Document Overview

Water Allocation for the Apalachicola-Chattahoochee-Flint (ACF) River Basin
Alabama, Florida, and Georgia
Draft Environmental Impact Statement

This Environmental Impact Statement (EIS) presents a framework to evaluate the proposed water allocation formula for the ACF River Basin currently being developed by the ACF Basin Compact Commission. This draft EIS is organized as follows:

Main Report

Executive Summary: brief summary of the document

Section 1– Purpose, Need, and Scope: background and history that led to the need for this EIS, as well as the evaluations completed for this EIS

Section 2 – Description of the Proposed Action: overview of the Federal decision required by the water allocation compact

Section 3 – Alternatives Considered: description of the no action and the action alternative flow scenarios

Section 4 – Affected Environment, Environmental Consequences, and Potential Mitigation Measures: description of existing conditions in the basin, as well as possible environmental impacts and mitigation remedies

Section 5 – List of Preparers: individuals who wrote and prepared this document

Section 6 – Coordination: Federal agencies, State agencies, Native American tribes, and other organizations, and individuals that will receive this draft EIS

Section 7 – Literature Cited: list of references used in preparing this document

Section 8 – Index: list of key terms by page number

Appendices

Supplementary technical information

Appendix Volume 1

Appendix A – Letters and Memorandums of Agreement and ACF Basin Compact
Appendix B – Agency Responsibilities
Appendix C – Public Involvement
Appendix D – Water Resources

Appendix Volume 2

Appendix E – Biological Resources
Appendix F – Socioeconomic Resources
Appendix G – Cultural Resources
Appendix H – Relevant Statutes and Executive Orders

A list of acronyms and abbreviations and a table summarizing the alternatives are provided immediately following the index. Note that the CD-ROM at the back of this document provides an electronic version of the entire report and Volumes 1 and 2 of the appendices.

Foreword

This Environmental Impact Statement (EIS) is being prepared by the Corps of Engineers and ten cooperating agencies to assist in a decision critical to the success of the Compact and the equitable allocation of surface water among the States of Alabama, Florida, and Georgia. The Federal Commissioner is charged by the President of the United States to approve the water allocation formula now being considered by the ACF Compact Commissioners. The responsibility of the Federal Commissioner is to assure that a formula, once agreed upon by the State Commissioners, is in compliance with Federal laws and national policies. This foreword will provide an overview of how this EIS relates to the process of approving an allocation formula.

One of the major questions and concerns you may have is why preparation of this draft EIS has begun before the ACF Compact Commissioners have agreed upon a formula. The ACF Compact contains specific procedures and mandated milestones by which certain actions must be accomplished, which were approved by the States and the U.S. Congress, and have now been incorporated into Federal law. The Compact specifies that the States must reach consensus on a water allocation formula by December 31, 1998. Provisions of the Compact also require the Federal Commissioner to reach a concurrence decision on the formula within 255 days following the States' proposed formula. Because the Federal Commissioner's decision represents a major Federal action, the procedures stipulated by the National Environmental Policy Act (NEPA) must be followed, to include the preparation of this draft EIS to evaluate the effects of the formula. The benefits of this process are that it addresses all of the relevant issues and involves the public in Federal decision-making. However, to accommodate the required technical evaluations and include adequate opportunity for public involvement, this process normally requires 18 to 24 months to complete. Therefore, this draft EIS process had to begin well before an allocation formula was proposed by the State Commissioners. A notice of intent to prepare an EIS was published in October 1997, at which time planning meetings with the interagency team of cooperating Federal agencies began. Technical studies and data gathering efforts also were initiated. In addition, a newsletter and scoping questionnaire were distributed to the public.

The mandated timeline generated the problem of beginning an evaluation process when the water allocation formula was not yet developed. This dilemma generated much discussion among the cooperating Federal agencies and the Federal legal community. The eventual conclusion on an approach, and the only one that could practically be implemented under these conditions, was to develop an evaluation framework against which an eventual formula could be evaluated. The framework developed, as presented in this draft EIS, is a range of possible flow conditions likely to "bracket" the flow conditions defined by the future allocation formula. The framework was designed with the understanding that the basin has only a certain amount of water available, and there are structural and practicable constraints within the basin that define a range of low to high flows that can be applied to that amount of water. Once the evaluation framework was established, the hydrologic, environmental and socioeconomic impacts of the range of flow conditions—low, moderate, and high—could be measured and compared to baseline conditions (also known as the no

action alternative). The future allocation formula can then also be evaluated using this same evaluation framework.

It is important to emphasize that development of an allocation formula and evaluation of the effects of the formula is a continuous process. The States are striving diligently to develop an allocation formula that will equitably allocate water resources within the basin to meet future needs. Because the specific details of the allocation formula are unknown at this time, the first phase of evaluation can only be completed at a planning level of detail, predicting the types and ranges of potential impacts that may occur within the basin if an allocation formula is implemented.

The second phase of evaluation is to develop plans for implementing actions related to the allocation formula. When the formula is approved by the State Compact Commissioners and the Federal Commissioner, decisions must be made by Federal and non-Federal project managers on how reservoir projects will be regulated to provide for allocation formula flow. Resource management programs within the basin that might be impacted by a change in water allocation within the basin must also be addressed.

This continuous process to refine the evaluation of impacts of the water resource management program as additional details of implementation plans are developed is referred to as *programmatic*. Programmatic EISs allow for evaluation of a project early in the planning stages so changes can be made in the implementing actions to avoid, minimize, or mitigate potential impacts. Programmatic EISs also serve as a baseline document for future management decisions within a study area. Once more defined implementation plans are identified, such as proposed changes in project authorizations or revisions to specific project operation or management plans, follow-on EISs or environmental assessments may be necessary and would include additional coordination with the public.

Many formal opportunities are provided for public participation throughout the EIS process. Many of you have responded to the scoping questionnaire and web page. This draft EIS has been distributed for public review and comment, and public meetings to discuss this draft EIS will be held in each State. Details announcing the times and locations of these meetings will be included in the newsletter and the local news media. Your participation is welcome at these meetings, as are your comments at any time.

Water Allocation for the Apalachicola-Chattahoochee-Flint River Basin
Alabama, Florida, and Georgia
Draft Environmental Impact Statement

Lead Agency:
U.S. Army Corps of Engineers,
Mobile District

Cooperating Agencies:
Environmental Protection Agency
Forest Service
Natural Resources Conservation Service
Maritime Administration
Fish and Wildlife Service
U.S. Geological Survey
National Park Service
National Marine Fisheries Service
National Ocean Service
Southeastern Power Administration

Abstract:

The Apalachicola-Chattahoochee-Flint (ACF) River Basin Compact Commission is developing a water allocation formula for the ACF River basin to provide an equitable sharing of water within the basin among the States of Alabama, Florida, and Georgia. Compact Commissioners include the Governors of each State and a Federal Commissioner appointed by the President of the United States as a non-voting member. Under the ACF River Basin Compact, the three State Commissioners must negotiate and agree on a proposed allocation formula and present the formula to the Federal Commissioner for concurrence before the allocation formula can be implemented. This environmental impact statement (EIS) uses a programmatic framework for evaluating a range of flow and reservoir conditions that were selected to bracket the flow conditions that may result from the allocation formula. The objectives of the EIS are to address the potential environmental impacts across the entire basin, serve as a baseline document for future implementing actions, and meet the schedule for completion of agency and public review prior to a Federal Commissioner decision in late summer 1999. Alternative flow conditions in the high, moderate, and low range were compared to the flow conditions for the no action alternative (existing operating conditions within the basin). Flow conditions were modeled by using a historic flow data record that represents 55 years of recorded stream flows. Hydrologic models and water demands used in the hydrologic models were developed as part of the ACT/ACF Comprehensive Study. Project conditions were for a planning period extending through the year 2050. Evaluations of potential impacts of the no action alternative and action alternative flow scenarios were based on studies completed during the Comprehensive Study and additional investigations completed by the U.S. Army Corps of Engineers and cooperating Federal agencies. With the no action alternative, river flows and reservoirs would be maintained similar to existing conditions, with reservoir drawdowns under dry conditions. As demands increase into the future, reservoir elevations would drop significantly, while river flows could be maintained close to flows that were present under 1995 demands. The greatest effect would occur in the summer and fall, when inflows are naturally lower. With the low flow scenario river flows would be substantially reduced compared with river flows under the no action alternative. Reservoir levels would be maintained near full pool, except under drought conditions. The moderate flow scenario produces river flows that are high in the winter, responding to reservoir seasonal drawdowns, and elevated in the summer, as upstream reservoirs augment river flows during the dry summer months. The high flow scenario would maintain river flows higher in the spring, summer, and fall. Follow-on National Environmental Policy Act (NEPA) documentation (tiered environmental assessments or EISs) may be necessary to document specific impacts of the future implementing actions.

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Send your comments to the above address by **December 18, 1998.**

Water Allocation for the Apalachicola-Chattahoochee-Flint (ACF) River Basin

Alabama, Florida, and Georgia

Main Report

Lead Agency

U.S. Army Corps of Engineers, Mobile District

Cooperating Agencies

Environmental Protection Agency
Fish and Wildlife Service
Forest Service
Maritime Administration
National Marine Fisheries Service
National Ocean Service
National Park Service
Natural Resources Conservation Service
Southeastern Power Administration
U.S. Geological Survey

September 1998

Contents

Executive Summary **ES-1**
Introduction ES-1
Background ES-2
Comprehensive Study ES-2
ACF River Basin Compact ES-3
Purpose and Need ES-4
Scope of the EIS ES-4
Proposed Action ES-5
Potential Water Allocation Mechanisms ES-5
Process and Status for Developing the Allocation Formula ES-6
Proposed Implementation Approach ES-6
Alternatives Considered ES-6
Continue Existing Operations: the No Action Alternative ES-7
Action Alternative Flow Scenarios ES-7
Potential Impacts Associated with the No Action and Action Alternatives ES-9
Geology and Soils ES-9
Water Resources ES-9
Water Quantity ES-9
Water Quality ES-11
Biological Resources ES-11
Vegetation Resources ES-11
Wildlife Resources ES-12
Fish and Aquatic Resources ES-12
Protected Species ES-13
Fish and Wildlife Management Facilities ES-13
Land Use ES-14
Socioeconomic Resources ES-15
Population/Demographics ES-15
Recreation ES-15
Economics ES-16
Air Quality and Noise ES-17
Cultural Resources ES-18
Potential Mitigation Measures ES-18
Regulatory Compliance ES-19
1. Purpose, Need, and Scope **1-1**
1.1 Introduction 1-1
1.1.1 Background 1-2
1.1.2 Competing Water Interests 1-3
1.1.3 Letters of Agreement 1-4
1.1.4 Memorandum of Agreement 1-5
1.1.5 Comprehensive Study 1-6
1.1.5.1 Process Support Elements 1-6
1.1.5.1.1 Population and Employment Forecasts 1-6

1.1.5.1.2 Database 1-6
1.1.5.1.3 Public Involvement for Comprehensive Study 1-7
1.1.5.2 Water Resources Availability 1-7
1.1.5.2.1 Surface Water 1-7
1.1.5.2.2 Groundwater 1-7
1.1.5.3 Water Demand Elements 1-8
1.1.5.3.1 Agricultural Water Demand 1-8
1.1.5.3.2 Apalachicola River and Bay Water Demand 1-8
1.1.5.3.3 Environmental Water Demand 1-8
1.1.5.3.4 Municipal and Industrial Water Demand 1-8
1.1.5.3.5 Navigation Water Demand 1-9
1.1.5.3.6 Power Resources Water Demand 1-9
1.1.5.3.7 Recreation Water Demand 1-9
1.1.5.3.8 Water Quality Water Demand 1-9
1.1.5.4 Comprehensive Management Strategy 1-9
1.1.5.4.1 Basinwide Management 1-9
1.1.5.4.2 Coordination Mechanism 1-10
1.1.6 ACF River Basin Compact 1-10
1.2 Purpose and Need 1-11
1.3 Scope of EIS 1-11
1.3.1 Programmatic Environmental Impact Statements 1-13
1.3.1.1 Schedule 1-14
1.3.1.2 Cooperating Agencies 1-14
1.3.2 Public Involvement 1-15
1.3.2.1 NEPA Public Involvement Process 1-15
1.3.2.1.1 Notice of Intent 1-15
1.3.2.1.2 Public Review of the EIS 1-15
1.3.2.1.3 Public Mailing List 1-16
1.3.2.1.4 Brochure and Questionnaire 1-16
1.3.2.1.5 Newsletters 1-16
1.3.2.1.6 Internet Web Page 1-16
1.3.2.1.7 Draft EIS 1-16
1.3.2.1.8 Public Meetings 1-16
1.3.2.1.9 Final EIS 1-17
1.3.2.1.10 Record of Decision 1-17
1.3.2.2 Scoping Issues 1-17
1.3.3 Impact Analyses Process 1-17
1.3.3.1 Framework for the Proposed Action 1-17
1.3.3.2 Baseline Data 1-19
1.3.3.3 Water Demand Scenarios 1-20
1.3.3.4 Hydrologic Modeling 1-23
1.3.3.5 Water Quality 1-23
1.3.3.6 Node Analyses 1-25
1.3.3.7 Ecological Analyses 1-25
1.3.3.7.1 Riverine Aquatic Resources Analyses 1-27
1.3.3.7.2 Riparian Wetland Analyses 1-27
1.3.3.7.3 Reservoir Fisheries Analyses 1-27
1.3.3.7.4 Protected Species Surveys 1-27

1.3.3.7.5 Freshwater Inflows and Oysters in Apalachicola Bay 1-27
1.3.3.8 Economic Analyses 1-28
1.3.3.9 Cultural Resources Predictive Model 1-29
1.3.4 Relevant Statutes and Executive Orders 1-29
2. Description of the Proposed Action 2-1
2.1 Introduction 2-1
2.1.1 Proposed Action 2-1
2.1.2 Summary of Available Water Allocation Mechanisms for the ACF Basin 2-1
2.1.2.1 Hydrologic Standards 2-2
2.1.2.2 Time Scale 2-2
2.1.2.3 Water Availability 2-2
2.1.2.4 Process and Status for Developing the Allocation Formula 2-3
2.2 Proposed Implementation 2-3
3. Alternatives Considered 3-1
3.1 Continue Existing Operations, the No Action Alternative 3-1
3.1.1 Existing Operations Model 3-2
3.1.2 No Action Alternative 3-2
3.1.3 Historical Operating Conditions 3-2
3.2 Action Alternatives Considered and Potential Mitigation Options 3-4
3.2.1 Range of Alternative Flow Conditions 3-4
3.2.2 Mitigation 3-5
3.2.2.1 Council on Environmental Quality Mitigation Guidance 3-5
3.2.2.2 Potential Mitigation Options 3-6
4. Affected Environment, Environmental Consequences, and Potential Mitigation Measures 4-1
4.1 Baseline for Analyses 4-1
4.1.1 Direct, Indirect, and Cumulative Impacts 4-2
4.1.2 Mitigation 4-2
4.1.3 Significance Criteria 4-3
4.2 Description of Basin 4-10
4.3 Geology and Soils 4-15
4.3.1 Geology 4-15
4.3.1.1 Affected Environment 4-15
4.3.1.2 Blue Ridge and Piedmont Physiographic Provinces 4-15
4.3.1.3 Coastal Plain Physiographic Province 4-19
4.3.1.4 Environmental Consequences 4-23
4.3.2 Soils 4-23
4.3.2.1 Affected Environment 4-23
4.3.2.1.1 Soil Types 4-23
4.3.2.1.2 Major Land Resource Areas 4-23
4.3.2.1.3 Prime Farmland 4-25
4.3.2.1.4 Erosion and Sedimentation 4-25
4.3.2.2 Environmental Consequences 4-34
4.4 Water Resources 4-35
4.4.1 Water Quantity 4-35
4.4.1.1 Affected Environment 4-37
4.4.1.1.1 Rivers 4-37

4.4.1.1.1.1 Chattahoochee River 4-40
4.4.1.1.1.2 Flint River 4-42
4.4.1.1.1.3 Apalachicola River 4-43
4.4.1.1.1.4 Navigation 4-44
4.4.1.1.2 Reservoirs 4-46
4.4.1.1.2.1 Lake Sidney Lanier 4-52
4.4.1.1.2.2 Bull Sluice Lake 4-53
4.4.1.1.2.3 West Point Lake 4-54
4.4.1.1.2.4 Lake Harding 4-54
4.4.1.1.2.5 Goat Rock Dam 4-54
4.4.1.1.2.6 Lake Oliver 4-54
4.4.1.1.2.7 Walter F. George Lake 4-55
4.4.1.1.2.8 Lake George A. Andrews 4-55
4.4.1.1.2.9 Lake Blackshear 4-55
4.4.1.1.2.10 Lake Worth 4-56
4.4.1.1.2.11 Lake Seminole 4-56
4.4.1.1.2.12 Potential Future Lakes 4-56
4.4.1.1.3 Groundwater 4-56
4.4.1.1.4 Water Supply Withdrawals 4-59
4.4.1.1.4.1 Municipal and Industrial Demands . 4-62
4.4.1.1.4.2 Agricultural Demand 4-62
4.4.1.1.4.3 Thermal Power Demand 4-64
4.4.1.2 Environmental Consequences 4-65
4.4.1.2.1 Basin Wide Hydrologic Modeling 4-65
4.4.1.2.1.1 1977 Operating Conditions Evaluation 4-66
4.4.1.2.1.2 Development of the Low, Moderate, and High Scenarios 4-67
4.4.1.2.1.3 Downstream Flow Targets 4-68
4.4.1.2.1.4 Critical Period Analysis 4-69
4.4.1.2.1.5 General Model Assumptions 4-70
4.4.1.2.2 Impact Analysis Approach 4-71
4.4.1.2.3 River Impacts 4-73
4.4.1.2.3.1 Upper Chattahoochee River Subbasin 4-73
4.4.1.2.3.2 Lower Chattahoochee River Subbasin 4-76
4.4.1.2.3.3 Flint River Subbasin 4-79
4.4.1.2.3.4 Apalachicola River Subbasin 4-82
4.4.1.2.4 Reservoir Impacts 4-88
4.4.1.2.4.1 Upper Chattahoochee River Subbasin 4-88
4.4.1.2.4.2 Lower Chattahoochee River Subbasin 4-90
4.4.1.2.4.3 Flint River Subbasin 4-96
4.4.1.2.4.4 Apalachicola River Subbasin 4-96
4.4.1.2.5 Groundwater Impacts 4-99
4.4.1.2.6 Navigation Impacts 4-99
4.4.1.2.7 Flood Control Impacts 4-102

4.4.1.2.8 Water Supply Withdrawals 4-104
4.4.1.2.8.1 Municipal and Industrial Demand .. 4-104
4.4.1.2.8.2 Thermal Demand 4-106
4.4.1.2.8.3 Agricultural Demand 4-107
4.4.2 Water Quality 4-108
4.4.2.1 Affected Environment 4-108
4.4.2.1.1 Comprehensive Study Summary 4-110
4.4.2.1.2 Chattahoochee River Basin 4-111
4.4.2.1.3 Flint River Basin 4-112
4.4.2.1.4 Apalachicola River Basin 4-113
4.4.2.1.5 Wastewater Discharges 4-113
4.4.2.1.6 Nonpoint Source Pollution 4-117
4.4.2.1.7 Groundwater 4-117
4.4.2.2 Environmental Consequences 4-118
4.4.2.2.1 Basin Water Quality Modeling 4-118
4.4.2.2.2 Upper Chattahoochee River Subbasin Impacts 4-119
4.4.2.2.3 Lower Chattahoochee River Subbasin Impacts 4-125
4.4.2.2.4 Flint River Subbasin Impacts 4-131
4.4.2.2.5 Apalachicola River Subbasin Impacts 4-132
4.4.2.2.6 Wastewater Discharge Impacts 4-135
4.4.2.2.7 Thermal Discharge Impacts 4-135
4.4.2.2.8 Groundwater Impacts 4-136
4.5 Biological Resources 4-137
4.5.1 Vegetation Resources 4-137
4.5.1.1 Affected Environment 4-137
4.5.1.1.1 Terrestrial Communities 4-137
4.5.1.1.2 Wetlands 4-139
4.5.1.1.2.1 Freshwater Wetlands 4-140
4.5.1.1.2.2 Estuarine Wetlands 4-141
4.5.1.2 Environmental Consequences 4-142
4.5.1.2.1 Terrestrial Communities 4-142
4.5.1.2.2 Wetlands 4-142
4.5.1.2.2.1 Freshwater Wetlands 4-142
4.5.1.2.2.2 Estuarine Wetlands 4-147
4.5.2 Wildlife Resources 4-148
4.5.2.1 Affected Environment 4-148
4.5.2.1.1 General Basin-Wide Wildlife Assemblages 4-148
4.5.2.2 Environmental Consequences 4-150
4.5.3 Fish and Aquatic Resources 4-150
4.5.3.1 Affected Environment 4-150
4.5.3.1.1 Riverine 4-150
4.5.3.1.1.1 Riverine Segments 4-150
4.5.3.1.1.2 Large River Habitat 4-151
4.5.3.1.1.3 Subsystems with Unregulated Flow 4-153
4.5.3.1.1.4 Flow-Regulated, Isolated Segments 4-153
4.5.3.1.2 Reservoir 4-154
4.5.3.1.3 Estuarine 4-156
4.5.3.2 Environmental Consequences 4-157
4.5.3.2.1 Riverine 4-157

4.5.3.2.1.1 Riverine Habitat Performance Measure Assessment 4-157
4.5.3.2.1.2 Water Quality Effects on Buford Dam Trout Fishery 4-164
4.5.3.2.1.3 Tributary Streams and Cool-Water Refugia 4-165
4.5.3.2.2 Reservoir 4-166
4.5.3.2.2.1 General Impacts of Alternative Flow Conditions 4-166
4.5.3.2.2.2 FWS Performance Measure Assessment 4-167
4.5.3.2.2.3 Impacts of Critical Low Flow Periods 4-170
4.5.3.2.3 Estuarine 4-172
4.5.4 Protected Species (Federal and State) 4-174
4.5.4.1 Affected Environment 4-175
4.5.4.2 Environmental Consequences 4-184
4.5.4.2.1 General Impacts 4-184
4.5.4.2.1.1 Alteration of Flow Regimes by Changes in Operations of Existing Dams and Reservoirs 4-184
4.5.4.2.1.2 Construction of New Dams and Reservoirs 4-184
4.5.4.2.1.3 Growth in Demand for Consumptive Uses of Water 4-185
4.5.4.2.1.4 Water Quality Degradation 4-185
4.5.4.2.2 Impacts of Modeled Alternatives 4-185
4.5.5 Fish and Wildlife Management Facilities 4-186
4.5.5.1 Affected Environment 4-187
4.5.5.1.1 Eufaula National Wildlife Refuge (ENWR) 4-187
4.5.5.1.2 Fish Hatcheries 4-188
4.5.5.2 Environmental Consequences 4-188
4.5.5.2.1 Eufaula National Wildlife Refuge (ENWR) 4-188
4.5.5.2.2 Fish Hatcheries 4-190
4.6 Land Use 4-191
4.6.1 Developed (Residential / Commercial / Industrial) 4-193
4.6.1.1 Affected Environment 4-193
4.6.1.2 Environmental Consequences 4-194
4.6.2 Agricultural Land 4-194
4.6.2.1 Affected Environment 4-195
4.6.2.2 Environmental Consequences 4-195
4.6.3 Forest/Timber 4-196
4.6.3.1 Affected Environment 4-196
4.6.3.2 Environmental Consequences 4-196
4.6.4 Barren Lands and Water 4-197
4.6.4.1 Affected Environment 4-197
4.6.4.2 Environmental Consequences 4-197
4.6.5 Recreation, National Parks, Refuges, Fish and Wildlife Management Facilities and Protected Sites 4-197

4.6.5.1 Affected Environment 4-197
4.6.5.2 Environmental Consequences 4-201
4.6.6 Contaminated Sites 4-201
4.6.6.1 Affected Environment 4-201
4.6.6.2 Environmental Consequences 4-202
4.6.7 Military Land Use 4-202
4.6.7.1 Affected Environment 4-202
4.6.7.2 Environmental Consequences 4-203
4.7 Socioeconomic Resources 4-204
4.7.1 Population/Demographics 4-204
4.7.1.1 Affected Environment 4-204
4.7.1.1.1 Demographics 4-204
4.7.1.1.2 Environmental Justice 4-205
4.7.1.1.3 Protection of Children 4-207
4.7.1.2 Environmental Consequences 4-207
4.7.1.2.1 Demographics 4-208
4.7.1.2.2 Environmental Justice 4-208
4.7.1.2.3 Protection of Children 4-209
4.7.2 Recreation 4-210
4.7.2.1 Affected Environment 4-210
4.7.2.1.1 Reservoir Recreation 4-211
4.7.2.1.2 Riverine Recreation 4-214
4.7.2.2 Environmental Consequences 4-215
4.7.2.2.1 Reservoir Recreation 4-215
4.7.2.2.1.1 Lake Sidney Lanier 4-217
4.7.2.2.1.2 West Point Lake 4-219
4.7.2.2.1.3 Walter F. George 4-219
4.7.2.2.1.4 Lake Seminole 4-220
4.7.2.2.2 Riverine Recreation 4-221
4.7.3 Economics 4-225
4.7.3.1 Affected Environment 4-225
4.7.3.1.1 Municipal and Industrial Water Demands 4-225
4.7.3.1.2 Navigation 4-225
4.7.3.1.3 Power Generation 4-226
4.7.3.1.4 Agricultural Water Supply 4-228
4.7.3.1.5 Flood Control 4-228
4.7.3.1.6 Fish and Wildlife Utilization 4-229
4.7.3.1.7 Recreation Economics 4-229
4.7.3.1.8 Income 4-231
4.7.3.1.9 Employment 4-232
4.7.3.2 Environmental Consequences 4-233
4.7.3.2.1 Municipal and Industrial Water Supply 4-233
4.7.3.2.2 Navigation 4-235
4.7.3.2.3 Power Generation 4-236
4.7.3.2.4 Agricultural Water Supply 4-238
4.7.3.2.5 Flood Control 4-238
4.7.3.2.6 Fish and Wildlife Utilization 4-239
4.7.3.2.7 Recreation Economics 4-239
4.7.3.2.8 Employment 4-240

4.7.3.2.8.1 Income 4-240
4.7.3.2.8.2 Employment 4-244
4.8 Air Quality and Noise 4-247
4.8.1 Air Quality 4-247
4.8.1.1 Affected Environment 4-247
4.8.1.2 Environmental Consequences 4-249
4.8.2 Noise 4-249
4.8.2.1 Affected Environment 4-249
4.8.2.2 Environmental Consequences 4-251
4.9 Cultural Resources 4-252
4.9.1 Affected Environment 4-252
4.9.2 Environmental Consequences 4-255
4.10 Cumulative Effects 4-261
4.10.1 Geology and Soils 4-261
4.10.2 Water Resources 4-262
4.10.2.1 Water Quantity 4-262
4.10.2.2 Water Quality 4-262
4.10.3 Biological Resources 4-263
4.10.3.1 Vegetation 4-263
4.10.3.2 Wildlife 4-263
4.10.3.3 Fish and Aquatic Resources 4-263
4.10.3.4 Protected Species 4-264
4.10.4 Land Use 4-264
4.10.5 Socioeconomic Resources 4-265
4.10.5.1 Population and Demographics 4-265
4.10.5.2 Recreation 4-265
4.10.5.3 Economics 4-265
4.10.6 Air Quality and Noise 4-266
4.10.7 Cultural Resources 4-266
4.11 Mitigation Considerations 4-267
4.11.1 Water Quantity 4-267
4.11.2 Water Quality 4-268
4.11.3 Aquatic Resources 4-268
4.11.4 Geology and Soils 4-268
4.11.5 Recreation 4-268
4.11.6 Conclusion 4-268
4.12 Other NEPA Considerations 4-269
4.12.1 Unavoidable Adverse Effects 4-269
4.12.2 Irreversible and Irretrievable Commitment of Resources 4-269
5. List of Preparers 5-1
6. Coordination 6-1
7. Literature Cited 7-1
8. Index 8-1

Tables

ES-1 Elements of the ACT/ACF Comprehensive Study ES-3
ES-2 Alternatives Considered Applicable to the ACF Basin EIS ES-8
1-1 Elements of the Comprehensive Study 1-6
1-2 Summary of Key Issues to be Addressed in the EIS 1-18
1-3 Baseline Data and Support Provided by Cooperating Agencies 1-19
1-4 Assumptions for the Municipal and Industrial Water Demand Scenarios 1-20
1-5 Assumptions for the Agricultural Water Demand Scenarios 1-21
1-6 Federal Environmental Statutes and Executive Orders Applicable to the ACF Basin EIS 1-29
3-1 Alternatives Considered Applicable to the ACF Basin EIS 3-3
4-1 Impacts Criteria Matrix for ACF Basin EIS 4-4
4-2 Historical Gage Data (in cfs) for the Chattahoochee River 4-41
4-3 Historical Gage Data (in cfs) for the Flint River 4-42
4-4 Historical Gage Data (in cfs) for the Apalachicola River 4-43
4-5 Existing Mainstem Dams/Reservoirs in the ACF Basin 4-48
4-6 Planned or Existing Reservoirs in the ACF Basin 4-49
4-7 Estimated Municipal and Industrial Water Demand (mgd), by State and Basin Total 4-62
4-8 Estimated 1995 Annual Average Agricultural Water Demands (mgd), by State and Basin Total 4-63
4-9 Thermal Power Generation Plants in the ACF Basin 4-64
4-10 Downstream Flow Targets Used in the HEC-5 Model (in cfs) 4-69
4-11 Apalachicola River at Sumatra, IHA Output for Select Statistical Flows, 1995 Demands 4-87
4-12 Modeled Annual Shortage (mgd) in Municipal and Industrial Demands by State for the ACF Basin, No Action Alternative 4-105
4-13 Water Use Classifications in the Study Area 4-110
4-14 Major Municipal and Industrial Discharges Into the ACF Basin 4-116
4-15 Upper Chattahoochee River Subbasin. River Water Quality. No Action Alternative 4-120
4-16 Upper Chattahoochee River Subbasin. Average Stream Percent Wastewater in Summer. No Action Alternative 4-122
4-17 Upper Chattahoochee River Subbasin. Reservoir Water Quality. No Action Alternative 4-122
4-18 Upper Chattahoochee River Subbasin. River Water Quality. Action Alternative. 2050 Demands 4-123
4-19 Upper Chattahoochee River Subbasin. Average Stream Percent Wastewater in Summer. Action Alternative 2050 Demands 4-124
4-20 Upper Chattahoochee River Subbasin. Reservoir Water Quality. Action Alternative. 2050 Demands 4-125
4-21 Lower Chattahoochee River Subbasin. River Water Quality. No Action Alternative 4-126
4-22 Lower Chattahoochee River Subbasin. Average Stream Percent Wastewater in Summer. No Action Alternative 4-127
4-23 Lower Chattahoochee River Subbasin. Reservoir Water Quality. No Action Alternative 4-128

4-24 Lower Chattahoochee River Subbasin. River Water Quality. Action Alternative. 2050 Demands 4-129
4-25 Lower Chattahoochee River Subbasin. Reservoir Water Quality. Action Alternative. 2050 Demands 4-130
4-26 Flint River Subbasin River Water Quality. No Action Alternative 4-131
4-27 Flint River Subbasin River Water Quality. Action Alternative. 2050 Demands 4-132
4-28 Apalachicola River Subbasin Water Quality. No Action Alternative 4-133
4-29 Apalachicola River Subbasin Water Quality. Action Alternative. 2050 Demands 4-134
4-30 Riparian Wetland Unit (RWU) Performance Measure Scores for the No Action and Action Alternatives 4-145
4-31 Inventory of Riverine Faunal Resources in the ACF Basin 4-151
4-32 Fish Species Identified as Critical in Evaluating Operating Alternatives for Reservoirs of the ACF Basin 4-155
4-33 Riverine Habitat Performance Measure Scores and Ranking of Scores Across All Flow Scenarios 4-161
4-34 Median (50th percentile) Reservoir Fisheries Performance Measure Scores and Ranking of Scores Across All Flow Scenarios 4-169
4-35 Flow Scenarios Used to Model Potential Oyster Growth and Mortality in Apalachicola Bay 4-173
4-36 Protected Species Potentially Affected by the Water Allocation Formula in ACF Basin 4-177
4-37 Drainages of the ACF Basin in Which Federally Protected Fish and Mussel Species Are Presently Known to Occur 4-183
4-38 Annual Average Differences (in feet) Between Recommended Daily Levels and Simulated Daily Levels on W.F. George Lake 4-190
4-39 Existing Land Cover in the ACF Basin, Assumed 1995 4-193
4-40 Urban Areas in the ACF Basin with Populations Greater than 25,000 4-193
4-41 Existing and Future Urban Land Use 4-194
4-42 Existing and Future Agriculture Land Use 4-195
4-43 Existing and Future Forest Land Use 4-196
4-44 Existing and Future Water Land Use 4-197
4-45 Public Land and Resource Protection Areas in the ACF Basin 4-198
4-46 Land and Water Acreage at Corps Projects in the ACF Basin 4-201
4-47 Military Installations in the ACF Basin 4-203
4-48 Population Growth in the ACF Basin 4-205
4-49 Demographics for the ACF Basin, 1990 4-206
4-50 Persons Below the Poverty Level in the ACF Basin, 1990 4-207
4-51 Projected Population Growth in the ACF Basin 4-208
4-52 ACF Study Projects Included in Phase I of the Comprehensive Study 4-210
4-53 Annual Boat Recreation Visitation Estimates for ACF Basin 4-211
4-54 Recreation Facilities on ACF Project Reservoirs 4-212
4-55 Annual Recreation Visitation Estimates for Reservoirs in the ACF Basin, 1995 4-213
4-56 Activity Participation on Project Reservoirs in the ACF Basin, 1995 4-213
4-57 Annual Recreation Visitation Estimates for Rivers in the ACF Basin, 1995 4-215
4-58 Activity Participation on Project Rivers in the ACF Basin, 1995 4-215
4-59 Recreation Trips, ACF Basin 4-217
4-60 Comparison of Seasonal Recreation Visitation for Lake Sidney Lanier, 2050 4-218

4-61 Optimal Flows for Recreation Activities in the Chattahoochee River from Buford Dam to Peachtree Creek 4-223
4-62 Modeled Flows in the Chattahoochee River between Buford Dam and Peachtree Creek 4-223
4-64 ACF Rivers Waterborne Commerce 4-226
4-64 Operative Main Stem Dams/Reservoirs in the ACF Basin 4-227
4-65 Peak Hour Demand (MH) and Net Annual Energy (MWh), Southern Subregion 4-228
4-66 Local and Total Per-Trip Spending, Total Annual Spending, Per-Trip National Economic Development (NED) Benefits, and Total Annual NED Benefits 4-230
4-67 Total Personal Income in the ACF Basin 4-231
4-68 Real Per Capita Income Trends in the ACF Basin 4-231
4-69 Employment Trends in the ACF Basin 4-232
4-70 Nonfarm Employment by Industry in the ACF Basin, 1995 4-233
4-71 Economic Impact of Action Alternative Flow Scenarios, ACF 4-234
4-72 Economic Impacts by State for Action Alternative Flow Scenarios 4-234
4-73 Annual Commodity Forecasts, Short Tons 4-235
4-74 Average Yearly Transportation Costs 4-236
4-75 Direct Impacts on Navigation 4-236
4-76 ACF Average Annual Energy Production (MWh) 4-237
4-77 ACF Average Annual Energy Loss (MWh) 4-237
4-78 ACF Average Annual Energy Direct Impacts (1998 $) 4-237
4-79 Recreation Economic Values ACF Basin 4-240
4-80 Impact Summary Annual Average, ACF Basin 4-240
4-81 Projected Real Per Capita Personal Income in the ACF Basin 4-241
4-82 Direct Economic Impacts by State and for ACF Basin for Action Alternative Scenarios 4-242
4-83 Regional Economic Impacts: State and ACF Basin Results for Action Alternative Scenarios 4-243
4-84 Projected Nonfarm Employment in the ACF Basin 4-245
4-85 Regional Economic Impacts: State and Basin Results for Action Alternative Scenarios 4-245
4-86 National Ambient Air Quality Standards 4-247
4-87 Class I Air Quality Areas in the ACF Basin 4-249
4-88 Percent Contribution of Each Source Identified by Respondents Classifying their Neighborhood as Noisy on a National Basis 4-250
4-89 Estimated Percentage of People Residing in Urban Areas that Are Exposed to Various Levels of Outdoor Day/Night Average Sound Level 4-250
4-90 Estimated Percentage of the Urban Population Residing in Areas with Various Day-Night Noise Levels Together with Customary Qualitative Description of the Area 4-251
4-91 Potential Cultural Resource Impacts by Alternative 4-257

Figures

1-1 Site Map of the ACF Basin 1-12
1-2 Public Involvement Opportunities in the EIS Process 1-15
1-3 Location of the Nodes for the ACF Basin 1-26

4-1 Map of the ACF Basin 4-11
4-1 Map of the Counties in the ACF Basin 4-12
4-3 Average Annual Precipitation in the ACF Basin 4-13
4-4 Physiographic Provinces and Districts of the ACF Basin 4-16
4-5 Major Aquifers and Subareas in the ACF and ACT Basins 4-17
4-6 Generalized Geologic and Hydrologic Units in the Coastal Plain of the ACF Basin 4-18
4-7 Stratigraphic and Hydrologic Units in the Lower ACF Basin 4-21
4-8 Major Land-Resource Areas in the ACF Basin 4-24
4-9 Prime Farmlands in the ACF Basin 4-26
4-10 Soil Mapping Units with High Leaching Rating in the ACF Basin 4-27
4-11 Soil Mapping Units with High Runoff Rating in the ACF Basin 4-28
4-12 Relationship of Stream Velocity to Erosion, Transport, and Deposition of Various Grain Sizes 4-29
4-13 Bed Material Median Grain Sizes in the Apalachicola River Below Jim Woodruff Dam 4-30
4-14 West Point Lake Shoaling 4-31
4-15 Walter F. George Lake Shoaling 4-32
4-16 Lake Seminole Shoaling 4-32
1-17 Lake Seminole, Tailwater Degradation, 1954 to 1994 4-34
4-18 Monthly Precipitation at Atlanta and Albany, Georgia, Based on 1956 to 1997 Data (ACF Basin) 4-36
4-19 Basin Water Gains and Losses (ACF Basin) 4-37
4-20 Water Resources Subbasin Map of the ACF Basin 4-38
4-21 Longitudinal Profile of the Apalachicola, Chattahoochee, and Flint Rivers 4-39
4-22 Comparison of Natural and Regulated Flows 4-41
4-23 Navigation Projects in the ACF Basin 4-45
4-24 Navigation Window Period – 1995 Apalachicola River at Chattahoochee, Florida (ACF Basin) 4-46
4-25 Location of Mainstem Dams and Power-Generating Plants in the ACF Basin 4-47
4-26 Schematic of Reservoir Storage (ACF Basin) 4-51
4-27 Lake Lanier Action Zones Within the Conservation Pool (ACF Basin) 4-51
4-28 Water Storage in the ACF Basin 4-52
4-29 Typical Daily Variation in Buford Dam Discharge 4-53
4-30 Surface Water Withdrawals from Thermal Power Plants and Municipalities Serving Populations of Greater than 10,000 4-60
4-31 Ground and Surface Water Withdrawals by Principal Water Use Categories in the ACF Basin, 1990 4-61
4-32 ACF Interbasin Transfer Schematic 4-61
4-33 Chattahoochee River at Whitesburg. 90 percent Exceedance. Critical Drought Period, No Action Alternative 4-74
4-34 Chattahoochee River at Whitesburg. Low Flows. Full Period, Action Alternative. 2050 Demands 4-74
4-35 Chattahoochee River at Whitesburg. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands 4-75
4-36 Chattahoochee River at Whitesburg. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands 4-76
4-37 Chattahoochee River at George Andrews Dam. 90 Percent Exceedance. Critical Drought Period, No Action Alternative 4-77

4-38 Chattahoochee River at George Andrews Dam. Low Flows. Full Period, Action Alternative. 2050 Demands 4-77
4-39 Chattahoochee River at George Andrews Dam. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands 4-78
4-40 Chattahoochee River at George Andrews Dam. 90 Percent Exceedance. Critical Drought Period, Action Alternative, 2050 Demands 4-79
4-41 Flint River at Albany. 90 Percent Exceedance. Critical Drought Period, No Action Alternative 4-80
4-42 Flint River at Montezuma. Low Flows. Full Period, Action Alternative. 2050 Demands 4-81
4-43 Flint River at Albany. Low Flows. Full Period, Action Alternative. 2050 Demands 4-81
4-44 Flint River at Bainbridge. Low Flows. Full Period, Action Alternative. 2050 Demands 4-82
4-45 Flint River at Albany. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands 4-83
4-46 Flint River at Albany. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands 4-83
4-47 Apalachicola River at Chattahoochee, Florida. 90 Percent Exceedance. Critical Drought Period, No Action Alternative 4-84
4-48 Apalachicola River at Chattahoochee, Florida. Low Flows. Full Period, Action Alternative. 2050 Demands 4-85
4-49 Apalachicola River at Sumatra. Low Flows. Full Period, Action Alternative. 2050 Demands 4-85
4-50 Apalachicola River at Chattahoochee, Florida. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands 4-86
4-51 Apalachicola River at Chattahoochee, Florida. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands 4-87
4-52 Lake Lanier. 90 Percent Exceedance, Critical Drought Period, No Action Alternative 4-88
4-53 Lake Lanier. Low Elevations. Full Period, Action Alternative. 2050 Demands 4-89
4-54 Lake Lanier. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands 4-90
4-55 Lake Lanier. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands 4-91
4-56 West Point Lake. 90 Percent Exceedance. Critical Drought Period, No Action Alternative 4-92
4-57 Walter F. George Lake. 90 Percent Exceedance. Critical Drought Period, No Action Alternative 4-92
4-58 West Point Lake. Low Elevations. Full Period, Action Alternative. 2050 Demands 4-93
4-59 Walter F. George Lake. Low Elevations. Full Period, Action Alternative. 2050 Demands 4-93
4-60 West Point Lake. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands 4-94
4-61 Walter F. George Lake. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands 4-95
4-62 West Point Lake. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands 4-95

4-63 Walter F. George Lake. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands 4-96
4-64 Lake Seminole. 90 Percent Exceedance. Critical Drought Period, No Action Alternative 4-97
4-65 Lake Seminole. Low Elevations. Full Period, Action Alternative. 2050 Demands.. 4-97
4-66 Lake Seminole. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands 4-98
4-67 Lake Seminole. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demand 4-98
4-68 Apalachicola River at Blountstown Navigation Channel Availability. No Action Model With 2050 Moderate Demands 4-100
4-69 Apalachicola River at Blountstown Navigation Channel Availability. Low Flow Scenario with 2050 Demands 4-101
4-70 Apalachicola River at Blountstown Navigation Channel Availability. High Flow Scenario with 2050 Demands 4-102
4-71 Peak Flood Frequency at West Point 4-103
4-72 Peak Flood Frequency at Lake Lanier 4-104
4-73 Municipal and Industrial Demand Shortages 4-106
4-74 General Water Quality Conditions in the ACF Basin 4-109
4-75 Major Municipal and Industrial Discharges in the ACF Basin 4-114
4-76 Dissolved Oxygen in Chattahoochee River at Whitesburg. No Action Alternative 4-120
4-77 Water Temperature Data for Upper Chattahoochee River Basin. No Action Alternative 4-121
4-78 Water Temperature Data for Upper Chattahoochee River Subbasin. 2050 Demands 4-123
4-79 Average Stream Percent Wastewater in Summer for Upper Chattahoochee River Subbasin. 2050 Demands 4-124
4-80 Summer Dissolved Oxygen in Lower Chattahoochee River Subbasin Reservoir Tailraces. No Action Alternative 4-126
4-81 Summer Chlorophyll *a* Concentrations in Reservoirs in the Lower Chattahoochee Subbasin. No Action Alternative 4-127
4-82 Summer Dissolved Oxygen in Lower Chattahoochee Subbasin Reservoirs. 2050 Demand. Action Alternative 4-129
4-83 Summer Chlorophyll *a* Concentrations in Reservoirs in the Lower Chattahoochee River Subbasin. 2050 Demands. Action Alternative 4-130
4-84 Summer Dissolved Oxygen in Apalachicola River Subbasin Riverine Section. No Action Alternative 4-133
4-85 Summer Dissolved Oxygen in Apalachicola River Subbasin Reservoirs. 2050 Demands. Action Alternative 4-134
4-86 Locations of Riverine Aquatic Resource and Riparian Wetland Study Sites in the ACF Basin 4-144
4-87 Habitat Associations for Five Species with EFH Designated in Apalachicola Bay (ACF Basin) 4-158
4-88 Riverine Habitat Performance Measure Scores, Lower Chattahoochee River (Site 3), Summer/Fall (ACF Basin) 4-164
4-89 Median Reservoir Fisheries Performance Measure Scores for Lake Lanier (ACF Basin) 4-168

4-90 Daily Reservoir Elevations of Lake Lanier. Action Alternative Flow Scenario for the Critical Low Flow Period (ACF Basin) 4-171
4-91 Water-Dependent Federally Endangered and Threatened Species by Subbasin Within the ACF Basin 4-176
4-92 Existing Land Cover in the ACF Basin 4-191
4-93 Land Use Cover Patterns in the ACF Basin 4-192
4-94 Major Pubic Lands and Resource Protection Areas in the ACF Basin 4-200
4-95 Population Distribution in the ACF Basin 4-205
4-96 Lake Lanier Comparison of Recreation Trips, 2050 (ACF Basin) 4-218
4-97 West Point Lake Comparison of Recreation Trips, 2050 (ACF Basin) 4-219
4-98 Walter F. George Lake Comparison of Recreation Trips, 2050 (ACF Basin) 4-220
4-99 Lake Seminole Comparison of Recreation Trips, 2050 (ACF Basin) 4-221
4-100 Apalachicola River Comparison of Recreation Trips for Action Alternative, 1995 4-222
4-101 Level of Relative Impact Significance to Cultural Resources 4-260

Appendices, Volume 1

Appendix A: Letters and Memorandums of Agreement and ACF Basin Compact

- Letters of Agreement
- Memorandums of Agreement
- ACF Basin Compact

Appendix B: Agency Responsibilities

Lead Agency
- U.S. Army Corps of Engineers

Cooperating Agencies
- Environmental Protection Agency
- Fish and Wildlife Service
- U.S. Geological Survey
- National Park Service
- Natural Resources Conservation Service
- Forest Service
- NOAA, National Marine Fisheries Service
- NOAA, National Ocean Service
- Southeastern Power Administration
- Department of Transportation, Maritime Administration

States of Alabama, Florida, and Georgia

Appendix C: Public Involvement

- Notice of Intent
- Summary of Scoping Questionnaire Responses

Appendix D: Water Resources

- Current Operation Model and 1977 Conditions Model *
- Flow Matrix Models: ACT and ACF Flow Allocation Formula Assessment *
- Investigation of the Impacts of Navigation Window Operation on the Apalachicola and Chattahoochee Rivers
- Hydrologic Flood Control Investigation: West Point, Allatoona, and Buford Projects
- Tailwater and Downstream Hydrographs
- Nonpoint Source Pollutant Loading Evaluation, ACT & ACF Water Allocation Formula Environmental Impact Statements *
- HEC-5Q Simulation of Water Quality in the ACF River Basin *

Appendices, Volume 2

Appendix E: Biological Resources

- Working Draft Fish and Wildlife Coordination Act Report for the ACF River Basin Water Allocation Formula
- Reservoir Fisheries Assessment for the ACT and ACF Water Allocation Formula Environmental Impact Statements
- Draft Environmental Impact Statement Report: Apalachicola Bay, Florida Component *

Appendix F: Socioeconomic Resources

- Draft Economic Analysis: ACF River Basin Water Allocation Formula Environmental Impact Statement
  - Section 1: Municipal and Industrial Water Supply
  - Section 2: Agricultural Water Supply
  - Section 3: Inland Navigation
  - Section 4: Electric Power Generation
  - Section 5: Recreation
  - Section 6: Urban Flood Control
  - Section 7: Indirect or Regional Economic Impacts
  - Section 8: Cumulative Economic Impacts
- Draft Riverine Recreation Analysis, Chattahoochee River National Recreation Area

Appendix G: Cultural Resources *

Appendix H: Relevant Statutes and Executive Orders

Archaeological Resources Protection Act of 1976 (16 U.S.C. § 470 et seq.)
Clean Air Act (42 U.S.C. § 7401-7671g)
Clean Water Act (33 U.S.C. § 1251 et seq.)
Endangered Species Act (16 U.S.C. § 1531 et seq.)
Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.)
Magnuson Fishery Conservation and Management Act (16 U.S.C. § 1801 et seq.)
Marine Protection, Research, and Sanctuaries Act of 1972
(33 U.S.C. § 1401- 1445; 16 U.S.C. § 1431 et seq.; also 33 U.S.C. § 1271)
National Environmental Policy Act of 1969 (42 U.S.C. § 4321-4347)
National Historic Preservation Act of 1966 (NHPA), as amended
(16 U.S.C. § 470 et seq.)
North American Wetlands Conservation Act (16 U.S.C. § 4401 et seq.)
Resource Conservation and Recovery Act (43 U.S.C. § 2101-2106)
Safe Drinking Water Act (42 U.S.C. § 300f et seq., 6939b; 15 U.S.C. § 1261 et seq.)
Watershed Protection and Flood Prevention Act (16 U.S.C. § 1001 et seq.;
33 U.S.C. § 701b)
Executive Order 12898, "Federal Actions to Address Environmental
Justice in Minority Populations and Low Income Populations," February 11, 1994
Executive Order 12088, "Federal Compliance with Pollution Control Standards,"
October 13, 1978
Executive Order 11988, "Floodplain Management," May 24, 1977
Executive Order 11990, "Protection of Wetlands," May 24, 1977
Executive Order 13045, "Protection of Children from Environmental
Health Risks and Safety Risks," April 21, 1997

* These appendix sections contain figures which are best viewed in color, but which have been reproduced in black and white in the hard copy version of the report. To view the figure in color, see the CD-ROM version of the report, a copy of which is included with each hard copy. Additional copies of the CD-ROM are available upon request from the Mobile District of the U.S. Army Corps of Engineers

Glossary

Action alternative: A flow condition that may result from the water allocation formula developed by the State Commissioners (see *bracket, alternative flow conditions,* and *range of flows*).

Alternative flow conditions: Alternative flow conditions include a range of flows (high, moderate, and low) for evaluation, which will serve as a surrogate for the flows that may result from the water allocation formula (see *surrogate, water allocation formula,* and *range of flows*).

Bankfull capacity: The stage at which a stream first overflows its natural banks.

Bracket: Range of flow conditions associated with the water allocation formula that will be negotiated by the states (see *water allocation formula*).

Brackish: Water with a salt concentration greater than freshwater and less than seawater.

Canopy: Tallest vegetation in a community, usually trees more than 30 feet tall or 3 inches in diameter; the tallest grasses or other herbaceous species.

Ceremonial mound: Large mound of earth used prehistorically for many different purposes including rituals.

Component: Any significant portion of an archaeological site or historic resource.

Comprehensive Study: Consensus-based study that determined the capabilities of the water resources of the basin, described the water resource demands of the basin, and evaluated alternatives that would use the water resources to benefit all user groups within the basin (see *action alternative* and *no action alternative*).

Confluence: Point of juncture of two or more streams.

Conservation pool: The portion of reservoir storage generally reserved for power production and water supply.

Consumptive uses: Activities that withdraw water from the basin and return only some or none back to the basin.

Control point: A defined point of interest included in the HEC-5 modeling effort for which HEC-5 computes hydrologic information.

Critical drought: The most severe drought for a region, either recorded or constructed.

Critical period: The time period containing the critical drought. Usually the time starts as the drought begins and reservoirs are full. The time ends after the reservoirs have been returned to full condition.

Daily time-step: The division of hydrologic information into a 24-hour period.

Detritus: Fresh to partly decomposed plant and animal matter.

Draft Environmental Impact Statement (EIS): Publication that documents the environmental conditions, issues, and effects associated with an action affecting the environment and on which the public is invited to review and comment. Comments received from regulatory agencies, organizations, and individuals are addressed in the final EIS (see *final EIS*).

Drainage area: Area measured in a horizontal plane which is enclosed by a location on the stream to the boundaries of the drainage divide.

Drawdown: The action of lowering a reservoir water level by beginning or increasing reservoir releases.

Emergent: Referring to plants that are entirely above water or mostly above water, with only the base remaining submerged.

Endemic: Characteristic of, or prevalent in, a particular area or environment.

Estuarine: Referring to deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

Euryhaline: An organism that is able to tolerate wide fluctuations in salinity.

Final EIS: The final product of the environmental impact statement process, which responds to comments received on the draft EIS (see *draft EIS*).

Flood control pool: The portion of reservoir storage generally reserved for storing peak flood flows.

HEC-5: The computer program, "Simulation of Flood Control and Conservation System" developed by HEC. Performs sequential reservoir operations based on specific project demands and constraints.

HEC-5Q: The computer program, *Simulation of Flood Control and Conservations Systems Water Quality Analysis,* including simulations for water temperature, several conservative and non-conservative constituents, dissolved oxygen, and phytoplankton.

Herbaceous: Nonwoody plant species, such as grasses.

Inactive pool: The portion of reservoir storage below the conservation pool that contains *dead storage.* No reservoir releases are made from the inactive pool.

Indicator of Hydrologic Alteration: A program developed by the Nature Conservancy to analyze complex hydrologic data using simple patterns relevant to ecological interests for each year of record.

Letter of Agreement (LOA): LOAs were used to formalize commitments, agreements, and cooperation between states.

Memorandum of agreement (MOA): An MOA was signed by the affected states (Alabama, Florida, and Georgia) and the United States in June 1983, committing to work together as partners through a Section 308 comprehensive study process to seek resolution of water resource issues and to develop a water management system for the basin. The MOA

identified short-term study efforts and long-range studies. These long-range studies were never completed due to inadequate funds. Subsequent to litigation filed by the State of Alabama, a second MOA was signed by Alabama, Florida, and Georgia in 1992 (see *Section 1.1.4* and *Comprehensive Study*). Several supplements to this MOA were signed during the course of the Comprehensive Study.

Mesic: Area with a moderate amount of moisture.

Minimum stream flow: A low river flow at a specified point in a river. The minimum flow may be a regulated minimum flow or a specific level needed for water supply or other purposes.

Mitigation: The Council on Environmental Quality (CEQ) requires federal agencies, in preparing an EIS, to address appropriate mitigation measures not already included in the proposed action or alternatives. Mitigation measures may avoid, minimize, rectify, reduce, eliminate, or compensate for impacts.

Navigation window: Typically, a 10-day period in which stored water is released to the river and held at specified levels so that shippers have a predetermined depth and adequate lead time to move into the system. The window is used in the summer and fall months when water conditions are too dry for continuous periods of adequate depth.

No action alternative: The no action alternative is the baseline or current operation condition against which the action alternatives are compared. The no action alternative provides the baseline flows for comparing the impacts of the potential allocation formula or future implementing actions.

Nodes: Physical locations or critical modeling points, such as environmental points of interest, USGS stream gauge locations, reservoirs, or other model-related control points.

Offlap: The progressive offshore regression of the updip terminations of the sedimentary units within a conformable sequence of rocks, in which each successively younger unit leaves exposed a portion of the older unit on which it lies. Also, the successive contraction in the lateral extent of strata (as seen in an upward sequence) due to their being deposited in a shrinking sea or on the margin of a rising land mass.

Overload capacity: The maximum amount of electric power delivered by a generating station (all units) under specific conditions. This capacity will equal or exceed the nameplate capacity specified by the manufacturer.

Palustrine: Generally, refers to nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 parts per thousand (ppt).

Peaking project: A project in which hydropower is generated several hours a day, typically on weekdays, in response to system demands. Flows below a peaking project can fluctuate rapidly.

Period of record: Typically, the period for which there are published records for a station. Typically, for the HEC-5 hydrologic modeling, the period of record has been limited to the 55 years included from January 1, 1939 to December 31, 1993.

Plan of Study (POS): A POS was completed in January 1992 to include scopes of work for completion of the Comprehensive Study.

Programmatic Environmental Impact Statement: A programmatic EIS covers general issues in a broad, program-oriented analysis, and provides the reference basis for future tiered evaluations of specific actions when an allocation formula is implemented.

Projectile point: Generic term for spear or arrowheads.

Range of flows: The action alternatives are represented by high, moderate, and low flow conditions that are intended to bracket the flow conditions that may result from the water allocation formula developed by the State Commissioners or future implementing actions (see *action alternative* and *alternative flow conditions*).

Record of Decision (ROD): The ROD will state the Federal Commissioner's decision to concur or not to concur with the water allocation formula developed by the State Commissioners (see *water allocation formula*). Requirement for Federal agencies to prepare a public decision document that demonstrates consideration of environmental impacts described in the EIS before a decision or a major Federal action. The ROD may also outline additional actions or conditions that may be required prior to implementation of the allocation formula or other management actions in the basin.

River basin compact (compact): The compact is an interstate agreement to equitably apportion the surface waters of the river basin.

River reach: The stream length between control points.

Rock outcrop: Area of exposed bedrock.

Run-of-river project: A project in which the reservoir does not fluctuate on a seasonal basis, or that does not seasonally redistribute flows.

Salinity: Measure of the salt concentration in water.

Settlement pattern: The way in which habitation areas are distributed across the landscape.

Stakeholders: Members of the public and representatives of various interest groups who have differing values and who have a "stake" in the outcome of a project.

Storage project: A reservoir designed to re-regulate natural streamflow, providing more dependable yield during the low-flow season. This involves redistributing flow volumes on a seasonal basis. In general, reservoirs are filled in high-flow seasons (winter and spring), and lowered during low-flow seasons (summer and fall).

Streamflow gauge: Location on a river at which water levels and streamflows are measured.

Subcanopy: Vegetation less than 30 feet tall or 3 inches in diameter in a vegetative community.

Submersed: Plants that are adapted to and normally occur entirely below water.

Surcharge storage: The portion of reservoir storage above the flood control pool that stores water above the emergency spillway.

Tailwater rating: The unique relationship between flow (cfs) and water surface elevation (feet), which exists immediately downstream of a dam.

Tiering: Multi-level approach to preparing National Environmental Policy Act documents. The first tier, or programmatic EIS, covers general issues in a broad, program-oriented analysis. Subsequent tiers incorporate by reference the general discussions from the broader EIS, while concentrating on issues specific to the action being evaluated. Agencies are encouraged to tier EISs to avoid repeating issues and to focus on the issues required for decision at each level of review.

Time step: The division of hydrologic information into incremental units of time for use in HEC-5 modeling.

Trophic level: Classification of organisms in an ecosystem according to feeding relationships.

Unimpaired flow: Historically observed flows adjusted to account for the construction of large surface water reservoirs, withdrawals and returns for municipal and industrial water uses, and withdrawals for crop irrigation.

Unregulated flow: Flows that would be present in a stream, at a specific location, if no reservoirs existed. Also, this definition applies to flows once the effects of a reservoir have been removed by some computational method.

Water allocation formula (allocation formula): As defined by the river basin compact, a means of equitably apportioning the surface waters of the basin while protecting water quality, ecology, and biodiversity.

Water demand scenario (scenario): The water demand scenarios represent assumptions of water consumption. Agreed to by a consensus of the Comprehensive Study partners, the scenarios reflect different levels of water demand and conservation in the basin and are used for purposes of analysis. Estimate of future consumption.

Withdrawal site: Facility that withdraws water from the river system.

Executive Summary

Introduction

This draft environmental impact statement (EIS) was prepared in response to the negotiated interstate agreement between Alabama, Florida, and Georgia, and the United States under the Apalachicola-Chattahoochee-Flint (ACF) River Basin Compact (Compact). This agreement may result in changes in the allocation of surface water within the basin, changes that could have significant impacts to the human and natural environment. As a result, the decision to implement a change in water allocation is considered a significant action and warrants the preparation of this EIS. This EIS, therefore, was developed to provide the information to be used by an appointed Federal Commissioner to either concur or not concur with the water allocation formula that will be developed by the ACF Compact Commission as required under the Compact.

Because the area affected is very large and represents multiple reservoirs and basins where these changes may take place, this EIS follows a *programmatic* or broad view of these potential impacts. Under the National Environmental Policy Act (NEPA), which provides the guidelines and regulations that define how an EIS is conducted, a programmatic EIS is appropriate if the proposed action may result in broad, regional impacts, or if the actual implementing actions are unknown but are likely to result in several predictable actions that could result in cumulative impacts within a study area. Once the decision has been made regarding the surface water allocation, specific actions that must be taken to implement the decision must be identified and may require follow-on site-specific environmental assessments (EAs) or EISs tailored to these individual implementing actions.

The allocation formula to be presented to the Federal Commissioner for a decision was not finalized at the time this draft EIS was produced. To provide an evaluation of potential impacts that might arise from the formula when it is finalized, an analytical framework was used in this draft EIS to "bracket" a range of flow scenarios that is expected to include the flow conditions that will result from the final formula adopted by the ACF Compact Commission. These impact analyses will be updated as necessary for the final EIS when the allocation formula has been completed.

This document has been prepared by the U.S. Army Corps of Engineers (Corps) Mobile District in cooperation with 10 other Federal agencies. These other agencies are:

- Environmental Protection Agency
- Fish and Wildlife Service
- Forest Service
- Maritime Administration
- National Marine Fisheries Service
- National Ocean Service
- National Park Service
- Natural Resources Conservation Service
- Southeastern Power Administration
- U.S. Geological Survey

The States of Alabama, Florida, and Georgia also provided input review, and comments during the preparation of this EIS.

Background

The ACF basin originates in north Georgia and Alabama, and terminates in Florida in Apalachicola Bay. It extends a distance of approximately 385 miles and encompasses an area of 19,600 square miles. The drainage area is comprised of the Apalachicola, Chattahoochee, and Flint Rivers and their tributaries. During the last 160 years, the water resources in the basin have been developed to meet various demands for municipal and industrial water supply, flood control, hydropower, navigation, fish and wildlife conservation, recreation, and agricultural water supply. There are hundreds of reservoirs in the basin, but 16 (5 Federal and 11 non-Federal) are located on these three principal rivers. They provide for regional uses of the basin water resources for navigation, hydropower, flood control, water supply, recreation, and fish and wildlife.

Rapid growth in the metropolitan Atlanta area and north Georgia since 1950 has caused large increases in water demands. As a result, the Corps received requests from several local municipalities in the 1980s to reallocate water in its north Georgia reservoirs. Droughts that occurred in 1981, 1986, and 1988 heightened the public's concern and awareness of water management in the basin. In the late 1980s, water supply reallocations were being studied by the Corps for Lake Allatoona, Carters Lake, and Lake Lanier. In November 1989, Alabama requested suspension of the reallocation studies pending completion of comprehensive economic and environmental impact analyses. In 1990, the Corps completed the Carters Lake report and recommended reallocation of reservoir storage to water supply for the City of Chatsworth, and the State of Georgia submitted plans for a water supply reservoir on the Tallapoosa River. Subsequently, the State of Alabama filed litigation challenging the proposed water reallocations in north Georgia. The States of Alabama, Georgia, and Florida and the Corps met to resolve this conflict outside the legal system. The initial meetings of the States and the Corps led to initiation of the Comprehensive Study of resources in the ACF basin and in the Alabama-Coosa-Tallapoosa River Basin (ACT basin) in 1992.

Comprehensive Study

The Comprehensive Study was undertaken by Alabama, Florida, Georgia, and the Corps for both the ACF and ACT basins, as directed by a memorandum of agreement (MOA) among the three States and the U.S. Department of the Army. The study was consensus based, requiring the approval of all participants on all of the elements. The purpose of the Comprehensive Study was:

> *. . . to determine the capabilities of the Water Resources of the basins, to describe the water resource demands of the basins, and to evaluate alternatives which utilize the Water Resources to benefit all user groups within the basins.*

The Comprehensive Study has provided technical understanding of the water resources in both river basins and basin-specific tools to evaluate the water management alternatives. *Table ES-1* presents the various elements of the Comprehensive Study that were approved and funded.

TABLE ES-1
Elements of the ACT/ACF Comprehensive Study

Process Support Elements	Water Resources Availability	Water Demand Elements	Comprehensive Management Strategy
Population and employment forecasts	Surface water	Agriculture water demand	Basinwide management
Database	Groundwater	Environmental water demand	Coordination mechanism
Public involvement		Power resources water demand	
		Municipal and industrial water demand	
		Navigation water demand	
		Recreation water demand	
		Water quality water demand	
		Apalachicola River and Bay water demand	

Source: Comprehensive Water Resource Study Partners, September 1995

ACF River Basin Compact

In 1996, Alabama, Florida, and Georgia agreed to develop and implement an interstate water compact for the ACF basin with the purposes stated above. State negotiations for the compact began in September 1996, with a series of negotiating sessions held through January 1997. On January 13, 1997, each of the States and the Federal government, represented by the Department of Justice, reached agreement on the compact language.

The ACF River Basin Compact was passed by the Georgia legislature in January 1997 by the Alabama legislature in February 1997, and by the Florida legislature in March 1997. In a joint letter dated May 14, 1997, the three governors submitted the ACF Compact to the three States' congressional delegations, which introduced the Compact into Congress on June 27, 1997. On November 7, 1997, Congress passed the Compact and sent the bill to the President, who signed it into law (Public Law [PL] 105-104) on November 20, 1997.

The Compact creates an interstate administrative agency, the ACF Basin Commission, which is composed of the Governors of Alabama, Florida, and Georgia (who make up the State Commissioners), and a Federal Commissioner appointed by the President of the United States.

The Compact directs the parties to the Compact to:

> *. . . develop an allocation formula for equitably apportioning the surface waters of the ACF Basin among the States while protecting the water quality, ecology, and biodiversity of the ACF, as provided in the Clean Water Act, 33 U.S. Code (U.S.C.) section 1251 et seq., the Endangered Species Act, 16 U.S.C. Sections 1532 et seq., the National Environmental Policy Act, 42 U.S.C. Sections 4321 et seq., the Rivers and Harbors Action of 1899, 33 U.S.C. Sections 401 et seq., and other applicable Federal laws.*

After the water allocation formula is developed and unanimously approved by the State Commissioners, it becomes binding:

> *. . . upon receipt by the Commission of a letter of concurrence with said formula from the Federal Commissioner. If, however, the Federal Commissioner fails to submit a letter of concurrence to the Commission within 210 days after the allocation formula is agreed upon by the State Commissioners, the Federal Commissioner shall within 45 days thereafter submit to the ACF Basin Commission a letter of nonconcurrence with the allocation formula setting forth therein specifically and in detail the reasons for nonconcurrence; provided, however, the reasons for nonconcurrence as contained in the letter of nonconcurrence shall be based solely upon Federal law. The allocation formula shall also become effective and binding upon the parties to this Compact if the Federal Commissioner fails to submit to the ACF Basin Commission a letter of nonconcurrence.*

In ratifying the Compact, Congress clarified that:

> *. . . the Federal Commissioner may submit a letter of concurrence with the allocation formula adapted by the State Commissioners within 255 days of such adoption.*

Purpose and Need

Article VII of the Compact requires the Federal Commissioner to concur or not concur with the water allocation formula as developed by the State Commissioners. This EIS evaluates the environmental and socioeconomic impacts of the proposed water allocation formula, including information and analyses provided by the cooperating Federal agencies. The EIS will be available to the public, the Federal Commissioner, Federal agencies, and the States to assist them in reviewing or developing an allocation formula. The EIS will form the basis for the Federal Commissioner's decision on the allocation formula approved by the State Commissioners. The EIS will also serve as a baseline document to assist the Corps in making future reservoir management decisions in the basin, and as an information base to assist Federal agencies in managing their programs in the basin.

Scope of the EIS

This EIS focuses on the potential impacts of surface water allocation within the watersheds of the Apalachicola, Chattahoochee, and Flint Rivers, including Apalachicola Bay. The EIS must address the potential impacts of water allocation and future basin management decisions on a very large basin that extends approximately 385 miles from northeast Georgia to Apalachicola Bay and the Gulf of Mexico in Florida. The watersheds of the Apalachicola, Chattahoochee, and Flint Rivers, which form this basin, encompass approximately 19,600 square miles. In addition, this EIS evaluates the effects of water allocation on a broad range of resources, including water resources, biological resources, socioeconomic resources, and cultural resources. Potential changes in stream flows associated with the water allocation are evaluated over a long planning period (1995-2050) to address incremental changes in water management and future changes that may be required to implement the final water allocation formula, taking into account future demands on water resources in the basin.

To address this wide geographic area and lengthy planning period, this EIS has been prepared as a *programmatic* document. Programmatic EISs are prepared when a proposed action will affect a large geographic area or will be composed of a series of smaller actions that will have similar and potentially cumulative effects, or to allow evaluation of a project early in the planning stages so that changes can be made, if needed, to minimize the potential impacts. Programmatic EISs focus on planning-level and conceptual impacts; they identify the resource areas that will require additional focus in the documents that tier from them. This is done because when a programmatic EIS is prepared, all of the details associated with the proposed action are often unknown, but it is accepted that a number of smaller actions or projects will be required to complete the proposed action.

For the ACF water allocation, the actual water allocation formula was not available at the time this draft EIS was prepared but it is assumed that operational changes at some of the reservoirs and lakes within the basin may be required in order to implement the formula. However, the types of changes that may be required and the reservoirs and lakes that will be affected will not be known until the final water allocation formula is known and the implementation strategy has been prepared. As a result, this EIS focuses on identifying environmental and socioeconomic resources that could potentially be affected by the implementation of the water allocation formula and describes them in a way that allows a planning-level review of the water allocation formula. Once the details of the water allocation formula are known and the implementation strategy has been prepared, project-specific NEPA documents will be prepared that focus on the environmental and socioeconomic impacts expected to occur once the water allocation formula is implemented at a specific reservoir or lake. The programmatic EIS can also be used as a baseline document for other Federal actions or programs in the basin. A separate EIS is also being prepared to address impacts of allocation of surface water resources within the ACT basin.

Proposed Action

At the time this draft EIS was prepared, Alabama, Florida, and Georgia were in negotiations to develop an allocation formula for the equitable allocation of water resources within the ACF basin. Under the ACF Compact between these States, a Federal Commissioner must approve the proposed allocation formula before it can be implemented. The Federal Commissioner's decision to concur or not concur with implementation of the allocation formula represents the proposed Federal action.

Potential Water Allocation Mechanisms

A number of approaches have been used by other States to develop water allocation formulas. The approaches that have been used vary in their treatment of the type of hydrologic standards used, the time scales over which the hydrologic variables are measured, and the need to determine water availability. Water allocation formulas based on hydrologic standards are typically easier to monitor because they rely on fixed flows or quantities of water at specific locations. The final formula, as stated in the Compact, *"may be represented by a table, chart, mathematical calculation, or any other expression of the Commission's apportionment of water"* (PL 105-104). The final EIS will contain a detailed description of the final negotiated water allocation formula and the approaches that will be used to allocate the surface water resources in the basin.

Process and Status for Developing the Allocation Formula

The difficult negotiation process to develop an allocation formula for the ACF basin has begun. State Allocation Formula Committee representatives have been appointed by the governors of the States. A Federal Commissioner has also been appointed by the President as a nonvoting member. The committee is holding meetings, which are open to the public, on a regular basis. Initial meetings discussed guiding principles and concepts that will form the basis of a negotiated allocation formula. Draft proposals for an allocation formula have also been presented by State Commissioners for consideration by the Compact Commission.

Proposed Implementation Approach

The approach that the ACF Compact Commission will adopt for the final water allocation formula may include a variety of hydrologic, time scale, and water availability allocation approaches. If implementing the water allocation formula requires changes in project authorizations or how the Corps operates its reservoirs in the ACF basin, new water control manuals and additional NEPA documentation may be necessary to evaluate the site-specific impacts that could result from these specific changes in operation. If implementing the water allocation formula requires changes in operations at reservoirs operated by private entities, such as Georgia Power Company, the ACF Commission will work with those entities and the appropriate regulatory agencies to make the changes in reservoir operations while maintaining, to the extent practicable, the goals and objectives of the specific project (power generation, water supply, and recreation).

Alternatives Considered

The alternatives considered for this draft EIS are the no action alternative (existing operating conditions) and a range of alternative flow conditions selected to bracket the water allocation formula to be developed by the State Commissioners. This EIS also presents a review of the historical changes in operations and demands that have occurred since approximately 1977. Operation of the Federal projects in the basin has changed incrementally since the late 1970s, when the last NEPA evaluation of water management in the basin was performed. The analysis of historical operations provides a perspective for evaluating impacts of the existing operating condition (no action alternative).

To provide a basis for evaluating the potential flows that could be included in the final water allocation formula and to meet a schedule for completing the final EIS by late summer 1999, this draft EIS uses a *programmatic evaluation framework.* Alternative flow scenarios in this framework provide a range of reservoir operations during critical low flow periods for evaluation. The range of flows resulting from these operations is intended to "bracket" or encompass the flows that may result from the final water allocation formula. To evaluate the potential environmental and socioeconomic impacts associated with different flows, hydrologic modeling of each of the alternative flow scenarios within the high, moderate, and low reservoir release range was compared with operations for the no action and the historical operating conditions alternatives. The environmental and socioeconomic impacts associated with this range of operations are expected to "bracket" or encompass the potential impacts associated with the flows that will result from the final water allocation formula developed by the States and approved by the Compact.

Continue Existing Operations: the No Action Alternative

As required by NEPA, the no action alternative is the baseline condition against which the action alternative flow scenarios are compared. The no action alternative provides the baseline flows for comparing the impacts of the potential range of alternative flow conditions. The baseline represents the conditions in the ACF basin at the time the Comprehensive Study elements were prepared. In this EIS, the no action alternative assumes that existing project operations will continue unchanged into the future.

Baseline conditions for the no action alternative were also addressed for future water supply demand conditions. There are other assumptions that could be considered, such as capping withdrawals at present permitted levels. However, the water supply demands used for the no action alternative were selected from the Comprehensive Study and provide the best current estimates of future water use. The no action alternative is based on current water use patterns, taking into account baseline water supply demands (1995 demand year) and increasing water supply demands in the future (2020 and 2050, future demand years targeted by the Comprehensive Study). ***Table ES-2*** summarizes the demand assumptions used for the no action and action alternative flow scenarios.

The last major evaluations of the environmental consequences of the individual operating reservoirs in the ACF basin were included in the EISs completed in the mid-to late-1970s. Since then, incremental changes have occurred in the project operations and water resource demands that have affected hydropower contracts and operating schedules, navigation flow requirements, and requirements for water quality environment demands or other uses of the system. Historical records maintained by the Corps illustrate the impacts of changes in operations or seasonal variations over time on pool levels and flow releases. Comparing historic operations with existing conditions provides a complete picture of the impacts related to changes in water demand and water resource management in the basin, as well as a perspective on existing flows to plan for future changes.

Action Alternative Flow Scenarios

A range of alternative flow conditions was evaluated in this draft EIS using a combination of projected water supply demands, and reservoir releases and operations that would represent the upper (high flow) and lower (low flow) boundaries during the time of year when minimum stream flows normally occur. The current and projected future water supply demands were selected from the Comprehensive Study and are presented in ***Table ES-2.*** The range of reservoir operations and releases was varied in the action alternative to provide a wide range of potential stream flows during critical low flow conditions.

Table ES-2 summarizes the three flow conditions evaluated for the action alternative flow scenarios: high, moderate, and low flows. These flow conditions represent the range of foreseeable options for municipal, industrial, and agricultural demand and reservoir operations that could result from the water allocation formula being developed by Alabama, Florida, and Georgia. The flow conditions using current day demands (1995 demand scenario) were used to evaluate the immediate to short-term environmental and socioeconomic effects that could occur when the water allocation formula is implemented, and to provide a baseline for comparison of future impacts due to increased demand

through time. The predicted flows for the years 2020 and 2050 served as the basis for evaluating environmental consequences for future time periods.

TABLE ES-2
Alternatives Considered Applicable to the ACF Basin EIS

		Action Alternative Flow Scenarios		
Year	**No Action Alternative**	**High Flow Conditions**	**Moderate Flow Conditions**	**Low Flow Conditions**
1995	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 3 with aggressive conservation	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 1 with no conservation
	Agricultural scenario 2 with no conservation	Agricultural scenario 3, low demand with conservation	Agricultural scenario 2, expected demand without conservation	Agricultural scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2020	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 3 with aggressive conservation	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 1 with no conservation
	Agricultural scenario 2 with no conservation	Agricultural scenario 3, low demand with conservation	Agricultural scenario 2, expected demand without conservation	Agricultural scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2050	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 3 with aggressive conservation	Municipal and industrial scenario 1 with no conservation	Municipal and industrial scenario 1 with no conservation
	Agricultural scenario 2 with no conservation	Agricultural scenario 3, low demand with conservation	Agricultural scenario 2, expected demand without conservation	Agricultural scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases

Note: Demand scenarios for municipal and industrial, and agricultural uses were developed for the Comprehensive Study (Planning and Management Consultants, 1996; NRCS, 1995).

Reservoir releases refers to the operation of reservoirs to maintain or enhance flows in the rivers during critical low flow periods.

High reservoir releases means that the reservoirs will be operated to maintain the highest practicable minimum flows in the rivers during critical low flow periods.

Low reservoir releases means that the reservoirs will be operated to maximize storage within the reservoirs and to provide the lowest reasonable releases or minimum flows in the rivers during critical low flow periods.

A combination of high reservoir releases and low water supply demand comprise the highest flow conditions. The lowest flow conditions are represented by a combination of low reservoir releases and high water supply demand. Reservoir releases for the moderate flow condition represent reservoir releases between the high and low flow conditions, combined with moderate water supply demands. These combinations of reservoir releases and water supply demands are expected to bracket the flow conditions for the water allocation formula developed by the State Commissioners.

Potential Impacts Associated with the No Action and Action Alternatives

The following section provides a summary of the potential impacts on each major resource area.

Geology and Soils

The physiographic provinces within the ACF basin include the Blue Ridge, Piedmont, and Coastal Plain physiographic provinces. Impacts on these geological resources under either the no action alternative or the action alternative flow scenarios would be insignificant. A cumulative effect of increased dependence on groundwater in conjunction with other demands for groundwater could increase localized subsidence; the formation of sinks could increase localized changes in groundwater recharges and discharges, and alter the landscape.

Soils are transported through erosion and sedimentation; therefore, variations in stream flow and reservoir elevations would potentially affect soil transport. Under the no action alternative, future water demand would cause minor decreases in stream flow and reservoir elevations through the year 2050. Some increases in sedimentation may result from the reduced stream velocity. These impacts would be similar to those found with the moderate flow scenario.

In the lowest flow scenario, stream releases would be reduced, particularly during dry conditions. Because the energy of stream currents affects movement of sediments in streams, these low flows could result in increased sediment deposition in some stream segments. In the low flow scenario, reservoirs would be maintained at higher, more stable levels. Some additional erosion along shorelines with erodible soils may be expected under this scenario in areas in which winds would produce wave action affecting these soils. With the highest flow scenario, stream flows would be higher in summer and lower during winter, as compared with other scenarios. The higher summer flows would benefit stream segments with high sediment deposits by transporting these materials downstream. In the reservoirs, water levels would be lower in summer and fall, thereby potentially reducing shoreline erosion problems.

Water Resources

Water Quantity

The three principal rivers in the ACF basin are the Chattahoochee, Flint, and Apalachicola Rivers. The Chattahoochee and Flint Rivers join to form the Apalachicola River in northwest Florida. The Chattahoochee River has a drainage area of 8,770 square miles. The drainage area of the Flint River measures 8,460 square miles. The remaining 2,680 square miles in the ACF basin drains directly into the Apalachicola River.

There are 16 reservoirs located on the mainstems of the Apalachicola, Chattahoochee, and Flint Rivers: 5 are Federally owned by the Corps and 11 are privately owned projects. Of the 16 reservoirs, 13 are on the Chattahoochee River, 2 are on the Flint River, and 1 is on the Apalachicola River. The water resources in the basin are used to meet a variety of demands including municipal and industrial, agricultural, power generation, and navigation.

The Corps modeled the no action and action alternative scenarios over a 55-year period of record during which there were low, average, and high precipitation conditions. During average and high flow years, these models indicate that a water allocation formula is not likely to be a significant issue because water quantities should be sufficient to meet demands. During dry periods, however, allocating flows may have more substantive effects on human and environmental resources. Therefore, the modeling focused on critical low flow periods.

Impacts were evaluated for each of four subbasins in the ACF basin to assess potential effects on flowing rivers, reservoirs in each subbasin, groundwater, navigation, and flood control. Potential impacts on municipal and industrial water demand, thermal power generation, and agricultural demand were also examined.

The no action alternative would maintain river flows and reservoirs similar to existing conditions, with reservoir drawdowns under dry conditions used to augment downstream flows. As demands increase into the future (2020 and 2050), the modeling indicated that reservoir elevations would drop significantly, while river flows could be maintained close to flows that were present under 1995 demands. The greatest effect of increased demands on river flows and reservoir levels under the no action alternative would occur during the summer, when inflows are naturally lower.

With the low flow scenario, river flows would be substantially reduced under all seasons and reservoir levels would be maintained near full pool, except under drought conditions. The low flow scenario would affect riverine resources by severely reducing the availability of water to meet municipal and industrial, thermal, and agricultural water demands. The availability of navigation flows would be reduced slightly in the low flow scenario. The reservoirs would be held near full pool under this scenario, resulting in more flashy downstream flows following rainfall events. These stream fluctuations would result in higher flows in the spring and summer after rainfall than with other scenarios.

The moderate flow scenario was established to maintain target flows between the low flow and high flow scenario target flows. The moderate flow scenario produces river flows that are high in the winter, responding to reservoir seasonal drawdowns, and elevated in the summer (compared to natural inflow conditions), as upstream reservoirs augment river flows during the dry summer months.

The high flow scenario would maintain high river flows in the spring, summer, and fall, but would produce lower flows in the winter than with other scenarios. Since the high flow scenario assumes that there are no seasonal reservoir drawdowns, the model predicted that this scenario would provide lower stream flows in late fall and winter. In contrast, the seasonal drawdowns associated with the low and moderate flow scenarios would provide additional water to augment flows during the late fall and winter. The high flow scenario would provide beneficial impacts on meeting water demands by increasing the amount of water available in rivers. However, the high flow scenario would actually have a negative impact on navigation in the Apalachicola River in the fall since there is no seasonal drawdown that might otherwise provide additional flow for navigation. Navigation availability is slightly higher in the summer under the high flow scenario as compared to the low and moderate flow scenarios.

A flood control analysis compared the impacts of reducing current flood control storage by half and also eliminating it in two reservoirs, Lake Lanier and West Point Lake, compared

to maintaining the current storage in the ACF basin. Eliminating half of the flood control storage was found to increase flood flows significantly below West Point Dam but not below Lake Lanier, compared to maintaining the current storage (no action alternative). Eliminating all flood control storage at Lake Lanier and West Point Lake would significantly increase flood flows below the dams.

Water Quality

Water quality in the ACF basin varies between the headwaters and coastal plain due to differences in land use and point source discharges. In the headwaters, water quality primarily is good although increasing development is increasing nonpoint source runoff. Urban development, municipal wastewater discharges, and combined sources in the middle Chattahoochee River area have degraded existing water quality. The lower Chattahoochee River is influenced by industrial discharges and agricultural runoff. In the Flint River, water quality conditions are influenced by urban runoff in the leadwaters near Atlanta and by agricultural land uses in the lower river basin.

Potential impacts of the no action and action alternative flow scenarios on rivers, reservoirs, and groundwater quality were evaluated for the ACF basin. Direct impacts on rivers under the low flow scenario were higher temperatures and lower dissolved oxygen. Under the high flow scenario, there would be substantial improvement in river water quality during the modeled critical dry periods.

In the reservoirs, the water quality model predicted modest increases in chlorophyll *a* concentrations and nutrient loadings to the reservoirs between 1995 and 2050 under the no action alternative. For all three action alternative flow scenarios, the model predicted generally lower chlorophyll *a* values, lower summer phosphorus loading, and higher retention times compared to the no action alternative. Of the three action alternative flow scenarios, the high flow scenario would produce the highest chlorophyll *a* concentrations and phosphorus loadings and the low flow scenario would produce the lowest reservoir chlorophyll *a* concentrations and phosphorus loadings.

In terms of wastewater discharges, there would be substantial adverse effects on water quality in rivers under the low flow scenario and generally improved water quality under high flow releases because of dilution. Thermal discharges into surface waters would have only localized impacts under any of the flow scenarios; however, for certain existing facilities, the thermal mixing zone requirements in their National Pollutant Discharge Elimination System (NPDES) permits might be exceeded during periods of reduced river flow. Potential indirect impacts on groundwater may result from the low flow scenario because groundwater would become an attractive alternative for a water source if stream flows are reduced.

Biological Resources

Vegetation Resources

The vegetation in the ACF basin with potential to be affected by an allocation formula includes primarily bottomland, riparian, and wetland communities associated with riverine systems. The largest percentage of these important habitats in the basin is found along the Apalachicola River.

Potential impacts on terrestrial communities, freshwater wetlands, and estuarine wetlands were evaluated for the ACF basin. Expected impacts on terrestrial vegetation would be minimal, under all alternatives as these habitats are not directly affected by system flows or water levels. The possible exception would be the construction of new reservoirs that may be required to meet additional water storage capacity.

A study of representative floodplain freshwater wetlands found that adverse impacts would not likely occur on wetland forest systems from any of the alternatives studied. Studies of wetland vegetation adjacent to two representative reservoirs, however, provided evidence that these systems would be affected by changes in reservoir water levels, although the changes in freshwater wetland vegetation communities would stabilize over time. Estuarine wetlands in the Apalachicola Bay would likely experience the least alteration in community structure under the moderate to high flow scenarios. Impacts would be greatest for the low flow scenario, but the extent of this change and its exact nature cannot be ascertained until the allocation formula has been developed.

Wildlife Resources

The wildlife of interest in the ACF basin relative to potential effects of a selected alternative are primarily those associated with riparian habitats. Terrestrial species that do not depend on reservoir or riverine systems would not be directly affected by any alternative related to the allocation formula. Those wildlife that are dependent on these resources are also not expected to be adversely affected by a selected alternative, since there is expected to be only limited habitat loss for very brief periods of time during critical low flow periods. The ability of many of these species, such as river otter and wood duck, to be able to locate other habitats also reduces the severity of any effects on these species. Similarly, wildlife in the Eufaula National Wildlife Refuge would not be affected by a flow allocation formula because even under low flow conditions, sufficient water would be available for waterfowl and other water-dependent species.

Fish and Aquatic Resources

The aquatic systems in the ACF basin provide habitat for a wide variety of freshwater and estuarine habitats. These habitats support important fish and shellfish resources of recreational and commercial value. Existing uses of the rivers and reservoirs in the basin affect the distribution and abundance of these aquatic resources.

Potential impacts were evaluated for riverine, reservoir, and estuarine habitat responses to the no action and action alternative flow scenarios. For the riverine habitat assessment, performance measures were developed to evaluate habitat-value functions using the Riverine Community Habitat Assessment and Restoration Concept. Flow scenarios for seven sites in the ACF basin were compared with river depth and velocity conditions that would be expected under unregulated, natural flow conditions. On an annual basis, the moderate flow scenario provides optimal flow conditions for maintenance of riverine habitat, with high flow conditions benefiting aquatic habitat during periods of drought in summer to early fall. In contrast, the no action alternative had lower scores than the action alternative flow scenarios for riverine habitat.

Performance measures were evaluated for five mainstem reservoirs to examine differences in the acceptability of water levels for critical sport fisheries of the no action and action alternative flow scenarios. The performance measure was lowest in acceptability for the no

action alternative due to greater water level fluctuations. The low flow scenario would maintain the most stable reservoir levels on an annual basis, and therefore provides the most acceptable conditions for reservoir fisheries. Potential impacts during critical low flow periods were examined to evaluate the magnitude of effects resulting from sustained drawdowns covering multiple critical periods for fisheries. For representative headwater storage reservoirs, the high flow scenario would result in the greatest impact by reducing acceptability levels for important fish guilds, and could adversely impact consecutive spawning and rearing seasons in Lake Lanier.

Impacts to the estuary were evaluated by the National Oceanic and Atmospheric Administration (NOAA) focusing on potential growth and mortality to oysters in Apalachicola Bay. Reduced freshwater inflow into Apalachicola Bay increases salinity, allowing the oyster drill, a predator of oysters, to colonize the oyster beds. Under the no action alternative, oyster mortality was predicted to be 9 percent across Apalachicola Bay. Among the action alternative flow scenarios, therefore, the low flow condition would have the most negative impact on the oysters and potentially other estuarine aquatic resources sensitive to direct or indirect effects of salinity increases.

Protected Species

There are 9 Federally listed threatened or endangered species of animals and an additional 12 species of Federally protected plants. Most of these species would not be adversely affected by a water allocation formula because their preferred habitats would not be affected. Protected species habitats in the Flint River and Apalachicola River subbasins would be especially sensitive to adverse impacts. Once the selected water allocation formula has been developed by the States, and new reservoir operational conditions determined, additional NEPA documentation will address these site-specific protected species issues. Implementation of a water allocation that requires additional reservoir construction could result in site-specific, indirect, or cumulative impacts on some species. Consultation with FWS under the Endangered Species Act will be addressed in the final EIS.

Fish and Wildlife Management Facilities

Fish and wildlife management facilities that withdraw water from the basin include Eufaula National Wildlife Refuge (ENWR) and four State and Federal fish hatcheries. The 11,184-acre ENWR contains 4,260 acres of open water, 3,025 acres of wetlands, 2,110 acres of woodlands, and 1,814 acres of croplands and grasslands. It is managed primarily to provide suitable habitat to migrating and wintering waterfowl. Water levels are manipulated by a series of pumps to provide appropriate wildlife food plants at the desired season.

Based on examination of water level fluctuations in the reservoir fisheries analysis and inspection of daily plots of reservoir levels during critical drought periods, the action alternative flow scenarios show little potential for significant adverse effects to shoreline vegetation and wildlife communities in the ENWR. Further, the allocation would not be expected to significantly affect the availability of reservoir storage each fall for pumping into the off-reservoir impoundments for waterfowl management. Comparisons of average annual differences between seasonal reservoir levels recommended by the Fish and Wildlife Service (FWS) and levels simulated under the no action and action alternative flow scenarios showed only minor differences between flow scenarios.

The Buford Trout Hatchery below Buford Dam withdraws water from the Chattahoochee River year-round. Water quality modeling results indicate only minor effects of the action alternative flow scenarios on water temperatures and dissolved oxygen levels of the cold-water releases from Buford Dam. Because water quantity would be sufficient to meet the hatchery's needs, no significant adverse effects on hatchery operations are anticipated. Other hatcheries in the basin are supplied mainly by groundwater and should be able to meet their future needs with additional deep wells. Potential indirect impacts on groundwater may result from the low flow scenario because groundwater would become an attractive alternative for a water source if stream flows are reduced.

Land Use

The major land uses in the ACF basin are developed land, agricultural land, forests and timber, and water. Future land use conditions were extrapolated using population forecasts developed as part of the Comprehensive Study. From these data, the U.S. Environmental Protection Agency (EPA) developed a land use forecast for future years. It may be expected that water availability would have an influence on population growth and land use change. However, the effects of water availability were not modeled in this EIS.

The ACF basin includes over 12.3 million acres, of which approximately 6 percent is residential and 2 percent is classified commercial and industrial. Regardless of the water allocation formula developed for the basin, residential land use is expected to increase by more than 60 percent between 1995 and 2050. Similarly, commercial and industrial land uses are expected to increase during this time period by 40 percent. Within the ACF basin, therefore, developed land would increase from 9 percent of total area to 12.4 percent of the total area under any of the alternative water allocation options.

Agricultural lands presently comprise approximately 24 percent of the basin with the majority of the agricultural land use found in the Flint River basin. Most of this acreage is cropland and pasture land, which is primarily irrigated with groundwater. Agricultural production land is expected to increase by only 2 percent by 2050.

Forest land in the ACF basin includes several national forests, such as the Chattahoochee National Forest located north of Lake Lanier and the Apalachicola National Forest at the extreme southern portion of the basin. Additionally, Georgia has more privately owned forest land than any other State in the ACF. This land use is expected to decline by 7 percent between 1995 and 2050 regardless of changes in water allocation; therefore, no impacts are anticipated.

Recreation, national parks, refuges, fish and wildlife management facilities and protected sites presently make up about 2 million acres in the basin. No significant changes are expected in public lands from any of the alternative flow scenarios.

Contaminated sites and military installations would not be affected by the water allocation options because none of the four Superfund sites located in the ACF basin are near river channels, and none of the four major military facilities would be affected by water allocation.

Socioeconomic Resources

Socioeconomic resources evaluated in this report include human population/ demographics, recreation, and economics. General population patterns in the ACF basin were developed from studies completed for the Comprehensive Study. Recreational opportunities from river and reservoir facilities were evaluated for the water allocation flow scenarios. Economic impacts are addressed by study and modeling completed by the Corps.

Population/Demographics

The ACF basin includes 59 counties with a total 1995 estimated population of 4,082,000. Approximately 89 percent of the population resides in Georgia, 8 percent in the Alabama portion of the basin, and 3 percent in the Florida portion. The 1995 population estimates from the Comprehensive Study were used to develop the municipal and industrial water demands for projection of future water needs. The estimated 1995 population differs from the actual 1995 population because it underestimates the rapidly growing bedroom communities, particularly around Atlanta.

Growth in the ACF basin is projected to continue to increase at an average of about 1 percent per year through 2050. At this projected growth rate, by 2050 the basin will include 6,881,000 people, with 90 percent residing in the Georgia part of the basin, 7 percent in the Alabama portion, and 3 percent in the Florida portion. It would be expected that population growth and demography in the basins will follow water availability. However, since alternative measures for water conservation and supply are feasible for any allocation formula that might be developed, it is not practical at this planning phase to predict a specific change in population distribution, other than projected growth rates.

Therefore, the analyses provided by the Corps assume that projected population growth would not be affected by water allocation and no differences are anticipated from the no action or action alternatives.

No disproportionate adverse effects on children, minority, or low-income populations are expected to occur.

Recreation

Ten recreational study areas were evaluated in the ACF basin to estimate current and future use for boating, canoeing, fishing, and other water-related recreational uses. Seven reservoirs (all on the Chattahoochee River) and three river segments (one each on the Chipola, Flint, and Apalachicola Rivers) were analyzed for recreational use. Lake Sidney Lanier, located north of Atlanta, is the most heavily visited Corps reservoir nationwide, with an estimated 3.5 million visitors annually.

The effects of each of the alternative flow scenarios on reservoirs were evaluated comparing the likely number of boat trips visitors might take at different water elevations in the reservoirs for each scenario. Alternative scenarios were evaluated for 1995, 2020, and 2050, taking into consideration water consumptive demand projections and population increases. In general, under the no action alternative, visitor use would be expected to increase 50 to 65 percent from 1995 to 2050. Under the low flow scenario, reservoir recreational opportunities would be optimal for most of the year; they would be less so under moderate and high flow scenarios.

Riverine recreation, such as wade fishing, canoeing, and rafting, depend on optimal stream and river depth and flow velocity. Because most of these activities take place in summer, the high flow scenario would provide the best riverine conditions by releasing water from reservoirs at this season, as compared to less desirable conditions that might result from either the moderate or low flow scenario.

Economics

Potential economic effects of implementing a water allocation formula were evaluated using the Economic Impact Forecasting System (EIFS) model developed by the U.S. Army Construction Engineering Research Laboratory. The EIS focuses on the economic impacts of the no action as compared to the action alternative flow scenarios on municipal and industrial water supply, navigation, hydropower generation, agricultural water supply, recreation, and employment.

Municipalities in the headwaters of the ACF basin would experience a substantially greater adverse impact than areas downstream. The economic study estimated the cost of buying replacement water to cover projected shortages. Under the low flow scenario, the average annual cost for water was projected to be approximately $13.4 million; with the moderate flow scenario, the average annual equivalent cost was $8 million; and under the high flow scenario, the average annual equivalent cost was $1 million.

Barge traffic for waterborne commerce in the ACF basin has been decreasing since the late 1980s when severe droughts adversely affected both the agricultural industry and navigation channel conditions. The commodities most often shipped today are sand and gravel, fertilizers, and petroleum products. Annual transportation costs did not differ significantly for no action and the flow scenarios that ranged from low flow to high flow; therefore, no significant economic impacts are expected for any of the alternative flow conditions.

The ACF rivers are heavily developed for hydropower generation with 13 facilities providing a total power capacity of 635 megawatts (MW). The two largest power producing facilities in this basin are both located on the Chattahoochee River. Of these, the Bartletts Ferry Dam (173 MW) is owned by the Georgia Power Company, and the W.F. George Lock and Dam (130 MW) is owned by the Corps. The analyses for this EIS indicated that the high flow scenario produced greater benefits to hydropower production than no action or either of the other flow scenarios because it did not have a seasonal drawdown for flood control; consequently, the net available head was greater during high flows for future energy production.

Potential economic impacts on the agricultural water supply were evaluated by the Natural Resources Conservation Service. Irrigation needs in the basin were examined, and their evaluation concluded that there would be no water supply shortages for irrigation under any of the alternative flow scenarios. In the lower Flint River area, over 80 percent of the irrigation water comes from groundwater. Consequently, the limited amount of surface water used for agriculture in the ACF basin is sufficient for all alternatives, and no economic impacts would occur.

The Corps includes flood control as a major focus for operating its reservoirs. Both the no action alternative and action alternative flow scenarios hold flood control storage constant, so the potential impacts are zero when the action and no action alternatives are compared.

In a separate analysis, the Corps determined impacts if flood control storage at Lake Lanier and West Point Lake was eliminated or reduced in half. If flood storage were completely eliminated, downstream property damage would be $51.2 and $5.1 million for areas below Lake Lanier and West Point Lake, respectively. If this storage is eliminated to zero, as is assumed for the high flow scenario, there would be the potential for property damages in some downstream floodplain areas, such as Lake Lanier and West Point Lake, where these damages were estimated to be over $51.2 and $5.1 million, respectively.

A survey of registered boaters was conducted to estimate per-trip spending at each of eight study projects (seven lakes, one river) selected to be representative of uses in the ACF basin. Lake Lanier accounted for the highest annual spending and for the greatest total annual National Economic Development benefit. With the exception of Lake Seminole and the Apalachicola River, all of the alternative flow scenarios were found to have higher economic benefits than the no action alternative. The low flow scenario had higher reservoir pool levels with less seasonal drawdown and provided the greatest recreation value.

A similar economic evaluation has not been made for recreational fisheries. However, because comparison of the alternative flow scenarios with the no action alternative indicates only minor direct effects that are likely to these resources, it would be expected that there also would be minimal impacts to economic impacts related to recreational fisheries.

Income and employment in the ACF basin have shown steady growth from 1975 to 1995. The greatest increases in both income and employment occurred from 1975 to 1985, with slower growth in the last decade. Per capita income is higher in the Georgia portion of the basin, as compared to the other portions of the basin, because it includes the Atlanta metropolitan area, Columbus, and Albany. More than 84 percent of all jobs in the ACF basin are provided by the private sector. To evaluate regional economic impacts of the alternatives, the EIFS model was used. According to this study, the flow scenarios only modified the expected business volume, personal income, or employment by no more than 0.1 percent, so no significant impacts are anticipated from the modeled alternative scenarios.

Air Quality and Noise

Potential impacts of a water allocation formula on air quality and noise were evaluated for the ACF basin based on existing conditions and information available from the EPA on national air quality standards and typical noise levels for different land uses. Except for two metropolitan areas, air quality is good throughout most of the basin. The Atlanta area is designated as nonattainment for ground level ozone and the Columbus, Georgia, area is designated as nonattainment for lead. The water allocation formula is not expected to result in any direct adverse effects on regional air quality, although indirect impacts are possible where demographics or land use changes occur as a result of an allocation formula; or if power generation sources change from hydropower to thermal generating plants utilizing fossil fuels.

The existing noise levels in the ACF basin were estimated by evaluating the percentage of the population residing in areas where outdoor day/night average sound levels typically exceed 60 decibels (dB). The majority of people living in urban areas were found to have outdoor sound levels less than 60 dB. Because population growth and increased urbanization were assumed to be independent of a water allocation formula, no impacts on

noise are anticipated from either the no action alternative or the action alternative flow scenarios.

Cultural Resources

To evaluate potential impacts on cultural resources in the ACF basin, the Corps summarized existing data on known cultural resources and estimated potential impacts on the resources from a change in water management. The period of evaluation of possible impacts for this study is 1995 through 2050; therefore, some standing structures that are relatively new today may be considered of historical importance near the end of this study period. The evaluation of impacts focused on three potential effects of changes in water level management: erosion, deposition of sediment, and access.

The primary characteristics affecting potential negative impacts on cultural resources is erosion around reservoir edges and in waterways or increased access to sites. The no action alternative was estimated to have the least adverse effect on existing cultural resources. Of the action alternative flow scenarios, the low flow scenario reservoir levels would remain more stable and downstream flows would have lower velocity, hence less opportunity to cause erosion of archeological sites.

Potential Mitigation Measures

The Council on Environmental Quality (CEQ) requires Federal agencies, in preparing an EIS, to address appropriate mitigation measures that are not included specifically as part of the proposed action or alternatives evaluated in the EIS (Title 40 of the *Code of Federal Regulations*, Part 1502.12 and 1502.16 [40 CFR 1502.14 and 1502.16]). Mitigation measures can include actions taken to avoid, offset, reduce, or compensate for adverse effects on the environment that may potentially result from implementation of a proposed action.

Proper consideration of mitigation requires that a full range of measures be identified (including, where appropriate, alternative means to mitigate a single impact), along with the cost of the measures, and their effectiveness in reducing the level of impact. This draft EIS includes the process that will be followed to identify appropriate mitigation options and types or categories of mitigation that might be appropriate for certain types of expected impacts. The Corps, the cooperating agencies, and the States will evaluate the potential mitigation options presented in the final EIS once a proposed allocation formula is known. The justification of recommended mitigation measures will be based on the environmental and socioeconomic analyses presented in the final EIS and regulatory agency requirements. Mitigation measures may be the responsibility of the government or non-government agents, Corps, private interests, or State or local governments. For example, the Corps may initiate a program for habitat enhancement in Federal reservoirs to address loss of fish spawning habitat resulting from water level changes; or more stringent State-imposed regulatory programs may be implemented to control point source or nonpoint source discharges to stream segments.

Regulatory Compliance

Compliance with environmental regulations is important in considering concurrence with or implementation of a water allocation formula. Changes in project authorizations may be required before the final water allocation formula can be implemented. It is expected that any changes required in the operations or authorizations at Corps facilities in the ACF basin will be in compliance with Federal laws and regulations. If additional NEPA documents are required to support changes in project authorizations or changes in operations at Corps facilities in the ACF basin, the status of regulatory compliance will be addressed in those documents.

1. Purpose, Need, and Scope

1.1 Introduction

This environmental impact statement (EIS) is being prepared by the U.S. Army Corps of Engineers (Corps) Mobile District in cooperation with 10 other Federal agencies because Alabama, Florida, Georgia, and the United States, represented by the Department of Justice (DOJ), have negotiated an interstate water Compact for the Apalachicola/Chattahoochee/Flint (ACF) river basin which may result in changes in the allocation of water resources within the river basin. The stated purposes of the Compact, entered into by Alabama, Florida, and Georgia, are:

> *. . . promoting interstate comity, removing causes of present and future controversies, equitably apportioning the surface waters of the ACF, engaging in water planning, and developing and sharing common databases.*

This EIS has been developed to provide information which will serve as the basis for concurrence or nonconcurrence of a Federal Commissioner with a water allocation formula for allocation of water resources, to be developed jointly by the States, as required by the interstate water Compact. At the time this EIS was prepared, there was no identified preferred action or alternative for an allocation formula. As a result, this EIS evaluates a range of alternative flow conditions projected to "bracket" a future allocation formula condition. Impacts for the range of flow conditions are addressed in this EIS. It is expected that the impacts resulting from the final water allocation formula will fall within the range of impacts presented in this EIS.

The States of Alabama and Georgia are also developing a water allocation formula for the Alabama-Coosa-Tallapoosa (ACT) River Basin, which is adjacent to the ACF basin. Simultaneously, the Corps is preparing an EIS to support the Federal Commissioner's decision on the water allocation formula being developed by the States for the ACT basin.

The following Federal agencies have agreed to act as cooperating agencies in preparing the EIS:

- Environmental Protection Agency
- Fish and Wildlife Service
- Forest Service
- Maritime Administration
- National Marine Fisheries Service
- National Ocean Service
- National Park Service
- Natural Resources Conservation Service
- Southeastern Power Administration
- U.S. Geological Survey

The States of Alabama, Florida, and Georgia also provided input, review, and comments during the preparation of this EIS. The following sections summarize the events that led to developing the interstate water Compact.

1.1.1 Background

Historically, there has been adequate water to meet the needs of most users in the ACF basin. However, with increased growth and development, the droughts of 1981, 1986, and 1988 created greater competition among users than had been experienced before.

During the 1981 drought, hydropower production was reduced and municipalities and industries were required to implement water conservation measures. Recreational use of reservoirs was also limited. Streamflow and groundwater levels in the ACF basin were at or below the lowest levels on record for the basin. The drought was so severe that many of the reservoirs did not refill during the normally wet winter and early spring that followed. Although the 1981 drought was not as severe as the subsequent droughts in 1986 and 1988, the 1981 drought depleted the storage in Corps-operated reservoirs to the point that the Southeastern Power Administration was forced to purchase replacement power to meet its contractual requirements. From October 1980 to September 1981, the City of Atlanta, Georgia, received 71 percent of the normal rainfall expected for the year. Flows in the lower ACF were the lowest measured since the early 1960s. Navigation was severely curtailed from April 1981 through December 1981.

During the 1986 drought, the estimated effects of water withdrawals and evaporation at Lake Lanier exceeded the monthly average inflow of water by 97 cubic feet per second, breaking the previous low flow record set during the 1981 drought. On the Apalachicola River, the stream gage at Bountstown dropped to its lowest daily reading, and all navigation was suspended from mid-July 1986 through September 1986.

During the 1986 drought, a Drought Management Committee was established for the ACF basin by Alabama, Florida, Georgia, and the Corps to assist in assessing and mitigating the adverse effects of the drought on all water users in the ACF basin. The impacts of the drought were significant, with more than $1 billion in agricultural losses recorded in Alabama and Georgia. Every county in Alabama was declared a disaster area based on the agricultural losses. The National Guard was called to assist the Alabama Department of Emergency Management in trucking water to municipalities with significant water shortages.

Between October 1987 and December 1988, the quantity of water entering Lake Lanier was only 37 percent of what would typically be expected and averaged 50 percent of normal between February 1988 and May 1988. The water level in Lake Lanier dropped to 1,053 feet by the end of December 1988, as compared to a normal winter elevation of 1,071 feet. Navigation was suspended on the Apalachicola River from June 1988 to September 7, 1988, when a navigation window could be opened for a 2-week period. Normal navigation operations resumed at the end of September 1988, when precipitation levels returned to normal. After the 1986 and 1988 droughts, the Corps developed a technique, called a navigation window, for providing a period of navigation on the Apalachicola River. The technique requires water to be stored in the Lake Lanier, Walter F. George, and West Point reservoirs and then carefully released to allow shipping traffic during controlled periods.

The periods of drought experienced in the 1980s directly demonstrated competing demands for water in the region. These droughts resulted in numerous adverse effects, including those to industrial water supply, navigation, power production, agricultural production, water quality, and fish and wildlife maintenance. During these drought periods, recreational interests and fish and wildlife habitat suffered adverse impacts as lakes in the

ACF basin experienced substantial drawdowns; restrictive measures were instituted on water use to conserve it for drinking water; inland navigation was curtailed because of protracted low-flow conditions; agricultural crops were heavily damaged or lost completely in some areas; and almost all of the residents in the region experienced some level of hardship and inconvenience.

1.1.2 Competing Water Interests

Considerable growth has occurred in the Atlanta-metropolitan area since 1950. The population in this area increased from less than 500,000 in 1950 to almost 3 million by 1990. This increase in population has resulted in a commensurately increased demand for water resources.

As early as 1982, the Corps received requests for water supply withdrawals from existing Corps reservoirs, including Lake Lanier on the ACF basin. In response to these requests, the Corps began preparing water supply reallocation reports to address the effects of the reallocation of existing storage in each reservoir from hydropower to water supply.

A basinwide water budget for the ACF basin was proposed for study in 1980, but was not funded. The importance of addressing short-term water supply problems became paramount during the droughts that occurred in 1981, 1986, and 1988.

In June 1983, the Governors of Alabama, Florida, and Georgia, and the Corps signed a memorandum of agreement (MOA) to develop a water management system for the ACF basin. In addition to several short-term study efforts (development of a water assessment, an interim drought management plan, and a navigation management plan), the MOA identified several long-range studies that would be completed under a new Section 308 comprehensive study (***Appendix A***).

A plan of study (POS) was completed in 1988, to include the development of a water budget for the basin, a long-range drought management plan, and an interstate coordination mechanism. However, insufficient funds were provided to complete the long-term studies. During this same period, Alabama and Georgia were experiencing similar drought-related problems in the Alabama-Coosa-Tallapoosa (ACT) river basin. These problems intensified after 1982 when the Corps received water supply withdrawal requests from the City of Chatsworth to withdraw water from Carters Lake, from the City of Cartersville to withdraw water from Lake Allatoona, and from the Cobb County-Marietta Water Authority to withdraw water from Lake Allatoona. In response to these requests, the Corps began preparing water supply reallocation reports to address the effects of the reallocation of existing storage in each reservoir, from hydropower to water supply.

Public meetings were held in August, October, and November 1989 to solicit input on the proposed water reallocations at Lake Allatoona, Carters Lake, and Lake Lanier. The public and reviewing agencies identified the following issues:

- Cumulative environmental and economic impacts from the reallocations
- Impacts on downstream water supply, hydropower, navigation, water quality, recreation, and fish and wildlife resources
- Impacts and amount of interbasin transfer

- Need for comprehensive baseline studies of the ACF basin
- Need for environmental impact statements to evaluate the proposed reallocations

In November 1989, the Governor of Alabama wrote to the Corps' South Atlantic Division Engineer, requesting a suspension of the reallocation activities. The State of Alabama also requested that its Congressional delegation intercede to prevent the Corps from moving forward with the reallocation of water from Carters Lake and Lake Allatoona until a comprehensive economic and environmental impact analysis was completed. Alabama was equally opposed to the proposed reallocation at Lake Lanier. The Chair of the House Appropriation Subcommittee for Energy and Water Development then requested that the Corps develop a conceptual plan to accomplish the study requested by Alabama.

The Corps provided the requested conceptual study plan to the House subcommittee in February 1990. The plan was subsequently provided to Congressional and other interests in Alabama and Georgia for review. The plan called for a two-phase approach: (1) a short-term management plan to address immediate water supply needs, and (2) a long-term or comprehensive management plan to address the long-term water needs.

In May 1990, the Corps completed the Carters Lake water supply reallocation report that recommended the reallocation of reservoir storage to provide water supply for Chatsworth, Georgia. In June 1990, the State of Georgia filed a Section 404 permit application with the Corps to construct the West Georgia Regional Reservoir on the Tallapoosa River, approximately 5 miles upstream from the Alabama-Georgia state line. Three days after Georgia filed the application for the new reservoir, Alabama filed litigation against the Corps, challenging the adequacy of its application of the National Environmental Policy Act (NEPA) process with respect to proposed water supply reallocations at Carters Lake, Lake Allatoona, and Lake Lanier. The lawsuit also alleged that the Corps violated its duty to operate these reservoirs in a neutral and objective manner consistent with Congressional mandates.

Shortly after Alabama filed litigation against the Corps for water allocation decisions in the ACT and ACF river basins, representatives from Alabama and Georgia, later joined by the Corps, began discussions seeking to resolve the conflicts between the two States. Florida joined the discussions in September 1990. During the discussions, the parties agreed that litigation was the least desirable option for resolving the water resource conflicts. The States agreed that the concept of a federally funded Comprehensive Study to address issues in both the ACT and ACF river basins, to provide factual information on water availability, to forecast water needs, and to explore options to meet the identified needs would be the best approach provided that concerns about objectivity and impartiality, as well as other state-specific needs, could be met. Subsequent to this tentative agreement, the State of Alabama requested that the U.S. District Court defer the litigation while settlement negotiations continued.

1.1.3 Letters of Agreement

Two letters of agreement (LOAs) have been completed since Alabama, Florida, and Georgia began developing cooperative approaches to resolve their water resource conflicts. These LOAs are summarized in the following discussion, and copies of the documents are provided in *Appendix A*.

In April 1991, an LOA was completed between Alabama and Georgia to formalize cooperation between the States. It included commitments to allow Cartersville and Chatsworth to expand water withdrawals to meet immediate needs; agreements on objectives and participation by Alabama and Georgia in the Comprehensive Study for the ACT and ACF basins; and agreements to stay further actions of the civil suit by Alabama. The LOA also superseded reallocation proposals that were underway for Lake Allatoona and Carters Lake, and included an agreement that Georgia would withdraw its request for permits to construct the West Georgia Regional Reservoir. A second LOA was completed between these two States in November 1996, providing for additional water withdrawals by Cartersville to accommodate the water demands of an existing industry. This agreement also restricted Georgia from submitting permit applications for the West Georgia Regional Reservoir until various aspects of the Comprehensive Study were completed.

1.1.4 Memorandum of Agreement

On January 3, 1992, the governors of Alabama, Florida, and Georgia, and the Assistant Secretary of the Army for Civil Works (ASA(CW)) signed an MOA, committing to work together as partners through the Comprehensive Study process to seek resolution of water resource issues. The MOA was developed to formalize the partnership of the States and the U.S. Army Corps of Engineers to work together to develop technical information related to water resources in the ACT and ACF basins and to recommend a coordination mechanism. Including specific study elements that would be required in the Comprehensive Study, the MOA also contained provisions governing the operations of the reservoirs, water allocations, and the litigation filed by Alabama during the conduct of the Comprehensive Study. The partners were required to develop a mechanism or mechanisms to implement the findings or recommendations of the Comprehensive Study. The MOA culminated 18 months of intense negotiations. ***Appendix A*** provides the full text of the MOA.

Before signing the MOA, the States and the Corps jointly prepared a Plan of Study (POS) to determine the scope for the Comprehensive Study. The draft POS was prepared and furnished to the public for review and comment. Using the draft POS as a starting point, a series of 11 public meetings were conducted in the two basins. The draft POS was revised, based on comments received at the public meetings, and was approved by the States and the Corps as the official guidance document for completing the Comprehensive Study.

This document was followed by five supplemental MOAs. The first was executed on January 18, 1994, and modified the agreement by agreeing to complete the Comprehensive Study by September 30, 1995, rather than 3 years after the Comprehensive Study Plan was completed. The next supplemental MOA, issued on April 7, 1995, extended the date for completing the Comprehensive Study by 1 year, to September 30, 1996. The September 24, 1996, supplement to the MOA recognized that all parties agreed that it was in their best interest to pursue interstate Compacts between Alabama and Georgia for the ACT basin and between Alabama, Florida, and Georgia for the ACF basin. The September 30, 1996, supplement made minor modifications to the MOA and extended the time to complete the Comprehensive Study to December 31, 1997. The latest supplemental MOA, dated November 20, 1997, reaffirmed the binding of the States to the agreements of the MOA until the Comprehensive Study was completed, and extended the date for completing the study to September 30, 1998. These supplemental MOAs are also included in ***Appendix A***.

1.1.5 Comprehensive Study

The Comprehensive Study was undertaken by Alabama, Georgia, Florida, and the Corps for both the ACT and the ACF river basins, as directed by the MOA described in Section 1.1.4. The study was consensus-based and, as a result, a number of extensions were required and approved to complete the technical investigations required to support the development of a water allocation formula. As expressed in the POS, the purpose of the Comprehensive Study is to:

> *. . . determine the capabilities of the Water Resources of the basins, to describe the water resource demands of the basins, and to evaluate alternatives which utilize the Water Resources to benefit all user groups within the basins.*

The Comprehensive Study has provided technical understanding of the water resources in both river basins and basin-specific tools to evaluate the water management alternatives. The goal of the Comprehensive Study is to:

> *. . . develop relevant technical information, strategies, and plans, and recommend a formal coordination mechanism for the long-term, basinwide management and use of the water resources to meet the environmental, public health, and economic needs of the basins.*

Table 1-1 presents the various elements of the Comprehensive Study that were approved to be evaluated, and funded by the study partners. Brief descriptions of each of the elements follow the table.

TABLE 1-1
Elements of the Comprehensive Study

Process Support Elements	Water Resources Availability	Water Demand Elements	Comprehensive Management Strategy
Population and employment forecasts	Surface water	Agriculture water demand	Basinwide management
Database	Groundwater	Environmental water demand	Coordination mechanism
Public involvement		Power resources water demand	
		Municipal and industrial water demand	
		Navigation water demand	
		Recreation water demand	
		Water quality water demand	
		Apalachicola River and Bay water demand	

Source: Comprehensive Water Resource Study Partners, September 1995

1.1.5.1 Process Support Elements

1.1.5.1.1 Population and Employment Forecasts

This element developed an economic model to provide forecasts of key economic and population variables. Based on the forecasts, the estimated demand for municipal, industrial, and recreational use of water was calculated.

1.1.5.1.2 Database

The database development element created a common database for the Comprehensive Study. The database consists of historical and forecasted water flow and water quality data,

tables, reports and other text documents, and Geographic Information System (GIS) data. Database management standards were developed to ensure that the data is easily accessible and usable by all of the members of the Comprehensive Study team.

1.1.5.1.3 Public Involvement for Comprehensive Study

An extensive public involvement program was developed for the Comprehensive Study. The objectives of the program have been to:

- Involve interested persons within each State and basin in the development of the POS and the comprehensive basin planning process.
- Obtain views and concerns from interest groups and the general public by holding public meetings and workshops to receive comments and identify issues during the study.
- Provide reports, share study outputs, and solicit comments from interested persons regarding the results of technical investigations and other aspects of the study.
- Prepare and distribute news releases and secure media coverage during the study.

Each of the Federal and State study participants was responsible for identifying and soliciting participation from individuals and groups throughout the Comprehensive Study process. This was accomplished in a number of ways, including task forces and work groups that reviewed and commented on scopes of work for specific study elements, as well as reviewed and provided comments on draft reports for those study elements. A series of 11 joint-basin meetings were held throughout the States to discuss the various elements of the Comprehensive Study. The States also held a series of other meetings and conferences to solicit input on specific study elements and to allow opposing stakeholder groups to interact and better understand each other.

1.1.5.2 Water Resources Availability

1.1.5.2.1 Surface Water

The surface water availability study quantified the amount of water in the streams and reservoirs in the ACT and ACF basins. Specifically, the study determined the existing and future availability of surface water within the ACT and ACF basins; conceptually determined how the ACT and ACF basins respond to variations in weather, river management, and water use; and provided simulated flow data for use in other study elements.

1.1.5.2.2 Groundwater

The groundwater availability study quantified how changes in surface and groundwater quantities in one part of the basin affect the quantity of surface and groundwater available in other parts of the basin. The study also identified where groundwater resources are being under- or overused, identified where groundwater could be used in place of surface water, and established water budgets for eight subareas in the ACT and ACF basins that show the amount of water that enters and leaves each basin and the sources of water inputs and withdrawals or other losses.

1.1.5.3 Water Demand Elements

1.1.5.3.1 Agricultural Water Demand

The agricultural water demand study forecast the quantities of water that would be needed to support agricultural activities from 1995 to 2050. The study element evaluated water needs for six basic agricultural categories: crops and orchards, turf farms, nurseries, aquaculture, livestock, and poultry.

1.1.5.3.2 Apalachicola River and Bay Water Demand

This element of the Comprehensive Study provided the information needed to determine how much fresh water is needed in a normal year to support the biota of the Apalachicola River and Bay ecosystems. Five separate studies were completed to determine how much water would be required. A three-dimensional model was developed for Apalachicola Bay, which predicts changes in the physical characteristics of the bay, such as salinity and circulation, that result from changes in the amount of freshwater flowing into the bay.

The second study characterized the riverine and floodplain habitats in the Apalachicola River floodplain. The study examined how the river and the floodplain habitats are connected and how changes in flow in the Apalachicola River would affect the floodplain habitats.

The third study examined the distribution of nutrients in the lower Apalachicola River and Apalachicola Bay and assessed the influence of the nutrients on the primary productivity (plant production) in the bay.

The fourth study examined the sources of plant production in the lower Apalachicola River and Apalachicola Bay and assessed their influence on secondary production (animal production, e.g., crabs, worms, fish, oysters).

The fifth study completed for the Apalachicola River and Bay water demand element was a statistical analysis of the long-term biological database developed by Florida State University and the new data generated during the first four studies. The study integrated physical, biological, and geochemical data to evaluate how changes in water quality observed in Apalachicola Bay were related to changes in observable environmental factors, such as salinity and river flow.

1.1.5.3.3 Environmental Water Demand

The environmental water demand study identified significant environmental water needs and described the environmental effects of potential changes in water management on resources. The study evaluated the effects of changes in water management on riverine resources (including anadromous fish), riparian wetlands habitat, reservoir fisheries habitat, protected species, and fish and wildlife management facilities (refuges, hatcheries, etc.).

1.1.5.3.4 Municipal and Industrial Water Demand

The municipal and industrial water demand study forecast the demand for water by municipalities and industries in the ACT and ACF basins through the year 2050. For the purposes of the study, municipal and industrial water use included all water uses, both public and self-supplied, described as residential, commercial, governmental, institutional, industrial, manufacturing, and other unaccounted-for uses. No agricultural demands were included in this study.

1.1.5.3.5 Navigation Water Demand

The navigation water demand study determined the amount of water required to support Congressionally authorized navigation projects in both the ACT and ACF basins. This was accomplished by developing an inventory of physical characteristics and navigation facilities in the basins; defining and describing the historic and current relationships between the availability of a navigation channel and river flows; determining how frequently the navigation channel has been used for barge traffic and predicting future use through the year 2050; examining the effect of various flow conditions on commercial barge traffic through the year 2050; forecasting water needs to support authorized navigation projects; and determining the economic relationships to navigation associated with various alternative modifications to the water resources in the two basins.

1.1.5.3.6 Power Resources Water Demand

The power resources water demand study described and quantified the existing power plant operating conditions in the basins for both the hydropower generating units and the coal, gas, and nuclear power facilities that rely on the rivers in the basin for cooling water. The study also estimated the electric load and resource needs for 1995, 2000, 2010, 2020, and 2050, as well as the need for and potential location of additional generating capacity. The potential effects of alternative flow conditions in the basin on power generation were also evaluated in the study.

1.1.5.3.7 Recreation Water Demand

The recreation water demand study used registered boat owners in the basin as a surrogate for recreational users of the reservoirs and lakes. The purpose of the study was to determine if there was a statistically significant relationship between reservoir levels and recreational use. The study also included an impact assessment, showing how recreational boaters would alter their recreational use of a specific lake based on changes in water level resulting from different management scenarios.

1.1.5.3.8 Water Quality Water Demand

The water quality water demand study described and quantified the existing and projected water quality conditions. The study also evaluated the effects of different water management alternatives on water quality in the basin. This study also included an inventory of water quality data from 1980 to 1993, compilation of existing point source water quality data, and projection of wastewater loading through the year 2050. Water quality modeling included development of a one-dimensional basin water quality model and more detailed two-dimensional models for Walter F. George, Weiss, and Neely Harry Lakes.

1.1.5.4 Comprehensive Management Strategy

1.1.5.4.1 Basinwide Management

The basinwide management study had a number of objectives, including addressing the water resource problems in the basin through 2050 for a wide range of hydrologic conditions; developing potential solutions for the projected problems and predicting the outcomes of implementing combinations of alternatives; measuring the effectiveness of the alternatives; analyzing the cumulative effects of a reasonable number of alternatives; and describing basinwide management strategies that can be used to address the water demands within the basin.

1.1.5.4.2 Coordination Mechanism

The coordination mechanism study addressed the requirement of the 1992 MOA for an appropriate coordination mechanism or mechanisms to implement the findings of the Comprehensive Study. A coordination mechanism is an arrangement, agreement, or response that governs how managers interact in the process of managing natural resources, such as water. This study element collected information on past coordination mechanisms and evaluated them for their applicability to the ACT and ACF basins, with the purpose of developing consensus among the State partners on one or more preferred coordination mechanisms. Through facilitated workshops, the States agreed to pursue interstate water compacts for both the ACT and ACF basins.

1.1.6 ACF River Basin Compact

In 1996, Alabama, Florida, and Georgia agreed to develop and implement an interstate water Compact for the ACF river basin. The purposes of the Compact are to:

> *. . . promote interstate comity, removing causes of present and future controversies, equitably apportioning the surface waters of the ACF, engaging in water planning, and developing and sharing common data bases.*

State negotiations regarding the Compact began with a series of negotiation sessions held from September 1996 to January 1997. On January 13, 1997, each of the States and the Federal government, represented by the Department of Justice, reached agreement on the Compact language. The ACF River Basin Compact was passed by the Georgia legislature in January 1997, by the Alabama legislature in February 1997, and by the Florida legislature in March 1997. In a joint letter dated May 14, 1997, the three governors submitted the ACF Compact to the three States congressional delegations, who introduced the Compact into Congress on June 27, 1997. The Congress passed the Compact and sent the bill to the President on November 7, 1997. The President signed the ACF River Basin Compact into law (PL 105-104) on November 20, 1997 (***Appendix A***).

The Compact states that:

> *This Compact shall extend to all of the waters arising within the drainage basin of the ACF in the States of Alabama, Florida, and Georgia. The parties to this Compact are the States of Alabama, Florida, and Georgia and the United States of America.*

The Compact creates an interstate administrative agency, the ACF Basin Commission, composed of the Governors of Alabama, Florida, and Georgia (who make up the State Commissioners), and a Federal Commissioner appointed by the President of the United States.

> *Each State shall have one vote on the ACF Basin Commission and the Commission shall make all decisions and exercise all powers by unanimous vote of the three State Commissioners. The Federal Commissioner shall not have a vote but shall attend and participate in all meetings of the ACF Basin Commission to the same extent as the State commissioners*

The ACF River Basin Compact directs the parties to the Compact to:

> *. . . develop an allocation formula for equitably apportioning the surface waters of the ACF Basin among the States while protecting the water quality, ecology, and biodiversity of the ACF, as provided in the Clean Water Act, 33 U.S. Code (U.S.C.) Sections 1251 et seq., the*

Endangered Species Act, 16 U.S.C. Sections 1532 et seq., the National Environmental Policy Act, 42 U.S.C. Sections 4321 et seq., the Rivers and Harbors Act of 1899, 33 U.S.C. Sections 401 et seq., and other applicable Federal laws.

