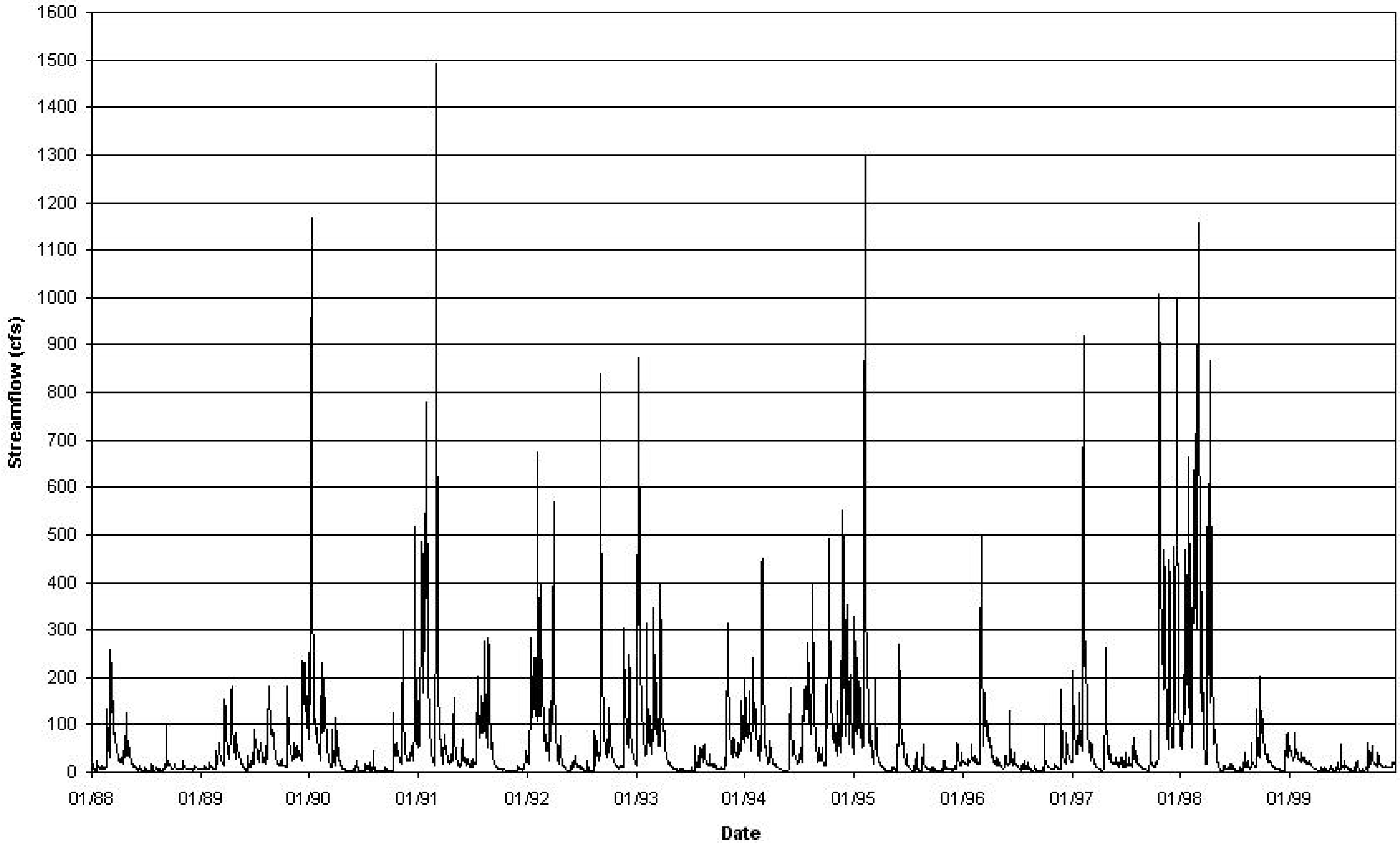


FIGURE D-9
TIGER CREEK - LITTLE CREEK TO PENDLETON CREEK
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

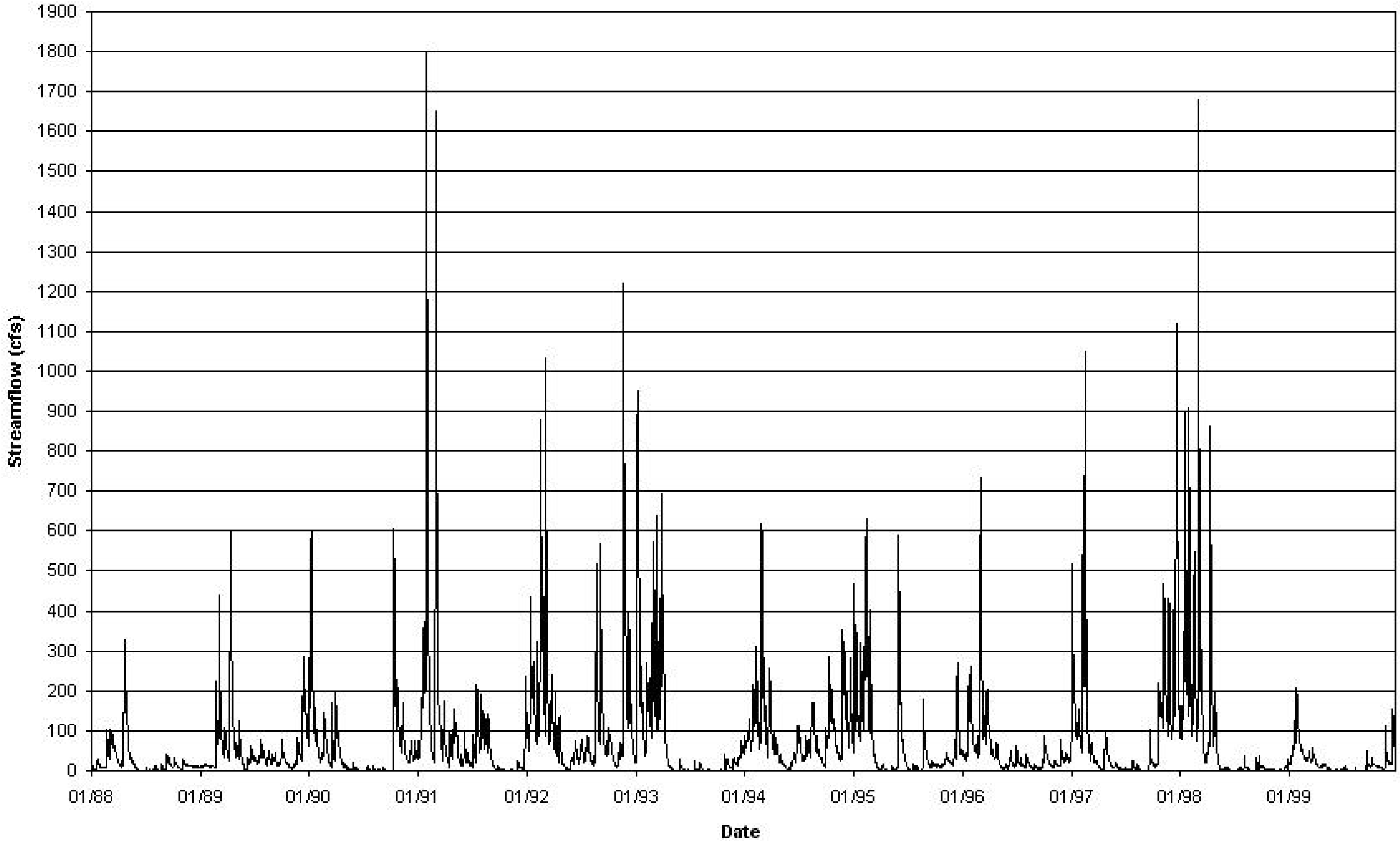


FIGURE D-10
PENDLETON CREEK - SAND HILL LAKE TO REEDY CREEK
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

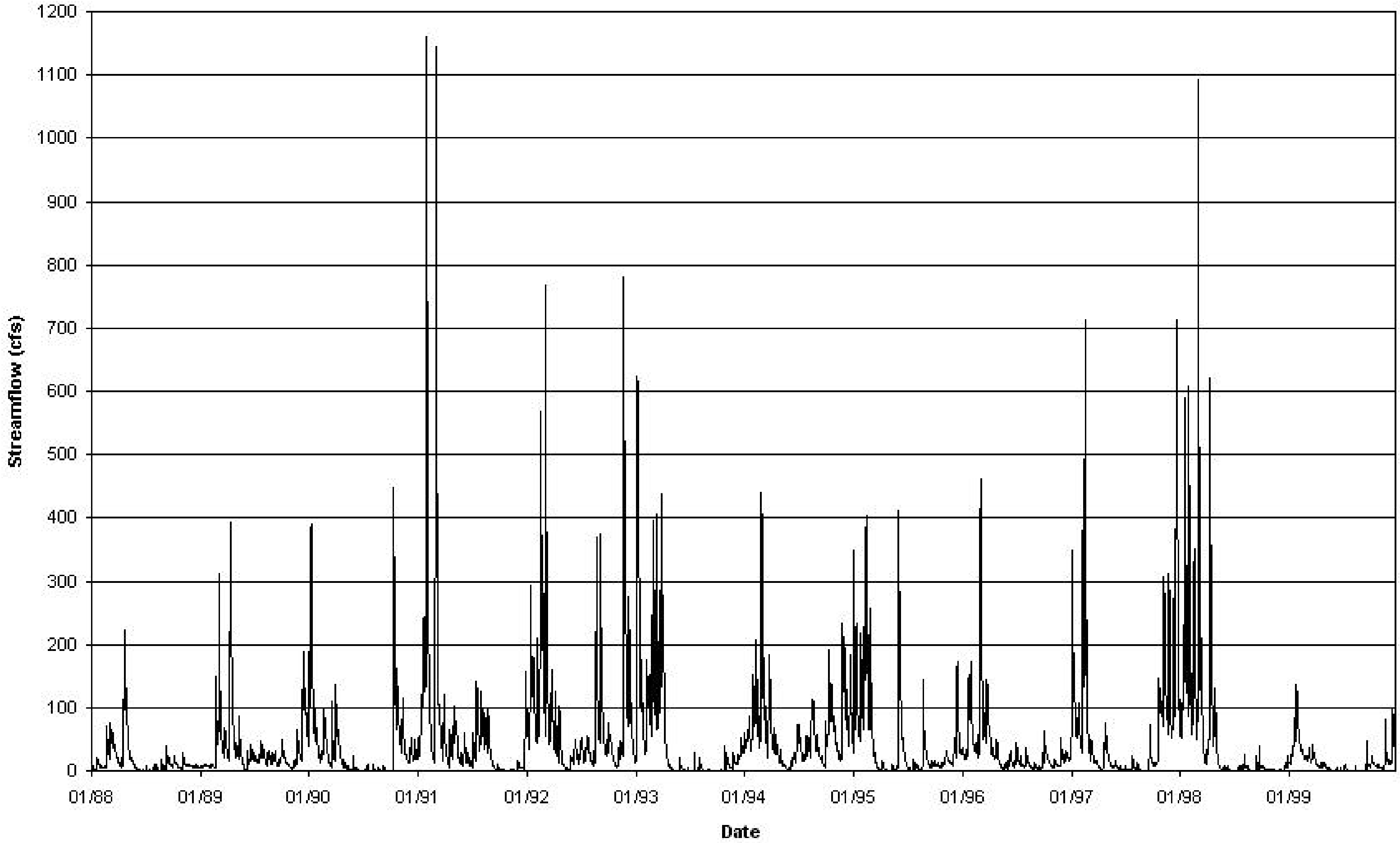


FIGURE D-11
PENDLETON CREEK -WILDWOOD LAKE TO TIGER CREEK
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

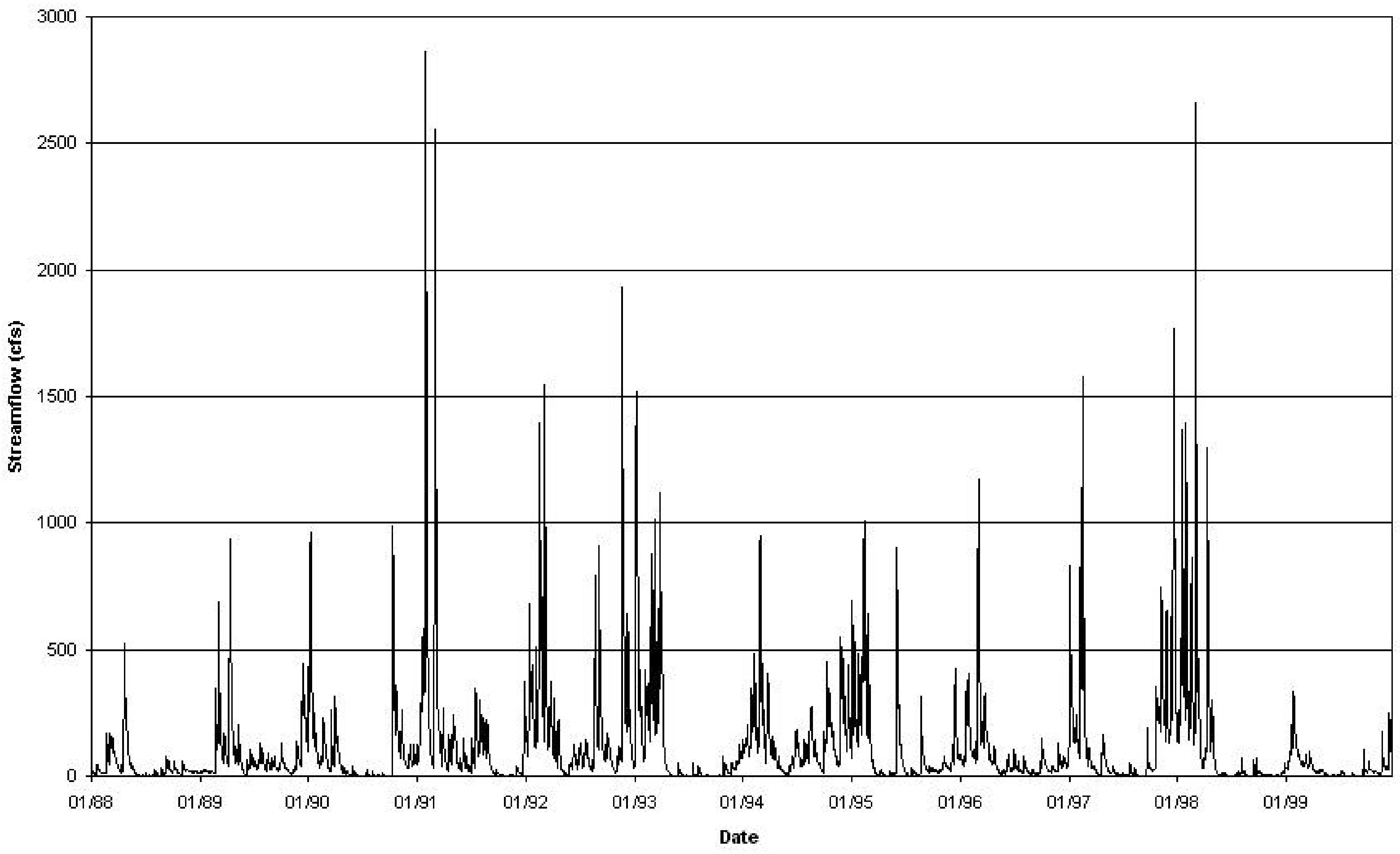


FIGURE D-12
ROCKY CREEK - GEORGIA HIGHWAY 130 TO LITTLE ROCKY CREEK
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

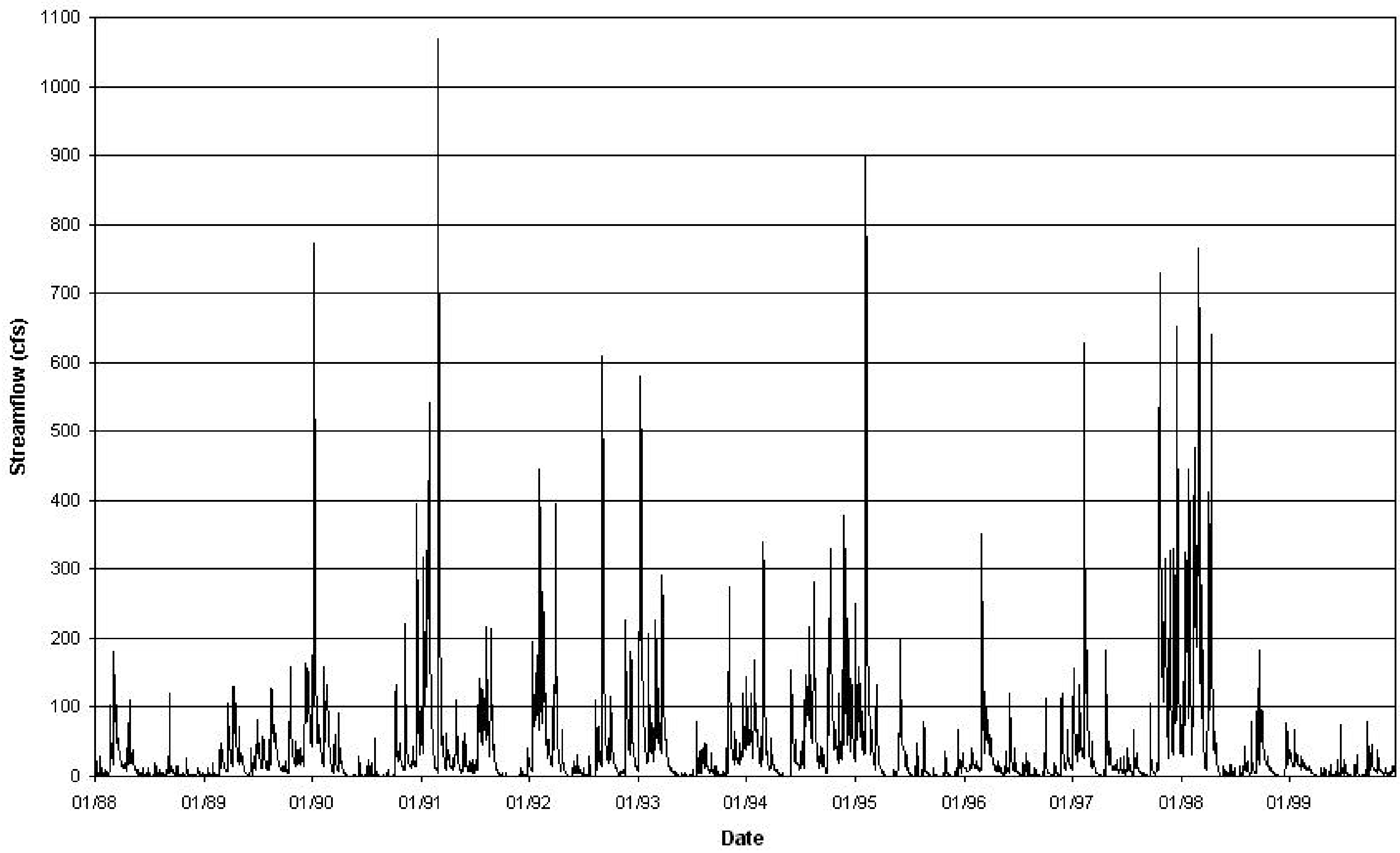


FIGURE D-13
MILLIGAN CREEK - UVALDA TO ALTAMAHA RIVER
SIMULATION PERIOD STREAMFLOW HYDROGRAPH

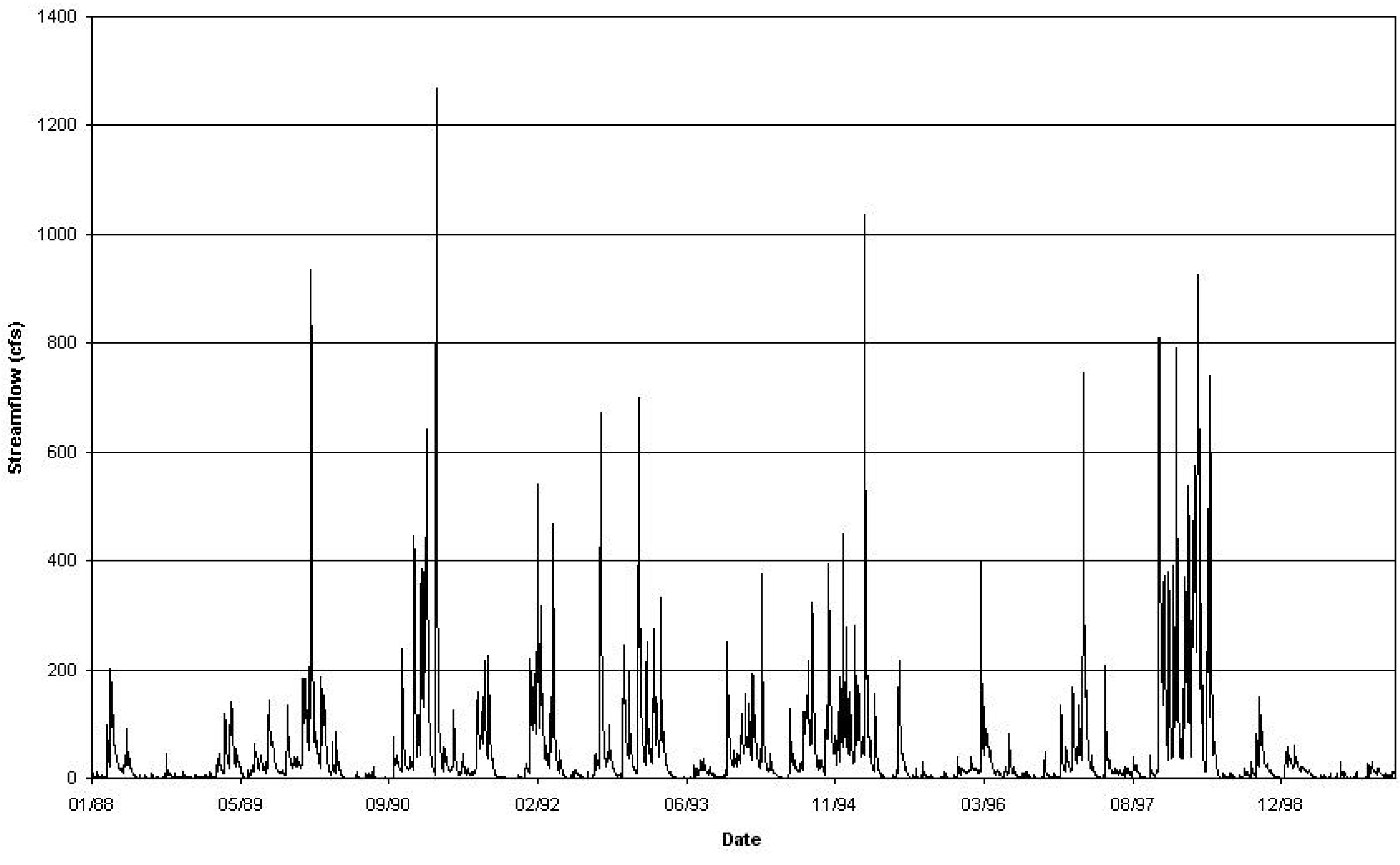
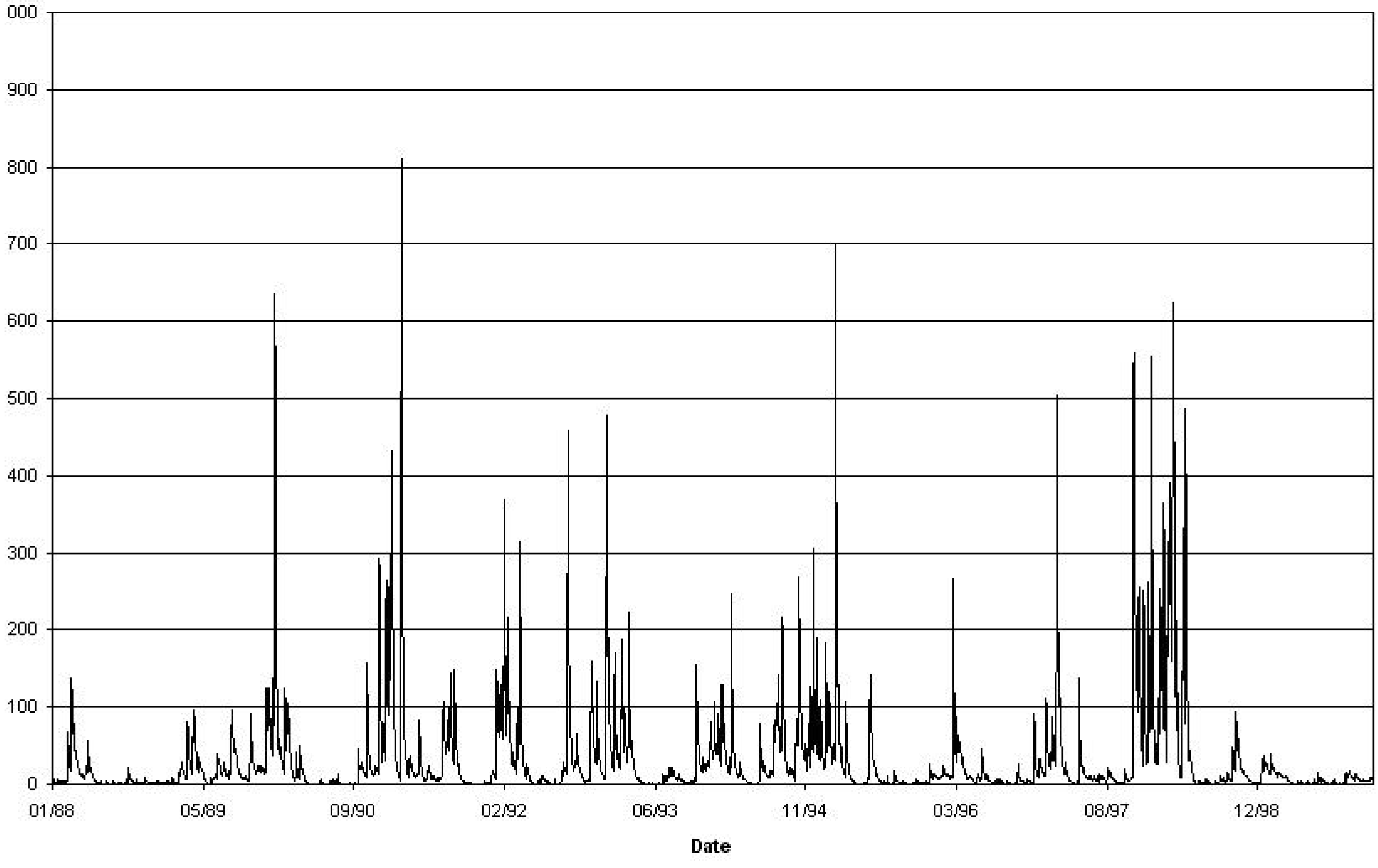