After the water allocation formula is developed and unanimously approved by the State Commissioners, it becomes binding:

> *. . . upon receipt by the Commission of a letter of concurrence with said formula from the Federal Commissioner. If, however, the Federal Commissioner fails to submit a letter of concurrence to the Commission within 210 days after the allocation formula is agreed upon by the State Commissioners, the Federal Commissioner shall within 45 days thereafter submit to the ACF Basin Commission a letter of nonconcurrence with the allocation formula setting forth therein specifically and in detail the reasons for nonconcurrence; provided, however, the reasons for nonconcurrence as contained in the letter of nonconcurrence shall be based solely upon Federal law. The allocation formula shall also become effective and binding upon the parties to this Compact if the Federal Commissioner fails to submit to the ACF Basin Commission a letter of nonconcurrence.*

In ratifying the Compact, Congress clarified that:

> *. . . the Federal Commissioner may submit a letter of concurrence with the allocation formula unanimously adopted by the State Commissioners within 255 days of such adoption.*

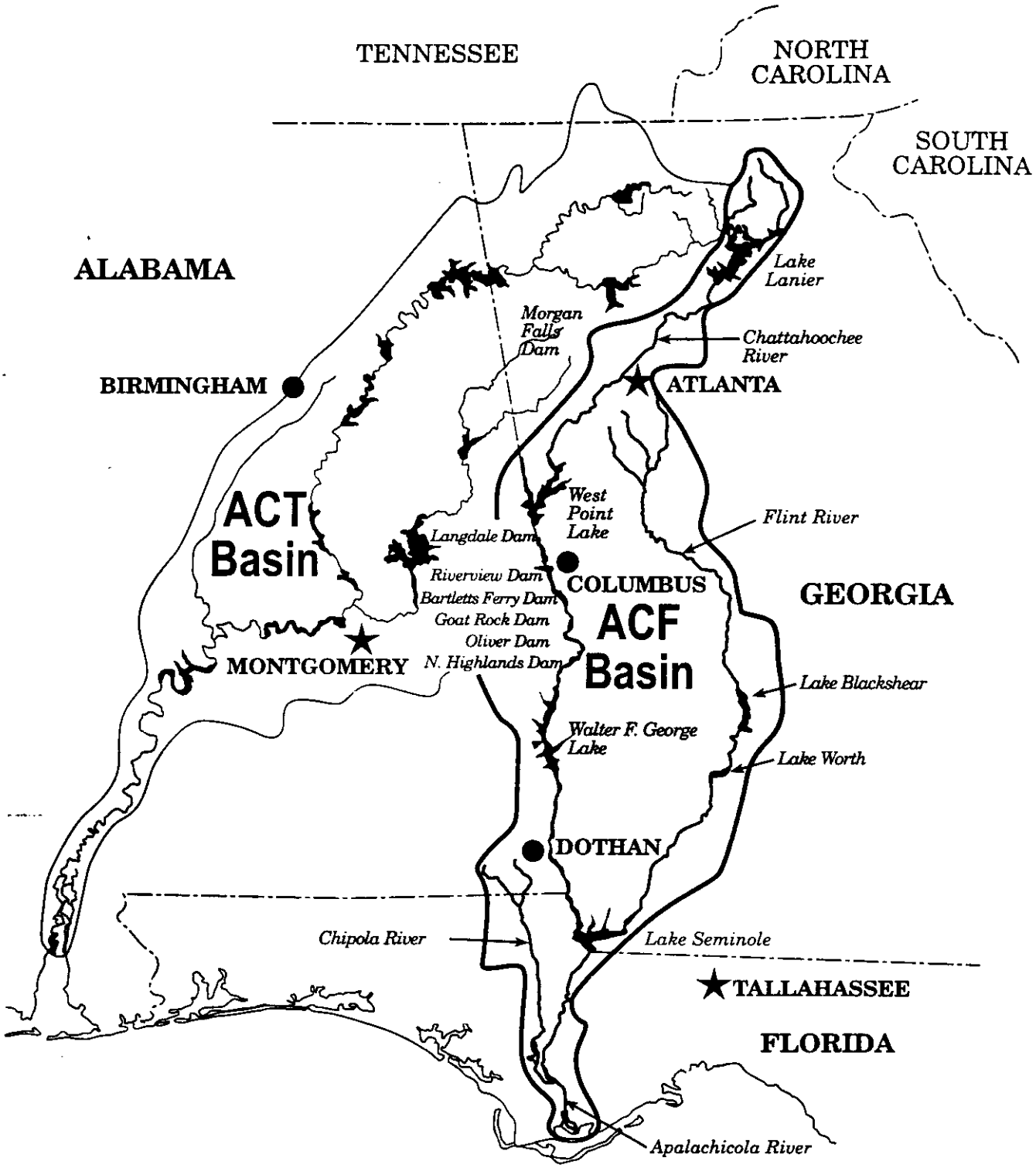
1.2 Purpose and Need

Article VII of the ACF River Basin Compact requires the Federal Commissioner to concur or not concur with the water allocation formula as developed by the State Commissioners. The overall purpose of the allocation formula is to fulfill multi-purpose water resource needs while balancing environmental interests. This EIS will evaluate the environmental and socioeconomic impacts of the proposed water allocation formula, including information and analysis provided by the cooperating Federal resource agencies. The EIS will be available to the public, the Federal Commissioner, Federal agencies, and the States to assist them in reviewing or developing an allocation formula. The EIS will form the basis for the Federal Commissioner's decision on the allocation formula approved by the State Commissioners. The EIS will also serve as a baseline document to assist the Corps in making future reservoir management decisions in the basin, and as an information base to assist Federal agencies in managing their programs in the basin.

1.3 Scope of EIS

This EIS will focus on the potential impacts of surface water allocation within the watersheds of the Apalachicola, Chattahoochee, and Flint Rivers, including Apalachicola Bay (***Figure 1-1***). The EIS must address the potential impacts of a water allocation formula and future basin management decisions on a very large basin that extends approximately 385 miles from northeast Georgia to Apalachicola Bay and the Gulf of Mexico in Florida. The watershed of the Apalachicola, Chattahoochee, and Flint Rivers, which form this basin, encompass approximately 19,600 square miles (***Figure 1-1***). In addition, the EIS evaluates the effects of the water allocation formula on a broad range of resources, including water resources, biological resources, socioeconomic resources, and cultural resources. Potential

FIGURE 1-1
Site Map of the ACF Basin



changes in stream flows associated with the a water allocation formula will be evaluated over a long planning period (1995 to 2050) to address incremental changes in water resource management and future changes that may be required to implement the final water allocation formula, taking into account future demands on water resources in the basin. To address this wide geographic area and lengthy planning period, a *programmatic* EIS will be completed. A separate EIS is being prepared to address impacts of the allocation of surface water resources within the ACT Basin.

1.3.1 Programmatic Environmental Impact Statements

A programmatic EIS approach was selected to allow an evaluation of a broad range of alternative operating conditions on human and environmental resources across the entire basin. This programmatic framework for analysis permits an overall assessment of impacts on the basin and provides the basis for future assessments of prospective operational plans as they are identified and/or developed.

Programmatic EISs provide a broader look at alternatives than project-specific EISs and identify long-range effects (Title 40 of the *Code of Federal Regulations* Subpart 1502.4(b)) [40 CFR 1502.4(b)]. When preparing an EIS for a "broad Federal action," the lead agency may evaluate the proposal based on common geographic locations, similarities of impacts, or stages of development. Preparing a programmatic EIS is an opportunity for a Federal agency to evaluate the potential cumulative impacts of the reasonably foreseeable actions under that program or within that geographical area (40 CFR 1502.4(c); Forty Questions No 24(b)).

The preparation of a programmatic EIS facilitates and expedites the preparation of subsequent project-specific NEPA documents through the use of tiering. Tiering refers to the concept of a multi-level approach to preparing NEPA documents. The first tier, or programmatic EIS, covers general issues in a broad program-oriented analysis. Subsequent tiers incorporate by reference the general discussions from the broader EIS, while concentrating on issues specific to the action being evaluated. Agencies are encouraged to tier EISs to avoid repeating issues and to focus on the issues required for decision at each level of review.

Programmatic EISs are prepared when a proposed action will affect a large geographic area or be composed of a series of smaller actions that will have similar and potentially cumulative effects, or to allow evaluation of a project early in the planning stages so that changes can be made, if needed, to minimize the potential impacts. Programmatic EISs focus on planning-level and conceptual impacts; they identify the resource areas that will require additional focus in the documents that tier from them. This is done because, when a programmatic EIS is prepared, often all of the details associated with the proposed action are unknown, but it is accepted that a number of smaller actions or projects will be required to complete it. For the ACF water allocation, the actual water allocation formula was not available at the time this draft EIS was prepared, but it is assumed that there will be operational changes at some of the reservoirs and lakes within the basin in order to implement the formula. However, the types of changes that may be required and the reservoirs and lakes that will be affected will not be known until the final water allocation formula is known and the implementation strategy has been prepared. As a result, this EIS focuses on identifying environmental and socioeconomic resources that could potentially be affected by the implementation of the water allocation formula and describes them in a way

that allows a planning-level review of the water allocation formula. Once the details of the water allocation formula are known and the implementation strategy has been prepared, project-specific NEPA documents will be prepared that focus on the environmental and socioeconomic impacts that are expected to occur once the water allocation formula is implemented at a specific reservoir or lake.

The proposed action for this EIS is the Federal Commissioner's decision to concur or not concur with the water allocation formula developed by the State Commissioners. Subsequent EISs or environmental assessments tiered to this EIS may be necessary if implementation of the water allocation formula requires a specific change in operation and/or project authorization at Corps or other Federal facilities in the ACF basin. Other Federal agencies could use this EIS as a base document for their implementing actions or other resource management actions within the basin. If implementing the water allocation formula requires changes in operations at reservoirs operated by private entities, such as the Alabama Power Company or the Birmingham Water Works Board, the ACF River Basin Commission will work with those entities and the appropriate regulatory agencies to facilitate the changes in reservoir operations while maintaining, to the extent practicable, the goals and objectives of the specific project (power generation, water supply, and recreation).

1.3.1.1 Schedule

The completion schedule for this programmatic EIS is controlled by the timelines legislated by the ACF River Basin Compact. Alabama, Florida, and Georgia must agree on a proposed water allocation formula by December 31, 1998, unless there is a unanimous vote to extend the deadline. After unanimous approval of the water allocation formula by the State Commissioners, the Federal Commissioner must submit a letter of concurrence or non-concurrence within 255 days to the ACF River Basin Commission. Because this EIS is intended to inform Federal agencies, the Federal Commissioner, the States, and the public on the impacts of the proposed allocation formula and alternatives, it must be completed well before this period elapses. An EIS typically takes between 18 months and 2 years to prepare. If the EIS were not initiated until after the water allocation formula were approved, there would be insufficient time to complete the EIS and make it available to assist in the review of a proposed allocation formula. Therefore, this EIS was initiated in the fall of 1997, using a programmatic evaluation framework to assist in assessing future allocation formulas to be developed by the States.

1.3.1.2 Cooperating Agencies

The Corps, as the lead agency, with assistance from 10 cooperating Federal agencies, is responsible for preparing the draft EIS, receiving comments from the public, and then preparing a final EIS in time to assist in review of a proposed allocation formula prior to the Federal Commissioner's decision. The role of the cooperating agencies is to provide baseline environmental information, to assist in preparing impact analyses for some resource areas, and to review technical documentation and assist in responding to public comments on the draft EIS. ***Appendix B*** provides details on the roles that the agencies played in preparing this programmatic EIS.

1.3.2 Public Involvement

1.3.2.1 NEPA Public Involvement Process

The Corps invites full public participation in the NEPA process to promote open communication and better decision-making. All persons and organizations that have a potential interest in the proposed action, including minority, low-income, disadvantaged, and Native American groups, are urged to participate in this NEPA environmental analysis process.

Public comments are invited at any time in the process. Formal opportunities for public participation began with the scoping meetings held in conjunction with the Comprehensive Study. In addition, this programmatic EIS process provides a series of opportunities to provide input, including a web site for electronic receipt of public comment, newsletters, review copies of the draft and final EISs, and public meetings on the draft EIS. Each of these steps in the process is briefly discussed below.

If you would like assistance or more specific information on how to participate, please contact Pat Robbins in the Mobile District Public Affairs Office, (334) 690-2505.

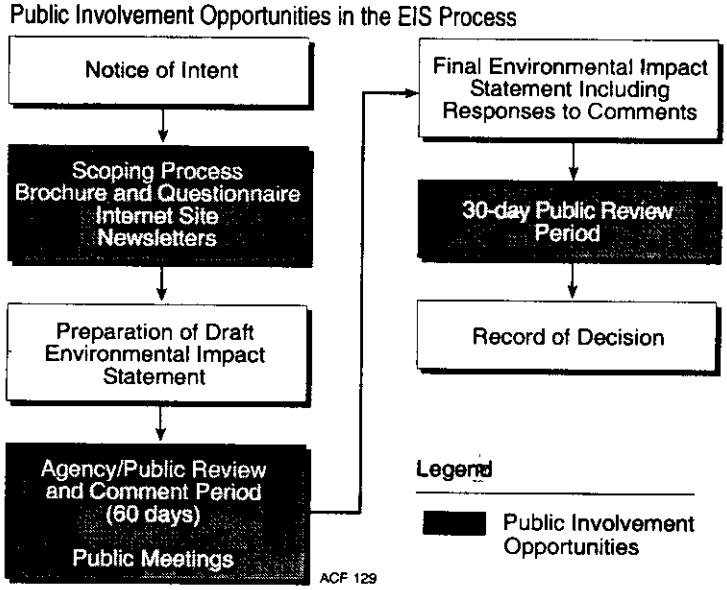
1.3.2.1.1 Notice of Intent

The public was notified of the intent to prepare this programmatic EIS and of opportunities for public involvement by publication of a Notice of Intent (NOI) (***Appendix C***) in the *Federal Register* on October 31, 1997. The NOI identified the Corps as the lead agency and identified cooperating agencies that will assist in preparing the EIS.

1.3.2.1.2 Public Review of the EIS

The EIS process is designed to involve the public in Federal decision-making. During the preparation of this EIS, comments from concerned individuals, agencies, and organizations are welcome at any time. Formal opportunities to comment and participate, such as during scoping and public review of the EIS, are outlined in ***Figure 1-2***. Comments received throughout this process will be included in the final EIS.

FIGURE 1-2
Public Involvement Opportunities in the EIS Process



1.3.2.1.3 Public Mailing List

A public mailing list was developed by the Corps and the cooperating agencies to include over 5,300 individuals, agencies, government entities, and special interest groups in the ACT and ACF basins and surrounding areas. Public mailing lists have been updated throughout the preparation of the EIS based on information received by the Corps and the cooperating agencies during the scoping process and the public review process.

1.3.2.1.4 Brochure and Questionnaire

A scoping brochure and questionnaire were mailed initially to over 4,870 individuals, agencies, and groups included on the public mailing list in October 1997. The purpose of the brochure was to inform the public about the project and to solicit scoping comments from the recipients. The questionnaire invited input on specific issues to be addressed, and requested information from respondents on how they would like to be contacted in the future to receive information. Issues identified by the public, interest groups, and agencies are summarized in Section 1.3.2.2.

1.3.2.1.5 Newsletters

Four newsletters mailed to individuals, groups, and agencies on the mailing list for this EIS are a part of the public involvement process. The first newsletter, composed of the scoping brochure and questionnaire, is discussed in the section above. The second newsletter was distributed in June 1998 and described the relationship of the EIS process to the Compact Commission efforts to develop an allocation formula, and the EIS evaluation framework. The third newsletter was mailed concurrently with the filing of this draft EIS and announced availability of the document and the schedule for the public meetings. The fourth newsletter will be mailed immediately prior to or concurrent with the filing of the final EIS. In addition to announcing meetings and availability of the EIS documents, the newsletters provided updates on the progress of the project to the public and other interested parties.

1.3.2.1.6 Internet Web Page

A web page was established to allow the public to obtain information on the project over the Internet. The web page includes a home page for the EIS, a page for each of the ACT and ACF river basins, a page summarizing the EIS process as well as links to the newsletters and scoping questionnaire, the annotated bibliography, and the NOI. The web page also will include information on the public meetings held during the draft EIS review process. The address for the web page is **www.sam.usace.army.mil/sam/pd/actacfeis**.

1.3.2.1.7 Draft EIS

The public is invited to review and comment on this draft EIS. A notice of availability was published in the *Federal Register*, public notices were mailed to those on the mailing list, and press releases were furnished to the local news media. A public comment period of 60 days begins with the publication of a notice of availability in the *Federal Register*. The comment period provides an opportunity for the public to review the issues addressed in the impact analysis and to comment on any aspect of the process. Comments on the draft EIS received from regulatory agencies, organizations, and individuals will be addressed in the final EIS.

1.3.2.1.8 Public Meetings

Public meetings will be held in each State within the basin to accept comments on this draft EIS. These meetings will follow an open house format rather than have a formal

presentation. A court reporter will be present at all of the meetings to record a transcript of statements presented at each meeting. As part of the public involvement program for the EIS, individuals, agencies, and groups are invited to provide written or oral comments on the draft EIS. Comments received during the meetings will be evaluated, and detailed responses will be included in the final EIS. Written comments on the draft EIS will be accepted for about 30 days after the public meetings are held. Public notices and newsletters are being sent to individuals, groups, and agencies on the mailing list for the draft EIS, announcing the meeting dates, locations, and times. News releases will also announce the meeting dates and times to the media in the project area.

1.3.2.1.9 Final EIS

The final EIS will evaluate and respond to comments received on the draft EIS. Copies of the final EIS will be furnished to all who comment on the draft EIS and to others requesting it. A notice of availability of the Final EIS will be published in the *Federal Register* and in local newspapers, and will be mailed to individuals, agencies, and groups on the mailing list.

1.3.2.1.10 Record of Decision

There will be a 30-day waiting period following filing of the EIS, after which a Record of Decision (ROD) will be prepared. The ROD will state the Federal Commissioner's decision to concur or not to concur with the water allocation formula alternatives developed by Alabama, Florida, and Georgia, considering the impacts addressed in the EIS, any mitigation measures that will be implemented, and an overview of the impacts associated with the allocation formula. The ROD will also reiterate the need for additional NEPA documents to address the impacts resulting from any changes in project operations or authorizations required to implement the water allocation formula alternatives at Corps-operated reservoirs if not adequately addressed in this programmatic EIS.

1.3.2.2 Scoping Issues

The first step in preparing an EIS is to scope, or identify, the issues to be addressed in the analysis and documentation. Often, at the beginning of the analysis, little is known about the potential impacts of a proposed action, so public and agency participation are solicited as early as possible to assist in identifying the critical issues to be analyzed in the document. The public, agencies, and various groups identified issues of concern during the public meetings and comprehensive evaluations conducted during the Comprehensive Study, during workshops, and in response to the scoping brochure and questionnaire. ***Table 1-2*** summarizes the issues identified. A more comprehensive list of questions and issues raised by the public can be found in ***Appendix C***.

1.3.3 Impact Analyses Process

1.3.3.1 Framework for the Proposed Action

This draft EIS evaluates an anticipated range of reasonable flows that could result from the final ACF basin water allocation formula. This programmatic approach was necessary because the proposed water allocation formula was not developed when the EIS was started. Presenting a range of realistic potential flows that could result from the final water allocation formula allows evaluation of a wide range of potential environmental and socioeconomic impacts. It is expected that the environmental and socioeconomic effects that result from the final water allocation formula will fall within the range of effects presented in the EIS. The basic framework for the analyses is based on the data collected and analyses

TABLE 1-2
Summary of Key Issues to be Addressed in the EIS

Water Resources: Quantity
Availability of water to meet future water supply needs for municipal, industrial, and agricultural uses
Potential effects of allocation on reservoir/lake levels and stream flows
Potential effects of allocation on availability of groundwater
Availability of adequate flows to support navigation
Potential changes in flood frequency as a result of the water allocations
Interaction of groundwater and surface water related to availability of surface water resources
Water Resources: Water Quality
Potential effects of changes in stream flows on assimilative capacity (for wastewater discharges)
Potential impacts on reservoir/lake water quality
Potential effects of erosion and sedimentation on water quality
Potential effects of nonpoint source pollution (all types) on water quality
Potential effects on groundwater quality
Biological Resources
Potential effects of changes in hydrologic regime on riverine habitat for native fish, mussels, and other aquatic organisms, and managed game fisheries
Potential effects of changes in reservoir levels on reservoir fisheries and other aquatic organisms
Potential effects of changes in hydrologic regime on anadromous fish habitat, including spawning and rearing habitat, summer thermal refugia, and upstream passage
Potential effects of changes in flow regime on estuarine habitats for finfish and shellfish
Potential effects of changes in hydrologic regime on riparian wetland habitat values
Potential effects of changes in reservoir levels on reservoir wetland structure and function
Potential effects of changes in hydrologic regime on estuarine wetland habitats, submerged aquatic vegetation, and primary productivity
Availability and timing of freshwater inflows to Apalachicola River and Bay
Potential effects of changes in hydrologic regime on wetland habitat value for terrestrial wildlife
Potential effects of changes in hydrologic regime on habitat for protected species of riparian plants, fish, mussels, and other aquatic species
Potential effects of changes in hydrologic regime on ability of State and Federal wildlife management facilities to withdraw surface waters for propagating fish and wildlife
Economics
Potential effects of altered stream flows on power generation
Potential effects of municipal and industrial water supply
Potential effects of altered flows, increased erosion, and sedimentation on navigation and the shipping industry
Potential effects of reduced stream flows on the agriculture industry
Potential effects of altered lake /reservoir levels on the recreation industry
Potential effects on commercial fishing in the river basin and Apalachicola Bay
Land Use: Recreation
Potential effects of altered lake /reservoir levels on water-based recreation users, including impacts on seasonal shoreline access, and boat access and launching
Potential effects of altered stream flows on utilization of the Chattahoochee River National Recreation Area

completed for the Comprehensive Study to the maximum extent practicable. These data and analyses were used because they have been rigorously reviewed by the States, the cooperating agencies, and the public. The baseline data and the analytical models and techniques used to develop and understand the impacts that could result from implementing the water allocation formula are described below.

1.3.3.2 Baseline Data

The baseline data, presented in Section 4 of this EIS, were derived from the various elements of the Comprehensive Study being completed by the Corps, the cooperating agencies; Alabama, Florida, and Georgia; and other State and Federal agencies. The study elements that comprise the Comprehensive Study as it applies to the ACF basin are described in Section 1.1.5. Current operations depict how the water management system is operating today, under existing conditions and with no allocation formula. A summary of current operations conditions has been incorporated into an existing operations model. Output from this model will provide baseline data on the impacts of the existing water management system.

The last major NEPA evaluations of water management operations in the ACF basin were completed in the mid- to late-1970s (Corps, 1974, 1976a, 1976b, 1977, 1979). Since the 1970s, several incremental changes in water management operations have been implemented in the ACF system. Operations in the basin in the mid-1970s differed in several respects from current operations due to changes in hydropower contracts and operating schedules, changes in navigation flow requirements, and other changes related to water quality, environmental, or other uses of the system. Historical records maintained by the Corps depict the observed impacts of changes in operations or seasonal variation over time on pool levels and flow releases from the Corps reservoirs. For purposes of this document, the observed baseline for relevant hydrologic statistics is available in ***Appendix D***. A review of historic project operations indicates that the operations conditions of 1977 is representative of the conditions of the basin projects at the time the last NEPA documents were prepared. This operational scenario has been incorporated into an historic operations (1977) HEC-5 model. Output data from this historical operations model can be used to evaluate impacts of the existing water management operations within the basin. Details of the differences in operations conditions for the historical operations model and the existing operations model are included in ***Appendix D***.

The Federal agencies cooperating in the EIS provided additional baseline information and assisted in evaluating potential impacts within their respective resource areas of responsibility. ***Table 1-3*** summarizes the areas of support/responsibility for each of the cooperating agencies.

TABLE 1-3
Baseline Data and Support Provided by Cooperating Agencies

Agency	Baseline Data/Responsibility
Environmental Protection Agency	Water quality data and land use data/evaluation of nonpoint source loadings and water quality impacts
Fish and Wildlife Service	Protected species, wetlands, and aquatic resources data/evaluation of impacts on these resources
U.S. Geological Survey	Geology and agricultural water use information/review of impacts on groundwater
National Park Service	Recreation information/review evaluation of recreation impacts

(CONTINUED)

TABLE 1-3 (CONTINUED)
Baseline Data and Support Provided by Cooperating Agencies

Agency	Baseline Data/Responsibility
Natural Resources Conservation Service	Soils and groundwater use data/evaluation of economic impacts on agriculture
Forest Service	National forest information/review impacts on national forests
National Marine Fisheries Service	Information on fisheries habitat in Apalachicola Bay
National Ocean Service	Information on Apalachicola Bay/hydrodynamic modeling of Apalachicola Bay; assessment of potential effects on oysters.
Maritime Administration	Navigation activities/review of potential impacts on navigation and shipping industry
Southeastern Power Administration	Federal hydropower facilities/evaluation of economic impacts on hydropower generation

1.3.3.3 Water Demand Scenarios

Water consumption assumptions for three municipal and industrial water demand scenarios were developed by the Corps, the Institute for Water Resources, the States, and the cooperating Federal agencies as part of the Comprehensive Study. All of the demand scenarios were agreed to by a consensus of the Comprehensive Study partners. These demand scenarios reflect differing levels of water conservation in the basin. Scenario 1 and Scenario 3 from the Comprehensive Study were selected for use in hydrologic models for this EIS as representative of realistic water demands in the ACF basin (and are shown in bold type in *Table 1-4*). These demands are averages of water needs over a wide range of climatic conditions and do not represent the worst case demands that may occur during drought periods.

TABLE 1-4
Assumptions for the Municipal and Industrial Water Demand Scenarios

Water Demand Scenario	Assumptions
Municipal and industrial scenario 1 with no conservation (extreme demand) (moderate and low flow)	**Water use projections based on residential and non-residential water use patterns and not considering water conservation (other than that measured in the water use modeling survey). Water demand projections were driven by projected changes in employment and housing characteristics in the basin for 1995, 2020, and 2050.**
Municipal and industrial scenario 2 with passive conservation	Water use projections based on residential and non-residential use patterns considering water use efficiency resulting from recently implemented plumbing codes, the natural replacement of water fixtures, and known increases in water and wastewater rates.

(CONTINUED)

TABLE 1-4 (CONTINUED)
Assumptions for the Municipal and Industrial Water Demand Scenarios

Water Demand Scenario	Assumptions
Municipal and industrial scenario 3 with aggressive conservation (extreme conservation) (High flow)	**Water use projections based on residential and non-residential water use patterns plus passive increases in water use efficiency resulting from recently implemented plumbing codes, the natural replacement of water fixtures, known increases in residential water and wastewater rates, basinwide implementation of selected active demand management programs, summer surcharge for residential customers, and a basinwide increase in residential water and wastewater rates. The active demand management programs factored into the demand projections are a residential rebate program for ultra-low-flow toilets, residential indoor-outdoor home water audit and retrofit, and commercial water audits.**

Note: Bold indicates scenario selected for modeling.

Source: Planning and Management Consultants, Ltd., 1996

The Natural Resources Conservation Service (NRCS) was responsible for developing the agricultural water demand estimates for agricultural demand used in this EIS. The data generated by the NRCS study were approved by the States and the cooperating State and Federal agencies as part of the Comprehensive Study. Six demand scenarios were developed, three with conservation and three without. The three scenarios selected for use in this EIS (shown in bold type in ***Table 1-5***) reflect the highest, moderate, and lowest water demand rates for agriculture.

TABLE 1-5
Assumptions for the Agricultural Water Demand Scenarios

Water Demand Scenario	Assumptions
Agricultural scenario 1 (high demand with no conservation, extreme demand) (Low flow)	**Assumes an optimistic agricultural market growth rate, a strengthened international position, an increase in agricultural exports, strong economic growth, and an improved standard of living.**
Agricultural scenario 2 (expected demand with no conservation, moderate demand) (Moderate flow)	**Assumes the continuation of the current rate of economic and technological growth and no substantial change in national agricultural policy, price supports, or agricultural exports.**
Agricultural scenario 3 (low demand with no conservation)	Assumes a reduction in agricultural price support programs, a gradual shift to the world market price structure, increased international competition for agricultural trade, and a reduction in agricultural exports.

(CONTINUED)

TABLE 1-5 (CONTINUED)
Assumptions for the Agricultural Water Demand Scenarios

Water Demand Scenario	Assumptions
Agricultural scenario 1 (high demand with conservation)	Assumes an optimistic agricultural market growth rate, a strengthened international position, an increase in agricultural exports, strong economic growth, and an improved standard of living. The following conservation measures are factored into the assessment: irrigation scheduling, moisture balancing techniques such as a water budget or moisture sensors; low energy precision application systems with low-pressure nozzles to reduce evaporation and soil erosion; improved pond management to reduce makeup water by allowing precipitation to be stored; and partial harvest at catfish farms using seine nets instead of draining the ponds to harvest.
Agricultural scenario 2 (expected demand with conservation)	Assumes the continuation of the current rate of economic and technological growth and no substantial change in national agricultural policy, price supports, or agricultural exports. The following conservation measures are factored into the assessment: irrigation scheduling, moisture balancing techniques such as a water budget or moisture sensors; low energy precision application systems with low-pressure nozzles to reduce evaporation and soil erosion; improved pond management to reduce makeup water by allowing precipitation to be stored; and partial harvest at catfish farms using seine nets instead of draining the ponds to harvest.
Agricultural scenario 3 (low demand with conservation, lowest demand) (High flow)	**Assumes a reduction in agricultural price support programs, a gradual shift to the world market price structure, increased international competition for agricultural trade, and a reduction in agricultural exports. The following conservation measures are factored into the assessment: irrigation scheduling; moisture balancing techniques such as a water budget or moisture sensors; low energy precision application systems with low-pressure nozzles to reduce evaporation and soil erosion; improved pond management to reduce makeup water by allowing precipitation to be stored; and partial harvest at catfish farms using seine nets instead of draining the ponds to harvest.**

Note: Bold indicates scenario selected for modeling.

Source: Natural Resources Conservation Service, 1995

1.3.3.4 Hydrologic Modeling

Hydrologic modeling tools were developed to achieve the goal of the Comprehensive Study to assess existing water resources needs in the basin and to evaluate the ability of the system to meet these needs, as well as to develop long-term, basinwide management alternatives. A modeling approach was needed to simulate the complex interrelationships between the competing water uses and to allow evaluation of the effects of various management strategies on environmental resources and other competing demands. Hydrologic modeling was conducted with continuous support and input from the stakeholders involved in the Comprehensive Study process.

HEC-5 and a number of water quality models were used to predict and analyze hydrologic data in the basin under existing and alternative management scenarios. These models are briefly described in the following text.

The HEC-5 model, developed by the Corps' Hydrologic Engineering Center (HEC), was used to define impacts of alternative flow scenarios for this EIS. HEC-5 works on a daily average flow basis. The HEC-5 model uses 55 years of historic streamflow data, including local inflows between gaged inflows, and the physical and operational characteristics of reservoirs (***Appendix D***). The HEC-5 modeling completed for this EIS was used to simulate the conditions that would exist in the rivers and reservoirs of the ACF basin under the alternatives evaluated. The data generated by the model enabled the interdisciplinary team to adequately assess the potential environmental and socioeconomic effects associated with each alternative.

The output from the HEC-5 model is voluminous. HEC-5 predicts the average stream flow and reservoir elevations at 31 nodes in the basin on a daily basis for 55 years of the historical record under each simulated operating scenario. While this is useful information in that it allows a comprehensive analysis of how the alternatives would affect basin resources under conditions that existed over a 55-year period, the volume of data is so large that analysis is difficult and time-consuming. Therefore, the Corps applied the Indicators of Hydrologic Alteration (IHA) data processing program, developed by the Nature Conservancy, to summarize output from the HEC-5 models in order to provide meaningful statistics on the large number of output parameters. The output from IHA included monthly frequency data at each node. These data formed an additional foundation for impact analyses by the various resource agencies for this EIS.

1.3.3.5 Water Quality

The water quality modeling completed for this EIS was used to simulate the conditions that would exist in the rivers and reservoirs of the ACF basin under the alternatives evaluated. The data generated by the models enabled the interdisciplinary team to adequately assess the potential environmental and socioeconomic effects associated with each alternative.

Water reallocation in the ACF basin could have substantial effects on water quality in both streams and reservoirs. Impacts due to increased or decreased streamflows, increased wastewater discharges, and changing land uses within the basin are evaluated in this EIS. To do so, it was necessary to first assess existing water quality in the basin and, second, to predict the effect of various water management alternatives on basin water quality conditions.

A basin-wide water quality inventory was completed by the Corps' Waterways Experiment Station (WES). Existing water quality, water quality standards, and main stem cross-sectional stream geometry data were collected for the entire basin. The data were analyzed to characterize water quality, and to identify water quality trends, areas of water quality concerns, and data gaps (Ashby et al., 1996).

Once the existing water quality in the basin was documented, predictive modeling was developed to assess the impacts of various alternatives. Three models were developed to assess water quality impacts: (1) a nonpoint source projection model, Better Assessment Science Integrating Point and Nonpoint Source (BASINS), which predicts the nonpoint source loadings for input to the HEC-5Q and CE-QUAL-W2 models; (2) a basin-wide one-dimensional water quality model (HEC-5Q) to evaluate stream and reservoir water quality throughout the basin; and (3) a two-dimensional reservoir water quality model (CE-QUAL-W2) to evaluate both longitudinal and vertical effects of various alternatives on Walter F. George reservoir (Lake Eufaula).

The U.S. Environmental Protection Agency (EPA) developed point source loadings for the HEC-5Q and CE-QUAL-W2 water quality models as part of the Comprehensive Study. EPA used Comprehensive Study-approved population and wastewater load projections for a number of target years, including 1995, 2020, and 2050. Formulas were developed to convert wastewater volume into water quality constituent loads, e.g., pounds of phosphorus, nitrogen, and BOD, based on the type of point source (municipal wastewater treatment plants and industrial treatment plants). Spreadsheets were developed to present the point source loading projections on a county-level basis for use in the water quality models. Preliminary final versions of the spreadsheets were used for the models in this draft EIS.

Pollutant loads from nonpoint sources can have as significant an impact as point source wastewater discharges on basin water quality. Population growth into the year 2050 will change land uses significantly, with resulting changes in nonpoint source pollutant loadings. The nonpoint source pollutant loadings for the years 1995, 2020, and 2050 were predicted by EPA's BASINS program. The results from the BASINS program were fed back into the HEC-5Q and CE-QUAL-W2 programs to analyze the overall impacts on streams and reservoirs. The CE-QUAL-W2 analysis was not completed for the draft EIS but will be included in the final EIS.

One-dimensional modeling with the HEC-5Q model was conducted by the Corps' HEC, with field data collection support from the U.S. Geological Survey (USGS) and EPA. The flow output data predicted by the HEC-5 model provided direct input into the HEC-5Q model. HEC-5Q simulates streamflow and water quality within the basin's network of streams and reservoirs. Impacts from changes in streamflows and increases in wastewater discharges were assessed with this model. The model was calibrated with data compiled by WES and supplemented by data collected by the USGS and EPA in 1994 and 1995.

The HEC-5Q model provided limited data on reservoir impacts of alternative water management scenarios. Therefore, a two-dimensional reservoir water quality model will be used for three reservoirs in the ACF basin to produce more detailed data. The hydrodynamic and water quality model, CE-QUAL-W2, was run for the Walter F. George Reservoir by the Corps's WES. Output data from HEC-5Q were used as input to this model to maintain consistency. This model was calibrated with data collected by the Alabama Department of Environmental Management (ADEM) in Walter F. George Reservoir from 1991 through 1994. The Corps' WES also developed a two-dimensional water quality model

for West Point Lake, and Limno Tech developed a two-dimensional model for Lake Lanier. Both of these projects were performed for the Georgia Department of Natural Resources (GDNR) using CE-QUAL-W2. Data from CE-QUAL-W2 for the three reservoirs modeled (West Point Lake, Lake Lanier, and Walter F. George Reservoir). More detailed water quality analyses for the proposed allocation formula will be included in the final EIS.

1.3.3.6 Node Analyses

Building a model using HEC-5 requires the identification of specific locations (called *nodes*) in which to input data such as demands on reservoir releases, and to provide output such as stream flows or reservoir levels. In the ACF basin model, there are 23 nodes (***Figure 1-3***). Nine nodes represent reservoirs such as Lake Lanier or Lake Seminole. Fourteen nodes represent other locations on the three main rivers. The river nodes were generally selected to correspond to locations in which there are existing stream gages since the stream gage data could then be used to calibrate the model.

Inputs at each node consist of items such as water withdrawals to meet consumptive demands and water discharges from treatment facilities. In reality, all withdrawals and discharges do not occur at just 23 locations in the basin; however, the model would become too complex if every withdrawal and discharge location were included in the model. Therefore, withdrawal and demands have been grouped at the various nodes.

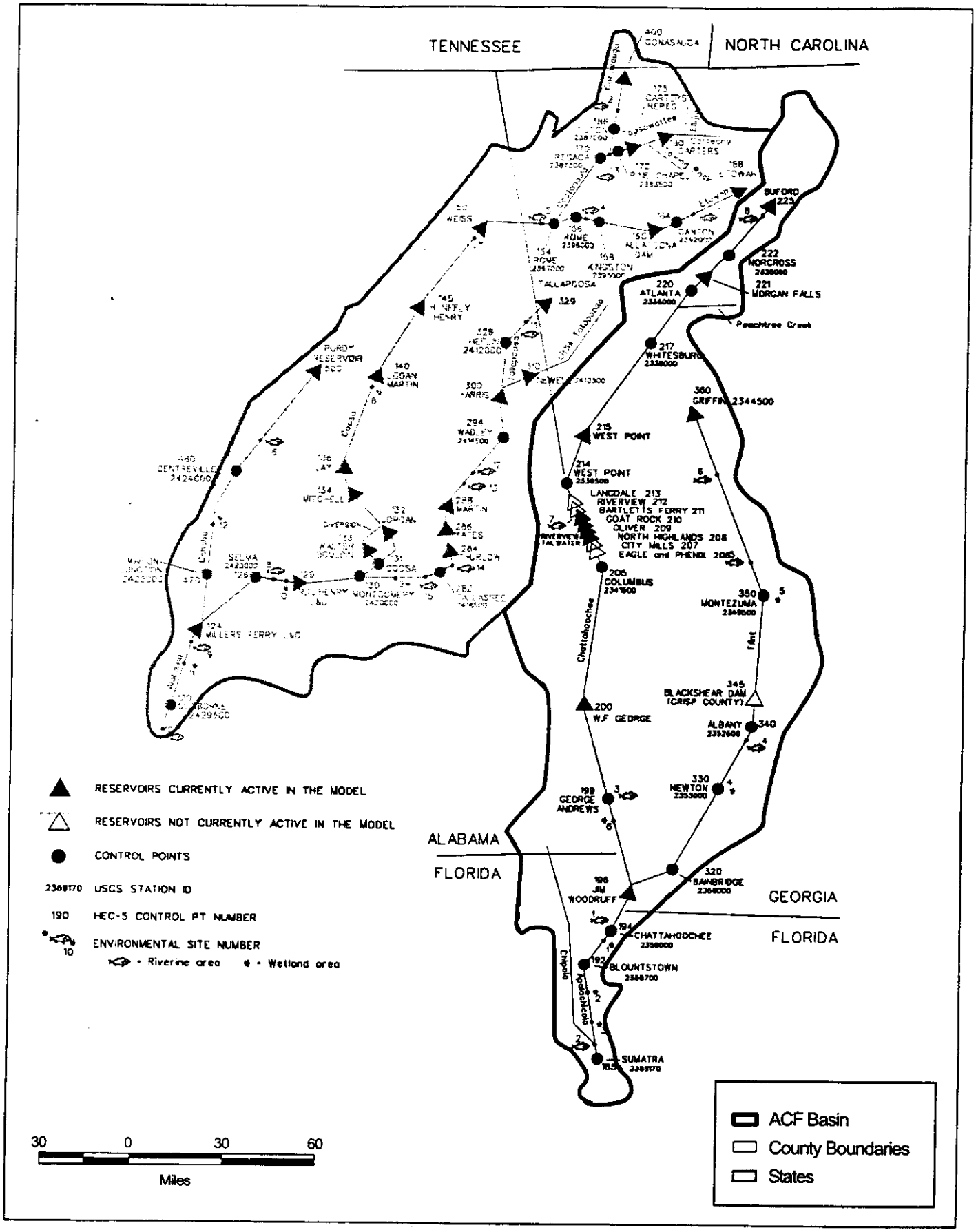
The HEC-5 model output consists of daily flows or reservoir elevations at each node for each management alternative modeled. The node analysis forms the basis of all impact assessments. By predicting flows and reservoir levels at multiple locations across the basin, the impacts can be assessed on a variety of stream and/or reservoir characteristics (e.g., a 25 percent reduction in stream flow would have a much different impact on the headwaters of the Chattahoochee River than on the mainstem Apalachicola River). Because the ACF basin is so large and physically diverse, it was critical to assess the impacts of different management alternatives on a representative selection of stream and reservoir characteristics. Section 4.4 provides detailed discussion of the nodes used for these representative sections.

Predicted streamflows and/or reservoir levels were provided by HEC-5 at each node for the existing (no action) alternative and for each of the demand and alternative flow condition scenarios. The impacts for all resources were then assessed based on the changes predicted by HEC-5 at each node for a particular alternative compared to the no action alternative. Analysis of impacts in this EIS is based on the nodal analysis of the HEC-5 predictions.

1.3.3.7 Ecological Analyses

Ecological impacts resulting from implementing the water allocation formula were evaluated by the Fish and Wildlife Service using direct output from the HEC-5 model) and also using summary statistic output from the range of variability approach (RVA), which is based on the IHA statistical program developed by The Nature Conservancy (Richter, et al., 1996, and Richter, et al., 1997). The IHA program summarizes the volume of data generated at each node into more manageable statistics applicable to the evaluations of aquatic resources. For the purposes of this EIS, model-generated data and environmental performance measures

FIGURE 1-3
Location of the Nodes for the ACF Basin



were used to evaluate potential impacts on riverine, aquatic resources, reservoir fisheries, and wetlands at specific locations in the basin that were established in the Comprehensive Study. The performance measures were modified for this EIS analysis from a monthly to a daily time-step.

1.3.3.7.1 Riverine Aquatic Resources Analyses

The environmental performance measure for riverine aquatic resources was developed during the Comprehensive Study and is based on a comparison of the unimpaired flows with the no action and range of alternative flow scenarios using the RVA approach. Details on these measures are included in *Appendix E.*

1.3.3.7.2 Riparian Wetland Analyses

A similar performance measure was used to evaluate impacts on riparian wetland communities. This measure, called the Riparian Wetland Unit, is an index of potential change between a reference condition (unimpaired flows) and both no action and the range of alternative flow scenarios. Details on these measures are included in *Appendix E.*

1.3.3.7.3 Reservoir Fisheries Analyses

Fisheries in the various reservoirs in the ACF basin were evaluated by using a modified performance measure developed by FWS that is based on acceptability ratings for different lake levels. Acceptability ratings were developed using an iterative survey of regional fishery experts (Ryder, et al., 1995). The ratings provided a score for the critical spawning and rearing periods (March through October), and then are weighted based on how lake levels change over this same period. When lake levels increase or stay the same, these average scores are multiplied by two; they remain unchanged if the lake levels stay the same or decrease. *Appendix E* includes the reservoir fisheries report.

Additional information on the environmental performance measures, the range of variability approach, the indicators of hydrologic alteration methodology, and how they were applied to this project can also be found in *Appendix E.*

1.3.3.7.4 Protected Species Surveys

Site-specific field surveys were conducted to supplement the protected species inventory developed during the Comprehensive Study. The USGS, through the Biological Resources Division, conducted surveys and mapped protected fish and invertebrate species in the Flint River basin. The inventory and identification of both State and Federal protected species within the ACF basin was completed to identify the species that could potentially be affected by changes in water management and to provide life history information on those species to help develop and evaluate the water allocation formula. *Appendix E* provides the results of protected species evaluation.

1.3.3.7.5 Freshwater Inflows and Oysters in Apalachicola Bay

Using the three-dimensional hydrodynamic model developed for Apalachicola Bay as part of the Comprehensive Study, the National Ocean Service (NOS) examined the effects of freshwater inflow on the circulation and salinity changes in Apalachicola Bay. Output from the hydrodynamic model was used in an integrated biological model to assess the potential effects of changes in freshwater inflow to Apalachicola Bay on oysters. Oysters were selected for this study because of their habitat requirements, commercial fishery importance, and potential response to fluctuations in flows from the Apalachicola River into the bay. *Appendix D* provides a detailed summary of the Apalachicola Bay modeling.

1.3.3.8 Economic Analyses

The regional economic effects of implementing the water allocation formula have been estimated using the Economic Impact Forecasting System (EIFS) model developed by the U.S. Army Construction Engineering Research Laboratory (CERL). The outputs generated by the EIFS model are discussed in terms of changes in employment and income directly related to implementing the water allocation formula. Inputs for the EIFS model were generated by evaluating the direct impacts on inland navigation, reservoir recreation, agricultural water supply, municipal and industrial water supply, electric power generation, and flood control.

- Impacts on inland navigation were estimated by changes in the shipping costs per ton of commerce moved by railroad, truck, or barge.
- Impacts to reservoir recreation were calculated as the difference between the gross value of recreation use and the value of diminished reservoir recreation use. Only boater recreation was evaluated. A qualitative assessment of impacts to riverine recreation was also conducted.
- Impacts on agricultural production and income were estimated through an agricultural water supply analysis conducted by the Natural Resources Conservation Service. The Corps completed an analysis of potential shortages in meeting agricultural demands for surface water based on the results of the HEC-5 modeling. This information was used by NRCS to evaluate the potential economic impacts on the agriculture industry.
- Municipal and industrial water supply impacts were estimated using the results of the HEC-5 model and a probability-based risk analysis to determine water supply shortages at locations within the basin. A qualitative evaluation of the predicted shortages was used to determine impacts in terms of their direct impacts on income and employment.
- Impacts on power generation operations were assessed using the Proprietary Hourly Power System Evaluation Model (PROSYM) power simulation software. The modeling evaluated the worst-case flow alternative first, followed by more moderately impacting flow alternatives. This step-wise manner of analysis helped in determining which flow alternatives contributed significant beneficial or adverse effects. PROSYM is the model used to determine energy values for projects that are owned and operated by the Corps. It provides a simulation of hour-by-hour operations of power plant operations to evaluate operating costs to meet power loads. The model can be run to give the most economic means for meeting demands and can be provided by region.
- The direct economic impacts to residential, commercial, and public structures in the 500-year floodplains downstream of Lake Lanier and West Point Lake were calculated based on computer modeling of the inundation of these structures and their contents with varying river levels and flows. Model output was provided in the form of induced monetary damages for the alternative water levels and flows simulated. Impacts associated with changes in flood control were not evaluated as part of the alternatives, but are provided in *Appendix F*.

Impacts were allocated by regions of influence that consisted of one or more counties. EIFS then compared these impacts to a rational threshold value (RTV) for that region of influence to determine if a significant impact had occurred. The RTV was calculated on the basis of

yearly historical fluctuations in employment, sales volume, and income within the affected region. For an impact to be significant, it must exceed the RTV.

1.3.3.9 Cultural Resources Predictive Model

The Corps developed a predictive model to identify sites in the ACF basin that could contain cultural resources. The predictive model uses the Geographic Information System (GIS) to evaluate topography, distance from a permanent water supply, historic land use information, and level of development or disturbance data to predict if an area has a high, moderate, or low probability of containing unknown archeological sites (***Appendix G***).

1.3.4 Relevant Statutes and Executive Orders

Table 1-6 lists statutes and executive orders relevant to decisions regarding water allocation formula alternatives. ***Appendix H*** summarizes the requirements for the relevant statues and executive orders.

TABLE 1-6
Federal Environmental Statutes and Executive Orders Applicable to the ACF Basin EIS

Acts
Apalachicola-Chattahoochee-Flint River Basin Compact (PL 105-104, 111 Stat. 2219)
Archaeological and Historic Preservation Act of 1974 (16 U.S. Code [USC] 470 et seq.)
Clean Air Act, as amended (42 USC 7401-7671g)
Clean Water Act, as amended (33 USC 1251, et seq.)
Endangered Species Act of 1973, as amended (16 USC 1531, et seq.)
Fish and Wildlife Coordination Act, as amended (16 USC 661, et seq.)
Magnuson-Stevens Fishery Conservation Management Act (16 USC 1801, et seq.)
Marine Protection, Research, and Sanctuaries Act of 1972 (33 USC 1401-1445, 16 USC 1431, et seq., and 33 USC 1271)
National Environmental Policy Act of 1969 (42 USC 4321-4347)
National Historic Preservation Act of 1966, as amended (16 USC 470 et seq.)
North American Wetlands Conservation Act (16 USC 4401 et seq.)
Resource Conservation and Recovery Act (43 USC 2101-2106)
Safe Drinking Water Act, as amended (42 USC 300f et seq, 6939b; 15 USC 1261 et seq.)
Watershed Protection and Flood Prevention Act of 1954 (16 USC 1101, et seq.; 33 USC 701b)
Executive Orders
American Heritage Rivers (Executive Order 13061)
Environmental Justice in Minority Populations and Low-Income Populations (Executive Order 12898)
Federal Compliance with Pollution Standards (Executive Order 12088)
Flood Plain Management (Executive Order 11988)
Protection of Wetlands (Executive Order 11990)
Protection of Children from Environmental Health risks and Safety Risks (Executive Order 13045)

2. Description of the Proposed Action

2.1 Introduction

2.1.1 Proposed Action

The ACF Compact Commissioners are currently in negotiations to develop an allocation formula for the equitable allocation of water resources within the ACF basin. Under the ACF River Basin Compact between these States (PL 105-104, November 20, 1997), the proposed allocation formula must be approved by a Federal Commissioner before it can go into effect. It has been determined that the Federal Commissioner's decision of concurrence or nonconcurrence represents a major Federal action that could result in significant impacts to the environment within the ACF basin. The draft EIS has been prepared to provide the information needed by the Federal Commissioner to make an informed decision of concurrence or nonconcurrence.

Under the Compact, the allocation formula is required to be completed by December 31, 1998, unless State Commissioners vote unanimously to extend this date. The Compact also requires the Federal Commissioner to reach a concurrence decision within 255 days of receipt of the State's proposed allocation formula. Because an EIS normally requires 18 to 24 months to complete documentation and coordination and must allow sufficient time for a review of potential impacts by the public and the decisionmakers, this EIS was initiated before the identification of a water allocation formula by the States. A programmatic evaluation framework was developed to assess the impacts that would likely result from a range of flow conditions which would likely "bracket" the flow conditions of the allocation formula that will be negotiated by Alabama, Georgia, and Florida.

This programmatic approach meets the requirements of the Compact and NEPA by providing sufficient information to assist in review of the impacts of a proposed allocation formula prior to the Federal Commissioner's decision and also allows the document to address the broad areas of water resources that could be affected by implementing an allocation formula. This evaluation framework could also be used to evaluate future modifications that could be made to the allocation formula. As a programmatic EIS, the environmental framework used for the analyses in this document will also facilitate the tiering of additional EAs and EISs as necessary to support future site-specific changes in water management strategies and water resource projects that may be required to implement the water allocation formula, or for other basin management actions or programs.

2.1.2 Summary of Available Water Allocation Mechanisms for the ACF Basin

The water allocation management formula developed by Alabama, Georgia, and Florida for the ACF basin may include a combination of approaches to meet the desired objectives of the Compact. Because the water allocation formula was not available at the time this draft EIS was prepared, the following text reviews the various options that may be used by these States to develop the formula. The final expression of the formula, as stated in the Compact,

"may be represented by a table, chart, mathematical calculation, or any other expression of the Commission's apportionment of water" (PL 105-104). It is intended that the final EIS will contain a detailed description of the final negotiated water allocation formula and the approaches that will be used to allocate surface water resources in the basin.

The approaches that may be used in the water allocation formula could vary in their treatment of the type of hydrologic standards used, the time scales over which the hydrologic variables are measured, and the need to determine water availability. The most common ways these variables have been treated in other water allocation formulas are as described in the following text.

2.1.2.1 Hydrologic Standards

Hydrologic standards generally use minimum flow standards, storage limitations, consumption or diversion limits, and delivery requirements, or combinations thereof.

Minimum flow approaches can be used in a number of situations and are useful when an allocation formula includes instream uses. This approach is easy to monitor because existing stream gaging stations can often be used. An example would be a formula that requires a State to regulate daily water use to meet some minimum flow at a specific gage during certain periods.

Reservoir storage approaches limit the volume of water that can be stored by a party to the water allocation formula. For example, an upper limit could be placed on how much water could be stored upstream.

Rights of consumption or diversion approaches are more complex than either minimum flow or reservoir storage because they usually rely on a percentage of the water available or specify fixed quantities that can be used. Water allocation formulas that use this approach typically require more monitoring than the other approaches.

Delivery requirement approaches are similar to those for minimum flow except that delivery requirements are volume, or quantity-based, instead of flow-based. For example, Georgia could be asked to deliver a minimum volume of water over a specific number of months or years.

2.1.2.2 Time Scale

Some hydrologic standards, such as flow minimums and storage maximums, are in effect at all times of the year. A water allocation formula that includes an approach based on consumption or delivery of water from other parts of a river basin often features long time periods with annual or multi-year monitoring requirements. In areas in which withdrawals and subsequent shortages result from agricultural demands, monitoring could be limited to the growing season.

2.1.2.3 Water Availability

Two water availability approaches may be used for a water allocation formula. One approach would specify a fixed quantity to be allocated for each user, while the other would rely on a percentage of the total water available. Water availability approaches also often include operational and allocation changes that become effective if there are

significant changes that affect water availability, such as drought (short-term temporary effects) or additional water development (long-term permanent effects).

2.1.2.4 Process and Status for Developing the Allocation Formula

The ACF Compact Committees, comprised of State members appointed by the Governors of Alabama, Florida, and Georgia, and the Federal Commissioner appointed by the President as a non-voting member, have adopted a protocol to facilitate the development of an allocation formula. Regular meetings have been scheduled, rotating among the States, and have been attended by the Committee Members and their Alternates, along with appropriate technical resources, other agencies, and representatives from public organizations. These meetings have provided opportunities for formal and informal presentations of ideas and approaches, technical evaluations, and public interests that could be considered in each State's proposal.

The ACF Compact requires the Commission to involve the public during the development, review, and approval of the water allocation formula. It states that:

> *All meetings of the Commission shall be open to the public. The signatory parties recognize the importance and necessity of public participation in activities of the Commission, including the development and adoption of the initial allocation formula and any modification thereto. Prior to the adoption of the initial allocation formula, the Commission shall adopt procedures ensuring public participation in the development, review, and approval of the initial allocation formula and any subsequent modification thereto. At a minimum, public notice to interested parties and a comment period shall be provided. The Commission shall respond in writing to relevant comments.*

In accordance with the requirements of the ACF Compact, each State provides appropriate notification to public stakeholders and the respective media, as well as an opportunity for public hearings, presentations by interested parties, and written comments to be considered during the allocation formula development.

Before the water allocation formula can be forwarded to the Federal Commissioner for review, it must be approved by the State Commissioners. The Compact requires that *"each state shall have one vote on the ACF Basin Commission and the Commission shall make all decisions and exercise all powers by unanimous vote of the three State Commissioners."* As a result, the water allocation formula must be approved by all of the State Commissioners before it can be forwarded to the Federal Commissioner. The water allocation formula will become effective and binding upon all parties *"upon receipt by the Commission of a letter of concurrence with said formula from the Federal Commissioner."*

2.2 Proposed Implementation

The approach that the ACF Compact Commission will adopt for the final water allocation formula may include a variety of hydrologic, time scale, and water availability approaches. If implementing the water allocation formula requires changes in project authorization or in how the Corps operates its reservoirs in the ACF basin, new water control manuals and additional NEPA documentation may be necessary to evaluate the site-specific impacts that could result from the changes in operations. As required by the ACF River Basin Compact:

The parties to this Compact recognize that the United States operates certain projects within the ACF Basin that may influence the water resources within the ACF Basin. The parties to this Compact further acknowledge and recognize that various agencies of the United States have responsibilities for administering certain federal laws and exercising certain federal powers that may influence the water resources within the ACF Basin. It is the intent of the parties to this Compact, including the United States, to achieve compliance with the allocation formula adopted in Accordance with this Article. Accordingly, once an allocation formula is adopted, each and every officer, agency, and instrumentality of the United States shall have an obligation and duty, to the maximum extent practicable, to exercise their powers, authority, and discretion in a manner consistent with the allocation formula so long as the exercise of such powers, authority, and discretion is not in conflict with federal law.

For example, if implementing the water allocation formula requires changes in project authorizations or how the Corps operates its reservoirs in the ACF basin, to the extent practicable and within the limits of existing federal laws, new water control manuals and separate NEPA documentation will be prepared to evaluate the site-specific impacts that could result from the required change in operations. In some cases, Congressional action, i.e., implementing legislation (33 CFR 2 Section 216), may be required to change how some Corps-operated reservoirs are managed. If implementing the water allocation formula requires changes in operations at reservoirs operated by private entities, such as Georgia Power Company or Crisp County, the ACF River Basin Commission will work with those entities and the appropriate regulatory agencies to facilitate the changes in reservoir operations while maintaining, to the extent practicable, the goals and objectives of the specific project (power generation, water supply, and recreation).

3. Alternatives Considered

The alternatives considered for this draft EIS include the no action alternative and a range of alternative flow conditions selected to bracket the water allocation formula to be developed by the State Commissioners. The no action alternative is defined by the existing operations conditions within the ACF basin. In addition, a review of historical operations is provided as part of this EIS to document incremental changes in operations and demands that have occurred since the last comprehensive environmental studies were conducted, approximately 20 years ago. This review provides a realistic perspective of current conditions that comprise the baseline, or the no action alternative.

To provide a basis for evaluating the allocation formula, and to meet a schedule for completing the final EIS by late summer 1999, this draft EIS uses a programmatic evaluation framework. This framework provides a range of alternative flow conditions that would econompass or "bracket" the flows that are likely to result from the water allocation formula. To evaluate the potential environmental impacts associated with different flow conditions, alternative flow conditions comprising the high, moderate, and low range can be compared to the flow conditions for the no action alternative and the historical operating conditions scenario. The environmental impacts associated with the range of flow conditions are expected to bracket the potential impacts associated with the flow conditions resulting from the final water allocation formula.

The above alternative flow conditions, including those produced by the no action alternative, were hydrologically modeled by using a historic flow record that represents 55 years of recorded stream flows. The evaluations in the draft EIS compare the effects of the range of flows for the years 1995, 2020, and 2050, accounting for water demand changes affecting stream flows during each time period. The water demands used in the models were developed as part of the Comprehensive Study and have been reviewed and approved by the Corps and by the States of Alabama, Florida, and Georgia. The assumptions associated with the water demands from municipal, industrial, and agricultural uses remain the same for each year. Specific elements of each of these alternatives are described in the following sections. ***Appendix D*** includes the relevant water demand estimates used to develop the range of alternative flow conditions.

3.1 Continue Existing Operations, the No Action Alternative

As required by NEPA, the no action alternative is the baseline condition against which the action alternatives are compared. The no action alternative provides the baseline flows for comparing the impacts of potential alternative allocation formulas. This baseline represents the conditions in the ACF basin at the time the Comprehensive Study elements were prepared. In this EIS, the no action alternative assumes that existing project operations will continue unchanged into the future, and demonstrates the impacts that would occur without implementation of an alternative allocation formula.

The action alternative flow scenarios will be compared, to the extent practicable, with the no action alternative to evaluate the environmental effects of the water allocation formula

developed by Alabama, Florida, and Georgia. This evaluation will assist in identifying the direct, indirect, and cumulative impacts expected to result from implementation of the allocation formula. This information will be used to support the Federal Commissioner's decision to concur or not to concur with the water allocation formula.

3.1.1 Existing Operations Model

As discussed in Section 1.3.3.4, a HEC-5 model was constructed to predict stream flows resulting from existing operations (no action) and potential future operations. The existing operations model was developed by using management and operations strategies currently in place at the various reservoir projects. These strategies prescribe reservoir operations for minimum flow releases, power generation rules, and storage management (i.e., to meet competing water uses, such as navigation, power generation, recreation, water supply, wastewater assimilation, fish and wildlife conservation, and flood control). ***Appendix D*** provides details on model development and current conditions.

3.1.2 No Action Alternative

The no action alternative assumes that current reservoir operations will continue, and that water supply demand will continue to increase through the year 2050. There are other approaches that could be considered, such as capping withdrawals at present permitted levels. However, the water supply demands used for the no action alternative were selected from the Comprehensive Study and provide the best current estimates of future water use. The no action alternative is based on current water use patterns and demands (1995), taking into account increasing water supply demands in the future (2020 and 2050).

The demands for the no action alternative are best reflected by the water demand scenarios, which include municipal and industrial demand (scenario 1) and agricultural demand (scenario 2) with no conservation, as defined by the Comprehensive Study (see ***Tables 1-4*** and ***1-5*** for descriptions of these demand-scenarios). These demands were selected because they were comparable and consistent for Alabama, Florida, and Georgia (Planning and Management Consultants, 1996; NRCS, 1995). Based on these demand scenarios, water supply demands for the years 1995, 2020, and 2050 were modeled for comparison with the alternative flow scenarios. The detailed assumptions for each of these demand scenarios are provided in Section 1.3.3.3. ***Table 3-1*** summarizes the assumptions for the no action alternative.

3.1.3 Historical Operating Conditions

The last major evaluations of the environmental consequences of the individual operating reservoirs in the ACF basin were included in the environmental impact statements completed in the 1970s. Since then, incremental changes have occurred in project operations due to changes in hydropower contracts and operating schedules, changes in navigation flow requirements, and other changes related to water quality, environment, or other uses of the system. Historical records maintained by the Corps illustrate the observed impacts of changes in operations or seasonal variations over time on pool levels and flow releases from Corps reservoirs. Comparing historic operations conditions with existing operations conditions provides a complete picture of the impacts related to changes in water demand and water resources management in the basin, as well as a perspective on existing flows to

TABLE 3-1
Alternatives Considered Applicable to the ACF Basin EIS

Demand Year	No Action Alternative	Action Alternative Flow Scenarios		
		High Flow Conditions	**Moderate Flow Conditions**	**Low Flow Conditions**
1995	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2020	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2050	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases

Demand scenarios for municipal and industrial, and agricultural uses were developed for the Comprehensive Study (Planning and Management Consultants, 1996; NRCS, 1995). Consumptive demands associated with thermal power generation were modeled and included in the calculation of total demands. One set of thermal power demands was used for all the alternatives.

Reservoir releases in this table refers to the operation of reservoirs to maintain or enhance flows in the river during critical low flow periods.

Note: This table is available as a foldout at the end of this report.

plan for future changes. *Appendix D* reviews the differences in operating conditions for the historical operations model and the existing operations model.

The historical operating conditions can be evaluated using the same modeling approach and 55 years of historic flow data used for modeling of the other alternatives. The flow data set has been translated into the historic operating conditions model, represented by operations in effect in the year 1977. This model incorporates water demands hindcast for the 1970s. This information was used to provide a comparative analysis of hydrologic conditions in 1977 with current conditions. The historic data set could be used to facilitate future evaluations related to implementing revised water control plans or other implementing actions.

3.2 Action Alternatives Considered and Potential Mitigation Options

The action alternatives considered for this draft EIS include a range of alternative flow conditions, also referred to as alternative flow scenarios, that would bracket the flow conditions that may result from any potential water allocation formula developed by the State Commissioners. A programmatic evaluation framework has been constructed because the allocation formula is not yet available for evaluation in the draft EIS. A proposed allocation formula may not be presented by the States until late 1998. If the EIS were not initiated until a proposed formula was known, there would not be sufficient time to complete the environmental evaluations for the EIS and make the EIS available to assist in the environmental review of the effects of the proposed formula prior to the scheduled date for the Federal Commissioner's decision in late summer of 1999. However, evaluating the environmental effects and potential mitigation for a range of flow conditions can provide sufficient information on the expected environmental impacts of flows that may result from an alternative allocation formula to support a Federal Commissioner decision.

The evaluation of the action alternatives follows a programmatic approach (described in Section 1.3.1) that will allow consideration of a range of possible allocation formulas. The modeled flow conditions evaluated in this EIS do not represent actual alternative plans for implementing an allocation formula. Rather, the range of flow conditions represents a framework to bracket the potential environmental consequences associated with possible water allocation formulas. The objective of this programmatic approach is to evaluate a range of flow conditions that is broad enough to encompass whatever flow conditions may result from the allocation formula to be developed by the State Commissioners. This programmatic evaluation framework is consistent with NEPA guidance requiring an evaluation of the full spectrum of possible alternatives.

3.2.1 Range of Alternative Flow Conditions

The range of flow conditions was developed based on combinations of projected water supply demands, as well as reservoir releases and operations that would result in the upper (high reservoir releases) and lower (low reservoir releases) boundaries of flow conditions during the time of the year when minimum stream flows normally occur (critical periods). The water supply demands for the years 1995, 2020, and 2050 are represented by projected demands that were selected from the Comprehensive Study. The selected demand scenarios provide the realistic estimates of potential demand (low to high) that may occur. It should

be noted that these demands do not reflect inter-annual changes in demands that may occur during critical drought periods. Peak water supply demands may be greater, in some cases; however, the differences in demands during drought years could not be determined. The reservoir releases and operations were varied in the alternative flow scenarios to provide the widest practicable range of potential stream flows during critical low flow periods.

Table 3-1 summarizes the no action alternative and the range of flow conditions evaluated for the action alternative. The alternative flow conditions represent the range of foreseeable options for municipal, industrial, thermal, and agricultural demand and reservoir operations that could result from the water allocation formula being developed by Alabama, Florida, and Georgia. The modeled flow conditions that incorporate 1995 water demands are used to evaluate the immediate to short-term environmental effects that could occur when the water allocation formula is implemented. The predicted flows for the years 2020 and 2050 serve as the basis for evaluating environmental consequences for future time periods. The effects of the alternative flow scenarios can then be compared to one another and to the no action alternative.

The term *reservoir releases* in ***Table 3-1*** refers to the operation of reservoirs to maintain or enhance flows in the rivers. *High reservoir releases* means that the reservoirs will be operated to maintain the highest practicable minimum flows in the rivers during critical low flow periods. *Low reservoir releases* means that the reservoirs will be operated to maximize storage within the reservoirs and to provide the lowest reasonable releases or minimum flows in the river during critical low flow periods. During low reservoir releases, the least possible flow augmentation would occur. During periods when flow augmentation is not required, water would be released from the reservoir at the same rate it flows into the reservoir. *Moderate reservoir releases* means that the reservoirs would be operated at some reasonable intermediate condition between the high-release and low-release conditions.

A combination of high reservoir releases during critical periods and low water supply demand comprise the high flow conditions scenario. The low flow conditions scenario is represented by a combination of low reservoir releases during critical periods and high water supply demand. Reservoir releases for the moderate flow condition would represent reservoir releases between the high and low flow conditions, combined with moderate water supply demands. Reservoir releases for all of the flow scenarios would be balanced over the year. For example, if high releases were required during certain periods, low releases could occur during other less critical periods. These combinations of reservoir releases and water supply demands are expected to provide a range of operation conditions and are expected to provide flow conditions that would bracket any water allocation formula developed by the State Commissioners.

3.2.2 Mitigation

3.2.2.1 Council on Environmental Quality Mitigation Guidance

The Council on Environmental Quality (CEQ) requires Federal agencies, in preparing an EIS, to address appropriate mitigation measures not already included in the proposed action or alternatives (40 CFR 1502.14 and 1502.16). Mitigation can include options that would:

- Avoid the impact altogether by not taking a certain action or parts of an action

- Minimize impacts by limiting the degree or magnitude of the action and implementation
- Rectify the impact by repairing, rehabilitating, or restoring the affected environment
- Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action
- Compensate for the impact by replacing or providing substitute resources or environments

For any proposed action that would result in a significant adverse effect on the environment, appropriate mitigation measures must be considered. All reasonable mitigation measures, even if they are outside the jurisdiction of lead or cooperating agencies, must be identified. To ensure that environmental effects of a proposed action are fairly assessed, the potential mitigation measures must also be discussed. This draft EIS includes a description of the process that will be followed to identify appropriate mitigation options, and the types of categories of mitigation that might be appropriate for certain types of expected impacts. Once an allocation formula is known, the final EIS will provide information regarding the likelihood that mitigation will be required, implementation plans, and responsible agencies.

3.2.2.2 Potential Mitigation Options

Potential mitigation of the impacts associated with the range of alternative flow conditions is addressed in this EIS. General mitigation measures to address impacts are summarized for each natural resource area (in Section 4). The measures identified are potential options that could be used to mitigate impacts. Proper consideration of mitigation requires that a full range of measures be identified (including, where appropriate, alternative means to mitigate a single impact), along with the relative cost of the measures and their effectiveness in reducing the level of impact. The Corps, the cooperating Federal agencies, and the States will evaluate the potential mitigation options presented in the final EIS. The justification of recommended mitigation measures will be based on the environmental and economic analyses presented in the EIS and regulatory agency requirements.

Mitigation measures to address unavoidable impacts associated with the final water allocation may be implemented by the Corps at existing Federal facilities, by private reservoir operators (e.g., FERC licensing conditions), or by State agencies, depending on the location of the area of impact. The specific details of the mitigation required at Federal facilities may be presented in the other site-specific NEPA documents that tier from this EIS (e.g., revisions to the water control manuals and their supporting NEPA documents), which may be required to bring about a change in current operations. For example, the Corps may initiate a program for habitat enhancement in federal reservoirs to address loss of fish spawning habitat due to increased water level changes. Mitigation of impacts due to increased stream flows downstream of Corps facilities may require stream bank protection or restoration. Mitigation of impacts on stream flows may also require implementation of drought management plans by the States to reduce water usage during these critical periods. More stringent regulatory criteria may be implemented by States for point source or nonpoint source discharge to particular stream segments. Restrictions on lawn watering, car washing, or surface or groundwater withdrawals for irrigation are typical conservation measures that may be implemented.

4. Affected Environment, Environmental Consequences, and Potential Mitigation Measures

This chapter of the document describes the affected environment, the environmental consequences, and potential mitigation measures in one chapter so that the reader can more easily evaluate existing conditions and environmental impacts on individual resource categories. The discussions in this section focus on those environmental parameters that may be affected by changes in allocation of water resources within the ACF River basin.

4.1 Baseline for Analyses

The Comprehensive Study provided the primary resource documents for describing the baseline conditions for the affected environment in the ACF basin. These Comprehensive Study documents were developed and approved by the various resource and/or cooperating agencies and the States of Alabama, Florida, and Georgia with the objective that they would provide the relevant technical data, tools, and analyses necessary to evaluate current conditions and future alternative management of the basin. As appropriate, these study elements have been supplemented with other information when necessary to meet the needs of this programmatic EIS. The cooperating Federal agencies (see Section 1.1) provided substantial information on existing or baseline conditions in the river basin. Additional information sources included previous environmental documentation, specific Internet web sites, recent mapping data, Corps hydrologic modeling studies and water quantity and quality modeling, protected species surveys and biological impact evaluations by the U.S. Fish and Wildlife Service, hydrodynamic modeling of Apalachicola Bay and modeling of estuarine habitat impacts by the National Oceanic and Atmospheric Administration, recreation and economics impact evaluations conducted by the Corps, and cultural resource impact modeling under contract to the Corps. Overviews of each information source used to describe the affected environment and support impact analyses are included in the main body of this EIS. More detailed technical sections of these Comprehensive Study elements and other additional data collection and analyses that support these discussions are provided in the appendices referenced in the appropriate section of this EIS.

The environmental consequences associated with each evaluated alternative are also discussed for each resource heading in the following sections. The hydrology analyses conducted by the Corps form the basis for evaluating the consequences of each alternative. The results of these analyses are used in the appropriate sections to determine if (1) there could be an effect or impact to a resource area, (2) what the magnitude of that effect might be relative to direct, indirect, or cumulative impacts, (3) the significance of those effects, and (4) whether these effects are likely to be mitigated. The hydrologic analyses, discussed in detail in Section 4.4.1, include evaluations of the no action alternative as well as a range of alternative minimum flow conditions (high, moderate, and low) within which it is

anticipated the allocation formula developed by the States will fall (see Section 3.3.1). This range of alternative minimum flow conditions forms the basis for evaluating the action alternative; i.e., the Federal Commissioner's concurrence with the States' proposed water allocation formula.

The approach used for impact evaluation is to compare the likely effects of the action alternative flow scenarios to the no action alternative (existing operations conditions) for each resource area for each of the modeled study years (i.e., 1995, 2020, and 2050). The approaches used to actually make these comparisons vary by technical resource area. Some resource area baseline descriptions include modeled data in addition to qualitative descriptions of existing conditions. When that is the case, current conditions may reflect modeled rather than actual data (see Section 4.7.1). The specific details for the impact analyses used are described under Environmental Consequences for each of the resource areas.

The application of these analyses to the types of impacts projected and the significance levels of these impacts are discussed in the following sections.

4.1.1 Direct, Indirect, and Cumulative Impacts

An EIS considers direct, indirect, and/or cumulative impacts that are likely to result from each alternative evaluated. The guidance used for determining the category into which impacts might occur is as follows:

- *Direct impact* is the direct effect that results from a particular action. An example could be an action that produces a flow regime that decreases habitat for an aquatic species.
- *Indirect impact* is an effect caused by the action that may occur later in time or farther removed in distance from the location of the effect, but is reasonably foreseeable. For example, the impact of an action that reduces hydropower generation could result in demand for nonrenewable resource power generation (coal or oil-fueled) and therefore have indirect effects on air quality.
- *Cumulative impact* is an effect on the environment that results from the impact of an action that is added to the impacts of past, other present, or reasonably foreseeable future actions. These effects might occur through a series of actions that are connected in some way. For example, the effects of flow diversions from a series of upstream reservoirs within a single drainage system might produce cumulative negative effects on water quality or quantity necessary to support commercial fisheries habitat in downstream reaches of the basin.

Direct and indirect impacts are addressed by resource area in Sections 4.3-4.9. Cumulative impacts are discussed separately and are summarized in Section 4.10.

4.1.2 Mitigation

Some or all of an alternative's negative effects on a particular resource area may be reduced or balanced by other actions or activities, i.e., mitigative actions. In developing this EIS, mitigative measures have been defined for each resource area to the extent that mitigation is believed feasible and practical, and would result in meaningful reductions in the projected negative impacts.

Potential mitigation options or actions are discussed in Section 4.11.

4.1.3 Significance Criteria

The final element in evaluating impacts to each resource is significance assessment. Significance criteria provide an objective measure of the degree of impact on each resource area that can be used in the significance assessment. For a programmatic EIS, this assessment must be based on broader interpretation and data evaluation than project-specific EISs. Three categories of impacts have been defined for this EIS—insignificant, significant, or beneficial. Some of these significance evaluations may be linked to a regulatory standard. For example, a violation of a water quality standard would be considered significant; no violation would be considered insignificant; and a change that provided even greater protection for the standard than currently exists would be considered beneficial. Other impacts may be evaluated on the weight of evidence and professional judgment. For example, a non-regulatory standard could include a change in reservoir levels or fluctuations. Fluctuations that result in increased erosion could be considered *significant*; minor changes in level or timing of fluctuations that would not produce observable increases in erosion could be considered *insignificant*; and changes or attenuation of rate of drawdown that would reduce the rate of erosion would be considered *beneficial*. In general, these categories of significance may be summarized as follows:

- *Significant impact* is defined as a violation of a regulation, standard, or published criterion, or an effect that would result in an unacceptable loss of a resource.
- *Insignificant impact* is the result of an alternative whereby no regulation, standard, or criterion is likely to be violated, and no meaningful loss of a resource occurs.
- *Beneficial impact* is the result of an alternative that may be expected to enhance or otherwise increase the value of a resource, as perceived by the resource agency and/or the public.

The significance criteria used in this EIS to evaluate impacts are based on recommendations provided by each of the resources and/or cooperating agencies during the preparation of this document. These criteria are summarized in ***Table 4-1***.

TABLE 4-1
Impacts Criteria Matrix for ACF Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
Geology and Soils					
Geology	Karst environments – sinkholes	Indirect effects on water quantity	Water quantity losses to groundwater	Groundwater losses that prevent meeting agricultural and municipal and industrial (M&I) demands	None
		Indirect effects on stability of surface environment	Surface environment stability affected by potential sinkhole formation/collapse	Flow changes could increase flow into or from karst environments, enhancing the conditions favorable for sinkhole formation (i.e., dissolution in vulnerable areas).	None
				Changes that result in dewatering aquifer in karst environment could increase the potential for sinkhole collapse.	None
Hydrogeology	Surface water contribution to groundwater recharge; effects on spring discharge; impacts on flow in the river and wetlands habitat	Effects on water quality	Surface water flows affected by groundwater interaction, effects on wetlands	Effects on surface water flows that impact water quality standards, or reduction in wetlands habitat for protected species or important game species	Restored hydrology and reconnection of floodplain

(CONTINUED)

TABLE 4-1 (CONTINUED)
Impacts Criteria Matrix for ACF Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
Soils	Erosion impacts on channel degradation and isolation of small tributaries	Indirect effects on wetlands, water quality, and aquatic and cultural resources; sedimentation into streams and reservoirs from NPS sites	Indirect effects on recreational uses and aesthetics; sedimentation and siltation of reservoirs and/or stream channels	Effects that increase water-related movement of erodible soils	Effects that reduce the areas of erodible soils affected or reduce sedimentation
Water Resources					
Water quantity	Surface water flows	Indirect effects on water quality, wetlands, and protected species	Indirect effects on other resources	Reduction in flows that produce impacts to regulated resources; impacts that result in exceeding established water control structure operations	Flow augmentation that enhances regulated resources
	Flood flows	Changes in flood hazard areas as defined by FEMA	Increased frequency or extent of flooding	Any increase in flooding extent or frequency affecting human health, property, or safety	Flood management that reduces impacts to human health, property, or safety; restored floodplain hydrology
	Navigation	None	Meet navigation requirements	Reduction in frequency of meeting navigation requirements; undue navigation delays	Enhance frequency of meeting navigation requirements
	Reservoir levels and fluctuation	Effects on cultural and protected biological resources	Effects on recreational, biological, or other uses; losses due to erosion	Increased impacts to regulated resources; increased erosion or loss of recreational or biological resources	Enhance protection of regulated resources; enhanced habitat or access to recreational facilities

(CONTINUED)

TABLE 4-1 (CONTINUED)
Impacts Criteria Matrix for ACF Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
	Water supply demands	None	Ability to meet agricultural and M&I demands	Reduction in ability to meeting water supply demand requirements	Enhanced ability to meet water supply demand requirements
Water quality	Water quality requirements to meet resource uses	Water quality standards and impacts to protected species	Water quality impacts to non-regulated uses[b], including aquatic resources and human contact uses	Reduction in water quality that violates standards or causes loss in other resource uses	Enhanced water quality
	Protect existing uses	Maintain anti-degradation standards	Water quality impacts to non-regulated uses, including aquatic resources and human contact uses	Change in water quality degrades stream quality below current conditions	Enhanced ability to meet or exceed current water quality and uses
Biological Resources					
Vegetation resources					
Terrestrial communities	Impacts from changes in elevations, flows, or durations or construction of new reservoirs	Losses of protected species	Losses related to increased flooding or erosion	Impacts to important or protected terrestrial populations	Changes in elevations, flows, or duration that decrease erosion or flooding of terrestrial communities
Fish and aquatic resources					
Wetlands	Loss of wetlands	Impacts to jurisdictional wetlands	Indirect effects on other resources that may be affected by wetland losses	Changes that result in substantive wetland losses or reduction in habitat value	Water quantity changes that enhance wetlands areas and/or functions

(CONTINUED)

TABLE 4-1 (CONTINUED)
Impacts Criteria Matrix for ACF Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
Riverine	Frequency, timing, and duration of flows	Losses of protected species or critical habitat	Losses of native biodiversity and impacts to recreational or commercial fishery resources, anadromous species, or their habitats	Impacts to regulated resources or substantive losses of other aquatic resources	Enhanced habitat or riverine values to support protected species, native riverine species, anadromous species, or other game fish species
Reservoir	Frequency, timing, and duration of reservoir level fluctuations	FERC license requirements for non-Federal projects; losses of protected species or critical habitat, authorized project purposes	Losses to recreational or commercial fishery resources or their habitats	Impacts that conflict with FERC licenses, affect protected species or other fishery resources, or affect ability to meet authorized project purposes	Enhanced habitat or reservoir values to support protected species, game fish species, or anadromous species; enhanced ability to meet authorized project purposes or FERC requirements
Estuarine	Change in salinity concentration, salinity variability, and water circulation	Protected species, essential fish habitat	Losses to recreational or commercial fishery resources and/or their habitats	Impacts to managed resources, anadromous species, or losses of other estuarine resources and habitats	Enhanced estuarine habitat values to support protected species, anadromous species, or essential fish habitat
Land Use					
General land use patterns	Relationship of land use and impervious surfaces and impacts to water quality	Water quality standards and approved stormwater plans	Indirect effects on aesthetics, and water quality uses	Induced changes in land use increasing nonpoint source loadings	Changes in land use or implementation of nonpoint source best management plans that reduce nonpoint source loadings

(CONTINUED)

TABLE 4-1 (CONTINUED)
Impacts Criteria Matrix for ACF Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
Agricultural uses	Effects of water supplies in meeting agricultural demands, flooding, or erosion of farmlands	None	Inadequate supplies reducing available farmlands and increasing flooding	Losses of crops or farmlands related to inadequate supplies or increased flooding or erosion	Enhanced ability to meet expanded agricultural demands, decreased flooding, or erosion
Socioeconomic Resources					
Population/ demographics	Impacts on population growth and quality of life	Local land use plans or policies	Growth or shift in population characteristics that affect approved plans	Substantial growth inducement or concentration of population that is inconsistent with local plans or policies	
Environmental justice/ protection of children	Impacts to minority, low income, and child populations	EO 12898 and EO 13045	Disproportionate risks and potential impacts to low income, minority, and child populations.	Changes that result in disproportionate impacts that affect low-income, minority, and child populations	Changes that result in reduced impacts to low income, minority, or child populations
Recreation					
Reservoir	Recreational access and uses of reservoirs	None	Losses of recreational uses or land values	Increased fluctuations or reductions in levels during major recreational use periods that affect uses or access	Reduced fluctuations or changes in levels that result in enhancement of uses, values, or access to recreational facilities
Riverine	Recreational uses	None	Losses of recreational uses or values	Reductions or increases in flows at times that cause reductions in recreational uses, access, or safety	Enhancement of recreational uses, access, or improved safety

(CONTINUED)

TABLE 4-1 (CONTINUED)
Impacts Criteria Matrix for ACF Basin EIS

Resource Area	Impacts Issues	Regulatory Standard	Professional Standard[a]	Significant Impact	Beneficial Impact
Regional economics					
	Effects on income and employment	None	Changes in rational threshold values[c] or NED benefits	Exceedance below rational threshold values generated by EIFS modeling; changes that decrease NED benefits	Exceedance above rational threshold values generated by EIFS modeling; changes that increase NED benefits
Hydropower	Reduction in hydropower generation due to changes in water availability	None	Reduced income from power generation	Substantial loss in income from hydropower generation below projections	Significant gain in income from hydropower generation
Air Quality and Noise	Increased dependence on non-renewable fuels and related air impacts due to reduction in hydropower generation	Air quality standards, potential local noise ordinances	Indirect effects on energy production that might induce additional power development	Effects that violate air quality or noise regulations	Changes that result in decreased air emissions or reduced noise levels
Cultural Resources					
Historic and archaeological resources	Erosion, sediment deposition, or change in access to resources	National Register of Historic Places (NRHP)	Potential effects on other areas of importance not eligible for listing on NRHP	Changes in surface water flows or reservoir levels that result in losses of NRHP sites, or have a high potential to impact areas with high probability to contain these sites	Reduced erosion and reduced access to cultural resource sites that would reduce potential losses of important resources

[a] Professional standard is a judgment made by an appropriate technical resource professional of the significance on an environmental or socioeconomic effect on that resource.

[b] Nonregulated uses include resources that may not be protected under State or Federal regulations, but may be subject to negative environmental effects.

[c] Rational threshold values are indicators of deviation from historic regional economic trends.

EIFS Economic Impact Forecast System
EO Executive Order
FEMA Federal Emergency Management Agency
FERC Federal Energy Regulatory Commission
NED National Economic Development

4.2 Description of Basin

The ACF basin drains 19,800 square miles in parts of southeastern Alabama, the northwest Florida, and central and western Georgia (see ***Figures 4-1*** and **4-2**). About 74 percent of the ACF basin lies in Georgia, 15 percent in Alabama, and the remaining 11 percent in Florida. The basin extends approximately 385 miles from the Blue Ridge Mountains to the Gulf of Mexico and has an average width of approximately 50 miles. The basin covers 50 counties in Georgia, 8 counties in Florida, and 10 counties in Alabama.

The ACF system empties into the Gulf of Mexico. The main tributaries of the basin are the Chattahoochee and Flint Rivers. These tributaries merge at Lake Seminole to form the Apalachicola River near the State lines of Alabama, Florida, and Georgia. The Apalachicola River flows into the Gulf of Mexico at Apalachicola Bay.

The ACF basin is a dynamic hydrologic system containing interactions between aquifers, streams, reservoirs, floodplains, and estuaries. Water resources in the ACF basin have been managed to serve a variety of purposes, including navigation, hydroelectric power, flood control, water supply, and recreation. There are 16 reservoirs on the mainstems of the Apalachicola, Chattahoochee, and Flint Rivers (5 Federal and 11 non-Federal projects), which have altered the natural streamflow and provided water supply improvements and recreational opportunities for the public in these resource areas. The interrelationship between operation of the dams and the resulting river flows has resulted in a highly regulated system over much of the basin. The principal rivers, particularly in the lower half of the basin, receive a substantial contribution of water from groundwater baseflow during dry times (Comprehensive Water Resources Study Partners, 1995).

The ACF basin is characterized by a warm and humid, temperate climate due to its latitude, altitude, and proximity to the Gulf of Mexico. Average annual temperature ranges from about 60° Fahrenheit (F) in the north to 70°F in the south. Average daily temperatures in the ACF basin range from about 40 to 55°F in January to 75 to 80°F in July. Summer temperatures are typically in the 70s to the 90s. Freezing temperatures in winter occur for only short periods (USGS, 1996).

Precipitation is highest at the north end of the basin in the mountains and at the south end of the basin near the Gulf of Mexico. Average annual precipitation is about 60 inches per year at both the north and south ends of the basin. The east-central part of the basin receives less precipitation, with an annual average of 45 inches (USGS, 1996) (see ***Figure 4-3***). Precipitation varies substantially on an annual basis, however. For example, in Columbus, near the center of the basin, annual precipitation has varied from 30 to 73 inches, with an annual average of 50 inches. Annual precipitation was less than 40 inches in 3 out of 5 years between 1984 and 1988, the most recent drought. Precipitation is generally highest in late winter and early spring, and then again in mid to late summer, when tropical depressions and tropical storms occasionally track up the basin.

Over half the water that falls as precipitation in the ACF basin is returned to the atmosphere as evapotranspiration (direct evaporation plus transpiration by plants). Evapotranspiration ranges from about 32 to 42 inches of water per year in the ACF basin, generally increasing from north to south (USGS, 1996).

FIGURE 4-1
Map of the ACF Basin

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FIGURE 4-2
Map of the Counties in the ACF Basin

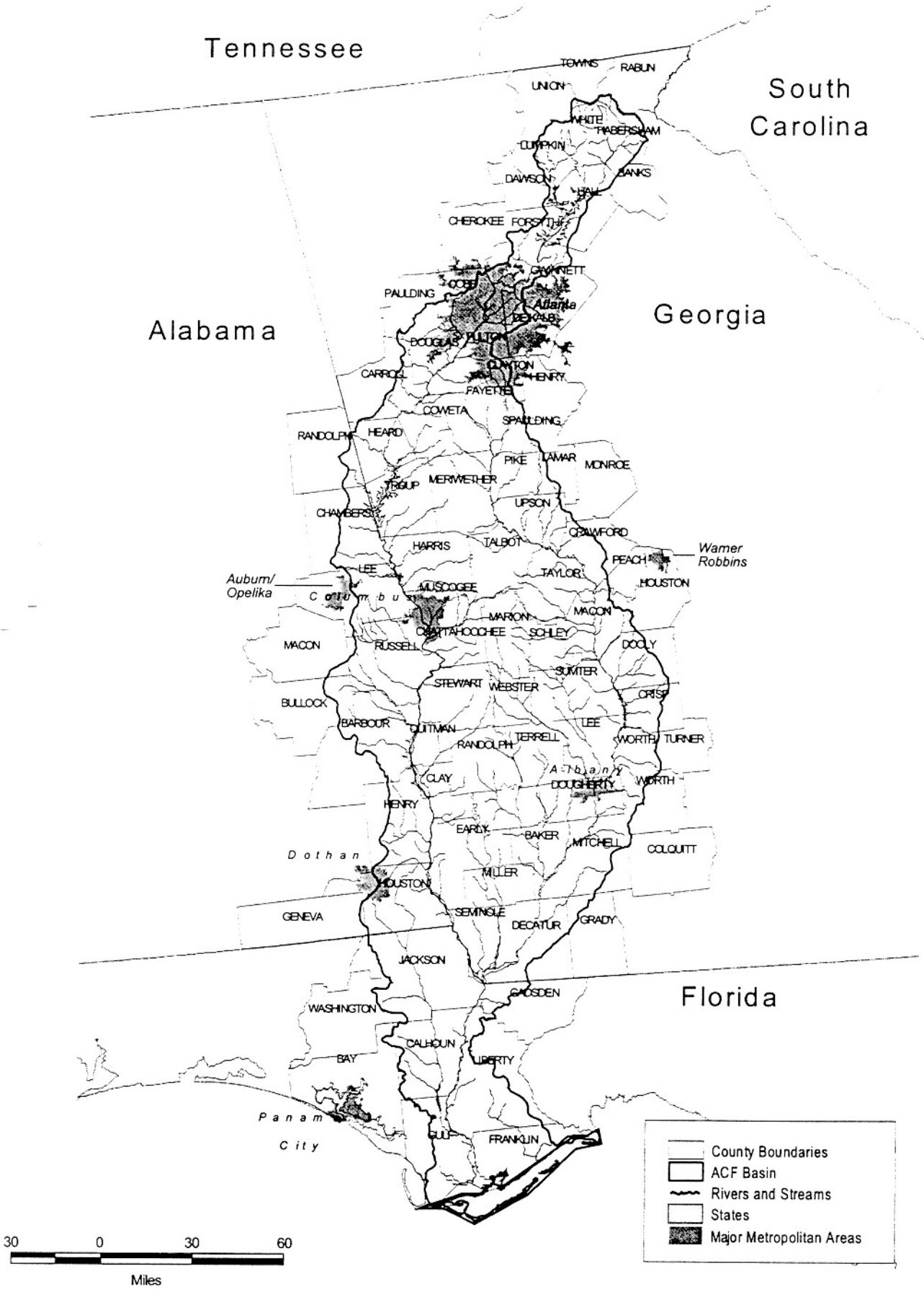

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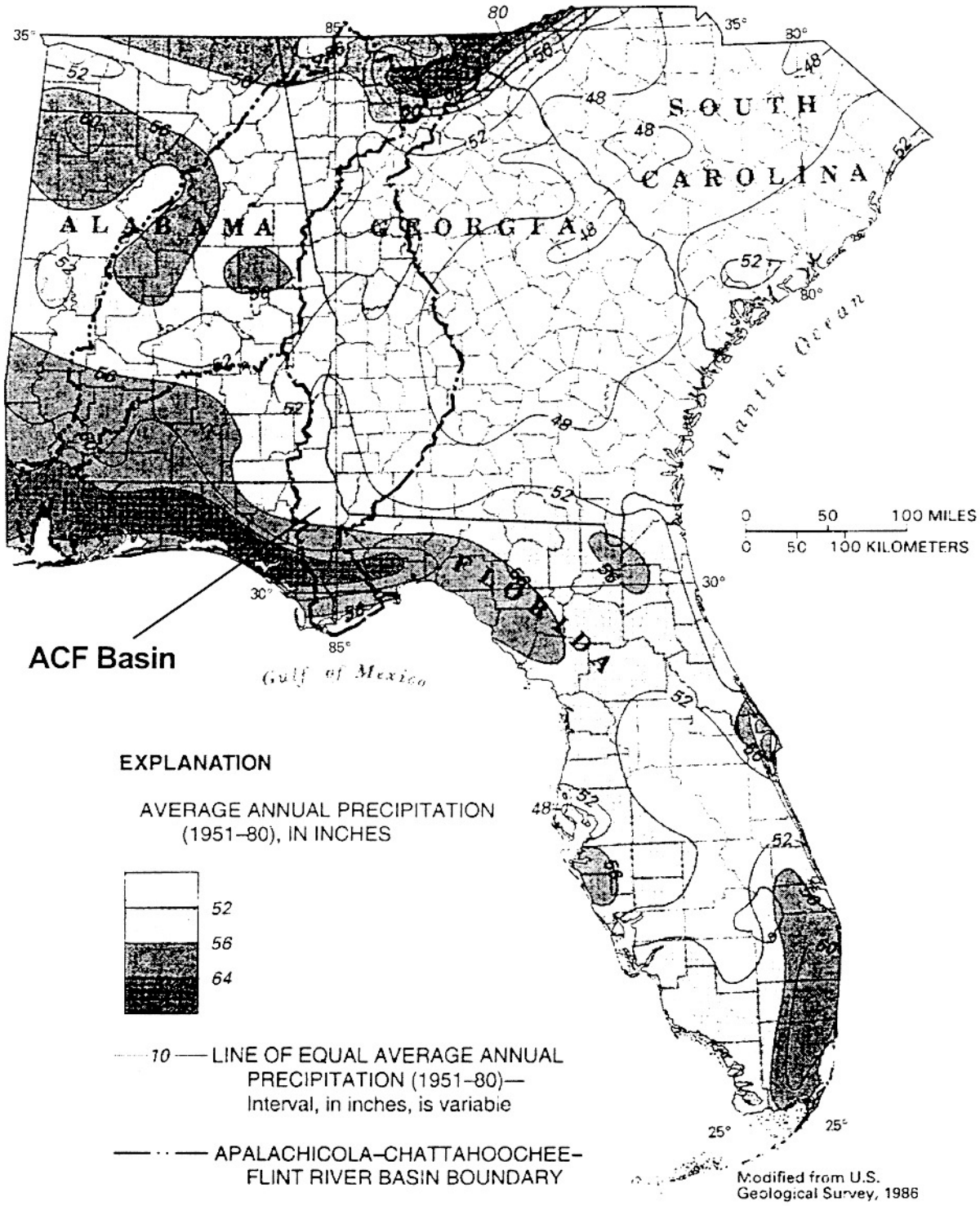
FIGURE 4-3
Average Annual Precipitation in the ACF Basin
Source: Couch et al., 1996



Average annual runoff basinwide ranges from 12 to 40 inches (or about 25 to 65 percent of average annual precipitation). Runoff is greatest in the Blue Ridge Mountains and near the Gulf coast (USGS, 1996).

Historically, there has been adequate water to meet the needs of most users in the ACF basin. However, during the droughts in the 1980s, hydropower production had to be reduced, navigation was significantly curtailed, municipalities and industries were required to implement water conservation measures, and recreational use of reservoirs was limited. Navigation was also suspended on the Apalachicola River for several months in 1988, and agricultural crops were heavily damaged. This drought period demonstrated the competing demands for water in the basin and prompted the States of Alabama, Georgia, and Florida to initiate a process for regional water resource planning (see Section 1.1).

4.3 Geology and Soils

This section addresses the geologic and soil environment in the ACF basin. For purposes of discussion, the boundaries and descriptions of the four subareas of the basin are consistent with those used by the USGS in evaluating the groundwater resources during the Comprehensive Study. The description and evaluation of geology and soils is based on studies conducted by the USGS as part of the National Water Quality Assessment (NAWQA) Program. Impact evaluations were completed by the Corp's contractor based on the results of the HEC-5 modeling of potential changes in stream flows (see Section 4.4). The USGS provided review and input on the impact analyses as a cooperating Federal agency.

4.3.1 Geology

The following section focuses on the geologic setting in the ACF basin that influences surface and groundwater availability and the potential impacts associated with changes in water resource management.

4.3.1.1 Affected Environment

The physiography of the ACF basin reflects a geologic history of mountain-building in the Appalachian Mountains and long periods of repeated land submergence in the Coastal Plain province.

The physiographic provinces within the ACF basin include the Blue Ridge, Piedmont and Coastal Plain physiographic provinces (***Figure 4-4***). A generalized map of the major aquifers in the ACF subareas (subareas 1, 2, 3, and 4) is presented in ***Figure 4-5*** (Chapman and Peck, 1997a). Geologic and hydrogeologic units of the ACF basin are presented in ***Figure 4-6***.

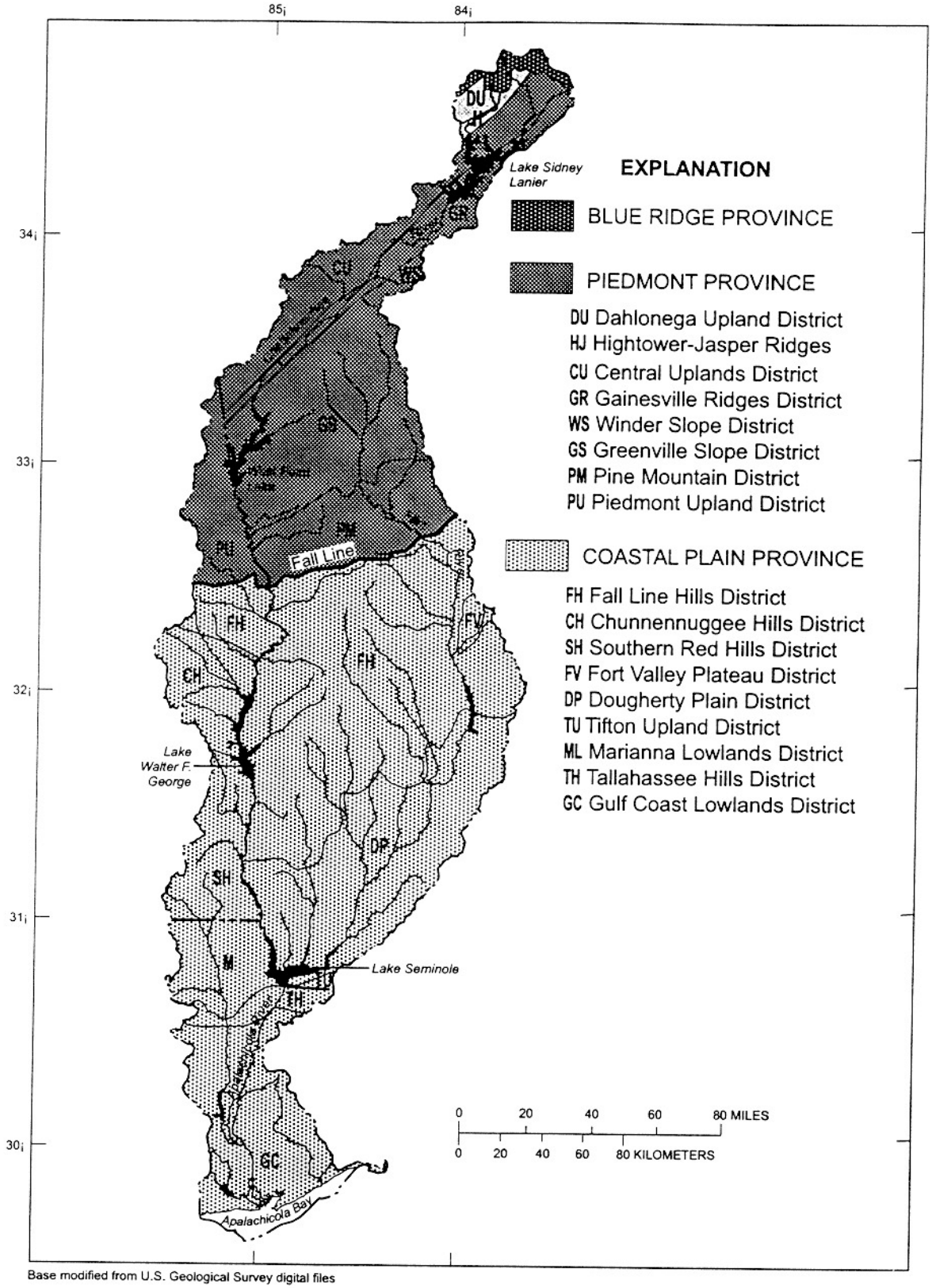
4.3.1.2 Blue Ridge and Piedmont Physiographic Provinces

In the ACF basin, the Blue Ridge province is limited to the northernmost portion of subarea 1, north of Lake Lanier, and makes up about 12 percent of subarea 1. This subarea is characterized by mountain ridges that range in altitude from between 3,000 and 3,500 feet (Couch et al., 1996; Chapman and Peck, 1997a). Headwaters of the Chattahoochee River originate in this area.

The remaining portion of subarea 1 (88 percent) and most of subarea 2 (99 percent) are located within the Piedmont Physiographic province, located in the northern portion of the basin (subareas 1 and 2). Both the Blue Ridge and Piedmont provinces are underlain by Precambrian and Paleozoic crystalline rocks, which include mica schist, felsic gneiss and schist, and granite and granite gneiss. Less extensive outcrops of quartzites are also present.

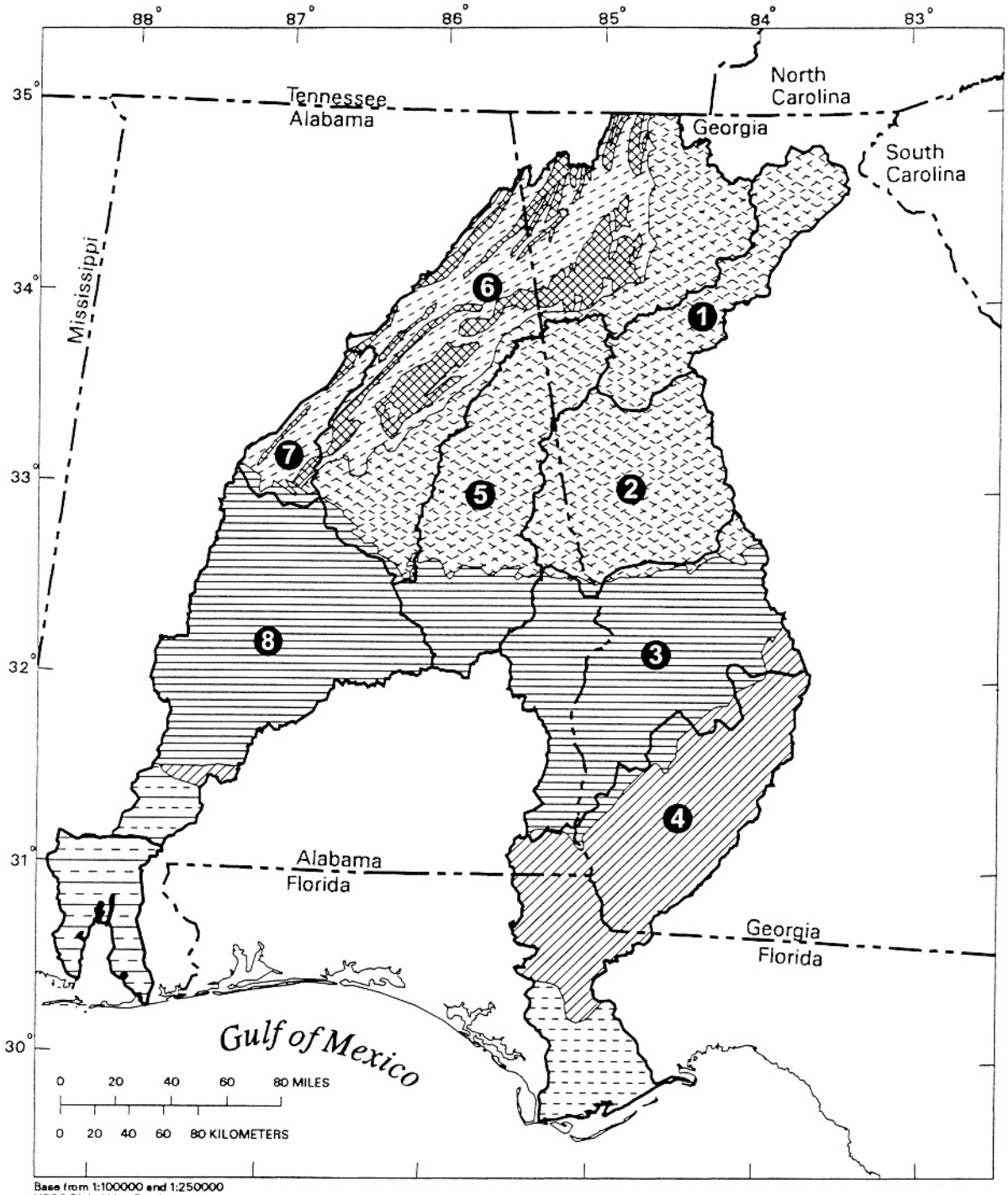
Northeast-trending ridges control the course of the Upper Chattahoochee River and its tributaries. The Piedmont contains major fault zones that generally trend northeast-southwest and form the boundaries between major rock groups (Georgia Geologic Survey, 1976). Highly fractured fault zones around Gainesville, Georgia, force the Chattahoochee River and its tributaries into a rectangular drainage pattern. One major fault zone is the Brevard Zone, which trends from Cornelia in northwest Georgia, through metropolitan Atlanta, and to Whitesburg, Georgia. The Chattahoochee River generally flows within or parallel to the Brevard Zone (Chapman and Peck, 1997b).

FIGURE 4-4
Physiographic Provinces and Districts of the ACF Basin
Modified from Copeland, 1968; Clark and Zisa, 1976; Leitman et al., 1983



Base modified from U.S. Geological Survey digital files

FIGURE 4-5
Major Aquifers and Subareas in the ACF and ACT Basins
Source: Modified from Chapman and Peck, 1997a



Base from 1:100000 and 1:250000
USGS Digital Line Graph

EXPLANATION
AQUIFERS

- Surficial aquifer system
- Coastal lowlands aquifer system
- Southeastern Coastal Plain aquifer system
- Floridan aquifer system
- Valley and Ridge and Cumberland Plateau aquifers: carbonate
- 1 Subarea 1
- Valley and Ridge and Cumberland Plateau aquifers: sandstone
- Piedmont and Blue Ridge (crystalline–rock) aquifers
- Boundaries

FIGURE 4-6
Generalized Geologic and Hydrogeologic Units in the Coastal Plain of the ACF Basin
Source: Couch et al., 1996; (Modified from Wagner and Allen,1984; Faye and Mayer, 1996 and Georgia Geologic Survey, Uncited Written Communication, 1996).

System	Series	Chattahoochee and Flint River Valley Geologic Units (North – South)	Northwest Florida Geologic Units	Hydrogeologic Units
Quaternary	Holocene-Pleistocene	Terrace and undifferentiated deposits	Terrace and undifferentiated deposits	Surficial aquifer system
Tertiary	Pliocene	Undifferentiated overburden	Citronelle Formation	
	Miocene	Hawthorn Formation	Undifferentiated deposits; Hawthorn Formation[1]; Alum Bluff Group	Floridan aquifer system
	Oligocene	Suwanee Limestone	Tampa Limestone[2]; Suwanee Limestone; Mariana Limestone	
	Eocene	Ocala Limestone; Moodys Branch Formation; Lisbon Formation; Tallahatta Formation	Ocala Limestone; Moodys Branch Formation; Lisbon Formation; Tallahatta Formation	Confining unit; Claiborne aquifer
	Paleocene	Hatchitigbee and Bashi Formations – Unnamed units; Tuscahoma Formation – Unnamed units; Nanafalia and Baker Hill Formations – Unnamed units; Porters Creek Clay – Unnamed units; Clayton Formation	Undifferentiated Paleocene and Upper Cretaceous strata	Confining unit; Clayton aquifer
Cretaceous	Upper Cretaceous	Providence Sand – Unnamed units; Ripley Formation – Unnamed units		Confining unit; Providence aquifer; Confining unit

Gray area represents principal water-bearing strata.

Blank area represents missing strata.

[1] Currently referred to as the Hawthorne Group (Scott, 1988)

[2] This unit is currently referred to as the "Tampa Member of the Arcadia Formation" and has been reported absent in northwest Florida, (Scott, 1988).

Groundwater is generally controlled by geology in the Blue Ridge and Piedmont provinces. In these provinces, parent rock is generally covered by a layer of weathered rock and soil (regolith), which can range in thickness from a few feet to more than 150 feet. From the land surface, the regolith zone consists of a porous and permeable zone that grades downward into a clay-rich, relatively impermeable zone that overlies or grades into a porous and permeable saprolite known as a transition zone (Heath, 1989), which in turn grades downward into unweathered bedrock. Groundwater is found in the regolith or in areas of alluvial and colluvial deposits known as porous-media aquifers. These aquifers usually have low yields and are limited to domestic uses (Chapman and Peck, 1997a).

The principal aquifers in the Blue Ridge and Piedmont provinces are fracture-conduit aquifers in the bedrock where water-bearing zones occur along geologic features such as lithologic contacts, foliation, joints, fractures, faults, folds, veins and pegmatites (Chapman et al., 1993).

4.3.1.3 Coastal Plain Physiographic Province

The northern boundary of the Coastal Plain is marked by the Fall Line, which generally follows the contact between crystalline rocks of the Piedmont and the unconsolidated sediments of the Coastal Plain. This line roughly corresponds to the northern boundary of subarea 3, with a small excursion into subarea 2. The geology in subarea 3, which is almost completely south of the fall line, consists of the surficial sediments of the Coastal Plain province, which are predominantly sands of the Pliocene to recent age. Across the fall line, streams undergo abrupt changes in gradient, marked by rapids and shoals. In the Coastal Plain, streams typically lack the riffles and shoals common to streams in the Piedmont, and exhibit greater flood plain development and increasing sinuosity (Couch et al., 1996).

Within the ACF, the coastal plain in Alabama, Florida, and Georgia is divided into three districts: a hilly region immediately below the Fall Line (Fall Line Hills District in Georgia and the Chunnennuggee and Southern Red Hills Districts in Alabama), a region of karst topography (Dougherty Plain and Tifton Upland Districts in Georgia and Marianna Lowlands District in Florida), and a low-lying coastal region (Tallahassee Hills District and Gulf Coast Lowlands District in Florida), as shown in ***Figure 4-4.***

The northernmost portion of subarea 3 is characterized by flat to moderately rolling sandy uplands dissected by deeply entrenched streams, which transition to sandy cuestas characterized by fairly steep escarpments with gently rolling backslopes. The southernmost portion of subarea 3 consists of relatively flat upland that slopes gently toward the south (Kidd, 1989). At the northern extent of subarea 4 lies the Fall Line Hills District at the updip limit of the Upper Floridan aquifer, which is drained by the Chattahoochee and Flint Rivers and their tributaries (Torak and McDowell, 1996). The area is highly dissected with relief ranging from 50 feet to 250 feet. Cretaceous sediments lie in a band immediately below the Fall Line and crop out into younger Eocene-Paleocene sediments of the low-lying Dougherty Plain District.

The Dougherty Plain of the Northwest Florida and South Georgia is an inland lowland consisting of a series of nearly level plains (Hicks et al., 1987); relief rarely exceeds 20 feet. This area is characterized by karst topography with numerous sinkholes ranging in size from a few feet to several hundred acres. Most depressions are filled with low permeability material and contain water year-round (Middleton, 1968). Active solutioning of the Ocala

Limestone in the area of the Dougherty Plain has created underground channels that capture surface drainage along larger streams in the terraced valleys (Hicks et al., 1987).

A steeply sloping, west-facing karst area known as the Solution Escarpment (MacNeil, 1947) or the Pelham Escarpment (Hayes et al., 1983) separates the Dougherty Plain from the Tifton Uplands District (***Figure 4-4***). The crest of this escarpment forms the eastern topographic and surface water divide between the Flint River and other river basins to the east (Torak and McDowell, 1996).

The Gulf Coastal Lowlands are sandy, flat, and slope towards the sea. The area was shaped mostly by wave and current activity during the Pleistocene era (Arthur and Rupert, 1989). The land surface is characterized by ancient marine bars, spits and sand-dunes, and marine terraces. Elevations in this district are less than 100 feet. As the Apalachicola River flows southward through the Gulf Coastal Lowlands, its floodplain broadens in width from 3 to 5 miles (Couch, et al., 1996).

The major hydrologic units of the Southeastern Coastal Plain aquifer system in subarea 3 of the Coastal Plain physiographic province in the lower ACF basin include:

- Lisbon aquifer (Alabama)
- Claiborne aquifer (Georgia)
- Nanfafalia-Clayton aquifer (Alabama)
- Providence aquifer (Georgia)
- Providence-Ripley aquifer (Alabama)
- Cussetta aquifer (Georgia)
- Blufftown aquifer (Georgia)
- Eutaw aquifer (Georgia)
- Tuscaloosa aquifer (Alabama and Georgia)

In addition, the major hydrologic units in subarea 4 of the Coastal Plain province in the lower basin include:

- Semiconfining unit (Georgia and Florida)
- Intermediate aquifer system (Florida)
- Underlying semiconfining unit (Florida)
- Upper Floridan aquifer (Georgia and Florida)
- Lower confining unit (Georgia)/Sub Floridan confining unit (Florida)

These hydrologic units (Torak and McDowell, 1996) are presented in ***Figure 4-7***.

Sediments forming the major aquifers in the lower ACF occur in an offlapping sequence toward the southeast, roughly parallel to the fall line. In this sequence, progressively younger sediments crop out and cover the older units, beginning with the oldest (Clayton-Claiborne group) and ending with the youngest (Intermediate system). The Clayton-Claiborne group forms the uppermost aquifers in subarea 3; the Upper Floridan aquifer and Intermediate system forms the uppermost aquifers in subarea 4. The undifferentiated intermediate system are the uppermost aquifers in subarea 4. The undifferentiated overburden (alluvium and weathered limestone) is continuous in extent, but variable in composition and character. As a result, the undifferentiated aquifer can function as a surficial aquifer in some places and as a semiconfining unit in other areas.

FIGURE 4-7
Stratigraphic and Hydrologic Units in the Lower ACF Basin
Source: Torak and McDowell, 1996

SERIES	GEORGIA		FLORIDA	
	GEOLOGIC UNIT	HYDROLOGIC UNIT	GEOLOGIC UNIT	HYDROLOGIC UNIT
HOLOCENE AND PLEISTOCENE	Terrace and undifferentiated deposits	Semiconfining unit	Terrace and undifferentiated deposits	Semiconfining unit
MIOCENE	Undifferentiated overburden (residuum)		Citronelle Formation	
	Miccosukee[1] Formation		Jackson Bluff Formation	Intermediate system
	Hawthorn Formation		Alum Bluff Group: Chipola Formation; Hawthorn Formation[2]	Underlying semiconfining unit
			Intracoastal Formation	
	Tampa Limestone	Upper Floridan aquifer	Tampa Limestone[3]	
	Suwannee Limestone		Suwannee Limestone	
			Marianna Formation	Upper Floridan aquifer
EOCENE	Ocala Limestone		Ocala Limestone	
	Clinchfield Sand			
	Lisbon Formation	Lower confining unit	Lisbon Formation	Sub-Floridan confining unit

[1] This unit has also been reported as being present in northwest Florida (Scott, 1988).

[2] Currently referenced to as the Hawthorne Group (Scott, 1988).

[3] This unit is currently referred to as the "Tampa Member of the Arcadia Formation" and has been reported absent in northwest Florida (Scott, 1988).

The uppermost aquifer in subarea 3 is the Claiborne (Georgia)/Lisbon (Alabama) aquifer. Recharge areas generally coincide with the outcrop area that extends southeast to the edge of subarea 3, where it is overlain in places by the Floridan aquifer system.

Cropping out north of and underlying the Claiborne aquifer is the Clayton (Georgia)Nanafalia-Clayton (Alabama) aquifer. The Claiborne and Clayton aquifers are separated by the Wilcox confining unit, which is composed of the Hatchetigbee, Tuscahoma, Nanafalia, and Clayton formations in Georgia, and the clays of the Upper Tuscahoma sand in Alabama. The Clayton/Nanafalia-Clayton aquifer generally coincides with the outcrop area that extends southeast to the northwestern edge of the overlying Claiborne aquifer.

Cropping out north of and underlying the Clayton/Nanafalia-Clay aquifer is the Providence aquifer and its western equivalent, the Providence-Ripley aquifer. Where present, the Providence/Providence-Ripley aquifer is separated from the Clayton/ Nanafalia-Clayton aquifer by the Clayton-Providence confining unit. The recharge area for the Providence/Providence-Ripley aquifers extends in an irregular fashion southwest to the northwest edge of sediments of the overlying Clayton/Nanafalia-Clayton aquifer.

Cropping out north of and underlying the Providence/Providence-Ripley aquifers in Alabama is the Eutaw aquifer, which is composed of the Eutaw Formation, which is subsequently underlain by the Tuscaloosa aquifer. In Georgia, these aquifers are present but are difficult to distinguish, and are mapped as one unit. The recharge area of the Eutaw and Tuscaloosa aquifers extend from Russell County, Alabama, across northern Chattahoochee and Marion Counties, Georgia, and northwest across northern Taylor and Southern Crawford Counties, Georgia (Mayer, 1997).

In subarea 4, the Intermediate system ranges in thickness from 20 feet in northern Florida to 300 feet toward the Gulf. Water-bearing units in the Intermediate system range in thickness from 30 to 250 feet and are mostly contained in the Chipola Formation. Groundwater flow in the Intermediate aquifer system is semi-confined below the aquifer by a massive, plastic dolosilt at the base of the Intercoastal Formation and above the aquifer by the Jackson Bluff Formation (Torak and McDowell, 1996).

A semi-confining unit located at the base of the Intermediate aquifer system is present south of central Calhoun County, Florida. This unit consists of a massive, clayey, dolosilt that confines the underlying Upper Floridan aquifer. The thickness of the clay bed generally ranges from about 5 to 30 feet.

According to Torak and McDowell (1996), the Upper Floridan aquifer ranges in thickness from a few feet at the updip limit to more than 700 feet in Florida. The aquifer is generally semiconfined beneath the undifferentiated overburden toward the north and exposed along sections of the Apalachicola, Chattahoochee, and Flint Rivers and in the vicinity of Spring Creek, where erosion has removed the overburden. The Upper Floridan aquifer can store and transmit large quantities of water due to the fractured nature of the Ocala Limestone and associated dissolution features in the limestone created by groundwater circulating along bedding planes and fractures, interconnected conduits, or solution openings.

The confining unit beneath the Floridan aquifer system in the lower ACF basin is the Lisbon Formation, which is a hard, well-cemented, argillaceous limestone. South of the Dougherty Plain, some domestic water supplies can be obtained from this formation.

4.3.1.4 Environmental Consequences

Impacts on geologic resources as a result of the no action and action alternative flow scenarios would be insignificant. Water that is being stored and transported throughout the basin under various management schemes is not expected to significantly influence major geological structures, and therefore there would be no foreseeable impacts on the resource. However, increased groundwater pumping in south Georgia could affect localized subsidence. The formation of sinks could affect groundwater recharge and discharge. In addition, localized erosive and depositional effects will continue under the no action and action alternatives. These effects are discussed in more detail in Section 4.3.2.2.

4.3.2 Soils

This section describes the existing soil conditions in the ACF basin and the potential environmental consequences of each alternative on soils.

4.3.2.1 Affected Environment

The following discussions are based on studies of the soils in the ACF basin conducted by the USGS (Couch et al., 1996).

4.3.2.1.1 Soil Types

Based on their research, three major soil orders—ultisols, entisols, and spodosols, and more than 50 soil series—are present in the ACF basin.

Ultisols are characterized by sandy or loamy surface horizons and loamy or clayey subsurface horizons. These deeply weathered soils occur as residual products of in-place weathering of the parent acid crystalline and metamorphic bedrock.

Entisols are young soils with little or no change from the parent material and with poorly developed subhorizons. These soils are frequently infertile and droughty because they are deep, sandy, well-drained, and subject to active erosion.

Spodosols are characterized by a thin sandy subhorizon underlying the A horizon or surface layer of soil. This sandy subhorizon is cemented by organic matter and aluminum.

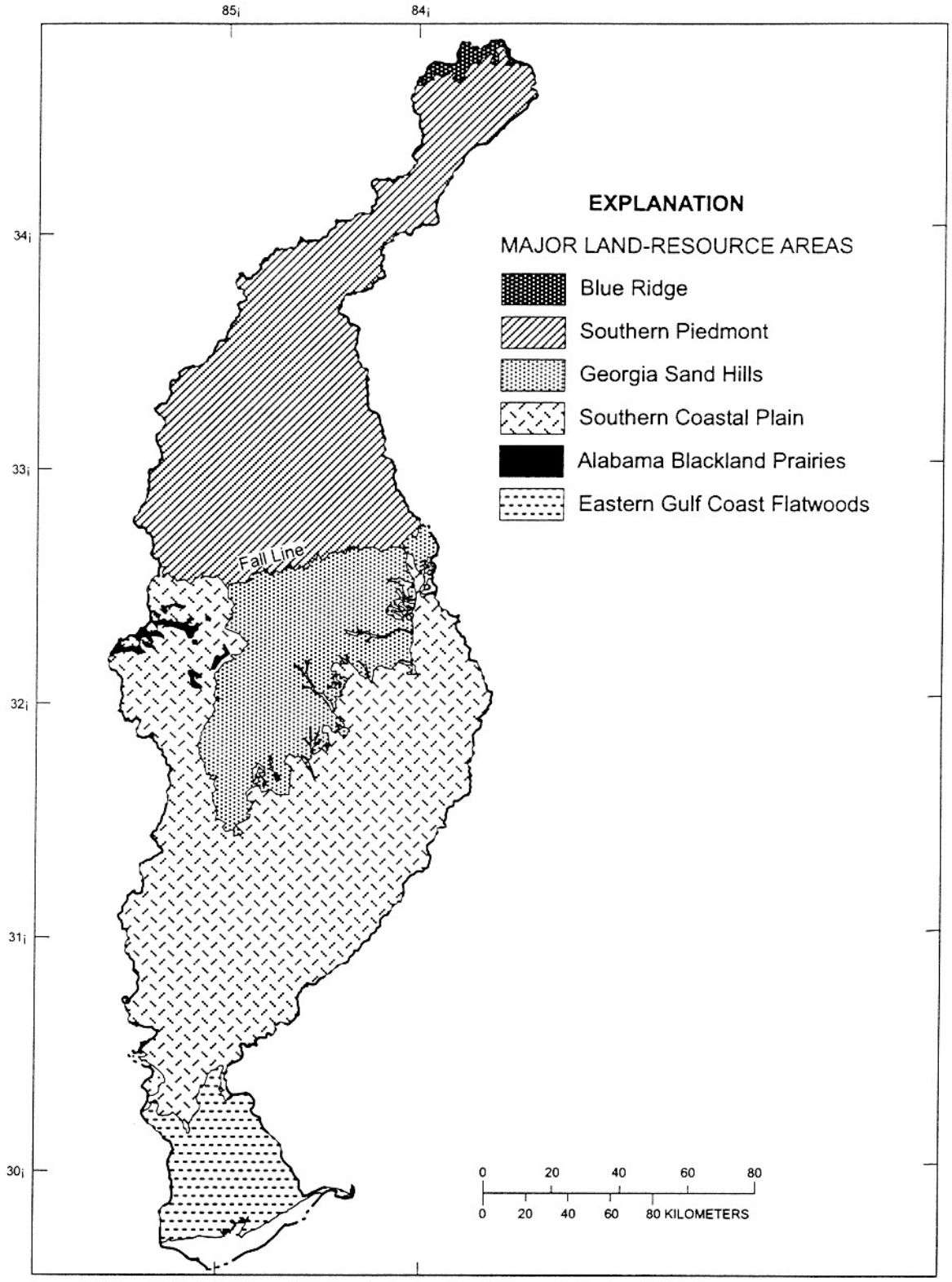
The ACF basin is similar to much of the southeastern coastal plain, with a dominance of ultisols. Entisols are found at and below the Fall Line and in the Dougherty Plain, and spodosols are found in the Gulf Coast Lowlands.

4.3.2.1.2 Major Land Resource Areas

Soils of the ACF basin are divided into six major land-resource areas, formerly called soil provinces (*Figure 4-8*). Four of these, the Southern Piedmont, Georgia Sand Hills, Southern Coastal Plain, and Eastern Gulf Coast Flatwoods land-resource areas, cover 97 percent of the basin. The Southern Piedmont is dominated by ultisols, which are acid and low in nitrogen and phosphorous. These soils generally lack the original topsoil because of erosion that began with intensive cultivation of cotton in the 1800s (Wharton, 1978).

Soils in the Southern Coastal Plain and the Georgia Sand Hills land-resource areas are derived from marine and fluvial sediments eroded from the Appalachian and Piedmont Plateaus. Ultisols are found throughout Southern Coastal Plain, with the exception of some areas in the Georgia Sand Hills and Dougherty Plain where entisols are locally present.

FIGURE 4-8
Major Land-Resource Areas in the ACF Basin
Source: Couch et al., 1996



Base modified from U.S. Geological Survey digital files using data from State Soil Geographic Database [STATSGO], Soil Conservation Service, and U.S. Department of Agriculture

The Eastern Gulf Coast Flatwoods land-resource area, which comprises much of the Apalachicola River basin, is dominated by spodosols, which are poorly to very-poorly drained (Couch et al., 1996).

4.3.2.1.3 Prime Farmland

As designated by the U.S. Department of Agriculture, prime farmland has the best combination of physical and chemical characteristics for producing beneficial crops, and is also available for this use. Prime farmland can be cropland, pastureland, range land, forest land, or other land, but not urban built-up land or water. In general, prime farmlands have an adequate and dependable water supply, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, few or no rocks, and soils that are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they do not flood frequently or are protected from flooding.

Based on information from the STATSGO database, approximately 28 percent of the ACF basin has been designated as prime farmland. Most prime farmland is concentrated below the Fall Line in areas along stream channels and where groundwater resources are more readily available, primarily in the southern third of the ACF basin (***Figure 4-9***). The presence of actively cultivated prime farmlands creates greater local demands on surface water and/or groundwater supplies for irrigation during the growing seasons from April through September for this region.

4.3.2.1.4 Erosion and Sedimentation

Based on the evaluations conducted by Couch et al. (1996) using the State Soil Geographic Database (STATSGO) developed by the Natural Resources Conservation Service (NRCS), basinwide patterns were mapped that illustrate soil leaching and runoff potential for the ACF basin. ***Figure 4-10*** shows the percent of soils series in each STATSGO soil-mapping unit with high leaching rates (permeability of more than 6.0 inches per hour). As this figure illustrates, soils with high leaching rates are concentrated in the sandy Cretaceous sediments below the Fall Line and in the sandy surficial sediments of the East Gulf Coast Flatwoods.

Under the USGS evaluation, runoff ratings were based on the inherent capacity of bare soil to permit infiltration, and consider the slope, the frequency of flooding during the growing season, and permeability. Soils with high runoff ratings were found to be distributed throughout the basin, but were concentrated in areas of low permeability and on steep slopes, where flooding is frequent or where the water table is near the surface, such as is found in floodplains and other low-lying areas. In the ACF basin, soils with the highest runoff rate are present on steep slopes in the Blue Ridge, several areas of the Piedmont province, the Fall Line Hills District, and the lower Apalachicola River basin where soils commonly remain saturated (***Figure 4-11***).

The two most significant ongoing processes that can impact the stability of soils in the area of the ACF basin are erosion and sedimentation. The effects of erosion occur as a result of the ability of environmental media, such as water and wind, to pick up and move soil and rock particles. In the context of this programmatic EIS, the main erosional medium of concern impacted by the application of the water allocation formula is water in the form of runoff, surface water flow, and groundwater flow. There is also erosion by wind transport in exposed areas. In river environments, erosional areas occur along unstable slopes, on the cut banks in stream bends, along reservoir banks, and in other areas where waters travel at

FIGURE 4-9
Prime Farmlands in the ACF Basin
Source: NRCS (STATSGO Database), 1998

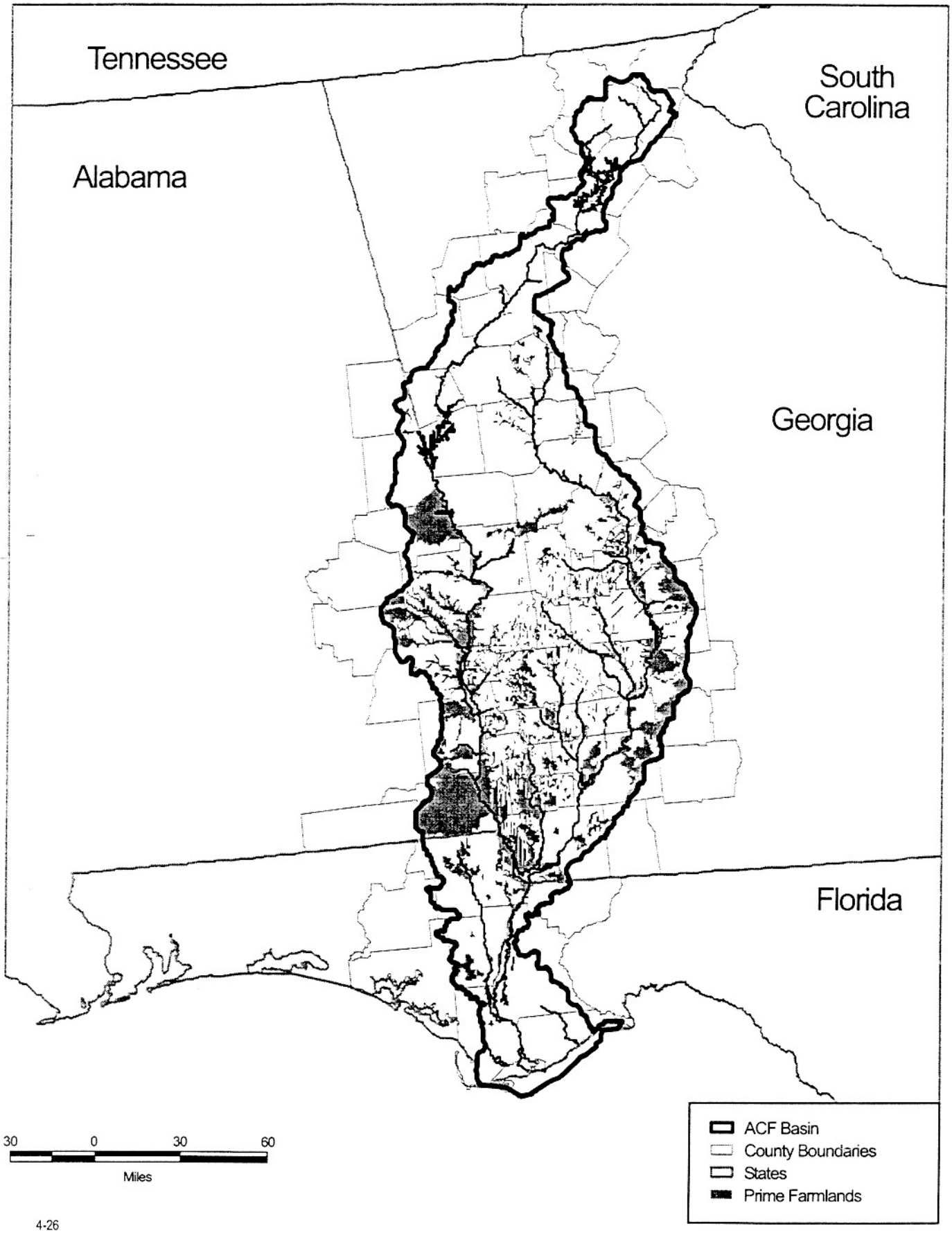


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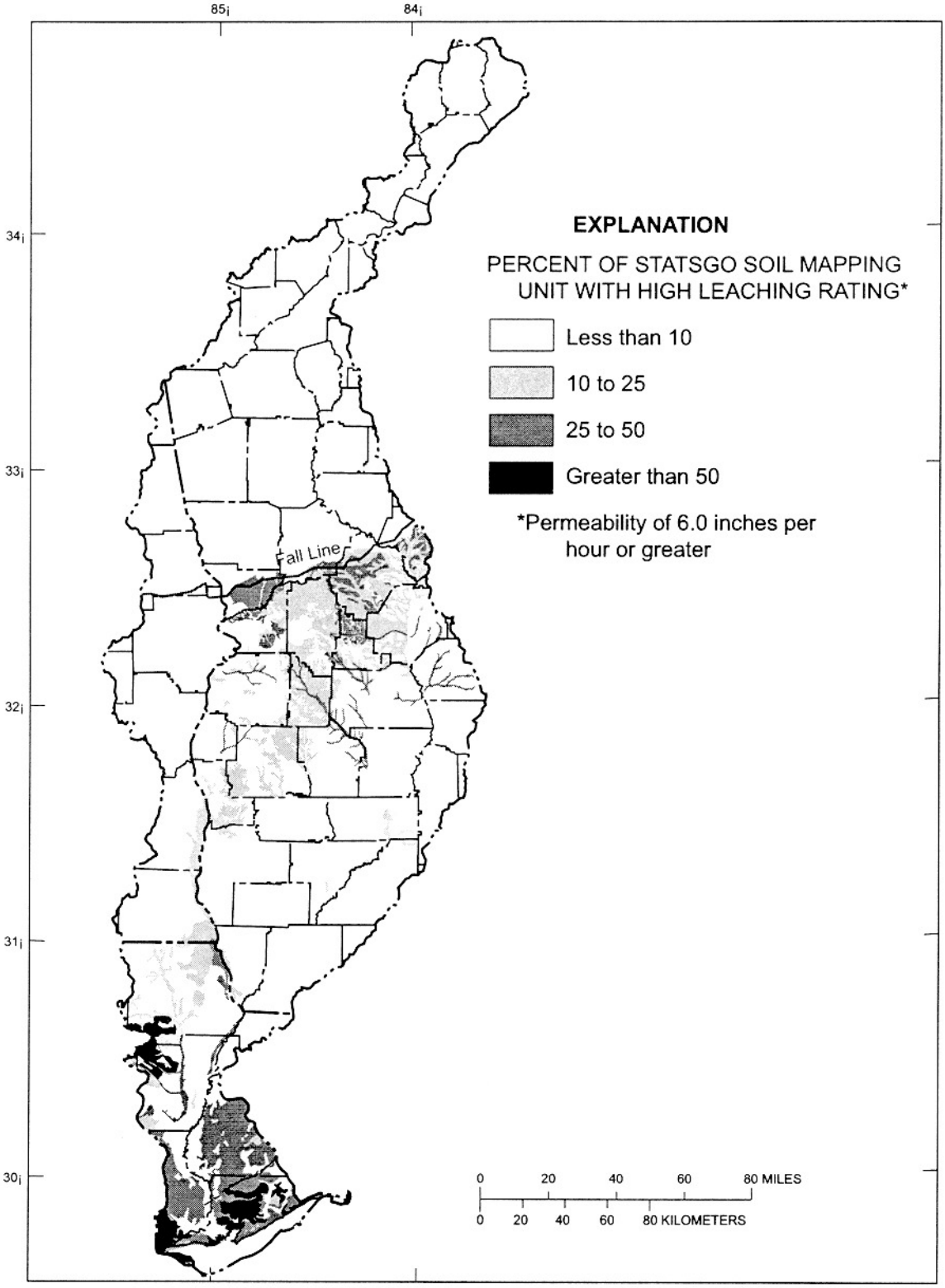
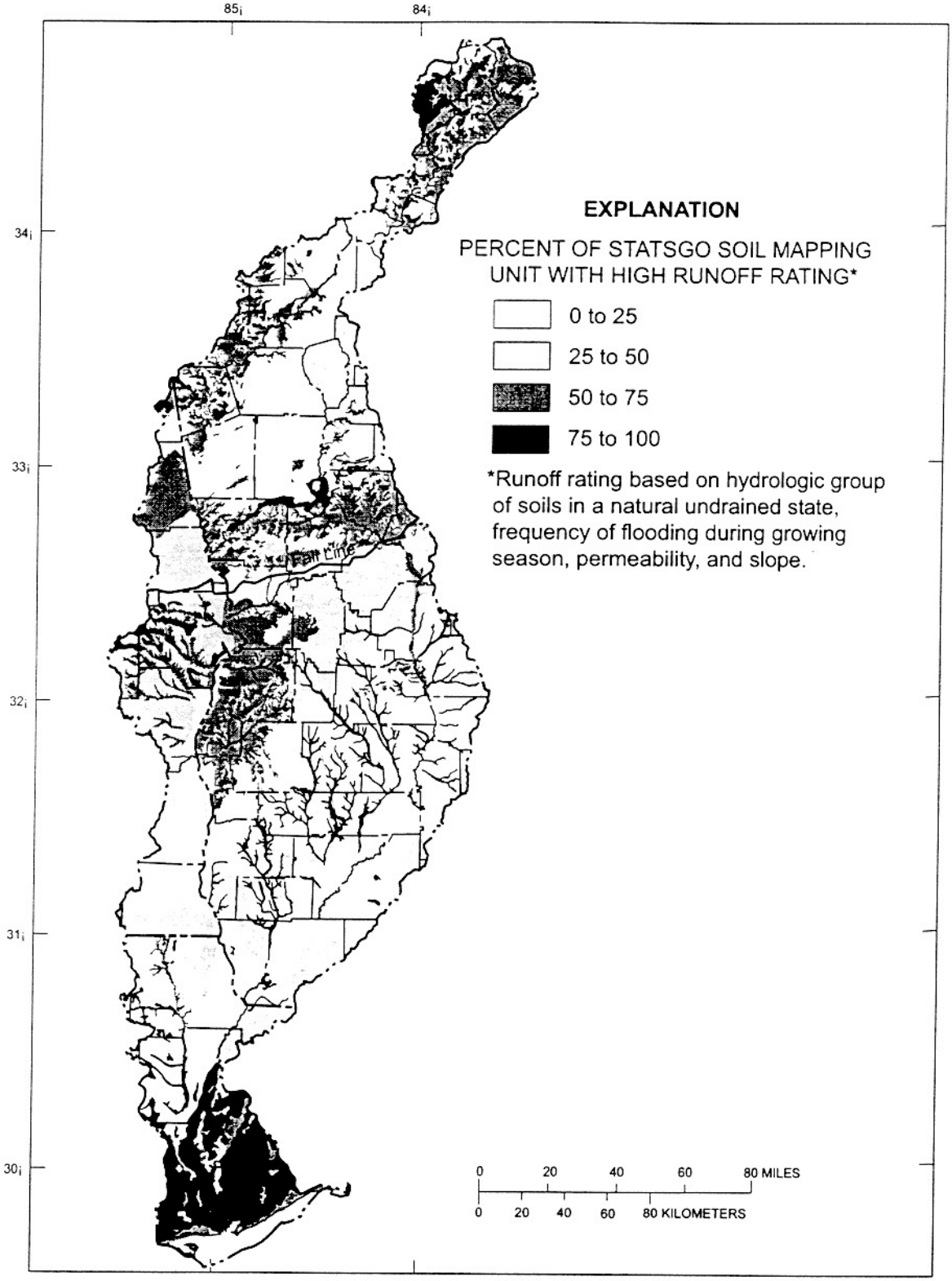
FIGURE 4-10
Soil Mapping Units with High Leaching Rating in the ACF Basin
Source: Couch, et. al., 1996



Base modified from U.S. Geological Survey digital files using data from State Soil Geographic Database [STATSGO], Soil Conservation Service, and U.S. Department of Agriculture).

FIGURE 4-11
Soil Mapping Units with High Runoff Rating in the ACF Basin
Source: Couch, et al., 1996

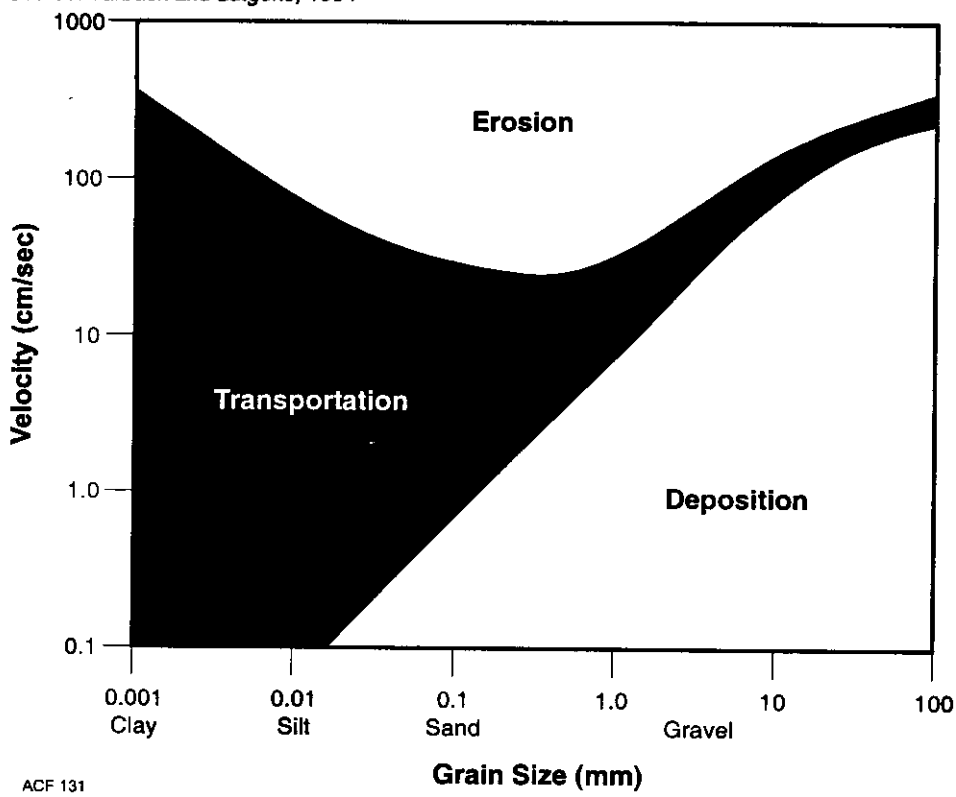


Base modified from U.S. Geological Survey digital files using data from State Soil Geographic Database [STATSGO], Soil Conservation Service, and U.S. Department of Agriculture).

velocities high enough to pick up the soil or rocks. Also, rapid water level fluctuation can contribute to increased bank erosion. While erosion is a natural process, variations in flow rates can seriously affect localized areas in which stream banks are cut further back, structural features are undermined, or slopes become unstable and dangerous. Similar patterns of induced erosion are also associated with increased fluctuations in reservoir levels.

In contrast, deposition, sedimentation, or siltation occurs when the velocities of flowing water are reduced and can no longer carry the suspended load of soil and rock. This results under a variety of conditions, such as when a stream enters a larger water body or shallower environment, or floods onto a broader flood plain, or when flows are reduced as a result of surface water withdrawal from the channel or surface water losses to groundwater. The complex relationships of water flow velocity and grain size to erosion, sedimentation, and transport are presented in ***Figure 4-12***.

FIGURE 4-12
Relationship of Stream Velocity to Erosion, Transport, and Deposition of Various Grain Sizes
Source: Tarbuck and Lutgens, 1984



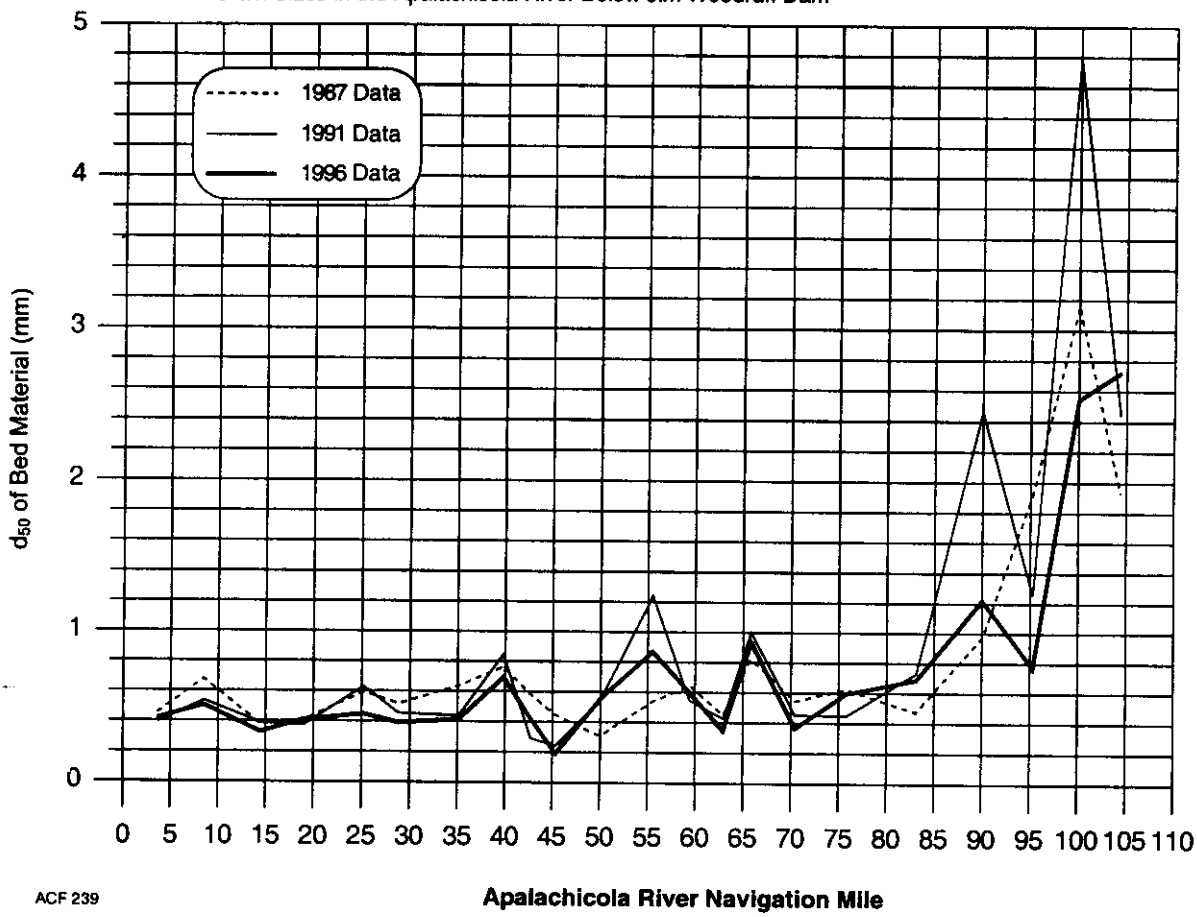
ACF 131

The sediment sizes of the streams and water courses of the ACF basin vary greatly, from cobbles and even boulders in the headwater streams to fine clays and silts in the lower reaches. This pattern is typical for the ACT and ACF basins because the channel slope is greatest in the headwaters of the basin and decreases in the downstream direction. Sediment sizes are generally inversely related to slope and drainage area.

Above the Fall Line, near Columbus, Georgia, the slope of the Chattahoochee River is approximately 2.7 feet per mile. Below the Fall Line, the slope of the Apalachicola is

approximately 0.4 feet per mile. Generally, the stream bed above the Fall Line is more controlled by less erodible outcrops in the bed and banks. Below the Fall Line, the bed is more sandy, and especially below Bountstown, the Apalachicola River is characterized as a meandering alluvial river. The bed material trend of fining in the downstream direction is locally interrupted by changes in the type of material through which the water flows as well as the constructed structures in the system. The bed material median grain sizes (d_{50}) on the Apalachicola River, below Jim Woodruff Dam show a definite fining in the downward direction, ranging from 2.5 to 4.0 millimeters (mm) just below the dam to approximately 0.5 mm near the mouth of the river (***Figure 4-13***). This trend corresponds to both changes in slope and composition of the bed.

FIGURE 4-13
Bed Material Median Grain Sizes in the Apalachicola River Below Jim Woodruff Dam

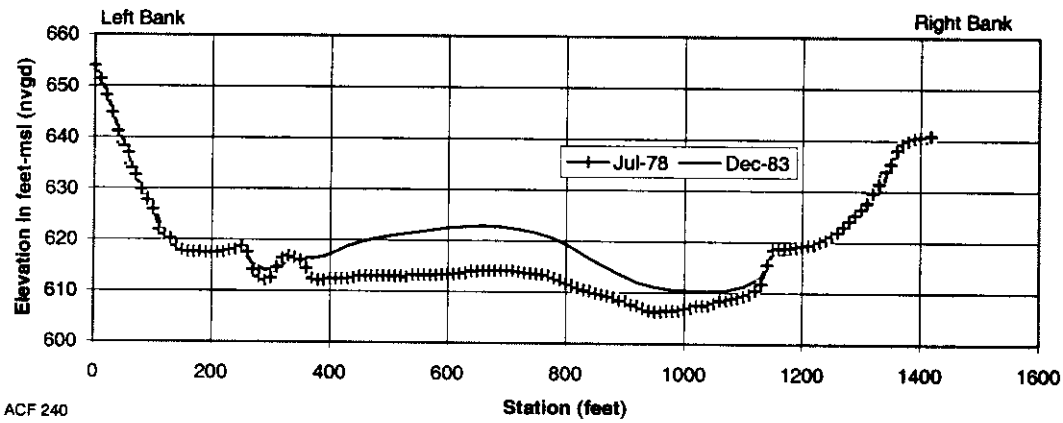


Retention structures in the system generally trap the heavier material in the pool and result in erosion below the structure. This shoaling is to be expected because the dam slows the velocity of the water, allowing much of the heavier sediment to shoal, and there is much less heavy sediment passed downstream to take the place of the ongoing erosion below the dam. The heavier and larger material falls out near the upstream end of the pool, and the finer material settles in the pool farther downstream. Sediment ranges are used to monitor changes in the lakes in the system.

Erosional problems at Lake Lanier have created a continuing need to install riprap along the lakeshore. Sedimentation/siltation is occurring in all coves at Lake Lanier, with the most seriously affected area near Longwood Park, and dredging activities are an ongoing operation (Lovelady, 1998). However, shoaling in Lake Lanier is not considered to be a problem because of the huge volume of storage available. Lake Sidney Lanier accounts for 50 percent of the storage volume in the basin. Walter F. George Lake is next largest, with 24 percent, followed by Lake Seminole with 9 percent and West Point with 8 percent. Typical shoaling in the other pools is shown in ***Figures 4-14*** through ***4-16***. The cross-sectional data presented in these figures are from the following locations:

- ***Figure 4-14:*** Approximately 22.3 river miles upstream from the West Point Dam on the Chattahoochee River
- ***Figure 4-15:*** Approximately 60 river miles upstream from the Walter F. George Lock and Dam on the Chattahoochee River
- ***Figure 4-16:*** Approximately 44 river miles upstream from Jim Woodruff Dam on the Chattahoochee River

FIGURE 4-14
West Point Lake Shoaling



At West Point Lake, erosional problems exist but are less severe in nature. However, shoaling and sedimentation in the headwaters of West Point Lake is a documented problem (***Figure 4-14***) and is currently being studied (Marshall, 1998). Downstream at Walter F. George Lake, problems with erosion due to wave action have been documented. This erosion has led to several bank reinforcement projects to install sheet piling walls or rip rap, most recently at Hardridge Creek Park. The banks are especially susceptible here due to the sandy nature of the soils. Sedimentation/siltation problems are also occurring in all of the creeks feeding Walter F. George Lake, primarily due to private development, agricultural practices, and runoff (Puhr, 1998). Bank stabilization problems have been addressed at Walter F. George Lake, and reinforcing rip rap has been installed in some of the recreational areas (Crichen, 1998).

FIGURE 4-15
Walter F. George Lake Shoaling

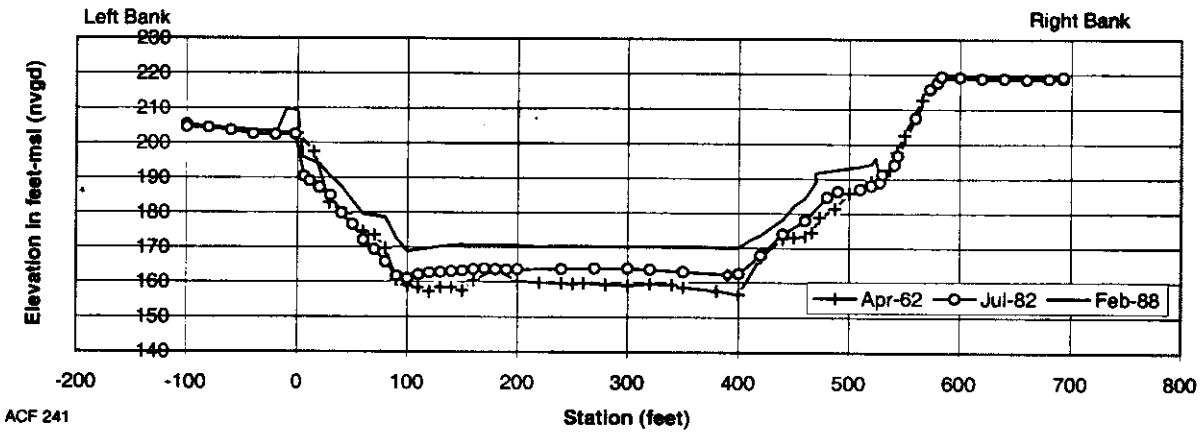
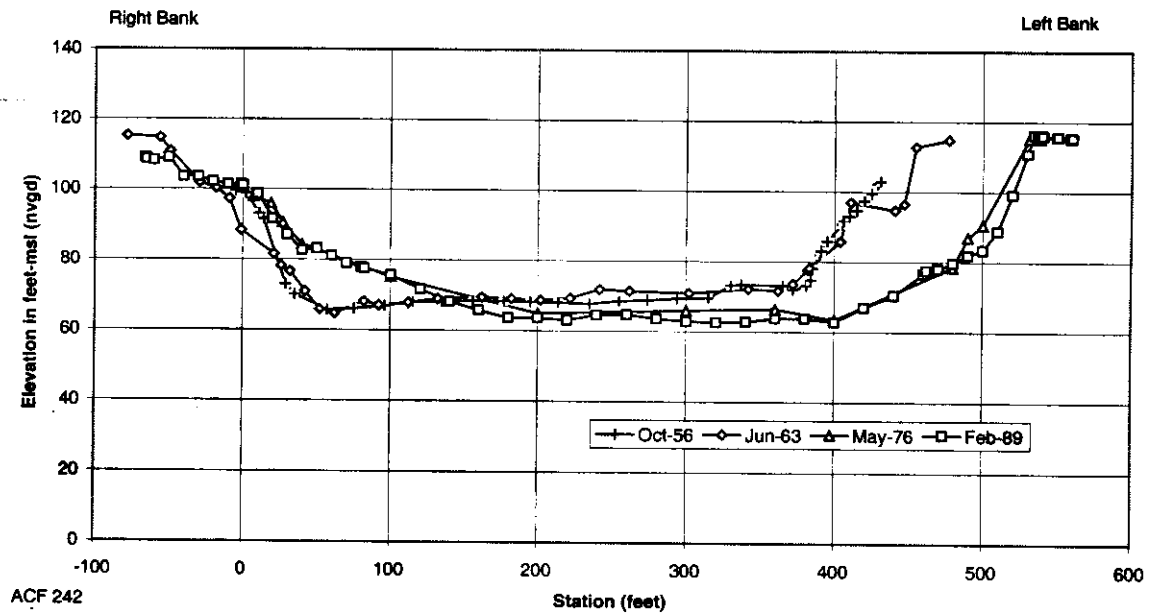


FIGURE 4-16
Lake Seminole Shoaling



Lake Blackshear on the Flint River is experiencing minor erosional activity due to waves generated by boat traffic with some banks being undercut by the wave action. In contrast, there is a substantial sedimentation/siltation problem at Lake Blackshear due the high sand content in the headwater areas and to the flushing of sediments that come with flood waters. Over the last 60 years, the lake has lost between 15 and 20 percent of its storage capacity (Cofer, 1998).

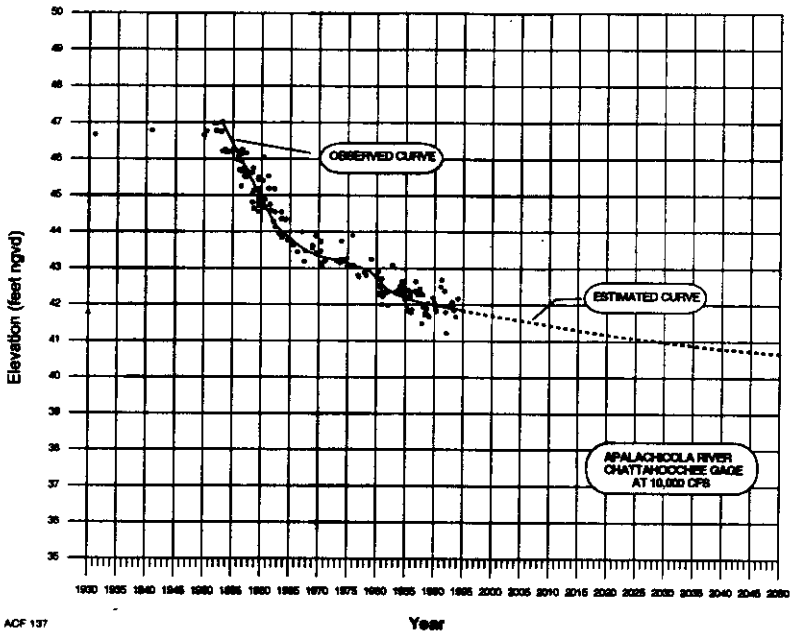
Along the Apalachicola River, Lake Seminole is also experiencing more problems associated with sedimentation/siltation than with erosion. Sedimentation is particularly heavy in the backwater areas. The sedimentation/siltation problems at Lake Seminole primarily are the result of sands being washed in by the Flint and Chattahoochee Rivers. However, there have been no major identifiable erosional issues at Lake Seminole (Brusse, 1998).

Shoaling also occurs in the streams at point bars, or convex bends in the river. Secondary currents in these bends in the river sweep bottom sediment toward the point creating these bars. Shoaling also occurs in areas of increased cross-sectional flow area, where flow velocity slows, or where erodible material occurs. Disposal Area 40 at Corley Slough near mile 36 on the Apalachicola River is a site where a high bank of easily erodible sand is located on the outside of a bend and contributes a large amount of material to the stream while increasing the cross-sectional area by erosion.

Downward degradation of the river below dams in the upper and middle reaches of the system is attenuated to some degree by the downstream dams. However, below the most downstream dam on the system, Jim Woodruff Dam, there is no controlled tailwater, and erosion occurs. The erosion continues for miles unless stopped by exposure of hard material in the river bed, or until the river attains a relative equilibrium in slope, sediment size and quantity, and flow. Recent measurements indicate that this reach, approximately 30 miles below Jim Woodruff Dam, is not at present degrading through time.

The tailwater degradation curve at Jim Woodruff Dam (Lake Seminole) for 10,000 cubic feet per second (cfs) is shown in *Figure 4-17*. The curve indicates the low water elevations below the dam through time. A projection of the future degradation of the tailwater over the life of the project was made and is shown in the drawing. The data were plotted at several scales and curve fits were attempted by several methods using several ranges of data. The best fit was by eye. The estimated degradation rate from the curve fit by eye matches approximately a linear least squares fit of the 1985 current data. This rate is approximately 1 foot in 40 years, or 0.025 foot per year. The data since 1985 might indicate stabilization of the rate of degradation, but, considering the episodic nature of geomorphic events, a short-term data record could be misleading. The entire record indicates that continued erosion could occur, and plans should be made for this contingency. It is expected that the degradation would not continue linearly, but would either be attenuated by outcrops of rock or gradually decrease as the slope of the river continues to decrease. For this study, it was estimated that the rate of erosion would gradually decrease as the slope of the river decreases. The observed and estimated parts are noted in the drawing.

FIGURE 4-17
Lake Seminole, Tailwater Degradation, 1954 to 1994



4.3.2.2 Environmental Consequences

With the no action alternative, future demand for water is expected to cause minor decreases in stream flow and reservoir elevations through the year 2050. This may increase sedimentation in rivers as river velocities decrease and provide more opportunity for deposition. These effects are expected to be minimal, however.

With the low flow scenario, river flows would be significantly reduced under critical dry flow conditions (see Section 4.4.1.2). Low river flows and the resulting low velocities would cause deposition of sediment that would otherwise remain in suspension. The low flow scenario would maintain relatively high and stable reservoir levels. This may increase problems associated with shoreline erosion where it is currently a concern, such as at Lake Lanier, West Point Lake, Walter F. George Lake, and Lake Seminole (see Section 4.3.2.1). Higher water levels, particularly under wind conditions, can exacerbate shoreline erosion.

With the high flow scenario, river flows are generally maintained higher in the summer and lower during the winter. The higher summer flows would improve stream segments where silt and sediment have built up over time, by providing regular scouring flows. The high flow scenario does not generally increase high flows, so no stream erosion concerns are expected. The high flow scenario may improve shoreline erosion problems around the reservoirs because it produces lower reservoir levels in the summer and fall. However, new erosional problems could be uncovered or could develop as reservoirs are drawn to regularly to lower levels than they currently experience.

4.4 Water Resources

This section examines the complex interrelationships between surface water, groundwater, and the numerous competing demands on water resources in the ACF basin. A significant amount of information that is used in this section was developed and approved during the Comprehensive Study by the States of Florida, Alabama, and Georgia, and the Corps, who were partners in the study. The Corps, using tools developed during the Comprehensive Study, developed a hydrologic model of the allocation scenarios for this EIS. Data analysis and technical expertise on water quality issues addressed in this EIS were provided by the U.S. Environmental Protection Agency (EPA) (surface water quality) and the U.S. Geological Survey (USGS) (groundwater quality).

The hydrologic modeling that the Corps performed on the reservoirs and rivers in the ACF basin is discussed first. This modeling provides the framework for evaluating environmental consequences in this EIS. Next, this section addresses water quantity issues, followed by water quality issues for the ACF basin. The water quantity and water quality sections first describe the affected environment, presenting an overview of the resource in the ACF basin, and then present the environmental consequences of the no action and action alternative.

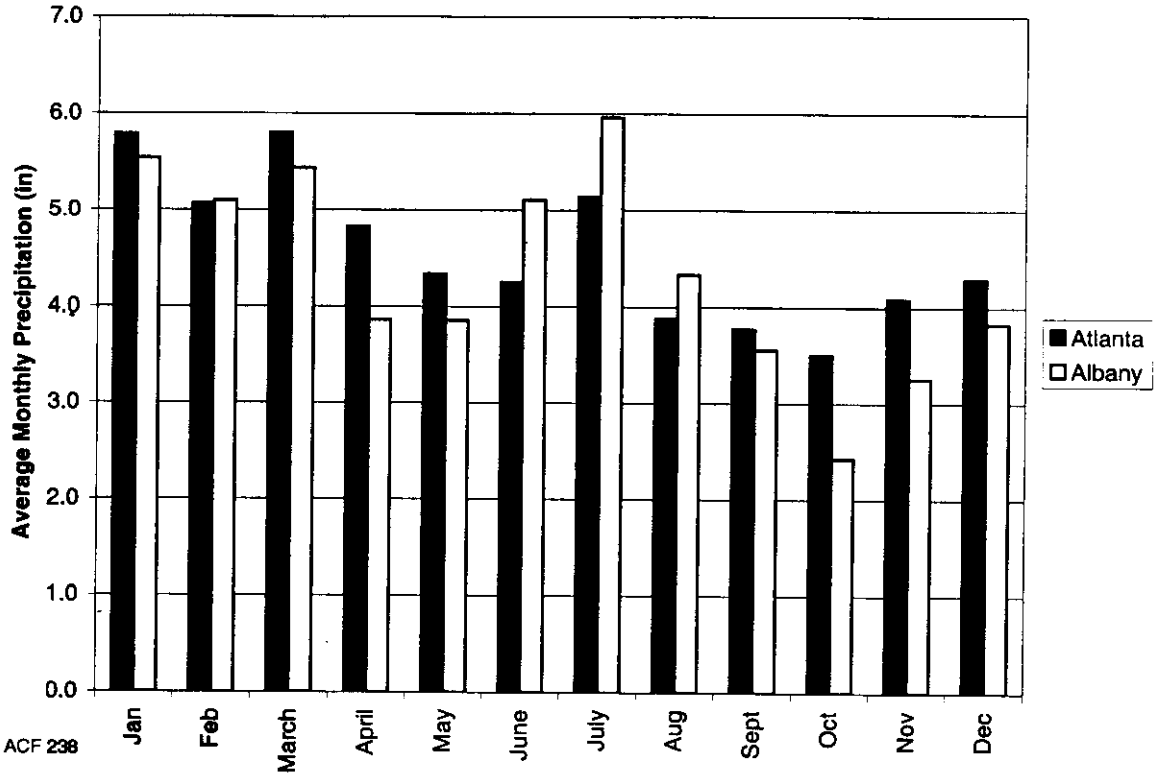
The water quantity modeling completed by the Corps provided the basis for evaluating impacts on water availability, instream flows, and reservoir water level elevations. This information was also used by the cooperating agencies to evaluate the potential impacts on each of the other resources areas (biological communities, economics, etc.). Water quality modeling was completed by the Corps Waterways Experiment Station (WES) and the Hydrologic Engineering Center (HEC). EPA participated in the water quality modeling effort and provided input on point and nonpoint source loadings for the water quality model. In addition, EPA assisted in the review and analysis of the results of the water quality modeling.

4.4.1 Water Quantity

This water quantity discussion addresses the amount of water in the ACF basin by examining such issues as flow rates, flow durations, reservoir water levels, and groundwater quantities. There are many factors that can affect water quantity, including weather, municipal and industrial (M&I) consumption, agricultural use for irrigation, and the operation of hydro- and thermal power plants, and flood control dams. This section discusses the quantity of water in the ACF basin under existing conditions, and then evaluates potential impacts to water quantity under the no action and action alternatives.

In the southeast U.S., rain falls nearly every month (***Figure 4-18***). However, the need for water in the summer and fall often is greater than the supply of water in the river basin. An important function of the many reservoirs in the ACF basin is to store water when there is an abundance of rain and to release water when there is less rain, ensuring that all water needs can be met throughout the year. This management of water is a complex process that must consider the many competing demands for water in the basin, take past and future hydrologic conditions into consideration, and determine the most appropriate operating conditions for all the reservoirs in the basin to optimize the use of water. The Corps takes an active role in water management in the ACF basin to supply water to meet the various competing demands.

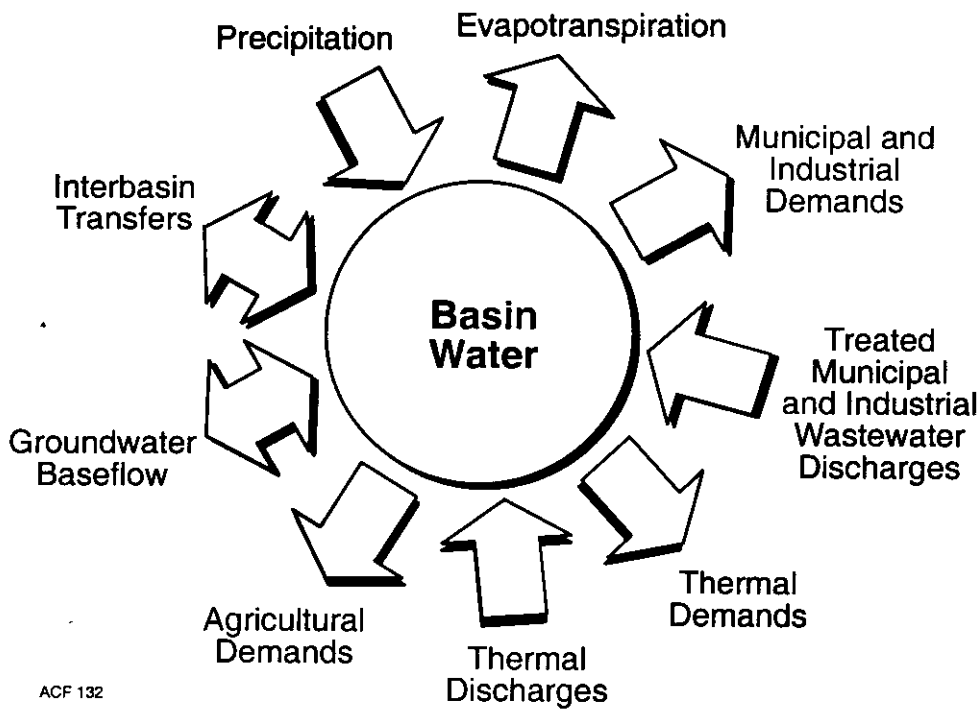
FIGURE 4-18
Monthly Precipitation at Atlanta and Albany, Georgia, Based on 1956 to 1997 Data (ACF Basin)



The various uses of water in the ACF basin include hydropower, navigation, water quality (such as assimilative capacity for wastewater discharges), water supply, flood control, fish and wildlife habitat, and recreation. Water demands can be consumptive or non-consumptive. *Consumptive* demands withdraw water from the basin for some purpose and do not return it back to the basin. Municipal, industrial, and thermal power water supply consume a portion of the withdrawn water and return a portion of the water back to the basin as treated wastewater. For purposes of this analysis, agricultural water supply withdrawals are assumed to provide no return flows to the surface water streams. In contrast, hydropower demand is a *non-consumptive* use of water. It uses the flow in the river to drive hydropower turbines to generate electricity, but no water is withdrawn or lost from the system.

In considering basin water management, it is critical to account for the various withdrawals/losses and returns/gains to the system. Water is lost through evapotranspiration (total of evaporation and plant transpiration), municipal and industrial water withdrawals, thermal water demands, agricultural water withdrawals, groundwater transfers, and interbasin transfers. Water is returned, or added, to the basin through precipitation; treated municipal and industrial wastewater discharges; thermal power plant discharges; groundwater baseflow contribution; and interbasin transfers. ***Figure 4-19*** schematically illustrates the gains and losses of water to the basin.

FIGURE 4-19
Basin Water Gains and Losses (ACF Basin)



Water resources in the ACF basin include both surface water (carried in rivers and reservoirs) and groundwater. There is significant interaction in the basin between the surface water and groundwater, especially in the southern portion of the basin. Surface water hydrology in the ACF basin is also greatly influenced by various management activities among the 16 mainstem reservoirs in the ACF basin. These reservoirs attenuate high river flows during wet periods and augment low flows during dry weather periods.

4.4.1.1 Affected Environment

The following sections review the water resources background for the ACF basin, and include discussions of the major rivers and their tributaries, constructed reservoirs that are within the river basin, and groundwater resources that may interact with these surface water systems. ***Figure 4-20*** illustrates the subbasins used for discussion of water quality and quantity issues. A longitudinal view of the basin and locations of locks and dams is included in ***Figure 4-21***. The last part of this section reviews the relationships between these water resources and water supply withdrawals in the ACF basin.

4.4.1.1.1 Rivers

The three principal rivers in the ACF basin are the Chattahoochee, Flint, and Apalachicola Rivers. The Chattahoochee and Flint Rivers join to form the Apalachicola River in northwest Florida. The Chattahoochee River has a drainage area of 8,770 square miles. The drainage area of the Flint River measures 8,460 square miles. The remaining 2,680 square miles of the ACF basin drains directly into the Apalachicola River. ***Figure 4-21*** is a longitudinal view of the basin including the Apalachicola, Chattahoochee, and Flint River.

FIGURE 4-20
Water Resources Subbasin Map of the ACF Basin

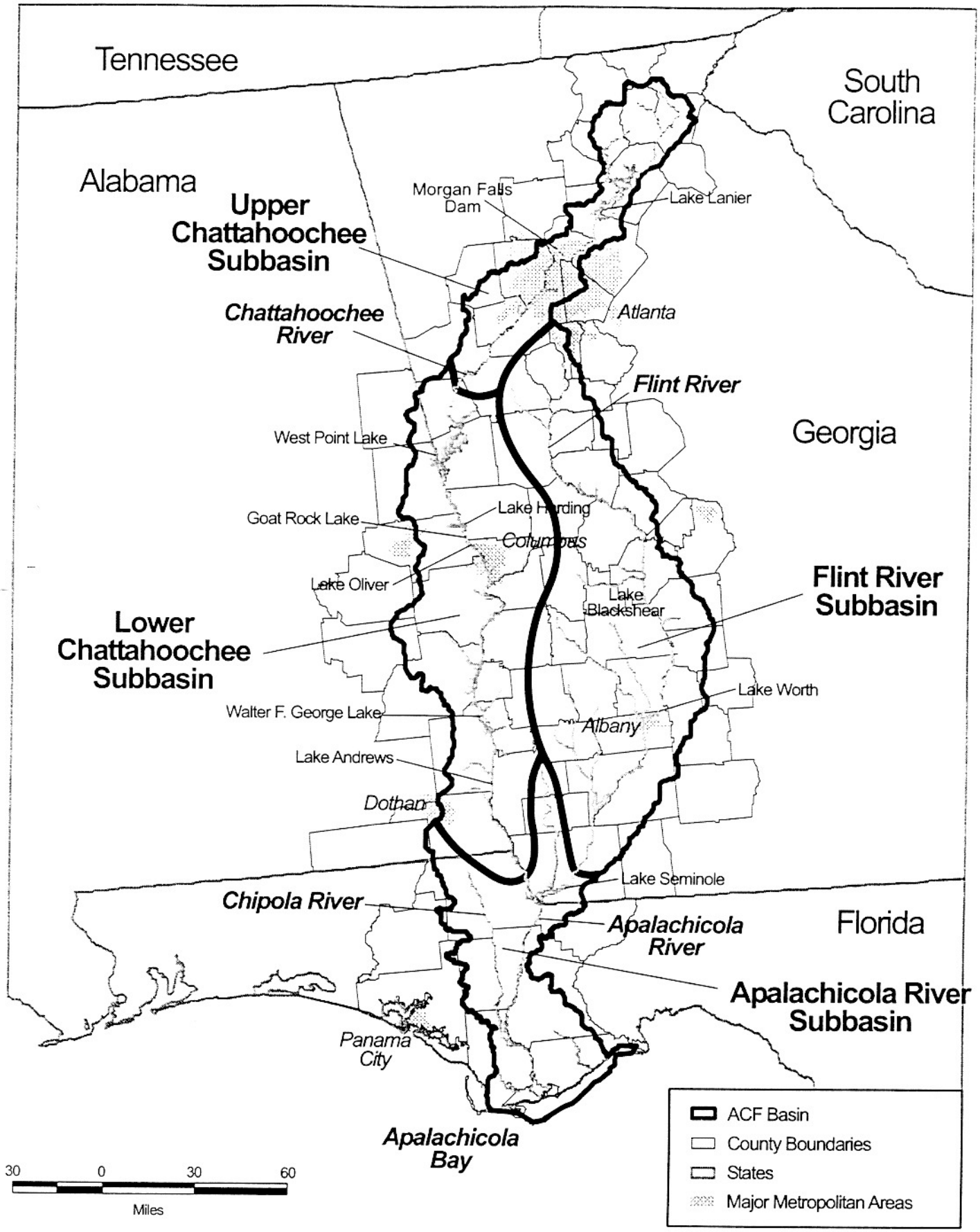


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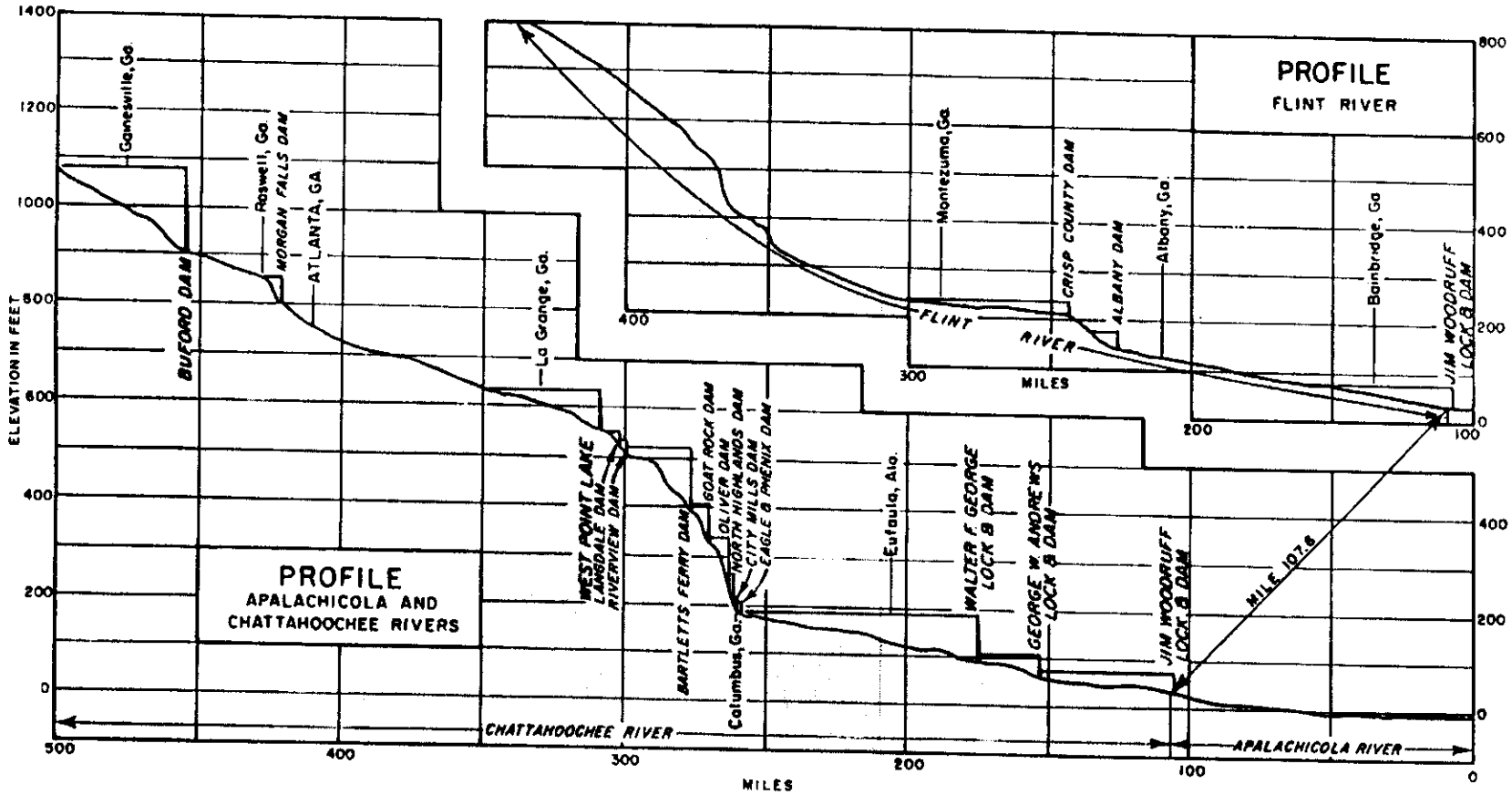
FIGURE 4-21
Longitudinal Profile of the Apalachicola, Chattahoochee, and Flint Rivers



Rivers in the ACF basin include both natural (unregulated) rivers and regulated rivers. Natural rivers exhibit a more consistent pattern, responding to precipitation and drought periods as expected with short periods of high flows and prolonged periods of low flows, respectively. Regulated streams exhibit a variable pattern, with daily variations due to hydropower operations (most prominent below peaking projects), navigation releases, lower flood peaks, and higher sustained minimum flows through dry periods as the upstream reservoirs augment low flows. A typical natural and regulated stream pattern over a year is illustrated in ***Figure 4-22***. Although the two rivers shown are different rivers with slightly different drainage areas, the figure demonstrates the distinctive characteristics of a natural and a regulated stream.

4.4.1.1.1.1 Chattahoochee River

The Chattahoochee River originates in the Blue Ridge Mountains of north Georgia, near the western-most tip of South Carolina, and extends to the southwest corner of the State. The Chattahoochee River covers a distance of 434 miles from the Blue Ridge Mountains to Lake Seminole. It flows out of the mountains, past metropolitan Atlanta, and reaches the Georgia-Alabama border, at which point it forms the border between the two States. From there, the Chattahoochee River flows south to its confluence with the Flint River at Lake Seminole and into the Apalachicola River (Georgia Department of Natural Resources [GDNR], 1997).

Over most of its length, the Chattahoochee River is controlled by dams and hydroelectric plants that release water for the production of hydropower and store water for flood control. The slope in the upper reaches is 3 feet per mile. The Chattahoochee River is free-flowing only in the headwaters upstream of Lake Lanier. Downstream of Lake Lanier, the river is affected by dam and reservoir operations. Many of the dams and hydroelectric plants operate in a peaking mode, which can result in daily water level fluctuations in the river of 4 feet or more (Couch et al., 1996). Flood control storage at several of the larger reservoirs reduces the peak flow in the river by storing much of the flood flow.

In contrast to the mainstem of the river, the numerous tributaries to the Chattahoochee River are free-flowing. These streams typically have higher sustained flows during winter months and show sharper responses to storm events throughout the year (Couch et al., 1996).

The capacity of the Chattahoochee River within its banks varies substantially throughout the river's length. Capacity is about 10,000 cubic feet per second (cfs) between Lake Lanier and Norcross, about 18,000 cfs from Atlanta to Whitesburg, and about 47,500 cfs near West Point and Columbus (Corps, 1997). Historically, flows at the USGS gage on the Chattahoochee River at Columbus have been as low as 480 cfs (in October 1931) and as high as 120,000 cfs (in February 1961). The river's slope becomes quite steep through the fall line hydropower projects, from West Point Dam to Columbus, Georgia, with a slope of 9 feet per mile. Downstream of Columbus, to the mouth, the slope of the river is relatively flat at 1 foot per mile.

The highest monthly average flows occur in the late winter/early spring months of February to April, which is typically the rainy season. Through late spring and summer, lower precipitation and high evapotranspiration combine to reduce river flows. The lowest average monthly flows typically occur at the end of the summer in September. Average annual flow at several gages in the Chattahoochee River basin is summarized in ***Table 4-2***.

FIGURE 4-22
Comparison of Natural and Regulated Flows

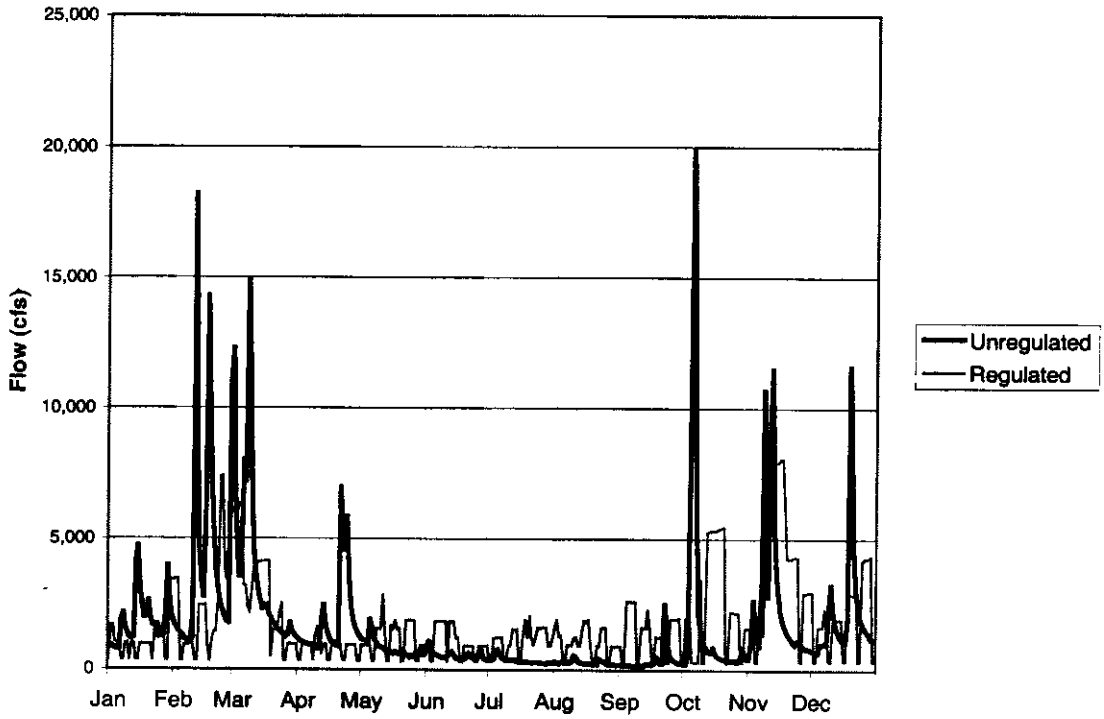


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TABLE 4-2
Historical Gage Data (in cfs) for the Chattahoochee River[a]

Month	Gage No. 02331600 at Cornelia	Gage No. 02338000 at Whitesburg	Gage No. 02341500 at Columbus	Gage No. 02343801 at Andrews Lock and Dam
January	996	4,820	8,554	14,045
February	1,047	5,420	10,841	17,157
March	1,266	5,925	11,418	19,823
April	1,106	5,433	8,992	14,254
May	901	4,220	6,487	10,093
June	702	3,221	5,081	7,442
July	577	3,282	5,535	8,492
August	579	3,476	5,501	7,439
September	477	3,088	4,735	6,615
October	564	3,271	4,915	6,793
November	658	3,335	5,778	8,501
December	776	3,621	7,592	11,438

[a]USGS average monthly flow data for water years 1976 through 1996 were used. This period represents the time after the final dam in the ACF basin was completed (West Point Dam, operational in 1975).

4.4.1.1.1.2 Flint River

The Flint River originates just south of Atlanta and flows about 350 miles in a southerly direction, curving to the west to join the Chattahoochee River at Lake Seminole in the southwest corner of Georgia. The Flint River drainage basin extends 215 miles from north to south, with an average width of about 40 miles, and an area of 8,460 square miles. The Flint River is generally fed by groundwater from its headwaters to its mouth. North of the Fall Line, the Flint River receives groundwater by diffuse leakage into the river bottom. South of the Fall Line, groundwater flow from springs becomes more prevalent (Torak, 1998).

Three tributaries of the lower Flint River have drainage areas of considerable size: Spring, Ichawaynochaway, and Muckafoonee Creeks with drainage areas of 710, 1,120, and 1,130 square miles, respectively. There are only two limited storage capacity reservoirs on the Flint River (Blackshear Lake and Lake Worth), and they do not substantially modify the flow in the river. The remainder of the river is free-flowing until it empties into Lake Seminole near the confluence with the Chattahoochee River. The slope of the Flint River is 9 feet per mile on the upper 130 miles, then flattens to 1 foot per mile to the mouth of the river.

The capacity of the Flint River within its banks ranges from about 30,000 cfs near Montezuma to about 35,000 cfs near Bainbridge, which is about 10 miles upstream of Lake Seminole. Historically, flows at the Albany gage, which is about midway between Lake Seminole and the Flint River's headwaters, have been as low as 327 cfs (in August 1930) and as high as 119,000 cfs (in July 1994 as a result of Tropical Storm Alberto).

Stream flows on the Flint River exhibit a more natural pattern than on the Chattahoochee River due to the lack of regulation on the Flint. There also is a substantial groundwater-to-surface water transfer in the lower portions of the Flint River, which helps sustain higher winter flows in the river. To illustrate, the highest monthly average winter flow at the Flint River gages is about 5 to 6 times greater than the lowest monthly average flow in the summer. In contrast, the highest monthly average winter flow at the Chattahoochee gages is only two to three times greater than the lowest monthly average flows in the summer. *Table 4-3* presents monthly average flows from several gages on the Flint River.

TABLE 4-3
Historical Gage Data (in cfs) for the Flint River[a]

Month	Gage No. 02344500 at Griffin	Gage No. 02347500 at Culloden	Gage No. 02349500 at Montezuma	Gage No. 02352500 at Albany
January	510	3,128	4,504	8,273
February	600	3,984	5,852	10,521
March	657	4,583	6,475	11,650
April	430	3,136	4,933	8,245
May	288	1,732	2,761	4,892
June	171	1,045	1,837	3,288
July	281	1,562	2,723	4,695
August	154	917	1,739	2,971
September	136	672	1,335	2,217
October	217	989	1,706	2,785
November	304	1,602	2,337	3,582
December	356	2,227	3,502	5,765

[a]USGS average annual flow data for water years 1976 through 1996 were used. This period represents the time after the final dam in the ACF basin was completed (West Point Dam, operational in 1975).

4.4.1.1.1.3 Apalachicola River

The Flint and Chattahoochee Rivers converge at Lake Seminole, which is formed by the Jim Woodruff Lock and Dam. The Apalachicola River flows unimpeded for approximately 106 miles from the dam near the Florida-Georgia State line to the Gulf of Mexico at Apalachicola Bay, a major fishery resource for oysters, shrimp, and fin fish. The river drains about 2,680 square miles, and its shallow estuary covers about 208 square miles. Tides in the Gulf of Mexico influence the Apalachicola River over approximately the lower 25 miles of the river. The tides have a mean range of 2 feet. The width of the river ranges from several hundred feet when confined to its banks to nearly 4.5 miles during flood flows. The discharge of the Apalachicola River accounts for 35 percent of the freshwater flow on the western coast of Florida (USGS, 1996). The slope of the Apalachicola River is fairly flat at 0.35 foot per mile over its entire length.

The Chipola River is the only sizable tributary to the Apalachicola River besides the Flint and Chattahoochee Rivers. The Chipola River basin drains 1,280 square miles, which accounts for about one-half of the Apalachicola River's drainage area in Florida. The Chipola River is a spring-fed river with baseflow derived principally from aquifers (USGS, 1996).

The capacity of the Apalachicola River within its banks is approximately 100,000 cfs at Chattahoochee, Florida. Historically, flows at the Chattahoochee gage have ranged from a low of 3,900 cfs (during the 1986 to 1987 drought) to a peak of 291,000 cfs in 1929 before many of the upstream flood control projects were built. More recently, flows have been as high as 203,000 cfs in July 1994 after Tropical Storm Alberto brought very heavy rains to Georgia.

Average annual flow at several gages in the Apalachicola River are summarized in *Table 4-4*. Similar to the pattern exhibited by the Chattahoochee and Flint Rivers, flows on the Apalachicola River hit their highest in spring and lowest in late summer. The large seasonal fluctuation in flow in the Apalachicola River is important to the ecological function of the river and its estuary (USGS, 1996).

TABLE 4-4
Historical Gage Data (in cfs) for the Apalachicola River[a]

Month	Gage No. 02358000 at Chattahoochee, FL	Gage No. 02358700 at Blountstown, FL	Gage No. 02359170 at Sumatra, FL
January	28,064	27,885	30,846
February	36,239	36,332	41,470
March	41,276	41,130	46,685
April	30,859	31,300	37,690
May	20,805	21,352	25,198
June	15,842	16,480	20,370
July	17,893	17,225	22,963
August	14,435	15,085	19,622
September	12,271	12,804	16,703
October	13,082	13,620	15,645
November	14,863	14,843	16,540
December	21,618	21,593	25,380

[a] USGS average annual flow data for water years 1976 through 1996 were used. This period represents the time after the final dam in the ACF basin was completed (West Point Dam, operational in 1975).

4.4.1.1.1.4 Navigation

Keeping the rivers clear for navigation was one of the first missions for the Corps of Engineers. Today's commercial barge lines still use rivers to move significant quantities of bulk materials by barge. *Figure 4-23* provides an overview of the authorized navigation projects in the ACF basin.

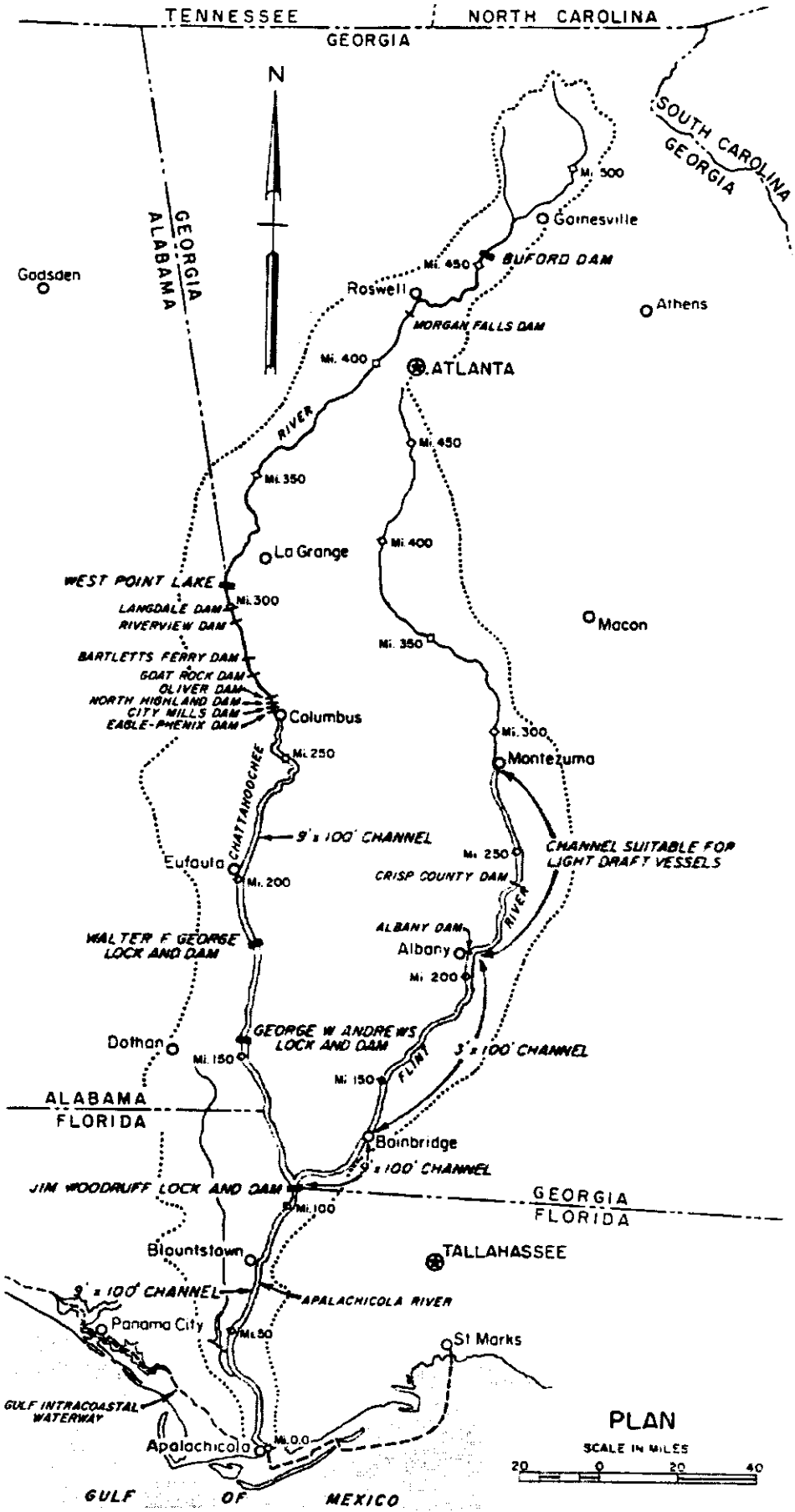
The Apalachicola River and the lower Chattahoochee and Flint Rivers provide a Federally maintained navigation channel for commercial barge traffic. Congress has authorized continuous navigation on the river, when sufficient water is available. Three locks and dams on the lower Chattahoochee River impound water to provide navigation depths in the lower reaches on the Chattahoochee River to Columbus, and on the lower Flint River to Bainbridge. Navigation depths are supported by a combination of dredging and flow augmentation on the Apalachicola River and lower Chattahoochee and Flint Rivers.

A 9-foot-deep by 100-foot-wide navigation depth is needed to provide the full authorized navigation channel on the Chattahoochee, Flint, and Apalachicola Rivers. The navigation channel extends from the Gulf Intracoastal Waterway up to Columbus, Georgia, on the Chattahoochee River and up to Bainbridge, Georgia, on the Flint River. The Corps determined the minimum flow required to provide the 9-foot-deep navigation channel during design of the project in the 1950s. Due to a combination of channel degradation and reduced dredging, the flow required to maintain the dredging reference profile has increased over the years, from a design value of 9,300 cfs to a current estimated minimum flow value of 11,000 cfs to 13,000 cfs after channel dredging is complete. Prior to completion of channel dredging, estimated flows of 13,000 to 16,000 cfs are required.

A minimum depth of 7.5 feet can provide only a limited amount of navigation. Navigation users indicated that a minimum 8-foot channel is necessary to support scheduling of shipments on the system. Under low flow conditions, even the 7.5-foot depth has not been available at all times. Over the period from 1976 to 1993, the 7.5-foot navigation channel was available 75 percent of the time and the 9-foot navigation channel was available only 55 percent of the time. To overcome the problems associated with insufficient water for navigation purposes, the Corps instituted a *navigation window* operation in 1990 to provide periods of navigation flows to allow some commercial traffic to travel through the lower Chattahoochee and Apalachicola Rivers during low flow periods (Corps, 1997).

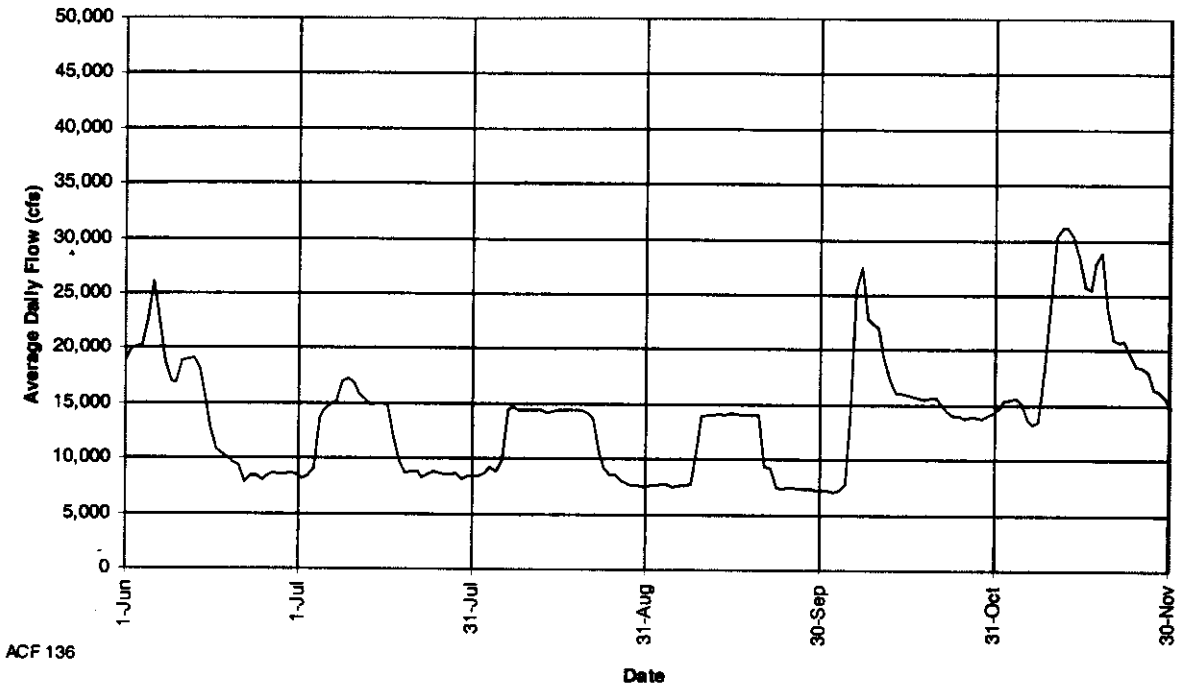
Allowing shipping to move into the system with some predictability, navigation windows are scheduled periods (approximately monthly) of higher flow releases during lower flow periods on the Apalachicola River. Navigation window schedules are announced in advance, allowing waterway users to plan shipments for delivery during a predictable navigation period. The navigation window season is typically from June through November. The navigation window period actually consists of two parts: a pre-window period and the navigation window period. During the pre-window period, flow in the river is reduced and water is stored in the upstream reservoirs. The average length of the pre-navigation window period is about 14 to 21 days, and the average daily flow is 8,100 cfs on the Apalachicola River at Chattahoochee, Florida. The average length of the navigation window is about 14 days with an average daily flow of 14,700 cfs at Chattahoochee, Florida. The navigation window usually provides an 8-foot channel. Usually, a 1- to 3-day transition period occurs between the pre-window and navigation window periods (CH2M HILL, 1998a). *Figure 4-24* shows a hydrograph depicting a typical navigation window period.

FIGURE 4-23
Navigation Projects in the ACF Basin



ATL\Scarlett\Graphics\144282.AO.PP\7-21-98\ACF\ACF118

FIGURE 4-24
Navigation Window Period – 1995 Apalachicola River at Chattahoochee, Florida (ACF Basin)



ACF 136

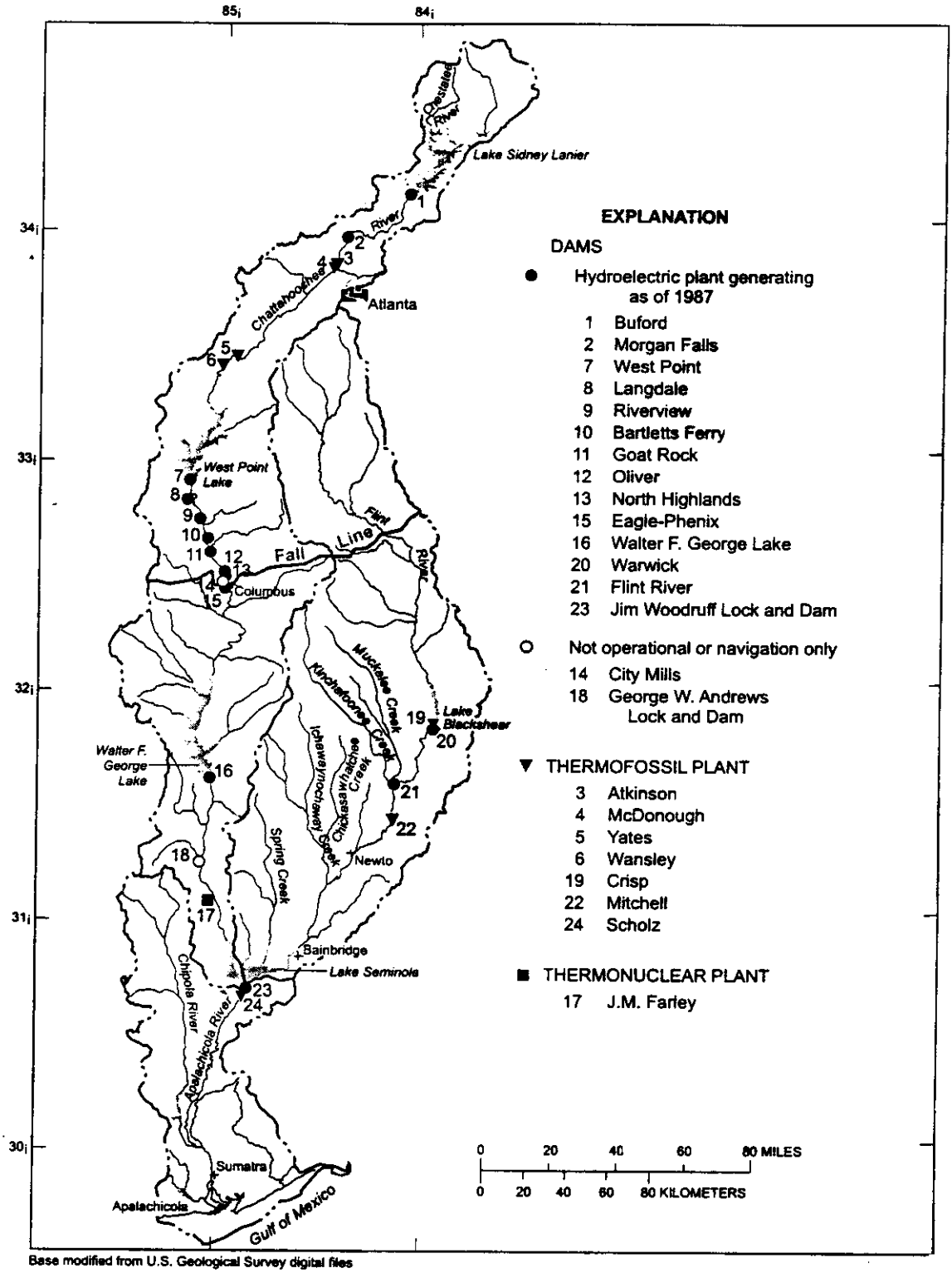
4.4.1.1.2 Reservoirs

There are 16 reservoirs located on the mainstems of the Apalachicola, Chattahoochee, and Flint Rivers: 5 are Federally owned by the Corps and 11 are privately owned projects. Of the 16 reservoirs, 13 are on the Chattahoochee River, 2 are on the Flint River, and 1 is on the Apalachicola River. The 16 projects and their key characteristics are listed in *Table 4-5*. Additional information on each reservoir is provide din more detail in *Appendix D*. *Figure 4-25* shows the location of mainstem dams and power-generating plants in the basin. *Table 4-6* lists other existing or planned impoundments that are in the ACF basin but are not on mainstem rivers.

The history of dam construction on the Chattahoochee River dates back to the early 1800s. Projects above Columbus, Georgia, were built to take advantage of the natural stream gradients for power production. Later projects were built for other purposes, such as flood control and navigation. The last dam (West Point) was completed in 1975.

As indicated in *Table 4-5*, most of the dams in the ACF basin have hydropower generating capability. Hydropower dams convert the force of falling water into electrical power. Although no longer the primary source of energy in the U.S., hydropower is still a very important source of electricity because it can be started quickly to provide immediate needs.

FIGURE 4-25
Location of Mainstem Dams and Power-Generating Plants in the ACF Basin
Source: Fanning, et al., 1991



Base modified from U.S. Geological Survey digital files

TABLE 4-5
Existing Mainstem Dams/Reservoirs in the ACF Basin

Basin/River/ Project Name	Owner/ Year Completed	Drainage Area (mi^2)	Reservoir Size (ac)	Total Reservoir Storage (ac-ft)	Conservation Storage[c] (ac-ft)	Total Overload Capacity[d] (kW)	Normal (Summer) Lake Elevation (ft)
			Chattahoochee River Basin				
Chattahoochee River		8,770					
Buford Dam/Lake Lanier	Corps/1957	1,040	38,542	1,957,000	1,087,600	100,000[d]	1,071
Morgan Falls Dam/Bulls Sluice Lake[a]	GPC/1903	1,340	580	2,250	1,960	16,800[e]	866
West Point Dam	Corps/1975	3,440	25,900	604,500	306,100	82,200	635
Langdale Dam[a]	GPC/1860	3,600	152	NA	NA	1[e]	548
Riverview Dam[a]	GPC/1902	3,600	75	NA	NA	480[e]	531
Bartletts Ferry Dam/Lake Harding[a]	GPC/1926	4,260	5,850	182,500	62,000	192,000[e]	521
Goat Rock Dam and Lake[a]	GPC/1912	4,500	1,050	11,000	4,950	26,000[d]	404
Oliver Dam and Lake[a]	GPC/1959	4,630	2,150	32,000	6,500	60,000[d]	337
North Highlands Dam[a]	GPC/1900	4,630	131	1,500'	430	36,000[d]	269
City Mills[b]	City Mills/ 1963	4,630	110	684	NA	740	226
Eagle and Phenix Dam[b]	Consolidated Hydro/1834	4,640	NA	260	NA	4,260	215
Walter F. George Lock and Dam and Lake	Corps/1963	7,460	45,180	934,400	244,400	160,000[d]	190
George W. Andrews Lock and Dam and Lake[a]	Corps/1963	8,210	1,540	18,180	8,200	None	102
			Flint River Basin				
Flint River		8,460					
Blackshear Dam and Lake[a]	Crisp Co./1930	3,500	8,700	144,000	NA	13,000[e]	237
Flint River Dam/Lake Worth[a]	GPC/1920	5,310	1,400	114	NA	5,400[e]	182
			Apalachicola River Basin				
Apalachicola River		19,600					
Jim Woodruff Lock and Dam/Lake Seminole[a]	Corps/1954	17,230	37,500	367,320	69,692	36,000[d]	77

[a] Run-of-river
[b] Currently inoperative
[c] Top of conservation pool (maximum) – top of inactive pool
[d] Overload capacity: represents maximum power generation capacity of units
[e] These values are nameplate capacity, or full-load continuous rating of generators

ac	acres	GPC	Georgia Power Company
ac-ft	acre feet	kW	kilowatts
Crisp Co.	Crisp County, Georgia	mi^2	square miles
ft	feet	NA	Not available/not applicable

TABLE 4-6
Planned or Existing Reservoirs in the ACF Basin

County	Stream	Name (if other than stream)	Project Status
Banks	Hudson River Tributary		
Carroll	Snake Creek		Not built
Cherokee	Yellow Creek		Completed
Clayton	Shoal Creek at Flint River	J.W. Smith	Completed
Clayton	Shoal Creek at Flint River	Shoal Creek	Under construction
Clayton	Little Cotton Indian Creek	Wm. J. Hopper	Completed
Clayton	Pates Creek	Edgar Blalock, Jr.	Completed
Dekalb	Chattahoochee River (two off stream)	Unnamed	Completed
Dekalb	Chattahoochee River (one off stream) Unnamed	Unnamed	Under construction
Douglas	Dog River		
Douglas	Bear Creek		
Fayette		Lake Kedron	Completed
Fayette		Lake Peachtree	Completed
Fayette	Horton Creek		Completed
Fayette	Line Creek	Lake McIntosh	Proposed
Fulton (Palmetto)	Cedar Creek		Completed
Fulton (Palmetto, Fairburn, Union City)	Unnamed Reservoir		Planned
Habersham	Nancy Town Creek		Completed
Habersham	Nancy Town Creek		
Hall	Cedar Creek		Under design
Henry	Lower Towaliga River	Steel's Mill	Completed
Henry	Indian Creek	S. Howell Gardner	
Henry	Walnut Creek	John Fargasson	Completed
Henry	Towaliga River	Long Branch	Completed
Henry	Upper Towaliga River	Edward Cole	Under construction
Henry	Tussahaw Creek		Planned
Henry	Unknown	Unnamed	Planned
Jackson	Bear Creek		
Lumpkin	Yahoola Creek		
Lumpkin	Jones Creek		
Spalding	Still Branch		

Much of the hydropower generation in the basin is *peaking* power. The generators are turned on when there is the most, or *peak*, demand for power. Air-conditioning and heating are the power uses that often cause the peak demand for power so the hydropower releases are usually made when temperatures are extreme. Peaking hydropower projects typically generate power during the peak electrical demand hours (generally for 2 to 8 hours per day) on the weekdays and then do not generate on the weekends. The amount of minimum generation per day is determined by a pre-set rule curve for each reservoir, with diminishing energy generation with declining storage. In contrast, run-of-river hydropower projects, in the ACF basin typically generate power by passing the available flows from upstream peaking projects. However, run-of-river projects do normally operate for a portion of the day, thus significantly influencing daily flows in the tailrace and downstream water courses. Unlike storage projects, run-of-river hydropower facilities do not follow a rule curve, nor do they fluctuate or redistribute flows..

This paragraph describes in very simplified terms the general process by which reservoir release decisions are made. For HEC-5 modeling purposes, each reservoir is typically subdivided into separate storage levels, as shown in ***Figure 4-26.*** The lowest level is the top of the inactive pool. No reservoir releases are made when the pool level is below this level. Level 2 is usually associated with the top of the conservation pool. The conservation pool can be subdivided into multiple action zones, as illustrated in ***Figure 4-27*** (see ***Appendix D*** for more information on storage levels for all reservoirs in the basin). Each action zone triggers a different operating schedule. Level 3 is the top of the flood control pool. Typically, the area between the top of conservation and flood control is active flood storage. Water is stored in this area when it cannot be safely passed through the downstream channel system. Usually, the top of the flood control level is not the maximum level. Typically, a reservoir has surcharge storage to accommodate water above the emergency spillway. In surcharge storage, the outflow is determined by the spillway capacity and cannot be controlled by the operators.

The majority of storage in the ACF basin is contained in two reservoirs: Lake Sidney Lanier and Walter F. George Lake. Lake Seminole and West Point Lake also add substantial storage to the basin (see ***Figure 4-28***). Of the 16 mainstem reservoirs in the ACF basin, 5 reservoirs are very small (less than 500 acres of surface area), and the impoundments are unnamed. The other 11 reservoirs are larger and contribute more in terms of environmental resources and water management (GDNR, 1996). These 11 reservoirs are discussed individually below. The reservoirs in the ACF basin do not maintain high levels of reserve storage. It has been reported that all major reservoirs in the ACF basin provide only a few months of available stream flow (Rose, 1998). For example, the ACF reservoirs can provide approximately 38 days of flow at Blountstown based on the mean annual flow, and approximately 74 days based on the mean September flow, the lowest average flow month.

FIGURE 4-26
Schematic of Reservoir Storage (ACF Basin)
Source: ***Appendix D***

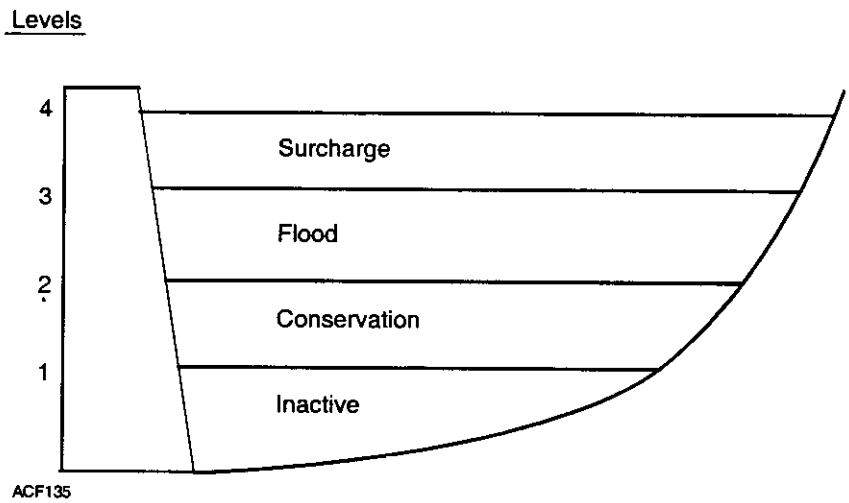


FIGURE 4-27
Lake Lanier Action Zones Within the Conservation Pool (ACF Basin)

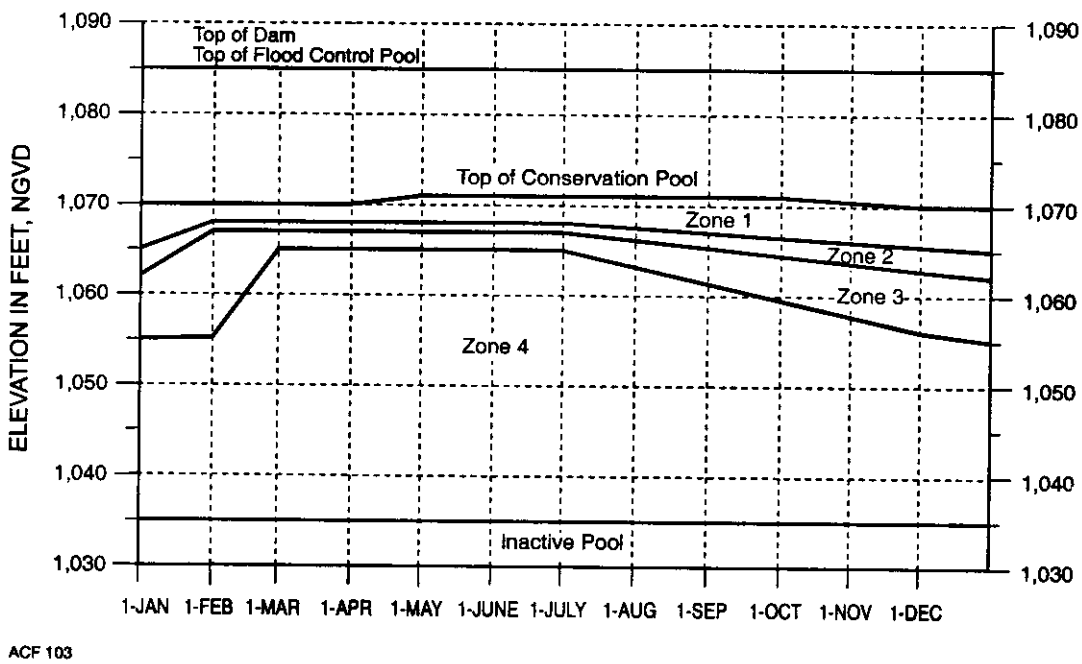
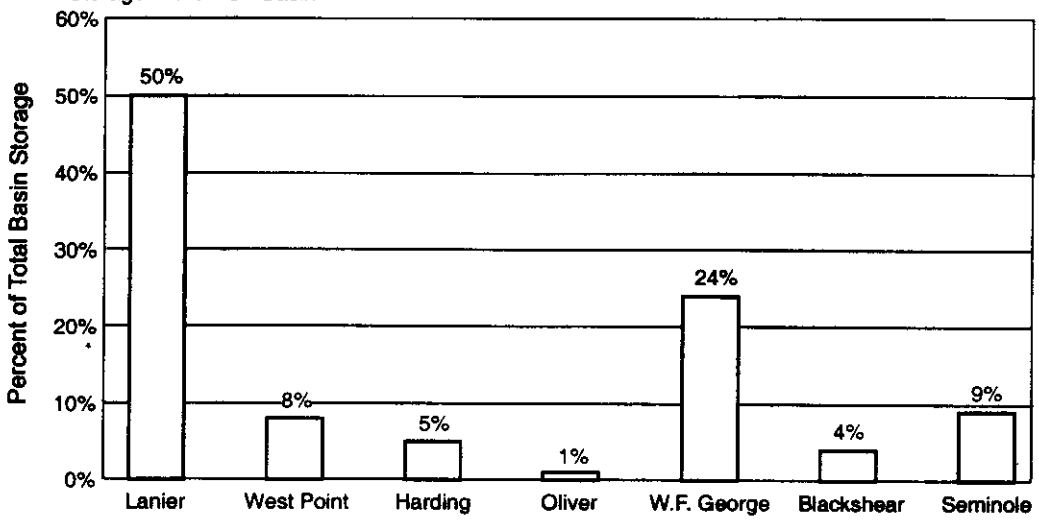


FIGURE 4-28
Water Storage in the ACF Basin



ACF102

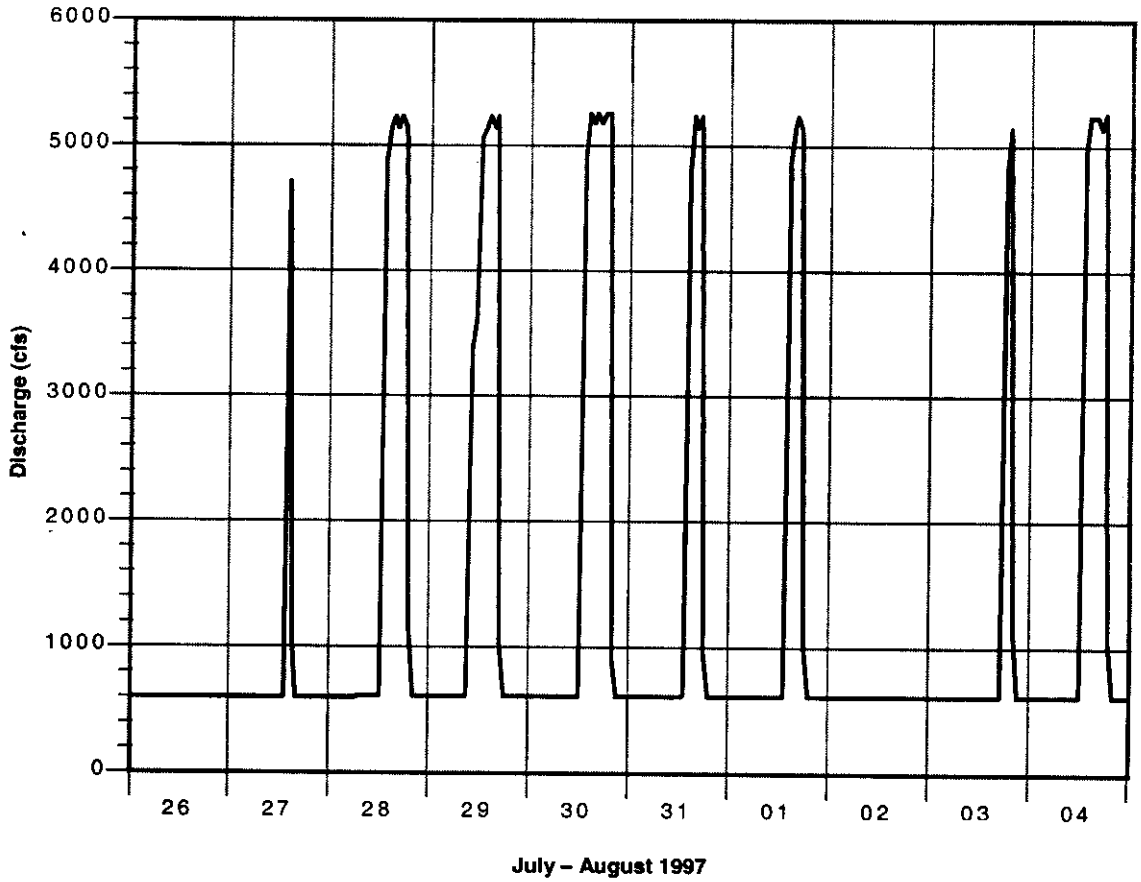
Reservoirs with less than 1% are not shown

4.4.1.1.2.1 Lake Sidney Lanier

Lake Lanier is formed by Buford Dam, which is located about 48 miles northeast of Atlanta on the Chattahoochee River. Lake Lanier is a multi-purpose water resource project constructed and operated by the Corps. The project provides hydroelectric power, flood control, water supply, water quality, navigation, and recreation benefits. The lake is a primary water supply source and discharge location for several municipalities, including the cities of Cumming and Gainesville, and Gwinnett County. Lake Lanier has a surface area of 38,500 acres. The reservoir has a maximum pool elevation of 1,085 feet, which represents the top of the flood control pool. Flood storage is maintained between elevation 1,085 and 1,070 feet in the winter and 1,071 feet in the summer. The 1,070- to 1,071-foot elevation represents the top of the conservation pool. The minimum conservation pool elevation (and minimum operating level) is 1,035 feet. The hydropower project is typically operated for peaking power on a 5-day-a-week schedule, with Saturday and Sunday off. The number of hours of generation per day depends on the available storage, conditions in the basin, and electrical demand. ***Figure 4-29*** shows a typical weekly pattern of flows downstream from the dam. ***Appendix D*** contains this information for other reservoirs in the basin.

A minimum flow of 600 cfs is provided constantly through a hydroelectric service unit. The penstock capacity is 12,000 cfs. The total nameplate capacity of the hydropower project is 86 megawatts (MW), and overload capacity is 100 MW (***Appendix D***). Lake Lanier waters are designated as "Recreation" in GDNR's water quality classification system. It has the highest annual recreational visitation of all the Corps lakes in the ACF basin, and its shoreline is highly developed. The project operates to maintain a minimum flow of 750 cfs at Atlanta.

FIGURE 4-29
Typical Daily Variation in Buford Dam Discharge



ACF 138

4.4.1.1.2.2 Bull Sluice Lake

The Chattahoochee River flows for approximately 30 miles below Buford Dam, dropping about 50 feet to the pool of the Morgan Falls Dam, known as Bull Sluice Lake. The Morgan Falls Dam is operated by Georgia Power Company for hydroelectric power and water quality purposes. The reservoir has a surface area of 580 acres. The normal lake elevation (and the top of the conservation pool) is 866 feet. The top of the dam is 868 feet. The 16.8-MW hydroelectric project is operated in a run-of-river mode and has little usable storage capacity. The Morgan Falls Dam was constructed in 1904 and since then has experienced a significant amount of sediment deposition. This has created broad and shallow pools and wetlands, which are attractive for recreation and fishing in the lake. The lake has low flow velocities, moderate algal productivity, and dispersed aquatic vegetation.

4.4.1.1.2.3 West Point Lake

The Chattahoochee River is free-flowing for over 120 miles from the Morgan Falls Dam to the upper part of West Point Lake. West Point Lake is a 25,900-acre reservoir on the Alabama-Georgia State line impounded by the West Point Dam. The dam is operated and maintained by the Corps. The Corps designed the reservoir for flood control, navigation, power generation, recreation, fishing, and wildlife habitat. In addition, the City of LaGrange uses the lake as a water supply source and discharge location. The reservoir has a target summer water surface elevation of 635 feet. The top of the flood control pool is elevation 641 feet. During the critical flood season, the Corps operates the reservoir with a maximum conservation pool of 625 feet to provide flood storage between elevations 625 and 635 feet. The top of the power pool is 636 feet in the summer and 628 feet in the winter. The bottom of the power pool and the conservation pool is 620 feet. Hydropower generating nameplate capacity at the dam is 73 MW. This is a peaking facility that typically operates 5 days a week, with Saturday and Sunday off. The number of hours of generation per day depends on the available storage, conditions in the basin, and electrical demand. A constant flow of 650 cfs is released through a hydropower service unit. The penstock capacity is 18,100 cfs.

4.4.1.1.2.4 Lake Harding

Below West Point Dam are a series of eight hydropower dams along approximately 32 miles of river. The first two dams, Langdale Dam and Riverview Dam, have very small reservoirs that are unnamed. The third hydropower dam below West Point Lake is Bartletts Ferry Dam, which impounds Lake Harding. All three dams are operated by Georgia Power Company as run-of-river hydropower facilities. Lake Harding is also used for water supply. Lake Harding is located about 7 miles northwest of Columbus, Georgia, on the Alabama-Georgia State line. The top of the conservation pool is at elevation 521 feet. The bottom of the conservation pool is 510 feet. The reservoir has a surface area of 5,850 acres at 521 feet elevation. The mean depth in the reservoir is 31 feet, and the maximum depth is 111 feet. The Bartletts Ferry dam has a generating capacity of 130 MW. The project operates to maintain a minimum flow of 1,160 at Columbus.

4.4.1.1.2.5 Goat Rock Dam

The Goat Rock Dam impounds a small lake (1,000 acres of surface area) called Goat Rock Lake, which is directly downstream of the Bartletts Ferry Dam and about 10 miles above Columbus, Georgia. Georgia Power Company operates this lake primarily for hydropower generation. The generating capacity of the project is 68 MW. The project was designed for hydropower peaking generation, with swimming, boating, and fishing as secondary benefits. The reservoir has a top of conservation pool elevation and a top of dam elevation of 405 feet. The bottom conservation pool has an elevation of 404 feet. This project is a run-of-river facility with limited storage capacity. It generally passes all inflow directly downstream.

4.4.1.1.2.6 Lake Oliver

Lake Oliver is another Georgia Power Company hydropower impoundment on the Chattahoochee River. Georgia Power Company operates this project in a run-of-river mode. The reservoir serves as the main water supply for the City of Columbus. The reservoir has a mean summer pool elevation of 337 feet (which is also the top of the conservation pool and the top of the dam) and a surface area of 2,150 acres. The bottom of the conservation pool is 335 feet. The hydropower generating capacity at this facility is 60 MW. This project is a run-

of-river facility with limited storage capacity. It generally passes all inflow directly downstream.

There are three small run-of-river dams at Columbus, Georgia, downstream of the Oliver Dam: the North Highlands Dam operated by Georgia Power Company, the City Mills Dam operated by City Mills, and the Eagle-Phenix Dam operated by Eagle and Phenix Mill. All three dams have small reservoirs (less than 250 acres). City Mills Dam and Eagle-Phenix Dam are currently inoperative.

4.4.1.1.2.7 Walter F. George Lake

The Chattahoochee River flows from the Eagle-Phenix Dam into the head of the lake formed by the Walter F. George Lock and Dam. The Walter F. George reservoir is the largest in the ACF basin, with a surface area of over 45,000 acres. This is a Corps facility that provides for hydroelectric power, navigation, fish and wildlife conservation, water quality, public recreation, and limited flood control benefits. The reservoir was completely filled in 1962. The reservoir has a target summer pool elevation of 190 feet and a mean depth of 20.3 feet. The top of the conservation pool is set at 188 feet during the winter and early spring months. The bottom of the conservation pool is at 184 feet. The Corps operates this as a peaking facility with a normal 5-day operation, but with the potential for weekend operation to coincide with customer schedules. The number of hours of generation per day depends on the available storage, system hydropower and navigation flow requirements, and other factors. The top of the power pool is 190 feet in the summer (May to September) and 188 feet in the winter (October to April). The bottom of the power pool is equal to the bottom of the conservation pool (i.e., 184 feet). Walter F. George Dam has historically had problems with lake water seeping beneath the structures. In 1982, a flow of about 30,000 gpm developed before the source was located and plugged. In 1992, another seepage occurred, with lake water entering the limestone foundation immediately upstream of the gated spillway and powerhouse, flowing beneath the concrete, and exiting back into the river near the downstream edge of the structures. This seepage increased in volume from about 250 gpm in 1993 to over 4,000 gpm in 1996. Two locations in which water was entering the limestone were discovered on the lake bottom in late 1996, and were subsequently plugged with concrete. Flow from the relief wells at the downstream of the structures is now about 150 gpm, an amount that is considered normal. To eliminate future problems with seepage, however, a concrete cutoff wall has been proposed for installation along the upstream toe of the powerhouse and spillway. The nameplate capacity of the project is 130 MW, but overload capacity is 160 MW.

4.4.1.1.2.8 Lake George A. Andrews

Lake Andrews is a small lake (surface area of 1,540 acres) created by the George W. Andrews Lock and Dam on the Chattahoochee River near Columbia, Alabama. The primary purpose of this Corps project is navigation. There is no hydropower production at this facility. The reservoir is typically operated at an elevation of 102 feet. The 28.3-mile-long lake has a 9-foot-deep by 100-foot-wide navigation channel extending over its entire length. Recreation facilities are also available at the project. Due to its long, narrow length, the reservoir acts more like a large river than a lake (Ashby et al., 1996).

4.4.1.1.2.9 Lake Blackshear

Lake Blackshear is the most upstream of two reservoirs on the Flint River. The Warwick Dam, which impounds the Flint River to create Lake Blackshear, is operated by Crisp County, Georgia, for hydropower production. The Crisp County steam plant is a major user

of water from lake Blackshear and also returns the thermal discharge back to the lake. The project is licensed to operate in a run-of-river mode. It has a generating capacity of 13 MW. The normal lake elevation is 237 feet.

4.4.1.1.2.10 Lake Worth

Georgia Power Company operates the Flint River Dam, which impounds a small run-of-river reservoir named Lake Worth. The facility has an installed capacity of 5.4 MW. The project was constructed in 1920 for hydropower production purposes. The reservoir has a surface area of 1,400 acres at the normal elevation of 182 feet.

4.4.1.1.2.11 Lake Seminole

Lake Seminole, impounded by the Jim Woodruff Lock and Dam at the confluence of the Chattahoochee and Flint Rivers, is the furthest downstream reservoir in the system. Lake Seminole is a Corps facility that was built for hydropower (run-of-river) and navigation purposes. Other project purposes include fish and wildlife conservation and public recreation. The project also provides for regulation of streamflow. Construction was completed in 1957. From the dam, the reservoir extends 47 river miles up the Chattahoochee River and 28 miles up the Flint River. The normal summer pool elevation is 77 feet. The water level typically fluctuates 1 to 2 feet. Seepage through the trash gates is approximately 200 cfs. There is no flood control storage available at this project. Lake Seminole has a surface area of 37,500 acres. The Corps maintains a 9-foot-deep, 100-foot-wide navigation channel extending commercial river transportation from the Gulf Coast through Lake Seminole upstream to Columbus on the Chattahoochee River and to Bainbridge on the Flint River. Installed capacity at the project is 30 MW, but overload capacity is 36 MW.

Due to the limestone formations in and around Lake Seminole, there is the potential for development of sinkholes. Water losses from the lake could be occurring through sinkholes. However, the extent of water losses through sinkholes has not been verified.

4.4.1.1.2.12 Potential Future Lakes

Future reservoir projects have been considered for the ACF basin to meet expanding or projected needs in the region for additional water supply and recreation (see ***Table 4-6***). These projects may be dependent upon future decisions that affect water allocation for the ACF basin. Individual tiered environmental assessments (EAs) and/or EISs for these specific projects that are outside the consideration of this programmatic EIS will be completed for these specific projects as they reach the appropriate stage of planning.

4.4.1.1.3 Groundwater

The major aquifers in the ACF basin include the surficial aquifer system, the Upper Floridan aquifer system, the Claiborne aquifer, the Clayton aquifer, the Providence aquifer, and the crystalline-rock aquifer. Groundwater in the ACF basin generally flows from northwest to southeast, with some variation in local flow. Near major stream channels, and in areas of major water withdrawals, the flow is vertically upward and downward, but is mainly perpendicular to the stream channel, which demonstrates good hydraulic connection between groundwater and surface water. Rivers and streams in the southern half of the basin are deeply incised into the underlying aquifers and can receive substantial amounts of groundwater. For example, the Upper Floridan aquifer is hydraulically connected to the Flint River and, consequently, groundwater discharge contributes more significantly to baseflow in the Flint River than in the Chattahoochee River. Groundwater

discharge to the Chattahoochee River is roughly 20 percent of the amount that is discharged to the Flint River (USGS, 1996).

The groundwater system underlying the ACT and ACF basins was delineated in the Comprehensive Study. Eight subareas were delineated; subareas 1, 2, 3, and 4 underlie the ACF basin (see ***Figure 4-5***). In subareas 1 and 2, which are located within the Blue Ridge and Piedmont provinces, the primary aquifer is the crystalline-rock aquifer, which is commonly overlain by the surficial (porous-media) aquifer. The crystalline rock aquifer may yield quantities of water suitable for public or industrial supply. However, groundwater yields may not support major municipal water needs in the Georgia Piedmont region of the ACF basin. Yields from wells completed in the fractured crystalline aquifer are highly variable. A high-yielding well produces 100 gallons per minute (gpm) or greater, and yields of as much as 550 gpm have been reported. Typical well yields, however, are generally between 1 and 25 gallons per minute. In the Blue Ridge and Piedmont provinces, groundwater storage is primarily in the overlying weathered bedrock (regolith or saprolite) that forms the porous media aquifer. The volume of water in storage in the regolith is controlled by porosity and thickness. To a lesser degree, the volume of water in storage in the crystalline-rock aquifer is controlled by the degree of fracturing.

In subareas 3 and 4, which are primarily located within the Coastal Plain province, the complexly interbedded strata contain numerous aquifers and confining units (see Section 4.3.1). In subarea 3, the uppermost aquifer is the Claiborne aquifer system. The Floridan aquifer is thin and not considered a major aquifer in subarea 3; however, further south in subarea 4 it does become a major aquifer. In subarea 4, the Floridan is overlain by semiconfining units.

The Upper Floridan aquifer has the ability to store and transmit large quantities of water. It is a highly transmissive aquifer. Computed values of transmissivity from field tests in the Upper Floridan aquifer generally range from about 2,000 to 1,300,000 square feet per day (ft^2/d). The wide variations in the transmissive ability of the aquifer are caused by variability in the size and distribution of solution openings. Effective regional values of transmissivity usually range from about 2,000 to 300,000 ft^2/d. Transmissivity is lowest where the aquifer is relatively thin and increases to the south (where the aquifer thickens) and adjacent to major streams where flowing water has accelerated the development of solution openings.

The Intermediate aquifer system in northwest Florida is affected by seasonal variations in recharge from precipitation and by seasonal changes in river stage, depending on the proximity to the Apalachicola River. In the Intermediate aquifer system, water levels tend to decline toward the Apalachicola River, and the river tends to regulate groundwater levels in its proximity. Water levels in the Imtermediate aquifer system are also affected seasonally by the water level fluctuations in the overlying semiconfining unit. Due to its low permeability, the Intermediate aquifer system is not a primary source of water supply. Groundwater levels in the Floridan aquifer also fluctuate seasonally in response to precipitation, evapotranspiration, and pumping (Torak and McDowell, 1996).

As part of the Comprehensive Study, groundwater modeling was conducted in subarea 4 by the USGS to investigate the long-term, or steady-state, effects of groundwater pumping on streamflow (Torak and McDowell, 1996). A major assumption built into the model runs was that groundwater withdrawal from the Upper Floridan aquifer was steady and continuous, and would allow steady-state conditions to be established in the stream-

reservoir-aquifer flow system. Results of this modeling suggested that, under these conditions for subarea 4, the effect of pumping 1 gallon of groundwater from the Upper Floridan aquifer would be about a 0.6-gallon reduction in the groundwater contribution to streamflow. That is, reductions in streamflow in subarea 4 caused by groundwater withdrawal occur in a 0.6-to-1 ratio of the amount of groundwater pumped under steady-state conditions. However, it should be noted that the model assumed that groundwater withdrawals occurred under conditions in which steady-state had been reached in the flow system, and steady-state conditions could only be established after the aquifer had been given an adequate amount of time to fully respond to the long-term effects of continuous groundwater withdrawal at a constant rate. In areas of the basin north of the Fall Line, the ratio was 1 to 1; i.e., for every 1 gallon of groundwater withdrawal, there was a 1 gallon reduction in river flow. In the Coastal Plain (the area below the Fall Line and north of the extent of the Upper Floridan aquifer), the ratio was found to be 0 to 1, i.e., groundwater withdrawal had no effect on surface water flows (Corps, 1997).

In reality, the effects of groundwater withdrawal on surface water are transient, i.e., neither steady nor continuous, because groundwater is not pumped at a continuous rate long enough to allow the system to fully respond. Other transient effects on the flow system are caused by changes in hydrologic boundaries with time, such as lateral and vertical flows into and out of the basin by recharge, vertical leakage, and regional flow. Therefore, because groundwater withdrawals fluctuate based on time of day, seasonal variations, weather conditions (e.g., drought) and a wide variety of economic factors, the stream-reservoir-aquifer water system never actually reaches the steady-state conditions necessary to create the 0.6-to-1 effect from groundwater pumping on streamflow. This is further confirmed by the actual hydrologic effects that have been observed historically. Aquifer response to groundwater withdrawal is not instantaneous. Instead, aquifer response lags in time behind changes to the pumping rate due to hydraulic storage properties in the aquifer and semiconfining units of the affected flow system. Major water-bearing units in the lower ACF basin do not exhibit long-term declines in water levels during drought conditions. During droughts of the early and late 1960s, 1980 to 1981, and 1986 to 1988, water levels declined to record or near-record levels, but recovered to pre-drought conditions with the return of normal precipitation (Torak and McDowell, 1996).

Surface water features have variable effects on groundwater levels in the lower ACF basin. Despite the potential for hydraulic connection between the Upper Floridan aquifer and Flint River, sudden changes in river stage for short durations do not necessarily cause corresponding water level changes in the aquifers. However, surface water impounded behind dams does locally affect groundwater levels. For example, at Lake Seminole, the pool elevation is maintained at an elevation of about 77 feet on a year-round basis, which causes the water levels nearby in the adjacent aquifer and overlying semiconfining unit to be nearly constant. However, it should be noted that groundwater levels in the Upper Floridan aquifer near Lake Worth are influenced by regional flow from the north.

Downstream from Lake Seminole, the stage of the Apalachicola River influences groundwater levels in the floodplain, which can act locally as an independent, discontinuous hydrologic unit, as described by Leitman et al. (1984). Observation wells across the flood plain near Blountstown and Sumatra, Florida, indicate that groundwater levels depend on the river stage; however, water level fluctuations in the river are dampened in the flood plain by movement of water through the flood plain soils.

USGS has proposed detailed studies of the interaction of surface and subsurface waters between Lake Seminole and remaining components of the Upper Floridan aquifer system, specifically to quantify vertical leakage that occurs into and out of the Upper Floridan aquifer and across the lake bottom; surface water inflows and outflows; groundwater flows that bypass the Jim Woodruff Dam and enter the Apalachicola River downstream; and the potential for sinkhole collapse in Lake Seminole (Torak, 1998). Personal communication with Joanne Brandt, Corps).

4.4.1.1.4 Water Supply Withdrawals

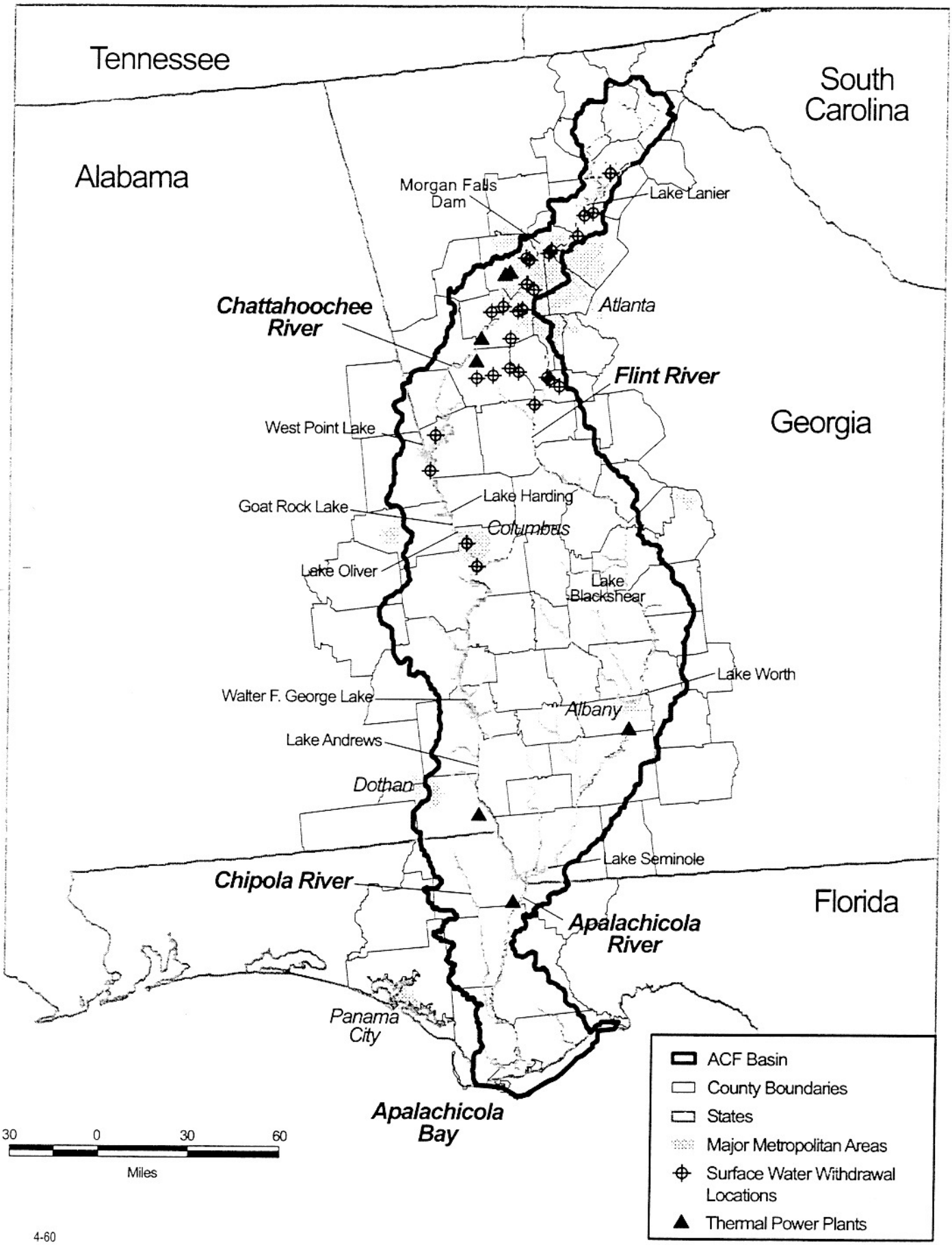
Fresh water is withdrawn from both surface water and groundwater sources in the ACF basin for water supply purposes. *Figure 4-30* shows the surface water withdrawals from municipalities in the ACF basin serving populations of more than 10,000 and from major thermal power plants. Surface water and groundwater withdrawals affect water quantity and project operations in the ACF basin. For example, Buford Dam and Morgan Falls Dam are operated interactively to ensure that the City of Atlanta has sufficient water to meet its current demand. In addition, project operations during drought periods must take water demands into consideration in providing minimum flows or reservoir levels.

Public water supply (for municipal and industrial uses) accounts for 24 percent of the total basin water withdrawals (both groundwater and surface water). Thermoelectric power generation accounts for 60 percent of total withdrawals. Commercial use accounts for 12 percent of the total water withdrawals, and agricultural water use accounts for 4 percent (see *Figure 4-31*). Nearly 87 percent of the basin's population in 1990 relied on public water supplies for drinking water. Groundwater provides 18 percent of public water supplies but 70 percent of agricultural supplies (USGS, 1996). About 80 percent of the withdrawn water was eventually returned to the surface or groundwater system. Of the water used for various water supplies, 86 percent came from surface water sources and 14 percent came from groundwater sources in 1990 (USGS, 1996).

Water withdrawals have increased substantially since 1970. From 1970 to 1990, surface water withdrawals (including thermoelectric, public water supply, and agricultural) increased by 29 percent, and groundwater withdrawals increased by 240 percent.

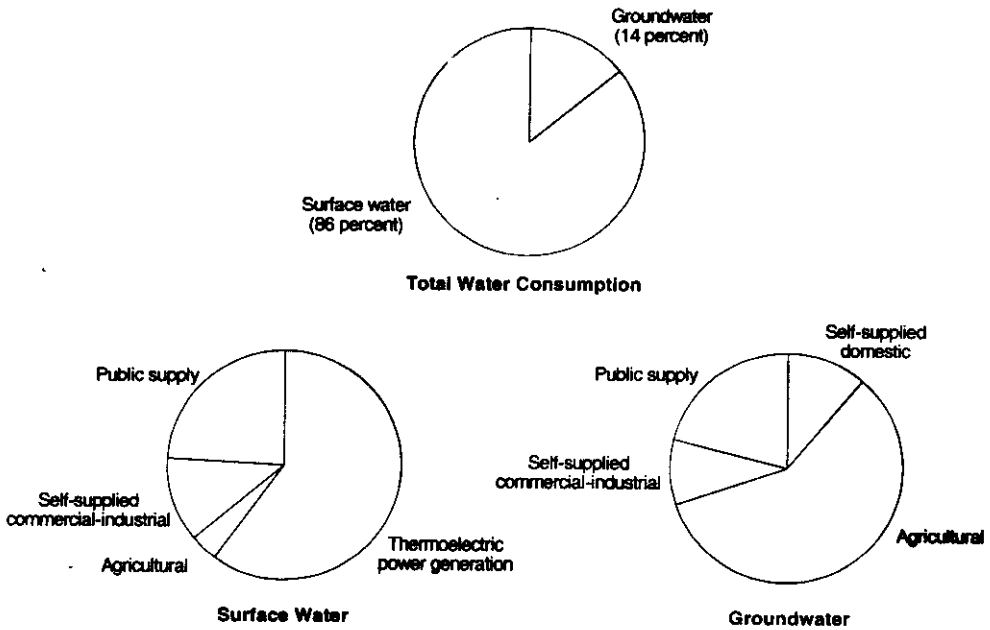
Interbasin transfers result when water is withdrawn from one basin and eventually discharged to another basin. Interbasin transfers of surface water were investigated as part of the Comprehensive Study and are summarized in *Figure 4-32*. These investigations focused on surface water interbasin transfers and did not address groundwater and surface water relationships. For example, the Upper Floridan aquifer provides significant inflow to the ACF basin from "other" basins (Torak and McDowell, 1996). For the ACF, transfers of surface water out of the basin included 9 million gallons per day (mgd) to the ACT basin and 78 mgd out of the study area. (Water withdrawals, discharges, and transfers are typically quantified in mgd. Streamflows and reservoir releases are typically quantified in cubic feet per second [cfs]. Conversion factor is 155 cfs = 1 mgd). Transfers into the ACF basin included 43 mgd from the ACT basin and 20 mgd from outside the study area. This produced a net transfer of 24 mgd out of the ACF basin (PMCL, 1996).

FIGURE 4-30
Surface Water Withdrawals from Thermal Power Plants and Municipalities
Serving Populations of Greater than 10,000 (ACF Basin)



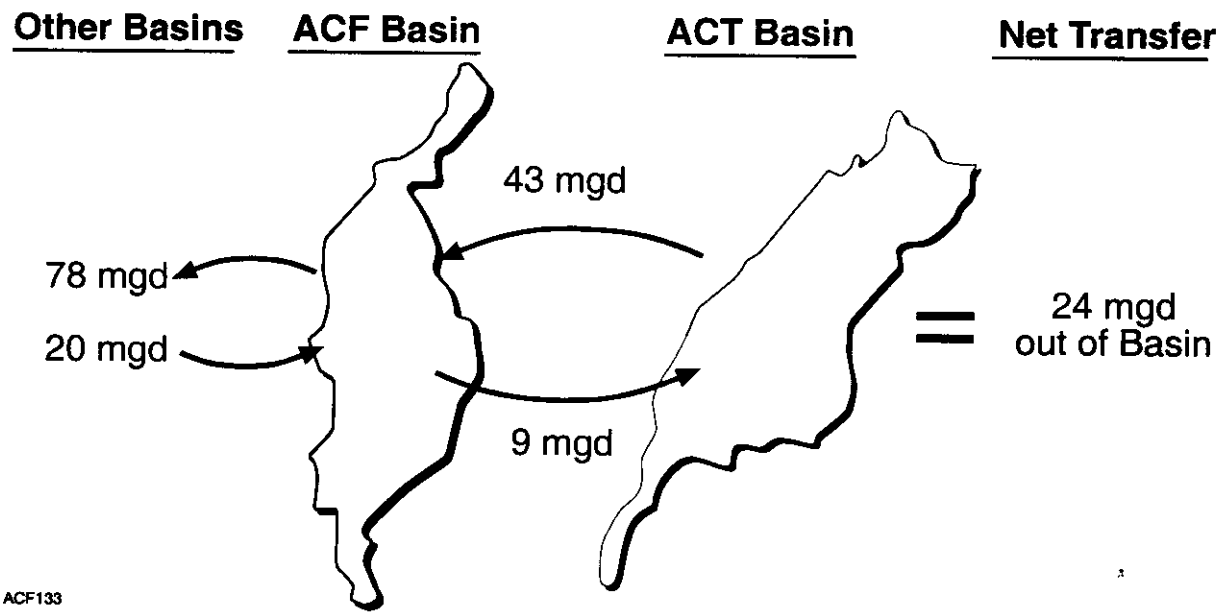
ATL\Scarlett\Graphics\144282.AO.PP\7-21-98\ACF\ACF120

FIGURE 4-31
Ground and Surface Water Withdrawals by Principal Water Use Categories in the ACF Basin, 1990
Data from Marella, et al., 1993



ACF134

FIGURE 4-32
ACF Interbasin Transfer Schematic



ACF133

4.4.1.1.4.1 Municipal and Industrial Demands

Municipal and industrial water demand includes all water uses, both publicly supplied and self-supplied, including residential, commercial, governmental/institutional, industrial, manufacturing, and other demands such as unaccounted for water use (e.g., system losses and firefighting). In water resource management, a portion of municipal and industrial uses are considered consumptive uses because at least some portion of municipal and industrial water demand is permanently removed from the system.

The water demands presented in this section are from Scenario 1 of the Planning and Management Consultants, Limited (PMCL) study (1996) completed for the Comprehensive Study. This scenario develops water use projections based on current water use patterns, but does not include additional water conservation (for the purpose of reducing demands) beyond that measured in the water use modeling data. The scenario is primarily driven by projected changes in population, employment, and housing characteristics in the study area. Since the accuracy of the estimated 1995 water demands is closely linked to the 1995 population estimates described in Section 4.7.1.1, differences between the actual and estimated population would translate into an over- or under-estimation of water demand. These water demands are annual averages of water needs over a wide range of climatic conditions and do not represent the worst-case demands that may occur during drought periods.

In areas in which population growth is not directly linked to employment growth (i.e., bedroom communities), water demands may be significantly underestimated. For this reason, county-level and subbasin-level data, which are used in the HEC-5 modeling, are not presented here. The States have approved the basinwide figures that are shown in this section through the Comprehensive Study.

Table 4-7 displays estimated municipal and industrial water demand for the ACF basin. These figures represent gross, unconstrained demand figures as presented in the Comprehensive Study (PMCL, 1996). Georgia's 1995 estimated municipal and industrial water demands were 618 mgd of the 781 mgd of total demand in the ACF basin (79 percent). Alabama had the next greatest demand for water with almost 14 percent of total demands. Florida required the remaining 7 percent of the basin's water.

TABLE 4-7
Estimated Municipal and Industrial Water Demand (mgd), by State and Basin Total

Area	1995	2020	2050
Alabama portion	106	120	113
Florida portion	57	79	64
Georgia portion	618	763	872
ACF basin total	781	962	1,049

Source: PMCL, 1996

4.4.1.1.4.2 Agricultural Demand

As part of the Comprehensive Study, the Natural Resources Conservation Service (NRCS) evaluated historic and existing agricultural activities and water demand in the ACF basin. The study prepared by NRCS developed projections of agricultural irrigation demands for 1995 and future years (NRCS, 1995). These projections included demands by the

agricultural sector, including irrigation of crops/orchards, turf grasses and plant nurseries, and water demands for aquaculture, livestock, and poultry.