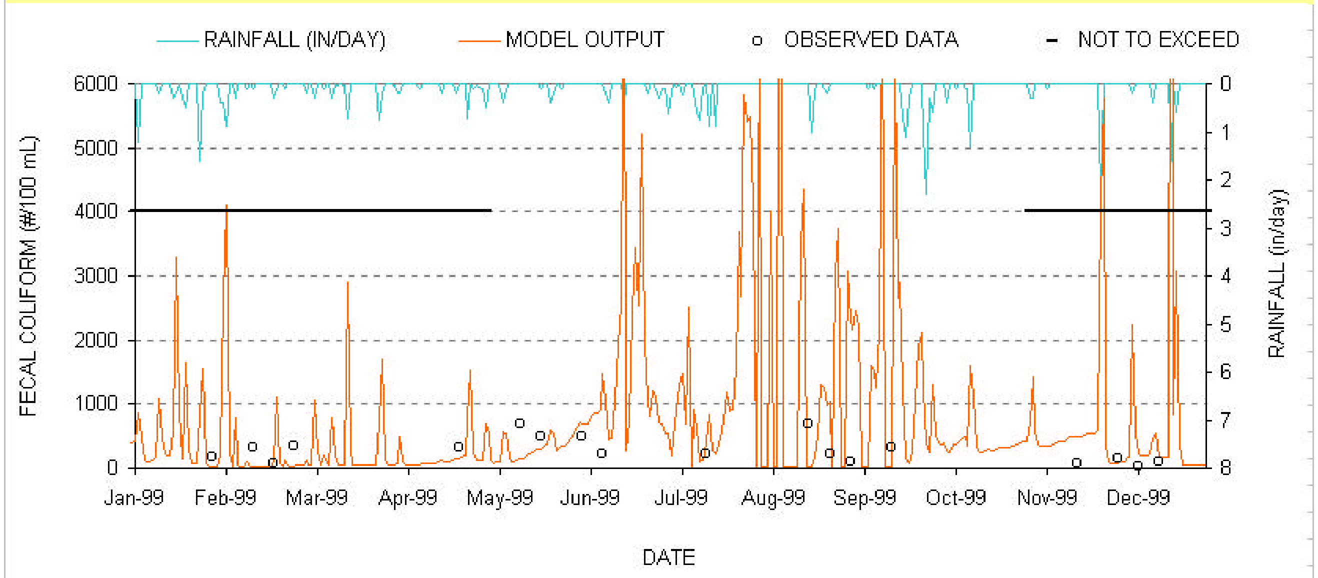
FIGURE D-14
OCONEE CREEK - HEADWATERS TO COBB CREEK
SIMULATION PERIOD STREAMFLOW HYDROGRAPH



APPENDIX E:

WATER QUALITY CALIBRATIONS

FIGURE E-1
WATER QUALITY CALIBRATION
OHOOPEE RIVER - DYERS CREEK TO BIG CEDAR CREEK



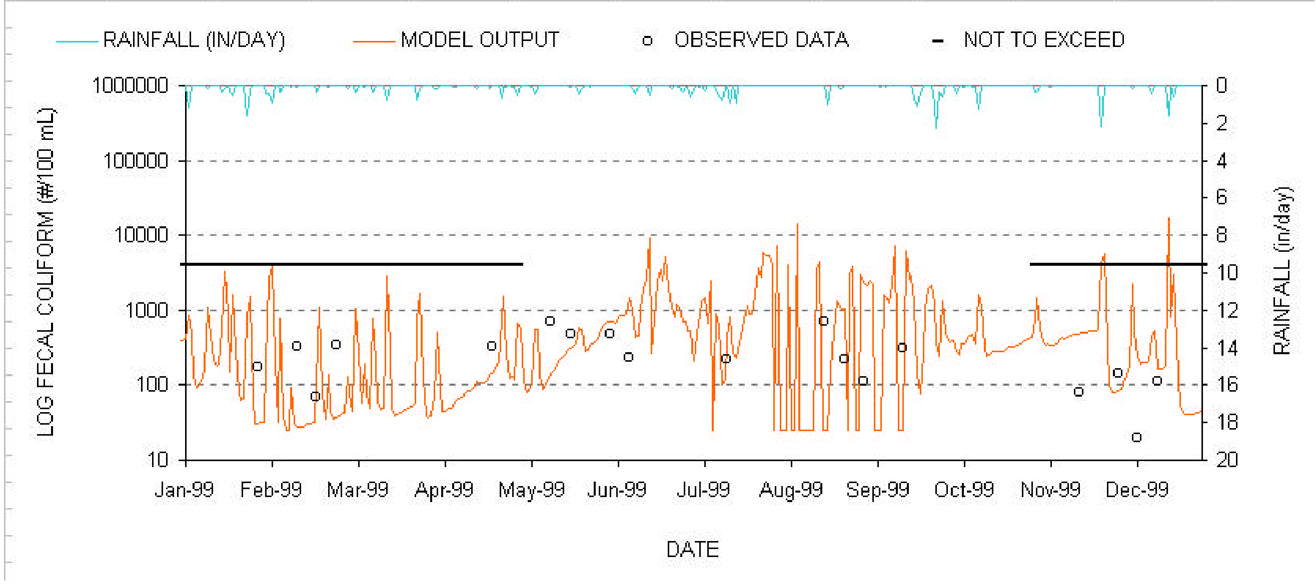
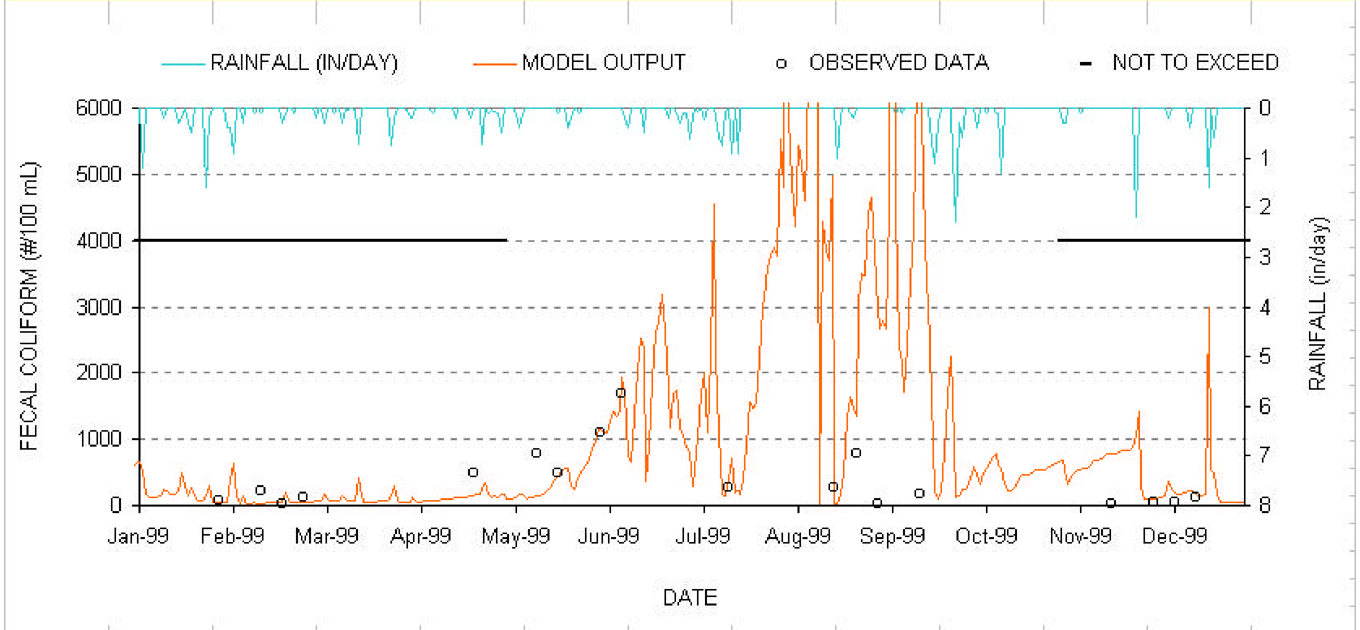


FIGURE E-2
WATER QUALITY CALIBRATION
BIG CEDAR CREEK - LITTLE CEDAR CREEK TO OHOOPEE RIVER



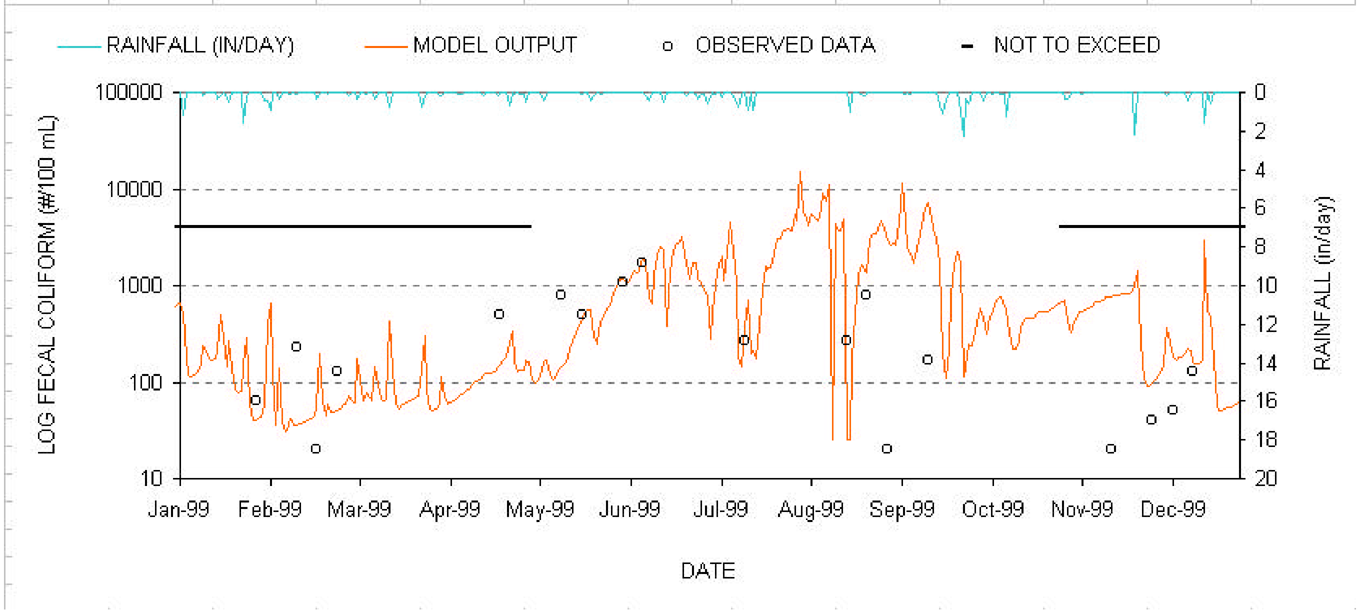


FIGURE E-3
WATER QUALITY CALIBRATION
OHOOPEE RIVER - NEELS CREEK TO LITTLE OHOOPEE RIVER

FIGURE E-4
WATER QUALITY CALIBRATION
LITTLE OHOOPEE RIVER - SARDIS CREEK TO OHOOPEE RIVER

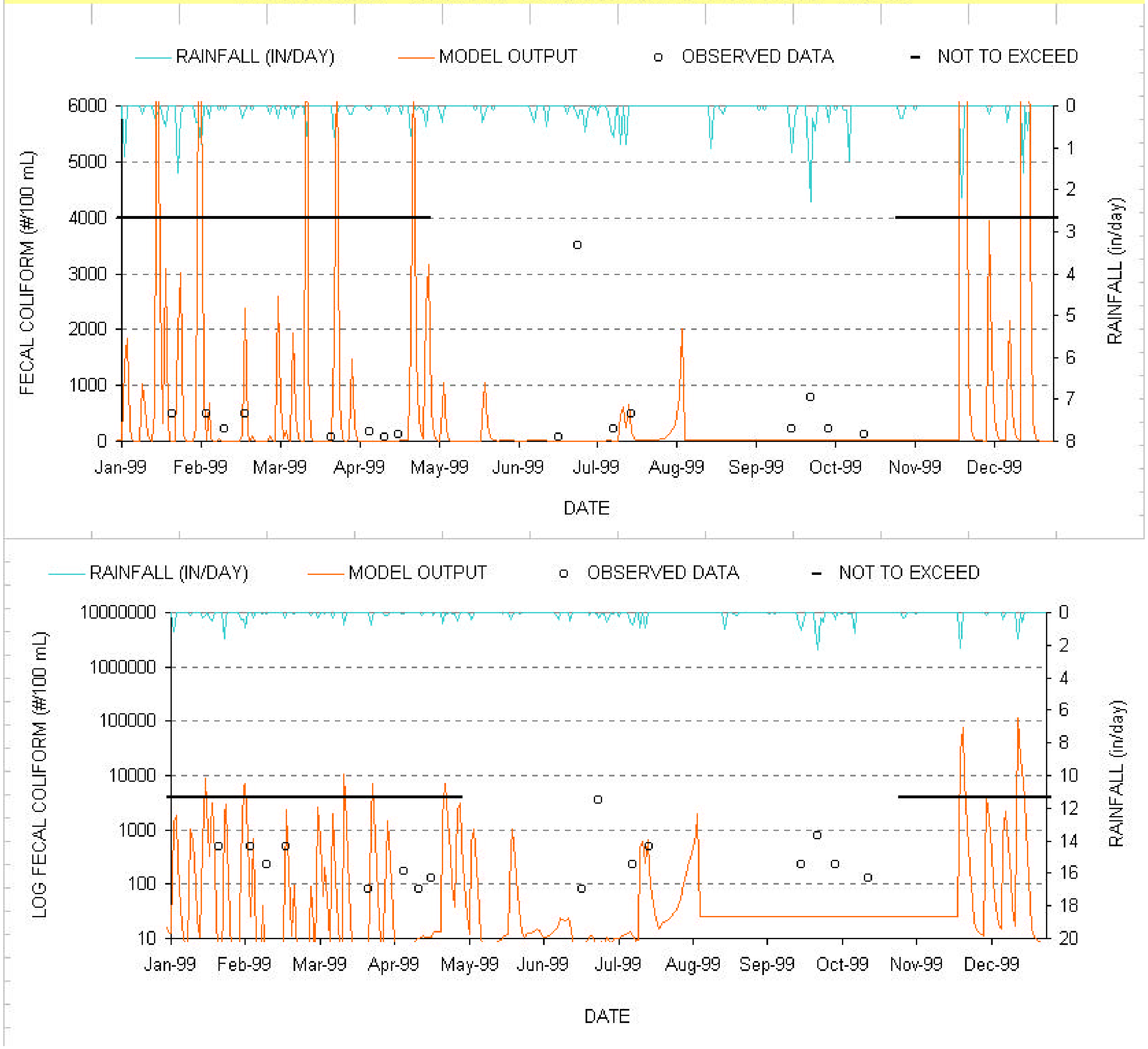
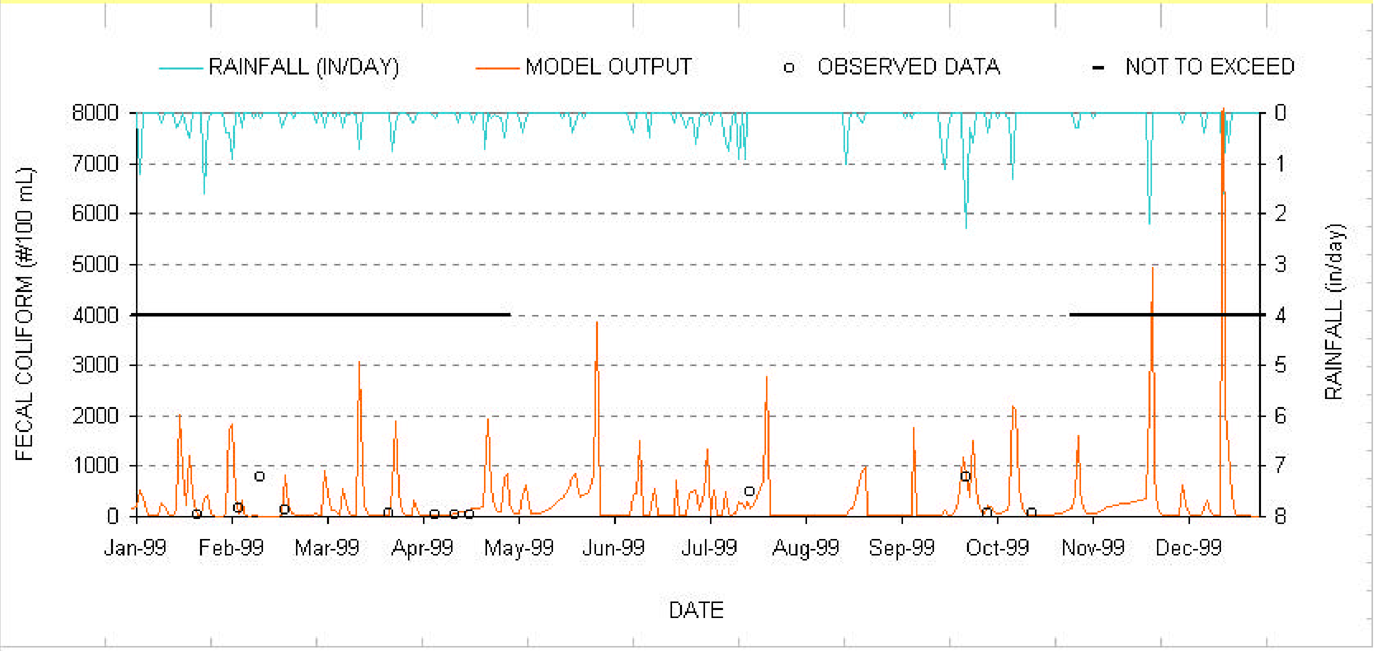
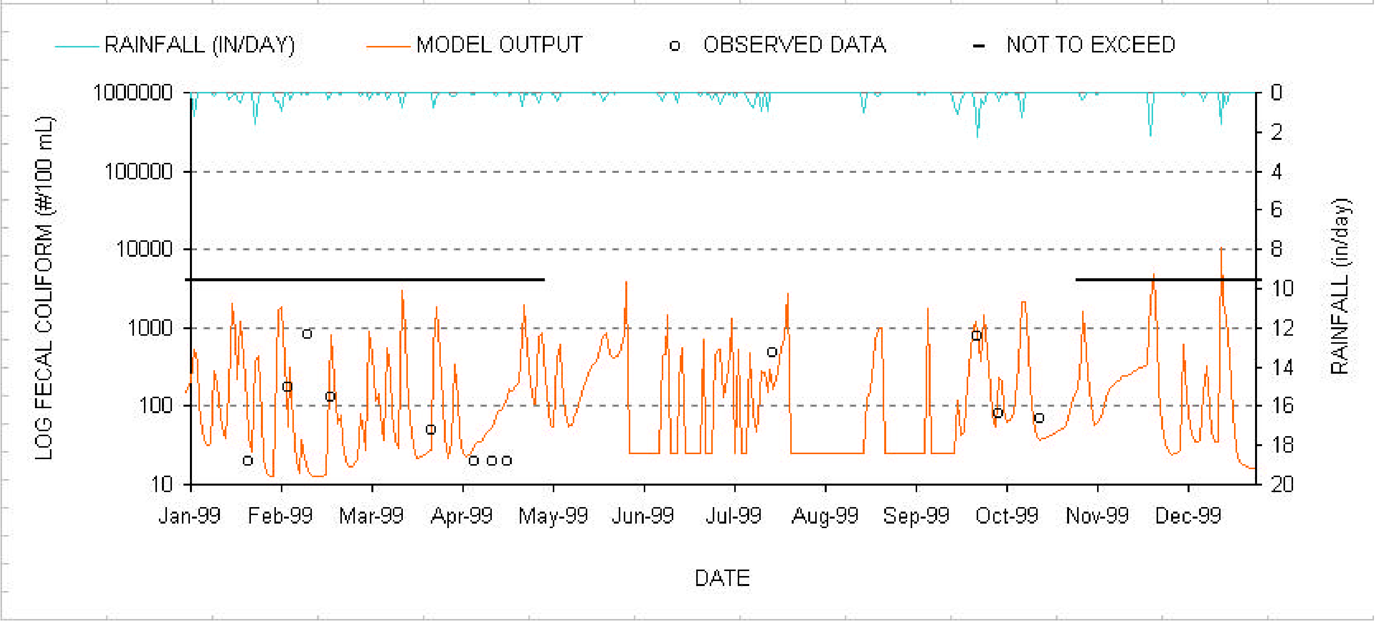