Annual average agricultural water demands have increased in Alabama and in 1995 were estimated to total 22.5 mgd, with crops and orchards representing 13.7 mgd of the total demand (***Table 4-8***). Use of irrigation in the Alabama portion of the ACF remains relatively low. Groundwater provides the majority of the agricultural water needs. Natural runoff is used for aquaculture.

TABLE 4-8
Estimated 1995 Annual Average Agricultural Water Demands (mgd), by State and Basin Total

Area	Crops and Orchards	Turf	Nursery	Aquaculture	Livestock/ Poultry	Total
Alabama portion	13.7	2.0	0.4	4.5	1.9	22.5
Florida	18.8	1.7	3.1	4.9	1.0	29.5
Georgia portion	308.6	6.3	2.8	11.4	21.6	350.7
ACF basin total	341.1	10.0	6.3	20.8	24.5	402.7

Source: NRCS, 1996

In the eight-county area of Florida in the ACF basin, agricultural water use is concentrated in Jackson County. Water demand is highest in the June through August period, when two-thirds of all agricultural water is used. Groundwater supplies the majority of the total water demanded. It was estimated that annual average agricultural water demands in the Florida portion of the ACF totaled 29.5 mgd, with crops and orchards accounting for 18.8 mgd of the demand.

Annual average water demands in the Georgia portion of the ACF basin were estimated to be 350.7 mgd, with 308.6 mgd attributable to crops and orchards. The Lower Flint planning area (the counties of Baker, Calhoun, Decatur, Dougherty, Early, Lee, Miller, Mitchell, Seminole, and Worth) is the predominant agricultural region of the Georgia portion of the ACF basin. This area contains almost half of the total acres devoted to harvestable commodities, and 70 percent of the irrigated acreage. The Georgia Geological Survey found that groundwater supplied the majority of the water used for crop and orchard commodities. Much of this is attributed to the widespread irrigation in the Lower Flint planning area. All other planning areas get the majority of their water from surface collection. Of the other agricultural sectors inventoried, only nurseries obtain water primarily from groundwater.

Seasonal water needs are critical to the production and quality of certain crops, particularly corn and peanuts. Lack of water during key growth stages can essentially destroy the crop. In Georgia, agricultural water demands in May through August account for the large majority of the annual demand. These months reflect the heart of the growing season for crops and orchards. Monthly demands between May and August are significantly greater than the annual average. For example, in the Lower Flint planning area, the annual average demand for 1995 was 221 mgd, whereas the demand in June was 1,083 mgd.

After completing the Agricultural Water Demand Technical Report and Appendix A, NRCS prepared the Basinwide Management Shared Vision Appendix (Appendix B) at the request

of the Basinwide Management Work Group (NRCS, 1996). The study completed for Appendix B used more detailed data for modeling than had been developed previously and included revised agricultural demand data. For this appendix, the original 17 subbasins used in the original analysis (discussed above) were further subdivided into 25 subbasins.

Table 4-8 presents the estimated 1995 annual average agricultural water demands in the ACF basin.

4.4.1.1.4.3 Thermal Power Demand

Thermal power generation demands were evaluated in the Comprehensive Study and the withdrawals were included in the HEC-5 model for the basin (***Appendix D***). As noted earlier in this section, surface water withdrawals for thermal power generation are significant in the ACF basin. ***Table 4-9*** lists the major thermal plants included in the HEC-5 model. The location of these withdrawals is shown in ***Figure 4-30***.

TABLE 4-9
Thermal Power Generation Plants in the ACF Basin

Facility	Basin
Southern Nuclear Farley Nuclear Plant	Chattahoochee
Scholz Electric Generating Plant	Apalachicola
Georgia Power Plant Yates	Chattahoochee
Georgia Power Plant Atkinson	Chattahoochee
Georgia Power Plant McDonough	Chattahoochee
Georgia Power Plant Mitchell	Flint
Georgia Power Plant Wansley	Chattahoochee

Source: ***Appendix D***

4.4.1.2 Environmental Consequences

The HEC-5 model was used to evaluate surface water quality impacts of the no action and alternative action flow scenarios on the major rivers and reservoirs in the ACF basin. The no action model of the ACF basin was built by the Corps in concurrence with the States during the Comprehensive Study. The Corps adapted and used the no action model during development of this draft EIS to compare the action alternative flow scenarios to the no action alternative. Details on model development and assumptions for the existing conditions (no action) model are found in ***Appendix D***.

The no action alternative and action alternative flow scenarios were simulated under 1995, 2020, and 2050 projected water demands, which are shown in ***Appendix F***, Section 1. The action alternative for the purpose of this draft EIS is a range of minimum instream flows that would be likely to bracket any allocation formula that will be submitted by the States. Each of the three scenarios (low, moderate, and high release scenarios) were also modeled using 1995, 2020, and 2050 projected water demands (see Section 1.3.3.3). Thus, a matrix of model runs was set up for evaluation in this draft EIS. The details of matrix model development and execution are also documented in ***Appendix D***.

The last major NEPA evaluations of water management operations at the various reservoir projects in the ACF basin were included in the environmental impact statements completed in the 1970s. To assess the impact of operational changes since that time, the HEC-5 model was also used to simulate conditions in the ACF basin under 1977 operations, which was selected as a representative year for historic operating conditions. The methods and assumptions that the Corps used in developing the 1977 model are detailed in ***Appendix D***.

4.4.1.2.1 Basin Wide Hydrologic Modeling

To simulate the effects of the allocation formula on water resources, the Corps' Mobile District constructed, with assistance from the Corps' Hydrologic Engineering Center (HEC), a hydrologic model of all the major streams and reservoirs in the basin using a computer modeling program called HEC-5. The HEC-5 computer program, *Simulation of Flood Control and Conservation Systems*, was originally developed by HEC. It allows simulation of the sequential operation of any reservoir system configuration during a specified period of time. The Corps constructed the HEC-5 model of the ACF and ACT basins in consultation and in cooperation with the States in the Surface Water Availability study element of the Comprehensive Study. The HEC-5 model, a tool to evaluate alternative water management scenarios, was constructed to simulate operation of the reservoirs and streams in the basin. The HEC-5 model uses 55 years of daily historic streamflow data (1939 to 1993), the physical and operational characteristics of reservoirs and river reaches, and the net consumptive water demands in the basin to determine basinwide surface water impacts for various operational scenarios.

The HEC-5 model was set up in a "node" framework, with 31 nodes representing the ACF basin (***Figure 1-3***). The nodes were selected to represent physical locations or critical modeling points, such as environmental points of interest, USGS stream gage locations, reservoirs, or other model-related control points. This node framework is discussed in more detail in Section 1.3.3.6. HEC-5 model output in terms of predicted streamflows and reservoir elevations were used to assess the impacts of operating the system under various management scenarios. The Corps documented the HEC-5 model of the ACF and ACT

basins in two reports prepared under the Comprehensive Study (Corps, 1997, 1998b). *Appendix D* of this EIS contains an overview of the model setup and assumptions.

4.4.1.2.1.1 1977 Operating Conditions Evaluation

Operations of the Federal projects in the ACF basin have changed incrementally since the last major NEPA evaluations of water management in the basin were completed. The primary differences between operations in 1977 and 1995 are changes in minimum dam releases, operational changes, and changes in the Federal projects' hydropower marketing contracts (see *Appendix D* for details). Required minimum flow releases increased from the Buford Dam from 1977 to 1995. Also, weekend releases were implemented at Walter F. George Lake, which allowed weekday releases to decrease. At West Point Lake, the winter pool level was increased 2 feet between 1977 and 1995. Between this same period, less emphasis was placed on releasing excess water for navigation purposes, and the Corps implemented a navigation windows program. In addition, there have been other operational changes due to modification of Federal hydropower marketing agreements that have changed since 1977. These changes generally affect how much and when energy is produced to meet the contract conditions.

Two 1977 HEC-5 models were developed for historic (1977) operating conditions: one with 1977 water demands and one with 1995 water demands. The first run was established to calibrate the model against actual 1977 flow gage data, and the second run was used to compare to the no action alternative with 1995 demands to assess the impact of the changed operations on water resources in the ACF basin.

The HEC-5 model results show that reservoir levels in the ACF basin would differ significantly under 1977 operations compared to 1995 operations. In general, winter (October to December) water levels at Lake Lanier would be up to 4 feet lower under the 1977 operations compared to 1995 operations. Reservoir water levels would be about 2 to 3 feet lower the rest of the year under 1977 operations compared to 1995 operations. At West Point Lake, the most significant differences are that the winter pool level is higher under 1995 operations and the lake reaches summer pool level later in the summer and begins drawing down earlier under 1995 operations, which results in lower water levels during peak summer months. At Walter F. George Lake, summer water levels are generally 1 to 2 feet higher under the 1995 operations compared to the 1977 operations.

A comparison of river flows at several key locations in the ACF basin under 1995 and 1977 operating conditions shows less substantial differences between the two operating scenarios. For example, flows at the Whitesburg gage on the upper Chattahoochee River show no significant difference between 1977 operations and 1995 operations. On the Chattahoochee River below George W. Andrews Lock and Dam, there would be a greater frequency of very low flows under 1977 operating conditions than under 1995 operating conditions. For example, in the summer months under low flow conditions, the flow would be less than 500 cfs about 10 percent more of the time under 1977 operations than under 1995 operations. This is likely due to the addition of weekend releases from Walter F. George Lake, which is upstream of the George W. Andrews Lock and Dam. On the Apalachicola River, flows at the Chattahoochee gage generally show little difference between 1977 operations and 1995 operations. It is only during the late summer months (August and September) that the model indicates that low flows (i.e, the 90 percent exceedance flow) under 1995 operations are lower than would be under 1977 operations. On the Flint River, there were no operational

changes included in the model; therefore, the model indicates no change in flows when comparing 1977 operations to 1995 operations.

The HEC-5 modeling analysis illustrates that minimum low flows necessary to meet water supply, water quality, navigation, and hydropower operation demands would be similar under both the 1977 and 1995 operations, although changes in minimum releases and weekend operations since 1977, in addition to navigation windows, have decreased the frequency of low flows on the lower Chattahoochee River. Reservoir levels, which are critical to reservoir recreational activities, would be substantially lower under 1977 operations compared to 1995 operations. The above summary information provides a perspective for evaluating impacts of the existing operating condition (no action alternative).

4.4.1.2.1.2 Development of the Low, Moderate, and High Scenarios

For the action alternative in this draft EIS, a range of reasonable, foreseeable minimum flows—low, moderate, and high—was developed to form a framework to evaluate the allocation formula now being negotiated between the States of Alabama, Florida, and Georgia. These flow scenarios do not represent a specific operational alternative. Instead, they are intended to bracket a range of flows that will include a flow represented by the final allocation formula. By analyzing this range of flows, it is reasonable to assume that the range of potential impacts of the actual allocation formula will be addressed as appropriate for a programmatic EIS. This EIS identifies and analyzes the range of impacts associated with this range of minimum flows.

The HEC-5 model was used to simulate conditions in the rivers and reservoirs of the ACF basin under three flow scenarios: low, moderate, and high. The flow scenario models were optimized for reservoir releases during the critical low flow periods: whether to release the highest flow rate and draw the reservoir to the lowest allowable elevation; to release the lowest flow rate and maintain the pool near the top the conservation pool; or to release a moderate flow rate between the low and high release rates.

The descriptions selected to name the three flow scenarios describes conditions in the river under low flow/dry weather conditions in the basin. That is, under dry conditions, the low release scenario will provide lower river flows than the moderate or the high release scenarios. However, each scenario was modeled for the full 55-year period of record, with the same amount of water to be managed under each of the three scenarios. Considering that the mass of water must be conserved within the model, if flows are lower during the dry weather periods for a given scenario, the flows for that scenario may be higher than the other two scenarios at other times of the year, such as under wet spring conditions. To appreciate the full effect of each scenario, the impacts must be viewed and evaluated on a monthly or seasonal basis.

Each flow scenario was modeled using 1995, 2020, and 2050 projected demands. The 1995 demands were included to illustrate the immediate impact of implementing an alternative flow scenario. The 2020 and 2050 demands were modeled to show the mid-term and long-term impacts expected from implementing the water allocation formula, taking into account future projected water demands. Water demands were held constant in the HEC-5 model for each year of the 55-year period of record, even though in reality, water demand will fluctuate around a mean, depending on the amount of rainfall in a given year. The water demands used in the HEC-5 models were developed during the Comprehensive Study.

Appendix D includes details on the development and modeling of this matrix of flow and demand scenarios. Each scenario is discussed individually below.

Low Flow Scenario. The low flow scenario focused on providing the lowest reservoir releases during low flow periods of the year that maintain reservoirs at or near the top of the conservation pool. This scenario incorporated the highest projected consumptive water demands, which varied monthly. Seasonal drawdown for flood control and basin management as defined in the regulation manuals is included in this scenario, although the drawdown was held to a higher level than under the no action scenario. The reservoirs do not augment navigation or existing downstream flow targets (see Section 4.4.1.2.1.3, below), nor do they explicitly provide for peaking hydropower operations. However, hydropower is generated anyway because some water is always being released from the dams. This scenario establishes the lowest reasonable flow rate that could occur during dry periods as a result of the flow allocation formula. The low flow scenario generally maintains reservoir elevations near full pool, even during low flow periods. Some slight drawdowns are necessary during very dry periods, but overall elevations remain high and stable. River flows under the low flow scenario are very low in the late summer/early fall, and generally lower during dry periods throughout the year, a consequence of maintaining higher reservoir levels.

Moderate Flow Scenario. The moderate flow scenario was established as an intermediate condition between the high and low flow scenarios. This scenario assumes moderate water demands. As with the other scenarios, the reservoirs were not modeled to augment navigation or existing downstream flow targets, nor do they explicitly provide for peaking hydropower operations. Seasonal drawdown was included in the model, but reservoirs were not drawn down as much as existing operations. The moderate flow scenario is most similar to the existing operation, with the notable exception that daily hydropower peaking operations and specific navigation releases were not simulated.

High Flow Scenario. Under the high flow scenario, reservoir releases are at their highest, allowing each reservoir to deplete its storage and to recover within a critical period. This scenario was run iteratively to determine the maximum reservoir release that still allowed the reservoir to recover its lost storage. Seasonal drawdown was eliminated in this scenario to preserve as much water in the reservoirs to maintain the high reservoir releases throughout the drier parts of the year. As with the other two scenarios, the reservoirs do not augment navigation or existing downstream flow targets, nor do they explicitly provide for peaking hydropower operations. However, as with the other two scenarios, hydropower is generated because some water is always being released from the dams. The response in river flows to the high flow scenario is higher, sustained low flows in the dry months, lower flows in the winter months (because there is no seasonal drawdown). In the reservoirs, the levels are much lower in the summer and early fall, as reservoirs are depleted to sustain higher stream flows, and higher in the winter due to the elimination winter drawdown to conserve water for the high flow releases the remainder of the year.

4.4.1.2.1.3 Downstream Flow Targets

The matrix models were developed around downstream minimum flow targets. Each storage reservoir operates to maintain a minimum flow (flow target) at the dam and/or a downstream location. The current downstream flow targets, such as Federally mandated minimum flows, are included in the no action scenario. These targets, however, were changed in the matrix models to provide for a range of minimum flows. This allowed for the

optimization of reservoir releases to supply the range of flow targets. It is acknowledged that no changes to the individual project operations can occur until they are re-evaluated and Federally approved once the allocation formula is finalized. The Corps will re-evaluate Federal projects. Non-Federal projects will be reevaluated during FERC relicensing. It should be recognized that changes in current minimum instream flows could affect existing wastewater discharge permit limits because the assimilative capacity of the river would be reduced. Therefore, changes in existing minimum flows would likely require changes in permit criteria or other regulatory actions to address wastewater discharges in the affected stream segments.

Reservoirs are currently operated to support a variety of uses, including hydropower generation, flood control, minimum downstream flows, water quality, and water supply. Under the matrix model analysis, all three modeled scenarios (low, moderate, and high) were optimized for reservoir releases. Because it is possible that the flow allocation would be manifested through instream flow targets, the action alternative models were designed to optimize reservoir releases. In this process, each reservoir was optimized to operate for the highest reservoir release (for the high flow scenario), the lowest reasonable reservoir releases (for the low flow scenario), and a reasonable reservoir release between the low and high releases (for the moderate flow scenario). The optimized releases were then established as *flow targets* (see ***Appendix D***). The flow targets were used in the HEC-5 models of the three action alternative scenarios. Each reservoir was operated to maintain a minimum flow (flow target) at the dam or downstream location. The flow targets used in the matrix models of the ACF basin are shown in ***Table 4-10***. These minimum flow targets do not represent recommended minimum flow targets for an actual allocation formula; they were selected only to provide a range of flow conditions broad enough to bracket any combination of minimum flows that may occur from the allocation formula.

TABLE 4-10
Downstream Flow Targets Used in the HEC-5 Model (in cfs)

	1995 Demand Year			2020 Demand Year			2050 Demand Year			1995, 2020, and 2050 Demands
Location	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	No Action
Norcross	350	740	1,130	350	710	1,070	350	670	990	
Atlanta	350	775	1,200	350	725	1,100	350	680	1,010	750
Whitesburg	370	785	1,200	370	735	1,100	370	690	1,010	
West Point	370	1,360	2,350	370	1,325	2,280	370	1,285	2,200	
Columbus	550	1,660	2,770	550	1,615	2,680	550	1,560	2,570	1,150
Walter F. George Lake	570	1,985	3,400	570	1,940	3,310	570	1,880	3,190	
George Andrews	678	2,210	3,720	678	2,170	3,640	678	2,215	3,570	
Chattahoochee	3,780	5,825		3,780	5,765		3,780	5,660		
Blountstown	3,850	5,860	7,870	3,850	5,800	7,750	3,850	5,695	7,540	5,000
Sumatra	4,920	6,395		4,920	6,335		4,920	6,230		

4.4.1.2.1.4 Critical Period Analysis

The no action and action alternative flow scenarios were modeled over a 55-year period of record. Within those 55 years, there were low, average, and high precipitation conditions. Some of the analysis in this draft EIS focuses on the critical periods, as defined by observed

conditions in the basin. Analysis of the full period of record is also included throughout this section.

The following timeframes represent critical drought periods in the ACF basin:

- September 1, 1939 to January 26, 1943
- June 1, 1954 to February 25, 1960[1]
- June 14, 1968 to January 19, 1969
- July 5, 1980 to February 18, 1982
- September 1, 1985 to October 1, 1989

To focus the analysis on those times when an allocation formula will have the greatest effect, the impacts were evaluated not only on the entire 55-year period of record, but also on the critical periods, as defined above. This allows a closer examination of low flow impacts, when allocation of water and the associated impacts are of critical concern. There are over 5,600 days within the defined critical periods. This represents over 28 percent of the entire 55-year period of record.

Model output data are produced by HEC-5 in the form of daily flows and reservoir elevations. The Indicators of Hydrologic Alteration (IHA) program was then used to statistically analyze the entire 55-year model output and to provide summaries of annual low and high flows and frequency distributions of the data (see ***Appendix D***). In addition, a frequency analysis of the flows and reservoir levels at key locations in the basin was conducted on only the critical periods, to evaluate impacts under dry/drought conditions when the allocation formula will be most essential.

4.4.1.2.1.5 General Model Assumptions

Reservoir operations cover the full array of hydrologic conditions from flood to drought. However, in the modeling more emphasis was placed on water supply operation since this study focuses on water availability in the basins. In addition, flood control operations are controlled on an hourly basis. Although high flow conditions were modeled within the 55-year period of record, true flood control operation of the reservoirs could not be duplicated using the daily time step that HEC-5 uses. Therefore, the model approximates the flood control operation at the daily time step. As a result, the model may predict higher flows than would actually occur under true operating conditions because the model cannot account for the hourly changes in operations that reduce peak flows. The Corps prepared a separate flood control analysis to evaluate the impacts of reduced flood control storage in the basin in the event that the allocation formula includes a requirement for reduced flood control storage (see ***Appendix D***).

In developing the three flow scenarios, several modeling decisions were made to attempt to bracket the potential minimum instream flows in the allocation formula that is being developed by the States, with no intent to influence the States' decision in any way. Therefore, several complex management techniques that are currently in place in the basin were not modeled under the three scenarios because that would have presumed knowledge of how the reservoirs would be operated to meet the States' allocation formula.

[1] A volume of water that represents the partial filling of a reservoir (Lake Lanier) was inadvertently omitted in the development of the historical baseline flow dataset as input to the ACF model. As a result, the severity of the 1954 to 1960 critical period is exaggerated in the HEC-5 models used in the analysis for this draft EIS. Future HEC-5 modeling for the final EIS will use the revised historical baseline flow dataset as input to the ACF models.

For example, under current conditions, a navigation window management technique is employed on the lower ACF basin to supplement low flows in scheduled intervals to support navigation. This operation affects reservoir elevations in the middle and upper basin during spring, summer, and fall. Because it could not be presumed that the States would recommend a continued navigation windows operation, the navigation windows were not included in the matrix models. However, a separate analysis of the effects of navigation windows was performed, and those results are presented in ***Appendix D.***

Another decision related to modeling assumptions concerned hydropower operations. The peaking hydropower projects in the basin operate under a complex rule curve system, whereby the number of hours that the project can operate each day depends on the amount of storage in the reservoir, the amount of storage in the basin, weather conditions and forecasts, and downstream needs. To incorporate this complex operation into the matrix models would have required the model to establish how each individual reservoir would be operated under each flow scenario. Because it is anticipated that the allocation formula will be manifested through instream flow targets, the model was designed to optimize reservoir releases. The daily fluctuating nature of peaking operations, which generally operate Monday through Friday and shut down on weekends, was modeled as a week-long constant release. Thus, the model results do capture hydropower operations on a weekly basis, but do not fully capture the daily variability in flows and reservoir levels that result from hydropower operations.

The operation of the low and moderate scenarios solely to meet target flows rather than to support hydropower or navigation resulted in less seasonal drawdown than under the no action alternative. For these reasons, absolute elevations and flows predicted by HEC-5 for the three action scenarios cannot be precisely compared to absolute elevations and flows for the no action scenario. The no action alternative will naturally exhibit more daily variability in flows and levels because it has captured the true nature of peaking operations and more seasonal variability because it supports navigation and hydropower target flows.

In the analysis in this draft EIS, the impacts of the action alternative flow scenarios were compared with the no action alternative under 1995, 2020, and 2050 water demands. The high scenario was compared to the moderate scenario, and the low scenario to the moderate scenario. Considering that the moderate scenario most closely resembles current operations with respect to minimum flows and demands, this relative comparison allows a general assessment of the impacts of the high scenario against current conditions. In addition, a general comparison can be made between low flows in the action alternative and the no action alternative. Although this is not a precise comparison, it does allow for general trends and ranges of impacts to be analyzed. This is adequate for the purposes of the draft EIS, which is to provide hydrologic information on a programmatic level of detail to the interdisciplinary team to assess the range of potential environmental and socioeconomic impacts of the allocation formula. In the final EIS, the impacts of the actual allocation formula will be evaluated, and a more precise comparison can be made to the no action alternative.

4.4.1.2.2 Impact Analysis Approach

This section describes the direct impacts to water quantity associated with the action alternative scenarios of high, moderate, and low flows compared to the no action alternative.

The impacts for current (1995) demands are evaluated, as well as the mid- and long-range impacts by analyzing the same scenarios under 2020 and 2050 year water demands.

Impacts to water resources in the ACF basin under the no action and alternative flow scenario will vary depending on where they occur in the basin. Because this is a programmatic EIS, impacts are analyzed on a basinwide basis rather than project by project. However, because impacts do vary over the basin, the basin was subdivided into four subbasins (***Figure 4-20***). The rivers and reservoirs within each subbasin were then analyzed as a group. For this programmatic analysis, one or two representative reservoirs and river flow locations were selected to summarize the analysis of the subbasin. The locations selected are described within the sections.

Subbasins were delineated according to hydrologic features within the ACF basin. The Chattahoochee River basin was subdivided into an Upper Chattahoochee River subbasin and a Lower Chattahoochee River subbasin. The upper subbasin is characterized by steep rivers with more variable flows in response to precipitation events. The Upper Chattahoochee River subbasin extends from the headwaters of the Chattahoochee River and its tributary streams to the Chattahoochee River at Whitesburg. The Whitesburg gage is located upstream of West Point Lake. River flows within the Upper Chattahoochee River subbasin were evaluated at Whitesburg. Lake Lanier and Bull Sluice Lake are the two major reservoirs within this subbasin.

The Lower Chattahoochee River subbasin has different hydrologic and geologic features than the upper subbasin. The rivers and tributaries in the lower subbasin tend to have gentler gradients than in the upper basin because the majority of the subbasin lies below the Fall Line. Being in the lower portion of a very large river basin, flows in the mainstem Chattahoochee River are significantly higher but less variable than the flows in the upper subbasin. River flows in the lower subbasin were analyzed at a model node on the Chattahoochee River below the George Andrews Lock and Dam. There are 11 major reservoirs in the lower subbasin. Operations at these projects collectively affect flows in the lower Chattahoochee River.

The Flint River subbasin was delineated as a separate subbasin because of it unique hydrologic nature. This subbasin is significantly affected by groundwater interaction. There are only two major reservoirs in the subbasin. Both operate essentially as run-of-river projects and thus do not greatly influence flows in the Flint River. The Flint River subbasin lies below the Fall Line and thus the rivers and stream in the subbasin have lower gradients than found in the Upper Chattahoochee River subbasin. Flows in this subbasin were evaluated on the Flint River at Montezuma, Albany, and Bainbridge.

The fourth subbasin evaluated is the Apalachicola River subbasin. This subbasin was also delineated based on hydrology. The Apalachicola River is the flattest river in the ACF basin and also has very diverse and critical environmental resources in the lower Apalachicola River and Apalachicola Bay. There is one major reservoir in this subbasin: Lake Seminole. Flows in this subbasin were evaluated on the Apalachicola River at Chattahoochee and Sumatra.

Direct impacts are the effects that a particular action has on the river flows and reservoir elevations in the basin. These effects occur as a direct result of the action. As discussed above, caution must be used in comparing the HEC-5 model results for the low, moderate, and high flow directly to the no action model results because of the modeling assumption

differences between the two sets of model runs. The low flow scenario and the high flow scenario can each be compared directly to the moderate flow scenario to assess impacts. Direct impacts of the no action alternative can also be displayed. However, only general comparisons between the no action alternative and the alternative flow scenarios can be made. Although this does not allow a precise value-by-value comparison, it is more than adequate to assess general impacts to water resources in the ACF basin for this programmatic draft EIS.

This analysis focuses on river flows and reservoir elevations that would occur as a result of the no action and action alternative flow scenarios during critical periods, as described earlier in this section. The HEC-5 modeling focused on the critical periods because the target flows were established to ensure maintenance of the minimum flows throughout the critical drought periods. The critical periods also show the greatest impact of the alternative flow scenarios. Environmental consequences would also occur during non-critical periods as reservoirs and rivers are operated to maintain the different target minimum flows of each scenario. Impacts under average flow conditions over the full period of record are also presented within each subbasin.

In the following sections, impacts are presented as a comparison of 50 percent exceedance flows and elevations and 90 percent exceedance flows and elevations. The 50 percent exceedance flows represent the flows that are exceeded 50 percent of the time. This can be considered close to average flow conditions. The 90 percent exceedance flow, or the flow that is exceeded 90 percent of the time, represents flow under low flow, or very dry conditions.

4.4.1.2.3 River Impacts

4.4.1.2.3.1 Upper Chattahoochee River Subbasin

The Whitesburg gage was selected as the representative location to assess impacts to riverine water resources in the Upper Chattahoochee River subbasin. The Whitesburg gage is located upstream of West Point reservoir. Two hydropower dams and reservoirs are located within this subbasin: Buford Dam (Lake Lanier) and Morgan Falls Dam (Bull Sluice Lake). These projects alter flows in the upper Chattahoochee River subbasin.

Under the no action alternative, the model predicted that 90 percent exceedance flows (the flow that is exceeded 90 percent of the time) during critical drought periods in the Chattahoochee River at Whitesburg would not change significantly from 1995 to 2050 (***Figure 4-33***), even though water demands would increase over the same period. The majority of effects due to increased demands were generally felt on the reservoirs in the system rather than on river flows, as will be demonstrated in the *Reservoirs* section of this analysis.

A comparison of the action alternative scenarios to the no action alternative (***Figure 4-34***) illustrates that the low and moderate flow scenarios would cause substantially lower 7-day, 30-day, and 90-day low flows than the no action alternative. The high flow scenario would produce significantly higher 7-day and 30-day low flows and only slightly higher 90-day low flows than the no action alternative.

FIGURE 4-33
Chattahoochee River at Whitesburg. 90 Percent Exceedance. Critical Drought Period, No Action Alternative

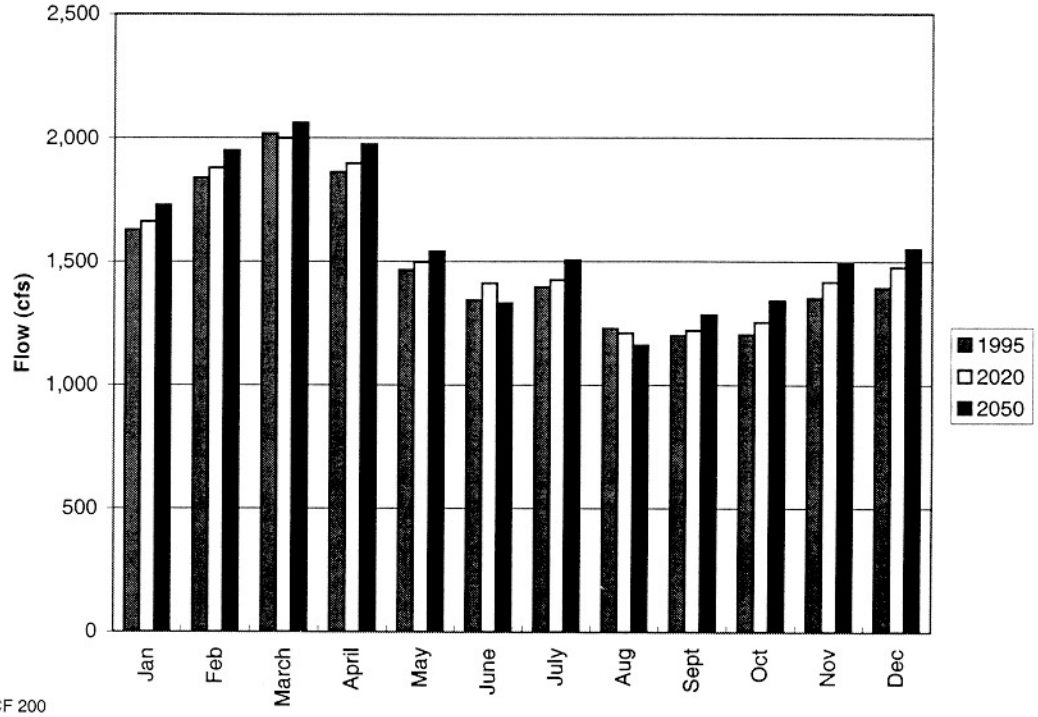


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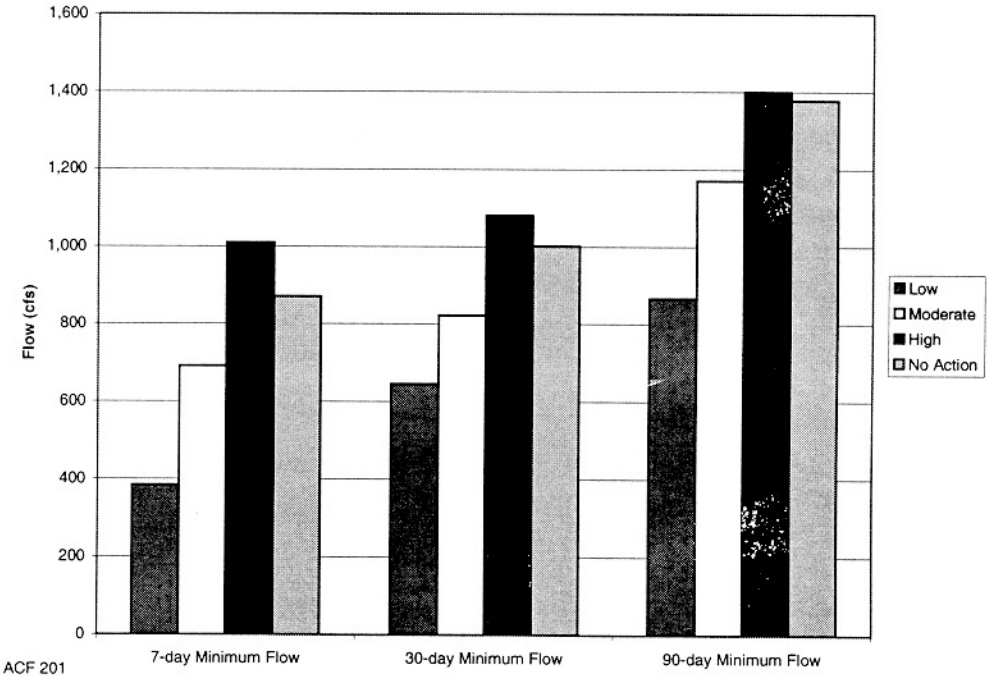
FIGURE 4-34
Chattahoochee River at Whitesburg. Low Flows. Full Period, Action Alternative. 2050 Demands



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The three action alternative scenarios were modeled to maintain target flows on the Chattahoochee River at Norcross, Atlanta, and Whitesburg nodes, as shown in ***Table 4-10***. To investigate the effects of the three action alternative scenarios in greater detail, ***Figure 4-35*** compares the 50 percent exceedance flow over the full period of record. This figure illustrates that there are seasonally varying differences between the three action alternative scenarios over the full period of record. Overall, the low flow scenario would produce higher winter flows than the moderate and high flow scenarios. Conversely, under the drier summer conditions, the low flow scenario produces flows substantially lower than the moderate and high flow scenarios.

The differences between the three scenarios are much more pronounced when reviewing the effects under critical periods for the 90 percent exceedance flows. ***Figure 4-36*** illustrates that the low flow scenario produces flows that are generally 30 percent less than the moderate and 60 percent less than the high flow scenario. The high flow scenario produces 90 percent exceedance flows substantially greater than the low and moderate flow scenarios in all months of the year, as illustrated in ***Figure 4-36***.

FIGURE 4-35

Chattahoochee River at Whitesburg. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands

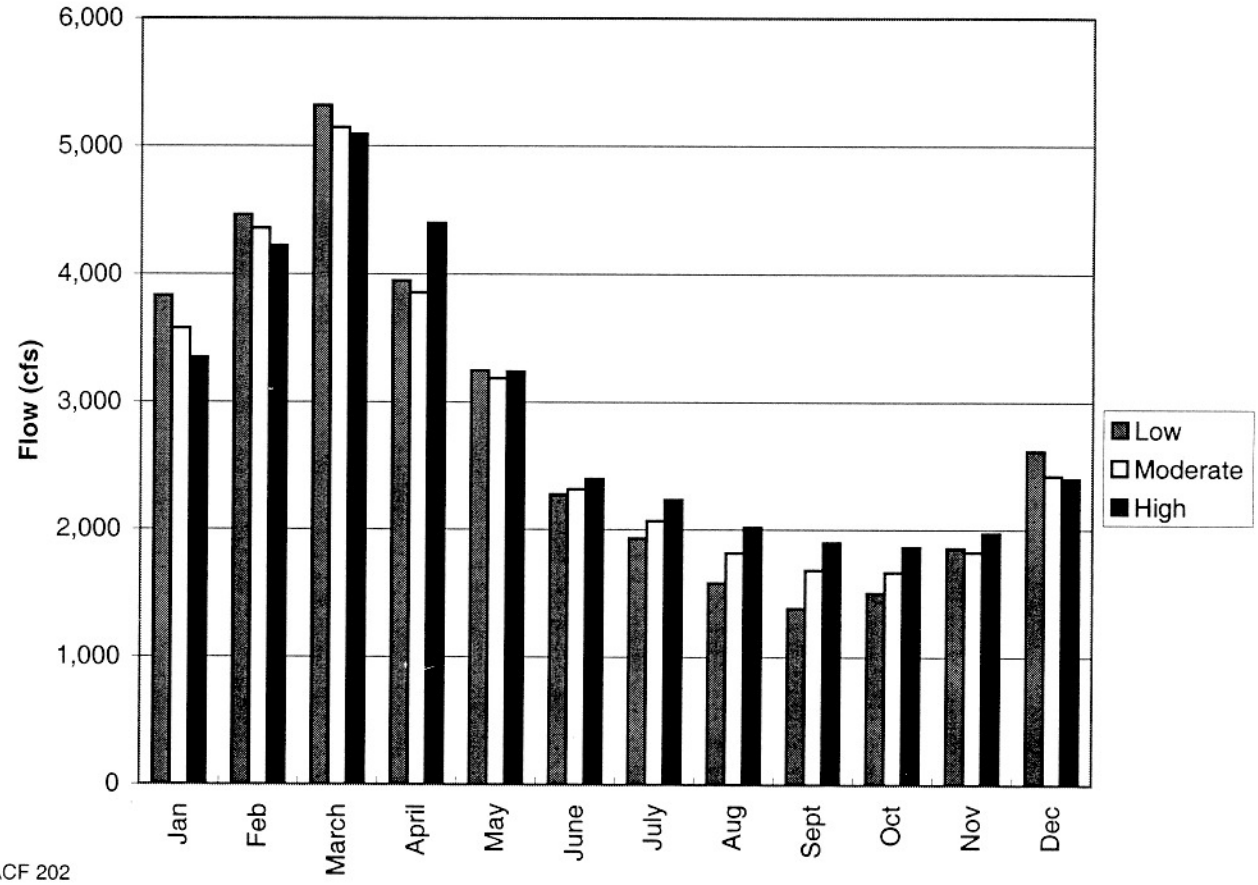

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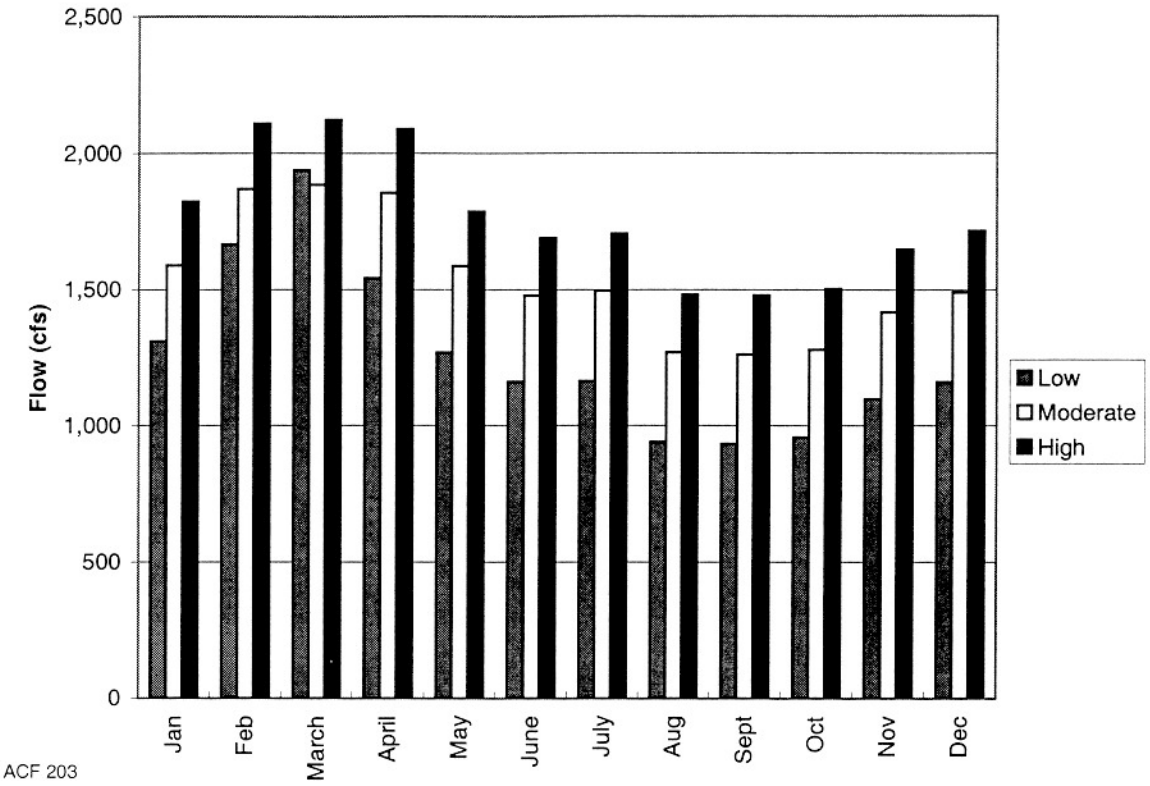
FIGURE 4-36
Chattahoochee River at Whitesburg. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands



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4.4.1.2.3.2 Lower Chattahoochee River Subbasin

Impacts to riverine water resources in the Lower Chattahoochee River subbasin were assessed at a key node on the Chattahoochee River located just below the George Andrews Lock and Dam. A series of 11 dams and reservoirs fall within the Lower Chattahoochee River subbasin, including West Point Dam, Walter F. George Lake Lock and Dam, and George W. Andrews Lock and Dam. These projects collectively influence flows in the lower Chattahoochee River. This section will address the cumulative effects of all the reservoirs on river flows at the most downstream point on the Chattahoochee River.

Under the no action alternative, a 50 percent exceedance flow in the Chattahoochee River below George Andrews Lock and Dam is much lower in the summer and fall (August to December) than the remainder of the year. Overall, flows are expected to decrease slightly, less than 10 percent, from 1995 to 2050. There would be no discernable change in flows between 1995 and 2050 in the summer months (***Figure 4-37***).

Comparing 7-day, 30-day, and 90-day low flows on the Chattahoochee River at George Andrews Dam demonstrates that the moderate flow scenario produces flows very similar to the no action alternative. In contrast, the low flow scenario would decrease these low flows by about 60 percent compared to the no action, and the high flow scenario would increase the 7-day, 30-day, and 90-day low flows by between 50 and 85 percent (***Figure 4-38***). These low flow statistics represent conditions in the basin under the driest conditions of the 55-year period of record.

FIGURE 4-37
Chattahoochee River at George Andrews Dam. 90 Percent Exceedance. Critical Drought Period, No Action Alternative

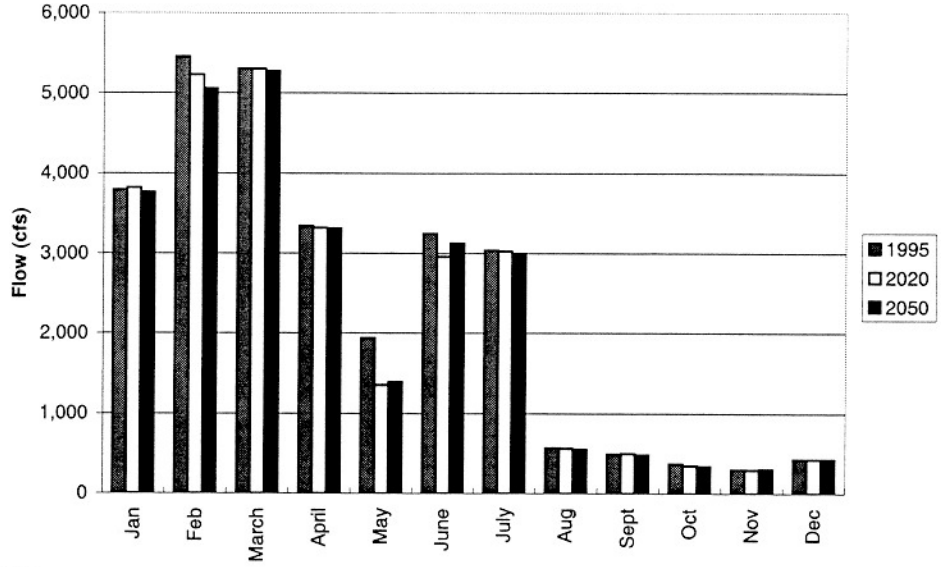

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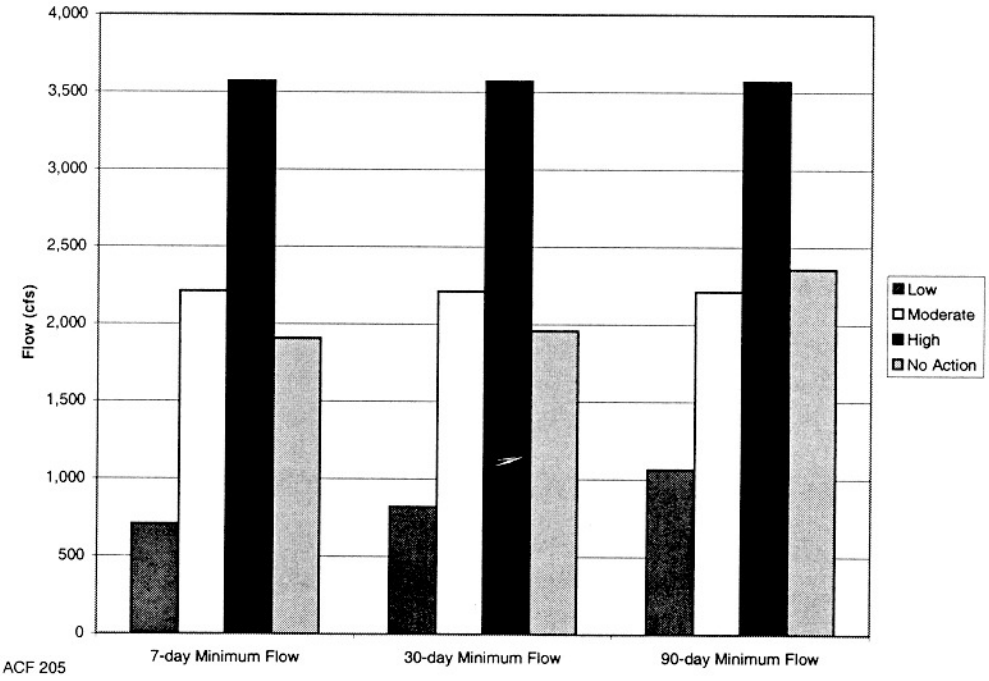
FIGURE 4-38
Chattahoochee River at George Andrews Dam. Low Flows. Full Period, Action Alternative. 2050 Demands



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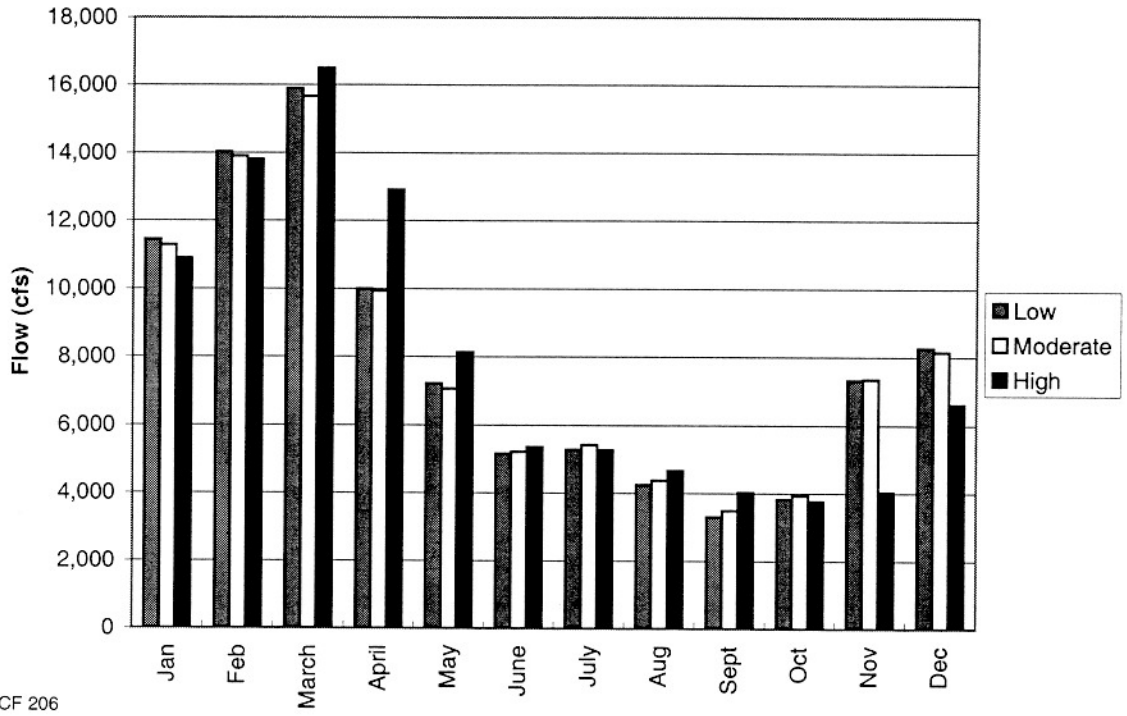
The three action alternative scenarios were modeled to maintain target flows on the Chattahoochee River below West Point, Columbus, Walter F. George Dam, and George Andrews Lock and Dam, as shown in ***Table 4-10***. In order to analyze the impacts of the three

action alternative scenarios throughout the year in more detail, ***Figure 4-39*** presents a comparison of the 50 percent exceedance flow over the full period of record. It is apparent in ***Figure 4-39*** that there are distinct seasonal effects of the three action alternative scenarios under typical, or average flow conditions. This figure illustrates that the high flow scenario produces flows that are substantially higher in the early spring and substantially lower in the late fall compared to the low and moderate flow scenarios. The low and moderate flow scenarios produce flows that are very similar to each other in both magnitude and seasonal patterns.

FIGURE 4-39
Chattahoochee River at George Andrews Dam. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands



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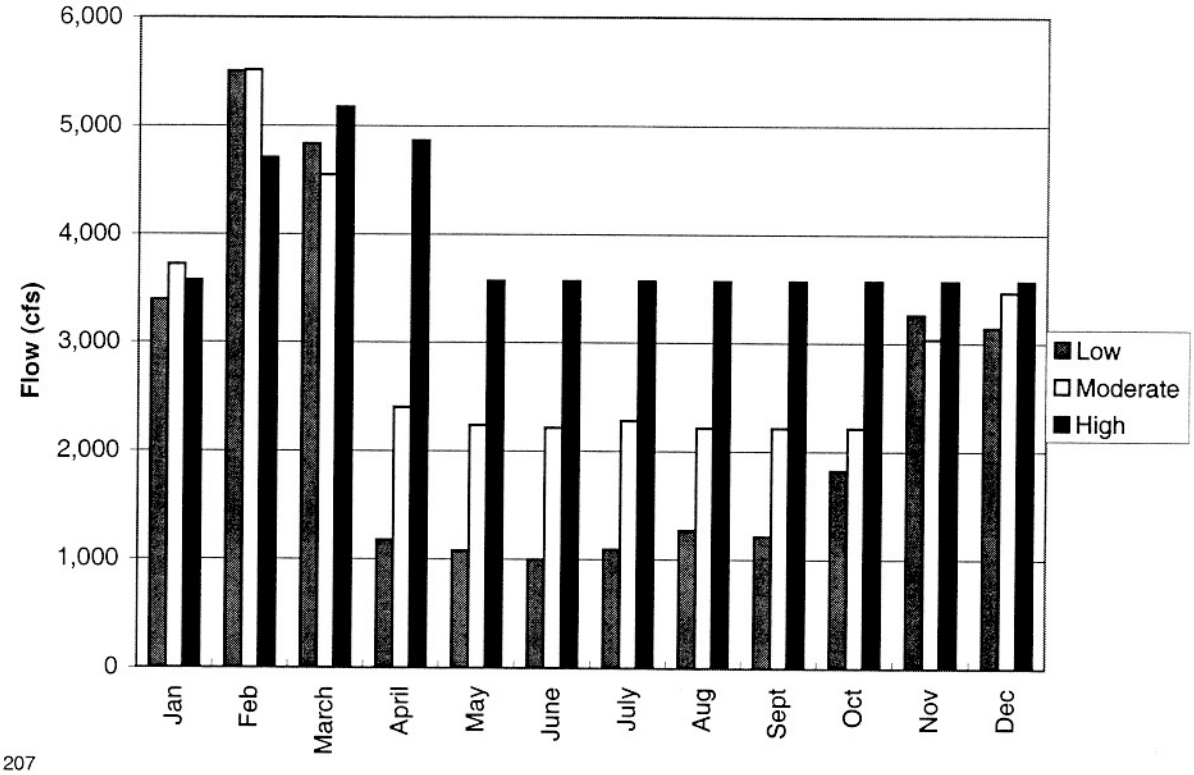
The differences between the three scenarios are magnified when viewing the effects of the 90 percent exceedance flow over the critical periods. ***Figure 4-40*** demonstrates graphically that the differences are greatest in the summer months, when the low flow scenario is about 45 percent less than the moderate scenario. During these dry summer months, the high flow scenario would maintain 90 percent exceedance flows about 60 percent higher than the moderate flow scenario and about 200 percent higher than the low flow scenario. The flow differences between scenarios are directly attributable to the differences in target flow established in the HEC-5 modeling (***Table 4-10***).

FIGURE 4-40
Chattahoochee River at George Andrews Dam. 90 Percent Exceedance. Critical Drought Period, Action Alternative, 2050 Demands



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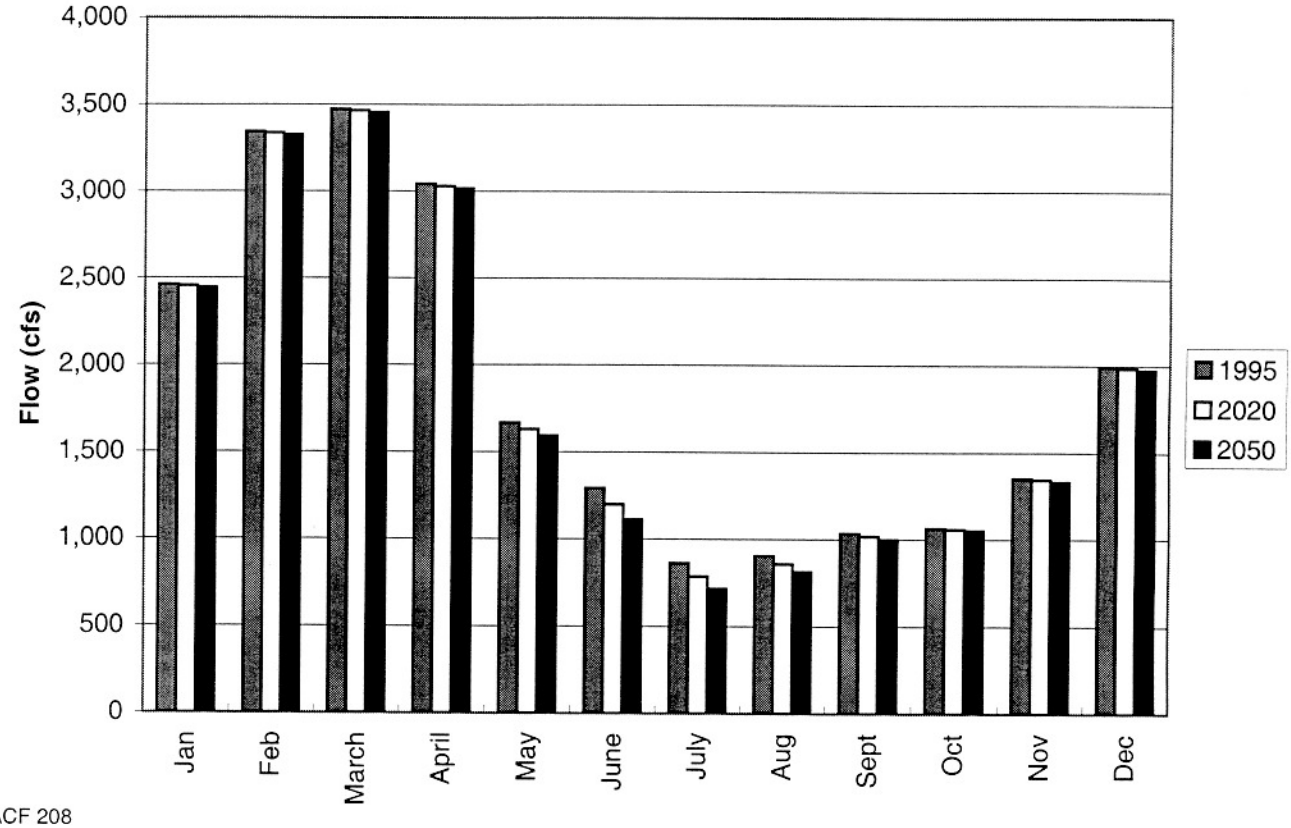
4.4.1.2.3.3 Flint River Subbasin

Impacts to riverine water resources in the Flint River subbasin were assessed on the Flint River at Montezuma and Albany and, further downstream, at Bainbridge. There are two reservoirs on the Flint River: Lake Blackshear and Lake Worth. Both operate essentially as run-of-river projects.

Under the no action alternative, the model predicted that 90 percent exceedance flows in the Flint River at Albany would decrease by about 3 percent from 1995 to 2050. The greatest effect would be in the summer months. For the months May through July, the 90 percent exceedance flow decreases about 10 to 20 percent from 1995 to 2050 (***Figure 4-41***). At Bainbridge, a similar trend is observed. The 7-day minimum flow, based on the IHA analysis over the full period of record, would decrease 6 percent from 1995 to 2050 at Bainbridge and 4 percent at Albany. These summer months correspond to the peak demand period for agricultural water use. Agricultural demands are particularly heavy on the Flint River. Unlike the Chattahoochee or Apalachicola Rivers, there are no large storage reservoirs on the Flint River to supplement low flows during dry periods.

FIGURE 4-41
Flint River at Albany. 90 Percent Exceedance. Critical Drought Period, No Action Alternative



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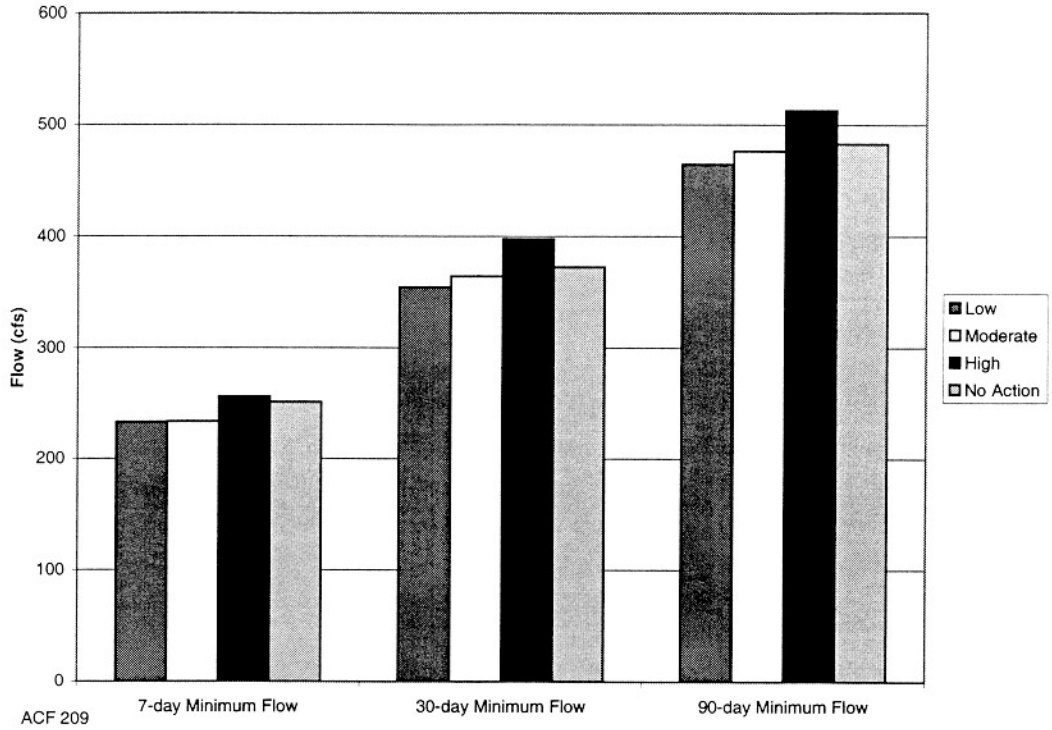
The 7-day, 30-day, and 90-day low flows over the full 55-year period of record would change slightly under the three action alternative scenarios compared to the no action alternative. These comparisons were made at three locations on the Flint River: at Montezuma (***Figure 4-42***), Albany (***Figure 4-43***), and Bainbridge (***Figure 4-44***). Overall, the low and moderate flow scenarios exhibit slightly lower low flows compared to the no action alternative at Montezuma and Bainbridge. At Albany, the low flow scenario would produce 7-day, 30-day, and 90-day flows only about 2 percent lower than the no action alternative, but the moderate flow scenario would produce low flow slightly higher than the no action alternative. The low flows at all three points on the Flint River would be 5 to 10 percent higher under the high flow scenario compared to the no action alternative. These comparisons illustrate that the differences in the 7-day, 30-day, and 90-day low flows on the Flint River would undergo only minor changes for the three action alternative scenarios compared to the no action alternative. The differences are due primarily to the different demand assumptions between the three scenarios and the no action alternative, rather than changes in operations (the two reservoirs on the Flint River operate essentially as run-of-river facilities and thus have minimal impact on river flows).

FIGURE 4-42
Flint River at Montezuma. Low Flows. Full Period, Action Alternative. 2050 Demands



ACF 209

FIGURE 4-43
Flint River at Albany. Low Flows. Full Period, Action Alternative. 2050 Demands

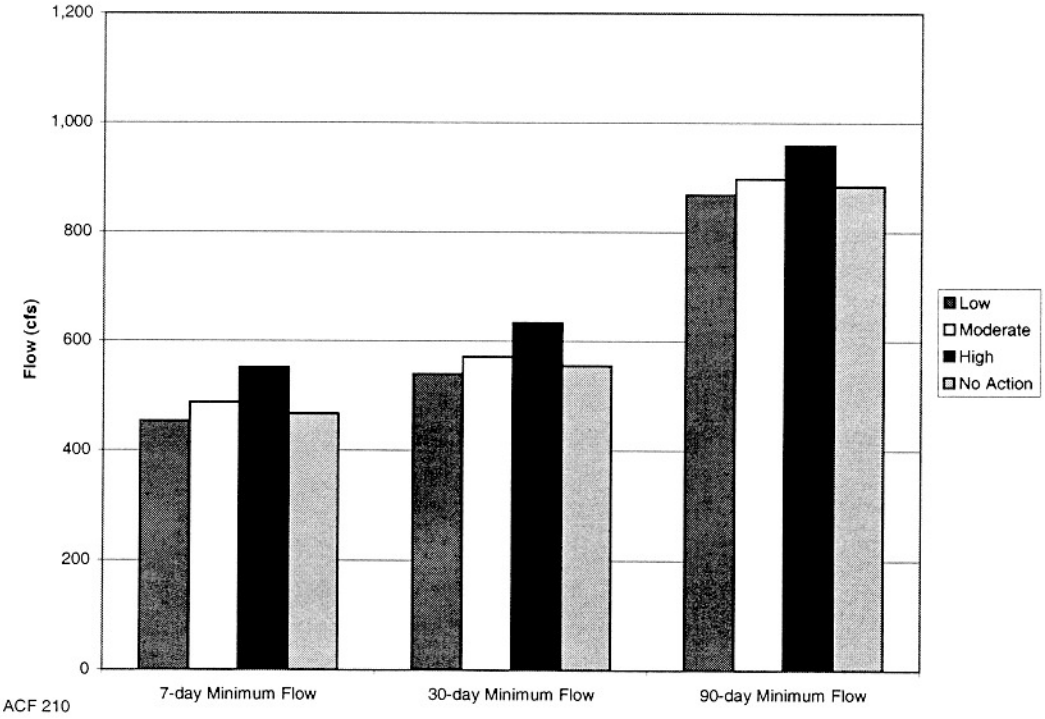


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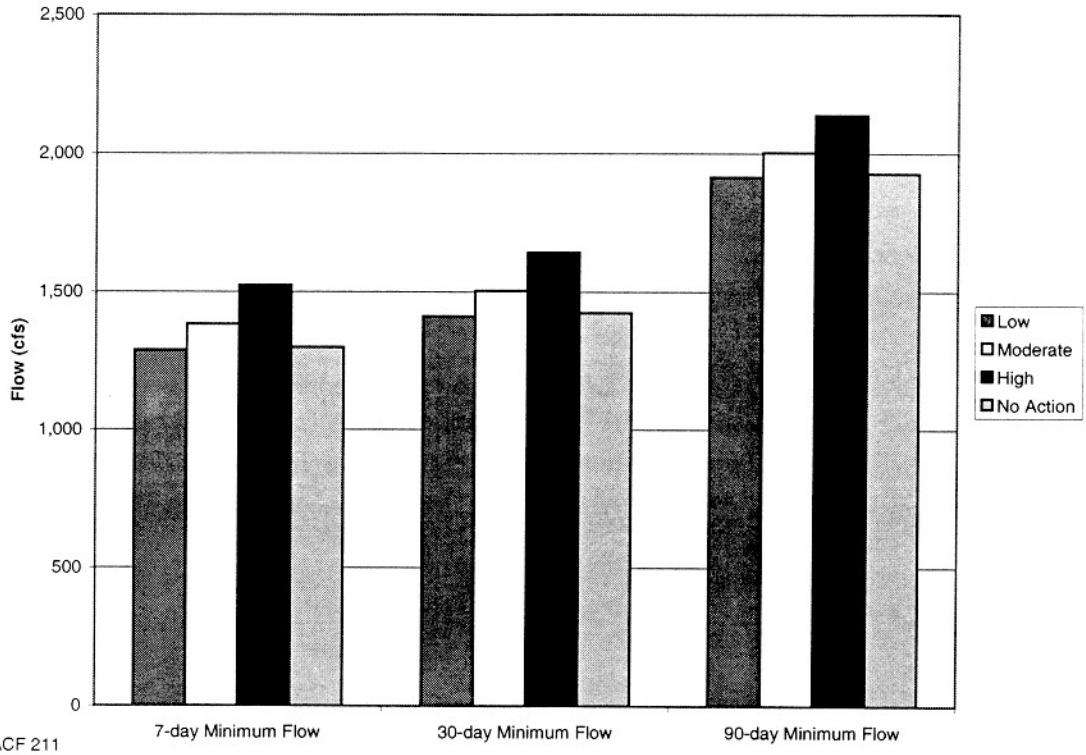
FIGURE 4-44
Flint River at Bainbridge. Low Flows. Full Period, Action Alternative. 2050 Demands



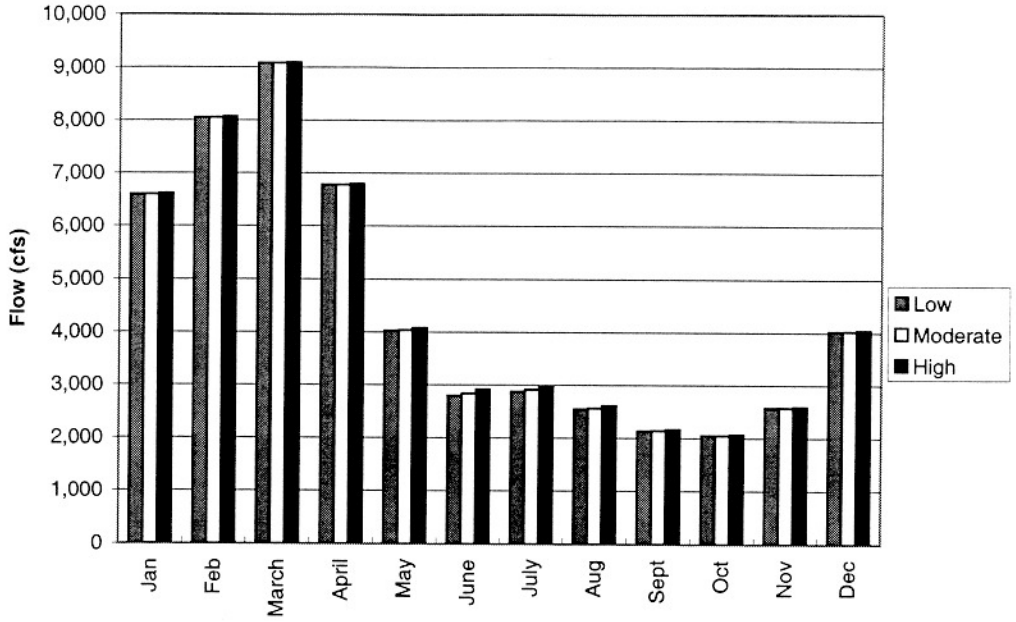
ACF 211

To analyze the impacts of the three action alternative scenarios in more detail, the 50 percent exceedance flows on the Flint River were compared over the full period of record (*Figure 4-45*). This figure illustrates little difference between the three action alternative scenarios. The greatest difference between the three scenarios can be seen in the summer months, when agricultural demands for water are the greatest. The trend is more pronounced when viewing the 90 percent exceedance flow under the critical periods (*Figure 4-46*). The differences between the three scenarios is more apparent, with the low flow scenario generally producing flows 10 percent lower than the moderate scenario. Likewise, in the dry summer months, the high flow scenario would produce flows about 10 percent higher than the moderate flow scenario. Overall, the impacts of the three action alternatives compared to the no action alternative on the Flint River would be minor. However, more substantial differences would occur in the summer months, when demands for agricultural water supply are greatest. Increased groundwater pumping during drought conditions would further reduce stream flows in the lower Flint River basin. These differences are much smaller than observed on the Chattahoochee River as a result of the action alternative scenarios.

4.4.1.2.3.4 Apalachicola River Subbasin

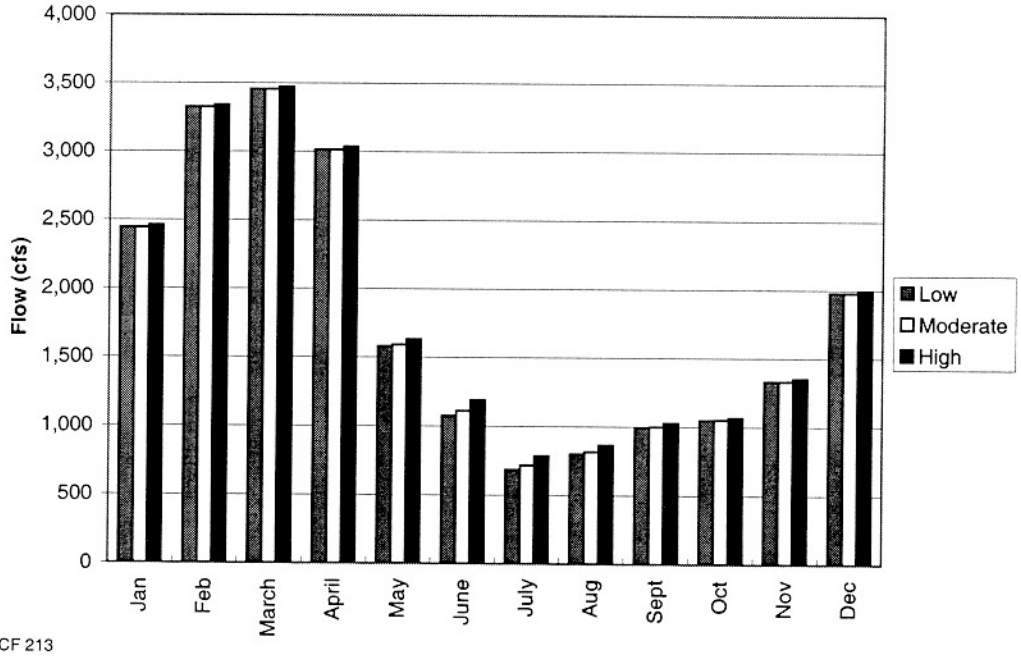
Impacts to riverine water resources in the Apalachicola River subbasin were assessed on the Apalachicola River at the Chattahoochee gage, which is located immediately downstream of Jim Woodruff Dam and further downstream at Sumatra gage. The Sumatra gage provides an indicator of the quantities of freshwater flow delivered to Apalachicola Bay.

FIGURE 4-45
Flint River at Albany. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands



ACF 212

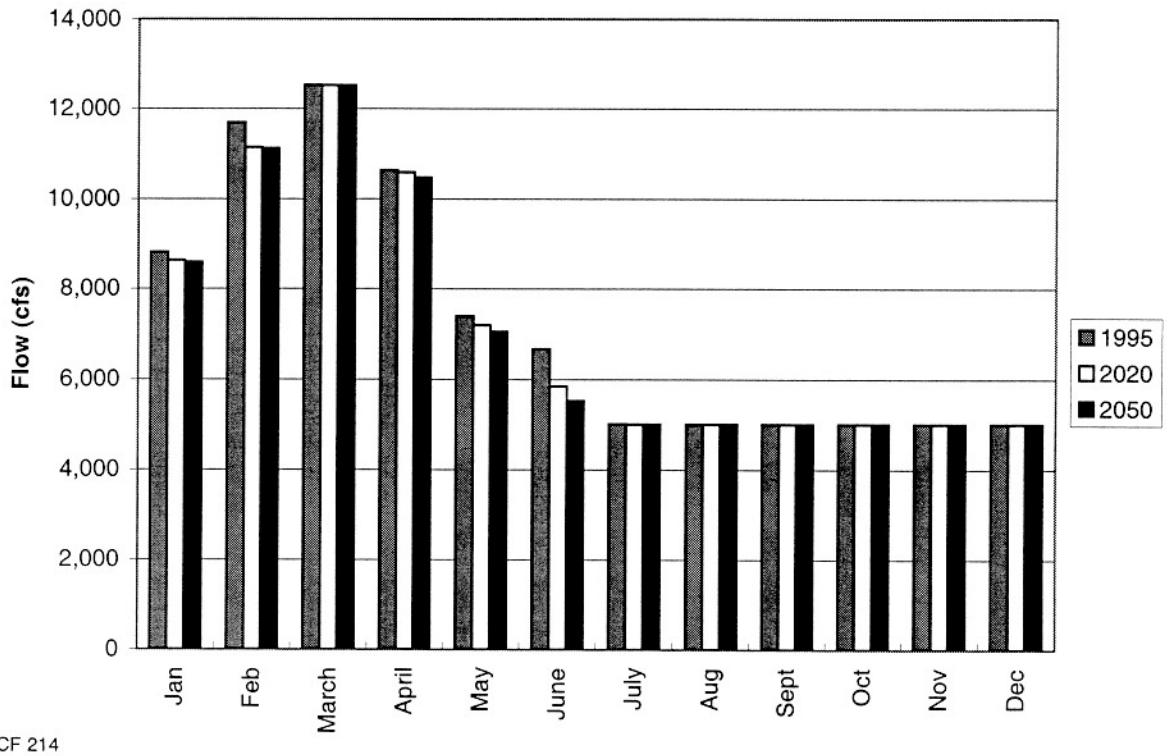
FIGURE 4-46
Flint River at Albany. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands



ACF 213

Under the no action alternative, the model predicted that the 90 percent exceedance flows under critical periods in the Apalachicola River at Chattahoochee, Florida, would decrease by 2 percent from 1995 to 2020 and by another 1 percent from 2020 to 2050 (***Figure 4-47***). The greatest decreases would occur in May and June. A similar trend was observed at the Sumatra gage, with flows decreasing very little between 1995 and 2050. The 7-day low flow at Sumatra would decrease by 3 percent from 1995 to 2050. Mean monthly flows decreased by about 5 percent from 1995 to 2050.

FIGURE 4-47
Apalachicola River at Chattahoochee, Florida. 90 Percent Exceedance. Critical Drought Period, No Action Alternative

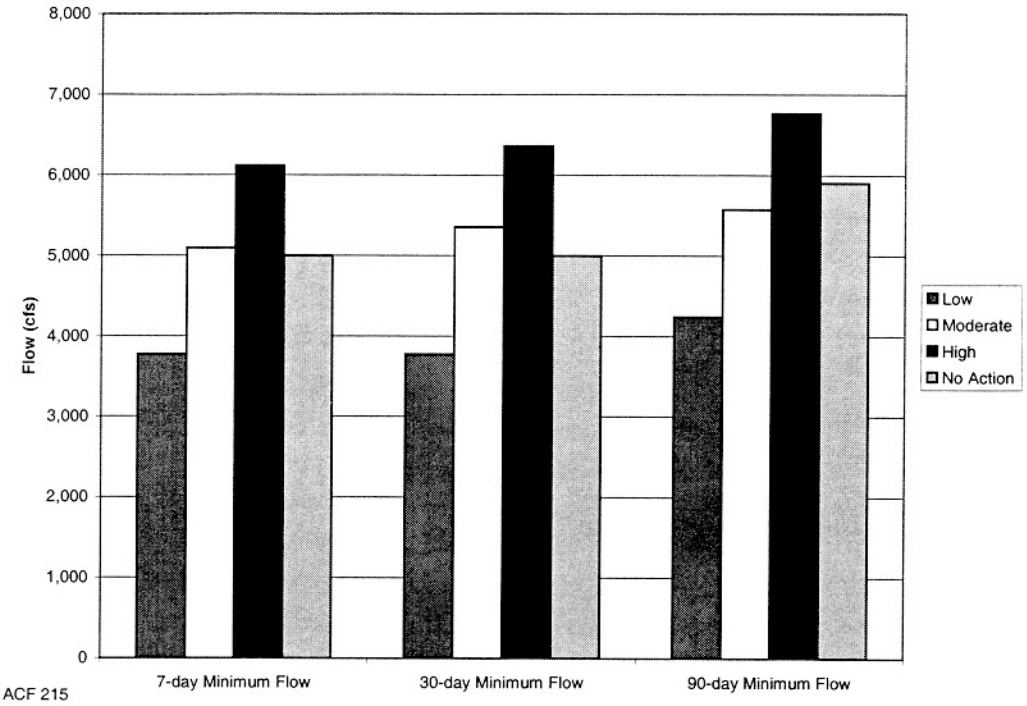


ACF 214

Figures ***4-48*** and ***4-49*** directly compare the three action alternative scenarios to the no action alternative on the Apalachicola River at Chattahoochee, Florida and Sumatra, respectively. The figures illustrate that the moderate flow scenario produces 7-day, 30-day, and 90-day low flows similar to the no action alternative. As expected, these low flows are about 30 percent lower under the low flow scenario compared to the no action alternative. The high flow scenario produces low flows about 15 to 20 percent higher than under the no action alternative. These low flow statistics represent conditions in the basin under the driest conditions of the 55-year period of record.

FIGURE 4-48

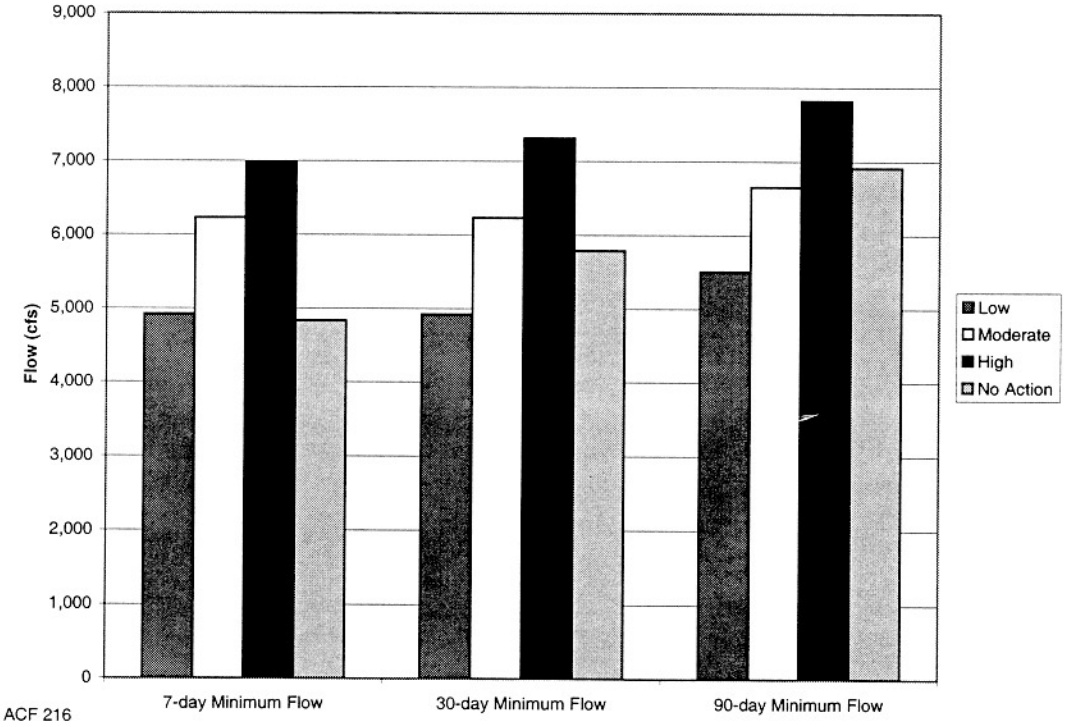
Apalachicola River at Chattahoochee, Florida. Low Flows. Full Period, Action Alternative. 2050 Demands



ACF 215

FIGURE 4-49

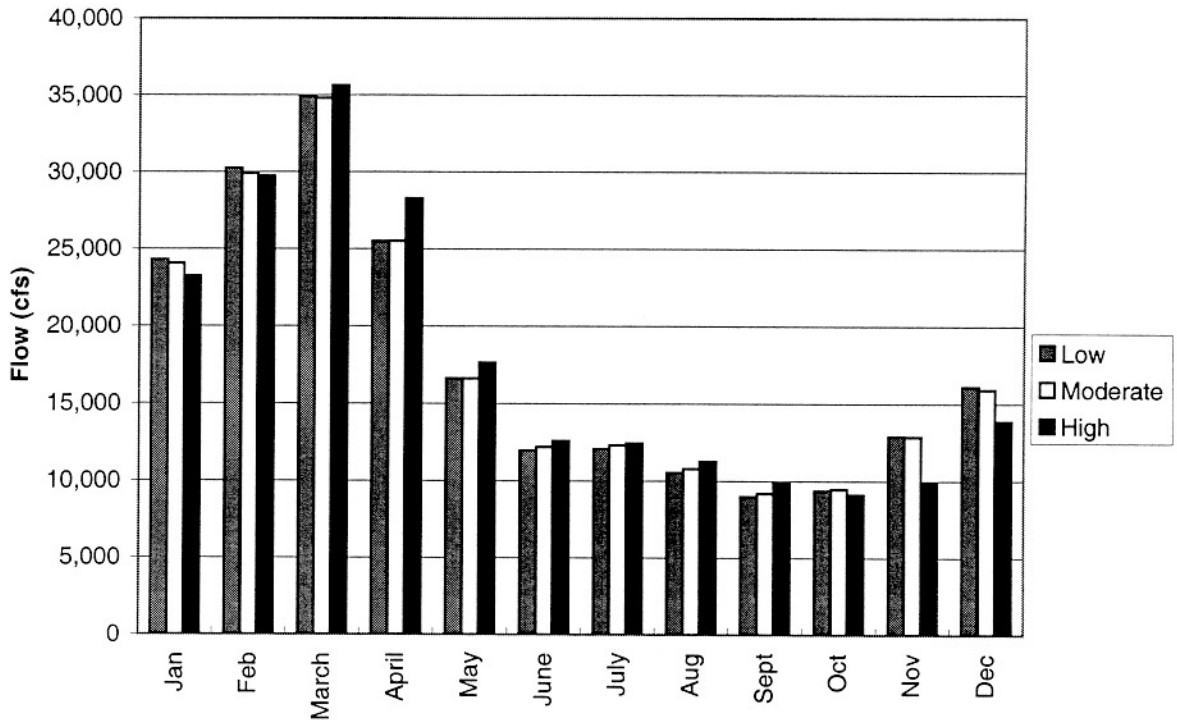
Apalachicola River at Sumatra. Low Flows. Full Period, Action Alternative. 2050 Demands



ACF 216

The action alternative scenarios were modeled to meet target flows on the Apalachicola River at Chattahoochee, Blountstown, and Sumatra, as shown in ***Table 4-10***. Taking a closer look at the differences between the three action alternative scenarios, ***Figure 4-50*** presents the 50 percent exceedance flows over the full period of record in the Apalachicola River at Chattahoochee, Florida. This figure illustrates that there are only minor differences between the three action alternative scenarios under the average conditions represented.

FIGURE 4-50
Apalachicola River at Chattahoochee, Florida. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands



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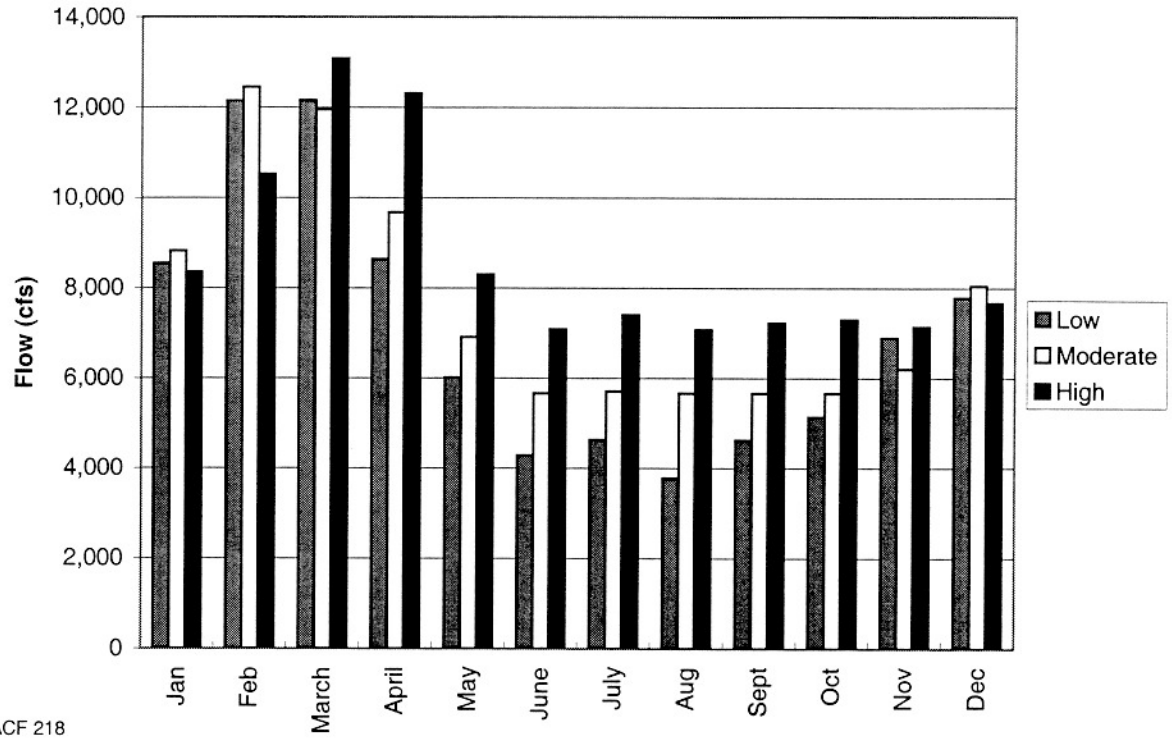
The differences between the three action alternative scenarios on the Apalachicola River are much more pronounced when considering low flows during critical periods. The 90 percent exceedance flows under critical periods exhibit differences of about 25 percent between the low and moderate flow scenarios and the low and high flow scenarios (***Figure 4-51***).

The 7-day minimum flow at the Chattahoochee gage, based on the IHA analysis of the full period of record, was 15 percent higher under the high flow scenario and 9 percent lower under the low flow scenario, compared to the moderate flow scenario. At Sumatra, the 7-day minimum flow was 10 percent higher under the high flow scenario and 5 percent lower

FIGURE 4-51
Apalachicola River at Chattahoochee, Florida. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands



ACF 218

under the low flow scenario compared to the moderate flow scenario. As shown in *Table 4-11*, the 30-day minimum flow shows only minor differences between the three scenarios, and the 90-day minimum shows no significant differences.

TABLE 4-11
Apalachicola River at Sumatra, IHA Output for Select Statistical Flows, 1995 Demands

	Low	Moderate	High
7-day minimum	9,230	9,740	10,676
30-day minimum	10,349	10,623	11,159
90-day minimum	12,742	12,883	12,648

Overall, the impacts of the action alternative scenarios on river flows in the ACF basin would be minor when considering the typical or average conditions over the full period of record. Changes in 50 percent exceedance flows would be greatest in the summer months, when demands for water are high and evapotranspiration is highest. Under low flows during critical periods, the three action alternative scenarios would differ significantly from the no action alternative. The differences would be greatest in the summer and fall. The low flow scenario would have substantially lower low flows, which could adversely affect

riverine aquatic resources, including vegetative resources and protected species. It could also adversely affect riverine recreation that is flow-dependent, such as rafting and kayaking. The high flow scenario, in contrast, would provide substantially higher flows during critical drought periods, which could enhance riverine resources. Specific impacts to these resources are addressed elsewhere in this draft EIS under the individual resources areas.

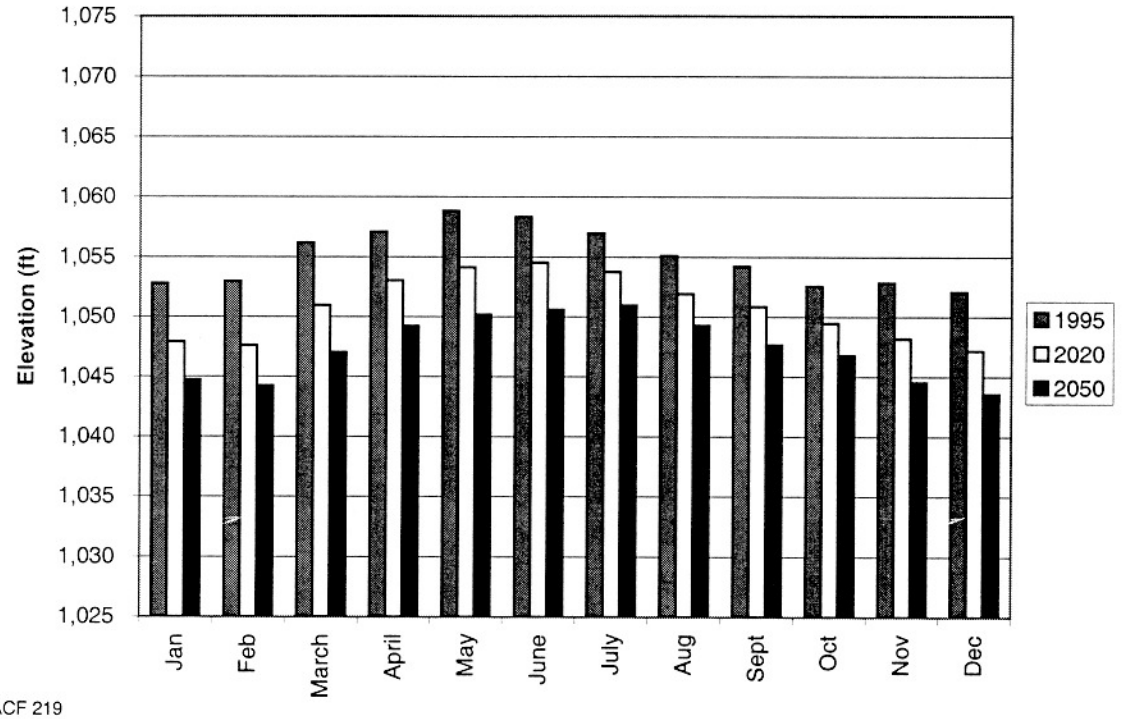
4.4.1.2.4 Reservoir Impacts

4.4.1.2.4.1 Upper Chattahoochee River Subbasin

There are two reservoirs in the Upper Chattahoochee River subbasin: Lake Sidney Lanier and Bull Sluice Lake (Morgan Falls Dam). Lake Lanier is the largest and most heavily used lake of the two. Impacts of the no action and action alternatives on Lake Lanier will be evaluated in this section.

Under the no action alternative, 90 percent exceedance reservoir levels during critical periods would decrease by 6 to 9 feet from 1995 to 2050 (***Figure 4-52***). At the same time, modeled flows downstream of Lake Lanier changed very little between 1995 and 2050, illustrating that the lake, rather than instream flows, would be primarily affected by future increased demands.

FIGURE 4-52
Lake Lanier. 90 Percent Exceedance, Critical Drought Period, No Action Alternative

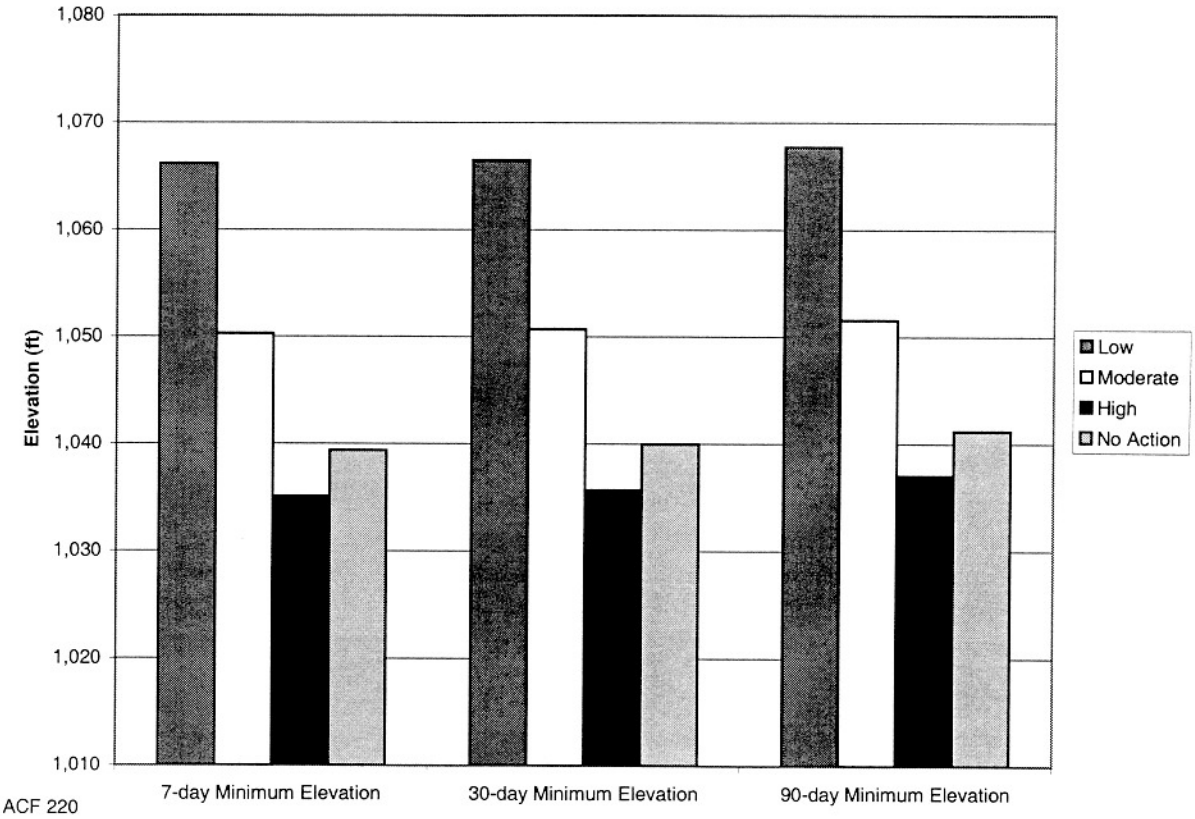


ACF 219

The action alternative scenarios would have significant effects on 7-day, 30-day, and 90-day minimum reservoir elevations at Lake Lanier compared to the no action alternative, as illustrated in ***Figure 4-53***. Both the low and moderate flow scenarios would increase minimum elevations substantially compared to the no action alternative. The low flow scenario would produce minimum elevations about 26 feet higher than the no action

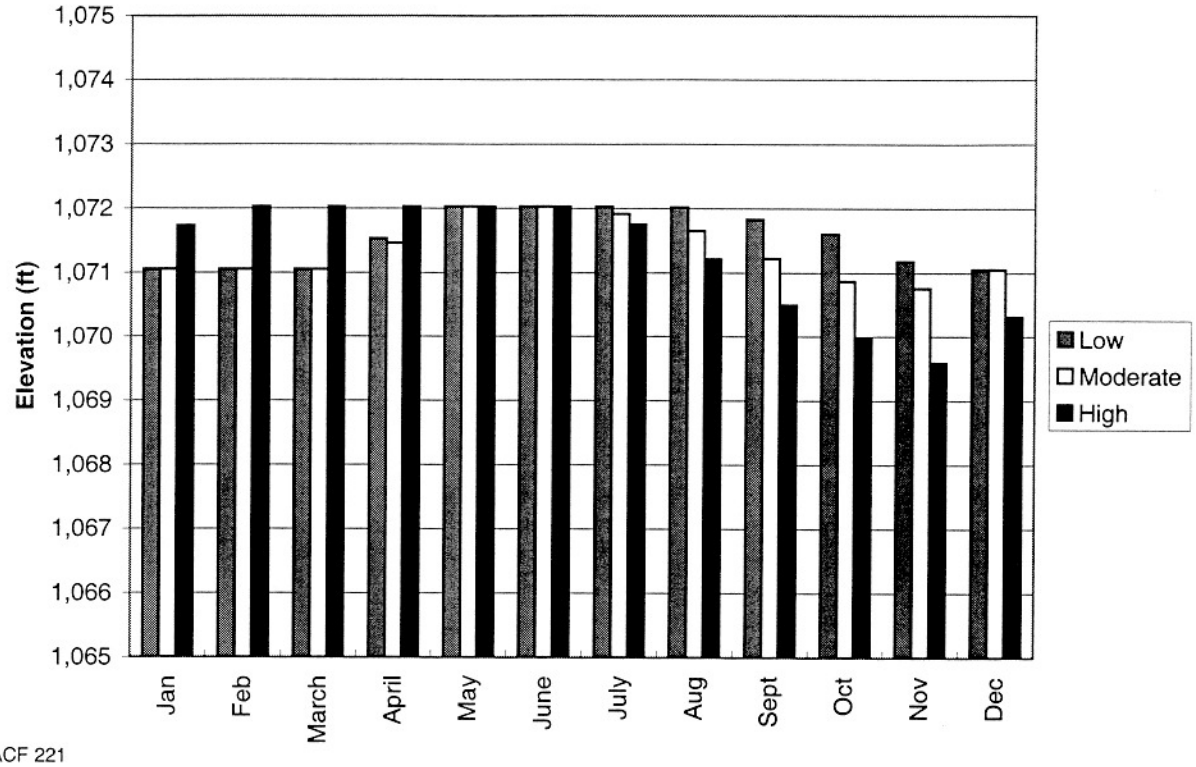
alternative; and the moderate flow scenario would produce minimum elevations 11 feet higher than the no action alternative. In contrast, the high flow scenario would produce minimum elevations about 4 feet lower than the no action alternative.

FIGURE 4-53
Lake Lanier. Low Elevations. Full Period, Action Alternative. 2050 Demands



The action alternative scenarios were modeled to draw Lake Lanier down as necessary to meet the minimum flow targets shown in ***Table 4-10*** on the Chattahoochee River at Whitesburg, Norcross, and Atlanta. To assess the impacts of the action alternative scenarios in greater detail, ***Figure 4-54*** presents 50 percent exceedance flows for the three scenarios under the full period of record. This figure demonstrates that there is very little difference between the low flow and moderate flow scenario under these conditions, which approximate average flow conditions over the full period of record. The high flow scenario, in contrast, maintains higher lake levels in the winter (due to the lack of winter drawdown in the modeling assumptions of the high flow scenario) and lower lake levels (up to 1 foot lower than the low and moderate scenarios) in the late summer and early fall. Overall, these differences between the three scenarios under average conditions are fairly minor.

FIGURE 4-54
Lake Lanier. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands



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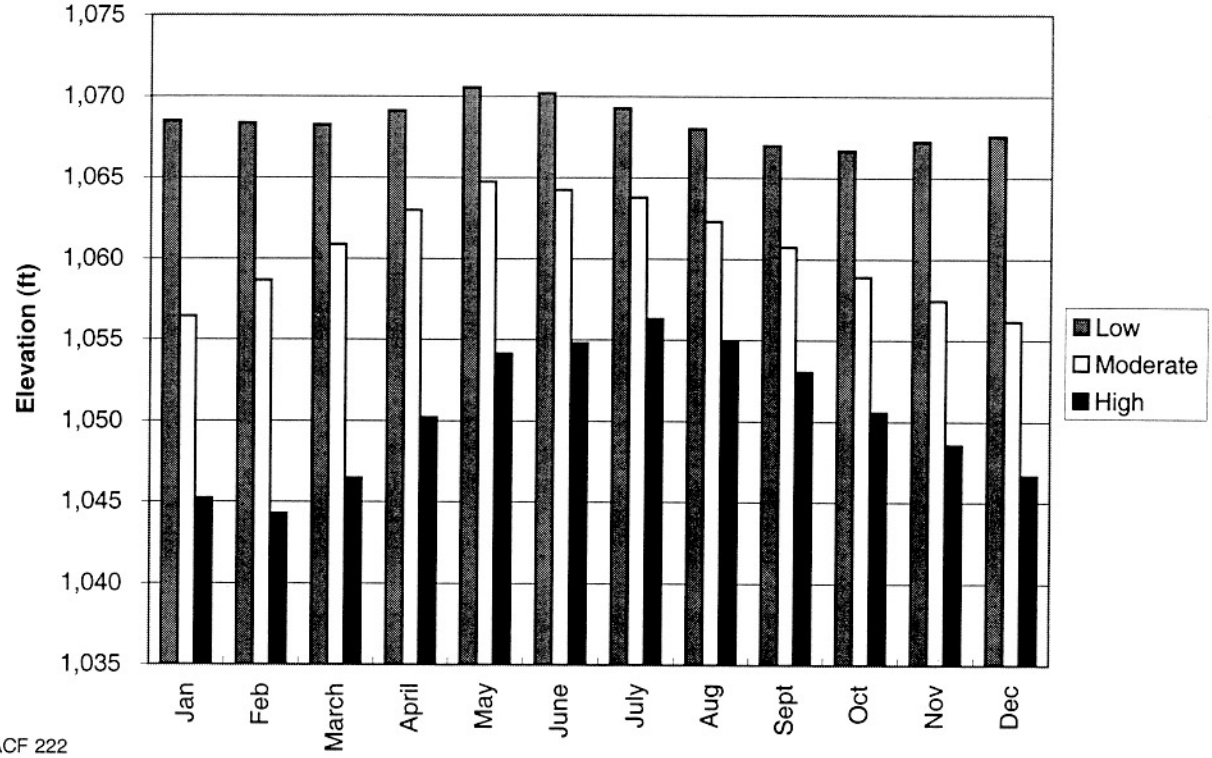
Differences between the three scenarios become more apparent when viewing 90 percent exceedance elevations for critical periods only. ***Figure 4-55*** shows substantial differences between the three scenarios in all months of the year, with the consistent trend of the low flow scenario producing the highest and most stable reservoir elevations and the high flow scenario producing substantial drawdowns compared to current operating levels. For example, the 90 percent exceedance elevations under the high flow scenario is July is about 15 feet lower than the typical summer operating level at Lake Lanier. This figure illustrates the substantial impacts that could result under critical conditions due to the three action alternative scenarios.

4.4.1.2.4.2 Lower Chattahoochee River Subbasin

There are 11 dams and reservoirs on the Chattahoochee River in the lower subbasin: West Point, Langdale, Riverview, Bartletts Ferry, Goat Rock, Oliver, North Highlands, City Mills, Eagle and Phenix, Walter F. George Lake, and George W. Andrews. West Point Lake and Walter F. George Lake are the largest and most highly visited lakes in the lower subbasin. These two lakes are evaluated in this section.

FIGURE 4-55
Lake Lanier. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands



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Under the no action alternative, increased water demands in the basin through the year 2050 would cause minor decreases in reservoir levels in both West Point Lake and Walter F. George Lake. To illustrate, ***Figures 4-56*** and ***4-57*** present the 90 percent exceedance levels under critical conditions for 1995, 2020, and 2050 at the two reservoirs. The figures demonstrate that West Point Lake would experience greater changes in water levels as water demands increase through the years. Water levels at Walter F. George would change very little with increasing water demands.

Reservoir water levels under critical dry periods illustrate substantial differences between low and moderate flow scenarios compared to the no action alternative. As shown in ***Figures 4-58,*** the 7-day, 30-day, and 90-day minimum reservoir elevations at West Point Lake, the low and moderate scenarios produce minimum elevations 8 feet higher than the no

FIGURE 4-56
West Point Lake. 90 Percent Exceedance. Critical Drought Period, No Action Alternative

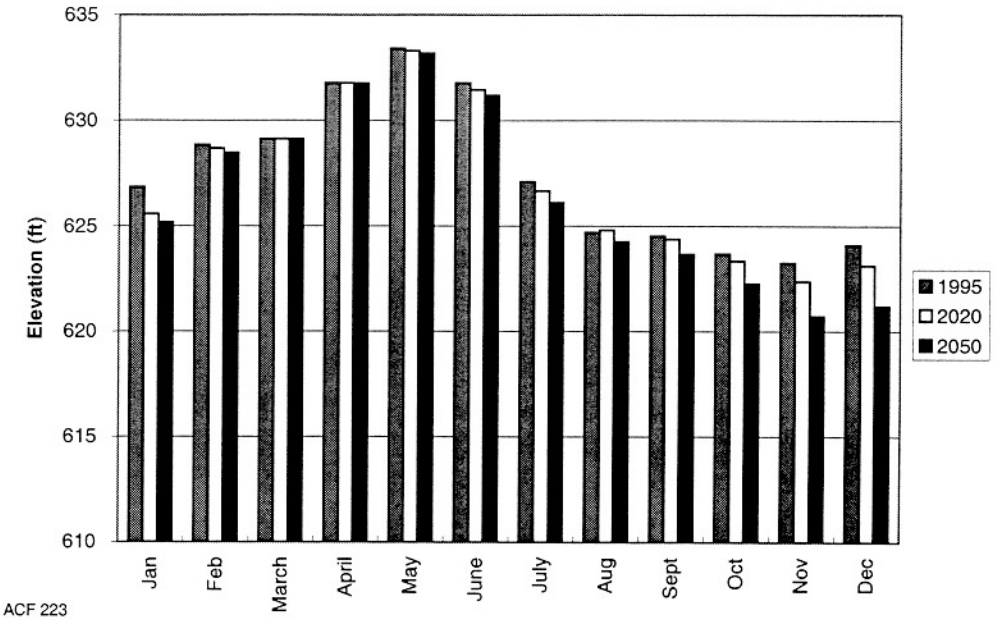

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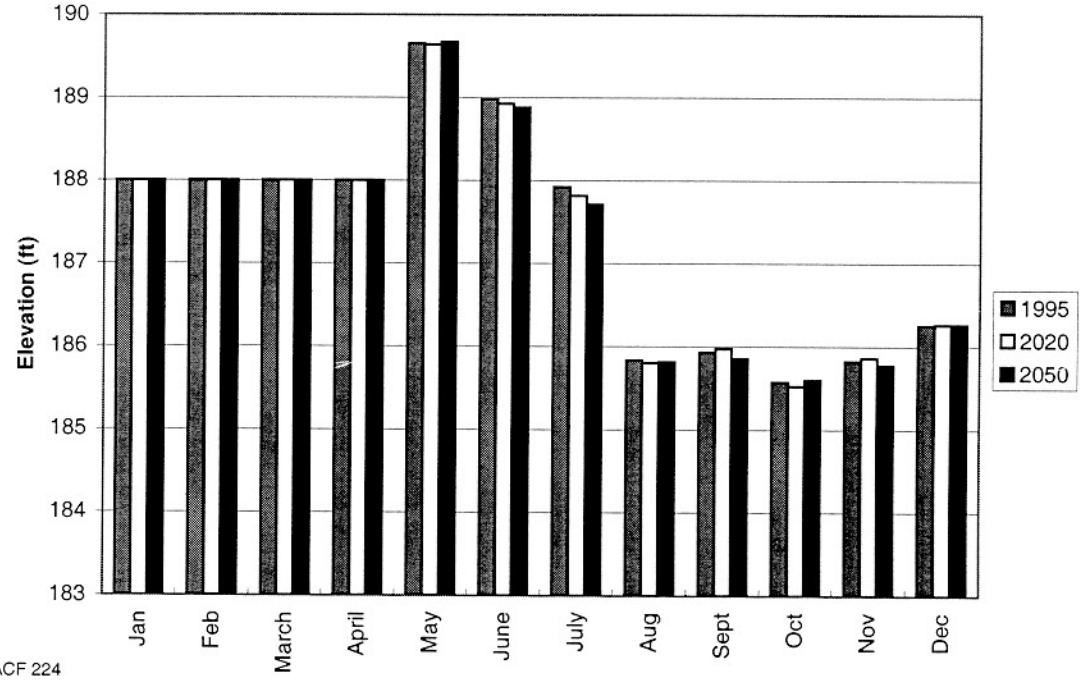
FIGURE 4-57
Walter F. George Lake. 90 Percent Exceedance. Critical Drought Period, No Action Alternative



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action alternative, while the high flow scenario exhibits minimum elevations very similar to the no action alternative. At Walter F. George Lake (***Figure 4-59***), the low and moderate flow scenarios have minimum elevations 2 to 3 feet higher than the no action alternative, whereas the high flow scenario has minimum elevations about 0.5 foot less than the no action alternative. These conditions represent the lowest 7-day, 30-day, and 90-day periods throughout the 55-year period of record.

FIGURE 4-58
West Point Lake. Low Elevations. Full Period, Action Alternative. 2050 Demands

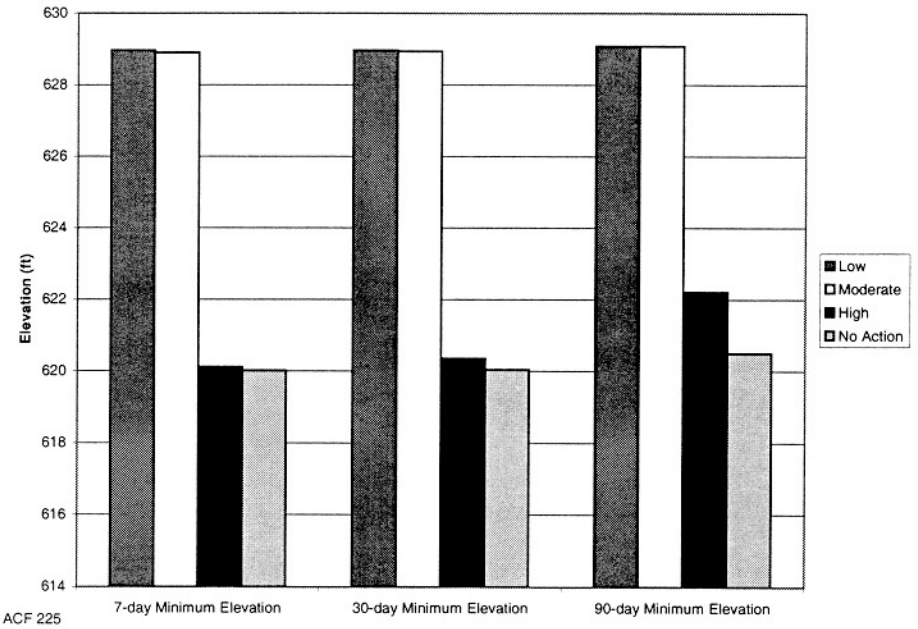

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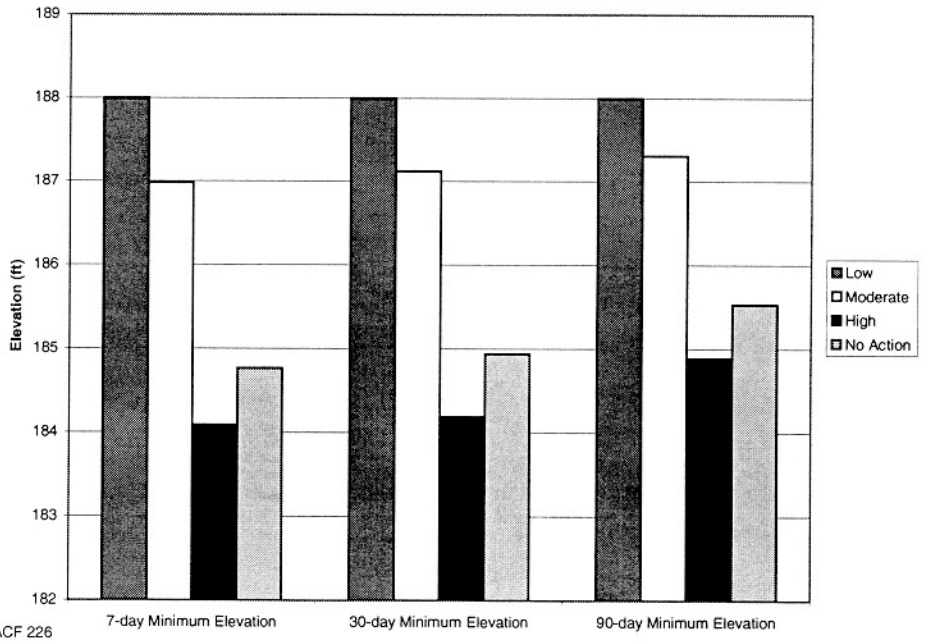
FIGURE 4-59
Walter F. George Lake. Low Elevations. Full Period, Action Alternative. 2050 Demands



ACF 226

Water levels in West Point and Walter F. George Lakes were drawn down in the HEC-5 modeling to meet downstream flow targets at West Point Dam, Columbus, Walter F. George Dam, and George Andrews Lock and Dam, as shown in ***Table 4-10***. ***Figures 4-60*** and ***4-61*** present a more detailed analysis of the action alternative scenarios at West Point Lake and Walter F. George Lake, respectively. These figures indicate that the 50 percent exceedance flows over the full period of record are very similar under the low and moderate scenarios. However, the figures illustrate the effects of the lack of winter drawdown in the high flow scenario. The high flow scenario would maintain reservoir elevations substantially higher than the low and moderate flow scenarios in the fall and winter under the average conditions represented in these figures. This implies that the reservoirs have sufficient water to supply the higher target flows under typical conditions, without significant drawdowns in the reservoirs.

FIGURE 4-60
West Point Lake. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands

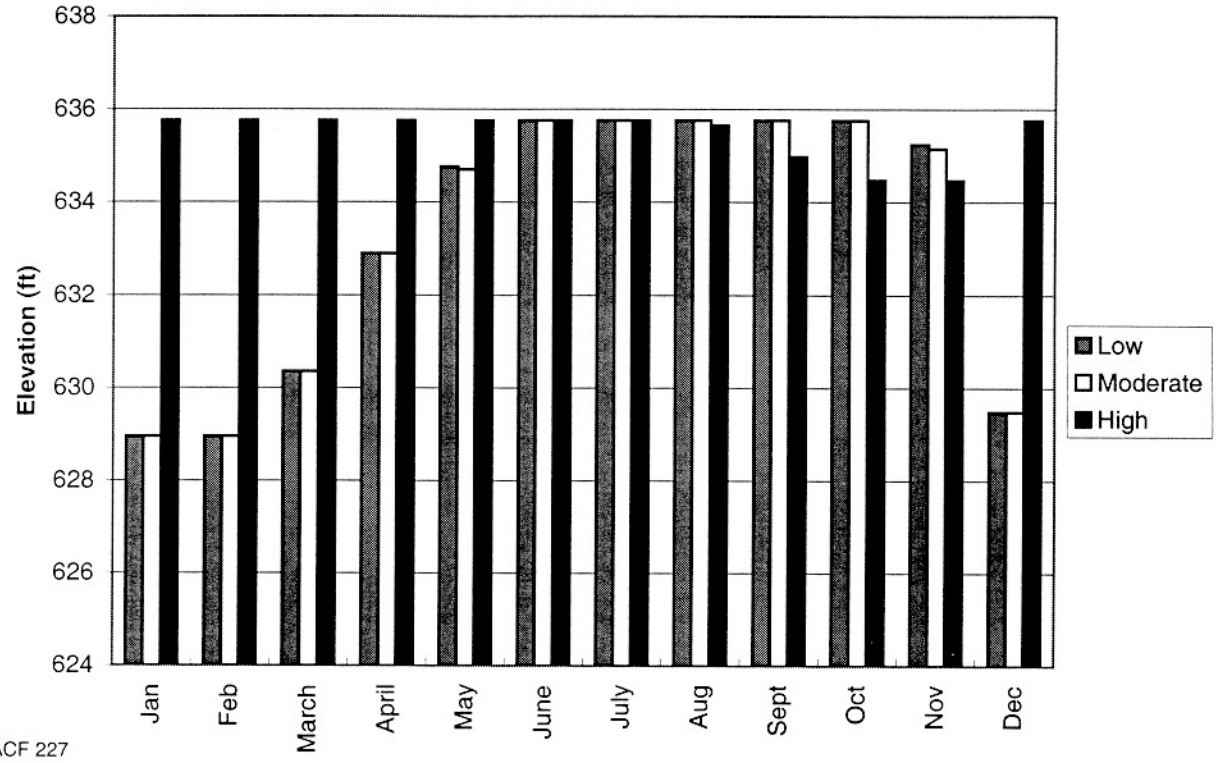


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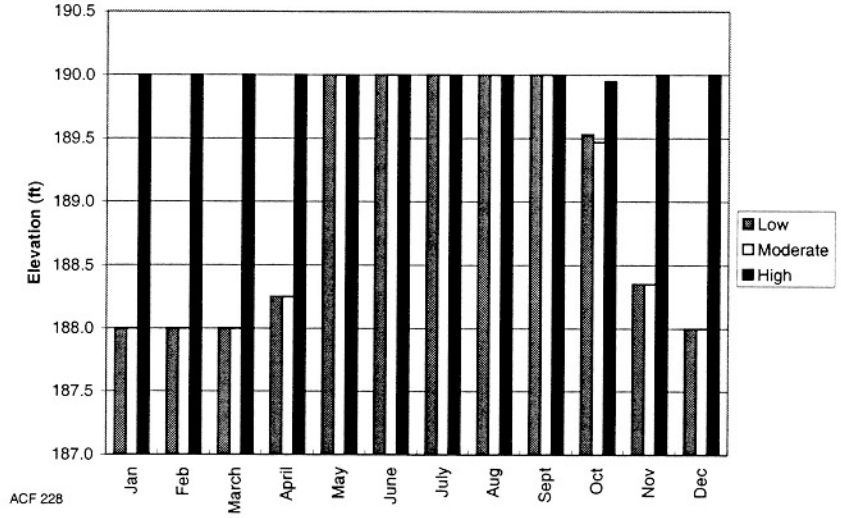
FIGURE 4-61
Walter F. George Lake. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands



Finally, the effects of the three action alternative scenarios were analyzed under critical periods, low flow conditions. ***Figures 4-62*** and ***4-63*** present the 90 percent exceedance elevations under critical periods at West Point Lake and Walter F. George Lake, respectively. The effects of the higher target flows under the high flow scenario are demonstrated in these figures. Unlike the previous analysis under average conditions, these figures illustrate that the reservoirs would be drawn down substantially under critical low flow conditions to meet the higher target flows of the high flow scenario. The low flow and moderate flow scenarios produce generally similar results under critical low flow conditions.

FIGURE 4-62
West Point Lake. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands

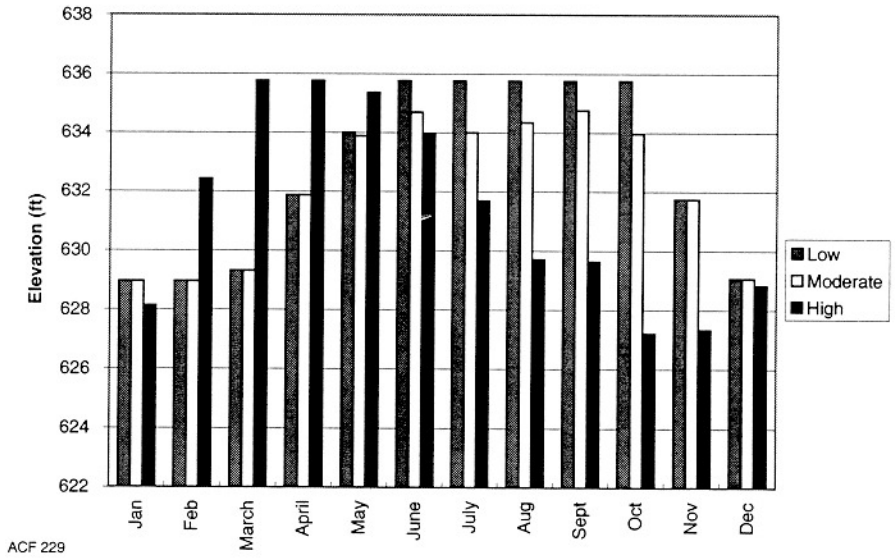
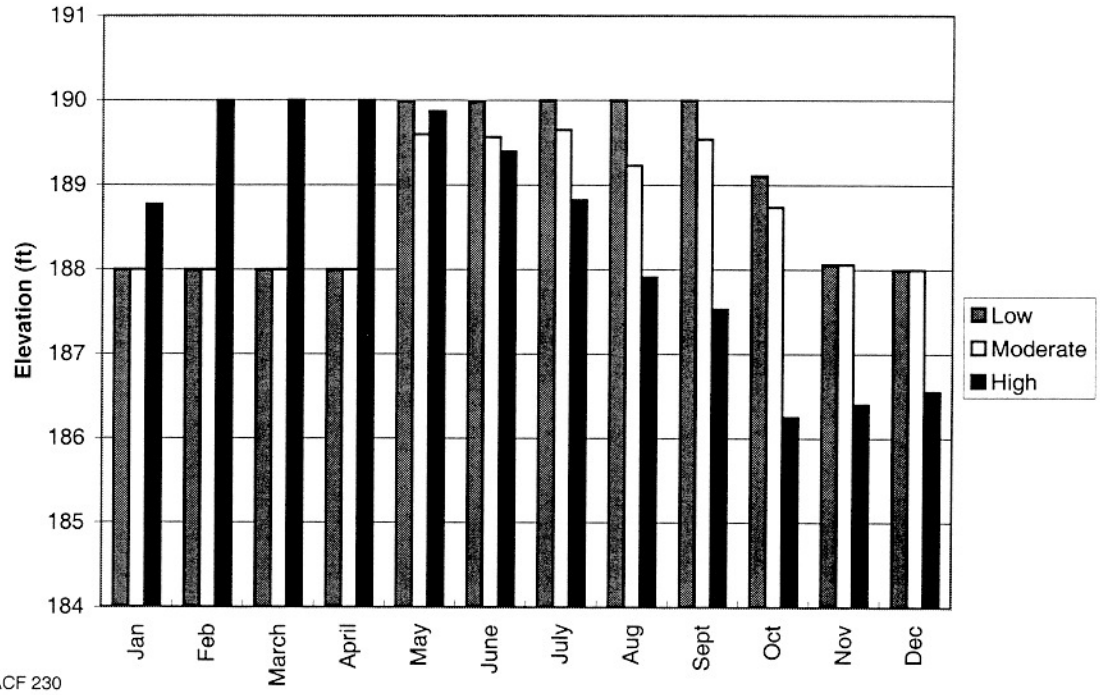


FIGURE 4-63
Walter F. George Lake. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demands



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4.4.1.2.4.3 Flint River Subbasin

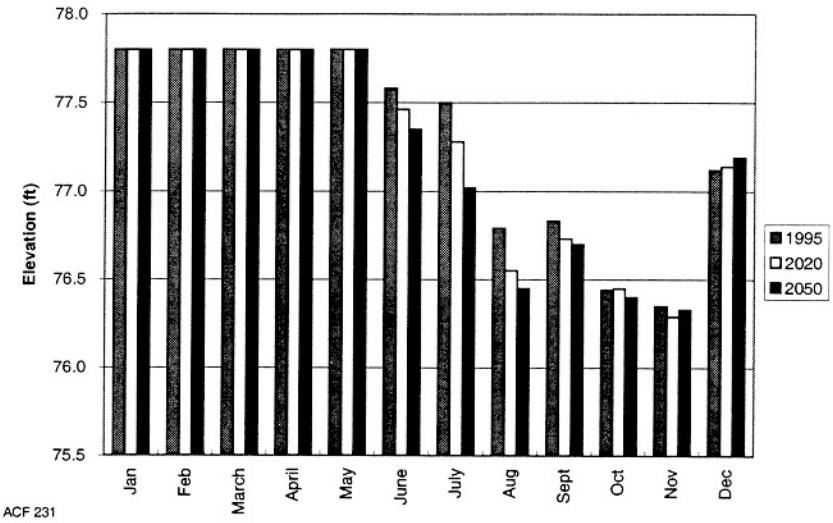
There are two reservoirs in the Flint River subbasin—Lake Blackshear and Lake Worth. Both reservoirs operate generally as run-of-river and thus were not explicitly modeled in HEC-5. The reservoirs levels would remain constant under each alternative and flow scenario. Thus, there would be no impact to reservoirs in the Flint River subbasin as a result of the action alternative and no significant impacts due to increased demands. The nature and extent of impacts on the Flint River flows were addressed earlier in Section 4.4.1.2.4.3.

4.4.1.2.4.4 Apalachicola River Subbasin

There is one reservoir in the Apalachicola River subbasin—Lake Seminole. Lake Seminole is located at the confluence of the Flint and Chattahoochee Rivers. Impacts to reservoir levels in this subbasin are evaluated at Lake Seminole under the various alternatives and scenarios considered.

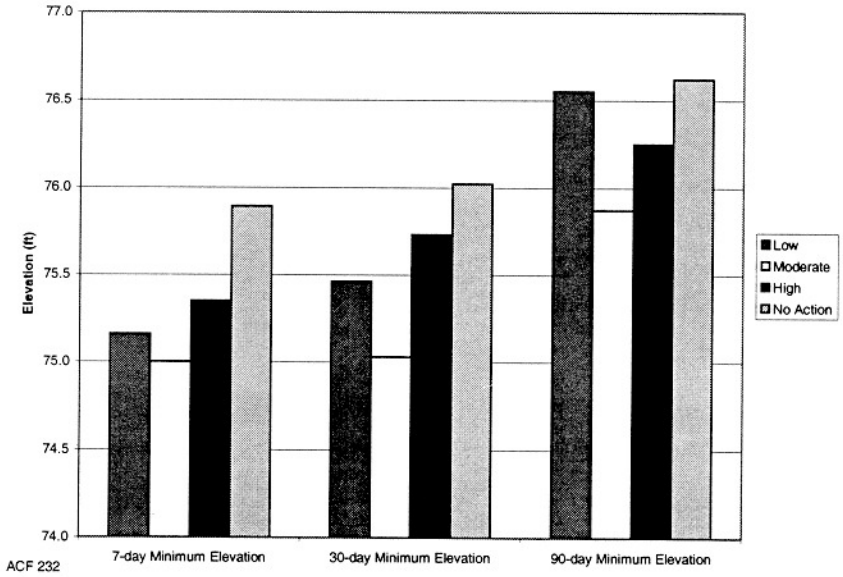
Lake levels at Lake Seminole remain fairly stable with little variation throughout the year. Under the no action alternative, the model predicted that 50 percent exceedance reservoir levels would not vary between 1995 and 2050. However, 90 percent exceedance reservoir levels would decrease slightly in the summer months, by about 0.1 to 0.2 feet (***Figure 4-64***). August experienced the largest change in reservoir levels between 1995 and 2050.

FIGURE 4-64
Lake Seminole. 90 Percent Exceedance. Critical Drought Period, No Action Alternative



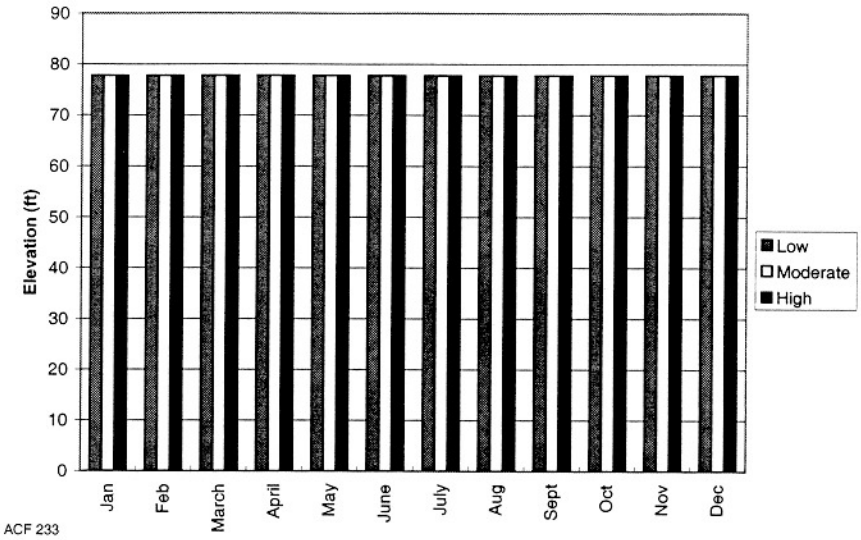
A direct comparison of minimum reservoir elevations under the action alternative scenarios and no action alternative reveals that all three action scenarios produce lower minimum elevations than the no action alternative (*Figure 4-65*). The differences between the action scenarios and the no action alternative range from 0.1 to 1.0 foot. This represents conditions during the lowest 7-day, 30-day, and 90-day reservoir levels in the 55-year period of record.

FIGURE 4-65
Lake Seminole. Low Elevations. Full Period, Action Alternative. 2050 Demands



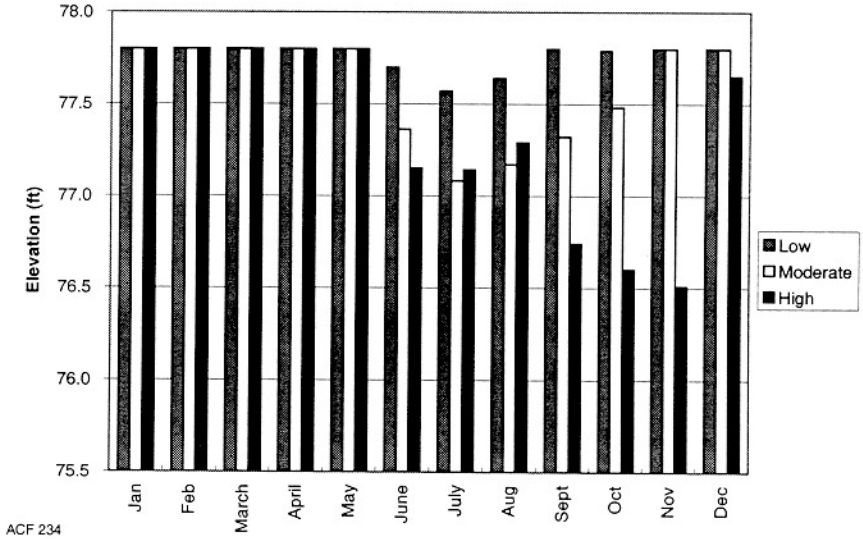
A more detailed analysis into the three action alternative scenarios finds no difference between the three scenarios in the 50 percent exceedance flows over the full period of record (*Figure 4-66*). However, under critical periods, the 90 percent exceedance elevations do show

FIGURE 4-66
Lake Seminole. 50 Percent Exceedance. Full Period, Action Alternative. 2050 Demands



substantial differences between the three scenarios, particularly in late summer and fall (*Figure 4-67*). The patterns of the three scenarios correspond to the level of target flows—as the reservoir is drawn down to meet the downstream target flows at Chattahoochee, Blountstown, and Sumatra. Water levels under the high flow scenario experience the greatest impact, as levels continue to decrease throughout the summer and fall to meet the high target flows. The low and moderate flow scenarios show some drawdowns in summer to meet the target flows, but water levels generally increase again in early fall.

FIGURE 4-67
Lake Seminole. 90 Percent Exceedance. Critical Drought Period, Action Alternative. 2050 Demand



Overall, impacts to reservoirs would be significant for the high flow scenario, which would draw reservoirs down to augment downstream flows. Impacts would be greatest under critical drought conditions. Under average conditions, the impacts would be much less severe although impacts would exist under average conditions. Substantial reservoir drawdowns under critical drought periods could adversely affect fisheries, vegetation, and recreation. Specific impacts to these resources are addressed within each resource section of this draft EIS. In contrast, the low flow scenario would offer substantial beneficial impacts by maintaining higher, more stable reservoirs. However, under precipitation events, the reservoir levels and flows below the reservoirs could experience more rapidly changing conditions under the low flow scenario due to the reduced amount of storage in the reservoirs to attenuate peak inflows.

4.4.1.2.5 Groundwater Impacts

Groundwater resources support municipal, industrial, and agricultural demands in the basin. Under the no action alternative, the use of groundwater resources would continue to increase as agricultural production increases in the basin. Under the low flow scenario, more pressure would be put on groundwater sources of water because the low river flows may be insufficient to support all the demands. Groundwater tables may be lowered due to the increased pumping in the basin. The increased groundwater pumping in the lower portion of the ACF basin could result in the formation of sinkholes or other subsidence features as the rate of carbonate dissolution is increased. These features could increase the flow of water into or out of the karst environment, causing localized changes in groundwater recharge and discharge. Collapse features have the potential to destroy agricultural crop land and shallow sinkhole ponds, thus altering the landscape, aquatic habitat, and land use patterns.

Under the moderate flow scenario, there would be little change expected in the demand for groundwater resources. Groundwater withdrawals would be expected to increase at about the same rate as the no action alternative.

The high flow scenario provides substantially higher summer flows compared to the no action alternative. This scenario would have little impact on groundwater resources because water demands would generally be met by stream flows. There may be a reduction in the amount of groundwater pumping required or a reduction in the rate at which groundwater reliance increases if more water can be withdrawn from surface water sources.

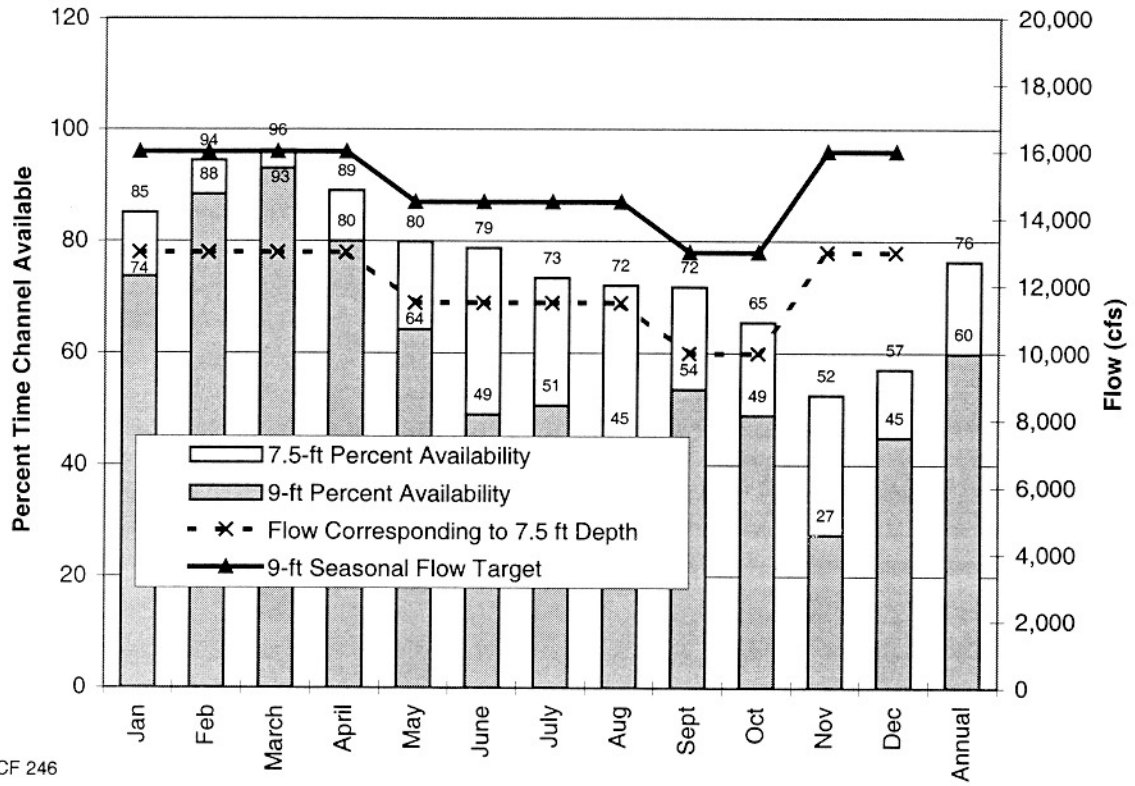
Overall impacts on groundwater quantity may be greater than modeled during a drought; however, the actual increase in groundwater usage cannot be quantified at this time.

4.4.1.2.6 Navigation Impacts

The Corps used the HEC-5 results at Blountstown to assess navigation channel availability on the Apalachicola River. A 9-foot channel is needed to fully support navigation, while a 7.5-foot channel is the minimal depth able to support a limited amount of navigation. Navigation users on the Apalachicola River indicate that a minimal 8.0-foot channel is necessary to support continued shipments on the system. A flow of 13,000 to 16,000 cfs is needed to support a 9-foot depth without dredging, and a flow of 10,000 to 13,000 cfs is needed for a 7.5-foot depth.

Under the no action alternative for the year 2050, a 7.5-foot channel is provided over 80 percent of the time from January to June (***Figure 4-68***). During the drier summer and fall months, a 7.5-foot channel is provided between 52 and 79 percent of the time. A 9-foot channel is provided over 50 percent of the time, except for June, August, and October through December. The no action alternative is modeled with a winter drawdown at some of the reservoirs, which helps augment flows in the late fall/early winter.

FIGURE 4-68
Apalachicola River at Blountstown Navigation Channel Availability. No Action Model With 2050 Moderate Demands



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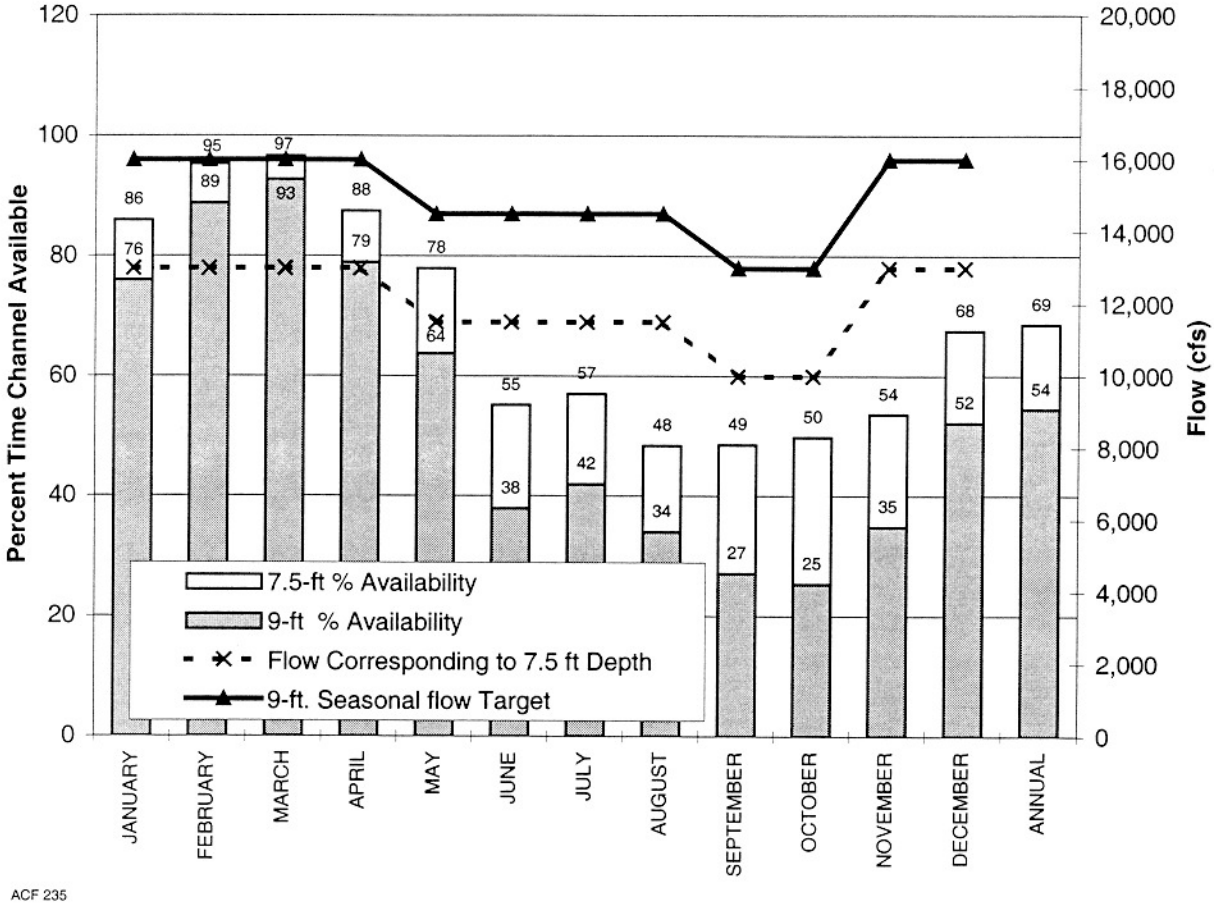
Overall, for each action alternative flow scenario, the percent of time that a 9-foot and 7.5-foot channel is available would decrease only slightly (generally less than 5 percent) from 1995 to 2050, due to increased consumptive demands in the basin.

The HEC-5 model predicts that the low flow action alternative scenario would maintain summer channel depths significantly lower than the no action alternative. Availability of the 9-foot channel is high (about 90 percent) in February and March, then decreases gradually through the summer to a low of 25 to 30 percent in September and October under the low flow scenarios (***Figure 4-69***). The 7.5-foot channel depth is between 95 and 100 percent for February and March, then decreases to about 50 percent through summer and early fall, before rising again in late fall.

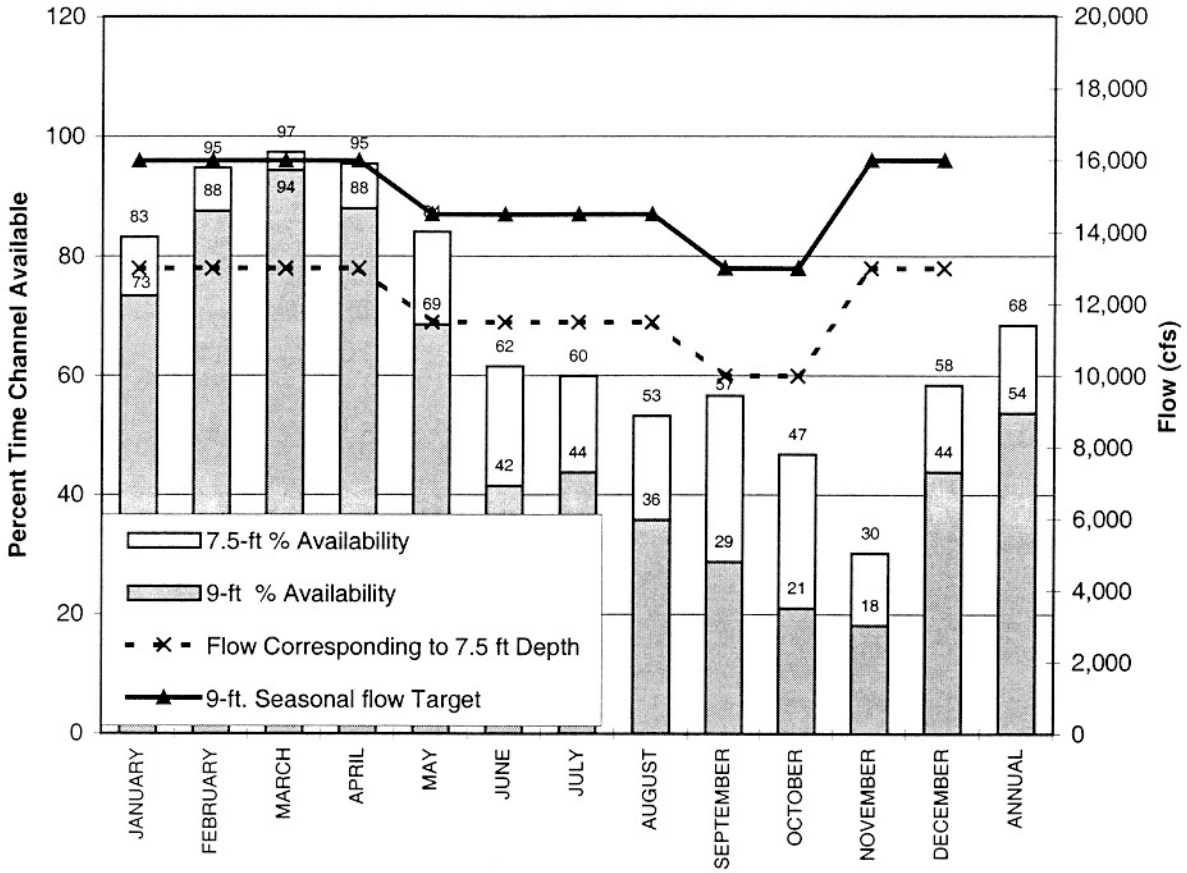
FIGURE 4-69
Apalachicola River at Blountstown Navigation Channel Availability. Low Flow Scenario with 2050 Demands



The annual pattern of channel availability is somewhat different for the high flow action alternative scenario, because the modeling assumed no winter drawdown of the reservoirs. The winter drawdown modeled under the low and moderate scenarios (and under the no action alternative) helps augment downstream flows through the late fall/early winter. Without that drawdown to augment navigation flows, the availability of navigation depths decreases substantially in November. The high flow scenario has the same pattern of channel availability in the winter and early summer as the no action and low flow scenarios, with high availability (95 to 100 percent) from February through April for the 7.5-foot channel and 85 to 90 percent for the 9-foot channel. The availability gradually decreases through the summer and fall, with the minimum availability occurring in November (when the 7.5-foot channel is available about 30 percent of the time and the 9-foot channel about 20 percent of the time (see ***Figure 4-70***).

FGURE 4-70

Apalachicola River at Blountstown Navigation Channel Availability. High Flow Scenario with 2050 Demands



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The Corps currently uses navigation windows in the summer and fall when adequate navigation depths cannot be maintained. A separate analysis determined the impact of the navigation windows management scheme on basin water resources. The full report is included in ***Appendix D***. That analysis concluded that navigation window operation ultimately results in more water stored in the downstream projects than would be stored without navigation windows operation. Reservoir levels at Lake Lanier are lower in every month and flows on the Chattahoochee River at Atlanta and Columbus are generally higher in the summer and lower in the fall with navigation window operation than without. To support the navigation windows, water is moved through the upper and middle Chattahoochee to maintain reservoir levels at the Walter F. George Lake and Lake Seminole. West Point Lake is filled earlier in the year and then used to augment flow in the downstream projects to provide navigation window releases. Overall, the analysis concluded that the navigation window operation has not impacted the seasonal distribution of flow in the Apalachicola River. There is no evidence in the hydrologic data that water is being held over and released between seasons to benefit navigation window operation.

4.4.1.2.7 Flood Control Impacts

Because the HEC-5 modeling conducted for evaluation of hydrologic data in this EIS is a low flow evaluation, it is not appropriate to use it to assess impacts on flood flows and flood

control. A separate analysis evaluates the downstream impacts of reallocating flood control in two major flood control reservoirs in the ACF basin: Lake Lanier and West Point Lake. The analysis compared the effects of maintaining current flood control storage, eliminating one-half of current flood control storage, and eliminating all flood control storage in these reservoirs. The impacts of these three options on downstream flows were analyzed using flood routing analysis. The detailed report is included in *Appendix D*.

The analysis concluded that eliminating half of the flood control storage would increase downstream flows substantially at West Point Lake. Eliminating half of flood control storage would increase downstream flows by about 30 percent for all frequency floods. Eliminating all flood storage at West Point would increase downstream flows from 100 percent for the 2- and 5-year floods to about 70 percent for the 50- to 250-year floods and 60 percent for the 500-year flood (*Figure 4-71*). At Lake Lanier, decreasing flood control storage by half had no effect on downstream flood flows less than the 500-year flood, although dam safety issues could become more of a concern because the level of stored water would increase closer to the spillway. Dam safety issues would have to be investigated closely if the option to reduce flood control storage is pursued. There would also be increased flooding upstream, although flood damage impacts were not evaluated in this analysis. Eliminating all flood storage at Lake Lanier would increase downstream flows by 160 percent for the 2-year flood, about 90 percent for the 5-year to 50-year floods, and 95 to 100 percent for the 100 to 500-year floods (*Figure 4-72*).

FGURE 4-71
Peak Flood Frequency at West Point

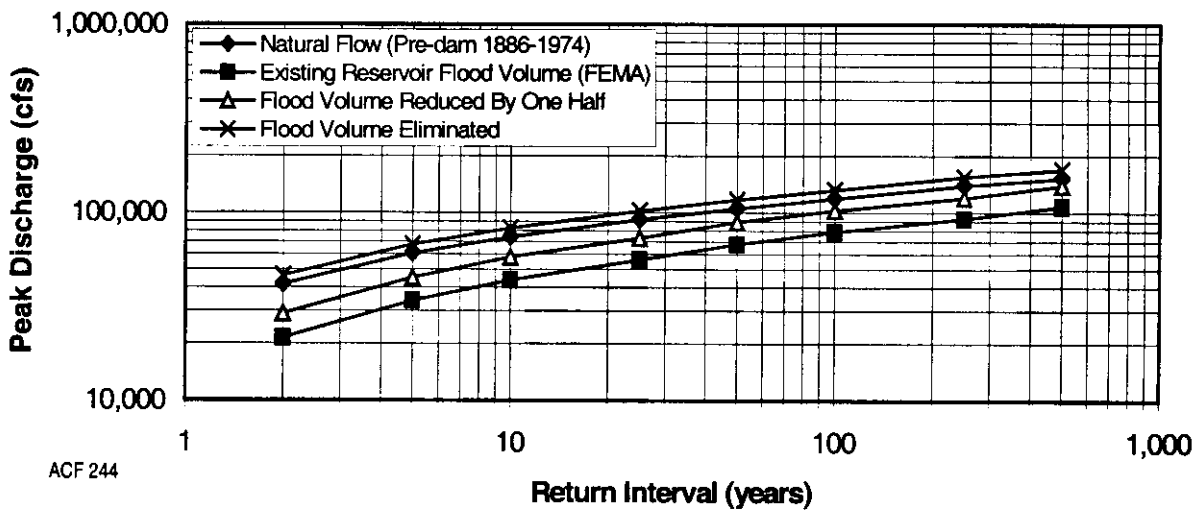
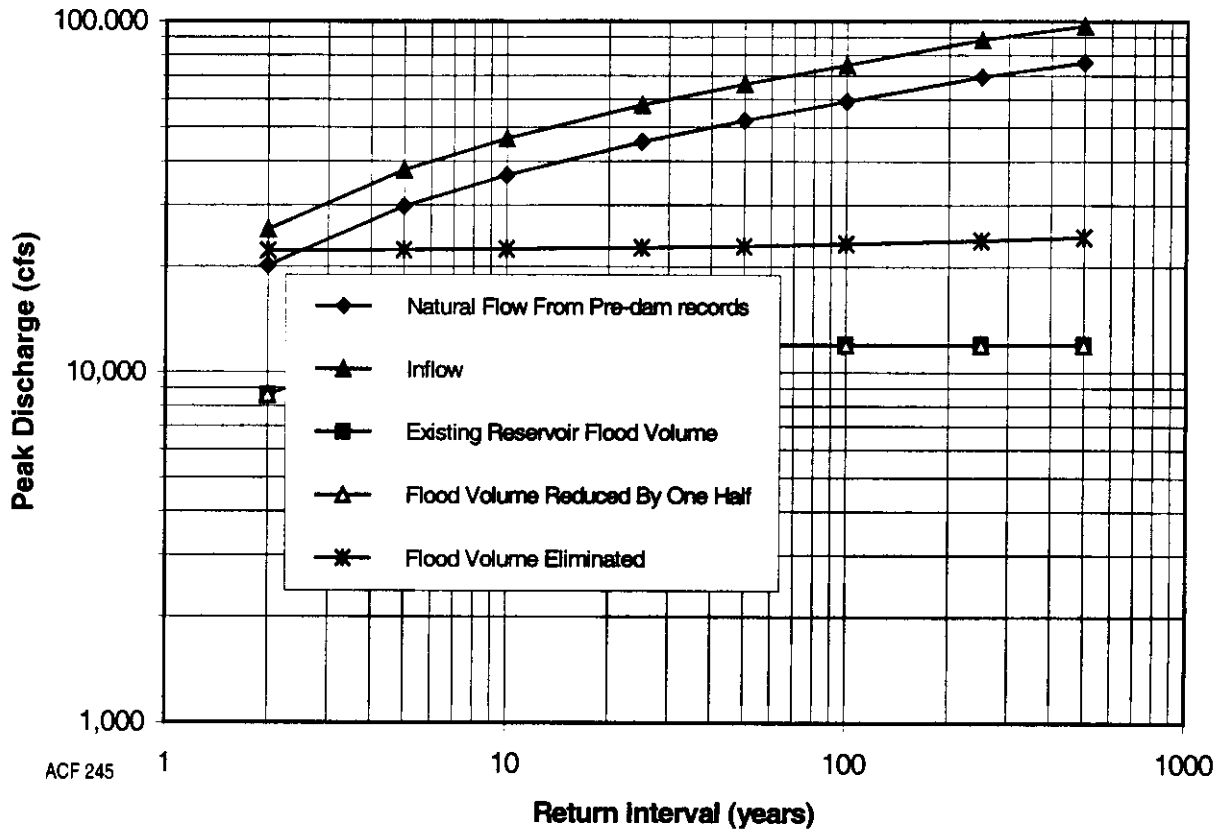


FIGURE 4-72
Peak Flood Frequency at Lake Lanier



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Walter F. George Lake also provides flood control storage below West Point Lake. Reallocation of flood control storage was not analyzed at Walter F. George Lake; however, any reallocation of flood control storage is expected to have impacts similar to those observed downstream of Lake Lanier and West Point Lake.

4.4.1.2.8 Water Supply Withdrawals

The analysis of potential effects of the alternative scenarios on water supply demands was based on the HEC-5 modeling described above and an additional analysis of potential shortages for each of the primary areas of demand: municipal and industrial, thermal power generation, and agriculture. The analysis of shortages was based on a statistical analysis of the HEC-5 model output that estimates the net flows at each of the nodes in the basin after all the consumptive uses are have been accounted for (see *Appendix F*).

4.4.1.2.8.1 Municipal and Industrial Demand

Estimates of shortages in municipal and industrial water demands were identified using the HEC-5 model. HEC-5 produces output in *net flows*, which are flows remaining after all consumptive uses have been taken out of the system. These net flows are based on water demand, but reflect the effects of wastewater returns, interbasin transfers, groundwater use, and other basin losses. Monthly probability distributions were then used to construct an

expected annual water budget consisting of mean net flow by month along with a standard deviation. With the mean and standard deviation known for each month, the probability of zero net flow was calculated. The probability of zero net flow indicates the likelihood of impacts to consumptive demand categories. *Appendix F* includes a detailed description of the approach used to determine shortages. It is important to note, however, that shortages do not imply that water faucets are running dry. In reality, demands would naturally vary during dry and wet periods. However, at this programmatic level, these changes could not be estimated or modeled. This EIS is, therefore, using the demands developed during the Comprehensive Study.

To model the effects of the shortages of the impacts to consumption demand categories, a hierarchy of demand priorities was developed by the Corps' EIS development team. In the model developed, agricultural water demands were determined to be the lowest priority and are impacted first by any water shortages in the river systems. Thermal (steam) power generation is impacted after agricultural water demands when in stream shows falls to zero during a water shortage. Since municipal and industrial water demands are assumed to be the highest priority consumptive use category, impacts to this demand category occur only after flows fall to the point at which there is no water available to meet the demands of agriculture and thermal power generation. Therefore, in addition to the shortages shown below in municipal and industrial water supplies under the no action alternative, there may be a shortage in agricultural and thermal water supplies that are in the same reach. *Table 4-12* shows modeled shortages by state for the no action alternative. It should be noted that most of the agricultural demand in the ACF basin is met by groundwater. These shortages are based on the estimated 1995 demands shown in *Table 4-8* and the modeled flows described in Section 4.4.2.

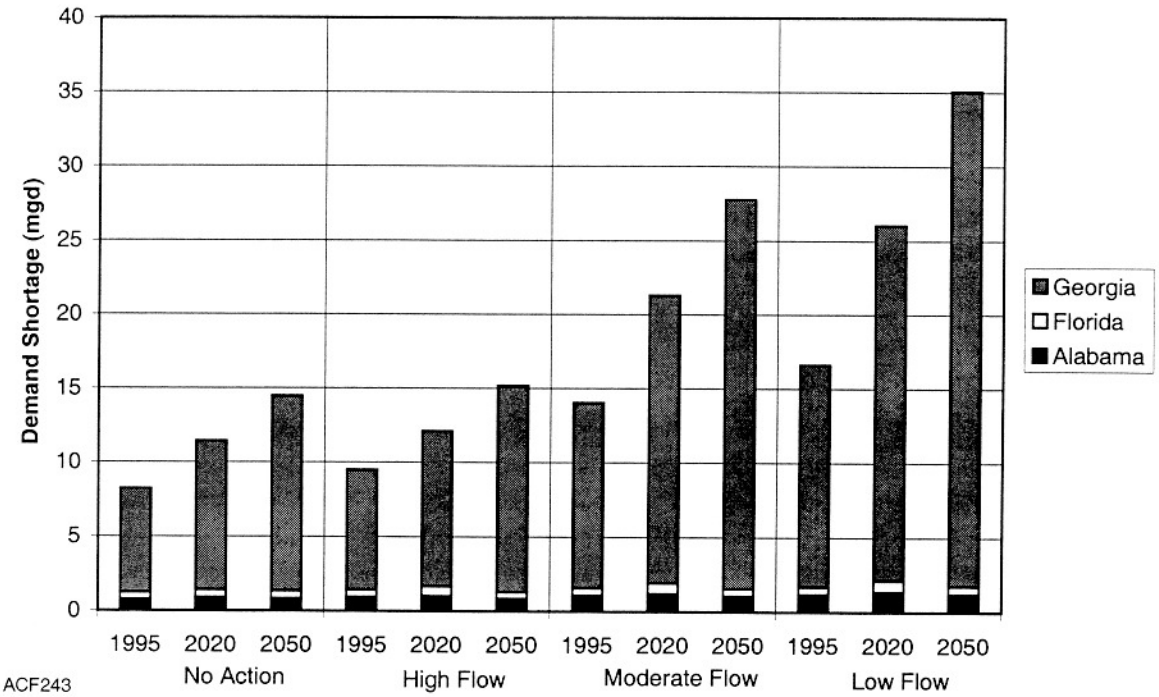
TABLE 4-12
Modeled Annual Shortage (mgd) in Municipal and Industrial Demands by State for the ACF Basin, No Action Alternative

Area	1995	2020	2050
Alabama portion	0.77	0.92	0.86
Florida portion	0.46	0.48	0.49
Georgia portion	6.99	10.02	13.1
ACF basin total	8.22	11.4	14.5

Source: ***Appendix F***

Municipal and industrial water supply demand shortages were evaluated over the entire basin shortages that were identified in the model for the no action alternative ranged from 8.2 mgd in 1995 to 14.5 mgd in 2050 (*Figure 4-73* and *Table 4-12*). These are minor shortages that account for only 1 percent of total basin demand. These shortages are primarily in Georgia along the river segments near Atlanta and Columbus (*Appendix F*) and accounted for between 86 and 91 percent of the shortages between 1995 and 2050. These shortages are modeled shortages and do not mean that water withdrawals were curtailed or that streams were actually dry.

FIGURE 4-73
Municipal and Industrial Demand Shortages



In the high flow scenario, the potential for water shortages is the lowest of the three action alternative scenarios (*Figure 4-73*) and ranged from 9.5 mgd in 1995 to 15.2 mgd in 2050. These shortages are minor and make up only 1 percent of total basin demand. The high flow scenario calls for the maximum release of water from storage reservoirs to meet downstream flow needs and, as a result, provides the greatest amount of flows to meet water supply demands.

Under the moderate flow scenario, the municipal and industrial shortages are slightly greater than the high flow scenario. The shortages for 1995 and 2050 were 14.1 and 27.8 mgd, respectively. The moderate scenario included similar municipal and industrial water demands to the no action scenario (see Section 3); however, the differences in reservoir operations resulted in greater shortages for the moderate alternative than for the no action alternative.

Municipal and industrial water supply shortages were expectedly highest for the low flow scenario, ranging from 16.6 mgd for 1995 to 35.1 mgd in 2050. This is approximately 2 to 3 percent of total basin demand. This scenario included no conservation measures. In this scenario, rivers have the least amount of available flows to meet demands.

4.4.1.2.8.2 Thermal Demand

Steam generation power plants that have closed loop systems with cooling towers have a consumptive use impact. Cooling towers may remove substantial quantities of water through effects of evaporative losses by cooling. In the ACF basin, these plants that have

consumptive use (i.e., are not once-through facilities) are Farley, Wansley, and Yates. In contrast, the once through cooling systems, noted in the section on Water Quality, have less effect on consumptive uses, since effectively all the water is returned to the surface water. Examples of some of these losses include values that are estimated to range from 1 to 6 mgd for the Yates Plant to over 14 mgd for the Wansley Plant (Corps' Unimpaired Flow Model, 1997). The actual losses vary depending on climatic conditions and facility operations.

Thermal requirements for closed loop systems were modeled in HEC-5 as a consumptive demand. If net flows, at a point where thermal demands are present, fell below zero then one or more of the consumptive demands at the point would be impacted.

The Atkinson, Mitchell, and McDonough power plants use once-through cooling, which characterizes them as non-consumptive use plants. Therefore, given the assumptions stated above, there are no water resource shortages at these sites (***Appendix F***).

The Yates and Wansley thermal plant flows are measured at the West Point-Atlanta modeling node. The HEC-5 model output data reveal that for the period of record, there were no flows below zero at this node. Therefore, all demands were met for the period of record with no direct impacts on these two facilities.

The Farley nuclear plant is in the Chattahoochee subbasin, and is modeled at the Jim Woodruff-George Andrews node. During the period of record, streamflows did not fall below zero at this node; therefore, there were no direct impacts to this facility.

This does not mean that extreme events that have not been recorded will not cause net flows to drop below zero at some point in time for some duration, resulting in a shortage for thermal power demands. The modeling of water demand shortages indicated municipal and industrial shortages but no thermal shortages because the net stream flows remained above zero in the stream segments with thermal power withdrawals. Thermal power plants have had to curtail operations during low flows because they could not meet the discharge temperature limits.

4.4.1.2.8.3 Agricultural Demand

Under all alternative scenarios (no action and action alternative scenarios), no impacts from water supply shortages were identified for agricultural irrigation needs. Results of the modeling indicate that no significant water shortages occur at any of the nodes or planning areas (***Appendix F***).

Surface water withdrawals from rivers and main stream reservoirs account for only a small portion of total agricultural water withdrawals in the ACF basin. Consequently, minor variations in historic river flows would not be expected to have a significant impact on agricultural production and income, even with increasing water demands. HEC-5 hydrologic modeling studies show this to be the case. Through normal flows and controlled releases from reservoirs, the HEC-5 model was able to satisfy all agricultural water needs in the ACF basin through 2050. Consequently it appears that the agricultural economy of the ACF basins should suffer no measurable loss of income as a result of alternative flows associated with potential water allocation formulas. It is important to remember that the findings in this report are based on the assumption that groundwater supplies are stable and will provide the major share of agricultural water needs projected in the Comprehensive Study. Reductions in groundwater availability forcing increased dependence on surface supplies could substantially change the conclusions of the study. It should be noted that the

modeling of agricultural demand shortages may not fully assess potential seasonal irrigation demands that would occur during a drought. For example, the State of Georgia has noted that the agricultural demand estimates may exceed the annual demands by a factor of 2 during a drought.

4.4.2 Water Quality

This discussion of water quality reviews the characteristics of the ACF basin that affect the ability of the water resources to meet the various regulatory standards and uses for which they are intended. The water quality of these resources is dependent on the natural characteristics of these basins (e.g., climate, precipitation, geology, vegetation, topography) as well as societally influenced effects (e.g., impoundments, point and nonpoint releases, development). The following sections relate these effects to water quality characteristics of each of the major river basins, along with an overview of the wastewater discharges that affect these resources in the ACF basin. A final section summarizes the water quality features of the groundwater in the ACF basin that may interact with these surface water systems.

4.4.2.1 Affected Environment

Water quality in the ACF basin is of great interest to the millions of people who live within the basin and use its water resources. Surface water is a primary drinking water source, and, thus, its quality is of utmost importance. The ACF basin has widely ranging land uses, which have significant effects on water quality. Water quality in the basin is well studied, because of its large urban population centers as well as its challenging water quality issues (***Figure 4-74***).

Although the quality of treated wastewater discharges in the basin has greatly improved since the 1970s with the adoption of improved wastewater treatment processes and increased regulatory controls (such as the stringent phosphorus standard adopted by the Georgia Legislature in 1990), water quality continues to be a concern as the sources of pollution have shifted to unregulated nonpoint sources (Couch et al, 1996). Nonpoint source pollution includes suspended sediment, bacteria, pesticides, fertilizer, metals, oils, grease, and a variety of other pollutants that are washed into surface waters from urban and rural runoff (GDNR, 1998). In addition, combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) contribute intermittent high loads of untreated or partially treated sewage to the rivers. Because of these continued sources of pollution to the basin's surface waters, a substantial number of rivers and lakes in the basin are either not supporting or only partially supporting their designated uses. Fish consumption advisories are also in place for several major reservoirs in the basin as a result of contaminated lake bottom sediment.

Federal law (the Federal Clean Water Act) and State laws (the State water quality regulations) regulate water quality in the ACF basin. State regulatory agencies establish water quality standards to protect the designated uses of the States' waters. Water quality standards consist of water use classifications, general narrative standards, and numeric standards for water quality parameters and toxic substances. Water use classifications for the rivers in the study area are shown in ***Table 4-13***.

FIGURE 4-74
General Water Quality Conditions in the ACF Basin

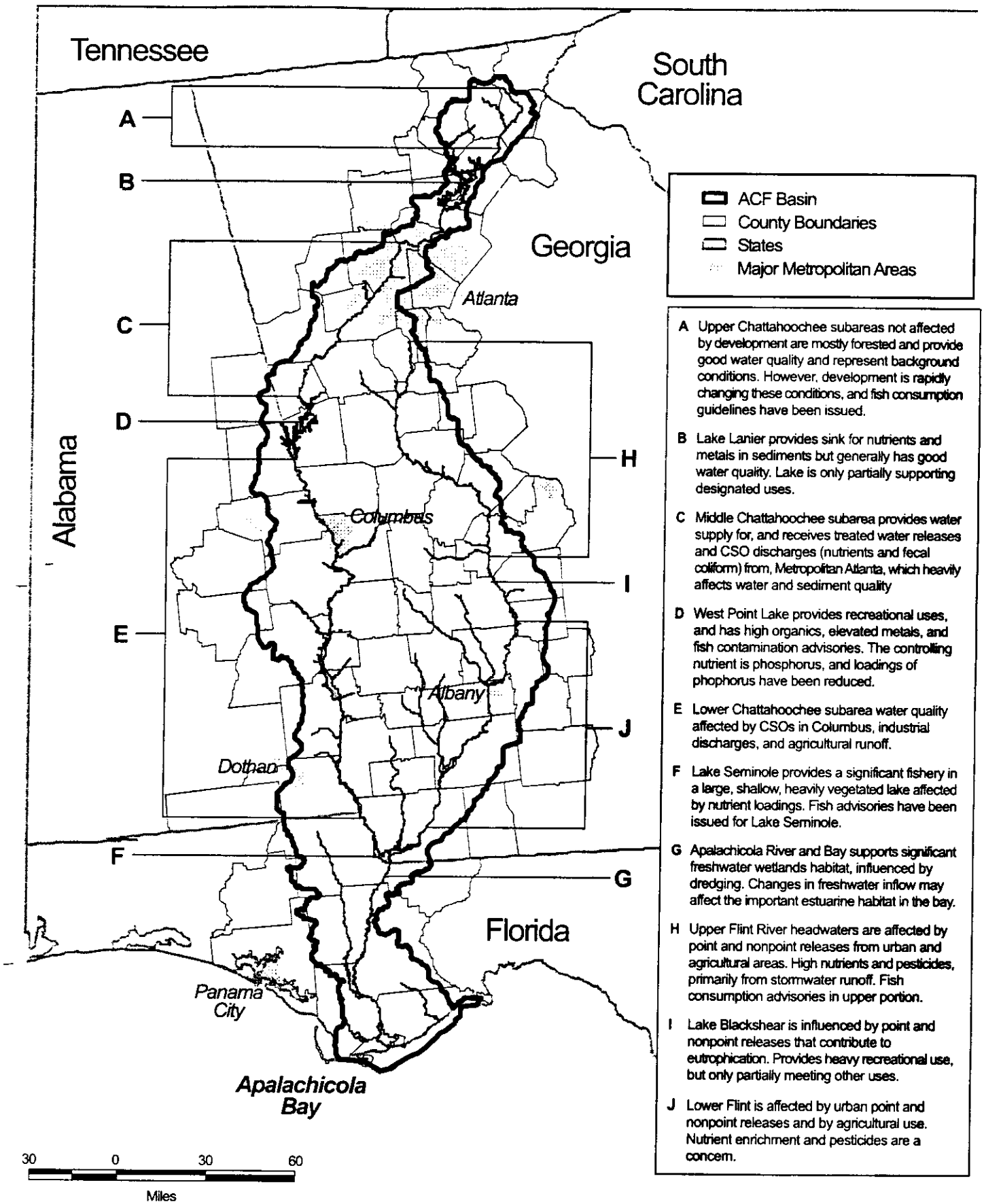


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TABLE 4-13
Water Use Classifications in the Study Area

State	Classification Description
Alabama	1. Public Water Supply
	2. Swimming and Other Whole Body Water-Contact Sports
	3. Fishing and Wildlife
	4. Agricultural and Industrial Water Supply
Florida	Class I - Potable Water Supply
	Class III - Recreation, Propagation, and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife
	Outstanding Florida Water
Georgia	1. Drinking Water Supply
	2. Recreation
	3. Fishing
	4. Primary Trout Fishing
	Secondary Trout Fishing
	1. Wild River/Scenic River

Source: Ashby et al., 1996

4.4.2.1.1 Comprehensive Study Summary

As part of the water quality element scope of work for the Comprehensive Study, data inventory, usability assessment, and summary analyses were conducted on water quality in both basins. The study included a compilation and assessment of water quality data for compliance with water quality standards (Ashby et al., 1996). Water quality data were collected from electronic sources, published and unpublished sources, and data discovery meetings with local, State, Federal, and private sources. Although the data were statistically analyzed, the primary goal of the study was to compile and assess the data for suitability for modeling and evaluation. Limited evaluations beyond these purposes were conducted.

The Comprehensive Study concluded that many of the surface waters in the study area were considered to have high or improved water quality. Water quality improvements, particularly in lower biochemical oxygen demand (BOD) and higher dissolved oxygen (DO) values, were noted in Georgia for the upper Flint River and several key tributaries. General concerns included water quality degradation associated with eutrophication, watershed development, and impacts on fisheries in the study area. The Comprehensive Study noted specific areas that were considered to be markedly impaired in Georgia, including impairments for fecal coliform on reaches of the Chattahoochee and Flint Rivers. In Florida, declines in fisheries, high turbidity, and algal blooms associated with nutrient enrichment were indicated as concerns for the Chipola and Apalachicola River basins. High suspended sediment values, flow alteration, and temperature fluctuations were considered responsible for the degraded water quality and habitat. High concentrations of heavy metals from

battery salvage operation and a noticeable decline in water quality during the 1980s were among the concerns indicated for the Chipola River. Bacterial counts were relatively high, with median values for total and fecal coliform of 3,500 and 4,900 per 100 milliliter (ml) for the ACF basin. Median values for temperature, pH, DO, and nutrient were all found to be within normal expected values (Ashby, et al., 1996).

The Comprehensive Study also compared water quality data collected in the study to water quality standards and criteria. This comparison revealed several areas of concern. DO was the parameter with the most frequent deviations from the standards, although the report indicated that depth of sample was not noted, so that some deviations could have been from bottom reservoir waters, where low DO is not unusual under thermal stratification conditions. Other parameters that exceeded standards included pH, fecal coliform bacteria, temperature, and metals. Exceedances for nutrients (particularly nitrogen) were also observed in the Comprehensive Study, mostly in the Apalachicola and Chipola Rivers. Exceedances of bacterial criteria were mostly observed in the Chattahoochee and Flint Rivers.

4.4.2.1.2 Chattahoochee River Basin

The Chattahoochee River basin includes the largest urban population centers and receives the majority of the basin's municipal wastewater effluent (Couch et al, 1996). In its 1998 Section 303(d) listing, the Georgia Department of Natural Resources (GDNR) reported that 218 miles (30 percent) of rivers and streams in the Chattahoochee River basin were only partially supporting their designated uses. GDNR also reported that 49 miles in the Chattahoochee River basin were not supporting their designated uses. In its most recent Section 303(b) report on the condition of water quality in the State, GDNR reported that 610 river miles in the Chattahoochee River basin were supporting their designated uses (GDNR, 1996). GDNR has issued fish consumption guidelines for the upper portion of the Chattahoochee River.

GDNR states that portions of several reservoirs in the basin are only partially supporting their designated uses—Lake Lanier, Goat Rock Lake, Lake Oliver, Walter F. George Lake, and Lake Andrews. Urban and nonpoint source runoff are listed as the primary causes of the violations. Fecal coliforms and metals are the principal parameters that are named for exceeding criteria. Fish consumption advisories are also in place for West Point Lake, Lake Harding, Goat Rock Lake, Lake Oliver, and Walter F. George Lake (GDNR, 1997). The Alabama Department of Environmental Management (ADEM) did not list any river segments in the Chattahoochee River as impaired, although it does list two lakes on the Chattahoochee River (West Point Lake and Lake Harding) as not supporting their designated uses (ADEM, 1998).

Sufficient flow for wastewater assimilation in the Chattahoochee River is most critical in the reach between Atlanta and West Point Lake. A minimum flow of 750 cfs has been established on the Chattahoochee River at Peachtree Creek (Atlanta) to provide for wastewater assimilation. This minimum flow must be met for compliance with the Clean Water Act (GDNR, 1996).

At West Point Lake, a joint EPD and EPA study in the late 1980s identified nutrient problems associated with point source loadings to the lake. To reduce nutrient loads to the lake, Georgia adopted water quality standards for West Point Lake and its tributaries in 1995. The

phosphorus reduction process was aided by a 1990 statewide ban on high phosphate detergents in Georgia. These actions, along with phosphorus reductions at Atlanta's wastewater treatment plants, have resulted in significant reductions in phosphorus loadings to West Point Lake (GDNR, 1996).

USGS recently completed an assessment of water quality in the ACF basin under the National Water Quality Assessment (NAWQA) Program (USGS, 1998). The NAWQA study traced the impact of the phosphorus reduction efforts in Georgia on water quality in the basin. Although wastewater discharges from the six largest metropolitan Atlanta wastewater treatment facilities increased by about 50 percent from 1980 to 1995, the total phosphorus load from these facilities decreased by about 83 percent from the largest load in 1988 (USGS, 1998). However, point source loads continue to contribute a major portion of the phosphorus load to the river. In addition, phosphorus loads from nonpoint sources continue to increase.

ADEM lists West Point Lake and Lake Harding as impaired due to contaminated sediments (ADEM, 1998). Chlordane was used extensively through the 1980s as a termiticide. Although its use was banned in 1988, high levels in lake bottom sediment still remain. Chlordane and PCBs in sediments in West Point Lake both show a slow rate of decline, indicating that fish consumption advisories may continue in the future (USGS, 1998). Overall, the NAWQA study found that the scores for pesticides and PCBs in sediment and fish tissue in 71 percent of the ACF river basin sites were higher than the median score nationwide. The higher scores in the ACF basin were found in urban, cropland, and mixed land use sites.

The NAWQA study also conducted age-dated depth profiles of metals concentrations in sediment cores to show historical patterns of upstream urban and industrial activity, upstream reservoir construction, and regional atmospheric deposition. Lakes that were most directly affected by urban and industrial activities (West Point Lake, Lake Harding, and Walter F. George Lake) revealed a more complex history of trace-element pollution (USGS, 1998). Lake Lanier was less directly affected by local sources of pollutants.

In the NAWQA study, USGS also compared seven major water quality characteristics for streams in the ACF basin to other NAWQA study units across the country. The findings included (USGS, 1998):

- Urban tributaries and the Chattahoochee River downstream from Atlanta were among the most degraded sites evaluated by NAWQA during 1992-95.
- Suburban and agricultural (cropland and poultry) tributaries and the Chattahoochee River upstream from Atlanta showed varying degrees of degradation that were comparable to many sites evaluated in the nation.
- Aquatic life criteria for bed sediment were exceeded downstream from Atlanta in West Point Lake (chlordane and PCBs).
- Aquatic life criteria for surface water were exceeded by median monthly concentrations of insecticides in an urban site (Peachtree Creek) and a suburban site (Scope Creek).

4.4.2.1.3 Flint River Basin

The Flint River basin is largely influenced by the agricultural land uses surrounding it. Poultry production, silviculture, and suburban and urban land uses all affect water quality in the tributaries and mainstem Flint River. Potential effects of silvicultural management on

aquatic ecosystems are primarily alterations in physical habitat (i.e., increased temperature and increased sedimentation). Nutrient enrichment and high concentrations of pesticides are a concern in the Flint River basin. Stormwater flows are a primary sources of nutrient and pesticide runoff loads into the Flint River and its tributaries (USGS, 1998).

In its 1998 Section 303(d) listing, GDNR reported that 222 miles (31 percent) of rivers and streams in the Flint River basin were only partially supporting their designated uses. GDNR also reported that 82 miles were not supporting their designated uses. In its most recent Section 305(b) report on the condition of water quality in the state, 675 river miles in the Flint River basin were fully supporting their designated uses (GDNR, 1996). GDNR has issued fish consumption advisories along the upper portion of the Flint River. GDNR also states that portions of Lake Blackshear and Lake Worth are only partially supporting their designated uses (GDNR, 1997).

In 1993, Lake Blackshear had the second highest value statewide for the trophic index, and seven lakes in the ACF basin fell in the top 10 of 27 lakes rated statewide. The NAWQA study's age-dated depth profiles of metals concentrations in sediment cores also showed that Lake Blackshear is affected by local sources of pollutants.

4.4.2.1.4 Apalachicola River Basin

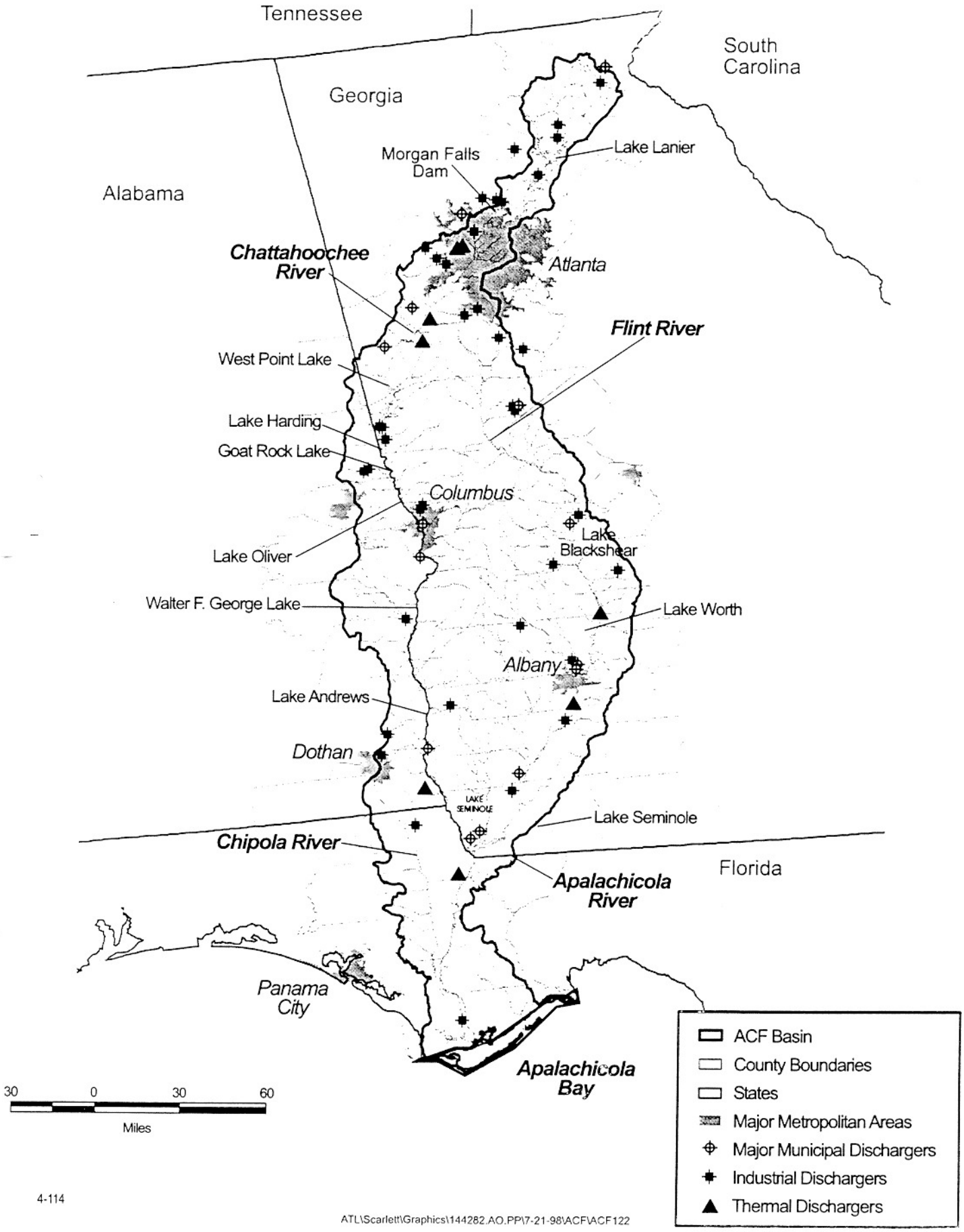
Although the Apalachicola River is free flowing from Lake Seminole to the Apalachicola Bay, the river has been physically altered by navigation channel maintenance and flow alteration from the series of hydropower projects in the upper portions of the basin (Couch et al., 1996). However, the NAWQA studied concluded that the Apalachicola River was found to be among the least degraded sites in the nation (USGS, 1998). The NAWQA study's age-dated depth profiles of metals concentrations in sediment cores did show that Lake Seminole is affected by local sources of pollutants.

The Florida Department of Environmental Protection (FDEP) lists the Apalachicola River, Apalachicola Bay, and Lake Seminole on its 1996 Section 303(d) list, which identifies water bodies that are not meeting current designated uses (FDEP, 1996). Most of the Apalachicola River, which flows into the Apalachicola Bay, is classified as an Outstanding Florida Water. Because of the river's connection to the southern Appalachians and Piedmont through the Flint and Chattahoochee Rivers, its biology is unique to Florida. About 90 percent of the State's harvestable oysters and about 10 to 15 percent of the nation's oysters come from Apalachicola Bay (FDEP, 1996). GDNR states that portions of Lake Seminole are only partially supporting their designated uses and that there are also fish consumption advisories for Lake Seminole (GDNR, 1997).

4.4.2.1.5 Wastewater Discharges

Point source discharges of treated wastewater affect the quantity, as well as quality, of water in the ACF basin. Point source discharges are regulated under the National Pollutant Discharge Elimination System (NPDES) and include both municipal and industrial discharges. Wastewater discharges in the ACF basin were identified for the HEC-5Q modeling (***Appendix D***) and the major discharges from EPA's BASINS database are presented in ***Figure 4-75***.

FIGURE 4-75
Major Municipal and Industrial Discharges in the ACF Basin



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In 1990, there were 137 NPDES-permitted municipal wastewater treatment facilities in the ACF basin. At that time, a total of 354 mgd of municipal wastewater were discharged within the basin (see ***Figure 4-75***). The vast majority of discharges were from Georgia (336 mgd). Seven Alabama facilities discharged about 14 mgd, and 12 Florida facilities discharged about 4 mgd into waters of the basin. Overall, 88 percent was discharged into the Chattahoochee River basin, 11 percent into the Flint River basin, and 1 percent into the Apalachicola River basin (USGS, 1996). To limit future eutrophication problems in West Point Lake, nearly all major municipal NPDES-permitted facilities between Buford Dam and West Point Lake are required to meet a phosphorus release limitation of 0.75 milligrams per liter (mg/L) on a monthly average. The City of Atlanta's phosphorus limit has been reduced to 0.65 mg/L. As a result of this phosphorus central program, West Point Lake is now meeting established water quality standards for chlorophyll *a*.

Industrial wastewater discharges are also significant point sources regulated under the NPDES program. Industrial discharges can consist of organic heavy oxygen-demanding waste loads from facilities such as pulp and paper mills and large quantities of non-contact cooling water. However, only a small number of the industrial discharges discharge significant amounts of flow. ***Table 4-14*** lists the major municipal and industrial discharges in the basin, as they were tabulated for use in the HEC-5Q water quality modeling.

Combined sewer overflows (CSOs) from Atlanta and Columbus, Georgia, are also a source of water quality pollution in the ACF basin. Combined sewers carry both sanitary and stormwater runoff in the same pipe. During wet weather events when the capacity of the sewers is insufficient to carry all the flow, a combination of stormwater and raw sewage overflows directly into the rivers. Columbus is currently implementing a program to control their CSO discharges, and Atlanta is beginning a program to identify approaches to control their CSO discharges.

Storm sewer discharges, if they are contained in a separate system and not combined with the sanitary flow, typically are discharged directly to surface waters. Stormwater runoff discharges (from both municipalities and industrial sites) are now subject to NPDES permitting. Pollutants typically found in urban stormwater runoff include pathogens (bacteria and viruses from human and animal waste), heavy metals, debris, oil and grease, petroleum hydrocarbons, and other compounds potentially toxic to aquatic life. In addition, runoff often contains sediment, excess organic material, fertilizers, herbicides, and pesticides, which can adversely affect water quality in the receiving stream. Stormwater runoff could also increase the temperature of the receiving stream, which is of particular concern in cold water trout streams. The quantity of urban runoff can also cause problems, contributing to flooding and erosion downstream (GDNR, 1997).

TABLE 4-14
Major Municipal and Industrial Discharges Into the ACF Basin[a]

Discharge Type[b]	Point Source Discharge Location[c]	Flow (mgd) 1995	BOD_5 (mg/L)	NH_3-N[d] (mg/L)	PO_4-P (mg/L)
Chattahoochee River Tributaries					
M	Gainesville WPCP	10.05	22.96	*	2.18
M	Gwinnett + John's Creek WPCP	7.06	12.73	*	0.75
M	Fulton Co. Big Creek WPCP	37.01	30	*	0.75
M	Atlanta South River WPCP	29.79	30	*	0.75
M	RM Clayton WPCP	81.92	30	*	0.75
M	Cobb County – Sutton WPCP	27.87	20	*	0.75
M	South Cobb WPCP	22.8	20	*	0.75
M	Atlanta Creek WPCP	29.79	30	*	0.75
M	Camp Creek WPCP + Douglasville	11.83	25.75	*	0.75
M	Lanette WWTP	3.53	30	15	5
M	La Grange WPCP	12.32	30	16.79	5
M	East Alabama WWTP	6.56	30	15	5
M	Phenix City WWTP	3.41	30	15	5
I	Mead Coated Board	24	49	4	2
M	Eufaula WWTP	2.41	30	15	5
I	Great Southern Paper Co.	72	32.25	4	2
M	Ft. Benning	2.95	30	15	5
I	Lockheed, Dobins AFB	7.8	30	2	2
M	Columbus WPCP	27.46	29.88	16.45	4.85
Apalachicola River Tributaries					
	Combined Apalachicola River Inflows	3.7	30	15	5
Flint River Tributaries					
M, T	Discharges to Flint River above Griffin	1.02	30	15	5
M+I, T	Discharges to Potato Creek	5.93	23.85	10.73	3.9
I	Procter & Gamble	21.6	38.25	4	2
I	Merck & Co.	7.5	19.2	24	2
M	Decatur Co. Industrial Airpark	1.7	30	15	5
M	Bainbridge WPCP	3	30	15	5
M	Albany WPCP	14.08	30	15	5
M	Montezuma	11.76	28.85	13.5	4.65
M	Coweta + Fayette Counties	4.45	30	15	5
M	Early + Houston Counties	10.71	30	7.21	5

[a] Major discharge to main stem rivers
[b] M = municipal, I = industrial, T = tributaries
[c] Several discharges include minor contributions from adjacent counties.
[d] Water quality loads are based on discharge permit levels.
[e] Nitrate and ammonia concentrations in Atlanta area discharges:

Month	NH_3	NO_3	Month	NH_3	NO_3
Jan	15.00	0.00	Jul	4.05	10.95
Feb	15.00	0.00	Aug	3.98	11.02
Mar	15.00	0.00	Sep	4.76	10.24
Apr	15.00	0.00	Oct	6.43	8.57
May	8.67	6.33	Nov	11.45	3.55
Jun	4.67	10.33	Dec	15.00	0.00

Source: ***Appendix D***

4.4.2.1.6 Nonpoint Source Pollution

Nonpoint source pollution includes suspended sediment, bacteria, pesticides, fertilizer, metals, oils, grease, and a variety of other pollutants that are washed into surface waters from urban and rural runoff. The Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) nonpoint source model was used to estimate current levels of nonpoint source pollution in the basin. The BASINS model was also used to predict loadings for 1995, 2020, and 2050 land uses, as further described in Section 4.4.2.2 and ***Appendix D***.

Five key parameters were looked at in the BASINS modeling: flow, BOD, total nitrogen, total phosphorus, and fecal coliform bacteria. The estimated annual pollutant loadings for 1995 from nonpoint sources in the ACF basin are as follows:

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

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

4.4.2.1.7 Groundwater

The natural quality of groundwater from all aquifers in the ACF basin is acceptable for public supply. However, the extent of localized contamination by volatile organic compounds in urban settings, and upward trends in nitrite and nitrate concentrations in agricultural settings, are concerns. Nitrite and nitrate concentrations in the areas of karst topography in the ACF basin are generally within drinking water standards, but are somewhat higher than concentrations found in other areas of Georgia (USGS, 1996).

Overall, groundwater quality in the ACF basin is very good for use as drinking water. Since most drinking water wells used in public water systems draw from deep aquifers, the number of contaminated wells is limited. However, in the Chattahoochee River subbasin, some public water system wells have been contaminated by local pollution sources, such as leaky underground storage tanks, malfunctioning septic tank systems, and spills (GDNR, 1997).

In the lower ACF basin, water of the Floridan aquifer is also of good quality and generally does not exceed the maximum contaminant limits established by EPA. In the northern part of the lower ACF basin, the water is generally hard and is less mineralized than water in the deeper aquifers. In the central part of the lower ACF basin, water in the Upper Floridan aquifer contains slightly higher specific conductance and concentrations of dissolved solids and phosphorous than in the northern part of the basin, indicating vertical movement of groundwater through overlying, phosphate-rich sediments. Potential sources of water-quality degradation from agriculture or industry are low, and the water is assumed to be of good quality and suitable for most purposes.

4.4.2.2 Environmental Consequences

The impacts on water quality were assessed based on model results. Three water quality models were used in this analysis: BASINS, HEC-5Q, and CE-QUAL-W2. The BASINS modeling was conducted by Tetra Tech, Inc. under direction of EPA and the Corps. The BASINS modeling was conducted to assess nonpoint sources and to provide nonpoint source flows and pollutants as inputs to the HEC-5Q and CE-QUAL-W2 models. The modeling used locations of tributary inflow points designated in the HEC-5Q model and major control points designated in the HEC-5 model. The BASINS model uses meteorological data, detailed land use data, and future growth projections to evaluate nonpoint source runoff in the basin. A CE-QUAL-W2 model is being performed by WES to verify and supplement the HEC-5Q results on a limited number of reservoirs in the basin. These results will be incorporated into the final EIS. HEC-5Q and BASINS model summary information are included in ***Appendix D***.

Reservoir-specific studies were also conducted on three reservoirs in the ACF basin during and after the Comprehensive Study. GDNR sponsored a two-dimensional water quality model of West Point Lake and Lake Lanier. WES conducted the modeling of West Point Lake, and Limno-Tech conducted the Lake Lanier modeling. WES also performed two-dimensional water quality modeling of Walter F. George Lake Reservoir as part of the Comprehensive Study.

4.4.2.2.1 Basin Water Quality Modeling

The Corps HEC conducted one-dimensional modeling of the rivers and reservoirs in the ACF basin using the HEC-5Q model. HEC-5Q takes input from the HEC-5 hydrologic model, point source load projection spreadsheets developed by EPA as part of the Comprehensive Study, and the BASINS nonpoint source runoff output and predicts average concentrations of critical parameters in streams and reservoirs.

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

The HEC-5Q analysis results are presented in ***Appendix D*** for select stream reaches in the basin. The stream reaches were chosen where impacts were most likely to occur, due to either natural or unnatural conditions (i.e., wastewater discharges or water withdrawals). In addition to other parameters, both water temperature and DO concentrations in the rivers were modeled with HEC-5Q. These two parameters were selected as key indicator parameters to assess water quality in the rivers, as discussed below.

DO concentration is one of many key parameters that can be used to determine the overall quality or health of a river, although other parameters are also important in fully assessing overall water quality. DO concentrations above 5 mg/L are desirable. On the other end of the spectrum, DO concentrations below 3 mg/L are not desirable for aquatic life, and

DO levels of 1 mg/L or below indicate very low levels of oxygen in the water, too low to support aquatic life. This indicates very poor water quality. The HEC-5Q model predicted the number of days per year that the river at a given point would be below certain DO levels.

Water temperature is also a critical parameter in evaluating impacts of various water management practices on water quality. Reservoirs tend to warm water. The longer the retention time in a reservoir, the warmer the temperature of the discharged water. State water quality standards typically specify a maximum allowable temperature (for example, 90°F in Georgia), which is designed to protect aquatic organisms from unnaturally high water temperatures. The model output summarized the number of days that temperature exceeded 55°F and 68°F in the reach of Chattahoochee River between Buford Dam and Peachtree Creek. The 55°F temperature is important to operation of the Buford Trout Hatchery located just downstream from Buford Dam. These model temperature outputs are for the May to December periods in 1984 through 1988. The 68°F temperature is important to sustain the feeding, growth, and reproduction of rainbow and brown trout. Temperature is also related to DO concentrations. The higher the temperature, the lower the DO saturation concentration. Thus, water temperature and DO typically exhibit contrasting trends, with DO highest when temperature is lowest, and vice versa.

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

Although the initial development and calibration of the HEC-5Q model was accomplished for hydrologic conditions from 1984 to 1988, subsequent simulations for the 1995, 2020, and 2050 water demand levels were also performed using the 1984 to 1988 hydrologic data. The majority of impacts here are presented for the average summer periods for the 5-year model simulation. For a detailed review of how the water quality results vary by year within the 5-year period, the complete model output is provided in ***Appendix D***. In general, 1986 conditions proved to be most critical within this timeframe. During 1986, the southeast was facing a serious drought, which lowered stream flows and water quality in many parts of the basin.

4.4.2.2.2 Upper Chattahoochee River Subbasin Impacts

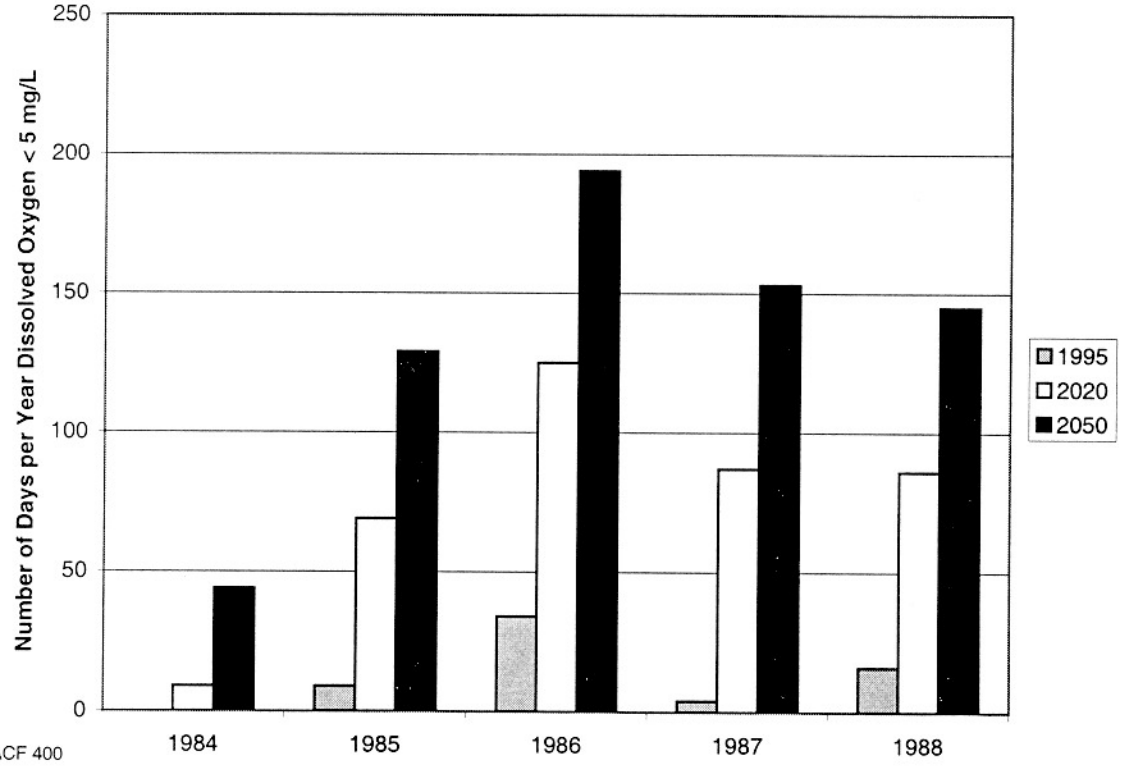
The Upper Chattahoochee River subbasin extends from the headwaters to the Whitesburg gage. There are two major reservoirs in the subbasin: Lake Lanier and Bull Sluice Lake. Under the no action alternative, the HEC-5Q model predicted low DO in the tailwaters of Buford Dam, but none in the tailwaters of the Morgan Falls Dam. On the Chattahoochee River itself, there were only a limited number of days with DO below 5 mg/L at various locations downstream to Whitesburg for 1995, although the number was predicted to increase substantially by the year 2050 (***Table 4-15***). The HEC-5Q model was run for 5 years: 1984 through 1988. The results in ***Table 4-15*** are presented as the average summer results over the 5 years. However, it is also interesting to assess the impacts for each of the 5 years modeled to determine the variability in water quality that can occur under various hydrologic conditions. As an example of the variability, the Chattahoochee River at Whitesburg was selected as a representative location at the downstream point of the subbasin to illustrate stream DO concentration variability over the years 1984 to 1988 (***Figure 4-76***).

TABLE 4-15
Upper Chattahoochee River Subbasin. River Water Quality. No Action Alternative

	1995	2020	2050
Reservoir Tailwater DO: Days Below 5 mg/L			
Buford	153	157	162
Bull Sluice	0	0	0
Chattahoochee River DO: Days Below 5 mg/L			
Norcross	9	9	9
Above Morgan Falls	0	0	0
Above Peachtree Creek	0	0	0
Highway 92	12	65	116
Whitesburg	13	75	133
Chattahoochee River Temperature: Days Above 68°F			
Midway between Buford/Norcross	0	0	0
Norcross	5	5	6
Above Morgan Falls	44	48	52
Above Peachtree Creek	117	117	118

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

FIGURE 4-76
Dissolved Oxygen in Chattahoochee River at Whitesburg. No Action Alternative



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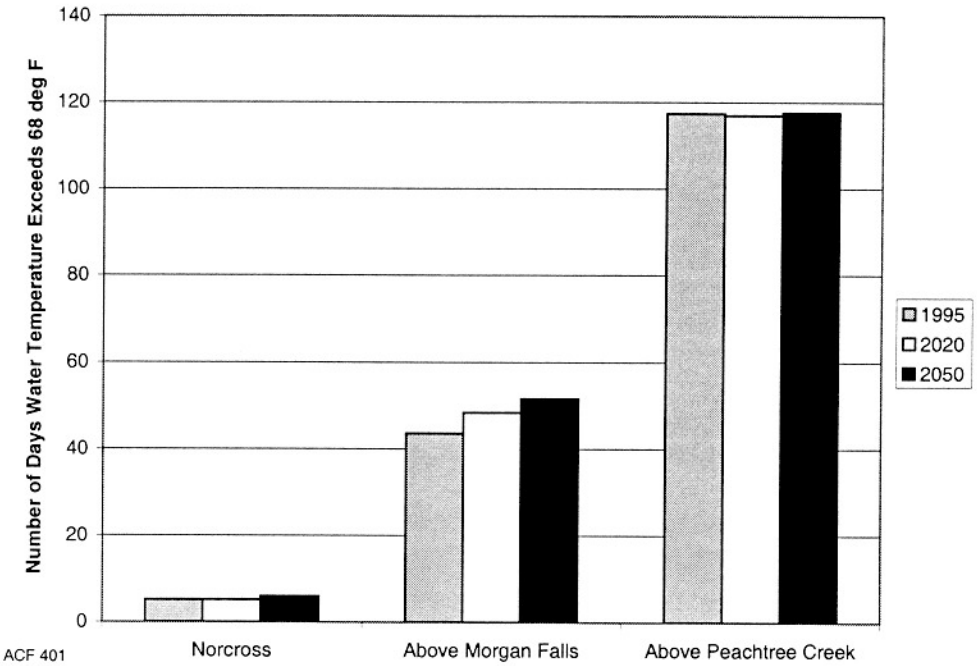
Under the no action alternative, the HEC-5Q model predicted an increasing number of days that the Chattahoochee River temperatures exceeded 68°F, moving from upstream (0 days at a point midway between Buford Dam and Norcross) to downstream (117 days at a point just above Peachtree Creek), as shown in ***Table 4-15***. This trend of increasing water temperature from upstream to downstream in the Chattahoochee River is illustrated in ***Figure 4-77***. The increase in water temperatures could adversely affect the put-and-take trout fishery in this reach of the Chattahoochee River (see Section 4.5.3.2). The number of days with temperatures greater than 68°F would increase only slightly from 1995 to 2050.

FIGURE 4-77
Water Temperature Data for Upper Chattahoochee River Basin. No Action Alternative



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The HEC-5Q model was also used to predict the number of days per year that the Chattahoochee River below Buford Dam exceeds 55°F. This was a special concern related to sustaining suitable temperatures at the Buford Trout Hatchery, which is located approximately 1.5 miles downstream from Buford Dam. HEC-5Q predicted that the water temperature below Buford Dam would not exceed 55°F except under the drought year conditions of 1986. The model predicted that, for 1986 hydrologic conditions, the Chattahoochee River below Buford Dam would exceed 55°F on 2 days per year under 1995 water demands, on 2 days per year under 2020 demands, and on 7 days per year under 2050 demands.

Table 4-16 compares the average percent of the stream flow that is made up of wastewater (both municipal and industrial combined). These data illustrate that the percentage increases in an upstream to downstream manner, and also would increase from 1995 demands to 2050 demands.

TABLE 4-16
Upper Chattahoochee River Subbasin. Average Stream Percent Wastewater in Summer. No Action Alternative

	1995	2020	2050
Norcross	0.7	0.9	0.9
Above Morgan Falls	1.4	2.1	2.5
Above Peachtree Cr.	6.6	8.2	9.4
Highway 92	22.2	29.2	35.8
Whitesburg	20.6	26.9	32.9

Average values predicted by HEC-5Q model for the years 1984 to 1988

Reservoirs in the upper Chattahoochee River subbasin include Lake Lanier and Bull Sluice Lake. Both had relatively low chlorophyll *a* concentrations according to the HEC-5Q model. Lake Lanier experiences high retention times due to its large volume, but fairly low phosphorus loading. Bull Sluice Lake, in contrast, had very short retention times and high phosphorus loading rates (***Table 4-17***). Overall, HEC-5Q predicted modest changes in water quality in rivers and reservoirs in the upper Chattahoochee River subbasin between 1995 and 2050.

TABLE 4-17
Upper Chattahoochee River Subbasin. Reservoir Water Quality. No Action Alternative

	1995	2020	2050
Summer Chlorophyll *a* (µg/L)			
Lake Lanier	2.7	3.2	3.4
Bull Sluice Lake	1.9	1.8	1.8
Summer Retention Time (days)			
Lake Lanier	164	152	145
Bull Sluice Lake	0.14	0.13	0.12
Summer Phosphorus Loading (pounds/acre/month)			
Lake Lanier	0.30	0.37	0.43
Bull Sluice Lake	61	82	103

Average May to October values predicted by HEC-5Q model for the years 1984 to 1988

A comparison of the action alternative scenarios to the no action alternative in the upper Chattahoochee River subbasin (***Table 4-18***) indicates that all three action alternative scenarios produce lower stream DO compared to the no action alternative. The action alternative scenarios were 10, 25, and 30 percent higher for the high, moderate, and low scenarios, respectively, compared to the no action alternative.

HEC-5Q results indicated that water temperatures (in days exceeding 68°F) under the moderate and high flow action alternative scenarios would be higher than the no action alternative. In contrast, the low flow scenario would have fewer days with temperatures greater than 68°F compared to the no action alternative at two of three stations assessed on the upper Chattahoochee River (***Figure 4-78***). The differences in water temperature among the three action alternative scenarios would be greatest upstream from Morgan Falls Dam. HEC-5Q predicted that the action alternative scenarios would have little impact on water temperature below Buford Dam. The number of days that the temperature exceeded 55°F was zero under the moderate flow scenario and was 3 in just one modeled year (1986) under

alternatives. According to HEC-5Q output, DO concentration problems first occur on the Chattahoochee River at Highway 92 and continue downstream (***Table 4-18***).

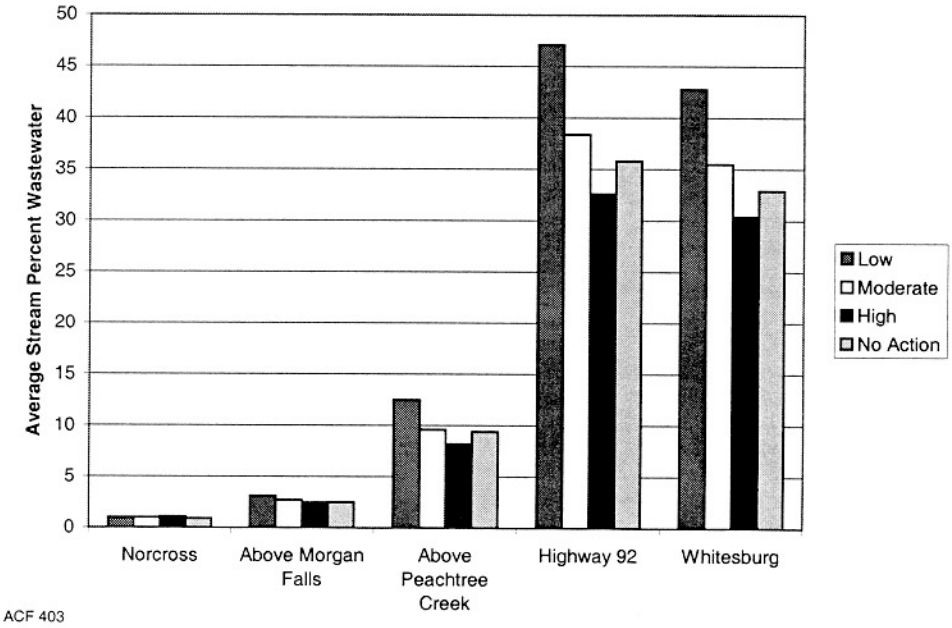
Table 4-19 illustrates the differences in percent wastewater component in stream flow under the action and no action alternatives. The low flow scenario produces the highest percentage of wastewater in stream flow, followed by the moderate and then the high flow scenarios. The low and moderate action alternatives both produced results greater than the no action alternative, whereas the high flow scenario produced stream percentages that were either very close to or less than the no action alternative (***Figure 4-79***).

TABLE 4-19
Upper Chattahoochee River Subbasin. Average Stream Percent Wastewater in Summer. Action Alternative 2050 Demands

	No Action	Low	Moderate	High
Norcross	0.9	1.0	1.0	1.1
Above Morgan Falls	2.5	3.1	2.7	2.5
Above Peachtree Creek	9.4	12.5	9.6	8.2
Highway 92	35.8	47.1	38.4	32.6
Whitesburg	32.9	42.8	35.5	30.4

Average values predicted by HEC-5Q model for the years 1984 to 1988

FIGURE 4-79
Average Stream Percent Wastewater in Summer for Upper Chattahoochee River Subbasin. 2050 Demands



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The HEC-5Q model predicted that chlorophyll *a* concentrations in Lake Lanier and phosphorus loading into the lake would be relatively low overall and would experience only minor changes under the action alternative scenarios compared to the no action alternative. However, HEC-5Q predicted that summer phosphorus loading into Bull Sluice Lake would be about 50 percent lower under all three action alternative scenarios compared to the no action alternative (***Table 4-20***). Summer retention time would also be longer under all three action alternative scenarios compared to the no action alternative. Some discrepancies

between the action alternative scenarios and the no action alternative can be attributed to the decisions made in establishing the HEC-5 model runs for the three scenarios (see Section 4.4.1.2). The HEC-5Q model used flow data input from HEC-5, so that the discussion in earlier sections regarding assumptions and the cautions concerning the analysis of the flow data are also applicable to the water quality data.

TABLE 4-20
Upper Chattahoochee River Subbasin. Reservoir Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Summer Chlorophyll *a* (µg/L)				
Buford	3.4	2.9	2.9	3.1
Bull Sluice	1.8	2.7	2.3	2.1
Summer Retention Time (days)				
Buford	145	235	201	171
Bull Sluice	0.12	0.26	0.22	0.19
Summer Phosphorus Loading (pounds/acre/month)				
Buford	0.43	0.36	0.37	0.40
Bull Sluice	103	54	59	63

Average values predicted by HEC-5Q model for the years 1984 to 1988

Overall, the action alternative scenarios appear to have some limited impacts on water quality in the upper Chattahoochee River subbasin. The impacts are less in the upper reaches of the subbasin and increase moving downstream toward the urban areas surrounding metropolitan Atlanta. In general, the high flow scenario would improve water quality in the streams in particular, due to the increased amount of dilution. The low flow scenario, with substantially lower flows available for dilution, would produce higher temperatures and lower DO concentrations in the streams.

4.4.2.2.3 Lower Chattahoochee River Subbasin Impacts

The Lower Chattahoochee River subbasin extends from the Chattahoochee River at Whitesburg down to the confluence with the Flint River at Lake Seminole. The HEC-5Q modeling analyzed water quality impacts at seven major reservoirs in this subbasin: West Point Lake, Lake Harding (Bartletts Ferry Dam), Goat Rock Lake, Lake Oliver, North Highlands Lake, Walter F. George Lake, and George Andrews Lake. Low DO was predicted by HEC-5Q for discharges from four of the seven reservoirs (***Figure 4-80***). HEC-5Q also predict a substantial number of days with DO less than 5 mg/L on the Chattahoochee River above West Point and above Bartletts Ferry Dam, but predicted no occurrence of DO below 5 mg/L at the Chattahoochee River at Columbus (***Table 4-21***).

The average percent of stream flow that is made up of wastewater discharges in the summer decreases uniformly downstream the Chattahoochee with the increasing base flow. The percentages are expected to increase by 25 to 30 percent from 1995 to 2050, based on HEC-5Q results (***Table 4-22***).

FIGURE 4-80
Summer Dissolved Oxygen in Lower Chattahoochee River Subbasin Reservoir Tailraces. No Action Alternative

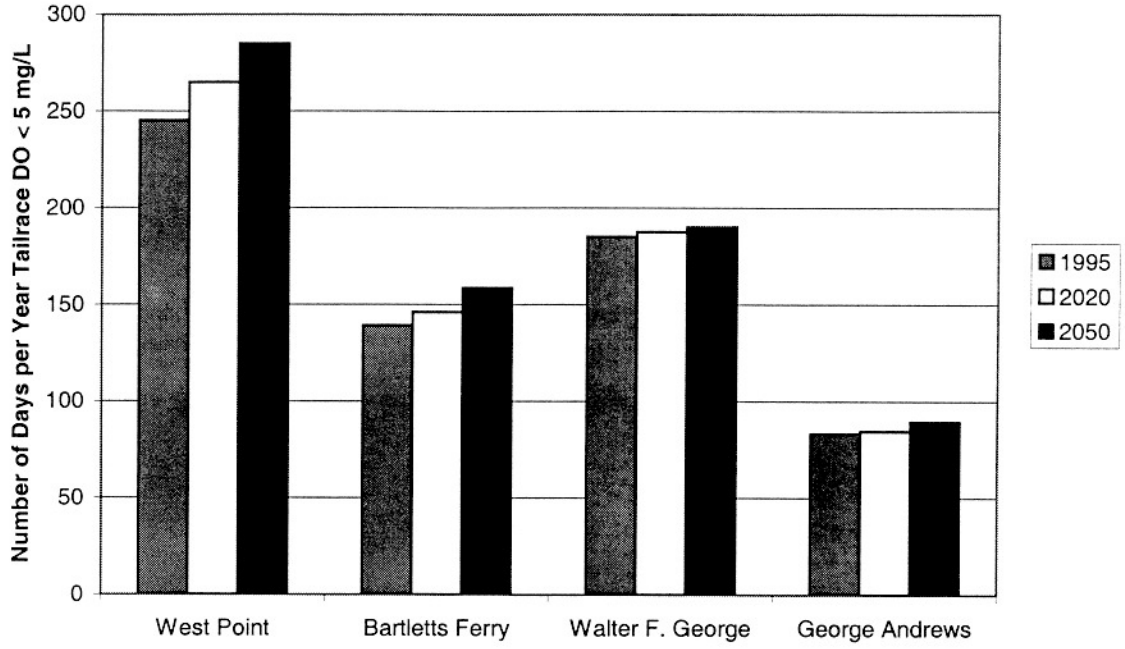

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TABLE 4-21
Lower Chattahoochee River Subbasin. River Water Quality. No Action Alternative

	1995	2020	2050
Reservoir Tailwater DO: Days Below 5 mg/L			
West Point	245	265	285
Bartletts Ferry	139	146	159
Goat Rock	0	1	2
Oliver Dam	0	0	0
North Highlands	0	0	0
Walter F. George	185.2	187.6	190
George Andrews	83	84	89
Chattahoochee River DO: Days Below 5 mg/L			
Above West Point	8	47	111
Above Bartletts Ferry	116	127	146
Columbus	0	0	0

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

TABLE 4-22
Lower Chattahoochee River Subbasin. Average Stream Percent Wastewater in Summer. No Action Alternative

	1995	2020	2050
Above West Point	19.8	25.9	31.5
Above Bartletts Ferry	13.4	16.9	20.3
Columbus	12.2	15.0	17.9

Average values predicted by HEC-5Q model for the years 1984 to 1988

The HEC-5Q modeling found an increased level of chlorophyll *a* in the reservoirs of the lower Chattahoochee River subbasin, compared to the upper subbasin. Chlorophyll *a* concentrations generally increased in downstream order, with the exception of the last two reservoirs, Walter F. George Lake and George Andrews Lake, which decreased compared to upstream reservoirs (Figure 4-56). West Point Lake was the only reservoir in the subbasin that had predicted substantial increases in chlorophyll *a* concentrations from 1995 to 2050 (increasing 12 percent). Chlorophyll *a* concentrations in the remainder of the reservoirs changed less than 5 percent between 1995 and 2050 (some increased and some decreased), as shown in ***Figure 4-81***.

For the no action alternative, summer retention time in the reservoirs predicted by HEC-5Q showed that Walter F. George has the longest retention time of the reservoirs in the lower subbasin, but it is substantially less than the retention time in Lake Lanier. No significant changes in retention time were predicted by the model under 1995 to 2050 demands (***Table 4-23***). Phosphorus loading into the reservoirs was also predicted by HEC-5Q. Of the seven reservoirs in the lower Chattahoochee River subbasin, Goat Rock and George Andrews Lake had the highest loading. The loadings increased modestly from 1995 to 2050.

FIGURE 4-81
Summer Chlorophyll *a* Concentrations in Reservoirs in the Lower Chattahoochee Subbasin. No Action Alternative

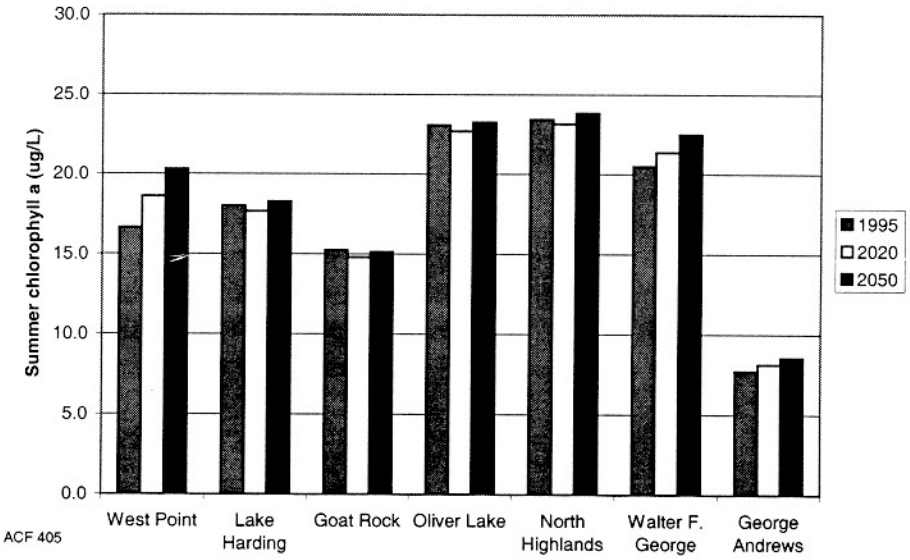

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TABLE 4-23
Lower Chattahoochee River Subbasin. Reservoir Water Quality. No Action Alternative

	1995	2020	2050
Summer Chlorophyll *a* (µg/L)			
West Point	16.6	18.6	20.3
Lake Harding	18.0	17.7	18.3
Goat Rock	15.2	14.8	15.1
Oliver Dam	23.1	22.7	23.3
North Highlands	23.4	23.2	23.8
Walter F. George	20.5	21.4	22.5
George Andrews	7.7	8.1	8.6
Summer Retention Time (days)			
West Point	21	20	19
Lake Harding	6.4	6.3	6.2
Goat Rock	0.30	0.29	0.29
Oliver Dam	1.1	1.1	1.0
North Highlands	0.052	0.052	0.052
Walter F. George	22.6	22.2	21.8
George Andrews	0.53	0.52	0.51
Summer Phosphorus Loading (pounds/acre/month)			
West Point	5.0	6.4	7.8
Lake Harding	12.0	12.2	13.0
Goat Rock	42.2	43.6	47.1
Oliver Dam	14.7	15.5	17.0
North Highlands	139	153	175
Walter F. George	3.0	3.4	3.8
George Andrews	32.4	35.8	38.8

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Under the action alternative scenarios, river water quality in the HEC-5Q model exhibited a greater number of days with DO below 5 mg/L compared to the no action alternative flow scenario. However, the differences between the action alternative scenarios and the no action alternative were generally minor at all comparison points except in the Chattahoochee River above West Point Lake. Above West Point Lake, the three action alternative flow scenarios had between 50 and 70 percent greater number of days with DO below 5 mg/L than the no action alternative (*Table 4-24*). In addition, the number of days that discharges from West Point Dam would be below 1 mg/L were twice as high under the low and moderate scenarios compared to the no action alternative. The high flow scenario was similar to the no action alternative in number of days below 1 mg/L for discharges from West Point Dam (*Figure 4-82*).

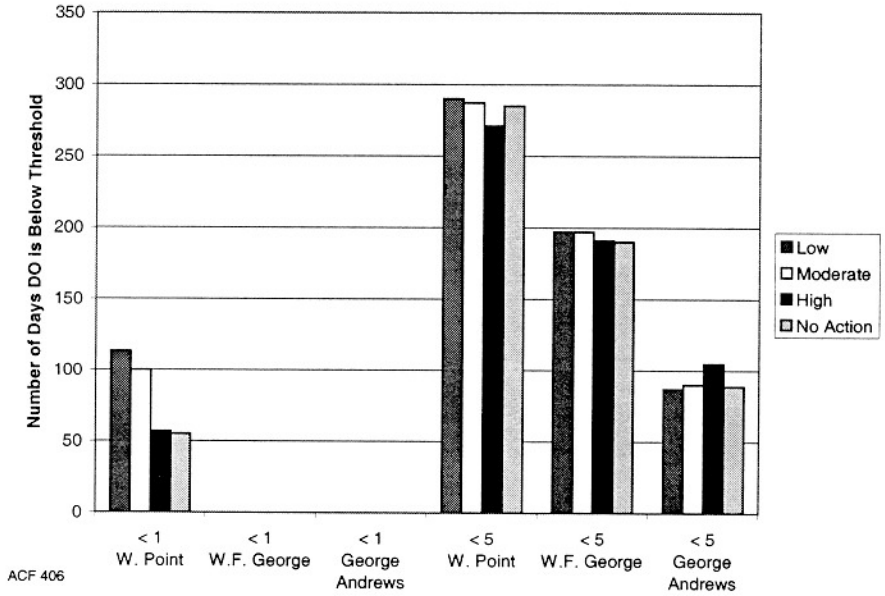
The average percent wastewater in the streams would be substantially higher under the low and moderate flow action alternative flow scenarios compared to the no action alternative (*Table 4-24*). The high flow scenario would be less slightly less than or equal to the no action alternative in terms of percent of stream flow as wastewater.

TABLE 4-24
Lower Chattahoochee River Subbasin. River Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Reservoir Tailwater DO: Days Below 5 mg/L				
West Point	285	290	287	271
Bartletts Ferry	159	163	161	157
Goat Rock	2	3	3	2
Oliver Dam	0	0	0	0
North Highlands	0	0	0	0
Walter F. George	190	197	197	191
George Andrews	89	87	90	105
Chattahoochee River DO: Days Below 5 mg/L				
Above West Point	111	188	172	166
Above Bartletts Ferry	146	150	150	161
Columbus	0	0	0	0
Chattahoochee River Summer Months: Average Stream Percent Wastewater				
Above West Point	31.5	40.5	33.9	29.3
Above Bartletts Ferry	20.3	22.9	21.7	20.1
Columbus	17.9	19.2	18.5	17.9

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

FIGURE 4-82
Summer Dissolved Oxygen in Lower Chattahoochee Subbasin Reservoirs. 2050 Demand. Action Alternative



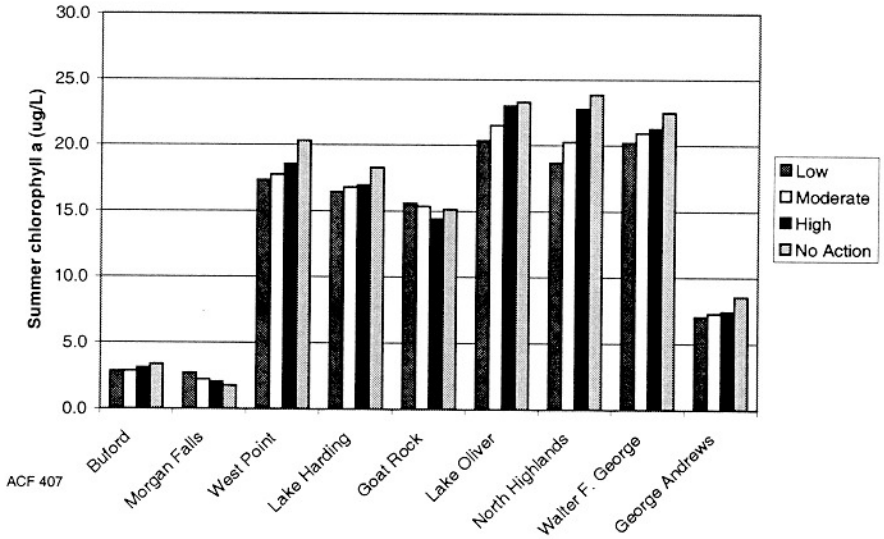
HEC-5Q predicted generally lower chlorophyll *a* values, lower summer phosphorus loading, and higher retention times for all three action alternative scenarios compared to the no action alternative (***Table 4-25***). Of the three action alternative scenarios, the high flow scenario has the highest chlorophyll *a* concentrations and phosphorus loadings; the low flow scenario has the lowest reservoir chlorophyll *a* concentrations and phosphorus loadings. Chlorophyll *a* concentrations are presented in ***Figure 4-83***. The high flow scenario has the lowest retention time of the three action alternative scenarios.

TABLE 4-25
Lower Chattahoochee River Subbasin. Reservoir Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Summer Chlorophyll *a* (µg/L)				
West Point	20.3	17.3	17.7	18.5
Lake Harding	18.3	16.4	16.8	17.0
Goat Rock	15.1	15.6	15.4	14.4
Oliver Dam	23.3	20.3	21.5	23.0
North Highlands	23.8	18.7	20.3	22.7
Walter F. George	22.5	20.2	20.9	21.3
George Andrews	8.6	7.1	7.3	7.4
Summer Retention Time (days)				
West Point	19	32	29	25
Lake Harding	6.2	9.0	8.2	7.1
Goat Rock	0.29	0.41	0.38	0.32
Oliver Dam	1.0	1.5	1.3	1.2
North Highlands	0.052	0.073	0.065	0.058
Walter F. George	21.8	31.3	29.1	25.4
George Andrews	0.51	0.72	0.68	0.58
Summer Phosphorus Loading (pounds/acre/month)				
West Point	7.8	6.2	6.3	6.4
Lake Harding	13.0	9.6	10.2	11.1
Goat Rock	47.1	31.9	34.4	38.4
Oliver Dam	17.0	11.0	11.9	13.5
North Highlands	175	116	121	129
Walter F. George	3.8	3.4	3.5	3.5
George Andrews	38.8	32.1	33.4	35.4

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

FIGURE 4-83
Summer Chlorophyll *a* Concentrations in Reservoirs in the Lower Chattahoochee River Subbasin. 2050 Demands. Action Alternative



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Overall, in the lower Chattahoochee River subbasin, water quality is not as good as in the upper basin. The combination of warmer temperatures, urban land use inputs, wastewater discharges, and flatter slopes combine to produce generally lower DO concentrations in the stream and high chlorophyll *a* concentrations in the reservoirs. The high flow scenario would improve DO concentration in the rivers by providing more dilution water, but it would also increase reservoir chlorophyll *a* concentrations and phosphorus loading. The low flow scenario would have the opposite effect of degrading river DO concentrations and improving reservoir quality. However, differences among the three action alternative scenarios were not great.

4.4.2.2.4 Flint River Subbasin Impacts

There are two reservoirs in the Flint River subbasin, but both operate essentially as run-of-river facilities and were not explicitly modeled in HEC-5 and HEC-5Q. Therefore, the impact discussion on water quality in the Flint River subbasin focuses on riverine impacts.

Under the no action alternative, the HEC-5Q model predicted only a few areas with DO concerns. The Flint River at Vienna has 19 days with DO below 5 mg/L. This is predicted to increase to 31 by the year 2050. No other point on the Flint River had more than 10 days with DO lower than 5 mg/L. The percent of wastewater in the stream was fairly low, ranging from 1.5 to 5.1 percent under 1995 water demands and from 1.9 to 6.9 under 2050 demands (***Table 4-26***).

TABLE 4-26
Flint River Subbasin River Water Quality. No Action Alternative

	1995	2020	2050
Days with DO Below 5 mg/L			
Highway 128	0	0	0
Montezuma	0	0	0
Vienna	19	35	31
Albany	7	5	5
Mitchell	3	1	1
Newton	0	0	0
Bainbridge	1	2	3
Flint River Summer Months: Average Stream Percent Wastewater			
Highway 128	2.3	3.0	2.9
Montezuma	1.5	1.9	1.9
Vienna	5.1	7.2	6.9
Albany	2.6	3.4	3.3
Mitchell	3.9	4.6	4.5
Newton	3.5	4.1	4.0
Bainbridge	2.6	3.0	3.1

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Under the action alternative scenarios, DO concentrations below 5 mg/L would continue to be a concern at one point on the Flint River: Vienna. The three action alternative scenarios would increase the number of days with DO concentrations below 5 mg/L by about 10 percent, compared to the no action alternative. However, there would be little difference among the three action alternative flow scenarios. (***Table 4-27***). Average stream percent wastewater would also increase under the action alternative scenarios compared to the no

action. All three action alternative scenarios would have wastewater in the stream about 10 percent higher than the no action alternative. Again, there would be little difference among the three action alternative scenarios.

TABLE 4-27
Flint River Subbasin River Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Flint River DO: Days Below 5 mg/L				
Highway 128	0	0	0	0
Montezuma	0	0	0	0
Vienna	31	35	35	34
Albany	5	5	4	4
Mitchell	1	1	1	1
Newton	0	0	0	0
Bainbridge	3	5	4	3
Flint River Summer Months: Average Stream Percent Wastewater				
Highway 128	2.9	3.2	3.2	3.1
Montezuma	1.9	2.1	2.1	2.1
Vienna	6.9	7.5	7.5	7.3
Albany	3.3	3.6	3.6	3.7
Mitchell	4.5	4.9	4.9	4.9
Newton	4.0	4.4	4.4	4.4
Bainbridge	3.1	3.3	3.3	3.3

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

In the Flint River subbasin, there would be little impact on water quality as a result of the action alternative flow scenarios. Because the reservoirs in the subbasin operate as run-of-river, the differences in flows would be due to the various demand scenarios. The HEC-5Q modeling indicates that the differences in demands would not significantly affect overall water quality in the Flint River. Increased groundwater pumping in the lower Flint River basin may also have an effect on surface water quality. However, it is not possible in this programmatic EIS to determine the specific water quality impacts of the interaction between groundwater and surface water.

4.4.2.2.5 Apalachicola River Subbasin Impacts

The Apalachicola River subbasin extends from Lake Seminole to Apalachicola Bay. Lake Seminole is the only reservoir in the subbasin. Riverine water quality was assessed on the Apalachicola River at Blountstown and Sumatra.

Under the no action alternative, HEC-5Q predicted stream DO concerns at Blountstown and in the tailrace of the Jim Woodruff Dam, but DO recovered by the Sumatra gage (*Figure 4-84*).

Chlorophyll *a* concentrations in Lake Seminole were predicted to be fairly high under the no action alternative, with minor increases between 1995 and 2050. Phosphorus loading would also increase from 1995 to 2050. Summer retention time would decrease slightly form 1995 to 2050 (*Table 4-28*).

FIGURE 4-84
Summer Dissolved Oxygen in Apalachicola River Subbasin Riverine Section. No Action Alternative

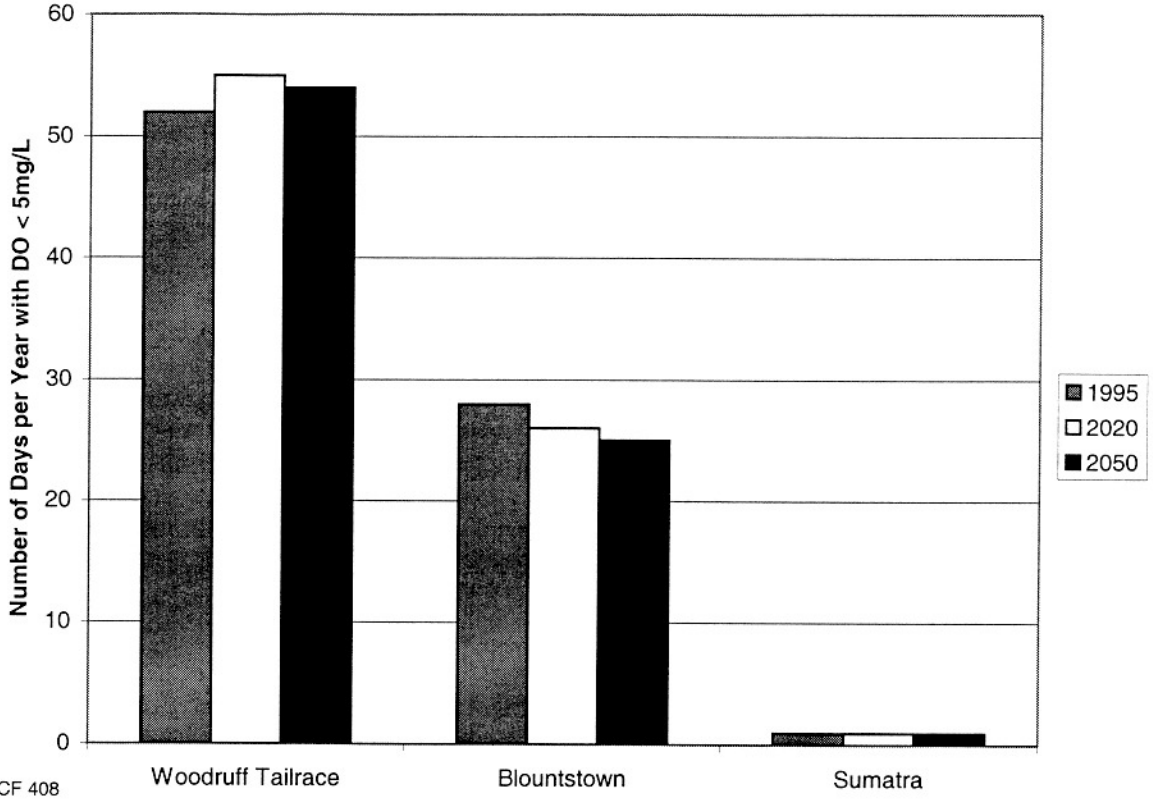


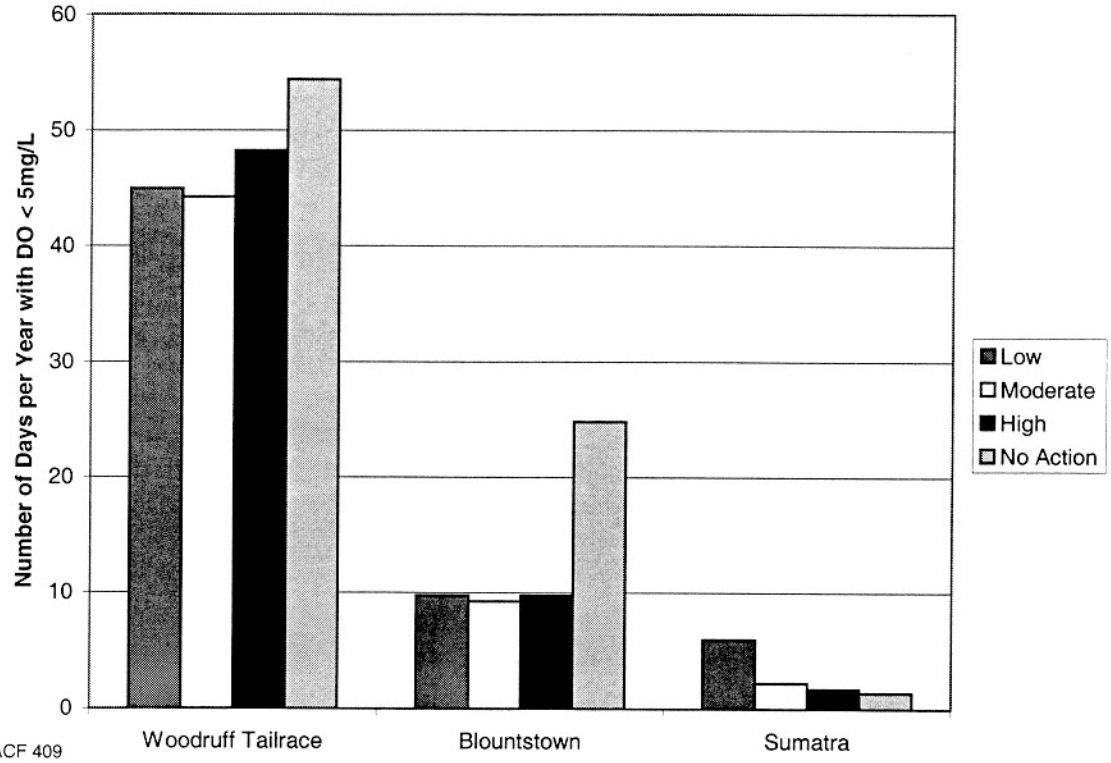
TABLE 4-28
Apalachicola River Subbasin Water Quality. No Action Alternative

	1995	2020	2050
Apalachicola River DO: Days Below 5 mg/L			
Blountstown	28	26	25
Sumatra	1	1	1
Apalachicola River Summer Months: Average Stream Percent Wastewater			
Blountstown	5.2	6.1	6.8
Sumatra	4.6	5.4	6.0
Lake Seminole Quality			
Reservoir tailwater DO (No. days < 5 mg/L)	52	55	54
Summer chlorophyll *a* (µg/L)	26.0	27.6	28.8
Summer retention time (days)	5	5	4
Summer phosphorus loading (pounds/acre/year)	4.25	4.80	5.33

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Under the action alternative scenarios, DO in the tailrace of Jim Woodruff Lock and dam would be generally improved compared to the no action alternative. This is particularly apparent at the tailwaters of the Jim Woodruff Lock and Dam and at the Blountstown gage. Farther downstream at Sumatra, DO conditions have improved and the differences between the no action alternative and the action alternative flow scenarios are less apparent (*Figure 4-85*).

FIGURE 4-85
Summer Dissolved Oxygen in Apalachicola River Subbasin Reservoirs. 2050 Demands. Action Alternative



The action alternative flow scenarios would produce higher chlorophyll *a* concentrations and lower summer phosphorus loading compared to the no action alternative. Retention time would be slightly increased under the action alternative flow scenarios compared to the no action. There are only slight differences among the three action alternative flow scenarios, however. Overall, HEC-5Q modeling results do not offer much differentiation among the three action alternative flow scenarios in terms of water quality in the Apalachicola River subbasin (***Table 4-29***).

TABLE 4-29
Apalachicola River Subbasin Water Quality. Action Alternative. 2050 Demands

	No Action	Low	Moderate	High
Apalachicola River DO: Days Below 5 mg/L				
Blountstown	25	10	9	10
Sumatra	1	6	2	2
Apalachicola River Summer Months: Average Stream Percent Wastewater				
Blountstown	6.8	6.4	6.6	7.1
Sumatra	6.0	5.5	5.7	6.3
Lake Seminole Quality				
Reservoir tailwater DO (No. days < 5 mg/L)	54	45	44	48
Summer chlorophyll *a* (µg/L)	28.8	28.9	29.4	29.4
Summer retention time (days)	4.4	5.6	5.3	4.7
Summer phosphorus loading (pounds/acre/year)	5.33	4.9	5.0	5.2

Average summer values predicted by HEC-5Q model for the years 1984 to 1988

Over the ACF basin as a whole, the high flow action alternative scenario would benefit riverine water quality by providing increased dilution and thus lowering concentrations of pollutants. This would also produce improvements in DO concentrations. However, the reservoirs may suffer degraded water quality as a result of the high flow action alternative scenario. Higher flow brings higher loadings to the reservoirs. The HEC-5Q model predicted that chlorophyll *a* concentrations in many reservoirs would increase under the high flow scenario compared to the no action alternative or the other action alternative flow scenarios. At the opposite end of the spectrum, the low flow scenario produces significantly reduced flows, especially under critical drought conditions, which would lower water quality in rivers and increase retention time in reservoirs.

4.4.2.2.6 Wastewater Discharge Impacts

Under the low flow scenario, the HEC-5Q model predicted substantial adverse effects on water quality in rivers in the ACF basin. The numerous wastewater treatment plants (both industrial and municipal) that discharge to these rivers would potentially face tighter discharge limits in order to preserve water quality under the low flow scenario. Alternatively, there would likely be no impact on permitted wastewater discharges as a result of the high flow scenario. The generally higher stream flows that are produced under the high flow scenario would enhance water quality in the streams and may allow new discharges to rivers where restrictions are currently in place due to degraded conditions. The high flow scenario would provide enhancements to onerous permitting requirements facing wastewater dischargers, although existing permit limits would not be revised due to antibacksliding rules.

4.4.2.2.7 Thermal Discharge Impacts

Thermal discharges into surface waters affect water quality by increasing rates of biological activities as well as reducing solubility of DO (DO) in water. Increased biological activity from thermal increases can increase rates of eutrophication, and reduce DO in areas where nutrient loading is high from point or nonpoint sources. Effects of thermal additions on oxygen solubility and reduction in DO are not likely to be significant, affecting only a limited zone near the discharge. Another potential impact is the killing of biota in the thermal plume near the discharge. The resultant fish kill can also produce an increase in BOD in the river, further reducing DO levels.

Plants that have once-through cooling systems add greater thermal load to receiving streams, which can further exaggerate these effects. Steam generation systems in the ACF basin that are once-through facilities include Georgia Power Plant Mitchell in Albany. Thermal effects directly related to changes in eutrophication rates or DO solubility, while locally important in the immediate area of a steam generation power plant, are not likely to significantly lower the levels of DO available for aquatic species within the basin. The effect of the no action alternative would depend on continued trends in water quality, in which nonpoint water quality issues combined with thermal additions in localized areas may continue the trend for eutrophication in these areas. Under conditions in which an allocation scenario of the action alternative resulted in reduced flows, there could be impacts to the current operating permits for these facilities. For example, under extreme low flow conditions, the thermal mixing zone requirements in the NPDES permits could be exceeded and thermal power generation facility may be required to limit operations to meet NPDES permit limits on temperatures.

4.4.2.2.8 Groundwater Impacts

Groundwater quality in the ACF basin is generally good, and water is suitable for consumption. Under the low flow scenario, when stream flows are significantly reduced, more emphasis could be placed periodically on groundwater resources during extreme drought conditions. These periodic, temporary increases in reliance on groundwater supplies could accelerate the formation of sinkholes or other subsidence features that could potentially act as conduits to directly introduce nonpoint source runoff into the groundwater regime. However, under the low flow scenario, the surface water shortfalls are not expected to be frequent or prolonged. As a result, the increased stresses on the aquifers are expected to be transitory in nature and only short term.

Under the high flow scenario, ample amounts of surface water supply should be available to meet current and future demands, so that no impacts on groundwater quality are anticipated beyond the normal growth in demand for groundwater projected under the no action alternative.

4.5 Biological Resources

The following sections address the potential effects on vegetation resources (including wetlands), wildlife resources, fish and aquatic resources, protected species, and fish and wildlife management facilities. The evaluation of these resources is based primarily on information developed under the Environmental Water Demand element of the Comprehensive Study and analyses of the alternative range of flow scenarios completed by FWS and summarized in the Fish and Wildlife Coordination Act (FWCA) report (***Appendix E***). Additional literature and information sources were used, as needed, to support the evaluation of resources not addressed by the Comprehensive Study elements or FWS analyses. Environmental performance measures were developed by FWS to address potential impacts on riverine aquatic resources, riparian wetlands, and reservoir fisheries. Brief summaries of the environmental performance measures are included under the appropriate resource sections, and the detailed descriptions are included in ***Appendix E***.

4.5.1 Vegetation Resources

The following section addresses potential impacts on terrestrial vegetation communities within the basin, as well as freshwater and estuarine wetland communities. Terrestrial vegetation was addressed in a qualitative manner based on existing literature.

4.5.1.1 Affected Environment

4.5.1.1.1 Terrestrial Communities

The following description of terrestrial habitats in the ACF is adapted from Couch et. al (1996) and Martin et al. (1993). The ACF basin contains parts of the Blue Ridge Piedmont and Southern Coastal Plain Physiographic provinces. By spanning three major ecoregions, each defined for its relatively distinct and homogenous ecological systems, the basin is unusually rich in biological diversity.

The ACF basin contains seven dominant native terrestrial vegetative communities: Appalachian oak forest, oak-hickory-pine forest, rock outcrop, grass-dominated, longleaf pine-turkey oak sandhill, maritime shrub, and evergreen maritime forest (Martin et al., 1993). These do not include areas modified for agricultural use, which include a mix of forests and grasslands, as well as cultivated areas. In areas not managed for timber production, the species present in plant communities are generally controlled by the soils, geology, and microclimate of the area. However, a number of the species present in the basin are highly adaptable and are broadly distributed. The three dominant terrestrial communities are described briefly below.

Appalachian oak forests in the ACF basin are limited to north central Georgia and the northern-most headwaters of the Chattahoochee River. Dominant canopy species can be divided into two groups: dry slope and mesic slope communities. Drier slopes in the headwaters are typically dominated by a number of oak species, including chestnut oak (*Quercus prinus*), northern red oak (*Quercus rubra*), and white oak (*Quercus alba*). Also present in the canopy are pitch pine (*Pinus rigida*), hickories (*Carya* spp.), red maple (*Acer rubrum*), and tulip poplar (*Liriodendron tulipifera*). The subcanopy typically includes saplings of the canopy species, as well as mountain laurel (*Kalmia latifolia*), various azaleas (*Rhododendron* spp.), and blueberries (*Vaccinium* spp.).

More mesic sites typically are dominated by red maple, American beech (*Fagus grandifolia*), basswood (*Tilia herterophylla*), hickories, tulip poplar, white ash (*Fraxinus americana*), and hemlock (*Tsuga canadensis*). Subcanopy species may be similar to those on drier sites, but may also include buckeye (*Aesculus* spp.), spicebush (*Lindera benzoin*), and hobblebush (*Lyonia* spp.).

Oak-hickory–pine forests are the most abundant native vegetative community in the ACF Basin (Martin et al., 1993). This forest type can be found throughout most of central and northern Alabama as well as western Georgia. The dominant canopy species in the oak-hickory-pine forests of the uplands include loblolly pine (*Pinus taeda*), shortleaf pine (*Pinus echinata*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), post oak (*Quercus stellata*), several hickories, tulip poplar, persimmon (*Diospyros virginiana*) and eastern red cedar (*Juniperus virginiana*). In areas managed primarily for forestry products, dominant canopy species are often limited to loblolly and short-leaf pine. Subcanopy species in the upland forests typically include flowering dogwood (*Cornus florida*), sourwood (*Oxydendrum arboreum*), eastern redbud (*Cercis canadensis*), shadbush (*Amelanchier canadensis*), black gum (*Nyssa sylvatica*), American holly (*Ilex opaca*), blackberry (*Rubus* spp.), viburnums (*Viburnum* spp.), sumacs (*Rhus* spp.), greenbriars (*Smilax* spp.), grapes (*Vitis* spp.), and Japanese honeysuckle (*Lonicera japonica*). These forested areas, especially if adjacent to bottomland hardwoods forests (see *Freshwater Wetlands* below), provide good habitat for game animals.

Rock outcrop communities are highly specialized plant communities associated with either granite or limestone outcrops. The ACF basin contains small areas of both communities. These plant communities are found in areas that lack sufficient soil to support large shrubs or trees, thus maintaining communities dominated by herbaceous species. Because of the temperature and moisture extremes associated with rock outcrop areas, a number of different vegetative communities have evolved to take advantage of the varying moisture and soil conditions. Each of these communities is composed of a unique assemblage of plants, although some species can be found in more than one community type. Many of these outcrop-adapted plant species are either officially protected or considered rare where they are found, and many are classified as endemic. Martin et al. (1993) identifies three limestone and eight granite outcrop communities in the ACF basin.

In the ACF basin, *grass-dominated communities* are limited to the middle Chattahoochee River in Alabama, in an area called the Black Belt (Martin et al., 1993). Typically, dominated by little bluestem (*Andropogon scoparius*), 58 other herbaceous species have been documented in the remnant Black Belt grasslands in Alabama. Although occasionally invaded by sweet gum and eastern red cedar, the remnant grass-dominated communities are maintained by periodic droughts and floods that prevent most tree and shrub species from becoming established. Periodic burns, resulting from lightning strikes or other sources, also minimize colonization by shrub and tree species in some areas.

The *longleaf pine-turkey oak sand hill community* is common in the lower portions of the Apalachicola River basin. Dominant plant species in this community are typically longleaf pine (*Pinus palustris*), turkey oak (*Quercus laevis*), bluejack oak (*Quercus incana*), mockernut hickory (*Carya tomentosa*), flowering dogwood, and wiregrass (*Aristida stricta*). This community is typically maintained by periodic burns. In areas where longleaf pine has been selectively removed, turkey oak and mockernut hickory dominate the canopy. Fire-

intolerant species, such as magnolia and holly, can invade areas that do not burn on regular intervals.

The *maritime shrub community* is limited to the coastal areas of Alabama and Florida. This community type is typically divided into two subcommunities that can be distinguished by their dominant canopy species and typical location along the coast, dune oak-buckthorn and oak scrub. The dune oak-buckthorn community typically occurs on the tops and landward slopes of dunes. The canopy of this community is typically comprised of live oak (*Quercus virginiana*), tough buckthorn (*Bumelia tenax*), red bay, slash pine (*Pinus elliotii*), and loblolly pine. Understory species include saw palmetto (*Serenoa repens*), hercules club (*Zanthoxylum clava-herculis*), myrtle, yaupon (*Ilex vomitoria*), rusty lyonia (*Lyonia ferruginea*), muscadine grape (*Vitis rotundifolia*), bamboo briar (*Smilax laurifolia*), pepper-vine (*Ampelopsis arborea*), and juveniles of the dominant canopy species.

Evergreen maritime forests are found along the coast in Alabama. These forest are dominated by magnolia (*Magnolia virginiana*), laurel oak, and live oak. Subcanopy species are often limited to juveniles of the dominant canopy species, red bay, cabbage palm, and slash pine.

4.5.1.1.2 Wetlands

Wetlands are transitional lands between terrestrial and deep-water habitats in which the water table is at or near land surface or the land is covered by shallow water (Cowardin et al., 1979). Palustrine wetlands include all nontidal wetlands dominated by trees, shrubs, persistent emergents, or emergent mosses or lichens, (e.g., freshwater marshes, swamps, bogs, fens, and wet prairies). Estuarine wetlands include deepwater tidal areas and adjacent tidal wetlands that are usually semi-enclosed by land but have access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

The ACT-ACF Comprehensive Study included a wetlands element, the findings of which were compiled in a three-volume final report: Volume I (Davis, 1997) presents relationships between flow rates and habitat values of riparian wetlands within the study area; Volume II (Dove and Kress, 1997a) presents the results of a riparian wetland inventory conducted within the study area; and Volume III (Dove and Kress, 1997b) presents the results of a study that located and characterized wetland resources around four mainstem reservoirs in the study area.

Most of the wetland area within the ACF basin is represented by forested palustrine wetlands located within the floodplains of rivers. These riparian (river-associated) forested systems are often referred to as bottomland hardwoods. Riparian palustrine systems within the ACF basin also include small areas of non-forested wetlands such as marsh or shrub wetlands. Riparian systems depend on the natural flooding regime of rivers and, in turn, influence the water and habitat quality of riverine ecosystems. The remaining wetland area within the ACF basin consists of estuarine wetlands, and palustrine wetlands that occur along reservoirs (reservoir-associated). Estuarine wetlands constitute a relatively small percentage of the total wetland area within the basin; however, because of the economic value of the estuarine ecosystem to coastal communities within the basin, the potential environmental impacts to estuarine wetlands associated with the water allocation alternatives are assessed in this EIS.

4.5.1.1.2.1 Freshwater Wetlands

The following general overview of palustrine wetlands is adapted from Couch et. al (1996).

Estimates of wetland acreage within the ACF basin as a whole vary because of differences in methods used to classify and inventory wetlands. However, approximately 5 percent (633,600 acres) of the basin was wetlands in the 1970s (USGS, 1996). Because of hilly topography, wetlands in the Blue Ridge and Piedmont provinces are small and scattered. Most wetlands of significant size are in the Coastal Plain province in the Flint River and the Apalachicola River basins. Approximately 90,000 acres are in the forested floodplain of the Flint River basin and in the floodplain and swamps associated with the Chickasawhatchee and Spring Creeks (FWS, 1998). The Apalachicola River basin contains about 27,000 acres of wetlands in the Chipola River floodplain, and 130,000 acres of wetlands in the floodplain and tidal marshes of the Apalachicola River (Wharton et al., 1977; Leitman, 1984).

The Apalachicola River floodplain is a vast wetland system of bottomland hardwood forests and tupelo-cypress swamps. Disturbances have been limited primarily to logging, which began during the lumber boom of 1870 to 1925 and has continued at a lower level to the present. Forty-seven tree species are found in this floodplain. The 10 dominant trees, in decreasing order of relative basal area, are water tupelo (*Nyssa aquatica*), Ogeechee tupelo (*Nyssa ogeeche*), bald cypress (*Taxodium distichum*), Carolina ash (*Fraxinus caroliniana*), swamp tupelo (*Nyssa sylvatica*), sweetgum (*Liquidambar styraciflua*), overcup oak (*Quercus lyrata*), planertree (*Planera aquatica*), green ash (*Fraxinus pennsylvanica*) and water hickory (*Carya aquatica*) (Leitman et al., 1983).