FIGURE E-5
WATER QUALITY CALIBRATION
YAM GRANDY CREEK - DOWNSTREAM OF CROOKED CREEK





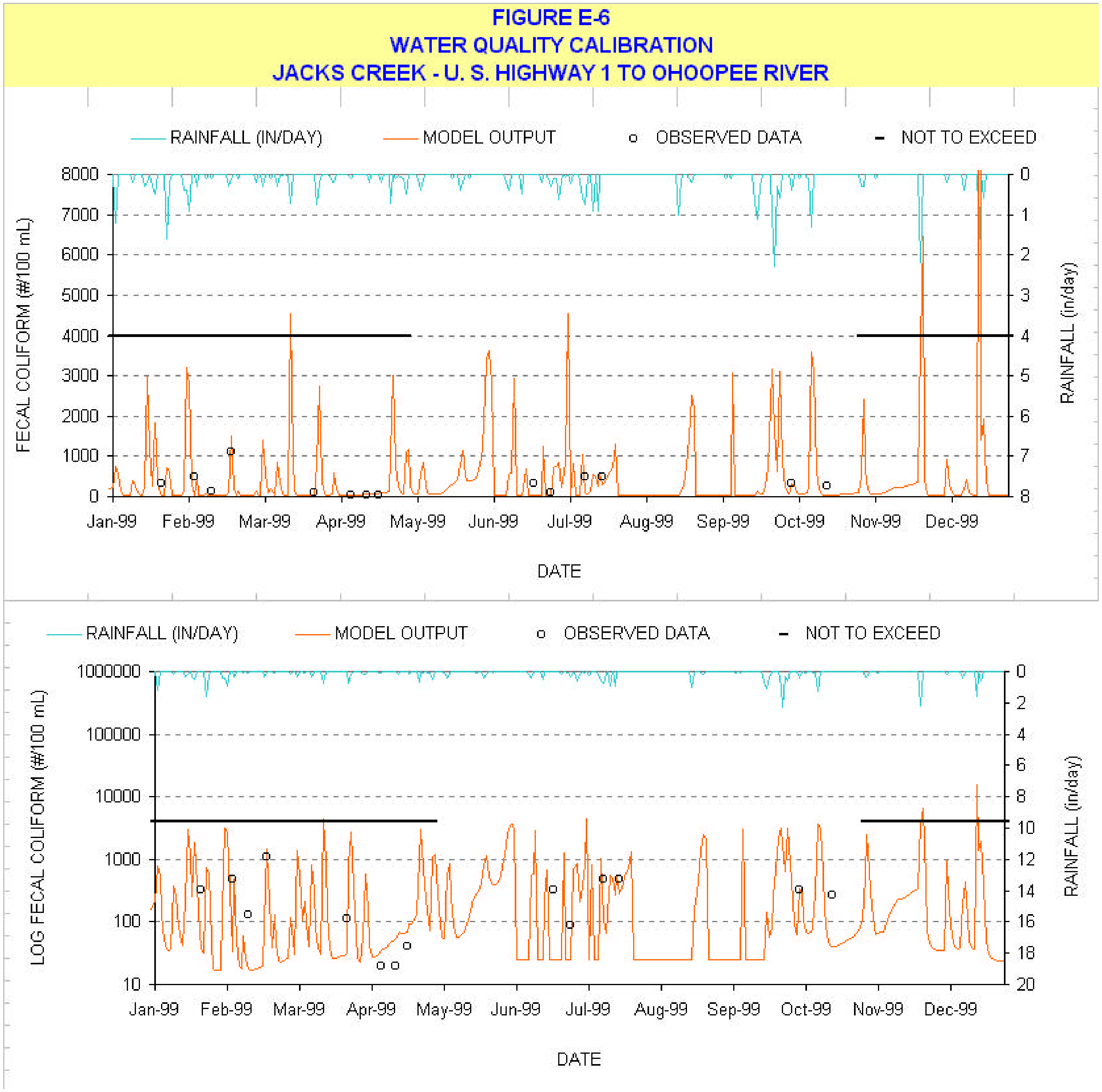


FIGURE E-6
WATER QUALITY CALIBRATION
JACKS CREEK - U. S. HIGHWAY 1 TO OHOOPEE RIVER
RAINFALL (IN/DAY)
MODEL OUTPUT
OBSERVED DATA
NOT TO EXCEED
FECAL COLIFORM (#/100 mL)
RAINFALL (in/day)
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan-99 Feb-99 Mar-99 Apr-99 May-99 Jun-99 Jul-99 Aug-99 Sep-99 Oct-99 Nov-99 Dec-99
DATE
RAINFALL (IN/DAY)
MODEL OUTPUT
OBSERVED DATA
NOT TO EXCEED
LOG FECAL COLIFORM (#/100 mL)
RAINFALL (in/day)
1000000
100000
10000
1000
100
10
Jan-99 Feb-99 Mar-99 Apr-99 May-99 Jun-99 Jul-99 Aug-99 Sep-99 Oct-99 Nov-99 Dec-99
DATE

FIGURE E-7
WATER QUALITY CALIBRATION
OHOOPEE RIVER - LITTLE OHOOPEE RIVER TO U.S. HIGHWAY 292

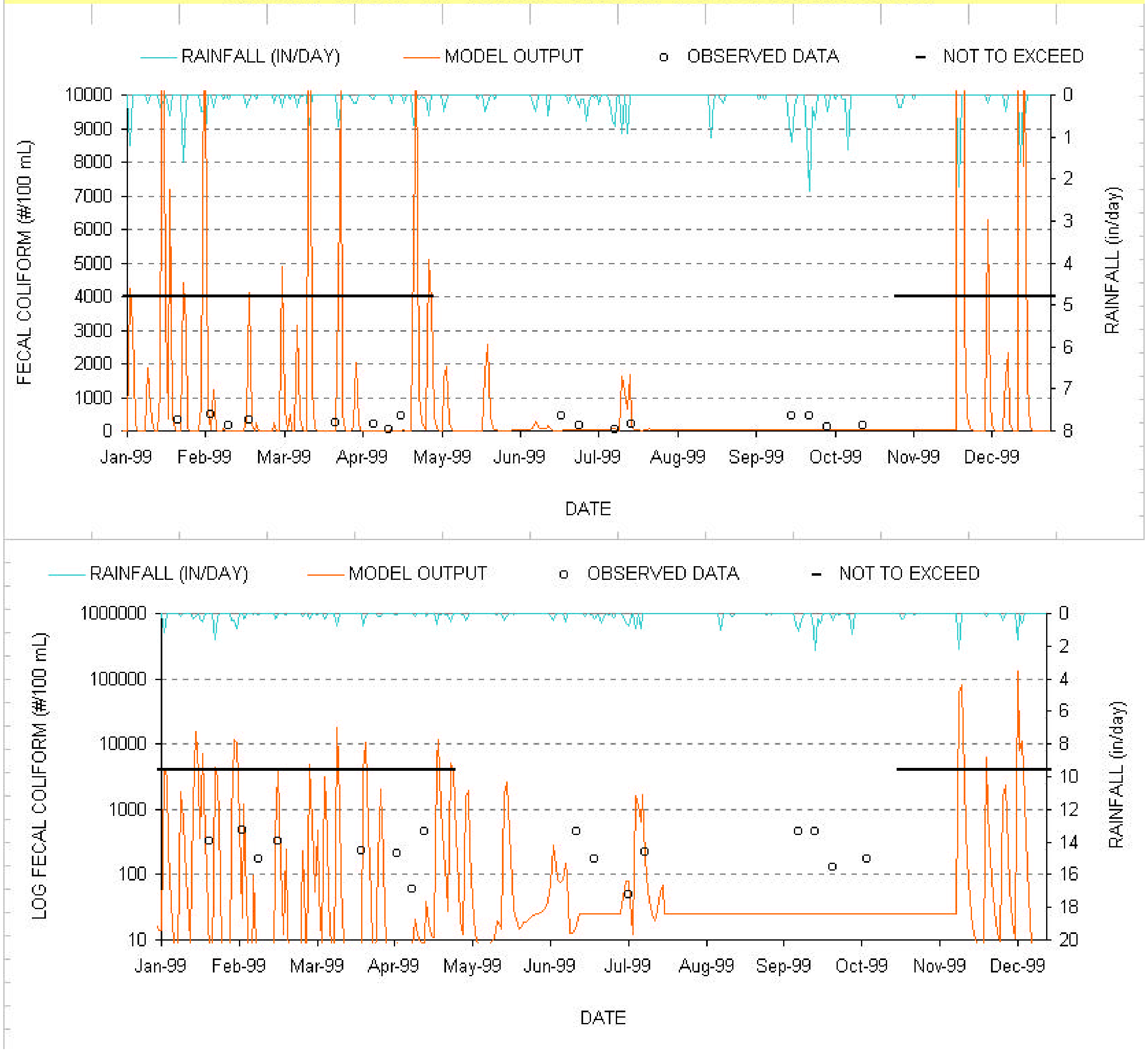
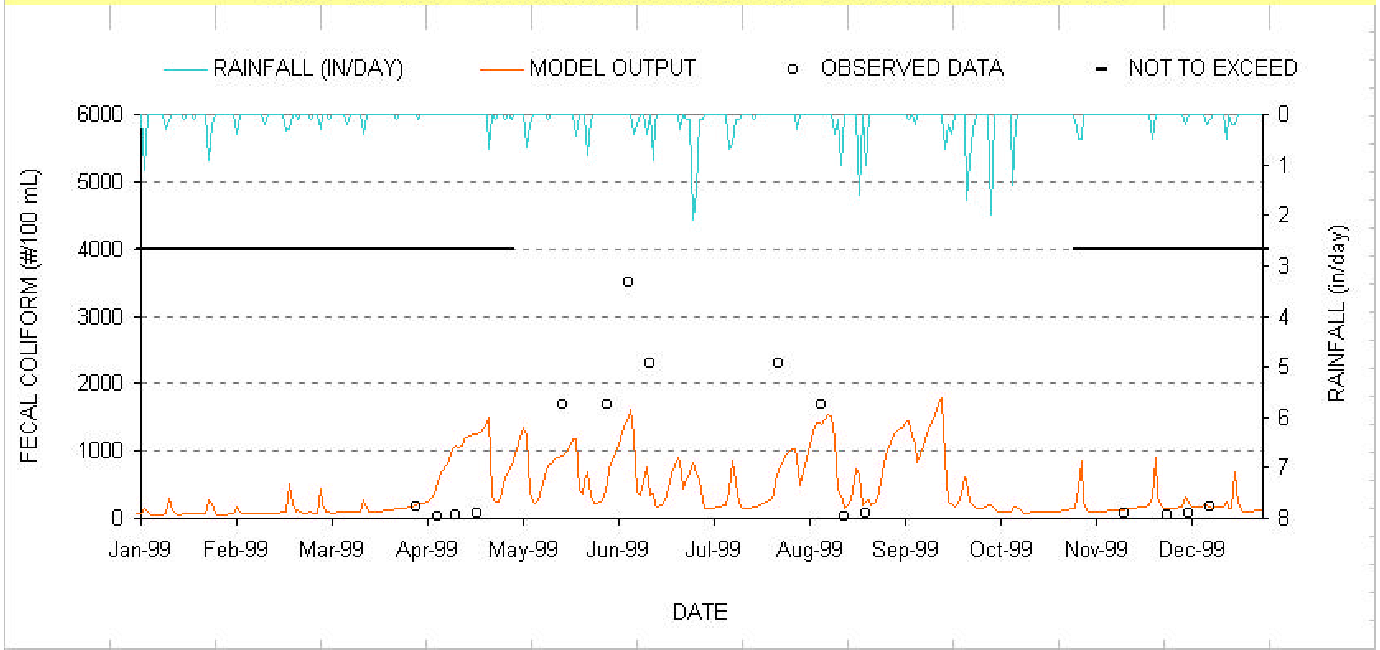


FIGURE E-8
WATER QUALITY CALIBRATION
SWIFT CREEK - OLD NORMANTOWN ROAD TO PENDLETON CREEK



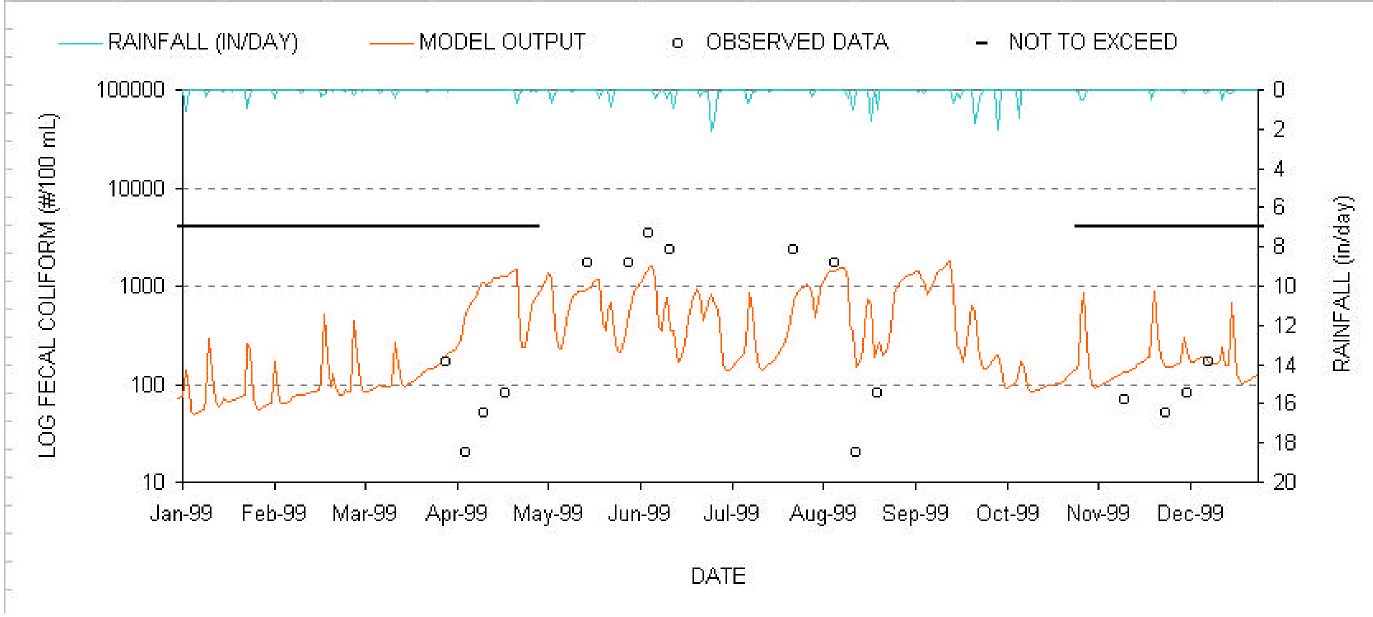
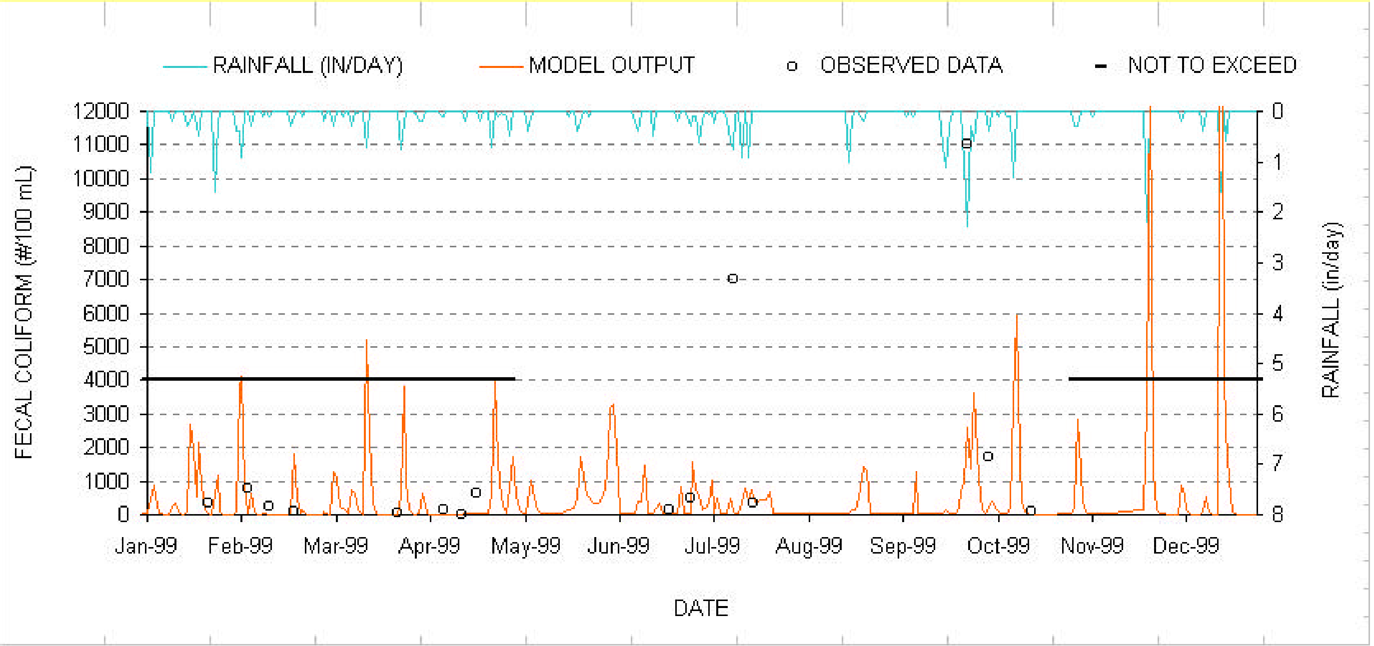