The Apalachicola River has one of the most productive floodplain forests found in warm, temperate regions (Elder and Cairns, 1982). Nutrients and detritus carried from the floodplain by river floods contribute significantly to the relatively high productivity of Apalachicola Bay (Mattraw and Elder, 1984). The species composition of the Apalachicola River floodplain forest is largely organized by the flood characteristics of the river, with the most flood-tolerant species dominating the most flood-prone areas. The floodplain is generally inundated annually for a period of 1 to 5 months. The flooding period is typically from January through April, during which the flood discharge may exceed by 100 times or more the low-flow discharge (Wolfe and Means, 1988). If the flooding cycle were significantly and permanently altered, the species composition and age structure of the floodplain forest would change.

Plant species composition and wildlife utilization both vary along a gradient of flooding frequency and duration in the floodplain. As a habitat situated between uplands and the river, the floodplain serves as habitat for numerous wildlife species during certain life stages or during certain seasons. Light et al. (1995) documented that at least 80 percent of Apalachicola River fish species use floodplain habitats, especially for spawning and foraging.

Most of the floodplain wetland coverage of the Apalachicola River exists in the lower river delta where the floodplain is the widest (Leitman et al., 1983). Dominant bottomland hardwood species include water tupelo (*Nyssa aquatica*), swamp tupelo (*Nyssa sylvatica*), Ogeechee tupelo (*Nyssa ogeeche*), bald cypress (Taxodium distichum), Carolina *ash* (*Fraxinum caroliniana*), sweetgum (*Liquidambar styraciflua*), and overcup oak (*Quercus lyrata*). The upper floodplain is typically dominated by tupelo, sweetgum, and cypress species. The

lower floodplain is characterized by coastal plain pine flatlands, coastal dunes, and freshwater and brackish marshes.

The size and distribution of wetland communities associated with two reservoirs in the ACF basin, Walter F. George Lake and Lake Seminole, were determined for the Comprehensive Study (Dove and Kress, 1977).

At Walter F. George Lake, 2,698 acres of wetland are supported at or below the normal pool elevation. Emergent wetlands comprise 31 percent of this total; forested wetlands comprise 28 percent; lacustrine littoral (lake edge) wetlands and various other types comprise 24 percent; and scrub-shrub wetlands make up the remaining 17 percent. The normal pool elevation at this reservoir is 190 feet, and the top-of-dam elevation is 209 feet. There are approximately 1,653 acres of additional wetlands between the normal pool and top-of-dam elevations.

At Lake Seminole, 7,418 acres of wetland are supported at or below the normal pool elevation. Lacustrine littoral aquatic bed wetlands comprise 57 percent of this total; forested wetlands comprise 20 percent; emergent wetlands comprise 15 percent, and a variety of other types make up the remaining 8 percent. The normal pool elevation at this reservoir is 77 feet, and the top-of-dam elevation is 79 feet. There are approximately 3,326 acres of additional wetlands between the normal pool and top-of-dam elevations.

4.5.1.1.2.2 Estuarine Wetlands

The only estuarine wetlands within the ACF basin are within the Apalachicola Bay estuary system, which is composed of six major subdivisions: the Apalachicola River delta, East Bay, Apalachicola Bay, St. Vincent Sound, St. George Sound, and Alligator Harbor. The Apalachicola Bay estuary covers approximately 210 square miles, and is partially bounded seaward by four barrier islands: St. Vincent Island, St. George Island, Cape St. George Island, and Dog Island. These features form four natural openings to the Gulf of Mexico: Indian Pass, West Pass, East Pass, and the expanse between Dog Island and Alligator Point. Average depth in the estuary ranges from 3 feet in East Bay to 9 feet in Apalachicola Bay, with maximum depths up to 20 feet occurring toward the barrier islands. The State of Florida has designated 60 percent of the estuary as the Apalachicola Aquatic Preserve. The Apalachicola National Estuarine Research Reserve, which includes the Bay, Cape St. George Island, and the Apalachicola River floodplain, is approximately 193,758 acres (Tonsmeire et al., 1996).

Muddy, soft bottom substrates comprise approximately 78 percent of the open water areas of the Apalachicola Bay estuary system. Phytoplankton are recognized as the most important primary producers in the open waters of the estuary. The sedimentary floor of the basin is composed generally of quartz sand with a thin cover of clay (Tonsmeire et al., 1996). Certain open water areas consist primarily of sand, whereas other areas have varying degrees of clay mixed with sand. Historically, the bay bottom was composed of silty clays, silty sands, and sand-silt-clay mixtures (Tonsmeire et al., 1996). Isphording (1985) hypothesized that the present scarcity of silt in estuarine sediments is due to either upstream reservoirs altering the sediment load carried by the Apalachicola River, events in the estuary that have acted to remove or bury silt, or a combination of both.

Most of the intertidal areas around the Apalachicola Bay estuary are surrounded by freshwater, brackish, or saltwater marshes. Approximately 14 percent of the total aquatic area of the estuary is composed of marsh habitat. The primary forms of marsh habitat

consist of freshwater and brackish marshes in the Apalachicola River delta above East Bay. These areas are dominated by sawgrass (*Cladium jamaicense*), bulrushes (*Scirpus* spp.), cattail (*Typha angustifolia*), brackish-water forms of cordgrass (*Spartina* spp.), and black needlerush (*Juncus roemerianus*). Mainland areas from Indian Lagoon to Alligator Point have limited marsh development; however, lagoon portions of St. George Island, Dog Island, and Alligator Point have light to moderate concentrations of fringing saltwater marshes, dominated by black needlerush and smooth cordgrass (*Spartina alterniflora*).

Seagrasses and other submersed vegetation, collectively known as grassbeds, account for approximately 10 percent of the total surface water area of the Apalachicola Bay estuary system. Grassbeds are highly productive and provide both food and habitat for various estuarine organisms. The naturally high rates of sedimentation in the estuary, together with the light-limiting potential of water color and turbidity resulting from river discharge restrict the range of grassbeds within the estuary. In East Bay, the grassbeds consist primarily of brackish-water species, such as tapegrass (*Vallisneria americana*), widgeon grass (*Ruppia maritima*), and pondweed (*Potamogeton* spp.). The introduced Eurasian watermilfoil (*Myriophyllum spicatum*) and hydrilla (*Hydrilla verticillata*)is also established in many of the bayous and inlets of the upper estuary. Submersed vegetation off St. George Island, Dog Island, and western portions of Alligator Point is dominated by shoal grass (*Halodule wrightii*), manatee grass (*Syringodium filiforme*), and turtle grass (*Thalassia testudium*). These species are adapted to higher salinity than occurs in East Bay, and are usually associated with macroalgal genera such as *Gracilaria*, *Caulerpa*, and *Padina*. Very little grassbed coverage occurs in St. Vincent Sound.

4.5.1.2 Environmental Consequences

4.5.1.2.1 Terrestrial Communities

The ACF River Basin Compact concerns surface water flow in the rivers of the basin. Such actions as modifications of Federal reservoir operations to comply with the formula are unlikely to themselves directly affect terrestrial habitats. Examples of possible exceptions may be a change in the operations of Buford Dam to generate power for daily peak demand periods, or utilization of flood control storage for additional water supply. The current operations, which raise and lower the river substantially on weekdays, are responsible for fairly high rates of bank erosion, affecting riparian terrestrial as well as aquatic habitats (Collier et al., 1996). Use of flood control storage could increase the "dead zone" around the edge of the lake. A change in these operations necessitated by the allocation formula would affect terrestrial habitats if the area subject to bank erosion were to change.

The allocation formula and other decisions of the ACF Commission could influence more than operations at the Corps reservoir projects, such as construction of new reservoirs in the basin for additional water storage capacity. Such actions could lead to indirect effects on terrestrial habitats, but the significance of these impacts would depend on location, size of the project, and other factors that would need to be addressed in project-specific assessments.

4.5.1.2.2 Wetlands

4.5.1.2.2.1 Freshwater Wetlands

Analysis of potential effects on freshwater wetlands in the ACF basin included studies on riparian forested wetlands associated with river and stream floodplains (Davis, 1997) and

wetlands associated with selected reservoirs (Dove and Kress, 1997b). Both studies were conducted by staff of the Corps' Waterways Experiment Station in Vicksburg, Mississippi.

Riparian Wetlands. The riparian wetland study selected six sites to represent floodplain forests in the three principal subbasins (Davis, 1997; see ***Figure 4-86***):

- Site 1: Apalachicola River, upper reach at river mile (RM) 100
- Site 2: Apalachicola River, middle reach at RM 61
- Site 3: Apalachicola River, lower reach at RM 35
- Site 4: Flint River, below Flint River Dam at RM 177
- Site 5: Flint River, upper reach at RM 285
- Site 6: Chattahoochee River, lower reach at RM 140

In cooperation with FWS, Davis (1997) developed a riparian wetlands performance measure for use in evaluating water management alternatives. The measure, referred to as the relative Riparian Wetland Unit (RWU), is an index of potential change between a reference condition and a simulated hydrologic condition. The reference hydrological condition is defined by a long-term record of river stages and a distribution of wetland acreage by elevation. The alternative condition is a flow regime that could occur under a hypothesized set of water demands and management rules, such as simulated by the shared vision models of the Comprehensive Study.

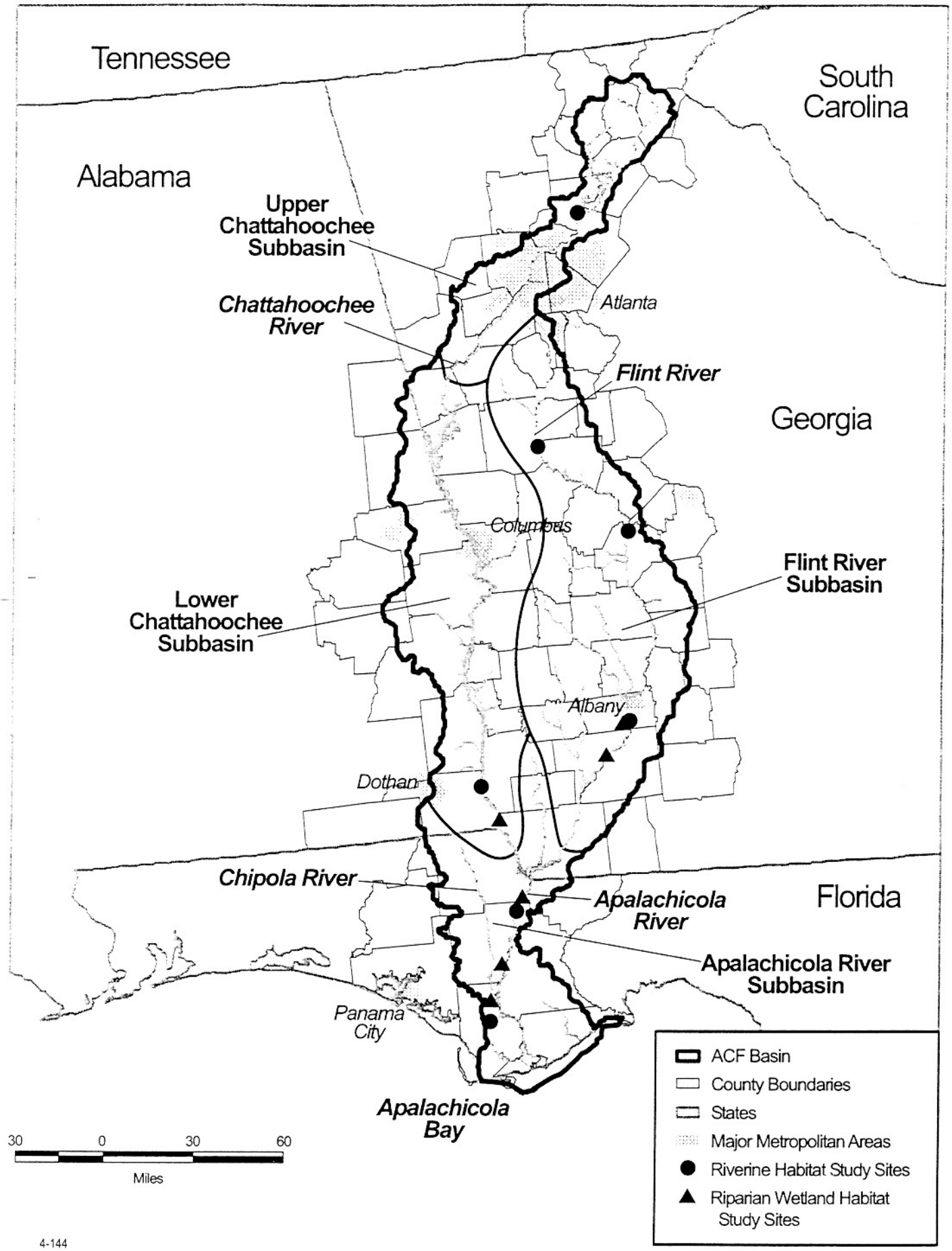
The rationale for Riparian Wetlands Units is as follows:

- The frequency and timing of inundation in the floodplain are major factors regulating riparian wetlands ecology
- Greater changes in the frequency and timing of inundation are likely to have greater impacts than lesser changes
- Changes affecting larger acreage of riparian wetlands are likely to have greater impacts than changes affecting smaller acreage

Under this approach, the frequencies with which specific river stages (1-foot elevation intervals) are exceeded in the reference and alternative hydrology data sets are computed for each month of the year. These frequencies are compared for the entire range of stages in which riparian wetlands occur. The acreage of riparian wetlands occurring in each 1-foot elevation interval is used as a quantity for prorating the potential impact of changes in the monthly exceedance frequencies. For the purposes of the Comprehensive Study, reference-condition flows for sites in unimpounded river reaches (Sites 1 to 5 on the Apalachicola and Flint Rivers) were the 55-year unimpaired flows data sets synthesized by the Corps (see ***Figure 4-86***). At the one impounded site, Site 6 on the lower Chattahoochee River, historic observed flows since the time of impoundment were used.

The final index is a ratio of the acreage-prorated exceedance frequencies under the reference condition to those under the alternative condition. Complete similarity between a water management alternative and the reference condition flows yields an index of 1.0. Arbitrarily, an alternative for which an order-of-magnitude dissimilarity in exceedance frequencies (e.g., a reference condition exceedance value of 10 percent is altered to 0 or

FIGURE 4-86
Locations of Riverine Aquatic Resource and Riparian Wetland Study Sites in the ACF Basin



ATL\Scarlett\Graphics\144282.AO.PP\7-21-98\ACF\ACF123

20 percent) is computed at all elevations during all months yields an index of 0.0. Davis (1997) concluded that there was not a specific flow-wildlife habitat relationship for riparian forested wetlands within the ACT and ACF basins. The optimum flow regime for habitat value would be the hydrological conditions under which the bottomland hardwood communities developed and to which wildlife is adapted. Therefore, the historic flows provide the reference conditions against which all water management alternatives can be compared for effects on wildlife habitat. Water management alternatives that result in the highest performance measures (riparian wetland units) indicate the least potential for impact to riparian wetland wildlife habitat.

Table 4-30 summarizes the results of the riparian wetlands performance measure study for the six sites under the twelve operational scenarios. The performance measures range from a low of 0.54 at Site 6 on the lower Chattahoochee River for the moderate releases with 2050 moderate demands, to a high of 0.93 at Site 5 on the Flint River for all but the low releases with 2050 high demands.

The performance measure generally varies little for a given site between the scenarios (***Table 4-30***). In fact, for the two Flint River sites, which are not influenced by the operations of large reservoirs, the results for all 12 scenarios are almost identical. This indicates that the 12 scenarios, as modeled, alter the reference condition hydrology to a similar degree in the range of elevations at which most of the wetlands acreage occurs.

TABLE 4-30
Riparian Wetland Unit (RWU) Performance Measure Scores for the No Action and Action Alternatives

	No Action Alternative			Action Alternative								
				High Flow			Moderate Flow			Low Flow		
Wetland	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**
Apalachicola River												
Site 1	0.84	0.84	0.83	0.84	0.83	0.83	0.80	0.81	0.81	0.80	0.80	0.80
Site 2	0.87	0.84	0.84	0.87	0.86	0.86	0.80	0.79	0.78	0.80	0.78	0.78
Site 3	0.84	0.83	0.82	0.88	0.87	0.86	0.81	0.80	0.80	0.80	0.80	0.79
Flint River												
Site 4	0.75	0.76	0.75	0.75	0.75	0.75	0.75	0.76	0.75	0.75	0.76	0.75
Site 5	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.92
Chattahoochee River												
Site 6	0.56	0.56	0.55	0.61	0.61	0.61	0.55	0.56	0.54	0.55	0.55	0.55

Source: FWS, 1998; ***Appendix E***

In general, the lack of strong variation in performance measure data suggests that the quality of wetland habitat, as defined by its value to floodplain-dependent wildlife and plant species, would not be significantly affected by any of these scenarios. For the Apalachicola and Chattahoochee River sites, the high releases scenario most closely replicates the reference hydrologic conditions in the range of elevations at which most of the wetlands acreage occurs. However, the magnitude by which the performance measures under the high releases scenario differs from those under the other operational scenarios is

relatively small and, therefore, a definitive correlation cannot be drawn from this apparent trend in the data. The similarity of the data among the operational scenarios suggests that riparian forested systems within the ACF basin would be impacted to a similar degree under all of them.

Riparian wetlands located downstream from the mainstem storage reservoirs on the Chattahoochee and Apalachicola Rivers would be the ones most likely to experience direct effects of alternative flow scenarios as evaluated using the RWU performance measure. However, wetlands located on other riverine segments could experience adverse effects from indirect actions related to allocation decisions, such as the construction of new reservoirs for additional storage capacity or increased groundwater pumping to meet growing agricultural demand. These indirect actions could occur under either the no action or action alternatives. Riparian wetlands at new reservoir sites would be inundated and replaced by open-water habitats, and downstream riparian wetlands would be affected by altered flow regimes. Increased groundwater pumping could seasonally lower the water table in wetland systems, reducing the area of available habitat for wetland-dependent species.

Riparian wetlands located along the mainstem and tributaries of the Flint River system and tributaries of the Apalachicola River would be especially sensitive to indirect impacts from new dam construction and groundwater pumping. These systems contain the longest remaining reaches of free-flowing river in the ACF basin. Bottomland hardwood wetlands in these systems help to protect water quality and adjacent riverine habitats, provide seasonal breeding sites for many species of fish, waterfowl, and amphibians, and harbor populations of protected plant species (see Section 4.5.4).

Reservoir Wetlands. Potential impacts to reservoir wetlands in the ACF basin were evaluated by examining wetland distribution data collected for Walter F. George Lake and Lake Seminole during the Comprehensive Study (Dove and Kress, 1997b) and by inspecting plots of daily water elevations for representative reservoirs (Lanier, West Point, and Walter F. George) for the 55-year period of record and selected critical low flow periods under the no action and action alternatives (CH2M HILL, 1998b; Appendix E). Comparisons of the magnitude and degree of seasonal fluctuation of reservoir levels under the different flow scenarios were then used to infer the potential for adverse impacts to adjacent wetland systems. Water level fluctuations would impact wetlands associated with reservoirs if the magnitude, frequency, and duration of drawdown or inundation substantially differed between scenarios to result in alterations to wetland community structure.

Based on the water elevation data, the magnitude of water level fluctuations experienced by reservoirs in the ACF basin during normal rainfall years is relatively small and similar among the no action alternative and action flow scenarios. However, during critical drought periods, significant drawdown of reservoir levels may occur in headwater storage reservoirs under the high flow scenario and, to a lesser degree, under the moderate flow scenario. The least amount of drawdown would occur under the low flow scenario. Drawdown during critical drought periods under the no action alternative is similar to that under the moderate flow scenario of the action alternative. Of the three reservoirs examined for critical drought periods, Lake Lanier exhibited significant drawdown of water levels under the high flow scenario, with drawdowns of 10 feet or more below normal pool extending for as many as three years (CH2M HILL, 1998b; ***Appendix E***). West Point and Walter F. George Lakes showed less pronounced differences between the action scenarios in

the duration of sustained drawdowns, the main difference being in the magnitude of drawdowns, with the high-flow scenario showing the greatest drawdown. Reservoirs such as Bull Sluice, Harding, Goat Rock, Oliver, Blackshear, and Worth would not be expected to show marked seasonal differences in water level management between the action scenarios, because they are operated more nearly in run-of-river modes. However, the smaller reservoirs on the Chattahoochee River, such as Goat Rock and Oliver, would be susceptible to daily fluctuations in water levels associated with hydropower operations at the upstream Corps storage reservoirs (i.e., Lanier and West Point).

During severe drought periods, wetlands associated with reservoirs that would experience significant sustained drawdown under the high-flow scenario, such as Lake Lanier, could undergo shifts in plant community structure. Drawdown conditions persisting for several years likely would cause the gradual replacement of lacustrine or emergent wetlands with other wetland communities that are more suited to drier conditions, such as certain shrub/forested systems. Under extreme drought conditions, substantial areas of wetland could be converted to upland; however, such impacts to reservoir-associated wetlands would be temporary. As water levels rise after the drought, the original wetland conditions gradually would be restored. Under the high flow scenario, severe drought conditions lasting one or more years could result in significant impacts to wetland-dependent wildlife and plant species in some of the headwater reservoirs in the basin.

In summary, there is a potential for wetlands associated with certain reservoirs, primarily those in the headwaters region of the basin, to experience temporary impacts as a result of significant drawdown during critical drought periods under the high flow scenario. Such impacts would be less pronounced under the no action alternative and the moderate flow scenario, and insignificant under the low flow scenario. The extent and duration of such impacts would be dependent on the magnitude and duration of the drought experienced. The systems eventually would revert back to original wetland conditions over time following the end of drought.

4.5.1.2.2.2 Estuarine Wetlands

The assessment of potential impacts to estuarine wetlands within the ACF basin is based on review of pertinent scientific literature on aquatic resources in the Apalachicola Bay estuary. Because no performance measure was developed for estuarine wetlands as part of the Comprehensive Study, the impact assessment presented in this EIS is limited to general discussion of how this resource may be impacted by alterations to the freshwater inflow regime.

Significant changes in the salinity of the Apalachicola Bay estuary system resulting from reduced freshwater inflow from the Apalachicola River could have a significant impact on the species composition and structure of wetland communities within the estuary, especially on submersed aquatic vegetation. For example, the coverage of brackish-water seagrass communities of East Bay, which are dominated by species such as tapegrass, widgeon grass, and pondweed, could be reduced in response to higher salinity conditions, with replacement by more salinity-tolerant species, such as shoal grass, manatee grass, and turtle grass, along with the types of macroalgae typically associated with these communities (e.g., *Gracilaria*, *Caulerpa*, and *Padina*). Similarly, the coverage of freshwater marshes in the Apalachicola River delta above East Bay could decrease in response to significant inflow reductions, with freshwater marsh species, such as sawgrass, bulrushes, and cattail, being replaced by brackish marsh species that are adapted to higher salinity regimes. Although

shoal grass, the dominant seagrass in Apalachicola Bay proper, has a broad salinity tolerance (NOAA, 1998), its productivity would likely be adversely affected.

Although reduced freshwater inflow could significantly alter existing seagrass assemblages within Apalachicola Bay, adverse effects likely would diminish and be limited in the western portion of St. George Sound (NOAA, 1998). The salinity regime of this portion of the estuary is not likely to be significantly altered as a result of reduced river flow because the net movement of water in the estuary as a whole is from east to west (Livingston, 1984). Also, the seagrass assemblages that occur in the western portion of St. George Sound are relatively tolerant of high salinity conditions. However, increases in salinity generally result in an overall growth reduction because plants expend energy in salt absorption to counteract increases in osmotic pressure rather than expending energy for growth (FWS, 1998). Conversely, significant reductions in river flow are likely to impact seagrass assemblages occurring in Apalachicola Bay proper.

In addition to altering the salinity regime of the Apalachicola Bay estuary, reduced river inflow could result in reduced nutrient loading. Decreased nutrient loading has the potential to decrease the productivity of estuarine wetland communities. Reductions in inflow volume also may act to decrease the spatial extent of wetland communities by altering the hydrology of the systems.

Based on the scientific literature, there is a high potential for the existing structure of estuarine wetland communities within the ACF basin to be altered in response to inflow reductions. However, the degree to which estuarine wetland communities would be affected is dependent on the magnitude of river inflow reductions and the position of each wetland community within the Apalachicola estuary system relative to the Apalachicola River. As a result, the extent to which estuarine wetland systems are potentially affected would increase as consumptive demand increases for both the no action alternative and the action alternative. Among the action alternative scenarios, the low flow (low release, high demand) scenario would likely result in the greatest community structure alterations relative to the moderate flow or high flow scenarios for a given year. Because the flow scenarios were not modeled for estuarine wetlands, only qualitative assessments can be made for comparing the no action alternative to the action alternative flow scenarios.

4.5.2 Wildlife Resources

Potential impacts on wildlife resources within the ACF basin address species that may be associated with terrestrial and riparian habitats. Due to the nature of the proposed water allocation formula, the evaluation focused on those species associated with riparian habitats. A component of the Comprehensive Study (Davis, 1997) developed by FWS included a hydrology-driven riparian floodplain wetland model and an associated wildlife habitat suitability model . The evaluation of potential impacts on wildlife is based on these models and existing literature.

4.5.2.1 Affected Environment

4.5.2.1.1 General Basin-Wide Wildlife Assemblages

The wildlife assemblages found in the ACF basin vary greatly with the vegetative community, although some species, such as white-tail deer raccoon, Virginia opossum, and grey squirrel, are found throughout the basin in a number of habitat types. Appalachian oak forests can support between 79 and 165 species of terrestrial and semi-aquatic animals

depending upon the successional stage of the forest compartment (FWS, 1998). The greatest species diversity has been documented in forests between 80 and 100 years of age. There are typically twice as many species supported by a forest of this successional stage as that supported by a forest of less than 5 years of age.

Oak-hickory forests in the ACF basin support between 18 and 26 common species and up to 9 Federally protected species and 30 State rare or protected species. Unlike the Appalachian oak forests, the shrub successional stage of this vegetation type supports the greatest number of species. Most of the rare or officially protected species, as well as species that typically have large home ranges, such as Cooper's hawk, require large tracks of mature forest.

Rock outcrops typically support animal communities that are a subset of that supported by the surrounding community. Except for Fowler's toads, amphibians are typically not found in large numbers because of the heat and low moisture associated with the outcrops. Even outcrops that contain pools of water in the spring rarely support breeding amphibians because the pools generally do not retain water long enough for tadpoles to reach maturity. Reptiles, especially lizards, are usually the most common species found on outcrops. Birds and mammals are usually transient visitors because most outcrop communities lack sufficient cover and food sources to support them in any numbers.

Because grasslands lack the structural diversity of forests, they typically support fewer species of wildlife. Many of the species typically found in grass-dominated areas are generalists that use the grassland and the forest edge as their home range, such as white-tail deer and red fox. Other species may include the grasslands as part of a foraging territory located a significant distance from breeding areas, such as red-tailed hawks. Other species, however, such as prairie deer mice (*Permyscus maniculatus bairdii*) and meadow voles (*Microtus pennsylvanicus*) occur only in maintained grasslands or pastures. There are no endemic species of wildlife known from the Alabama portion of the Black Belt and no studies have been completed to document the more common species of wildlife that use the area, primarily because the remnant native grasslands are small and disjunct, typically surrounded by agricultural fields and pastures.

Longleaf pine-turkey oak sandhill communities typically support a number of mammal species, 11 of which are considered characteristic of the community. Up to 33 species of birds and more than 60 species of reptiles and amphibians can also be found in the longleaf pine-turkey oak sandhill community. A number of the species supported by this community are officially listed as threatened or endangered by FWS, Alabama, or Florida. Of note are the two endemic mammals found in this community, the Florida mouse (*Podomys floridanus*) and the Big Cypress fox squirrel (*Sciurus niger avicennia*).

Maritime shrub communities and evergreen maritime forests support communities similar to those found in more inland locations: raccoon, cottontail rabbit, as well as a number of species of mice. White-tail deer is the largest mammal native to the coastal region. Maritime and coastal areas support large numbers of bird species, especially during migrations. Up to 300 species of birds have been documented in the coastal areas of Alabama and Florida during spring and fall migrations.

Because of the changing conditions associated with coastal areas, many of the small mammal, reptile, and amphibian species that use coastal areas, especially beaches, have

been recognized by taxonomists and regulatory agencies as distinct subspecies. As a result, a large number of them are considered rare or are officially protected. Most of these species, however, are typically found on barrier islands, although some can be found in areas that are largely undeveloped.

Forested wetlands, typically called bottomland hardwood forests provide valuable and diverse habitat for many animal species (FWS, 1998). Because they are transition areas between upland areas and pure aquatic habitats, they can be considered edge systems, and typically support a greater diversity of wildlife species than the two adjacent habitats. The enormous number of mammals, birds, reptiles, amphibians, and invertebrates that use forested wetlands prohibit a comprehensive listing of the species typically found in them (FWS, 1998).

Generally, the floodplain can be divided into a detritus-dominated aquatic area that graduates to drier, upland areas as elevation and distance from the aquatic community increases. The near-upland areas of floodplain forests typically support a greater diversity of animals than the wetter areas because they provide greater amounts of food for herbivorous and omnivorous species.

4.5.2.2 Environmental Consequences

The water allocation formula is not expected to have any significant adverse direct effects on terrestrial wildlife because no terrestrial habitats will be affected by changes in flows in the rivers. Minor losses of reservoir shoreline habitat could occur as a result of the high-flow scenario that calls for increased reservoir storage to supplement downstream flows.

Semi-aquatic and aquatic species, such as river otter and wood duck, are also not expected to be adversely effected by the water allocation formula. As discussed above in Section 4.5.1.2, none of the flow scenarios analyzed as part of the action alternative have a significant adverse effect on the floodplain habitats.

4.5.3 Fish and Aquatic Resources

The following sections address the potential impacts on riverine aquatic resources, reservoir fisheries, and estuarine resources. These resources have the greatest potential for effects as a result of the water allocation formula and, therefore, have been addressed in more detail than some of the other biological resources. Impacts were evaluated using environmental performance measures developed by FWS during the Comprehensive Study. Detailed results of FWS analyses of riverine aquatic resources and riparian wetlands are provided in *Appendix E*. The evaluation of reservoir fisheries was also based on a performance measure developed by FWS. Results of the reservoir fisheries analysis are summarized in a separate report prepared by CH2M HILL (*Appendix E*). Impacts on estuarine resources were evaluated based in part on an integrated biological model developed by NOAA (1998) for oysters in Apalachicola Bay (*Appendix E*).

4.5.3.1 Affected Environment

4.5.3.1.1 Riverine

4.5.3.1.1.1 Riverine Segments

Riverine habitats associated with the mainstem channels of the ACF basin were addressed under the Comprehensive Study (Freeman et al. 1997). The following description of

significant river sections and riverine faunal resources in the ACF basin is adapted from Freeman et al. (1997).

Sixteen dams in the ACF basin impound 342 miles of mainstem rivers, including 277 miles in the Chattahoochee River and 65 miles in the Flint River. The remaining unimpounded river segments in the basin total about 548 river miles and differ widely in size and in character of their natural resource values. ***Table 4-31*** lists the river segments that presently or potentially support diverse native faunal communities, protected species, or valued fisheries. These segments may be broadly categorized in three groups: unimpounded larger-river habitat, river subsystems with unregulated flow, and flow-regulated segments isolated between impoundments. The best available data were used to describe natural resource values of these segments; however, these data remain incomplete and necessarily address the best-studied portions of the fauna (primarily fishes).

4.5.3.1.1.2 Large River Habitat

The Apalachicola River flows freely from Jim Woodruff Lock and Dam, and represents the only unimpounded large-river habitat remaining in the ACF basin. This habitat is not pristine, however, because streamflow is regulated by upstream impoundments, and navigation channels are dredged annually. FWS compared pre-impoundment and post-impoundment hydrologic regimes in the Apalachicola River using the Range of Variability Approach (RVA) (Richter et al., 1997) to characterize existing altered flow conditions

TABLE 4-31
Inventory of Riverine Faunal Resources in the ACF Basin

River System, Subsystem, or Segment	Aquatic Faunal Resources
Chattahoochee River system upstream of Lake Lanier	Supports populations of native species (including at least one endemic, undescribed fish species) eliminated downstream in the Chattahoochee by impoundment and water quality degradation. Headwaters support trout; lower reaches support a fishery for redeye bass, and spawning habitat for walleye, white bass in Lake Lanier[a].
Chattahoochee River downstream of Buford Dam	Reach from Buford Dam to the confluence of Peachtree Creek supports a valued stocked trout fishery[a].
Chattahoochee River system between Morgan Falls Dam and West Point Lake	Extensive reach of riverine habitat including shoals in vicinity of Franklin, GA provides spawning habitat for white bass migrating upstream from West Point Lake. Degraded water quality may impact faunal integrity[a].
Tributaries to middle Chattahoochee River	Provide habitat for species diminished in the mainstem by impoundment or degraded water quality; some tributaries, including Snake, Whooping, Centralhatchee, and Hillabahatchee Creeks, retain high biotic integrity[a] and function as refugia for Chattahoochee River fauna.
Flint River system upstream of Lake Blackshear	Supports a large fraction of the native ACF fish assemblage, including five endemic species[a] and relict populations of imperiled mussels[a]. Important habitat for fishes and mussels occurs in mainstem and in tributaries. Almost unique in retaining continuity of riverine habitat from Piedmont to the Coastal Plain, providing for downstream flow of energy and nutrients, exchange among populations, and natural inundation of riparian wetlands in the corridor above Lake Blackshear.

(CONTINUED)

TABLE 4-31 (CONTINUED)
Inventory of Riverine Faunal Resources in the ACF Basin

River System, Subsystem, or Segment	Aquatic Faunal Resources
Tributaries to the Flint River	Represent potential sources of recolonizers to mainstem populations decimated by poor water quality or natural catastrophes. Ichawaynochaway Creek system supports a diverse fish assemblage of at least 55 species[a], including five endemic species, and summer refuge habitat for migratory striped bass (as, historically, did Spring Creek)[a]. Other tributaries (e.g., Kinchafoonee and Muckalee creek systems) support populations of mussels that have disappeared from the mainstem[a]. Potato, Lazer, Auchumpkee, and Ulcohatchee Creeks represent potential faunal refugia.
Lower Flint River system	Flow regulated by two upstream impoundments. Supports sport fisheries and contains summer refuge and spawning habitat for striped bass[a]. Potential habitat for mussels and native non-game fishes.
Apalachicola River system	The system comprises, in addition to the mainstem, tributaries (including the Chipola River) and distributaries in a matrix of forested wetlands of exceptional extent. Historically supported diverse aquatic assemblages including abundant mussels and fishes[b]. Flow is regulated by Woodruff Dam and upstream dams, and the channel is maintained for navigation. Diverse fish assemblages[a] and populations of imperiled mussels[a] persist in natural channel habitats. Anadromous Gulf sturgeon, striped bass, and Alabama shad ascend the river, with potential spawning habitat in upper portion of the river[a].

[a] FWS, 1998
[b] Light et al., 1995

Source: Freeman et al., 1997

(*Appendix E*). The assessment showed significant post-impoundment hydrologic alterations to include increased February mean flow, decreased July mean flow, decreased duration of high flow pulses, and changes in the rate and frequency of change in water conditions.

Integral habitat features of the Apalachicola River extend beyond the main channel to include tributaries, backwaters (oxbow lakes, sloughs) and the floodplain (Light et al. 1995; Sparks 1995). At least 80 percent of fish species found in the main channel also occupy floodplain habitats, especially for spawning and foraging (Light et al., 1995) from April through July (FWS, 1998). At least 12 tributary streams in the upper reach of the river have been reported to provide cool-water thermal refugia for striped bass (Light et al., 1997). Adult striped bass use these thermal refugia from about May through November (FWS, 1998). The main channel of the Apalachicola River also provides important habitat for mussels and anadromous fishes, including the Gulf sturgeon, striped bass, and Alabama shad.

Entrenchment of the Apalachicola River channel, which occurred after construction of Jim Woodruff Lock and Dam up until about 1981, has lowered river stages and decreased accessibility of tributary streams to fishes in the main channel (Light et al., 1997). A flow of about 11,000 cfs presently is required, as measured at the Chattahoochee gage, to provide sufficient depths at tributary mouths for fish to move between the tributaries and main channel, compared to a flow of about 5,500 cfs prior to impoundment (Light et al., 1997).

Under present conditions, the extent of connected aquatic floodplain habitat increases substantially with flows exceeding 29,000 cfs (Light et al., 1997).

4.5.3.1.1.3 Subsystems with Unregulated Flow

A second group of river segments have unregulated flow and maintain significant portions of native species assemblages. These systems and subsystems mostly occur in the upstream-most portions of the drainages and in some cases represent refugia for species eliminated from downstream segments by impoundments. The upper and middle Flint River system, and the upper-most Chattahoochee River system, along with some tributary systems to the Flint and Chattahoochee Rivers, are known to support significant remnants of the native riverine faunal communities. Unimpeded flow from the Piedmont to the Coastal Plain physiographic province significantly contributes to natural resource value in the Flint River system, because river continuity between the distinct habitats above and below the Fall Line facilitates the natural flow of water, energy and nutrients to downstream habitats, and allows the potential exchange of individuals among populations experiencing different habitat regimes. Connectivity to tributary streams is valuable for the same reasons. In all cases, identification of high quality segments implicitly includes tributary streams as important system components.

4.5.3.1.1.4 Flow-Regulated, Isolated Segments

The lower Flint River system is the sole representative of the third group of river segments that are flow regulated and isolated between impoundments, and still maintain portions of native species assemblages and support valued fisheries. Flows are regulated by the upstream Blackshear and Flint River Dams, which principally operate in run-of-river modes. RVA analysis downstream of Flint River Dam at Albany reveals typical effects of hydropower operations associated with patterns of storage and release; however, these effects are not as pronounced as in other regulated reaches in the basin. The fish and mussel communities of the Flint River and several of its tributaries were surveyed in fall 1997 by the USGS.

The Chattahoochee River downstream of Buford Dam includes the following flow-regulated, isolated, unimpounded reaches totaling 115 river miles:

- Buford Dam to the upstream end of Morgan Falls Lake (32 river miles)
- Morgan Falls Dam to the upstream end of West Point Lake (77 river miles)
- West Point Dam to the upstream end of Langdale Lake (6 river miles)

Cold-water hypolimnetic (bottom) releases from Buford Dam presently support a highly popular, urban, put-and-take trout fishery in the 48-mile reach of the Chattahoochee River between Buford Dam and the I-285 West Bridge in Atlanta. The reach is classified by the GDNR Wildlife Resources Division as secondary trout waters. Secondary trout streams show no evidence of natural reproduction but are capable of sustaining stocked trout throughout the year. The river is stocked annually with about 250,000 adult and juvenile rainbow trout and brown trout. Formerly a warm-water stream, this reach of the Chattahoochee River now supports one of the southernmost tailwater trout fisheries (Nestler et al., 1986).

Water quality criteria for secondary trout streams in Georgia specify that elevations of natural stream temperatures shall not exceed 2°F (GDNR, 1998a). For waters designated as

trout streams, dissolved oxygen concentrations must be no less than 5.0 mg/L and average at least 6.0 mg/L on a daily basis.

Based on an instream flow study conducted by Nestler et al. (1986), habitat values for trout in the Chattahoochee River generally peak at river flows under 2,000 cfs and decline to minimum values at flows of 12,000 cfs. The largest area of suitable trout habitat in the reach occurs below Morgan Falls Dam in association with extensive rocky shoals. A principal factor limiting the downstream distribution of stocked trout in the Chattahoochee River is water temperature. Rainbow trout and brown trout generally require water temperatures below 77°F for survival and prefer temperatures below 68°F for feeding, growth, and reproduction (Eaton et al., 1995; Raleigh et al., 1984, 1986).

Based on RVA analysis comparing pre- and post-impoundment conditions downstream of Buford Dam, significant hydrologic alterations reflected in current conditions include generally higher flows in late summer and autumn, and lower or more variable flows in spring (FWS, 1998; *Appendix E*). Low-flow pulses and high-flow pulses are both more frequent yet shorter in duration, corresponding with current hydropower peaking operations at Buford Dam. Daily releases typically vary between about 1,000 and 8,000 cfs, resulting in substantial downstream fluctuations in stream levels. These pronounced fluctuations destabilize the day-to-day distribution and availability of aquatic habitat for native aquatic biota and trout.

The middle Chattahoochee River, between Morgan Falls Dam and West Point Reservoir, also contains extensive riverine habitat but with degraded water quality. The low diversity and abundance of native riverine fishes in the Chattahoochee River downstream of Atlanta may be largely attributable to decades of industrial and municipal wastewater discharge, and sedimentation and other nonpoint source run-off from the rapidly growing metropolitan area.

Nine dams impound nearly the entire reach of the Chattahoochee River between West Point Dam and Walter F. George Lock and Dam. Riverine habitat exists as short fragments isolated between an upstream dam and the backwaters of the next downstream impoundment. Fishes in the tailwater segments have at times suffered scouring and stranding effects of rapid flow fluctuations, and low dissolved oxygen levels resulting from hypolimnetic releases or from crowding of fish stranded by rapidly dropping water levels (FWS, 1998). RVA analysis shows that these segments experience substantially altered flow regimes from hydropower operations (FWS, 1998).

4.5.3.1.2 Reservoir

In the ACF basin, the vast majority of lacustrine habitat is associated with the 16 mainstem reservoirs. The operations of these reservoirs are the principal means by which flows in the mainstem rivers may be managed and, therefore, are likely to figure somehow in the allocation formula adopted by the ACF Commission. Conceivably, the lacustrine environment is the most likely to be affected by the Commission's decisions.

The ACF reservoirs support popular sport fisheries, some of which have achieved national acclaim for trophy-size catches of largemouth bass. The Comprehensive Study funded two reservoir fisheries elements that were designed to describe relationships between reservoir levels and fisheries in the two basins, but did not fund an inventory of current fishery conditions at the basins' reservoirs. Barkuloo et al. (1987) summarized the fisheries of the ACF reservoirs, but we are not aware of any comprehensive descriptions compiled since.

Ryder et al. (1995) surveyed the basin's reservoir fisheries biologists to determine which reservoirs and which species were of critical importance in assessing reservoir operations. *Table 4-32* shows the list they compiled for 10 of the 16 ACF reservoirs. Six reservoirs, Morgan Falls, North Highlands, Langdale, Riverview, City Mills, and Phenix, were omitted because of their small size and relatively small storage capacity, and therefore their operations are unlikely to be affected on a seasonal basis by the allocation formula.

TABLE 4-32
Fish Species Identified as Critical in Evaluating Operating Alternatives for Reservoirs of the ACF Basin

Reservoir	Critical Species
Chattahoochee River:	
Lake Lanier	Crappie, largemouth bass, spotted bass, striped bass, walleye, white bass
West Point Lake	Crappie, gizzard shad, striped bass-white bass hybrid (hybrid bass), largemouth bass, striped bass, threadfin shad, white bass
Harding Lake[a]	Bluegill, crappie, gizzard shad, hybrid bass, largemouth bass, spotted bass, striped bass, threadfin shad, white bass
Goat Rock Lake	Channel catfish, crappie, largemouth bass, threadfin shad
Oliver Lake	Bluegill, crappie, largemouth bass, threadfin shad
George Andrews Lake	Crappie, largemouth bass
Walter F. George Lake	Crappie, hybrid bass, largemouth bass, shad
Flint River:	
Lake Blackshear	Bluegill, crappie, largemouth bass, shad, sunfish
Lake Worth	Bluegill, largemouth bass
Apalachicola River:	
Lake Seminole	Bluegill, crappie, largemouth bass, redear sunfish, striped bass, threadfin shad

[a] Harding Lake is referred to as Bartlett's Ferry Reservoir in Ryder et al. (1995).

Source: Ryder et al., 1995

The combination of stable water levels, shallow depths, sedimentation, excessive nutrient inputs, and a mild climate provide conditions favorable to the proliferation of aquatic vegetation, particularly introduced species. In the ACF basin, several reservoirs have experienced noxious growths of aquatic plants. The problem is most severe in Lake Seminole, where as much as 68 percent of the lake's surface area has been covered by aquatic plants (Corps, 1998b). Gholson (1984) noted noxious growth of aquatic plants in Lake Seminole in 1955, when the reservoir was still initially filling. Since then, the Corps has documented over 900 species of aquatic and wetlands plants at Seminole (Corps, 1998b). Several noxious exotic species have become well-established, including Eurasian milfoil (*Myriophyllum spicatum*), water hyacinth (*Eichornia crassipes*), and hydrilla (*Hydrilla verticillata*). In recent years, the worst of these has been hydrilla. The Corps (Corps, 1998b) has recently issued a Hydrilla Action Plan, which adopts a mix of chemical, biological, and mechanical measures to manage the lake's hydrilla.

4.5.3.1.3 Estuarine

The Apalachicola Bay estuary consists of numerous habitat types, including marine waters, brackish bays and marshes, and inland rivers and swamps. Because of its habitat diversity, the estuary provides spawning, nursery, and feeding grounds for a great number of estuarine-dependent fish and aquatic invertebrates.

Benthic (bottom) invertebrates, which include both infaunal (living in) and epifaunal (living on) organisms, represent one of the most important links for the overall biological production within Apalachicola Bay. Two of the most abundant infaunal organisms that occur in Apalachicola Bay sediments are the polychaete worms, *Mediomastus ambiseta* and *Streblospio benedicti*. Crustaceans such as amphipods and isopods are also very common in the estuary. Many species of polychaetes, amphipods, and isopods feed primarily on organic detritus that enters the estuary via the Apalachicola River. These organisms reach their numerical peaks in winter and spring when river discharge and, thus, organic detritus input into the estuary is highest. The epifaunal benthos within the Apalachicola Bay estuary system is dominated by penaeid shrimp, blue crabs, squid, and various mollusks.

The Apalachicola Bay estuary is considered one of the most important commercial fishing resources in North America. The primary commercial fishery species in the estuary have been the American oyster (*Crassostrea virginica*), penaeid shrimp (brown shrimp, *Penaeus aztecus*; white shrimp, *P. setiferus*; and pink shrimp, *P. duorarum*), blue crab (*Callinectes sapidus*), and various finfish (e.g., mullet, flounder, and spotted seatrout).

The Apalachicola Bay estuary accounts for approximately 90 percent of the oysters harvested in Florida. At present, oyster beds cover approximately 7 percent of the aquatic area of the estuary; however, approximately 40 percent of the aquatic surface area of the estuary is considered suitable for oyster bar development. In addition to the commercial value of the oyster itself, the oyster reefs of the Apalachicola Bay estuary support numerous fish and aquatic invertebrates that are important components of the estuarine foodweb. The primary factors that limit the distribution and productivity of oysters in the estuary are temperature, rainfall/river flow (and hence salinity), productivity, bottom substrate type, and predation. Salinity is generally considered to be the most significant limiting factor for oysters in the estuary. Prolonged high salinities due to drought conditions allow predators to infiltrate the bars, and are also indicative of lower food availability in the estuary. Prolonged low salinities eliminate many of the predators, but also stress the oyster and may cause direct mortality. The most serious oyster predators in the estuary are the southern oyster drill (*Thais haemostoma*) and stone crab (*Menippe mercenaria*). The pathogen, Dermo (*Perkinsus marinus*) also can cause significant mortality to adult oysters during times of stress (Menzel, 1983).

The most abundant true estuarine fish species (resident throughout entire life cycle) in the Apalachicola Bay estuary is the bay anchovy (*Anchoa mitchilli*). Other species that use the estuary as nursery and/or feeding grounds during a portion of their life cycle include the striped mullet (*Mugil cephalus*), flounder (*Paralichthys lethostigma*), and members of the sciaenid family: speckled seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), croaker (*Micropogon undulatus*), spot (*Leiostomus xanthurus*), and sand seatrout (*Cynoscion arenarius*). These species spawn offshore and spend their juvenile and adult stages in the estuary. Anadromous fish, which spend a portion of their life cycle in the estuary when migrating from the ocean to their spawning grounds upstream, include the Gulf sturgeon (*Acipenser*

oxyrhynchus desotoi), striped bass (*Morone saxatilis*), Alabama shad (*Alosa alabamae*), and skipjack herring (*Alosa chrysochloris*). Species such as bluegill (*Lepomis macrochirus*), large-mouth bass (*Micropterus salmoides*), and mosquito fish (*Gambusia affinis*) occur in the Apalachicola River delta and may enter the upper reaches of the estuary during winter and spring flooding.

As mandated by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), the Gulf of Mexico Fishery Management Council (GMFMC) prepared a draft amendment to its Fishery Management Plans (FMPs) in June 1998, designating essential fish habitat (EFH) for 21 of the more than 60 species that the Council manages (NOAA, 1998). EFH refers to those waters and substrate necessary to support a sustainable fishery, including habitat for spawning, breeding, feeding, or growth to maturity. GMFMC is delineating EFH for the most important commercial and recreational species in the Gulf of Mexico to include areas in which a species is common, abundant, or highly abundant, based upon catch per unit effort data (NOAA, 1998). Additional designations will be included in subsequent FMP amendments as more data are gathered on the remaining species. As part of the review of this draft EIS, NOAA's National Marine Fisheries Service (NMFS)/National Ocean Service (NOS) will assess whether the consultation process for EFH must be implemented due to potential impacts on habitat and areas designated as EFH in the final amendment and associated FMPs.

The draft FMP amendment delineates Apalachicola Bay up to the limit of permanent fresh water as EFH for red drum, gray snapper (*Lutjanus griseus*), brown, white, and pink shrimp, and Gulf stone crab. Food, salinity, temperature, and/or refuge areas (e.g., vegetation, oyster reefs) are the primary factors determining the distribution and abundance of these species in the estuary. In addition, the shrimp and other estuarine-dependent species provide prey for nearshore juvenile stages of the snapper-grouper complex of at least nine species, which is also managed under MSFCMA. ***Figure 4-87*** characterizes key aspects of habitat associations for the shrimp species, gray snapper, and red drum (Pattillo et al., 1997).

A National Estuarine Research Reserve (NERR) site is located in Apalachicola Bay, Florida. The NEER system is a nationwide network of State and Federal protected areas designated and supported by NOAA. The Apalachicola National Estuarine Research Reserve represents a relatively unaltered estuarine ecosystem and is dependent on freshwater inflow (Livingston, 1983). The NERR supports a diverse community of freshwater, Full page—ACF300 estuarine, and marine animals and plants, including two species of special concern in Florida: redeye bass (*Micropterus coosae*) and bluestripe shiner (*Notropis callitaenia*).

4.5.3.2 Environmental Consequences

4.5.3.2.1 Riverine

4.5.3.2.1.1 Riverine Habitat Performance Measure Assessment

This section analyzes the potential relative effects of the no action and action alternatives on riverine biota using the riverine habitat performance measure developed as part of the Comprehensive Study (Freeman et al., 1997). The performance measure uses the Riverine Community Habitat Assessment and Restoration Concept (RCHARC) to derive habitat-value functions describing the relative similarity of depth and velocity conditions under alternative flow scenarios to depth and velocity conditions occurring under unregulated, natural flow conditions (Nestler et al., 1993, 1995). RCHARC is based on the premise that

FIGURE 4-87

Habitat Associations for Five Species with EFH in Designated Apalachicola Bay (ACF Basin)

Species	Life stage	Domain: Freshwater: Lacustrine	Riverine - coastal plain	Riverine - inland	Estuarine: Inlet mouth	Channel	Inter- and subtidal flats	Salinity Range: NEI: Tidal fresh (0-0.5‰)	Mixing (0.5-25‰)	Seawater (>25‰)	Venice System: Limnetic (0-0.5‰)	Oligohaline (0.5-5‰)	Mesohaline (5-18‰)	Polyhaline (18-30‰)	Euhaline (>30‰)	Temperature Range: 32-41°F	41-50°F	51-60°F	61-68°F	69-77°F	78-86°F	>86°F	Marine: Beach/surf	Neritic	Oceanic	Substrate Preference: Mud/silt/clay	Sand	Pebble/cobble/gravel	Boulder/rocky outcrop	Shell	Submergent vegetatio	Emergent vegetation	Floating vegetation	None	Depth Preference: Littoral: Intertidal	Subtidal	Sublittoral: Inner shelf (32-164 ft)	Middle shelf (164-328	Outer shelf (328-656 f
Brown shrimp	A				●				●	●		●	●	●	●	●	●	●	●	●	●	●		●		●	●										●	●	
Penaeus	S									●					●				●	●	●			●		●	●											●	
aztecus	J				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●					●	●			●	●			
	L					●			●	●				●	●			●	●	●	●	●		●		●					●			●			●	●	
	E									●					●						●	●		●										●				●	
Pink shrimp	A				●	●	●			●				●	●		●	●	●	●	●	●		●		●	●			●						●	●	●	
Penaeus	S									●					●				●	●	●	●		●		●	●			●						●	●		
duorarum	J						●		●	●		●	●	●	●	●	●	●	●	●	●	●				●	●			●	●	●	●		●	●	●		
	L									●					●					●	●			●	●									●		●	●		
	E									●					●					●	●	●		●	●									●		●	●		
White shrimp	A					●			●	●		●	●	●	●		●	●	●	●	●	●		●		●	●						●				●		
Penaeus	S									●					●				●	●	●			●		●	●										●		
setiferus	J					●	●		●	●		●	●	●	●		●	●	●	●	●	●				●	●				●	●	●		●	●			
	L									●					●			●	●	●	●			●							●			●			●		
	E									●					●				●	●	●			●										●			●		
Gray snapper	A				●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●		●		●		●	●	●	●					●	●	
Lutjanus	S									●					●					●	●			●		●		●	●	●						●	●		
griseus	J				●	●	●	●	●	●	●	●	●	●	●				●	●	●	●		●		●			●	●	●	●			●	●	●		
	L								●	●		●	●	●	●				●	●	●			●		●					●					●	●		
	E									●				●	●					●	●			●					●	●							●	●		
Red drum	A				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●			●						●	●	●	
Sciaenops	S																			●				●									●			●	●		
ocellatus	J		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●			●	●		●		●	●			
	L						●	●	●	●	●	●	●	●	●				●	●	●	●		●		●	●				●		●		●	●			
	E						●		●	●				●	●					●	●			●										●		●	●		

E Egg
L Larvae
J Juveniles
S Spawning
A Adults

Source: Pattillo et al., 1997

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native riverine communities of fish, freshwater mussels, and other aquatic organisms evolved under patterns of spatial and temporal variability in physical habitat prevalent in unregulated streams. Therefore, managing regulated streams to mimic the spatial and temporal variability of natural streams should protect native riverine biodiversity. The habitat-value functions are useful for comparing alternative flow scenarios but do not quantify habitat suitability of a given flow regime for specific aquatic species or species assemblages (Freeman et al., 1997).

The RCHARC performance measure uses the 55-year unimpaired flows data set synthesized by the Corps (1997) as the best available approximation of natural flows in the basin. The performance measure computes a composite measure of habitat similarity based on empirically determined habitat-discharge relationships and mean monthly flow exceedance values extracted from the unimpaired daily flows data set and the HEC-5 model output for the no action and action alternatives. Scores range from 0 for no overlap in depth-velocity characteristics to 1.0 for identical representation of depth-velocity characteristics.

RCHARC performance measures were developed for the following six sites in the ACF basin as documented by Freeman et al. (1997):

- Site 1: Upper reach of the Apalachicola River downstream of Jim Woodruff Lock and Dam at river mile 106.5; representing limestone shoal habitat.
- Site 2: Lower reach of the Apalachicola River flowing through an extensive floodplain and distributary system at river mile 21.1-21.6; representing mostly deep-channel habitat.
- Site 3: Lower reach of the Chattahoochee River downstream of Andrews Lock and Dam at river mile 44.5-46.0; representing mostly deep-channel habitat.
- Site 4: Lower reach of the Flint River downstream of Flint River Dam at river mile 91.4; representing deep-channel habitat, rocky shoals, and pools.
- Site 5: Middle reach of the Flint River upstream of Lake Blackshear in the Coastal Plain at river mile 192; representing low-gradient, meandering channel with deep-fast, raceway, and pool habitats.
- Site 6: Upper reach of the Flint River in the Piedmont at river mile 252; representing diverse riffle, pool, and run habitats.

For the Chattahoochee River below Buford Dam (Site 8), the habitat-discharge relationship developed for adult brown trout and rainbow trout in an instream flow study previously conducted by Nestler et al. (1986) was used as the performance measure. The detailed results of the performance measure assessment of potential impacts to riverine habitat at each of the seven sites are provided by FWS (1998) in *Appendix E*. *Table 4-33* summarizes the performance measure scores and ranking of scores across the no action and action alternatives. Results for the Flint River sites are not included because operational differences were not simulated for the Flint River. A graphic example of riverine performance measures for the lower Chattahoochee River (Site 3) is provided in ***Figure 4-88***.

Under the no action alternative, RCHARC performance measure scores ranged from 0.287 at Apalachicola River Site 2 to 0.742 at Apalachicola River Site 1 (***Table 4-33***). All three sites

on the Apalachicola and Chattahoochee rivers showed little variation in performance scores between the three consumptive demand scenarios within a given season, with a general trend of slightly decreasing similarity to unimpaired flows (i.e., lower scores) with increasing demand. The greatest variation across demand scenarios within a season was observed for Site 3 on the lower Chattahoochee River (0.189). For the Apalachicola River sites, the greatest similarity to unimpaired flows occurred during summer/fall or winter, with the lowest similarity occurring in spring/summer. For the lower Chattahoochee River, the greatest similarity to unimpaired flows occurred during winter, with the lowest similarity in spring/summer or summer/fall depending on the demand scenario. The greatest seasonal variation in performance measure score under the no action alternative was observed for Site 2 on the lower Apalachicola River between summer/fall and spring/summer using 2020 demands (0.421).

Under the no action alternative, the performance measure for Site 8 on the upper Chattahoochee River showed little sensitivity, with scores varying from 0.831 to 0.871 (***Table 4-33***). The greatest habitat area (normalized weighted usable area) for trout occurred in spring/summer, and the lowest values occurred in summer/fall.

Among the three action scenarios, the Apalachicola River sites achieved the highest performance measure scores under the low flow scenario in winter, under the high flow scenario in spring/summer, and under the moderate flow scenario in summer/fall (***Table 4-33***). The greatest range of variation between action scenarios for these sites occurred during summer/fall. The lower Chattahoochee River site showed the greatest similarity to unimpaired flows under the high flow scenario for winter and spring/summer, and under the moderate flow scenario for summer/fall. Based on the rather wide ranges of scores observed across the action scenarios at this site, the lower Chattahoochee River shows the greatest potential for adverse effects to riverine resources under alternative flow scenarios (***Figure 4-88***). The performance measure representing the potential for impacts to trout habitat in the upper Chattahoochee River shows little overall variation, with slightly higher scores under the high flow scenario in winter and summer/fall, and slightly higher scores under the moderate flow scenario in spring/summer.

Based on the sum of ranks of the individual riverine sites across action scenarios by season, the low flow scenarios rank highest in overall similarity of riverine habitat conditions to unimpaired flows during winter, the high flow scenarios rank highest in spring/summer, and the moderate flow scenarios rank highest in summer/fall (***Table 4-33***). The overall weighted sum of ranks shows the moderate flow scenarios as generally providing the most optimal flow conditions for maintenance of riverine habitat on an annual basis, followed by high flow scenarios.

TABLE 4-33
Riverine Habitat Performance Measure Scores and Ranking of Scores Across All Flow Scenarios

				Action Alternative									
	No Action Alternative			High Flow			Moderate Flow			Low Flow			
Riverine Site	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**Range**
Winter (January-March)													
Apalachicola River													
Site 1	0.742	0.712	0.674	0.746	0.743	0.726	0.820	0.786	0.762	0.837	0.812	0.783	0.111
Rank	9	11	12	7	8	10	2	4	6	1	3	5	
Site 2	0.402	0.368	0.356	0.377	0.358	0.349	0.464	0.435	0.421	0.465	0.454	0.428	0.116
Rank	7	9	11	8	10	12	2	4	6	1	3	5	
Chattahoochee River													
Site 3	0.542	0.503	0.490	0.643	0.620	0.590	0.600	0.583	0.534	0.620	0.591	0.568	0.109
Rank	9	11	12	1	2.5	6	4	7	10	2.5	5	8	
Site 8	0.837	0.851	0.856	0.827	0.831	0.832	0.791	0.803	0.809	0.786	0.795	0.799	0.046
Rank	3	2	1	6	5	4	11	8	7	12	10	9	
Sum of Ranks	28	33	36	22	25.5	32	19	23	29	16.5	21	27	
Scenario Ranking	**8**	**11**	**12**	**4**	**6**	**10**	**2**	**5**	**9**	**1**	**3**	**7**	
Spring/Summer (April-July)													
Apalachicola River													
Site 1	0.562	0.527	0.462	0.520	0.485	0.460	0.418	0.397	0.369	0.416	0.386	0.354	0.166
Rank	1	2	5	3	4	6	7	9	11	8	10	12	

(CONTINUED)

TABLE 4-33 (CONTINUED)
Riverine Habitat Performance Measure Scores and Ranking of Scores Across All Flow Scenarios

				Action Alternative									
	No Action Alternative			High Flow			Moderate Flow			Low Flow			
Riverine Site	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**Range**
Site 2	0.325	0.287	0.294	0.316	0.298	0.285	0.279	0.267	0.256	0.279	0.258	0.251	0.065
Rank	1	5	4	2	3	6	7.5	9	11	7.5	10	12	
Chattahoochee River													
Site 3	0.473	0.409	0.352	0.510	0.466	0.397	0.177	0.168	0.160	0.175	0.162	0.150	0.360
Rank	2	4	6	1	3	5	7	9	11	8	10	12	
Site 8	0.860	0.867	0.871	0.908	0.914	0.917	0.920	0.929	0.935	0.904	0.912	0.920	0.031
Rank	12	11	10	8	6	5	3.5	2	1	9	7	3.5	
Sum of Ranks	16	22	25	14	16	22	25	29	34	32.5	37	39.5	
Scenario Ranking	**2.5**	**4.5**	**6.5**	**1**	**2.5**	**4.5**	**6.5**	**8**	**10**	**9**	**11**	**12**	
Summer/Fall (August-December)													
Apalachicola River													
Site 1	0.708	0.723	0.659	0.708	0.671	0.617	0.857	0.862	0.828	0.836	0.840	0.811	0.245
Rank	8.5	7	11	8.5	10	12	2	1	5	4	3	6	
Site 2	0.668	0.708	0.703	0.763	0.751	0.719	0.922	0.933	0.910	0.881	0.885	0.876	0.214
Rank	12	10	11	7	8	9	2	1	3	5	4	6	
Chattahoochee River													
Site 3	0.533	0.392	0.344	0.206	0.222	0.256	0.651	0.705	0.760	0.512	0.499	0.514	0.554
Rank	4	8	9	12	11	10	3	2	1	6	7	5	

(CONTINUED)

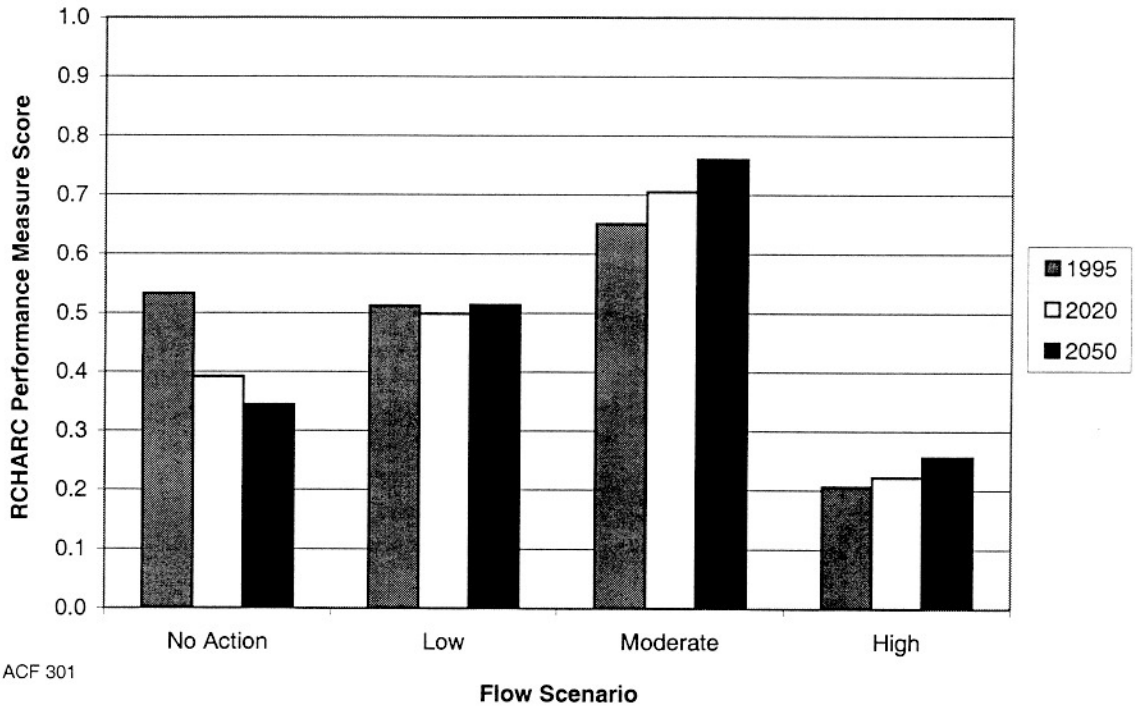
TABLE 4-33 (CONTINUED)
Riverine Habitat Performance Measure Scores and Ranking of Scores Across All Flow Scenarios

				Action Alternative									
	No Action Alternative			High Flow			Moderate Flow			Low Flow			
Riverine Site	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**1995**	**2020**	**2050**	**Range**
Site 8	0.831	0.841	0.846	0.978	0.981	0.983	0.956	0.965	0.971	0.913	0.919	0.938	0.070
Rank	12	11	10	3	2	1	6	5	4	9	8	7	
Sum of Ranks	36.5	36	41	30.5	31	32	13	9	13	24	22	24	
Scenario Ranking	**11**	**10**	**12**	**7**	**8**	**9**	**2.5**	**1**	**2.5**	**5.5**	**4**	**5.5**	
Overall Weighted Sum of Ranks	330.5	367	413	274.5	295.5	344	222	230	288	299.5	321	359	
Overall Scenario Ranking	**8**	**11**	**12**	**3**	**5**	**9**	**1**	**2**	**4**	**6**	**7**	**10**	

The performance measure used for Sites 1, 2, and 3 was the Riverine Community Habitat and Restoration Concept (RCHARC) of Nester et al. (1993, 1995). The performance measure used for Site 8 was the habitat (weighted usable area)-discharge relationship developed for adult brown trout and rainbow trout in instream flow studies conducted by Nestler et al. (1986).

Source: FWS, 1998; ***see Appendix E***

FIGURE 4-88
Riverine Habitat Performance Measure Scores, Lower Chattahoochee River (Site 3), Summer/Fall (ACF Basin)



River segments located downstream of the mainstem storage reservoirs on the Chattahoochee and Apalachicola Rivers would be the ones mostly likely to experience direct effects of alternative water management scenarios. However, indirect effects, such as the construction of new reservoirs for additional storage capacity or increased groundwater pumping for irrigation, could result in significant adverse effects on other river segments through habitat loss and fragmentation, altered flow regimes, and associated water quality changes. Because the Flint River and its tributaries support such a large portion of the native fish diversity of the ACF basin, including several endemic species and relict populations of federally protected mussel species (see Section 4.5.4), riverine habitat in this system would be especially sensitive to indirect impacts resulting from an allocation formula.

4.5.3.2.1.2 Water Quality Effects on Buford Dam Trout Fishery

Water quality modeling of the rivers conducted by the Corps' WES using the HEC-5Q model for the dry years 1984 through 1988 (see Section 4.4.2.2) shows that the suitability of water temperatures in the upper Chattahoochee River for sustaining the feeding and growth of stocked trout declines substantially in the downstream direction. Under the no action alternative, the number of days per year that average daily water temperatures exceed 68°F increase from 6 or fewer days in the segment between Buford Dam and Norcross, to more than 40 days above Morgan Falls and nearly 120 days above Peachtree Creek (*Figure 4-77*). Hence, water temperature begins to become a major limiting factor to

year-round maintenance of a put-and-take trout fishery downstream of Morgan Falls Dam. The model predicts only a slight increase in the number of days with temperatures exceeding 68°F from 1995 to 2050 (***Figure 4-77***).

Under the no action alternative, the HEC-5Q model predicts that water temperature below Buford Dam would not exceed 55°F except under drought conditions (see Section 4.4.2.2). For the dry years 1984 through 1988, the model indicates that average daily temperatures of Buford Dam releases exceed 55°F less than 1 day per year with 1995 demands, compared to about 2 days per year with 2050 demands (***Appendix D***). Because the releases originate from the oxygen-poor bottom waters of Lake Lanier, the model predicts that average daily dissolved oxygen concentrations immediately below Buford Dam fall below 6 mg/L about 183 to 188 days per year. However, re-aeration occurs rapidly as the river flows downstream from the dam. At Morgan Falls, average daily dissolved oxygen levels exceed 6 mg/L under all three demand years (***Appendix D***).

Under the moderate flow action alternative scenario, the suitability of water temperatures for trout would decrease dramatically in the downstream direction between Norcross and Morgan Falls. With 2050 demands, the number of days that average daily water temperatures exceeding 68°F would increase from 5 or fewer days per year in the segment between Buford Dam and Norcross, to 80 days above Morgan Falls and 136 days above Peachtree Creek (***Figure 4-78***). Average daily dissolved oxygen concentrations would fall below 6 mg/L about 207 days per year below Buford Dam, but would fall below this level less than 1 day per year downstream at Morgan Falls.

Under the low flow scenario, the number of days per year with temperatures exceeding 68°F would double over the moderate scenario at Norcross to about 10 days, and would increase by 39 percent just above Morgan Falls to 111 days (***Figure 4-78***). Under the high flow scenario, temperature conditions for stocked trout would improve over the moderate scenario. The number of days with water temperatures exceeding 68°F would decline over the moderate scenario by 40 percent at Norcross to 3 days, and would decrease by 39 percent just above Morgan Falls to about 49 days (***Figure 4-78***).

With 2050 demands, the average daily temperatures of Buford Dam releases would vary little among the three action flow scenarios, indicating that the hypolimnion of Lake Lanier would not become depleted under the high flow scenario. Releases would exceed 55°F less than 1 day per year under all three flow scenarios (***Appendix D***). Average daily dissolved oxygen concentrations of Buford Dam releases would fall below 6 mg/L about 208 days per year under the moderate and low flow scenarios, and about 192 days per year under the high flow scenario. There would be little difference among the action flow scenarios in dissolved oxygen levels at Morgan Falls, with average daily concentrations falling below 6 mg/L less than 1 day per year under all three scenarios (***Appendix D***).

4.5.3.2.1.3 Tributary Streams and Cool-Water Refugia

In the Apalachicola River, the three action flow scenarios also would affect the frequency and duration that river flows exceed critical thresholds for connecting main channel aquatic habitats with those in direct tributary streams and adjacent floodplains (FWS, 1998). The low flow scenario would be most likely to adversely affect the ability of striped bass to utilize cool-water refugia in tributary streams between May and November. Similarly, the low flow scenario could adversely affect the ability of fishes to move between the main

channel and aquatic floodplain habitats between April and July. The high flow scenario would likely improve conditions for maintaining connectivity between main channel and floodplain habitats during critical periods in the life histories of native aquatic biota.

In the lower Flint and Apalachicola Rivers, impacts to cool-water refugia for striped bass and other riverine aquatic species also could occur as a result of increasing groundwater use for agricultural irrigation, especially under the no action alternative and the low flow scenario. Increased groundwater pumping would reduce groundwater discharge to in-channel springs, limiting the extent of cool-water habitats available in the vicinity of the springs.

4.5.3.2.2 Reservoir

This section describes the general types of impacts to reservoir fisheries and other aquatic resources associated with changes in flow conditions and then provides a detailed assessment focusing on 5 of the 16 mainstem reservoirs in the basin for which current operations result in substantial variation in water levels over the course of the year. These reservoirs are Lake Lanier, West Point Lake, Lake Harding (Bartlett's Ferry), Walter F. George Lake, and Lake Seminole. The detailed assessment uses a performance measure developed by FWS, based on work products of the Comprehensive Study, to characterize the potential for fisheries impacts under the alternative flow scenarios. Other reservoirs were excluded from the detailed assessment because most are operated more nearly in run-of-river modes, which tend to minimize pronounced variations in water levels. In addition, daily reservoir elevations under critical low flow periods are assessed relative to the potential for impacts associated with sustained drawdowns covering multiple spawning and rearing seasons.

Reservoirs also provide important habitats for migratory birds, particularly waterfowl and shorebirds. Potential impacts to these resources are evaluated for Eufaula National Wildlife Refuge under Section 4.5.5, Fish and Wildlife Facilities.

4.5.3.2.2.1 General Impacts of Alternative Flow Conditions

The alternative flow scenarios would affect habitat for reservoir fisheries and other aquatic resources mainly through changes in water levels, changes in reservoir flushing rates (retention times), and associated changes in water quality parameters, such as primary productivity, nutrient loading, dissolved oxygen concentrations, and vertical stratification.

Seasonal water level fluctuations substantially changing the area of shallow-water habitats and shoreline vegetation inundated can significantly influence the reproductive success of resident fish populations. High water levels inundating shoreline vegetation during spawning periods frequently have been associated with enhanced reproductive success and strong year class development for largemouth bass, spotted bass, bluegill, crappie, and other littoral species (Ploskey and Reinert, 1996; Ryder et al., 1995). Conversely, low or declining water levels can adversely affect reproductive success by reducing the area of available littoral spawning and rearing habitats. In West Point Lake, falling water levels during the rearing season were correlated with a decline in survival of young-of-year largemouth bass, although surviving fish were larger (Miranda et al., 1984).

A recent study of 11 Alabama reservoirs, which included two reservoirs in the ACF basin, found consistent relations between the production of strong crappie year classes and wet winters prior to crappie spawning (Maceina and Stimpert, 1998). Wet winters resulted in shorter retention time (i.e., higher flushing rates) in reservoirs with stable water levels, and

higher water levels in fluctuating reservoirs, such as West Point Lake and Walter F. George Lake, which annually fluctuate about 15 feet and 6 feet, respectively. High winter inflows may favor crappie production by increasing nutrient loading, which in turn stimulates primary and secondary production later in the growing season (Maceina and Stimpert, 1998; Ploskey and Reinert, 1996). In reservoirs with stable water levels and low retention, longer post-winter retention also was associated with greater crappie production, possibly related to reduced flushing of young-of-year fish in the discharge from the impoundment and more stable feeding conditions (Maceina and Stimpert, 1998).

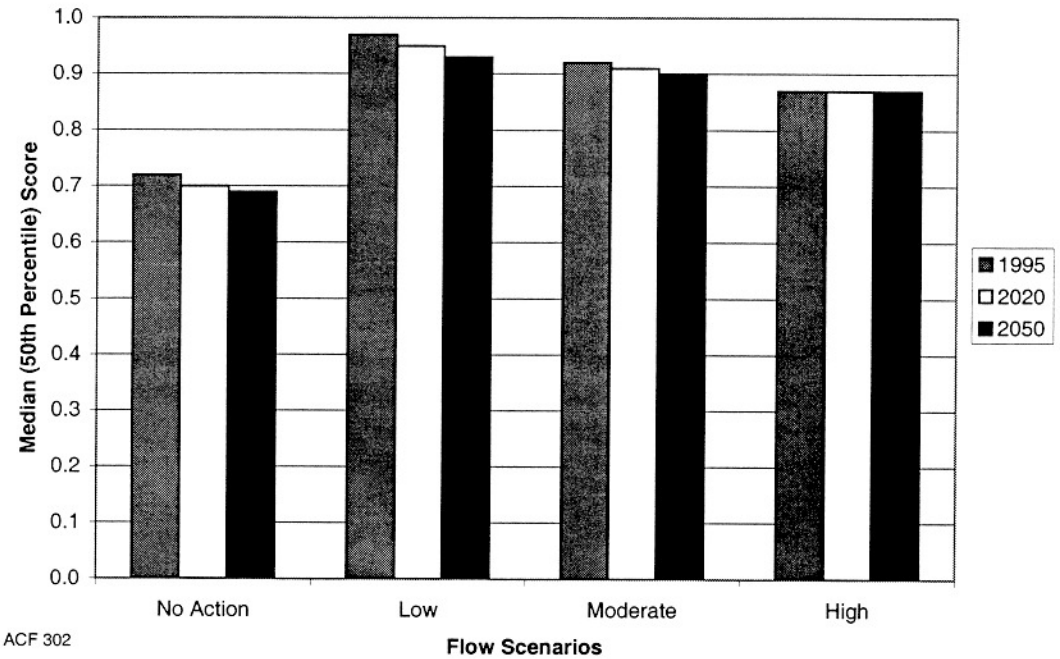
Substantial daily or weekly fluctuations in reservoir levels associated with hydropower peaking operations may negatively affect reservoir fisheries by dewatering spawning and nursery habitats for littoral species, exposing nests and eggs deposited in shallow-water habitats, and reducing the availability of shoreline cover and its associated invertebrate food supply.

4.5.3.2.2.2 FWS Performance Measure Assessment

FWS developed a performance measure to assess relative effects of the no action and alternative flow scenarios on reservoir fisheries habitat, based on the premise that greater departure of reservoir levels from optimum levels for critical guilds of fishes (e.g., littoral spawning, rearing) result in greater impacts to their habitats. The performance measure uses HEC-5 modeling output of daily reservoir elevations over the 55-year period of record and "acceptability levels" of reservoir elevations (i.e., suitability criteria) for critical guilds as identified for each reservoir by regional fisheries experts in an iterative questionnaire survey (Ryder et al., 1995). The performance measure also incorporates day-to-day reservoir level stability over critical spawning and rearing periods as a weighting factor, with stable or rising levels having a positive effect and falling levels having a negative effect on fish habitat. Performance measure scores were computed for each year in the period of record for each reservoir evaluated. Scores range between 0 for least acceptable and 1.0 for most acceptable reservoir level habitat conditions. The detailed results of this assessment are provided in the *Reservoir Fisheries Assessment* report (CH2M HILL, 1998b) (see ***Appendix E***). A graphical example of performance measures for Lake Lanier is illustrated in ***Figure 4-89***.

Median (50th percentile) performance measure scores under the no action alternative ranged from 0.65 at West Point Lake to 0.97 at Lake Seminole (***Table 4-34***). All five reservoirs showed little or no variation in performance scores between the three consumptive demand scenarios. Lake Lanier and West Point Lake exhibited the greatest potential for reservoir fisheries impacts (i.e., lowest scores) under the no action alternative, with performance scores between 0.65 and 0.72. Substantial seasonal water level fluctuations associated with operations for flood control (e.g., winter drawdowns), downstream flow targets, hydropower operations, and navigation largely account for these comparatively low performance values. Lake Harding and Lake Seminole currently operate at closer to optimum water levels for critical fishery guilds with less seasonal fluctuation, as indicated by performance scores of 0.93 and 0.97, respectively. Walter F. George Lake showed intermediate potential for fisheries impacts related to reservoir levels, as indicated by a performance value of 0.81.

FIGURE 4-89
Median Reservoir Fisheries Performance Measure Scores for Lake Lanier (ACF Basin)



ACF 302

For Lake Lanier, West Point Lake, and Walter F. George Lake, the no action alternative showed the greatest potential for reservoir fisheries impacts compared to the high, moderate, and low flow scenarios for the alternative flow scenarios (***Table 4-34*** and ***Figure 4-89***). However, because the matrix of modeled scenarios was intended to bracket any foreseeable allocation formula, reservoir fisheries impacts under the no action alternative would be expected to fall within the range of impacts represented by the matrix of scenarios. The principal factor contributing to these lower scores under no action was the simulation of more pronounced seasonal drawdowns than under the low and moderate flow scenarios. For Lake Lanier, the magnitude of seasonal drawdowns was about 5 feet less under the low and moderate flow scenarios. The HEC-5 model of the high flow scenario eliminated seasonal drawdowns for flood control. In addition, daily hydropower peaking operations in the basin could not be reasonably modeled under the high, moderate, and low flow scenarios (see Section 4.4.1.2). Peaking operations, which were reflected under the no action alternative, typically result in daily to weekly water level fluctuations, which also would be expected to contribute to lower performance measure scores.

Because of the differences in modeling assumptions masking seasonal and daily variations under the three action scenarios, absolute performance measure scores are not directly comparable between the action scenarios and the no action alternative. The range of potential impacts represented by the high, moderate, and low flow scenarios would be wider, and likely bracket the no action impacts, if seasonal drawdowns and hydropower peaking operations approaching existing levels were incorporated into the respective models. In considering that the moderate flow scenario most closely resembles existing operations in the basin, it provides the best basis for comparing general trends and ranges of impacts among the three action scenarios (see Section 4.4.1.2).

TABLE 4-34
Median (50th percentile) Reservoir Fisheries Performance Measure Scores and Ranking of Scores Across All Flow Scenarios.

				Action Alternative									
	No Action Alternative			High Flow			Moderate Flow			Low Flow			
Reservoir	1995	2020	2050	1995	2020	2050	1995	2020	2050	1995	2020	2050	Range
Lake Lanier	0.72	0.70	0.69	0.87	0.87	0.87	0.92	0.91	0.90	0.97	0.95	0.93	0.10
Rank	10	11	12	8	8	8	4	5	6	1	2	3	
West Point Lake	0.68	0.66	0.65	0.77	0.77	0.76	0.82	0.82	0.82	0.84	0.84	0.84	0.08
Rank	10	11	12	7.5	7.5	9	5	5	5	2	2	2	
Harding Lake[a]	0.93	0.93	0.93	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.00
Rank	11	11	11	5	5	5	5	5	5	5	5	5	
Walter F. George Lake	0.81	0.81	0.81	0.88	0.88	0.88	0.84	0.83	0.84	0.85	0.85	0.85	0.04
Rank	11	11	11	2	2	2	7.5	9	7.5	5	5	5	
Lake Seminole	0.97	0.97	0.97	0.97	0.97	0.98	1.00	1.00	1.00	1.00	1.00	1.00	0.03
Rank	10	10	10	10	10	7	3.5	3.5	3.5	3.5	3.5	3.5	
Sum of Ranks	52	54	56	32.5	32.5	31	25	27.5	27	16.5	17.5	18.5	
Scenario Ranking	10	11	12	8.5	8.5	7	4	6	5	1	2	3	

Individual reservoirs were ranked across all 12 flow scenarios in order of highest performance measure score (rank=1) to lowest score (rank=12). To avoid unequal weighting of reservoirs in summing the ranks, scenarios tied with the same score were each assigned a rank equivalent to the average of the rank positions occupied by the scenarios (e.g., three way tie for first: rank = (1+2+3)/3 = 2).

[a] In the reservoir fisheries report (CH2M HILL, 1998b) provided in ***Appendix E***, Harding Lake is referred to as Bartlett's Ferry Reservoir.

Source: CH2M HILL, 1998b, ***Appendix E***

Among the three action scenarios, Lake Lanier and West Point Lake achieved the highest performance measure scores (i.e., lowest potential for impacts) under the low flow scenario (***Table 4-34*** and ***Figure 4-89***). These larger headwater reservoirs would control most of the flow allocation crossing the Georgia-Alabama state line. Hence, the low flow scenario, which requires the lowest reservoir releases, would maintain the most stable reservoir levels on an annual basis. Based on the range of performance measure scores observed across the action scenarios (***Table 4-34***), these two reservoirs show the greatest potential for adverse effects to reservoir fisheries habitat under alternative flow scenarios. The three downstream reservoirs exhibited variable responses; however, the narrower ranges of scores among the scenarios suggest a lower overall potential for adverse effects due to water level fluctuations. Lake Harding showed no sensitivity across the action scenarios.

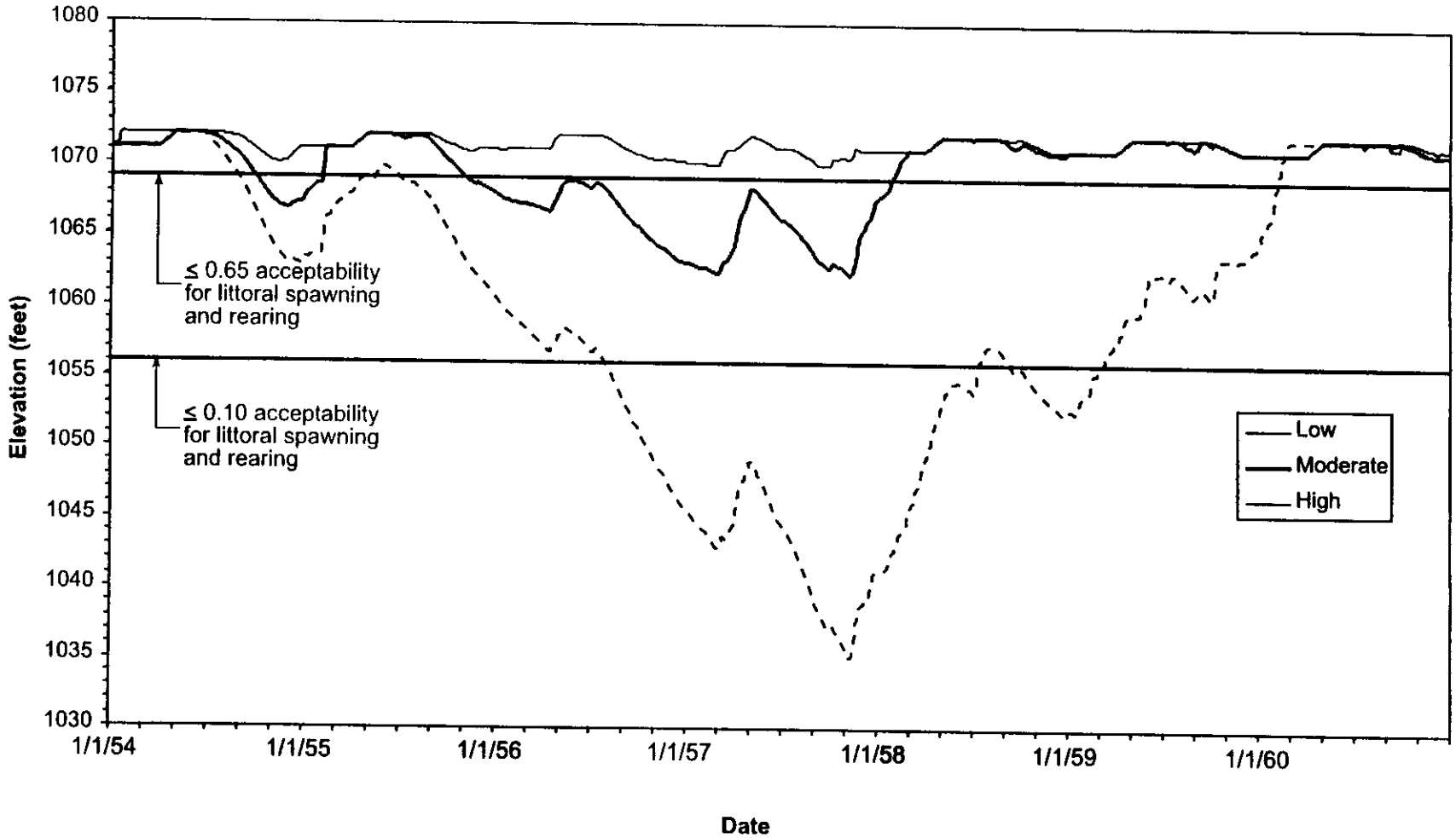
Based on the sum of ranks of individual reservoirs under each action scenario, the low flow scenarios ranked the highest as maintaining the most acceptable reservoir levels basin-wide for reservoir fisheries (***Table 4-34***). This result is consistent with the expectation that lower reservoir releases during low flow periods are beneficial in sustaining higher and more stable reservoir levels.

4.5.3.2.2.3 Impacts of Critical Low Flow Periods

While FWS performance measure provides a means of comparing relative impacts between scenarios, it does not distinguish potential impacts resulting from sustained drawdowns covering multiple critical periods, such as spawning seasons. Examination of daily plots of reservoir water elevations for critical low flow periods indicates that, for headwater storage reservoirs, such impacts could be severe (CH2M HILL, 1998b; see ***Appendix E***). An example of reservoir elevation changes for the critical drought periods is provided in ***Figure 4-90***.

For Lake Lanier, the optimum pool elevation for littoral spawning and rearing guilds of sport fishes is 1,071 feet. Water levels falling 3 feet or more below this elevation (1,068 feet and lower) show acceptability levels of 0.65 and lower, with zero acceptability occurring at water levels of 15 feet or more below optimum (1,056 feet and lower) (Ryder et al., 1995). Comparison of the modeled action scenarios (1995 demands) for the critical low flow years of 1954 through 1960 shows that reservoir levels under the low flow scenario would not fall below 1,068 feet, whereas sustained drawdowns below 1,068 feet would extend about 9 months under the moderate flow scenario and 54 months for the high flow scenario. The high flow scenario would substantially impact four consecutive spawning and rearing seasons for the critical species largemouth bass, spotted bass, white bass, and crappie (Ryder et al., 1995). Further, under the high flow scenario, water levels would fall below 1,056 feet (zero acceptability) for 23 consecutive months covering two spawning seasons. Therefore, the high flow scenario under critical drought conditions could dramatically limit reproductive success and recruitment of multiple year classes of sport fishes, with potentially catastrophic consequences for some populations.

FIGURE 4-90
Daily Reservoir Elevations of Lake Lanier. Action Alternative Flow Scenarios for the Critical Low Flow Period (ACF Basin)



For the two other reservoirs examined for critical drought periods (West Point Lake and Walter F. George Lake), there was much less contrast between action scenarios in the duration of sustained drawdowns below critical levels (CH2M HILL, 1998b; ***Appendix E***). Under the high flow scenario, none of the reservoirs would experience sustained drawdowns extending for more than one spawning season. The main difference would be in the magnitude of drawdowns occurring on an annual basis, with the high flow scenario showing the greatest impact on reducing acceptability levels for important guilds.

4.5.3.2.3 Estuarine

The assessment of potential impacts to the Eastern oyster (*Crassostrea virginica*) in Apalachicola Bay (NOAA, 1998) is based, in part, on use of a three-dimensional hydrodynamic model of the Bay developed by the Northwest Florida Water Management District (NWFWMD) under the Comprehensive Study (Huang and Jones, 1997). NOAA (1998) adapted the hydrodynamic model and used data on oysters and their predators to develop integrated models of potential oyster mortality and growth in Apalachicola Bay under various freshwater flow scenarios and associated salinity regimes (***Appendix E***). The hydrodynamic model was executed for selected years within the 55-year flow record, to represent flow conditions of a wet year (1991), an average flow year (1985), and a drought year (1986).

Table 4-35 presents the reservoir and demand scenarios used in conjunction with the above background flow years. In addition, 1985, the average flow year, was selected as a reference year for the no action alternative runs. The conclusions of the NOAA study can be used to infer potential impacts for this EIS because the analysis framework is conceptually similar to the low, moderate, and high flow scenarios. The flow scenarios used in the NOAA study are expected to bracket the high and low ends of the range of flow scenarios chosen for this EIS and are only applicable to potential impacts on the oyster. Oysters were selected as a representative species in part because of their high significance to the regional and State economy and culture, their sensitivity to water quality changes that might affect their survival, and the potential predator-prey relationships that are influenced by changes in salinity. An assessment of potential impacts on other estuarine fish and aquatic resources in Apalachicola Bay was not conducted as part of the NOAA study.

The oyster potential mortality model was constructed using data on growth and mortality measured at specific sites in Apalachicola Bay from April 1985 through May 1986 (Livingston et al., in prep). The biological oyster mortality model was coupled with the three-dimensional hydrodynamic model under the existing operation and alternative flow scenarios (***Table 4-35***).

For brevity, only the results of the most representative average (no action) flow conditions (1985 modeled flow with 1995 demand), low flow conditions (1986 modeled flow with 1995 and 2050 demands), and high flow conditions (1991 modeled flow with 1995 demand) for the action alternatives are discussed in this impact assessment. Overall mean potential oyster mortality under average flow conditions for the no action alternative (1985 flows) was predicted to be 9.2 percent. Under low flow conditions during a drought year (1986 flows with 2050 demands), the potential oyster mortality for most of the Bay was predicted to range from 25 to 49 percent (average mortality 38 percent), with the majority of this mortality occurring over the most productive eastern oyster bars of Cat Point and East Hole. This scenario represents a worst-case condition involving drought conditions and very high consumptive water demands. Under high flow conditions for a drought year

TABLE 4-35
Flow Scenarios Used to Model Potential Oyster Growth and Mortality in Apalachicola Bay

	No Action	Action Alternative Flow Scenario	
Demand Year	Existing Operating Conditions (Moderate Demands)	High Flow (Low Demands)	Low Flow (High Demands)
1995	1985 (average year)	1985 (average year) 1986 (drought year) 1991 (wet year)	
2050	1985 (average year)		1985 (average year) 1986 (drought year) 1991 (wet year)
2050X[a]	(2.5 times agricultural demand)		1985 (average year) 1986 (drought year)

[a] Source: NOAA, 1998; see ***Appendix E*** for results of all NOAA model runs.

No action = existing operations and moderate demand
High flow = highest reservoir releases and lowest 1995 demand
Low flow = lowest reservoir releases and highest 2050 demand

(1986 with 1995 demands), the potential oyster mortality would range from 25 to 49 percent for most of the Bay, and the most productive eastern oyster reefs could experience 16 to 49 percent mortality. Therefore, under natural drought conditions, potential oyster mortality could be significant regardless of operational scenario. Under high flow conditions (1991 flows with 1995 demands), most of the bay could exhibit potential oyster mortality ranging from 0 to 9 percent (NOAA, 1998), which is comparable to the upper range of the no action alternative.

Reduced freshwater inflow into Apalachicola Bay directly increases salinity and reduces salinity variability. Such alterations of the salinity regime enable predators of oysters, primarily the oyster drill, to colonize oyster beds. The results of the NOAA study suggest that decreases in freshwater inflow, especially during naturally low flow and high consumptive demand periods, may significantly increase oyster mortality through predation. The potential impacts would be greatest at the eastern oyster bars of Cat Point and East Hole where current oyster production is highest. The western oyster bars, which exhibit the fastest growth rates of young oysters (Livingston et al., in press), would also be expected to be significantly impacted under naturally low flow and high consumptive demand conditions.

The flow scenarios used in the NOAA study are expected to "bracket" the high and low ends of the range of the flow scenarios chosen for this EIS. The results of the NOAA (1998) study suggest that Apalachicola Bay could experience significantly high oyster mortality under worst-case conditions involving extreme low flow (drought) conditions and very high consumptive demands (25 to 49 percent in most areas; up to 64 percent in some areas). Under high flow conditions with aggressive conservation measures (low demand), the NOAA model predicts 4 to 9 percent oyster mortality. The model predictions of oyster mortality are a combination of two factors: 1) natural river flow fluctuations resulting from varying annual rainfall levels, and 2) water demand and reservoir operations for a specific flow scenario. Although it was not determined how much each factor contributed to potential oyster mortality, the NOAA oyster model indicated that the greatest effects on Apalachicola Bay oysters resulted from reservoir operations releasing lower river flows. Thus, even in a normal- to somewhat low-flow year, a low flow reservoir operations

scenario with very high consumptive demands could produce drought-like river flow conditions, resulting in decreased oyster production in Apalachicola Bay.

Decreases in freshwater inflow could have significant ecological impacts throughout the entire Apalachicola Bay estuarine foodweb (Livingston et al., 1997). The degree to which components of the estuarine food web would be impacted is directly dependent on the magnitude of the inflow reductions. In addition to altering the salinity regime of the estuary, reduced river inflow would result in reduced nutrient loading. Decreased nutrient loading has the potential to have far-reaching ramifications throughout the estuarine system.

The quantity, quality, and timing of river discharge into the Apalachicola Bay estuary is an integral component of estuarine habitat, affecting temperature and salinity regimes, nutrient loading, and primary productivity. These, in turn, largely determine the distribution and availability of habitats for estuarine-dependent life stages of fish, shellfish, and other aquatic organisms. Significant changes in the season-specific salinity characteristics of the estuary could preclude certain species' life stages from using previously suitable refuges, feeding areas, and nursery grounds. Substantial alterations in freshwater inflow could dramatically reduce the area or availability of some bottom types preferred by certain species or life stages (e.g., oyster reefs), resulting in crowding and interspecific competition for food or space. Significantly increased summer salinities also could allow nearshore juvenile stages of the snapper-grouper complex of species to enter estuaries and to prey upon shrimp and other estuarine-dependent species in areas previously serving as safe refuge.

To further examine the effects of the no action and action alternative flow scenarios on fresh water flow regimes into Apalachicola Bay, FWS applied the RVA methodology (Richter et al., 1997) using the synthesized unimpaired flows data for the gage near Sumatra, Florida, as the basis for comparison (FWS, 1998; see *Appendix E*). The Sumatra gage is the most down-stream river gage on the Apalachicola River. The no action alternative shows the most extreme hydrologic alterations from unimpaired flow conditions, as reflected by low annual minimum flow extremes, elevated frequency and duration of low flow pulses, and high rates of change in flow conditions. However, this is likely due to the more variable reservoir release operations associated with the seasonal reservoir drawdowns and daily hydropower peaking operations that were modeled under the no action alternative (see Section 4.4.1.2).

Among the three action scenarios, the moderate flow scenario most closely resembles existing operations (Section 4.4.1.2). The low flow scenario exhibits the greatest potential to adversely affect the quantity and timing of river discharge into the estuary, which in turn influences the temporal and spatial distribution of estuarine habitats for fish, shellfish, and other aquatic resources. Within each flow scenario, the potential for adverse effects increases as consumptive demands increase.

4.5.4 Protected Species (Federal and State)

This section discusses the Federal and State threatened and endangered species that may be impacted by the alternative flow scenarios. The evaluation of protected species is based on an inventory of the basin completed by FWS under the Comprehensive Study (Ziewitz et al., 1997) and a comparison of the probable species in the basin with changes in stream flows and reservoir levels. Results of the analyses completed by FWS are summarized in the

FWCA report (*Appendix E*). Supplemental surveys, completed by USGS under contract to the Corps, have been conducted and will be used to evaluate the potential impacts on key aquatic species. Data from these surveys were not available at the time this draft EIS was prepared but will be presented in the final EIS.

4.5.4.1 Affected Environment

The ACF basin spans over 500 miles across the Blue Ridge, Piedmont, and Coastal Plain physiographic provinces. These diverse landscapes are home to a diverse flora and fauna, including many species that are found nowhere else in the world. However, that diversity is declining as many habitats are lost or substantially altered for cities, farms, pine plantations, and other uses of the landscape. For several fish and mussels species, habitat loss due to reservoir construction and sedimentation have been cited as primary causes of decline (Couch et al., 1996).

Many species native to the ACF are presently protected under Federal and state laws. The Protected Species Report of the ACT/ACF Comprehensive Study identified 224 species with special status in the ACF. Of these, 44 were accorded only informal status as Federal species of concern (formerly Candidate Category 2 species). *Appendix E* lists the names, status, and general habitat associations of the other 180 species, 41 of which are listed, proposed, or formal candidates for protection under the Federal Endangered Species Act of 1973. State statutes and regulations protect the remaining 139 species.

Table 4-36 lists the Federal and State protected species that are typically found in or near water systems and, therefore, may be affected by the final water allocation formula in the ACF basin. *Table 4-37* provides specific information on the locations of the Federally listed fish and mussels species. *Figure 4-91* shows the numbers of potentially affected protected species by subbasin.

Of the Federally protected species, the only bird listed as potentially affected by the water allocation changes in the ACF basin is the wood stork. No rookeries are known to occur in the basin but this species is sensitive to changes in water elevations at feeding areas. The wood stork feeds by tactile-location of small fish in shallow pools; with too little water, the fish are absent, and with excess water in the pools, tactile-location is ineffective.

The Gulf sturgeon is a Federally listed threatened fish that occurs in large to medium-sized rivers in northwest Florida and coastal Alabama areas. Adult Gulf sturgeon ascend coastal rivers in spring to spawn while juveniles remain in riverine and estuarine habitats throughout the year.

Six Federally protected mussels are found in the basin. The fat three-ridge mussel is an endangered species endemic to the ACF basin. It may now be extirpated from the Flint River and is present only in the Apalachicola and Chipola Rivers. This species is primarily found in a range of substrates from rocky rubble to sandy clay in the main channels of small to large rivers with slow to moderate currents. The Chipola River slabshell, a threatened species, is considered endemic to the Chipola River drainage. It is found in silty sand substrates, in slow to moderate current. Another Federally listed threatened mussel, the purple bankclimber, is found only in the main river channels of the ACF basin. It is present on sand, sand and mud, or gravel substrates with moderate currents. The shiny-rayed pocketbook mussel, an endangered species, has been found recently in major tributaries of the Flint River. It has been associated with sandy substrates in slow to moderate currents

FIGURE 4-91
Water-Dependent Federally Endangered and Threatened Species by Subbasin Within the ACF Basin

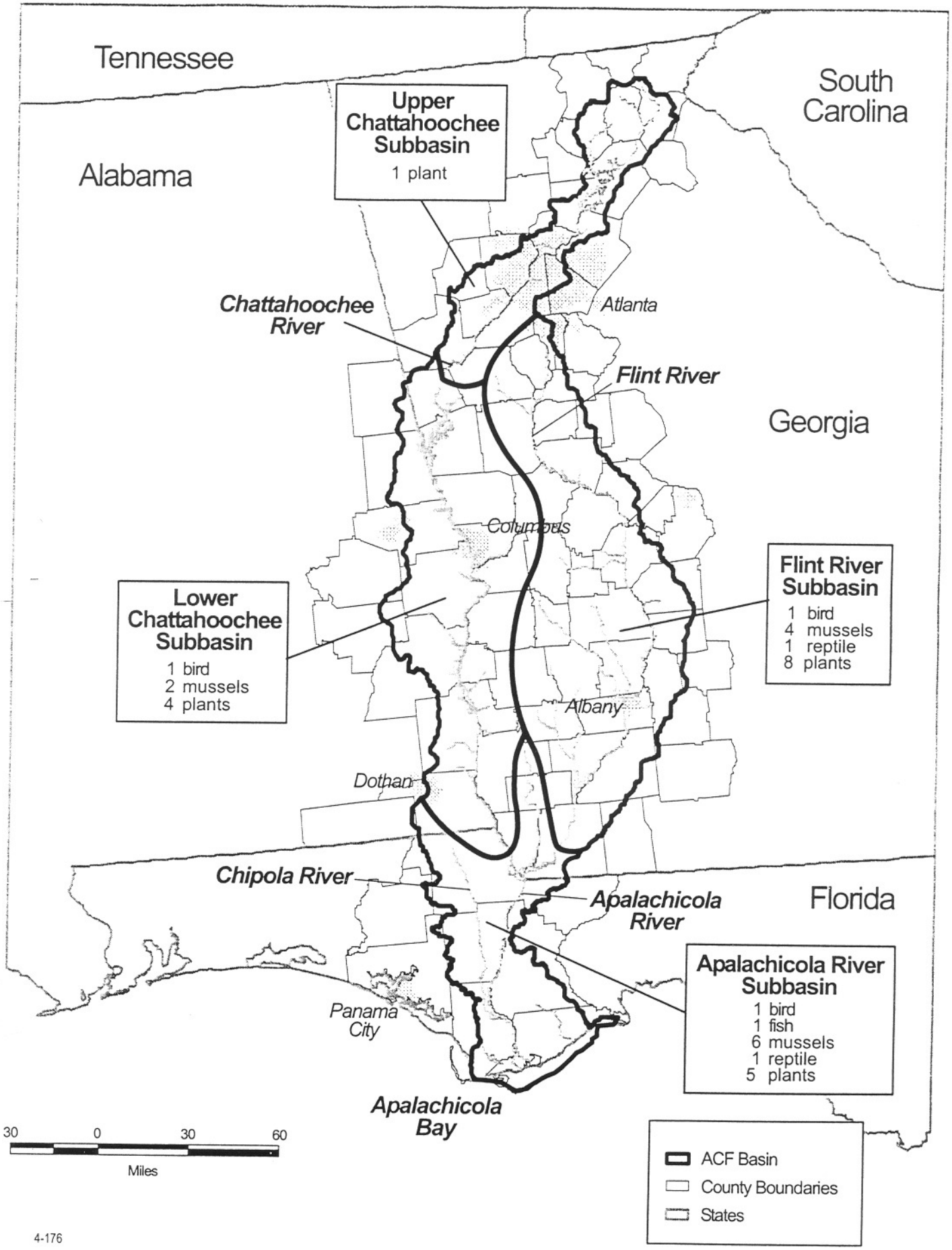


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TABLE 4-36
Protected Species Potentially Affected by the Water Allocation Formula in ACF Basin

Scientific Name	Common Name	Endemic	Federal Status	Alabama Status	Florida Status	Georgia Status	Subbasin	Habitat Description
Birds								
Mycteria americana	Wood stork		E	SP	E	E	LCA, AP, F	Palustrine, forested, emergent, lacustrine
Fish								
Acipenser oxyrinchus desotoi	Gulf sturgeon		T	SP	SSC		AP	Riverine/mainstream, marine, estuarine
Cyprinella callitaenia	Bluestripe shiner	Y	SC			T	LCA, AP, F, UCA	Riverine/mainstream/large tributary
Notropis hypsilepis	Highscale shiner		SC			T	LCA, F, UCA	Riverine/tributary, stream confluences
Mussels								
Amblema neislerii	Fat three-ridge	Y	E				AP	Riverine/main channel
Elliptio chipolaensis	Chipola slabshell	Y	T				AP	Riverine/main channel of Chipola River
Elliptoideus sloatianus	Purple bankclimber		T				AP, F	Riverine/main channel
Lampsilis subangulata	Shiny-rayed pocketbook		E				LCA, F, AP	Riverine/medium creeks to large rivers
Medionidus penicillatus	Gulf moccasinshell		E				AP, F	Riverine/medium creeks to large rivers
Pleurobema pyriforme	Oval pigtoe		E				LCA, F, AP	Riverine/tributary and main channel estuarine

(CONTINUED)

TABLE 4-36 (CONTINUED)
Protected Species Potentially Affected by the Water Allocation Formula in ACF Basin

Scientific Name	Common Name	Endemic	Federal Status	Alabama Status	Florida Status	Georgia Status	Subbasin	Habitat Description
Mammals								
Neofiber alleni	Round-tailed muskrat		SC			T	AP	Palustrine/emergent
Reptiles								
Alligator mississippiensis	American alligator		T(s/a)	SP	SSC		AP, F	Palustrine, lacustrine, riverine, estuarine
Graptemys barbouri	Barbour's map turtle	Y		SP	SSC	T	LCA, F, AP	Riverine, mainstream, run, pool, lacustrine
Macroclemys temminckii	Alligator snapping turtle		SC	SP	SSC	T	LCA, F, AP	Riverine, lacustrine, estuarine
Plants								
Amphianthus pusillus	Little amphianthus		T			T	LCA, F	Palustrine/open "perched pools"
Asclepias viridula	Southern milkweed		SC		T		AP	Palustrine/forested
Aster spinulosus	Pinewoods aster		SC		E		AP	Palustrine/forested/emergent
Bumelia lycioides	Buckthorn				E		AP	Palustrine/forested, common in silt levees
Bumelia thornei	Buckthorn		SC		E	E	AP, F, LCA	Palustrine/forested
Carex dasycarpa	Velvet sedge					E	F, LCA	Palustrine/forested/emergent
Chamaecyparis thyoides	Atlantic white-cedar					R	F	Palustrine/forested/ submersed
Croomia pauciflora	Croomia				E	T	AP, LCA, F	Palustrine/forested/emergent
Cryptotaenia canadensis	Canada honewort				E		AP	Palustrine/forested/floodplain
Drosera intermedia	Spoon-leaved sundew				T		AP	Palustrine/emergent/peat bogs

(CONTINUED)

TABLE 4-36 (CONTINUED)
Protected Species Potentially Affected by the Water Allocation Formula in ACF Basin

Scientific Name	Common Name	Endemic	Federal Status	Alabama Status	Florida Status	Georgia Status	Subbasin	Habitat Description
Erythronium umbilicatum	Trout lily				E		AP	Palustrine/terrestrial/loamy and calcareous soils
Fimbristylis perpusilla	Harper fimbristylis		SC			E	F, AP, LCA	Palustrine/emergent
Fothergilla gardenii	Dwarf witch-alder					T	F	Palustrine/forested/low flat swampy areas
Gentiana pennelliana	Wiregrass gentian		SC		E		AP	Palustrine
Harperocallis flava	Harper's beauty	Y	E		E		AP	Palustrine/forested, pineland bogs
Hepatica nobilis var. obtusa	Liverleaf				E		AP	Palustrine; rich, calcareous sites
Hymenocallis coronaria	Shoals spiderlily		SC			E	F, LCA	Riverine, mainstream/rocky shoals
Hymenocallis henryae	Panhandle spiderlily		SC		E		AP	Palustrine, forested, emergent
Ilex amelanchier	Serviceberry holly				T		AP	Palustrine
Illicium floridanum	Florida anise				T	E	AP	Palustrine, forested, emergent
Isoetes melanospora	Black-spored quilwort		E			E	LCA, F	Palustrine, emergent
Isotria verticillata	Large whorled pogonia				E		AP	Palustrine/forested, terrestrial
Justicia crassifolia	Thick-leaved water willow		SC		E		AP	Palustrine/forested/emergent
Leitneria floridana	Corkwood		SC		T		F, AP	Riverine/palustrine/estuarine
Lindera melissifolia	Pondberry		E			E	F	Palustrine/forested, seasonally flooded wetlands

(CONTINUED)

TABLE 4-36 (CONTINUED)
Protected Species Potentially Affected by the Water Allocation Formula in ACF Basin

Scientific Name	Common Name	Endemic	Federal Status	Alabama Status	Florida Status	Georgia Status	Subbasin	Habitat Description
Linum westii	West's flax		SC		E		AP	Palustrine/emergent, wet soil or shallow water
Litsea aestivalis	Pond spice		SC			T	F	Palustrine/emergent, swamps and ponds
Lythrum curtissii	Curtiss loosestrife		SC		E	T	LCA, F, AP	Palustrine/emergent/open/ forested
Macbridea alba	White birds-in-a-nest		T		E		AP	Palustrine/forested/emergent/ terrestrial
Macranthera flammea	Hummingbird flower				E		AP	Palustrine/bogs, boggy thickets, edges of bays
Malaxis unifolia	Green adder's-mouth				E		AP	Palustrine/forested/terrestrial
Myriophyllum laxum	Loose water milfoil		SC			T	AP, F, LCA	Palustrine/lacustrine/riverine shallow water
Nolina atopocarpa	Florida beargrass		SC		T		AP	Palustrine/low-peridocially wet pine flat-woods
Oxypolis canbyi	Canby's dropwort		E			E	F	Palustrine/submersed, peat muck in cypress ponds
Oxypolis greenmanii	Giant water-dropwort				E		AP	Palustrine/shallow water of ponds, bogs and marshes
Panicum hirstii	Hirst panic grass		SC			E	F	Palustrine/peaty, grass-sedge mats
Parnassia grandifolia	Large-flowered grass-of-parnassus				E		AP	Palustrine/forested
Physostegia leptophylla	Narrowleaf obedient plant					T	F, AP	Palustrine/emergent, estuarine/intertidal

(CONTINUED)

TABLE 4-36 (CONTINUED)
Protected Species Potentially Affected by the Water Allocation Formula in ACF Basin

Scientific Name	Common Name	Endemic	Federal Status	Alabama Status	Florida Status	Georgia Status	Subbasin	Habitat Description
Pinguicula ionantha	Godfrey's (violet) butterwort		T		E		AP	Palustrine/open area with saturated soils
Pinguicula planifolia	Chapman's butterwort		SC		T		AP, LCA	Palustrine/shallow water
Pinguicula primuliflora	Clearwater butterwort				E	T	LCA, F	Riverine/tributary, palustrine/ emergent
Platanthera integra	Yellow fringeless orchid				E		AP	Palustrine/emergent, wet meadows, boggy depressions;
Platanthera integrilabia	Monkeyface orchid		SC			T	LCA, UCA	Palustrine/red maple-blackgum swamps
Ptilimnium nodosum	Harperella		E			E	F	Palustrine/riverine
Rhexia parviflora	Meadowbeauty		SC		E		AP, F	Palustrine/wet, high peat content sands
Rhododendron austrinum	Orange azalea				E		AP	Palustrine/forested/emergent
Rhododendron prunifolium	Plumleaf azalea	Y				T	LCA	Palustrine/moist soils of rich hardwood ravines
Salix eriocephala	Heart-leaved willow				E		AP	Palustrine/forested/emergent (alluvia woodlands)
Salix floridana	Florida willow		SC		E	E	AP, LCA	Palustrine/seasonally flooded areas
Sarracenia leucophylla	Whitetop pitcherplant		SC		E	E	AP, F, LCA	Palustrine/bogs, wet areas
Sarracenia oreophila	Green pitcherplant		E			E	F, LCA, UCA	Palustrine/forested, bogs, streambanks
Sarracenia psittacina	Parrot pitcherplant				T	T	AP, LCA, F	Palustrine/open/acidic soils

(CONTINUED)

TABLE 4-36 (CONTINUED)
Protected Species Potentially Affected by the Water Allocation Formula in ACF Basin

Scientific Name	Common Name	Endemic	Federal Status	Alabama Status	Florida Status	Georgia Status	Subbasin	Habitat Description
Sarracenia purpurea	Purple pitcherplant				T	E	LCA, F, AP	Palustrine/open, sphagnum bogs pineland savannahs
Sarracenia rubra	Sweet pitcherplant				T	E	LCA, F	Palustrine/open, acidic soils
Schisandra glabra	Bay-starvine					T	LCA, UCA, F	Palustrine/forested/emergent
Schwalbea americana	American chaffseed		E		E	E	LCA, AP, F	Palustrine/open/terrestrial
Scutellaria floridana	Florida skullcap		T		E		AP	Palustrine/emergent, wetland
Stachydeoma graveolens	Mock pennyroyal		SC		E		AP	Palustrine/terrestrial
Thalictrum cooleyi	Cooley meadowrue		E		E	E	F	Palustrine/open/forested
Veratrum woodii	Ozark bunchflower				E	R	LCA, UCA, F, AP	Palustrine/forested/emergent
Verbesina chapmanii	Chapman's crownbeard		SC		T		AP	Palustrine/emergent
Waldsteinia lobata	Piedmont barren strawberry					T	LCA, UCA, F	Rocky, acidic woods along with mountain laural
Xyris scabrifolia	Harper's yellow-eyed grass		SC		T		AP, F	Palustrine, moist to wet sandy peats of acid sphagnum bogs

E Listed endangered
C Candidate for listing as threatened or endangered
T Listed as threatened
s/a Species protected because of similarity to another officially listed species in the area
SC Federal state species of special concern, no legal status
SSC State species of special concern, no legal status
R Rare, no legal status
SP Species formally protected
Y Species is endemic to basin

Subbasins: LCA = Lower Chattahoochee; AP = Apalachicola; F = Flint; UCA = Upper Chattahoochee

TABLE 4-37
Drainages of the ACF Basin in Which Federally Protected Fish and Mussel Species Are Presently Known to Occur

Drainage	Gulf Sturgeon	Fat-Three-Ridge	Chipola Slabshell	Purple Bankclimber	Shiny-Rayed Pocketbook	Gulf Moccasin-shell	Oval Pigtoe
Apalachicola	x	x		x			
Chipola		x	x		x	x	x
Lower Chattahoochee Tributaries						x	x
Middle Chattahoochee					x		
Lower Flint				x		x	x
Middle Flint				x		x	
Upper Flint				x	x	x	x
Major Flint Tributaries:							
Spring Creek					x		
Ichawaynachaway Creek					x	x	X
Kinchafoonee and Muckalee Creeks					x	x	X

and is generally absent from silty or detrital areas. The Gulf moccasinshell mussel is found throughout the ACF basin in medium-sized streams to large rivers with moderate current. It can be present in muddy sand substrates around tree roots and in sandy areas with a slight current. The oval pigtoe mussel is an endangered species formerly common throughout the ACF system but now found only in the Georgia and Florida portions of the basin. It occurs in both tributaries and main channels. Suitable habitat for the oval pigtoe mussel ranges from silty sand to gravel substrates, and in slow to moderate currents.

No mammals in the ACF basin are Federally protected. One reptile species, the American alligator, is Federally listed as threatened because of its similarity of appearance to the protected crocodile.

Of the 63 species of protected plants listed in *Table 4-36*, eight are Federally listed as endangered and four are Federally listed as threatened. The most water-dependent species listed is the loose water milfoil, a Federal species of concern and a Georgia threatened species. It is a perennial aquatic plant endemic to the southeastern Atlantic and Gulf Coastal plains, growing in shallow waters of natural ponds, sinkholes, beaver ponds, impoundments, blackwater sloughs, ditches, and canals. Its abundance fluctuates from year to year because of local changes in the water table or in water quality. This species would be sensitive to changes in water elevation that might result from implementation of a water allocation formula in the ACF basin. Species descriptions for other protected plants may be found in *Appendix E* and are not summarized here.

4.5.4.2 Environmental Consequences

4.5.4.2.1 General Impacts

The allocation formula may influence four types of direct or indirect actions that could affect the habitats of Federal and State protected species listed in ***Table 4-36***.

- Alteration of flow regimes in the operations of existing dams and reservoirs
- Construction of new dams and reservoirs (see Section 4.4.1.1)
- Growth in demand for consumptive uses of water
- Water quality degradation

The agencies implementing or regulating these types of actions in compliance with the allocation formula would be responsible for determining the project-specific impacts to protected species, because the impacts would depend on where and how the actions occur. The following discussion of each of the four general types of actions that may affect protected species is intended to guide assessment efforts when those choices are faced.

4.5.4.2.1.1 Alteration of Flow Regimes by Changes in Operations of Existing Dams and Reservoirs

Little information is available on the linkages between flow regime characteristics and the life histories of protected species occurring in the basin. It might be possible to quantify optimal flow regimes for some or all of the riverine-dependent species, or even minimal flow regimes that would barely ensure each species' persistence in the basin. Such an effort would show that some species do best in wet years and others do best in dry years. However, overall biological diversity and ecosystem function benefit from inter-annual variations in species success (Tilman et al., 1994). Previous efforts at riverine ecosystem restoration have demonstrated that it is not possible to simultaneously optimize conditions for all species (Sparks 1992, 1995; Toth 1995). Therefore, the best strategy for protecting the ecology and biodiversity of the basin, including its protected species, is to maintain or restore to some extent the natural patterns of variability of flow regimes throughout the basin.

4.5.4.2.1.2 Construction of New Dams and Reservoirs

The construction of dams in riverine ecosystems abruptly, severely, and permanently alters many important physical and biological processes involving the movement of water, energy, sediments, nutrients, and biota (Gup, 1994). Sixteen dams impound mainstem channels of the ACF basin—eliminating, fragmenting, and dramatically altering riverine habitat.

The Comprehensive Study's Protected Species Report (Ziewitz et al., 1997) highlighted one effect of the conversion of flowing water habitat to still water: the decline or loss of river-dependent species, particularly fresh water mussels and snails. The Riverine Resources Report (Freeman et al., 1997) discussed the habitat fragmentation effects of dams in the ACF, in which 547 out of 890 total mainstem river miles (61 percent) remain unimpounded in 8 segments isolated by dams and reservoirs. Ziewitz (1997) described similar declines in habitat for anadromous fishes, which is now restricted to the 107-mile segment below Jim Woodruff Lock and Dam. The Aquatic Habitats in Relation to River Flow in the Apalachicola River Floodplain report (Light et al. 1997) examined how river bed degradation downstream of Jim Woodruff Lock and Dam has changed the frequency of floodplain inundation and altered the ecology of the river. New dams in the ACF would

replicate many of these impacts elsewhere in the basin and add to the cumulative alteration of natural flow regimes and habitat fragmentation. Depending on location, size, operating modes, and other factors, new dams would likely adversely affect, and possible extirpate, some of the species listed in *Table 4-36*.

4.5.4.2.1.3 Growth in Demand for Consumptive Uses of Water

The impacts analysis sections on riverine and estuarine communities show that the habitat performance measures and hydrologic parameters generally differ more between flow scenarios than between demand levels within flow scenarios; however, differences between demand levels are still evident. Because of simplifying assumptions necessary in the modeling efforts (Section 4.4.1.2), these differences may be underestimated in the simulated flow scenarios. Demands may actually vary substantially from year to year and may exert greater impacts on riverine and estuarine communities than suggested by the current simulations.

In some reaches, even the normal-year projections for monthly average demands levels can represent a substantial fraction of the natural stream flow. The year 2050 demands in the months of August through October for the Chattahoochee River upstream of Atlanta are about 750 cfs, equal to the current minimum flow requirement for the river at the mouth of Peachtree Creek.

Torak et al. (1993) studied the potential for pumping water from the Floridan aquifer along the Flint near Albany, Georgia, about 75 miles upstream of Jim Woodruff Lock and Dam. For pumping rates of up to 72 million gallons per day, they found that about 81 percent of groundwater pumped in this area would otherwise discharge to the Flint River. The Floridan aquifer also discharges to several tributaries of the Flint River. Unlimited growth in demands for groundwater could affect protected riverine-dependent species, such as Federally listed mussel species, by reducing discharges of the aquifer, converting perennial streams to intermittent streams, and altering the temperature and other water quality parameters of the receiving streams.

4.5.4.2.1.4 Water Quality Degradation

Riverine communities generally require clean water with sufficiently high dissolved oxygen concentration and appropriate temperatures. Although water quality has improved in the ACF basin since the 1970s due to controls on point-source pollutant discharges under the Clean Water Act, water quality problems related largely to nonpoint source sedimentation and other contaminants continue in many river reaches. For example, urban runoff is the major source of water quality degradation for the Chattahoochee River in the reach between Atlanta and Whitesburg, Georgia (Stamer et al., 1979). Biological conditions in the ACF basin are most severely degraded in the urbanized reaches of the basin (Frick et al., 1998).

Water quality degradation is a frequently cited concern for the riverine-dependent species included in the Comprehensive Study's Protected Species Report (Ziewitz et al., 1997). It is quite likely that water quality is a limiting factor for several of these species, including the six Federally listed mussels. Any actions under the formula that may alter water quality must address effects on the protected species.

4.5.4.2.2 Impacts of Modeled Alternatives

Under the no action alternative, no terrestrial protected species would be affected because terrestrial habitats would not be adversely affected. Based on the analyses conducted for

freshwater wetlands, no adverse impacts to floodplain-dependent and semi-aquatic protected species are anticipated from the no action alternative. Aquatic species also would not experience direct adverse effects from the no action alternative.

Under the range of flow alternatives, no direct impacts to protected terrestrial and wetland species are likely because these habitats would be minimally affected by any of the three flow scenarios (high, medium, or low flow). Impacts to aquatic species would be site-specific depending on the species' habitat (reservoir or flowing waters) and on the season of greatest sensitivity to water level perturbations.

Federal and state protected species occurring in or near water systems in the ACF basin, and which therefore potentially could be affected by a water allocation formula, are listed in ***Table 4-36***. The numbers of potentially affected Federally endangered and threatened species are shown in ***Figure 4-91*** for each of four major subbasins. In the upper Chattahoochee subbasin, one Federally endangered plant species could be affected by water allocation but no Federally protected fish or mussel species presently are known to occur there. The more sensitive reaches of riverine and riparian habitats occur in the lower portions of the ACF basin. The lower Chattahoochee River and its tributaries provide habitat for two endangered mussel species (***Table 4-36***), the endangered wood stork, and four protected plant species. Because ten mainstem reservoirs are located in the lower Chattahoochee subbasin, some of these species could be adversely affected by changes in operation of these reservoirs or withdrawal permits.

Protected species habitats in the Flint River and Apalachicola River subbasins would be especially sensitive to adverse effects from indirect actions related to allocation decisions, such as the development of new water supply reservoirs or increased surface water and groundwater withdrawal to meet water demands in southwestern Georgia. These rivers contain the longest remaining reaches of free-flowing river in the ACF basin. Federally protected species in the Flint River subbasin include four mussels (***Table 4-36***), the wood stork, American alligator, and eight plants that live in riverine or wetland habitat. The Apalachicola River subbasin currently provides habitat for the Federally threatened Gulf sturgeon, six protected freshwater mussel species, the wood stork, the American alligator, and five protected plant species.

Section 7 consultation will be required if implementation of the final allocation formula requires changes in operations that would affect Federally protected species. A biological assessment, if needed, will be completed for the final EIS.

4.5.5 Fish and Wildlife Management Facilities

Fish and wildlife management facilities include all fish hatcheries, wildlife refuges, and fish and wildlife management areas in the basin. An inventory of these facilities was completed for the Comprehensive Study and was used as the primary source of information for this evaluation. The key facility in the ACF basin is the Eufala National Wildlife Refuge, which is managed by FWS; therefore, FWS completed the evaluation of potential impacts on this refuge. Potential impacts on other facilities in the basin were based on a review of the potential water shortages and water quality changes throughout the basin.

4.5.5.1 Affected Environment

4.5.5.1.1 Eufaula National Wildlife Refuge (ENWR)

ENWR was established in 1964 on the Walter F. George Lake (Lake Eufaula) in cooperation with the U.S. Army Corps of Engineers. The refuge objectives are to provide habitat for migratory waterfowl and other birds, to provide habitat and protection for endangered species, and to provide recreation and environmental education for the public. The refuge lies on the upper reaches of the reservoir from river mile 104 to mile 116 within Barbour and Russell Counties, Alabama, and Stewart and Quitman Counties, Georgia. The 11,184-acre refuge was once heavily forested with longleaf and slash pine ridge tops and hardwood bottoms, but past land-use practices have changed the land cover and habitat. The refuge contains 4,260 acres of open water, 3,025 acres of wetlands, 2,110 acres of woodlands, and 1,814 acres of croplands and grasslands. The refuge is managed intensively to meet the needs of migrating and wintering waterfowl, nesting wood ducks, colonial nesting birds, neotropical migrant birds, and wood storks.

Pump systems, dikes, and water control structures are used to manage a constructed system of impoundments to create off-reservoir wetland areas. Water levels are manipulated seasonally to provide desirable food plants for wildlife. Vegetation is also manipulated by burning, mechanical, and chemical control methods.

ENWR supports a diversity of flora and fauna of the Gulf Coastal Plain region. Habitat management focused on waterfowl also benefits other species. The refuge has 281 documented bird species, 36 mammal species, 95 herptile species, and roughly 30 fish species. Federally listed species that use the refuge are the bald eagle, peregrine falcon, American alligator, and wood stork. A complex of impounded areas, ephemeral wetlands, and reservoir backwaters comprise a significant foraging area on the refuge for wood storks.

Forty-nine species of shorebirds, gulls, and terns have been observed along the mudflats and sandbars of the reservoir, and within the ephemeral wetlands and agricultural fields of the refuge. Ten of these are considered common (killdeer, greater and lesser yellowlegs, spotted, least and pectoral sandpiper, dunlin, common snipe, ring-billed gull and Forster's Tern). Woodstorks use the shallow and backwater areas of the reservoir while herons and egrets consistently forage in all wetland areas. Bald eagles have been noted on mudflats feeding on carrion.

The refuge supports three major heron rookeries. Ideal conditions for these rookeries are high reservoir levels in spring for nest protection and lower levels in late spring and summer for foraging.

Waterfowl populations in the winter range from 10,000 to 15,000 birds. Historically, the population peaked at 35,000 ducks and geese. The refuge provides wintering waterfowl foraging and resting habitat. Croplands flooded in the fall may attract 75 percent of all waterfowl on the refuge. The river and reservoir at low water levels provide significant foraging and resting habitat.

Water management is the most important technique that the refuge uses to enhance habitats for wildlife. The refuge has eight pump sites serving five different impoundments. Over 1,800 acre feet of water is pumped annually into the impoundments from the river during late fall and returned to the river in early spring. This pattern of water use was described in

the Fish and Wildlife Facilities Report of the Comprehensive Study (Ziewitz and Luprek 1996).

The refuge has a cooperative farming program that can put up to 1,200 acres under cultivation. Crops include hay, oats, rye, corn, sorghum, millet, and peanuts. Presently, two farmers cultivate the land and leave up to 25 percent of all crops grown in the field as part of their lease agreement. The crops are flooded for waterfowl and other wildlife. Farming on the refuge is dependent on irrigation. Approximately 500 acres are irrigated with 3 to 4 inches of water during the growing season for corn and peanuts.

4.5.5.1.2 Fish Hatcheries

Four fish hatcheries located in the ACF basin use an average of about 10 mgd of water annually (Ziewitz and Luprek, 1996). These facilities and their average annual use of water are:

- Buford Trout Hatchery on the Chattahoochee River below Buford Dam in Georgia, operated by GDNR with an average annual use of 7.02 mgd of surface water from the Chattahoochee River
- Cordele Fish Hatchery in Cordele, Georgia, operated by GDNR with an average annual use of 0.34 mgd of groundwater
- Steve Cocke Fish Hatchery in Dawson, Georgia, operated by GDNR with an average annual use of 0.39 mgd of groundwater; and
- Warm Springs Regional Fisheries Center in Warm Springs, Georgia, operated by FWS with an average annual use of 2.45 mgd of groundwater

Buford Trout Hatchery is the only fish hatchery in the basin that relies on surface flows for its operations and is the largest user of water.

4.5.5.2 Environmental Consequences

4.5.5.2.1 Eufaula National Wildlife Refuge (ENWR)

The potential for impacts to ENWR are primarily related to reservoir levels maintained at W. F. George Lake. Management of reservoir levels influences ENWR in three critical respects (FWS, 1998): 1) direct effects on habitat availability for wildlife; 2) effects on vegetation communities, especially the spread of undesirable invasive species; and 3) the availability of water in the fall (October and November) for pumping into the off-reservoir impoundments for waterfowl habitat management (Ziewitz and Luprek, 1996).

Perritt and Drennen (1995) described the effects of current patterns of reservoir level management on vegetation and wildlife. These included effects on brood-rearing habitat for wood ducks, heron rookeries, foraging conditions for bald eagles, wood storks, and other species, and habitat for waterfowl and other migratory birds. Since then, other wildlife responses to variable reservoir levels have been observed, such as ring-billed gulls feeding on mussels at reservoir levels less than 186 feet mean sea level (msl) (Drennen, 1995), which are not available at higher levels. Refuge personnel also have observed large turtles (Florida softshell, common snapper, and common sliders) nesting on sandbars and mudflats within the reservoir when levels were below 186 feet msl.

During extended periods with low water levels, aggressive and undesirable native and exotic vegetation out-competes desirable moist soil vegetation. Alligatorweed is the most prolific invader of ephemeral wetlands on the refuge. Fluctuating reservoir levels provide many opportunities for it to spread. ENWR has about 1,000 acres of wetland vegetation where alligatorweed is a significant component. Other undesirable plants that have been noted to respond positively to fluctuating reservoir levels are black willow, *Sesbania*, and cutgrass.

Although reservoir levels less than 186 feet provide excellent wading bird habitat during spring and fall and concentrate waterfowl in the winter, pumping water into the five off-reservoir impoundments in the late fall is dependent on reservoir levels above 185 feet. This also provides the possibility of gravity-flow flooding of the impoundments. In spring, the ability to gravity-flow water out is preferred because water levels can be lowered more precisely and cost-effectively.

Based on the reservoir fisheries analysis for W. F. George Lake, which examined seasonal fluctuations and day-to-day stability in reservoir levels, the no action alternative exhibited the greatest potential to adversely affect littoral zone and shoreline habitats (see Section 4.5.3.2). The three action alternative flow scenarios showed only minor differences in water level effects, suggesting a similar low potential for significant adverse effects to shoreline vegetation and wildlife communities at ENWR as a result of this scenario. In addition, inspection of daily plots of reservoir water elevations at W. F. George Lake for critical low-flow periods (CH2M HILL, 1998b; ***Appendix E***) indicate that reservoir levels would nearly always remain above 185 feet under the no action and action alternative flow scenarios, even during the fall. Therefore, neither alternative would be expected to significantly affect the ability of W. F. George Lake to provide the 13.4-mgd pumped annually each fall on average (Ziewitz and Luprek, 1996) to the off-reservoir impoundments.

ENWR managers have developed recommendations for seasonal reservoir level management at W. F. George Lake that would best accommodate the needs of the refuge for providing wildlife habitat, controlling undesirable vegetation, and manipulating off-reservoir impoundments for waterfowl. Justification for these levels and comparison to existing operations are provided by FWS (1998) in ***Appendix E***. FWS (1998) computed the annual average differences between the recommended daily levels and the simulated daily levels for the no action and action alternative flow scenarios (***Table 4-38***). The no action alternative flow scenario shows less deviation from recommended reservoir levels than any of the action alternative flow scenarios. Median (50th percentile) average annual differences show only negligible distinction between the three action flow scenarios. Therefore, either alternative will have only minor effects on the management of ENWR.

TABLE 4-38
Annual Average Differences (in feet) Between Recommended Daily Levels and Simulated Daily Levels on W.F. George Lake

	No Action			High Flows			Moderate Flows			Low Flows		
	1995	2020	2050	1995	2020	2050	1995	2020	2050	1995	2020	2050
Minimum	1.44	1.42	1.40	1.68	1.67	1.70	1.98	1.93	1.88	2.67	2.67	2.67
10%	2.30	2.13	2.11	2.32	2.32	2.30	2.68	2.68	2.69	2.72	2.72	2.72
25%	2.43	2.38	2.34	2.65	2.64	2.65	2.75	2.75	2.76	2.77	2.77	2.77
50%	2.62	2.61	2.58	2.81	2.81	2.81	2.79	2.79	2.79	2.80	2.80	2.80
75%	2.70	2.69	2.67	2.85	2.85	2.85	2.81	2.81	2.81	2.81	2.81	2.81
90%	2.76	2.76	2.74	2.86	2.86	2.86	2.83	2.83	2.83	2.83	2.83	2.83
Maximum	2.90	2.90	2.90	2.86	2.86	2.86	2.91	2.91	2.92	2.91	2.91	2.91

4.5.5.2.2 Fish Hatcheries

Buford Trout Hatchery withdraws about 7 mgd (11 cfs) of flow from the Chattahoochee River below Buford Dam year-round (Ziewitz and Luprek, 1996). Hatchery personnel indicate that current supplies would be sufficient for the facility's future needs. The results of HEC-5Q water quality modeling for the dry period 1984 through 1988 indicate only minor effects of the action alternative flow scenarios on water temperatures and dissolved oxygen concentrations of cold-water bottom discharges from upstream Buford Dam (see Sections 4.4.2.2 and 4.5.3.2). Because the water quantity of the action flow scenarios would be sufficient to meet the needs of the hatchery, no significant adverse effects on hatchery operation are anticipated as a result of modified operations at Buford Dam to accommodate high, moderate, or low flow scenarios.

Of the three hatcheries supplied by groundwater sources, the Warm Springs and Cordele hatcheries report present or potential groundwater shortages (Ziewitz and Luprek, 1996). Warm Springs Regional Fisheries Center needs an additional 100 gpm throughout the year to meet its future production goals, and Cordele Fish Hatchery is susceptible to reduced groundwater availability in the summer from agricultural and industrial groundwater use, and drought conditions. However, both hatcheries have indicated that deep wells could meet their future water needs (Ziewitz and Luprek, 1996). Hence, either alternative would not be expected to adversely affect these facilities.

4.6 Land Use

This section summarizes the existing land uses in the ACF basin and the potential impacts on land use from implementation of the water allocation formula. A key assumption in this EIS was that water availability would not affect population growth or land use changes. This assumption was made because the potential effects of water availability on population and land use changes could not be quantified and were not addressed in the Comprehensive Study. However, it should be recognized that water availability actually would influence population growth and land use change. For example, a local increase in water availability would likely promote increased growth in population and developed land uses.

A land cover data layer developed for EPA Region IV (1997a) is the primary source for land cover information in the ACF basin. The data were specifically developed to provide generalized and consistent land use coverage for the south-central portion of EPA Region IV. A "first order" land cover classification product was constructed from leaves-off Landsat thematic mapping (TM) satellite inquiry acquired from 1988 to 1993. The major land cover uses in the ACF basin are categorized as Residential, Commercial and Industrial, Agricultural Production Land, Confined Feeding Operations, Other Agricultural Land, Forest Land, Barren Land, and Water. The overall proportions of these land cover categories in the ACF are illustrated in ***Figure 4-92***, and the acreage associated with these land cover categories are summarized in ***Table 4-39***. The following sections provide additional information for the major land cover categories and relevant information about other land use in the region, including areas designated for special uses such as recreation areas, national parks, and designated areas for fish and wildlife; areas with significant contaminated sites; and significant military land use areas. ***Figure 4-93*** illustrates the distribution of these categories in the ACF basin.

FIGURE 4-92
Existing Land Cover in the ACF Basin

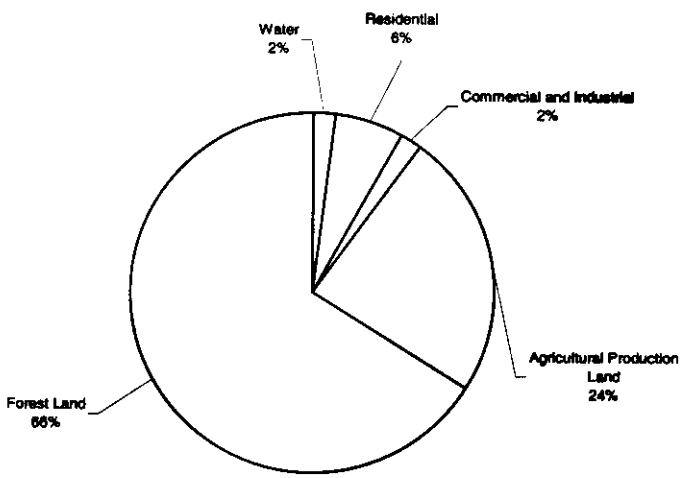

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FIGURE 4-93
Land Use Cover Patterns in the ACF Basin

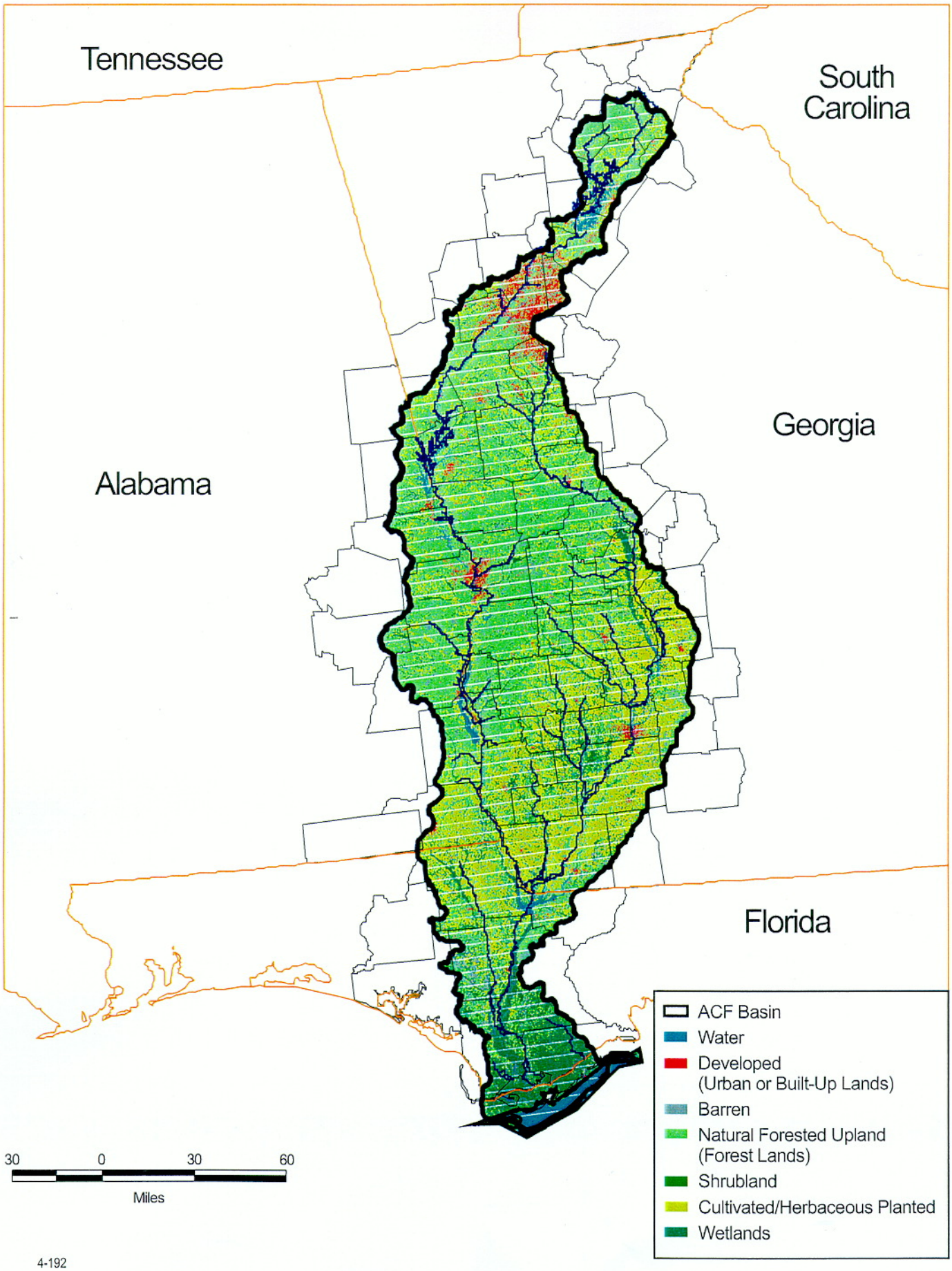

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TABLE 4-39
Existing Land Cover in the ACF Basin, Assumed 1995

Land Use Classifications	Acres	% of Total
Residential	679,700	6
Commercial and industrial	243,700	2
Agricultural production land	3,006,200	24
Confined feeding operations	6,900	0.1
Forest land	8,120,800	66
Barren land	10,000	0.1
Water	236,600	2
Total	**12,303,900**	**100**

Source: ***Appendix D***

4.6.1 Developed (Residential / Commercial / Industrial)

The following section characterizes developed land uses within the ACF basin. Industrial, commercial, and residential land uses are combined for discussion purposes. In addition, this section highlights communities with populations over 25,000, as most development is clustered in the vicinity of these urban areas.

4.6.1.1 Affected Environment

Developed land represents approximately 8 percent of total land use in the ACF basin. Types of land uses in this category include low and high intensity residential, golf courses, urban parks, high intensity commercial and industrial uses, and some transitional uses. The majority of the urban land growth is concentrated in the Chattahoochee River basin around metropolitan Atlanta. In 1990, nearly 50 percent of the population of Georgia lived within the 20-county Atlanta metropolitan statistical area (MSA). This area accounts for a small but growing portion of the developed lands within the basin. North of Atlanta, rapid growth in the headwaters of the ACF basin has transformed the character of this basin from rural farmland and forests to a mix of residential, commercial, and industrial development. South of Atlanta, concentrations of urban land can be found in the cities of Columbus, Georgia, and Dothan, Alabama (both in the Chattahoochee River basin); and in Albany, Georgia, in the Flint River basin. ***Table 4-40*** lists those urban areas with populations greater than 25,000 persons.

TABLE 4-40
Urban Areas in the ACF Basin with Populations Greater than 25,000

Metropolitan Areas	County Name	Subbasin	1990 Census Population[a]
Atlanta, Ga[b]	Fulton	Chattahoochee River	396,052
Roswell, Ga[b]	Fulton	Chattahoochee River	47,923
Marietta, Ga[b]	Cobb	Chattahoochee River	44,129
East Point, Ga[b]	Fulton	Flint River	34,402
Smyrna, GA[b]	Cobb	Chattahoochee River	30,981
LaGrange, GA	Troup	Chattahoochee River	25,597
Phoenix City, AL	Russell	Chattahoochee River	25,312
Columbus, GA	Muscogee	Chattahoochee River	178,861
Albany, GA	Dougherty	Flint River	78,122

[a] Population estimates based on the 1990 U.S. Census
[b] Part of the Atlanta metropolitan statistical area
Sources: EPA, 1996a

Residential land use comprises approximately 6 percent of the total land uses in the ACF basin. The majority of this residential land is found in the Atlanta metropolitan area. The communities surrounding Atlanta, for example, comprise a population estimated at over 2.5 million. Only part of this total is in the ACF basin, and only a small percentage is within the defined city limits summarized in *Table 4-40*.

Industrial land use accounts for 2 percent of total use in the basin. Associated with the region are a number of localized industrial and commercial areas of significance, such as the Fulton Industrial Park along the Chattahoochee River west of Atlanta, and the Hartsfield International Airport along the headwaters of the Flint River south of Atlanta. These industrial lands reflect uses that have potential demands and effects on water resources in the region.

4.6.1.2 Environmental Consequences

Future land use conditions are extrapolated using population forecasts developed as part of the Comprehensive Study. A single population forecast was developed for the basin, independent of water allocation scenarios because it is not possible to determine the effects of water availability on land use at this time. Similar to the population and growth forecasts, EPA developed a single future land use forecast for future years. EPA used several sources to develop future land use projections for the various land use categories. These sources and the approach for future land use are documented in *Appendix D*, in the document titled Non-point Source Pollutant Loading Evaluation.

Table 4-41 details existing and future urban land use for the basin. Residential land use is expected to increase by more than 60 percent between 1995 and 2050, from 679,700 acres to 1,100,000 acres. The percent of total land use devoted to residential will increase from 6 percent to 9 percent. Commercial and industrial land uses are expected to increase by over 40 percent between 1995 and 2020, from 243,700 acres to 350,300 acres. The percent of total land devoted to commercial and industrial uses, however, will not change. This is expected regardless of the water allocation formula developed for the basin. No significant impacts to urban land use or municipalities are anticipated. Because there are only minor percent changes anticipated in the amount of land devoted to both residential and commercial/ industrial uses, no impact is anticipated under any of the action scenarios. However, some changes in developed land uses are likely to result from changes in water availability.

TABLE 4-41
Existing and Future Urban Land Use

Land Use Category	1995 (acres)	% of Total	2020 (acres)	% of Total	2050 (acres)	% of Total
Residential	679,700	6	873,000	7	1,100,000	9
Commercial and industrial	243,700	2	301,000	2	350,300	3

4.6.2 Agricultural Land

This section discusses the land areas that have been modified for management for various agricultural uses in the ACF basin. These land uses relate to water resource issues as a result of seasonal demands to meet irrigation requirements. In addition, some areas are significant sources of nonpoint source runoffs into surface waters.

4.6.2.1 Affected Environment

Agricultural lands include pasture and cropland, and confined feeding operations. Prime farmlands, which may comprise a significant component of agricultural lands, are addressed in Section 4.3.2. Agricultural land uses comprise the second largest land use in the ACF basin, accounting for approximately 24 percent of the total. The majority of agricultural land use is found in the Flint River basin. Most of this agricultural acreage is cropland and pasture land, which are primarily irrigated with groundwater (see Section 4.4.2.1). Crops cultivated in the basin include corn, soybean, and peanuts. Most of the pasture and range uses are managed for beef and dairy cattle grazing. Large rural areas have a mix agricultural uses, including chicken and hog farms, turf farms, and other mixed rural land uses. These areas are scattered throughout the basin. The effects of agricultural land use on the basin's water quality and water supply are discussed in Section 4.4.2.1, Agricultural Demand, and Section 4.4.3, Water Quality.

4.6.2.2 Environmental Consequences

Table 4-42 details future land use totals for agricultural operations based on the land use forecast referenced in the introduction to this section. Agricultural production land is expected to increase a minor amount (2 percent) between 1995 and 2050, from 3,006,200 acres to 3,080,800 acres. The percent of land use devoted to this land use will increase from 24 percent to 25 percent. Approximately 6,900 acres are devoted to confined feeding operation land uses; this number is expected to remain constant in future years. These changes in future agricultural land uses are expected regardless of the water allocation formula developed for the basin and represent less than 1 percent change in the amount of land devoted to agricultural operations. Additionally, Section 4.7.3 documents that, while there would be minor shortages in meeting agricultural water demand requirements, there would not be significant impacts under any of the action scenarios. Although the effects of surface water availability on agricultural land use changes were not modeled, increases in agricultural land uses would likely be less under the low flow scenario, because surface water would not be as readily available for irrigation purposes. Under the high flow scenario, additional agricultural land use could be supported by surface water withdrawals and may result in increased agricultural land use. Indirect effects of land use changes that may follow implementation of an allocation formula could also result in losses of agricultural and prime farmlands, but specific impacts cannot be quantified at this time.

TABLE 4-42
Existing and Future Agriculture Land Use

Land Use Category	1995 (acres)	% of Total	2020 (acres)	% of Total	2050 (acres)	% of Total
Agricultural production land	3,006,200	24	2,991,100	24	3,080,800	25
Confined feeding operations	6,900	0.1	6,900	0.1	6,900	0.1

4.6.3 Forest/Timber

This section reviews the current land uses that include either natural wooded vegetation (forests) or areas managed for silviculture to provide wood products for pulp, lumber, or other needs (forested and shrub wetlands are also included in the forest category; detailed discussion of wetlands can be found in Section 4.5.1 of this document). Included in these areas are local, State, and national forests that provide multiple values related to public use and recreation, affect water resource issues by providing water retention and runoff controls, and reduce erosion and enhance water quality.

4.6.3.1 Affected Environment

Included in the forest category are deciduous forest, evergreen forest, mixed forest, deciduous shrubland, grassland/herbaceous, woody wetlands, and herbaceous wetlands. Forest land is the predominant land use in the ACF basin and accounts for approximately 66 percent of total land use. Georgia currently has more privately owned forest land than any other state in the nation (NRCS, 1995). The mixed stands of hardwoods and pine covering the State support widespread lumber and pulpwood production. Northern Georgia contains several national forests; much of the area north of Lake Lanier falls within the Brasstown, Chattooga, Chestatee, Tallulah, and Toccoa Ranger Districts of the Chattahoochee National Forest. Located in the extreme southern portion of the basin, the Apalachicola National Forest contains 564,000 acres and is the largest forest in Florida (Apalachicola National Forest, 1998).

4.6.3.2 Environmental Consequences

The amount of land devoted to forest uses is forecast to decline 7 percent between 1995 and 2050—from 8,120,800 to 7,519,600 acres (***Table 4-43***). The percent of land in the basin devoted to forest use will decline from 66 percent to 61 percent. These changes are expected regardless of the water allocation formula developed for the basin and represent less than 5 percent change in the amount of land devoted to forest use. Although the effects of the no action and action alternatives on forest land were not modeled, it is likely that surface water availability would effect changes in forest lands in the basin. For example, under the low flow scenario, less urban development may occur and would result in less change in forest land. In the high flow scenario, more urban development may occur and a greater amount of forest land would be lost. The actual influence of the alternative on forest land cannot be quantified in this programmatic EIS.

TABLE 4-43
Existing and Future Forest Land Use

Land Use Category	1995 (acres)	% of Total	2020 (acres)	% of Total	2050 (acres)	% of Total
Forest land	8,120,800	66	7,886,100	64	7,519,600	61

4.6.4 Barren Lands and Water

This section summarizes area distribution of barren lands and water-related uses in the ACF basin.

4.6.4.1 Affected Environment

Barren lands, which include bare rock and sand, quarries, strip mines, and gravel pits, cover approximately 10,000 acres, or less than 0.1 percent of the lands in the basin. Water, which includes bays and estuaries, lakes, reservoirs and streams, covers approximately 236,600 acres or 2 percent of the basin.

4.6.4.2 Environmental Consequences

The amount of land devoted to each of these land categories is forecast to remain constant in future years, and neither increase nor decrease (***Table 4-44***). This is expected regardless of the water allocation formula developed for the basin. As noted for forest land use, the actual influence of the alternatives on land use change cannot be quantified in this programmatic EIS. However, it is possible that additional reservoirs may be required in the no action alternative or low flow scenario, which would increase the amount of open water area in the basin.

TABLE 4-44
Existing and Future Water Land Use

Land Use Category	1995 (acres)	% of Total	2020 (acres)	% of Total	2050 (acres)	% of Total
Barren land	10,000	0.1	10,000	0	10,000	0
Water	236,600	2	236,600	2	236,600	2

4.6.5 Recreation, National Parks, Refuges, Fish and Wildlife Management Facilities and Protected Sites

This section discusses the land use areas that have been designated for particular public or fish and wildlife uses. These include local, State, and Federal land areas that are designated to provide these uses.

4.6.5.1 Affected Environment

The ACF basin contains a variety of public lands and resource protection areas totaling approximately 2 million acres, which are described in ***Table 4-45*** and shown in ***Figure 4-94***. Northern Georgia, in which the upper part of the ACF basin is located, contains several heavily used reservoirs, national forests, national and State parks, and resort communities, which are favorite weekend and vacation destinations. ***Figure 4-94*** illustrates several of the major public land areas in the basin. There are four national park and historic site facilities in the basin, including the popular Chattahoochee River National Recreation Area. This series of recreation areas along the Chattahoochee River provides important recreation opportunities for Atlanta residents. The ACF basin has approximately 18 State park facilities.

TABLE 4-45
Public Land and Resource Protection Areas in the ACF Basin

Facility Name	County, State	Area (acres)
National Park and Historic Areas		
Andersonville National Historic Site	Macon/Sumter, GA	44
Chattahoochee River National Recreation Area	Cobb/Forsyth/Fulton/Gwinnett, GA	714
Jimmy Carter National Historic Site	Sumter, GA	1
Kennesaw Mountain National Battlefield Park	Cobb, GA	267
State Parks		
Bainbridge State Park	Decatur, GA	1
Sweetwater Creek State Park	Douglas, GA	1,986
Chattahoochee State Park	Houston/Jackson/Seminole, GA/FL/AL	596
Chehaw State Park	Dougherty /Lee, GA	112
Fairchild State Park Area	Jackson/Seminole, GA/FL	168
Florence Marina State Park (Walter F. George)	Stewart, GA	150
Franklin D. Roosevelt State Park	Harris/Meriweather, GA	10,000
George T. Bagby State Park & Lodge (Walter F. George)	Clay, GA	308
Georgia Veterans Memorial State Park (Lake Blackshear)	Crisp, GA	1,322
John Gorrie State Museum (Apalachicola Bay)	Franklin, FL	1
Kolomoki Mounds State Park	Early, GA	1,293
Providence Canyon State Conservation Park	Stewart, GA	1,108
Florida Caverns State Park	Jackson, FL	1,306
Constitution Convention State Museum	Liberty, FL	13
Dead Lakes State Recreation Area	Gulf, FL	83
Fort Gadsden Historic Site	Franklin, FL	2,294
Seminole State Park	Seminole, GA	343
Senoia State Park	Coweta, GA	10
State Park-Forest Lands	Chambers/Jackson/Troup, AL/ GA/ FL	349
Torreya State Park	Jackson, FL	2,534
Three Rivers State Recreation Area	Gadsden, FL	686
Lakepoint Resort State Park (on Walter F. George)	Barbour, AL	1,220
Unicoi State Park	White, GA	1,081
Smithgall Woods Conservation Area	White, GA	5,562
Sprewell Bluff State Park (on the Flint River)	Upson/Talbot, GA	1,400
National Forest Lands		
Apalachicola National Forest	Franklin/Leon/Liberty/Wakula, FL	569,596
Chattahoochee National Forest	North Georgia	794,454

(CONTINUED)

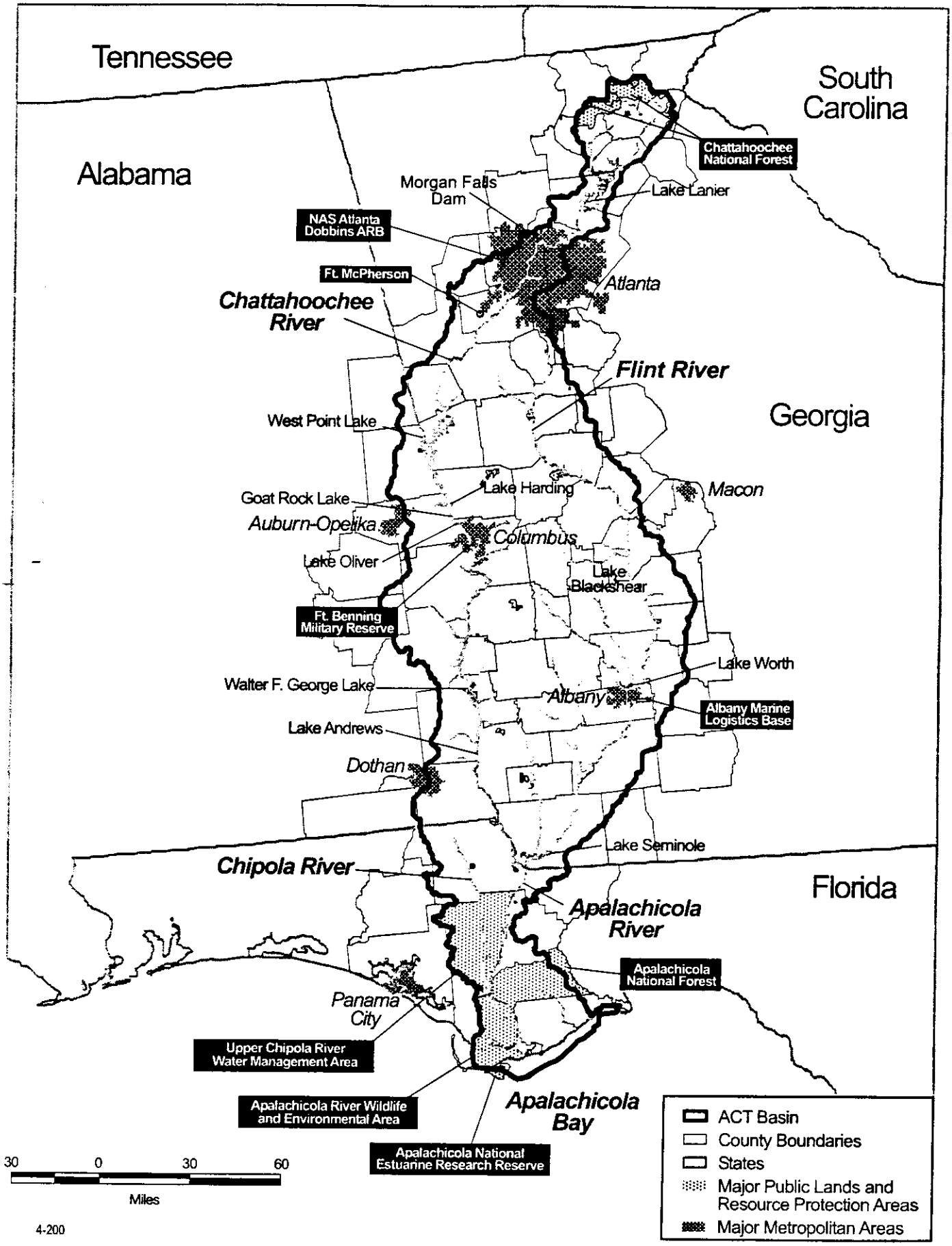
TABLE 4-45 (CONTINUED)
Public Land and Resource Protection Areas in the ACF Basin

Facility Name	County, State	Area (acres)
Wildlife Management Area		
Apalachicola National Estuarine Research Reserve	Franklin/Liberty/Gulf, FL	240,000
Apalachicola Wildlife Management Area	Jackson, FL	7,952
St. Vincent National Wildlife Refuge	Franklin/Gulf, FL	12,489
Albany Nursery WMA	Dougherty, GA	300
Big Lazer Creek WMA	Talbot, GA	5,850
Blanton Creek WMA	Harris, GA	4,500
Chattahoochee WMA (CNF)	White, GA	25,000
Chestatee WMA (CNF)	Lumpkin, GA	25,000
Chickasawhatchee WMA	Dougherty, GA	13,000
ELMODEL WMA	Baker, GA	1,576
Flint River WMA	Dooley, GA	2,500
Hannahatchee Creek WMA	Stewart, GA	5,640
Joe Kurz WMA	Meriweather, GA	3,654
Mayhaw WMA	Miller, GA	4,718
Swallow Creek WMA	White, GA	19,000
West Point WMA	Heard, GA	9,999
Wilson Shoals WMA	Hall, GA	2,800
G.V. Parker WMA		
Apalachicola Bluffs and Ravine Preserve	Liberty, FL	6,248
Apalachicola River Water Management Area	Gulf/Liberty, FL	35,495
Apalachicola River Wildlife and Environmental Area	Franklin/Gulf, FL	55,652
Apalachicola Savannah Research Natural Area	Liberty, FL	448
Cape St. George State Reserve	Franklin, FL	2,294
St. George Island State Park	Franklin, FL	1,962
Judges Cave Wildlife and Environmental Area	Jackson, FL	37
Rock Hill Preserve	Washington, FL	373
St. Joseph Bay State Buffer Preserve	Gulf, FL	701
Tate's Hell State Forest	Frankin/Liberty, FL	131,255
Upper Chipola River Water Management Area	Jackson, FL	7,374
Total Facility Acreage		**2,006,753**

AL Alabama
CNF Chattahoochee National Forest
GA Georgia
FL Florida
WMA Wildlife Management Area
NPRES National Preserve

Sources: Environmental Systems Research Institute, Inc. (ESRI), 1997
National Park Service, 1998
Alabama State Parks, 1998
Florida Game and Fresh Water Fish Commission, July 1998
Georgia State Parks, 1998
Georgia Wildlife Management Areas, 1998

FIGURE 4-94
Major Public Lands and Resource Protection Areas in the ACF Basin



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Approximately 235,291 acres, or 2 percent, of land and water in the ACF basin are managed by the Corps, Mobile District. ***Table 4-46*** summarizes these acreages by project area. These lands are often bordered by other public lands and resource protection areas as noted in ***Table 4-46***.

TABLE 4-46
Land and Water Acreage at Corps Projects in the ACF Basin

Project	Land Acreage	Water Acreage	Total Acreage
Lake Sidney Lanier	19,187	38,024	57,211
West Point Lake	31,070	25,900	56,970
Walter F. George Lake	9,470	45,190	54,660
George W. Andrews Lake	1,165	1,570	2,735
Lake Seminole	26,215	37,500	63,715
ACF Basin Total	**87,107**	**148,184**	**235,291**

Source: ***Appendix D***

4.6.5.2 Environmental Consequences

No change to all but one of these sites is expected under any of the no action or action scenarios. However, a change in water levels may impact the Eufaula National Wildlife Refuge (ENWR). Potential consequences include effects to wildlife and habitat availability; vegetation (especially due to the potential spread of undesirable invasive species); and fall and winter waterfowl habitat (due to filling and draining the off-reservoir impoundments).

4.6.6 Contaminated Sites

This section includes a review of published accounts by EPA of abandoned contaminated waste sites on the EPA National Priorities List (NPL), as determined by the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and as amended by the Superfund Amendment and Reauthorization Act of 1986 (SARA). Contamination at active facilities is not included because these conditions are addressed under other programs, such as those enacted in accordance with the Resource Conservation and Recovery Act (RCRA) and the Clean Water Act (CWA) through their facility-specific operating permits. These land uses have a potential effect on water resource issues through events that may cause a release of contaminants from these sites into surface or groundwater resources.

4.6.6.1 Affected Environment

The following contaminated sites in the ACF basin have been identified by EPA to be of sufficient concern, applying Superfund Criteria, to be placed on the NPL:

- Sapp Battery Salvage, C-280 Alford, Jackson County, Florida
- U.S. Marine Corps Logistics Base 555, Fleming Road, Albany, Dougherty County, Georgia

- Agriculture and Nutrition, 1401 Schley Avenue, Albany, Dougherty County, Georgia
- Firestone Tire & Rubber Company, 3300 Sylvester Road, Albany, Dougherty County, Georgia

The Sapp Battery site is located proximal to the Chattahoochee River drainage system, and the other three sites are within the Flint River basin. These sites are all in various stages of site management and remediation.

4.6.6.2 Environmental Consequences

The potential for environmental consequences to water quality from contaminated sites is primarily related to how close each contaminated site is to the river and stream channels being affected by the water allocation scenarios. In this context, the only potential major consequence is likely to result from the effects of erosion that could occur under allocation scenarios that have increased flows. Under this circumstance, increased flows could either transport contaminated materials into the river and stream channels or could compromise the integrity of any containment systems or structures already in place; however, this would only occur in those channels in which increasing flows are sufficient to initiate or accelerate erosion. Based on information available from the EPA Superfund database, it appears that none of the four Superfund sites located within the ACF basin are situated along main river channels affected by the various water allocation scenarios (EPA, 1998a). At all four sites, there are no anticipated environmental consequences to surface water quality due to the presence of the Superfund sites, and it is unlikely that the various allocation scenarios will impact these sites. However, given the nature of this programmatic EIS, it will be necessary to evaluate the potential effects of any future proposed activities on any of these Superfund sites under project-specific environmental assessments.

4.6.7 Military Land Use

This section identifies major military lands within the ACF basin with readily available data, such as state map atlases and the U.S. Military SITES Installations database.

4.6.7.1 Affected Environment

There are four major military installations in the ACF basin (see ***Table 4-47***). The first, Naval Air Station Atlanta/Dobbins Air Reserve Base, is located on Rottenwood Creek, a tributary to the Chattahoochee River in Cobb County, Georgia. Fort McPherson is located approximately 3 miles from downtown Atlanta on a tributary to the Chattahoochee River. Fort Benning is located on the Chattahoochee River near Columbus, Georgia. Fort Benning spreads over 182,000 acres and is home to the U.S. Army Infantry Training Brigade, U.S. Infantry School, Ranger Training Brigade, Airborne School, and School of the Americas. The fourth installation, Albany Marine Corps Logistics Base, is located in the Flint River basin near Albany, Georgia.

TABLE 4-47
Military Installations in the ACF Basin

Facility Name	River Basin	State	Acres
Naval Air Station Atlanta/Dobbins Air Reserve Base	Chattahoochee	Georgia	2,064
Fort Benning Military Reservation	Chattahoochee	Georgia	182,000
Albany Marine Corps Logistics Base	Flint	Georgia	3,327
Fort McPherson	Chattahoochee	Georgia	487

Source: U.S. Military, 1998

4.6.7.2 Environmental Consequences

No impacts are anticipated on military land uses from the action alternative flow scenarios or the no action alternative.

4.7 Socioeconomic Resources

Socioeconomic resources evaluated in this EIS include human population/demographics and economics. The population evaluation (Section 4.7.1) addresses general population patterns in the ACF basin as well as environmental justice and children protection issues. The population projections are based on the studies completed for the Comprehensive Study (PMCL, 1996) and correspond with the population data used to develop the water demands included in the HEC-5 model (see Section 4.7.1 and ***Appendix G***). The economics section (Section 4.7.3) addresses municipal and industrial water demands, navigation, electric power generation, agricultural water demands, flood control, recreation, income, and employment. The economics sections were prepared by the Mobile District Corps' staff and are based on information developed during the Comprehensive Study and on economic modeling completed by the Corps specifically for this EIS. Existing or baseline conditions and potential environmental consequences resulting from the alternatives are presented.

4.7.1 Population/Demographics

The evaluation of population/demographics is based on population estimates developed for the Comprehensive Study to provide consistency between the water demands used in the hydrologic modeling (see Sections 1.3.3.3 and 4.4.1). This section summarizes the existing demographic conditions based on the Comprehensive Study and evaluates the potential environmental consequences of the alternatives.

4.7.1.1 Affected Environment

4.7.1.1.1 Demographics

As part of the Comprehensive Study, DRI/McGraw-Hill developed population projections through 2050 for each of the 59 counties in the Comprehensive Study-designated ACF basin. Forecasts through 2018 for the nation, for Florida, Georgia, and Alabama, and for metropolitan areas within these states were generated using the DRI/McGraw-Hill August 1993 long-term forecast (DRI/McGraw-Hill, 1996). The forecast horizon was extended to 2050 at the national level. Customized subbasin models were created to capture the unique characteristics of each region. Finally a modeling system was developed to generate population forecasts for specific counties. The methodology used to develop the county-level population projections links population growth to job growth, with no incorporation of changes in commuter patterns. Therefore, counties currently emerging as "bedroom communities" are likely to have population projections that significantly underestimate current and future growth. While county-level population projections are expected to be less accurate, the basinwide figures presented in this section have been approved by the States and are expected to capture the overall growth of fast-developing areas, such as those in the upper Flint River basin.

The 59-county area in the ACF basin has experienced increases in population from 1975 to 1990, with the trend continuing into the 1990s. From 1975 to 1995, the population increased roughly 43 percent, or an average of 1.8 percent annually. ***Table 4-48*** presents the population growth in the ACF basin that has occurred between 1975 and 1995.

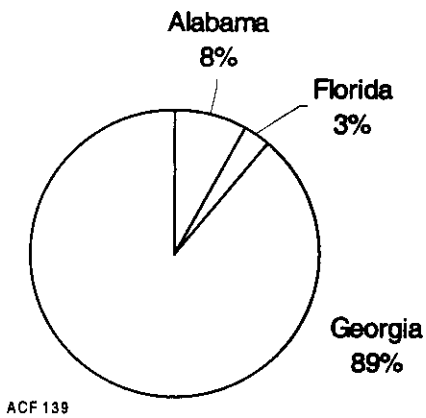
TABLE 4-48
Population Growth in the ACF Basin

Area	1975	1980	1985	1990	1995 Estimated
Alabama portion	265,000	278,000	285,000	293,000	314,000
Florida portion	109,000	114,000	115,000	120,000	130,000
Georgia portion	2,482,000	2,701,000	3,043,000	3,302,000	3,638,000
ACF basin	2,856,000	3,093,000	3,443,000	3,715,000	4,082,000

Source: DRI/McGraw-Hill, 1996

Approximately 89 percent of the population in the ACF basin resided in Georgia. Alabama claimed 7.7 percent of the population, with Florida having the remaining 3.2 percent of the residents. *Figure 4-95* illustrates the population distribution in the basin.

FIGURE 4-95
Population Distribution in the ACF Basin



The 1995 population estimates presented here were used to develop the municipal and industrial water demands presented in Section 4.7.3.1.

4.7.1.1.2 Environmental Justice

On February 11, 1994, President Clinton issued Executive Order (EO) 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations. The order requires that federal agencies identify and address, as appropriate, disproportionately high and adverse human-health or environmental effects of its programs, policies, and activities on minority and low-income populations. By the memorandum of February 11, 1994, the President directed EPA to ensure that agencies analyze environmental effects on minority and low-income communities, including human-health, social, and economic effects.

The term *minority population* includes persons who identify themselves on the Census as African-American, Asian or Pacific Islander, Native American or Alaskan Native, or Hispanic (CEQ, 1996). A minority population exists if the percentage of minorities in an

affected area either exceeds 50 percent or is meaningfully greater than in the general population of the larger surrounding area (EPA, 1996b).

A minority community may be either a group of individuals living in geographic proximity to one another, or a geographically dispersed/transient set of individuals (such as migrant workers or Native Americans). Either group experiences common conditions of environmental exposure or effect. A selected appropriate unit of geographic analysis may be a governing body's jurisdiction, a neighborhood, a census tract, or another similar unit with no artificial dilution or inflation of the affected minority population. A minority population also exists if there is more than one minority group present and the aggregate minority percentage meets one of the above-stated thresholds.

Analysis of demographic data for the ACF basin shows that the population is over 67 percent white. African-Americans represent the next largest ethnic group, comprising almost 30 percent of the basin's population. ***Table 4-49*** shows the demographic characteristics of the basin. For each of the states in the ACF basin, the proportion of minority persons living inside the basin is higher than for the state as a whole. However, only the Florida portion of the basin (34 percent African-American) could be considered meaningfully higher than the state (13.6 percent African-American).

TABLE 4-49
Demographics for the ACF Basin, 1990

Total	White	African-American	American Indian, Eskimo, or Aleut	Asian or Pacific Islander	Other Race	Hispanic
Alabama portion of basin	202,691	87,283	616	1,999	415	1,597
	69.2%	29.8%	0.2%	0.7%	0.1%	0.5%
Florida portion of basin	77,535	40,596	547	223	630	2,116
	64.9%	34.0%	0.5%	0.2%	0.5%	1.8%
Georgia portion of basin	2,233,305	981,064	7,554	53,879	26,967	66,279
	67.6%	29.7%	0.2%	1.6%	0.8%	2.0%
ACF basin total	2,513,531	1,108,942	8,717	56,101	28,012	69,992
	67.7%	29.8%	0.2%	1.5%	0.8%	1.9%
State of Alabama	2,975,247	1,019,743	18,295	21,754	5,548	23,579
	73.6%	25.2%	0.5%	0.5%	0.1%	0.6%
State of Florida	10,755,698	1,755,958	42,619	150,200	233,451	1,555,031
	83.1%	13.6%	0.3%	1.2%	1.8%	12.0%
State of Georgia	4,603,396	1,744,882	15,283	73,757	40,898	101,379
	71.1%	26.9%	0.2%	1.1%	0.6%	1.6%
3-state area	18,334,341	4,520,583	76,197	245,711	279,897	1,679,989
	78.2%	19.3%	0.3%	1.0%	1.2%	7.2%

Source: U.S. Bureau of the Census

The existence of low-income persons in the ACF basin was determined from the 1990 U.S. Census statistical poverty threshold, which is based on income and family size. For example, according to the U.S. Census, a family of four with two children under 18 would fall below the poverty threshold if its 1989 total income was below $12,575. The Bureau of the Census defines a *poverty area* as having 20 percent or more of the residents with incomes below the poverty threshold. Overall, 13.2 percent of the population is below the poverty level (***Table 4-50***). Within the basin, the proportion of persons below the poverty level is much higher in Alabama (20.1 percent) and Florida (22 percent) than in Georgia (12.3 percent). For Alabama and Florida, the proportion of low-income residents is higher in the area in the basin than in each state as a whole, and both of those portions of the basin meet the definition of a poverty area. For Georgia, which makes up the greatest part of the basin, the percentage of low-income persons is lower in the basin than in the state as a whole.

TABLE 4-50
Persons Below the Poverty Level in the ACF Basin, 1990

Total	Persons for Whom Poverty Status Is Determined	Persons Below the Poverty Level	Percentage of Persons Below the Poverty Level
Alabama portion of basin	293,004	58,978	20.1%
Florida portion of basin	119,531	26,348	22.0%
Georgia portion of basin	3,283,024	402,314	12.3%
ACF basin	3,695,559	487,640	13.2%
State of Alabama	4,040,587	723,614	17.9%
State of Florida	12,937,926	1,604,186	12.4%
State of Georgia	6,478,216	923,085	14.2%
3-state area	10,518,803	1,646,699	15.7%

Source: U.S. Census Bureau, 1998

4.7.1.1.3 Protection of Children

On April 21, 1997, the President issued Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, which recognizes that a growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health and safety risks. This EO requires federal agencies, to the extent permitted by law and mission, to identify and assess such environmental health and safety risks.

While the EO 13045 does not provide guidance on what age children are to be protected, the Federal Interagency Forum on Child and Family Statistics, which was founded in 1994 and formally established by the EO, focuses on those aged 17 and under (Federal Interagency Forum on Child and Family Statistics, 1997). In the ACF basin, there were 967,412 children 17 and under identified in the 1990 Census. This represents more than 26 percent of the basin-wide population. Almost 89 percent of the children in the basin were residents of Georgia (860,236). The Alabama portion of the ACF basin had 75,481 children (7.8 percent of the basin total), with Florida having 31,695 children (3.3 percent of the basin total).

4.7.1.2 Environmental Consequences

The evaluation of potential environmental consequences on population and demographics was based on the population projections developed during the Comprehensive Study

(DRI/McGraw-Hill, 1996). A key assumption of the Comprehensive Study and the EIS has been that population growth will continue as projected, regardless of the availability of water.

4.7.1.2.1 Demographics

Growth in the ACF basin is projected to continue to increase at an average of about 1 percent per year throughout the 55-year study period. *Table 4-51* presents the population projections for the basin through 2050. In 1995, approximately 89 percent of the population in the ACF basin resided in Georgia. Alabama claimed 7.7 percent of the population, with Florida having the remaining 3.2 percent of the residents. By 2050, Georgia's share of the population is expected to increase slightly, with 89.6 percent of the basin's residents living in that state. The percentage anticipated to be living in Alabama will decrease to 7.1 percent, with Florida's share increasing to 3.3 percent.

TABLE 4-51
Projected Population Growth in the ACF Basin

	1995	2020	2050
Alabama portion of basin	314,000	392,000	490,000
Florida portion of basin	130,000	174,000	224,000
Georgia portion of basin	3,637,000	4,782,000	6,167,000
ACF basin	4,081,000	5,348,000	6,881,000

Population distribution over the basin will change as an indirect result of the decision made by the Federal Commissioner. Intuitively, populations will increase in areas where water resources become more available and induce growth in some communities, while population declines may occur in other areas. These demographic changes will have additional secondary impacts on land use changes for residential development and support services, will affect water and wastewater treatment demands, and will affect local economics. However, these changes will be localized following water resource changes that are made by the States after the Federal Commissioner has made a decision on the allocation formula. Thus, although there will be impacts from population changes resulting from the selection of an alternative, this programmatic EIS cannot predict specific areas where these changes will take place. Further, because local and regional decisions may be made to implement specific water conservation and water quality measures, the impacts of these changes are also unpredictable until implementation EAs or EISs are completed. Therefore, for the purposes of modeling, it is assumed that there are no differences in population growth among the no action and action alternative flow scenarios.

4.7.1.2.2 Environmental Justice

Analysis of demographic data indicates a low-income population in the ACF basin. However, the water allocation alternatives are not designed to create either a benefit or an adverse effect for any group or individual, and are not expected to create disproportionately high or adverse human health or environmental impacts on minority or low income populations in the ACF basin. As indicated in Section 4.7.3.2, no significant impacts to the economy of the basin are expected to arise from the no action or action alternative scenarios evaluated in this EIS. Likewise, no human health risks that would disproportionately

impact minority or low income communities have been identified in this EIS. However, the programmatic nature of this EIS precludes identifying specific areas with low-income and minority population in the basin that might experience demographic impacts, as explained above.

4.7.1.2.3 Protection of Children

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, directs federal agencies to ensure that their policies, programs, activities, and standards address disproportionate risks to children that result from environmental health or safety risks. No human health risks (see Section 4.6.6.2) or safety risks arising from the no action and action alternative flow scenarios that would disproportionately impact children have been identified through this EIS process. However, specific impacts arising from changes in stream flows or elevated or lowered lake levels cannot be addressed in a programmatic EIS such as this one, but will be addressed in the EAs that tier off of this document.

4.7.2 Recreation

The following section summarizes the existing recreation conditions in the ACF basin and the potential impacts on recreation associated with implementing the water allocation formula. Recreational opportunities associated with the reservoirs and riverine reaches are addressed separately. The evaluation of recreation within the ACF basin is based on information developed in the Comprehensive Study (Allen et al., 1997), which is in final draft form, and on the evaluation of impacts completed by the Mobile District Corps economics and planning staff.

4.7.2.1 Affected Environment

Phase I of the Comprehensive Study report (Allen et al., 1997) examined recreation at 25 reservoirs, rivers, and river reaches in the ACT and ACF basins. The 10 ACF projects included in the study are listed in ***Table 4-52***. Five of the 10 study projects are reservoirs operated by the Corps, and two reservoirs are operated by Georgia Power Company (GPC). The remaining three projects are river segments. The study projects were chosen by the Comprehensive Study Technical Coordination Group (TCG) based on their representation of the entire range of project characteristics in the basins. This analysis focuses on those projects for which uniform data are available. There are other major recreation areas in the basin that were not analyzed as part of the Comprehensive Study, most notably, National Park Service sites and U.S. Forest Service sites. Information and use data on those recreation sites are presented to the extent that data was available.

TABLE 4-52
ACF Study Projects Included in Phase I of the Comprehensive Study

River	Official Name	Operated by	Common Name
Chattahoochee	Lake Sidney Lanier/Buford Dam	Corps	Lake Sidney Lanier
	West Point Lake	Corps	West Point Lake
	Bartletts Ferry Dam	GPC	Bartletts Ferry Lake (Lake Harding)
	Oliver Dam	GPC	Lake Oliver
	Walter F. George Lock and Dam	Corps	Lake Walter F. George (Lake Eufaula)
	George W. Andrews Lock and Dam	Corps	Lake George W. Andrews
	Jim Woodruff Lock and Dam	Corps	Lake Seminole
Chipola	River segment	Not applicable	
Flint	River segment	Not applicable	
Apalachicola	River segment	Not applicable	

The reservoirs, rivers, and streams of the ACF basin are heavily used for recreation purposes. The basin contains several national forests, national and State parks, and resort communities that are favorite weekend and vacation destinations. Much of the area in the north portion of the basin (north of Lake Sidney Lanier) falls within the Chattahoochee National Forest. The area in the southern portion of the basin falls within the Apalachicola National Forest (the largest forest in Florida). These national forests provide both developed and dispersed recreation opportunities. The developed sites

provide a range of primitive to modern facilities. Dispersed activities include hunting, fishing, boating, hiking, and off-road vehicle riding.

Lake Sidney Lanier, located north of Atlanta, has more than 16 million visitors annually and the highest visitation rate among Corps reservoirs nationwide (Couch et al., 1996). Within metropolitan Atlanta, the Chattahoochee River National Recreation Area is a popular recreation area, receiving an estimated 3.5 million visitors annually (National Park Service, 1998). South of Atlanta, several reservoirs in the basin, including West Point Lake, Lake Walter F. George, and Lake Seminole, are major regional fishing destinations.

Recreational fisheries in the ACF basin consist of cold-water trout fisheries in the Chattahoochee River basin in the mountains above Lake Sidney Lanier and in the river below Buford Dam. Warm-water recreational fisheries exist in the remainder of the Chattahoochee River basin and in the Flint and Apalachicola River basins.

Recreation use data were obtained from a survey administered to registered boat owners in the 101 counties located in the ACT and ACF basins. The Phase I survey consisted of a telephone survey that was administered to collect information on boater recreational use at the ACF project sites during the 1995 recreation year. Estimates of number of trips were then adjusted based on the output of the hydrologic modeling (see the Corps recreation report in ***Appendix F***). Based on this, the Corps estimates that approximately 2 million boating trips were made to the study projects in the ACF basin in 1995, representing nearly 8 million visitor-days of recreational boating. Summer was the most popular boating season, followed by spring. Together, these two seasons account for 78 percent of the recreation use that occurs in the basins. Fall and winter, combined, account for only 22 percent of recreation use (***Table 4-53***).

TABLE 4-53
Annual Boat Recreation Visitation Estimates for ACF Basin

Total Trips (1995)	Total Visitor-Days	Winter (%)	Spring (%)	Summer (%)	Fall (%)
2,037,920	7,970,400	12	34	44	10

Source: The estimates of trips are based on a survey (Allen et al., 1997) that was adjusted based on the output of the hydrologic modeling (see Corps recreation report in ***Appendix F***).

4.7.2.1.1 Reservoir Recreation

Seven reservoirs in the ACF basin provide various recreation opportunities and receive varying degrees of usage. Six of the reservoirs are located on the Chattahoochee River, and one at the confluence of the Chattahoochee and Flint Rivers. As stated earlier, five reservoirs are operated by the Corps, and two by GPC. Recreation facilities on the reservoirs provide public docks, fishing piers, and access sites; boat launches; swim areas; camping facilities; and playground areas. ***Table 4-54*** details recreation facilities on each of the reservoirs. Where available, information on reservoir level effects to recreation facilities and opportunities is provided.

TABLE 4-54
Recreation Facilities on ACF Project Reservoirs

Reservoir/Surface Area	No. of Parks	No. of Marinas	No. of Campgrounds	Comment
Lake Sidney Lanier/38,542 acres	93	10	10	Day use areas contain swim areas, boat ramps, picnic shelters/tables, restrooms, showers, campsites. Fifty-four boat launch lanes are available on the lake. In addition to public recreation facilities, Lake Lanier Islands Beach and Water Park offers swimming; power boat, sailboat and bicycle rentals; water skiing; fishing, and horseback riding. An 18-hole, par 72 championship golf course is located next to the Water Park at the Lake Lanier Islands Hilton Resort. Recreation impacts begin to occur with a 5- to 7-foot draw-down. At an 8-foot draw-down, all the Corps swimming beaches are unusable. When the reservoir is 11 feet below normal pool, boating is increasingly hazardous in the fringe areas.
West Point Lake/25,900 acres	34	2	12	Day use areas contain boat launches, swim areas, picnic shelters/tables, restrooms, showers, and campsites.
Bartlett's Ferry/5,850 acres	3	1	2	Small public and private marinas line the southern section of the lake; the north is undeveloped. There are nine boat ramps and fishing access areas below the dam. Blanton Creek Wildlife Management Area has camping, nature trails, and wildlife viewing.
Lake Oliver/2,150 acres	NDA	NDA	NDA	There is one public boat access site on the lake.
Walter F. George Lake /45,180 acres	13	4	4	There are three State parks on the lake, numerous bank shore fishing opportunities, fishing piers, and 13 boat ramp areas. Recreation impacts begin to occur with draw-downs of 1 foot below normal pool elevation. A 4-foot draw-down results in 80 percent of boat ramps being unusable, and a decrease in residential user access to the lake.
George W. Andrews/1,540 acres	3	NDA	5	Three public use boat ramp areas are available on the lake.
Lake Seminole/17,230 acres	16	6	5	There are two State parks on the lake. Known nationally as one of the best sites for sports fishing in America.

NDA No data available

Sources: Corps, 1998a; Brown and Smith, 1997

The Corps estimated 1995 annual boating use on the project reservoirs to be 1.8 million trips, translating to 7.2 million visitor-days. Lake Sidney Lanier is the most heavily visited project, with more than 3.5 million visitor-days, accounting for nearly 50 percent of total visitor-days for all reservoirs. Lake George W. Andrews is the least visited project, with fewer than 45,000 visitor-days (less than 1 percent of total visitor-days for

all reservoirs). At three of the reservoirs (Lake Sidney Lanier, Bartlett's Ferry, and Lake Oliver), summer is the most popular recreation season. At Lake Walter F. George, spring and summer seasons receive equal use. Spring is the most popular season at the remaining three reservoirs (West Point Lake, George W. Andrews, and Lake Seminole). *Table 4-55* provides detailed information for each reservoir.

TABLE 4-55

Annual Recreation Visitation Estimates for Reservoirs in the ACF Basin, 1995

Location	Total Trips	Total Visitor-Days	Winter (%)	Spring (%)	Summer (%)	Fall (%)
Lake Sidney Lanier (Corps)	862,332	3,519,700	12	29	47	12
West Point Lake (Corps)	260,369	916,800	16	38	36	11
Bartlett's Ferry (GPC)	102,955	616,700	9	35	48	8
Lake Oliver (GPC)	37,132	72,600	9	31	60	0
Lake Walter F. George (Corps)	353,534	1,443,000	13	39	37	10
Lake George W. Andrews (Corps)	13,551	43,700	23	41	28	8
Lake Seminole (Corps)	148,703	576,400	18	43	34	4
Total	1,778,616	7,188,900				

Source: The estimates of trips are based on a survey (Allen et al., 1997) that was adjusted based on the output of the hydrologic modeling (see Corps recreation report in ***Appendix F***).

Table 4-56 details activity participation at each ACF reservoir. On all reservoirs but Lake Sidney Lanier, boat-based fishing is the most popular recreation activity, followed by pleasure boating, swimming, and picnicking. At Lake Sidney Lanier, pleasure boating is the predominant activity, followed by fishing from a boat, and swimming.

TABLE 4-56

Activity Participation on Project Reservoirs in the ACF Basin, 1995

Reservoir	Total Trips	Fishing: Shore (%)	Fishing: Boat (%)	Pleasure Boating (%)	Water Skiing (%)	Jet Skiing (%)	Swimming (%)	Camping (%)
Lake Sidney Lanier	862,332	18	61	65	36	11	61	20
West Point Lake	260,369	17	91	36	19	7	28	19
Bartlett's Ferry	102,955	14	80	40	22	17	28	5
Lake Oliver	37,132	5	62	59	29	15	28	NDA
Lake Walter F. George	353,534	13	85	45	20	8	32	18
Lake George W. Andrews	13,551	2	82	27	5	4	9	10
Lake Seminole	148,703	8	84	31	13	7	21	6

NDA No data available

Note: Activities are not mutually exclusive, therefore, data will sum to more than 100 percent.

Source: The estimates of trips are based on a survey (Allen et al., 1997) that was adjusted based on the output of the hydrologic modeling (see Corps recreation report in ***Appendix F***).

4.7.2.1.2 Riverine Recreation

The major rivers in the ACF basin include the Chattahoochee, Flint, Apalachicola, and Chipola. There are also tributaries to each of these rivers, but because tributary flows would not be affected by the proposed project, they are not discussed. The Comprehensive Study assessed river recreation use for the Flint, Apalachicola, and Chipola Rivers. Because the Chattahoochee River was not part of its study, other sources are relied on for assessing recreation use on that river.

The Chattahoochee River receives the most recreation use of the rivers in the basin. The Chattahoochee River National Recreation Area (NRA), managed by the National Park Service, is a popular recreation destination for rafting, tubing, canoeing, kayaking, and fly fishing. The Chattahoochee River NRA receives an estimated 3.5 million visitors annually, with the summer season having the highest recreation use, and winter season having the lowest (National Park Service, 1998). Canoeing and kayaking takes place on several segments of the Chattahoochee River or its tributaries, including:

- Upper Chattahoochee River: Buford Dam to West Point Lake (Class I-II)
- Lower Chattahoochee River: south of Columbus to Lake Seminole (Class I)
- Big Creek (tributary): Oxbo Road to Chattahoochee Nature Center on Chattahoochee River (Class II-III)
- Sweetwater Creek (tributary): Blairs Bridge Road to Lower River Road (Class II-IV) (Sehlinger and Otey, 1995)

Based on the hydrologic modeling, the Corps estimated 1995 annual boating use on the Apalachicola, Chipola, and Flint Rivers to be 266,000 trips, translating to nearly 800,000 visitor-days (see ***Table 4-57***). Generally, spring is the most popular season for river recreation, with over 40 percent of recreation use. On the Flint River, summer recreation use is just as high as in the spring; while on the other two rivers, summer use is not as high. The Chipola River receives a significant number of recreationists in the winter. Recreation use is lowest on all rivers in the fall season. The Apalachicola River is the only riverine segment with available information about recreation access as it relates to river depths. The Corps determined that 8 feet is the ideal depth for recreation opportunities on this river. When depths fall to between 6 and 5 feet, boat ramps become unusable; and when depths fall to between 3 feet and 1 foot, sand bars at creek mouths close access to the main channel, and 65 percent of boat ramps become unusable (Allen, et al., 1997).

Canoeing occurs on the Flint River from above Georgia Highway 18 to south of the Georgia Highway 36 Bridge (Brown and Smith, 1997). The Apalachicola River, which begins below Lake Seminole, is used by both recreation boats and barge traffic. The river from that point to Apalachicola Bay consists of a coastal river through a broad-forested floodplain, with great diversity of waterfowl and wildlife. Large portions of the Apalachicola River floodplain have been purchased by the State of Florida for wildlife management areas. Occasional springs and ravines are also found. The Chipola River contains the Chipola River Canoe Trail, which begins south of Florida Caverns State Park. This river trail flows through river swamp and hardwood forests.

TABLE 4-57
Annual Recreation Visitation Estimates for Rivers in the ACF Basin, 1995

River	Total Trips	Total Visitor-Days	Winter (%)	Spring (%)	Summer (%)	Fall (%)
Apalachicola River	102,103	330,800	19	44	32	5
Chipola River	33,244	69,300	25	43	25	5
Flint River	123,957	381,400	11	42	42	5
Total	259,304	781,500				

Note: The Chattahoochee River was not selected by the Comprehensive Study Technical Coordination Group (TCG) to be analyzed and surveyed as part of the Comprehensive Study. Therefore, uniform data is not available.

Source: The estimates of trips are based on a survey (Allen et al., 1997) that was adjusted based on the output of the hydrologic modeling (see Corps recreation report in ***Appendix F***).

Table 4-58 provides activity participation levels for the Apalachicola, Chipola, and Flint Rivers. On all three rivers, fishing by boat is the predominant activity, and accounts for the majority of recreation use. Pleasure boating is the next highest activity use, but it is far less common than fishing.

TABLE 4-58
Activity Participation on Project Rivers in the ACF Basin, 1995

Riverine Projects	Total Trips	Fishing: Shore (%)	Fishing: Boat (%)	Pleasure Boating (%)	Water Skiing (%)	Jet Skiing (%)	Swimming (%)	Camping (%)
Apalachicola River	111,312	9	83	45	7	7	22	14
Chipola River	33,244	11	95	33	5	6	27	17
Flint River	123,957	13	84	32	13	7	25	8

Note: Activities are not mutually exclusive, therefore, data will sum to more than 100 percent.

Source: The estimates of trips are based on a survey (Allen et al., 1997) that was adjusted based on the output of the hydrologic modeling (see Corps recreation report in ***Appendix F***).

4.7.2.2 Environmental Consequences

4.7.2.2.1 Reservoir Recreation

The effects on recreation visitation (estimated number of boat trips) was evaluated for two alternatives: the no-action alternative and the three alternative flow scenarios modeled for the action alternative (low flow, moderate flow, and high flow). The effects of the various alternatives were evaluated by overall annual visitation as well as seasonally, recognizing that the spring and summer seasons represent the highest visitation to the reservoirs and account for 70 percent of the boat trips in the ACF basin).

These three scenarios are measured against the no action alternative. However, because of modeling constraints (see Section 4.4.1.2), comparing the action alternative flow scenarios to the no action alternative is difficult because the model excluded flood control, navigation, and hydropower operations because of the complexity of the modeling. The effect of the modeling constraints is evident when comparing the range of the action alternative flow scenarios to the no action alternative. In most cases, the modeling predicts that the range of possible flow scenarios produce higher visitation

than the no action alternative. This would not necessarily be the case. In some cases, the low, moderate, and high scenarios would experience lower elevations, and lower visitation, than the model predicts.

To compare the effect of alternative operating scenarios on reservoirs, the evaluation relied on the water level/recreation visitation value functions, developed as part of the Comprehensive Study. In that study, recreation use data were obtained through a two-phase recreation survey administered to registered boat owners in the 101 counties located in the ACT and ACF basins. The Phase I survey collected information on boater recreational use at each of the ACT and ACF project sites during the 1995 recreation year. The Phase II survey was a contingent use survey that queried respondents on how their recreation use of one of six impact projects would change as the result of low water conditions. From this information, value functions were developed for each ACF recreation project for each season. The water level/trip visitation value functions provided estimates of the number of recreation trips boaters would make at any specific pool level within a range of water levels.

All alternatives were evaluated for 1995, 2020, and 2050 water consumptive demands. Population forecasts that were used to determine the recreation demand for the years were obtained from the Comprehensive Study. The establishment of recreation demand forecasts were based on two assumptions. First, that demand for recreation is directly related to population, so changes in recreation demand correspond to changes in population. Second, that recreation use in each forecast year can be estimated by calculating the percent change in population from the baseline year to a given forecast year and then multiplying the baseline use estimates by the percent population change.

Because of modeling constraints (see Section 4.4.1.2), in some individual reservoir cases the modeling predicts that the range of possible flow scenarios produces higher visitation than the no action alternative. This would not necessarily be the case. In some cases, the low, moderate, and high scenarios would experience lower elevations, therefore lower visitation, than the model predicts because the model did not include specific operations for peaking, navigation, or flood control. Nonetheless, this analysis compares the action alternative flow scenarios to the no action alternative.

Examination of the results of the ACF recreation summary analysis (***Table 4-59***) shows that the action alternative flow scenarios all provide higher recreation visitation than the no action alternative. The pattern shows decreasing or equal positive impacts from the low to moderate conditions and increasing positive impacts from the moderate to high flow conditions.

TABLE 4-59
Recreation Trips, ACF Basin

Year	No Action Alternative	Action Alternatives		
		High Flow Scenario	Moderate Flow Scenario	Low Flow Scenario
1995	1,778,576	1,935,703	2,043,800	2,081,643
2020	2,201,801	2,497,980	2,609,653	2,674,612
2050	2,788,618	3,192,920	3,299,323	3,400,677

These data include the following reservoirs: Lake Sidney Lanier, Wet Point Lake, Bartletts Ferry, Lake Oliver, Lake Walter F. George, Lake George W. Andrews, and Lake Seminole.

The model predicts that reservoir levels would yield 2.8 million recreation trips for 2050 throughout the ACF basin under the no action alternative. In comparison, the low and moderate flow scenarios would yield 3.4 million trips and 3.3 million trips, respectively (or 500,000 to 600,000 more recreation trips annually). The high flow scenario would yield 3.2 million trips in 2050 (or 140,000 more trips annually than under the no action alternative).

The low flow scenario emphasizes maximum water conservation, thus higher pool levels. Annual visitation with this scenario was slightly higher than the moderate flow scenario (which most closely approximates existing conditions), and was higher than the no action alternative.

Recreation trips under the high flow scenario were about 3 percent lower than the moderate flow scenario, and 15 percent higher than under the no action alternative. Two factors resulted in visitation being higher with this scenario than with the no action alternative. The first factor, which resulted in lower lake levels, was the high downstream minimum flow target. The second factor did not include the seasonal drawdown for flood control in the modeling, which caused average annual lake levels to be higher than would expected.

For run-of-the-river and river projects, there was no seasonal drawdown of the reservoirs. Therefore, as the minimum flow release was increased from the low to moderate to high scenarios, there were decreasing positive impacts as lake levels or flow decreased.

The following discussion describes impacts to individual reservoirs in year 2050. Note that Bartlett's Ferry, Lake Oliver, and Lake George W. Andrews were modeled as run-of-river projects. Therefore, the pool elevation at these projects will remain constant and a water allocation formula will not affect the pool elevation at these reservoirs. As a result, these projects were not included in determining direct impacts to recreation resulting from implementing a water allocation formula. The analysis compares the action alternative flow scenarios to the no action alternative. However, because the moderate flow scenario was modeled to be similar to current operations, this scenario was also used as a basis for comparing the different action alternative flow scenarios.

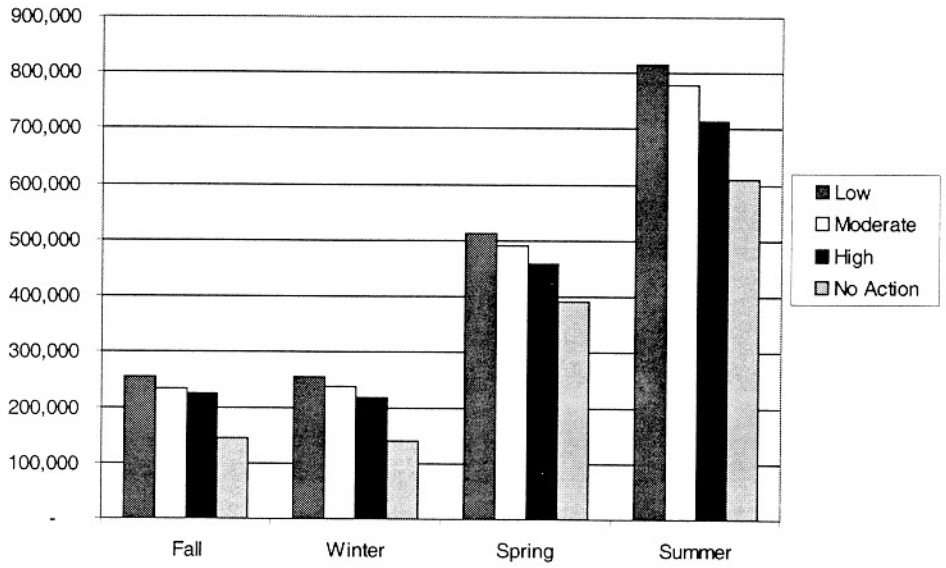
4.7.2.2.1.1 Lake Sidney Lanier

Lake Lanier receives the highest recreation use of all reservoirs in the ACF basin, with over 75 percent of use occurring in the spring and summer seasons. The model predicts

that, for all seasons, the action alternative flow scenarios would provide significantly higher recreation visitation than the no action alternative (***Figure 4-96***). This may not be the case, as the model did not account for hydropower, navigation, or flood control.

The range of action alternative flow scenarios appears to provide significantly higher recreation visitation than the no action alternative. For instance, the high flow scenario yields 25 percent more recreation trips, and the low flow scenario yields 43 percent more than the no action alternative ***(Table 4-60)***. However, this is not necessarily true. The high, moderate and low flow scenarios did not incorporate peaking, navigation, or flood control in the modeling. Therefore, these scenarios appear to experience higher elevations, and therefore, higher visitation. It is expected that the difference between action and no action would not be as significant.

FIGURE 4-96
Lake Lanier Comparison of Recreation Trips, 2050 (ACF Basin)



ACF 700

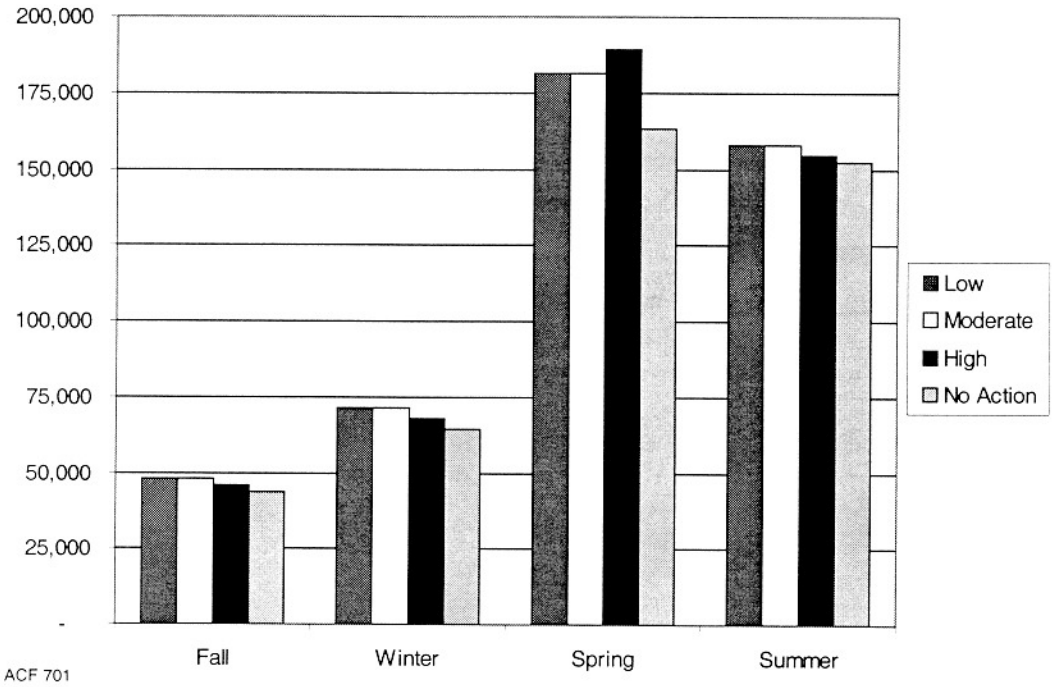
TABLE 4-60
Comparison of Seasonal Recreation Visitation for Lake Sidney Lanier, 2050

Season	No Action Alternative	Action Alternatives		
		High Flow Scenario	Moderate Flow Scenario	Low Flow Scenario
Fall	145,545	224,815	233,852	255,390
Winter	139,845	217,886	237,843	255,126
Spring	391,621	457,685	491,334	513,719
Summer	610,449	715,011	778,133	816,322
Total	**1,287,460**	**1,615,396**	**1,741,162**	**1,840,557**

4.7.2.2.1.2 West Point Lake

West Point Lake is the third most visited reservoir in the ACF basin. It receives approximately 25 percent of the recreation use that Lake Lanier receives. Approximately 73 percent of that recreation use occurs in the spring and summer seasons. The model predicts that, with the exception of the spring season, recreation visitation is nearly the same for both the no action alternative and the action alternative flow scenarios (high, moderate, and low flows). In fall and winter seasons, there is a 10 percent difference in visitation between the alternatives; in the summer season, the difference is 3 percent. Spring is the season when the three action alternative flow scenarios (ranging from 20,000 to 30,000 fewer visitors) yield noticeably higher recreation visitation than the no action alternative. *Figure 4-97* compares seasonal recreation visitation in 2050 for the alternatives.

FIGURE 4-97
West Point Lake Comparison of Recreation Trips, 2050 (ACF Basin)

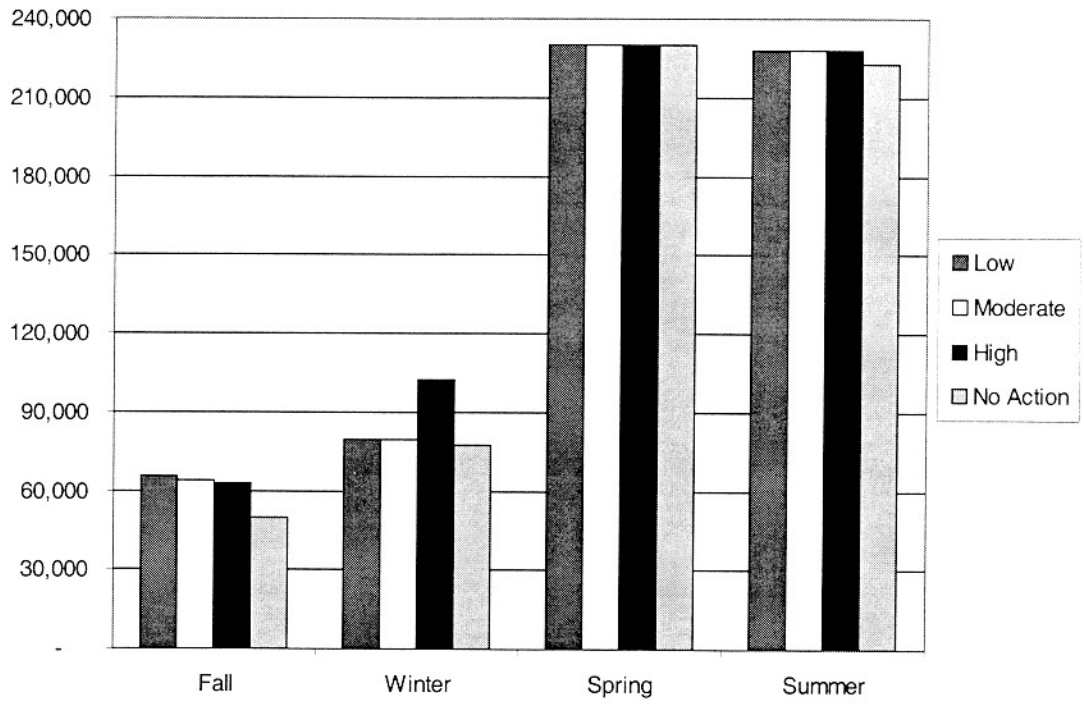


4.7.2.2.1.3 Walter F. George

Walter F. George is the second most visited reservoir in the basin, receiving about one-third of the use that Lake Lanier receives. Similar to the other reservoirs, the majority of recreation use occurs in the spring and summer seasons. The modeling predicts that, in the spring and summer seasons, recreation visitation would remain relatively constant for both the no action alternative and the action alternative flow scenarios (high, moderate, and low flows). In winter, visitation is predicted to be greater under the high flow scenario than the other modeled flows (the low and moderate scenario and the no action alternative would all yield the same amount of recreation visitation). In fall, the model predicts that the action alternative flow scenarios would yield higher visitation

than the no action alternative. *Figure 4-98* compares seasonal recreation visitation for the action alternative flow scenarios and the no action alternative.

FIGURE 4-98
Walter F. George Lake Comparison of Recreation Trips, 2050 (ACF Basin)



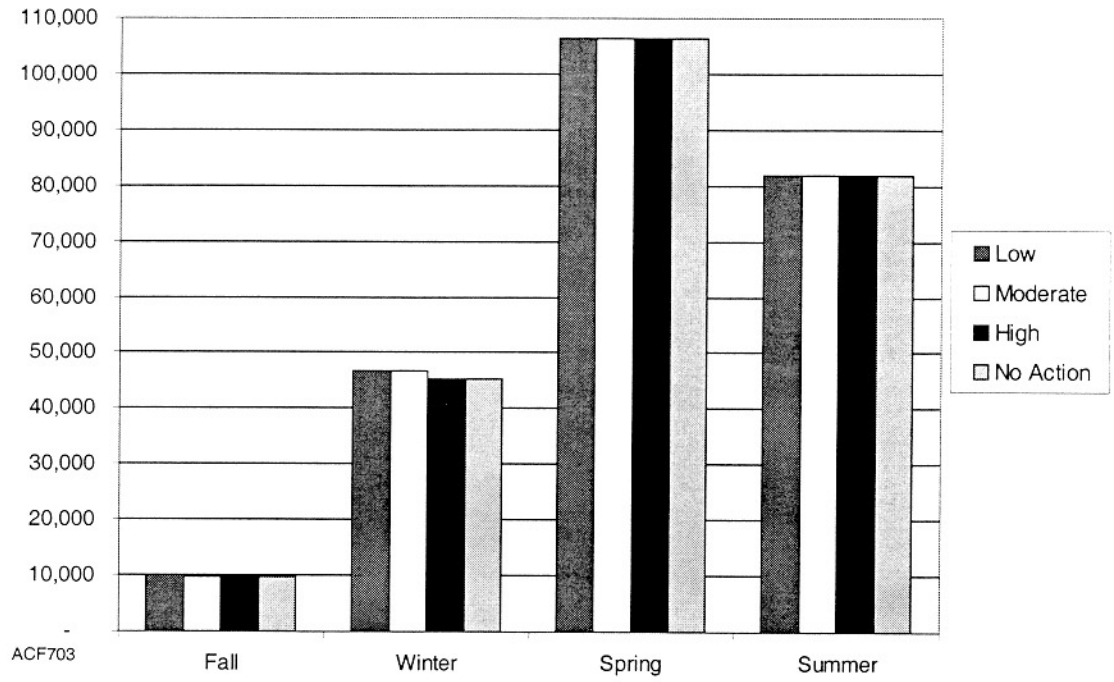
ACF 702

4.7.2.2.1.4 Lake Seminole

Lake Seminole is the fourth most visited reservoir in the basin. Like the other reservoirs, spring and summer are the predominant seasons for recreation use. Comparing the action alternative flow scenarios to no action alternative, recreation visitation would generally be the same for all alternatives in all seasons. *Figure 4-99* compares seasonal recreation visitation for the action alternative flow scenarios and the no action alternative.

Overall in the ACF basin, the low flow scenario provides the most benefit for recreation. This scenario maintains stable reservoir levels, which enhance recreation in the summer, the most popular season. This, in turn, leads to increased recreation visitation over the no action scenario. In contrast, the high flow scenario provides consistent flows in the rivers, which often leads to reduced reservoir levels (depending on the season). Further, the lack of several parameters within the modeling effort (e.g., specific operations for peaking, navigation, or flood control) makes it difficult to reconcile some of the data. For instance, at most of the reservoirs, the high flow scenario looks better in the winter months than it would actually be if the additional parameters were factored into the modeling. In some cases, the low, moderate, and high flow scenarios would experience lower elevations, and therefore, lower visitation, than the model predicts.

FIGURE 4-99
Lake Seminole Comparison of Recreation Trips, 2050 (ACF Basin)



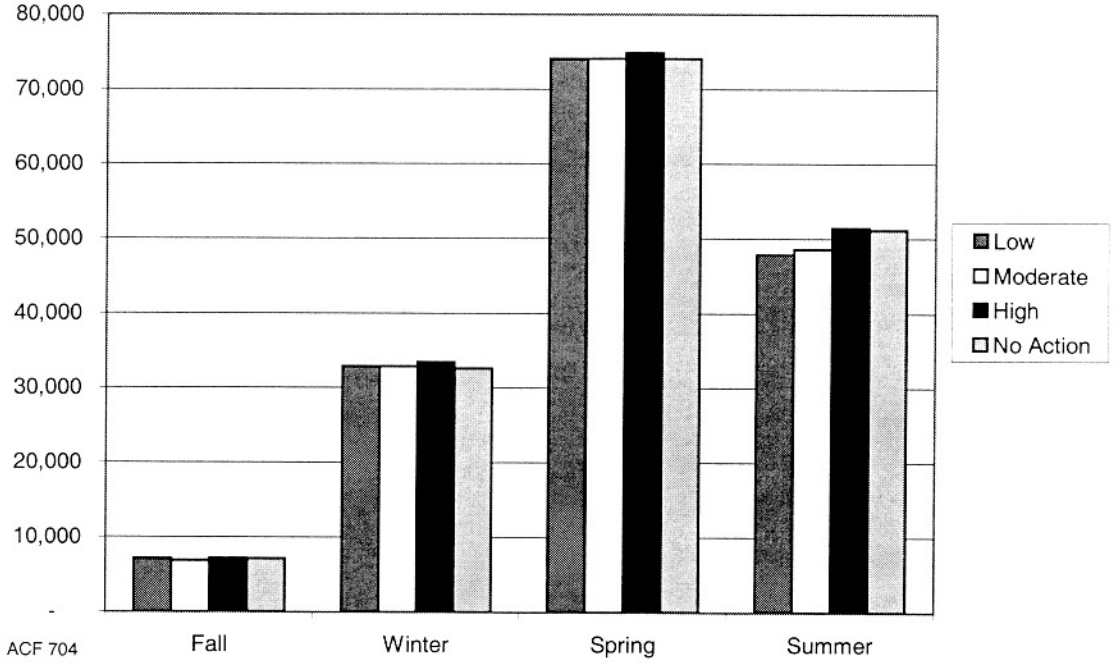
4.7.2.2.2 Riverine Recreation

The model predicts that, under the no action alternative, flows in the Apalachicola River levels would yield just over 100,000 recreation boat trips for 1995. For 2020, visitation would rise by 29 percent to over 131,600 million boat trips. By 2050, visitation would increase over 2020 numbers by 25 percent to nearly 165,000 trips. Winter and spring visitation is predicted to increase by 65 percent; visitation in summer and fall is predicted to increase by 50 to 55 percent.

Comparing the action alternatives, the high flow scenario, which results in higher river flows, would have greater recreation visitation (6 percent more) compared to the moderate flow scenario, which most closely approximates existing conditions. ***Figure 4-100*** compares seasonal recreation visitation for the low, moderate, and high flow scenarios.

In addition to the analysis of the Apalachicola River, flows were analyzed in the Chattahoochee River between Buford Dam and Peachtree Creek within the Chattahoochee River National Recreation Area. Data for determining suitable recreation were obtained from the WES report, which established the relationship between the quality of river recreation and flow conditions in the study area (Corps, 1985).

FIGURE 4-100
Apalachicola River Comparison of Recreation Trips for Action Alternative, 1995



Evaluation of water-based recreation was analyzed by two activity categories: angling and nonangling. In the WES report, several optimal flows were established by using the Physical Habitat Simulation System (PHABSIM) model, which was developed by FWS's Instream Flow Group as a tool to perform instream flow studies. For fish species, PHABSIM is based on the observation that most fish species prefer certain combinations of water depth, velocity, and cover and tend to avoid combinations of these parameters that are not desired. PHABSIM is also used to establish this same relationship for river-borne recreational activities with regard to water depth and velocity. For example, a beginning canoeist requires minimum water depth to float a canoe and minimum water velocity to navigate a boat through the water. Excessive water depths or currents may create hazards for the beginner canoeist. Thus, the hydraulic limits within which a beginner canoeist operates can be described by suitability criteria. Once the relationship between the criteria (the relative value of different depths and velocities for each species or recreational activity) and the hydraulic conditions (for different discharges) is established, the quality of the resource potential for recreational activities at different discharges can be established.

The results of PHABSIM analyses are typically presented in terms of weighted useable area (WUA) per some length of river. WUA is defined as the surface area of river (square feet) available for either a target fish species or recreational activity. *Weighted* refers to the way the area calculation is made. The cell within a cross section of the river, the smallest unit of measure for the analysis, can have a value between zero (no value) and one (maximum value). A weighted value is obtained for each cell in the river cross

section. The final value for each river reach is obtained by summing the cells within the reach.

Optimal flows developed in the WES report are detailed, by activity, in ***Table 4-61***.

TABLE 4-61
Optimal Flows for Recreation Activities in the Chattahoochee River from Buford Dam to Peachtree Creek

Activity	Optimal Flow (cfs)
Novice preferred rafting	1,250-1,750
Novice rafting	3,500-5,000
Wading	1,500
Novice canoeing	1,500-2,000
Mid-level canoeing	Maximum 7,000
Wade fishing	At or below 750
Tube fishing	At or below 1,000
Low-power boat fishing	2,500-5,000
Non-power boat fishing	1,500

Source: Corps, 1985

Table 4-62 provides the minimum flow targets met by HEC-5 modeling of the area between Buford Dam and Peachtree Creek for each of the analysis years and flow alternatives (within the Chattahoochee River National Recreation Area). These data, along with the recreation relationships established for river flow and weighted useable area can be used to determine the effects that the alternative flow conditions could potentially have on riverine recreation.

TABLE 4-62
Modeled Flows in the Chattahoochee River between Buford Dam and Peachtree Creek

	Low Flow (cfs)	Moderate Flow (cfs)	High Flow (cfs)
1995	350	775	1200
2020	350	725	1100
2050	350	680	1010

Source: Corps recreation report in ***Appendix F***

The potential for wade- and tube-fishing peaks at or near 1,000 cubic feet per second (cfs). Therefore, the alternatives modeled would not affect these forms of fishing. The potential for non-boat fishing varies between reaches; however, it peaks at 1,500 cfs. Any flow above this results in a sharp decline in this method of fishing. Therefore, the flows analyzed, although less than optimal, provide adequate flow and water depth. Low-power boat fishing peaks between 2,500 and 5,000 cfs. Flows below the high flow scenarios evaluated would not provide adequate flow and depth for this form of fishing.

Optimal flows for novice canoeing is between 1,500 and 2,000 cfs. Discharges below 1,250 cfs impede canoeing, especially in shoal areas. The weighted usable area for mid-level canoeing increases greatly until 7,000 cfs, then increases at a decreasing rate.

Therefore, the discharges modeled for the various alternatives would not likely provide adequate flow for this recreation activity. The high flow alternatives might allow for this activity with some inconveniences along shoal areas.

The effects of flow alterations on rafting are complex due to the different rafting experiences (rafting, raft landing, and raft take-out). Each of these activities requires a different optimum discharge. Any increase in stream flows will increase the WUA for novice and midlevel rafting. The low flow conditions analyzed will not be conducive for rafting. The WUA peaks at discharges greater than those modeled; however, the moderate and high flow conditions would allow for novice and mid-level rafting as well as raft-landing.

The weighted usable area for wading decreases as discharge increases; therefore, since the alternative conditions analyzed are of lower flows, the discharges modeled would be ideal for this recreation activity.

4.7.3 Economics

The direct economic impacts of implementing a water allocation formula were evaluated by comparing the action alternative flow scenarios to the no action alternative. Modeling was completed by the Corps and focuses on the impacts to municipal and industrial water supply, navigation, electric power generation, agricultural water supply, recreation, and employment. Indirect impacts were determined using the Economic Impact Forecasting System model (EIFS), developed by the U.S. Army Construction Engineering Research Laboratory. For its input, the EIFS model uses the direct economic impacts as changes in spending (see Section 1.3.3.7 and ***Appendix F*** for a description of the economic modeling approach).

4.7.3.1 Affected Environment

This section describes the affected environment, or the baseline conditions, for the economic resources in the ACF basin. Municipal and industrial water demands, navigation, power generation, agriculture, recreation, and flood control are discussed.

4.7.3.1.1 Municipal and Industrial Water Demands

A critical function of the ACF rivers is to supply water. Municipalities draw water from the rivers and reservoir pools for their water supplies. Industrial plants, such as pulp and paper mills and poultry processing operations, use water in their production processes. Recreation-related businesses, such as country clubs, use water to irrigate golf courses. Various state and county parks use water for irrigation and water supply. In many ways, these water uses support local jobs and contribute to the economy. Section 4.4.2 summarizes the municipal and industrial water demands for 1995 developed for the Comprehensive Study.

4.7.3.1.2 Navigation

The federal navigation project for the Apalachicola, Chattahoochee, and Flint Rivers was originally authorized in Section 2 of the River and Harbor Act of 1945, and was further modified by the Water Resources Development Act of 1986 (Public Law 99-662). This legislation provides for a 9-foot by 100-foot navigation channel from Apalachicola, Florida, to the Phoenix City, Alabama/Columbus, Georgia, area on the Chattahoochee River and to Bainbridge, Georgia, on the Flint River. Channel dimensions are provided by dredging, cutoffs, training works or other open-river methods; a series of locks and dams; and flow regulation from upstream storage projects.

The commercial traffic in the ACF basin is almost entirely related to the movement of local natural resources. The majority of the commerce that moves on the waterway is sand and gravel, which is dredged from river and lake bottoms. The remaining commerce in the ACF basin includes agricultural chemicals, petroleum products, and limited amounts of industrial chemicals, asphalt, wood products, and cotton seeds. The most recent data from the Corps' Waterborne Commerce Statistics Center (WCSC) indicate that about 10 percent of the traffic in the basin is outbound, approximately 50 percent is inbound, and the remainder is internal to the waterway.

Traffic volume on the waterways in the ACF basin has been decreasing. Interviews with users indicate that the decline in traffic volume in the late 1980s was largely related to the series of droughts that adversely affected both the agricultural industry and navigation

channel conditions. Persistent channel problems since that time have been attributed to a process of degradation or lowering of the channel bottom below Woodruff Lock and Dam. Shippers also stated that Florida's comparatively stringent water pollution regulations have discouraged the movement of petroleum products and, in particular, fuel oil, which has not moved on the waterway since 1993. Nonetheless, petroleum products still comprise 18 percent of the traffic on the ACF rivers. Along with sand and gravel (44 percent), a significant portion (28 percent) of traffic in the ACF basin contains agricultural chemicals (fertilizers). ***Table 4-63*** shows waterborne commerce in tonnage in 1995.

TABLE 4-63
ACF Rivers Waterborne Commerce

Commodity	1995 Projected Tonnage
Farm products	21,000
Forest products	2,000
Sand and gravel	261,000
Chemicals	28,000
Fertilizers	166,000
Petroleum products	108,000
All others	2,000
Total	**588,000**

[a] Rounded to the nearest thousand

Source: Institute of Water Resources, 1997

4.7.3.1.3 Power Generation

The ACF rivers are heavily developed for hydropower generation. The power resources serve residential, commercial, agricultural, and industrial users. Some of the agricultural and industrial users are dependent on economical power sources for continued operations. Hydropower facilities in the basin are operated by private power companies, municipalities, and the Corps. Georgia Power Company is the primary private operator in the ACF basin.

The ACF basin's electrical power resource is dominated by thermal (steam) generation. Thermal and hydroelectric resources are 69 percent of the total. Sixty percent is steam turbine, 26 percent is nuclear power, 10 percent is hydropower, and 5 percent is combustion turbine (percentages do not add to 100 because of rounding). Net annual energy demand for 1995 was estimated to be 48,199,131 megawatt hours (MWh). Private utilities produce approximately 50 percent (316 megawatts [MW]) of the megawatts generated through hydropower; the remainder of hydropower generation occurs at federal projects. All energy produced by steam and combustion turbines (4,303 MW) and nuclear power (1,720 megawatts) in the ACF basin is generated at facilities owned by private entities. ***Table 4-64*** presents the mainstem dams/reservoirs, the owner, and the total power capacity.

TABLE 4-64
Operative Main Stem Dams/Reservoirs in the ACF Basin

River/Project Name	Owner	Total Capacity[a] (MW)
Chattahoochee River		
Buford Dam/Lake Lanier	Corps	100
Morgan Falls Dam	GPC	17
West Point Dam and Lake	Corps	82
Langdale Dam	GPC	1[b]
Riverview Dam	GPC	0.5[b]
Bartletts Ferry Dam	GPC	192
Goat Rock Dam	GPC	26
Oliver Dam	GPC	60
North Highlands Dam	GPC	36
Eagle and Phenix Dam	Consolidated Hydro	4[b]
W. F. George Lock and Dam and Lake	Corps	160
George W. Andrews Lock and Dam and Lake	Corps	None
Flint River		
Blackshear Dam and Lake	Crisp County	13[b]
Flint River Dam/Lake Worth	GPC	5[b]
Apalachicola River		
Jim Woodruff Lock and Dam/Lake Seminole	Corps	36
Total		654.9

[a] Overload capacity represents maximum power generation capability of units.

[b] These values are nameplate capacity, or full-load continuous rating of generators.

GPC Georgia Power Company

Source: ***Appendix D***; Slater, 1990

The Southern Subregion of the Southeastern Electrical Reliability Council (SERC) and the larger North American Electric Reliability Council (NERC) consists of three control areas, i.e., areas controlled by Alabama Electric Cooperative, South Mississippi Electric Power Association, and the Southern Company. (The Southern Company has five operating companies: Alabama Power Company, Georgia Power Company, Gulf Power Company, Mississippi Power Company, and Savannah Electric and Power Company.) SERC collects monthly peak hour demand data and net energy for the Southern Subregion. Each utility's peak hour demand and net energy were aggregated for each month. Then a summer and winter peak hour demand was identified by the month with the highest peak in each season. The net annual energy is the summation of the aggregated monthly net energies. Peak hour demand (MW) and net annual energy (MWh) for the Southern Subregion are presented in ***Table 4-65*** (Corps, unpublished draft).

TABLE 4-65
Peak Hour Demand (MH) and Net Annual Energy (MWh), Southern Subregion

Year	Gross National Product (1987 Dollars), billion	Peak Hour Demand (MW)	Net Annual Energy (MWh)	Demand Change (Percent)	Energy Change (Percent)	Load Factor
1995	$ 5,354	35,098	180,234	2.58	0.35	0.59

4.7.3.1.4 Agricultural Water Supply

Agriculture is a vital component of the regional economy and, therefore, the availability of adequate water supplies for agricultural purposes is important. According to the U.S. Census, in 1990 approximately 40,500 people in Alabama were employed in the agriculture, forestry, or fisheries industries; in Florida, this figure was 167,418; in Georgia 73,647. Potential shortages in meeting agricultural water demands could result in significant economic impacts in portions of the ACF basin. Section 4.4.2 summarizes the 1995 agricultural water demands for the basin.

4.7.3.1.5 Flood Control

Flood control has long been an important focus of the Corps and the reservoirs it operates. Within the ACF basin, Lake Lanier and West Point Lake provide important flood control storage with spillway capacities sufficient to discharge floods with return intervals of 500 years.

The 500-year floodplain south of Lake Lanier extends through Forsyth, Gwinnett, Fulton, and Cobb Counties. The floodplain begins at Buford Dam and concludes down-river of the Chattahoochee River's confluence with Peachtree Creek. At the maximum flood control pool elevation of 1,085, the lake has an area of 47,182 acres and a gross capacity of 2,554,000 acre-feet, of which 637,000 acre-feet is reserved for flood control storage.

The floodplain south of the Buford Dam consists of 5,108 residential structures (2,401 houses and 1,877 apartment homes), 16 public structures, and 218 commercial structures. Tax assessor-appraised residential structure values range from a $5,000 trailer to several $1.4 million homes, with a floodplain total residential structure value of $1 billion. Residential structure content values are estimated to total $466 million. Public structures in the floodplain have a total value of $30.6 million. The structures range in value from a $7,500 storage building to a $14 million water treatment plant. Public structure inventory and equipment values total $19.7 million and $5.6 million, respectively. The floodplain tax-appraised commercial structure values range from a $2,500 storage building to a $23 million power plant, with a floodplain total commercial value of $109.2 million. Commercial structure inventory and equipment values total $34.2 million and $208.6 million, respectively. The total land value in the floodplain below Buford Dam is approximately $1,874 million.

West Point Lake, located at the Georgia-Alabama state line, has a 500-year floodplain that incorporates areas of Troup and Harris Counties in Georgia and Chambers County, Alabama. At the maximum flood control pool elevation of 638 feet, the lake has a gross capacity of 685,801 acre-feet, of which 302,294 acre-feet is reserved for flood control storage.

The floodplain south of the West Point Lake Dam consists of 171 residential structures, 18 public structures, and 220 commercial structures. Tax assessor-appraised residential structure values range from $2,500 to $130,000, with a floodplain total residential structure value of $5.3 million. Residential structure content values range from $1,000 to $58,000, with a total floodplain value of $2.3 million. Public structures in the West Point floodplain have a total value of $2.6 million. The value of the structures range from $1,000 for a storage building to several $500,000 municipal buildings. Public structure inventory equipment values total $893,000 and $2 million, respectively. The floodplain tax-appraised commercial structures have a total value of $28.4 million, with structure values ranging from a $1,250 storage building to a $3.9 million industrial plant. Commercial structure inventory and equipment values total $60 million and $88.8 million, respectively. The total value of property in the floodplain below West Point Lake Dam is approximately $130 million.

The Water Management Office (EN-HW) of the Corps has developed an *Annual Damage Reduction Summary* that estimates the flood damages prevented by two projects in the ACF basin: West Point Lake and Buford Dam (Lake Sydney Lanier). The cumulative flood damages prevented by West Point Lake through 1996 were estimated to be $299,733. It was estimated that the Lake Lanier project prevented cumulative damages of approximately $34.2 million through 1996.

4.7.3.1.6 Fish and Wildlife Utilization

In 1995, the total commercial fishery landings in Florida were approximately $198 million, or 27 percent of the $724.6 million generated in the Gulf of Mexico (U.S. Department of Commerce, 1996a). In 1995, commercial fishery landings at Apalachicola, Florida, were valued at $10.2 million, or 5 percent of the total landings in the State. However, both state and local fisheries fluctuate considerably from year to year based on climatic conditions, normal variations in biological productivity, and numbers and effectiveness of commercial operators. For example, in Apalachicola, in recent years, the value of landings have varied from $7.9 million in 1993 to $22.4 million in 1994 and back again to $14.1 million in 1996. Franklin County, which includes most of the Apalachicola Bay and drainage system, has a very high economic dependence on the commercial fisheries in the area (Livingston, 1983).

The most commercially important species included shrimp, menhaden, blue crab, snapper, grouper, and oysters (U.S. Department of Commerce, 1996b). Recreational fishing in the Gulf of Mexico accounts for 25 percent of the total number of trips in the United States. The most commonly caught nonbait species were spotted seatrout, pinfish, saltwater catfish, and striped bass. The economic value of wildlife that use the basin has not been quantified but is expected to represent significant direct value for recreational hunting and other uses.

4.7.3.1.7 Recreation Economics

The Phase I survey, completed in conjunction with the Comprehensive Study (Allen et al., 1997), estimated spending at the eight study projects in ACF. Because the survey was restricted to registered boaters, per-trip spending estimates were probably higher than those for the entire population of recreation users. Other recreation studies have shown that boaters have higher per-trip expenditures and higher levels of discretionary spending than non-boaters.

The Phase I survey used to gather information on expenditures consisted of 1) a pre-mailer kit including an introductory letter and boat use and expenditures worksheet, and 2) a telephone interview. A total of 2,000 interviews were completed for the area of the ACT and

ACF basins. The survey collected information expenses for an average trip to the project visited most often.

Information gathered for the Phase I survey indicated that boat owners spent a total of $338.9 million dollars in 1995 during their trips to the projects in the ACF basin, with $145.9 million dollars contributed directly to the projects' local economies. These expenditures included such items as gas, meals and lodging, fees, and groceries, but did not include expenditures for boats. Two types of expenditures were reported: those made inside a 30-mile radius of the project (local) and those made outside a 30-mile radius.

Per-visit National Economic Development (NED) benefits were also developed. These benefits measure consumer surplus, or the difference between the maximum amount someone will pay for a resource and the actual price paid. Travel cost models, based on observed behavior, provide a means of estimating NED benefits. Travel cost analysis can be used to estimate a demand curve, which shows the relationship between price and quantity demanded. Since nearby visitors face a lower cost for travel-related expenses, they are expected to visit more frequently than those who live a greater distance. The relationship between visitation rates and the travel costs from different zones or areas are used to calculate consumer surplus, or NED benefits.

Table 4-66 presents local and total per-trip spending, total annual spending, per-trip NED benefits, and total annual NED benefits for the eight study reservoirs in the ACF basin.

Annual spending was highest at Lake Lanier, both within the local economy ($63 million) and in total ($161 million). Average trip expenditures were highest for the Apalachicola River, at $203.20 per trip. The NED benefit per trip was highest at Lake George W. Andrews ($41.82); the total annual NED benefit was highest at Lake Lanier ($21.8 million).

TABLE 4-66
Local and Total Per-Trip Spending, Total Annual Spending, Per-Trip National Economic Development (NED) Benefits, and Total Annual NED Benefits

Project	Total Trips	Local Spending Per Trip	Total Spending Per Trip	Total Annual Spending	NED Benefits Per Trip	Total Annual NED Benefits
Lake Sidney Lanier	862,332	$72.50	$187.20	$161,428,550	$25.29	$21,808,376
West Point Lake	260,369	$58.60	$119.30	$31,062,021	$21.90	$5,702,081
Bartlett's Ferry	102,995	$81.80	$120.40	$12,400,598	$33.00	$3,397,515
Lake Oliver	37,132	$17.00	$39.60	$1,470,427	$14.09	$523,190
Lake Walter F. George	353,534	$65.60	$117.50	$41,540,245	$23.76	$8,399,968
Lake George W. Andrews	13,551	$12.00	$49.40	$669,419	$41.82	$566,703
Lake Seminole	148,703	$49.30	$75.60	$11,241,947	$24.92	$3,705,679
Apalachicola River	102,103	$53.60	$203.20	$20,747,329	$28.32	$2,891,557
Total				**$280,560,536**		**$46,995,069**

Note: The accuracy of the per-trip expenditures vary with the number of responses received per recreation area and the ability of the respondent to correctly remember and report expenses for an average trip.

Source: Perr, 1997; ***Appendix F***

4.7.3.1.8 Income

According to estimates prepared for the Comprehensive Study, total personal income in the 59-county ACF basin was nearly $93.2 billion in 1995, almost double the 1985 total personal income of $47.6 billion (*Table 4-67*). Personal income includes both wage (labor) and non-wage income, such as dividends, interest, and transfer payments.

TABLE 4-67
Total Personal Income in the ACF Basin

	1985	1995 (estimated)
Alabama portion of basin	$2,896,000,000	**$5,437,000,000**
Florida portion of basin	$986,000,000	**$1,999,000,000**
Georgia portion of basin	$43,747,000,000	**$85,749,000,000**
ACF basin	$47,629,000,000	**$93,185,000,000**

Source: DRI/McGraw-Hill, 1996

Per capita personal income is the total personal income in an area, divided by the number of people living there. A comparison of real per capita personal income (in 1987 dollars, to adjust for inflation) in the ACF basin shows steady growth, at an average of 3.1 percent annually from 1975 to 1985 but slowing to 1.4 percent annually from 1985 to 1995 (*Table 4-68*).

Real per capita income has historically been higher in the Georgia portion of the ACF basin than in the Alabama or Florida portions, and has tended to exceed per capita income statewide as well. The Georgia portion of the basin includes much of the counties surrounding metropolitan Atlanta, as well as Columbus and Albany. Per capita incomes are the lowest in the Florida portion of the ACF basin. The Florida portion is largely rural (dominated by Gulf of Mexico beachfront and the Apalachicola National Forest) but is influenced by Tallahassee, the capital of Florida. The Alabama portion of the ACF basin is mostly influenced by the Dothan metropolitan area, which includes Fort Rucker. Incomes in both the Florida and Alabama portions tend to be lower than overall per capita income in their respective states (*Table 4-68*).

TABLE 4-68
Real Per Capita Income Trends in the ACF Basin[a]

	1975	Annual Average 1975-1985	1985	Annual Average 1985-1995	1995[b]
Alabama portion of basin	$8,589	2.7%	$10,919	1.8%	$12,889
Florida portion of basin	$7,477	2.3%	$9,217	2.4%	$11,446
Georgia portion of basin	$11,823	3.1%	$15,446	1.4%	$17,546
ACF basin	$11,357	3.1%	$14,862	1.4%	$16,994
Alabama	$9,518	2.3%	$11,706	2.0%	$13,997
Florida	$11,887	2.7%	$15,094	1.1%	$16,756
Georgia	$10,428	3.2%	$13,717	1.5%	$15,730

[a] To adjust for inflation in annual comparisons, all dollar values are adjusted to 1987 equivalents.
[b] Estimated values

Source: DRI/McGraw-Hill, 1996

In current dollars, 1995 per capita income was estimated to be $22,831 in the ACF basin as a whole, or $23,570 in the Georgia portion, $15,345 in the Florida portion, and $17,287 in the Alabama portion.

4.7.3.1.9 Employment

In 1995, according to the Comprehensive Study, total employment in the ACF basin was nearly 2.1 million non-farm jobs. The Georgia portion of the basin accounts for 92 percent of total non-farm employment in the ACF basin, while the Alabama and Florida portions account for only 6 percent and 2 percent, respectively.

Employment levels in the ACF basin showed strong growth between 1975 and 1985, at an average of 5.5 percent per year. Between 1985 and 1995, employment in the ACF basin slowed down (2.6 percent annual average), specifically in the Georgia and Alabama portions, but increased in the tiny Florida portion of the basin (*Table 4-69*). The employment growth rate in the ACF basin outpaced employment growth in the rest of the State of Georgia, but did not increase as fast as the rest of the State of Florida.

TABLE 4-69
Employment Trends in the ACF Basin[a]

	1975 Employment	Annual Average 1975-1985	1985 Employment	Annual Average 1985-1995	1995 Employment[b]
Alabama portion of basin	76,480	3.1%	100,090	2.8%	128,143
Florida portion of basin	25,581	1.9%	30,548	2.7%	38,842
Georgia portion of basin	946,900	5.8%	1,499,542	2.6%	1,892,304
ACF basin	1,050,961	5.5%	1,630,179	2.6%	2,059,288
Alabama	1,155,445	2.4%	1,427,114	2.3%	1,762,052
Florida	2,746,642	6.1%	4,409,497	3.3%	5,873,725
Georgia	1,755,674	4.6%	2,569,502	2.5%	3,213,460

[a] Total nonfarm employment
[b] Estimated values
Source: DRI/McGraw-Hill, 1996

More than 84 percent of all jobs in the ACF basin are provided by the private sector (*Table 4-70*). The primary sources of employment are wholesale and retail trade, which provided an estimated 26.5 percent and 26.3 percent, respectively, of all jobs in 1995. The government, which includes the state capitals and municipal centers of Atlanta and Tallahassee as well as four Army installations in Georgia and Alabama, employed 15.8 percent of all workers in 1995. Because Tallahassee is the only major employment center in the Florida portion of the ACF basin, the government sector dominates there.

Manufacturing, also an important part of the regional economy with 13.3 percent of non-farm jobs in 1995, is much more important to the Alabama portion of the basin than to the other portions. However, the manufacturing sector has been shrinking in the ACF basin, having fallen from 19.9 percent of non-farm jobs in 1975, to 17.7 percent in 1985, to 13.3 percent in 1995.

TABLE 4-70
Nonfarm Employment by Industry in the ACF Basin, 1995[a]

	Alabama Portion of Basin		Florida Portion of Basin		Georgia Portion of Basin		ACF Basin	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total Nonfarm Employment	**128,143**	**100**	**38,842**	**100.0**	**1,892,304**	**100.0**	**2,059,288**	**100**
Mining	110	0.1	290	0.7	1,129	0.1	1,529	0.1
Construction	5,769	4.5	1,439	3.7	82,537	4.4	89,744	4.4
Manufacturing	34,493	26.9	4,886	12.6	234,680	12.4	274,059	13.3
Transportation and public utilities	6,828	5.3	1,303	3.4	145,647	7.7	153,777	7.5
Wholesale and retail trade	29,928	23.4	8,843	22.8	506,867	26.8	545,638	26.5
Finance, insurance, and real estate	3,931	3.1	1,033	2.7	123,026	6.5	127,990	6.2
Services	21,915	17.1	5,725	14.7	513,930	27.2	541,570	26.3
Private Sector Subtotal	**102,974**	**80.4**	**23,519**	**60.6**	**1,607,816**	**85.0**	**1,734,307**	**84.2**
Government	25,169	19.6	15,323	39.4	284,489	15.0	324,981	15.8

[a] Estimated values

Source: DRI/McGraw-Hill, 1996

4.7.3.2 Environmental Consequences

4.7.3.2.1 Municipal and Industrial Water Supply

This section presents economic impacts resulting from municipal and industrial (M&I) supplies associated with the water allocation scenarios. The analysis of existing and expected future water demand and an analysis of alternative scenarios under which M&I may be impacted are presented in Section 4.4.1.2.

This analysis, to the extent possible, addresses direct economic impacts (also referred to as NED impacts) only. The extent to which this analysis addresses NED impacts is limited by lack of information on alternative water supply sources. To identify the actual NED impact, the costs associated with alternatives to the resource would be developed and compared to the quantified risk of using the current resource. The difference between the two costs would then represent the NED impact. As a result, this analysis displays and refers to impact figures that represent the maximum willingness to pay to avoid the risk of shortage.

To summarize and annualize the impacts of water shortage risk, impacts are presented here in both net present value (NPV) and equivalent annual cost (EAC) terms at the state and basin levels. ***Table 4-71*** summarizes aggregate impacts for each scenario for the entire basin for 1995, 2020, and 2050. The last two columns present impacts in NPV and EAC terms, respectively.

The economic value of the projected shortages under the low flow scenario would be $5.5 million (average annual equivalent) more than the moderate flow scenario. The economic value under the high flow scenario would be $6.9 million less than the moderate flow scenario. The economic numbers are presented in ***Table 4-71***. The majority of impacted areas for all three scenarios are concentrated in the headwaters area of the ACF basin. Impacts above Columbus on the Chattahoochee are much more substantial than those below Columbus, Georgia. There are few notable impacts on the Flint system. Based on the analysis, Cobb, Dekalb, Fulton, Hall, and Paulding counties would experience the greatest economic impact caused by shortages. Full details on this analysis can be found in ***Appendix F***.

TABLE 4-71
Economic Impact of Action Alternative Flow Scenarios, ACF

Scenario	1995	2020	2050	Net Present Value	Average Annual Equivalent
Low Flow	($7,734,600)	($13,200,600)	($18,123,600)	($184,070,598)	($13,419,500)
Mod. Flow	($5,169,000)	($6,895,800)	($9,448,200)	($109,238,291)	($7,963,800)
High Flow	($934,800)	($517,200)	($433,200)	($14,392,472)	($1,049,300)

Source: Municipal and Industrial Water Supply Report in ***Appendix F***

Table 4-72 displays a summary of impacts by state. The values represent a year's impact. Since the headwaters of the basin are concentrated in Georgia, that state is expected to experience the majority of the impacts.

TABLE 4-72
Economic Impacts by State for Action Alternative Flow Scenarios

State	Scenario	1995	2020	2050	Net Present Value	Average Annual Equivalent
Alabama	Low	($289,200)	($331,800)	($309,600)	($4,520,346)	($329,500)
	Moderate	($198,000)	($214,200)	($188,400)	($3,000,842)	($218,700)
	High	$0	$0	$0	$0	$0
Florida	Low	($3,600)	($7,200)	($10,200)	($79,123)	($5,700)
	Moderate	($3,000)	($4,200)	($4,800)	($52,552)	($3,800)
	High	$0	$0	$0	$0	$0
Georgia	Low	($8,809,800)	($15,702,000)	($20,654,400)	($179,087,248)	($13,056,300)
	Moderate	($5,888,400)	($8,507,400)	($11,089,200)	($105,987,775)	($7,726,900)
	High	($1,165,200)	($758,400)	($674,400)	($14,392,472)	($1,049,300)

No significant economic impacts to water supply for M&I were identified. Results of the hydrologic modeling and the risk-based analysis of water supply shortages show that there were only small, seasonal shortages expected to occur for all of the action alternative flow scenarios.

As might be expected, the low flow scenario has the greater impact across the basin, with an Average Annual Equivalent adverse impact of $13.4 million. The moderate flow scenario is expected to result in a $8.0 million adverse impact. The high flow scenario is expected to result in an adverse impact of approximately $1.0 million. The vast majority of impacted areas for all three scenarios are concentrated in the headwaters area of the ACF basin. Impacts above Columbus on the Chattahoochee are much more substantial than those below Columbus. There are few notable impacts on the Flint system.

4.7.3.2.2 Navigation

The evaluation of navigation impacts was completed by the Corps and summarized in a separate report (***Appendix F***). The following section provides a summary of this analysis.

Results of the HEC-5 modeling described in Section 4.4 were used to determine the percent of time depth would be available for navigation on the lower Apalachicola River. Availability of four navigation depths, including 9 feet (full navigation), 8.5 feet, 8.0 feet, and 7.5 feet, were determined for the action alternative scenarios of high, moderate, and low flow, respectively. These statistics are provided for each month to address the seasonal trends that occur yearly during wet and dry periods.

The annual commodity forecasts were also determined and seasonally apportioned by month on the basis of past patterns, as extracted from the Lock Performance Monitoring System records (Corps' National Inland Waterways Lock Statistics database). Annual commodity forecasts from the Navigation Element of the Comprehensive Study are summarized in ***Table 4-73*** for the years 1995, 2020, and 2050. To evaluate cost impacts associated with lack of available river depth, transportation costs for each commodity were developed on the assumption that commodities that could not be shipped by water because of inadequate navigation depths would have to be shipped by other methods (***Appendix F***). These transportation costs were estimated for each year in the HEC-5 period of record (1939 to 1993) and converted to an annual average value. This approach was used to determine average yearly transportation costs for the no action and action alternative scenarios (***Table 4-74***).

TABLE 4-73
Annual Commodity Forecasts, Short Tons

	Farm Products	Metals & Ores	Non-Metallic	Forest Products	Industrial Chemicals	Agricultural Chemicals	Petroleum Products	Commodity Total
1995	10,267	1,200	307,933	2,867	38,000	148,133	103,133	611,533
2020	15,675	2,455	310,366	5,629	49,045	237,511	153,867	768,919
2050	23,766	4,726	298,861	10,513	60,660	388,868	255,816	1,032,697

Source: Comprehensive Study, Navigation Element

TABLE 4-74
Average Yearly Transportation Costs

Year	No Action	Action Alternative		
		High Flow	Moderate Flow	Low Flow
1995	$4,439,831	$4,656,240	$4,642,425	$4,599,973
2020	$6,332,281	$6,559,778	$6,497,686	$6,490,238
2050	$9,497,502	$9,802,260	$9,694,120	$9,699,698

The annual direct impacts on navigation were estimated by determining the difference between the no action and action alternative flow scenario average annual shipping costs (*Table 4-75*). Direct navigation impacts are assumed to be distributed to the States of Alabama, Georgia, and Florida based on the number of counties serviced by the waterway in each state. This distribution is used in the analysis of impacts on employment and income. Results of this analysis indicate that the economic impacts associated with the alternatives are small compared to total transportation costs. Impacts ranged from 2.5 percent ($157,957) in transportation costs for the no action alternative under the low flow scenario in 2020 to 3.2 percent ($304,758) for the high flow 2050 flow scenario.

TABLE 4-75
Direct Impacts on Navigation

	High Flow	Moderate Flow	Low Flow
1995	($216,409)	($202,594)	($160,142)
2020	($227,497)	($165,405)	($157,957)
2050	($304,758)	($196,617)	($202,196)
Average annual	($228,815)	($182,309)	($162,065)

4.7.3.2.3 Power Generation

The power values of the ACF hydropower projects were based on the detailed analysis of two separate years. Because the benefit analysis was based on hourly data, it was not practical to run simulations for all 55 years of historic data. The analysis assumes that the water conditions in 1992 represent an "average" year, and energy generation in this year is assumed to represent the average annual condition.

Tables 4-76, 4-77, and *4-78* present the overall direct impacts in the ACF basin for all hydropower projects. Average annual direct impacts were negative $300,606; negative $357,058; and negative $495,403 for the high, moderate, and low flow scenarios, respectively. These impacts are assumed to occur proportionately across the states of Alabama, Florida, and Georgia, at negative $100,202 for high flow; negative $119,019 for moderate flow; and negative $165,135 for low flow impacts. This assumption is supported by the fact that the power goes to the marketing agency that primarily serves preference customers in the three states for all the projects, whether they are in Alabama, Florida, or Georgia.

TABLE 4-76
ACF Average Annual Energy Production (MWh)

	No Action	High Flow	Moderate Flow	Low Flow
1995	2,016,172	2,000,302	2,004,559	2,000,910
2020	1,980,243	1,972,870	1,967,231	1,962,034
2050	1,948,208	1,944,110	1,935,537	1,927,211

TABLE 4-77
ACF Average Annual Energy Loss (MWh)

	High Flow	Moderate Flow	Low Flow
1995	-15,870	-11,613	-15,262
2020	-7,372	-13,012	-18,209
2050	-4,098	-12,670	-20,996

TABLE 4-78
ACF Average Annual Energy Direct Impacts (1998 $)

	High Flow	Moderate Flow	Low Flow
1995	($455,623)	($333,408)	($438,166)
2020	($211,653)	($373,549)	($522,763)
2050	($117,652)	($363,752)	($602,790)
Average annual	($300,606)	($357,058)	($495,403)

Generally, the high flow scenario produced greater hydropower benefits than the other scenarios because it had slightly more flow because of lower consumptive demands. The high flow scenario also did not have a seasonal drawdown for flood control, which would reduce the net available head for energy production.

In many cases, the moderate and low flow results are similar as the low flow had slightly less available flow because of the use of higher consumptive demands, while the moderate flow scenario had slightly lower heads because of higher minimum flow release requirements. The two factors tended to balance one another.

The above impacts on energy generated in the basin do not capture all of the potential impacts (e.g., capacity issues) on power generation. For example, a signification portion of the revenue collected by the Federal Government through the Federal Power Program is capacity based. Capacity reductions can occur as a result of lower flows. While flows may be available for thermal generation, a plant's intake may not function because of its elevation during unusually low flow periods. Since steam plants are an integral part of the electrical system in the Southeast, the stability of the electrical system could become an issue if low flows caused any one or more of these plants to shut down. Further,

transmission restraints may prevent additional energy from simply being purchased from off-system. *Appendix F*, Section 4, presents additional information on impacts on power generation that are expected to result under the action alternative flow scenarios, along with information on the limitations of the modeling.

4.7.3.2.4 Agricultural Water Supply

The evaluation of potential economic affects on the agricultural water supply was completed by NRCS, based on the studies completed by NRSC during the Comprehensive Study and a review of potential water supply shortages developed by the Corps (Section 4.4.2.3). Any water supply shortages identified for agriculture were to be used to estimate potential economic impacts based on crop damage data developed during the Comprehensive Study. The methodology to estimate crop damage was designed to identify the loss of yield and associated income with the decreasing availability of irrigation water during key plant growth stages for major crops in the basin. *Appendix F* includes the agricultural impact report prepared by the NRCS and the Municipal and Industrial Water Supply report developed by the Corps which provide detailed descriptions of the methodology used to assess agricultural water supply impacts.

Under all alternative scenarios (no action and action alternatives), no impacts from water supply shortages were identified for agricultural irrigation needs. The HEC-5 model used to develop the water supply shortage estimates focuses on water withdrawn from the primary rivers in the ACF basin. Because over 80 percent of all agricultural water supply used in the lower Flint River planning area of the ACF basin is supplied by groundwater, shortages in meeting agricultural water supply needs would not be expected. Consequently, the limited amount of surface water used for agricultural purposes in the ACF basin are met under all the alternatives. No significant impacts on agricultural production and income are expected under any of the alternatives, and, therefore, no economic effects would occur.

4.7.3.2.5 Flood Control

The no action and the action alternative flow scenarios hold permanent flood control storage allocations constant. Since the alternatives all preserve the permanent flood control allocations, flood control impacts are zero for the action alternatives, as compared to the no action alternative. The high flow alternative flow scenario assumes that seasonal drawdowns are eliminated. No evaluation of the impacts associated with this operating approach has been performed.

By examining the impacts (damages) that would arise from eliminating this storage, an estimate of the value the existing allocations provide can be calculated. For the ACF basin, the impacts of eliminating permanent flood control storage at Lake Lanier and West Point Lake were examined. The total average annual impact of decreasing the existing storage allocation to zero is estimated to be ($51,246,500) at Lake Lanier and ($5,085,090) at West Point Lake and depends on the extent of flood flows in the period under review. These impacts represent damages that would occur to property located in the floodplain downstream of Buford Dam (at Lake Lanier) and West Point Lake Dam.

Additional detail of the Economic Analysis Section's broad-brush analysis of flood control impacts is included in *Appendix F*.

4.7.3.2.6 Fish and Wildlife Utilization

The economic benefits of fisheries and wildlife uses in the basin show wide-ranging fluctuations that follow natural events related to predation, climate, land use changes, and natural resource management in the region. No detailed economic analysis has been completed for the range of species that might be affected under either the no action or action alternative flow scenarios. However, as discussed in the previous Biological Resources sections, action alternative flow scenarios that reduce available habitat area or use for these resources may be expected to include parallel impacts on the economic attributes of these species. Thus, the low flow scenario would afford positive economic benefits to recreational uses of reservoir fisheries but would have a negative impact on benefits that might be provided for downstream fisheries, such as trout fishing. Conversely, the high flow scenario would be expected to have a negative economic impact on recreational fishing in reservoirs.

The impacts of these alternatives on the commercial and recreational fish and shellfish uses of the Apalachicola Bay have not been specifically evaluated for this programmatic EIS. Additional analyses were completed for oysters in the Bay, which represent a significant commercial crop for the region and the nation (90 percent of the state's oyster fishery and 10 percent of the U.S. oyster fishery). Losses of some of these populations in some areas of Apalachicola Bay have been estimated to reach as high as 50 percent under certain conditions of critical low flows with the low flow scenario. Negative impacts on the oyster fishery in Apalachicola Bay could have substantial local economic effects.