FIGURE E-9
WATER QUALITY CALIBRATION
TIGER CREEK - LITTLE CREEK TO PENDLETON CREEK



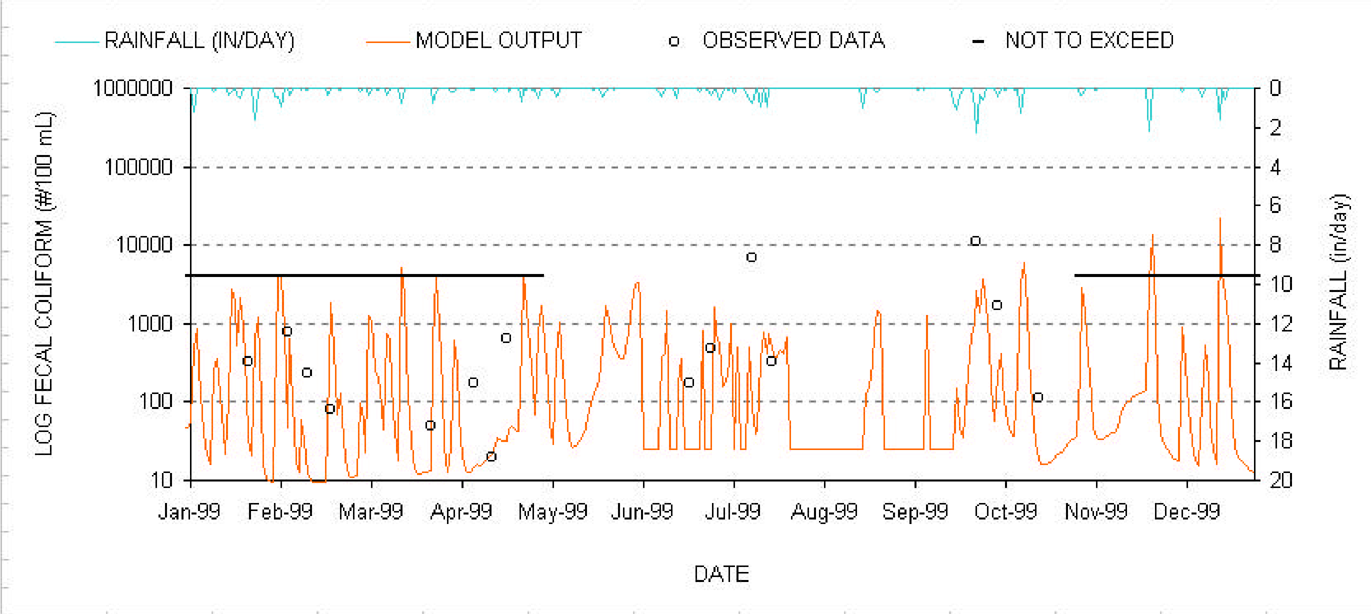


FIGURE E-10
WATER QUALITY CALIBRATION
PENDLETON CREEK - SAND HILL LAKE TO REEDY CREEK

FIGURE E-11
WATER QUALITY CALIBRATION
PENDLETON CREEK - WILDWOOD LAKE TO TIGER CREEK

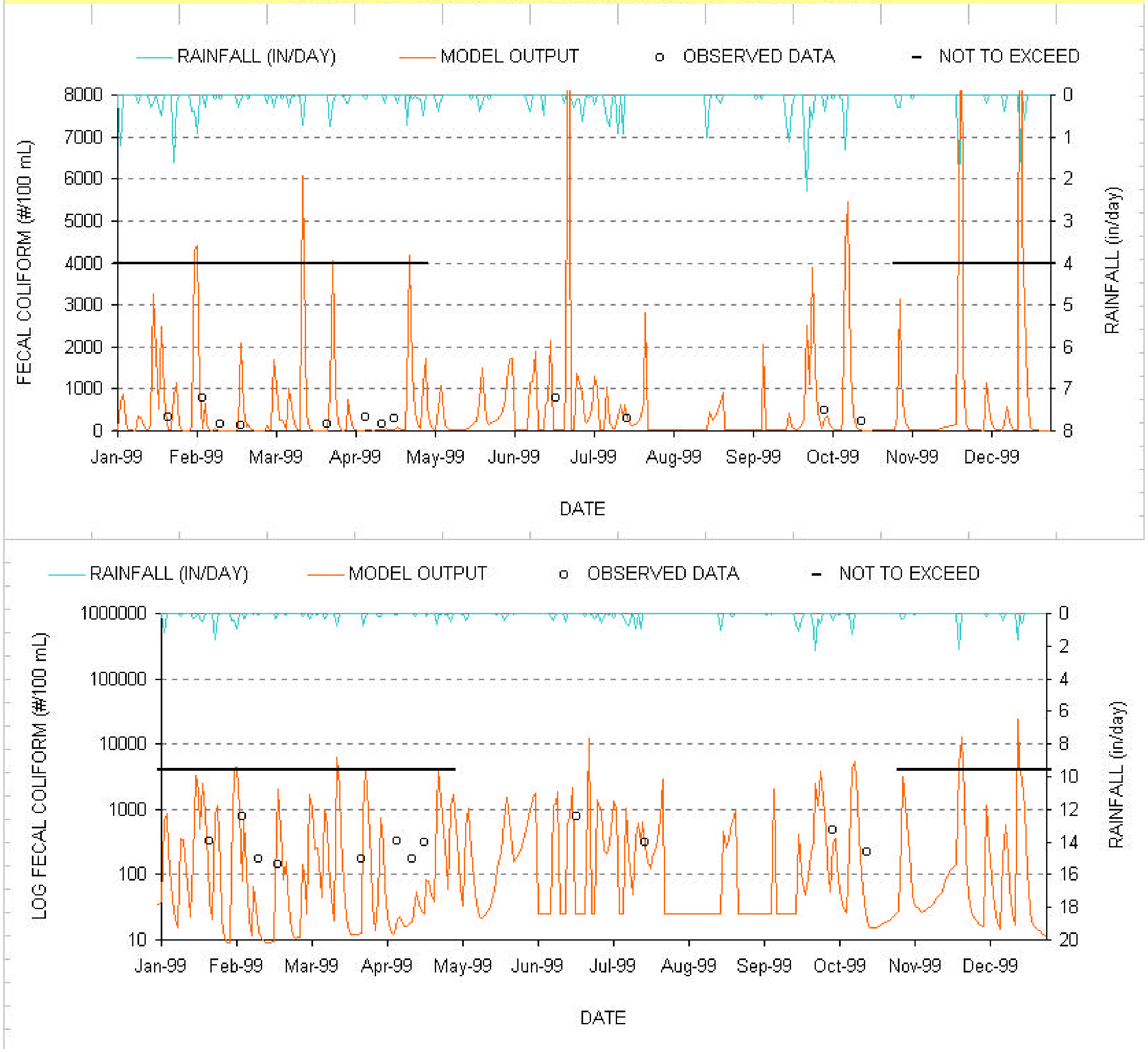


FIGURE E-12
WATER QUALITY CALIBRATION
ROCKY CREEK - GEORGIA HIGHWAY 130 TO LITTLE ROCKY CREEK

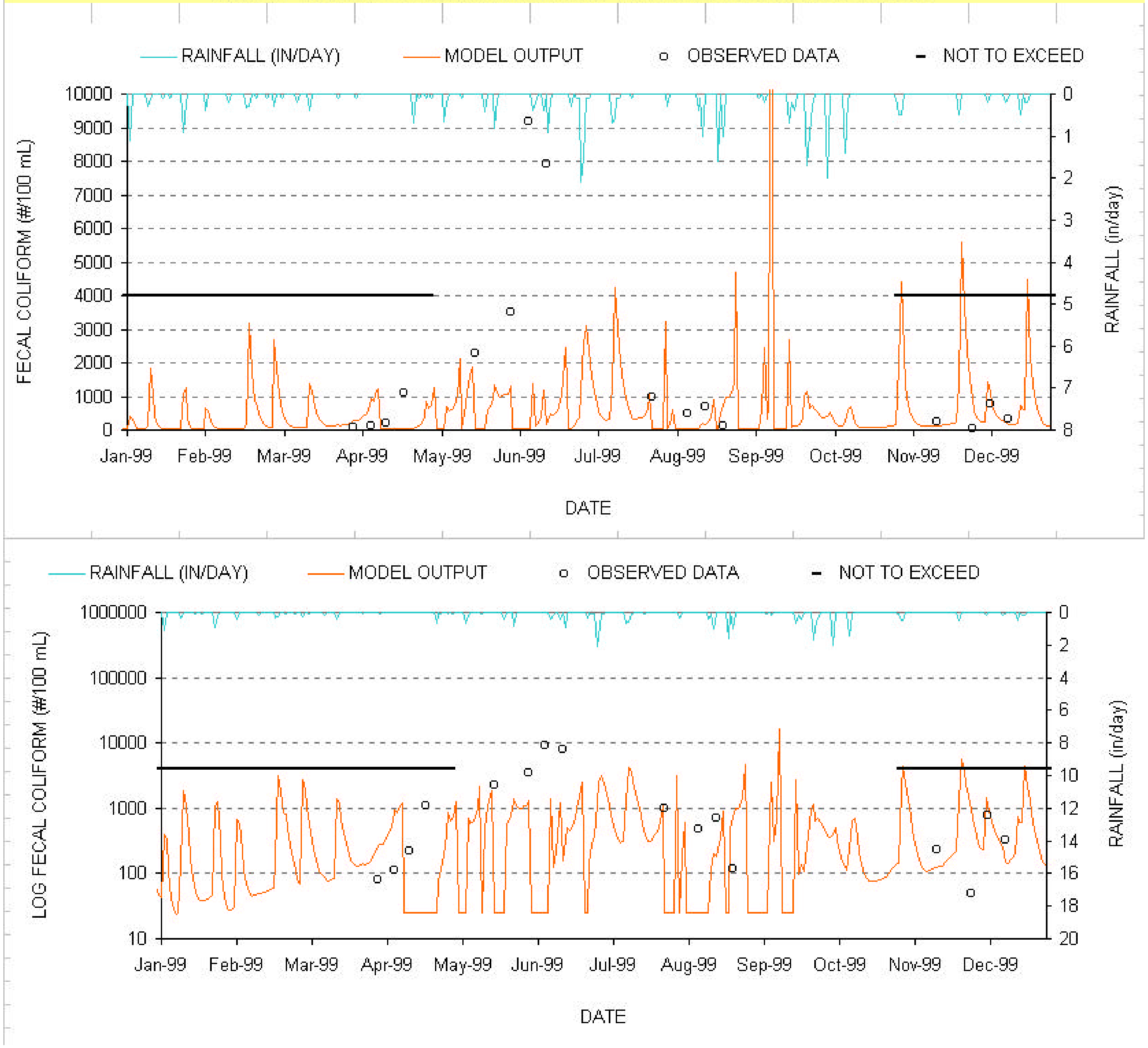
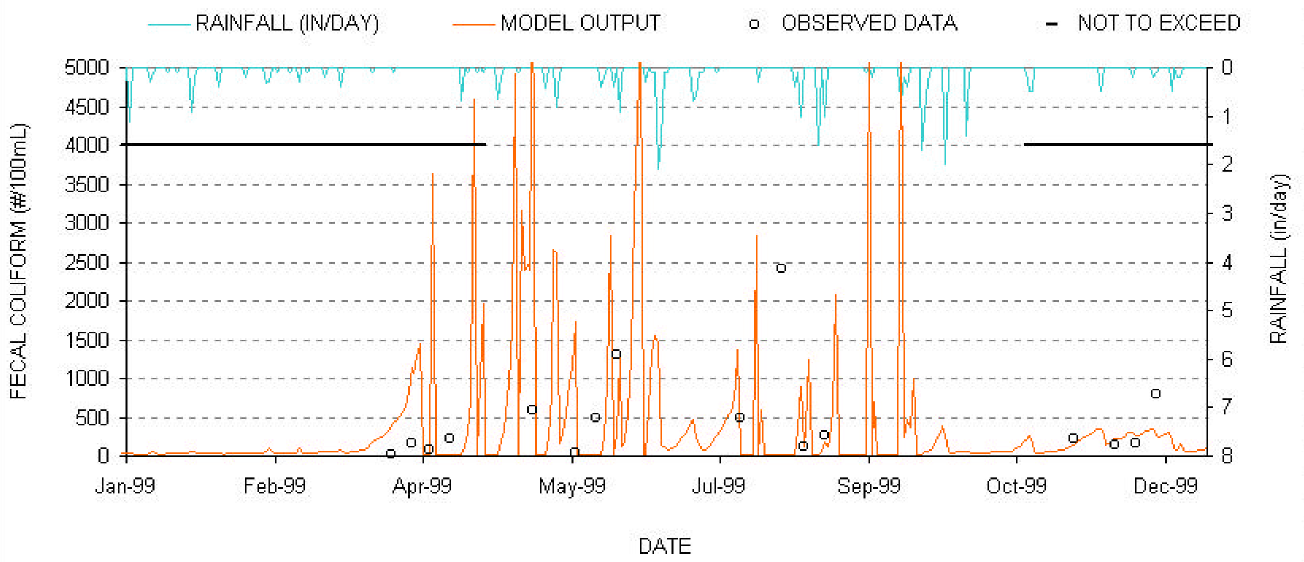


FIGURE E-13
WATER QUALITY CALIBRATION
MILLIGAN CREEK - UVALDA TO ALTAMAHA RIVER



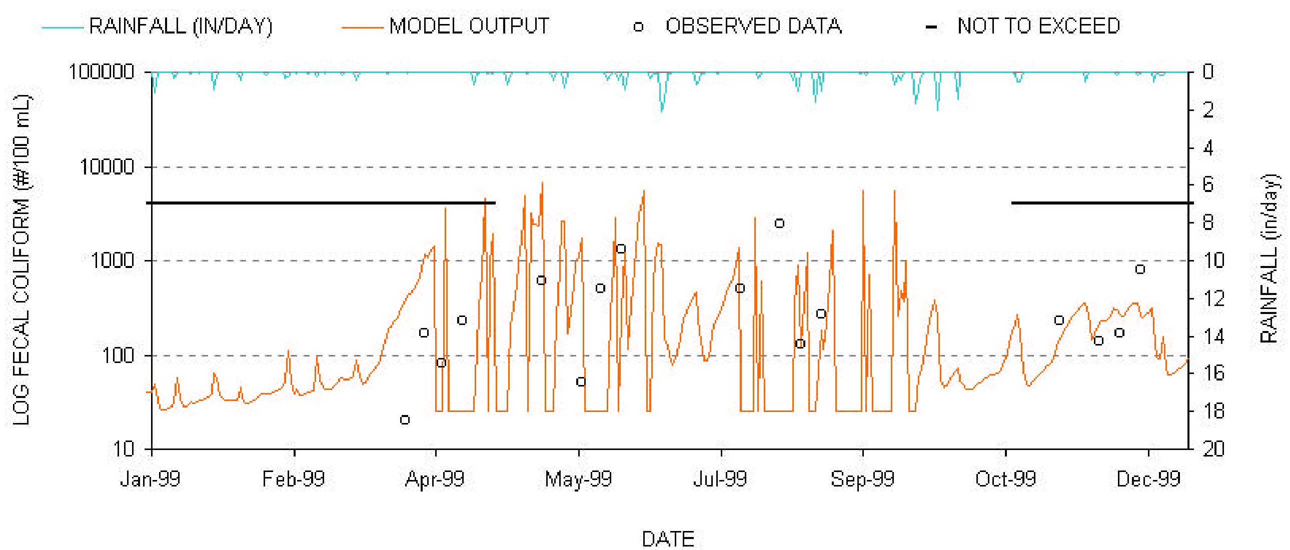
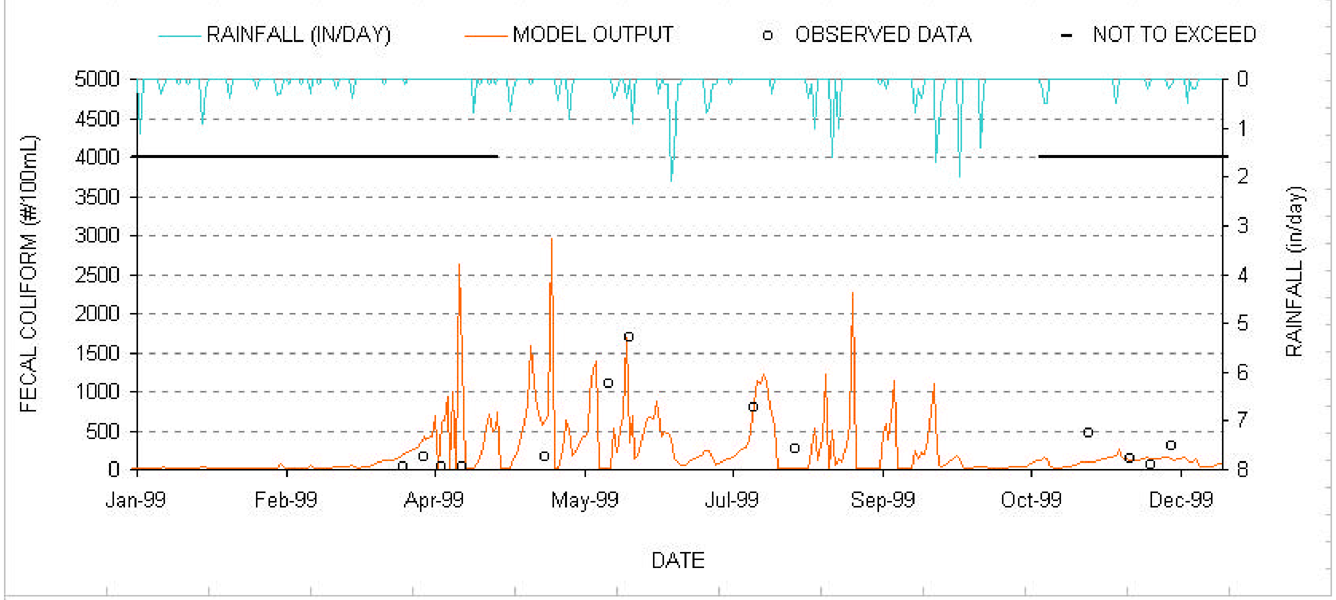
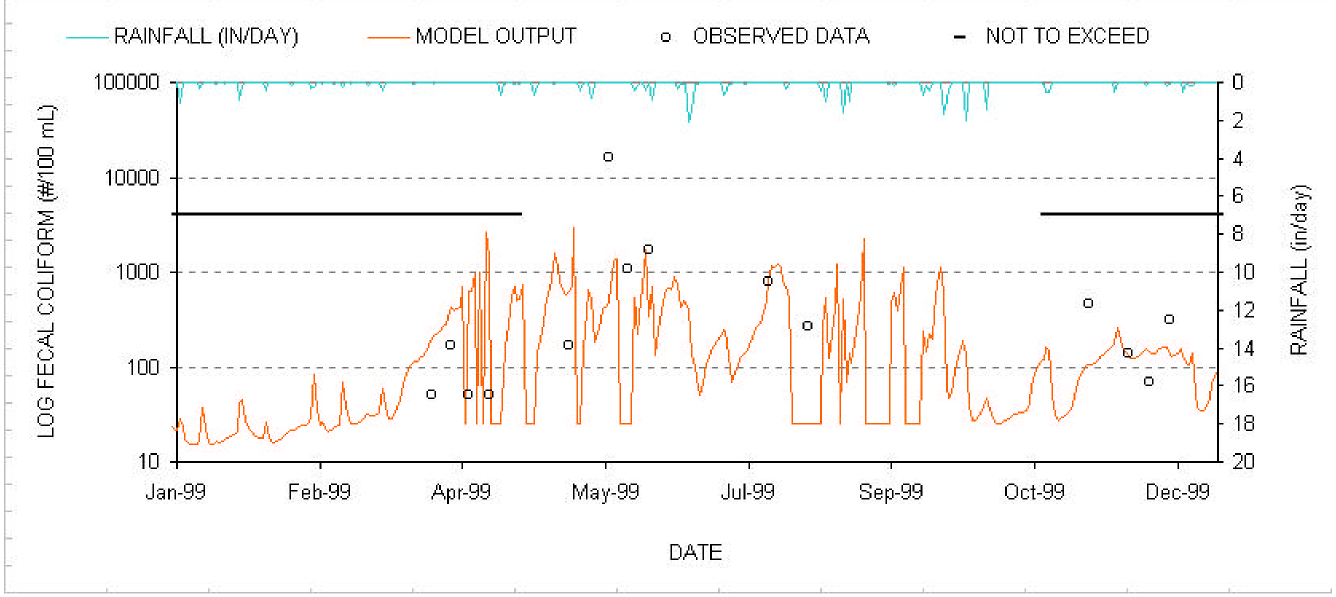


FIGURE E-14
WATER QUALITY CALIBRATION
OCONEE CREEK - HEADWATERS TO COBB CREEK





APPENDIX F:

SIMULATED FECAL COLIFORM

30-DAY GEOMETRIC MEAN

FOR EXISTING AND TMDL CONDITIONS

FIGURE F-1

SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN

OHOOPEE RIVER - DYERS CREEK TO BIG CEDAR CREEK

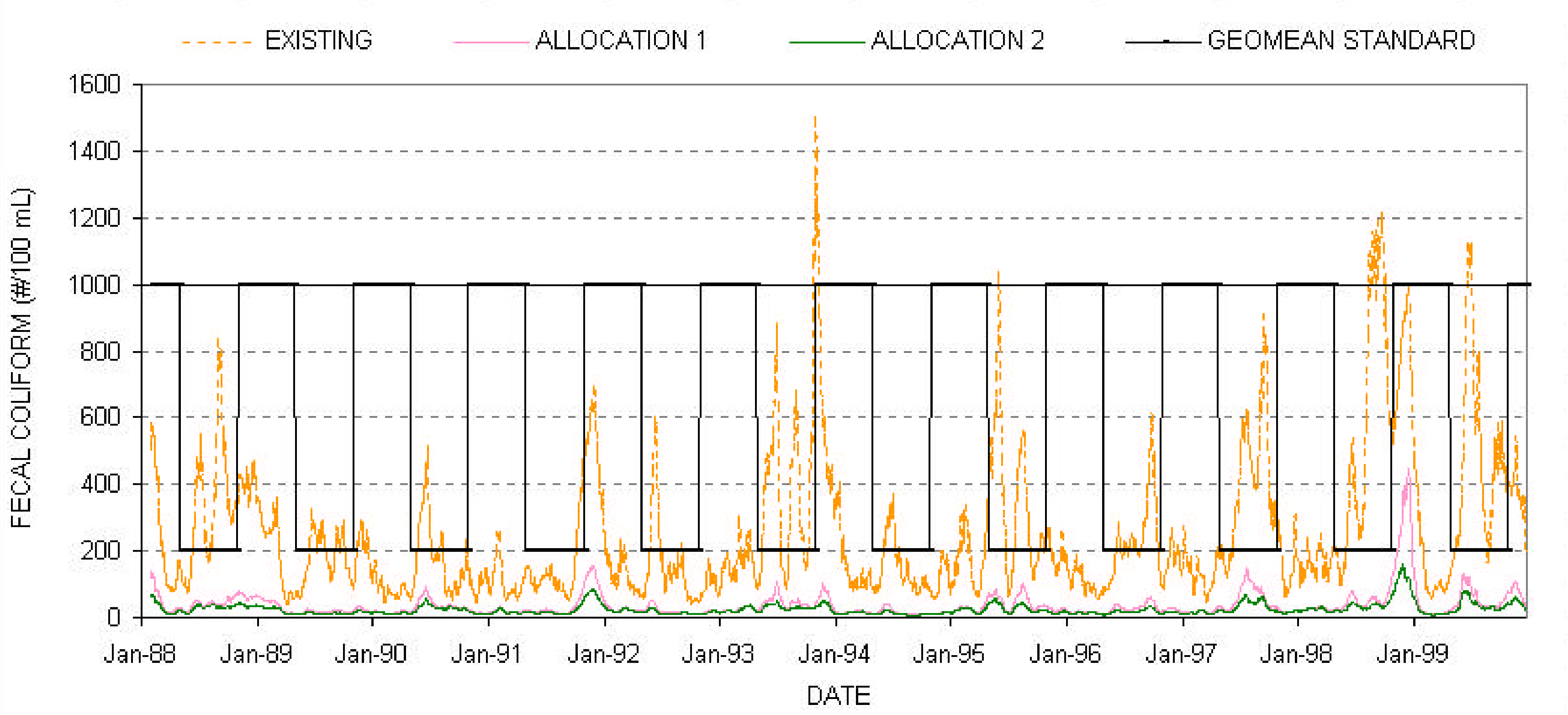


FIGURE F-2

SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN

BIG CEDAR CREEK - LITTLE CEDAR TO OHOOPEE RIVER

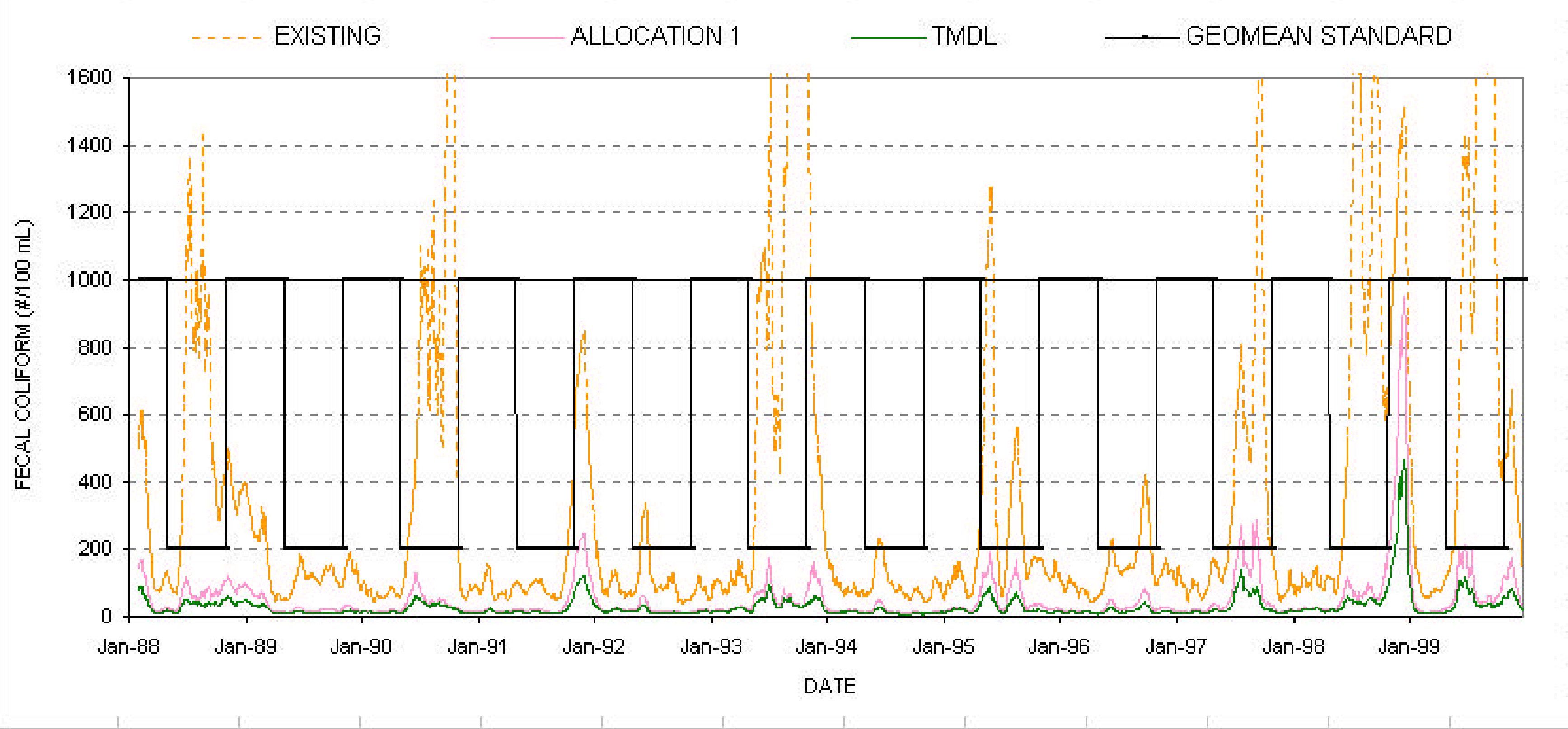


FIGURE F-3

SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN

OHOOPEE RIVER - NEELS CREEK TO LITTLE OHOOPEE RIVER

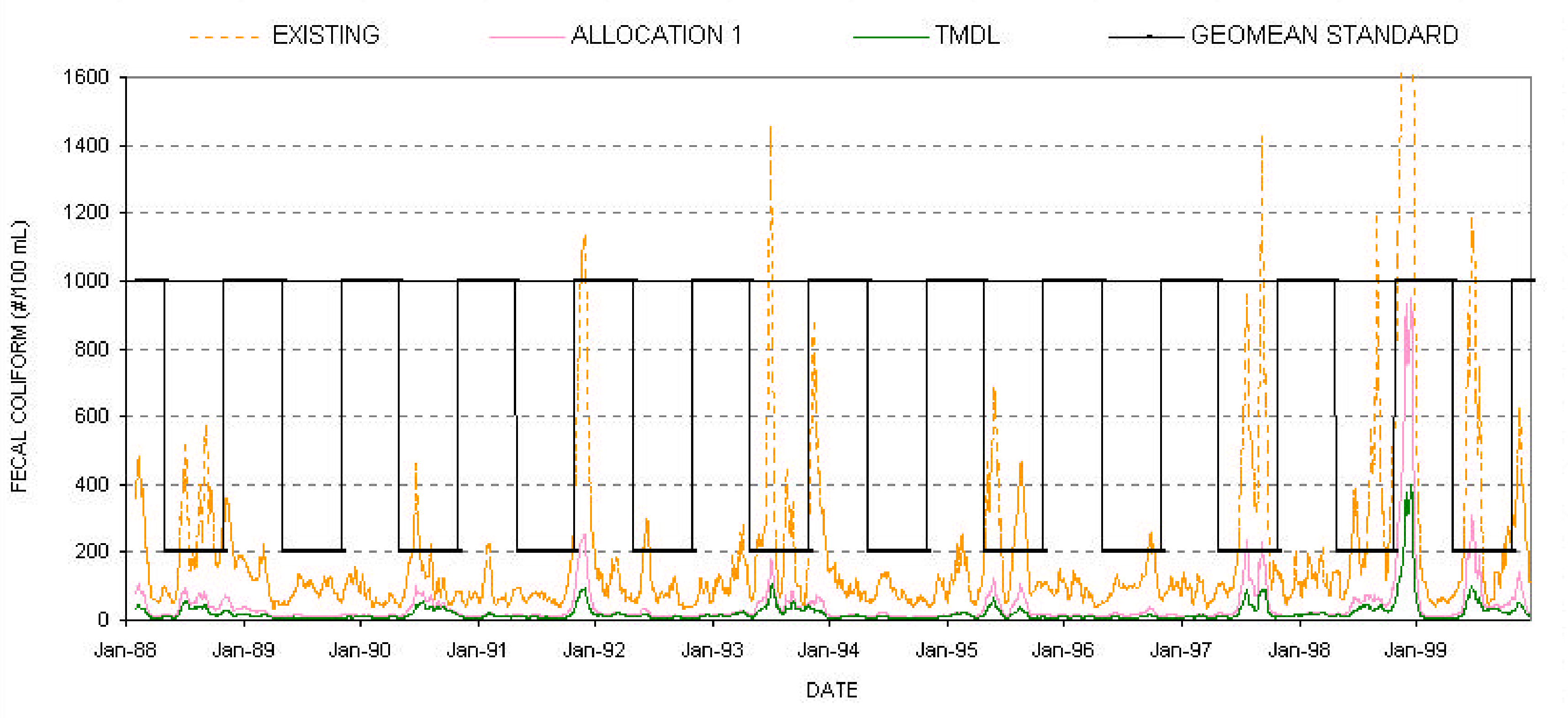
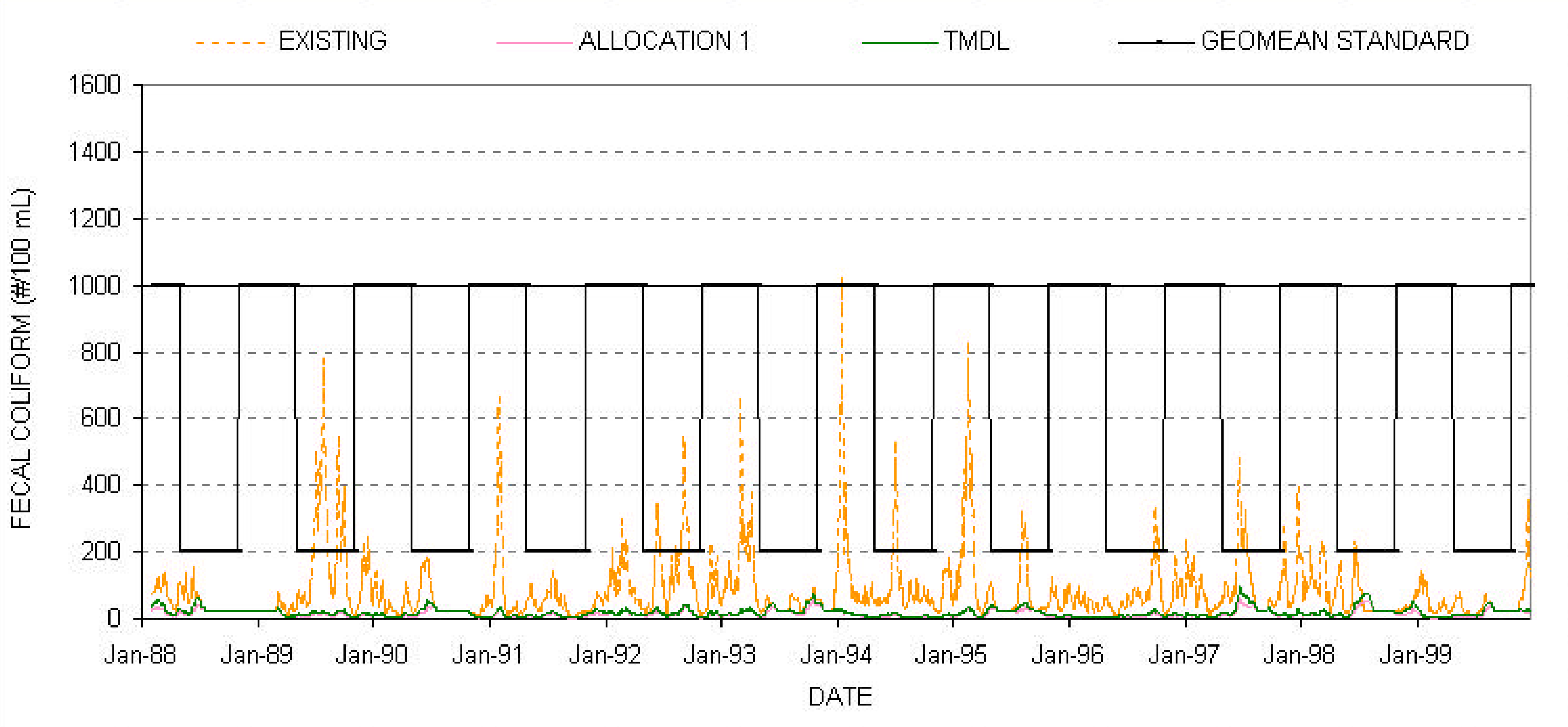


FIGURE F-4

SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN

LITTLE OHOOPEE RIVER - SARDIS CREEK TO OHOOPEE RIVER



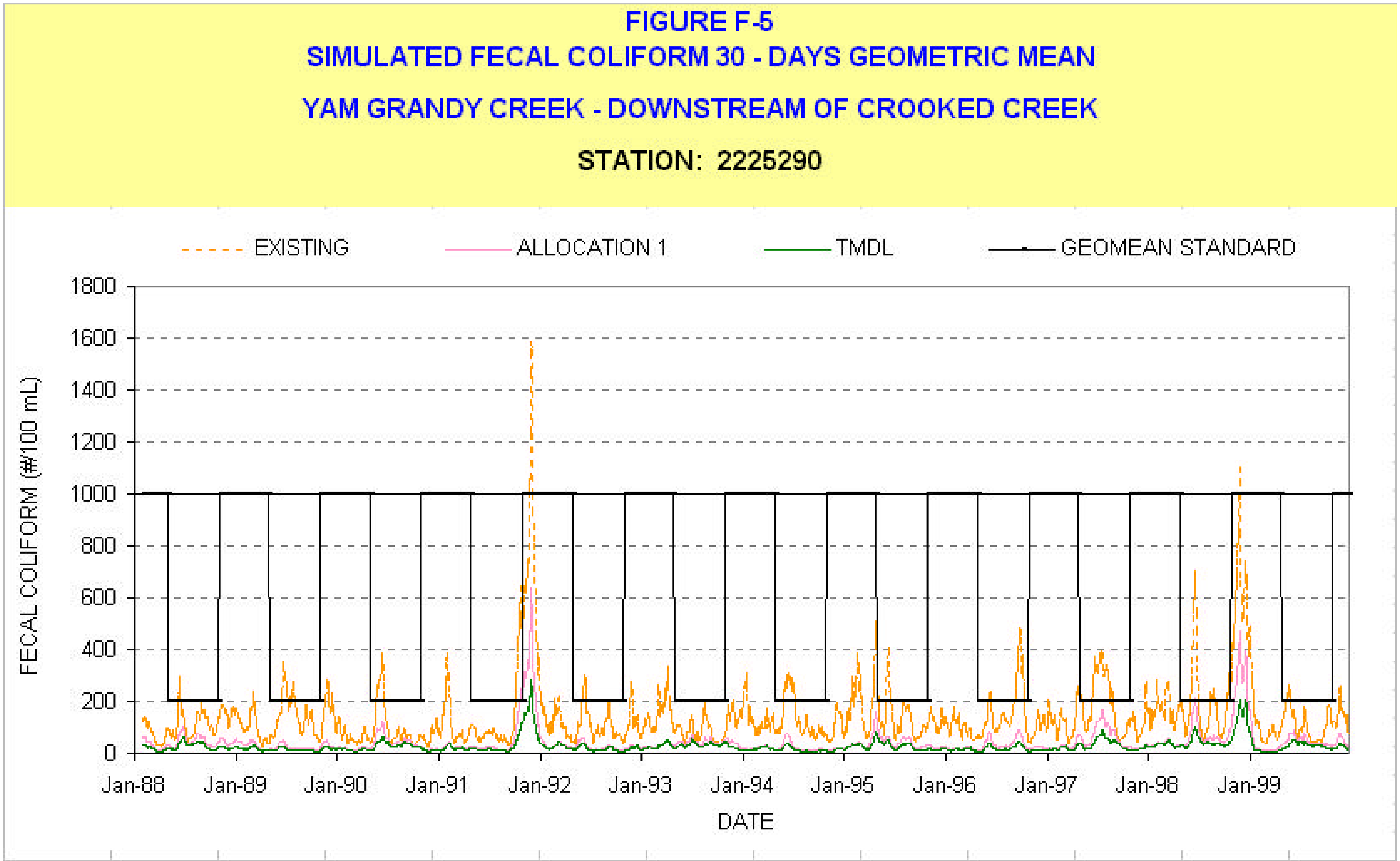


FIGURE F-5
SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN
YAM GRANDY CREEK - DOWNSTREAM OF CROOKED CREEK
STATION: 2225290
EXISTING
ALLOCATION 1
TMDL
GEOMEAN STANDARD
FECAL COLIFORM (#/100 mL)
1800
1600
1400
1200
1000
800
600
400
200
0
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
DATE

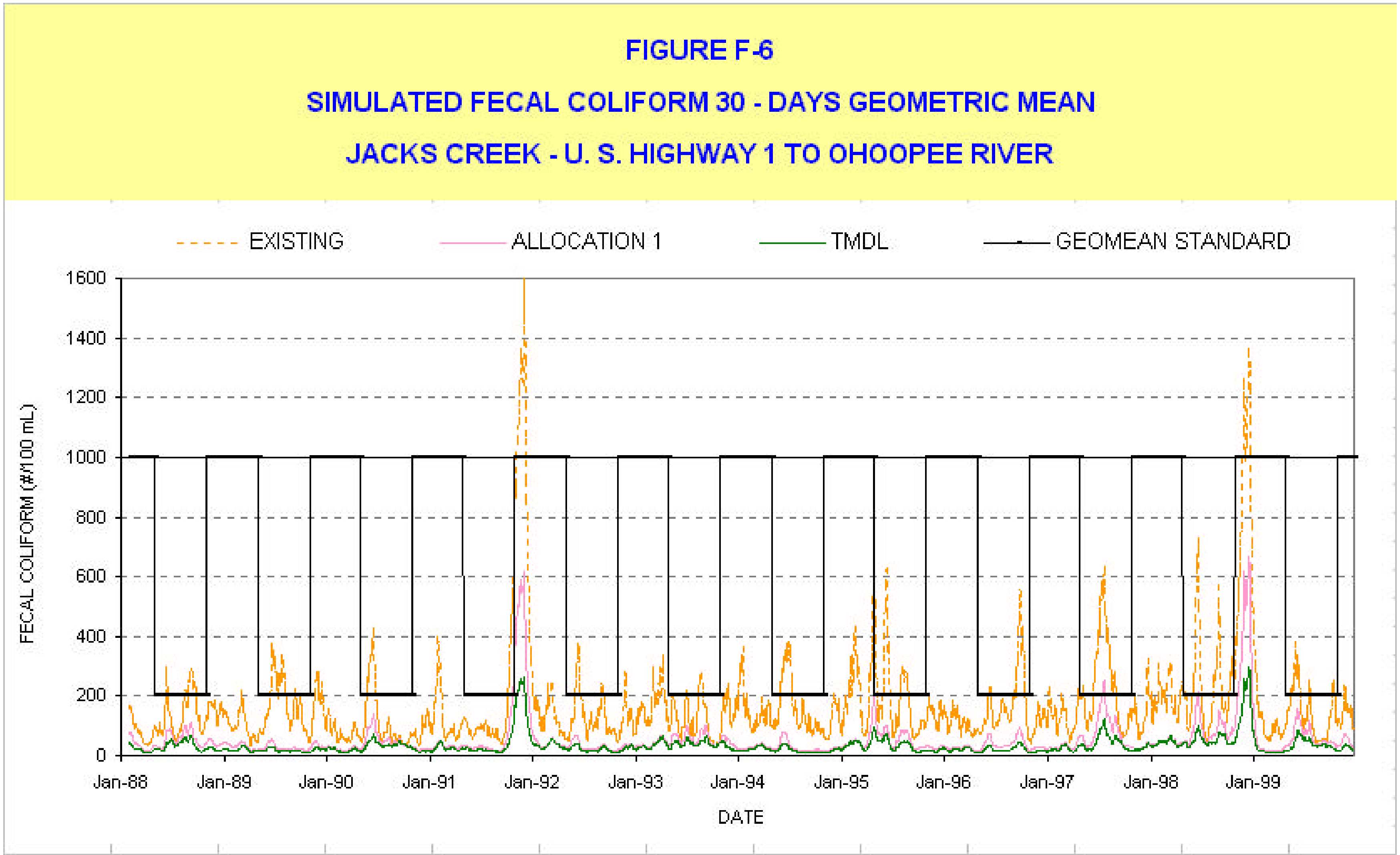


FIGURE F-6
SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN
JACKS CREEK - U. S. HIGHWAY 1 TO OHOOPEE RIVER
EXISTING
ALLOCATION 1
TMDL
GEOMEAN STANDARD
FECAL COLIFORM (#/100 mL)
0
200
400
600
800
1000
1200
1400
1600
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
DATE

FIGURE F-7

SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN

OHOOPEE RIVER - LITTLE OHOOPEE RIVER TO U.S. HIGHWAY 292

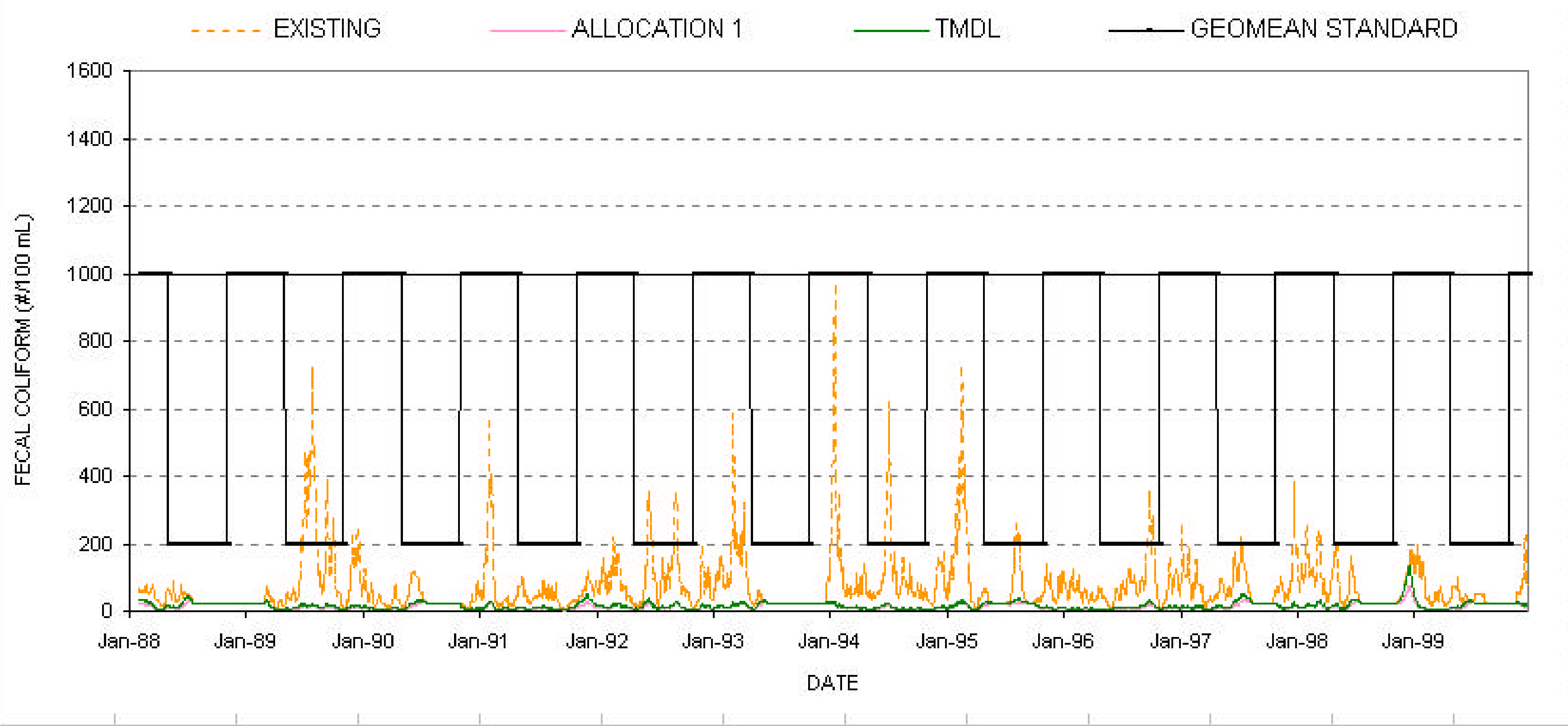


FIGURE F-8

SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN

SWIFT CREEK - OLD NORMANTOWN ROAD TO PENDLETON CREEK

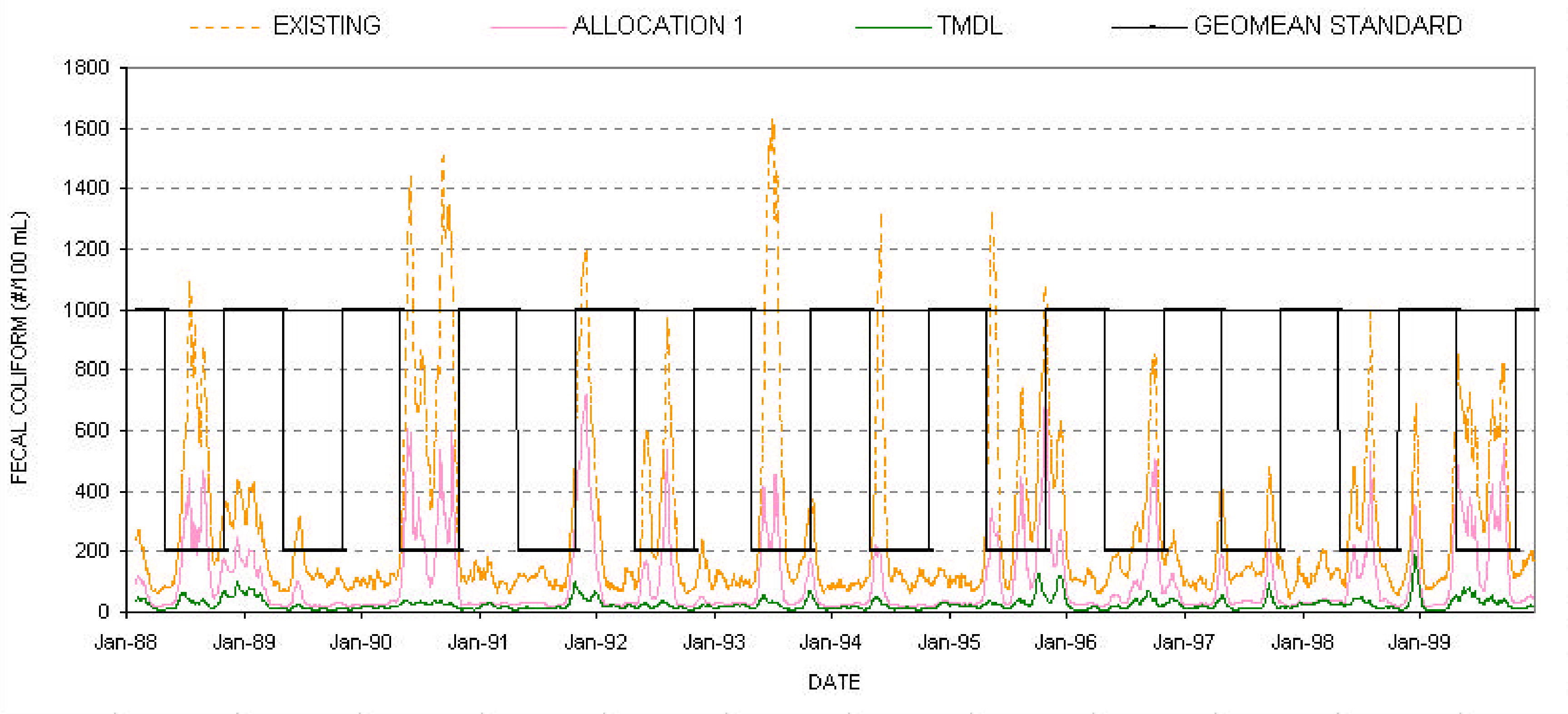
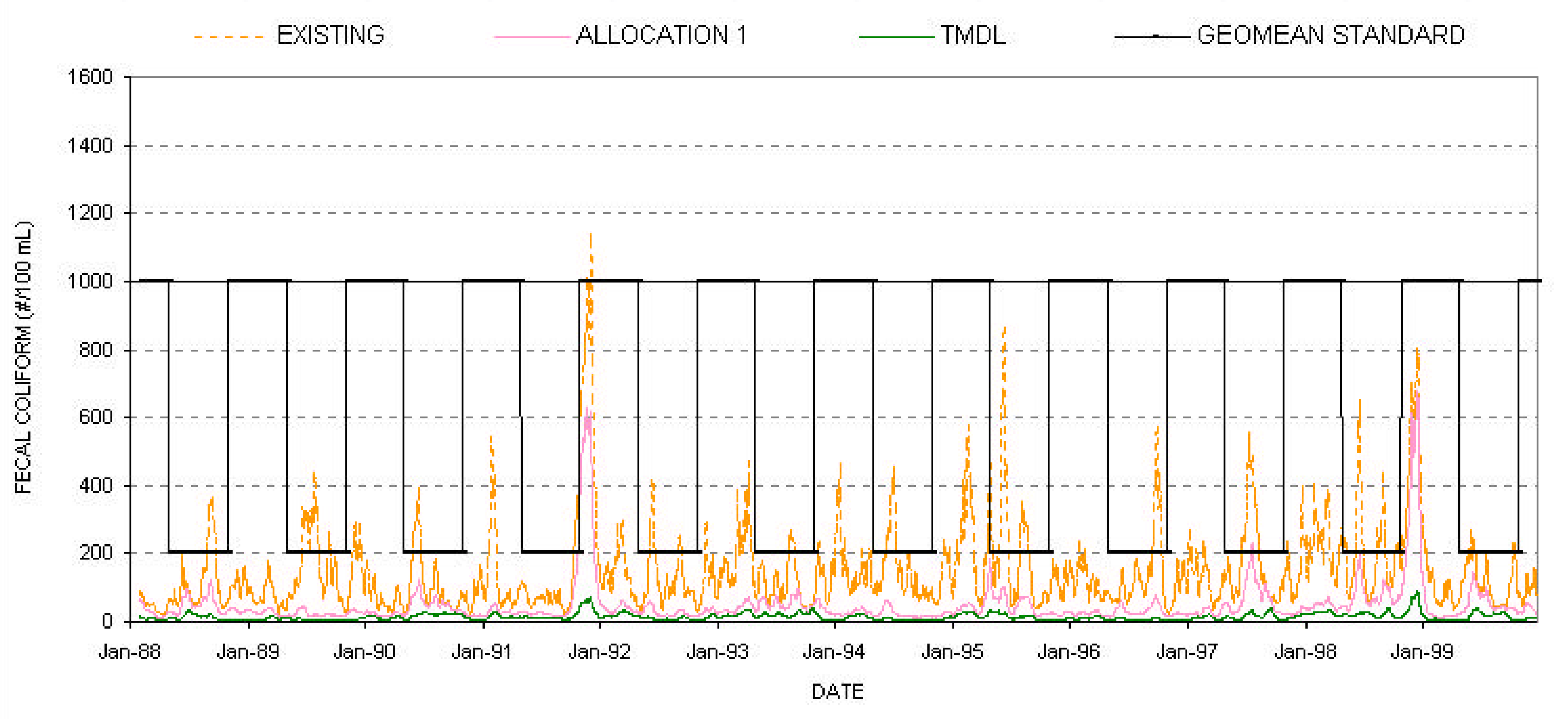