4.7.3.2.7 Recreation Economics

The following is a discussion of the development of the direct economic impacts for ACF projects. It should be noted, however, that Bartlett's Ferry, Lake Oliver, and Lake George W. Andrews were modeled in the HEC-5 program as run-of-river projects. Therefore, the pool elevation at these projects will remain constant, and a water allocation formula applied to the basin will not affect the pool elevation at these reservoirs. As a result, these projects were not included in the determination of direct economic impacts to recreation resulting from implementation of a water allocation formula.

Examination of the results of the ACF recreation summary analysis (***Table 4-79***) shows that the action scenarios all have higher economic benefits than the no action alternative. The pattern shows decreasing or equal positive impacts from the low to moderate conditions, and increasing positive impacts from the moderate to high flow conditions.

The low flow scenario emphasizes maximum water conservation, thus higher pool levels. Average annual benefits under this scenario were higher than the no action alternative and slightly higher than the moderate flow scenario, which most closely approximates existing conditions.

Recreation benefits under the high flow scenario were about 5 percent less than the moderate flow scenario, but significantly higher than the no action alternative. Two factors resulted in benefits being higher than the no action alternative. The first factor, which resulted in lower lake levels, was the high downstream minimum flow target. The second factor was not including the seasonal drawdown for flood control in the modeling, which caused average annual lake levels to be higher than would expected.

For run-of-the-river and river projects, there was no seasonal drawdown of the reservoirs. Therefore, as the minimum flow release was increased from the low to moderate to high scenarios, there were decreasing positive impacts as lake levels or flow decreased.

TABLE 4-79
Recreation Economic Values ACF Basin

		Action Alternative		
	No Action Alternative	High Flow Scenario	Moderate Flow Scenario	Low Flow Scenario
Year	Recreation Value ($)	Recreation Value ($)	Recreation Value ($)	Recreation Value ($)
1995	45,313,169	49,425,590	52,268,119	53,287,406
2020	56,502,967	63,760,514	66,706,766	68,454,983
2050	70,751,775	81,519,329	84,280,539	86,997,310

Source: Corps recreation report in ***Appendix F***

A summary of the direct economic impacts to the ACF basin by state is displayed in *Table 4-80*.

TABLE 4-80
Impact Summary Annual Average, ACF Basin

State	Low ($)	Moderate ($)	High ($)
Alabama	347,554	329,399	512,865
Georgia	10,458,750	8,970,412	5,816,113
Florida	(101,804)	(128,269)	(49,345)
Total	**10,704,500**	**9,171,542**	**6,279,633**

Source: Corps recreation report in ***Appendix F***

4.7.3.2.8 Employment

4.7.3.2.8.1 Income

This section presents the future conditions for income in the ACF Basin and addresses the anticipated indirect impacts on income associated with the water allocation scenarios. Information presented in this section is summarized from economic reports prepared by the Corps (*Appendix F*).

According to projections for the Comprehensive Study, personal income in the ACF basin is expected to exceed $380 billion by 2020 and exceed $1,688 billion by 2050. *Table 4-81* shows slower projected growth in real per capita income in the future. Real per capita income throughout the ACF basin is expected to increase 1.2 percent annually from 1995 to 2020, but only 0.8 percent annually between 2020 and 2050, adjusting for inflation. Factors contributing to this slower economic growth include a continued loss of higher paying manufacturing jobs because of productivity gains and competitive pressures, and an

increase in the number of residents with retirement incomes, driven by the aging of the "baby-boom" demographic group.

TABLE 4-81
Projected Real Per Capita Personal Income in the ACF Basin[a]

	1995[b]	Annual Average 1995-2020	2020	Annual Average 2020-2050	2050
Alabama portion of basin	$12,889	1.0%	$16,258	0.5%	$18,441
Florida portion of basin	$11,446	1.2%	$14,966	0.7%	$17,692
Georgia portion of basin	$17,546	1.2%	$22,812	0.8%	$27,309
ACF basin	$16,994	1.2%	$22,077	0.8%	$26,365

[a] To adjust for inflation in annual comparisons, all dollar values are adjusted to 1987 equivalents.
[b] Estimated values

Source: DRI-McGraw-Hill, 1996

To estimate regional economic impacts, direct changes in income are conveyed to a regional economic impact model, called the Economic Impact Forecasting System (EIFS). This model estimates regional economic impacts for the study area, as well as sub-areas within the study area. Four factors are examined as the primary indicators of socioeconomic change: business volume, employment, personal income, and population. Population impacts are discussed in Section 4.7.1.

The model also provides rational threshold values (RTVs), which are used to assess the level of significance of any regional economic impacts that may be identified. The RTVs provide a basis for comparing the impacts of an action to the historical fluctuations in a particular area. The RTV analysis uses the fluctuations of the four indicator variables from the average growth rates within the affected area, over time, to set boundaries (threshold values) that can be used to assess the magnitude of an action's impacts. These boundaries determine the amount of change required to significantly affect an individual area. If the changes predicted by the EIFS forecast models fall outside these boundaries, the changes may affect the economy of the region significantly. Additional information about the EIFS model and the RTV method is provided in ***Appendix F***.

The total direct economic impact, when comparing the action alternative flow scenarios to no action alternative (no impact), is an annual decrease of $3,372,469 for the ACF basin. The total direct economic impact, when comparing the no action alternative to the moderate flow scenario, is an annual increase of $668,413 for the ACF basin. The total direct economic impact when comparing the no action alternative to the high flow scenario, is an annual increase of $4,700,913 for the ACF basin. The average annual values by economic use for the basin and states are displayed in ***Table 4-82***.

TABLE 4-82
Direct Economic Impacts by State and for ACF Basin for Action Alternative Scenarios

Economic Use	ACF Basin Total	Alabama Total	Florida Total	Georgia Total
Low Flow Scenario				
Recreation	$10,704,500	$347,554	($101,804)	$10,458,750
M & I water supply	($13,419,500)	($329,500)	($33,700)	($13,056,300)
Inland navigation	($162,065)	($54,022)	($54,022)	($54,022)
Electric power	($495,404)	($165,135)	($165,135)	($165,135)
Agricultural water supply	$0	$0	$0	$0
Total Direct Impacts	**($3,372,469)**	**($201,103)**	**($354,661)**	**($2,816,707)**
Moderate Flow Scenario				
Recreation	$9,171,541	$329,399	($128,269)	$8,970,412
M & I water supply	($7,963,800)	($218,700)	($18,200)	($7,726,900)
Inland navigation	($182,309)	($60,770)	($60,770)	($60,770)
Electric power	($357,019)	($199,006)	($199,006)	($199,006)
Agricultural water supply	$0	$0	$0	$0
Total Direct Impacts	**$668,413**	**($149,077)**	**($406,245)**	**$755,761**
High Flow Scenario				
Recreation	$6,279,633	$512,865	($49,345)	$5,816,113
M & I water supply	($1,049,300)	$0	$0	($1,049,300)
Economic Use	**ACF Basin Total**	**Alabama Total**	**Florida Total**	**Georgia Total**
Inland navigation	($228,815)	($76,272)	($76,272)	($76,272)
Electric power	($300,605)	($100,202)	($100,202)	($100,202)
Agricultural water supply	$0	$0	$0	$0
Total Direct Impacts	**$4,700,913**	**$336,391**	**($225,819)**	**$4,590,339**

All dollar values used in the EIFS model are adjusted to 1987 equivalents; however, values presented in this table are stated at a 1998 price level.

M & I Municipal and industrial

The regional, or indirect, impacts on personal income and business volume associated with the low, moderate, and high flow scenarios for the ACF Basin and individual states are displayed in *Table 4-83*. The RTVs for the basin and states are presented for comparison. Little or no impacts on the regional economies of the affected areas were identified for any of the scenarios. Also, none of the impacts approached RTV levels for the ACF basin or the states of Alabama, Florida, or Georgia.

TABLE 4-83
Regional Economic Impacts: State and ACF Basin Results for Action Alternative Scenarios

Category	Annual Change	Percent Change	RTV Required for Significance (%)	Significance of Impact
Low Flow Scenario				
ACF Basin				
Business volume	($13,208,000)	-0.006	-7.285	No
Personal income	($1,445,000)	-0.001	-5.103	No
ACF Basin – State of Alabama				
Business volume	($406,562)	-0.006	-6.786	No
Personal income	($61,341)	-0.001	-3.577	No
ACF Basin – State of Florida				
Business volume	($587,732)	-0.028	-6.195	No
Personal income	($52,782)	- 0.003	-4.558	No
ACF Basin – State of Georgia				
Business volume	($10,713,267)	-0.005	-7.387	No
Personal income	($1,154,066)	- 0.001	-5.311	No
Moderate Flow Scenario				
ACF Basin				
Business volume	$2,618,000	0.001	8.760	No
Personal income	$287,000	0.000	8.144	No
ACF Basin – State of Alabama				
Business volume	($101,284)	-0.001	-6.786	No
Personal income	($15,692)	0.000	-3.577	No
ACF Basin – State of Florida				
Business volume	($533,524)	-0.026	-6.195	No
Personal income	($48,502)	-0.002	-4.558	No
ACF Basin – State of Georgia				
Business volume	$3,803,138	-0.002	-8.912	No
Personal income	$409,415	0.000	-8.345	No
High Flow Scenario				
ACF Basin				
Business volume	$18,411,000	0.008	8.760	No
Personal income	$2,014,000	0.002	8.144	No
ACF Basin – State of Alabama				
Business volume	$830,243	0.012	8.304	No
Personal income	$125,535	0.002	5.860	No
ACF Basin – State of Florida				
Business volume	($345,221)	-0.017	-6.195	No
Personal income	($31,384)	-0.002	-4.558	No
ACF Basin – State of Georgia				
Business volume	$16,967,190	0.008	8.912	No
Personal income	$1,827,389	0.002	8.345	No

According to the EIFS model, the low flow scenario, when compared to the no action alternative, would cause personal income to decrease by $1.4 million annually within the ACF basin, compared to the total personal income of $93.2 billion in 1995 in the basin. That represents an annual change of only 0.001 percent. Most of the impact on personal income would occur in Georgia.

The moderate flow scenario, when compared to the no action alternative, would directly or indirectly cause personal income to increase by $287,000 annually within the ACF basin. That represents an annual change of only 0.001 percent for the basin. However, this increase in personal income would occur in Georgia, while income in Alabama and Florida would decrease slightly.

The high flow scenario, when compared to the no action alternative, would directly or indirectly cause personal income to increase by $18.4 million annually within the ACF basin. That represents an annual change of only 0.008 percent for the basin. This increase in personal income would occur mostly in Georgia and to a lesser degree in Alabama, while income in Florida would decrease slightly. None of the state and basin impacts are significant when compared to the RTVs.

4.7.3.2.8.2 Employment

This section presents the future conditions for employment in the ACF basin and the expected indirect impacts to employment associated with the water allocation scenarios. Information presented in this section is summarized from economic reports prepared by the Corps (*Appendix F*).

According to the Comprehensive Study, between 1995 and 2050, employment will continue to grow in all three portions of the ACF basin, but more slowly than in the previous decades, at an annual average of 1.1 percent (***Table 4-84***). The regional economy will continue its transition away from a water-dependent manufacturing base towards a service-based economy, as the Atlanta and Columbus metropolitan areas continue to expand and international competition affects the domestic textile and apparel industry. By 2050, manufacturing is expected to provide only 3.6 percent of jobs in the ACF basin, while the service sector is expected to provide over 44 percent of the jobs.

According to the EIFS model, the low flow scenario, when compared to the no action alternative, would cause employment to decrease by an annual total of 51 jobs in the ACF basin, mostly in Georgia. When compared to a baseline of nearly 2.1 million non-farm jobs in 1995; to the (annual average) employment growth of 1.1 percent projected to occur between 1995 and 2050; and to the calculated RTVs, which represent typical historic fluctuations in employment, for the ACF basin, this represents little or no impact.

The moderate flow scenario, when compared to the no action alternative, would cause employment to increase minimally, by an annual total of 10 jobs in the ACF basin (***Table 4-85***). This growth would occur in Georgia, while employment would decrease minimally in Florida and Alabama.

TABLE 4-84
Projected Nonfarm Employment in the ACF Basin

	Alabama Portion of Basin	Florida Portion of Basin	Georgia Portion of Basin	ACF Basin
1995 employment (a)	128,143	38,842	1,892,304	2,059,288
2020 employment (b)	152,697	51,502	2,557,538	2,761,738
2050 employment (b)	172,073	61,526	3,116,650	3,350,249
Annual average growth 1995-2020	**(0.6%)**	**(1.1%)**	**(1.2%)**	**(1.1%)**

[a] Estimated values
[b] Forecasted values

Source: Regional Economic Forecast of Population and Employment

TABLE 4-85
Regional Economic Impacts: State and Basin Results for Action Alternative Scenarios

Category	Annual Change	Percent Change	RTV Required for Significance (%)	Significance of Impact
Low Flow Scenario				
ACF Basin				
Employment	(51)	-0.002	-4.485	No
ACF Basin – State of Alabama				
Employment	(3)	-0.002	-3.292	No
ACF Basin – State of Florida				
Employment	(3)	-0.006	-2.612	No
ACF Basin – State of Georgia				
Employment	(41)	-0.002	-4.670	No
Moderate Flow Scenario				
ACF Basin				
Employment	10	0.000	5.019	No
ACF Basin – State of Alabama				
Employment	(1)	-0.001	-3.292	No
ACF Basin – State of Florida				
Employment	(2)	-0.006	-2.612	No
ACF Basin – State of Georgia				
Employment	14	0.001	5.329	No
High Flow Scenario				
ACF Basin				
Employment	72	0.003	5.019	No
ACF Basin – State of Alabama				
Employment	6	0.004	3.871	No
ACF Basin – State of Florida				
Employment	(2)	-0.004	-2.612	No
ACF Basin – State of Georgia				
Employment	64	0.003	5.329	No

The high flow scenario, when compared to the no action alternative, would cause employment to increase modestly, by an annual total of 72 jobs in the ACF basin. Most of this growth would occur in Georgia, with a minimal increase in employment in Alabama and a minimal decrease in Florida. These changes represent little or no impact on regional and state employment.

4.8 Air Quality and Noise

This section of the EIS addresses the potential impacts of the proposed water allocation formula on air quality conditions and noise levels in the ACF basin. Air quality is addressed on a basin-wide basis and focuses on areas with existing air quality problems or non-attainment areas. Noise conditions are summarized and future impacts evaluated based on typical noise levels expected around general land use areas (urban vs. suburban).

4.8.1 Air Quality

Air quality conditions in the ACF basin and the potential impacts on air quality are summarized in this section. The analysis of air quality is based on information available from EPA (1998b). No modeling was required to complete the air quality evaluation. In addition, the analysis of air quality assumes, as noted in Sections 4.6 and 4.7.1, that water availability would not influence growth and land use changes that would have negative impacts on air quality.

4.8.1.1 Affected Environment

EPA has established national ambient air quality standards for the following seven criteria pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter less than or equal to 2.5 microns ($PM_{2.5}$), particulate matter less than or equal to 10 microns (PM_{10}), and sulfur dioxide (SO_2). *Table 4-86* lists the national ambient air quality standards for each pollutant in terms of the level of the standard, the associated averaging time, and the form of the statistic used to evaluate compliance. There are two types of standards: primary and secondary. Primary standards protect against adverse health effects, whereas secondary standards protect against welfare effects, such as damage to crops, vegetation, buildings, and decreased visibility.

TABLE 4-86
National Ambient Air Quality Standards

Pollutant	Primary Standard (Human Health-Related)		Secondary Standard (Human Welfare-Related)	
	Type of Average	Standard Level Concentration[a]	Type of Average	Standard Level Concentration
Carbon monoxide (CO)	8-hour[b]	9 ppm (10 mg/m^3)	No secondary standards	
	1-hour[b]	35 ppm (40 mg/m^3)	No secondary standards	
Lead (Pb)	Maximum quarterly average	1.5 μg/m^3	Same as primary standard	
Nitrogen dioxide (NO_2)	Annual arithmetic mean	0.053 ppm (100 5 μg/m^3)	Same as primary standard	

(CONTINUED)

TABLE 4-86 (CONTINUED)
National Ambient Air Quality Standards

Pollutant	Primary Standard (Human Health-Related)		Secondary Standard (Human Welfare-Related)	
	Type of Average	Standard Level Concentration[a]	Type of Average	Standard Level Concentration
Ozone (O_3)	8-hour	0.08 ppm[d] (156 μg/m^3)	Same as primary standard	
Particulate matter < 2.5 microns ($PM_{2.5}$)	Annual arithmetic mean[b]	15 μg/m^3	Same as primary standard	
	24-hour[c]	65 μg/m^3	Same as primary standard	
Particulate matter < 10 microns (PM_{10})	Annual arithmetic mean[b]	50 μg/m^3	Same as primary standard	
	24-hour[c]	150 μg/m^3	Same as primary standard	
Sulfur dioxide (SO_2)	Annual arithmetic mean[b]	0.03 ppm (80 μg/m^3)	3-hour[c]	0.50 (1,300 μg/m^3)
	24-hour[c]	0.14 ppm (365 μg/m^3)		

μg/m^3 Micrograms per cubic meters

a Parenthetical value is an approximately equivalent concentration.
b Particulate standards use PM 10 as the indicator pollutant. The annual standard is attained when the expected annual arithmetic number mean concentration is less than or equal to 50 μg/m 3; the 24-hour standard is attained when the expected number of days per calendar year above 150 μg/m 3 is equal to or less than one, as determined by Appendix K of the Particulate Matter (PM) NAAQS.
c Not to be exceeded more than once per year.
d The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than one, as determined according to Appendix H of the Ozone National Ambient Air Quality Standards (NAAQS).

Source: EPA, 1997b

There are primary standards for all of the criteria pollutants; some pollutants (PM_{10} and SO_2) have primary standards for both long-term (annual average) and short-term (24 hours or less) averaging times. Short-term standards protect people from any adverse health effects associated with peak short-term exposures to air pollution, while long-term standards protect people from adverse health effects associated with short- and long-term exposures to air pollution. There are secondary standards for each criteria pollutant except CO. Secondary standards are identical to the primary standard with the exception of SO_2.

Air quality in the ACF basin is generally good with most of the basin in attainment for the seven priority pollutants monitored by EPA. There are, however, are two designated nonattainment areas. The Atlanta metropolitan area is designated in serious nonattainment for ozone and the Columbus, Georgia, area is designated in nonattainment for lead. The ozone nonattainment in the Atlanta metropolitan area has been attributed primarily to automobile emissions. The lead nonattainment area around Columbus has been attributed to industrial emissions (EPA, 1997b).

There are a number of Class I air quality areas located in the ACF basin. The Class I air quality designation is designed to protect areas of significant natural, cultural, or historic

value from significant adverse effects that could result from an impact on air quality. Class I air quality areas include national parks, wilderness areas, national wildlife refuges, national historic parks, national monuments, and national seashores. *Table 4-87* lists the Class I air quality areas in the ACF basin.

TABLE 4-87
Class I Air Quality Areas in the ACF Basin

Site	General Location
Andersonville National Historic Site	Macon/ Sumter, GA
Jimmy Carter National Historic Site	Sumter, GA
Kennesaw Mountain National Battlefield Park	Cobb, GA

4.8.1.2 Environmental Consequences

The water allocation formula is not expected to result in any direct adverse effects on regional air quality. Although air quality is partially a function of population, for the purposes of this EIS, population is assumed to be independent. As a result, it is assumed than any pollutant nonconformities that develop during the period evaluated in this EIS would have occurred under the range of flow scenarios or the no action alternative. However, impacts on air quality will occur as growth continues across the basin. Reductions in hydropower use that might result in increased dependence on fossil fueled generation plants could result in cumulative effects on air quality.

4.8.2 Noise

This section provides an overview of the noise concerns typically evaluated for an EIS, a summary of the existing conditions, and an evaluation of the potential impacts on noise levels in the ACF basins associated with the no-action and action alternatives.

Noise levels in the environment are usually expressed in terms of hourly equivalent sound pressure levels (L_{eq}) in terms of decibels on the A-weighted scale (dBA). When expressed in this manner, noise levels approximate the response of the human ear by filtering out some of the noise in the low and high frequency ranges that the ear does not easily detect. The A-weighted scale is also used in most local ordinances and standards. The L_{eq} is defined as the average noise level, on an energy basis, for a specific period of time (e.g., hourly). Many environmental studies use the day-night noise level (L_{dn}) because it accounts for the greater annoyance of noise during nighttime hours. The L_{dn} values are typically calculated by averaging hourly L_{eq} sound levels for a 24-hour period and adding a weighting factor to the nighttime L_{eq} values. The weighting factor, which reflects the increased sensitivity to noise during nighttime hours, is added to each hourly L_{eq} sound level before the 24-hour L_{dn} is calculated.

4.8.2.1 Affected Environment

Existing noise levels in the ACF basin were estimated by using a number of reports prepared by EPA on general noise conditions in the United States. A summary report by EPA (1974) indicates that national noise level trends can be used to represent regional noise conditions on a broad basis. Individual discrepancies may occur, especially in areas with a

high concentration of specialized industrial land uses, but in general the noise levels are consistent within a specific land use area across the country.

The range of L_{dn} in the United States is very large, from 20 to 30 dB estimated for a quiet wilderness area to 80 to 90 dB in the most noisy urban areas, and to still higher values within the property boundaries of some governmental, industrial, and commercial areas that are not accessible to the general public. The measured range of values of day-night sound levels outside dwelling units ranges from 44 dB on a farm to 88.8 dB outside an apartment located adjacent to a highway. The dominant sources for outdoor noise in urban residential areas are motor vehicles, aircraft, and voices as indicated in ***Table 4-88.***

TABLE 4-88
Percent Contribution of Each Source Identified by Respondents Classifying their Neighborhood as Noisy on a National Basis

Source	Percentage
Motor vehicles	55
Aircraft	15
Voices	12
Radio and TV sets	2
Home maintenance equipment	2
Construction	1
Industrial	1
Other noises	6
Not ascertained	6

Source: Bolt Beranek and Newman, Inc., 1971

The percentage of the population in the ACF basin estimated to reside in areas in which the day-night sound level exceeds various values is given in ***Table 4-89***. The values in the table are based on national values (EPA, 1973, and Galloway and Eldred, no date). In the areas in which the L_{dn} exceeds 60 dB, the proportion between the number of people residing in areas in which the outdoor noise environment is dominated by aircraft and those residing in areas in which motor vehicles dominate is approximately one to four. This proportion is almost identical to the proportion found in the national survey, previously summarized in ***Table 4-89,*** when people were asked to judge the principal contributing sources of neighborhood noise.

TABLE 4-89
Estimated Percentage of People Residing in Urban Areas that Are Exposed to Various Levels of Outdoor Day/Night Average Sound Level

	Noise Caused by			
Outdoor L_{dn} Exceeds	Urban Traffic	Freeway Traffic	Aircraft Operations	Total
60	44	2	12	58
65	18	2	5	25
70	5	1	3	9
75	<1	<1	<1	<1

TABLE 4-89 (CONTINUED)
Estimated Percentage of People Residing in Urban Areas that Are Exposed to Various Levels of Outdoor Day/Night Average Sound Level

	Noise Caused by			
Outdoor L_{dn} Exceeds	**Urban Traffic**	**Freeway Traffic**	**Aircraft Operations**	**Total**
80	<1	<1	<1	<1

Sources: EPA, 1973; Galloway and Eldred, no date

Using the data presented in *Table 4-90,* it is possible to estimate the percentage of urban population in the ACF basin exposed to various noise levels. The data summarized in *Table 4-90* show that the majority of people residing in urban areas in the ACF basin have outdoor L_{dn} values ranging from 48 dB to 72 dB with a median value of 59 dB. The majority of the remainder of the population residing in rural or other nonurban areas is estimated to have outdoor L_{dn} values ranging from 35 to 50 dB.

TABLE 4-90
Estimated Percentage of the Urban Population Residing in Areas with Various Day-Night Noise Levels Together with Customary Qualitative Description of the Area

Description	Typical Range L_{dn} in dB	Average L_{dn} in dB	Estimated Percentage of Urban Population	Average Census Tract Population Density, Number of People Per Square Mile
Quiet suburban residential	48-52	50	12	630
Normal suburban residential	53-57	55	21	2,000
Urban residential	58-62	60	28	6,300
Noisy urban residential	63-67	65	19	20,000
Very noisy urban residential	68-72	70	7	63,000

Source: EPA, 1974

4.8.2.2 Environmental Consequences

The water allocation formula is not expected to result in any direct adverse effects on noise. Although noise is partially a function of population, for the purposes of this EIS, population is assumed to be independent. As a result, it is assumed than any increase in noise levels in specific areas that develop during the period evaluated in this EIS would have occurred under the range of flow alternatives or the no action alternative.

4.9 Cultural Resources

This section summarizes the existing conditions of cultural resources in the ACF basin and the potential environmental consequences on those resources. Unlike many of the other environmental resources areas addressed in this EIS, cultural resources were not inventoried during the Comprehensive Study. Therefore, the Mobile District Corps completed a basinwide evaluation of cultural resources to summarize the existing conditions and to estimate the potential impacts on the resources from a change in water management. No site-specific surveys were completed. Instead, the Corps used an extensive literature search and predictive modeling based on information provided by the Alabama, Georgia, and Florida State Historic Preservation Office site files to evaluate cultural resources at a programmatic level.

The area of cultural resources encompasses a wide range of phenomena, including:

- Archaeological sites — artifact concentrations, features, or structural remains
- Standing structures — commercial or residential dwellings, schools, bridges, or other facilities
- Landscapes and multiple resources — battlefields, rural or residential districts, and associated groups of buildings, facilities, or communities
- Traditional cultural properties — places of particular traditional importance to Native Americans
- American communities or tribes

Significant cultural resources have the ability, or potential ability, to contribute important information to the broad patterns of our collective history, or to embody important historical styles or characteristics, or to faithfully represent a locality associated with a significant historic event or person(s). This value is measured by the resources' eligibility for nomination to the National Register of Historic Places, under the guidelines of the National Historic Preservation Act.

4.9.1 Affected Environment

This section outlines the cultural and historical background associated with the project area, focusing on identifying general associations between resources and their prehistoric or historic time periods. A review of specific historic patterns with detailed references is provided in *Appendix G.*

The extent of human settlement in North America generally and the ACF basin specifically can be categorized by the following archaeological and historical time periods:

- Paleoindian (10,000 to 8,000 BC)—initial colonization, and early hunting and gathering
- Archaic (8,000 to 1,000 BC)—development of regional territories, and hunting and gathering
- Woodland (1,000 BC to 900 AD)—agricultural communities and spread of pottery technology

- Mississippian (900 to 1500 AD)—large villages, ceremonial mounds, and large trade networks
- Exploration (1500 to 1700 AD)—early European contact with explorers and missionaries
- Colonial (1700 to 1781 AD)—British, French, and Spanish colonialism to the revolution
- Antebellum (1781 to 1865 AD)—southern agronomy, plantation societies, and steamboats
- Postbellum (1865 to 1890 AD)—tenant farming, reconstruction, and population out-migration
- Industrialization (1890 to 1929 AD)—urbanization, factories, and railroad expansion
- Great Depression (1929 to 1941 AD)—economic collapse, Work Projects Administration (WPA), and major reservoir projects
- World War II (1941 to 1945 AD)—economic restructuring and wartime industries
- Cold War Era (1945 to 1989 AD)—prosperity, suburbanization, and decentralized settlement

Each time period provides specific types of resources to the archaeological and historical records that may be affected by one or more of the alternatives assessed in this EIS.

Paleoindian archaeological sites consist of either surface finds of isolated fluted projectile points, or deeply buried features and artifacts, sometimes associated with the remains of a now-extinct prey species (usually mammoths, mastodons, ground sloths, archaic bison, camels, or horses). Poor preservation has limited the number of substantial Paleoindian sites found in the east, but they can occur in near-river areas and can be adversely impacted by the effects of erosion. Because the rarity of Paleoindian period projectile points has made them particularly prized by collectors, a known Paleoindian site may undergo vandalism if access to the site is unrestricted.

Archaic resources, which are more numerous than earlier Paleoindian ones, frequently do not provide significant information to the study of prehistory. Since the sites were widely distributed in the uplands, and were usually of short duration, a large proportion of Archaic sites are not likely to be adversely affected by the hydrologic alternatives. However, some Archaic period sites do occur in near-river or near-reservoir areas and represent longer duration occupations. These sites in particular provide a much needed understanding of the regional settlement patterns of Archaic people and provide insight into their social relationships. Such sites are likely to be adversely affected by increased erosion and unlimited or increased access.

Woodland period resources are not as frequently encountered as Archaic period sites, due to the reduced dispersement associated with increased horticulture. However, Woodland sites are more frequently encountered in near-river or near-reservoir areas. They also are more likely to contain significant subsurface remains. Erosion of riverbanks or floodplains caused by an increase in hydrological flow or rapid fluctuations of reservoir levels might adversely affect the significant component of these archaeological resources. Some archaeological resources, such as fish weirs, are located in very high impact areas, such as the river channel itself. Although not just associated with the Woodland period, these resources could

possibly face increased erosion and/or vandalism due to increased and decreased rates of flow.

The *Mississippian* period is typically associated with the construction of large-scale ceremonial mounds. As aboveground resources, mounds are not only adversely affected by erosion and very high levels of vandalism, but since they are frequently incorporated into State or Federal monuments or parks, they include a strong visual component that may be adversely affected by increased rates of flooding and deposition. Deposition could conceivably adversely affect other types of archaeological sites, but generally burial of an archaeological locality by sediment helps to preserve it. (Mounds and aboveground resources are associated with other time periods as well, especially Woodland and even Archaic).

The period of *European contact and early exploration* presents the first introduction of European manufactured goods to the region, but since historical documentation enhances our understanding of the timeframe, we know that there were only minimal levels of interaction. Typical archaeological resources include some of the first substantial European architectural remains (missions and early fortifications), trails, and battlefields (historic landscapes). Many of these sites are in near-river or near-reservoir areas and would be adversely affected by increased rates of erosion, deposition (for visual components), and unregulated access.

The *Colonial* period provides many of the same types of sites to the archaeological and historical records, but missions disappear and fortifications increase. Due to the historical significance of the American Revolution, battlefields become more important. The Colonial period is also the first time period with known, standing historic structures. Since early communities were frequently located near waterways, the effects of erosion and deposition on known, historic standing structures may be adverse. Likewise, adverse affects due to increased erosion on in-water resources, such as shipwrecks and ferries, can be expected.

The *Antebellum* period is represented by the development of the southern plantation system. Examples of historical standing structures and substantial archaeological components are more frequent. Steamboats began to travel up and down the waterways, contributing to the creation of waterway control mechanisms. Antebellum archaeological components in the river channels or back swamps include mill remnants, steamboat and ferry wrecks, and both inundated and functioning locks and dams. Near-river or near-reservoir resources include standing structures, historic communities, early railroads, structural remains, Civil War battlefields, and plantation landscapes. Increased erosion and deposition would cause the largest adverse effects on such resources. Vandalism due to unregulated access would especially adversely affect Civil War battlefields.

Since the *Postbellum* period is a largely a time of abandonment and reconstruction, it does not contribute a high percentage of unique archaeological or structural components to the basin. Tenant farming on the old plantations was a dominant activity with a consequential increase in deforestation due to clearing of new fields for cotton. The demise of the steamboat was paralleled by the rise of the railroad. Waterways came under further control for navigation, reservoir construction, and flood protection. Railroad bridges are a common Postbellum in-water resource, subject to the adverse effects of increased erosion.

The *Industrial* period, based primarily on the expanse of wartime industries to meet the needs of a burgeoning urban population, introduced some of the first large-scale industrial complexes. Railroad yards and support facilities are frequently located in near-river areas and are subject to the effects of both erosion and deposition through frequent flooding. Entire residential communities linked to industrial complexes are still preserved in some near-river areas. Although there are fewer significant archaeological localities associated with the Industrial period, the number of standing structures increases dramatically. The effects of increased access to these resources may be minimal, but changes to rates of flooding are critical.

The *Great Depression* brought about the creation of the Works Progress Administration (WPA). This government program rapidly increased the effort spent on waterway management. Many of the existing reservoirs, locks, and dams were created during this time period. Although most are still active in the system, they are associated with a pattern of historic activity. The engineering facilities themselves may be considered historically significant. The alternatives assessed in this report should be expected to affect them on some level, although perhaps not adversely.

The *World War II and Cold War* eras brought about the creation of several types of historic resources likely to be affected by the proposed alternatives. With the growth of suburbs around the time of World War II and the increased availability of automobiles, commuting time was reduced. It became possible to live further outside the city, thus escaping increased smog and congestion. Suburban neighborhoods developed and brought with them their own unique architectural styles and rapidly expanding roadways. Many of these resources are located in near-reservoir areas and might be adversely affected by rising reservoir levels. In contrast, some other historically significant structures are located almost exclusively on military facilities, and are important for their association with the Cold War (especially relating to nuclear weapons manufacturing or storage). Military facilities are frequently located in near-river areas and their Cold War resources may be adversely affected by increased erosion or deposition due to changes in flooding patterns.

A large number of standing structures, principally residential or commercial buildings not yet 50 years of age, are currently ineligible for historical significance evaluation. However, many are considered excellent examples of important architectural styles and will "come of age" within the next few decades. Since the proposed alternatives consider conditions through 2050, an evaluation of the impacts to potentially important resources (possibly up to very recently built structures) needs to be addressed. Many of the adverse affects projected by the three alternatives may apply to such resources.

4.9.2 Environmental Consequences

This section presents the expected effects of the alternative flow scenarios assessed in this EIS on cultural resources in the basin. The information presented in this section is general unless specific sites or properties would be adversely affected by one or more of the alternatives. Impacts are identified and assessed as having little or no impact, low significance, or high significance as defined in Section 4.1.

In the previous section, the overview of cultural resources in the ACF basin summarized the kinds of effects expected to occur after implementing one or more of the hydrologic alternatives. Specifically, the expected types of effects are:

- Erosion: removal of soil or other material that protects or supports a resource
- Deposition: addition of sediment or other materials to a resource
- Access: any effect that allows visitation to a resource

These types of effects will not occur uniformly across the basin, and some level of each is currently occurring (or would also occur in a no action hydrologic scenario). Therefore, the discussion of impacts to cultural resources is derived from a baseline condition represented by the current level of ongoing effects.

The primary sources of *erosion* to all cultural resources in the basin are hydrologic flow (in-channel and near-shore currents, plus periodic dam or flood gate releases), runoff (rain water, flooding, and reservoir draw-down), wave action (at reservoir and river margins), and animal disturbance (trampling along shore and water crossings in pasture areas). Each of these sources can cause slumping and landslides in particularly steep areas with erodable soils, as well as channeling and scouring of soils. Exposure of artifacts or archeological features in such situations will cause redeposition of materials, chemical alterations, rapid deterioration, and/or complete disappearance both in and out of the water. For historic properties and landscapes, the effects are more likely to include undermining of supports or retaining walls, visual or structural damage, and alteration of the visual setting of the resource.

The principal sources of *deposition* to all cultural resources in the basin are flood deposition (sediment fallout from seasonal and periodic inundation of floodplains) and underwater siltation (sediment fallout from in-channel or near-shore currents). Deposition sources generally provide additional protection from erosion or vandalism to archaeological localities, but they can also introduce chemical alterations and prevent discovery (particularly for shipwrecks). For historic properties, the principal effects of deposition may include an alteration of the visual or aesthetic appeal of a property or landscape.

Access is a type of impact that cannot easily be predicted or regulated. Recreational visits to both archaeological and historic properties frequently lead to their damage or alteration. Much of the damage may be inadvertent (such as pathway or trail cutting), but some is due to indirect or direct forms of vandalism. Avocational surface collection of projectile points is probably the most common form of human-induced site alteration, but the occasional small- or large-scale evacuation may do the most damage. Similarly, direct or indirect physical damage may often be inflicted on historic structures or landscapes. When access to cultural resources is limited (as with restricted or monitored parks and structures, deeply buried or inundated sites, and controlled access to location information), it becomes possible to keep direct or indirect vandalism at a minimum. With changes in the hydrologic scenarios, however, the control over vandalism will decrease since previously inundated or eroded areas may become open to visitation. That control may be regained over time with continual monitoring efforts.

To address the potential effects most efficiently, and to evaluate the differences between the proposed alternative scenarios, a series of spatial "areas of concern" were defined. Each of these spatial categories are the areas most likely to show some kind of impact from the proposed hydrologic models. ***Table 4-76*** lists the area categories by alternatives and the number of acres impacted. The spatial calculations are based on the Geographic Information System (GIS) model discussed in ***Appendix G***.

Using the databases of recorded cultural resources for Alabama, Florida, and Georgia, a model was constructed to calculate areas of high potential for encountering cultural resources. This "predictive model" (discussed in detail in *Appendix G*) was overlaid on a digital base map of the ACF basin by using a GIS model. In conjunction, a model was developed that highlighted each of the spatial categories described in *Table 4-91*. That digital model was also overlaid on the same base map. Areas were then calculated for the intersection between the two models.

TABLE 4-91
Potential Cultural Resource Impacts by Alternative

Categories of Areas with High Cultural Resources Sensitivity	Year	No action Alternative (acres)	Action Alternatives: Low Flow Conditions (acres)	Action Alternatives: Moderate Flow Conditions (acres)	Action Alternatives: High Flow Conditions (acres)
Inside river bend	1995	107,894	108,227	108,326	108,361
	2020	107,862	108,217	108,324	108,348
	2050	107,834	108,215	108,314	108,326
Outside river bend	1995	29,415	29,506	29,531	29,541
	2020	29,405	29,504	29,531	29,538
	2050	29,397	29,501	29,528	29,531
Inundated by river channel	1995	312,947	313,918	314,200	314,301
	2020	312,853	313,889	314,198	314,269
	2050	312,777	313,884	314,168	314,200
Inundated by reservoir	1995	177,349	178,115	178,058	177,897
	2020	177,294	178,097	178,055	177,880
	2050	177,250	178,058	178,040	177,877
Below dam release gates or lock	1995	5,115	5,130	5,135	5,137
	2020	5,112	5,130	5,135	5,135
	2050	5,110	5,130	5,135	5,135
Near slack water	1995	1,239,987	1,243,832	1,244,949	1,245,347
	2020	1,239,612	1,243,714	1,244,942	1,245,221
	2050	1,239,310	1,243,696	1,244,823	1,244,949
Total for all areas	1995	1,872,704	1,878,726	1,880,199	1,880,584
	2020	1,872,136	1,878,546	1,880,189	1,880,394
	2050	1,871,681	1,878,486	1,880,006	1,880,018

No effort was made to project decreases or increases in impact because of the tendency for archaeological research activities to decline (i.e., more complete areas being thoroughly surveyed) or the potential for recent structures to become historically significant in the coming years. With this in mind, it is apparent that although there are hydrologic models for 2020 and 2050, they are not particularly meaningful for cultural resources.

The hydrologic flow formulas calculated for each of the alternative scenarios were used to develop a basic understanding of the differences across the basin for each of the flow scenarios. The baseline data (the intersection between the spatial categories and the predictive model) was used to represent the current levels of erosion and deposition, with the no action alternative or high, moderate, or low flow action alternative scenarios, signaling a proportional change in impacts equivalent to the difference in flow rates. The

acres of impact, therefore, represent a relative summary of the difference in total impact by alternative.

To compare the no action alternative and the action alternative flow scenarios, a summary of the total culturally sensitive area affected in each spatial category by flow scenario was calculated. Along with an understanding of the types of impacts generated by each hydrologic effect, those totals were used to develop an alternatives analysis.

The *no action alternative* is expected to be nearest the current rates of erosion, deposition, and access. It is assumed that the pool elevations of reservoirs will not change, along with the water levels in the river channel itself. Over time, the same impacts will occur as in the action alternative flow scenarios described in the following text, but to a lesser degree, mostly because a lack of change will not immediately affect the impact of access to resources. Clearly, access impacts to cultural resources will increase as reservoir levels go down in the coming decades, but they will be counteracted by the decrease in erosion and deposition that will also occur.

The *high flow action alternative scenario* will generate the most significant increases in erosion and deposition. The most likely places for erosion are along the outside riverbends because the increased rate of flow causes faster rates of river meandering. Generally, this will affect archaeological localities either on the riverbank, or above steep slopes adjacent to it. The most erodable soils are located below the Fall Line, and they will undergo the greatest increase to adverse impacts from erosion. It is anticipated that rates of erosion will increase above the Fall Line as well, but river meandering will be proportionally slower due to less erodable rocky soils. The extreme upland tributaries will undergo the least amount of change to rates of erosion and are less likely to contain significant archaeological resources as well.

The high flow scenario will also greatly affect riverbed deposits. The increased erosion is most likely to occur in channel deposits below dam spill gates or in shoals. The greatest effects will be removing the soil that protects deeply buried archaeological sites, destroying fish weirs, undermining dams and bridges, and disturbing shipwrecks. Further downstream, these effects are likely to be proportionally greater.

Increased rates of deposition will result as well. As the river increases its meandering, the inside riverbends will catch a large percentage of the sediment removed from the outside riverbends. This is likely to expand sandbars toward the river channel and to bury additional archaeological deposits. This is considered beneficial since it prevents access and protects the site from erosion, but it is not likely to play a large part in protecting resources, since few intact significant resources will be located in such areas.

Deposition in flood zones will increase with the high flow scenario, since more water will fill the river channel and less will be stored in reservoirs. At times of high precipitation, large expanses of flat terraces will become inundated. As the waters recede, sediment will be deposited on top of archaeological sites. However, at the same time, receding floodwaters will carve channels in some places, as well as chemically alter archaeological deposits. The effects to historic structures will be most damaging with structural or visual alterations.

The high flow scenario is likely to mean a lowering of the pool elevation in many of the reservoirs. This will expose archaeological sites in the draw-down zone to the effects of both

erosion and increased access. Many such sites may already be highly disturbed, but the impact is adverse nonetheless.

The *moderate flow action alternative scenario* will likely be a compromise between the high and low flow scenarios. It is assumed that the pool elevations of reservoirs may change, along with the water levels in the river channel itself, but not as drastically in either direction as the high or low flow scenarios. The same impacts will occur as in the high flow scenario, but to a lesser degree. Likewise, more of those impacts will occur than in the low flow scenario.

Because of the tendency for access to be unrestricted in both the high and low flow scenarios for different areas, the moderate flow scenario will likely have the lowest levels of impact on access to resources. Either increasing or decreasing flow results in access impacts, but keeping the water at moderate levels (near where they currently are) leaves access impacts unchanged. The degree of access impacts is unknown at this time but it is expected to be great, considering the large amount of land within or adjacent to the draw-down zones of reservoirs (the entire reservoir could be considered within the draw-down zone).

The *low flow action alternative scenario* will reduce the levels of erosion that are currently taking place over much of the basin. The reduced level of sediment in suspension will likewise reduce the amount of deposition. However, since more water will be held in reservoirs, the areas currently within the reservoir draw-down zones might expand. Inundation of near-reservoir land would increase the number of archaeological sites subject to underwater siltation and subsequent chemical alteration. Therefore, an increase in deposition rates and the need for additional archaeological or historic structure surveys may be necessary.

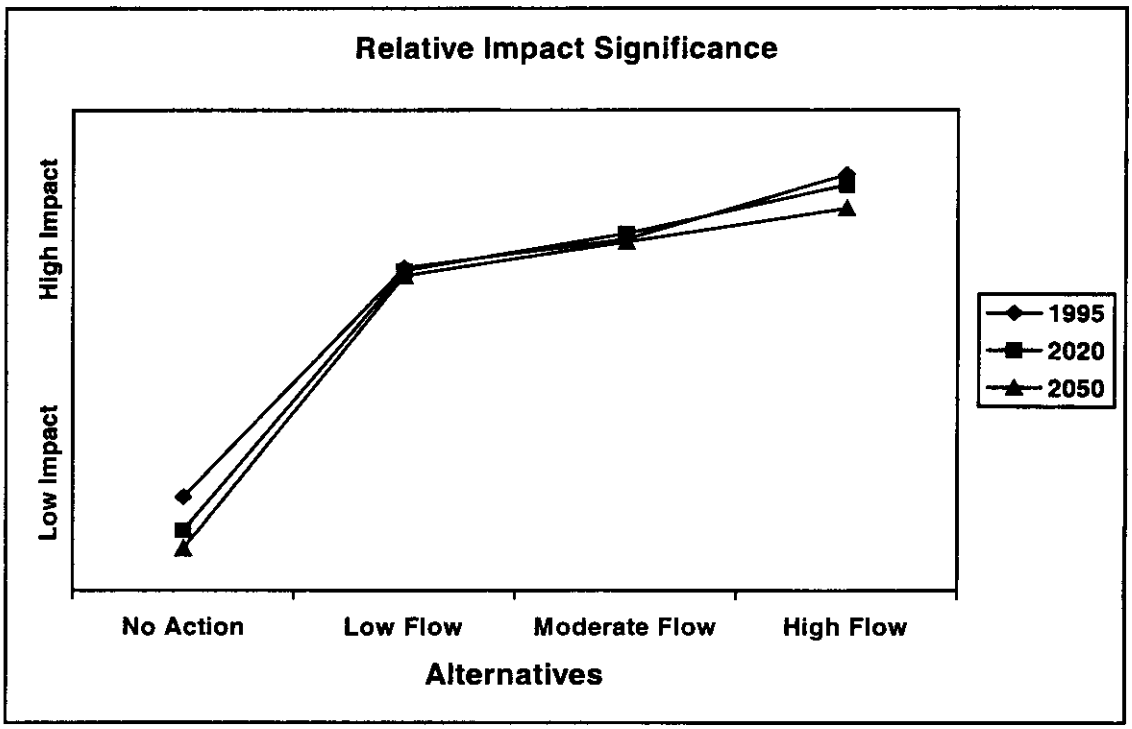
The lowering of the water level in river channels would also expose previously inundated sites to access by potential vandals. This would be especially significant for large historical components, such as shipwrecks. The impact may increase surveying for such resources but would complicate means for their protection. Likewise, access to island sites may become easier.

Since flooding would not be as dramatic as in the high flow scenario, the effects of erosion and deposition on floodplain archaeological sites and historic structures will be reduced. Some sites may still undergo erosion from upland runoff, and even at slightly higher levels of impact since additional sediment is not being added to the sites. However, that impact is substantially smaller than would be expected in the high flow-increased flood scenario.

Generally, the effects estimated for the low flow scenario are more beneficial or involve fewer potential adverse effects to existing resources than the high or moderate scenarios. The no action alternative is the least adverse for cultural resources; however, cultural resources are affected.

For the range of flow scenario action alternatives, there are potentially adverse issues with access to sites, and the need for additional surveying around reservoirs, but overall those impacts are not as adverse as the effects of erosion on in-water or near-water resources predicted by both the moderate and high flow scenarios. Charted graphically in ***Figure 4-101***, the level of relative impact significance suggests that the no action alternative would have the lowest potential for impacts on cultural resources, followed by the low flow scenario.

FIGURE 4-101
Level of Relative Impact Significance to Cultural Resources



In any scenario, however, one of the most adverse effects may be the increased erosion caused by rapid fluctuation in flow release rates. It would be expected that regardless of the overall hydrologic flow rate, any rapid draw-down or daily pool fluctuations would cause significant damage to both inundated and near-shore cultural resources. If daily fluctuations were minimized, then the low flow scenario might be considered the least damaging alternative flow scenario. If daily or otherwise rapid fluctuations were present, however, all of the action alternative scenarios would result in larger amounts of erosion than might be expected.

4.10 Cumulative Effects

Cumulative effects are defined in 40 CFR 1508.7 as follows:

> *...the impact on the environment which results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.*

Cumulative effects may arise from single or multiple actions and may result in additive or interactive effects. Additive effects include multiple actions affecting a single resource that singly have little or no impact but collectively result in greater, potentially less desirable impacts. Interactive effects may be either countervailing or synergistic. Countervailing effects occur when the net adverse cumulative effect is less than the sum of the individual effects; i.e., the combined effects reduce the impacts that might otherwise be expected from the individual impacts. Synergistic effects result in a net adverse cumulative effect that is greater than the sum of the effects by individual actions (CEQ, 1997).

An evaluation of cumulative effects must address activities or actions that take place over a specified geographic area (spatial) and time period (temporal). For this EIS the spatial component includes the ACF basin of 19,800 square miles, and the temporal aspects cover the specific time frames that reflect impacts for 1995, 2020, and 2050. Thus, the consideration of impacts over such a large area and for an extensive planning period (greater than 50 years) reflects many of the cumulative impacts that might be expected for the alternatives evaluated. However, consideration of specific cumulative effects has been included in the following section for each resource area.

4.10.1 Geology and Soils

The only potential cumulative effect related to geology is the potential occurrence of sinkholes that may arise under certain conditions where increased dependence on groundwater, in addition to or in conjunction with other demands for groundwater, could affect localized subsidence. The formation of sinks could increase localized changes in groundwater recharge and discharge. In addition, sinkholes have the potential to alter the landscape, aquatic habitats, and localized land use patterns.

Cumulative impacts related to soils include the potential for increased sedimentation over time and along multiple reaches or reservoirs within a basin or subbasin. This increase in sedimentation over time, in conjunction with other sources of sedimentation, could produce localized areas of reduced habitat for aquatic resources. The magnitude and location of these effects would be more likely under conditions that increase reservoir or streambank erosion (high flow conditions), although the greater flows may transport or flush the sediments farther downstream over time. Conversely, under a low flow scenario, sediments from upstream or other sources may be more likely to accumulate in reservoirs (reducing transport downstream), and where erodable materials are transported in streams, the sediments are less likely to be flushed out over time and sediments could accumulate. Scenarios in water allocation that are likely to promote increased urbanization and development may also be expected to introduce additional sediment for transport and deposition in streams.

4.10.2 Water Resources

4.10.2.1 Water Quantity

Incremental changes in water quantity may result in cumulative effects on natural resources, economics, land use, cultural resources, and air quality. These cumulative effects are discussed below for the respective resource areas. Effects on water supply demands, including M&I, thermal and hydropower generation, agriculture, and navigation, are directly linked to the quantity of water available in the basin under the no action alternative and range of flow scenarios (action alternative).

With the no action alternative, water demands would continue to increase but with no changes in water management. The cumulative increase in water withdrawals would result in water shortages and failure to meet the various demands. Cumulative impacts on natural resources, power generation, navigation, and M&I needs would result.

In the low flow scenario, the maximum amount of reservoir storage is reserved for water supply, so that the cumulative effects on water availability from the reservoirs would be minimized. Low releases from multiple reservoirs in a single subbasin would result in cumulative effects on resources in the lower basin that are dependent on greater flows during critical low flow periods. In addition, the decreased availability of water for agricultural irrigation would result in cumulative increases in groundwater usage and potential impacts on the aquifers, and further reductions in contribution of groundwater to stream flow in the basin.

With the high flow scenario, where less water is reserved for water supply storage and more water is released for downstream flow needs during critical periods, the cumulative effects on reservoir water availability would result in the need for alternative strategies to meet water demands in the upper portions of the basin. The increases in water shortages under the high flow scenario could result in an increase in interbasin water transfers into the ACF basin to meet the additional demands, resulting in cumulative effects on adjacent river basins. Water shortages could also increase the potential for additional water supply reservoir construction in the upper portions of the basin.

4.10.2.2 Water Quality

Cumulative impacts that could result in decreased water quality are projected to occur under the no action alternative as a result of continued increases in wastewater discharges and nonpoint source pollution, along with increased consumptive surface water withdrawals. The low flow scenario results in the lowest stream flows in the basin during critical periods, and would cause the greatest cumulative effects. For example, the assimilative capacity of the rivers, which may already be stressed by existing discharges, would be further reduced as a result of the decreased flows, and wastewater discharges would have to be reevaluated to ensure that NPDES wastewater permit limits are sufficient to maintain water quality. Degradation in water quality under the low flow scenario would also increase the level of treatment required for water supply to meet drinking water quality standards. Under the high flow scenario, the additional stream flows during critical periods would provide additional dilution and mixing, resulting in reduced impacts on water quality, and could have a cumulative positive effect on water quality and other resource uses in the basin.

4.10.3 Biological Resources

4.10.3.1 Vegetation

The potential cumulative effects on terrestrial vegetation communities are limited to indirect effects over time as a result of continued societal growth and development. Loss of forested habitat would continue under the no action alternative, but at a very low rate. Cumulative effects resulting in increased loss of terrestrial vegetation communities may be associated development of additional local or community-based reservoirs to meet local water supply demands. These changes in land use would have a cumulative effect on vegetation resources. Under the low flow scenario, as reservoirs are held full through the flood season, increased severity of flood events could occur downstream, resulting in increased erosional loss of bank vegetation.

Wetland communities are not predicted to experience significant impacts under any of the modeled scenarios. Cumulative losses would occur under any alternative that promotes added pressure for land use changes and urban or residential development. Increased demand for water supply reservoirs has the greatest potential for wetlands loss over time through construction and impoundment. In addition, under the low flow scenario, water shortages for agricultural demands in the lower basin would be met by increased groundwater use. The increased use of groundwater, especially in southern Georgia where groundwater pumping rates are already high, would likely result in cumulative effects on wetlands in the localized areas of high groundwater pumping.

4.10.3.2 Wildlife

Wildlife resources are not likely to be affected due to the changes in water management in the basin. Any alternative that promotes continued development in areas of important wildlife habitat would result in a cumulative loss of wildlife. Greater potential for cumulative loss of these habitats may be expected under any flow scenario where, over time, increased pressure will be placed on local communities to build additional water supply reservoirs. Cumulative changes in stream flows and reservoir water levels may also affect wildlife management practices at the Eufaula National Wildlife Refuge on Walter F. George Lake.

4.10.3.3 Fish and Aquatic Resources

Continued incremental instream flow reductions, which are predicted for the no action alternative, are likely to have cumulative negative effects on fish and aquatic resources. With the low flow scenario, it is likely that sediments would build up in some reaches of riverine habitats over time as a result of reduced frequency of flushing flows and would reduce the available habitat critical for fish spawning. Reduction in water quality in riverine reaches under this scenario would also reduce available habitat for aquatic resources. Increased habitat for reservoir fisheries, however, may be expected under this scenario.

Conversely, the selection of an allocation formula that follows the high flow scenario may be expected to provide improved riverine habitat for fish and other aquatic resources, promote improvements in water quality, and flush sediments from streams. Additional reservoirs that might be required over time to meet water demands in the upper basin may also have a negative, localized impact on stream aquatic resources that are in areas affected by these impoundments. The high flow scenario, over time, would reduce the available

habitat for reservoir fisheries, although new reservoir development would provide replacement habitats for these species. Incremental increases in groundwater use, especially in south Georgia, as a result of decreased surface water availability would reduce the groundwater contribution to stream flow through springs. This reduction could limit the extent of cold-water habitats for fish in the vicinity of the springs.

Cumulative effects on estuarine communities in Apalachicola Bay would be expected to occur under the no action alternative but would be most detrimental under the low flow scenario. These cumulative effects would be most likely to occur on oysters, although other species that have narrow tolerances for changes in salinity may also be affected. Minor reductions in the volume of freshwater inflow to the bay could result in increased areas of oyster mortality through greater susceptibility to predators. Minor impacts from year to year could result in substantial reductions in oyster reefs and other estuarine communities that use these habitats throughout the bay. Although most of the estuarine-dependent fish and shellfish in the bay are fairly tolerant of salinity changes and may not be significantly affected by slow incremental changes, it is uncertain what the effect of the loss of habitat associated with oyster reefs within the bay would have on the survival of other estuarine species.

4.10.3.4 Protected Species

There are a number of protected species that could potentially be affected in the ACF basin, with mussels and fish the species of greatest concern. Impacts on these aquatic species would depend on site-specific conditions and the incremental changes in stream flows and reservoir levels. The cumulative effects of the construction and operation of reservoirs throughout the ACF basin have been significant. The reduction in unregulated stream habitat has resulted in impacts on a number of freshwater mussels and fish (particularly migratory) species.

With the no action alternative, cumulative negative effects on aquatic protected species are likely to continue. The low flow scenario would likely result in greater cumulative effects on aquatic protected species than the high flow scenario as a result of reductions in water quality and increased sedimentation. Also, increased construction of new water supply reservoirs on small rivers and streams in the upper basin area, which would continue the incremental loss of habitat for some of the protected species.

4.10.4 Land Use

It is intuitive that land use changes will follow decisions made concerning water allocation. However, because of the myriad of site-specific reservoir operations available to implement an allocation formula, and the very localized impacts that would result from changes in land use, this programmatic EIS has not included direct impacts of an allocation formula on land use changes in the modeling of alternatives.

Cumulative effects of the water allocation decision on land use would probably occur and may result in indirect or secondary impacts on other resources associated with this change in land use. The primary cumulative effect would be conversion of agricultural or forested lands to urban and residential land uses. Some of this conversion would continue under the no action alternative. With the high flow scenario, it is possible that growth would slow in the urban areas of Georgia due to water shortages; these cumulative changes in land use would be less than with the no action alternative. However, induced demand for additional

water supply reservoirs would promote localized changes in land use elsewhere in the basin, and increased demand for interbasin transfers to satisfy this demand may result in decreased water availability and resultant decreased opportunity for development in adjacent river basins.

4.10.5 Socioeconomic Resources

4.10.5.1 Population and Demographics

Population changes would follow decisions made regarding water allocation, with increased growth in areas that are able to provide expanded supplies to meet M&I demands. However, because of the options available in implementing an allocation formula, and the very localized impacts that would result from changes in population demographics, this programmatic EIS has not included direct impacts of water allocations on population changes in the analysis. Although it is difficult to accurately determine what changes would occur, water availability is likely to affect population growth in the basin. Cumulative effects can be expected on the existing most populated areas, including Atlanta and Columbus, Georgia. However, changes in water availability may also shift rates of population growth in the ACF basin to other basins within the region. Alternatively, interbasin transfers into the ACF basin may allow continued growth in the Atlanta or Columbus areas, at the expense of assured growth in the other basins.

4.10.5.2 Recreation

Recreation is most important on the larger reservoirs in the basin that afford opportunities for boating, fishing, and camping, including Lake Lanier, Walter F. George Lake, and West Point Lake. Cumulative effects on recreation may occur if adequate water is not available to support the recreation activities within the basin. This may result in the redistribution of recreational activity to other areas inside or outside of the basin, possibly leading to losses to the local economy.

With the low flow scenario, reservoir-related recreation uses would expand, resulting in increased boat traffic and increased demand for the recreational resources on the reservoirs. The frequency of recreational use in streams or river reaches during low flow periods would decline. Conversely, under a high flow scenario, recreational uses that include rafting, kayaking, and trout fishing may expand, with a concomitant reduction in reservoir recreational uses over time.

4.10.5.3 Economics

Because this is a programmatic EIS that covers a range of potential water allocation alternatives, the economic impacts have, in many ways, already been evaluated from a cumulative perspective when compared to a normal single-project EIS. Cumulative effects analyses were conducted within the context of resource, ecosystem, and human community thresholds/levels of stress beyond which the desired condition degrades. The magnitude and extent of the effect on a resource depends on whether the cumulative effects exceed the capacity of the resource to sustain itself and remain productive. The natural ecosystem and the human community have maximum levels of cumulative effects that they can withstand before the desired conditions of ecological functioning and human quality of life deteriorate. Three indicators of community stress that may reflect cumulative impacts are economic indicators, population density, and housing shortages.

With the no action alternative, continued demands would have localized impacts that affect the ability to sustain economic growth in urban areas, and pressure would continue for seeking alternative strategies that meet these demands away from populated areas. The cumulative effects of these changes may be substantial negative impacts on larger urban areas. With the low flow scenario, shifting operations to reduce downstream releases could have negative cumulative economic impacts due to reductions in hydropower generation, agricultural uses, and navigation. Positive benefits reflected in increased M&I growth in the upper basin would be expected in areas using these retained water supplies. The high flow scenario, while providing positive economic benefits to hydropower, agricultural, and navigation needs, could be expected to have localized negative impacts on meeting M&I demands near upstream urban areas.

4.10.6 Air Quality and Noise

No significant cumulative effects on air quality or noise are likely for any of the alternatives evaluated. It is possible that the incremental increase in growth in the basin during the planning period could result in cumulative effects on air quality. With the no action alternative, air quality is likely to decline as a result of the continued population and industrial growth in the basin. This decline in air quality would be caused by the cumulative emissions of all existing and new sources in the area. Alternative scenarios that result in localized changes in land use and expanded population growth may also be expected to cause continued or increased deterioration in air quality, especially around urban areas. Reductions in hydropower use that might result from a low flow scenario could also result in cumulative effects on air quality in the region through a shift to fossil fuel powered plants.

4.10.7 Cultural Resources

Cumulative effects on cultural resources would occur for the no action and all of the range of alternative flow scenarios evaluated. The low flow scenario was predicted to have the least overall direct impact on cultural resources and would probably have the least cumulative effect. Lower stream flows during critical periods would expose fewer resources along stream banks. Also, reservoir levels would fluctuate less in the low flow scenario, resulting in less bank erosion along the reservoir shoreline. However, more frequent downstream flood events could occur, resulting in increased erosion or exposure of cultural resources during flood events over time. The incremental changes in sediment deposition, erosion, and vandalism (through site access in reservoir areas) resulting from the high flow scenario may be expected to have the greatest cumulative impact over time by expanding the areas where opportunities would increase for loss of these resources.

4.11 Mitigation Considerations

Mitigation actions are measures taken to avoid, offset, reduce, or compensate for the adverse effects to the environment that may potentially result from implementing the proposed action. Specific mitigation actions cannot be addressed until a specific allocation formula has been identified and specific plans are developed to implement the formula. The purpose of this section in this draft programmatic EIS is to recognize the responsibility to identify those mitigation actions that may be necessary once the agreed upon formula is known; and to describe the process to determine appropriate mitigation measures for implementation of an allocation formula. At this stage of the evaluation process, only broad categories of mitigation for certain types of impacts can be addressed. After receiving public review and comments on the draft EIS, and after an allocation formula is agreed to by the States, the potential for certain types of impacts that may result from implementation of the allocation formula can be determined. The final programmatic EIS will evaluate the range of impacts anticipated to result from implementating the formula, and will address the appropriate categories of mitigation actions for certain anticipated types of impacts at the conceptual level of planning. Specific mitigation actions would be developed in conjunction with development of the specific plans for implementing the formula.

The next step in the process of implementing the formula, after it has been agreed upon, is to determine how the various water control structures (dams or reservoirs) within the river basin would be regulated or operated to achieve the flows or other parameters required by the formula. Once the specific operation plans for the water control projects are determined, then specific mitigation measures will be also be developed, as determined necessary, to compensate for impacts related to these changes in operations. Prior to implementation of these specific alternative operation plans, the proposed actions and proposed mitigation actions would be addressed in tiered, or follow on site-specific NEPA documents. These tiered NEPA documents could be in the form of follow-on EISs or environmental assessments, depending upon the nature and scope of the changes and associated impacts.

Effects upon all relevant resources resulting from implementing the formula will be evaluated to determine if mitigation measures are appropriate. Mitigation actions would address direct, indirect and cumulative impacts, as identified. Appropriate mitigation actions may not be limited to actions taken by the Federal government, but could also include certain mitigation actions that could be taken by local, regional, or state governments or by private entities. Typical examples of the how the appropriate categories of mitigation will be identified and evaluated are described below:

4.11.1 Water Quantity

The main focus of the formula development being addressed by the Water Allocation Compact Commission is to equitably allocate water quantity among the concerned States. Each State will then in turn determine how the quantity and uses will be distributed within the State. Mitigation of impacts on water quantity is an inherent part of the State's responsibility. Mitigation methods to meet remaining water demands could include alternative sources of water supply, alternative conservation methods, and public programs to encourage wise use of water resources.

4.11.2 Water Quality

Should implementation of the formula have the potential to lower ambient conditions below established standards, methods to avoid or offset the effect will be identified. These methods may include upgrading wastewater treatment facilities in affected stream segments and/or examining ways of controlling runoff and effluent discharges during critical periods.

4.11.3 Aquatic Resources

Should implementation of the formula adversely effect aquatic biological resources such as fish, wildlife, wetlands, commercial species (e.g., oysters), or especially any threatened or endangered species or habitat, methods to avoid or offset the effects may include establishing rigidly controlled flow conditions at those specific sites, or during certain critical periods. There may even be opportunities to enhance those resources while addressing appropriate mitigation measures. Impacts related to increased groundwater pumpage, such as decreased flow in springs that provide cold water habitat for fish, could be mitigated by controlling the location or timing of pumpage, through local or State programs, during critical periods.

4.11.4 Geology and Soils

The most likely effect from implementing the formula may be increased erosion and sedimentation problems within the basin. Regulation of specific reservoir levels and flow releases will be closely evaluated not only to meet the formula requirements but to avoid adding to the current erosion problems. Additional local measures may be necessary to reduce sedimentation into streams and reservoirs. The potential for localized sinks or subsidence features could be mitigated by limiting groundwater pumpage in the vicinity of specific, localized vulnerable areas. This type of action would be implemented by local or State programs.

4.11.5 Recreation

Should implementation of the formula affect recreational activities within the basin, methods of avoiding or offsetting the effects may include controlling flows to the desired levels, if feasible, during critical periods. Again, just as for the aquatic resources, opportunities to enhance recreation may be determined during the mitigation identification process.

4.11.6 Conclusion

The above examples are not intended to be inclusive but are intended to present the methodology in addressing mitigation measures in this ongoing evaluation process. Each of the resources and the effects described in Section 4, Affected Environment and Consequences, will be evaluated in detail with appropriate mitigation measures identified in the follow-on, site-specific NEPA documents as specific operation plans are developed for implementating the allocation formula.

4.12 Other NEPA Considerations

4.12.1 Unavoidable Adverse Effects

Unavoidable adverse effects are those environmental consequences of an action that cannot be avoided either by changing the nature of the action or through mitigation. Under the alternatives considered for this EIS, the physical laws that affect sedimentation and erosion that might result from increased reservoir fluctuations or changes in stream flow are unavoidable and potentially adverse. These effects include damage or increased access to cultural resources and impacts to water quality and biological resources. There also are losses for some recreational uses when reservoirs or streams are below certain levels that are also unavoidable. Other reductions in water level elevations that may be linked to conditions of drought under the low flow scenario can also have an unavoidable effect on navigation.

4.12.2 Irreversible and Irretrievable Commitment of Resources

An irreversible commitment of resources is defined as the loss of future options. The term usually refers to non-renewable resources, such as minerals or cultural resources, or to those resources that are renewable only over a very long period of time, such as wetlands and riparian habitats. Irretrievable commitments apply to the loss of production, harvest, or use of renewable natural resources, such as might arise from a seasonal shift in water use that affected the growth of a particular crop during a critical season.

For example, erosion of soils as a result of increased reservoir fluctuations or downstream export of these soils by increased stream flows would result in irreversible and irretrievable losses. Similar losses of resources that would be irreversible and irretrievable might include impacts to protected species or cultural resources where these losses were not recoverable.

5. List of Preparers

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Staff/Section	Education	Years of Experience	Technical Expertise
			resources
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Courtney Koenig	B.A., Environmental Policy	8	Public involvement
Heather Kunz	B.A., Journalism	11	Public involvement advisor
Tunch Orsoy	M.S., Marine Science	6	Estuarine ecology, wetlands, wildlife
Dale Jones	M.S., Biology	3	Fisheries biology
Christine Washburn	M.U.P., Urban Planning	12	Recreation analysis
Virginia Lane	B.L.A., Landscape Architecture	20	Socioeconomics task leader
Diane Reilly	M.A., Economics	3	Socioeconomics
Heather Dyke	M.C.P., Environmental Planning	3	Land use analysis
Ginny Farris	B.A., Psychology	15	Economics analysis
Kris Garcia	M.S., Geology	14	Geology/hydrogeology
Marie Strum	M.S., Environmental Engineering	11	Water resources co-task leader

Staff/Section	Education	Years of Experience	Technical Expertise
Jerry Scheller	M.S., Civil and Environmental Engineering	8	Navigation window analysis task leader
Chris Coates	Ph.D., English	4	Web and computer technologies
Jane Medved	M.A., Mass Communication	20	Editorial support
Tom Rigert	M.S., Physics	23	Editorial support
RMA			
Don Smith, P.E.	B.S., Civil Engineering	30	Water quality modeling
Brockington and Associates, Inc.			
Paul Brockington	Ph.D., Anthropology	29	Cultural resources
Thomas Whitley	M.A., Anthropology	12	Cultural resources, GIS modeling
Tetra Tech, Inc.			
Rick Whetsel	M.S., Resource Economics	1	Environmental modeling
Andrew Parker	M.E., Environmental Engineering	2	Environmental engineering
Mohammed Lahlou	Ph.D., Environmental Engineering	18	Principal manager

6. Coordination

Copies of the draft EIS were distributed to the following elected officials, agencies, tribes, organizations, individuals, and others for review in late September 1998. Newsletters and news releases were published announcing the availability of the draft EIS. Copies of the document were sent to approximately 60 libraries in the ACT and ACF river basins.

Federal Elected Officials and State Governors

Senator Richard Shelby	Alabama	Washington, DC
Senator Jeff Sessions	Alabama	Washington, DC
Senator Bob Graham	Florida	Washington, DC
Senator Connie Mack	Florida	Washington, DC
Senator Max Cleland	Georgia	Washington, DC
Senator Paul Coverdell	Georgia	Washington, DC
Congressman Sonny Callahan	Alabama	Washington, DC
Congressman Terry Everett	Alabama	Washington, DC
Congressman Bob Riley	Alabama	Washington, DC
Congressman Robert Aderholt	Alabama	Washington, DC
Congressman Robert Cramer, Jr.	Alabama	Washington, DC
Congressman Spencer Bachus	Alabama	Washington, DC
Congressman Earl Hilliard	Alabama	Washington, DC
Congressman Joe Scarborough	Florida	Washington, DC
Congressman Allen Boyd	Florida	Washington, DC
Congressman Jack Kingston	Georgia	Washington, DC
Congressman Sanford Bishop, Jr.	Georgia	Washington, DC
Congressman Mac Collins	Georgia	Washington, DC
Congressman Cynthia McKinney	Georgia	Washington, DC
Congressman John Lewis	Georgia	Washington, DC
Congressman Newt Gingrich	Georgia	Washington, DC
Congressman Bob Barr	Georgia	Washington, DC
Congressman Saxby Chambliss	Georgia	Washington, DC
Congressman Nathan Deal	Georgia	Washington, DC
Congressman Charlie Norwood	Georgia	Washington, DC
Governor Fob James	Alabama	Montgomery, AL
Governor Lawton Chiles	Florida	Tallahassee, FL
Governor Zell Miller	Georgia	Atlanta, GA

Federal Agencies

Department of Energy (10)	Office of Environmental Compliance	Washington, DC
Southeastern Power Administration (3)		Elberton, GA
Federal Energy Regulatory Commission (5)	Advisor on Environmental Quality	Washington, DC
Department of the Interior (12)	Office of Environmental Policy	Washington, DC
Department of the Interior (2)	Office of Environmental Policy and Environmental Compliance	Atlanta, GA
National Park Service (5)	Regional Office	Atlanta, GA
Fish and Wildlife Service (3)	Panama City Field Office	Panama City, FL
Fish and Wildlife Service (2)	Daphne Field Office	Daphne, AL
Fish and Wildlife Service (1)	Brunswick Field Office	Brunswick, GA
Fish and Wildlife Service (1)	Brunswick Suboffice	Ft. Benning, GA
Fish and Wildlife Service (1)	Eufaula National Wildlife Refuge	Eufaula, AL
U.S. Geological Survey (2)	Regional Office	Norcross, GA
U.S. Geological Survey (2)	Alabama District Office	Montgomery, AL
U.S. Geological Survey (2)	Florida District Office	Tallahassee, FL

Federal Agencies (continued)

U.S. Geological Survey (2)	Georgia District Office	Atlanta, GA
U.S. Geological Survey (1)		Snellville, GA
U.S. Geological Survey (1)	Biological Resources Division	Athens, GA
Federal Emergency Management Agency (5)		Washington, DC
Federal Emergency Management Agency (1)	Regional Director	Atlanta, GA
Environmental Protection Agency (5)	Office of Federal Activities	Washington, DC
Environmental Protection Agency (10)	Region IV	Atlanta, GA
National Oceanic And Atmospheric Administration (4)	Ecology and Environmental Conservation	Washington, DC
National Oceanic And Atmospheric Administration (1)	National Marine Fisheries Service	Silver Springs, MD
National Oceanic And Atmospheric Administration (2)	National Ocean Service	Silver Springs, MD
Advisory Council on Historic Preservation (1)		Washington, DC
Federal Maritime Administration (1)	Office of the Secretary	Washington, DC
Federal Maritime Administration (1)		New Orleans, LA
U.S. Coast Guard (2)	8th District	New Orleans, LA
U.S.D.A., Forest Service (2)	Southern Regional Office	Atlanta, GA
U.S.D.A., Natural Resources Conservation Service (3)	Alabama State Conservationist	Auburn, AL
U.S.D.A., Natural Resources Conservation Service (1)		Abbeville, AL
U.S.D.A., Natural Resources Conservation Service (2)	Florida State Conservationist	Tallahassee, FL
U.S.D.A., Natural Resources Conservation Service (3)	Georgia State Conservationist	Athens, GA
U.S. Department of Housing and Urban Development (2)		Atlanta, GA
Federal Highway Administration (2)		Atlanta, GA
U.S. Department of Health and Human Services (2)	Center for Env. Health, Special Programs	Atlanta, GA
Heritage Conservation and Recreation Service (1)	Environmental Compliance, SE Region	Atlanta, GA
ACF River Basin Commission (1)	Federal Commissioner Lindsay Thomas	Atlanta, GA
U.S. Army Corps of Engineers (3)	Hydrologic Engineering Center	Davis, CA
U.S. Army Corps of Engineers (2)	Waterways Experiment Station	Vicksburg, MS
U.S. Army Environmental Policy Institute (1)		Atlanta, GA
U.S. Department of Justice (2)		Washington, DC

Native American Tribes

Mississippi Band of Choctaw Indians	Tribal Chief	Philadelphia, MS
Eastern Shawnee Tribe of Oklahoma	Chief	Seneca, MO
Absentee-Shawnee Tribe of Oklahoma	Governor	Shawnee, OK
United Keetoowah Band of Cherokee Indians	Chief	Tahlequah, OK
Eastern Band of Cherokee Indians	Principal Chief	Cherokee, NC
Miccosukee Tribe	Chairman	Miami, FL
Poarch Band of Creek Indians	Chairman	Atmore, AL
Cherokee Nation of Oklahoma	Principal Chief	Tahlequah, OK
Seminole Tribe of Florida	Chairman	Hollywood, FL
Alabama-Quassarte Tribal Town		Henryetta, OK
Muscogee (Creek) Nation	Principal Chief	Okmulgee, OK
Seminole Nation of Oklahoma	Principal Chief	Wewoka, OK
Thlopthlocco Tribal Town	Town King	Okemah, OK
Kialegee Tribal Town	Town King	Wetmuka, OK
Coushatta Tribe	Chairman	Elton, LA
Alabama-Coushatta Tribe of Texas	Chairperson	Livingston, TX

State and Local Agencies

Alabama Department of Economic and Community Affairs (3)	Office of Water Resources	Montgomery, AL
Alabama Department of Environmental Management		Montgomery, AL
Alabama Department of Conservation and Natural Resources	Game and Fish Division	Montgomery, AL
Alabama State Historic Preservation Officer	Alabama Historic Commission	Montgomery, AL
Alabama State Docks		Mobile, AL
East Alabama Regional Planning and Development Commission		Anniston, AL
Lee-Russell Council of Governments		Opelika, AL
Southeast Alabama Regional Planning and Development Commission		Dothan, AL
Tuscaloosa Park and Recreation Authority		Tuscaloosa, AL
Mobile County Health Department		Mobile, AL
City of Leesburg		Leesburg, AL
City of Jacksonville		Jacksonville, AL
City of Kinsey		Kinsey, AL

State and Local Agencies

Phenix City Utilities		Phenix City, AL
Northwest Florida Water Management District (2)		Havana, FL
Florida Department of Environmental Protection (2)		Tallahassee, FL
Florida Department of Environmental Protection		East Point, FL
Florida State Clearinghouse (12)		Tallahassee, FL
Florida State Historic Preservation Officer	Division of Historic Resources	Tallahassee, FL
Florida Department of Transportation		Chipley, FL
Georgia Department of Natural Resources (3)	Environmental Protection Division	Atlanta, GA
Georgia Department of Natural Resources	Wildlife Resources Division	Social Circle, GA
Georgia Department of Natural Resources (2)	Wildlife Resources Division	Albany, GA
Georgia State Clearinghouse (5)		Atlanta, GA
Georgia Department of Community Affairs		Atlanta, GA
Georgia State Historic Preservation Officer	Historic Preservation Section	Atlanta, GA
Board of Commissioners		Ft. Gaines, GA
Paulding County Water Authority		Dallas, GA
City of Cordele		Cordele, GA
City of Gainesville		Gainesville, GA
City of Kennesaw		Kennesaw, GA
Public Works Commission		Stone Mountain, GA
Southwest Georgia Regional Development Commission		Camilla, GA
Dougherty County	Environmental Health	Albany, GA
City of Donalsonville		Donalsonville, GA
City of Bainbridge		Bainbridge, GA
City of Roswell		Roswell, GA
Columbus Water Works		Columbus, GA

Public and University Libraries

Adelia M. Russell Library	Alexander City, AL
Gadsden Public Library	Gadsden, AL
Monroe County Public Library	Monroeville, AL
Auburn Public Library	Auburn, AL
Mobile Public Library	Mobile, AL
Chilton-Clanton Public Library	Clanton, AL
Selma Public Library	Selma, AL
Jacksonville Public Library	Jacksonville, AL
Montgomery City-County Library	Montgomery, AL
St. Clair County Library	Pell City, AL
Rainwater Memorial Library	Childersburg, AL
White Smith Memorial Library	Jackson, AL
Chambers County Library	Valley, AL
Anniston Main Library	Anniston, AL
Houston Love Memorial Library	Dothan, AL
Birmingham Central Library	Birmingham, AL
Evergreen Public Library	Evergreen, AL
Carnegie Library	Eufaula, AL
Jacksonville State University	Jacksonville, AL
University of Alabama at Birmingham	Birmingham, AL
University of Alabama	Tuscaloosa, AL
Auburn University	Auburn, AL
University of South Alabama	Mobile, AL
Apalachicola Municipal Library	Apalachicola, FL
Calhoun County Public Library	Blountstown, FL
Leon County Public Library	Tallahassee, FL
Bay County Public Library	Panama City, FL
Chattahoochee Public Library	Chattahoochee, FL
Jackson County Public Library	Marianna, FL
Florida State University	Tallahassee, FL
University of Florida	Gainesville, FL
U.S. Environmental Protection	Atlanta, GA
LaGrange Memorial Library	LaGrange, GA
Thomasville Cultural Center Library	Thomasville, GA
Dougherty County Public Library	Albany, GA

Public and University Libraries

Southwest Georgia Regional Library	Bainbridge, GA
Cordele/Crisp County Carnegie Library	Cordele, GA
North Columbus Branch Library	Columbus, GA
Macon/Bibb County Public Library	Macon, GA
Griffin/Spalding County Library	Griffin, GA
Rome/Floyd County Library	Rome, GA
Newnan/Coweta Public Library	Newnan, GA
Cobb County Library System	Acworth, GA
Douglas County Public Library	Douglasville, GA
Calhoun/Gordon County Library	Calhoun, GA
Dalton Regional Library	Dalton, GA
Bartow County Library	Cartersville, GA
Athens Regional Library	Athens, GA
Cobb County Library System	Marietta, GA
Atlanta/Fulton County Public Library	Atlanta, GA
East Hall Public Library	Gainesville, GA
Lumpkin County Library	Dahlonega, GA
Chatsworth/Murray County Library	Chatsworth, GA
Georgia Institute of Technology	Atlanta, GA
University of Georgia Libraries	Athens, GA
Kennesaw State University	Kennesaw, GA
Georgia State University	Atlanta, GA
Gainesville College	Gainesville, GA
Columbus State University	Columbus, GA
State University of West Georgia	Carrolton, GA

Organizations

First Name	*Last Name*	*Organization*	*City*	*State*
Earl	Carlile	Carlile Realty	Dothan	AL
Richard	Monroe	Easter Seals	Jackson's Gap	AL
Robert	Powers	Eufaula Agency, Inc	Eufaula	AL
C.	Blevins	Soil & Water Conservation District	Falkville	AL
Eddie	Lanier	WestPoint Pepperell	Valley	AL
Stephen	Shimmel	Chipola Junior College	Marianna	FL
Ernie	Estevez	Mote Marine Laboratory	Sarasota	FL
Donald	Wood	St. Joe Paper Company	Carrabelle	FL
Charles	Nix	LaGrange Daily News	LaGrange	GA
David	Long	Alabama River Companies	Lilburn	GA
William	Tietjen	Biology Department	Plains	GA
Marcus	Waters	Crisp County Power Commission	Cordele	GA
Jim	Rhoden	Futren Corporation	Atlanta	GA
Arthur	Ford	Georgia Institute of Technology	Albany	GA
Don	Miller	Georgia-Pacific	Cedar Springs	GA
Ken	Manning	Highland Marina & Resort	LaGrange	GA
John	Hurd	LaGrange College	LaGrange	GA
Harland	Cofer	Lake Blackshear Watershed Association	Americus	GA
E.	Hughes	Lake Lanier Association Board of Directors	Gainesville	GA
Gary	Bible	Lake Lanier Homeowners Association	Buford	GA
Malcolm	Horrell, Jr.	Lake Lanier Property Owners Assoc.	Buford	GA
William	Prescott	Lake Lanier Property Owners Assoc.	Cumming	GA
Lucille	Davenport	Lake Lanier Property Owners Assoc.	Gainsville	GA
Douglas	Smith	Lake Lanier Property Owners Assoc.	Cummings	GA
Robert	Carver	University of Georgia	Athens	GA
Susan	Foster	Plan Graphics	Frankfort	KY

Organizations

First Name	*Last Name*	*Organization*	*City*	*State*
Walter	Dennis	International Paper South Carolina Region	Natchez	MS
Samuel	Kunkle	Colorado University	Santa Fe	NM
William	Cunningham	AFIT/LAL	WPAFB	OH
James	Mobley	Alabama Peanut Producer Association	Dothan	AL
Roy	Kendrick	Alabama Soil and Water Conservation District	Montgomery	AL
Dennis	Block	Alabama Water Resources Research Institute	Auburn	AL
David	Bayne	Auburn University	Auburn	AL
Glenn	Waddell	Balch & Bingham	Birmingham	AL
William	Satterfield	Balch & Bingham	Birmingham	AL
		Bio-Diversity	Birmingham	AL
		Birmingham Audubon Society	Birmingham	AL
Jim	Bain	c/o Russell Lands, Inc.	Alexander	AL
Fred	Dobbs	Dobbs Realty	Alexander City	AL
Bill	Whatley	First Realty	Alexander City	AL
Bill	Irby	James River Corporation	Pennington	AL
Jim	Bain	Lake Martin Living Magazine	Alexander City	AL
John	Glasier	Lake Watch of Lake Martin	Dadeville	AL
Don	Greer	Logan Martin Lake Protection Association	Pell City	AL
Brian	Frennea	Ryan-Walsh	Mobile	AL
Nicholas	Barchie	Seaport Shipping of Alabama	Mobile	AL
Margie	Welch	Sierra Club - Alabama Chapter	Mobile	AL
Dan	Patel	Southern Company Services	Birmingham	AL
William	Andreen	The University of Alabama School of Law	Tuscaloosa	AL
Gena	Todia	Wetland Resources	Daphne	AL
Neil	Grigg	Colorado State University	Fort Collins	CO
		Appalachian Regional Comm	Washington	DC
		Earth Justice Legal Defense Fund	Tallahassee	FL
William	Landing	Florida State University	Tallahassee	FL
Bill	Harley	Florida Wildlife Federation	Tallahassee	FL
Irene	Harley	Florida Wildlife Federation	Tallahassee	FL
James	Martin	ASCL Corp.	Athens	GA
Laurie	Ashmore	Brown & Caldwell Consultants	Conyers	GA
Harry	McGinnis	Burriss Institute, Kennesaw State College	Kennesaw	GA
George	Stanton	Columbus State University	Columbus	GA
Ken	Edelstein	Creative Loafing	Atlanta	GA
W.	Gray	Dellinger Management Co., Inc.	Cartersville	GA
Mark	Crisp, P.E.	GDS & Associates, Inc.	Marietta	GA
Bob	Herrington	Georgia Southwestern State University	Americus	GA
Bill	Frazier	Georgia's Streams/Fish Traps	Decatur	GA
David	Ashley	Jordan, Jones and Goulding, Inc.	Atlanta	GA
Roger	Bauer	Lake Lanier Advisory Council	Cumming	GA
Gene	Blakley	Minutemen Recreation Association	Kennesaw	GA
Tim	Cole	Paulding County Water Authority	Dallas	GA
Robert	Rowe	Rowe Realty Co., Inc.	Columbus	GA
Harold	Jones	Southeastern Power Administration	Elberton	GA
John	Fleetwood	Stamp Creek Subdivision	White	GA
Sally	Bethea	Upper Chattahoochee Riverkeeper	Atlanta	GA
Sally	Bethea	The Georgia Conservancy	Atlanta	GA

Organizations

First Name	*Last Name*	*Organization*	*City*	*State*
Jackie	Sellers	The University of Georgia	Athens	GA
James	Emery	Emery & Garrett Groundwater, Inc	Meredith	NH
Chester	McConnell	Wildlife Management Inst	Lawrenceburg	TN
Dave	Pendleton	Sea Port Marine Corp	Chesapeake	VA
Richard	Palmer	University of Washington	Seattle	WA
Constance	Hunt	World Wildlife Fund	Washington	DC
Wesley	Woolf	Southern Environmental Law Center	Atlanta	GA

Individuals

First Name	*Last Name*	*City*	*State*
E.	Bishop	Dothan	AL
Benny	Buchanan	Dothan	AL
Aaron	Dansby	Abbeville	AL
John	Davis	Dothan	AL
Lawrence	Durden	Abbeville	AL
Cecil	Dykes	Dothan	AL
W.	Faust	Ozark	AL
Blakeney	Gillett	Tuscaloosa	AL
Danny	Goldsboro	Dothan	AL
Tom	Grimmer	Dothan	AL
Clyde	Hayes	Dothan	AL
Wayne	Higgins	Dothan	AL
Hayne	Hollis	Dothan	AL
Johnny	Jackson	Hartford	AL
Dot	Jackson	Hartford	AL
Shafford	Lasley	Valley	AL
Bernard	Lattman	Abbeville	AL
Sam	Marley	Dothan	AL
James	McInnish	Cowarts	AL
Rupel	McInnish	Cowarts	AL
Paul	Montana	Dothan	AL
Devon	Nooner	Abbeville	AL
Coy	Poitevitit	Dothan	AL
Dan	Raymond	Ozark	AL
Rebecca	Robinson	Dothan	AL
J.	Roland	Dothan	AL
Lynwood	Rutland	Daleville	AL
William	Sirmons	Webb	AL
Marcus	Smith	Eufaula	AL
George	Sowell	Pansey	AL
Jack	Spikes	Gordon	AL
Charles	Swicord	Dothan	AL
David	Wade	Abbeville	AL
Carlton	Wilhouser	Dothan	AL
Lowell	Yearta	Dothan	AL
Marilyn	Barger	Tallahasee	FL
Kenneth	Cowen	Quincy	FL

Individuals

First Name	*Last Name*	*City*	*State*
Linda	Fitzhugh	Panama City	FL
Jim	Lewis	Tallahassee	FL
Jesse	Newell	Southport	FL
Cana	Nudi	Tallahassee	FL
William	Palmer	Altha	FL
Greg	Seamon	Bristol	FL
Dennis	Tharp	Chattahoochee	FL
Warren	Yeager	Port St. Joe	FL
Floyd/Frances	Amend	Gainesville	GA
M.	Bales	Dawsonville	GA
James	Ballengee	Columbus	GA
Phillip	Beard	Buford	GA
Robert	Bumbalough	Buford	GA
Harold	Coppinger	Bainbridge	GA
Karmen	Duchon	Atlanta	GA
Gene	Dusenberry	Gainesville	GA
John	Edwards	Atlanta	GA
Michael	Elliott	Atlanta	GA
Phil	Farkas	Georgetown	GA
Bruce	Hansen	Stone Mountain	GA
Wade	Hutcheson	Griffin	GA
Richard	Ivey	Cumming	GA
David	LaVance	Gainesville	GA
I.	Levine	Gainesville	GA
Steve	Lykins	Duluth	GA
Cam	McNair	Peachtree City	GA
William	Miller	Gainesville	GA
William	Moorr	Jonesboro	GA
Stuart	Moring	Roswell	GA
Rick	Morris	LaGrange	GA
Robert	Pounds	Chamble	GA
Mark	Reed	Baldwin	GA
Michael	Revitsky	Atlanta	GA
Mark	Risse	Athens	GA
George	Slappey	Decatur	GA
Nancy	Smallwood	Cumming	GA
W.	Smith	Turin	GA
Frank	Stephens	Lawrenceville	GA
Lyman	Strickland	Dunwoody	GA
J.	Swicord	Bainbridge	GA
Richmond	Tevvy	West Point	GA
Ellis	Webb	Georgetown	GA
Hoy	Williams	Cumming	GA
Ted	Wurl	Bainbridge	GA
Nancy	Wylie	Atlanta	GA
Colleen	Williams	New Orleans	LA
Ronnie	Avery	Phenix	AL
Rosemary	Benedict	Alexander City	AL

Individuals

First Name	*Last Name*	*City*	*State*
Karl	Beulurth	Montgomery	AL
Vance	Braswell	Cropwell	AL
Alvin	Diamond	Troy	AL
Joseph	Donofro	Dothan	AL
Danny	Dyess	Dothan	AL
Phillip	Gadilhe	Birmingham	AL
Greg	Harber	Birmingham	AL
Mel	Osingd	Cropwell	AL
Scott B.	Pierce	Mobile	AL
Lem	Rainwater	Pell City	AL
Robert	Reid, Jr.	Birmingham	AL
Chris	Spivey	Pell City	AL
Dell	Stone	Alexander City	AL
Albert	Townes	Cropwell	AL
Sam	Vrachalus	Mobile	AL
Gerald	Watson	Abbeville	AL
Bill	Winters	Satsuma	AL
Dan	Tonsmeire	Midway	FL
Jerry	Buchanan	Columbus	GA
Tom	Burnett	Chamblee	GA
Alvin	Burrell	Decatur	GA
Kip	Duchon	Decatur	GA
Boyd	Duncan	Duluth	GA
Daniel	Fobas	Dunwoody	GA
Glynn	Groszmann	Roswell	GA
Harold	Hudgens	Albany	GA
Peter	Kalla	Powder Springs	GA
Doug	Mercer	Cumming	GA
Ralph	Moore	Union City	GA
Judy	Noles	Atlanta	GA
Jim	Patsios	Woodland	GA
Robert	Phelps	Atlanta	GA
Dan	Provence	Bainbridge	GA
Richard	Santiago	Tyrone	GA
John	Springer	Midland	GA
John	Strickland	Dalton	GA
James	Swancy	Ranger	GA
James	Williams	Gainesville	GA
Michael	Wolfe	Atlanta	GA
Mr. & Mrs.	Fitzpatrick	Pass Chrictian	MS
Walter	Wunderlich	Knoxville	TN

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8. Index

ACF Basin, 1-1, 1-2, 1-3, 1-4, 1-5, 1-7, 1-8, 1-9, 1-10, 1-11, 1-12, 1-14, 1-16, 1-17, 1-19, 1-20, 1-23, 1-24, 1-25, 1-26, 1-27, 1-29, 2-1, 2-3, 2-4, 3-1, 3-2, 4-1, 4-4, 4-5, 4-6, 4-7, 4-8, 4-9, 4-10, 4-14, 4-15, 4-20, 4-22, 4-23, 4-25, 4-29, 4-35, 4-36, 4-37, 4-40, 4-41, 4-42, 4-43, 4-44, 4-46, 4-50, 4-52, 4-55, 4-56, 4-57, 4-58, 4-59, 4-62, 4-63, 4-64, 4-65, 4-66, 4-67, 4-69, 4-70, 4-71, 4-72, 4-73, 4-87, 4-99, 4-103, 4-105, 4-106, 4-107, 4-108, 4-111, 4-112, 4-113, 4-115, 4-117, 4-118, 4-135, 4-137, 4-138, 4-139, 4-140, 4-141, 4-142, 4-145, 4-146, 4-147, 4-148, 4-149, 4-150, 4-153, 4-154, 4-158, 4-163, 4-165, 4-174, 4-182, 4-183, 4-184, 4-185, 4-187, 4-191, 4-193, 4-194, 4-195, 4-196, 4-197, 4-201, 4-202, 4-204, 4-205, 4-206, 4-207, 4-208, 4-210, 4-211, 4-214, 4-215, 4-217, 4-219, 4-220, 4-225, 4-226, 4-228, 4-229, 4-230, 4-231, 4-232, 4-234, 4-235, 4-236, 4-238, 4-240, 4-241, 4-242, 4-244, 4-246, 4-247, 4-248, 4-249, 4-250, 4-251, 4-252, 4-255, 4-257, 4-261, 4-262, 4-264, 4-265
ACF Basins, 4-230, 4-249
ACF Compact, 1-10, 2-1, 2-3
ACF River Basin Compact, 1-10, 1-11, 4-142
Aesthetics, 4-5, 4-7
Agricultural Demand, 3-2, 3-5, 4-62, 4-105, 4-107, 4-108, 4-172, 4-195, 4-263
Agricultural Demands, 1-8, 1-28, 2-2, 4-8, 4-79, 4-82, 4-99
Agricultural Land Use, 4-112, 4-195
Agricultural Water Demand, 4-63, 4-195
Agricultural Water Demands, 1-28, 4-36, 4-82, 4-105, 4-204, 4-228, 4-238
Air Pollution, 4-248
Alabama, 1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 1-10, 1-14, 1-17, 1-19, 1-24, 3-1, 3-2, 3-5, 4-1, 4-10, 4-14, 4-19, 4-20, 4-22, 4-35, 4-40, 4-54, 4-55, 4-62, 4-63, 4-67, 4-105, 4-110, 4-111, 4-115, 4-116, 4-138, 4-139, 4-148, 4-151, 4-155, 4-165, 4-169, 4-174, 4-176, 4-177, 4-178, 4-179, 4-180, 4-181, 4-186, 4-193, 4-199, 4-204, 4-205, 4-206, 4-207, 4-208, 4-225, 4-227, 4-228, 4-231, 4-232, 4-233, 4-234, 4-236, 4-240, 4-241, 4-242, 4-243, 4-244, 4-245, 4-246, 4-252, 4-257
Alabama Power Company, 4-227
Albany, 4-36, 4-42, 4-72, 4-79, 4-80, 4-81, 4-83, 4-116, 4-131, 4-132, 4-135, 4-152, 4-184, 4-193, 4-199, 4-201, 4-202, 4-203, 4-231
Anadromous Fish, 1-8, 1-18, 4-155
Apalachicola Bay, 1-8, 1-11, 1-18, 1-20, 1-27, 4-1, 4-10, 4-43, 4-72, 4-82, 4-113, 4-132, 4-198, 4-214, 4-239, 4-264
Apalachicola River, 1-2, 1-6, 1-8, 1-25, 1-27, 4-10, 4-14, 4-20, 4-25, 4-30, 4-33, 4-37, 4-40, 4-43, 4-44, 4-46, 4-48, 4-58, 4-59, 4-66, 4-72, 4-82, 4-84, 4-85, 4-86, 4-87, 4-96, 4-99, 4-101, 4-102, 4-110, 4-113, 4-115, 4-116, 4-132, 4-133, 4-134, 4-138, 4-140, 4-141, 4-143, 4-144, 4-146, 4-147, 4-150, 4-151, 4-154, 4-155, 4-156, 4-158, 4-159, 4-160, 4-161, 4-164, 4-173, 4-183, 4-199, 4-211, 4-214, 4-215, 4-221, 4-222, 4-227, 4-230, 4-235
Aquatic, 4-2, 4-5, 4-6, 4-7, 4-115, 4-149
Aquatic Habitats, 4-261
Aquifer, 4-4, 4-19, 4-20, 4-22, 4-56, 4-57, 4-58, 4-59, 4-117, 4-184, 4-262
Atlanta, 1-2, 1-3, 4-15, 4-36, 4-40, 4-42, 4-52, 4-59, 4-69, 4-75, 4-89, 4-102, 4-105, 4-107, 4-111, 4-112, 4-115, 4-116, 4-117, 4-125, 4-152, 4-153, 4-184, 4-193, 4-194, 4-197, 4-202, 4-203, 4-211, 4-231, 4-232, 4-244, 4-248, 4-265
Bartletts Ferry, 4-48, 4-54
Baseflow, 4-10, 4-36, 4-43, 4-56
Basins, 1-4, 1-5, 1-6, 1-9, 1-16, 1-24, 4-20, 4-29, 4-57, 4-59, 4-65, 4-66, 4-70, 4-107, 4-108, 4-110, 4-113, 4-140, 4-144, 4-153, 4-210, 4-211, 4-216, 4-262, 4-265
Biodiversity, 1-10, 4-7, 4-158, 4-183
Biological Diversity, 4-137, 4-183

Biological Oyster Mortality Model, 4-171
Birmingham Water Works Board, 1-14
Boating, 4-54, 4-211, 4-212, 4-213, 4-214, 4-215, 4-265
Bottomland Hardwood Forest, 4-140, 4-149
Buford Dam, 4-48, 4-52, 4-53, 4-59, 4-66, 4-73, 4-115, 4-119, 4-121, 4-122, 4-142, 4-150, 4-152, 4-153, 4-158, 4-163, 4-164, 4-187, 4-189, 4-210, 4-211, 4-214, 4-221, 4-223, 4-227, 4-228, 4-229, 4-238
Buford Trout Hatchery, 4-119, 4-121, 4-123, 4-187, 4-189
Carters Lake, 1-3, 1-4, 1-5
CEQ, 3-5
CE-QUAL-W2, 1-24, 1-25, 4-118
Chattahoochee River, 1-18, 1-25, 4-15, 4-29, 4-31, 4-37, 4-40, 4-42, 4-44, 4-46, 4-48, 4-49, 4-52, 4-53, 4-54, 4-55, 4-56, 4-66, 4-67, 4-72, 4-73, 4-74, 4-75, 4-76, 4-77, 4-78, 4-79, 4-82, 4-88, 4-89, 4-90, 4-102, 4-111, 4-112, 4-115, 4-116, 4-117, 4-119, 4-120, 4-121, 4-122, 4-123, 4-124, 4-125, 4-126, 4-127, 4-128, 4-129, 4-130, 4-131, 4-137, 4-138, 4-143, 4-144, 4-146, 4-150, 4-152, 4-153, 4-154, 4-158, 4-159, 4-160, 4-161, 4-163, 4-184, 4-187, 4-189, 4-193, 4-194, 4-197, 4-198, 4-202, 4-211, 4-214, 4-215, 4-221, 4-223, 4-225, 4-227, 4-228
Chattahoochee River National Recreation Area, 4-214, 4-221
City of Atlanta, 1-2, 4-59, 4-115
Clean Air Act, 1-29
Clean Water Act, 1-10, 1-29, 4-108, 4-111, 4-201
Compact, 1-1, 1-5, 1-10, 1-11, 1-14, 1-16, 2-1, 2-3, 2-4
Comprehensive Study, 1-3, 1-4, 1-5, 1-6, 1-7, 1-8, 1-10, 1-15, 1-17, 1-18, 1-19, 1-20, 1-21, 1-23, 1-24, 1-27, 3-1, 3-2, 3-3, 3-4, 4-1, 4-15, 4-35, 4-57, 4-59, 4-62, 4-64, 4-118, 4-137, 4-139, 4-141, 4-143, 4-145, 4-146, 4-147, 4-149, 4-153, 4-156, 4-165, 4-173, 4-174, 4-183, 4-184, 4-185, 4-187, 4-191, 4-194, 4-204, 4-207, 4-210, 4-214, 4-215, 4-216, 4-225, 4-229, 4-231, 4-232, 4-235, 4-238, 4-240, 4-244, 4-252
Cooperating Agencies, 1-14, 1-16, 1-18, 1-19, 1-20, 3-6, 4-1, 4-3, 4-35
Corps of Engineers, 1-1, 1-5, 1-6, 4-44, 4-186
Corps Waterways Experiment Station, 4-35
Council on Environmental Quality, 3-5
Critical Low Flow Periods, 3-1, 3-3, 3-5, 4-67, 4-145, 4-165, 4-169, 4-262
Cultural Resources, 1-11, 1-29, 4-1, 4-5, 4-9, 4-252, 4-255, 4-256, 4-257, 4-258, 4-259, 4-260, 4-266
Designated Use, 4-108
Economic Impact Forecasting System Model, 4-225
Endangered Species, 1-11, 1-29, 4-173, 4-174, 4-186, 4-268
Environmental Justice, 1-29, 4-8, 4-205, 4-208
Environmental Protection Agency, 1-1, 1-19, 1-24, 4-35
EPA, 1-24, 4-35, 4-111, 4-113, 4-117, 4-118, 4-119, 4-191, 4-193, 4-194, 4-201, 4-202, 4-205, 4-206, 4-247, 4-248, 4-249, 4-250, 4-251
Erosion, 1-18, 1-22, 4-3, 4-5, 4-6, 4-8, 4-9, 4-115, 4-142, 4-196, 4-202, 4-253, 4-254, 4-255, 4-256, 4-257, 4-258, 4-259, 4-260, 4-261, 4-266, 4-268
Essential Fish Habitat, 4-7
Estuarine, 1-18, 4-1, 4-7, 4-139, 4-141, 4-146, 4-155, 4-156, 4-171, 4-199, 4-264
Eufaula National Wildlife Refuge, 4-165, 4-186, 4-187, 4-201, 4-263
Evapotranspiration, 4-10, 4-36, 4-40, 4-87
Exceedance, 4-9
Executive Order 11988, 1-29
Executive Order 11990, 1-29
Executive Order 12088, 1-29
Executive Order 12898, 1-29
Executive Order 13045, 1-29
Federal Commissioner, 1-1, 1-10, 1-11, 1-14, 1-17, 2-1, 2-3, 3-2, 3-4, 4-2, 4-208
Fish, 1-18, 1-20, 3-6
Fish and Wildlife Coordination Act, 1-29, 4-137
Fish and Wildlife Service, 1-1, 1-19, 1-25
Fisheries, 1-1, 1-8, 1-18, 1-20, 1-27, 4-2, 4-99, 4-110, 4-137, 4-149, 4-150, 4-151, 4-152, 4-153, 4-154, 4-165, 4-166, 4-167, 168, 4-169, 4-188, 4-211, 4-263, 4-264
Fisheries Habitat, 4-2

Flood Control, 1-28, 3-2, 4-10, 4-35, 4-36, 4-40, 4-43, 4-46, 4-50, 4-52, 4-54, 4-55, 4-56, 4-65, 4-102, 4-142, 4-166, 4-167, 4-204, 4-215, 4-216, 4-217, 4-218, 4-220, 4-225, 4-228, 4-237, 4-238, 4-239
Floodplain, 4-4, 4-5, 4-20, 4-58, 4-140, 4-141, 4-143, 4-144, 4-147, 4-149, 4-151, 4-152, 4-158, 4-164, 4-177, 4-183, 4-184, 4-214, 4-228, 4-229, 4-238, 4-259
Florida, 1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 1-8, 1-10, 1-11, 1-14, 1-17, 1-19, 2-1, 2-3, 3-1, 3-2, 3-5, 4-1, 4-10, 4-14, 4-19, 4-20, 4-22, 4-35, 4-37, 4-43, 4-44, 4-46, 4-58, 4-62, 4-63, 4-67, 4-84, 4-85, 4-86, 4-87, 4-105, 4-110, 4-113, 4-115, 4-139, 4-141, 4-148, 4-155, 4-156, 4-171, 4-173, 4-174, 4-176, 4-177, 4-178, 4-179, 4-180, 4-181, 4-182, 4-187, 4-196, 4-198, 4-199, 4-201, 4-204, 4-205, 4-206, 4-207, 4-208, 4-210, 4-214, 4-225, 4-226, 4-228, 4-229, 4-231, 4-232, 4-233, 4-234, 4-236, 4-240, 4-241, 4-242, 4-243, 4-244, 4-245, 4-246, 4-252, 4-257
Forest Service, 1-20, 4-210
Forests, 1-20
FWS, 1-27, 4-144, 4-150, 4-164, 4-169, 4-173, 4-185, 4-187, 4-188
GDNR Wildlife Resources Division, 4-152
George W. Andrews Lake, 4-201
Georgia, 1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 1-10, 1-11, 1-14, 1-17, 1-19, 1-25, 2-1, 2-2, 2-3, 2-4, 3-1, 3-2, 3-5, 4-1, 4-10, 4-14, 4-15, 4-19, 4-20, 4-22, 4-23, 4-29, 4-35, 4-36, 4-40, 4-42, 4-43, 4-44, 4-46, 4-48, 4-53, 4-54, 4-55, 4-56, 4-57, 4-62, 4-63, 4-64, 4-67, 4-105, 4-108, 4-110, 4-111, 4-112, 4-115, 4-117, 4-119, 4-135, 4-137, 4-138, 4-152, 4-169, 4-176, 4-177, 4-178, 4-179, 4-180, 4-181, 4-182, 4-184, 4-186, 4-187, 4-193, 4-196, 4-197, 4-198, 4-199, 4-201, 4-202, 4-203, 4-204, 4-205, 4-206, 4-207, 4-208, 4-210, 4-214, 4-225, 4-226, 4-227, 4-228, 4-231, 4-232, 4-233, 4-234, 4-236, 4-240, 4-241, 4-242, 4-243, 4-244, 4-245, 4-246, 4-248, 4-252, 4-257, 4-263, 4-264, 4-265
Georgia Department of Natural Resources, 4-40, 4-111
Georgia Power Company, 2-4, 4-54, 4-55, 4-210
Groundwater, 1-2, 1-7, 1-18, 1-19, 1-20, 4-4, 4-19, 4-22, 4-56, 4-59, 4-63, 4-72, 4-82, 4-99, 4-104, 4-105, 4-107, 4-108, 4-117, 4-163, 4-165, 4-184, 4-195, 4-201, 4-238, 4-261, 4-262, 4-263, 4-264, 4-268
Groundwater Flow, 4-25, 4-42
Groundwater Recharge, 4-4, 4-99, 4-261
Groundwater Sources, 4-59, 4-99
Groundwater Use, 4-104, 4-165, 4-189, 4-263, 4-264
Groundwater Withdrawal, 3-6, 4-57, 4-58
Habitat, 4-268, 4-269
HEC-5, 1-19, 1-23, 1-24, 1-25, 1-28, 3-2, 4-15, 4-50, 4-62, 4-64, 4-65, 4-66, 4-67, 4-69, 4-70, 4-71, 4-72, 4-73, 4-78, 4-94, 4-96, 4-99, 4-100, 4-102, 4-104, 4-107, 4-118, 4-125, 4-131, 4-204, 4-223, 4-235, 4-238, 4-239
HEC-5Q, 1-24, 4-113, 4-115, 4-118, 4-119, 4-120, 4-121, 4-122, 4-123, 4-124, 4-125, 4-126, 4-127, 4-128, 4-129, 4-130, 4-131, 4-132, 4-133, 4-134, 4-135
Housing, 1-20
Hydrodynamic Model, 1-27, 4-1, 4-171
Hydroelectric, 4-10, 4-40, 4-52, 4-53, 4-55, 4-226
Hydrogeology, 4-4
Hydrologic Engineering Center, 1-23, 4-35, 4-65
Hydrologic Modeling, 4-1, 4-107, 4-204, 4-211, 4-213, 4-214, 4-215, 4-235
Hydrology, 4-1, 4-4, 4-5, 4-37, 4-143, 4-144, 4-147
Hydropower, 1-2, 1-3, 1-9, 1-19, 1-20, 3-2, 4-2, 4-9, 4-14, 4-36, 4-40, 4-46, 4-50, 4-52, 4-54, 4-55, 4-56, 4-66, 4-67, 4-68, 4-69, 4-71, 4-73, 4-113, 4-146, 4-152, 4-153, 4-166, 4-167, 4-173, 4-215, 4-218, 4-226, 4-236, 4-237, 4-262, 4-266
Hydropower Generation, 1-20, 4-2, 4-9, 4-69, 4-226, 4-262, 4-266
Income, 1-15, 1-28, 1-29
Industrial Demands, 4-62, 4-105
Industrial Discharges, 4-113, 4-115
Industrial Water Demands, 4-62, 4-104, 4-105, 4-106, 4-204, 4-205, 4-225
Industrial Water Supply, 1-2, 1-18, 1-28, 4-105, 4-106, 4-233, 4-234, 4-238
Industrial Water Use, 1-8
Interbasin Transfers, 4-6, 14-104, 4-265
Irrigation Demands, 4-62, 4-108

Jim Woodruff Lock And Dam, 4-34, 4-43, 4-48, 4-56, , 4-133, 4-150, 4-151, 4-158, 4-183, 4-184, 4-210, 4-227
Karst,4-4, 4-19, 4-20, 4-99, 4-117
Lake Allatoona, 1-3, 1-4, 1-5
Lake Blackshear, 4-33, 4-55, 4-79, 4-96, 4-113, 4-198
Lake Eufaula, 1-24, 4-210
Lake George W. Andrews, 4-210, 4-212, 4-213, 4-217
Lake Lanier, 1-2, 1-3, 1-4, 1-25, 4-15, 4-31, 4-34, 4-40, 4-48, 4-51, 4-52, 4-66, 4-72, 4-73, 4-88, 4-89, 4-90, 4-91, 4-102, 4-103, 4-104, 4-111, 4-112, 4-118, 4-119, 4-122, 4-124, 4-127, 4-145, 4-146, 4-150, 4-154, 4-164, 4-165, 4-166, 4-167, 168, 4-169, 4-170, 4-196, 4-212, 4-217, 4-218, 4-219, 4-227, 4-228, 4-229, 4-230, 4-238, 4-265
Lake Seminole, 1-25, 4-10, 4-31, 4-32, 4-33, 4-34, 4-40, 4-42, 4-43, 4-50, 4-56, 4-58, 4-59, 4-72, 4-96, 4-97, 4-98, 4-102, 4-113, 4-125, 4-132, 4-133, 4-134, 4-141, 4-145, 4-154, 4-165, 4-166, 168, 4-201, 4-210, 4-211, 4-212, 4-213, 4-214, 4-217, 4-220, 4-221, 4-227, 4-230
Lake Walter F. George, 4-230
Lake Worth, 4-42, 4-56, 4-58, 4-79, 4-96, 4-113, 4-154
Letter of Agreement, 1-4
Magnuson-Stevens Fishery Conservation and Management Act, 1-29, 4-156
Mainstem Rivers, 4-46, 4-150, 4-153
Marine Protection, Research, and Sanctuaries Act, 1-29
Maritime Administration, 1-1, 1-20
Maritime Forest, 4-137
Maritime Shrub, 4-137, 4-139
Memorandum of Agreement, 1-3
Minority Populations, 4-205
Mitigation, 4-1, 4-2
Morgan Falls, 4-48, 4-53, 4-54, 4-59, 4-73, 4-88, 4-119, 4-120, 4-122, 4-123, 4-124, 4-150, 4-152, 4-153, 4-154, 4-163, 4-164, 4-227
Municipal Water Needs, 4-57
Mussels, 1-18, 4-264
National Environmental Policy Act, 1-29
National Historic Preservation Act, 1-29, 4-252
National Marine Fisheries Service, 1-20, 4-156
National Oceanic and Atmospheric Administration, 4-1
National Park Service, 1-1, 1-19, 4-199, 4-210, 4-211, 4-214
National Pollutant Discharge Elimination System, 4-113
National Register of Historic Places, 4-9, 4-252
National Water Quality Assessment Program, 4-15, 4-112
Natural Resources Conservation Service, 1-1, 1-20, 1-21, 1-22, 1-28, 4-25, 4-62
Navigation Channel, 1-9, 4-44, 4-55, 4-56, 4-99, 4-113, 4-150, 4-225, 4-226
Navigation Flow Requirements, 1-19, 3-2, 4-55
Navigation Flows, 4-101
Navigation Projects, 1-9, 4-44
Navigation Windows, 4-44, 4-66, 4-67, 4-71, 4-102
NEPA, 1-4, 1-13, 1-14, 1-15, 1-17, 1-19, 2-3, 2-4, 3-1, 3-4, 3-6, 4-267, 4-268
NMFS, 4-156
Node, 1-23, 1-25, 1-26, 4-65, 4-72, 4-76, 4-107
Non-Renewable Fuel, 4-9
Notice of Intent, 1-15, 1-16
NPDES, 4-113, 4-115, 4-135, 4-262
NPS, 4-5
NRCS, 8, 1-21, 1-28, 3-2, 3-3, 4-25, 4-62, 4-63, 4-196, 4-238
Outstanding Florida Water, 4-113
Oyster, 1-27, 4-155, 4-156, 4-171, 4-172, 4-173, 4-239
Oysters, 1-8, 1-20, 1-27, 4-229, 4-239, 4-264, 4-268
Peak Hour Demand, 4-227, 4-228
Performance Measures, 1-25, 1-27, 4-137, 4-144, 4-149, 4-158, 4-166, 4-184
Phosphorous, 4-117
Pollution, 1-18, 4-108, 4-112, 4-115, 4-117, 4-226, 4-248, 4-262
Population, 4-108, 4-111, 4-186, 4-191, 4-193, 4-194, 4-204, 4-205, 4-206, 4-207, 4-208, 4-216, 4-229, 4-241, 4-249, 4-250, 4-251, 4-253, 4-254, 4-265
Populations, 1-29, 4-6, 4-8, 4-150, 4-151, 4-152, 4-163, 4-165, 4-169, 4-186, 4-239
Power Plants, 4-35
Precipitation, 4-108

Protected Species, 1-8, 1-18, 1-27, 4-1, 4-4, 4-5, 4-6, 4-7, 4-88, 4-173, 4-264
Public Health, 1-6
Public Involvement, 1-6, 1-15, 1-16, 1-17
Public Review, 1-15, 1-16
Rational Threshold Value, 1-28, 4-9, 4-241
Record of Decision, 1-17
Recreation, 1-3, 1-9, 1-14, 1-18, 1-19, 1-28, 2-4, 3-2, 4-1, 4-10, 4-36, 4-52, 4-53, 4-54, 4-55, 4-56, 4-88, 4-99, 4-186, 4-191, 4-196, 4-197, 4-204, 4-210, 4-211, 4-212, 4-213, 4-214, 4-215, 4-216, 4-217, 4-218, 4-219, 4-220, 4-221, 4-222, 4-223, 4-224, 4-225, 4-229, 4-239, 4-265
Reservoir, 4-2, 4-5, 4-7, 4-8, 4-9, 4-108, 4-118, 4-153, 4-165, 4-197, 4-211, 4-212, 4-213, 4-227, 4-228, 4-253
Reservoir Fisheries, 1-8, 1-18, 1-27, 4-137, 4-149, 4-153, 4-154, 4-165, 4-166, 4-167, 4-168, 4-169, 4-188, 4-239, 4-263, 4-264
Resource Conservation and Recovery Act, 1-29, 4-201
Riparian Wetland, 1-8, 4-137, 4-139, 4-143, 4-144, 4-149
River Basin Compact, 1-11, 1-14, 2-1, 2-3
Riverine, 4-7, 4-8, 4-149, 4-214
Riverine Aquatic Resources, 4-88, 4-137, 4-149
Riverine Habitat, 4-263
Riverine Resources, 1-8, 4-88, 4-159
ROD, 1-17
RTV, 1-28, 1-29
Safe Drinking Water Act, 1-29
Scenario, 3-2, 3-3
Scoping, 1-15, 1-16, 1-17
Sediment, 4-5, 4-9, 4-29, 4-30, 4-33, 4-34, 4-53, 4-108, 4-110, 4-112, 4-113, 4-115, 4-117, 4-141, 4-155, 4-183, 4-254, 4-256, 4-258, 4-259, 4-261, 4-266
Southeastern Power Administration, 1-1, 1-2, 1-20
State Commissioners, 1-11, 1-14, 3-4, 3-5
Subbasin, 4-62, 4-72, 4-73, 4-76, 4-79, 4-82, 4-88, 4-90, 4-96, 4-107, 4-117, 4-119, 4-122, 4-125, 4-127, 4-131, 4-132, 4-134, 4-193, 4-204, 4-261, 4-262
Surface Water, 1-6, 2-2, 4-4, 4-5, 4-9, 4-20, 4-25, 4-29, 4-35, 4-36, 4-37, 4-42, 4-56, 4-58, 4-59, 4-64, 4-65, 4-99, 4-107, 4-108, 4-112, 4-115, 4-142, 4-187, 4-194, 4-195, 4-196, 4-202, 4-238, 4-262, 4-264
Surficial Aquifer, 4-20
Tailwater Degradation, 4-33
Tallapoosa River, 1-4
Terrestrial, 1-18, 4-6, 4-137, 4-139, 4-142, 4-147, 4-149, 4-178, 4-179, 4-181, 4-184, 4-185, 4-263
Thermal, 1-18, 3-3, 3-5, 4-64, 4-105, 4-106, 4-107, 4-135, 4-151, 4-226, 4-237
Threatened Species, 4-174, 4-182
Trout Fisheries, 4-211
Trout Streams, 4-115, 4-152
U.S. Army Corps of Engineers, 1-1, 1-5, 1-6, 4-186
U.S. Department of Agriculture, 4-25
U.S. Environmental Protection Agency, 1-24, 4-35
U.S. Fish and Wildlife Service, 4-1
U.S. Geological Survey, 1-1, 1-19, 1-24, 4-35
USGS, 1-24, 1-27, 4-10, 4-14, 4-15, 4-23, 4-25, 4-35, 4-40, 4-43, 4-57, 4-59, 4-65, 4-112, 4-113, 4-115, 4-117, 4-140, 4-152, 4-174
W.F. George Lake, 4-189
Walter F. George Lake, 4-31, 4-32, 4-34, 4-50, 4-55, 4-66, 4-69, 4-76, 4-90, 4-91, 4-92, 4-93, 4-94, 4-95, 4-96, 4-102, 4-104, 4-111, 4-112, 4-118, 4-125, 4-127, 4-141, 4-145, 4-154, 4-165, 4-166, 4-167, 168, 4-171, 4-186, 4-201, 4-212, 4-220, 4-263, 4-265
Warm Springs Regional Fisheries Center, 4-187, 4-189
Wastewater, 1-18, 1-20, 1-21, 3-2
Water Allocation Compact Commission, 4-267
Water Demand Scenario, 1-20, 1-21, 1-22
Water Quality, 1-2, 1-3, 1-6, 1-8, 1-9, 1-10, 1-18, 1-19, 1-23, 1-24, 3-2, 4-2, 4-3, 4-4, 4-5, 4-6, 4-7, 4-35, 4-36, 4-52, 4-53, 4-55, 4-67, 4-69, 4-108, 4-110, 4-111, 4-112, 4-113, 4-115, 4-118, 4-119, 4-122, 4-125, 4-128, 4-131, 4-132, 4-134, 4-135, 4-150, 4-151, 4-153, 4-163, 4-165, 4-171, 4-182, 4-184, 4-185, 4-189, 4-195, 4-196, 4-202, 4-208, 4-262, 4-263, 4-264
Water Quality Standard, 4-3, 4-4, 4-6, 4-7, 4-108
Water Supply, 2-4, 3-2, 3-4, 3-5, 4-6, 4-25, 4-36, 4-37, 4-52, 4-54, 4-56, 4-59, 4-67,

4-69, 4-70, 4-104, 4-106, 4-107, 4-142, 4-195, 4-225, 4-233, 4-235, 4-238, 4-242
Water Supply Demand, 3-2, 3-4, 3-5, 4-6, 4-262
Water Supply Demands, 4-104, 4-106
Water Supply Reallocation, 1-3
Water Supply Shortages, 1-28, 4-107, 4-235, 4-238
Water Supply Withdrawals, 4-59
Waterfowl, 4-165, 4-186, 4-187, 4-188, 4-201, 4-214
Watershed, 1-11, 1-29, 4-110
Watershed Protection and Flood Prevention Act, 1-29
Waterways Experiment Station, 1-24, 4-35, 4-142
West Point Lake, 1-25, 4-31, 4-34, 4-50, 4-54, 4-66, 4-72, 4-90, 4-91, 4-92, 4-93, 4-94, 4-95, 4-102, 4-103, 4-104, 4-111, 4-112, 4-115, 4-118, 4-125, 4-127, 4-128, 4-150, 4-152, 4-154, 4-165, 4-166, 4-167, 168, 4-169, 4-171, 4-201, 4-210, 4-211, 4-212, 4-213, 4-214, 4-219, 4-228, 4-229, 4-230, 4-238, 4-265
Wetland, 1-18, 1-19, 1-29, 4-5, 4-6, 4-139, 4-141, 4-142, 4-53
Wildlife Habitat, 1-2, 4-144, 4-147, 4-188, 4-263
Wildlife Habitat Suitability Model, 4-147

Acronyms and Abbreviations

ACF	Apalachicola-Chattahoochee-Flint (Rivers)
acre	acre
ac-ft	acre-foot
ACT	Alabama-Coosa-Tallapoosa (Rivers)
ACHP	Advisory Council on Historic Preservation
ADCNR	Alabama Department of Conservation and Natural Resources
ADECA	Alabama Department of Economics and Community Affairs
ADEM	Alabama Department of Environmental Management
AL	Alabama
ASA(CW)	Assistant Secretary of the Army for Civil Works
BASINS	Better Assessment Science Integrating Point and Nonpoint Source
BOD	biochemical oxygen demand
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERL	(U.S. Army) Construction Engineering Research Laboratory
CFR	Code of Federal Regulations
cfs	cubic feet per second (1 cfs = 0.646 mgd)
CNF	Chattahoochee National Forest
CO	carbon monoxide
Corps	U.S. Army Corps of Engineers
CSO	combined sewer overflow
CWA	Clean Water Act
dBA	decibels on A-weighted scale
DO	dissolved oxygen
DOJ	(U.S.) Department of Justice
EA	environmental assessment
EFH	essential fish habitat
EIFS	Economic Impact Forecasting System
EIS	Environmental Impact Statement
ENWR	Eufaula National Wildlife Refuge
EO	Executive Order
EOP	end-of-period
EPA	(U.S.) Environmental Protection Agency
ESA	Endangered Species Act
FDEP	Florida Department of Environmental Protection
FEMA	(U.S.) Federal Emergency Management Agency
FERC	(U.S.) Federal Energy Regulatory Commission
FGFWFC	Florida Game and Fresh Water Fish Commission
FL	Florida
FMP	Fishery Management Plan
FR	Federal Register
FS	(U.S.) Forest Service, Department of Agriculture
ft^2/d	square feet per day
FWCA	Fish and Wildlife Coordination Act
FWS	Fish and Wildlife Service, Department of the Interior
FY	fiscal year
GA	Georgia
GDNR	Georgia Department of Natural Resources
GEPD	Georgia Environmental Protection Division
GIS	Geographic Information System
GMFMC	Gulf of Mexico Fishery Management Council
GPC	Georgia Power Company
gpm	gallons per minute
GWRD	Georgia Wildlife Resources Division
HEC	Hydrologic Engineering Center (U.S. Army Corps of Engineers)
IHA	Indicators of Hydrologic Alteration
kW	kilowatt
LOA	letter of agreement
$\mu g/m^3$	micrograms per cubic meters
MA	(U.S.) Maritime Administration (Department of Transportation)
mgd	million gallons per day (1 mgd = 1.55 cfs)
mg/L	milligrams per liter
M&I	municipal and industrial
mi^2	square miles
mL	milliliter
MOA	memorandum of agreement

MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSA	metropolitan statistical area
MW	megawatt
MWh	megawatt hour
NAAQS	National Ambient Air Quality Standards
NAWQA	National Water Quality Assessment
NDA	no data available
NED	National Economic Development
NERR	National Estuarine Research Reserve
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Council
NHPA	National Historic Preservation Act
NMFS	(U.S.) National Marine Fisheries Service (NOAA)
NOAA	(U.S.) National Oceanic and Atmospheric Administration (Department of Commerce)
NOI	Notice of Intent
NOS	(U.S.) National Ocean Service (NOAA)
NO_X	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPRES	National Preserve
NPL	National Priorities List
NPS	U.S. National Park Service (Department of the Interior)
NRA	National Recreation Area
NRCS	Natural Resources Conservation Service (Department of Agriculture)
NRHP	National Register of Historic Places
NWFWMD	Northwest Florida Water Management District
PHABSIM	Physical Habitat Simulation System
PL	Public Law
PM_{10}	particulate matter (less than 10 microns in aerodynamic diameter)
PMCL	Planning and Management Consultants Limited, Inc.
POS	plan of study
ppt	parts per thousand
PROSYM	Propriety Hourly Power System Evaluation Model
RCHARC	Riverine Community Habitat Assessment and Restoration Concept
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
ROI	region of influence
RTV	rational threshold value
RVA	Range of Variability Approach
RWU	Riparian Wetland Unit
SARA	Superfund Amendment and Reauthorization Act of 1986
SEPA	(U.S.) Southeastern Power Administration (Department of Energy)
SERC	Southeastern Electrical Reliability Council
SHPO	State Historic Preservation Officer
SIP	state implementation plans
SMSA	Standard Metropolitan Statistical Area
SO_2	sulfur dioxide
SSO	sanitary sewer overflow
STATSGO	State Soil Geographic Database
TCG	Technical Coordination Group
TM	thematic mapping
USC	United States Code
USGS	U.S. Geological Survey (Department of the Interior)
WES	Waterways Experiment Station (U.S. Army Corps of Engineers)
WCSC	Waterborne Commerce Statistics Center
WMA	Wildlife Management Area
WPA	Works Projects Administration
WPCP	water pollution control plant
WUA	weighted usable area
WWTP	wastewater treatment plant

Alternatives Considered Applicable to the ACF Basin EIS

Demand Year	No Action Alternative	Action Alternative Flow Scenarios		
		High Flow Conditions	Moderate Flow Conditions	Low Flow Conditions
1995	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2020	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases
2050	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 3 with aggressive conservation	Municipal and industrial demand scenario 1 with no conservation	Municipal and industrial demand scenario 1 with no conservation
	Agricultural demand scenario 2 with no conservation	Agricultural demand scenario 3, low demand with conservation	Agricultural demand scenario 2, expected demand without conservation	Agricultural demand scenario 1, high demand without conservation
	Existing operations	High reservoir releases	Moderate reservoir releases	Low reservoir releases

Demand scenarios for municipal and industrial, and agricultural uses were developed for the Comprehensive Study (Planning and Management Consultants, 1996; NRCS, 1995). Consumptive demands associated with thermal power generation were modeled and included in the calculation of total demands. One set of thermal power demands was used for all the alternatives.

Reservoir releases in this table refers to the operation of reservoirs to maintain or enhance flows in the river during critical low flow periods.