FIGURE F-9

SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN

TIGER CREEK - LITTLE CREEK TO PENDLETON CREEK

STATION: 2225371



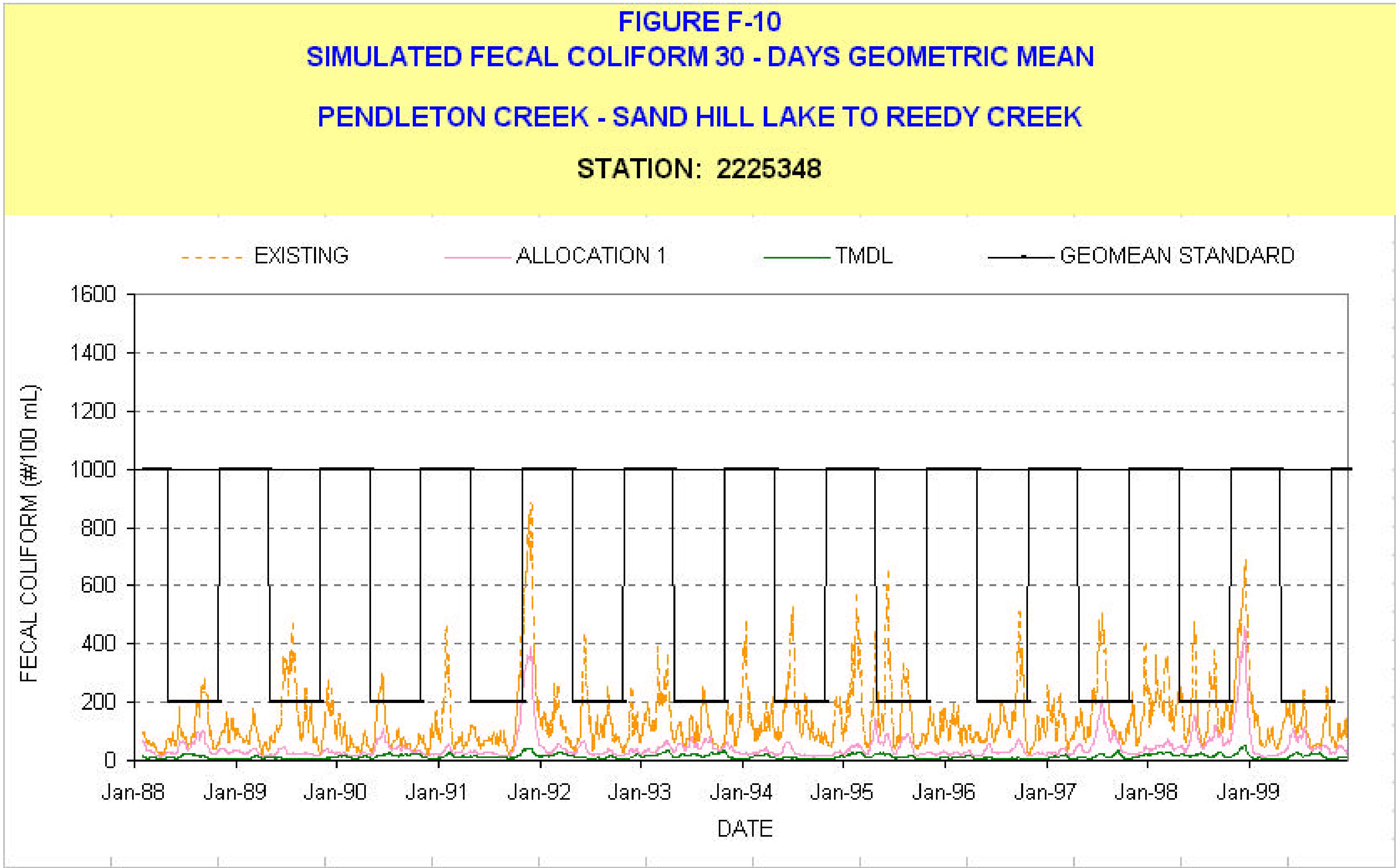


FIGURE F-10
SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN
PENDLETON CREEK - SAND HILL LAKE TO REEDY CREEK
STATION: 2225348
EXISTING
ALLOCATION 1
TMDL
GEOMEAN STANDARD
1600
1400
1200
1000
800
600
400
200
0
FECAL COLIFORM (#/100 mL)
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
DATE

FIGURE F-11
SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN
PENDLETON CREEK - WILDWOOD LAKE TO TIGER CREEK
STATION: 2225360

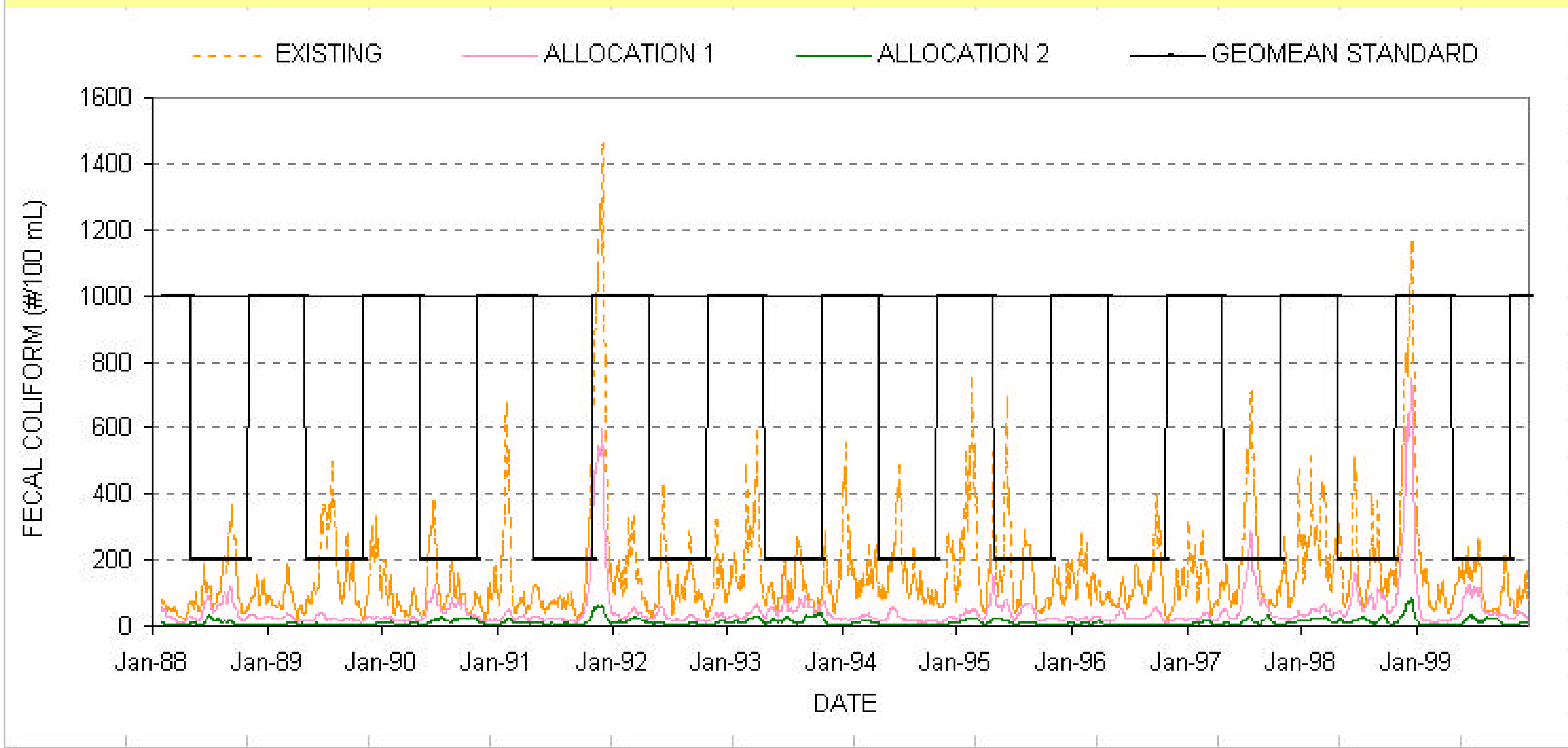


FIGURE F-12

SIMULATED FECAL COLIFORM 30 - DAYS GEOMETRIC MEAN
ROCKY CREEK - GEORGIA HIGHWAY 130 TO LITTLE ROCKY CREEK

STATION: 2225590

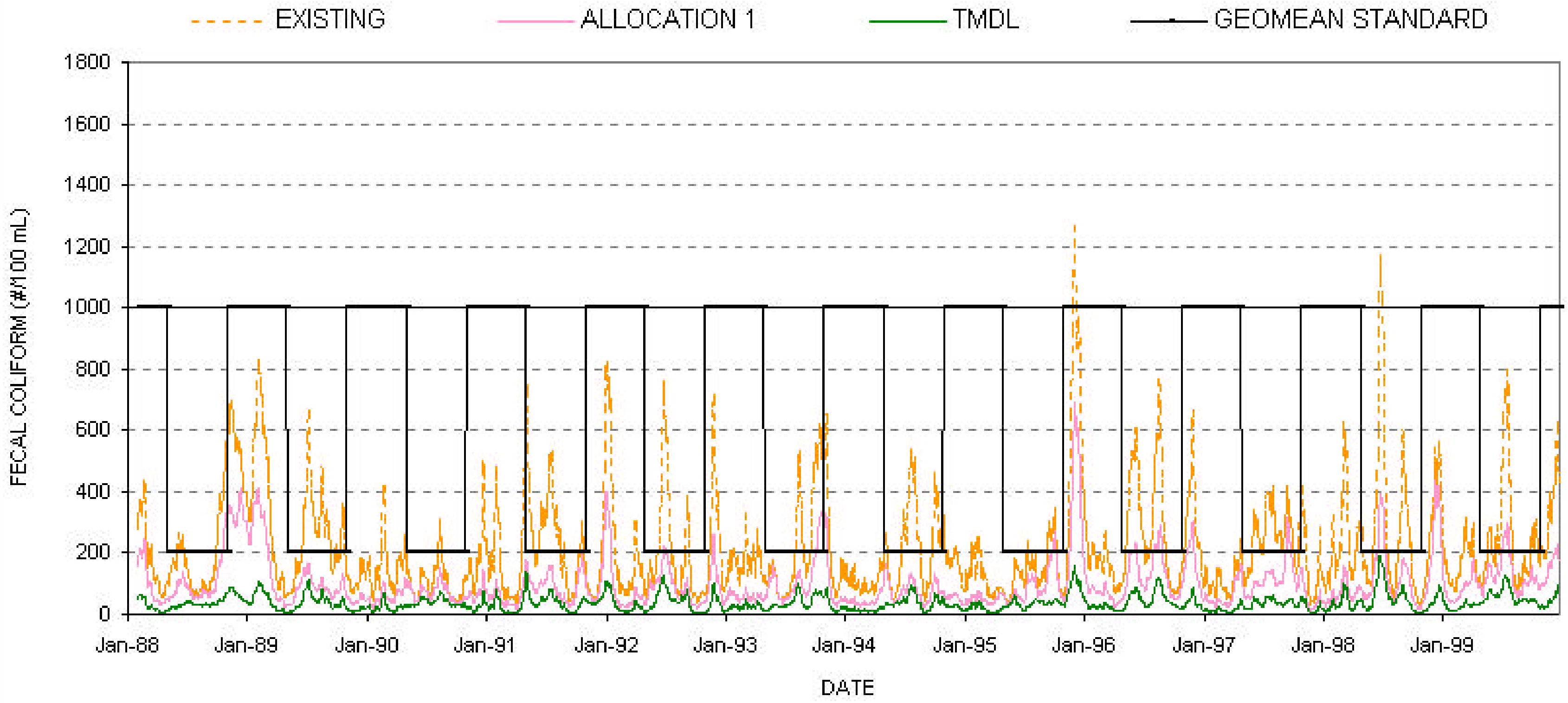


FIGURE F-13

SIMULATED FECAL COLIFORM 30-DAY GEOMETRIC MEAN

MILLIGAN CREEK - UVALDA TO ALTAMAHA RIVER

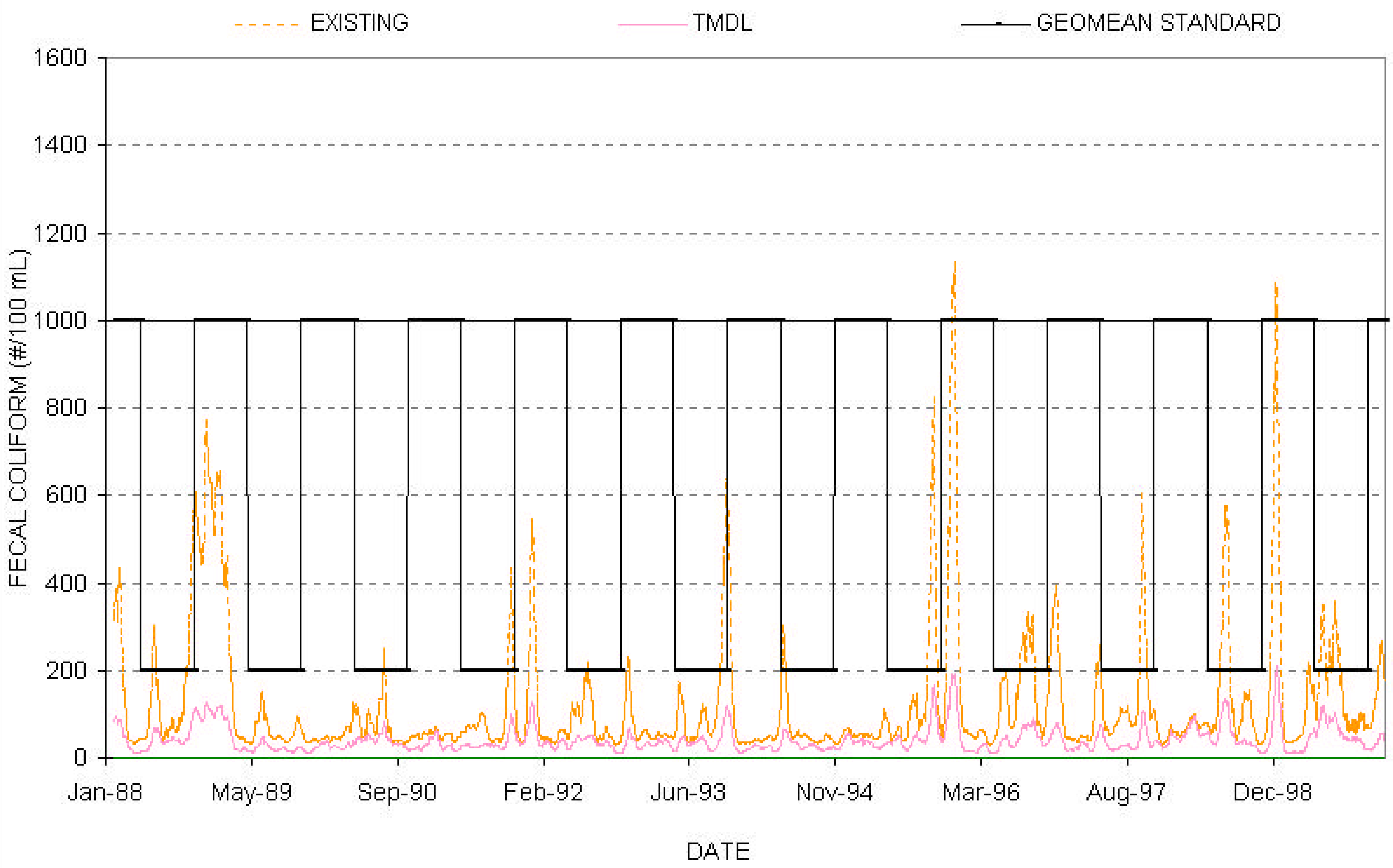
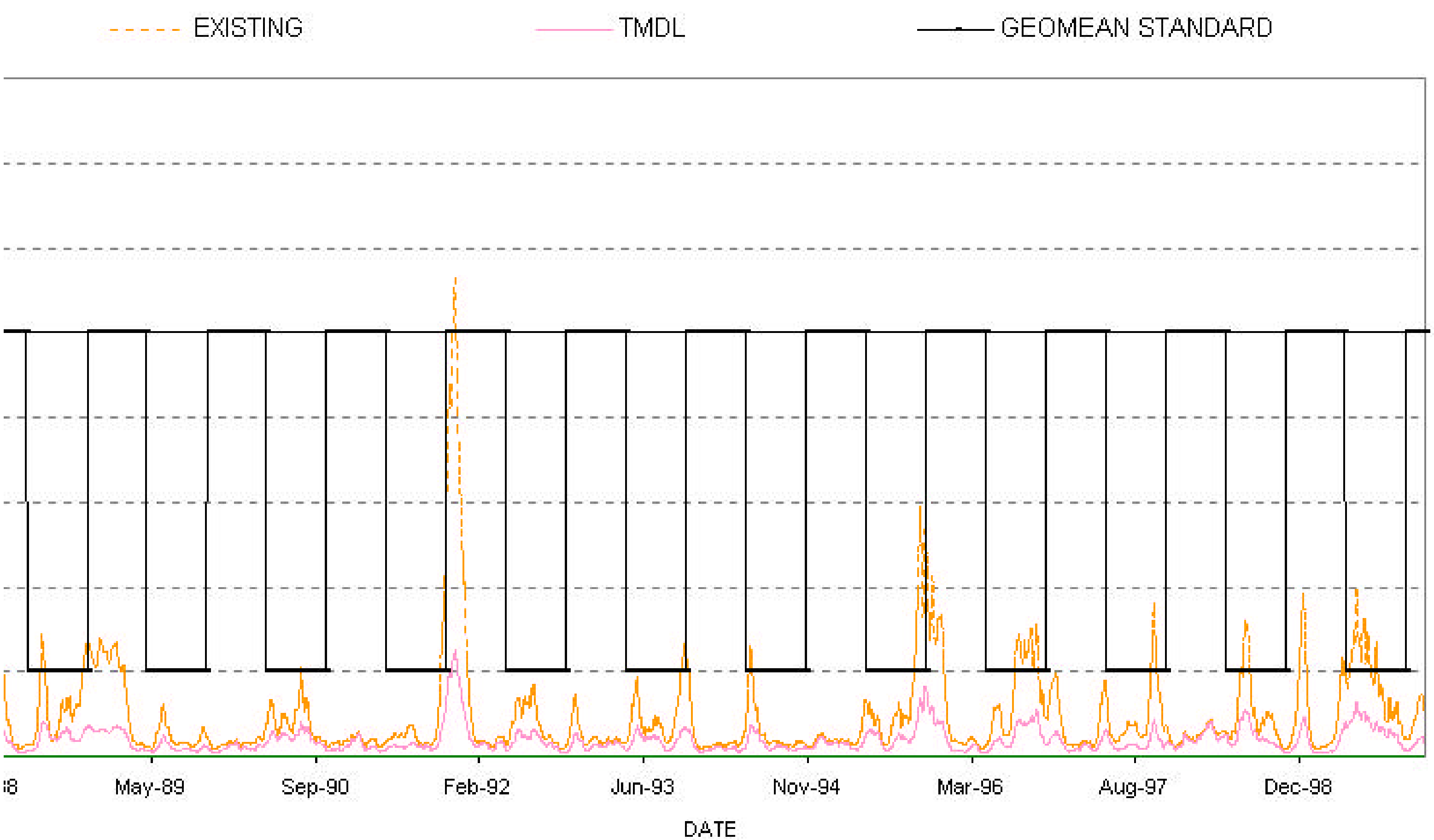


FIGURE F-14

SIMULATED FECAL COLIFORM 30-DAY GEOMETRIC MEAN

OCONEE CREEK - HEADWATERS TO COBB CREEK



APPENDIX G:

PROJECT INFORMATION

FOR WATERSHED MODELS

ALTAMAHA RIVER BASIN (03070106)

Georgia Middle 3 Basins TMDL Development

303(d) Listed Impaired Segments for Fecal Coliform
Altamaha Basin

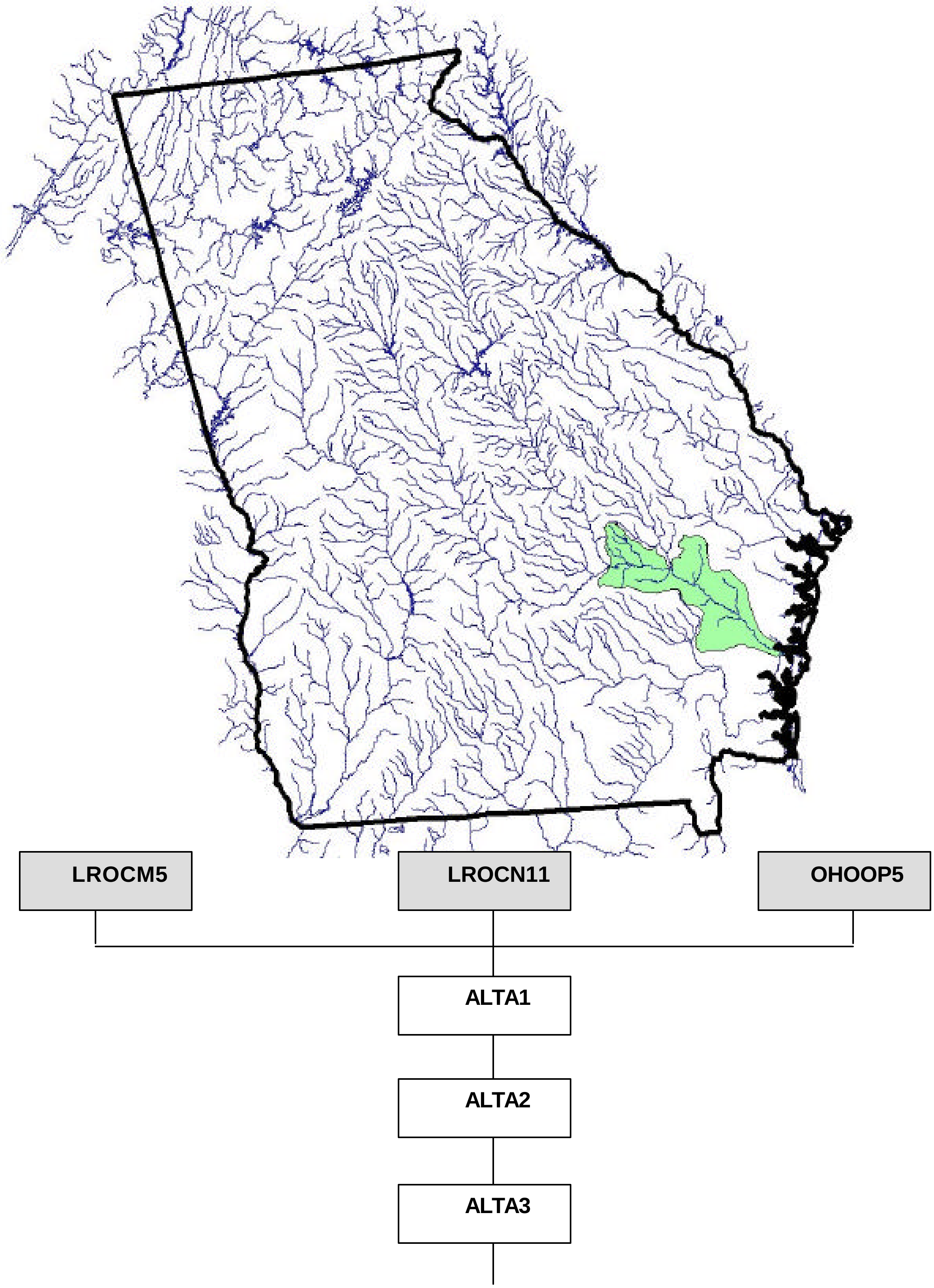
Not Supporting Designated Use

STREAM	1999 MONITORING STATION	PROJECT NAME	SUBWATERSHED ID	12 DIGIT HUC ID
DOCTORS CREEK	02226060	ALTA03	609	030701060405
MILLIGAN CREEK	02224995	ALTA01	632	030701060102
OCONEE CREEK	02225015	ALTA01	629	030701060104

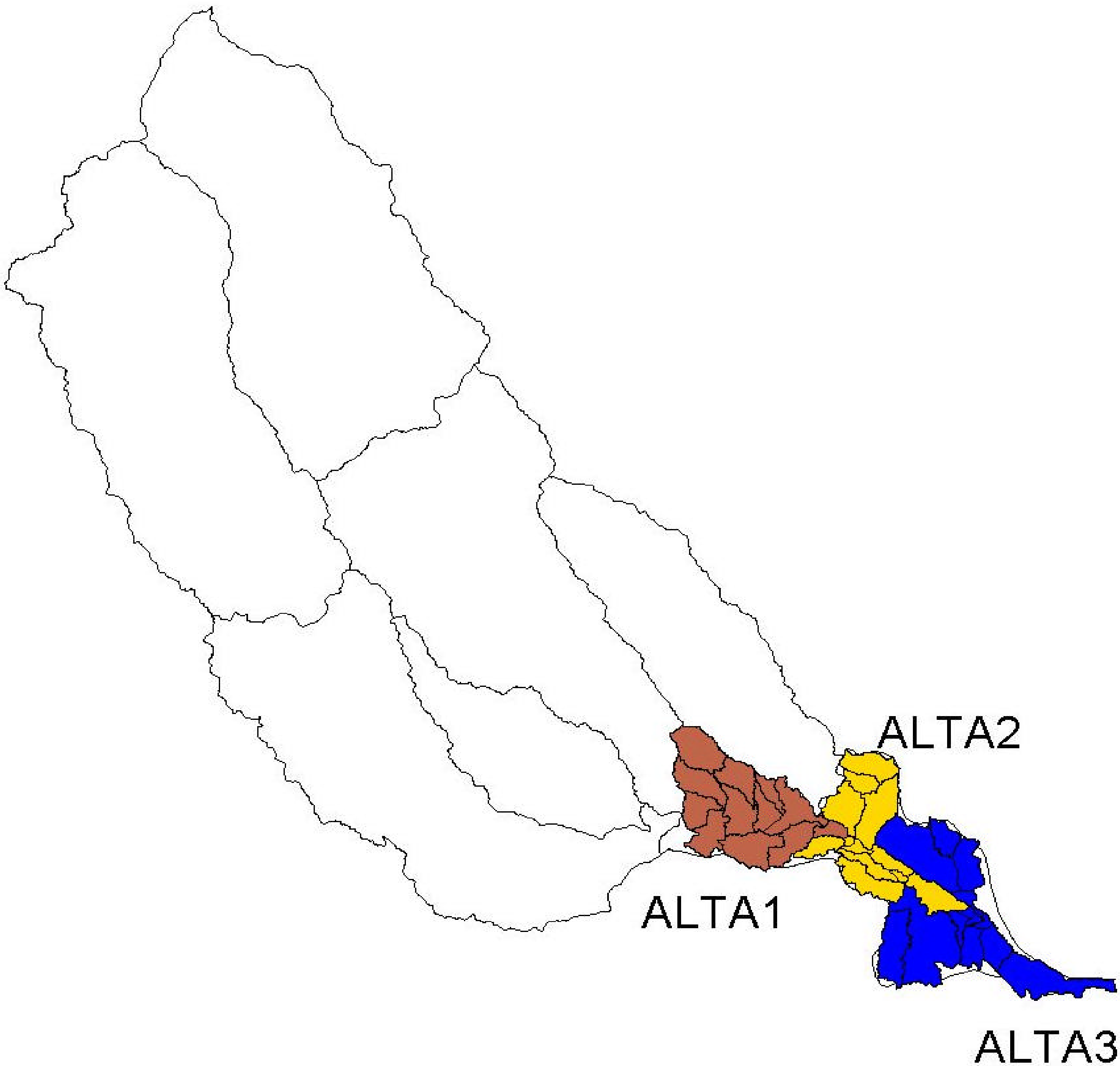
Partially Supporting Designated Use

STREAM	1999 MONITORING STATION	PROJECT NAME	SUBWATERSHED ID	12 DIGIT HUC ID
GOOSE CREEK	02225980	ALATA02	614, 636	030701060308, 030701060307

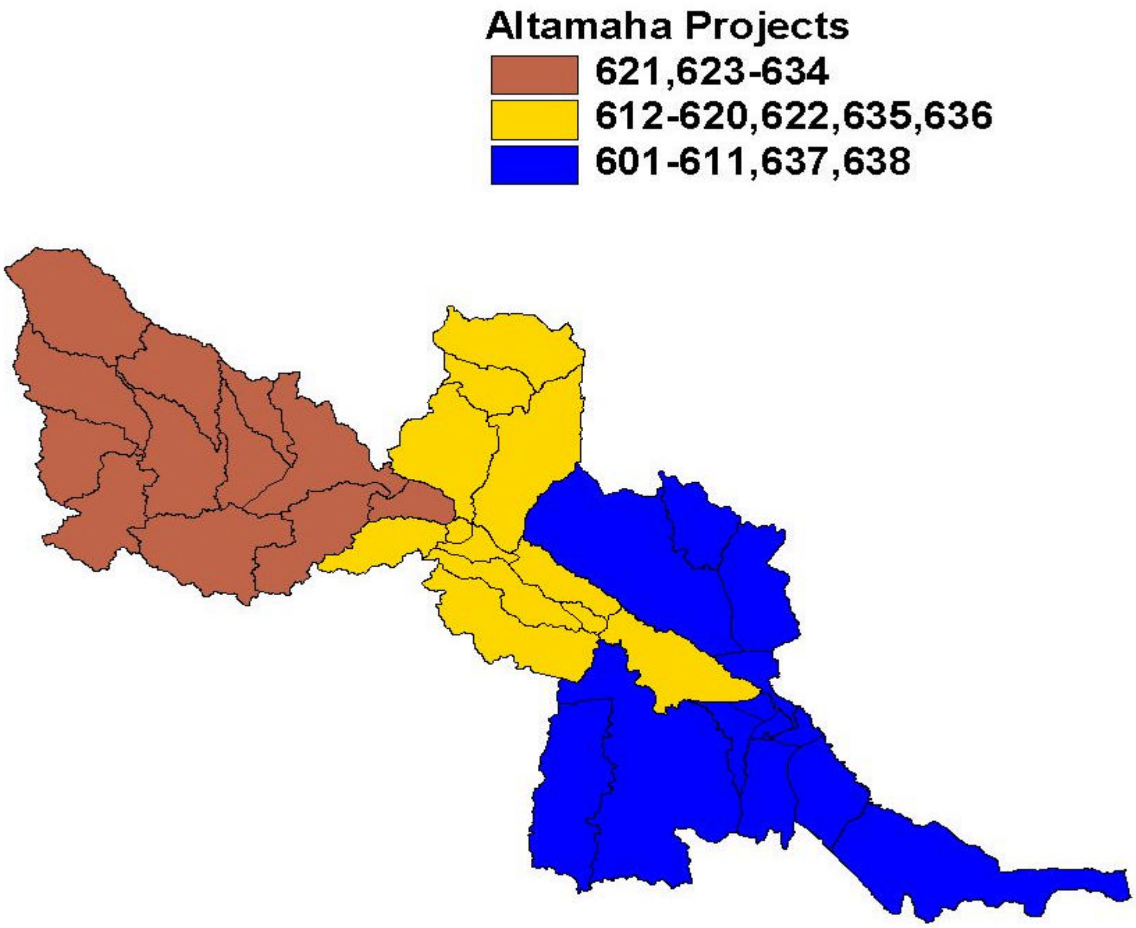
Modeling Schematic of the Altamaha River Basin (03070106)



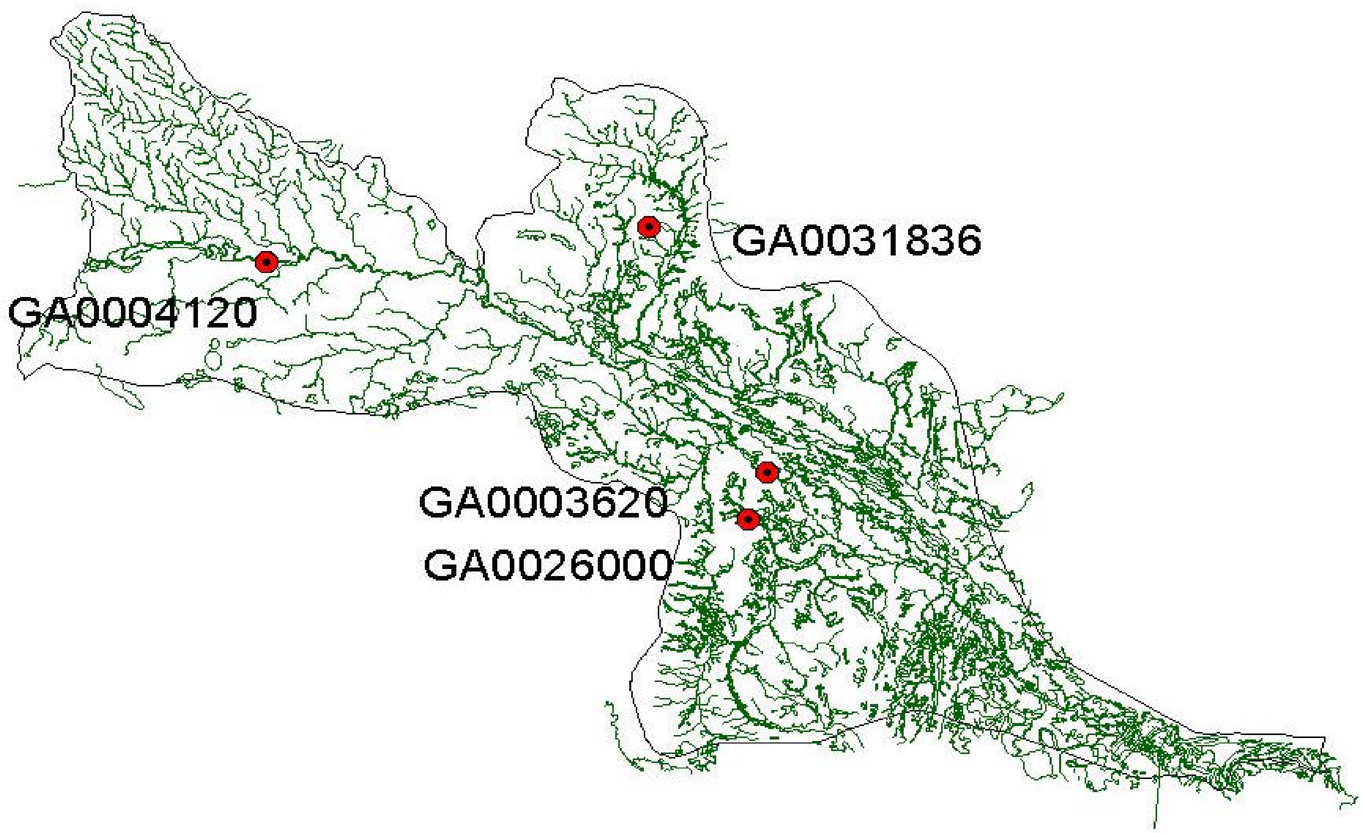
Altamaha River Basin Projects



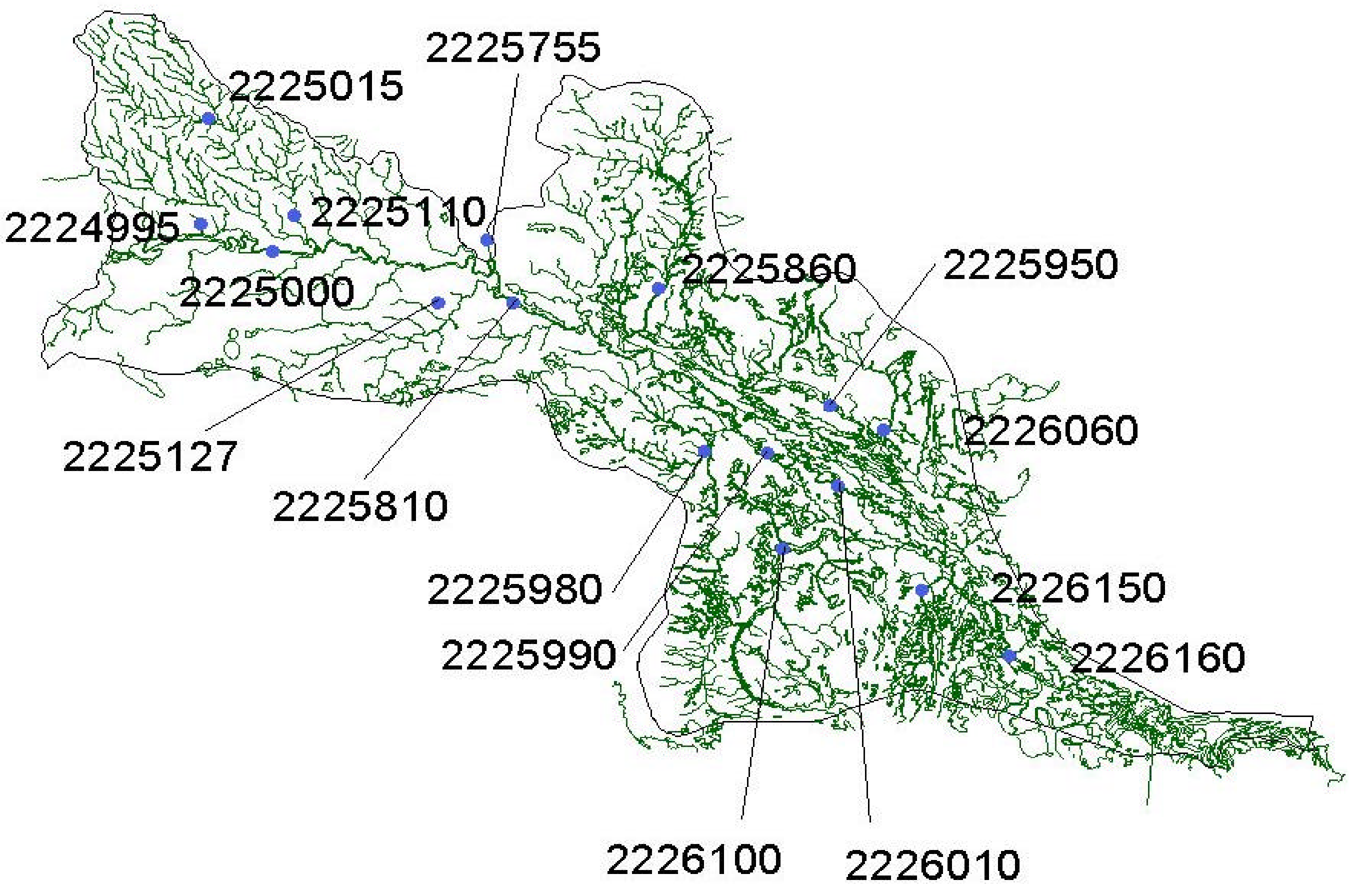
Altamaha River Basin
Delineated Subwatersheds for Modeling



Altamaha River Basin
Active Permitted Point Sources for Modeling



Altamaha River Basin
1999 Water Quality Monitoring Stations



Listed Segments in Project

Subwatershed ID	Listed Segment
621	NA
623	NA
624	Ten Mile Creek (DO)
625	NA
626	NA
627	Cobb Creek (DO)
628	NA
629	Oconee Creek (DO and FC)
630	NA
631	NA
632	Milligan Creek (DO and FC)
633	NA
634	NA

Notes:
DO = Dissolved Oxygen
FC = Fecal Coliform

Point Sources in Project

Sub ID	NPDES ID and Name	Receiving Stream	Permitted Flow (cfs)
621			
623			
624			
625			
626			
627			
628	GA0004120 Georgia Power Hatch	Altamaha	67.270
629			
630			
631			
632			
633			
634			

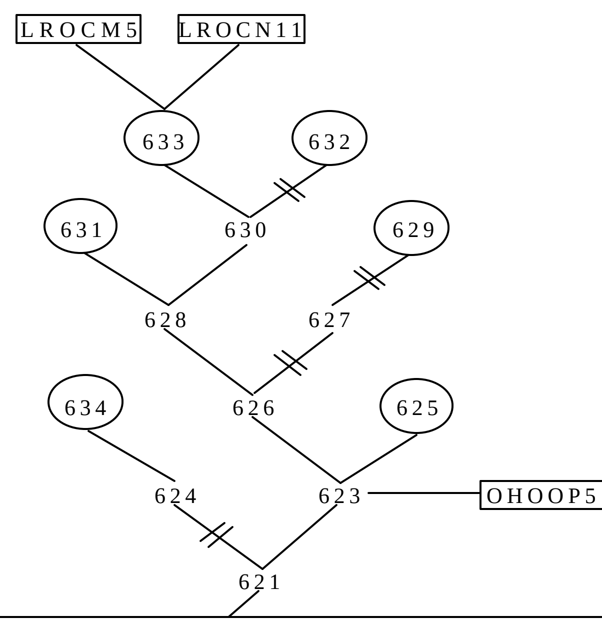
Projects Entered as Point Sources

Subwatershed ID	Project Name
633	LROCM5
633	LROCN11
623	OHOOP5

WDM Stations Assigned in Project

Subwatershed ID	WDM Station
621	Jesup
623	Claxton
624	Hazlehurst
625	Hazlehurst
626	Hazlehurst
627	Hazlehurst
628	Hazlehurst
629	Hazlehurst
630	Hazlehurst
631	Hazlehurst
632	Hazlehurst
633	Hazlehurst
634	Hazlehurst

Schematic of Project Subwatersheds
(Modeling Framework)



Batch Files to Run for Project

LinkLrocm5andLrocn11andOhoop5toAlta1.bat

Listed Segments in Project

Subwatershed ID	Listed Segment
612	NA
613	NA
614	Goose Creek (FC)
615	NA
616	NA
617	NA
618	NA
619	NA
620	NA
622	NA
635	NA
636	Goose Creek (FC)

Notes:
DO = Dissolved Oxygen
FC = Fecal Coliform

Point Sources in Project

Subwatershed ID	NPDES ID and Name	Receiving Stream	Permitted Flow (cfs)
612	GA0003620 Rayonier Inc, Jesup	Altamaha	103.850
613			
614			
615	GA0031836 Glennville	Brickyard Creek	1.364
616			
617			
618			
619			
620			
622			
635			
636			

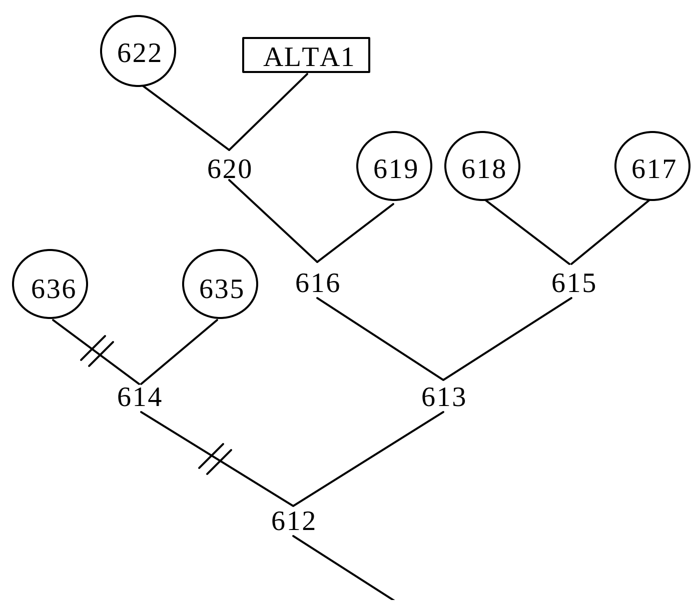
Projects Entered as Point Sources

Subwatershed ID	Project Name
620	ALTA1

WDM Stations Assigned in Project

Subwatershed ID	WDM Station
612	Jesup
613	Jesup
614	Jesup
615	Jesup
616	Jesup
617	Claxton
618	Claxton
619	Claxton
620	Jesup
622	Jesup
635	Jesup
636	Jesup

Schematic of Project Subwatersheds
(Modeling Framework)



Batch Files to Run for Project
LinkAlta1toAlta2.bat

GA Middle 3 Basins TMDL Development – HSPF Project Summary Sheet
Project Name: ALTA3

Listed Segments in Project

Subwatershed ID	Listed Segment
601	NA
602	NA
603	NA
604	Alex Creek (DO)
605	NA
606	NA
607	Penholoway River (DO)
608	NA
609	Doctors Creek (DO and FC)
610	Jones Creek (DO)
611	NA
637	Penholoway River (DO)
638	NA

Notes:
DO = Dissolved Oxygen
FC = Fecal Coliform

Point Sources in Project

Sub ID	NPDES ID and Name	Receiving Stream	Permitted Flow (cfs)
601			
602			
603			
604			
605			
606			
607			
608			
609			
610			
611			
637	GA0026000 Jesup WPCP	Penholoway	3.875
638			

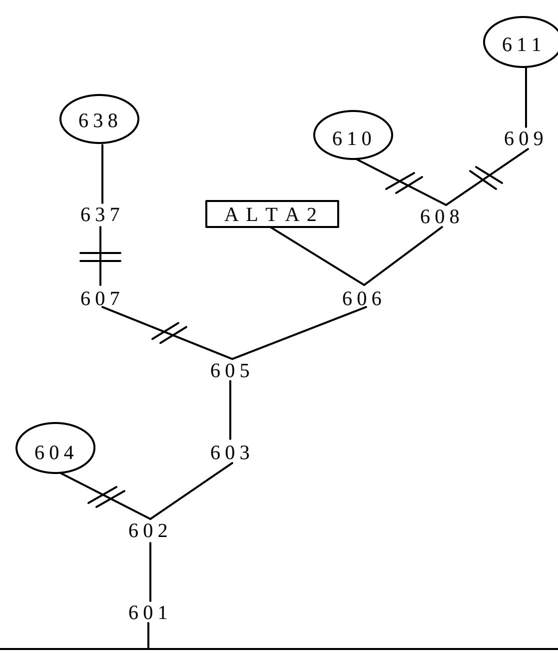
Projects Entered as Point Sources

Subwatershed ID	NPDES ID and Name
606	ALTA2

WDM Stations Assigned in Project

Subwatershed ID	WDM Station
601	Jesup
602	Jesup
603	Jesup
604	Jesup
605	Jesup
606	Jesup
607	Jesup
608	Jesup
609	Jesup
610	Jesup
611	Jesup
637	Jesup
638	Jesup

Schematic of Project Subwatersheds
(Modeling Framework)



Batch Files to Run for Project
LinkAlta2toAlta3.bat

OHOOPEE RIVER BASIN (03070107)

Georgia Middle 3 Basins TMDL Development

303(d) Listed Impaired Segments for Fecal Coliform
Ohoopee Basin

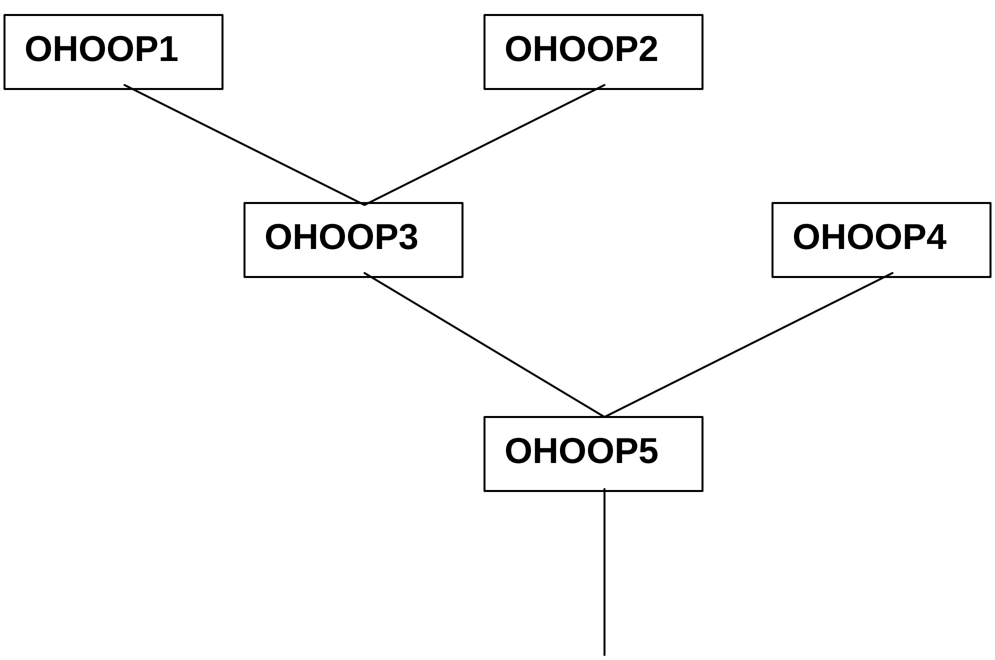
Not Supporting Designated Use

STREAM	1999 MONITORING STATION	PROJECT NAME	SUBWATERSHED ID	12 DIGIT HUC ID
BIG CEDAR CREEK	02225157	OHOOP1	736	030701070104
OHOOPEE RIVER	02225143	OHOOP1	737	030701070102
JACKS CREEK	02225318	OHOOP3	712	030701070303
YAM GRANDY CREEK	02225290	OHOOP3	714	030701070302
SWIFT CREEK	02225420	OHOOP4	741	030701070404
TIGER CREEK	02225371	OHOOP4	745, 747	030701070405, 030701070403
ROCKY CREEK	02225590	OHOOP5	749	030701070503

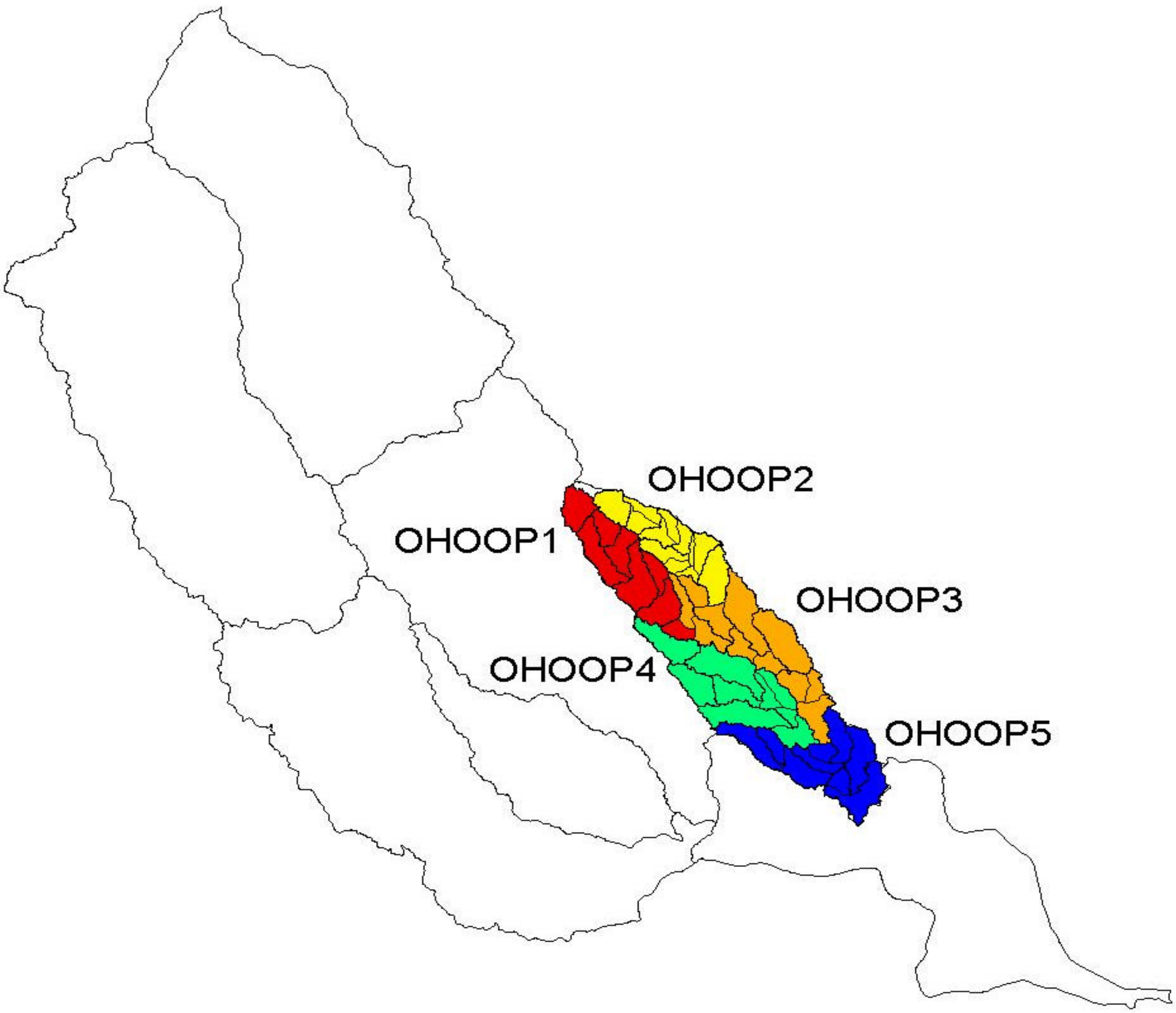
Partially Supporting Designated Use

STREAM	1999 MONITORING STATION	PROJECT NAME	SUBWATERSHED ID	12 DIGIT HUC ID
LITTLE OHOOPEE RIVER	02225255	OHOOP2 OHOOP3	718, 716	030701070205, 030701070206
OHOOPEE RIVER	02225175	OHOOP1 OHOOP3	732, 733, 717	030701070108, 030701070107, 030701070108
OHOOPEE RIVER	02225270, 02225340	OHOOP3	708, 711, 713, 715	030701070304, 030701070304, 030701070301, 030701070301
PENDLETON CREEK	02225348	OHOOP4	744, 746	030701070402, 030701070401
PENDLETON CREEK	02225360	OHOOP4	744	030701070402
THOMAS CREEK	02225695	OHOOP5	702	030701070505

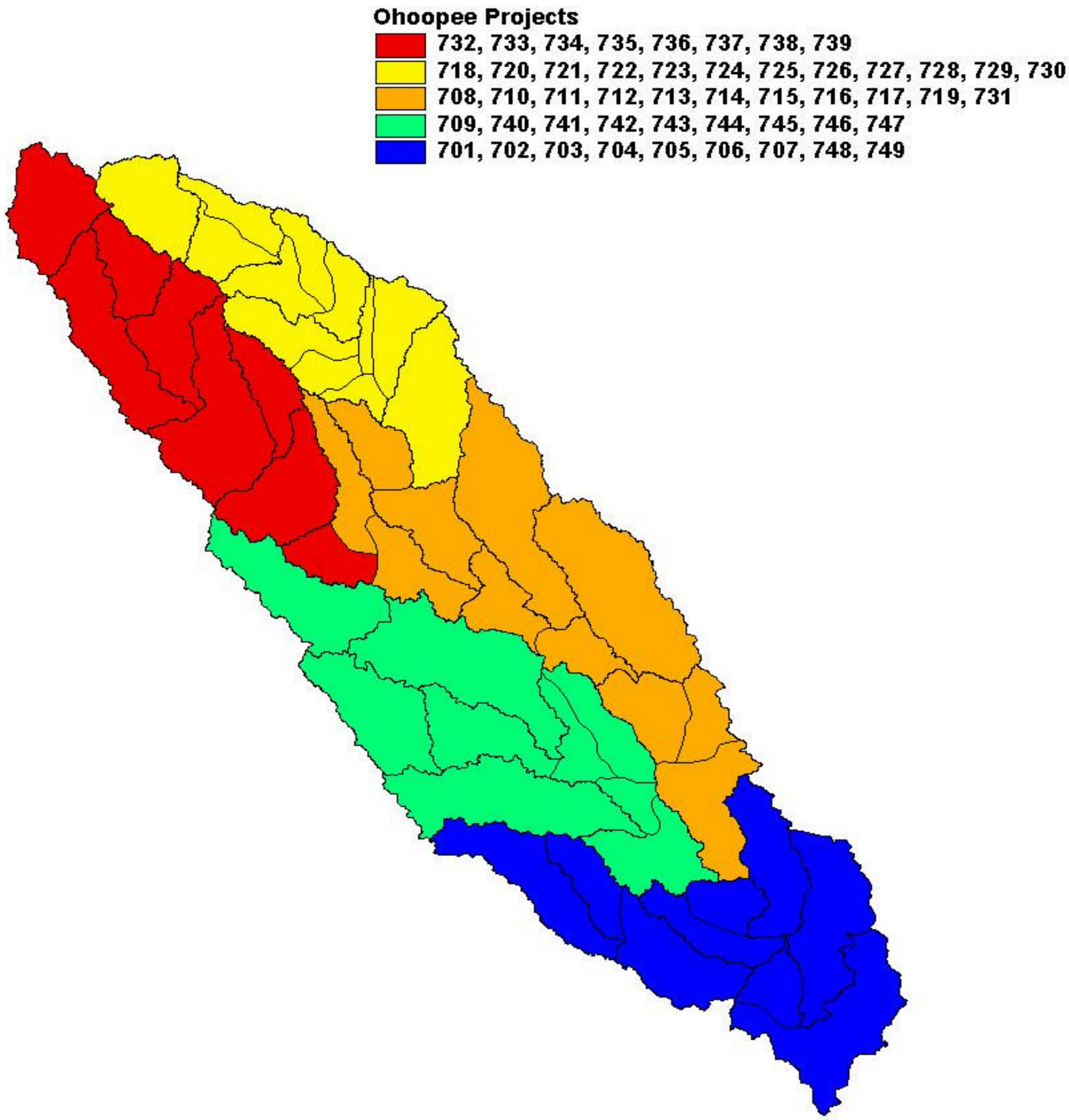
Modeling Schematic of the Ohoopee River Basin (03070107)



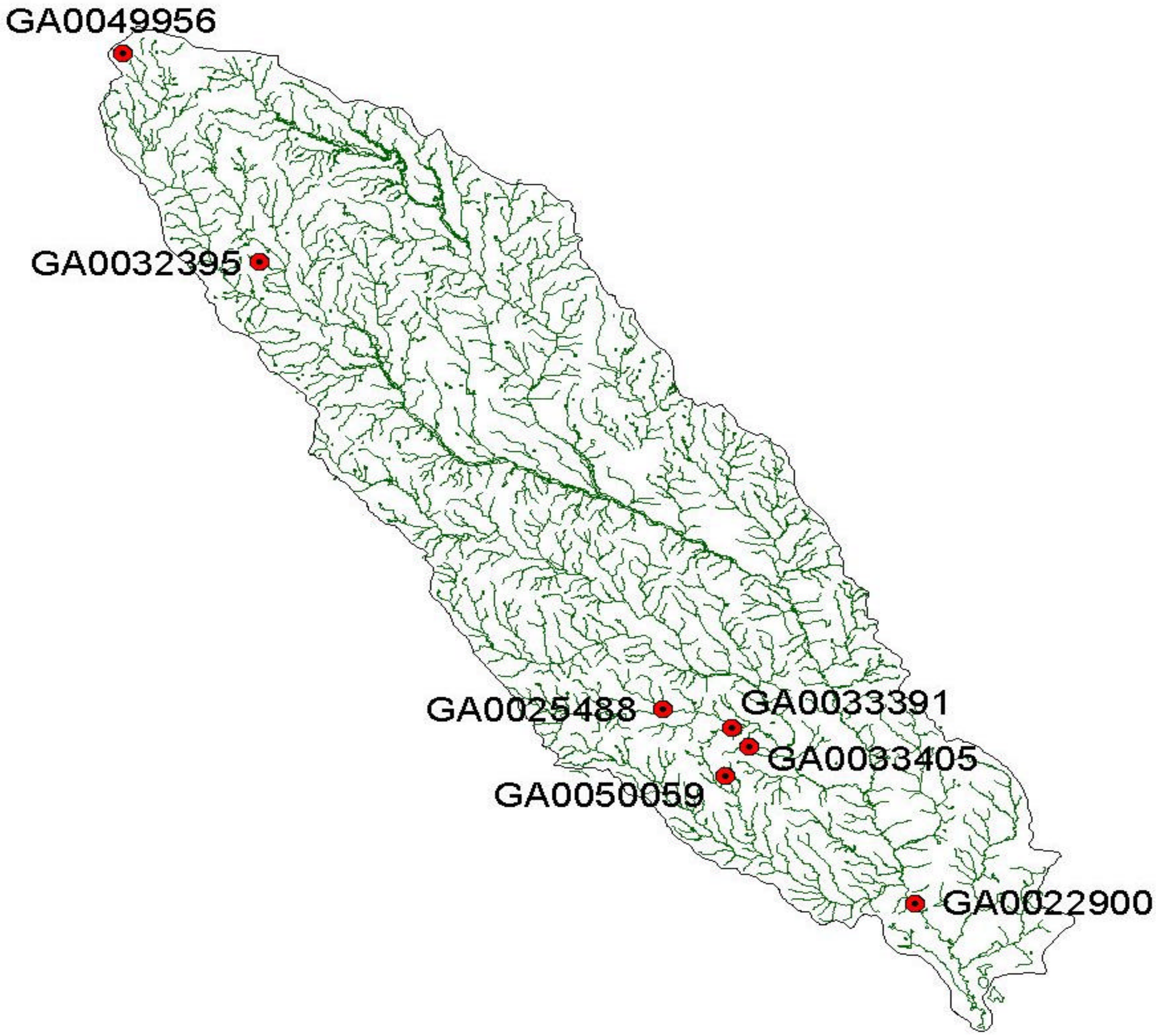
Ohoopee River Basin Projects



Ohoopee River Basin
Delineated Subwatersheds for Modeling



Ohoopee River Basin
Active Permitted Point Sources for Modeling



Ohoopee River Basin
1999 Water Quality Monitoring Stations

GA Middle 3 Basins TMDL Development – HSPF Project Summary Sheet
Project Name: OHOOP1

Listed Segments in Project

Subwatershed ID	Listed Segment
732	Ohoopee River (DO and FC)
733	Ohoopee River (DO and FC)
734	NA
735	NA
736	Big Cedar Creek (DO and FC)
737	Ohoopee River (FC)
738	NA
739	NA

Notes:
DO = Dissolved Oxygen
FC = Fecal Coliform

Point Sources in Project

Subwatershed ID	NPDES ID and Name	Receiving Stream	Permitted Flow (cfs)
732			
733			
734			
735			
736	GA0032395 Wrightsville Pond	Big Cedar Creek Trib	1.155
737			
738			
739	GA0049956 Tennille Pond	Dyers Creek – Ohoopee River	0.698

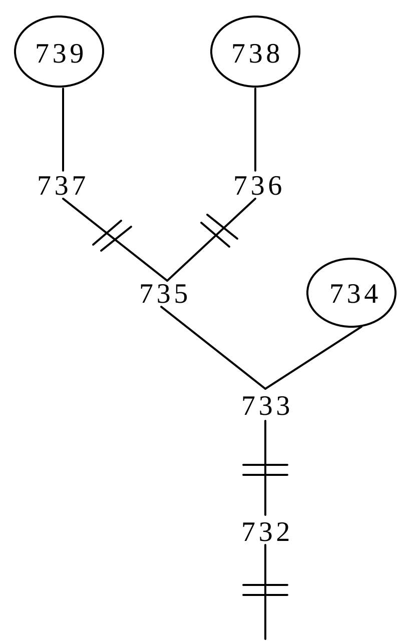
Projects Entered as Point Sources

Subwatershed ID	Project Name
NA	NA

WDM Stations Assigned in Project

Subwatershed ID	WDM Station
732	Dublin 2
733	Dublin 2
734	Dublin 2
735	Dublin 2
736	Dublin 2
737	Dublin 2
738	Dublin 2
739	Dublin 2

Schematic of Project Subwatersheds
(Modeling Framework)



Batch Files to Run for Project
None

GA Middle 3 Basins TMDL Development – HSPF Project Summary Sheet
Project Name: OHOOP2

Listed Segments in Project

Subwatershed ID	Listed Segment
718	Little Ohoopee River (DO and FC)
720	NA
721	Little Ohoopee River (DO)
722	NA
723	Little Ohoopee River (DO)
724	Little Ohoopee River (DO)
725	Little Ohoopee River (DO)
726	NA
727	Little Ohoopee River (DO)
728	NA
729	Little Ohoopee River (DO)
730	Little Ohoopee River (DO)

Notes:
DO = Dissolved Oxygen
FC = Fecal Coliform

Point Sources in Project

Subwatershed ID	NPDES ID and Name	Receiving Stream	Permitted Flow (cfs)
718			
720			
721			
722			
723			
724			
725			
726			
727			
728			
729			
730			

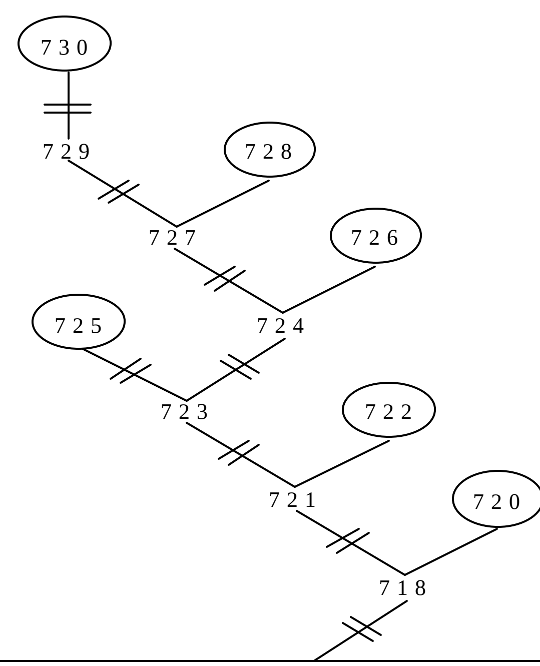
Projects Entered as Point Sources

Subwatershed ID	Project Name
NA	NA

WDM Stations Assigned in Project

Subwatershed ID	WDM Station
718	Louisville 1E
720	Louisville 1E
721	Louisville 1E
722	Louisville 1E
723	Louisville 1E
724	Louisville 1E
725	Louisville 1E
726	Louisville 1E
727	Louisville 1E
728	Louisville 1E
729	Louisville 1E
730	Louisville 1E

Schematic of Project Subwatersheds (Modeling Framework)



Batch Files to Run for Project

None

GA Middle 3 Basins TMDL Development – HSPF Project Summary Sheet
Project Name: OHOOP3

Listed Segments in Project

Subwatershed ID	Listed Segment
708	Ohoopee River (DO and FC)
710	NA
711	Ohoopee River (DO and FC)
712	Jacks Creek (DO and FC)
713	Ohoopee River (DO and FC)
714	Yam Grandy Creek (DO and FC)
715	Ohoopee River (DO and FC)
716	Little Ohoopee River (DO and FC)
717	Ohoopee River (DO and FC)
719	NA
731	NA

Notes:
DO = Dissolved Oxygen
FC = Fecal Coliform

Point Sources in Project

Subwatershed ID	NPDES ID and Name	Receiving Stream	Permitted Flow (cfs)
708			
710			
711			
712			
713			
714			
715			
716			
717			
719			
731			

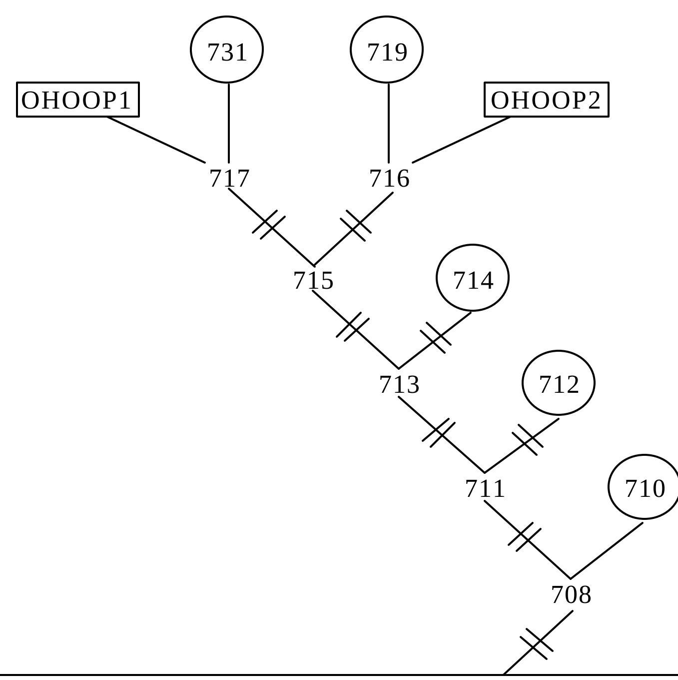
Projects Entered as Point Sources

Subwatershed ID	Project Name
717	OHOOP1
716	OHOOP2

WDM Stations Assigned in Project

Subwatershed ID	WDM Station
708	Hazlehurst
710	Hazlehurst
711	Hazlehurst
712	Dublin 2
713	Dublin 2
714	Dublin 2
715	Dublin 2
716	Dublin 2
717	Dublin 2
719	Dublin 2
731	Dublin 2

Schematic of Project Subwatersheds
(Modeling Framework)



Batch Files to Run for Project
LinkOhoop1and2toOhoop3.bat

GA Middle 3 Basins TMDL Development – HSPF Project Summary Sheet
Project Name: OHOOP4

Listed Segments in Project

Subwatershed ID	Listed Segment
709	NA
740	NA
741	Swift Creek (DO and FC)
742	NA
743	NA
744	Pendleton Creek (DO and FC)
745	Tiger Creek (DO and FC)
746	Pendleton Creek (DO and FC)
747	Tiger Creek (DO and FC)

Notes:
DO = Dissolved Oxygen
FC = Fecal Coliform

Point Sources in Project

Sub ID	NPDES ID and Name	Receiving Stream	Permitted Flow (cfs)
709	GA0033405 Lyons Pond #1	Unnamed Tributary	1.039
740			
741	GA0025488 Vidalia WPCP GA0033391 Lyons North WPCP #2	Swift Creek Swift Creek	2.914 1.039
742			
743			
744			
745			
746			
747			

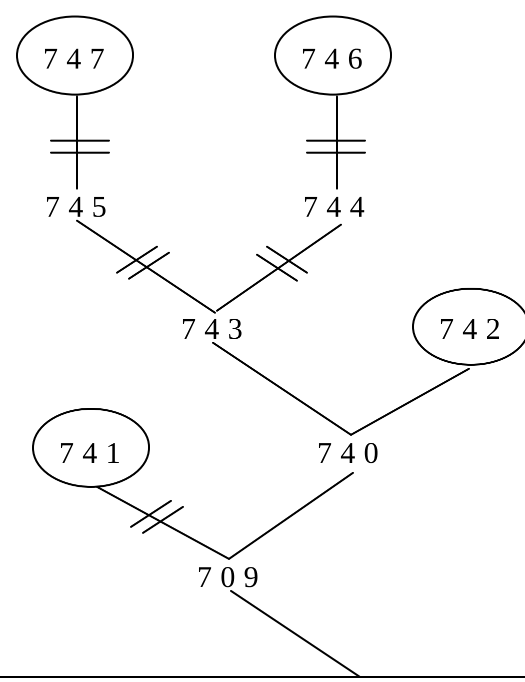
Projects Entered as Point Sources

Subwatershed ID	Project Name
NA	NA

WDM Stations Assigned in Project

Subwatershed ID	WDM Station
709	Hazlehurst
740	Hazlehurst
741	Hazlehurst
742	Hazlehurst
743	Hazlehurst
744	Dublin 2
745	Dublin 2
746	Dublin 2
747	Dublin 2

Schematic of Project Subwatersheds
(Modeling Framework)



Batch Files to Run for Project

None

GA Middle 3 Basins TMDL Development – HSPF Project Summary Sheet
Project Name: OHOOP5

Listed Segments in Project

Subwatershed ID	Listed Segment
701	NA
702	Thomas Creek (DO and FC)
703	NA
704	NA
705	Rocky Creek (DO)
706	NA
707	NA
748	NA
749	Rocky Creek (DO and FC)

Notes:
DO = Dissolved Oxygen
FC = Fecal Coliform

Point Sources in Project

Subwatershed ID	NPDES ID and Name	Receiving Stream	Permitted Flow (cfs)
701			
702			
703	GA0022900 Doc Rogers Correct Inst	Ohoopee River	1.318
704			
705			
706			
707			
748	GA0050059 Santa Claus Pond	Unnamed Tributary	0.016
749			

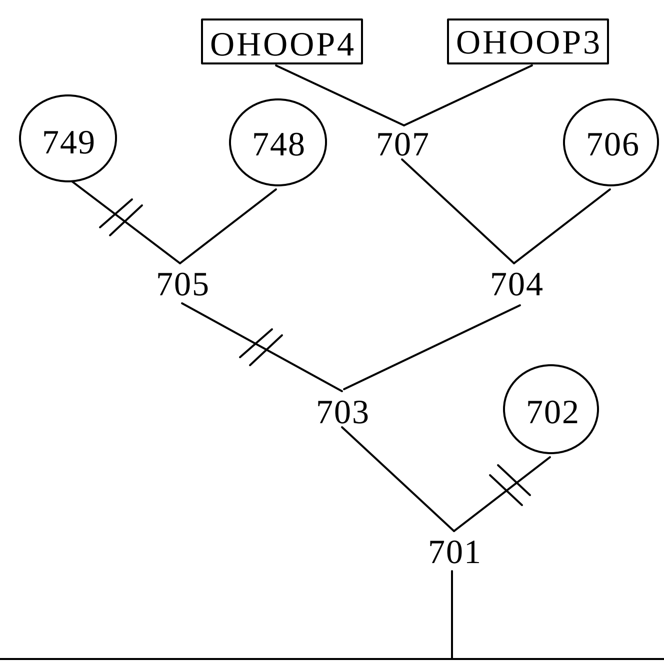
Projects Entered as Point Sources

Subwatershed ID	Project Name
707	OHOOP3
707	OHOOP4

WDM Stations Assigned in Project

Subwatershed ID	WDM Station
701	Hazlehurst
702	Hazlehurst
703	Hazlehurst
704	Hazlehurst
705	Hazlehurst
706	Hazlehurst
707	Hazlehurst
748	Hazlehurst
749	Hazlehurst

Schematic of Project Subwatersheds
(Modeling Framework)



Batch Files to Run for Project
LinkOhoop3and4toOhoop5.bat